ADVANCED NAVIGATION



Certus Rugged
Certus Evo Rugged

Reference Manual

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1 Certus & Certus Evo Rugged

Certus and Certus Evo products are a miniature GNSS / Inertial Navigation System (INS) that provides accurate position, velocity, acceleration and orientation under demanding conditions. They combines temperature calibrated accelerometers, gyroscopes, magnetometers and a pressure sensor with a dual antenna RTK GNSS receiver. These are coupled in a sophisticated fusion algorithm to deliver accurate and reliable navigation and orientation.



Figure 1: Certus Evo Rugged

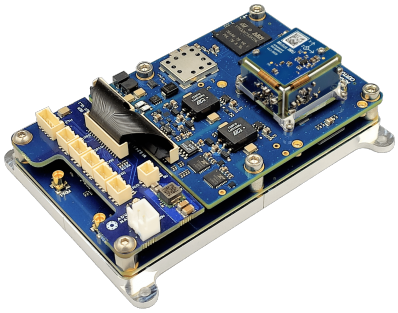


Figure 2: Certus Evo OEM



Figure 3: Certus OEM

1.1 Foundational Knowledge

Before working with an Inertial Navigation System, you should have background knowledge of geospatial concepts, and principles of Inertial Navigation Systems.

Helpful resources include:

- **Inertial Navigation Systems Primer**
- **Glossary**

1.2 Disclaimer

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2 Manual Revision History

Version	Date	Changes
2.12	2026-08-24	Updated Firmware v2.11 release notes, including X20P GNSS Receiver Variants, MX5 GNSS Receiver Variants, and Configuration Resilience Added PCB Design Tips for OEM Restored INS Manager troubleshooting, including FTDI driver issues Disclaimer update
2.11	2026-08-11	Updated to Certus / Certus Evo firmware 2.11 which includes GNSS Receiver Support, Configuration Resilience, and Septentrio Mosaic-X5 Reliability Updated to align with INS Manager 8.1, including new Aiding Sources Configuration window Updated ANPP packet documentation Minor manual corrections and refinements
2.10	2026-03-13	Corrected dual antenna spec statement
2.9	2026-02-27	Minor doc corrections
2.8	2025-12-11	Update to firmware 2.02
2.7	2025-12-01	Update to INS Manager 8.0 Added accessory part numbers Numerous minor doc improvements
2.6	2025-10-22	Updated to firmware 2.01
2.5	2025-10-01	Certus Evo hardware upgrades to support for X20P and MX5 GNSS receivers Merged Certus OEM and Rugged Manual history to align to the same source content
2.4.5	2025-08-21	Clarify Network Time Protocol server
2.4.4	2025-08-18	Clarification added to spec for voltage
2.4.3	2025-07-30	Clarify antenna description and protocols
2.4.2	2025-03-24	Expanded description of firmware v1.90 updates
2.4.1	2025-03-14	Minor doc corrections Correct antenna description
2.4	2024-12-16	Updated to firmware 1.90 Added monitoring pages for External Data to the Web UI Manager
2.3	2024-03-20	Updated firmware, see **2.1 Firmware Changelog**

Version	Date	Changes
2.2	2024-03-05	Updated firmware changelog, see **2.1 Firmware Changelog** Updated automatic magnetometer calibration explanation to reflect firmware changes, see **7.6 Magnetic Calibration** ANPP packets 70 (Raw DVL Data Packet) and 185 (Installation Alignment Packet) updated Minor editorial changes
2.1	2023-11-15	Updated weights and improved detail of **5.4 Hardware Specifications** Added **5.4.4.3 Centre of Gravity Location of Certus** Removed magnetometer sensor range Expanded topic on **Using Certus Manager** Updated software changelog, see **Using Certus Manager**
2.0	2023-02-17	Updated software changelog, see **Using Certus Manager** Updated software installation information to include Java 11 requirement, see **Using Certus Manager** and **Installation Checklist** Updated instructions for running manager on MacOS, see **Using Certus Manager**
1.9	2022-12-23	Updated hardware changelog, see **2.2 Hardware Changelog** Updated firmware changelog, see **2.1 Firmware Changelog**
1.8	2022-11-18	Updated firmware changelog, see **2.1 Firmware Changelog** Removed note that firmware can only be upgraded using the primary ANPP data port, see **9.6.1.33 ANPP Input** and **9.6.1.46 ANPP Output** Added information on disabling dual antenna heading for single antenna configurations, see **10.6.6 Filter Options Packet** and **Configuration Menu**
1.7	2022-10-20	Updated software changelog, see **Using Certus Manager** Updated Logging information as per Manager v6.2, see **Tools Menu** Added inrush current to specifications, see **5.7 Electrical Specifications** Added a link to the product page to find the SDK, see **8.7 Using ANPP** Updated External Time Packet to show it is Read only, see **10.4.33 External Time Packet** Added disclaimer about affected ports for Packets Period Packet, see **10.6.2 Packets Period Packet** Separated Licenses from Accessories and updated license part numbers, see **4 Part Numbers and Ordering** Added disclaimer than some GNSS and Antenna Flags are only applicable to Aries GNSS Receivers, see **Status**, **10.4.1 System State Packet** and **10.4.10 Raw GNSS Packet** Updated External Time Packet to show it is Read only, see **10.4.33 External Time Packet**
1.6	2022-04-20	Updated hardware changelog, see **2.2 Hardware Changelog** Updated software changelog, see **Using Certus Manager** Updated firmware changelog, see **2.1 Firmware Changelog** Updated Device ID table, see **10.3 System Packets** Added disclaimer that 2D and 3D Magnetic Calibration are not available for Certus Evo, see **7.6 Magnetic Calibration** Added automatic calibration information for 3D vehicle profiles, see **7.6 Magnetic Calibration** Added Device Discovery section for Certus Manager, see **Using Certus Manager**

Version	Date	Changes
		Updated Logging information to include user configurable Log Path, see **Log Converter** Reformatted 1PPS Output information, see **9.6.1.2 1PPS Output** Added Basestation Packet, see **10.4.48 Basestation Packet** Breakout cable diagrams updated to show DC connector size, see **5.9 IO Connection** Pin location diagrams added, see **5.8 Connector Pin-out** Added additional information to **10.4.40 Raw Satellite Ephemeris Packet** Added disclaimer that **10.6.4 Sensor Ranges Packet** is invalid for Certus Evo Updated mechanical drawings, see **5.4.4 Rugged Mechanical Drawings**
1.5	2021-09-06	Migrated documentation platform, various formatting and copy changes Updated Firmware Changelog Updated GNSS Specifications Added information about ANPP packets 13, 14, 85 and 197
1.4	2021-02-19	Updated Firmware Changelog Updated Hardware Changelog Update to Navigation specifications Update to GNSS specifications
1.3	2021-01-13	Clarified sensor range applicability Updated Firmware Changelog Added reference to OEM variant section Updated Advanced web user interface Fixed packet data tables
1.2	2020-11-02	Added note on slip angle value Updated Certus Evo sensor specifications
1.1	2020-09-23	Added Trimble BD992 part numbers Corrected navigation specifications Added Trimble BD992 receiver option Updated hardware specifications Clarified connector details Added BD992 packet information
1.0	2020-01-20	Initial Release

Table 1: Revision History

2.1 Firmware Changelog

Version	Date	Changes
2.11	2026-07-21	**X20P GNSS Receiver Variants:** Added dual-antenna heading support for u-blox ZED-X20P variants. **MX5 GNSS Receiver Variants:** Resolved intermittent issues affecting heading stability, dual-antenna behavior and GNSS status reporting. **Configuration Resilience:** Fixed intermittent reset events when changing device settings.

Version	Date	Changes
		Known issue: Units purchased before October 2020 will see a "Systems Error" message after updating the device firmware through INS Manager. (You can revert to an older release). For these units, we recommend contacting AdNav support to discuss options.
2.10	2026-07-07	**Expanded Septentrio Mosaic-X5 Support:** Fixed-base RTK positioning via RTCM input is now fully supported on variants equipped with the Septentrio Mosaic-X5 GNSS receiver. **Improved External Aiding Configuration:** Improved external aiding source lever-arm and alignment configurations and status reporting across aiding sources. **Known issue:** Configuration for several packets may revert to default if upgrading from sufficiently old firmware, but there is no problem if updating from the previous release. Save and restore configuration before and after the firmware update if upgrading from an older release.
2.02	2025-12-11	Certus Evo only: * Improved wind estimator. * Improved DVL and depth input. * Fixed minor sensor input bugs.
2.01	2025-10-22	Certus Evo only: * Added support for MX5 GNSS receiver. * Improved sensor fusion algorithms. * Additional minor fixes.
1.90	2024-11-14	New Features: Added surge and sway outputs to the heave algorithm, including velocity and acceleration. Added support for Water Linked DVL (TCP/IP). Added support for Nortek Nucleus DVL (serial). Added support for inputting Packet 70 (Raw DVL Data). Added a dedicated profile for train applications. Added an option to disable navigation and run as AHRS-only. Improvements: Web UI: Expanded Heave page to include Vessel Motion. Web UI: Improved chart visuals for clarity. Web UI: Added an external data viewer. Added support for NavIC (IRNSS) on BD992 GNSS receivers. Extended Factory restore to now reset BD9xx GNSS settings. Improved accuracy of water velocity reports from Water Linked DVL. Improved boot reliability (in particular around NMEA GPZDA + 1PPS initialization, and system failure warnings). Note: Boot sequence time is slightly longer. Bug Fixes: Fixed external GNSS still being used after switching to internal GNSS. Fixed BD992 not enabling QZSS correctly via the Web UI.
1.81	2024-03-20	Fixed pressure sensor reporting NaN values on v1.3 HW

Version	Date	Changes
1.80	2024-03-01	Updated supported L-band satellite frequencies for Trimble receivers Added support for Trimble BD992 receiver with v5.61 and ProPoint v6.21 FW Implemented web UI status display when COCOM limits are removed for Trimble BD9xx receivers Fixed malformed CANOpen packets Added UTM grid position output to the CANopen protocol Added ANPP80 Basestation packet to web UI Fixed CRC mismatch for bootloader packet acknowledgement Fixed intermittent web UI not accessible on boot up after firmware update Fixed PTP performance impacted by web server load Fixed TCP server issue after using PTP client Improved reliability of Device Discovery Fixed occasional failures when downloading log files Fixed sensor ranges configuration not being reset on factory restore Improved state orientation during turns Improved reliability of onboarding time Fixed Ethernet connection issue after connecting via Manager Extended external GNSS lever arm offset range to 50 m horizontal and 100 m vertical Fixed time filter flicker when using external GNSS Updated DVL input to use Odometer Offset Added 8Hz option in NMEA0183 packet rates in the web UI Improved saving of configuration, eliminating potential for corruption Fixed DNS server selection not respected when DHCP is enabled Improved navigation performance when GNSS is denied Updated Aries GNSS receiver firmware to v1.21 - Improved GNSS operation when transitioning between Fix to No Fix - Improved ANPP29 packet timing - Reduced erroneous reporting of GNSS Fix Updated Certus Evo IMU firmware to v2.4
1.71	2022-12-23	Updated to support v1.3 hardware. **Minimum FW version for v1.3 hardware**
1.64	2022-11-18	Improved Aries GNSS Receiver performance Added ability to operate as single antenna configuration by disabling dual antenna heading Improved satellite display for BD992 GNSS Receiver Added ability to update firmware using any ANPP dataport Added hardware version check on startup, sending the unit to bootloader if the firmware is incompatible with the hardware Fixed PTP clock syncing issues Added Disk Full error message in the Web UI Logging page and fixed raising Data Overrun status flag instead of Logging Failure when internal logging memory is full Removed Auto DNS option in Network Configuration when not in DHCP mode Fixed error message when saving changes on Dataports web page Fixed inverse reporting of Automatic Dual Antenna offsets when antenna configuration was Left/Right or Right/Left Adjusted ANPP Packet timing to align with UTC seconds Allowed CAN COB-ID to be set outside of valid PDO range

Version	Date	Changes
		Fixed network dataports not closing existing connection when mode is changed Fixed CANopen PDO objects stop transmitting if the bus is broken then restored Allowed setting RTCM Corrections Input function on Aux port via Web UI Dataports page Fixed BD992 variant doesn't show primary sat SNR in web UI table Fixed GNSS passthrough functionality Fixed bug preventing internal logging of GNSS Passthrough data Fixed Manual Initialisation from Web UI Various bug fixes
1.60	2022-03-29	Updated to support v1.2 hardware pressure sensor from sub-component. **Minimum FW version for v1.2 hardware** Added configuration import/export functionality to web UI Improved stability and performance of automatic magnetometer calibration algorithm for some vehicle profiles, see **7.6 Magnetic Calibration** Improved handling of NTRIP server connections Fixed intermittent dropping of network connection Fixed System Failure flag set when powering up the unit after a long period of inactivity Increased limit on NTRIP mount point list Updated available BD992 L Band satellites Fixed Manual Initialisation from Web UI General reliability improvements
1.54	2021-11-26	Improved reliability of saving configuration changes in Web UI Improve GNSS fix type when using RTCM via Aux port Fix time jump after time filter initialisation with BD992 receiver Improve indicator behaviour in Web UI on disconnect/timeout Improve map view on Web UI to update key to latest Fix intermittent filter error, triggered under very rare circumstances
1.53	2021-10-08	Update Certus to support Spatial MEMS IMU hardware v2.2 Update Certus Evo to support v2.3 Evo MEMS IMU hardware Add support for Trimble BD992 firmware v5.50 Update Aries GNSS Receiver to firmware v1.14 Add ability to modify the NodeID used for CANopen Introduced restrictions that prohibit configuring a TX PDO as an SDO COB-ID System Status 'Low Voltage Alarm' bit redefined as 'Internal Data Logging Error' Fix GPIO 1PPS Out of sync Fix CAN output to support data rates up to 100 Hz Fix NMEA 0183 GPGSV output missing Fix unable to turn off SBAS on BD992 GNSS receiver Improved dedicated 1PPS to always output Improve SBAS Fix reliability Improve PTP timing accuracy
1.51	2021-07-16	Various Web UI improvements and fixes Add Packet 61 (Raw Ephemeris Packet) Update Aries GNSS Receiver to firmware v1.13 Fix 3D magnetic calibration not working Update Certus Evo to support v2.2 sensor firmware Fixed network failure after several network cable reconnections

Version	Date	Changes
		Fix logging issue on OEM variants
1.49	2021-04-13	Several bug fixes Added ability to set Omnistar frequencies to the Web UI Added GNSS Configuration page Updated Aries GNSS Receiver to firmware v1.12 Packet rate updated to reflect GNSS Sample Rate General stability improvements
1.47	2021-02-15	Improve navigation performance when using antenna offsets
1.46	2021-01-06	Add body velocity packet to CANopen dictionary
1.45	2020-12-23	Update for PCB revision for Certus OEM support. **Minimum version for v1.1 hardware**. Add ability to set all CAN rates
1.44	2020-12-15	Update to support latest Certus Evo sensor hardware
1.43	2020-11-09	Various bug fixes Packet 60 is limited to 10 Hz output for both GNSS receivers (note that the packet rates can only be set to 10Hz).
1.42	2020-10-29	Various bug fixes Update Aries GNSS Receiver to firmware v1.10
1.41	2020-10-08	Fix Artificial Horizon (Web UI) doesn't show Airspeed or Altitude Update Aries GNSS Receiver to firmware v1.09
1.40	2020-09-04	Packet 60 is limited to 10 Hz output for both GNSS receivers (note that the packet rates can only be set to 10 Hz) UpdateAries GNSS Receiver to firmware v1.08. Update Aries 20 Hz packet rates to 10 Hz
1.39	2020-08-28	Fix IP configuration packet does not update the IP when a DHCP lease is renewed. Fix packet 192 is not serviced correctly in the Web UI. Feature add support BD992 (firmware v5.37).
1.38	2020-08-18	Update Aries GNSS Receiver to firmware v1.07. Fix Certus does not report filter options correctly in the web UI. Fix can't save user data. Fix comms errors on network data port with GNSS passthrough Fix repeated connect/disconnect on dataport causes networking to crash on Certus Fix magnetometer temperature not populated correctly Fix TCP server drops connections while connected
1.37	2020-07-08	Feature to add status reporting to log page. Update Aries GNSS Receiver to firmware v1.06. Improved NTRIP client should automatically determine if it needs to transmit position.
1.36	2020-06-26	Fix system time jumps back 15 s when no antenna plugged in Fix setting network configuration using multi-cast fails Fix Primary and Aux not setting RS232, RS422 Mode

Version	Date	Changes
1.35	2020-06-18	Fix issue when setting sensor ranges NTRIP client improvements Timing improvements to non-ANPP packet outputs eg NMEA messages Website will warn when packet rates are too high for the current baud rate UTC Time on website now displayed with the alphanumerical month to avoid confusion
1.34	2020-06-10	Include sub-component firmware with Certus firmware Add serial data inputs to data ports Improvements to logging functionality Improvements to NTRIP client
1.33	2020-05-22	Packet 60 now sets the overflow fault if it can't be sent out of any port Dual antenna configuration packet now reports the baseline if set to automatic Add packet 85 (sensor temperatures) support to the web UI and serial/data ports. Fix configuration packets not being correctly saved at the beginning of a log. Packet timing improved Add magnetometer calibration web page Allow all serial inputs to be used in the data ports
1.32	2020-05-11	Fix bug in web server causing system crash 1PPS Output defaults to GNSS 1PPS instead of Certus' internal generated 1PPS.
1.31	2020-04-30	Fix Certus Evo pressure sensor Remove 1PPS synchronisation from Packet Timer - packets now output at the correct rate. Causes, packets are no longer synchronised to UTC. Fix to populate the CAN state data
1.30	2020-04-10	Add NTRIP client Improve packet 60 output Improve on-board logging reliability Improve RTCM serial input
1.21	2020-03-05	Minor user interface improvements
1.20	2020-02-28	Add Certus Evo support Add subcomponent Information to View menu Add ANPP packet 60 output functionality Add RTCM serial input functionality
1.10	2020-02-11	Activate logging functionality.
1.02	2020-01-31	Allow network settings to be updated without reboot. Ensure mDNS can handle multiple Certus devices on a network. Support packet 84 in data ports.
1.00	2020-01-10	Initial release

Table 2: Firmware Changelog

2.2 Hardware Changelog

Version	Date	Changes
1.31	2025-10-01	Update to address component obsolescence
1.3	2022-06-02	Update to address component obsolescence Removed redundant pressure sensor.
1.2	2021-07-23	Updated magnetometers Updated pressure sensor Mechanical design for manufacture change to improve assembly
1.1	2020-11-01	Update to support OEM
1.0	2020-01-10	Initial rugged release

Table 3: Hardware Changelog

3 Getting Started

1. Plug the 8 pin interface cable into the IO1 connector on the Certus.
2. Connect an Ethernet cable from the Ethernet socket on the breakout cable to your network or router.
3. Plug the power supply into the power connector on the breakout cable and then into the wall socket.
4. Download and install the Bonjour ZeroConf networking utility from the link **https://www.advancednavigation.com/Bonjour64.msi**.
5. In a web browser, type in the address **http://certus.local**

There are additional factors that you must review before you proceed with the installation. For more information, see **6 Installing**

4 Part Numbers and Ordering

4.1 Standalone Units

The Certus is available in a few different variants. Part numbers for the unit and it's evaluation kit are listed in the following table.

Part - Standalone Unit	Part - Evaluation Kit	Description
CERTUS-EVO-X20P-BLK	CERTUS-EVO-X20P-BLK-EK	Certus Evo INS with black housing and GNSS/INS Unit with Ublox X20P GNSS receivers
CERTUS-EVO-MX5-BLK	CERTUS-EVO-MX5-BLK-EK	Certus Evo INS with black housing and GNSS/INS Unit with Septentrio Mosaic X5 GNSS receivers
CERTUS	CERTUS-EK	Certus INS with Ublox F9P GNSS Receivers
CERTUS-BD992	CERTUS-BD992-EK	Certus INS with Trimble BD992 GNSS Receivers

Table 4: Standalone Unit Part Numbers

4.2 Evaluation Kits



Figure 4: Certus Evaluation Kit transport case

Each evaluation kit includes a Certus unit, along with the accessories needed to set up and connect the unit. Accessories may be purchased separately.

Included accessories are listed in the table below.

Part Number	Description	CERTUS-EVO-X20P-BLK-EK	CERTUS-EVO-MX5-BLK-EK	CERTUS-EK	CERTUS-BD992-EK
G5ANT-53A4T1	Antcom L1/L2 RTK Antenna			2	2
CALIAN-POLE-MOUNT	Pole mount bracket for Calian Antennas Black. Powder coated steel	2	2		
Calian TW3990XF-G	Calian TW3990XF Full Band GNSS + L-Band (separate ground plane) dark gray, TNC connector	2			
Calian AJ977XF	Calian AJ977XF Anti-Jam Multi-Constellation Triple-Band Antenna with TNC		2		
CABLE-FTDI	FTDI USB to RS232/RS422 (switchable) 1m cable	1	1	1	1
CABLE-PPC-16-BREAKOUT	Cable push-pull circular 16 pin breakout 2 m	1	1	1	1
CABLE-PPC-8-BREAKOUT	Cable push-pull circular 8 pin breakout 2 m	1	1	1	1
BF046WS180427-03	SMA to TNC 4m cable	2	2	2	2
PPC-DUSTCAP	Blanking cap push-pull circular (single cap)	1	1	1	1
SUPPLY-24V	24V DC Power Supply	1	1	1	1
BOREAS90-KIT-CASE	Certus / Boreas EK Case		1		
CERTUS-EK-CASE	Certus EK Case	1		1	1

Table 5: Evaluation Kit Part Numbers

4.3 GNSS Receiver License Upgrades

These licenses are only applicable to units with a Trimble BD992 GNSS Receiver, variants: CERTUS-BD992 and CERTUS-EVO-OEM-BD992.

Part Number	Description
BD992-LIC-10CM	Upgrade Trimble BD992 GNSS Receiver from 30 cm to 10 cm RTK accuracy.
BD992-LIC-8MM	Upgrade Trimble BD992 GNSS Receiver from 30 cm to 8 mm RTK accuracy. Add Galileo and BeiDou constellations.

Table 6: Ordering Part Numbers for GNSS Receiver Licence Upgrades

4.4 Accessories

Part Number	Description
CABLE-PPC-16-UNT-3M	Certus 3 m cable with 16-pin plug and unterminated connectors
CABLE-PPC16--UNT-10M	Certus 10 m cable with 16-pin plug and unterminated connectors
CABLE-PPC-8-UNT-3M	Certus 3 m cable with 8-pin plug and unterminated connectors
CABLE-PPC-8-UNT-10M	Certus 10 m cable with 8-pin plug and unterminated connectors
MOUNT-SUCT	Suction cup 5/8" GNSS antenna survey mount for easy installation of GNSS antenna on vehicles
VSP6337L	Tallysman VeroStar GNSS Antenna - L1/L2/L5 plus L-band, pole mount, TNC Female connector
CAR12VPWR	Car auxiliary power supply to DC jack power supply
OBDII-ODOMETER	OBDII Odometer Interface

Table 7: Ordering Part Numbers for Accessories

5 Specifications

For details, review the following specifications for Certus:

5.1 Navigation Specifications

Parameters	Certus	Certus Evo
Horizontal Position Accuracy (Standalone)	1.2 m	1.2 m
Horizontal Position Accuracy (SBAS)	0.6 m	0.6 m
Horizontal Position Accuracy (RTK)	0.006 m + 1 ppm	0.006 m + 1 ppm
Velocity Accuracy	0.05 m/s	0.05 m/s
Roll & Pitch Accuracy	0.1 °	0.03 °
Slip Accuracy	0.1 °	0.1 °
Heave Accuracy	5 % or 0.05 m	5 % or 0.05 m
Hot Start Time	500 ms	500 ms
Internal Filter Rate	1000 Hz	1000 Hz
Output Data Rate	Up to 1000 Hz	Up to 1000 Hz

Table 8: Navigation Specifications, assuming the X20P unit variant, and associated GNSS receiver.

5.2 Sensor Specifications

5.2.1 Certus

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Range (dynamic)	±2 g ±4 g ±16 g	±250 °/s ±500 °/s ±2000 °/s	±8 G	10 to 120 KPa
Bias Instability	20 ug	3 °/hr	-	10 Pa
Initial Bias	< 5 mg	< 0.2 °/s	-	< 100 Pa
Initial Scaling Error	< 0.06 %	< 0.04 %	< 0.07 %	-
Scale Factor Stability	< 0.06 %	< 0.05 %	< 0.09 %	-
Non-linearity	< 0.05 %	< 0.05 %	< 0.08 %	-
Cross-axis Alignment Error	< 0.05 °	< 0.05 °	0.05 °	-

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Noise Density	100 ug/√Hz	0.004 °/s/√Hz	210 uG/√Hz	0.56 Pa/√Hz
Bandwidth	400 Hz	400 Hz	110 Hz	50 Hz

Table 9: Certus Sensor Specifications

5.2.2 Certus Evo

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Range (dynamic)	±10 g	±475 °/s	±8 G	10 to 120 KPa
Bias Instability	8 ug	0.2 °/hr	-	10 Pa
Initial Bias	< 0.45 mg	< 3 °/hr	-	< 100 Pa
Initial Scaling Error	< 0.03 %	< 0.02 %	< 0.07 %	-
Scale Factor Stability	< 0.04 %	< 0.03 %	< 0.09 %	-
Non-linearity	< 0.05 %	< 0.03 %	< 0.08 %	-
Cross-axis Alignment Error	< 0.05 °	< 0.05 °	0.05 °	-
Noise Density	2 ug/√Hz	6 °/hr/√Hz	210 uG/√Hz	0.56 Pa/√Hz
Bandwidth	250 Hz	200 Hz	110 Hz	50 Hz

Table 10: CertusEvo Sensor Specifications

5.3 GNSS Receiver Specifications

5.3.1 GNSS Satellite Constellation and Signals

The following table shows constellations and signals supported, based on unit variants. Different variants have different GNSS receiver included.

	F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
GPS	L1, L2	L1C/A, L2C, L5	L1C/A, L1PY, L2C, L2P(Y), L5	L1 C/A, L2E, L2C, L5
Galileo	E1, E5b	E1-B/C, E5a, E6	E1, E5a, E5b, E5 AltBoc, E6	E1, E5A, E5B,

	F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
				E5AltBOC, E6
BeiDou	B1I, B2I	B1I, B1C, B2a, B3I	B1I, B1C, B2a, B2I, B2b, B3I	B1, B2, B3
QZSS	L1C/A, L2C	L1 C/A, L2C, L5	L1C/A, L1 C/B, L2C, L5	L1 C/A, L1 SAIF, L2C, L5
NavIC (IRNSS)		L5-SPS	L5	L5
GLONASS	L1, L2	L1, L2	L1CA, L2CA, L2P, L3 CDMA	L1 C/A, L2 C/A, L3 CDMA

Table 11: GNSS Constellations / Signals supported depending on GNSS Receiver included.

Note: X20P and MX5 variants are available for Certus Evo, but not available for Certus.

Note: See **GNSS Configuration** for update rate relevant to particular constellation configurations.

Note: For X20P unit variants, GLONASS is disabled in current firmware v2.0. It is planned to be re-enabled in future releases.

5.3.2 Supported SBAS Systems

The following table shows SBAS systems supported, based on unit variants.

	F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
Egnos	Yes	Yes	Yes	Yes
WAAS	Yes	Yes	Yes	Yes
GAGAN	Yes	Yes	Yes	Yes
MSAS	Yes	Yes	Yes	Yes
QZSS	Yes	Yes	Yes	Yes
SDCM			Yes	
Fugro/Omnistar				Yes
Trimble RTX				Yes

Table 12: SBAS Systems supported depending on GNSS Receiver included.

Note: X20P and MX5 variants are available for Certus Evo, but not available for Certus.

Note: Trimble and Omnistar accuracy requires purchase of additional software license, see **4.3 GNSS Receiver License Upgrades**

5.3.3 GNSS Receiver Performance Specifications

The following table summarizes published performance based on unit variants.

	F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
Max Update Rate	25 Hz	25 Hz	100 Hz	50 Hz
Time to First Fix: Signal Re-aquisition	2 s	2 s	1 s	2 s
Time to First Fix: Cold Start	25 s	25 s	< 45 s	< 45 s
Horizontal Position Accuracy (Standalone)	1.5 m	1.2 m	1.2 m	1.00 m
Horizontal Position Accuracy (SBAS)	1.0 m	0.6 m	0.6 m	0.50 m
Horizontal Position Accuracy (RTK)	0.01 m + 1 ppm	0.006 m + 1 ppm	0.006 m + 0.5 ppm	0.008 m
Velocity Accuracy	0.05 m/s	0.05 m/s	0.03 m/s	0.007 m/s
Timing Accuracy	30 ns	20 ns	< 20 ns	20 ns
Acceleration Limit	4 *g*	≤ 4 *g*		11 *g*
Reference Inputs	RTCM v3.x	RTCM v3.x	RTCM v2.x, v3.x	RTCM v2.1, 2.2, 2.3, 3.0, 3.1, 3.2, CMR, CMR+

Table 13: GNSS receiver performance specifications

Note: X20P and MX5 variants are available for Certus Evo, but not available for Certus.

Note: Trimble quoted RTK accuracy requires purchase of additional software license, see **4.3 GNSS Receiver License Upgrades**

Note: See **GNSS Configuration** for update rate relevant to particular constellation configurations.

5.4 Hardware Specifications

5.4.1 Certus Hardware Specifications

Parameter	Specification	
	Aries GNSS Receiver	Trimble BD992 Receiver
Weight	250 grams	280 grams
Dimensions	78 x 115 x 34 mm	
Hot Start Battery Capacity	> 48 hours	
Hot Start Battery Endurance	> 10 years	
Mean Time between Failure (MTBF)	140,000 hours	

Table 14: Hardware Specifications for Certus Rugged Variant

5.4.2 Certus Evo Hardware Specifications

Parameter	Specification	
	Aries GNSS Receiver	Trimble BD992 Receiver
Weight	310 grams	340 grams
Dimensions	78 x 115 x 44 mm	
Hot Start Battery Capacity	> 48 hours	
Hot Start Battery Endurance	> 10 years	
Mean Time between Failure (MTBF)	140,000 hours	

Table 15: Hardware specifications for Certus Evo Rugged Variant

5.4.3 Certus and Certus Evo Environmental Specifications

Parameter	Specification	Standard
Operating and Storage Temperature	-40 °C to 85 °C	MIL-STD-810H Method 501.7 & 502.7
Humidity	Natural Cycle B1	MIL-STD-810H Method 507.6
Salt Fog	48 hours	MIL-STD-810H Method 509.7
Ingress Protection	IP67	IEC 60529 MIL-STD-810H Method 512.6
Vibration	7.7 g rms	MIL-STD-810H Method 514.8E-1 & 514.8C-3
Shock	40 g 11 ms 150 g 6 ms	MIL-STD-810H Method 516.8

Table 16: Environmental specifications for Certus and Certus Evo Rugged Variants

5.4.4 Rugged Mechanical Drawings

5.4.4.1 Certus Rugged Mechanical Drawings

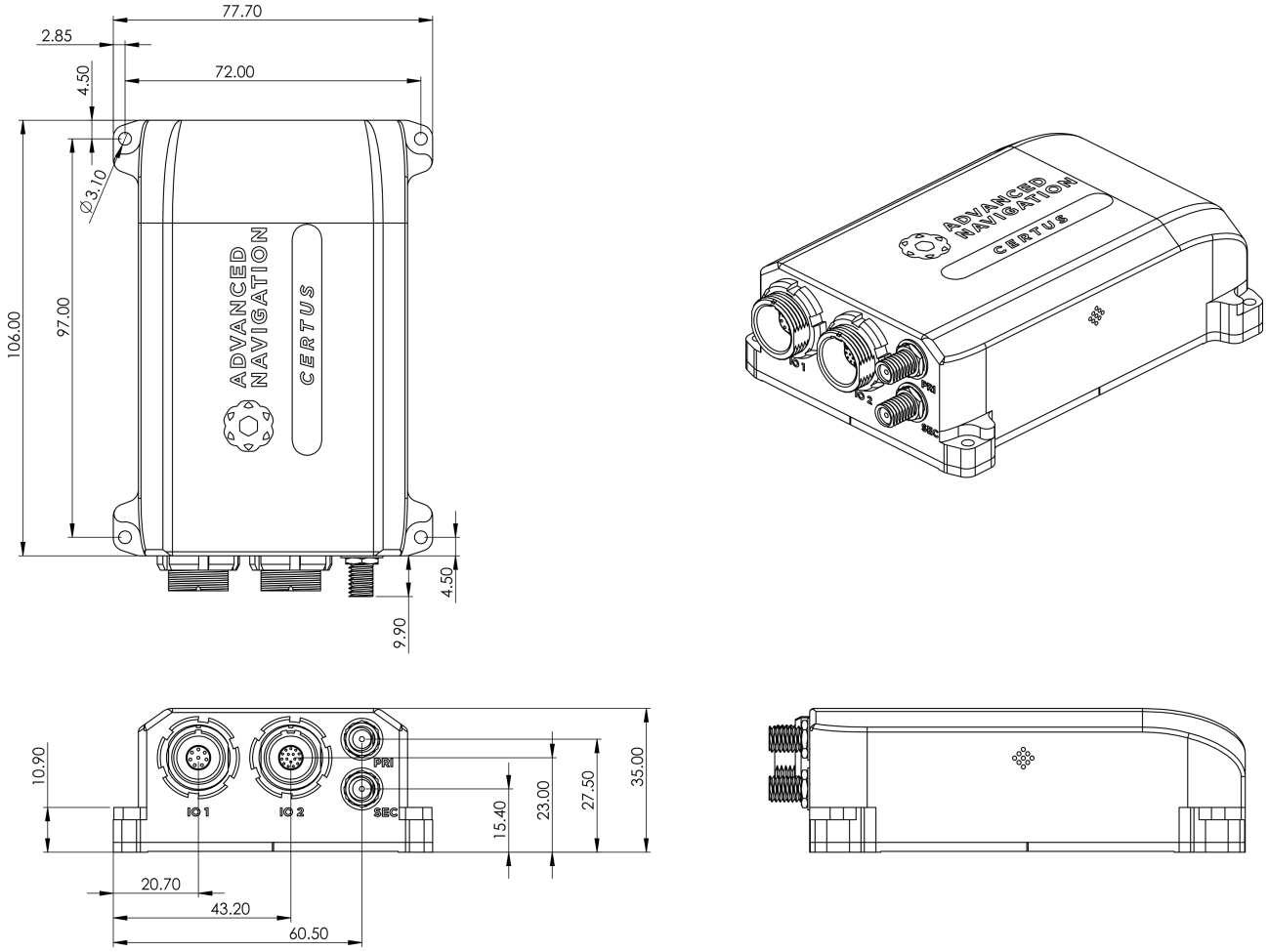


Figure 5: Mechanical drawings of Certus

5.4.4.2 Certus Evo Rugged Mechanical Drawings

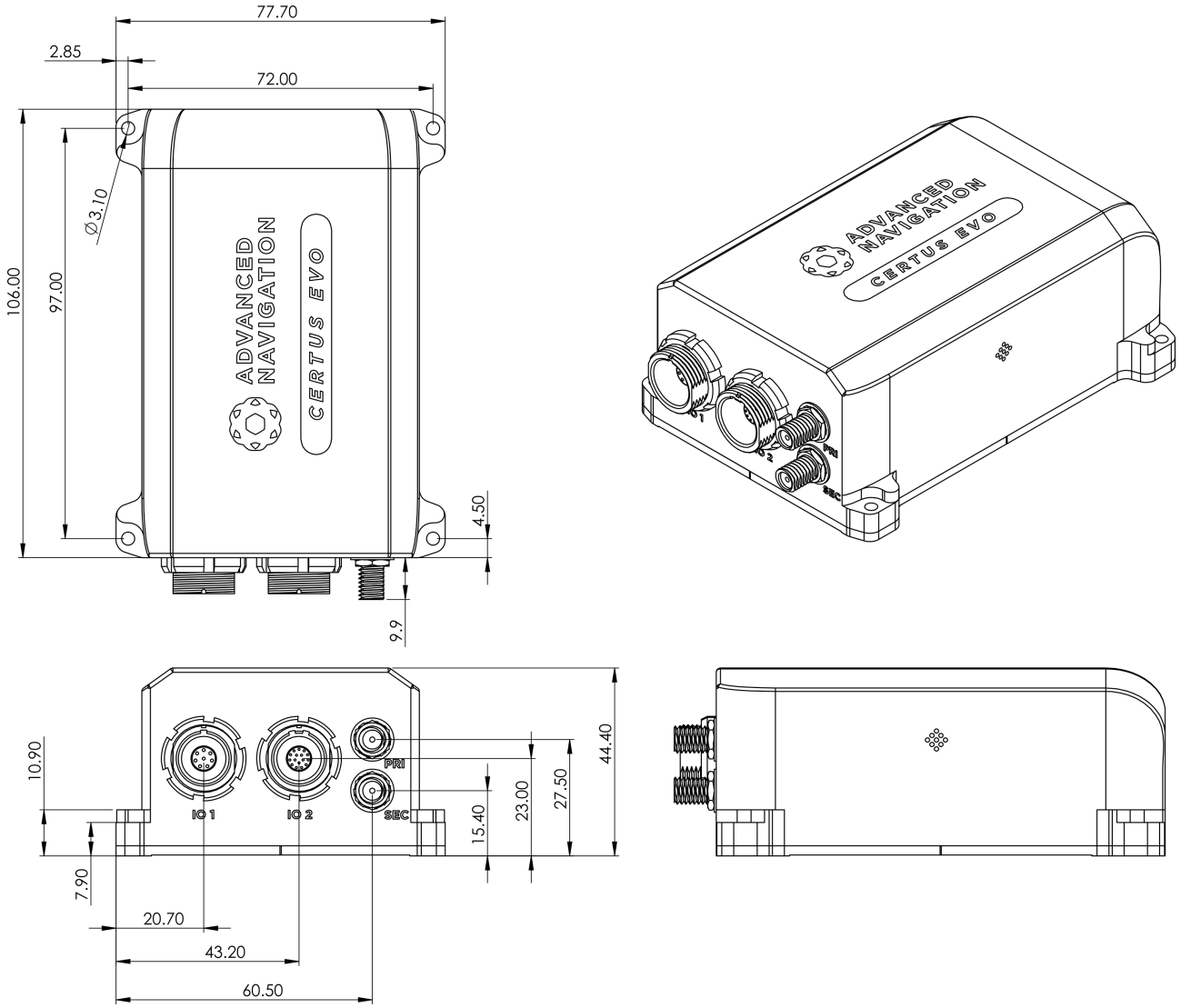


Figure 6: Mechanical Drawings of Certus Evo

5.4.4.3 Centre of Gravity Location of Certus

Parameter	Specification (in mm ±0.5 mm)	
	Aries GNSS Receiver	Trimble BD992 Receiver
x	59.8	62.1
y	39.5	39.4
z	17.2	16.2

Table 17: Center of Gravity Measurements for Certus Rugged Variant

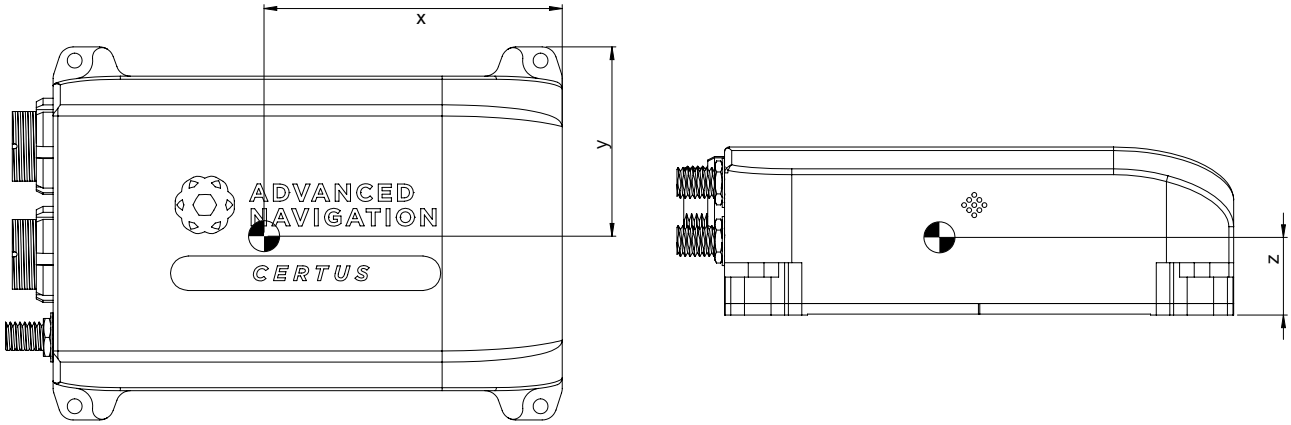


Figure 7: Centre of Gravity of Certus

5.4.4.4 Centre of Gravity Location of Certus Evo

Parameter	Specification (in mm ±0.5 mm)	
	Aries GNSS Receiver	Trimble BD992 Receiver
x	57.8	59.9
y	40.2	40.1
z	21.1	19.9

Table 18: Center of Gravity Measurements for Certus Evo Rugged Variant

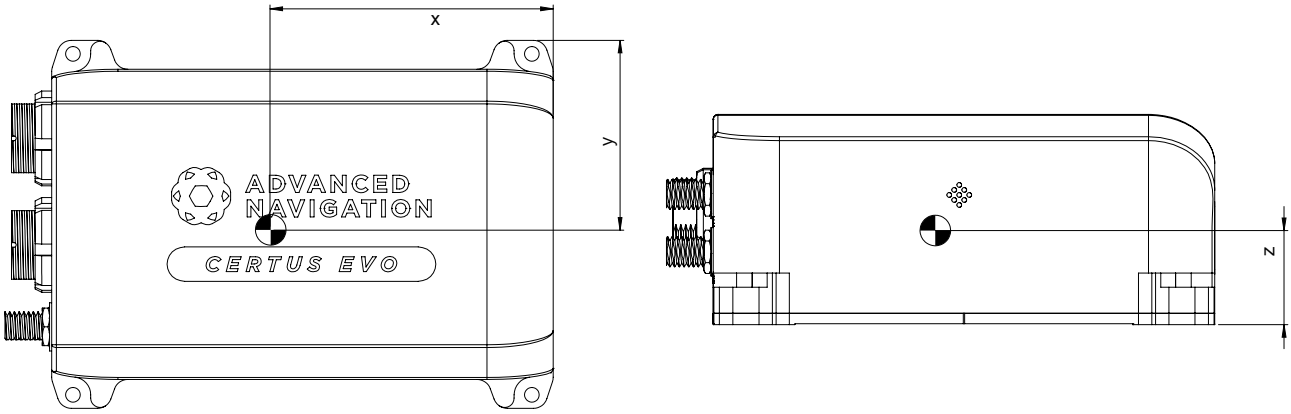


Figure 8: Centre of Gravity of Certus Evo

5.5 Serial Number

Units can be identified and tracked using the device serial number. This can be observed in a numbers of ways:

- Through the Device Information page in the web UI (**View Menu**)
- Through the Device Information page in the **Certus Manager** application.
- Via the 2D data matrix bar code on the outside rear of the enclosure. Applications are available for most smart-phones that can scan the 2D data matrix bar code to display the serial number. The label also contains the hardware version and build date.



Figure 9: Certus External Serial Number Sticker

5.6 Communication Specifications

Parameter	Value
Interfaces	Ethernet RS232/RS422 CAN
Speed	100 Mbit (Ethernet) 4800 to 4 M baud (RS232/RS422) 125000 to 1 M baud (CAN)
Protocols	AN Packet Protocol NMEA 0183
Peripheral Interface	2 x GPIO for serial, timing, digital inputs / outputs
GPIO Functions	1PPS Input/output Odometer Stationary Air Data Input NMEA input/output Novatel GNSS input Trimble GNSS input AN Packet Protocol CAN/CANopen Event Trigger
GPIO Operating Voltage Levels	3.3 V 5 V

Parameter	Value
	RS232
GPIO Port Serial Interface	RS232
GPIO Port Serial Speed	4800 to 250 K baud
Default Primary, Auxiliary, GPIO Serial Speed	115200 baud

Table 19: Communication Specifications for Rugged Variants

5.7 Electrical Specifications

Parameter	Minimum	Typical	Maximum
Operating Voltage*	9 V		36 V
Input Protection	-40 V		+100 V
Power Consumption		Certus 2.64 W Certus Evo 2.9 W	Certus 4.5 W Certus Evo 5.0 W
Inrush Current		1.5 A at 12 V	
RS232			
Tx Voltage Low		-5.4 V	-5 V
Tx Voltage High	5 V	5.4 V	
Tx Short Circuit Current			±60 mA
Rx Threshold Low	0.6 V	1.2 V	
Rx Threshold High		1.5 V	2.0 V
RS422			
Tx Differential Output	1.5 V		
Tx Short Circuit Current			±250 mA
Rx Differential Threshold	-0.2 V		-0.05 V
GPIO when set to 5 V			
Output Voltage Low	0 V		0.3 V
Output Voltage High	4.8 V		5 V
Input Voltage	-20 V		20 V
Input Threshold Low			1.5 V
Input Threshold High	3.5 V		
Output Current			5 mA
1PPS when set to 5 V			
Output Voltage Low	0 V		0.3 V
Output Voltage High	4.5 V		5 V
Output Current			50 mA

Parameter	Minimum	Typical	Maximum
GPIO when set to 3.3 V			
Output Voltage Low	0 V		0.3 V
Output Voltage High	3 V		3.3 V
Output Current			5 mA
Input Voltage	-5 V		5 V
Input Threshold Low			0.8 V
Input Threshold High	2 V		
1PPS when set to 3.3 V			
Output Voltage Low	0 V		0.1 V
Output Voltage High	3 V		3.3 V
Output Current			50 mA
GNSS Antenna			
Active Antenna Supply Voltage	4.5 V		4.6 V
Antenna Supply Current			200 mA

Table 20: Electrical Specifications

Note: * Devices should be designed to operate within the bounds of the operating voltage to avoid tripping the built-in protection circuitry.

5.8 Connector Pin-out

Power supply and signal connections are made through the two push-pull type connector – one has 8 pins, the other has 16 pins. The connectors provide reliable and rugged connections to Certus under demanding conditions and are rated to IP67 in the mated position.

Advanced Navigation produces tested cable assemblies as either a breakout cable (see **5.9.1 8 Pin IO Breakout Cable** and **5.9.2 16 Pin IO Breakout Cable**), or a 3 metre or 10 metre unterminated cable (see **4 Part Numbers and Ordering**). Advanced Navigation supplied cable assemblies are shielded TPE cable, with each individual wire colour-coded FEP coated 24 AWG wire (for the 8 pin cable) or 28 AWG wire (for the 16 pin cable).

If sourcing and assembling your own cables, the connectors are interchangeable across different manufacturers as detailed below:

Connector	Manufacturer & Series	Part Number	Notes
8 pin circular pushpull connector plug	LEMO K	FGG.1K.308.CLAC60Z	Size 1 1 key
	ODU MINI-SNAP K	S11K0C-P08MFG0-6000	
	Amphenol FLO K	FLKC-08FGMS-GCP-213	
16 pin circular pushpull connector plug	LEMO K	FGA.1K.316.CLAC60Z	Size 1 2 key
	ODU MINI-SNAP K	S11KAC-P16MCC0-6000	
	Amphenol FLO K	FLKC-16FGMS-ACP-213	

Note: Both of the two connectors have a power supply connection. Only one of these power supplies should be connected. Connecting two different power supplies could result in damage to the unit.

Certus features galvanic isolation between different pins to prevent interference. This means that there are different grounds that apply for different pins. See **6.4 Electrical Domains** for more information on the different ground domains.

5.8.1 8 Pin Connector

See **Figure 11: 8 Pin Harness connector pin locations** below for pin locations. The image is a pin side view, meaning a view looking into the pins on the harness connector.

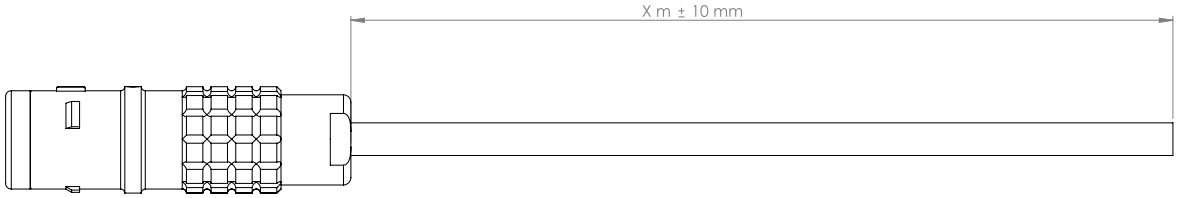


Figure 10: 8 Pin Plug with Unterminated Connectors

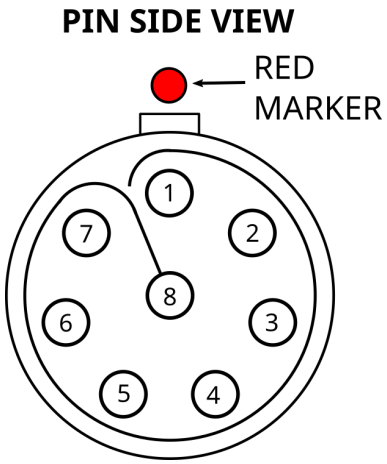


Figure 11: 8 Pin Harness connector pin locations

Pin	Colour	Function
1	Black	Power Ground (see **6.4 Electrical Domains**)
2	Red	Power Supply
3	Grey / Black Stripe	1PPS
4	White / Green Stripe	Ethernet T+
5	Green	Ethernet T-
6	White/Orange Stripe	Ethernet R+
7	Orange	Ethernet R-
8	Grey	1PPS (GPIO) Ground (see **6.4 Electrical Domains**)
Housing	Cable Braided Shield	Chassis Ground (see **6.4 Electrical Domains**)

Table 21: Pin Allocation for 8 Pin Connector

5.8.2 16 Pin Connector

See **Figure 13: 16 Pin Harness connector pin locations** below for pin locations. The image is a pin side view, meaning a view looking into the pins on the harness connector.

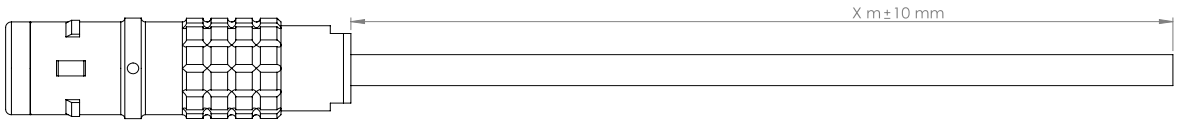


Figure 12: Certus 16 pin plug with Unterminated Connectors

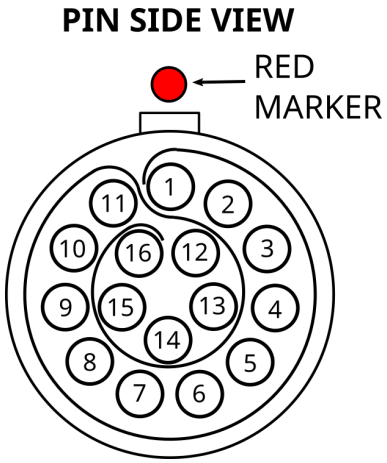


Figure 13: 16 Pin Harness connector pin locations

Pin	Colour	Function
1	Black	Power Ground (see **6.4 Electrical Domains**)
2	Red	Power Supply
3	Violet	Primary RS422 Tx+ / RS232 Tx
4	Violet / Black Stripe	Primary RS422 Tx-
5	Yellow	Primary RS422 Rx+ / RS232 Rx
6	Yellow / Black Stripe	Primary RS422 Rx-
7	Light Brown	CAN L
8	Light Brown / Black Stripe	CAN H
9	Blue	GPIO 1
10	Grey	GPIO Ground (see **6.4 Electrical Domains**)
11	Brown	GPIO 2
12	Light Blue	Auxiliary RS422 Tx+ / RS232 Tx
13	Light Blue / Black Stripe	Auxiliary RS422 Tx-
14	Light Green	Auxiliary RS422 Rx+ / RS232 Rx
15	Light Green/Black Stripe	Auxiliary RS422 Rx-
16	White	Serial Ground (see **6.4 Electrical Domains**)

Pin	Colour	Function
Housing	Cable Braided Shield	Chassis Ground (see 6.4 Electrical Domains)

Table 22: Pin Allocation for 16 Pin Connector

5.9 IO Connection

Advanced Navigation offers two pre-terminated IO breakout cables (one for the 8 pin connector and one for the 16 pin connector) for quick connection to Certus. All external signal and power connections are 2m long. The evaluation IO breakout cables are supplied as part of the Certus Evaluation Kit. See Evaluation Kit.

Custom cable lengths are not available for pre-terminated cables.

Note: Both the connectors have a power supply connection. Only one of these power supplies should be connected. Connecting two different power supplies could result in damage to the unit.

5.9.1 8 Pin IO Breakout Cable

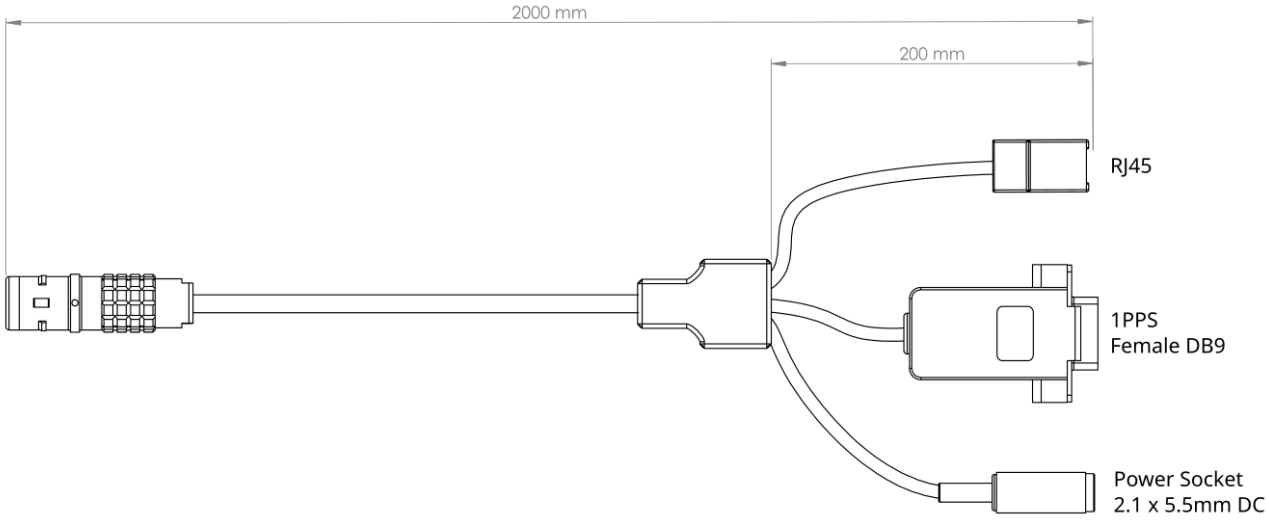


Figure 14: Certus 8 pin IO Breakout Cable

Pin	Function	RJ45	1PPS	Power
1	Power Ground	-	-	Ring
2	Power Supply	-	-	Tip
3	1PPS	-	2	-
4	Ethernet T+	1	-	-
5	Ethernet T-	2	-	-
6	Ethernet R+	3	-	-
7	Ethernet R-	6	-	-
8	1PPS (GPIO) Ground	-	5	-
Housing	Chassis Ground	-	-	-

Table 23: Certus 8 Pin IO Breakout Cable Connector Pin-out

5.9.2 16 Pin IO Breakout Cable

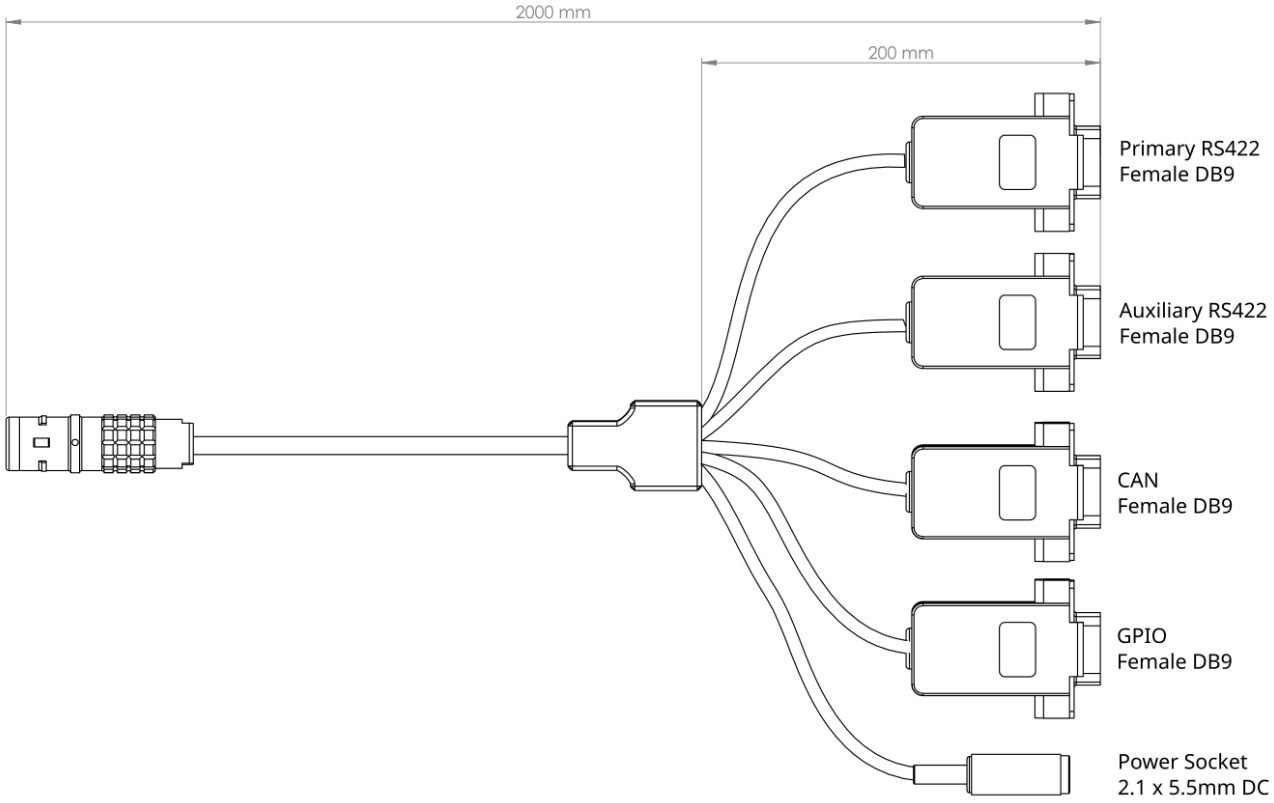


Figure 15: Certus 16 pin IO Breakout Cable

Pin	Function	Primary	Auxiliary	CAN	GPIO	Power
1	Power Ground	-	-	-	-	Ring
2	Power Supply	-	-	-	-	Tip
3	Primary RS422 Tx+ / RS232 Tx	2	-	-	-	-
4	Primary RS422 Tx-	8	-	-	-	-
5	Primary RS422 Rx+ / RS232 Rx	3	-	-	-	-
6	Primary RS422 Rx-	7	-	-	-	-
7	CAN L	-	-	2	-	-
8	CAN H	-	-	7	-	-
9	GPIO 1	-	-	-	2	-
10	GPIO Ground	-	-	-	5	-
11	GPIO 2	-	-	-	3	-
12	Auxiliary RS422 Tx+ / RS232 Tx	-	2	-	-	-

Pin	Function	Primary	Auxiliary	CAN	GPIO	Power
13	Auxiliary RS422 Tx-	-	8	-	-	-
14	Auxiliary RS422 Rx+ / RS232 Rx	-	3	-	-	-
15	Auxiliary RS422 Rx-	-	7	-	-	-
16	Serial Ground	5	5	6	-	-
Housing	Chassis Ground	-	-	-	-	-

Table 24: Certus 16 Pin IO Breakout Cable Connector Pin-out

6 Installing

Refer to **3 Getting Started**, for a summary of steps to get started.

Note: For ordering an evaluation kit, a standalone kit or accessories for Certus, see **4 Part Numbers and Ordering**.

6.1 Mounting Certus

When installing Certus into a vehicle, the mounting position and alignment of the unit are essential for achieving optimal performance. Position refers to the physical location within the vehicle where the unit is installed while alignment refers to the orientation of the unit with respect to the orientation of the vehicle.

Before you install Certus, review the considerations for selecting a location and instructions alignment of the unit outlined below.

When planning a mounting location for Certus, be mindful of the following recommendations:

- Mount the unit in an area that will not exceed the rated temperature range, and with minimal temperature swings.
- Mount the unit away from high levels of vibration where possible.
- Mount the unit within several metres of the GNSS antennas where possible.
- Mount close to the centre of gravity of the vehicle where possible.
- Mount the unit at least 10 cm away (and preferably as far as possible) from sources of dynamic magnetic interference such as high current wiring or large motors for best performance.
- Do not obstruct the two vents on the side of the enclosure unless **7.10 Atmospheric Altitude** will be disabled.

The Certus mounting plate and hole guide are shown in **6.1.1 Mounting Plate Layout**. The holes are designed for M3 screws.

For instructions on alignment of the unit within a vehicle, see **6.2 Mounting Alignment**.

6.1.1 Mounting Plate Layout

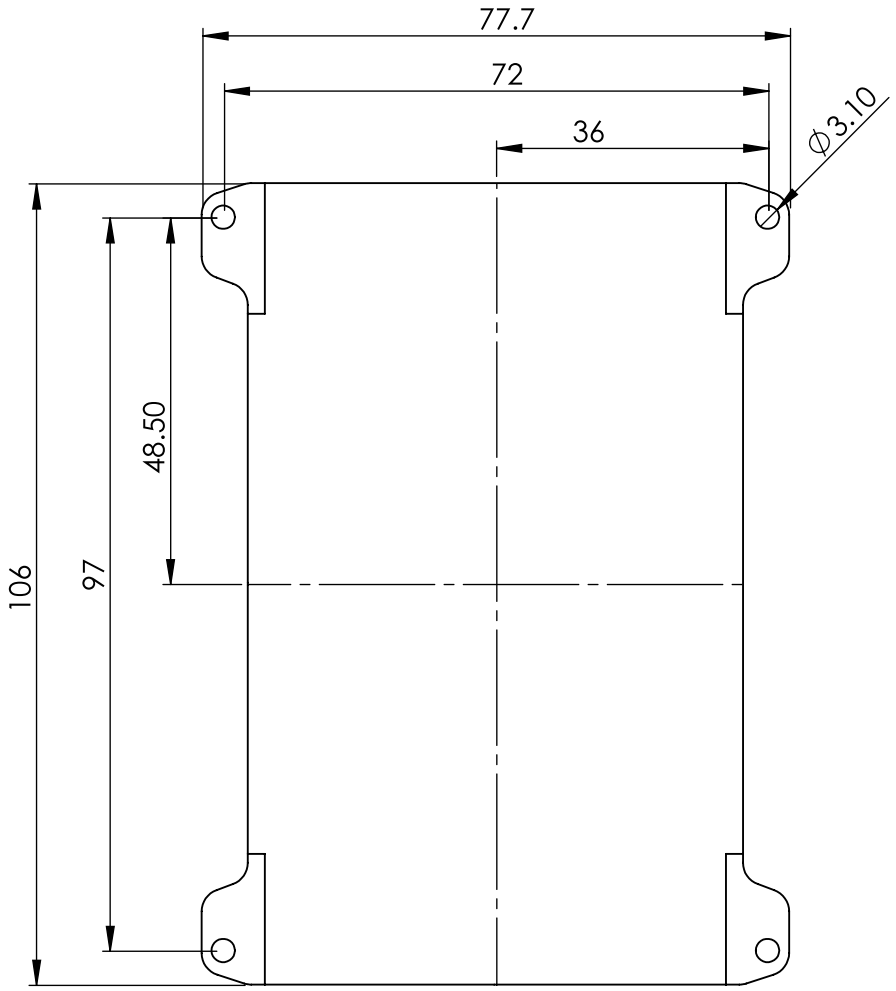


Figure 16: Bottom View of Certus Mounting Plate

6.2 Mounting Alignment

The easiest way to align Certus is by installing the unit with its sensor axes aligned with the vehicle axes. There are notches marked on the X and Y axis to assist with alignment. Install the unit such that the X+ axis points forward towards the front of the vehicle and the Z+ axis points straight down towards the ground as shown below.

If aligning Certus with the vehicle axes is not possible within vehicle size or shape constraints, it may be mounted in a different alignment and the alignment offset can be configured **Using the Web User Interface** or **Using Certus Manager**. For easy roll and pitch alignment, use the **Set Zero Orientation** button in the Alignment page to set the current orientation as the level alignment.

Note: This will only correct for roll and pitch offsets. Any heading offset will need to be entered manually and saved after using this function.

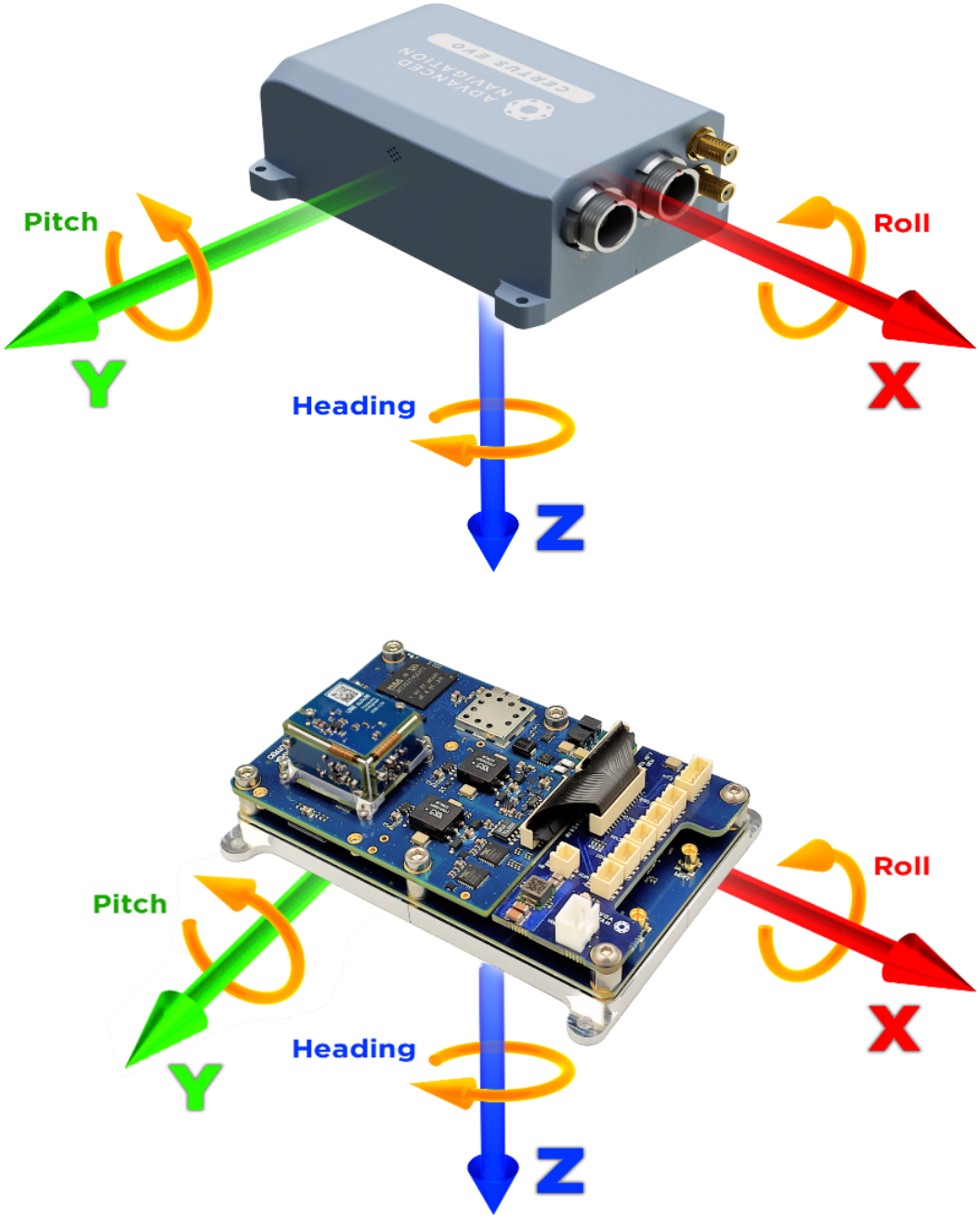


Figure 17: Mounting Axes

6.3 Power Supply

A high level of power supply filtering has been built into the unit, to meet EMC/EMI compliance.

Power supply filtering has been built into the unit.

However, a power supply with low noise and ripple levels, and adequate transient response is still recommended.

The rugged unit contains a fully isolated power supply and has separate grounds for power and signals to ensure that power supply noise does not corrupt communications or cause ground loops with other equipment.

The OEM unit contains a non-isolated power-supply.

The power supply must be able to reliably provide the maximum current at the chosen voltage, especially in systems with substantial load variations. Make sure that all system components are rated (including safety factors) for the anticipated environmental operating conditions and stressors of the system. Refer to the Hardware Specifications for further information.

The unit contains an active protection circuit on the power supply input that protects the unit from:

- Under Voltage
- Over Voltage
- Reverse Polarity

It is recommended to always operate the unit at a voltage higher than the minimum mentioned in the Electrical Specifications. Take caution when using a supply voltage close to the minimum voltage as minor voltage fluctuations could trigger under-voltage protection, leading to unexpected oscillations between the on and off states.

Note: Both connectors have a power supply connection. Only one of these power supplies should be connected. Connecting two different power supplies could result in damage to the unit.

6.4 Electrical Domains

The rugged unit contains separate electrically isolated domains. Each domain is isolated from the others to minimise noise injection and avoid ground loops. Where possible, this isolation should be preserved by externally connected devices. We recommend connecting the enclosure to your vehicle ground where possible for the best electrical noise performance.

Note: OEM variants do not include an electrically isolated power supply.

Domain Name	Affected Components and Ports
Chassis	Enclosure, GNSS receiver, GNSS antennas
Power	Power Supply
Serial	Primary port, Auxiliary port, CAN port
GPIO	GPIO 1 port, GPIO 2 port, 1PPS port
Ethernet	Ethernet port

Table 25: Certus Electrical Domains

6.5 GNSS Antenna Installation

Correct antenna placement and configuration are critical for achieving accurate positioning with an Inertial Navigation System (INS). It involves maximising signal reception and minimising signal loss. Recommendations vary slightly depending on whether your device uses standard or anti-jam GNSS receivers.

6.5.1 General Placement Requirements

1. Ensure a Clear View: Install the antennas level with respect to each other, ensuring a clear, unobstructed view of the sky down to the horizon.
2. Mitigate Interference: Mount the antennas away from reflective surfaces to reduce multipath interference.
3. Avoid RF Emitters: Position the antennas away from powerful Radio Frequency (RF) emitters, such as radars, high-powered communication links, or high-current wiring.
4. Use a Ground Plane: Place the antenna over a flat, conductive ground plane (such as a piece of plate aluminium). The minimum recommended ground plane radius is 60 mm, or as specified by the antenna supplier.
5. Ensure Stability: Securely mount the antenna to prevent movement or vibration.

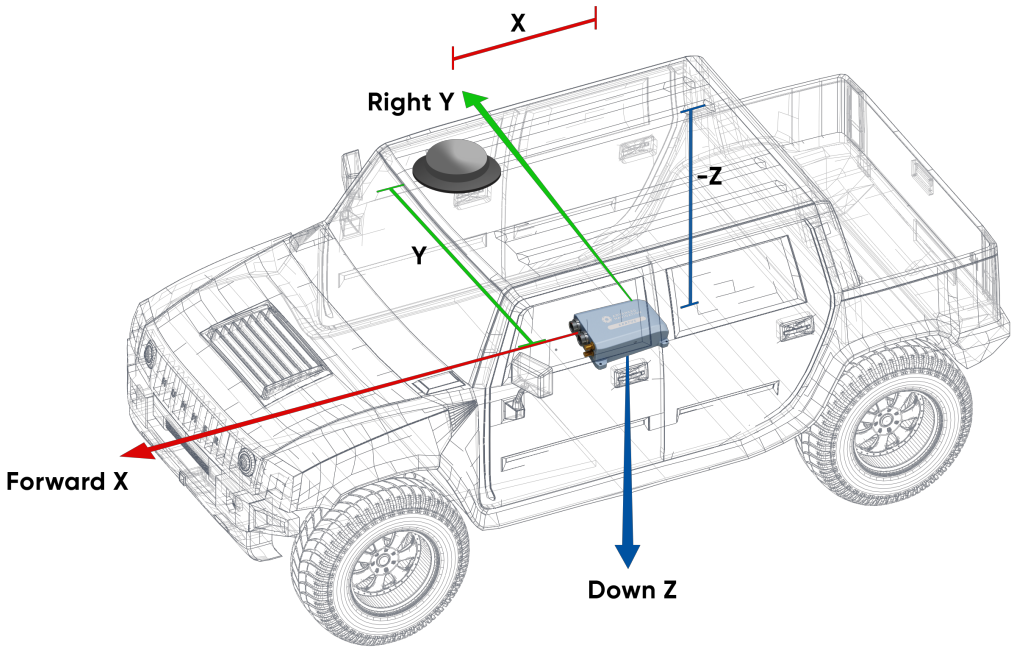


Figure 18: Antenna Offset Isometric View

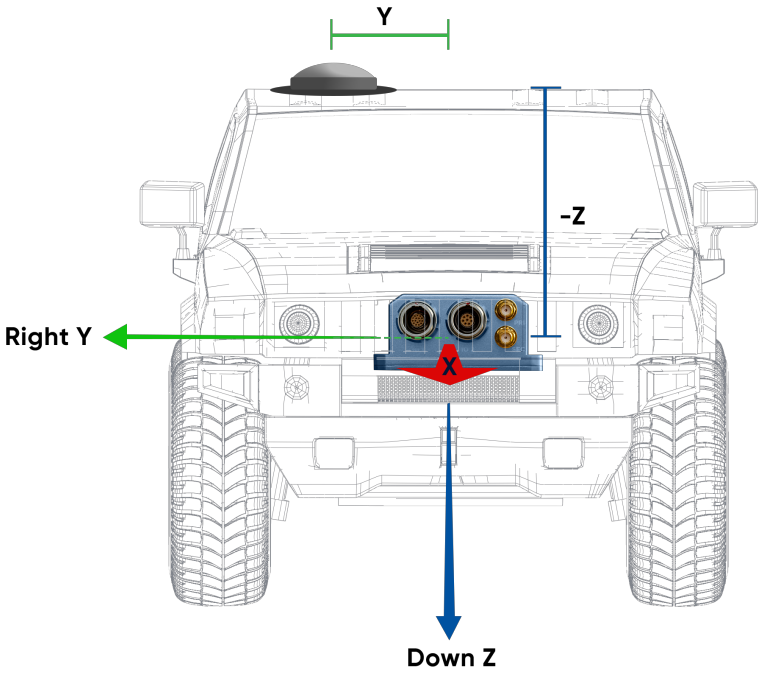


Figure 19: Antenna Offset Front View

6.5.2 Dual-Antenna Heading Configuration

For systems utilizing dual-antenna heading, precise configuration is key.

1. Configure Primary Antenna Offset: Accurately configure the physical offset from the INS unit's centre to the primary GNSS Antenna Reference Point (ARP) in the system's software (Web UI or Manager). The offset is measured in the body coordinate frame: X+ forward, Z+ down.

    - **Note**: The Z-axis is positive downwards. Mounting the antenna above the INS unit requires a negative Z offset.

    - **Note**: An inaccurate offset leads to performance degradation during angular rotations and turns because the INS cannot correctly compensate for lever arm velocities.

2. Position Secondary Antenna: Ideally, mount the secondary antenna directly behind the primary antenna, in line with the vehicle's long axis.
3. Maximize Separation: Increase the antenna separation distance whenever possible, as greater separation directly improves heading accuracy.
4. Verify Phase Centre: Ensure the antenna has an accurate phase centre. This is required for correct dual-antenna heading functionality and RTK capability.

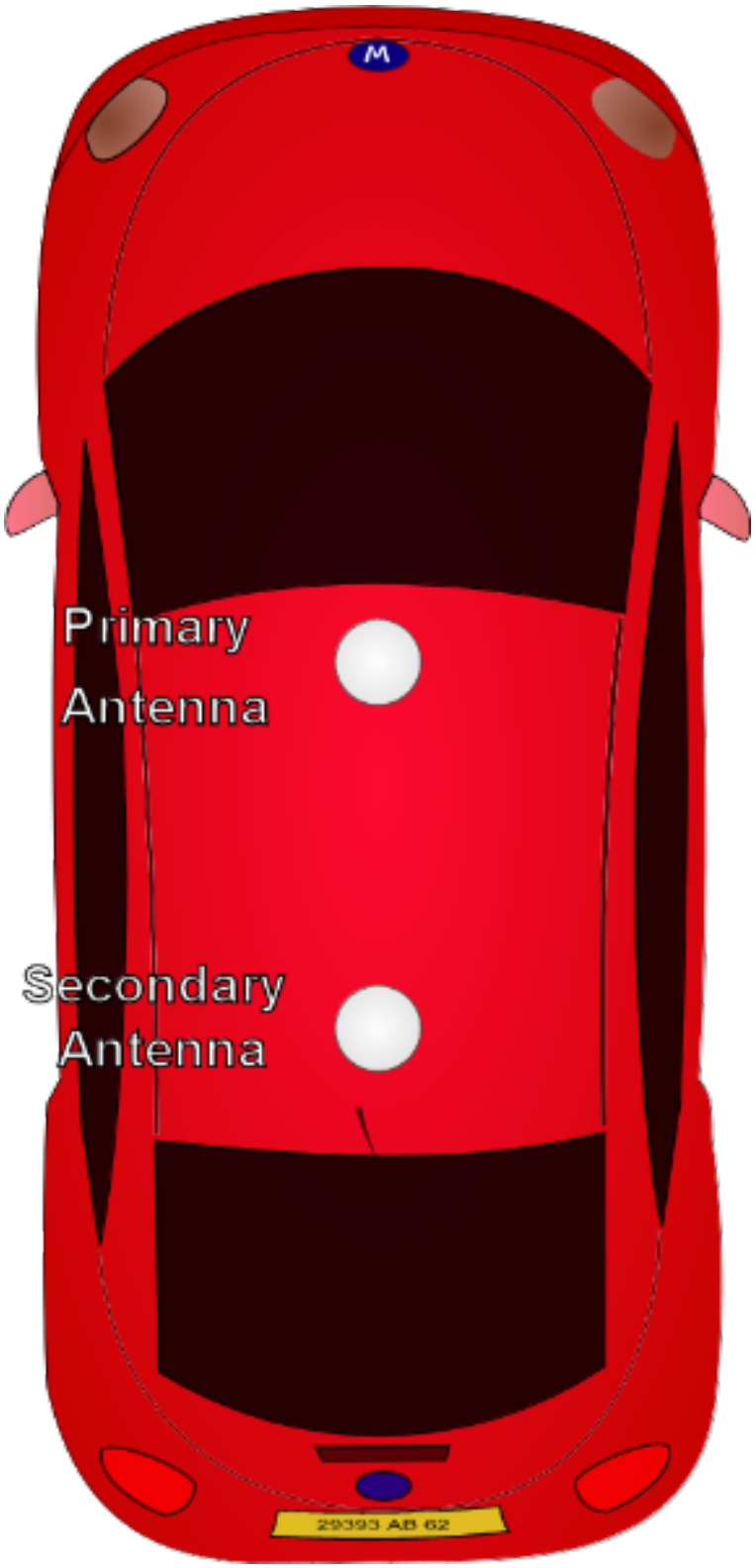


Figure 20: Recommended Second Antenna Placement

6.5.3 Anti-Jam Antennas

Anti-Jam (AJ) antennas have stricter and slightly differing requirements which extend or slightly override standard GNSS antenna instructions. Anti-jam antennas filter interference by shaping their radiation pattern and so are very sensitive to mounting geometry. Consequently, you should closely follow the manufacturer's specific guidelines.

6.5.3.1 Calian AJ977XF Mounting Recommendations

1. Ground Plane Diameter: Use a ground plane with a diameter of 30 cm or less to maintain the integrity of the radiation pattern.
2. Antenna Mounting Height: Mount the antenna base 25 mm to 50 mm above the ground plane surface.
3. Separation from Ground Plane: Maintain an optimal vertical separation of 25 mm to 50 mm between the bottom of the antenna and the ground plane surface.
4. Ensure Stability: Securely mount the antenna to prevent movement or vibration.

6.5.3.2 Effects of Incorrect Mounting

Deviating from guidelines significantly degrades anti-jamming performance and overall system accuracy:

1. Pattern Distortion: Oversized ground planes can cause significant changes to the Right Hand Circular Polarisation (RHCP) gain, making it more directive and unstable. Extremely large ground planes can result in the creation of multiple nulls due to side lobes and ripples in both RHCP and Left Hand Circular Polarisation (LHCP) patterns.
2. Increased Multipath Susceptibility: Larger ground planes cause the LHCP gain at and above the horizon to generally increase. This gain results in degradation of the axial ratio, amplifying reflected signals, making the system more vulnerable to position errors in reflective environments. This leads to high susceptibility to multipath interference.
3. Null Shift: Increasing the ground plane diameter shifts the intended filtering null down in elevation (approximately 5° for every 15 cm diameter change). This alters the antenna's protection zone, potentially reducing jammer rejection capability or blocking desired satellite signals.

6.5.4 Antenna Cables

Proper cable management minimizes signal loss and protects the system from interference.

1. Cable Length: Try to keep the antenna cables the same length and as short as possible for the application.
2. Route Safely: Route cables away from powerful RF emitters, high current wiring, high temperatures, and machinery. Do not coil excess cable; find the shortest viable run.
3. Bending: Do not bend the cable tighter than its minimum bend radius, and prevent denting. Secure cables using wide, loosely fixed cable ties.
4. Connectors: Use recommended antenna cable connectors listed in Part Numbers and Ordering.
5. Signal Loss: Ensure the entire cable run (including all connectors) allows the GNSS receiver to receive a minimum of 33 dB of gain at its connector. Use lower-loss cables (LMR series) for longer runs to meet this requirement.

Cable Type	Minimum Bend Radius	Signal Loss
RG-58/U Low Loss	20 mm	~0.92 dB/m
LMR240	20 mm	~0.33 dB/m
LMR300	22.2 mm	~0.26 dB/m
LMR400	25.4 mm	~0.17 dB/m

6.5.5 Antenna Suction Cup Mount

Use a suction cup mount when you need to mount antennas temporarily or on surfaces unsuitable for permanent installation.

1. Applicability: Use a suction cup mount when installing antennas at any angle or on smooth, non-porous surfaces, such as a window or vehicle bodies made of aluminium or fibreglass.
2. Benefit: This type of mount allows for quick attachment and removal.
3. Caution: Ensure the suction cup surface is clean and the seal is maintained during operation.

6.6 Networking

The default configuration for Certus is for the DHCP Client to be Enabled. This makes it a plug-and-play solution for most users. It is possible to change Certus to a fixed IP address system once a connection has been established.

Certus supports the Zero Configuration (Zeroconf) networking feature. On Linux and MacOS systems no additional software is required. If you are using Microsoft Windows, install the Apple Bonjour software from **https://www.advancednavigation.com/Bonjour64.msi** if it's not already installed. Open a web browser and type in the address **http://certus.local/** to discover the device and access the web interface.

Note: If more than one device is connected to the network, a running number suffix will be added to the allocated device addresses i.e. "http://certus-1.local", "http://certus-2.local", "http://certus-3.local", etc.

Note: A factory reset will re-enable the DHCP Client and lose any static IP address settings.

6.7 Odometer

On ground vehicles, the use of an odometer input will greatly improve the Certus navigation and orientation solution during GNSS outages.

There are several different options for odometer that are explained as follows.

6.7.1 Factory VSS Signal

Most mass-market vehicles since 1980 contain a VSS (vehicle speed sensor) signal that can be wired directly into one of the Certus GPIO pins. Any voltage limits on this pin that must be taken into consideration.

To set up the odometer, the appropriate GPIO pin should be set to Odometer Input using INS Manager. The odometer pulse length must then be set either manually or automatically, see **7.11 Odometer Pulse Length** for more information.

For more information on the GPIO signals and their requirements see **9.6 GPIO Pins and the Auxiliary Port**.

6.7.2 OBDII Odometer Interface

For applications where it is undesirable to modify the vehicle or the system needs to be used with multiple vehicles, the OBDII odometer interface may be a better solution. OBDII is a vehicle diagnostic port standard and most vehicles from the mid 1990s onwards contain an OBDII port in the drivers side foot well. Advanced Navigation produces an inexpensive OBDII Odometer Interface that plugs into this OBDII port and feeds Certus with odometer data over the Auxiliary RS232 port. See the figure below. Contact the Advanced Navigation sales team at **sales@advancednavigation.com** for more information.



Figure 21: Advanced Navigation OBDII Odometer

6.7.3 Aftermarket Wheel Speed Sensor

Applications requiring very high performance without GNSS for any length of time are recommended to use a high precision aftermarket wheel speed sensor. Advanced Navigation recommends aftermarket wheel speed sensors from Kistler, Pegasem or GMH Engineering.



Figure 22: Aftermarket Wheel Speed Sensor

6.7.4 Radar Speed Sensor

For applications requiring high performance in harsh conditions where aftermarket wheel speed sensors are not feasible, a radar speed sensor is recommended. Advanced Navigation recommends radar speed sensors from Stalker or GMH Engineering.



Figure 23: Radar Speed Sensor

6.8 Magnetics

Certus contains magnetometers which it can use to measure the Earth's magnetic field in order to determine its heading. The principle is the same as that of a compass. When operating Certus with magnetic heading enabled, sources of magnetic interference can degrade the Certus solution if not compensated for.

Note: Magnetic interference affects the performance of gyroscopes by causing rotation errors; it is recommended that you mount Certus away from magnetic interference.

There are two types of magnetic interference: **Static** and **Dynamic**.

Sources of static magnetic interference are predominantly ferrous materials (e.g. steel, iron, nickel, cobalt), high- current cables and permanent magnets located near the Certus. Static disturbances are easily compensated for by running a magnetic calibration. A magnetic calibration should always be performed after installation into a vehicle if accurate magnetometer heading is required. See **7.6 Magnetic Calibration** for instructions on how to calibrate your device.

Dynamic magnetic interference is a much more complex and problematic issue due to its many variable factors and unpredictability. Sources of dynamic magnetic interference include high current wiring, electric motors, servos, solenoids and nearby large masses of metal that don't move with Certus. Certus should be mounted as far as possible from these interference sources.

Certus contains a special algorithm to reduce the effects of dynamic magnetic interference. This is able to compensate for most typical interference sources encountered, however certain types of prolonged dynamic interference cannot be compensated for. The best way to check for dynamic magnetic interference is to use the Raw Sensors view in the web UI or INS Manager and watch the magnetometer outputs whilst the vehicle is operating but stationary. See **Using the Web User Interface** or **Using Certus Manager**. The values should be constant: if the values are fluctuating there is dynamic magnetic interference present.

If dynamic magnetic interference is causing performance problems and there is no way to mount Certus away or, where practical, magnetically shield it from these interference sources, the magnetometers should be disabled and an alternative heading source should be used, see **7.6.4 Disabling Magnetometers**.

6.9 Vibration

High vibration levels can degrade the performance of an Inertial Navigation System (INS). While Certus is designed to tolerate high vibration levels, we recommend reviewing our **Best Practices for INS Damping and Isolation** knowledge base article for optimal setup.

Monitor the *INS Manager > Raw Sensors* view to look for over-range events, and address in your design as required.

See our **7.7 Sensor Ranges** section about dynamically changing the range supported by sensors.

7 Using Certus

This section covers the following topics:

7.1 Initialization for Optimal Performance

The performance of an Inertial Navigation System (INS) is dependent on the quality of its initialization.

For advice, refer to our Knowledge Base article, **How to Initialize your INS for Optimal Performance.**

7.2 Filter Initialisation

There are four different levels of filter initialisation on Certus. These are orientation, navigation, heading and time.

The initialisation of each can be monitored by inspecting the **Status** view in the web UI or **8.6.2 View Menu** in the INS Manager.

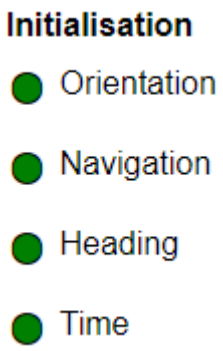


Figure 24: Initialisation Levels

After all four levels of initialisation, the Certus INS filter takes several minutes to achieve its full accuracy. It is recommended to wait two minutes after initialisation for applications requiring high accuracy.

7.2.1 Orientation Initialisation

Orientation initialisation occurs automatically upon power on and typically completes within seconds. To determine its orientation it uses the accelerometers to measure the gravity vector. Random accelerations from environmental sources can disturb this process, which can introduce minor orientation errors that will be corrected within several seconds. To prevent this, Certus monitors the accelerometers and gyroscopes and restarts the orientation detection if there are sudden movements. It is however still possible under some circumstances for it to miss minor movements and start with a small orientation error. Certus will progressively correct the orientation error over a period of several seconds.

Once orientation initialisation is complete, the roll, pitch and angular velocity values will be valid.

7.2.2 Navigation Initialisation

Navigation initialisation completes once the system has determined a starting absolute position. The most common method of navigation initialisation is for the system to get a 3D GNSS fix or better. If the system is hot-starting it will remember its position at the time it was switched off and use this as the starting position. The other possibility for navigation initialisation is an external position source to be used, see **10.4.26 External Position Packet** for more information. In a situation where a GNSS fix is not available to initialise navigation, it can be initialised manually by entering a position into the **Manual Initialisation** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the INS Manager.

Once navigation initialisation is complete, the position, velocity and acceleration values will be valid.

7.2.3 Heading Initialisation

Heading initialisation completes once the system has determined a heading using one of its several methods. The conditions required to determine a heading depend upon the heading source being used, see **7.5 Heading Sources**. The default heading source is dual antenna, which will initialise the heading to a high accuracy within several minutes of power on assuming that both antennas are connected with an unobstructed view of the sky. The system can be stationary or moving during this initialisation. If velocity heading is enabled and the vehicle is moving, this will be very fast. If the system hot-starts, the last known heading value will be used. However, in order for the Heading Filter to initialise, the system must have a valid heading source.

Until the heading has been initialised, the system will not be able to navigate without a GNSS fix, and the roll and pitch values will not reach full accuracy.

7.2.4 Time Initialisation

Time initialisation completes once the system has determined time accurately. This requires:

- A valid timestamp from a GNSS, which occurs once the GNSS obtains its first fix, and
- A 1PPS signal.

These signals can either be sourced internal to the device if it has an internal GNSS, or input from an external source.

External timestamps can be delivered via 11.4.32 External Time Packet. This may be used if:

- Time is required prior to the GNSS obtaining a GNSS fix, or
- The GNSS antenna doesn't have visibility of satellites, or
- The GNSS is disabled.

An external 1PPS signal can be input via a user GPIO port configured as 1PPS input. If the device has an internal GNSS then `Filter Options > Internal GNSS` must be set to disabled.

After time initialisation completes:

- The `Filter Status > Time Valid` flag will be set to true, and
- The timestamps in all output messages (eg: `ANPP Unix time`, `ANPP Formatted time`, `NMEA`, etc) will contain correct times, and
- The 1PPS output will be accurately synchronised to UTC seconds.

7.3 Hot Start

Hot-start functionality allows the unit to sustain navigational state parameters and accurate time for many hours after losing power.

When the unit hot-starts, it assumes that it is in the same state as it was when it lost power and begins navigating from that position.

For units with GNSS capability, retained ephemeris, almanac and time information is provided to the GNSS receiver. This enables the GNSS receiver to achieve a GNSS fix faster than it otherwise could.

7.4 Time

Certus is designed to provide an accurate time reference via an internal oscillator.

The oscillator is a temperature compensated disciplined oscillator.

For a device with a GNSS receiver, when a GNSS fix is available, the internal oscillator uses GNSS time to precisely correct itself to within the accuracy specified for the GNSS receiver.

When a GNSS fix is lost, time accuracy will slowly drift.

The time can be accessed via the following means:

- A dedicated **9.3 1PPS Signal**. This is the preferred means to obtaining the most accurate timing output.
- A 1PPS output over GPIO or the Auxiliary port, see **9.6.1.2 1PPS Output** of the Dynamic Pin Functions.
- A built-in Precision Time Protocol (PTP) version 2 server for synchronisation with network-connected devices which require high accuracy time. The PTP server broadcasts PTP messages (Sync, Follow Up, Announce) to multicast IP address 224.0.1.129. The PTP broadcasts are sent whenever an Ethernet connection is established and cannot be disabled.
- A built-in Network Time Protocol (NTP) server:
    - The NTP message will be broadcast on the IP address of the device, on UDP port 123.

Note: The time filter will need to be initialised before the device will start sending NTP or PTP messages.

7.5 Heading Sources

There are several different heading sources available for Certus. The heading sources can be configured using the **Filter Options** page in the web UI (see **Using the web user interface**) or in the Manager application (see **Certus Manager**). It is possible to use multiple heading sources and this can provide performance benefits.

7.5.1 Dual Antenna Heading

For devices that support dual GNSS antenna input, this is the heading source that provides the most accurate heading while GNSS is available. Dual antenna heading only works when a good GNSS fix is available to both antennas. It requires a clear view of the sky with minimal nearby sources of interference or multipath. The

greater the antenna separation, the higher the accuracy (see 5.1 Navigation Specifications). A minimum antenna separation of 0.5 metres is required.

Certus will operate with a single primary antenna connected, but this will prevent dual-antenna heading being used, although velocity heading will still be possible.

7.5.2 Velocity Heading

For devices that support either single or dual GNSS input, velocity heading works by deriving heading from the direction of velocity and acceleration. Velocity heading works well with cars, fixed wing aircraft and other vehicles that don't move sideways. Velocity heading cannot work for helicopters and other vehicles where the vehicle is pointed somewhere other than the direction of travel. Velocity heading requires a horizontal speed of over 1.15 m/s with a GNSS fix. Velocity heading is disabled by default.

7.5.3 Magnetic Heading

This is the default heading source and works well in the majority of cases. When using magnetic heading, magnetic calibration is required every time the static magnetic field around the Certus changes. This can occur, for example, when moving the mounting location of the unit, or making significant structural changes to the vehicle that alter the distribution of ferrous materials. The downside of magnetic heading is that prolonged exposure to dynamic magnetic interference can cause significant heading errors. See 6.8 Magnetics and 7.6 Magnetic Calibration for further information. Magnetic heading is enabled by default.

7.5.4 External Heading

This can be used if there is some other way to derive heading that is external to Certus. The heading must be supplied to Certus using the 10.4.29 External Heading Packet or an NMEA message, see 9.6.1.29 NMEA Input.

7.5.5 External Magnetometers Packet

Heading can derived using the magnetometers of an additional external Advanced Navigation product to input external magnetometer values. See 10.4.47 External Magnetometers Packet for details.

7.6 Magnetic Calibration

Static magnetic interference is resolved through magnetic calibration. Dynamic magnetic interference is compensated by a filter algorithm, but should be minimised where possible by selecting the best possible mounting location or implementing magnetic shielding — see 6.8 Magnetics for more information. To compensate for static magnetic interference, magnetic calibration should be performed whenever the Certus mounting location or operation environment changes.

Certus contains a dynamic magnetic compensation filter that is able to mitigate the effects of short term magnetic interference sources while in operation. For example, if Certus is installed in a car and the car drives over a large piece of magnetised steel, this will be compensated for. Another example is driving through a tunnel which is built from reinforced concrete, which can distort the local magnetic field substantially. It is important to note that for the Certus dynamic magnetic compensation filter to operate correctly, Certus needs to get a GNSS fix at least once every time it is moved more than 50 km. Each time Certus moves more than 50 km the new position is stored permanently and allows Certus to update its world magnetic model values.

There are three types of magnetic calibration available: 2D calibration, 3D calibration and automatic calibration. The three magnetic calibration types and their respective typical applications are described as follows.

- 2D calibration involves at least one full rotation of the vehicle about the Z-axis and is designed for vehicles that are not intended to travel whilst turned upside down, such as full-sized cars, passenger planes and boats.
- 3D calibration involves at least two full rotations of each axis (X, Y and Z) and is designed for vehicles that are intended to be manoeuvred and travel upside down, such as underwater vehicles. 3D calibration offers slightly better performance, and is recommended where possible. Be mindful that the support mechanism used to support the vehicle during calibration can influence the results.
- Automatic magnetic calibration continuously and automatically calibrates for static magnetic interference while the unit is in operation. While it is not as accurate as 2D or 3D calibration, and can take significantly longer to calibrate, automatic magnetic calibration is very convenient for applications where it is impractical to employ those methods.

Note: If Certus is going to be used in a vehicle, the calibration should be performed while Certus is mounted in and fixed to that vehicle. This means that the whole vehicle must be moved to perform the calibration. The calibration needs to be performed in an area away from other sources of magnetic interference. For example if Certus is installed in a car, the calibration should not involve driving over steel drains or reinforced concrete etc. If Certus is being calibrated to operate standalone, the calibration should not be done on a desk with a steel frame.

7.6.1 2D Magnetic Calibration

The following procedure should be used to perform a 2D magnetic calibration.

7.6.1.1 2D Magnetic Calibration Using the web UI or Certus Manager Software

1. The unit should be powered on while the vehicle is in a level orientation and kept stationary. It is recommended this be done in an outdoor area away from metal or obstructions.
2. After power on wait 5 minutes for the temperature and filter to stabilise.
3. Open the web UI or Certus Manager and connect to the device.
4. In the **Tools** menu, open **Magnetic Calibration**. Click the **2D Calibration** button.
5. Whilst keeping as level as possible, rotate the vehicle in either direction through one and a quarter full rotations. In a car or boat his can be achieved by driving in one and a quarter circles.
6. Check the status in the **Magnetic Calibration** window to ensure that the calibration completed successfully. If not successful, click **Cancel**, wait 2 minutes and repeat from step 4.

Note: Do **not** press the Save button in the lower half of the page, this will overwrite the new calibration values. The auto-generated calibration values are automatically saved internally by Certus.

7.6.1.2 2D Magnetic Calibration Using the Packet Protocol

1. The unit should be powered on while the vehicle is in a level orientation and kept stationary.
2. After power on wait 5 minutes for the temperature and filter to stabilise.

3. Ensure that the device has a position fix, either from a GNSS receiver, or using the External Position and Velocity packet #44 or the External Position packet #45, before proceeding.
4. Send the **10.6.9 Magnetic Calibration Configuration Packet** with the action **Start 2D Magnetic Calibration**.
5. Whilst keeping as level as possible, rotate the vehicle in either direction through one and a quarter full rotations. In a car this can be achieved by driving in one and a quarter circles.
6. Read the **10.6.10 Magnetic Calibration Status Packet** to ensure that the calibration completed successfully. If not successful, send the **10.6.9 Magnetic Calibration Configuration Packet** with the action **Cancel**, wait 2 minutes and repeat from step 4.

7.6.2 3D Magnetic Calibration

The following procedure should be used to perform a 3D magnetic calibration.

7.6.2.1 3D Magnetic Calibration Using the web UI or Certus Manager Software

1. The unit should be powered on and the vehicle kept stationary. It is recommended this be done in an outdoor area away from metal or obstructions.
2. After power on wait 5 minutes for the temperature and filter to stabilise.
3. Open the web UI or Certus Manager and connect to the device. Ensure that the device has a GNSS fix before proceeding.
4. In the **Tools** menu, open **Magnetic Calibration**. Click the **3D Calibration** button. The following steps 5, 6 and 7 can be performed in any order.
5. Slowly rotate the vehicle twice around the X-axis (roll).
6. Slowly rotate the vehicle twice around the Y-axis (pitch).
7. Slowly rotate the vehicle twice around the Z-axis (heading).
8. Check the status in the **Magnetic Calibration** window to ensure that the calibration completed successfully. If not successful click **Cancel**, wait 2 minutes and repeat from step 4. Do **not** press the save button in the lower half of the page, this will over write the new calibration values. The auto-generated calibration values are automatically saved internally by Certus.

7.6.2.2 3D Magnetic Calibration Using the Packet Protocol

1. The unit should be powered on and the vehicle kept stationary.
2. After power on wait 5 minutes for the temperature and filter to stabilise.
3. Ensure that the device has a position fix, either from a GNSS receiver, or using the External Position and Velocity packet #44 or the External Position packet #45, before proceeding.
4. Send the **10.6.9 Magnetic Calibration Configuration Packet** with the action **Start 3D Magnetic Calibration**. The following steps 5, 6 and 7 can be performed in any order.
5. Slowly rotate the vehicle twice around the X-axis (roll).
6. Slowly rotate the vehicle twice around the Y-axis (pitch).
7. Slowly rotate the vehicle twice around the Z-axis (heading)

8. Read the **10.6.10 Magnetic Calibration Status Packet** to ensure that the calibration completed successfully. If not successful, send the **10.6.9 Magnetic Calibration Configuration Packet** with the action **Cancel**, wait 2 minutes and repeat from step 4.

7.6.3 Automatic Magnetic Calibration

Automatic magnetic calibration is an algorithm that continuously and automatically calibrates for static magnetic interference. Automatic magnetic calibration is enabled by default and it is recommended to keep it enabled for all vehicle types. When used on top of a 2D or 3D calibration it can give the best results from magnetic heading.

The automatic calibration for 2D vehicles differs from that for 3D vehicles. To ensure the correct calibration is being applied, ensure the correct vehicle profile is selected for your application in the **Filter Options** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the Certus Manager.

7.6.3.1 2D Vehicle Profiles

2D vehicles are those which cannot easily or safely be turned upside down, and typically include vehicles such as cars and bicycles.

Each time Certus is powered on in a cold start (48 hours without power) the automatic calibration is reset. The automatic magnetic calibration starts operating when Certus is travelling at a speed over 5 m/s with a GNSS fix and either dual antenna is the heading source or velocity heading is turned on.

Automatic magnetic calibration is not as accurate as 2D or 3D calibration, however, it is sufficient for most vehicles and allows Certus to be installed into vehicles and operated without user intervention.

Automatic magnetic calibration can be turned off using the **Filter Options** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the Certus Manager.

7.6.3.2 3D Vehicle Profiles

3D vehicles are those which can easily or safely be turned upside down, and typically include vehicles such as humans, underwater vehicles and fixed wing planes.

Each time Certus is powered on in a cold start (48 hours without power) the automatic calibration is reset, and a new calibration will begin if a significant change in calibration values is detected. The automatic calibration for 3D vehicle profiles requires no prior calibration or minimum velocity to begin.

The calibration time is dependent upon the rotation about each axis; approximately, 1 degree of uniform motion in each axis will take up to an hour to converge, motion as low as 0.2-0.5 degrees will take upwards of 12 hours to converge, and 10 degrees of motion will take around 40 seconds to converge. These time estimates are dependent on the environment and nature of the motion.

Automatic magnetic calibration can be turned off using the **Filter Options** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the Certus Manager.

7.6.4 Disabling Magnetometers

In situations where there are very strong dynamic magnetic disturbances present, it is recommended to disable the magnetometers. When the magnetometers are disabled, an alternative heading source is required or else Certus may become inaccurate. Dual antenna heading is the recommended source. See **7.5 Heading Sources** for information. The magnetometers can be disabled using the Magnetic Heading setting on Filter Options page in the web UI or Certus Manager. See **Using the Certus Web User Interface** or **Using Certus Manager**.

7.7 Sensor Ranges

Note: Certus Evo does not support configurable sensor ranges, the following functionality only applies to Certus

Certus supports dynamically changing the range on its sensors using the *INS Manager* > *Sensor Ranges* page.

At lower ranges the sensor performance is better, but at higher ranges Certus can be used in more extreme dynamics. The best performance is achieved by choosing the lowest range where your application won't generate over-range events.

Sensor over-range events can be detected in the **Filter Status field** and the *INS Manager* toolbar, where the status indicator will go orange to indicate that a sensor has gone over-range. When a sensor goes over-range this causes the filter to become inaccurate, and in some cases it can cause the filter to reset.

By default Certus comes configured to the lowest (most sensitive) sensor ranges. In this configuration it is possible to send the gyroscopes over-range by quickly rotating the unit in your hand.

7.8 Data Anti-aliasing

Internally the Certus filters update at 1,000 Hz. When Certus outputs data, most applications require the data at a much lower rate (typically less than 100 Hz). This causes a problem for time-based data such as velocities and accelerations where aliasing will occur at the lower rate. To prevent this problem, if the output rate is lower than 1000 Hz, Certus will low-pass filter the values of the time dependent data between packets to prevent aliasing. This is only the case when a packet is set up to output at a certain rate. If the packet is simply requested, no anti-aliasing will occur. Additionally there is no anti-aliasing for non time-dependent fields such as position.

7.9 Vehicle Profiles

Certus supports a number of different pre-configured vehicle profiles. These vehicle profiles impose constraints upon the filter to increase performance. If your application matches one of the available vehicle profiles, it is required that you select it for use in the **Filter Options** page in the web UI or INS Manager. For a list of the different vehicle profiles, see **10.6.6.1 Vehicle Types**. If the wrong vehicle profile is selected, it can cause a significant decrease in performance. It is recommended to Reset the unit after changing vehicle profiles to ensure that any relevant setting are updated in the GNSS receiver.

7.10 Atmospheric Altitude

Certus contains an internal atmospheric pressure sensor. This is used as an altitude aid in the filter. If Certus is mounted in an area subject to unusual pressure waves, for example helicopters, or is mounted inside an enclosure that is not exposed to atmospheric pressure, the pressure sensor input should be disabled. This can be done by disabling Atmospheric Altitude in the **Filter Options** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the INS Manager.

7.11 Odometer Pulse Length

For Certus to use a wheel speed sensor or odometer input, it must know the pulse length of the signal. The pulse length is the distance in metres between low to high transitions of the signal. By default, the odometer will

automatically calibrate itself. To automatically calibrate the odometer pulse length, see **7.11.1 Calibrating Odometer Automatic Pulse Length**.

7.11.1 Calibrating Odometer Automatic Pulse Length

1. Ensure that the signal is connected correctly and that the GPIO pin is configured as an odometer input using the **GPIO configuration** page in the web UI or the **8.6.3.7 GPIO** dialogue in the INS Manager.
2. Wait until Certus has a continuous GNSS fix from a GNSS receiver and then conduct the test in an area with no obstructions over the test circuit.
3. Open INS Manager, connect to Certus and open the Odometer Configuration dialogue. In the **Odometer Configuration** dialogue select the **Automatic pulse length calibration** check box and click **Save**.
4. If Certus loses a GNSS fix for any extended period of time during the calibration, the distance travelled will be reset. The distance travelled can be checked in the Odometer Configuration dialogue to ensure that it has passed 1,000 metres.
5. Once 1000 metres has been driven, check that the automatic pulse length check box has become un-ticked and the Pulse Length value has changed. This indicates a successfully completed calibration.

Note: To enter the pulse length manually, use the **Odometer** page in the Configuration menu in the **INS Manager**.

Note: Maximum speed that can be processed by Certus is 216 km/h. If the maximum speed is exceeded, the Odometer Automatic Pulse Length Calibration will reset. Calibration will restart once speed drops below the maximum speed.

7.12 Reversing Detection

Reversing detection is an algorithm that can detect when the vehicle is travelling backwards. Knowledge of reverse motion is important when using velocity heading or odometer input to provide correct results. If Certus is fitted to a vehicle that does not reverse or doesn't use velocity heading or an odometer, this function should be disabled. Reversing detection is enabled by default and it can be disabled using the Filter Options page in the web UI or INS Manager. See **Using the Certus Web User Interface** or **Using Certus Manager**.

7.13 RTK

The Certus internal GNSS receiver(s) supports RTK GNSS which uses correction data (RTCM messages) from a nearby base station to provide accuracy of up to 0.01 m in real time. An RTK system requires additional infrastructure equipment to generate and receive corrections data, and is not practical for all applications. Customers who require this level of accuracy but do not need it in real time should consider using **Kinematica**.

There are two different methods for receiving RTK corrections:

- Network
- Radio modem

For applications where Certus can achieve internet access, network RTK corrections (NTRIP) are recommended.

For applications that are unable to access the internet, radio modems can be used to communicate between Certus and the base station, see **7.13 RTK**.

Note: If you do not need high accuracy positioning in real time, for example if you are planning to use Kinematica to post-process log files, an RTK system may not be necessary at all.

7.13.1 Network RTK Corrections (NTRIP)

NTRIP can be configured as follows:

1. Using the Certus web UI **NTRIP Client** in the Configuration Menu.
2. Using the INS Manager application, select **8.6.4.6 NTRIP Client** under the Tools menu.

Any of these NTRIP clients can connect to a network RTK service to stream RTK corrections to Certus. This requires that the client is connected to the internet, and a valid subscription with a local network RTK service.

7.13.2 Radio Modem RTK Corrections



Figure 25: Trimble R4 Base Station



Figure 26: Trimble TDL 450L Radio Modem

Base station radio modem RTK corrections require both a base station and a radio modem receiver. The base station is set up at a fixed location and transmits corrections to the radio modem receiver that is connected to the mobile Certus unit (the “rover”). The radio modem receiver and Certus unit must remain within radio range of the base station to receive these corrections. The base station should be located no more than 50 km from the Certus, and ideally closer. Advanced Navigation recommends contacting a local surveying company for assistance setting up a base station.

7.13.3 RTCM Messages

The following RTCM v3.3 messages are recommended for the internal GNSS receiver in Certus.

Message Number	Description
1005	Stationary RTK reference station ARP
1006	Stationary RTK reference station ARP with antenna height
1007	Antenna descriptor

Message Number	Description
1033	Receiver and antenna description
1074	GPS MSM4
1075	GPS MSM5
1077	GPS MSM7
1084	GLONASS MSM4
1085	GLONASS MSM5
1087	GLONASS MSM7
1094	Galileo MSM4
1095	Galileo MSM5
1097	Galileo MSM7
1124	BeiDou MSM4
1125	BeiDou MSM5
1127	BeiDou MSM7
1230	GLONASS code-phase biases
4072.0	Reference station PVT
1002	Deprecated (supported but not recommended)
1004	Deprecated (supported but not recommended)
1008	Deprecated (supported but not recommended)
1010	Deprecated (supported but not recommended)
1012	Deprecated (supported but not recommended)
1019	Deprecated (supported but not recommended)
1020	Deprecated (supported but not recommended)
1044	Deprecated (supported but not recommended)
1045	Deprecated (supported but not recommended)

Table 26: Recommended RTCM v3.3 messages

7.13.4 Trimble BD992 GNSS Receiver RTCM Messages

The following **RTCM v3.2** messages are required for RTK on devices with Trimble receivers:

RTCM v3.2 Message	Rate
1006	7 sec
1033	13 sec
1074	1 Hz
1084	1 Hz
1094	1 Hz
1104	1 Hz
1114	1 Hz
1124	1 Hz
1230	13 sec

The following **RTCM v3.0/3.1** messages are required for RTK on devices with Trimble receivers:

RTCM v3.0/v3.1 Message	Rate
1006	7 sec
1033	13 sec
1004	1 Hz
1012	1 Hz

7.13.5 CMR Corrections

For devices fitted with BD992 GNSS receivers, Trimble specific CMR corrections (Compact Measurement Record) are supported via GNSS Receiver serial passthrough.

7.14 DVL Integration

To understand how to integrate a Doppler Velocity Log (DVL) with your INS, refer to **Advanced Navigation INS & DVL Integration.**

7.15 Raw Satellite Data

Certus supports the output of raw satellite data. This data can be used by post-processing software to achieve high-accuracy kinematic positioning.

The maximum output rate for raw satellite data is 20 Hz, subject to the **GNSS Configuration**.

It can be enabled by turning on the **10.4.39 Raw Satellite Data Packet** (ID 60) in the **Data Ports** page in the web UI, or via the Packet Rates dialog in the **Configuration** menu of the INS Manager, see the figure below.

This packet will be automatically converted to RINEX v3.02 by the **8.6.4.5 Log Converter** utility in the **Tools** menu of the INS Manager.

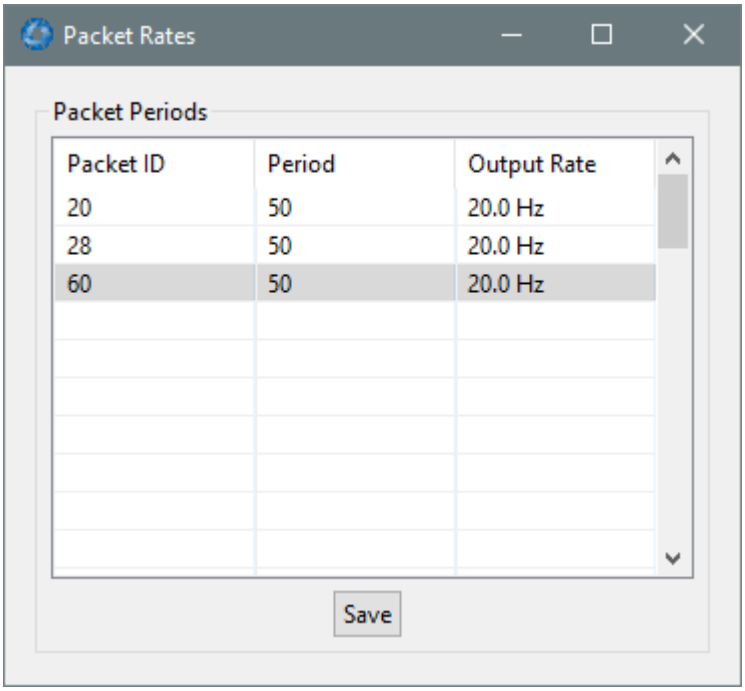


Figure 27: Enabling Packet 60

7.16 Kinematica Post Processing

Certus can be used with Advanced Navigation's post-processing platform Kinematica to achieve high-accuracy positioning of as low as 10 mm and significantly improved dead reckoning performance. You need to record a ANPP-format log file with certain packets enabled.

Refer to the Kinematica documentation found at https://www.advancednavigation.com/solutions/kinematica for details.

7.17 Vents

Rugged units contain a sophisticated venting system that allows it to measure air pressure whilst preventing water ingress. There are two sets of vent holes on either side of the enclosure. It is very important that these remain clear of debris and blockages. Should debris get into the vents they should be gently rinsed with fresh water. Foreign bodies should never be poked into the vent holes, as this will break the environmental seal and void the warranty on the unit. The vents are not resistant to high-pressure jet washing or to waves. Do not direct streams of water directly at the unit.

7.18 RAIM

RAIM stands for Receiver Autonomous Integrity Monitoring. It allows a GNSS receiver to detect and exclude both faulty and fraudulent satellite signals. The Certus internal GNSS receiver is equipped with RAIM and it is enabled by default.

An improved class of RAIM, Fault Detection and Exclusion (FDE), is used in some GNSS receivers. The objective of FDE is to detect positioning failure and exclude the source of failure; however, it may not identify the specific source. FDE uses a minimum of six satellites to detect and exclude a possible faulty satellite from the navigation solution to ensure that the navigation function remains uninterrupted.

The availability of RAIM and FDE might be slightly lower for mid-latitude operations and slightly higher for equatorial and high-latitude regions because of the nature of the orbits. The availability of RAIM and FDE can be enhanced by using satellites from multiple GNSS constellations or using SBAS satellites as additional ranging sources.

7.19 Environmental Exposure

Whilst the rugged unit is environmentally protected, there are limits to this protection that must be observed to avoid damaging the device.

Certus is only protected when its connectors are mated (or sealed with the blanking caps). If any of these connections are not tightened to the recommended torque, the unit will not achieve its rated protection.

Spanners or tools should never be used to tighten the connectors. Use your fingers to firmly tighten the connectors.

OEM units offers limited environmental protection. Care should be taken in choosing a suitable mounting location.

7.19.1 Temperature

The unit should not be subjected to temperatures outside of its operating range. Subjecting the unit to temperatures outside of the specified operating range can affect the factory sensor calibration, potentially causing a permanent reduction in performance or premature failure.

7.19.2 Water

The rugged unit complies with IP67 standard, which means that it can be submersed in water to a depth of up to 1 m deep for a maximum of 30 minutes. Submersion to depths beyond 1 metre can cause water entry and destruction of the internal electronics, and the sealing is not designed for prolonged or repetitive immersion. Do not direct streams of water directly at the unit even at low pressure. For cleaning the unit, ensure that no pressure is used.

Note: Connectors must be installed or blanking caps must be used if the unit is likely to be exposed to water.

7.19.3 Salt

The rugged unit housing is made from hard-anodized marine-grade aluminium and stainless fittings to provide good corrosion resistance, however cannot tolerate extended periods of time in salt water environments. After any contact with salt water or salt spray, Certus should be rinsed with distilled or RO water.

7.19.4 Dirt and Dust

The rugged unit is completely sealed against dirt and dust entry whenever all connectors are mated. When disconnecting the connectors, any dirt or dust should be rinsed or wiped off with fresh water and then dried to minimise the chance of contaminants entering the connectors or plugs.

7.19.5 pH Level

Environments with acidic or alkaline water or atmospheres can cause the Certus enclosure to corrode or discolor. If Certus comes into contact with these environments it should be rinsed in fresh water as soon as possible. It is not recommended to operate Certus in non-neutral pH environments.

7.19.6 Shocks

Certus is a rugged piece of equipment that can withstand reasonable amounts of shock. However, continuous shocks may cause premature failure as a result of materials fatigue, and may also affect the sensor calibration resulting in degraded performance.

Shocks applied directly to the Certus enclosure can affect the unit. Therefore, care should be taken when handling the unit prior to mounting. When mounted in a vehicle, the effect of most operating shocks is negligible.

7.19.7 Atmospheres

Hydrogen-rich atmospheres may damage the MEMS. Certus is not rated for use where explosive gases may be present.

7.20 Upgrading the Certus Firmware

Advanced Navigation regularly provides firmware updates to improve performance and add features. These are described on the Advanced Navigation website. Advanced Navigation recommends that you upgrade to the latest version whenever available.

The firmware update function is robust, such that power loss, file corruption or other issues cannot brick the device.

See **8.6.4.2 Firmware Update** for instructions on how to upgrade the firmware using the INS Manager.

See **Firmware Update** for instructions on how to update the firmware using the web UI.

8 INS Manager (Web and Desktop)

Configuration, monitoring and log analysis of Advanced Navigation Inertial Navigation System (INS) products is done using one of our INS Manager products, or directly via API calls:

- **INS Manager - Web** provides a web user interface, accessed via a web browser, which connects via ethernet to a web server running on the INS.
- **INS Manager - Desktop** is a java based desktop application, which connects to the INS via a serial or ethernet cable.
- Direct API calls using Advanced Navigation Packet Protocol (**8.7 Using ANPP**) .

8.1 What's the difference between Desktop and Web Interfaces?

INS Manager - Web and *INS Manager - Desktop* provide a very similar look-and-feel and offer most of the same features, but they are technically two different products. The following table summarizes the differences.

Feature	INS Manager - Desktop	INS Manager - Web
Availability	All INSs (No Subsea)	Most INSs with ethernet (Subsea)
Ease of installation	Java desktop installation	Zero installation, browser based
Connection	Serial / Ethernet	Ethernet (Wifi for Hydrus)
Majority of functions	Good	Good
High bandwidth data	Good	Network constrained
Download logs	No	Yes
Convert logs	Yes	No

Table 27: Summary of differences between INS Manager and web interfaces.

8.2 Which products have hidden pages?

The interface dynamically hides pages that are not relevant to the connected INS.

Notably, products without an internal or externally connected GNSS receiver will not have access to GNSS specific pages.

8.3 Which products support Desktop and Web interfaces?

The following table describes which Advanced Navigation products support the INS Manager Desktop and Web interfaces.

Product	INS Manager - Desktop?	INS Manager - Web?	Internal Logging?
Boreas 50/70/90	Yes	Yes	Yes
Certus / Certus Evo	Yes	Yes	Yes
Certus Mini	Yes	No	No
Motus	Yes	No	No

Product	INS Manager - Desktop?	INS Manager - Web?	Internal Logging?
GNSS Compass	Yes	Yes	No
Hydrus	No	Yes (via WiFi)	No
Subsonus	No	Yes	No
Subsonus Tag	No	No (Uses mobile app + bluetooth)	No
Legacy Products			
Spatial	Yes	No	No
Spatial Dual	Yes	No	No
Orientus	Yes	No	No
Spatial FOG	Yes	No	No
Spatial FOG Dual	Yes	No	No

Table 28: Products which support INS Manager and web interfaces.

8.4 Installing INS Manager - Desktop

This section is applicable to the desktop variant of INS Manager. Check if the web interface is easier for you.

Note: The *INS Manager Desktop* is only available for systems with x64 and ARM architectures.

Note: The older Java version 11 is required by *INS Manager Desktop*.

- Install the latest version of Java 11 from **Adoptium**, selecting the correct operating system and architecture for your computer. Adoptium JRE 11 is the recommended Java installer to be used on all platforms.
- Download *INS Manager Desktop* from the Advanced Navigation website.
- Double click the *INS Manager Desktop* icon on your computer to start the application.
- Connect to the INS, following instructions in the following section: *Using INS Manager*.

8.4.0.1 Troubleshooting

Symptom	Likely Cause	Resolution
The *INS Manager Desktop* application fails to launch or start.	A 32-bit version of the Java Runtime Environment (JRE) is installed on a 64-bit operating system, causing an architecture mismatch execution failure.	Uninstall the existing 32-bit Java version from your system and install a compatible 64-bit version.
Cannot view *INS Manager - Web* page (such as http://boreas.local) for ethernet enabled units	Active internet connectivity is unavailable.	Verify the local network internet connection status and ensure routing endpoints are clear.
The *INS Manager - Java Desktop* fails to discover	Active internet connectivity is unavailable.	Verify the local network internet connection status and ensure routing endpoints are clear.

Symptom	Likely Cause	Resolution
or list any connected network devices.	An explicit Inbound block configuration rule exists inside Windows Defender Firewall against *INS Manager Desktop*, or AdNav *INS Studio* or java. Because Windows firewall priority rules dictate that an active "Block" action immediately supersedes an active "Allow" rule, all network discovery traffic (such as UDP multicast/broadcasts or TCP polling) is blocked.	1. Open **Windows Defender Firewall with Advanced Security** on your laptop. 2. Navigate to the **Inbound Rules** pane in the left-hand column. 3. Locate the offending rule and change from "Block" to "Allow". 4. Relaunch the application.
The *INS Manager - Java Desktop* cannot see the INS unit via a serial connection.	Serial or USB communication settings (COM interface, wiring protocol, or data rate) are misconfigured or experiencing connectivity dropouts.	1. Ensure the physical **RS232 / RS422** hardware switch toggle matches the required network configuration mode. The default hardware mode is RS422. 2. Verify the targeted **COM port** assignment. If ambiguous, cycle connection stability by unplugging and re-inserting the physical USB connector to re-initialize hardware handshake rules. 3. Confirm that the application data transmission **baud rate** configuration matches the source device transmission specification. The factory default is 115200 bps.
The serial port does not show up when you plug in the FTDI USB to RS232/RS422 adaptor cable.	The FTDI Virtual COM Port (VCP) driver is not installed. Windows usually installs it automatically, but it can be missing on some systems.	1. Download and install the FTDI VCP drivers from **ftdichip.com/drivers/vcp-drivers**. 2. Unplug and reconnect the USB cable. 3. Confirm a COM port appears under **Ports (COM & LPT)** in Windows Device Manager.
On Linux, the serial port does not show up, or cannot be opened, when the FTDI USB to RS232/RS422 adaptor cable is plugged in.	The user account does not have permission to access serial ports (not a member of the `dialout` group).	Add the user to the `dialout` group, then log out and log back in: sudo adduser username dialout
	ModemManager has claimed the FTDI USB-serial device.	If you are not using a modem, remove ModemManager: sudo apt-get remove modemmanager
After connecting the FTDI USB-to-serial cable on Windows, the mouse	Windows serial enumerator (`serenum.sys`) misidentifies serial data from the INS as a	A computer restart often resolves the problem. Alternatively:

Symptom	Likely Cause	Resolution
pointer jumps around the screen or clicks randomly, like a “crazy mouse”.	legacy serial mouse (Microsoft Serial Ballpoint) and loads a mouse driver for the COM port.	1. Unplug the FTDI USB cable (or power off the INS) to regain control of the mouse. 2. Reconnect the cable. In Windows Device Manager, expand **Ports (COM & LPT)** and open the USB Serial Port. 3. Select **Properties** > **Port Settings** > **Advanced**, then clear the **Serial Enumerator** check box. 4. If a **Microsoft Serial Ballpoint** (or Microsoft serial mouse) appears under **Mice and other pointing devices**, disable it.
Data packet loss occurs when running the INS at very high data rates.	High driver latency within the FTDI USB-to-serial communication pipeline leads to buffer overruns and dropped telemetry frames.	In the *INS Manager's* Advanced Settings, reduce the **Latency Timer** to **1 ms**.

8.5 INS Manager Changelog

Version	Date	Changes
8.1	2026-06-26	**Improved External Aiding Configuration:** Added Aiding Sources Configuration window. Improved external aiding source lever-arm and alignment configurations and status reporting across aiding sources. **Improved Diagnostics and Monitoring:** Device Information now displays navigation filter version when available; Velocity and Acceleration window adds velocity standard deviation plotting; Satellites window indicates stale data. **Improved Reliability:** Resolved excessive memory use over long sessions, map rendering instability when position or orientation data is invalid, and NTRIP mountpoint download failures on some servers.
8.0	2025-11-12	Key Features: This INSManager connects to all Advanced Navigation’s INS/AHRS products. Previously there was a different Manager for each product. Added support for Boreas 50 series. Added support for Mosaic X5 receiver. Added support for X20P receiver. Added support for Certus Mini receiver. Added support for GNSS Jamming and Spoofing status in new packets 92 GNSS PVT and 93 GNSS Orientation. Extra changes: Added baud rates check before being sent to the device. Added log conversion of IP configuration packet.

Version	Date	Changes
		Added drop-down to set plots timescale. Added plot units. Added Follow function to the map view. Added units to attitude indicator. Added indication of datarate in NTRIP window. Added warning when packet period is not multiple of a timestamped packet period. Added menu item pointing to the online device documentation. Added device type to window title when a device is connected. Improved Trimble receiver firmware update. Improved alignment window antenna position. Added plot lines can be hidden by clicking their legend label. Increased maximum number of packet rates that can be configured. Increased maximum number of satellites displayed in table. Added automatic disconnection if USB-to-serial cable is unplugged. Updated Omnistar L-Band frequencies. Fixed serial baud rate restore after failed firmware update. Fixed alignment parameters input on Linux. Fixed error caused by empty packet rates period. Fixed UDP Server connection mode. Fixed NTRIP disconnection error. Fixed leap seconds download error. Fixed Zero Current Orientation. Fixed multi-part ANPP packets log conversion. Fixed support for Mondo Pin NTRIP mountpoints.
7.4	2024-08-19	Release to support Certus Mini hardware
7.3	2024-04-11	Added support for Boreas A variants Added vessel motion packet, updated and expanded Heave window to Vessel Motion, including surge and sway Added Train profile as Filter Option vehicle type Improved Trimble license options decoding Added support for NavIC configuration on Trimble receiversImproved usage and syntax information in the command line help Added support for more GPIO functions during log conversion Added command line argument to connect to the device on launch Added argument to open the Manager window maximised Updated device information window to show "BOOTLOADER" when applicable to software version
7.2	2023-11-10	Clear map history on reconnection Fix incorrect timezone text displayed in terminal.csv Updated leap-seconds list URL Add automatically log configuration at the start of a new log Added support for NavIC satellite system Fixed indicators behaviour on disconnect Updated support for Mac silicon with latest macOS Added ability to Factory Restore via Tools > Device Discovery Corrected list of available auxiliary functions Fix unable to change offsets in alignment window

Version	Date	Changes
		Added support for extra NMEA 0183 messages Removed GNSS status indicator Fixed issue with opening windows containing charts Renamed External GNSS Enabled to Internal GNSS Enabled Increased NTRIP client timeout Update support for Trimble BD9xx RTX frequencies as of 30 Sep 2022 Show COCOM status of Trimble BD9xx receivers in the licence field In satellites window, only populate azimuth and elevation fields in the table view when the values have been determined Added elevation to the gimbal state packet Add support for Boreas subtypes Add ability to set Packet Timer period
7.0	2023-02-13	Updated from JDK8 to JDK11. **JRE11/JDK11 required to run this release** Refresh Port Mode information on reconnection Refresh Packet Rates information on reconnection Fixed Ethernet Settings Static IP setting Improved reliability of firmware update Changed Low Voltage label to Internal Data Logging Error to support newer firmware Fixed issue with NTRIP client streaming from some servers When the NTRIP sourcetable says authentication type is any of '', 'B', 'N', then use Basic Authentication. This is to workaround NTRIP servers that incorrectly populate the authentication field Overwrite/clear existing packet rates on import of configuration Added Disable Dual Antenna Heading option Updated Seastar frequencies for Trimble receivers Updated RTX frequencies for Trimble receivers Added support for ARM (aarch64) processors with 64-bit OS Added support for Apple M1 processors and improved MacOS support Various UI improvements
6.2	2022-10-10	Fixed Heading indicator reporting as invalid after a successful Coarse Heading Alignment Added Moving Base output to GPIO configuration Fixed Packet Rates not being refreshed after a save Removed unavailable GPIO options Fixed status indicator message in case of a logging error Fixed configuration import via network Added allow firmware update over ANPP using Auxiliary, GPIO and Ethernet ports Added GNSS Firmware Update for BD992 variants Added CAN settings configuration Added ANPP14 Subcomponent information to Log Converter Added support for NTRIP Casters that request Username & Password to retrieve source table Added copying version numbers etc from Device Information and GNSS Receiver Information dialog boxes Renamed Log Conversion menu item Added Settings menu item BaseStation.csv output "Fix Type" column now split into "Base Fix Type" and

Version	Date	Changes
		"Rover Fix Type" Added GPIO voltage selection Removed of SBAS corrections option when SBAS is not supported on the device Fixed configuration export for POE variant Improved reliability of GNSS Firmware update Various bug fixes Renamed position error to position standard deviation in position page of view menu
6.1.1	2022-02-18	Device information updated automatically after a firmware update Fixed configuration export Add ability to control log file location Included software version number in title Improved NTRIP server reconnection Improve export configuration reliability Added external GNSS Filter option Improved Log files saved by default in the directory from where the application is launched Improved NTRIP mountpoint selection. Added handling of nonstandard NTRIP server responses Force the device to exit bootloader mode if a firmware update is not in progress
6.1	2022-02-18	Initial release of Boreas Manager Improved NTRIP mountpoint selection Added handling of non-standard NTRIP server responses Changed "Low Voltage" Status Flag to "Internal Data Logging Error" Added EMSAT, OCSAT, IOSAT, etc and corresponding default frequencies to the Omnistar GNSS Configuration list Added ability to set custom L Band satellite frequency and baud GNSS receiver information is updated after applying a receiver option Updated source of map tiles Improved NTRIP server reconnection Improved export configuration reliability Added Device Discovery tool to find Advanced Navigation devices on the network Improve display of Trimble receiver options Added the ability to configure the Manager logging folder
6.0	2021-10-29	Major update to support v2.0 hardware and v2.0+ firmware
5.9	2021-06-28	Add ability to disable logging Add ability to control log file location Add GNSS configuration page, support GNSS auto detect Log Converter now writes program version/name to output file Extract Magnetometers Enabled and Automatic Magnetic Calibration Enabled to Configuration.txt Add sensor temperatures packet to log converter Reset running time display upon connection Support new style GPIO output packet Fix GPIO output configuration window not working Fix NTRIP NMEA Message Output at Irregular Periods

Version	Date	Changes
		Various bug fixes
5.7	2020-09-23	Added support for Certus Evo Configuration Export and Import
5.6	2020-09-09	Updated raw sensors dialogue to include all temperatures Fixed bug with communications statistics dialogue cutting off numbers Added zero angular velocity update GPIO function Added Mavlink output GPIO function
5.3	2020-06-30	Add support for serial firmware update via Certus application for ANFW >2MB Fix bug in Extended Satellites display where it could show stale data. Add ability to set port modes (eg RS232 / RS422)
5.2	2020-05-20	Initial Release

Table 29: INS Manager Software Changelog

8.6 Using INS Manager

The following sections describe how to use the Desktop and Web versions of the INS Manager.

Note: The web and desktop variants have slightly different features.

Note: The features available varies slightly by INS product type, and a feature described here might not be available on your product.

8.6.1 Main View

The Main View is accessible via `View > Map`.

It provides an immediate overview of the system's status, attitude, GNSS connectivity, and current position on the map.

The desktop version additionally includes controls for serial connection, while the web version includes the current time and position readout .

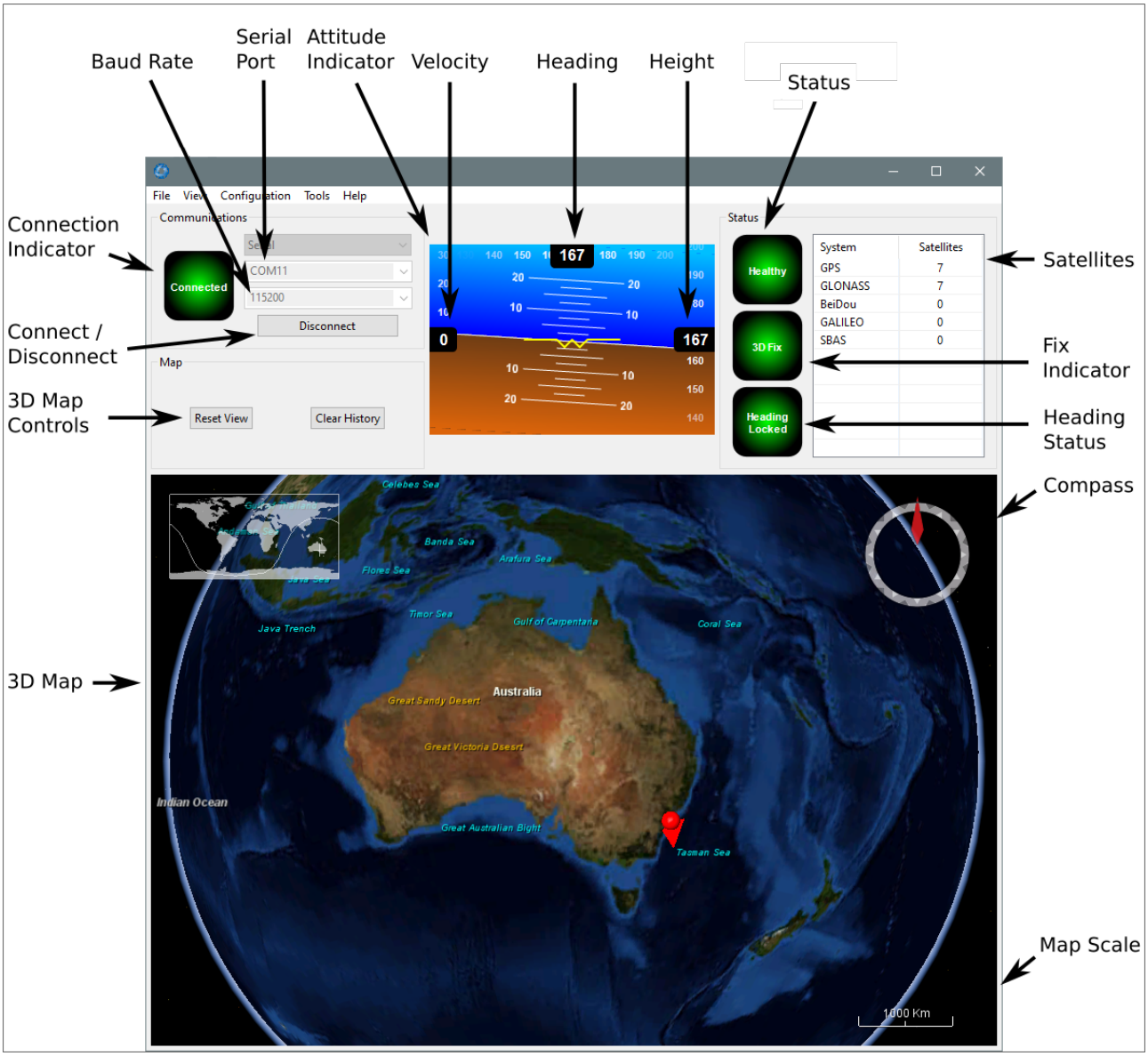


Figure 28: INS Manager Desktop Main View

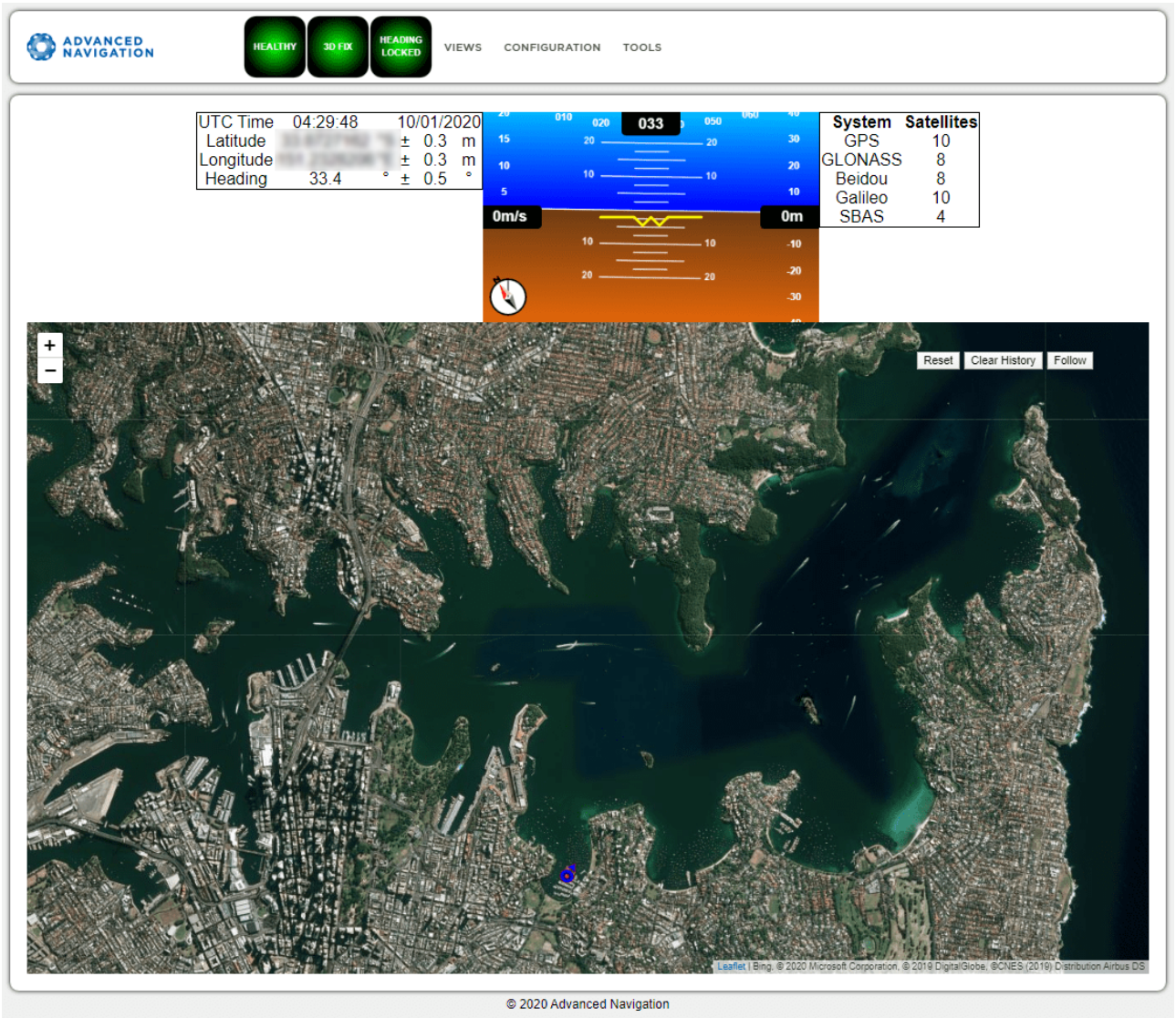


Figure 29: INS Manager Web Main View

Tip

1. *INS Manager* is best viewed on a screen size of 1280 x 1024 or larger.
2. When viewing *INS Manager - Web* from a small screen, you can change your browser zoom level better use screen real estate.

8.6.1.1 Communications Section

[INS Manager Desktop only]

Within the Communications Pane, you can select to connect to a device using a `Serial` or `Network` connection.

For serial communications:

- Select `Serial`
- Select `COM Port`
- Select `Baud Rate` (default is 115200)

For network communications. In most cases, you can find your device from `Tools > Device Discovery`

- Select `Tools > Device Discovery`
- Select your device from the list.
- Select `Connect` (default is 115200)
- Close the `Device Discovery` Popup

Alternatively you can select parameters directly

- Select `Network`
- Select `IP Address`
- Select `Port` (Default 16718. Can use up to 4 ports.)

Select `Connect / Disconnect` to connect the Desktop application to the INS unit.

8.6.1.2 Current Time, Position and Heading

[INS Manager Web only]

This section displays the current UTC time, position, and heading. The data will only be valid if the INS has a HEALTHY status, there is a 3D GNSS fix or better, and the Heading is initialised.

8.6.1.3 Attitude Indicator

The Attitude Indicator visualises roll and pitch using a standard artificial horizon, similar to a traditional aircraft instrument. Heading, velocity, and height are displayed adjacent to the horizon. All displayed units are in SI (metric) and degrees.

8.6.1.4 Satellites Table

The Satellites page provides the satellites visible to the primary antenna. More detailed information is available in `View > Satellites`.

Note: The satellites table will only display satellite data if your device has an internal GNSS receiver, or is interfaced to an external GNSS receiver.

8.6.1.5 Status Indicator

The Status Indicator section provides immediate visual feedback on the operational state of the INS unit. These indicators are visible on every page of the interface.

- Status Indicator: This indicator reports any critical problems. Before initialisation, the status may show “Filter not initialised” or similar. Once the filter has initialised, it will show HEALTHY.
- GNSS Fix / Fix Indicator: This indicates the quality of the GNSS position fix. Under normal conditions, this will show 3D FIX or SBAS FIX. Visibility issues may result in 2D FIX or NO FIX.
- Heading Status: This indicator shows the current status of the heading filter. When a valid source of heading is active, it will show HEADING LOCKED.
- Satellites Table: This table shows the number of active satellites contributing to the current GNSS solution.

8.6.1.6 Map

[Option in INS Manager Web. Available from main page in INS Manager Desktop.]

The map provides a visual representation of the unit's current position on Earth and displays a red trail showing the position history since the last reset. Upon filter initialisation, the map automatically centers the view on the unit's current position. Basic map controls include:

- Movement: Click and drag on the map to move the camera view.
- Zoom: Use the mouse scroll wheel to zoom in and out.
- 3D Camera View: *[INS Manager Desktop only]* To manipulate the camera angle in 3D, use right click and drag or shift click and drag.

8.6.1.7 Map Controls

The map controls are functionally identical across both the Web and Desktop interfaces:

Reset

This resets the map view to center on the unit's current position.

Clear History

This clears the current red position history trail, immediately restarting the trail from the current location. This action does not impact active data logging.

Follow

This button automatically keeps the map view centered and tracking the device's current position.

8.6.2 View Menu

From the `View` menu, you can select pages to view real-time data from the INS.

8.6.2.1 Map

[INS Manager - Desktop only]

`View > Map` takes the user back to the home which features the map display.

8.6.2.2 Device Information

`View > Device Information` displays the unit's:

- Serial number.
- Device ID.
- Firmware version.
- Hardware version.

This page is useful when requesting technical support.

8.6.2.3 Subcomponent and GNSS Receiver Information

The `INS Manager Web > View > Subcomponent Information` and `INS Manager Desktop > View > GNSSS Receiver Information` displays detailed information about the GNSS receiver fitted to the INS.

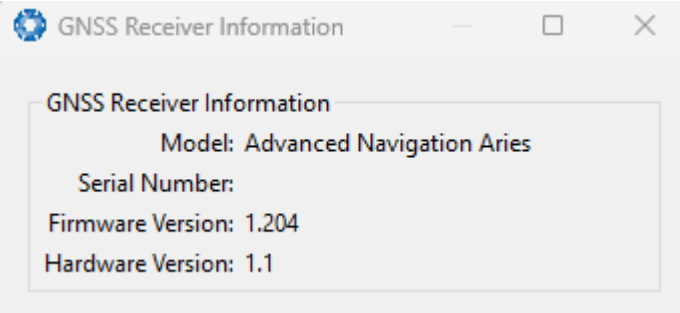


Figure 30: INS Manager Desktop GNSS Receiver Information Dialogue

If your device is fitted with a Trimble GNSS receiver, the Desktop dialogue features a `License Update` text field. To upgrade your licence, copy and paste the license key into the `License Update` field and click `Send`.

8.6.2.4 Status

`View > Status` shows the current system status, filter status, and GNSS status flags, as reported by **10.4.1 System State Packet** (ID#20) and **10.4.10 Raw GNSS Packet**. (ID#29)

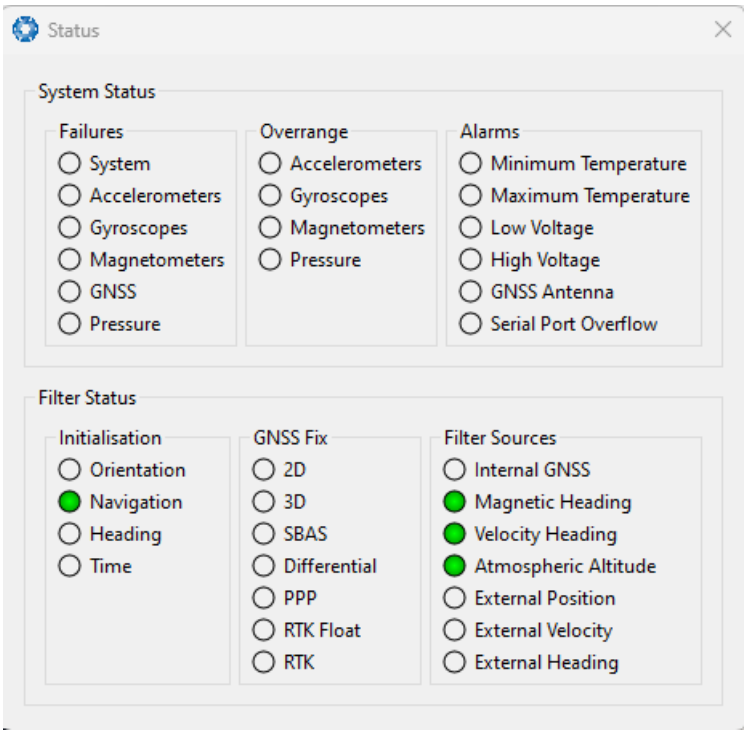
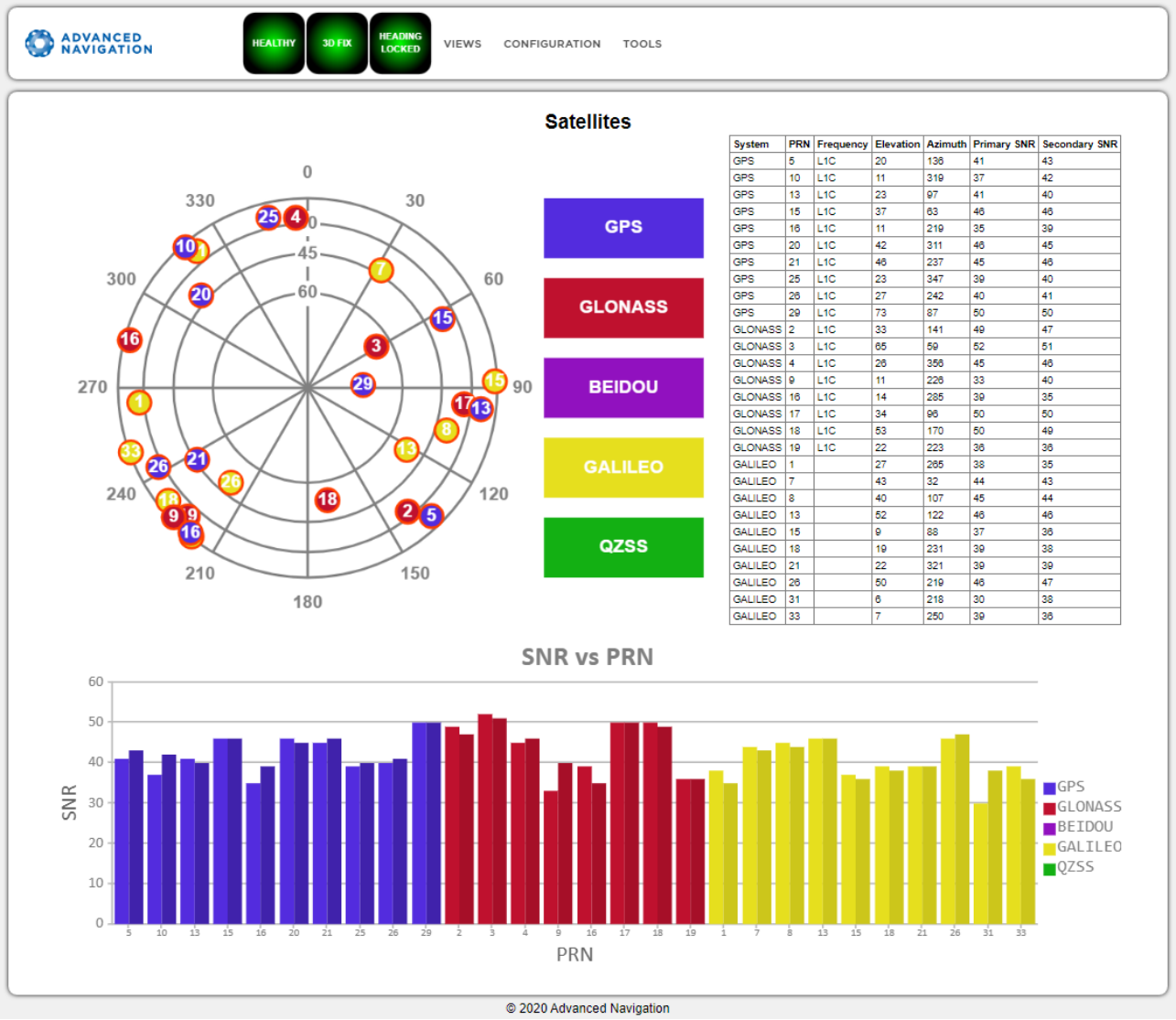


Figure 31: INS Manager Desktop Status Dialogue

8.6.2.5 Satellites

`View > Satellites` shows detailed information on the satellites visible to the INS GNSS receiver. The display includes a satellite skyplot, a table, and an SNR (Signal-to-Noise Ratio) graph.

The plot shows the SNR of each satellite or each satellite at the primary and secondary antenna. As a guideline, SNRs should be within 5-10 dB of each other in the absence of cable or antenna faults. Elevation and azimuth are displayed in units of degrees.



System	PRN	Frequency	Elevation	Azimuth	Primary SNR	Secondary SNR
GPS	5	L1C	20	136	41	43
GPS	10	L1C	11	319	37	42
GPS	13	L1C	23	97	41	40
GPS	15	L1C	37	63	46	46
GPS	16	L1C	11	219	35	39
GPS	20	L1C	42	311	46	45
GPS	21	L1C	46	237	45	46
GPS	25	L1C	23	347	39	40
GPS	26	L1C	27	242	40	41
GPS	29	L1C	73	87	50	50
GLONASS	2	L1C	33	141	49	47
GLONASS	3	L1C	65	59	52	51
GLONASS	4	L1C	26	356	45	46
GLONASS	9	L1C	11	226	33	40
GLONASS	16	L1C	14	285	39	35
GLONASS	17	L1C	34	96	50	50
GLONASS	18	L1C	53	170	50	49
GLONASS	19	L1C	22	223	36	36
GALILEO	1		27	265	38	35
GALILEO	7		43	32	44	43
GALILEO	8		40	107	45	44
GALILEO	13		52	122	46	46
GALILEO	15		9	88	37	36
GALILEO	18		19	231	39	38
GALILEO	21		22	321	39	39
GALILEO	26		50	219	46	47
GALILEO	31		6	218	30	38
GALILEO	33		7	250	39	36

Figure 32: INS Manager Web Satellites Table

8.6.2.6 Raw Sensors

`View > Raw Sensors` displays the raw IMU sensor values.

The plots include accelerometer, gyroscope, and magnetometer readings. Temperature readings are provided for a range of sensors, including T(Ax), T(Ay), T(Az) for the accelerometer axes; T(Gx), T(Gy), T(Gz) for the gyroscope axes; T(M) for the magnetometer; and T(P) for the pressure sensor.

The lower plot visualizes air pressure. Internal temperature sensors are also reported but do not reflect the general environmental temperature.

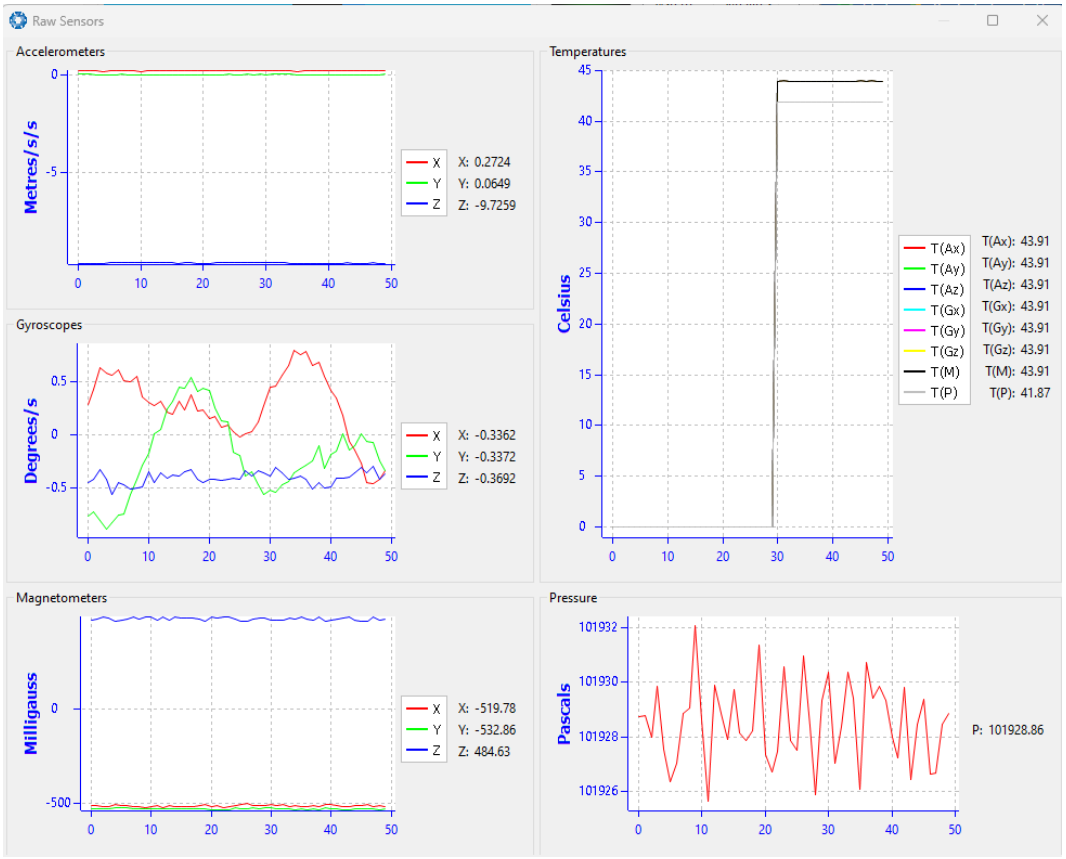


Figure 33: INS Manager Desktop Raw Sensor Outputs

8.6.2.7 Orientation

`View > Orientation` shows the INS orientation, angular velocity, and orientation error.

- `Course` is the path determined by measuring sequential positions.

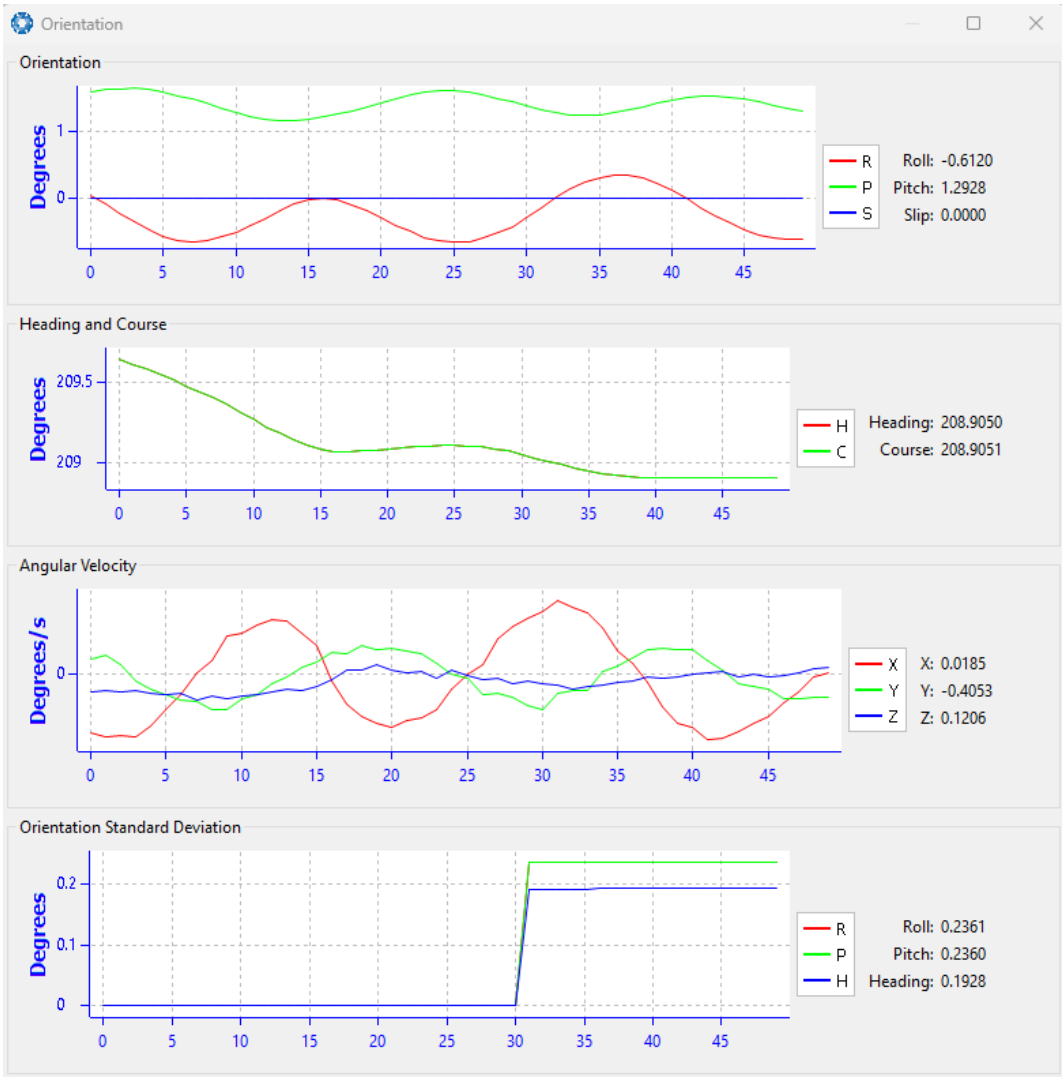


Figure 34: INS Manager Desktop Orientation Outputs

8.6.2.8 Position

`View > Position` shows the INS position and position error (standard deviation). Latitude and longitude are converted to North and East metres from a reference point.

The position reference point can be reset in `INS Manager - Desktop` or by refreshing the web page in your browser with `INS Manager - Web`.

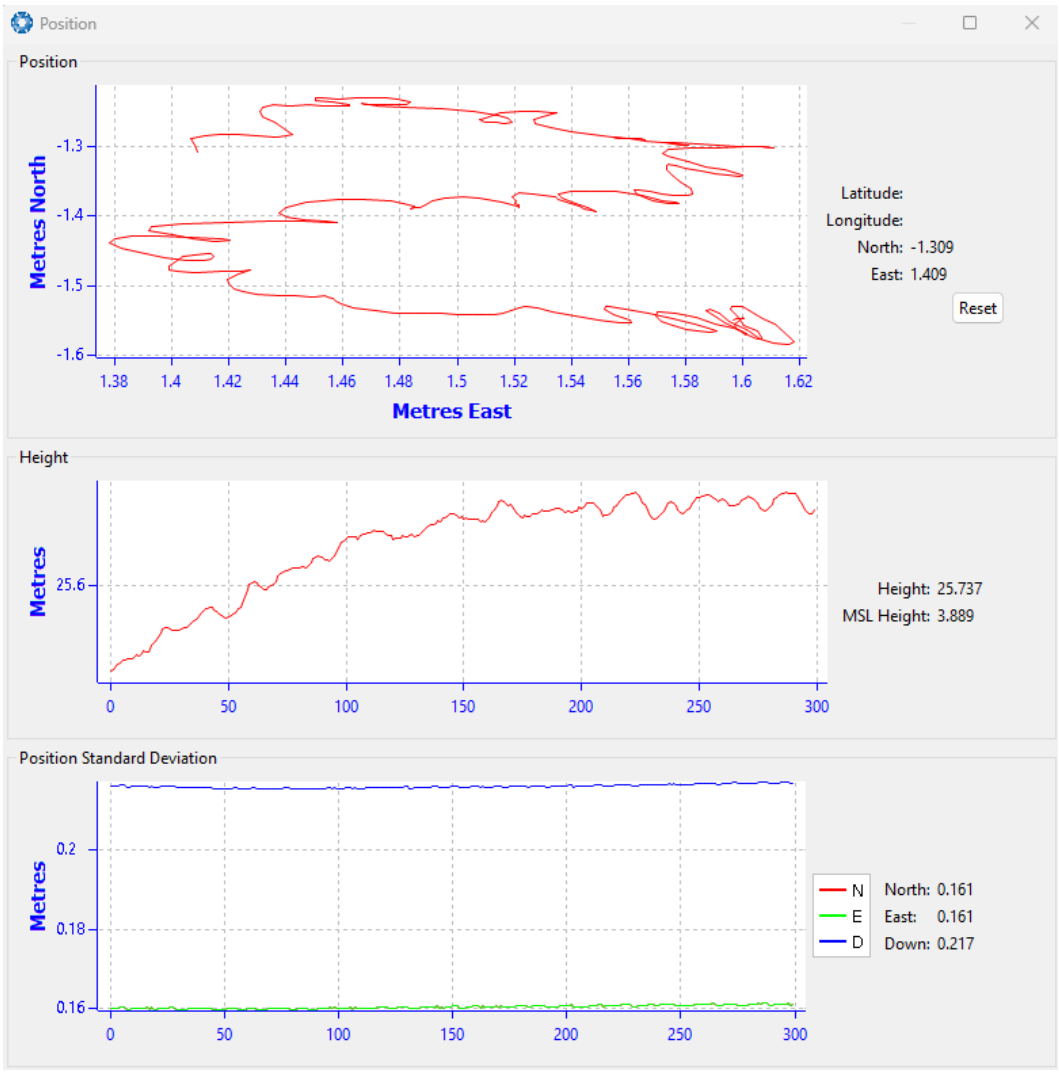


Figure 35: INS Manager Desktop Position Outputs

8.6.2.9 Velocity and Acceleration

`View > Velocity and Acceleration` shows the INS velocity, acceleration, and g-force over time.

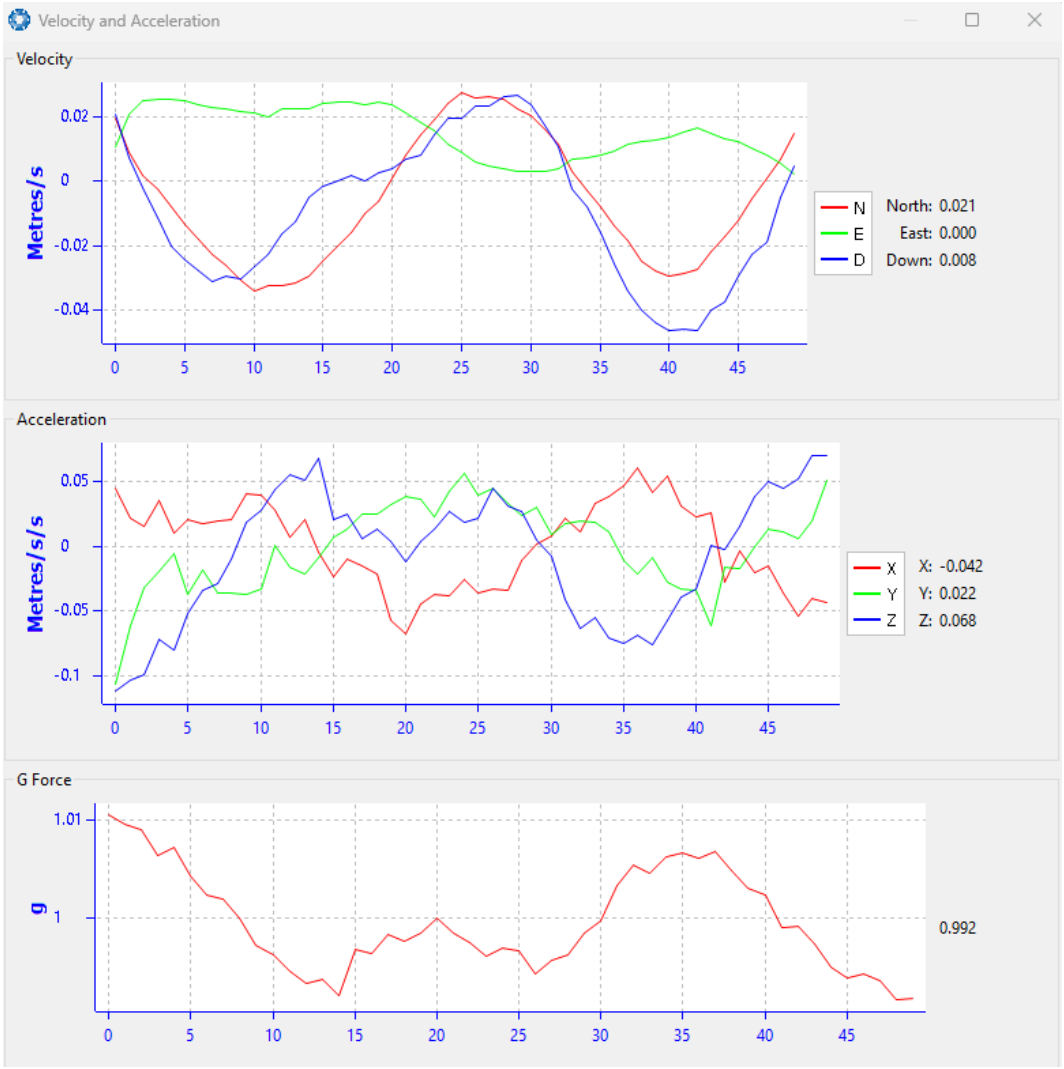


Figure 36: INS Manager Desktop Velocity and Acceleration Outputs

8.6.2.10 Time

[INS Manager - Desktop only]

`View > Time` displays the time for the connected device in Unix, UTC, or Local time formats, ensuring accurate timekeeping and synchronisation across systems.

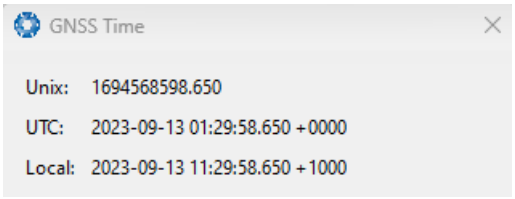


Figure 37: INS Manager Desktop Time Dialogue

8.6.2.11 Communications

[INS Manager - Desktop only]

`View > Communications` shows statistics on the data packets received from the INS (e.g., packets decoded, bytes discarded, LRC/CRC errors and is useful for diagnosing any signal quality problems on the connection, such as signal strength or connectivity.

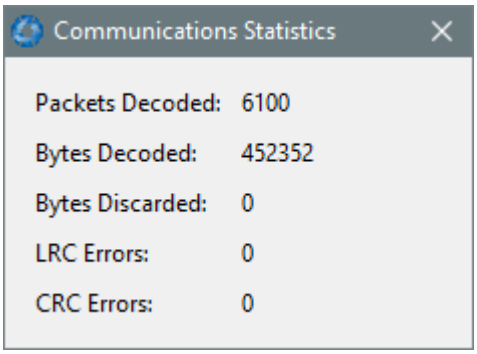


Figure 38: INS Manager Desktop Communications Dialogue

8.6.2.12 Vessel Motion

`View > Vessel Motion` This page displays the vessel motion (heave, surge, sway) at up to 4 reference points. For data to display, the Vessel Motion Packet (ID 89) must be configured in the **8.6.3 Configuration Menu** dialogue. Reference point offsets are configured in the **8.6.3 Configuration Menu** dialogue.

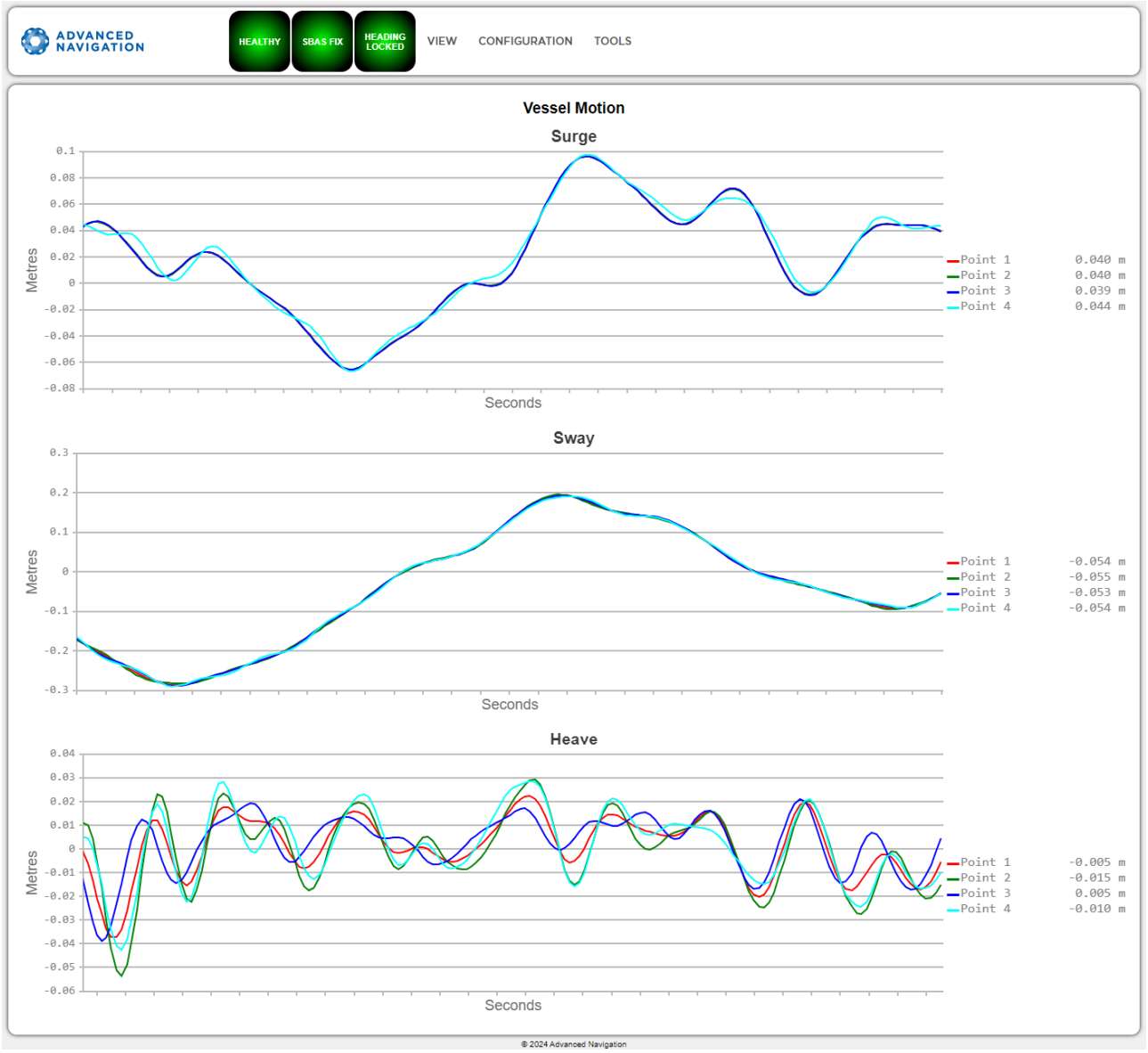


Figure 39: INS Manager Web UI Vessel Motion Page

8.6.2.13 Heave

`View > Heave` displays the heave at up to 4 reference points. For data to display, the Heave Packet (ID 58) is configured in the **8.6.3 Configuration Menu** dialogue. Reference point offsets are configured in the **8.6.3 Configuration Menu** dialogue.

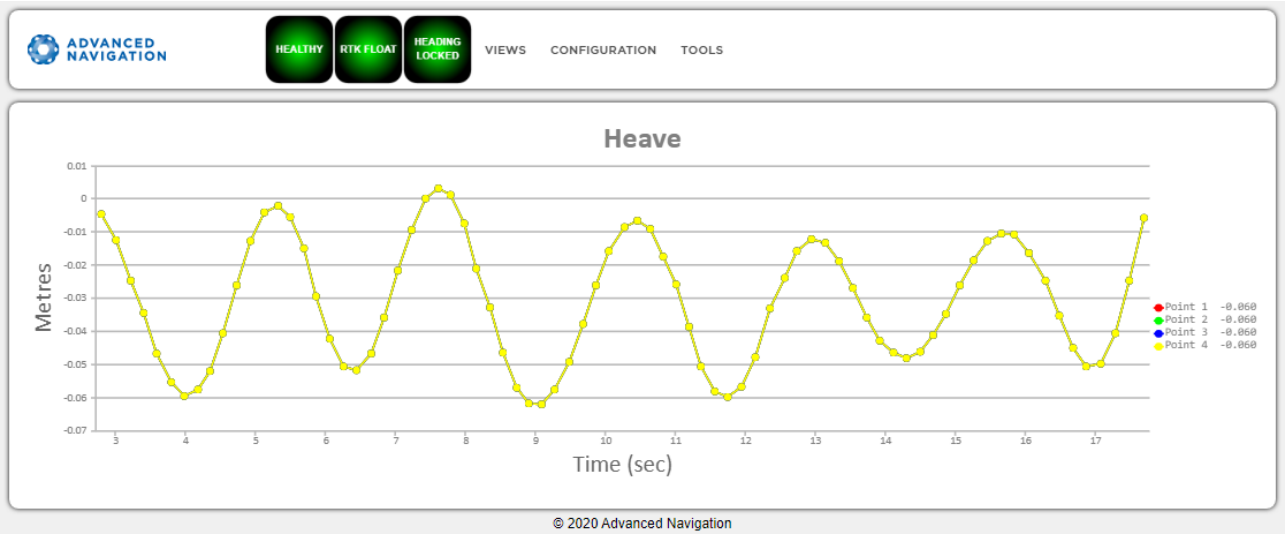


Figure 40: INS Manager Web UI Heave Page

8.6.2.14 North Seeking Status

`View > North Seeking Status` displays the current status and initialization messages.

Note: North Seeking Alignment is used to derive the heading based on gyrocompassing, which determines true north from the rotation of the earth. Gyrocompassing is utilised to establish a heading reference when alternative sources, such as dual-antenna GNSS or velocity heading, are unavailable.

Status Messages	Description
Awaiting position via GNSS or manual initialisation	An approximate position is required. Initialisation commences once position is available (via GNSS or the **Manual Initialisation** page).
Initialising, please wait	The process of determining heading has started.
Alignment initialised via alternate source	Alignment is bypassed because heading has been successfully established via an alternate source (e.g., dual antenna, velocity, or external input).
Heading alignment complete	The system has successfully determined heading.

Table 30: Heading Alignment - Status Messages

Warning Messages	Description
Initialisation restarted - excessive motion detected	The initialization has restarted due to excessive motion.
Initialisation restarted - change in latitude detected	The initialization has restarted due to a significant change in latitude.

Warning Messages	Description
Initialisation restarted - Change in COG lever arm detected	The initialization has restarted due to a change in the Centre of Gravity (COG) lever arm **configuration**.
Warning - Check latitude, value out of range	A discrepancy between the current latitude and the alignment algorithm was detected. Verify the current latitude is correct.

Table 31: Heading Alignment - Warning Messages

8.6.2.15 External Data

[INS Manager - Web only]

`View > External Data` acts as a jump page to open time-based data graphs for each supported external source. External sources must be connected and configured appropriately for the corresponding packet to report valid data.

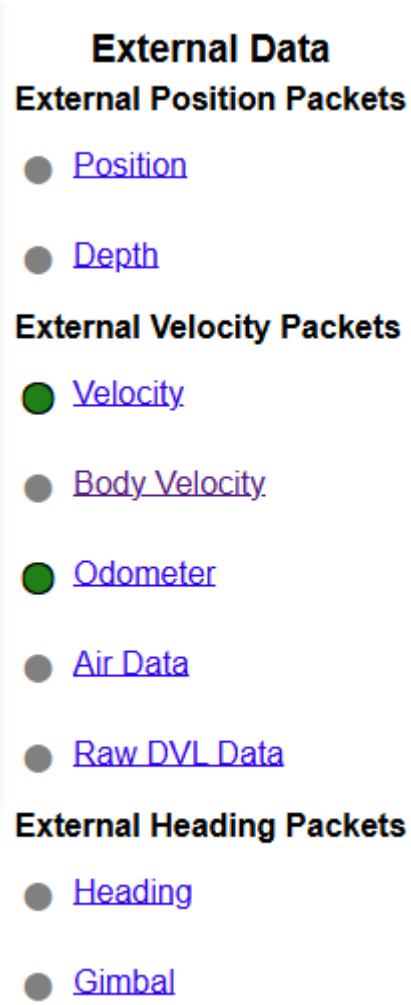


Figure 41: INS Manager Web UI External Data Selection Page

The indicator color next to the External Packet Link reflects the data validity:

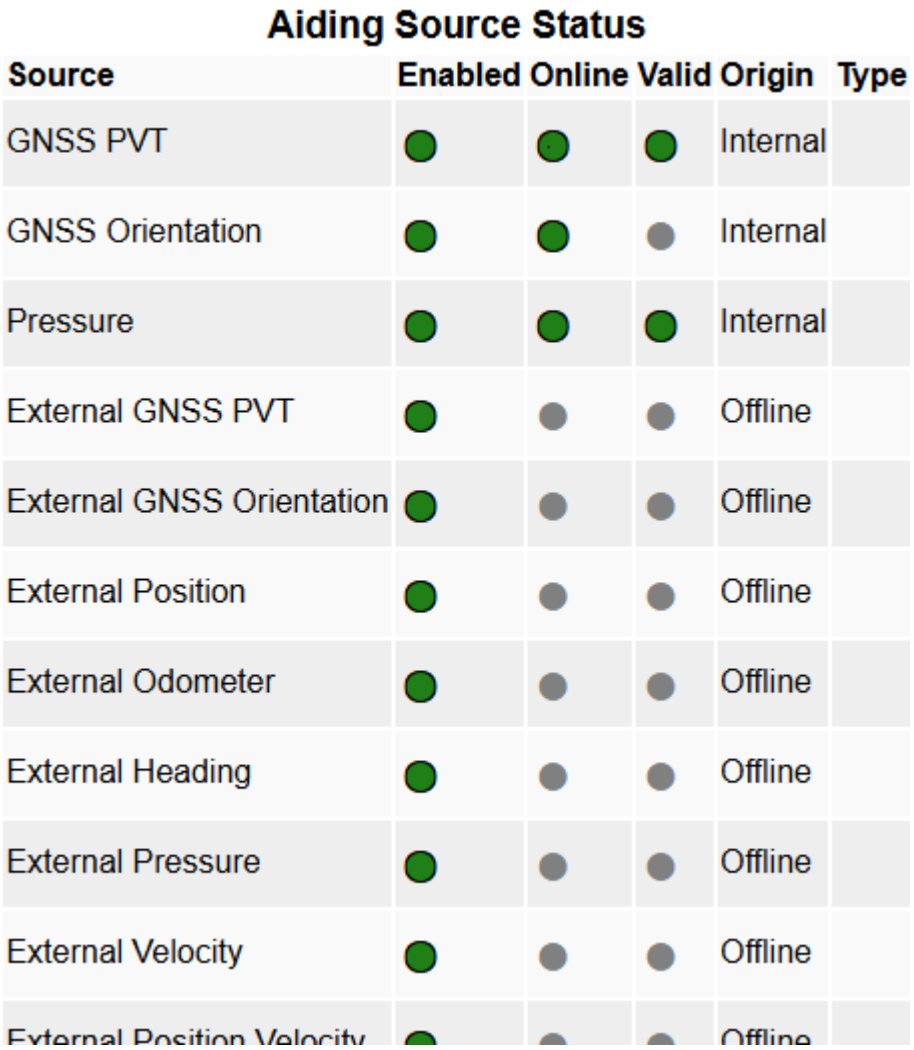
Indicator color	Validity of incoming data
Green	Valid
Grey	Invalid

8.6.2.16 Aiding Source Status

`View > Aiding Source Status` Shows the status of Aiding Sources, covering:

- Enabled
- Online: Receiving data

- Valid: Data is valid and usable by the filter
- Origin: (Internal, [Port], Offline)
- Type: [Format] such as "ANPP"



Aiding Source Status

Source	Enabled	Online	Valid	Origin	Type
GNSS PVT	●	●	●	Internal	
GNSS Orientation	●	●	○	Internal	
Pressure	●	●	●	Internal	
External GNSS PVT	●	○	○	Offline	
External GNSS Orientation	●	○	○	Offline	
External Position	●	○	○	Offline	
External Odometer	●	○	○	Offline	
External Heading	●	○	○	Offline	
External Pressure	●	○	○	Offline	
External Velocity	●	○	○	Offline	
External Position Velocity	●	○	○	Offline	

Figure 42: INS Manager Web UI Aiding Source Status

8.6.3 Configuration Menu

The Configuration menu contain options to configure the INS.

8.6.3.1 Configuration Export

`Configuration > Configuration Export` is used to export or import all the INS settings to or from a file. This is useful to restore a unit to a preset configuration at a later date or for batch configuration of multiple units.

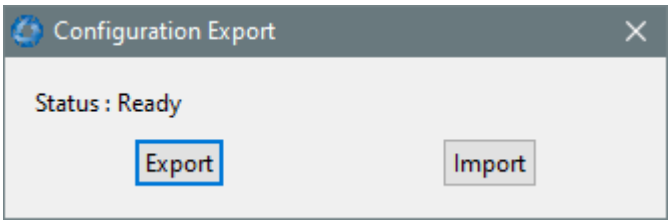


Figure 43: INS Manager Desktop Configuration Export Dialogue

8.6.3.2 Filter Options

`Configuration > Filter Options` are used to enable or disable aiding sources and optimize algorithms bases on known conditions.

For Vehicle Type, select the most appropriate option for your application.

For most applications, filter options can be left as their defaults.

See **7.2 Filter Initialisation** for more information on these specific settings.

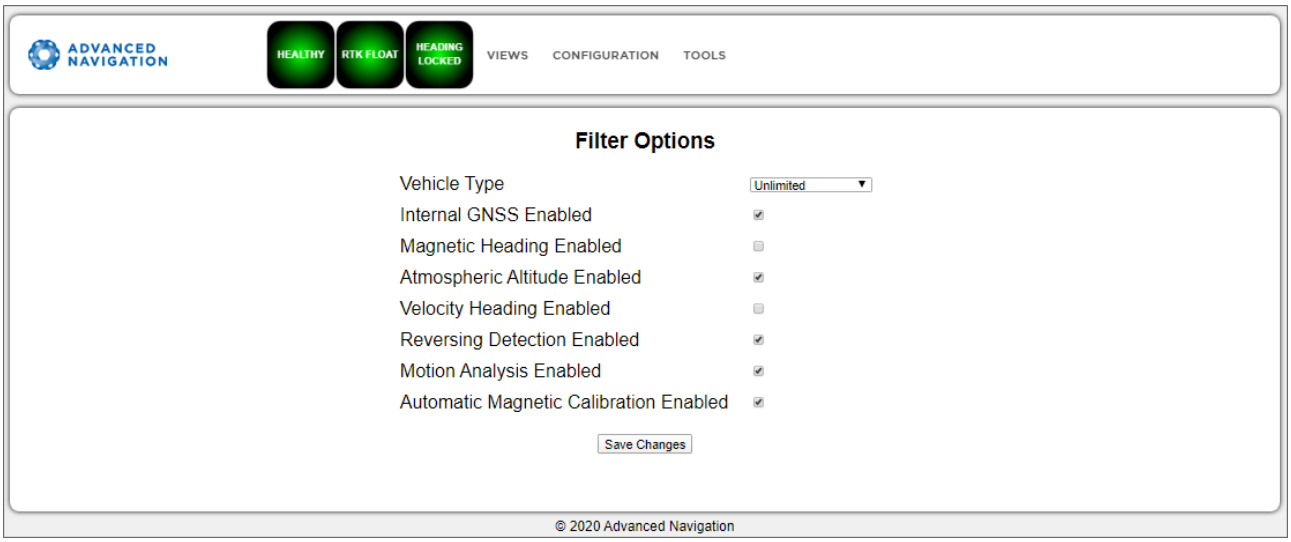


Figure 44: INS Manager Web Filter Options Page

8.6.3.3 Sensor Ranges

Note: The sensor range page is available for some of the INS products, (including Certus, Certus Mini, GNSS Compass). The sensor range can only be modified for these products; other products offer a fixed sensor range.

`Configuration > Sensor Ranges` page is used to set the dynamic range of the sensors. If you are experiencing over-range events during operation, these settings should be used to increase the range of the sensor which is reporting the over-range. The lowest ranges give the best performance, so make changes slowly and monitor the results.

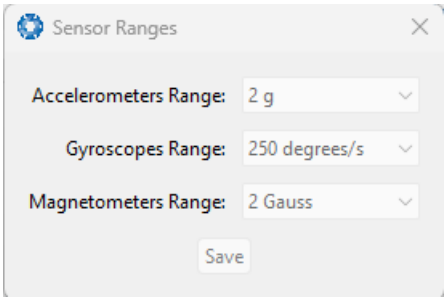


Figure 45: INS Manager Desktop Sensor Ranges Dialogue

8.6.3.4 Data Ports / Packet Rates

`Configuration > Data Ports` (Web) `Configuration > Packet Rates` (Desktop) allows you to specify which data packets or messages are output on a periodic basis and at what rate via serial or Ethernet ports.

The default packets enabled for the primary port are the **10.4.1 System State Packet** (ID #20) and the **10.4.9 Raw Sensors Packet** (ID #28) at 20 Hz and these typically provide all the data that a user will require. These two packets need to be enabled for the data graphs to update in the INS Manager. Other ANPP format state packets can be enabled as required.

Note: Packet rate configuration applies only to the data port which the Manager is connected to. To configure other ports, the Manager must be connected to that port.

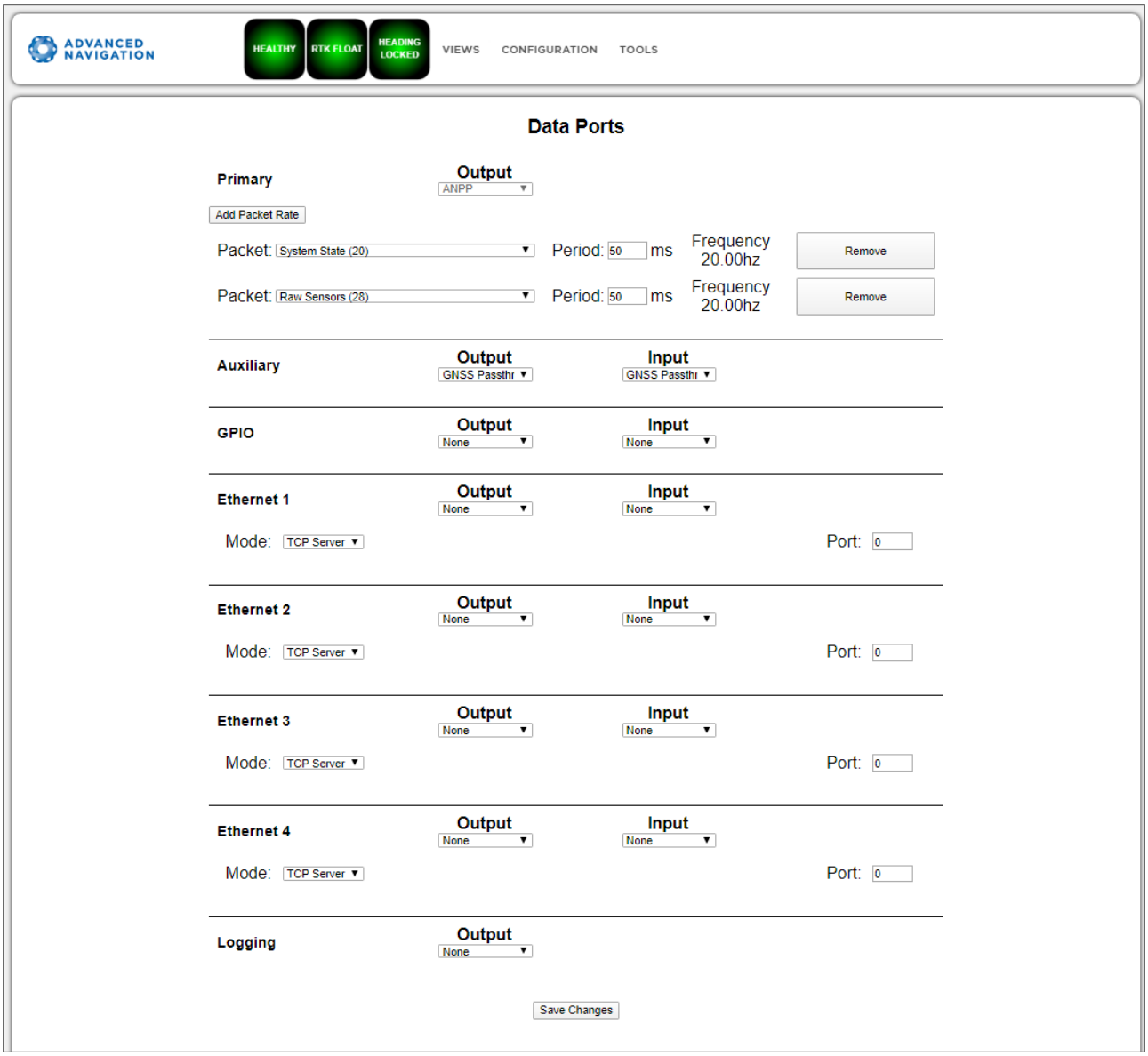


Figure 46: INS Manager Web Data Ports Page

8.6.3.5 Alignment

`Configuration > Alignment` is used to set the alignment offsets of the system installation. It is important to set the values correctly to ensure accurate results.

For most applications, only the GNSS antenna offset values need to be entered and the rest of the values can be left at their factory defaults of zero.

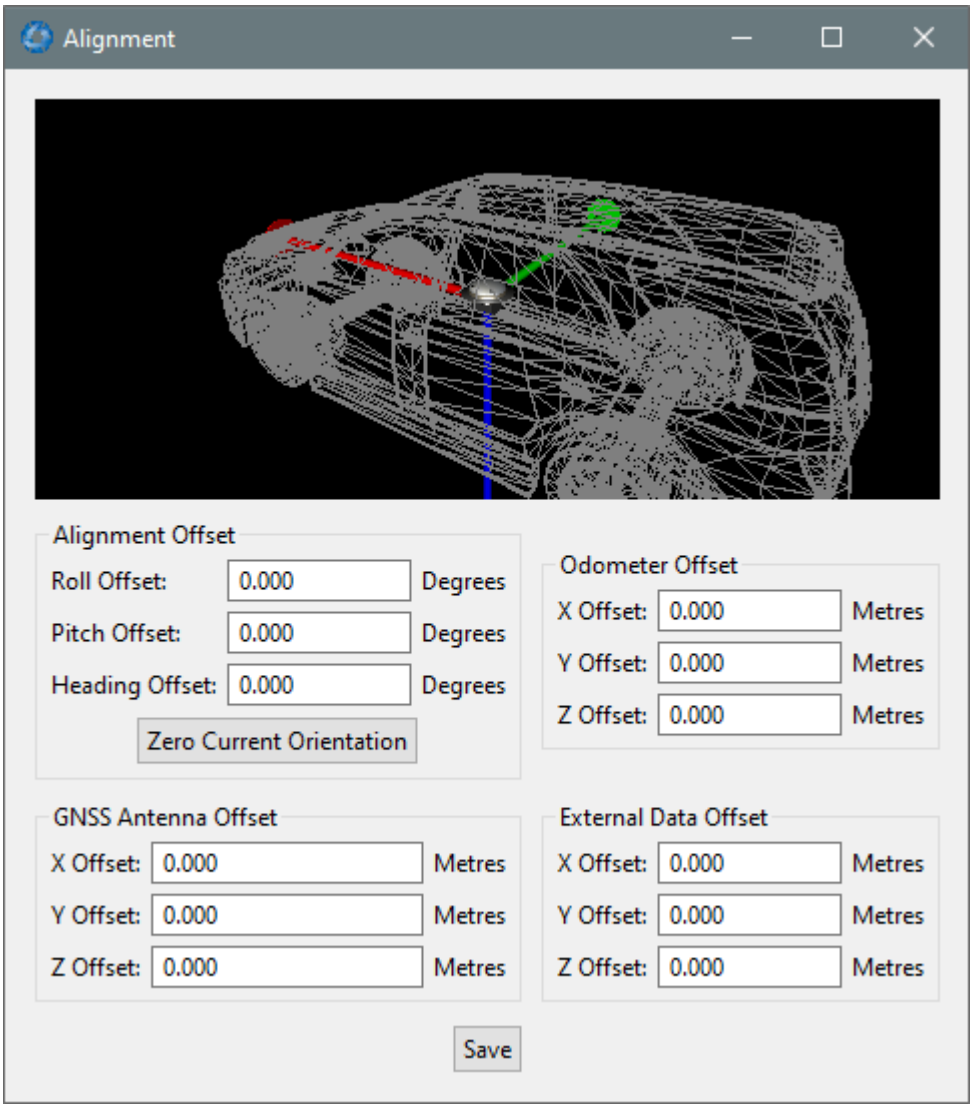


Figure 47: INS Manager Desktop Alignment Dialogue

Alignment Offset

If the INS is installed into the vehicle with the positive X axis pointing forwards and the positive Z axis pointing down, then no alignment offset is required and the roll, pitch and heading offset values can remain at the factory defaults of zero.

If the unit is installed in a different orientation then the roll, pitch and heading offset must be entered. For example, if the unit is installed on its side with the X axis pointing up and the Z axis pointing forwards and no change to the Y axis, then this would result in a pitch offset of +90 degrees with roll and heading remaining zero.

If there is a small misalignment due to mechanical mounting error this can be compensated for by setting the vehicle stationary on a level surface and clicking the `Zero Current Orientation` button.

Note: Zero Current Orientation will only correct for roll and pitch offsets, the Heading offset must be entered manually and saved after using this function.

GNSS Antenna Offset

The GNSS antenna offset is measured from the centre of the INS unit to the phase centre of the primary antenna in the orientation of the Body Coordinate Frame: (X positive forward, Z positive down).

Odometer Offset

The odometer offset is measured from the centre of the INS unit to the point at which the vehicle's tyre being measured makes contact with the road in the body co-ordinate frame (X positive forward, Z positive down). If your odometer is not measuring a specific wheel, the offset should be to the point on the ground beneath the measurement point. If, for example, your car is a front wheel drive and you are using the velocity from the car OBDII port, the measurement point would be midway between the two front wheels.

External Data Offset

These values are only required for speciality applications operating with an external source of velocity and position data. The offsets are used when providing NMEA Input, External GNSS, or with an Air Data Unit. When using a DVL, use the odometer offset.

8.6.3.6 Baud Rates/Port Mode and Baud Rates

`Configuration > Baud Rates` (Web) `Configuration > Port Mode and Baud Rates` (Desktop) is for setting the baud rates for the GPIO, primary and auxiliary ports.

The factory default baud rate value for these ports is 115200 bps.

Note: Some machines running Microsoft Windows do not support higher baud rates. When changing baud rates, it is recommended to test the baud rate configuration first, without ticking the Permanent box. This way, if it is not possible to communicate at the higher baud rate, a power cycle can be used to revert to the previous baud rate setting.

For newer INS products, the ports can be configured in software to RS232 or RS422. The factory default is dependant on your product.

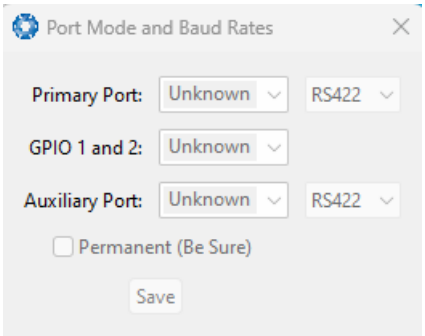


Figure 48: INS Manager Desktop Baud Rates Dialogue

8.6.3.7 GPIO

`Configuration > GPIO` allows the user to configure the input and output functions of the GPIO and Auxiliary ports. These functions are described in detail in **9.6.1 Dynamic Pin Functions**. These functions change dynamically and are effective immediately upon clicking `Save Changes`.

Note: The GPIO port functions at RS232 levels for data functions and 0 to 5 volt (or 0 to 3.3 V) levels for all other functions. The auxiliary port functions at RS232 or RS422 levels for data functions and 0 to 5 volt (or 0 to 3.3 V) levels for all other functions. The internal hardware automatically reconfigures based upon the selected function.

The default values for these settings are Inactive. The dedicated 1PPS signal is active by default.

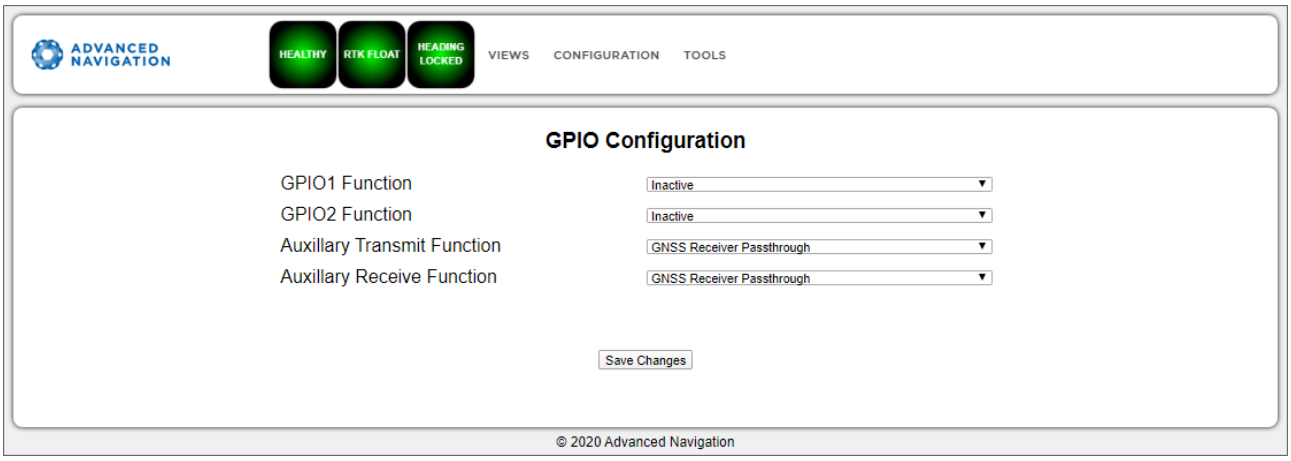


Figure 49: INS Manager Web GPIO Configuration Page

8.6.3.8 Odometer

`Configuration > Odometer` allows the user to configure the odometer pulse length and offset. See **6.7 Odometer** and **7.11 Odometer Pulse Length** for more information on the use of odometers. The odometer offset is also applied when using a DVL input.

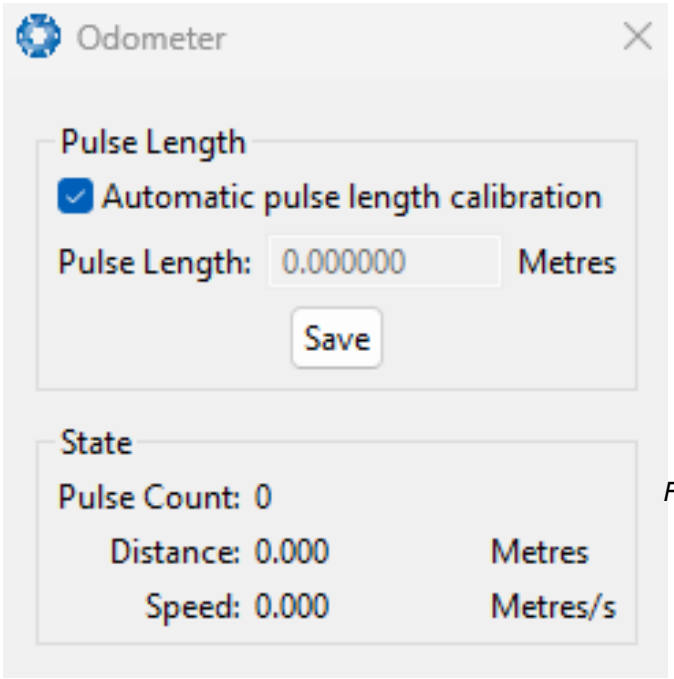


Figure 50: INS Manager Desktop Odometer Dialogue

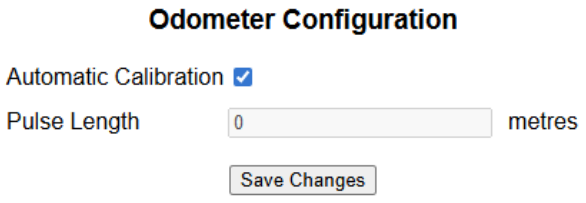


Figure 51: INS Manager Web Odometer Dialogue

8.6.3.9 Reset

`Configuration > Reset`. From this page you can select buttons:

- `Reset` Perform a powers cycle. No configuration settings or state data are lost.
- `Cold Start` Clears all filters, and connections are reset and must be re-established. No configuration settings are lost.
- `Factory Restore` Resets all INS settings back to their factory defaults, including state data and all configuration settings. Re-enable the DHCP Client and loses any static IP address settings. Erases the hot start data so that the system is forced to perform a cold start.

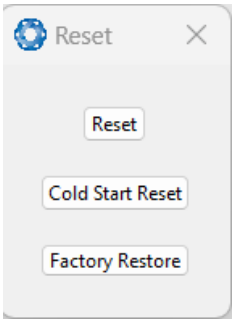


Figure 52: INS Manager Desktop Reset Dialogue

8.6.3.10 Reference Point Offsets

`Configuration > Reference Point Offsets` page allows the user to set measurement points away from its default position at the physical centre of the INS unit. The primary reference point offset applies to data from all ANPP packets as well as all peripheral output such as NMEA messages and Heave Point 1. When the values are zero the measurement point is the centre of the INS unit.

The Heave Points 2 to 4 allow the user to offset reference points for the heave values 2 to 4 in the **10.4.38 Heave Packet**.

The Centre of Gravity (COG) Lever Arm Offset should be used to define where the centre of gravity is for the vehicle. It is useful in applications, such as a surface vessels, to improve the ability of the North Seeking Gyrocompass Heading to complete alignment.

These offsets are applied to the values in the **10.4.38 Heave Packet** and **10.4.52 Vessel Motion Packet**.

Note: These values only apply to the Heave Packet and Vessel Motion Packet. NMEA, TSS and Simrad heave is not affected by the values in this dialogue which are always measured at the centre of the INS unit.

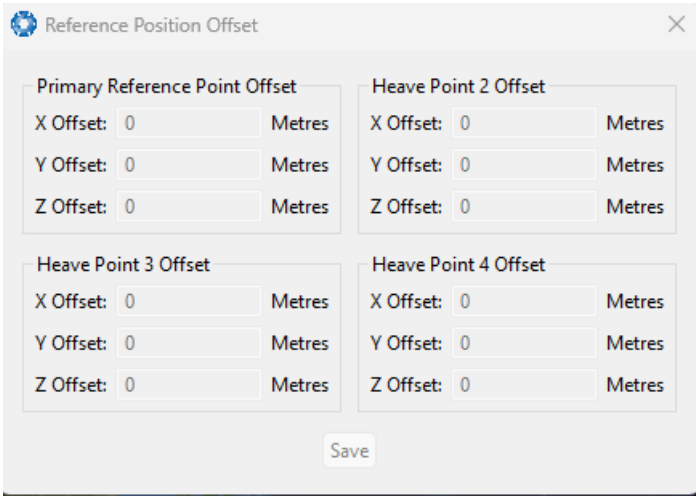


Figure 53: INS Manager Desktop Reference Position Offset Dialogue

8.6.3.11 GPIO Output

[INS Manager Desktop only]

`Configuration > GPIO Output` page allows the user to configure the NMEA0183, TSS1 and SIMRAD output rates for the GPIO and Auxiliary port. These output rates will be observed with respect to the actual output selected in the **8.6.3.7 GPIO** port configuration.

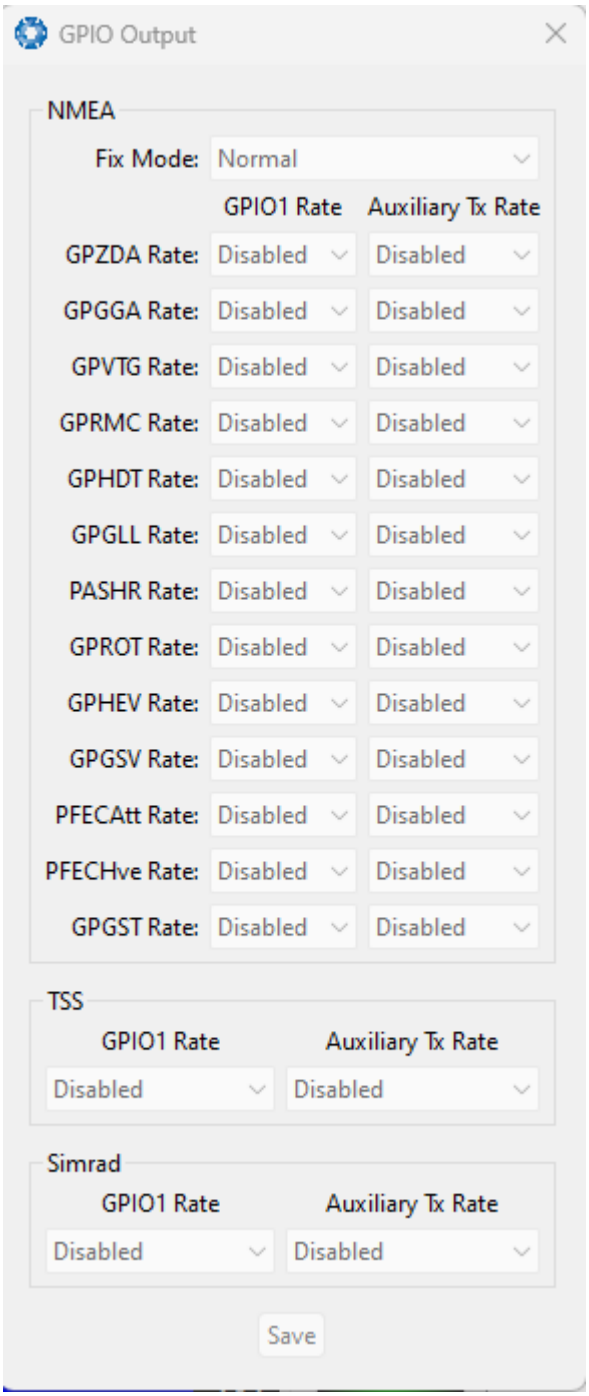


Figure 54: INS Manager Desktop GPIO Output Dialogue

8.6.3.12 Manual Initialisation

`Configuration > Manual Initialisation` is used to manually initialise the INS when a GNSS fix is not available. Setting the position will initialise the navigation filter. Setting the heading will also initialise the heading filter.

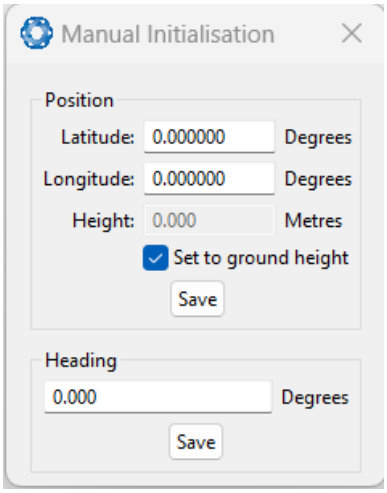


Figure 55: INS Manager Desktop Manual Initialisation Dialogue

8.6.3.13 Gimbal

[INS Manager Desktop only]

`Configuration > Gimbal` is used in gimbal specific applications.

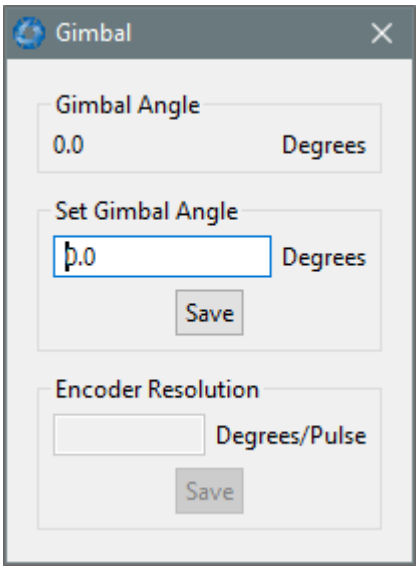


Figure 56: INS Manager Desktop Gimbal Dialogue

8.6.3.14 Ethernet Settings

`Configuration > Ethernet Settings` allows you to switch between DHCP and Static IP selection. When the DHCP Client is disabled you need to enter the TCP/IP settings if you wish to access the INS Manager Web interface.

If you are only connecting to the INS via the primary serial port these settings can be ignored.
The default is for the Ethernet mode to be set to DHCP.

Note: Ethernet settings are only available for INS devices with an ethernet interface.

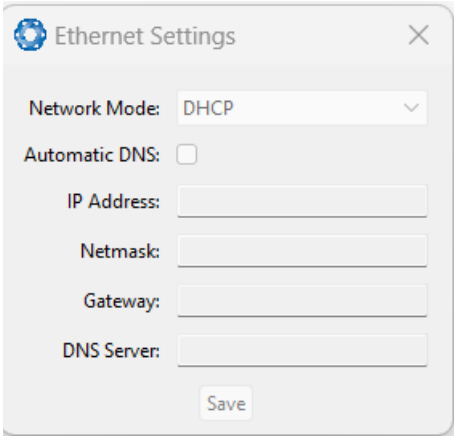


Figure 57: INS Manager Desktop Ethernet Settings Dialogue

8.6.3.15 NTRIP Client

[INS Manager Web only]

`Configuration > NTRIP` is used to connect to a network DGPS (Differential GPS, an older standard for GNSS corrections of lower performance than RTK) or RTK service to stream correction data to the INS for DGPS or RTK. The NTRIP client requires the INS has an available internet connection to the NTRIP Caster to function.

The source of the corrections data can be either your own base station, configured as an NTRIP Caster, or a third-party service. Either way, you will need the login details for connecting to and authenticating with the NTRIP Caster, and identifying the nearest mountpoint. For more details on the connection steps, refer to the Manual Initialisation page.

Troubleshooting NTRIP Caster Connections

Some mount points require the INS send its position. To do this, click the `Report Position` check box, and then click `Save Changes`. The current INS position will then be sent to the NTRIP Caster every 10 seconds.

If you cannot get the list of mount points, ensure the Host Address and Port number are correct for your NTRIP Caster.

If the Connection Status is not green, and says UNAUTHORISED this indicates an incorrect username or password.



Figure 58: INS Manager Web NTRIP Client Page

8.6.3.16 CAN Settings

`Configuration > CAN Settings` allows you to enable or disable the CAN functionality. If you are only connecting to the INS via the primary serial port then these settings can be ignored.

The default for CAN is Enabled at 1,000,000 baud rate. A CANOpen EDS file is bundled with the firmware download or can be downloaded from the Advanced Navigation webpage.

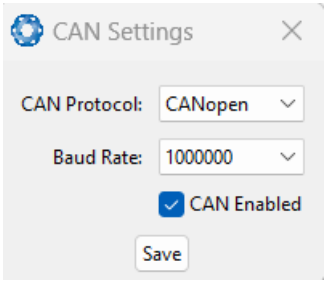


Figure 59: INS Manager Desktop CAN Settings Dialogue

8.6.3.17 Advanced

[INS Manager Web only]

`Configuration > Advanced` page allows you to set the voltage level of the GPIO and 1PPS signals lines along with the packet rates.

The options are 5 V, 3.3 V, or Disabled. The default is 5 V.

Note: The dedicated 1PPS signal is active whenever the voltage is set to 5 V or 3.3 V, and is therefore active by default.

The CANopen output packet rates can be configured as the period between packets in milliseconds within the range of 10 ms to 10,000 ms. The default is 50 ms.

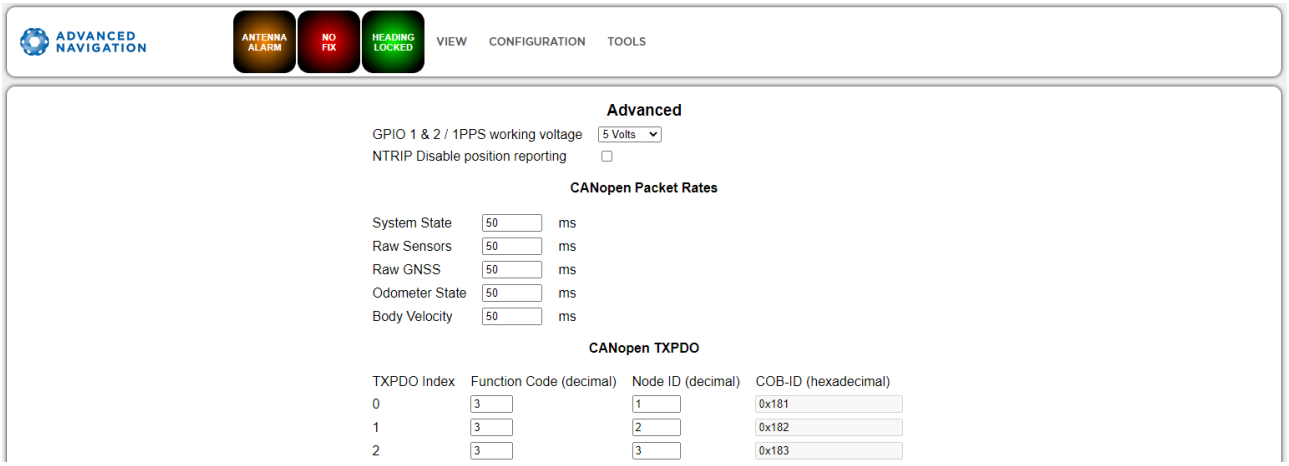


Figure 60: INS Manager Web Advanced Page

8.6.3.18 GNSS Configuration

`Configuration > GNSS Configuration` allows you to select constellation configurations based on the type of GNSS receiver installed.

If an invalid configuration is entered, the system will revert to the previous configuration when you try to save the changes. To confirm that changes have been successfully saved, close and re-open the GNSS Configuration page.

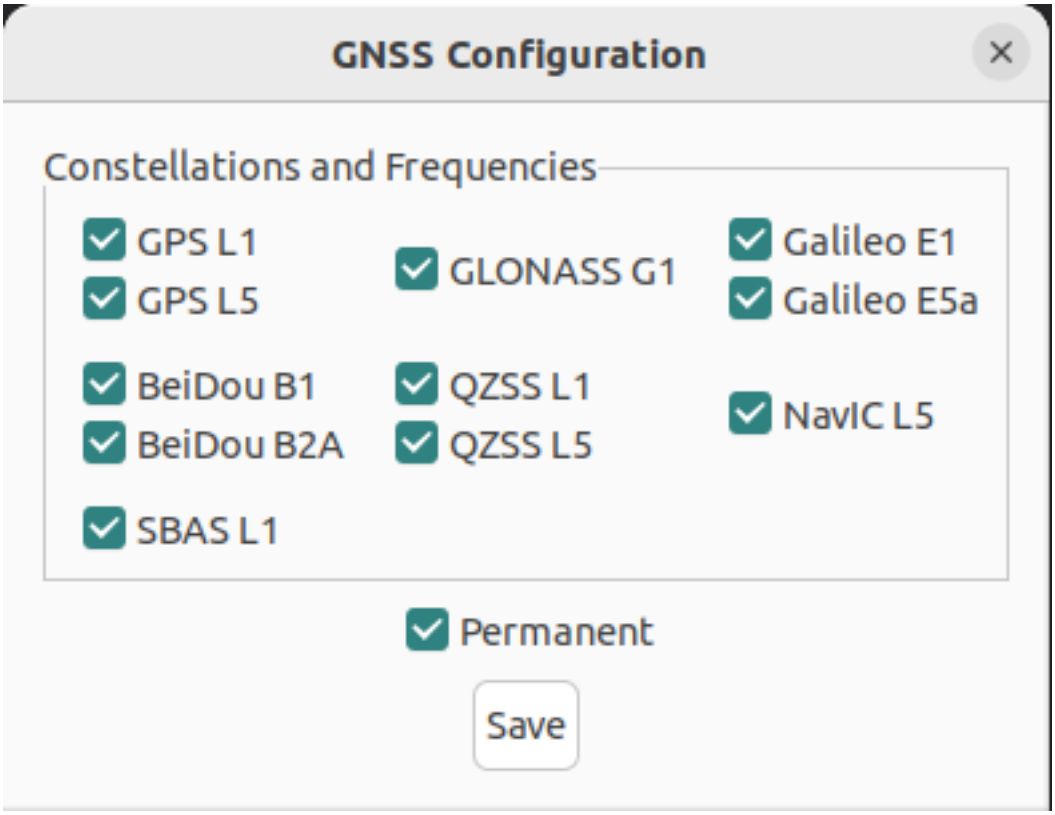


Figure 61: INS Manager Desktop GNSS Configuration Dialogue

U-blox GNSS Receiver Configuration

When using a u-blox GNSS receiver, the following configuration rules are applicable:

- By default, GPS, Galileo and GLONASS are enabled, along with SBAS and QZSS correction services.
- When selecting a GNSS constellation, all frequencies for that constellation must be selected, with the exception of GPS and Beidou.
- GPS and Beidou can be enabled with L1/B1 frequency only, and a second frequency is optional.
- SBAS and QZSS correction services can also be enabled for all constellation configurations, except when using GPS, Galileo and BeiDou together, or when GPS L1 is not enabled.

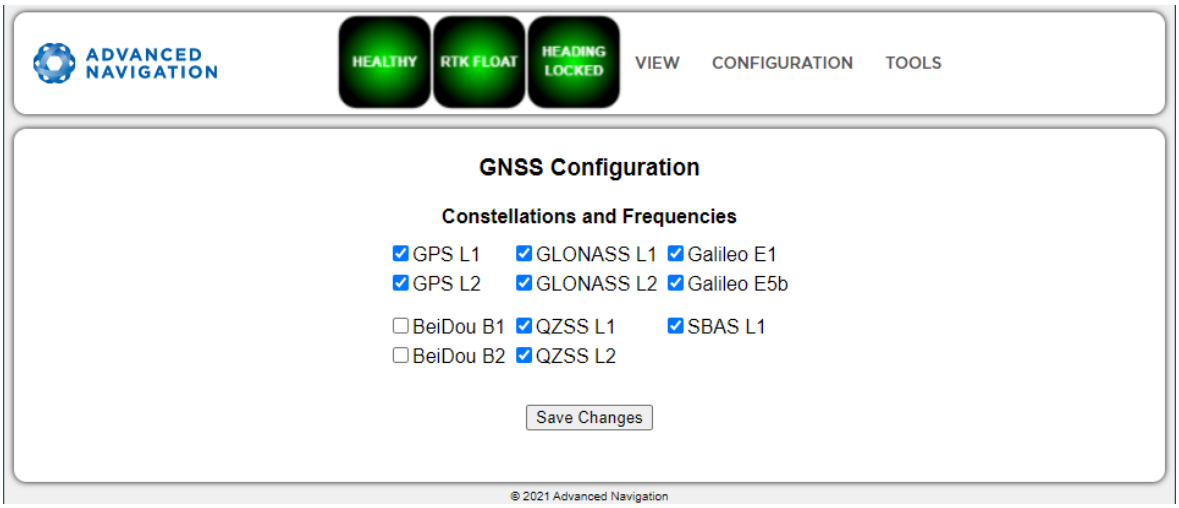


Figure 62: INS Manager Web U-blox GNSS Configuration Page

The table below lists the supported constellations and the corresponding GNSS sample period depending upon the number of constellations selected. When setting the **8.6.3 Configuration Menu**, the packet rate of the **10.4.10 Raw GNSS Packet** and **10.4.39 Raw Satellite Data Packet** are automatically adjusted to the next lower integer multiple of the sample period.

# of Constellations Configured	Sample Period	Example Effective Packet 60 Rate	Supported Constellation Configurations
1	40 ms	1 ms - 39 ms = 40 ms (25 Hz)	GPS
	50 ms	1 ms - 99 ms = 50 ms (20 Hz) 100 ms - 149 ms = 100 ms (10 Hz) 150 ms - 199 ms = 150 ms (6.67 Hz)	Galileo GLONASS BeiDou NVC
2	67 ms	1 ms - 133 ms = 67 ms = 15 Hz	GPS & GLONASS
	72 ms	1 ms - 143 ms = 72 ms = 14 Hz	GPS & Galileo

# of Constellations Configured	Sample Period	Example Effective Packet 60 Rate	Supported Constellation Configurations
	100 ms	1 ms - 199 ms = 100 ms (10 Hz) 200 ms - 299 ms = 200 ms (5 Hz)	GPS & BeiDou All other combinations
3	125 ms	1 ms - 249 ms = 125 ms (8 Hz) 250 ms - 374 ms = 250 ms (4 Hz)	GPS, GLONASS & Galileo GPS, GLONASS & BeiDou (no correction services) All combinations
4	143 ms	1 ms - 285 ms = 143 ms (7 Hz)	GPS, Galileo, GLONASS & BeiDou All combinations
5	200 ms	1 ms - 399 ms = 200 ms (5 Hz)	All combinations

Table 32: U-blox Supported GNSS Constellation Configurations

Trimble BD992 GNSS Receiver Configuration

When using a Trimble BD992 GNSS receiver, the following configuration rules are applicable:

- For any given constellation, the first (1) frequency must be enabled in order to receive additional frequencies
- Galileo and BeiDou are licensed separately.
- L Band corrections are available on this receiver, however require an additional subscription to Omnistar or RTX. Advanced Navigation does not supply these, contact Trimble for further details.

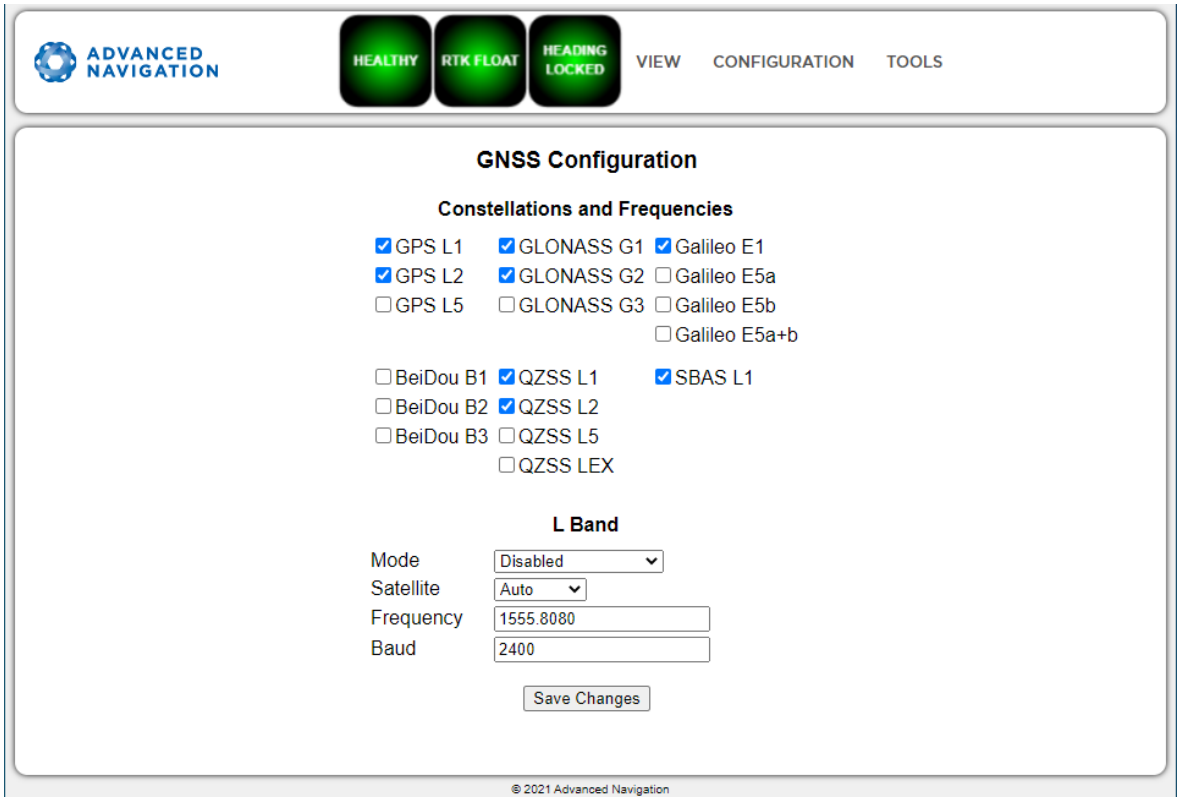


Figure 63: INS Manager Web BD992 GNSS Configuration Page

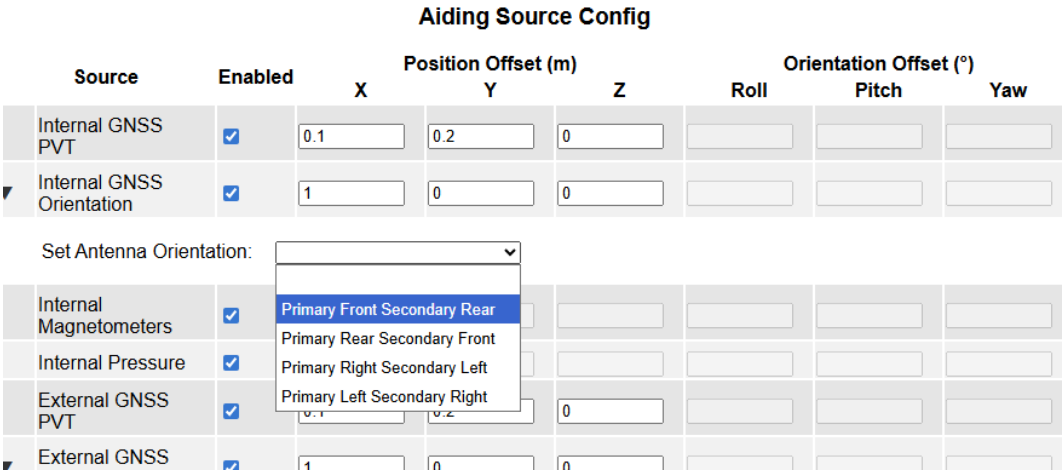
8.6.3.19 Aiding Source Configuration

`Configuration > Aiding Source` allows you to configure aiding sources:

- Enable: Off/On
- Position Offset
- Orientation Offset

Note: The Position Offset refers to the position of the sensor from the *INS defined body point* (typically the center of the INS), in body coordinates.

Note: For dual antenna GNSS, the GNSS antenna orientation values represent the position of the primary antenna from the secondary antenna, in body coordinates.



Note: Remember to select *Save Changes* after entering new parameters.

8.6.4 Tools Menu

The Tools menu contains tools for performing functions with the INS and INS data.

8.6.4.1 Device Discovery

[INS Manager Desktop only]

`Tools > Device Discovery` allows network discovery and reconfiguration of devices on the local network regardless of network settings.

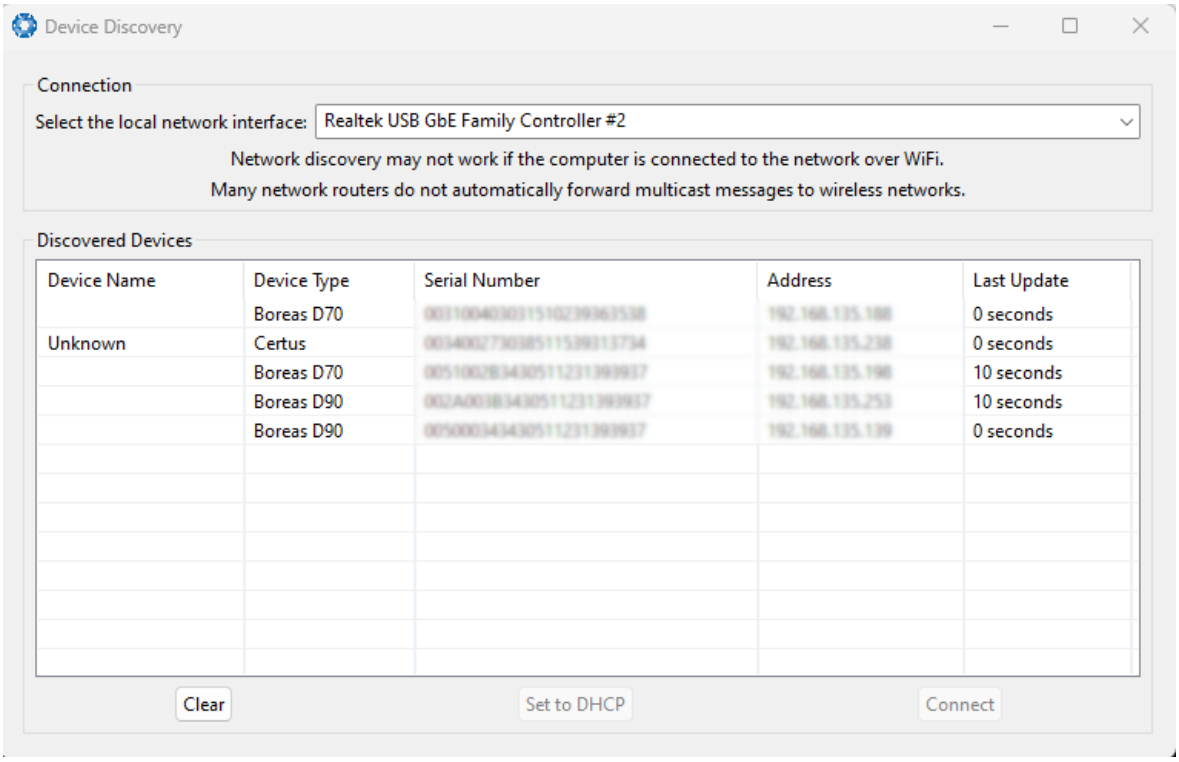


Figure 64: INS Manager Desktop Device Discovery Dialogue

Set to DHCP

Once devices are discovered, any devices on uncontactable network addresses can be reset to DHCP by pressing the “Set to DHCP” button for that device.

8.6.4.2 Firmware Update

`Tools > Firmware Update` is used to update the INS device firmware.

Advanced Navigation regularly provides firmware updates to improve performance and add features. These are described on the INS product page of the Advanced Navigation website. Advanced Navigation recommends that you upgrade to the latest version whenever available. The firmware update function is robust, such that power loss, file corruption or other issues cannot brick the device.

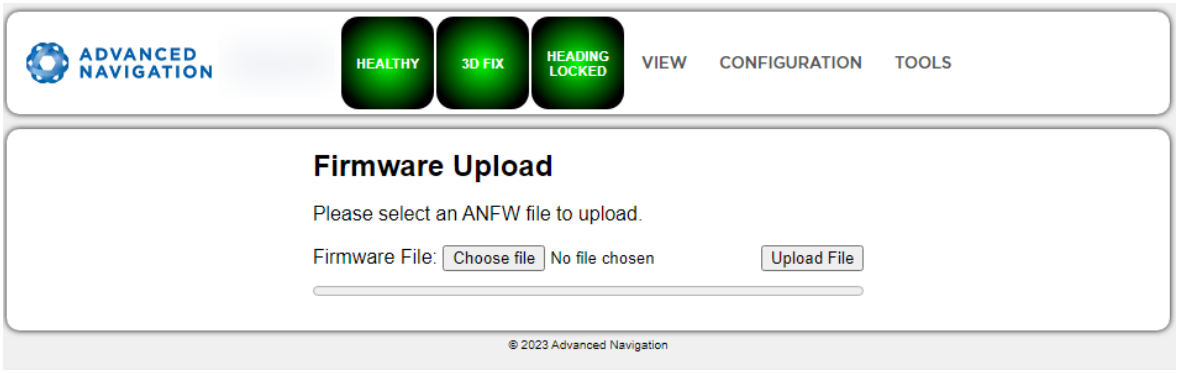


Figure 65: INS Manager Web Firmware Update Page

Click "Choose File" and select the appropriate ANFW file for upload.

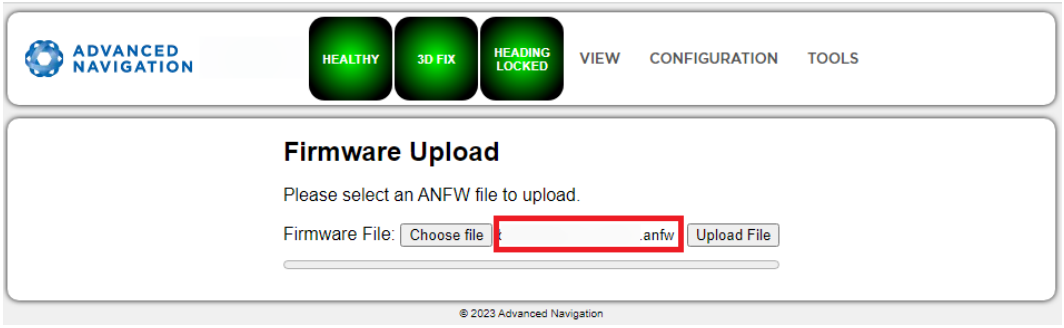


Figure 66: INS Manager Web Firmware Update Choose File

Wait while the system uploads the firmware.

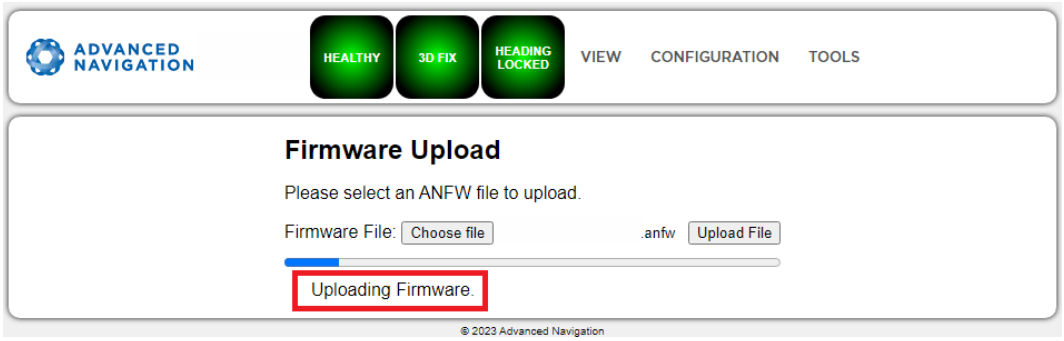


Figure 67: INS Manager Web Firmware Update Uploading Firmware

Once uploaded, the system will automatically verify the firmware prior to reboot.

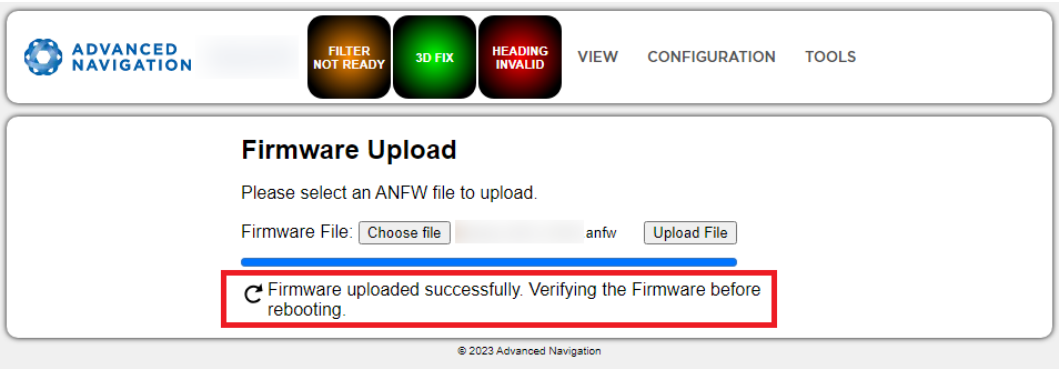


Figure 68: INS Manager Web Firmware Update Verifying

Upon successful verification, a dialog box will appear indicating the device is rebooting to apply the update.

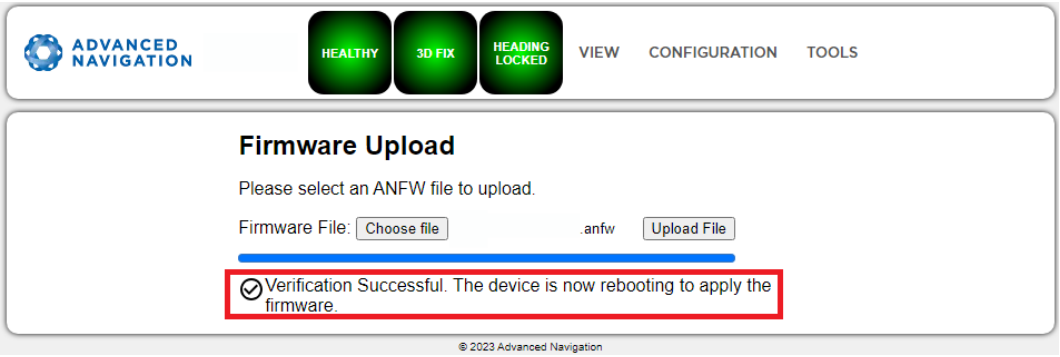


Figure 69: INS Manager Web Firmware Update Complete

8.6.4.3 Magnetic Calibration

`Tools > Magnetic Calibration` allows you to perform magnetic calibration, view and modify the magnetic calibration values. The actual magnetic calibration is performed inside the INS unit.

This page is available for INS units which include a magnetic sensor. This includes the Certus series, and excludes the Boreas FOG series.

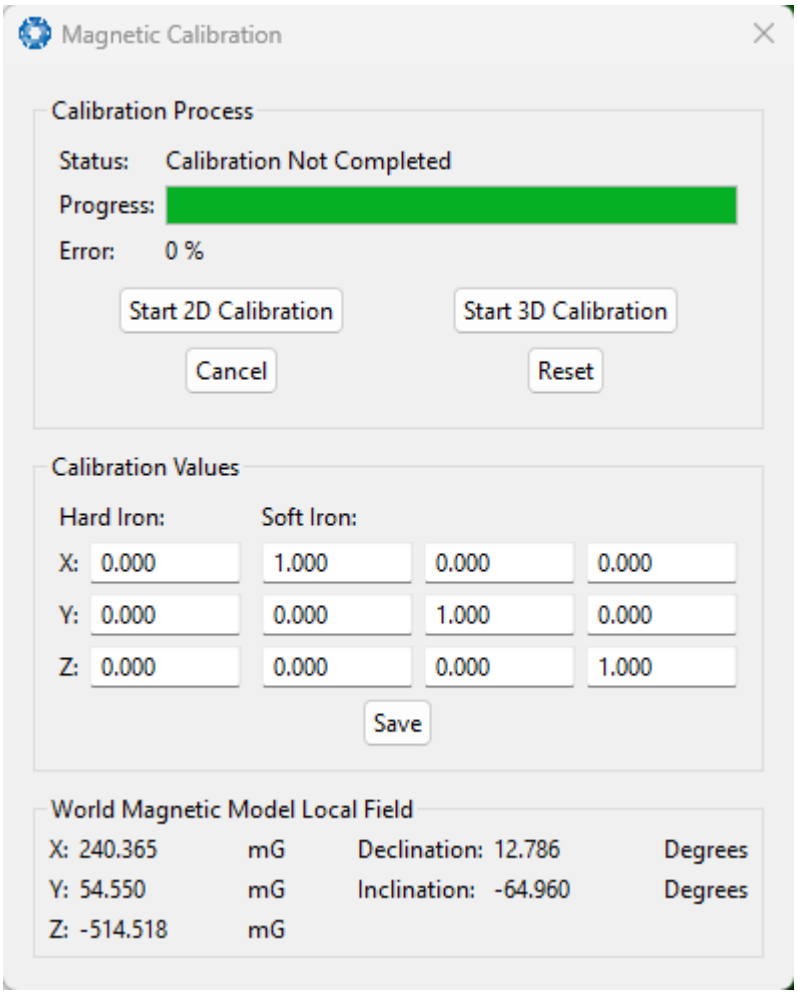


Figure 70: INS Manager Desktop Magnetic Calibration Dialogue

8.6.4.4 Logs

[INS Manager Web only]

Applicable to: Certus and Boreas products. Doesn't include Certus Mini.

`Tools > Logs`

Our higher-end INS products include an on-board high capacity data logging system. Logging is enabled by default, but by default no specific data is configured to be logged. To enable logging of specific data packets or messages, see the page section: `Configuration > Data Ports > Logging`.

The log file name includes the date and time the log file recording commenced, using UTC time, in the format `[Product Name]Log_yy-mm-dd_hh-mm-ss.xxx`. The log file extension identifies the file type.

If the time and date in the log file name is incorrect, this usually indicates the does not have a GNSS fix and has therefore not yet determined the correct time.

The logging configuration and recorded log files can only be accessed from INS Manager Web (via the ethernet interface). You cannot use the serial port interfaces.

Note: If there is a requirement not to store potentially sensitive information, it is possible to order the INS without internal storage. If this is the case, no internal logging will be possible.

Enabling and Disabling Logging

To enable or disable the logging functionality, select or deselect the `Enable Logging` check box and click `Save Changes`. The log file currently being recorded is highlighted in green. If recording an ANPP-format log file, the log file will include the current INS device configuration.

Limiting the Maximum Log File Size

If you wish to limit the maximum file size for individual log files, select the `Enable Splitting` check box, enter a `Max Log Size` (in MiB), and then click the `Save Changes` button. This will not affect pre-existing log files but will affect the currently recording log file. Note this will round down to an integer if you enter a number with decimal places.

Downloading Log Files

You can download individual log files by simply clicking on them. Note, only one log file can be downloaded at a time using this method. To download multiple log files, first select the files required, and then click the `Download Selected` button. This will download all the files to your computer and compress them into one ZIP file. Note, it may appear that nothing is happening during this process, and it can take some time to complete. You can select all log files using the `Select All` button, or individually select log files using the check box on the left of the log file name.

Deleting Log Files

You can delete log files by selecting the specific log file(s) using the check box to the left of the log file name, or using the `Select All` button, and then click the `Delete Selected` button. For bulk erasing ALL log files you can use the `Format` button. This will erase all log files irrecoverably. Note, it can take some time.

Starting New Log Files

The `Start New Log` button will stop writing the current log file and commence writing a new file. This new file will also include the current INS device configuration. If logging is currently not enabled, this button will not do anything.

The ANPP log files are binary data and are therefore not in a human-readable format. To convert the ANPP log files you can use the Log Converter function of `INS Manager Desktop > Tools > Log Converter`. This will create CSV and KML files for your analysis. All the ANPP packets are described in detail in **10 Advanced Navigation Packet Protocol**. NMEA0183 log files are ASCII text and can be opened in any text editor.

8.6.4.5 Log Converter

[INS Manager Desktop only]

`Tools > Log Converter` allows the user to convert INS log files into various standard formats, including:

- CSV: Comma Separated Value
- GPX: GPS Exchange Format
- KML: Keyhole Markup Language
- IMR: Inertial Measurement and Reference
- RINEX files

The Position Offset settings are used to project the exported position of origin to a point other than the actual centre of the INS unit. For most users, these values should be left at zero.

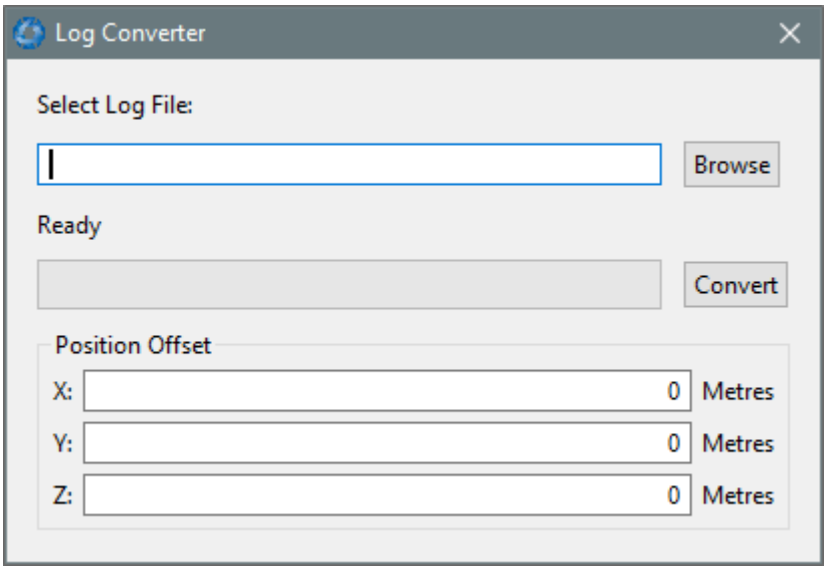


Figure 71: INS Manager Desktop Log Converter Dialogue

8.6.4.6 NTRIP Client

[INS Manager Desktop only]

`Tools > NTRIP Client`

This page can be used to connect to a network DGPS or RTK service to stream correction data to the INS for DGPS or RTK. The NTRIP client requires an internet connection to function.

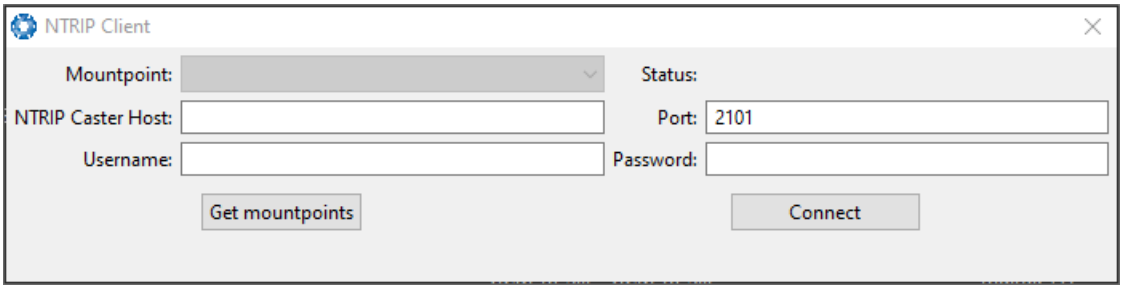


Figure 72: INS Manager Desktop NTRIP Client Dialogue

8.6.4.7 Network Connect

[INS Manager Desktop only]

`Tools > Network Connect` allows INS Manager to make a connection to the INS over a TCP/IP network rather than the primary serial port connection.

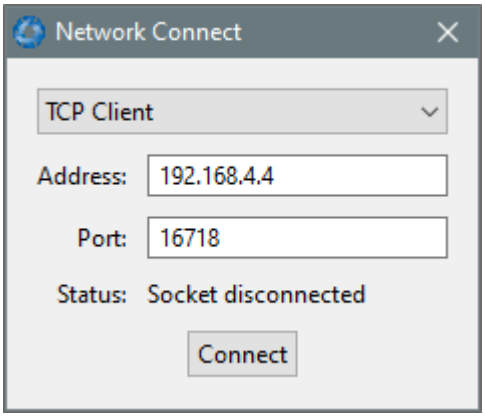


Figure 73: INS Manager Desktop Network Connect Dialogue

8.6.4.8 Serial Passthrough

[INS Manager Desktop only]

`Tools > Serial Passthrough` allows pass-through communication through either GPIO 1 and 2 or the Auxiliary port.

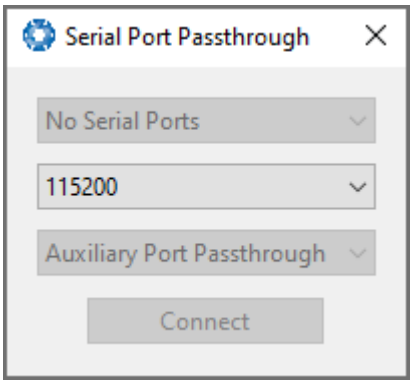


Figure 74: INS Manager Desktop Serial Port Passthrough Dialogue

8.7 Using ANPP

Advanced Navigation units can be configured and monitored using the Advanced Navigation Packet Protocol (ANPP), which is detailed fully in **10 Advanced Navigation Packet Protocol**.

A software development kit (SDK) is available to assist you when developing your own applications. It contains example code in a number of programming languages, ready to compile and test. It can be downloaded from the Advanced Navigation website.

9 Interfacing

Communication with Certus is possible on the following ports:

- 9.1 Ethernet
- 9.2 Serial Interface
- 9.3 1PPS Signal
- 9.4 CAN Interface
- 9.6 GPIO Pins and the Auxiliary Port

Each port has different input and output capabilities.

9.1 Ethernet

The Ethernet interface offers a 100 MBit port for connection to a network, router or laptop/computer. The interface offers a web UI, as well as 4 (four) configurable data ports. Each Data Port

- can be configured as a TCP Server, TCP Client or a UDP Client as detailed in 9.1.1 Ethernet Modes
- can be configured with an Input and/or Output for a number of protocols as detailed in 9.1 Ethernet.
- should only be used to establish a connection with a single remote computer/device at any one time.

9.1.1 Ethernet Modes

Ethernet Mode	Description	Required Configuration
TCP Server	Certus will establish a TCP Server listening on the defined port. A connected client is able to receive Output data and send Input data based on the defined Input and Output functions.	Port
TCP Client	Certus will continuously attempt to establish a TCP connection to the defined Destination IP and Port. Once established, a connected client is able to receive Output data and send Input data based on the defined Input and Output functions.	Client Destination IP address Port
UDP Client	Certus will send UDP Output data to the defined Destination IP and Port. A client can also send UDP Input data to Certus this same Port.	Client Destination IP address Port

Table 33: Ethernet Data Port Modes

9.1.2 Ethernet Functions

Function Type	Name
Ethernet Input	9.1.2.1 NMEA Input
	9.1.2.25 GNSS Receiver Passthrough
	9.1.2.2 Novatel GNSS Input
	9.1.2.3 Topcon GNSS Input
	9.1.2.5 ANPP Input
	9.1.2.6 RTCM Differential GNSS Corrections Input
	9.1.2.7 Trimble GNSS Input
	9.1.2.8 u-blox GNSS Input
	9.1.2.9 Hemisphere GNSS Input
	9.1.2.10 Teledyne DVL Input
	9.1.2.11 Tritech USBL Input
	9.1.2.12 Linkquest DVL Input
	9.1.2.13 Nortek DVL Input
	9.1.2.15 Nortek Nucleus DVL Input
	9.1.2.14 Water Linked DVL Input
	9.1.2.4 Septentrio GNSS Input
Ethernet Output	9.1.2.17 NMEA Output
	9.1.2.18 ANPP Output
	9.1.2.19 TSS1 Output
	9.1.2.20 Simrad 1000 Output
	9.1.2.21 Simrad 3000 Output
	9.1.2.22 Serial Port Passthrough
	9.1.2.24 Nortek Nucleus DVL Output
	9.1.2.25 GNSS Receiver Passthrough

Table 34: Ethernet Data Port Functions

9.1.2.1 NMEA Input

Description: This function accepts external data in the NMEA 0183 format. Advanced Navigation recommends against using NMEA 0183 input wherever possible due to the inefficiency, low accuracy and precision and weak error checking of the format. All NMEA messages received must have a valid checksum. Supported messages are listed below. The recommended combination of messages are RMC with optional messages GPGSV and GPGSA. If RMC is not available, GGA and VTG can be used.

Message ID	Description	Notes
GPGGA GNGGA	3D position	All constellations
GPGLL GNGLL	2D position	All constellations
GPRMC GNRMC	2D position, 2D velocity and coarse time	All constellations
GPVTG GNVTG	2D velocity	All constellations
GPHDT GNHDT HEHDT	Heading	All constellations
GPGSV GNGSV	Satellites	Only GPS (GPGSV)
GPGSA GNGSA	Dilution of Precision	
xxPIPS	Depth below surface	
xxVBW	Water speed, ground speed	
xxHDM	Magnetic heading	
PSIMSSB	SSBL position	
xxVHW	Water speed and heading	
xxDBS	Depth below surface	

Table 35: Supported NMEA messages

9.1.2.2 Novatel GNSS Input

Description: This function is designed for interfacing Certus with a Novatel GNSS receiver. It accepts data in the Novatel binary format and requires messages BESTPOS and BESTVEL at rates higher than 1 Hz (20Hz recommended). The message BESTSATS is optional to display detailed satellite information. The message HEADING is also supported for ALIGN capable receivers.

9.1.2.3 Topcon GNSS Input

Description: This function is designed for interfacing Certus with a Topcon GNSS receiver. It accepts data in the GRIL TPS binary format and expects messages PG and VG at rates higher than 1 Hz.

9.1.2.4 Septentrio GNSS Input

Description: This function is designed for interfacing Certus with a Septentrio GNSS receiver. It accepts data in the Septentrio Binary Format (SBF) and requires blocks PVTGeodetic, PosCovGeodetic and VelCovGeodetic at rates higher than 1 Hz (10 Hz recommended). The blocks DOP, ReceiverTime, ChannelStatus, ReceiverStatus, RFStatus and MeasEpoch are optional to display detailed status and signal information. The blocks BaseVectorGeod and AttCovEuler are also supported for dual-antenna Septentrio receivers.

9.1.2.5 ANPP Input

Description: This function accepts data in the ANPP format as specified in **10 Advanced Navigation Packet Protocol**.

9.1.2.6 RTCM Differential GNSS Corrections Input

Description: This function accepts RTCM v3 GNSS corrections messages. This allows for Differential GNSS or RTK with the Certus internal GNSS receiver.

9.1.2.7 Trimble GNSS Input

Description: This function is designed for interfacing Certus with an external Trimble GNSS receiver. It accepts data in the Trimble binary format GSOF and expects packet 0x40 with records 1, 2, 8, and 12 at rates higher than 1Hz (20Hz recommended) and optional records 9 and 34 at 1 to 2Hz.

9.1.2.8 u-blox GNSS Input

Description: This function is designed for interfacing Certus with an external u-blox GNSS receiver. It accepts data in the u-blox binary format and expects message NAV-PVT at rates higher than 1Hz.

9.1.2.9 Hemisphere GNSS Input

Description: This function is designed for interfacing Certus with an external Hemisphere GNSS receiver. It accepts data in the Hemisphere binary format and expects message Bin1 at rates higher than 1Hz. For Hemisphere receivers that provide heading using two antennas, NMEA should be used instead as the binary format does not allow for transmission of heading information.

9.1.2.10 Teledyne DVL Input

Description: This function accepts DVL data from a Teledyne DVL.

9.1.2.11 Tritech USBL Input

Description: This function accepts USBL data from a Tritech USBL.

9.1.2.12 Linkquest DVL Input

Description: This function accepts DVL data from a Linkquest DVL. The DVL should be configured to output in NQ1 format.

9.1.2.13 Nortek DVL Input

Description: This function accepts DVL data in the Nortek DVL binary format. It accepts the packets 0x1B (DVL Bottom Track) and 0x1D (DVL Water Track). The recommended update rate is 8Hz.

9.1.2.14 Water Linked DVL Input

Description: This function accepts DVL data in Water Linked DVL. The recommended update rate is 8 Hz.

9.1.2.15 Nortek Nucleus DVL Input

Description: This function accepts DVL data in the Nortek DVL binary format. It accepts the packets 0xB4 (DVL Bottom Track) and 0xBE (DVL Water Track). The recommended update rate is 8Hz.

9.1.2.16 Water Linked DVL Input

Description: This function accepts DVL data in the Waterlinked DVL binary format. It accepts the packets 0x1B (DVL Bottom Track) and 0x1D (DVL Water Track).

9.1.2.17 NMEA Output

Description: This function outputs a configurable combination of the NMEA messages GPZDA, GPGGA, GPVTG, GPRMC, GPHDT, PASHR, GPROT, GPHEV, GPGSV, PFECGPAtt, and PFECGPHve at up to 50 Hz. The messages output and the output rate can be configured using the web UI or INS Manager. An example output is shown below.

```
$GPZDA,031644.460,07,05,2013,00,00*52

$GPGGA,031644.460,3352.3501851,S,15112.2355488,E,6,00,1.4,150.
0,M,0.0,M,,*7E

$GPVTG,089.19,T,089.19,M,000.00,N,000.00,K,E*27

$GPRMC,031644.460,A,3352.3501851,S,15112.2355488,E,0.0,89.2,07
0513,12.5,W,E*02

$GPHDT,89.2,T*06

$PASHR,031644.460,089.19,T,-00.01,-00.47,-00.00,,,,0,0*2E
```

9.1.2.18 ANPP Output

Description: This function outputs data in the ANPP format as specified in **10 Advanced Navigation**

Packet Protocol. This function is for ANPP peripheral devices only.

9.1.2.19 TSS1 Output

Description: This function outputs the TSS1 format at a user configurable rate of up to 50 Hz. The output rate can be configured using the page in the web UI.

9.1.2.20 Simrad 1000 Output

Description: This function outputs the Simrad 1000 format at a user configurable rate of up to 50 Hz. The output rate can be configured using the Data Ports page in the web UI.

9.1.2.21 Simrad 3000 Output

Description: This function outputs the Simrad 3000 format at a user configurable rate up to 50 Hz. The output rate can be configured using the Data Ports page in the Web user interface.

9.1.2.22 Serial Port Passthrough

Description: This function allows passthrough communication through either GPIO 1 and 2 or the Auxiliary port. To transmit data use the 10.3 System Packets. When data is received it will be sent back using the same 10.3 System Packets.

9.1.2.23 Water Linked DVL Input

Description: This function accepts DVL data in the Waterlinked DVL binary format. It accepts the packets 0x1B (DVL Bottom Track) and 0x1D (DVL Water Track).

9.1.2.24 Nortek Nucleus DVL Output

Description: Upon receiving the login prompt via the Nortek Nucleus DVL Input function, this function transmits the default 'nortek' password string followed by the 'start' string required to place the DVL into measurement mode.

9.1.2.25 GNSS Receiver Passthrough

Description: This function allows for pass through connection to the internal GNSS receiver. This is useful for firmware updates of the internal GNSS receiver.

9.2 Serial Interface

There are two serial ports available for use. The GPIO port can also be used as a serial port, with less functionality.

Model	Primary Port	Auxiliary Port	GPIO Port
Certus (Rugged)	ANPP only over RS232 or RS422. **No** dynamic pin functions	ANPP over RS232 or RS422, 9.6.1 Dynamic Pin Functions	ANPP over RS232, 9.6.1 Dynamic Pin Functions
Certus	ANPP only over UART. **No**	ANPP over UART, 9.6.1	ANPP over RS232, 9.6.1

Model	Primary Port	Auxiliary Port	GPIO Port
(OEM)	dynamic pin functions	Dynamic Pin Functions	Dynamic Pin Functions

Table 36: I/O Ports Available

9.2.1 Baud Rate

The primary and auxiliary port baud rate can be set in the INS Manager. It is important to select a baud rate that is capable of carrying the amount of data that Certus has been configured to output. See **10.1.4 Packet Rates** for more details on the data output calculation. The data rate in bytes per second can be calculated by dividing the baud rate by 10. For example if the baud rate is 115,200, the data rate is 11,520 bytes per second. If the selected data rate is insufficient, data may be lost without warning.

9.2.2 Format

The format is fixed at 1 start bit, 8 data bits, 1 stop bit and no parity. See **10 Advanced Navigation Packet Protocol** for details on the ANPP protocol.

9.3 1PPS Signal

There is a dedicated 1PPS signal available on the **5.8 Connector Pin-out**. See the **Advanced** section of the Configuration Menu for information on changing 1PPS and GPIO settings, and see **9.6.1 Dynamic Pin Functions** for information on 1PPS and GPIO output voltage.

The 1PPS signal reference ground is the GPIO ground domain. See **6.4 Electrical Domains** for more information.

The signal is normally low and pulses high for 100 milliseconds to signal the precise second, which starts on the rising edge of the signal.

This dedicated 1PPS signal is the recommended 1PPS signal to use as it is more accurate. The validity of this 1PPS signal can be monitored using the time initialised status flag.

9.4 CAN Interface

The CAN interface is available on the Connector Pin-out, and is used for low-level device integration with other vehicle systems.

9.5 External Data

External sources of position, velocity and/or heading can be integrated into the Certus filter solution. The data can be sent to Certus in the ANPP format over the primary (RS232 or RS422), auxiliary (RS232 or RS422) or GPIO ports (RS232 only) or in a number of different formats. If using the ANPP format, use the table below to find the relevant section.

Packet
10.4.24 External Position and Velocity Packet
10.4.26 External Position Packet
10.4.27 External Velocity Packet
10.4.28 External Body Velocity Packet

Packet
10.4.29 External Heading Packet
10.4.33 External Time Packet
10.4.34 External Depth Packet
10.4.41 External Odometer Packet
10.4.42 External Air Data Packet
10.4.47 External Magnetometers Packet

Table 37: ANPP External Data Packets

9.6 GPIO Pins and the Auxiliary Port

In addition to the primary port and CAN port, Certus contains two general purpose input/output (GPIO) pins and an auxiliary port on the IO Breakout Connector. These pins are multi function and can be used to extend Certus with additional peripherals, sensors and data formats. Both GPIO pins have digital input, digital output, frequency input and frequency output functionality.

GPIO1 can also function as an RS232 (only) serial transmit line and GPIO2 can function as an RS232 (only) serial receive line. The GPIO serial baud rate can be configured anywhere from 4800 to 250 K baud. The auxiliary serial baud rate can be configured anywhere from 4800 to 4 M baud. See **10.6.3.1 Supported Baud Rate**. Changes to these baud rates can be made by using the Baud Rates page in the **web UI** or **INS Manager**.

The available GPIO and auxiliary functions are listed in the section **9.6.1 Dynamic Pin Functions**. The function of a GPIO pin or the auxiliary port can be changed at any time using the GPIO Configuration page in the Certus **web UI** or **Manager**. GPIO 1 and GPIO 2 operate at standard voltage levels for digital input, digital output, frequency input and frequency output, but when a serial data function is selected, this GPIO pin automatically switches to RS232 voltage level.

9.6.1 Dynamic Pin Functions

Function Type	Name
Tristate	9.6.1.1 Inactive
Digital Output	9.6.1.2 1PPS Output
	9.6.1.3 GNSS Fix Output
Digital Input	9.6.1.4 Zero Velocity Input
	9.6.1.5 Disable Magnetometers
	9.6.1.6 Disable GNSS
	9.6.1.7 Disable Pressure
	9.6.1.8 Set Zero Orientation Alignment
	9.6.1.9 System State Packet Trigger
	9.6.1.10 Raw Sensors Packet Trigger
	9.6.1.11 1PPS Input
	9.6.1.12 Event 1 Input
	9.6.1.13 Event 2 Input
	9.6.1.14 Odometer Direction, Forward Low
	9.6.1.15 Odometer Direction, Forward High
	9.6.1.16 Reverse Alignment, Forward Low
	9.6.1.17 Reverse Alignment, Forward High
	9.6.1.18 Zero Angular Velocity Input
Frequency Input	9.6.1.19 Odometer Input
	9.6.1.20 Pitot Tube Input
	9.6.1.21 Pressure Depth Transducer (deprecated)
	9.6.1.22 Left Wheel Speed Sensor
	9.6.1.23 Right Wheel Speed Sensor
	9.6.1.24 Wheel Speed Sensor
	9.6.1.25 Wheel Encoder Phase A
	9.6.1.26 Wheel Encoder Phase B
	9.6.1.27 Gimbal Encoder Phase A
	9.6.1.28 Gimbal Encoder Phase B

Function Type	Name
Serial Receive	9.6.1.29 NMEA Input
	9.6.1.30 Novatel GNSS Input
	9.6.1.31 Topcon GNSS Input
	9.6.1.33 ANPP Input
	9.6.1.34 RTCM Differential GNSS Corrections Input
	9.6.1.35 Trimble GNSS Input
	9.6.1.36 u-blox GNSS Input
	9.6.1.37 Hemisphere GNSS Input
	9.6.1.38 Teledyne DVL Input
	9.6.1.39 Tritech USBL Input
	9.6.1.40 Linkquest DVL Input
	9.6.1.42 Water Linked DVL Input
	9.6.1.41 Nortek DVL Input
	9.6.1.43 Nortek Nucleus DVL Input
	9.6.1.32 Septentrio GNSS Input
Serial Transmit	9.6.1.45 NMEA Output
	9.6.1.46 ANPP Output
	9.6.1.47 TSS1 Output
	9.6.1.48 Simrad 1000 Output
	9.6.1.49 Simrad 3000 Output
	9.6.1.50 Nortek Nucleus DVL Output
Serial	9.6.1.51 Serial Port Passthrough
	9.6.1.52 GNSS Receiver Passthrough

Table 38: Dynamic Pin Functions

9.6.1.1 Inactive

Type: Tristate
GPIO Port: 1, 2
Auxiliary: All

9.6.1.2 1PPS Output

Type: Digital Output
GPIO Port: 1, 2
Auxiliary: Transmit

Description: There is a difference between the output of the GPIO and auxiliary ports when set to 1PPS output mode.

1PPS Source	Voltage Level	Trigger
Auxiliary	-5 V to 5 V	Falling Edge
GPIO	0 to 5 V, 0 to 3.3 V	Rising Edge

Figure 75: 1PPS Specifications

The pin is normally low and pulses high for 50 milliseconds to signal the precise second. The 1PPS line starts pulsing approximately 100 milliseconds after power up and always fires irrespective of whether Certus has accurate time or not. It is important to note that when Certus acquires time corrections from it's GNSS receiver, the 1PPS signal may fire at an interval of less than 1 second. This typically only occurs the first time the GNSS receiver obtains a fix after startup. The time initialised status flag can be used to determine whether the time and 1PPS line is accurate or not.

The dedicated **9.3 1PPS Signal** on the Connector Pin-out or the auxiliary transmit are the recommended 1PPS signals as they have less jitter than the GPIO ports. The validity of the dedicated 1PPS signal can be monitored using the “time initialised” flag in the **10.4.1 System State Packet**.

9.6.1.3 GNSS Fix Output

Type: Digital Output

GPIO Port: 1, 2

Auxiliary: Transmit

Description: In this function, the pin is low when there is no GNSS fix or a 2D fix and high when there is a 3D, SBAS, Differential or RTK GNSS fix.

9.6.1.4 Zero Velocity Input

Type: Digital Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: When using this function, a high state indicates to Certus that it is stationary. The low state indicates that the vehicle is not stationary. Use of this function can prevent drift during periods when a GNSS signal is not available.

9.6.1.5 Disable Magnetometers

Type: Digital Input

GPIO Port: All

Auxiliary: Receive

Description: This function accepts a digital input with a low state enabling the magnetometers and a high state disabling the magnetometers.

9.6.1.6 Disable GNSS

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function accepts a digital input with a low state enabling the GNSS and a high state disabling the GNSS.

9.6.1.7 Disable Pressure

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function accepts a digital input with a low state enabling the atmospheric pressure sensor and a high state disabling the atmospheric pressure sensor.

9.6.1.8 Set Zero Orientation Alignment

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function accepts a digital input. The input is normally low and a transition from low to high causes Certus to set its alignment so that the current orientation is zero. Due to the risk of exhausting the flash cycles, the change is not permanent and will disappear on reset. To make it permanent the **10.6.5 Installation Alignment Packet** must be read and then sent back to Certus with the permanent flag set. This function requires de-bouncing if attached to a switch.

9.6.1.9 System State Packet Trigger

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function accepts a digital input. The input is normally low and a transition from low to high causes Certus to send the System State Packet. This function requires de-bouncing if attached to a switch.

9.6.1.10 Raw Sensors Packet Trigger

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function accepts a digital input. The input is normally low and a transition from low to

high causes Certus to send the **10.4.9 Raw Sensors Packet**. This function requires debouncing if attached to a switch.

9.6.1.11 1PPS Input

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function is designed to allow external GNSS receivers to synchronise time with Certus. It triggers on a transition from low to high.

9.6.1.12 Event 1 Input

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function is designed to allow external events to be recorded by Certus. The event is recorded in the Filter Status (see **10 Advanced Navigation Packet Protocol**), and resets after the next packet is output. The event triggers on a transition from low to high.

9.6.1.13 Event 2 Input

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function is designed to allow external events to be recorded by Certus. The event is recorded in the Filter Status (see **10 Advanced Navigation Packet Protocol**), and resets after the next packet is output. The event triggers on a transition from low to high.

9.6.1.14 Odometer Direction, Forward Low

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function is designed to take a reversing indication input for direction with an odometer or wheel encoder. It should be used in combination with Odometer Input or Wheel Speed Sensor.

9.6.1.15 Odometer Direction, Forward High

Type:	Digital Input
GPIO Port:	1, 2
Auxiliary:	Receive
Description:	This function is designed to take a reversing indication input for direction with an

odometer or wheel encoder. It should be used in combination with Odometer Input or Wheel Speed Sensor.

9.6.1.16 Reverse Alignment, Forward Low

Type: Digital Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed to reverse the alignment settings for vehicles that can have two vehicle forward directions, such as locomotives.

9.6.1.17 Reverse Alignment, Forward High

Type: Digital Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed to reverse the alignment settings for vehicles that can have two vehicle forward directions, such as locomotives.

9.6.1.18 Zero Angular Velocity Input

Type: Digital Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: In this function, a high state indicates to Certus that the vehicle is not rotating. The low state indicates that the vehicle could be rotating. Use of this function can significantly improve heading drift performance when a GNSS signal is not available.

9.6.1.19 Odometer Input

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed for low-resolution vehicle speed sensors and odometers. It expects a normally low input with a high state for the trigger. If the pulse length is more than 0.1 metres then this odometer input function should be used. If it is less than 0.1 metres, the wheel speed sensor function should be used.

Parameter	Value
Trigger	Low → High
Maximum Frequency	600 Khz
Maximum Pulse Rate	4294967 pulses/metre

Table 39: Odometer Specifications

9.6.1.20 Pitot Tube Input

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function allows fixed wing aircraft to measure airspeed to improve navigation performance. It requires a differential pressure sensor that has a frequency output such as the Kavlico P992 (frequency output option) or the Paroscientific series 5300.

9.6.1.21 Pressure Depth Transducer (deprecated)

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed for interfacing with a legacy pressure depth transducer. These are no longer available and the function is now deprecated.

9.6.1.22 Left Wheel Speed Sensor

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed for the left wheel of a vehicle with dual wheel speed sensors.

9.6.1.23 Right Wheel Speed Sensor

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed for the right wheel of a vehicle with dual wheel speed sensors.

9.6.1.24 Wheel Speed Sensor

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: Receive

Description: This function is designed for high resolution vehicle speed sensors and wheel speed sensors. It expects a normally low input with a high state for the trigger. If the pulse length is more than 0.1 metres the odometer input function should be used, if it is less than 0.1 metres the wheel speed sensor function should be used.

Parameter	Value
Trigger	Low → High
Maximum Frequency	40 MHz
Maximum Pulse Rate	4,294,967,295 pulses/metre

Table 40: Wheel Speed Sensor Specifications

9.6.1.25 Wheel Encoder Phase A

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: N/A

Description: This function is designed for rotary incremental quadrature encoders. It should be used in combination with Wheel Encoder Phase B.

9.6.1.26 Wheel Encoder Phase B

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: N/A

Description: This function is designed for rotary incremental quadrature encoders. It should be used in combination with Wheel Encoder Phase A.

9.6.1.27 Gimbal Encoder Phase A

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: N/A

Description: This function is designed for interfacing with a rotary incremental quadrature encoder to measure the azimuth angle of a gimbal in which Certus is installed. It should be used in combination with Gimbal Encoder Phase B.

9.6.1.28 Gimbal Encoder Phase B

Type: Frequency Input

GPIO Port: 1, 2

Auxiliary: N/A

Description: This function is designed for interfacing with a rotary incremental quadrature encoder to measure the azimuth angle of a gimbal in which Certus is installed. It should be used in combination with **Gimbal Encoder Phase A**.

9.6.1.29 NMEA Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts external data in the NMEA 0183 format. Advanced Navigation recommends against using NMEA 0183 input wherever possible due to the inefficiency, low accuracy and precision and weak error checking of the format. All NMEA messages received must have a valid checksum. Supported messages are listed below. The recommended combination of messages are RMC with optional messages GPGSV and GPGSA. If RMC is not available, GGA and VTG can be used.

Message ID	Description	Notes
GPGGA GNGGA	3D position	All constellations
GPGLL GNGLL	2D position	All constellations
GPRMC GNRMC	2D position, 2D velocity and coarse time	All constellations
GPVTG GNVTG	2D velocity	All constellations
GPHDT GNHDT HEHDT	Heading	All constellations
GPGSV GNGSV	Satellites	Only GPS (GPGSV)
GPGSA GNGSA	Dilution of Precision	
xxPIPS	Depth below surface	
xxVBW	Water speed, ground speed	
xxHDM	Magnetic heading	
PSIMSSB	SSBL position	
xxVHW	Water speed and heading	
xxDBS	Depth below surface	

Table 41: Supported NMEA messages

9.6.1.30 Novatel GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with a Novatel GNSS receiver. It accepts data in the Novatel binary format and requires messages BESTPOSB and BESTVELB at rates higher than 1 Hz (20 Hz recommended). The message BESTSATSB is optional to display detailed satellite information. The message HEADING is also supported for ALIGN capable receivers.

9.6.1.31 Topcon GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with a Topcon GNSS receiver. It accepts data in the GRIL TPS binary format and expects messages PG and VG at rates higher than 1 Hz.

9.6.1.32 Septentrio GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with a Septentrio GNSS receiver. It accepts data in the Septentrio Binary Format (SBF) and requires blocks PVTGeodetic, PosCovGeodetic and VelCovGeodetic at rates higher than 1 Hz (10 Hz recommended). The blocks DOP, ReceiverTime, ChannelStatus, ReceiverStatus, RFStatus and MeasEpoch are optional to display detailed status and signal information. The blocks BaseVectorGeod and AttCovEuler are also supported for dual-antenna Septentrio receivers.

9.6.1.33 ANPP Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts data in the ANPP format as specified in **10 Advanced Navigation Packet Protocol**.

When this function is enabled, the GPIO and auxiliary ports function the same as the primary port, with one exception:

- When setting the ANPP packet and message output rates, the changes only apply to the port you are connected to. For example, you cannot change the primary port or GPIO port packet and message rates when connected to the auxiliary port.

9.6.1.34 RTCM Differential GNSS Corrections Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts RTCM v3 GNSS corrections messages. This allows for Differential GNSS or RTK with the Certus internal GNSS receiver.

9.6.1.35 Trimble GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with an external Trimble GNSS receiver. It accepts data in the Trimble binary format GSOF and expects packet 0x40 with records 1, 2, 8, and 12 at rates higher than 1Hz (20 Hz recommended) and optional records 9 and 34 at 1 to 2 Hz.

9.6.1.36 u-blox GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with an external u-blox GNSS receiver. It accepts data in the u-blox binary format and expects message NAV-PVT at rates higher than 1 Hz.

9.6.1.37 Hemisphere GNSS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function is designed for interfacing Certus with an external Hemisphere GNSS receiver. It accepts data in the Hemisphere binary format and expects message Bin1 at rates higher than 1 Hz. For Hemisphere receivers that provide heading using two antennas, NMEA should be used instead as the binary format does not allow for transmission of heading information.

9.6.1.38 Teledyne DVL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts DVL data from a Teledyne DVL.

9.6.1.39 Tritech USBL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts USBL data from a Tritech USBL.

9.6.1.40 Linkquest DVL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts DVL data from a Linkquest DVL.

9.6.1.41 Nortek DVL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts DVL data in the Nortek DVL binary format. It accepts the packets 0x1B (DVL Bottom Track) and 0x1D (DVL Water Track). The recommended update rate is 8 Hz.

9.6.1.42 Water Linked DVL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts DVL data in Water Linked DVL. The recommended update rate is 8 Hz.

9.6.1.43 Nortek Nucleus DVL Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts DVL data in the Nortek Nucleus DVL binary format. It accepts the packets 0xB4 (DVL Bottom Track) and 0xBE (DVL Water Track). The recommended update rate is 8 Hz.

9.6.1.44 Valeport SVS Input

Type: Serial Receive

GPIO Port: 2

Auxiliary: Receive

Description: This function accepts data from a Valeport SVS. It accepts input from the Valeport standard format expecting pressure, temperature and speed of sound.

9.6.1.45 NMEA Output

Type: Serial Transmit

GPIO Port: 1

Auxiliary: Transmit

Description: This function outputs a configurable combination of the NMEA messages GPZDA, GPGGA, GPVTG, GPRMC, GPHDT, PASHR, GPROT, GPHEV, GPGSV, PFECGPAtt, and PFECGPHve at up to 50 Hz. The messages output and the output rate can be configured using the web UI or INS Manager. An example output is shown below.

```
$GPZDA,031644.460,07,05,2013,00,00*52

$GPGGA,031644.460,3352.3501851,S,15112.2355488,E,6,00,1.4,150
.0,M,0.0,M,,*7E

$GPVTG,089.19,T,089.19,M,000.00,N,000.00,K,E*27

$GPRMC,031644.460,A,3352.3501851,S,15112.2355488,E,0.0,89.2,0
70513,12.5,W,E*02

$GPHDT,89.2,T*06

$PASHR,031644.460,089.19,T,-00.01,-00.47,-00.00,,,,0,0*2E
```

9.6.1.46 ANPP Output

Type: Serial Transmit

GPIO Port: 1

Auxiliary: Transmit

Description: This function outputs data in the ANPP format as specified in **10 Advanced Navigation Packet Protocol**. This function is for ANPP peripheral devices only.

When this function is enabled, the GPIO and auxiliary ports function except for:

- When setting the ANPP packet and message output rates, the changes only apply to the port you are connected to. For example, you cannot change the primary port or GPIO port packet and message rates when connected to the auxiliary port.

9.6.1.47 TSS1 Output

Type: Serial Transmit

GPIO Port: 1

Auxiliary: Transmit

Description: This function outputs the TSS1 format at a user configurable rate of up to 50 Hz. The output rate can be configured using the page in the web UI.

9.6.1.48 Simrad 1000 Output

Type: Serial Transmit

GPIO Port: 1

Auxiliary: Transmit

Description: This function outputs the Simrad 1000 format at a user configurable rate of up to 50 Hz. The output rate can be configured using the **GPIO** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the INS Manager.

9.6.1.49 Simrad 3000 Output

Type:	Serial Transmit
GPIO Port:	1
Auxiliary:	Transmit
Description:	This function outputs the Simrad 3000 format at a user configurable rate up to 50 Hz.The output rate can be configured using the **GPIO** page in the web UI or the **8.6.3 Configuration Menu** dialogue in the INS Manager.

9.6.1.50 Nortek Nucleus DVL Output

Type:	Serial Transmit
GPIO Port:	1
Auxiliary:	Transmit
Description:	Upon receiving the login prompt via the Nortek Nucleus DVL Input function, this function transmits the default 'nortek' password string followed by the 'start' string required to place the DVL into measurement mode.

9.6.1.51 Serial Port Passthrough

Type:	Serial
GPIO Port:	1, 2
Auxiliary:	All
Description:	This function allows passthrough communication through either GPIO 1 and 2 or the Auxiliary port. To transmit data use the **10.3 System Packets**. When data is received it will be sent back using the same **10.3 System Packets**.

9.6.1.52 GNSS Receiver Passthrough

Type:	Serial
GPIO Port:	1, 2
Auxiliary:	All
Description:	This function allows for pass through connection to the internal GNSS receiver. This is useful for firmware updates of the internal GNSS receiver.

10 Advanced Navigation Packet Protocol

The Advanced Navigation Packet Protocol (ANPP) is a binary protocol designed with high error checking, high efficiency and safe design practices. It has a publicly defined and flexible specification. Each Advanced Navigation product uses a subset of all the ANPP packets. This manual describes ANPP packets relevant to this product.

The following packet types are available:

- System Packets
- State Packets
- Configuration Packets

Note: You can access you're device via ANPP messages via one our web based or desktop applications, such as *INS Manager*.

System Packets

Packet ID	Name	Length	R/W
System Packets			
0	10.3.1 Acknowledge Packet	4	R
1	10.3.2 Request Packet	Varies	W
2	10.3.3 Boot Mode Packet	1	R/W
3	10.3.4 Device Information Packet	24	R
4	10.3.5 Restore Factory Settings Packet	4	W
5	10.3.6 Reset Packet	4	W
10	10.3.7 Serial Port Passthrough Packet	Varies	R/W
11	10.3.8 IP Configuration Packet	30	R/W
13	10.3.9 Extended Device Information Packet	36	R
14	10.3.10 Subcomponent Information Packet	24	R

System Packets

State Packets

Packet ID	Name	Length	R/W
State Packets			
20	10.4.1 System State Packet	100	R
21	10.4.2 Unix Time Packet	8	R
22	10.4.3 Formatted Time Packet	14	R
23	10.4.4 Status Packet	4	R
24	10.4.5 Position Standard Deviation Packet	12	R
25	10.4.6 Velocity Standard Deviation Packet	12	R

Packet ID	Name	Length	R/W
26	10.4.7 Euler Orientation Standard Deviation Packet	12	R
27	10.4.8 Quaternion Orientation Standard Deviation Packet	16	R
28	10.4.9 Raw Sensors Packet	48	R
29	10.4.10 Raw GNSS Packet	74	R/W
30	10.4.11 Satellites Packet	13	R
32	10.4.12 Geodetic Position Packet	24	R
33	10.4.13 ECEF Position Packet	24	R
34	10.4.14 UTM Position Packet	26	R
35	10.4.15 NED Velocity Packet	12	R
36	10.4.16 Body Velocity Packet	12	R
37	10.4.17 Acceleration Packet	12	R
38	10.4.18 Body Acceleration Packet	16	R
39	10.4.19 Euler Orientation Packet	12	R
40	10.4.20 Quaternion Orientation Packet	16	R
41	10.4.21 DCM Orientation Packet	36	R
42	10.4.22 Angular Velocity Packet	12	R
43	10.4.23 Angular Acceleration Packet	12	R
44	10.4.24 External Position and Velocity Packet	60	R/W
45	10.4.26 External Position Packet	36	R/W
46	10.4.27 External Velocity Packet	24	R/W
47	10.4.28 External Body Velocity Packet	16 or 24	R/W
48	10.4.29 External Heading Packet	8	R/W
49	10.4.30 Running Time Packet	8	R
50	10.4.31 Local Magnetic Field Packet	12	R
51	10.4.32 Odometer State Packet	20	R
52	10.4.33 External Time Packet	8	W
53	10.4.34 External Depth Packet	8	R/W
54	10.4.35 Geoid Height Packet	4	R
55	10.4.36 RTCM Corrections Packet	Varies	W
57	10.4.37 Wind Packet	12	R/W
58	10.4.38 Heave Packet	16	R
60	10.4.39 Raw Satellite Data Packet	Varies	R
61	10.4.40 Raw Satellite Ephemeris Packet	Varies	R

Packet ID	Name	Length	R/W
67	10.4.41 External Odometer Packet	13	W
68	10.4.42 External Air Data Packet	25	R/W
69	10.4.43 GNSS Receiver Information Packet	Varies	R
70	10.4.44 Raw DVL Data Packet	60	R
72	10.4.45 Gimbal State Packet	8	R/W
73	10.4.46 Automotive Packet	24	R
75	10.4.47 External Magnetometers Packet	17	R/W
80	10.4.48 Basestation Packet	45	R
83	10.4.49 Zero Angular Velocity Packet	8	W
84	10.4.50 Extended Satellites Packet	Varies	R
85	10.4.51 Sensor Temperature Packet	32	R
89	10.4.52 Vessel Motion Packet	48	R
90	10.4.53 Automatic Magnetic Calibration Status Packet	78	R
91	10.4.25 External SVS Packet	28	R/W
92	10.4.54 GNSS Position Velocity Time Packet	76	R/W
93	10.5 GNSS Orientation Packet	36	R/W
95	10.5.2 Aiding Source Status Packet	64	R/W

State Packets

Configuration Packets

Packet ID	Name	Length	R/W
Configuration Packets			
180	10.6.1 Packet Timer Period Packet	4	R/W
181	10.6.2 Packets Period Packet	Varies	R/W
182	10.6.3 Baud Rates Packet	17	R/W
184	10.6.4 Sensor Ranges Packet	4	R/W
185	10.6.5 Installation Alignment Packet	73	R/W
186	10.6.6 Filter Options Packet	17	R/W
188	10.6.7 GPIO Configuration Packet	13	R/W
189	10.6.8 Magnetic Calibration Values Packet	49	R/W
190	10.6.9 Magnetic Calibration Configuration Packet	1	W
191	10.6.10 Magnetic Calibration Status Packet	3	R
192	10.6.11 Odometer Configuration Packet	8	R/W
193	10.6.12 Set Zero Orientation Alignment Packet	5	W

Packet ID	Name	Length	R/W
194	10.6.13 Reference Point Offsets Packet	49	R/W
195	10.6.14 GPIO Output Configuration Packet	183	R/W
196	10.6.15 Dual Antenna Configuration Packet	17	R/W
197	10.6.16 GNSS Configuration Packet	85	R/W
198	10.6.17 User Data Packet	64	R/W
199	10.6.18 GPIO Input Configuration Packet	65	R/W
202	10.6.19 IP Dataports Configuration Packet	30	R/W
203	10.6.20 CAN Configuration Packet	11	R/W
207	10.6.21 Aiding Source Configuration Packet 1	243	R/W
208	10.6.22 Aiding Source Configuration Packet 2	243	R/W

Table 42: Configuration Packets

10.1 About Packets

10.1.1 Packet Structure

The ANPP packet structure and the header format are shown in the tables below. Example source code is provided in a SDK, available from the Advanced Navigation website.

Header				
Header LRC	Packet ID	Packet Length	CRC16	Packet Data

Table 43: ANPP Packet Structure

Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Header LRC
2	1	u8	1	Packet ID
3	2	u8	1	Packet Length
4	3	u16	2	CRC

Table 44: ANPP Header Format

10.1.1.1 Header LRC

The header LRC (Longitudinal Redundancy Check) provides error checking on the packet header. It also allows the decoder to find the start of a packet by scanning for a valid LRC. Only the lower 8 bits of the calculation below are provided in the LRC field of the packet header. The LRC can be found using the following:

$$LRC = (PacketID + PacketLength + crc_0 + crc_1) \oplus \mathbf{0xFF} + 1$$

10.1.1.2 Packet ID

The packet ID is used to distinguish the contents of the packet. Packet IDs range from 0 to 255. See 10 Advanced Navigation Packet Protocol.

System packets have packet IDs in the range 0 to 19. These packets are implemented the same by every device using ANPP.

State packets are packets that contain data that changes with time, i.e. temperature. State packets can be set to output at a certain rate. State packets are packet IDs in the range 20 to 179.

Configuration packets are used for reading and writing device configuration. Configuration packets are packet IDs in the range 180 to 255.

10.1.1.3 Packet Length

The packet length denotes the length of the packet data, i.e. from byte index 5 onwards inclusive. Packet length has a range of 0 – 255.

10.1.1.4 CRC

The CRC is a CRC16-CCITT. The starting value is 0xFFFF. The CRC covers only the packet data.

10.1.2 Packet Requests

Any of the state and configuration packets can be requested at any time using the **10.3 System Packets**.

10.1.3 Packet Acknowledgement

When configuration packets are sent to Certus, it will reply with an acknowledgement packet that indicates whether the configuration change was successful or not. See **10.3 System Packets**.

External data packets will also generate negative acknowledgement packets if there is a problem with the packet. Positive acknowledgements will not be sent. See **9.5 External Data** for a list of External Data Packets.

10.1.4 Packet Rates

The packet rates can be configured either using the web UI, or INS Manager or through the **10.6.2 Packets Period Packet**. By default Certus is configured to output the **10.4.1 System State Packet** at 20 Hz and the **10.4.9 Raw Sensors Packet** at 20 Hz. When configuring packet rates it is essential to ensure the baud rate is capable of handling the data throughput. This can be calculated using the rate and packet size. The packet size is calculated by adding the packet overhead to the packet length; the packet overhead is a fixed value of 5. For example to output the system state packet at 50Hz the calculation would be:

Data throughput = (100 (packet length) + 5 (fixed packet overhead)) * 50 (rate)

Data throughput = 5250 bytes per second

Minimum baud rate = data throughput x 10 bits per byte (including framing bits) x 1.1 (10% margin) = 57750 Baud

Closest standard baud rate = 115200 Baud

When multiple packets are set to output at the same rate, the order the packets output is from lowest ID to highest ID.

10.1.5 Packet Timing

Packets are output in order of packet ID from lowest ID to highest ID and all packets that are output in one sequence have their data matched to the same time of validity. The time of validity can be found in either the **10.4.1 System State Packet**, the **10.4.2 Unix Time Packet** or the **10.4.3 Formatted Time Packet**. For example if the **10.4.2 Unix Time Packet**, **10.4.4 Status Packet** and **10.4.15 NED Velocity Packet** packet were all set to output at 10 Hz, at each 0.1 second period the three packets would output consecutively by order of packet ID with all data synchronised between them and the **10.4.2 Unix Time Packet** providing the time of validity for the other two packets.

10.2 Data Types

The following data types are used in the packet protocol. All data types in the protocol are little endian byte ordering.

Abbreviation	Bytes	Also known as
u8	1	unsigned char, unsigned byte, uint8_t
s8	1	char, byte, int8_t
u16	2	unsigned short, uint16_t
s16	2	short, int16_t
u32	4	unsigned int, unsigned long, uint32_t
s32	4	int, long, int32_t
u64	8	unsigned long long, uint64_t
s64	8	long long, int64_t
fp32	4	float
fp64	8	double

Table 45: Data Type Abbreviations used in the ANPP

10.3 System Packets

10.3.1 Acknowledge Packet

Acknowledgement Packet				
Packet ID				0
Length				4
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Packet ID being acknowledged
2	1	u16	2	CRC of packet being acknowledged
3	3	u8	1	**10.3.1.1 Acknowledge Result**

Table 46: Acknowledge Packet

10.3.1.1 Acknowledge Result

Value	Description
0	Acknowledge success
1	Acknowledge failure, CRC error
2	Acknowledge failure, packet size incorrect
3	Acknowledge failure, values outside of valid ranges
4	Acknowledge failure, system flash memory failure
5	Acknowledge failure, system not ready
6	Acknowledge failure, unknown packet

Table 47: Acknowledge Result

10.3.2 Request Packet

Request Packet				
Packet ID				1
Length				1 x number of packets requested
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Packet ID requested
+				Field 1 repeats for additional packet requests

Table 48: Request Packet

10.3.3 Boot Mode Packet

Boot Mode Packet				
Packet ID				2
Length				1
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	10.3.3.1 Boot Mode Types

Table 49: Boot Mode Packet

10.3.3.1 Boot Mode Types

Value	Description
0	Bootloader
1	Main Program

Table 50: Boot Mode Types

10.3.4 Device Information Packet

Device Information Packet				
Packet ID				3
Length				24
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Software version
2	4	u32	4	10.3.4.1 Device ID
3	8	u32	4	Hardware revision
4	12	u32	4	Certus Serial number part 1
5	16	u32	4	Certus Serial number part 2
6	20	u32	4	Certus Serial number part 3

Table 51: Device Information Packet

10.3.4.1 Device ID

Value	Description
1	Spatial
4	Spatial FOG
5	Spatial Dual
11	Orientus v3
13	Air Data Unit 1
14	Subsonus
16	Spatial FOG Dual
17	Motus
19	GNSS Compass
21	Subsonus Tag
22	Poseidon
26	Certus
28	Boreas D90
41	Boreas D70
43	Boreas A90
44	Boreas A70
49	Certus Mini A
50	Certus Mini N
51	Certus Mini D
54	Boreas D50
56	Boreas A50
69	Air Data Unit 2

Table 52: Device IDs

10.3.5 Restore Factory Settings Packet

Note: A Factory Reset will re-enable the DHCP Client and lose any static IP address settings.

Restore Factory Settings Packet				
Packet ID				4
Length				4
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Verification sequence (set to 0x85429E1C)

Table 53: Restore Factory Settings Packet

10.3.6 Reset Packet

Reset Packet				
Packet ID				5
Length				4
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	10.3.6.1 Verification Sequence Values

Table 54: Reset Packet

10.3.6.1 Verification Sequence Values

Value	Description
0x21057A7E	Standard hot start reset
0x9A5D38B7	Cold start reset

Table 55: Verification Sequence Values

10.3.7 Serial Port Passthrough Packet

Serial Port Passthrough Packet				
Packet ID				10
Length				Variable, up to 255 bytes
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Passthrough Route
2	1			Passthrough Data

Table 56: Serial Port Passthrough Packet

10.3.7.1 Passthrough Route

Value	Description
1	GPIO 1 and 2
2	Auxiliary

Table 57: Passthrough Route

10.3.8 IP Configuration Packet

IP Configuration Packet	
Packet ID	11
Length	30

IP Configuration Packet				
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	10.3.8.1 DHCP Mode
3	2	u32	4	IP Address
4	6	u32	4	IP Netmask
5	10	u32	4	IP Gateway
6	14	u32	4	DNS Server
7	18	u32	4	Certus Serial number part 1
8	22	u32	4	Certus Serial number part 2
9	26	u32	4	Certus Serial number part 3

Table 58: IP Configuration Packet

10.3.8.1 DHCP Mode

Bit	Description
0	DHCP Enabled
1	Automatic DNS
2-4	Link Mode. See 10.3.8.2 Link Mode Index
5-7	Reserved (set to zero)

Table 59: DHCP Mode

10.3.8.2 Link Mode Index

Value	Bit 4	Bit 3	Bit 2	Description
0	0	0	0	Auto

Table 60: Link Mode Index

10.3.8.3 Discovery Network Setting Overwrite

Settings 7,8 and 9 are optional over standard network interfaces but required to overwrite settings over multi-cast discovery. To overwrite network settings for a device over multi-cast send this packet to address 239.48.81.7 port 48817, the serial number must be set to the serial number of the device you want to overwrite settings for.

10.3.9 Extended Device Information Packet

Extended Device Information Packet	
Packet ID	13
Length	36
Read / Write	Read

Extended Device Information Packet				
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Software version
2	4	u32	4	**10.3.4.1 Device ID**
3	8	u32	4	Hardware Revision
4	12	u32[3]	12	Serial Number
5	24	u32	4	**10.3.9.1 Device Sub-type**
6	28	u32	4	Bootloader Software Version
7	32	u32	4	Navigation Filter Version

Table 61: Extended Device Information Packet

10.3.9.1 Device Sub-type

Device ID	Device Sub-type Value	Description
26 - Certus	0	Certus
	1	Certus Evo
	2	Certus OEM
	3	Certus Evo OEM

Table 62: Device Sub-type

10.3.10 Subcomponent Information Packet

Only Advanced Navigation sub-components will be shown here, for GNSS Receiver see **10.4.43 GNSS Receiver Information Packet**

Subcomponent Information Packet				
Packet ID				14
Length				24 x number of subcomponents
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Subcomponent Software version
2	4	u32	4	**10.3.10.1 Subcomponent Device ID**
3	8	u32	4	Subcomponent Hardware Revision
4	12	u32[3]	12	Subcomponent Serial Number
Fields 1-4 repeat for additional subcomponents				

Table 63: Subcomponent Information Packet

10.3.10.1 Subcomponent Device ID

Value	Description
5	Spatial MEMS IMU
17	Evo MEMS IMU
27	Aries

Table 64: Subcomponent Device IDs

10.4 State Packets

10.4.1 System State Packet

System State Packet				
Packet ID				20
Length				100
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u16	2	**10.4.1.1 System Status**
2	2	u16	2	**10.4.1.2 Filter Status**
3	4	u32	4	**10.4.1.4 Unix Time Seconds**
4	8	u32	4	**10.4.1.5 Microseconds**
5	12	fp64	8	Latitude (rad)
6	20	fp64	8	Longitude (rad)
7	28	fp64	8	Height (m)
8	36	fp32	4	Velocity north (m/s)
9	40	fp32	4	Velocity east (m/s)
10	44	fp32	4	Velocity down (m/s)
11	48	fp32	4	Body acceleration X (m/s/s)
12	52	fp32	4	Body acceleration Y (m/s/s)
13	56	fp32	4	Body acceleration Z (m/s/s)
14	60	fp32	4	G force (g)
15	64	fp32	4	Roll (radians)
16	68	fp32	4	Pitch (radians)
17	72	fp32	4	Heading (radians)
18	76	fp32	4	Angular velocity X (rad/s)
19	80	fp32	4	Angular velocity Y (rad/s)

System State Packet				
20	84	fp32	4	Angular velocity Z (rad/s)
21	88	fp32	4	Latitude standard deviation (m)
22	92	fp32	4	Longitude standard deviation (m)
23	96	fp32	4	Height standard deviation (m)

Table 65: System State Packet

10.4.1.1 System Status

This field contains 16 bits that indicate problems with the system. These are boolean fields with a zero indicating false and one indicating true.

Use the Raw GNSS packet #29 to identify which of the GNSS receivers or antennas has a problem.

Bit	Description
0	System Failure
1	Accelerometer Sensor Failure
2	Gyroscope Sensor Failure
3	Magnetometer Sensor Failure
4	Pressure Sensor Failure
5	GNSS Failure
6	Accelerometer Over Range
7	Gyroscope Over Range
8	Magnetometer Over Range
9	Pressure Over Range
10	Minimum Temperature Alarm
11	Maximum Temperature Alarm
12	Internal Data Logging Error
13	High Voltage Alarm
14	GNSS Antenna Connection (open or short circuit, primary or secondary antenna). NOTE: This bit is not applicable to units with a Trimble BD992 GNSS Receiver
15	Data Output Overflow Alarm

Table 66: System Status

10.4.1.2 Filter Status

This field contains 16 bits that indicate the status of the filters. These are boolean fields with a zero indicating false and one indicating true.

Bit	Description
0	Orientation Filter Initialised
1	Navigation Filter Initialised
2	Heading Initialised
3	UTC Time Initialised
4	10.4.1.3 GNSS Fix Status
5	
6	
7	Event 1 Occurred
8	Event 2 Occurred
9	Internal GNSS Enabled
10	Dual Antenna Heading Active
11	Velocity Heading Enabled
12	Atmospheric Altitude Enabled
13	External Position Active
14	External Velocity Active
15	External Heading Active

Table 67: Filter Status

10.4.1.3 GNSS Fix Status

Value	Description
0	No GNSS fix
1	2D GNSS fix
2	3D GNSS fix
3	SBAS GNSS fix
4	Differential GNSS fix
5	PPP GNSS fix
6	RTK Float GNSS fix
7	RTK Fixed GNSS fix

Table 68: GNSS Fix Status

10.4.1.4 Unix Time Seconds

This field provides the Unix time in seconds, using the standard epoch of January 1, 1970.

10.4.1.5 Microseconds

This field provides the sub-second component of time. It is represented as microseconds since the last second. Minimum value is 0 and maximum value is 999999.

10.4.2 Unix Time Packet

Unix Time Packet				
Packet ID				21
Length				8
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Unix time stamp (seconds). See **10.4.1.4 Unix Time Seconds**
2	4	u32	4	**Microseconds**

Table 69: Unix Time Packet

10.4.3 Formatted Time Packet

Formatted Time Packet				
Packet ID				22
Length				14
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Microseconds
2	4	u16	2	Year
3	6	u16	2	Year day, 0 - 365
4	8	u8	1	Month, 0 - 11
5	9	u8	1	Month Day, 1 - 31
6	10	u8	1	Week Day, 0 – 6 (0 = Sunday)
7	11	u8	1	Hour, 0 - 23
8	12	u8	1	Minute, 0 - 59
9	13	u8	1	Second, 0 - 59

Table 70: Formatted Time Packet

10.4.4 Status Packet

Status Packet				
Packet ID				23
Length				4
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u16	2	System Status
2	2	u16	2	Filter Status

Table 71: Status Packet

10.4.5 Position Standard Deviation Packet

Position Standard Deviation Packet				
Packet ID				24
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Latitude standard deviation (m)
2	4	fp32	4	Longitude standard deviation (m)
3	8	fp32	4	Height standard deviation (m)

Table 72: Position Standard Deviation Packet

10.4.6 Velocity Standard Deviation Packet

Velocity Standard Deviation Packet				
Packet ID				25
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Velocity north standard deviation (m/s)
2	4	fp32	4	Velocity east standard deviation (m/s)
3	8	fp32	4	Velocity down standard deviation (m/s)

Table 73: Velocity Standard Deviation Packet

10.4.7 Euler Orientation Standard Deviation Packet

Euler Orientation Standard Deviation Packet				
Packet ID				26
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Roll standard deviation (rad)
2	4	fp32	4	Pitch standard deviation(rad)
3	8	fp32	4	Heading standard deviation(rad)

Table 74: Euler Orientation Standard Deviation Packet

10.4.8 Quaternion Orientation Standard Deviation Packet

Quaternion Orientation Standard Deviation Packet				
Packet ID				27
Length				16
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Q0 standard deviation
2	4	fp32	4	Q1 standard deviation
3	8	fp32	4	Q2 standard deviation
4	12	fp32	4	Q3 standard deviation

Table 75: Quaternion Orientation Standard Deviation Packet

10.4.9 Raw Sensors Packet

10.4.9.1 Raw Sensors Packet - INS

Raw Sensors Packet				
Packet ID				28
Length				48
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Accelerometer X (m/s/s)
2	4	fp32	4	Accelerometer Y (m/s/s)
3	8	fp32	4	Accelerometer Z (m/s/s)
4	12	fp32	4	Gyroscope X (rad/s)
5	16	fp32	4	Gyroscope Y (rad/s)
6	20	fp32	4	Gyroscope Z (rad/s)
7	24	fp32	4	Magnetometer X (mG)
8	28	fp32	4	Magnetometer Y (mG)
9	32	fp32	4	Magnetometer Z (mG)
10	36	fp32	4	IMU Temperature (deg C)
11	40	fp32	4	Pressure (Pascals)
12	44	fp32	4	Pressure Temperature (deg C)

Table 76: Raw Sensors Packet - INS

10.4.10 Raw GNSS Packet

This packet represents the raw data as it is received from the GNSS receiver. The position is not corrected for antenna position offset and the velocity is not compensated for the antenna lever arm offset. The INS position and velocity that are in the other packets are corrected for antenna position offset and lever arm.

Note: This packet is supported, but is superseded by **10.4.54 GNSS Position Velocity Time Packet** and **10.5 GNSS Orientation Packet** which provide additional information.

Raw GNSS Packet				
Packet ID				29
Length				74
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Unix time stamp (seconds)
2	4	u32	4	Microseconds
3	8	fp64	8	Latitude (rad)
4	16	fp64	8	Longitude (rad)
5	24	fp64	8	Height (m)
6	32	fp32	4	Velocity north (m/s)
7	36	fp32	4	Velocity east (m/s)
8	40	fp32	4	Velocity down (m/s)
9	44	fp32	4	Latitude standard deviation (m)
10	48	fp32	4	Longitude standard deviation (m)
11	52	fp32	4	Height standard deviation (m)
12	56	fp32	4	Tilt (rad)
13	60	fp32	4	Heading (rad)
14	64	fp32	4	Tilt standard deviation (rad)
15	68	fp32	4	Heading standard deviation (rad)
16	72	u16	2	Status. See **10.4.10.1 Raw GNSS Status**

Table 77: Raw GNSS Packet

10.4.10.1 Raw GNSS Status

Bit	Description
0	**GNSS Fix Status**
1	
2	
3	Doppler velocity valid

Bit	Description
4	Time valid
5	External GNSS
6	Tilt valid
7	Heading valid
8	Floating ambiguity heading
9	Reserved (set to zero)
10	Antenna 1 disconnected (not applicable to units with Trimble BD992 GNSS receiver)
11	Antenna 2 disconnected (not applicable to units with Trimble BD992 GNSS receiver)
12	Antenna 1 short (not applicable to units with Trimble BD992 GNSS receiver)
13	Antenna 2 short (not applicable to units with Trimble BD992 GNSS receiver)
14	GNSS1 failure
15	GNSS2 failure (not applicable to units with Trimble BD992 GNSS receiver)

Table 78: Raw GNSS Status

10.4.11 Satellites Packet

Satellites Packet				
Packet ID				30
Length				13
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	HDOP
2	4	fp32	4	VDOP
3	8	u8	1	GPS satellites
4	9	u8	1	GLONASS satellites
5	10	u8	1	BeiDou satellites
6	11	u8	1	GALILEO satellites
7	12	u8	1	SBAS satellites

Table 79: Satellites Packet

10.4.12 Geodetic Position Packet

Geodetic Position Packet				
Packet ID				32
Length				24
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp64	8	Latitude (rad)
2	8	fp64	8	Longitude (rad)
3	16	fp64	8	Height (m)

Table 80: Geodetic Position Packet

10.4.13 ECEF Position Packet

ECEF Position Packet				
Packet ID				33
Length				24
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp64	8	ECEF X (m)
2	8	fp64	8	ECEF Y (m)
3	16	fp64	8	ECEF Z (m)

Table 81: ECEF Position Packet

10.4.14 UTM Position Packet

UTM Position Packet				
Packet ID				34
Length				26
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp64	8	Northing (m)
2	8	fp64	8	Easting (m)
3	16	fp64	8	Height (m)
4	24	u8	1	Zone number
5	25	s8	1	Zone character

Table 82: UTM Position Packet

10.4.15 NED Velocity Packet

NED Velocity Packet				
Packet ID				35
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Velocity north (m/s)
2	4	fp32	4	Velocity east (m/s)
3	8	fp32	4	Velocity down (m/s)

Table 83: NED Velocity Packet

10.4.16 Body Velocity Packet

Body Velocity Packet				
Packet ID				36
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Velocity X (m/s)
2	4	fp32	4	Velocity Y (m/s)
3	8	fp32	4	Velocity Z (m/s)

Table 84: Body Velocity Packet

10.4.17 Acceleration Packet

This packet includes the acceleration due to gravity.

Acceleration Packet				
Packet ID				37
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Acceleration X (m/s/s)
2	4	fp32	4	Acceleration Y (m/s/s)
3	8	fp32	4	Acceleration Z (m/s/s)

Table 85: Acceleration Packet

10.4.18 Body Acceleration Packet

This packet does not include the acceleration due to gravity.

Body Acceleration Packet				
Packet ID				38
Length				16
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Body acceleration X (m/s/s)
2	4	fp32	4	Body acceleration Y (m/s/s)
3	8	fp32	4	Body acceleration Z (m/s/s)
4	12	fp32	4	G force (g)

Table 86: Body Acceleration Packet

10.4.19 Euler Orientation Packet

Euler Orientation Packet				
Packet ID				39
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Roll (rad)
2	4	fp32	4	Pitch (rad)
3	8	fp32	4	Heading (rad)

Table 87: Euler Orientation Packet

10.4.20 Quaternion Orientation Packet

Quaternion Orientation Packet				
Packet ID				40
Length				16
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	QS
2	4	fp32	4	QX
3	8	fp32	4	QY
4	12	fp32	4	QZ

Table 88: Quaternion Orientation Packet

10.4.21 DCM Orientation Packet

DCM Orientation Packet				
Packet ID				41
Length				36
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	DCM[0][0]
2	4	fp32	4	DCM[0][1]
3	8	fp32	4	DCM[0][2]
4	12	fp32	4	DCM[1][0]
5	16	fp32	4	DCM[1][1]
6	20	fp32	4	DCM[1][2]
7	24	fp32	4	DCM[2][0]
8	28	fp32	4	DCM[2][1]
9	32	fp32	4	DCM[2][2]

Table 89: DCM Orientation Packet

10.4.22 Angular Velocity Packet

Angular Velocity Packet				
Packet ID				42
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Angular velocity X (rad/s)
2	4	fp32	4	Angular velocity Y (rad/s)
3	8	fp32	4	Angular velocity Z (rad/s)

Table 90: Angular Velocity Packet

10.4.23 Angular Acceleration Packet

Angular Acceleration Packet				
Packet ID				43
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Angular acceleration X (rad/s/s)
2	4	fp32	4	Angular acceleration Y (rad/s/s)
3	8	fp32	4	Angular acceleration Z (rad/s/s)

Table 91: Angular Acceleration Packet

10.4.24 External Position and Velocity Packet

External Position and Velocity Packet				
Packet ID				44
Length				60
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp64	8	Latitude (rad)
2	8	fp64	8	Longitude (rad)
3	16	fp64	8	Height (m)
4	24	fp32	4	Velocity north (m/s)
5	28	fp32	4	Velocity east (m/s)
6	32	fp32	4	Velocity down (m/s)
7	36	fp32	4	Latitude standard deviation (m)
8	40	fp32	4	Longitude standard deviation (m)
9	44	fp32	4	Height standard deviation (m)
10	48	fp32	4	Velocity north standard deviation (m/s)
11	52	fp32	4	Velocity east standard deviation (m/s)
12	56	fp32	4	Velocity down standard deviation (m/s)

Table 92: External Position and Velocity Packet

10.4.25 External SVS Packet

External SVS Packet				
Packet ID				91
Length				28
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Pressure (dBar)
2	4	fp32	4	Temperature (°C)
3	8	fp32	4	Sound Velocity (m/s)
4	12	fp32	4	Salinity (ppt)
5	16	fp32	4	Density (kg/m^3)
6	20		8	Reserved (set to zero)

Table 93: External SVS Packet

10.4.26 External Position Packet

External Position Packet				
Packet ID				45
Length				36
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp64	8	Latitude (rad)
2	8	fp64	8	Longitude (rad)
3	16	fp64	8	Height (m)
4	24	fp32	4	Latitude standard deviation (m) Must be non-zero positive value
5	28	fp32	4	Longitude standard deviation (m) Must be non-zero positive value
6	32	fp32	4	Height standard deviation (m) Must be non-zero positive value

Table 94: External Position Packet

10.4.27 External Velocity Packet

External Velocity Packet	
Packet ID	46
Length	24
Read / Write	Read / Write

External Velocity Packet				
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Velocity north (m/s)
2	4	fp32	4	Velocity east (m/s)
3	8	fp32	4	Velocity down (m/s)
4	12	fp32	4	Velocity north standard deviation (m/s)
5	16	fp32	4	Velocity east standard deviation (m/s)
6	20	fp32	4	Velocity down standard deviation (m/s)

Table 95: External Velocity Packet

10.4.28 External Body Velocity Packet

This packet has been defined to support a single velocity standard deviation for all three axes, or, different values for all three axes. Modify the packet length in the packet header accordingly, depending on which format you are using.

External Body Velocity Packet				
Packet ID				47
Length				16 or 24
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Velocity X (m/s)
2	4	fp32	4	Velocity Y (m/s)
3	8	fp32	4	Velocity Z (m/s)
4	12	fp32	4	Velocity X standard deviation (m/s)
5	16	fp32	4	OPTIONAL: Velocity standard deviation Y (m/s)
6	20	fp32	4	OPTIONAL: Velocity standard deviation Z (m/s)

Table 96: External Body Velocity Packet

10.4.29 External Heading Packet

External Heading Packet				
Packet ID				48
Length				8
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Heading (rad)
2	4	fp32	4	Heading standard deviation (rad)

Table 97: External Heading Packet

10.4.30 Running Time Packet

This packet provides the running time in seconds since the most recent power on.

Running Time Packet				
Packet ID				49
Length				8
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Running time (seconds)
2	4	u32	4	**10.4.1.5 Microseconds**

Table 98: Running Time Packet

10.4.31 Local Magnetic Field Packet

Local Magnetic Field Packet				
Packet ID				50
Length				12
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Local magnetic field X (mG)
2	4	fp32	4	Local magnetic field Y (mG)
3	8	fp32	4	Local magnetic field Z (mG)

Table 99: Local Magnetic Field Packet

10.4.32 Odometer State Packet

Odometer State Packet				
Packet ID				51
Length				20
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	s32	4	Odometer pulse count
2	4	fp32	4	Odometer distance (m)
3	8	fp32	4	Odometer speed (m/s)
4	12	fp32	4	Odometer slip (m)
5	16	u8	1	Odometer active
6	17		3	Reserved (set to zero)

Table 100: Odometer State Packet

10.4.33 External Time Packet

External Time Packet				
Packet ID				52
Length				8
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	**10.4.1.4 Unix Time Seconds**
2	4	u32	4	**10.4.1.5 Microseconds**

Table 101: External Time Packet

10.4.34 External Depth Packet

External Depth is the measured distance below Mean Sea Level

External Depth Packet				
Packet ID				53
Length				8
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Depth (m)
2	4	fp32	4	Depth standard deviation (m)

Table 102: External Depth Packet

10.4.35 Geoid Height Packet

This packet provides the offset at the current location between the WGS84 ellipsoid and the EGM96 geoid model. This can be used to determine the current height above mean sea level and also depth through the following equations:

Height Above Mean Sea Level = WGS84 Height – Geoid Height

Depth = Geoid Height – WGS84 Height

WGS84 Height is the height at the current location in the System State packet, see **10.4.1 System State Packet**

Geoid Height Packet				
Packet ID				54
Length				4
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Geoid height (m)

Table 103: Geoid Height Packet

10.4.36 RTCM Corrections Packet

This packet is used to encapsulate RTCM v3 correction data to be sent to the Certus internal GNSS receiver for DGPS or RTK GNSS functionality.

RTCM Corrections Packet				
Packet ID				55
Length				Variable, up to 255 bytes
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0			RTCM corrections data

Table 104: RTCM Corrections Packet

10.4.37 Wind Packet

This packet provides the Certus current 2D wind velocity. These values are only valid when external air data is provided to Certus. This can be either through the **10.4.42 External Air Data Packet** or when a pitot tube is interfaced to one of the GPIO pins. When this packet is written to the device, it disables the wind estimation filter and the wind values provided are used statically.

Wind Packet				
Packet ID				57
Length				12
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Wind velocity north (m/s)
2	4	fp32	4	Wind velocity east (m/s)
3	8	fp32	4	Wind velocity standard deviation (m/s)

Table 105: Wind Packet

10.4.38 Heave Packet

Note: For surge and sway values, see **10.4.52 Vessel Motion Packet**.

Heave Packet				
Packet ID				58
Length				16
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Heave point 1 (m)
2	4	fp32	4	Heave point 2 (m)
3	8	fp32	4	Heave point 3 (m)
4	12	fp32	4	Heave point 4 (m)

Table 106: Heave Packet

10.4.39 Raw Satellite Data Packet

The INS Manager Log Converter will automatically convert this packet to RINEX 3.02 format.

Note: When this packet is enabled, Packet 61 (**10.4.40 Raw Satellite Ephemeris Packet**) is also automatically enabled .

Raw Satellite Data Packet	
Packet ID	60
Length	16 + Satellites * (6 + Frequencies * 26)

Raw Satellite Data Packet				
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	**Unix time (seconds)**
2	4	u32	4	Nanoseconds
3	8	s32	4	Receiver clock offset (nanoseconds)
4	12	u8	1	Receiver number
5	13	u8	1	Packet number (range 1 to Total)
6	14	u8	1	Total packets
7	15	u8	1	Number of satellites
For each satellite				
8	16	u8	1	**Satellite Systems**
9	17	u8	1	PRN or satellite number
10	18	u8	1	Elevation (degrees)
11	19	u16	2	Azimuth (degrees)
12	21	u8	1	Number of frequencies
For each frequency of each satellite				
13	22	u8	1	**Satellite Frequencies**
14	23	u8	1	**Tracking Status**
15	24	fp64	8	Carrier phase (cycles)
16	32	fp64	8	Pseudo range (m)
17	40	fp32	4	Doppler frequency (Hz)
18	44	fp32	4	Signal to noise ratio (dB-Hz)

Table 107: Raw Satellite Data Packet

10.4.39.1 Satellite Systems

Value	System
0	Unknown
1	GPS
2	GLONASS
3	BeiDou
4	Galileo
5	SBAS
6	QZSS
7	Reserved
8	Omnistar
9	Reserved
10	NavIC

Table 108: Satellite Systems

10.4.39.2 Satellite Frequencies

Value	GPS	GLONASS	Galileo	BeiDou	SBAS	QZSS	Omnistar	NavIC
0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	L1 C/A	
1	L1 C/A	G1 C/A	E1 OS	B1	L1 C/A	L1 C/A		
2	L1 C		E1 PRS			L1 C		
3	L1 P	G1 P				L1 SAIF		
4	L1 M							
5	L2 C	G2 C/A	E6 CS	B2		L2 C		
6	L2 P	G2 P	E6 PRS			LEX		
7	L2 M							
8	L5	G3	E5 a	B3	L5	L5		L5
9			E5 b					
10			E5 a+b					

Table 109: Satellite Frequencies

10.4.39.3 Tracking Status

Bit	Description
0	Carrier phase valid
1	Carrier phase cycle slip detected
2	Carrier phase half-cycle ambiguity
3	Pseudo range valid
4	Doppler valid
5	SNR valid
6-7	Reserved (set to zero)

Table 110: Tracking Status

10.4.40 Raw Satellite Ephemeris Packet

INS Manager will automatically convert this packet to RINEX 3.02 format.

Note: This packet is enabled automatically when packet 60 (10.4.39 Raw Satellite Data Packet) is enabled. This packet cannot be enabled independently of Packet 60.

Raw Satellite Ephemeris Packet				
Packet ID				61
Length				Varies
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Unix timestamp (seconds)
2	4	u8	1	Satellite System
3	5	u8	1	Satellite number (PRN)
For GPS Satellites (132 bytes)				
5	6	u32	4	Time of ephemeris (Toe) (s)
6	10	u16	2	Issue of Data Clock [IODC] (s)
7	12	u16	2	Issue of Data Ephemeris [IODE] (s)
8	14	fp32	4	Satellite Clock Bias [af0] (s)
9	18	fp32	4	Satellite Clock Drift [af1] (s/s)
10	22	fp32	4	Satellite Clock Drift Rate [af2] (s/s/s)
11	26	fp32	4	Crs (m)
12	30	fp32	4	Delta N (rad/s)
13	34	fp64	8	M0 (rad)
14	42	fp32	4	Cuc (rad)

Raw Satellite Ephemeris Packet				
15	46	fp64	8	Eccentricity [e]
16	54	fp32	4	Cus (rad)
17	58	fp64	8	√A (√m)
18	66	fp32	4	Cic (rad)
19	70	fp64	8	OMEGA0 (rad)
20	78	fp32	4	Cis (rad)
21	82	fp64	8	i0 (rad)
22	90	fp32	4	Crc (m)
23	94	fp64	8	Omega (rad)
24	102	fp64	8	Omega dot (rad/s)
25	110	fp64	8	IDOT (rad/s)
26	118	fp32	4	TGD (s)
27	122	u16	2	Ephemeris week number
28	124	u32	4	Transmission time (s)
29	128	u16	2	User range accuracy (m)
30	130	u16	2	10.4.40.1 GPS Flags
For GLONASS satellites (94 Bytes)				
5	6	fp32	4	Satellite clock bias (s)
6	10	fp32	4	Satellite frequency bias [gamma]
7	14	fp64	8	Satellite position X (m)
8	22	fp64	8	Satellite position Y (m)
9	30	fp64	8	Satellite position Z (m)
10	38	fp64	8	Satellite velocity X (m/s)
11	46	fp64	8	Satellite velocity Y (m/s)
12	54	fp64	8	Satellite velocity Z (m/s)
13	62	fp64	8	Satellite acceleration X (m/s/s)
14	70	fp64	8	Satellite acceleration Y (m/s/s)
15	78	fp64	8	Satellite acceleration Z (m/s/s)
16	86	u32	4	Message frame start time (s)
17	90	u8	1	Age of operational information [E] (days)
18	91	s8	1	Frequency slot number
19	92	u8	1	Satellite Health
20	93		1	Reserved (set to zero)

Table 111: Raw Satellite Ephemeris Packet

10.4.40.1 GPS Flags

Bit	Description
0	Data flag for L2 P-code
1-2	Codes on L2 channel
3	Anti-spoof flag
4-9	Satellite health
10	Fit interval flag
11	URA bad
12-14	Satellite block type

Table 112: GPS Flags

10.4.41 External Odometer Packet

External Odometer Packet				
Packet ID				67
Length				13
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Estimated delay (s)
2	4	fp32	4	Speed (m/s)
3	8		4	Reserved (set to zero)
4	12	u8	1	Odometer flags

Table 113: External Odometer Packet

10.4.41.1 Odometer Flags

Bit	Description
0	Reversing detection supported
1-7	Reserved (set to zero)

Table 114: Odometer Flags

10.4.42 External Air Data Packet

External Air Data Packet				
Packet ID				68
Length				25
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Barometric altitude delay (s)
2	4	fp32	4	Airspeed delay (s)
3	8	fp32	4	Barometric altitude (m)
4	12	fp32	4	True Airspeed (TAS) (m/s) when temperature sensor **is** connected. Indicated Airspeed (IAS) (m/s) when temperature sensor **is not** connected.
5	16	fp32	4	Barometric altitude standard deviation (m)
6	20	fp32	4	Airspeed standard deviation (m/s)
7	24	u8	1	Flags

Table 115: External Air Data Packet

10.4.42.1 External Air Data Flags

Bit	Description
0	Barometric altitude set and valid
1	Airspeed set and valid
2	Barometric altitude sensor over-range
3	Airspeed sensor over-range
4	Barometric altitude sensor failure
5	Airspeed sensor failure
6-7	Reserved (set to zero)

Table 116: External Air Data Flags

Barometric altitude does not need to be referenced to any co-ordinate frame or QNH. If the barometric altitude reference is changed during operation, the barometric altitude reference reset flag should be set for the next packet.

10.4.43 GNSS Receiver Information Packet

10.4.43.1 Aries GNSS Receiver

GNSS Receiver Information Packet				
Packet ID				69
Length				68
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	**GNSS manufacturer ID**
2	1	u8	1	**GNSS receiver model**
3	2	s8 [24]	24	GNSS serial number in ASCII character string
4	26	u32	4	Firmware version
5	30	u32	4	Hardware version
6	34		34	Reserved (set to zero)

Table 117: GNSS Receiver Information Packet

10.4.43.2 Trimble BD992 GNSS Receiver

GNSS Receiver Information Packet				
Packet ID				69
Length				48
read/Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	**GNSS manufacturer ID**
2	1	u8	1	**GNSS receiver model**
3	2	s8[10]	10	GNSS serial number in ASCII character string
4	12	u32	4	Firmware version
5	16	u32[3]	12	Software license code
6	28	u32	4	Omnistar serial number
7	32	u32	4	Omnistar subscription start unix time
8	36	u32	4	Omnistar subscription expiry unix time
9	40	u8	1	**Omnistar engine mode**
10	41	u8	1	**RTK Software license accuracy**
11	42		6	Reserved (set to zero)

Table 118: GNSS Receiver Information Packet

10.4.43.3 GNSS Manufacturer IDs and Receiver Models

Manufacturer		Receiver	
ID	Description	Value	Description
0	GNSS Manufacturer Unknown	0	GNSS Receiver Model Unknown
1	Trimble	0	GNSS Receiver Model Unknown
		5	Trimble MB-Two
		7	Trimble BD992
2	u-blox	0	GNSS Receiver Model Unknown
		5	u-blox NEO-F9P
3	Advanced Navigation	0	GNSS Receiver Model Unknown
		1	Aries
		2	Aries GC2

Table 119: GNSS Manufacturer IDs and Receiver Models

Note: After a factory restore, devices with a GNSS will take up to ~ 20 sec to report the GNSS receiver type.

10.4.43.4 Omnistar Engine Modes

Value	Description
0	Omnistar engine not active
1	HP
2	XP
3	G2
4	HP+G2
5	HP+XP

Table 120: Omnistar Engine Modes

10.4.43.5 RTK Software License Accuracy

Value	Description
0	RTK accuracy unknown
1	0.3m horizontal, 0.3m vertical
2	0.1m horizontal, 0.1m vertical
3	0.1m horizontal, 0.02m vertical
4	0.008m horizontal, 0.1m vertical
5	0.008m horizontal, 0.02m vertical

Table 121: RTK Software License Accuracies

10.4.44 Raw DVL Data Packet

Note: The Raw DVL Data packet will be output each time it is received, unless a certain output rate has been set in "Configuration"→"Packet Rates" of INS Manager.

Raw DVL Data Packet				
Packet ID				70
Length				60
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	Unix timestamp (seconds)
2	4	u32	4	Microseconds
3	8	u32	4	Flags, see 10.4.44.1 Raw DVL Data Flags
4	12	fp32	4	Bottom velocity X (m/s)
5	16	fp32	4	Bottom velocity Y (m/s)
6	20	fp32	4	Bottom velocity Z (m/s)
7	24	fp32	4	Bottom velocity standard deviation (m/s)
8	28	fp32	4	Water velocity X (m/s)
9	32	fp32	4	Water velocity Y (m/s)
10	36	fp32	4	Water velocity Z (m/s)
11	40	fp32	4	Water velocity standard deviation (m/s)
12	44	fp32	4	Water velocity layer depth (m)
13	48	fp32	4	Depth (m)
14	52	fp32	4	Altitude (m)
15	56	fp32	4	Temperature (deg C)

Table 122: Raw DVL Data Packet

10.4.44.1 Raw DVL Data Flags

Bit	Description
0	Bottom velocity valid
1	Water velocity valid
2	Temperature valid
3	Depth valid
4	Altitude valid

Table 123: Raw DVL Data Flags

10.4.45 Gimbal State Packet

Certus will accept (write) Current angle values between -2pi and 2pi exclusive.

Certus will output (read) values between -pi and pi for current angle.

Gimbal State Packet				
Packet ID				72
Length				8
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Current angle (rad)
2	4		4	Reserved (set to zero)

Table 124: Gimbal State Packet

10.4.46 Automotive Packet

The value of the slip angle will be zero unless velocity is greater than 3.45 m/s and heading is valid.

Automotive Packet				
Packet ID				73
Length				24
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Virtual odometer distance (m)
2	4	fp32	4	Slip Angle (rad) Value reported is zero, unless heading is valid and the velocity is greater than 3.45 m/s
3	8	fp32	4	Velocity X (m/s)
4	12	fp32	4	Velocity Y (m/s)
5	16	fp32	4	Distance standard deviation (m)
6	20		4	Reserved (set to zero)

Table 125: Automotive Packet

10.4.47 External Magnetometers Packet

Heading can be derived using the magnetometers of an additional external Advanced Navigation product to input external magnetometer values.

The 2D, 3D or automatic magnetic calibration of Certus cannot be used to calibrate the external magnetometer values. External magnetometers need to be calibrated before feeding into Certus.

To use External Magnetic Heading, disable Magnetic Heading Enabled and Automatic Magnetic Calibration Enabled options in the **8.6.3 Configuration Menu**of the Configuration Menu.

When sending external magnetometers the external heading flag will become active.

External Magnetometers Packet				
Packet ID				75
Length				17
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Delay (s)
2	4	fp32	4	Magnetometer X (milligauss)
3	8	fp32	4	Magnetometer Y (milligauss)
4	12	fp32	4	Magnetometer Z (milligauss)
6	16	u8	1	External Magnetometer Flags

Table 126: External Magnetometers Packet

10.4.47.1 External Magnetometers Flags

Bit	Description
0	Magnetometers failure
1	Magnetometers over-range

Table 127: External magnetometers Flags

10.4.48 Basestation Packet

Basestation Packet				
Packet ID				80
Length				45
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u32	4	**10.4.1.4 Unix Time Seconds**
2	4	u32	4	**10.4.1.5 Microseconds**
3	8	fp64	8	Basestation position, latitude (rad)
4	16	fp64	8	Basestation position, longitude (rad)
5	24	fp64	8	Basestation position, altitude (rad)
6	32	fp32	4	Basestation relative position, north (m)
7	36	fp32	4	Basestation relative position, east (m)
8	40	fp32	4	Basestation relative position, down (m)
9	44	u8	1	**10.4.48.1 GNSS Fix Status**

Table 128: Basestation packet

10.4.48.1 GNSS Fix Status

Value	Description
0	No GNSS fix
1	2D GNSS fix
2	3D GNSS fix
3	SBAS GNSS fix
4	Differential GNSS fix
5	Omnistar/Starfire GNSS fix
6	RTK Float GNSS fix
7	RTK Fixed GNSS fix

Table 129: GNSS Fix Status

10.4.49 Zero Angular Velocity Packet

Zero Angular Velocity Packet				
Packet ID				83
Length				8
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Duration. See 10.4.49.1 Zero Angular Velocity Duration
2	4		4	Reserved (set to zero)

Table 130: Zero Angular Velocity Packet

10.4.49.1 Zero Angular Velocity Duration

Duration is the duration that the unit has been stationary for about the heading axis. The minimum value is 0.1 seconds and the maximum value is 2 seconds.

10.4.50 Extended Satellites Packet

Extended Satellites Packet				
Packet ID				84
Length				2 + 9 x number of satellites
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Total number of extended satellites packets
2	1	u8	1	Packet number (range 1 to Total)
3	2	u8	1	Satellite System
4	3	u8	1	Satellite number (PRN)

Extended Satellites Packet				
5	4	u8	1	10.4.50.2 Satellite Frequencies
6	5	u8	1	Elevation (deg)
7	6	u16	2	Azimuth (deg)
8	8	u8	1	SNR receiver 1
9	9	u8	1	SNR receiver 2
10	10	u8	1	Flags. See Extended Satellites Flags
+				Fields 3-10 repeat for additional satellites

Table 131: Extended Satellites Packet

The maximum number of satellites per packet is 28. If there are more than 28 satellites to report, multiple packets will be sent per epoch. In this case the total number of packets in field #1 will be greater than 1, and the Packet Index in field #2 will increment accordingly.

10.4.50.1 Satellite Systems

Value	System
0	Unknown
1	GPS
2	GLONASS
3	BeiDou
4	Galileo
5	SBAS
6	QZSS
7	Reserved
8	Omnistar
9	Reserved
10	NavIC

Table 132: Satellite Systems

10.4.50.2 Satellite Frequencies

Bit	GPS	GLONASS	Galileo	BeiDou	SBAS	QZSS	Omnistar	NavIC
no bits							L1 C/A	
0	L1 C/A	G1 C/A	E1 OS	B1	L1 C/A	L1 C/A		
1	L1 C		E1 PRS	B1C		L1 C		
2	L1 P	G1 P				L1 SAIF		
3	L1 M							
4	L2 C	G2 C/A	E6 CS	B2I		L2 C		
5	L2 P	G2 P	E6 PRS	B2A		LEX		
6	L2 M							
7	L5	G3	E5	B3	L5	L5		L5

Table 133: Satellite Frequencies

10.4.50.3 Extended Satellites Flags

Bit	Description
0	Visible by receiver 1
1	Visible by receiver 2
2	Used in primary position solution
3	Used in moving baseline solution
4-7	Reserved (set to zero)

Table 134: Extended Satellites Flags

10.4.51 Sensor Temperature Packet

Sensor Temperatures Packet				
Packet ID				85
Length				32
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32[3]	12	Accelerometer temperature
2	12	fp32[3]	12	Gyroscope temperature
3	24	fp32	4	Magnetometer temperature
4	28	fp32	4	Pressure sensor temperature

Table 135: Sensor temperature packet

10.4.52 Vessel Motion Packet

Vessel Motion Packet				
Packet ID				89
Length				48
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	fp32	4	Surge Point 1 (m)
2	4	fp32	4	Surge Point 2 (m)
3	8	fp32	4	Surge Point 3 (m)
4	12	fp32	4	Surge Point 4 (m)
5	16	fp32	4	Sway Point 1 (m)
6	20	fp32	4	Sway Point 2 (m)
7	24	fp32	4	Sway Point 3 (m)
8	28	fp32	4	Sway Point 4 (m)
9	32	fp32	4	Heave Point 1 (m)
10	36	fp32	4	Heave Point 2 (m)
11	40	fp32	4	Heave Point 3 (m)
12	44	fp32	4	Heave Point 4 (m)

Table 136: Vessel Motion Packet

10.4.53 Automatic Magnetic Calibration Status Packet

Automatic Magnetic Calibration Status Packet				
Packet ID				90
Length				78
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	**Method**
2	1	u8	1	**Flags**
3	2	fp32	4	Convergence
4	6	fp32	4	Scale Factor X
5	10	fp32	4	Scale Factor Y
6	14	fp32	4	Scale Factor Z
7	18	fp32	4	Soft Iron X
8	22	fp32	4	Soft Iron Y

Automatic Magnetic Calibration Status Packet				
9	26	fp32	4	Soft Iron Z
10	30	fp32	4	Hard Iron X
11	34	fp32	4	Hard Iron Y
12	38	fp32	4	Hard Iron Z
13	42	fp32	4	Scale Factor SD X
14	46	fp32	4	Scale Factor SD Y
15	50	fp32	4	Scale Factor SD Z
16	54	fp32	4	Soft Iron SD X
17	58	fp32	4	Soft Iron SD Y
18	62	fp32	4	Soft Iron SD Z
19	66	fp32	4	Hard Iron SD X
20	70	fp32	4	Hard Iron SD Y
21	74	fp32	4	Hard Iron SD Z

Table 137: Automatic Magnetic Calibration Status Packet

10.4.53.1 Automatic Magnetic Calibration Status Method

Value	Description
0	Disabled
1	GNSS Aided
2	Online

Table 138: Automatic Magnetic Calibration Status Method

10.4.53.2 Automatic Magnetic Calibration Status Flags

Bit	Description
0	Ready
1	Coarse Complete
2	Existing Calibration
3	Awaiting Filters
4	Manual Calibration in Progress
5	Invalid Vehicle Type
6	Magnetic Heading Disabled
7	Reserved (set to zero)

Table 139: Automatic Magnetic Calibration Status Flags

10.4.54 GNSS Position Velocity Time Packet

This packet provides the raw Position, Velocity, and Time (PVT) data as it is received from the GNSS receiver.

The position and velocity reported describe the location of the GNSS primary antenna (not the vehicle reference point).

Note: This packet partly supersedes the Raw GNSS Packet (Packet ID 29).

GNSS Position Velocity Time Packet				
Packet ID				92
Length				76
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	10.4.54.1 GNSS ID
2	1		1	Reserved (set to zero)
3	2	u16	2	10.4.54.2 GNSS Position Velocity Time Status Bit-field
4	4	u32	4	Posix time (s)
5	8	u32	4	Posix time (µs)
6	12	fp64	8	Latitude (rad)
7	20	fp64	8	Longitude (rad)
8	28	fp64	8	Altitude above ellipsoid (m)
9	36	fp32	4	Position standard deviation, North (m)
10	40	fp32	4	Position standard deviation, East (m)
11	44	fp32	4	Position standard deviation, Down (m)
12	48	fp32	4	Velocity, North (m/s)
13	52	fp32	4	Velocity, East (m/s)
14	56	fp32	4	Velocity, Down (m/s)
15	60	fp32	4	Velocity standard deviation, North (m/s)
16	64	fp32	4	Velocity standard deviation, East (m/s)
17	68	fp32	4	Velocity standard deviation, Down (m/s)
18	72	u32	4	Latency (µs)

Table 140: GNSS PVT Packet

10.4.54.1 GNSS ID

Value	Description
0	Internal GNSS
Other values	External GNSS sources

Table 141: GNSS ID Status Bitfield

10.4.54.2 GNSS Position Velocity Time Status Bitfield

This packet provides the raw Position, Velocity, and Time (PVT) solution data from the GNSS receiver. This packet supersedes the Raw GNSS Packet (ID 29).

Boolean fields have zero indicating false, and one indicating true.

Bit Range	Num Bits	Description
0-2	3	**10.4.1.3 GNSS Fix Status**
3-5	3	Spoofing Status, per: **10.4.54.3 Spoofing and Interference Status**
6-8	3	Interference Status, per: **10.4.54.3 Spoofing and Interference Status**
9	1	Velocity valid
10	1	Time valid
11	1	Antenna disconnected
12	1	Antenna short
13	1	GNSS Failure
14-15	2	Reserved (set to zero)

Table 142: GNSS PVT Status Bitfield

10.4.54.3 Spoofing and Interference Status

Status values for Spoofing and Interference, as set in the *GNSS Position Velocity Time* and *GNSS Orientation Status* Bitfield.

Value	Description
0	Unknown
1	None
2	Detected and mitigated
3	Detected and unmitigated
4-7	Reserved (set to zero)

Table 143: Spoofing and Interference Status

10.5 GNSS Orientation Packet

10.5.1 GNSS Orientation Packet

This packet represents the raw orientation data as it is received from the GNSS receiver.

GNSS Orientation Packet is only applicable for Dual Antenna installations. It does not apply to Single Antenna installations.

The orientation is that of the line between the two dual GNSS antennas (not of the vehicle body) and is described in the NED frame.

Note: This packet partly supersedes the Raw GNSS Packet (Packet ID 29).

GNSS Orientation Packet				
Packet ID				93
Length				36
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	10.4.54.1 GNSS ID
2	1		1	Reserved (set to zero)
3	2	u16	2	10.5.1.1 GNSS Orientation Status Bitfield
4	4	u32	4	Posix time (s)
5	8	u32	4	Posix time (µs)
6	12	fp32	4	Azimuth of GNSS antennas baseline (rad)
7	16	fp32	4	Azimuth Standard Deviation (rad)
8	20	fp32	4	Tilt of GNSS antennas baseline (rad)
9	24	fp32	4	Tilt Standard Deviation (rad)
10	28	fp32	4	Baseline length (m)
11	32	u32	4	Latency (µs)

Table 144: GNSS Orientation Packet

10.5.1.1 GNSS Orientation Status Bitfield

Bit Range	Num Bits	Description
0-2	3	10.4.1.3 GNSS Fix Status
3	1	Antenna disconnected
4	1	Antenna short
5	1	GNSS Failure
6-8	3	Spoofing Status, per: 10.4.54.3 Spoofing and Interference Status
9-11	3	Interference Status, per: 10.4.54.3 Spoofing and Interference Status
12-15	4	Reserved (set to zero)

Table 145: GNSS Orientation Status Bitfield

10.5.2 Aiding Source Status Packet

Aiding Source Status Packet				
Packet ID				95
Length				64
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u16	2	10.5.2.1 Aiding Source Status Field
2	2	u16	2	Internal GNSS Orientation Status
3	4	u16	2	Internal Magnetometers Status
4	6	u16	2	Internal Pressure Status
5	8	u16	2	External GNSS PVT Status
6	10	u16	2	External GNSS Orientation Status
7	12	u16	2	External Position Status
8	14	u16	2	External Odometer Status
9	16	u16	2	External Heading Status
10	18	u16	2	External Pressure Status
11	20	u16	2	External Velocity Status
12	22	u16	2	External Position Velocity Status
13	24	u16	2	External Body Velocity Status
14	26	u16	2	External Air Data Status
15	28	u16	2	External Magnetometers Status
16	30	u16	2	External LVS Status
17	32	u16	2	Internal Depth Sensor Status

Aiding Source Status Packet				
18	34	u16	2	External Subsonus Status
19	36	u16	2	External DVL Data Status
20	38	u16	2	External Depth Status
21	40	u16	2	External USBL Status
22	42		22	Reserved (set to zero)

10.5.2.1 Aiding Source Status Field

All aiding source status fields share the same definition:

Bit	Description
0	Online - Communicating with device
1	Valid - Providing valid filter information
2	Fault - Reporting a fault
3-9	Reserved (set to zero)
10-15	**Aiding Source Origin** • 0: Internal • 1: Primary Port • 2: Aux Port • 3: GPIO • 4: Data Stream 1 • 5: Data Stream 2 • 6: Data Stream 3 • 7: Data Stream 4

10.6 Configuration Packets

Configuration packets can be both read from and written to the Certus. On many of the configuration packets the first byte is a permanent flag. A zero in this field indicates that the settings will be lost on reset, a one indicates that they will be permanent (i.e. stored in flash).

Note: The number of configuration packets with the permanent flag set to high should be minimised to reduce the risk of exhausting the flash cycles.

10.6.1 Packet Timer Period Packet

Packet Timer Period Packet	
Packet ID	180
Length	4

Packet Timer Period Packet				
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	10.6.1.1 UTC Synchronisation
3	2	u16	2	10.6.1.2 Packet Timer Period

Table 146: Packet Timer Period Packet

10.6.1.1 UTC Synchronisation

This is a boolean value that determines whether or not the packet timer is synchronised with UTC time, with zero for disabled and one for enabled. For UTC Synchronisation to be enabled the packet timer period must multiply into 1000000 evenly. For example if the packet timer period is 10000 (10 ms), 1000000/10000 = 100 which is valid for UTC synchronisation. If the packet timer period is 15000 (15 ms), 1000000/15000 = 66.6666 which is not valid for UTC synchronisation. To get the rate, use the following formula:

Packet Timer Rate = 1000000/(Packet Timer Period) Hz

10.6.1.2 Packet Timer Period

This is a value in microseconds that sets the master packet timer period. The minimum value is 1000 (1 ms) or 1000 Hz and the maximum value is 65000 (65 ms) or 15.38 Hz. The packet timer period must be in increments of 1000.

10.6.2 Packets Period Packet

This packet allows the user to configure, add, remove, modify and clear state packets (packets 20 through 180).

Note: This packet will only affect the port from which the packet is sent, leaving the other ports unaffected. e.g. If you are connected to the Primary serial port, sending this packet will only change the ANPP output for the Primary serial port.

Packets Period Packet				
Packet ID				181
Length				2 + (5 x number of packet periods)
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	Clear Existing Packet Periods
3	2	u8	1	Packet ID
4	3	u32	4	Packet Period
+				Fields 3-4 repeat for additional packet periods

Table 147: Packets Period Packet

10.6.2.1 Clear Existing Packets

This is a boolean field, when set to one it deletes any existing packet rates. When set to zero existing packet rates remain. Only one packet rate can exist per packet ID, so new packet rates will overwrite existing packet rates for the same packet ID.

10.6.2.2 Packet Period

This indicates the period in units of the packet timer period. The packet rate can be calculated as follows.

Packet Rate = 1000000/(Packet Period x Packet Timer Period) Hz

For example if the packet timer period is set to 1000 (1 ms). Setting packet ID 20 with a packet period of 50 will give the following.

Packet 20 Rate = 1000000/(50 x 1000)

Packet 20 Rate = 20 Hz

10.6.3 Baud Rates Packet

Baud Rates Packet				
Packet ID				182
Length				17
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u32	4	Primary RS232 and RS422 see **10.6.3.1 Supported Baud Rate** bit #31: 0 = RS232, 1 = RS422
3	5	u32	4	GPIO 1 & 2 **Maximum Baud Rate 250000** see **10.6.3.1 Supported Baud Rate**
4	9	u32	4	Auxiliary RS232 see **10.6.3.1 Supported Baud Rate** bit #31: 0 = RS232, 1 = RS422
5	13		4	Reserved (set to zero)

Table 148: Baud Rates Packet

10.6.3.1 Supported Baud Rate

Note: Not all Advanced Navigation products support minimum and maximum baud rates.

Supported Baud Rates - Bits 0-30
2400
4800
9600
19200

Supported Baud Rates - Bits 0-30
38400
57600
115200
230400
250000
460800
500000
800000
921600
1000000
1250000
2000000
4000000

Table 149: Supported Baud Rates

10.6.4 Sensor Ranges Packet

Note: The Sensor Ranges Packet is only valid for Certus units. This packet is not applicable for Certus Evo units.

Sensor Ranges Packet				
Packet ID				184
Length				4
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	10.6.4.1 Accelerometers Range
3	2	u8	1	10.6.4.2 Gyroscopes Range
4	3		1	Reserved (set to zero)

Table 150: Sensor Ranges Packet

10.6.4.1 Accelerometers Range

Value	Description
0	2 g (19.62 m/s/s)
1	4 g (39.24 m/s/s)
2	16 g (156.96 m/s/s)

Table 151: Accelerometers Range

10.6.4.2 Gyroscopes Range

Value	Description
0	250 degrees/second
1	500 degrees/second
2	2000 degrees/second

Table 152: Gyroscopes Range

10.6.5 Installation Alignment Packet

Installation Alignment Packet				
Packet ID				185
Length				73
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	fp32	4	Alignment DCM[0][0]
3	5	fp32	4	Alignment DCM[0][1]
4	9	fp32	4	Alignment DCM[0][2]
5	13	fp32	4	Alignment DCM[1][0]
6	17	fp32	4	Alignment DCM[1][1]
7	21	fp32	4	Alignment DCM[1][2]
8	25	fp32	4	Alignment DCM[2][0]
9	29	fp32	4	Alignment DCM[2][1]
10	33	fp32	4	Alignment DCM[2][2]
11 <add [3] jhere]	37	fp32	4	GNSS antenna offset X (m)[1]
12 <add [3] jhere]	41	fp32	4	GNSS antenna offset Y (m)[1]
13 <add [3] jhere]	45	fp32	4	GNSS antenna offset Z (m)
14	49	fp32	4	Odometer offset X (m)[2]
15	53	fp32	4	Odometer offset Y (m)[2]
16	57	fp32	4	Odometer offset Z (m)[2]
17	61	fp32	4	External data offset X (m)[3]
18	65	fp32	4	External data offset Y (m)[3]

Installation Alignment Packet				
19	69	fp32	4	External data offset Z (m)[3]

Table 153: Installation Alignment Packet

[1]Update to GNSS Antenna offset results in an update to fields:

- **10.6.21 Aiding Source Configuration Packet 1**: #3 Internal GNSS PVT - Position Offset
- **10.6.21 Aiding Source Configuration Packet 1**: #5 External GNSS PVT - Position Offset

[2]Update to Odometer offset results in an update to fields:

- **10.6.21 Aiding Source Configuration Packet 1**: #8 External Odometer - Position Offset
- **10.6.22 Aiding Source Configuration Packet 2**: #6 External DVL Data - Position Offset

[3]Update to External data offset results in an update to fields:

- **10.6.21 Aiding Source Configuration Packet 1**: #7 External Position - Position Offset
- **10.6.21 Aiding Source Configuration Packet 1**: #11 External Velocity - Position Offset
- **10.6.21 Aiding Source Configuration Packet 1**: #12 External Position Velocity - Position Offset
- **10.6.21 Aiding Source Configuration Packet 1**: #13 External Body Velocity - Position Offset
- **10.6.22 Aiding Source Configuration Packet 2**: #3 Internal Depth Sensor - Position Offset
- **10.6.22 Aiding Source Configuration Packet 2**: #4 External Subsonus - Position Offset
- **10.6.22 Aiding Source Configuration Packet 2**: #9 External USBL Position Offset

10.6.5.1 Alignment DCM

The alignment DCM (Direction Cosine Matrix) is used to represent an alignment offset of Certus from its standard alignment. A DCM is used rather than Euler angles for accuracy reasons. To convert Euler angles to DCM, use the formula below with angles in radians.

DCM[0][0] = cos(heading) * cos(pitch)

DCM[0][1] = sin(heading) * cos(pitch)

DCM[0][2] = -sin(pitch)

DCM[1][0] = -sin(heading) * cos(roll) + cos(heading) * sin(pitch) * sin(roll)

DCM[1][1] = cos(heading) * cos(roll) + sin(heading) * sin(pitch) * sin(roll)

DCM[1][2] = cos(pitch) * sin(roll)

DCM[2][0] = sin(heading) * sin(roll) + cos(heading) * sin(pitch) * cos(roll)

DCM[2][1] = -cos(heading) * sin(roll) + sin(heading) * sin(pitch) * cos(roll)

DCM[2][2] = cos(pitch) * cos(roll)

10.6.6 Filter Options Packet

Filter Options Packet				
Packet ID				186
Length				17
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	10.6.6.1 Vehicle Types
3	2	u8	1	Internal GNSS enabled (boolean)
4	3		1	Magnetic Heading enabled (boolean)
5	4		1	Atmospheric altitude enabled (boolean)
6	5	u8	1	Velocity heading enabled (boolean)
7	6	u8	1	Reversing detection enabled (boolean)
8	7	u8	1	Motion analysis enabled (boolean)
9	8		1	Automatic magnetic calibration enabled (boolean)
10	9	u8	1	Dual antenna disabled
11	10		7	Reserved (set to zero)

Table 154: Filter Options Packet

10.6.6.1 Vehicle Types

Value	Description
0	Unlimited
1	Bicycle or Motorcycle
2	Car

Value	Description
3	Hovercraft
4	Submarine
5	3D Underwater Vehicle
6	Fixed Wing Plane
7	3D Aircraft
8	Human
9	Boat
10	Large Ship
11	Stationary
12	Stunt Plane
13	Race Car
14	Train

Table 155: Vehicle Types

10.6.7 GPIO Configuration Packet

GPIO Configuration Packet				
Packet ID				188
Length				13
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	GPIO1 function. See **10.6.7.1 GPIO Functions**
3	2	u8	1	GPIO2 function. See **10.6.7.1 GPIO Functions**
4	3	u8	1	Auxiliary RS232 transmit function. See **10.6.7.2 Auxiliary Functions**
5	4	u8	1	Auxiliary RS232 receive function. See **10.6.7.2 Auxiliary Functions**
6	5	u8	1	**10.6.7.3 GPIO Voltage Selection**
7	6		7	Reserved (set to zero)

Table 156: GPIO Configuration Packet

10.6.7.1 GPIO Functions

Value	Description	GPIO Function Type
0	Inactive	GPIO1, GPIO2
1	1PPS Output	
2	GNSS Fix Output	
3	Odometer Input	
4	Zero Velocity Input	
5	Pitot Tube Input	
6	NMEA Input	GPIO2
7	NMEA Output	GPIO1
8	Novatel GNSS Input	GPIO2
9	Topcon GNSS Input	
11	ANPP Input	
12	ANPP Output	GPIO1
13	Disable Magnetometers	GPIO1, GPIO2
14	Disable GNSS	GPIO1, GPIO2
15	Disable Pressure	GPIO1, GPIO2
16	Set Zero Orientation Alignment	
17	System State Packet Trigger	
18	Raw Sensors Packet Trigger	
19	RTCM Differential GNSS Corrections Input	GPIO2
20	Trimble GNSS Input	
21	u-blox GNSS Input	
22	Hemisphere GNSS Input	
23	Teledyne DVL Input	
24	Tritech USBL Input	
25	Linkquest DVL Input	

Value	Description	GPIO Function Type
26	Pressure Depth Transducer	GPIO1, GPIO2
27	Left Wheel Speed Sensor	
28	Right Wheel Speed Sensor	
29	1PPS Input	
30	Wheel Speed Sensor	
31	Wheel Encoder Phase A	
32	Wheel Encoder Phase B	
33	Event 1 Input	
34	Event 2 Input	
38	GNSS Receiver Passthrough	GPIO1, GPIO2
39	TSS1 Output	GPIO1
40	Simrad 1000 Output	
41	Simrad 3000 Output	
42	Serial Port Passthrough	GPIO1, GPIO2
43	Gimbal Encoder Phase A	
44	Gimbal Encoder Phase B	
45	Odometer Direction, Forward Low	
46	Odometer Direction, Forward High	
51	Nortek DVL Input	GPIO2
53	Reverse Alignment, Forward Low	GPIO1, GPIO2
54	Reverse Alignment, Forward High	
55	Zero Angular Velocity Input	
59	Water Linked DVL Input	GPIO2
63	Nortek Nucleus DVL Input	
64	Nortek Nucleus DVL Output	GPIO1
65	Valeport SVS Input	GPIO2
66	Septentrio GNSS Input	GPIO2

Table 157: GPIO functions

10.6.7.2 Auxiliary Functions

Value	Description	Auxiliary Function Type
0	Inactive	Transmit, Receive
1	1PPS Output	Transmit
2	GNSS Fix Output	

Value	Description	Auxiliary Function Type
3	Odometer Input	Receive
4	Zero Velocity Input	
5	Pitot Tube Input	
6	NMEA Input	
7	NMEA Output	Transmit
8	Novatel GNSS Input	Receive
9	Topcon GNSS Input	
11	ANPP Input	
12	ANPP Output	Transmit
13	Disable magnetometers	Receive
14	Disable GNSS	Receive
15	Disable Pressure	
16	Set Zero Orientation Alignment	
17	System State Packet Trigger	
18	Raw Sensors Packet Trigger	
19	RTCM Differential GNSS Corrections Input	
20	Trimble GNSS Input	
21	u-blox GNSS Input	
22	Hemisphere GNSS Input	
23	Teledyne DVL Input	
24	Tritech USBL Input	
25	Linkquest DVL Input	
26	Pressure Depth Transducer	
27	Left Wheel Speed Sensor	
28	Right Wheel Speed Sensor	
29	1PPS Input	
30	Wheel Speed Sensor	
33	Event 1 Input	
34	Event 2 Input	
35	Linkquest USBL Input	
38	GNSS Receiver Passthrough	Transmit, Receive
39	TSS1 Output	Transmit
40	Simrad 1000 Output	
41	Simrad 3000 Output	

Value	Description	Auxiliary Function Type
42	Serial Port Passthrough	Transmit, Receive
45	Odometer Direction, Forward Low	Receive
46	Odometer Direction, Forward High	
51	Nortek DVL Input	
53	Reverse Alignment, Forward Low	
54	Reverse Alignment, Forward High	
55	Zero Angular Velocity Input	
59	Water Linked DVL Input	
63	Nortek Nucleus DVL Input	
64	Nortek Nucleus DVL Output	Transmit
65	Valeport SVS Input	Receive
66	Septentrio GNSS Input	Receive

Table 158: Auxiliary Functions

10.6.7.3 GPIO Voltage Selection

Value	Description
0	5V
1	3.3V
2	Power Disabled

Table 159: GPIO Voltage Selection

10.6.8 Magnetic Calibration Values Packet

This packet can be used to inspect the magnetic calibration values or write custom magnetic calibration values to the system. Under normal operation with automatic magnetic calibration the user should not need to use this packet.

Magnetic Calibration Values Packet				
Packet ID				189
Length				49
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	fp32	4	Hard iron bias X
3	5	fp32	4	Hard iron bias Y
4	9	fp32	4	Hard iron bias Z
5	13	fp32	4	Soft iron transformation XX

Magnetic Calibration Values Packet				
6	17	fp32	4	Soft iron transformation XY
7	21	fp32	4	Soft iron transformation XZ
8	25	fp32	4	Soft iron transformation YX
9	29	fp32	4	Soft iron transformation YY
10	33	fp32	4	Soft iron transformation YZ
11	37	fp32	4	Soft iron transformation ZX
12	41	fp32	4	Soft iron transformation ZY
13	45	fp32	4	Soft iron transformation ZZ

Table 160: Magnetic Calibration Values Packet

10.6.9 Magnetic Calibration Configuration Packet

Magnetic Calibration Configuration Packet				
Packet ID				190
Length				1
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	10.6.9.1 Magnetic Calibration Actions

Table 161: Magnetic Calibration Configuration Packet

10.6.9.1 Magnetic Calibration Actions

Value	Description
0	Cancel magnetic calibration
2	Start 2D magnetic calibration
3	Start 3D magnetic calibration
4	Reset calibration to defaults

Table 162: Magnetic Calibration Actions

10.6.10 Magnetic Calibration Status Packet

Magnetic Calibration Status Packet				
Packet ID				191
Length				3
Read / Write				Read
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	10.6.10.1 Magnetic Calibration Status
2	1	u8	1	Magnetic calibration progress (%)

Magnetic Calibration Status Packet				
3	2	u8	1	Local magnetic error (%)

Table 163: Magnetic Calibration Status Packet

10.6.10.1 Magnetic Calibration Status

Value	Description
0	Magnetic calibration not completed
1	2D magnetic calibration completed
2	3D magnetic calibration completed
3	Custom values magnetic calibration completed
5	2D calibration in progress
6	3D calibration in progress
7	2D calibration error: excessive roll
8	2D calibration error: excessive pitch
9	Calibration error: sensor over range event
10	Calibration error: time-out
11	Calibration error: system error
12	Calibration error: interference error

Table 164: Magnetic Calibration Status

10.6.11 Odometer Configuration Packet

Odometer Configuration Packet				
Packet ID				192
Length				8
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	Automatic pulse measurement active
3	2		2	Reserved (set to zero)
4	4	fp32	4	Pulse length (m)

Table 165: Odometer Configuration Packet

10.6.12 Set Zero Orientation Alignment Packet

Set Zero Orientation Alignment Packet	
Packet ID	193
Length	5

Set Zero Orientation Alignment Packet				
Read / Write				Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u32	4	Verification sequence (set to 0x9A4E8055)

Table 166: Set Zero Orientation Alignment Packet

10.6.13 Reference Point Offsets Packet

The reference point offsets packet can be used to adjust the measurement point that all data is referenced to. By default all the values of this packet are zero and the measurement point that all data is referenced to is the centre of the Certus unit. The primary reference point offset can be used to adjust the measurement point to a different location on the vehicle, in the body co-ordinate frame. The primary reference point offset applies to all data output including NMEA etc as well as heave point 1.

The other heave point offsets do not apply to heave point 1 in the **10.4.38 Heave Packet**.

Reference Point Offsets Packet				
Packet ID				194
Length				49
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	fp32	4	Heave point 1 offset X (m) / Primary reference point offset X (m)
3	5	fp32	4	Heave point 1 offset Y (m) / Primary reference point offset Y (m)
4	9	fp32	4	Heave point 1 offset Z (m) / Primary reference point offset Z (m)
5	13	fp32	4	Heave point 2 offset X (m)
6	17	fp32	4	Heave point 2 offset Y (m)
7	21	fp32	4	Heave point 2 offset Z (m)
8	25	fp32	4	Heave point 3 offset X (m)
9	29	fp32	4	Heave point 3 offset Y (m)
10	33	fp32	4	Heave point 3 offset Z (m)
11	37	fp32	4	Heave point 4 offset X (m)
12	41	fp32	4	Heave point 4 offset Y (m)
13	45	fp32	4	Heave point 4 offset Z (m)

Table 167: Reference Point Offsets Packet

10.6.14 GPIO Output Configuration Packet

GPIO Output Configuration Packet				
Packet ID				195
Length				183
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	Auxiliary port Input Mode. See **10.6.14.1 Port Input Modes**
3	2	u8	1	Auxiliary port Output Mode. See **10.6.14.2 Port Output Modes**
4	3	u8	1	Auxiliary port NMEA fix behaviour. See **10.6.14.3 NMEA Fix Behaviour**
5	4	u8	1	Auxiliary port GPZDA Rates. See **10.6.14.4 Port Output Rates**
6	5	u8	1	Auxiliary port GPGGA Rates. See **10.6.14.4 Port Output Rates**
7	6	u8	1	Auxiliary port GPVTG Rates. See **10.6.14.4 Port Output Rates**
8	7	u8	1	Auxiliary port GPRMC Rates. See **10.6.14.4 Port Output Rates**
9	8	u8	1	Auxiliary port GPHDT Rates. See **10.6.14.4 Port Output Rates**
10	9	u8	1	Auxiliary port GPGLL Rates. See **10.6.14.4 Port Output Rates**
11	10	u8	1	Auxiliary port PASHR Rates. See **10.6.14.4 Port Output Rates**
12	11	u8	1	Auxiliary port TSS1 Rates. See **10.6.14.4 Port Output Rates**
13	12	u8	1	Auxiliary port Simrad Rates. See **10.6.14.4 Port Output Rates**
14	13	u8	1	Auxiliary port GPROT Rates. See **10.6.14.4 Port Output Rates**
15	14	u8	1	Auxiliary port GPHEV Rates. See **10.6.14.4 Port Output Rates**
16	15	u8	1	Auxiliary port GPGSV Rates. See **10.6.14.4 Port Output Rates**
17	16	u8	1	Auxiliary port PFECAtt Rates. See **10.6.14.4 Port Output Rates**

GPIO Output Configuration Packet				
18	17	u8	1	Auxiliary port PFECHve Rates. See **10.6.14.4 Port Output Rates**
19	18	u8	1	Auxiliary port GPGST Rates. See **10.6.14.4 Port Output Rates**
20	19		8+	Reserved (set to zero)
+				Fields 2-20 Repeat 6 more times (a total of 7 copies) for: GPIO port Logging port Data Port #1 Data Port #2 Data Port #3 Data Port #4

Table 168: GPIO Output Configuration Packet

10.6.14.1 Port Input Modes

Value	Description
0	Inactive
6	NMEA0183
11	ANPP
38	GNSS Receiver Passthrough

Table 169: Port Input Modes

10.6.14.2 Port Output Modes

Value	Description
0	Inactive
7	NMEA0183
12	ANPP
38	GNSS Receiver Passthrough
39	TSS1
40	Simrad 1000
41	Simrad 3000

Table 170: Port Output Modes

Note: The Port Input and Output Modes are read only for the auxiliary and GPIO ports. For compatibility with legacy devices, the modes for these two ports are set using the GPIO Configuration Packet.

10.6.14.3 NMEA Fix Behaviour

Value	Description
0	Normal

Value	Description
1	Always indicate 3D fix when the navigation filter is initialised

Table 171: NMEA Fix Behaviour

10.6.14.4 Port Output Rates

Value	Bit 3	Bit 2	Bit 1	Bit 0	Description
0	0	0	0	0	Disabled
1	0	0	0	1	0.1 Hz
2	0	0	1	0	0.2 Hz
3	0	0	1	1	0.5 Hz
4	0	1	0	0	1 Hz
5	0	1	0	1	2 Hz
6	0	1	1	0	5 Hz
7	0	1	1	1	10 Hz
8	1	0	0	0	25 Hz
9	1	0	0	1	50 Hz
10	1	0	1	0	8 Hz

Table 172: Port Output Rates

10.6.15 Dual Antenna Configuration Packet

This packet reports manual offset values.

Note: The Automatic offset orientation field is deprecated and not used. The field exists in order to support backward compatibility.

Dual Antenna Configuration Packet				
Packet ID				196
Length				17
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u16	2	Reserved (set to zero) Deprecated: **Offset type**
3	3	u8	1	Reserved (set to zero) Deprecated: **Automatic offset orientation**
4	4		1	Reserved (set to zero)
5	5	fp32	4	Manual offset X (m)

Dual Antenna Configuration Packet				
6	9	fp32	4	Manual offset Y (m)
7	13	fp32	4	Manual offset Z (m)

Table 173: Dual Antenna Configuration Packet

10.6.15.1 Offset Types

Value	Description
0	Manual offset
1	Automatic offset (Deprecated)

Table 174: Offset Types

10.6.15.2 Automatic Offset Orientations (Deprecated)

Note: The Automatic offset orientation field is deprecated and not used. The field exists in order to support backward compatibility.

Value	Description
0	Primary front and secondary rear
1	Primary rear and secondary front
2	Primary right and secondary left
3	Primary left and secondary right

Table 175: Automatic Offset Orientations

10.6.16 GNSS Configuration Packet

10.6.16.1 GNSS Receiver

This packet responds differently depending on the GNSS Receiver included with the unit, as shown below. Refer to your unit variant to determine the receiver included.

GNSS Receiver Configuration Packet				F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
Packet ID				197			
Length				85			
Read / Write				Read / Write			
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**			
1	0	u8	1	Permanent			
2	1	u64	8	GNSS frequencies. This is a bitfield where each bit describes whether a particular frequency is enabled. For a list of the fields that are currently available, see			

GNSS Receiver Configuration Packet				F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
				10.6.16.2 GNSS Frequency Bitfields.			
3	9	fp32	4	Reserved (set to zero)			PDOP threshold - the Position Dilution of Precision to achieve a fix
4	13	fp32	4	Reserved (set to zero)			TDOP threshold - The Time dilution of Precision to achieve a fix
5	17	u8	1	Reserved (set to zero)			Elevation mask (degrees) - Minimum elevation of the satellite that will be used when calculating fix
6	18	u8	1	Reserved (set to zero)			SNR Mask (dB) - Signal-to-noise (SNR) ratio of a satellite signal to allow it to be used when calculating a fix
7	19	u8	1	Reserved (set to zero)			SBAS corrections enabled
8	20	u8	1	Reserved (set to zero)			10.6.16.3 L Band Modes
9	21	u32	4	Reserved (set to zero)			L band frequency (Hz)
10	25	u32	4	Reserved (set to zero)			L band baud rate
11	29	u32	4	Reserved (set to zero)			Primary antenna type

GNSS Receiver Configuration Packet				F9P (Ublox ZED-F9P)	X20P (Ublox ZED-X20P)	MX5 (Septentrio Mosaic X5)	BD992 (Trimble BD992)
12	33	u32	4	Reserved (set to zero)			Secondary antenna type
13	37	u8	1	Reserved (set to zero)			10.6.16.4 L Band Satellite IDs - this refers to the satellite name
14	38		47	Reserved (set to zero)			Reserved (set to zero)

Table 176: GNSS Receiver Configuration Packet

10.6.16.2 GNSS Frequency Bitfields

Each boolean bit in this field indicates whether the GNSS signal is tracked.

- 0 = False: Signal **is not** tracked.
- 1 = True: Signal **is** tracked.

Each signal is associated with a combination of a constellation and a frequency.

Bit	Signal / Constellation is tracked?
0	GPS L1CA
1	GPS L1C
2	GPS L1P
3	GPS L2C
4	GPS L2P
5	GPS L2M
6	GPS L5
7	GLONASS G1CA
8	GLONASS G1P
9	GLONASS L1OC
10	GLONASS L1SC
11	GLONASS G2CA
12	GLONASS G2P
13	GLONASS L2OC
14	GLONASS L2SC
15	GLONASS L3OC
16	GLONASS L3SC

Bit	Signal / Constellation is tracked?
17	BEIDOU B1
18	BEIDOU B2
19	BEIDOU B3
20	GALILEO E1
21	GALILEO E5A
22	GALILEO E5B
23	GALILEO E5AB
24	GALILEO E6
25	QZSS L1CA
26	QZSS L1SAIF
27	QZSS L1C
28	QZSS L2C
29	QZSS L5
30	QZSS LEX
31	SBAS L1CA
32	SBAS L5
33	NavIC L5
34	NavIC S1
35	BEIDOU B2A

Note: For X20P unit variants, GLONASS is disabled in current firmware v2.0. It is planned to be re-enabled in future releases.

10.6.16.3 L Band Modes

L Band Mode	L Band Mode Name
0	Disabled
2	Omnistar Auto
3	Omnistar HP
4	Omnistar XP
5	Omnistar VBS
8	Omnistar G2
9	Omnistar HP+G2
10	Omnistar HP+XP
11	Trimble RTX

L Band Mode	L Band Mode Name
13	Omnistar L1 Only
14	Omnistar G4 Only
15	Omnistar G2+ Only
16	Omnistar G4+ Only

Table 177: L Band Modes

10.6.16.4 L Band Satellite IDs

L Band Satellite ID	Satellite Name
110	Auto
100	Custom
2	IOSAT
8	AORET
15	RTXMX
16	AMSAT
17	WASAT
18	OCSAT
19	RTXAL
20	RTXIO
22	CONNA
23	RTXNA
27	RTXPA
29	RTXEA
30	EMSAT

Table 178: L Band Satellite IDs

10.6.17 User Data Packet

This packet is for storage of users data. The data itself is not used by Certus.

User Data Packet				
Packet ID				198
Length				64
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0		64	User Data

Table 179: User Data Packet

10.6.18 GPIO Input Configuration Packet

GPIO Input Configuration Packet				
Packet ID				199
Length				65
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	fp32	4	Gimbal radians per encoder tick
3	5		60	Reserved (set to zero)

Table 180: GPIO Input Configuration Packet

10.6.19 IP Dataports Configuration Packet

IP Dataports Configuration Packet				
Packet ID				202
Length				30
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u16	2	Reserved (set to zero)
2	2	u32	4	TCP/UDP IP Address
3	6	u16	2	TCP/UDP Port
4	8	u8	1	**10.6.19.1 IP Dataport Mode**
+				Fields 2-4 Repeat 3 times (a total of 4 copies) for each of the 4 data ports

Table 181: IP Dataports Configuration Packet

10.6.19.1 IP Dataport Mode

Value	Description
0	MODE_NONE
1	Reserved (set to zero)
2	MODE_TCP_SERVER
3	MODE_TCP_CLIENT
4	MODE_UDP

Table 182: IP Dataport Mode

10.6.20 CAN Configuration Packet

CAN Configuration Packet				
Packet ID				203
Length				11
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u8	1	Enabled
3	2	u32	4	Baud Rate
4	6	u8	1	**CAN Protocol**
5	7		4	Reserved (set to zero)

Table 183: CAN Configuration Packet

10.6.20.1 CAN Protocol

Value	Description
0	CANopen

Table 184: CAN Protocol

10.6.21 Aiding Source Configuration Packet 1

Aiding Source Configuration Packet 1				
Packet ID				207
Length				243
Read / Write				Read / Write
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u16	2	**10.6.21.1 Aiding Source Bitmask 1**
3	3	f32[3]	12	Internal GNSS PVT - Position Offset
4	15	f32[3]	12	Internal GNSS Orientation - Orientation Offset
5	27	f32[3]	12	External GNSS PVT - Position Offset
6	39	f32[3]	12	External GNSS Orientation - Orientation Offset
7	51	f32[3]	12	External Position - Position Offset
8	63	f32[3]	12	External Odometer - Position Offset
9	75	f32[3]	12	External Heading - Orientation Offset
10	87	f32[3]	12	External Pressure - Position Offset
11	99	f32[3]	12	External Velocity - Position Offset

Aiding Source Configuration Packet 1				
12	111	f32[3]	12	External Position Velocity - Position Offset
13	123	f32[3]	12	External Body Velocity - Position Offset
14	135	f32[3]	12	External Body Velocity - Orientation Offset
15	147	f32[3]	12	External Air Data - Position Offset
16	159	f32[3]	12	External Air Data - Orientation Offset
17	171	f32[3]	12	External Magnetometers - Orientation Offset
18	183	f32[3]	12	External LVS - Position Offset
19	195	f32[3]	12	External LVS - Orientation Offset
20-22	207		36	Reserved (set to zero)

10.6.21.1 Aiding Source Bitmask 1

Bit	Aiding Source
0	Internal GNSS PVT
1	Internal GNSS Orientation
2	Internal Magnetometers
3	Internal Pressure
4	External GNSS PVT
5	External GNSS Orientation
6	External Position
7	External Odometer
8	External Heading
9	External Pressure
10	External Velocity
11	External Position Velocity
12	External Body Velocity
13	External Air Data
14	External Magnetometers
15	External LVS

10.6.22 Aiding Source Configuration Packet 2

Aiding Source Configuration Packet 2	
Packet ID	208
Length	243
Read / Write	Read / Write

Aiding Source Configuration Packet 2				
Field #	**Bytes Offset**	**Data Type**	**Size**	**Description**
1	0	u8	1	Permanent
2	1	u16	2	10.6.22.1 Aiding Source Bitmask 2
3	3	f32[3]	12	Internal Depth Sensor - Position Offset
4	15	f32[3]	12	External Subsonus - Position Offset
5	27	f32[3]	12	External Subsonus - Orientation Offset
6	39	f32[3]	12	External DVL Data - Position Offset
7	51	f32[3]	12	External DVL Data - Orientation Offset
8	63	f32[3]	12	External Depth -Position Offset
9	75	f32[3]	12	External USBL -Position Offset
10	87		156	Reserved (set to zero)

10.6.22.1 Aiding Source Bitmask 2

Bit	Aiding Source
0	Internal Depth Sensor
1	External Subsonus
2	External DVL Data
3	External Depth
4	External USBL
5-15	Reserved (set to zero)