

**ADVANCED
NAVIGATION**



**Certus OEM
Certus Evo OEM**

Reference Manual

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1 Revision History

Version	Date	Changes
1.6	17 February 2023	Updated software changelog, see 8.2.1 Software Changelog Updated software installation information to include Java 11 requirement, see 8.2.3 Installation and Starting Updated instructions for running manager on MacOS, see 8.2.3 Installation and Starting
1.5	23 December 2022	Updated hardware changelog, see 2.2 Hardware Changelog Updated firmware changelog, see 2.1 Firmware Changelog
1.4	18 November 2022	Updated firmware changelog, see 2.1 Firmware Changelog Removed note that firmware can only be upgraded using the primary ANPP data port, see 9.6.1.32 ANPP Input and 9.6.1.43 ANPP Output Added information on disabling dual antenna heading for single antenna configurations, see 10.5.6 Filter Options Packet and 8.1.3 Configuration Menu
1.3	20 October 2022	Updated software changelog, see 8.2 Using Certus Manager Updated Logging information as per Manager v6.2, see 8.2.8 Tools Menu Added a link to the product page to find the SDK, see 8.4 Using ANPP Updated External Time Packet to show it is Read only, see 10.4.32 External Time Packet Added disclaimer about affected ports for Packets Period Packet, see 10.5.2 Packets Period Packet Separated Licenses from Accessories and updated license part numbers, see Part Numbers and Ordering Options Added disclaimer that some GNSS and Antenna Flags are only applicable to Aries GNSS Receivers, see 8.1.2.4 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 10.4.32 External Time Packet
1.2	20 April 2022	Updated hardware changelog, see 2.2 Hardware Changelog Updated software changelog, see 8.2 Using Certus Manager Updated firmware changelog, see 2.1 Firmware Changelog Updated Device ID table, see 10.3.4 Device Information Packet Added disclaimer that 2D and 3D Magnetic Calibration are not available for Certus Evo OEM, see 7.5 Magnetic Calibration Added automatic calibration information for 3D vehicle profiles, see 7.5 Magnetic Calibration Added Device Discovery section for Certus Manager, see 8.2 Using Certus Manager Updated Logging information to include user configurable Log Path, see 8.2 Using Certus Manager Reformatted 1PPS Output information, see 9.6.1.2 1PPS Output Added Basestation Packet, see 10.4.47 Basestation Packet Added additional information to 10.4.39 Raw Satellite Ephemeris Packet Added disclaimer that 10.5.4 Sensor Ranges Packet is invalid for Certus OEM Evo Various formatting changes

Version	Date	Changes
1.1	6 September 2021	Migrated documentation platform, various formatting and copy changes Added note on observing polarity. See 6.4 Power Supply
1.0	22 January 2021	Initial Release

Table 1: Revision History

2 Introduction

Certus OEM is a next-generation miniature GNSS / INS & AHRS system that provides accurate position, velocity, acceleration and orientation under the most demanding conditions. It 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 OEM

Certus OEM will provide outstanding results when mounted, configured and operated correctly. It is recommended you read through this manual carefully to ensure a successful outcome for your application.

Certus is available in a number of variants. Any reference to Certus OEM can be assumed to refer to either, with any specific exceptions noted.

- Performance: Certus and Certus Evo base units are available with different MEMS sensors, offering differing levels of Pitch & Roll, and Heading performance
- GNSS receiver: the standard GNSS receiver is an Advanced Navigation Aries. A Trimble BD992 variant may be available upon request.

A Certus Development Kit is available that includes all the cables you will need to get you started quickly. Optional antennas and accessories are also available for purchase.

If you have any questions, contact support@advancednavigation.com.

Note: Certus OEM is an electrostatic sensitive device and must be handled with care. Precautions must be taken when operating the unit.

2.1 Firmware Changelog

Certus OEM uses the same firmware as Certus Rugged.

Note: Certus OEM requires a minimum firmware version of v1.44. Do not attempt to downgrade to a lower firmware version as the unit may become unrecoverable.

Version	Date	Changes
1.71	23 December 2022	Updated to support v1.3 hardware. Minimum FW version for v1.3 hardware
1.64	18 November 2022	<p>Improved Aries GNSS Receiver performance</p> <p>Added ability to operate as single antenna configuration by disabling dual antenna heading</p> <p>Improved satellite display for BD992 GNSS Receiver</p> <p>Added ability to update firmware using any ANPP dataport</p> <p>Added hardware version check on startup, sending the unit to bootloader if the firmware is incompatible with the hardware</p> <p>Fixed PTP clock syncing issues</p> <p>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</p> <p>Removed Auto DNS option in Network Configuration when not in DHCP mode</p> <p>Fixed error message when saving changes on Dataports web page</p> <p>Fixed inverse reporting of Automatic Dual Antenna offsets when antenna configuration was Left/Right or Right/Left</p> <p>Adjusted ANPP Packet timing to align with UTC seconds</p> <p>Allowed CAN COB-ID to be set outside of valid PDO range</p> <p>Fixed network dataports not closing existing connection when mode is changed</p> <p>Fixed CANopen PDO objects stop transmitting if the bus is broken then restored</p> <p>Allowed setting RTCM Corrections Input function on Aux port via Web UI Dataports page</p> <p>Fixed BD992 variant doesn't show primary sat SNR in web UI table</p> <p>Fixed GNSS passthrough functionality</p> <p>Fixed bug preventing internal logging of GNSS Passthrough data</p> <p>Disallowed changing GPIO voltage on Certus OEM</p> <p>Fixed Manual Initialisation from Web UI</p> <p>Various bug fixes</p>
1.60	29 March 2022	<p>Updated to support v1.2 hardware pressure sensor from sub-component. Minimum FW version for v1.2 hardware</p> <p>Added configuration import/export functionality to web UI</p> <p>Improved stability and performance of automatic magnetometer calibration algorithm for some vehicle profiles, see 7.5 Magnetic Calibration</p> <p>Improved handling of NTRIP server connections</p> <p>Fixed intermittent dropping of network connection</p> <p>Fixed System Failure flag set when powering up the unit after a long period of inactivity</p> <p>Increased limit on NTRIP mount point list</p>

Version	Date	Changes
		Updated available BD992 L Band satellites Disabled selection of RS232/RS422 mode in Web UI for OEM variants Fixed Manual Initialisation from Web UI General reliability improvements
1.54	26 November 2021	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	8 October 2021	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	16 July 2021	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 Fix logging issue on OEM variants
1.49	13 April 2021	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	15 February 2021	Improve navigation performance when using antenna offsets
1.46	6 January 2021	Add body velocity packet to CANopen dictionary
1.45	23 December 2020	Update for PCB revision for Certus OEM support. Minimum version for v1.1 hardware. Add ability to set all CAN rates
1.44	15 December	Update to support latest Certus Evo sensor hardware

Version	Date	Changes
	2020	
1.43	9 November 2020	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	29 October 2020	Various bug fixes Update Aries GNSS Receiver to firmware v1.10
1.41	8 October 2020	Fix Artificial Horizon (Web UI) doesn't show Airspeed or Altitude Update Aries GNSS Receiver to firmware v1.09
1.40	4 September 2020	Packet 60 is limited to 10 Hz output for both GNSS receivers (note that the packet rates can only be set to 10 Hz) Update Aries GNSS Receiver to firmware v1.08. Update Aries 20 Hz packet rates to 10 Hz
1.39	28 August 2020	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	18 August 2020	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	8 July 2020	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	26 June 2020	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
1.35	18 June 2020	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	10 June 2020	Include sub-component firmware with Certus firmware Add serial data inputs to data ports Improvements to logging functionality Improvements to NTRIP client
1.33	22 May 2020	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

Version	Date	Changes
		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	11 May 2020	Fix bug in web server causing system crash 1PPS Output defaults to GNSS 1PPS instead of Certus' internal generated 1PPS.
1.31	30 April 2020	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	10 Apr 2020	Add NTRIP client Improve packet 60 output Improve on-board logging reliability Improve RTCM serial input
1.21	5 Mar 2020	Minor user interface improvements
1.20	28 Feb 2020	Add Certus Evo support Add subcomponent Information to View menu Add ANPP packet 60 output functionality Add RTCM serial input functionality
1.10	11 Feb 2020	Activate logging functionality.
1.02	31 Jan 2020	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	10 Jan 2020	Initial release

Table 2: Firmware Changelog

2.2 Hardware Changelog

Version	Date	Changes
1.3	02 June 2022	Baseboard update to improve manufacturing
1.2	23 July 2021	Updated Magnetometers Updated pressure sensor Updated IMU (Certus OEM only, not applicable to Certus Evo OEM)
1.1	November 2020	Initial release

Table 3: Hardware Changelog

3 OEM Development Kit

Certus OEM is available in a Development Kit that contains everything required to get started operating the system right away. The Development Kit is supplied in a rugged transport case to protect the equipment during transit.

Note: Antennas and antenna cables are not included in the Development Kit. See [4 Part Numbers and Ordering Options](#) for antenna cable options and for ordering of antenna.



Figure 2: Certus OEM Kit Transport Case

3.1 Certus OEM Development Kit Contents

Part Number	Quantity	Description	Notes
CERTUS-OEM or CERTUS-EVO-OEM	1	Certus OEM unit	Model varies depending on kit ordered OEM unit includes non-removable breakout board
BRL5521-JST	1	Power Socket 5.5 mm x 2.1 mm to JST 35 cm	DC power breakout cable to barrel
RJ45FEM-MOLEX	1	RJ45 female to Molex 30 cm	Ethernet breakout cable to RJ45 socket
MOLEX-PICO-3PIN-30	5	Molex Pico-Spox cable, 3 pin, female to female, 30 cm	3-pin data breakout cable to female Molex plug Minimum Order Quantity 5
BF046WS140116-04	2	Female SMA to MMCX Cable Assembly	For connecting external antenna cable
SUPPLY-24V	1	24 V DC Power Supply	100-240 V AC Mains to 24 V DC Power Supply (DC jack) Includes 2-pin plug types A/C/G/I
CERTUS-EK-CASE	1	Transport case	Rugged transport case

Table 4: Certus OEM Development Kit Contents

4 Part Numbers and Ordering Options

4.1 Development Kits

See [3.1 Certus OEM Development Kit Contents](#) for details on what is included in each kit.

Part Number	Description	Notes
CERTUS-OEM-DK	Certus OEM Development Kit	Certus OEM Aries GNSS Development Kit
CERTUS-EVO-OEM-DK	Certus Evo OEM Development Kit	Certus Evo OEM Aries GNSS Development Kit

Table 5: Development Kit Part Numbers

4.2 Standalone Units

Part Number	Description	Notes
CERTUS-OEM	Certus OEM Unit	Certus OEM unit Aries GNSS Receiver GPS, GLONASS, BeiDou and Galileo 1 cm RTK
CERTUS-EVO-OEM	Certus Evo OEM Unit	Certus Evo OEM unit Aries GNSS Receiver GPS, GLONASS, BeiDou and Galileo 1 cm RTK

Table 6: Standalone Unit Part Numbers

4.3 Antennas

The antennas listed below are available for purchase. For more information on antenna selection, see [6.7 GNSS Antennas](#) for more details.

Part Number	Description	Notes
Cables		
BF046WS140116-04	SMA to MMCX Cable Assembly	SMA female panel mount to MMCX, 10cm cable Connects breakout board to common antenna connections
BF046WS180427-03	GNSS antenna cable 4 m	4 m RG-58A/U SMA male to TNC female
Antennas		
G5ANT-53A4T1	Antcom GNSS Antenna	Antcom G5 L1/L2/L5 GNSS antenna with survey mount, TNC Female connector Use with BF046WS180427-03
VSP6337L	Tallysman VeroStar GNSS Antenna	VeroStar GNSS Antenna - L1/L2/L5 plus L-band, pole mount, TNC Female connector Use with BF046WS180427-03

Part Number	Description	Notes
Antenna Accessories		
MOUNT-SUCT	Suction Cup Antenna Mount	Suction cup 5/8" GNSS antenna survey mount for easy installation of GNSS antenna on vehicles

Figure 3: Antenna Part Numbers

4.4 Accessories

Part Number	Description	Notes
BRL5521-JST	Power Socket 5.5x2.1 to JST 35cm	Power Socket 5.5x2.1 to JST 35 cm for DC input power
RJ45FEM-MOLEX	RJ45 Female to Molex 30 cm	RJ45 female to Molex 30 cm for Ethernet connection
MOLEX-PICO-3PIN-30	Molex 3-pin F-F 30 cm	Molex Pico-SPOX cable, 3 pin, female to female, 30 cm for data connections Up to 5 may be required
SUPPLY-24V	24V DC Power Supply	100-240 V AC Mains to 24V DC Power Supply (DC barrel jack) Includes 2-pin plug types A/C/G/I
CAR12VPWR	Car auxiliary power outlet supply	Car auxiliary power supply to DC jack power supply
OBDII-ODOMETER	OBDII Odometer	OBDII Odometer Interface. See OBDII Odometer Interface of the reference manual for details
Various Air Data Units	Air Data Unit	Air data unit provides pitot and static air velocity data aiding for Certus in fixed wing aircraft

Table 7: Accessories Part Numbers

5 Specifications

For details, review the following specifications for Certus:

- [5.1 Navigation Specifications](#)
- [5.3 Hardware Specifications](#)
- [5.5 Communication Specifications](#)
- [5.6 Electrical Specifications](#)
- [5.7 Connector Pin-out](#)

5.1 Navigation Specifications

5.1.1 Certus Specifications

Parameters	Specification
	Aries GNSS Receiver
Horizontal Position Accuracy	1.2 m
Vertical Position Accuracy	2.0 m
Horizontal Position Accuracy (SBAS)	0.5 m
Vertical Position Accuracy (SBAS)	0.8 m
Horizontal Position Accuracy (RTK or Kinematica Post Processing)	0.01 m
Vertical Position Accuracy (RTK or Kinematica Post Processing)	0.015 m
Velocity Accuracy	0.05 m/s
Roll & Pitch Accuracy	0.1 °
Heading Accuracy (1.0 m antenna separation)	0.1 °
Roll & Pitch Accuracy (Kinematica Post Processing)	0.03 °
Heading Accuracy (Kinematica Post Processing)	0.06 °
Slip Accuracy	0.1 °
Heave Accuracy	5 % or 0.05 m
Orientation Range	Unlimited
Hot Start Time	500 ms
Internal Filter Rate	1000 Hz
Output Data Rate	Up to 1000 Hz

Table 8: Certus Navigation Specifications

5.1.2 Certus Evo Specifications

Parameter	Specification
	Aries GNSS Receiver
Horizontal Position Accuracy	1.2 m
Vertical Position Accuracy	2.0 m
Horizontal Position Accuracy (SBAS)	0.5 m
Vertical Position Accuracy (SBAS)	0.8 m
Horizontal Position Accuracy (RTK or Kinematica Post Processing)	0.01 m
Vertical Position Accuracy (RTK or Kinematica Post Processing)	0.015 m
Velocity Accuracy	0.05 m/s
Roll & Pitch Accuracy	0.03 °
Heading Accuracy (1 m antenna separation)	0.05 °
Roll & Pitch Accuracy (Kinematica Post Processing)	0.01 °
Heading Accuracy (Kinematica Post Processing)	0.01 °
Slip Accuracy	0.1 °
Heave Accuracy	5 % or 0.05 m
Orientation Range	Unlimited
Hot Start Time	500 ms
Internal Filter Rate	1000 Hz
Output Data Rate	Up to 1000 Hz

Table 9: Certus Evo Navigation Specifications

5.1.3 Heading Accuracy

Antenna Separation	Certus Accuracy	Certus EvoAccuracy
0.5 m	0.16 °	0.12 °
1 m	0.1 °	0.05 °
2 m	0.07 °	0.02 °
5 m	0.05 °	0.01 °
10 m	0.02 °	0.005 °

Table 10: Heading Accuracy

5.2 Sensor Specifications

5.2.1 Certus Specifications

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Range (dynamic)	±2 g ±4 g ±16 g	±250 °/s ±500 °/s ±2000 °/s	±2 G ±4 G ±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 °	-
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 11: Certus Sensor Specifications

5.2.2 Certus Evo Specifications

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

Parameter	Accelerometers	Gyroscopes	Magnetometers	Pressure
Bandwidth	250 Hz	200 Hz	110 Hz	50 Hz

Table 12: CertusEvo Sensor Specifications

5.2.3 GNSS Specifications

Parameter	Specification
	Aries GNSS Receiver
Supported Navigation Systems	GPS L1, L2 GLONASS L1, L2 Galileo E1, E5b BeiDou B1, B2
Supported SBAS Systems	WAAS EGNOS MSAS GAGAN QZSS
RTCM Input	Version 3.3
Update Rate	Up to 20 Hz ³
Hot Start First Fix	2 s
Cold Start First Fix	30 s
Horizontal Position Accuracy	1.2 m
Horizontal Position Accuracy (with SBAS)	0.5 m
Horizontal Position Accuracy (with RTK)	0.010 m
Velocity Accuracy	0.05 m/s
Timing Accuracy	20 ns
Acceleration Limit	4 g

Table 13: GNSS Specifications

¹ Requires purchase of Omnistar or Trimble RTX subscription

² Requires purchase of additional software license, see [GNSS Receiver License Upgrades](#)

³ See [8.1.3.16 GNSS Configuration](#) for update rate relevant to particular constellation configurations

5.3 Hardware Specifications

5.3.1 Certus OEM Hardware Specifications

Parameter	Value
Operating Voltage	9 to 30 V (or 5 V)
Input Protection	None
Power Consumption (typical)	2.64 W

Parameter	Value
Power Consumption (maximum)	4.5 W
Hot Start Battery Capacity	> 48 hours
Hot Start Battery Charge Time	30 minutes
Hot Start Battery Endurance	> 10 years
Operating Temperature	-40 °C to 85 °C
Mean Time between Failure (MTBF)	140,000 hours
Shock Limit	2000 g
Dimensions	75 x 101.5 x 24 mm
Weight	110 grams

Figure 4: Hardware Specifications for Certus OEM Variant

5.3.2 Certus Evo OEM Hardware Specifications

Parameter	Value
Operating Voltage	9 to 30 V (or 5 V)
Input Protection	None
Power Consumption (typical)	2.9 W
Power Consumption (maximum)	5.0 W
Hot Start Battery Capacity	> 48 hours
Hot Start Battery Charge Time	30 minutes
Hot Start Battery Endurance	> 10 years
Operating Temperature	-40 °C to 85 °C
Mean Time between Failure (MTBF)	140,000 hours
Shock Limit	2000 g
Dimensions	75 x 101.5 x 40.2 mm
Weight	125 grams

Table 14: Hardware Specifications for Certus Evo OEM Variant

5.3.3 OEM Mechanical Drawings

5.3.3.1 Certus OEM Mechanical Drawings

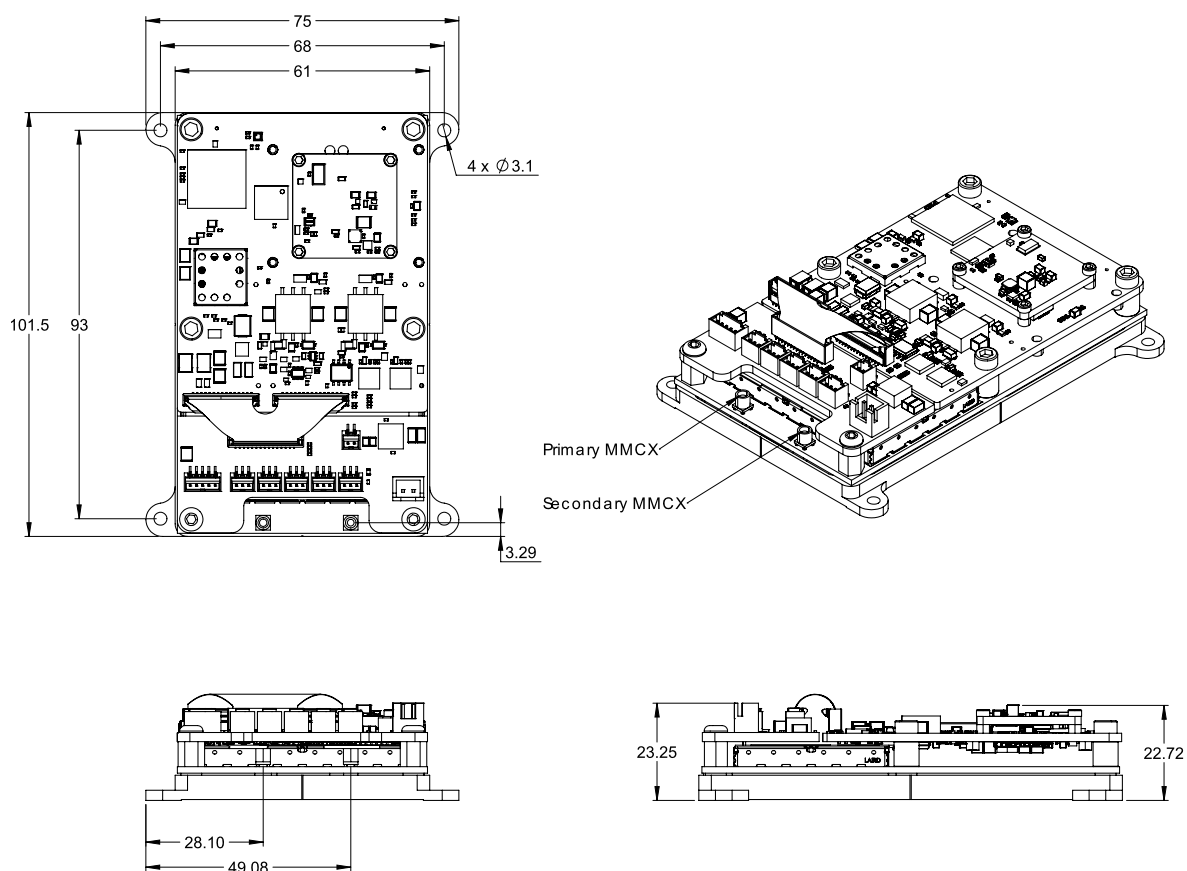


Figure 5: Mechanical Drawings of Certus OEM

5.3.3.2 Certus Evo OEM Mechanical Drawings

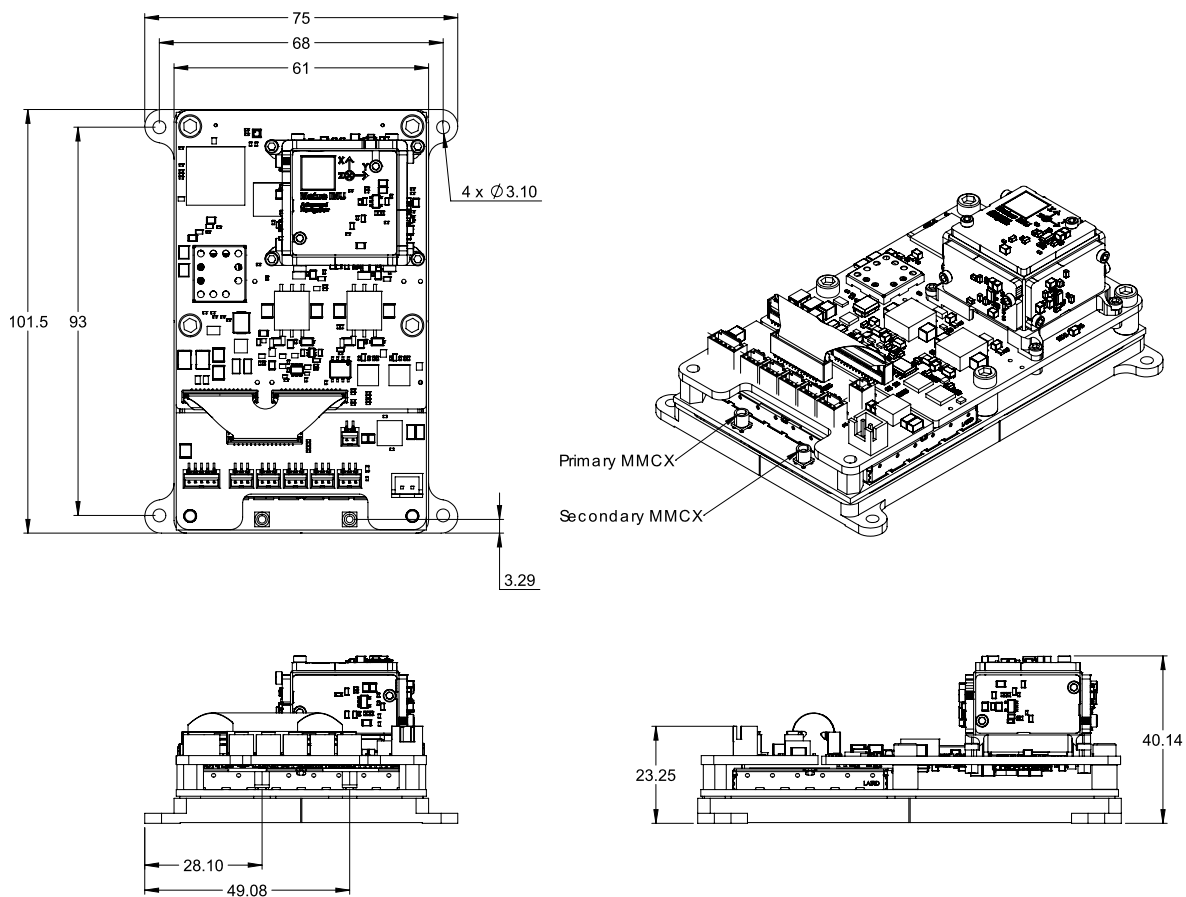


Figure 6: Mechanical Drawings of Certus Evo OEM

5.4 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 ([8.1.2 View Menu](#))
- Through the Device Information page in the [8.2 Using Certus Manager](#) application.
- Via the 2D data matrix bar code on top rear of the unit. Applications are available for most smart-phones that can scan the 2D data matrix bar code to display the serial number. The correct label can be identified by the blue ADVANCED NAVIGATION logo, and includes the hardware version and build date.

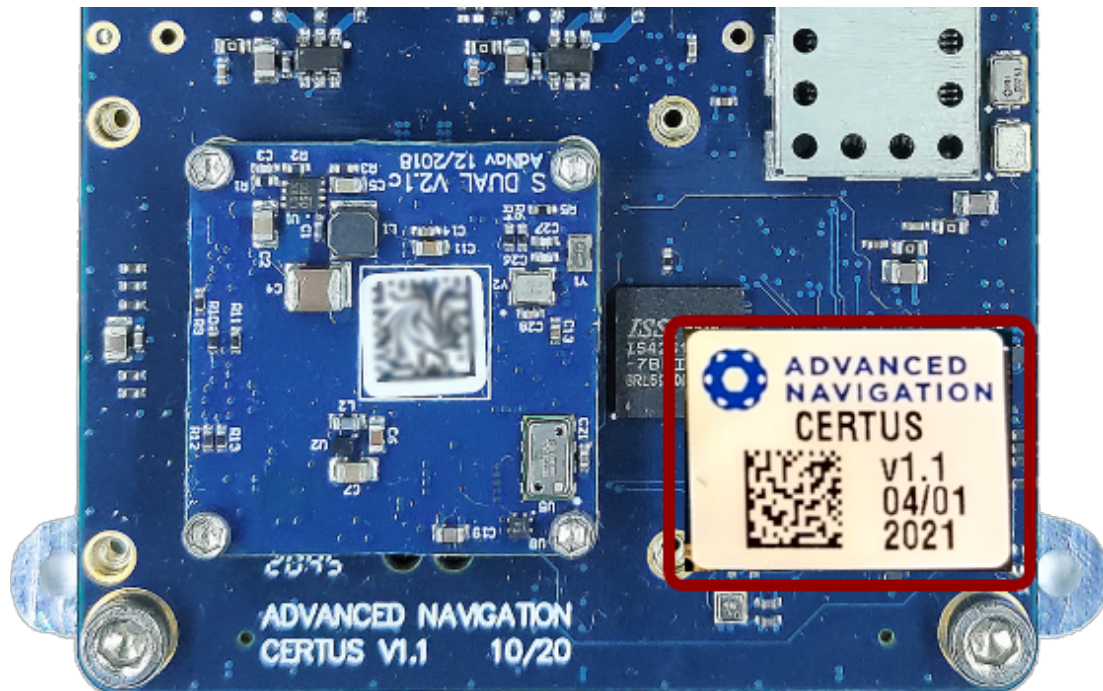


Figure 7: Certus OEM Serial Number Sticker

5.5 Communication Specifications

Parameter	Value
Interfaces	Ethernet UART CAN 1PPS
Speed	100Mbit (Ethernet) 4800 to 4M baud (UART) 125000 to 1M baud (CAN)
Protocols	AN Packet Protocol NMEA 0183 NMEA 2000
Peripheral Interface	2x GPIO for serial, timing, digital inputs/ outputs
GPIO Operating Voltage Levels	Disabled, 3.3 V, 5 V or RS232
GPIO Port Serial Interface	RS232
GPIO Port Serial Speed	4800 to 250K baud
Default Primary, Auxiliary, GPIO Serial Speed	115200 baud

Figure 8: Communication specifications for OEM variants

5.6 Electrical Specifications

Parameter	Minimum	Typical	Maximum
Operating Voltage (9 - 30 V input)		9 V	30 V
Input Protection (9 - 30 V input)		-40 V	+10 V
Operating Voltage (5 V input)	4.95 V	5 V	5.05 V
Input Protection (5 V input)		Nil	
Power Consumption		Certus 2.64 W Certus Evo 2.9 W	Certus 4.5 W Certus Evo 5.0 W
Primary and Auxiliary Port (UART)			
Tx Voltage Low	0 V		
Tx Voltage High			3.3 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
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
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

Parameter	Minimum	Typical	Maximum
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 15: Electrical Specifications

5.7 Connector Pin-out

The electrical connection to the Certus OEM is through Molex and JST connectors to board mounted connectors.

5.7.1 Connection Layout

The following illustration shows the connection locations on the CertusOEM unit.

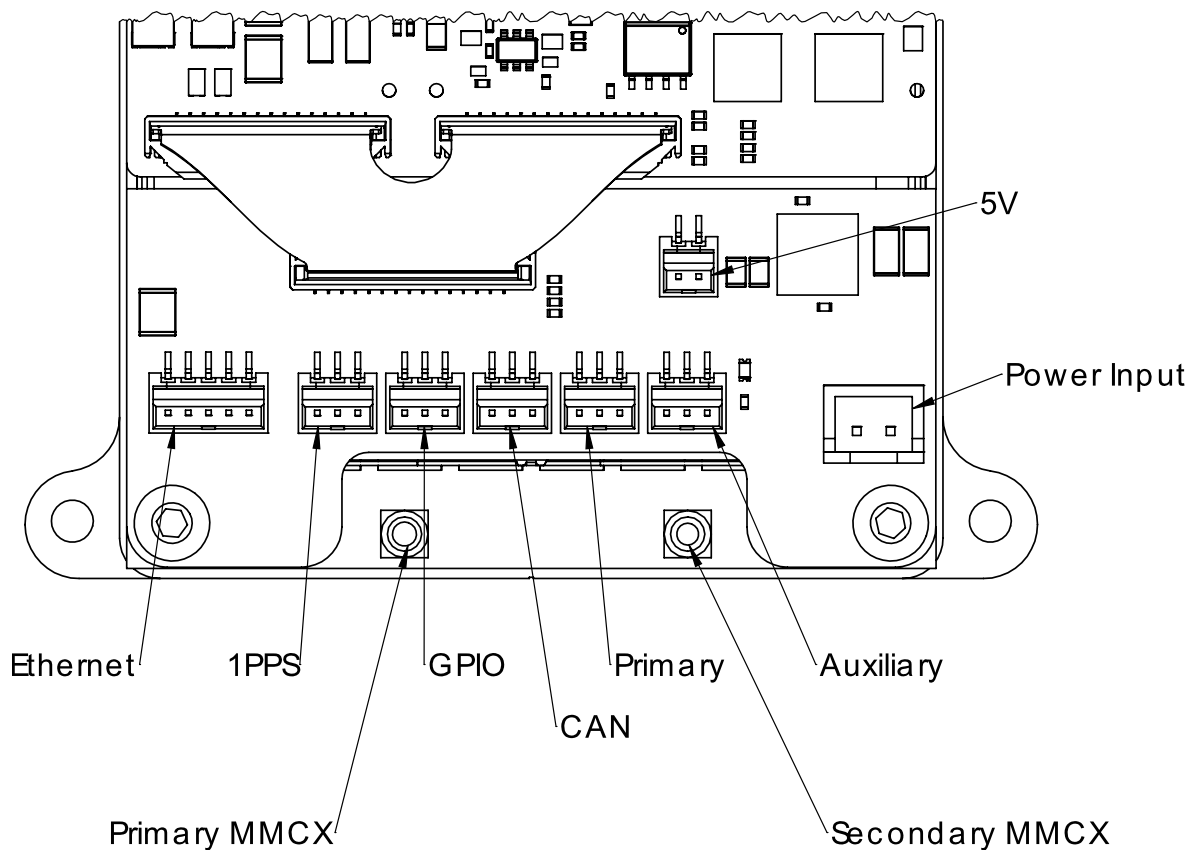


Figure 9: Certus OEM Breakout Connector Locations

5.7.2 Connection Schematic

The following illustration shows the schematic of the breakout connections.

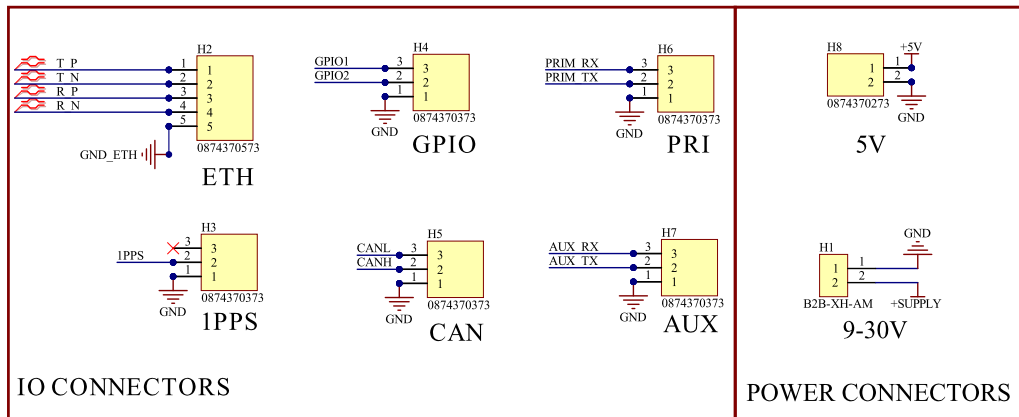


Figure 10: CertusOEM Connection Schematic

5.7.3 Electrical Connectors

The following table describes the function of each connection and the type and ordering information for connection. CertusOEM PCB Connector is the connector supplied on the CertusOEM PCB ready for customer connection. Mating Connector for Cables is the manufacturers mating connector and part number, plus the part number for a precrimped 15 cm cable.

This information is provided to make it easier for you to design the appropriate type and length of connections for your specific application. To make development easier, we also provide standard ~30 cm pre-prepared as described in section [4 Part Numbers and Ordering Options](#).

Label	Function	CertusOEM PCB Connector	Mating Connector for Cables
9-30 V	9-30 V DC input power	JST 2 pin B2B-XH-AM	JST XHP-2 (Percrimped wires: JST ASXHSXH22K305)
5 V	5 V DC input power	Molex 2 pin 0874370273	Molex 0874390200 (Percrimped wires: Molex 0797580016)
PRI	Primary Serial UART	Molex 3 pin 0874370373	Molex 0874390300 (Percrimped wires: Molex 0797580016)
AUX	Auxiliary Serial UART		
1PPS	1PPS communications		
CAN	CAN Communications Bus		
GPIO	General Purpose Input/Output		
ETH	Ethernet network connectivity	Molex 5 pin 0874370573	Molex 0874390500 (Percrimped wires: Molex 0797580016)
PRIM	Primary GNSS antenna	Female MMCX	Male 5.7.6 MMCX RF Connector
SEC	Secondary GNSS antenna	Female MMCX	Male 5.7.6 MMCX RF Connector

Table 16: Connector Descriptions

5.7.4 Connector Pin Allocation

The following table shows the relevant pin allocation for each connection. Take care to accurately identify Pin 1 when making cables/connections.

Connection	Pin	Function
Power Input 9-30 V	1	Ground
	2	Supply Voltage
5 V	1	Optional 5 V input, see section 9.2.2
	2	Ground
Primary PRI	1	Ground
	2	Primary UART transmit
	3	Primary UART receive
Auxiliary AUX	1	Ground
	2	Primary UART transmit
	3	Primary UART receive
1PPS	1	Ground
	2	1PPS
	3	No Connection
CAN	1	Ground
	2	CANL
	3	CANH
GPIO	1	Ground
	2	GPIO1
	3	GPIO2
Ethernet ETH	1	Transmit positive +
	2	Transmit negative -
	3	Receive positive +
	4	Receive negative -
	5	Ground

Table 17: Connector Pin Allocation

5.7.5 Interoperability with Different Voltage Systems

All signals are 3.3 volt level, however inputs are tolerant to 5 volt signals from the target interface. If you require a different voltage level to be compatible with your target system it is recommended that you install a voltage level translator between the signals of each device.

5.7.6 MMCX RF Connector

The CertusOEM antenna connections are through MMCX connectors on the board. It is recommended to use a MMCX to SMA adapter cable to allow connection to standard GNSS antennas. The MMCX connector is fragile

and should be handled with care. It is not designed for repeated connection and disconnection.

6 Installing Certus OEM

To install and quickly get started with Certus OEM, follow the instructions provided in the [6.1 Installation Checklist](#)

More Information...

See	For
6.2 Mounting Certus OEM	Guidelines for selecting the mounting location alignment
6.3 Mounting Alignment	Guidelines on setting the alignment with respect to the vehicle and antennas.
6.4 Power Supply	Recommendations for setting up power supply.
6.5 Electrical Domains	Information on how to minimise interference due to noise.
6.7 GNSS Antennas	Guidelines on how to install GNSS antennas and route cables.
6.8 Networking	Information about changing Certus to a fixed IP address system after establishing a connection.
6.9 Odometer	Different options using an odometer to improve the navigation and orientation.
6.10 Magnetism	Information on the effects of magnetic interference.
6.11 Vibration	Steps to mitigate the adverse effects of vibration on the performance.

Note: For ordering a development kit, a standalone unit or accessories for Certus OEM, see [4 Part Numbers and Ordering Options](#).

6.1 Installation Checklist

The following instructions serve as a quick start when using the cables supplied with the Development Kit. Refer to [5.7 Connector Pin-out](#) for details on identifying and connecting to the Molex and JST connectors.

1. Plug the power supply into the power connector on the breakout cable and then into the wall socket. See [6.4 Power Supply](#).
2. Plug an Ethernet cable into the Ethernet socket on the breakout cable, and into your network.
3. Download and install the Bonjour ZeroConf networking utility from the link <https://www.advancednavigation.com/Bonjour64.msi>.
4. In a web browser, type in the address <http://certus.local>.
5. Mount the unit in the standard alignment of X+ pointing forward and Z+ pointing down. For more information, see [6.3 Mounting Alignment](#).
6. Mount the two GNSS antennas in a level orientation with a clear view of the sky. The primary antenna should be positioned directly forwards of the secondary antenna with separation of at least 0.5 metres. See [6.7 GNSS Antennas](#).
7. Connect the coaxial antenna cables between the antennas and Certus. The antenna cables should not be coiled.
8. Accurately measure the GNSS antenna offset from the centre of the Certus unit to the central base of the primary antenna in the body co-ordinate frame (X+ forward and Z+ down, see [11.3 The Body Co-ordinate Frame](#)) and enter these values into the [8.1.3.4 Alignment](#) screen under the **Configuration** menu. See [6.7 GNSS Antennas](#) for more details.
9. Choose a Vehicle Profile in the [8.1.3.2 Filter Options](#) screen under the **Configuration** menu. This should be the closest available match to your vehicle type. If you need more information, contact Support at support@advancednavigation.com.
10. Check that all filters are initialised. See [7.1 Filter Initialisation](#).
The system is now ready for use.

6.2 Mounting Certus OEM

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 [7.9 Atmospheric Altitude](#) will be disabled.

The Certus mounting plate and hole guide are shown in [6.2.1 Mounting Plate Layout](#). The holes are designed for M3 screws.

For instructions on alignment of the unit within a vehicle, see [6.3 Mounting Alignment](#).

6.2.1 Mounting Plate Layout

Note: The mechanical structure of Certus OEM forms an integral part of the OEM product in order to provide rigidity, ensure factory calibration repeatability and performance accuracy. No mechanical pieces should be removed from the Certus OEM product.

Certus OEM is secured using four M3 screws and washers and nuts on the back side of the mounting surface. The length of the M3 screws will be dependent on the thickness of the mounting surface.

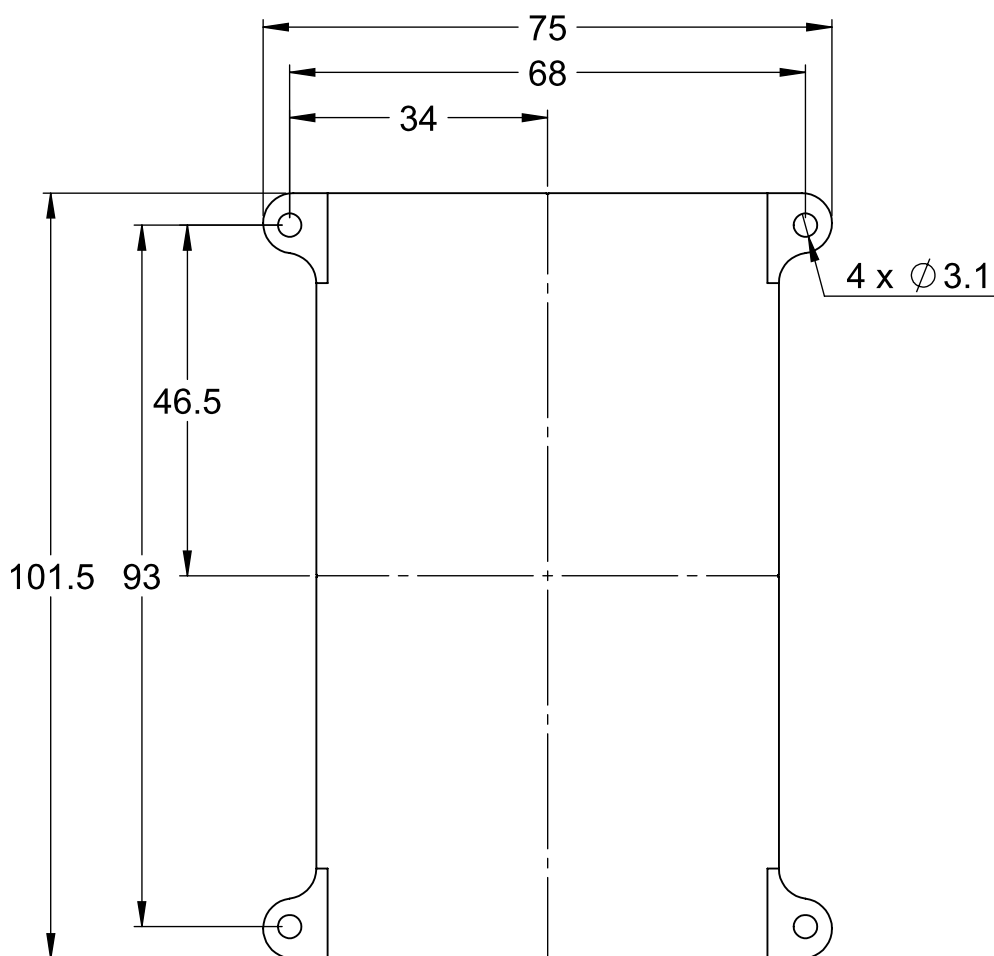


Figure 11: Bottom View of Certus OEM Mounting Plate

6.3 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 [8.1 Using the Web User Interface](#) or [8.2 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.

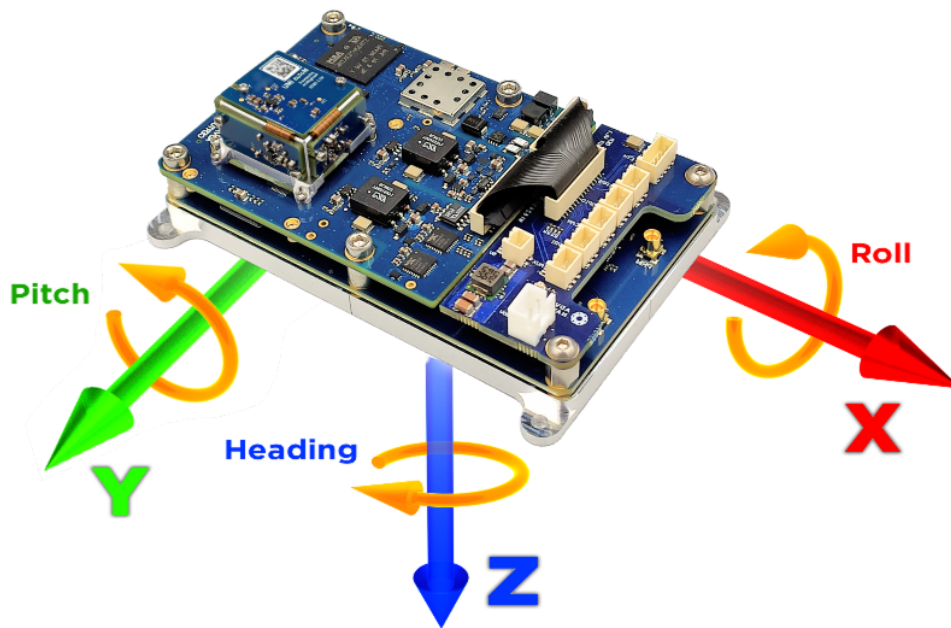


Figure 12: Mounting Axes

6.4 Power Supply

There are two options for powering Certus OEM, either a wide input 9-30 VDC that passes through an onboard regulator or a clean and regulated 5 VDC supply. See [5.7 Connector Pin-out](#) for details

Note: Only one power supply should be connected to the unit at any one time. Connecting power supplies to both inputs may result in damage to the unit.

On start-up of the Certus OEM the device will initially draw an increased impulse current (2 A for 2 microseconds) whilst it charges on board capacitors. It is important that the user's circuit is tolerant to these small impulses on start-up to avoid unsuccessful power up. It is recommended that a supply is selected that can provide a maximum current of 2 A. Switch-mode supplies are suitable as Certus OEM has on-board filters to remove any supply noise and ripple.

6.4.1 9-30 V Input

A wide range 9-30 V input is available which connects to Certus OEM's onboard regulator. The power supply should be able to supply the maximum current at the chosen voltage, calculated from the maximum power

indicated in [5.3 Hardware Specifications](#). For the avoidance of doubt, if wiring your own JST connector, observe the + and – polarity indicated on the PCBA.

Take care when using a supply voltage close to the under-voltage lockout of 9.1 V, as small voltage changes could engage the under-voltage shutdown and potentially oscillate between the on and off state unexpectedly. It is recommended that the unit is always run at 9.5 V or higher.

6.4.2 Regulated 5 V Input

The 5 V input is only rated for inputs from 4.95 V to 5.05 V, exceeding 5.5 V can cause permanent damage to the unit. The 5 V supply must be low noise (< 20 mV peak-to-peak).

6.5 Electrical Domains

Certus OEM ground planes are interconnected, and not electrically isolated across each domain.

6.6 Onboard Memory Logging

Certus OEM features an onboard high capacity memory for operation and data logging. The memory card is not a user serviceable part, and should not be removed or modified as it is used during normal operation of the unit.

6.7 GNSS Antennas

The GNSS antennas should be installed level with respect to each other, with a clear unobstructed view of the sky, away from reflective surfaces and with the shortest cable run to the Certus unit permitted by the application. The antennas should be mounted away from any RF emitters such as radars, high-powered communication links, etc. It is important to have a ground plane (flat conductive surface such as a piece of plate aluminium) under the antenna with a minimum radius of 60mm or as recommended by the antenna supplier. Correct antenna positioning is critical for Certus's dual-antenna heading function.

The primary GNSS antenna position offset should be configured in the Certus unit by using the Alignment page in the web UI or Certus Manager. See [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#). The antenna offset is measured from the physical centre of the Certus unit to the central base (ARP) of the primary GNSS antenna in the body co-ordinate frame (X+ forward, Z+ down).

Note: The Z axis is positive downwards, mounting the antenna above the Certus unit will require a negative Z offset. It is very important to set this antenna offset accurately as Certus corrects for lever arm velocities. An incorrect GNSS antenna offset will lead to performance degradation under turning and angular rotations.

An example installation with the body co-ordinate frame axes marked is shown below in Certus antenna offset isometric view and Certus antenna offset front view. In this installation below with an antenna mounted on the right-hand side of the vehicle roof, further forward from the Certus unit, there would be a positive X antenna offset value, a positive Y antenna offset value and a negative Z offset value.

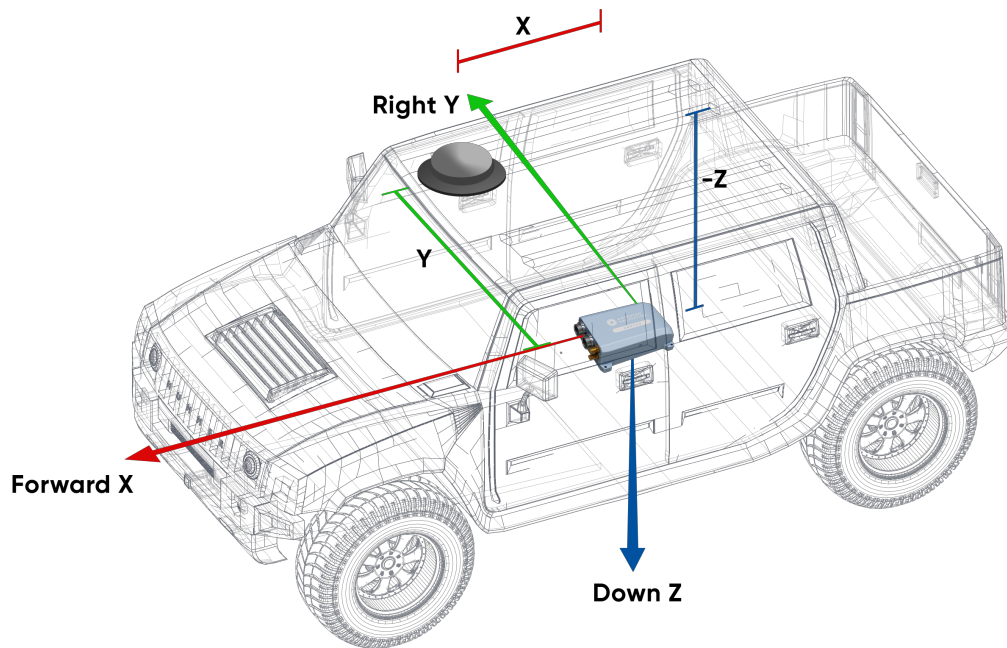


Figure 13: Antenna Offset Isometric View

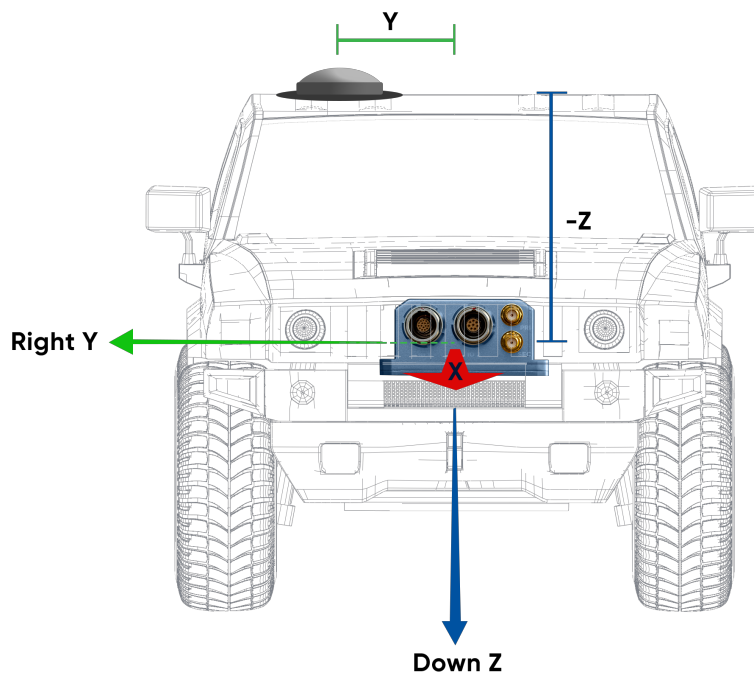


Figure 14: Antenna Offset Front View

The secondary antenna should be mounted behind the primary antenna with as much separation as possible, and in line with the long axis of the vehicle, in the direction of travel, with as much separation as practically possible. The heading accuracy can be improved by increasing the antenna separation. See [5.1 Navigation Specifications](#) specifications.

If it is impractical to mount the secondary antenna directly behind the primary antenna due to physical constraints, it can be mounted in another position. In this case the secondary antenna configuration must be

entered into the Dual Antenna page in the web UI or Certus Manager. See [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#).

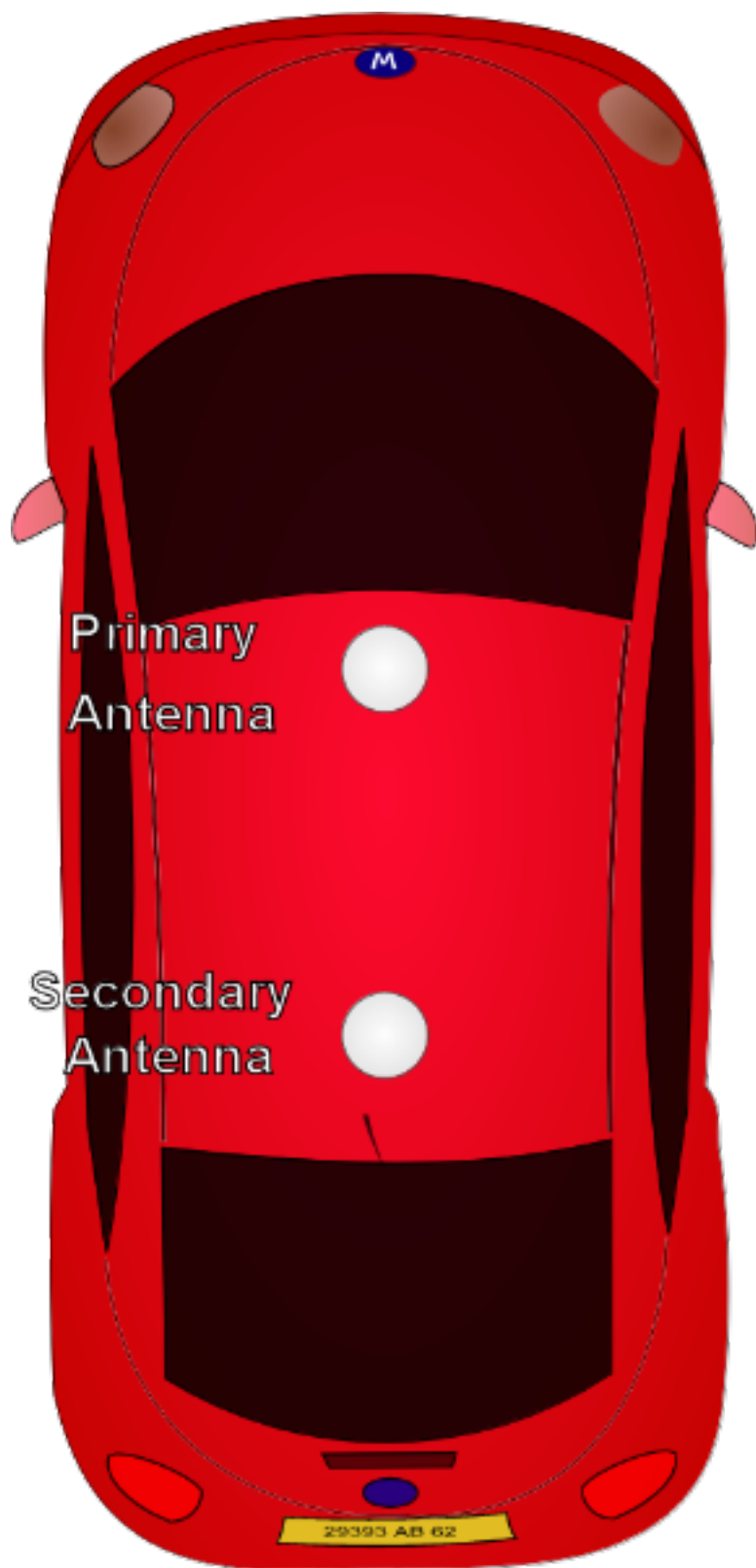


Figure 15: Recommended Second Antenna Placement

If you are sourcing your own antennas, note the following antenna guidelines:

- The antenna should be capable of receiving both L1 and L2. Heading performance will be significantly degraded with an L1-only antenna.
- Active antennas should have sufficient LNA gain, which when accounting for cable losses, provides at least 33 dB of gain at the connector of the unit.
- The antenna needs to have an accurate phase centre to be RTK capable. This is also required for the dual antenna heading to function correctly. Low performance (low cost) antennas are typically not able to achieve good heading performance.
- The antenna should support GPS, GLONASS, BeiDou, and Galileo.
- The antenna should be environmentally sealed, including connectors.

6.7.1 Antenna Cables

The antenna cables should be routed away from powerful RF emitters, high current wiring, high temperatures and any rotating or reciprocating machinery. It is very important not to bend the antenna cable tighter than its minimum bend radius, or to allow it to be dented. It is recommended to use wide cable ties, loosely fixed in order to avoid damaging the insulation or shielding. The cables should not be coiled. Advanced Navigation recommends:

- Keeping the antenna cables the same length, and as short as possible.
- Using either RG58 low loss or LMR240 coaxial cable combined with high quality connectors. LMR300 and LMR400 can also be used to minimise loss for very long antenna cables.

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

Table 18: GNSS antenna co-axial cable properties

If you are sourcing your own antenna cables it is important to ensure that the antenna has enough gain to support the signal loss over the cable. Certus requires a minimum of 33 dB of gain at the connector. With the standard 4 metre RG-58A/U antenna cables supplied by Advanced Navigation, the minimum antenna gain required is 36.5 dB.

6.7.2 Antenna Suction Cup Mount

A suction cup mount can be used when antennas need to be mounted at any angle or on a smooth, non-porous surface such as a window or on vehicles with aluminium or fibreglass bodies. A suction cup mount can be attached and removed quickly and can easily be moved from one location to another. See [Accessories](#).

6.7.3 Antcom Antenna Survey Mount Assembly

If using the optional Antcom G5ANT-53A4T1 antenna, mount it to a panel or mount to a standard 5/8"-11 survey mount with the included survey mount kit. See the figure below for assembly of each antenna with the survey mount kit.

Note: The ground planes are not optional.

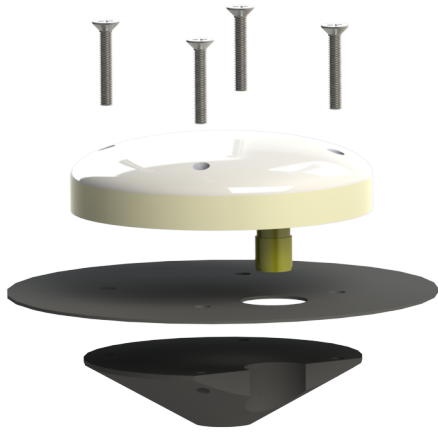


Figure 16: Antenna Survey Mount

6.8 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.

If you cannot establish a connection using a DHCP-capable network, you can connect to and configure the Certus using the Primary port RS232 serial interface and the Certus Manager application.

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

6.9 Odometer

On ground vehicles, the use of an odometer input will greatly improve the Certus navigation and orientation solution during GNSS outages. With a high resolution wheel encoder Certus can be used to navigate indoors without GNSS.

There are several different options for odometer installation which are listed below.

6.9.1 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 Certus Manager. The odometer pulse length must then be set either manually or automatically, see [7.10 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](#).

6.9.2 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 17: Advanced Navigation OBDII Odometer

6.9.3 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 18: Aftermarket Wheel Speed Sensor

6.9.4 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 19: Radar Speed Sensor

6.10 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.

Static magnetic interference is caused by steel and other magnetic materials 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 [7.5 Magnetic Calibration](#) for instructions on how to calibrate your device.

Dynamic magnetic interference is much more harmful issue. Sources of dynamic magnetic interference include high current wiring, electric motors, servos, solenoids and nearby large masses of steel that don't move with Certus. Certus should be mounted as far as possible from these interference sources.

Certus contains a special algorithm to remove 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 Certus Manager and watch the magnetometer outputs whilst the vehicle is operating but stationary. See [8.1 Using the Web User Interface](#) or [8.2 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 from these interference source, the magnetometers should be disabled, see [7.5.4 Disabling Magnetometers](#). Note that by default Certus has the magnetometers disabled.

6.11 Vibration

Certus is able to tolerate a high level of vibration compared to other inertial systems. This is due to a unique gyroscope design and a special filtering algorithm among other things. There is, however, a limit to the amount of vibration that a unit can tolerate, There may be temporarily degraded accuracy while operating under high vibration.

When mounting Certus to a platform with vibration present, there are several options to mitigate the negative performance effects. It is recommended to conduct a brief operating check to confirm performance is within

specification before conducting longer runs. The Raw Sensor view in the web UI or Certus Manager can give you a good idea of how bad the vibrations are. If the vibrations or shocks in operation are causing the sensors to go over range, you will need to increase the sensor range because this will significantly degrade position and orientation estimates. See [7.6 Sensor Ranges](#) for details.

If there are persistent issues:

- Try to find a mounting point with less vibration.
- Certus can be mounted with a small flat piece of rubber to provide some isolation. This must not be very soft foam which may result in an incorrect level over time.
- Mount Certus to a plate which is then mounted to the platform through vibration isolation mounts. Be mindful that a plate with very soft mounts may also cause problems with shifts in orientation over time.

7 Using Certus

This section covers the following topics:

- [7.1 Filter Initialisation](#)
- [7.2 Hot Start](#)
- [7.3 Time](#)
- [7.4 Heading Sources](#)
- [7.5 Magnetic Calibration](#)
- [7.6 Sensor Ranges](#)
- [7.7 Data Anti-aliasing](#)
- [7.8 Vehicle Profiles](#)
- [7.9 Atmospheric Altitude](#)
- [7.10 Odometer Pulse Length](#)
- [7.11 Reversing Detection](#)
- [7.12 Motion Analysis](#)
- [7.13 RTK](#)
- [7.14 Raw Satellite Data](#)
- [7.15 Kinematica Post Processing](#)
- [7.16 RAIM](#)
- [7.17 Heave](#)
- [7.18 Environmental Exposure](#)
- [7.19 Upgrading the Certus Firmware](#)

7.1 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 [8.1.2.4 Status](#) view in the web UI or [8.2.6 View Menu](#) in the Certus Manager.

Initialisation

- Orientation
- Navigation
- Heading
- Time

Figure 20: 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.

7.1.1 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.

7.1.2 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 [10.4.25 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 [8.1.3.10 Manual Initialisation](#) page in the web UI or in [Certus Manager](#).

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

7.1.3 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 [7.4 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 is hot-starting then it will use the heading from the heading from when it was last switched off as the starting heading until another source becomes available.

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.

7.1.4 Time Initialisation

Time initialisation completes once the system has determined time accurately. This occurs as soon as the GNSS receiver obtains its first fix. For this to occur the system must receive rough time as well as a 1PPS signal on one of the GPIO pins. It is also possible to acquire time from an external source, see [10.4.32 External Time Packet](#) for more information.

Until the time has initialised, the Unix or formatted time that Certus outputs will be flagged as invalid.

7.2 Hot Start

Advanced Navigation GNSS/INS devices were the first on the market with hot-start functionality. This hot-start functionality allows Certus to start inertial navigation within 500 ms to 1 s, and obtain a GNSS fix in as little as 2 seconds. The hot-start functionality is always on and fully automatic. See [5.1 Navigation Specifications](#) for details.

A next generation backup battery system within Certus provides the hot-start ability for more than 48 hours without power. When Certus hot-starts, it assumes that it is in the same state it was when it lost power and begins navigating from that position. The hot-start also provides ephemeris, almanac and time information to the GNSS receiver which allows it to achieve a GNSS fix far more quickly than it otherwise could. When the GNSS achieves its first fix, Certus will jump to the new position without disturbing the filter.

Whenever Certus is without power it continues to accurately keep time so that it is immediately valid for a hot-start.

The hot-start functionality is of particular benefit to vehicle tracking and robotics applications. The primary benefits are immunity and fast recovery from power failure as well as fast start up time.

7.3 Time

Certus has been designed to provide a highly accurate time reference. It contains a temperature compensated disciplined oscillator that corrects itself very precisely using GNSS time. When a GNSS fix is available, the Certus time is accurate to within 20 nanoseconds.

When the GNSS fix is lost, the Certus time will slowly lose accuracy at a rate of approximately 3 microseconds per hour.

When Certus hot-starts the time accuracy is typically within 1 second immediately on startup and corrected to within 50 nanoseconds as soon as a GNSS fix is achieved.

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.

7.4 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 [8.1 Using the Web User Interface](#)) or in the Manager application (see [8.2 Using Certus Manager](#)). It is possible to use multiple heading sources and this can provide performance benefits.

7.4.1 Dual Antenna Heading

This is the default heading source and 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.

7.4.2 Velocity Heading

Velocity heading works by deriving heading from the direction of velocity and acceleration. Velocity heading works well with cars, boats, 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 metres/second with a GNSS fix. It is recommended not to use velocity heading with Certus unless a dual antenna heading fix is not possible. Velocity heading is disabled by default.

7.4.3 Magnetic Heading

When using magnetic heading, magnetic calibration is required every time the Certus installation is changed. The downside of magnetic heading is that prolonged dynamic magnetic interference sources can cause significant heading errors. See [6.10 Magnetics](#) and [7.5 Magnetic Calibration](#) for further information. Magnetic heading is disabled by default.

7.4.4 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 [10.4.28 External Heading Packet](#) or an NMEA message, see [9.6.1.29 NMEA Input](#).

7.5 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 through installation location – see [6.10 Magnetics](#) for more information. To compensate for static magnetic interference, magnetic calibration should be performed whenever the Certus installation 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 50km. Each time Certus moves more than 50km 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.

- 2D calibration involves at least one full rotation of the vehicle about the Z axis and is designed for vehicles that cannot easily or safely be turned upside down, such as full size cars, planes and boats.
- 3D calibration involves at least two full rotations of each axis (X, Y & Z) and is designed for vehicles that can easily and safely be rotated 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. It is not as accurate as the 2D or 3D calibration, however it 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.

7.5.1 2D Magnetic Calibration

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

7.5.1.1 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. Ensure that the device has a GNSS fix before proceeding.
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 this 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 over write the new calibration values. The auto-generated calibration values are automatically saved internally by Certus.

7.5.2 3D Magnetic Calibration

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

7.5.2.1 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. See . 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.

7.5.3 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 [8.1.3.2 Filter Options](#) page of the Web UI or Certus Manager.

7.5.3.1 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 [8.1.3.2 Filter Options](#) page in the web UI or Certus Manager.

7.5.3.2 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 [8.1.3.2 Filter Options](#) page in the web UI or Certus Manager.

7.5.4 Disabling Magnetometers

In situations where there is 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 [7.4 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 [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#). The magnetometers are disabled by default.

7.6 Sensor Ranges

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

Certus supports dynamic ranging on its sensors. Each of the three sensors have three different range settings. 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 that your application won't generate over-range events.

Sensor over-range events can be detected in the [Filter Status field](#). In the web UI and Certus Manager 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. It is recommended to monitor the web UI or Certus Manager when you do this.

The sensor range can be set using the [8.1.3.1 Sensor Ranges](#) page in the web UI or using the [8.2 Using Certus Manager](#).

7.7 Data Anti-aliasing

Internally the Certus filters update at 1000 Hz. When Certus outputs data, most applications require the data at a much lower rate (typically < 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.

7.8 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 Certus Manager. For a list of the different vehicle profiles, see [10.5.6.1 Vehicle Types](#). If the wrong vehicle profile is selected, it can cause a significant decrease in performance.

7.9 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 [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#).

7.10 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, use the procedure outlined below.

7.10.1 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 Certus Manager. See [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#).
2. Open Certus 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**.
3. Wait until Certus has a continuous GNSS fix and then conduct the test in an area with no obstructions over the test circuit.
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 1000 metres.
5. Once 1000 metres has been driven, check that the automatic pulse length check box has become unticked 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 [Certus Manager](#).

7.11 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 Certus Manager. See [8.1 Using the Web User Interface](#) or [8.2 Using Certus Manager](#).

7.12 Motion Analysis

Motion analysis is an artificial intelligence algorithm that associates patterns in high frequency inertial data with the speed of the vehicle. After power on it takes some time to match patterns with speed before it will become active. Motion analysis only activates when dead reckoning and is most effective when the vehicle is near stationary. Motion analysis does not work in all situations and its primary benefit is for ground vehicles. It should

be enabled in any car application. Motion analysis is enabled by default and can be disabled using the [8.1.3.2 Filter Options](#) page in the web UI or Certus Manager.

7.13 RTK

The Certus internal GNSS receiver 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 in three ways:

1. Using the Certus Web UI [8.1.3.13 NTRIP Client](#) in the Configuration Menu.
2. Using the Certus Manager application, select [8.2.8.5 NTRIP Client](#) under the Tools menu.
3. Using the Spatial Manager for Android application. This is convenient for field testing or when temporary RTK corrections are required, for example for performance trials. Download from the [Google Play](#) store.

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. Contact [Support](#) if you need assistance in setting up for network RTK corrections.

7.13.2 Radio Modem RTK Corrections



Figure 21: Trimble R4 Base Station



Figure 22: 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 Supported RTCM Messages

The internal GNSS receiver in Certus supports receiving the following RTCM v3 messages.

Message Number		
1002	1010	1045
1004	1012	MSM4
1005	1019	MSM5
1006	1020	MSM6
1007	1033	MSM7
1008	1044	

Table 19: Supported RTCM v3 messages

7.14 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 [8.1.3.16 GNSS Configuration](#).

It can be enabled by turning on the [10.4.38 Raw Satellite Data Packet](#) (ID 60) in the [8.1.3.3 Data Ports](#) page in the Web UI, or via the Packet Rates dialog in the **Configuration** menu of the Certus Manager, see the figure below.

This packet will be automatically converted to RINEX v3.02 by the [8.2.8.4 Log Converter](#) utility in the **Tools** menu of the Certus Manager.

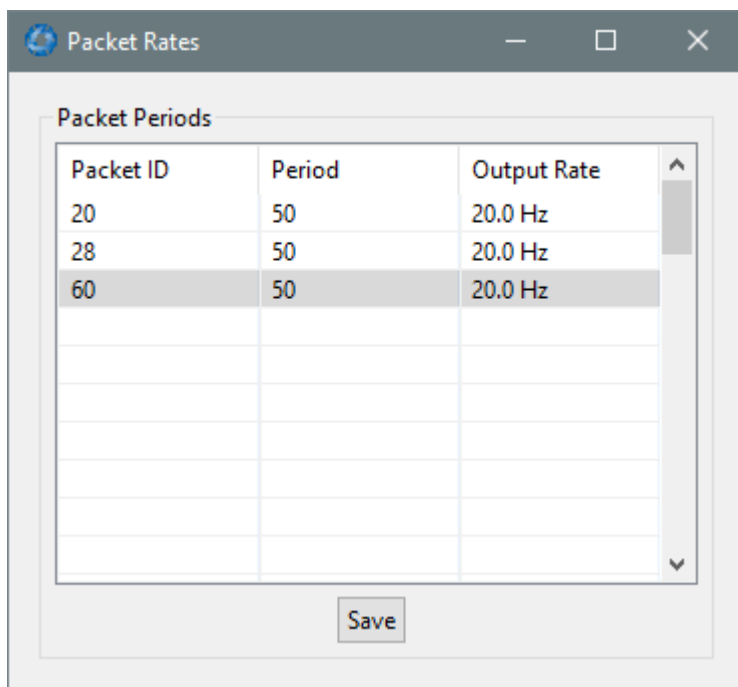


Figure 23: Enabling Packet 60

7.15 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 www.advancednavigation.com/solutions/kinematica for details.

7.16 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.

7.17 Heave

Certus can provide vertical heave position at four different points on a ship. The Certus heave filter is always on and fully automatic. After power on, Certus requires approximately 5 minutes for its heave filter to converge upon an accurate solution. Heave works without a GNSS fix, however best heave performance is achieved when Certus has a GNSS fix.

By default Certus provides heave from the point at which the Certus unit is mounted, however it can provide heave at four different offset points on the ship. To configure Heave, use the [8.1.3.9 Reference Point Offsets](#) page in the web UI or use the [8.2 Using Certus Manager](#).

7.18 Environmental Exposure

Certus OEM offers limited environmental protection, care should be taken in choosing a suitable mounting location.

7.18.1 Temperature

Certus should not be subjected to temperatures outside of its operating range. Subjecting Certus to temperatures outside of the operating range can affect the factory sensor calibration, potentially causing a permanent reduction in performance or premature failure. For information about the operating temperature range, see [Hardware Specifications](#).

7.18.2 Salt, Dirt and Dust

Certus OEM is not resistant to water, dirt or dust. Certus OEM must be mounted in a suitable enclosure to prevent exposure to moisture, dirt or dust.

7.18.3 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.

7.18.4 Atmospheres

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

7.19 Upgrading the Certus Firmware

Certus contains firmware which is regularly updated to improve performance and add features. 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 cause problems with units. Check the [Certus](#) product page of the Advanced Navigation website periodically for updates.

Follow these steps:

1. Navigate to the Firmware Update page under the **Tools** menu.
2. Click **Choose File** and select the firmware file.

3. Click **Upload File**.
4. Wait for the system to restart.

8 Configuring and Monitoring Certus

Certus can be configured and monitored through:

- the [web user interface](#), accessed on a connected computer via Ethernet
- Certus [Manager](#), accessed on a computer via a serial adaptor

Note: Certus Manager is only available for systems with x64 architecture.

- the [Android App](#)
- the Advanced Navigation Packet Protocol ([8.4 Using ANPP](#))

The Certus Web UI is the recommended interface to configure as it is designed to be simple and easy to use without any software or system requirements. The Web UI is compatible with all modern web browsers.

8.1 Using the Web User Interface

The web user interface allows you to manage Certus through the following:

- [8.1.1 Main View](#)
- [8.1.2 View Menu](#)
- [8.1.3 Configuration Menu](#)
- [8.1.4 Tools Menu](#)

8.1.1 Main View

The Main View is accessible from other pages via the **Map** menu item under the **View** menu.

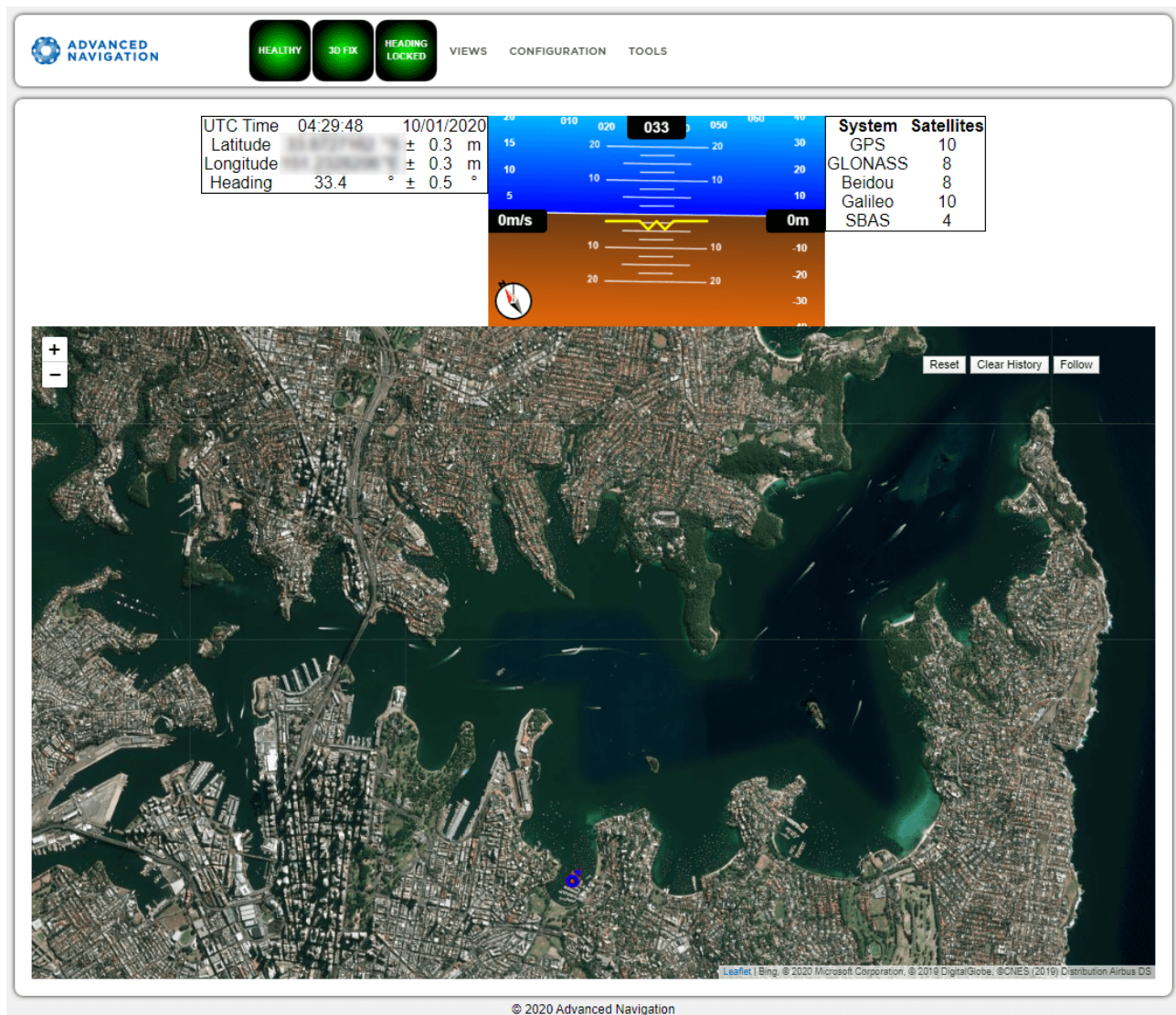


Figure 24: Certus Web UI Home Page

8.1.1.1 Status Indicator

The Status Indicator section contains the current Certus status, the GNSS fix type indicator, and the heading status. These are visible on every page.

- **Status Indicator:** This indicator shows any problems with Certus. Once the filter has initialised it will show "HEALTHY".
- **GNSS Fix:** This indicator shows the status of the GNSS fix. Under normal operating conditions it should show "3D FIX". When satellite visibility is poor it may show either "2D FIX" or "NO FIX".
- **Heading Status:** This indicator shows the current status of the heading filter. When there is a valid source of heading it will show "HEADING LOCKED".

8.1.1.2 Current Time, Position and Heading

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

8.1.1.3 Altitude Indicator

The Attitude Indicator visualises roll and pitch using a standard artificial horizon. Heading, velocity and height are shown to the side. All units are SI (metric) and degrees.

8.1.1.4 Satellites Table

The Satellites table shows the number of satellites visible by the primary antenna. More detailed information can be found in the Satellites screen under the **View** menu.

8.1.1.5 Map

The map shows the Certus position on Earth as well as a red trail showing position history since the last reset. When the filter initialises the map will automatically reset the view to the Certus position. To move the camera click and drag on the map. To zoom in and out, use the mouse scroll wheel.

Use **Reset** to reset the map view to the current position of Certus.

Clear History clears the current red trail showing the position history. This will immediately restart from the current position. Note that this does not affect any logging currently active.

8.1.1.6 Map Controls

Reset

This resets the map view to the current position of Certus.

Clear History

This clears the current red trail showing the position history. This will immediately restart from the current position. Note that this does not affect any logging currently active.

Follow

This button makes the map follow the device.

8.1.2 View Menu

The View menu contains the options for viewing pages of data from Certus.

8.1.2.1 Map

This takes you back to the home page of the web UI with the map display.

8.1.2.2 Device Information

The Device Information page is useful when requesting technical support and for tracking your serial number, firmware version and hardware version.



Figure 25: Certus Web UI Device Information Page

8.1.2.3 Subcomponent Information

The Subcomponent Information page shows the serial numbers and hardware version information for the Certus subcomponents. This will be useful information to include when contacting our support team.

8.1.2.4 Status

The Status page shows the current status of Certus as reported by the System State packet (ID #20) and Raw GNSS Packet (ID #29), detailed in sections [10.4.1 System State Packet](#) and [10.4.10 Raw GNSS Packet](#).

Note: The following Status flags do not update for Certus units with a Trimble BD992 GNSS Receiver. These flags are only applicable to Aries GNSS Receivers:

GNSS 2

Antenna 1 disconnected

Antenna 2 disconnected

Antenna 1 short

Antenna 2 short

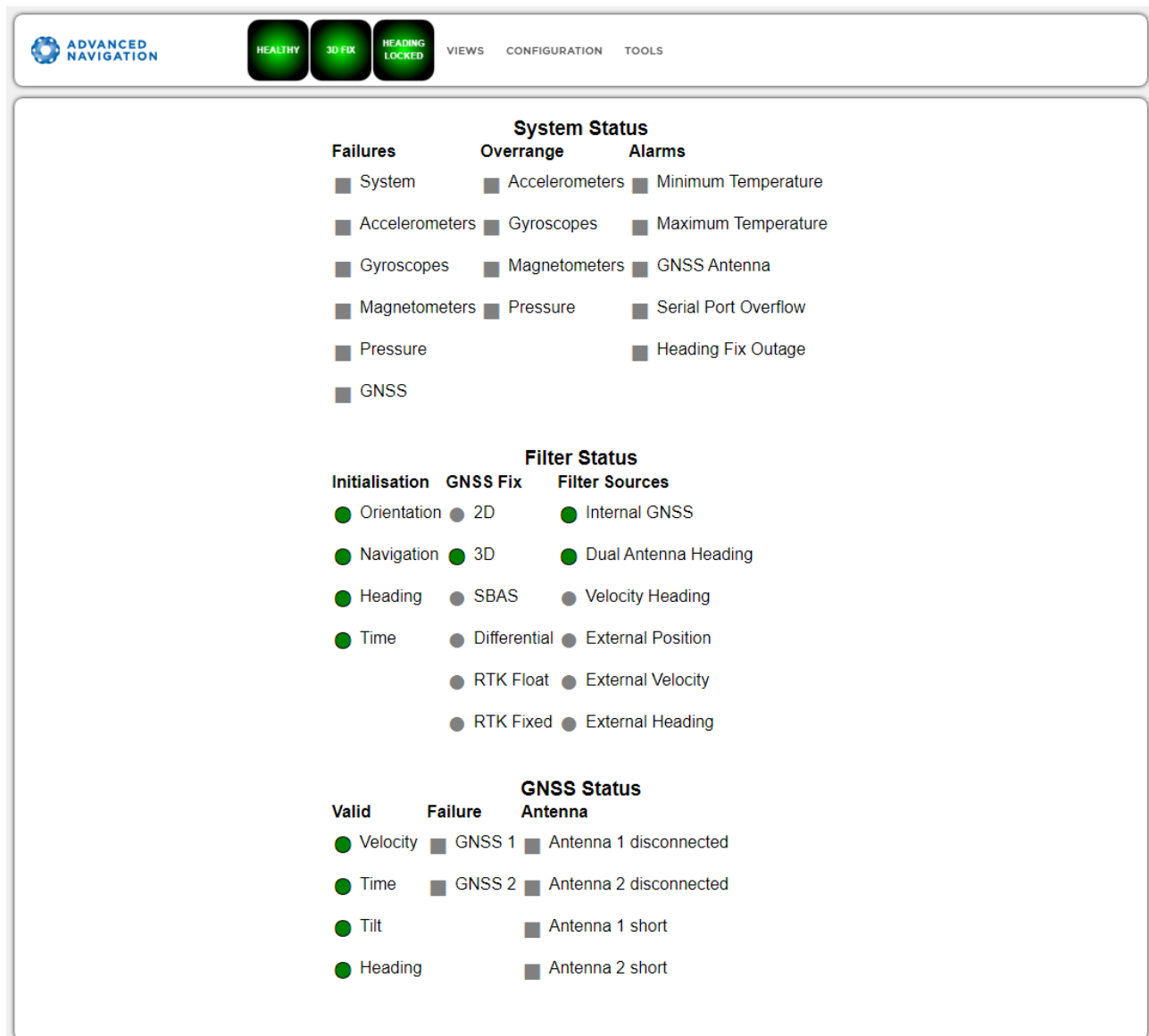


Figure 26: Certus Web UI Status Page

8.1.2.5 Satellites

The Satellites page shows detailed information on the satellites that are visible to both antennas of the Certus GNSS receiver.

The information is displayed as a satellite skyplot, a table and an SNR graph. A maximum of 28 satellites will be displayed, even if more are accessible. This plot shows the SNR of each satellite at the primary and secondary antenna. As a guideline, these should be within 5-10 dB of each other in the absence of cable or antenna faults

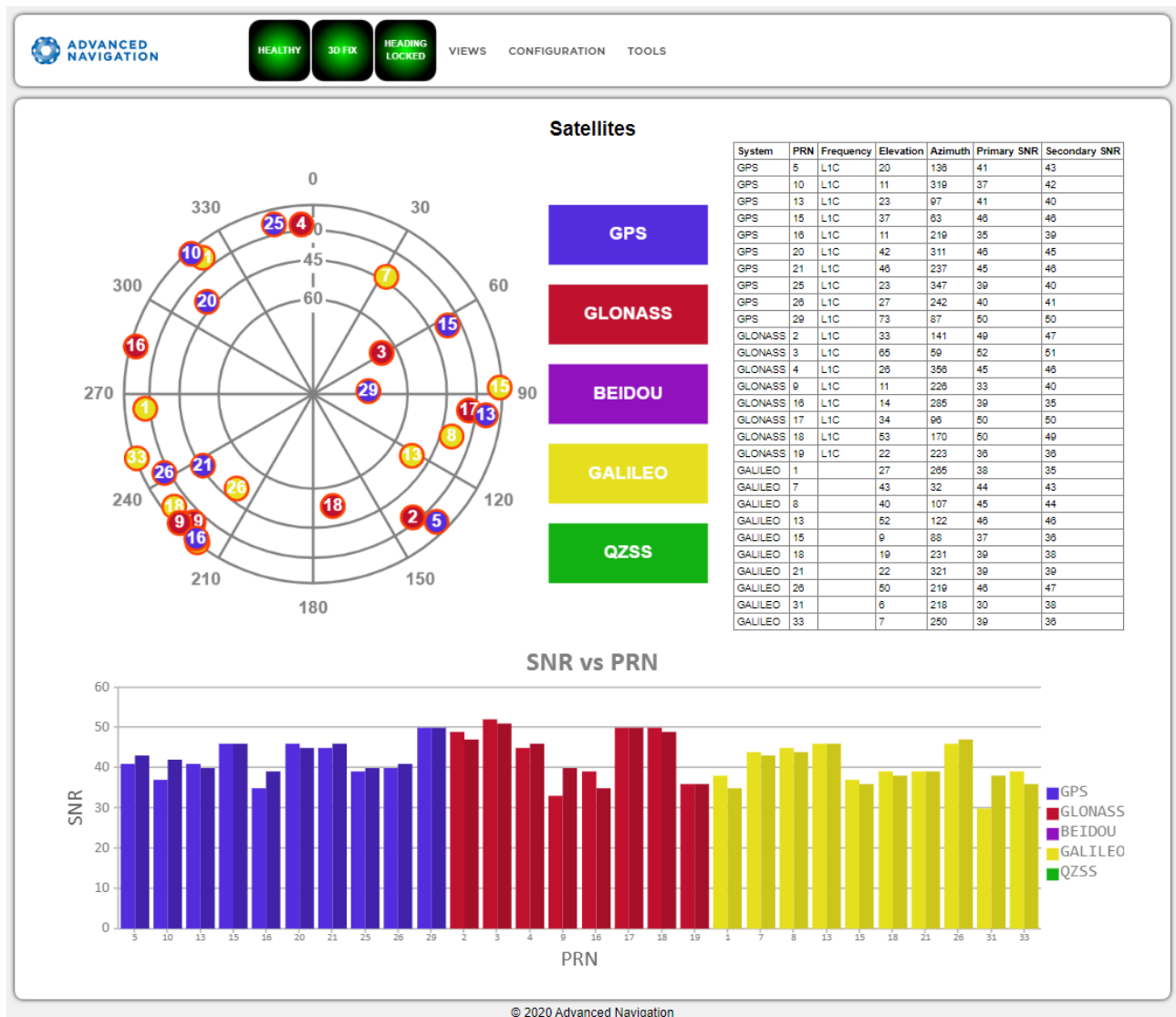


Figure 27: Certus Web UI Satellites Page

8.1.2.6 Raw Sensors

The Raw Sensors page shows the temperature-calibrated raw IMU sensor values. In the lower plot only the air pressure is plotted. The current value from the internal temperature sensors are given on the right. These do not provide general environmental temperature.

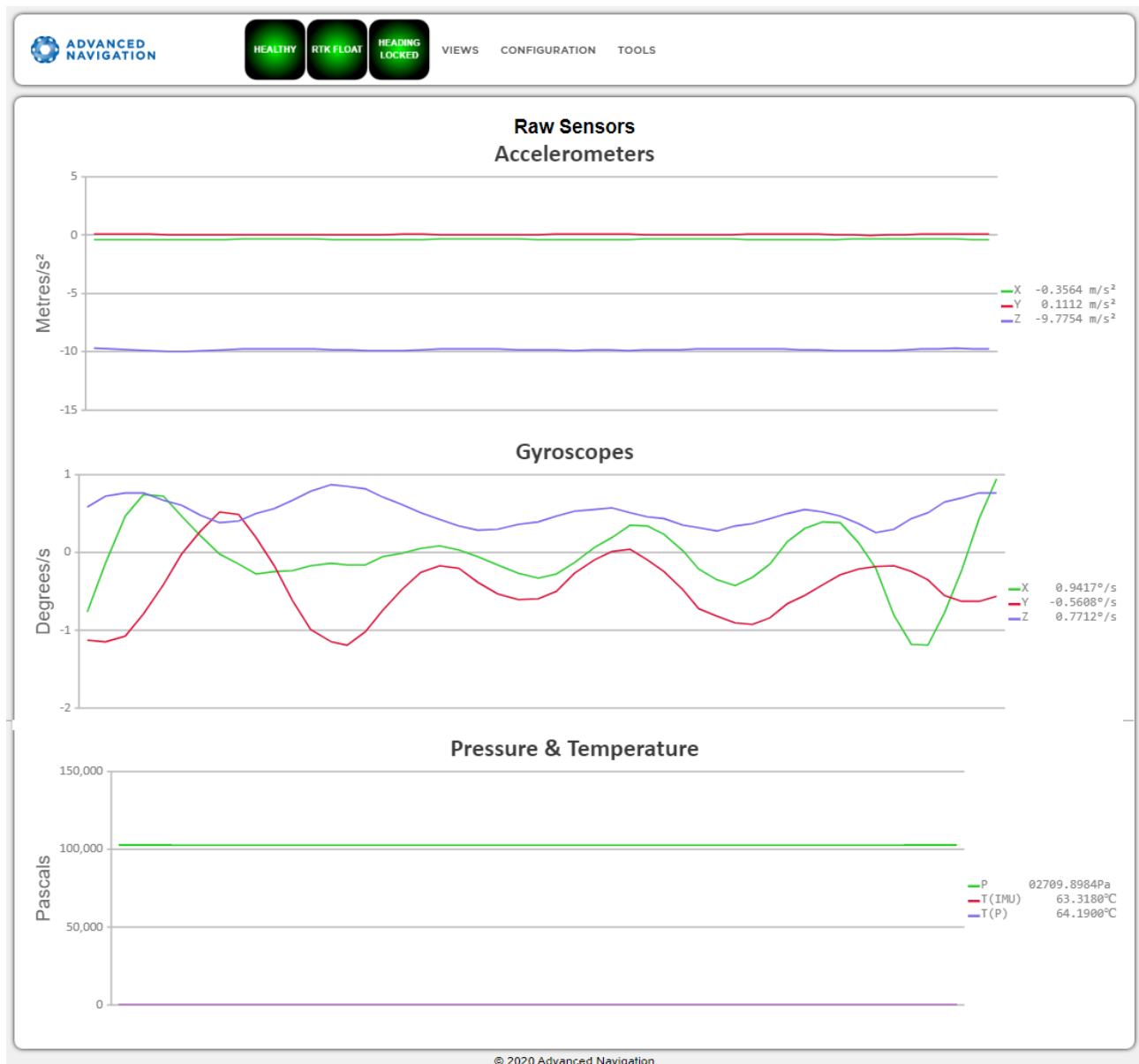


Figure 28: Web UI Raw Sensors Page

8.1.2.7 Orientation

The Orientation page shows the Certus orientation and angular velocity. Course is determined by measuring sequential positions. Slip is the difference between the heading and the course.

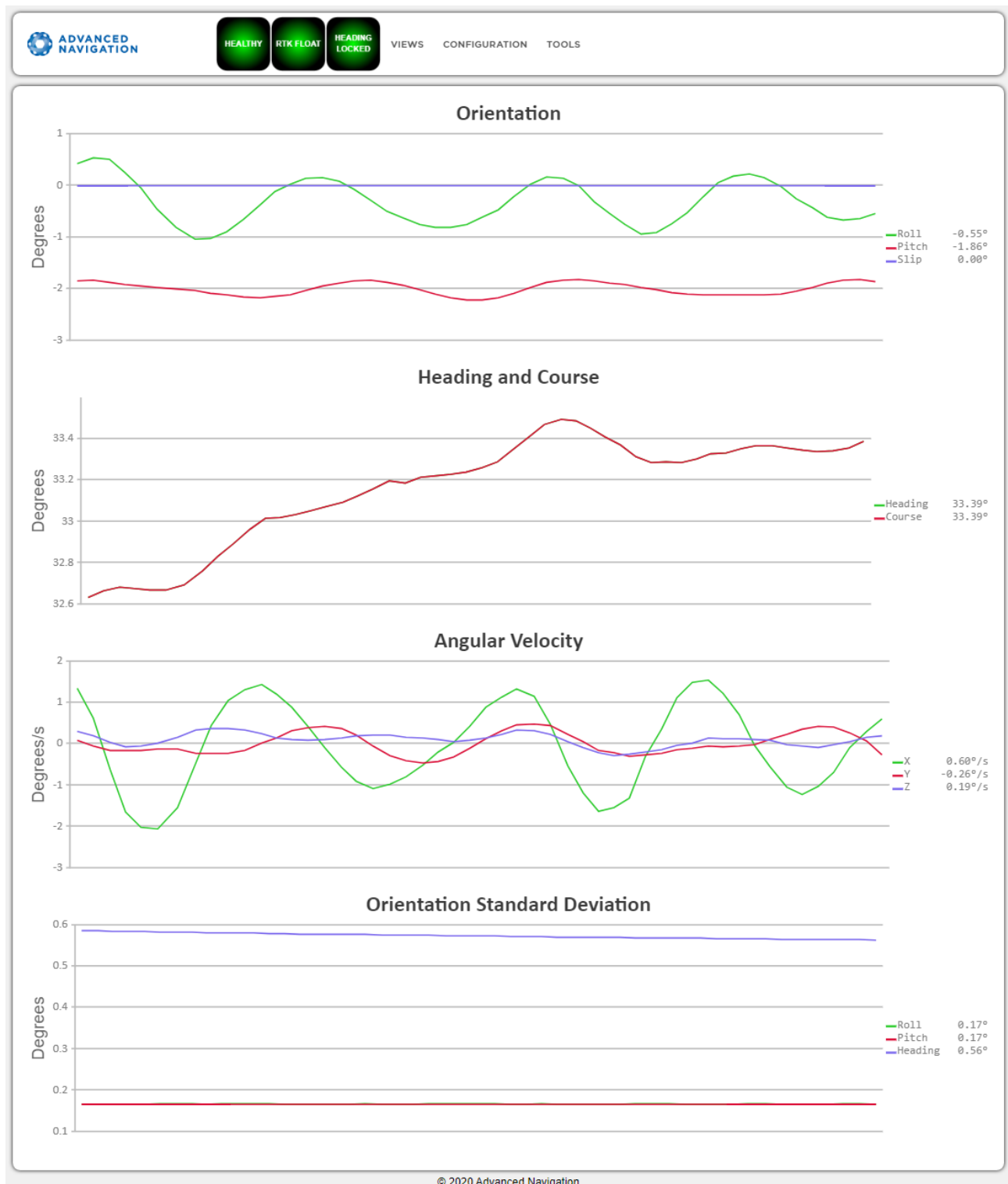


Figure 29: Certus Web UI Orientation Page

8.1.2.8 Position

The Position page shows the Certus position and position standard deviation. Latitude and longitude are converted to North and East metres from a reference point that can be reset by refreshing the web page in your browser.



Figure 30: Certus Web UI Position Page

8.1.2.9 Velocity and Acceleration

The Velocity and Acceleration page shows the Certus velocity, acceleration and g-force.

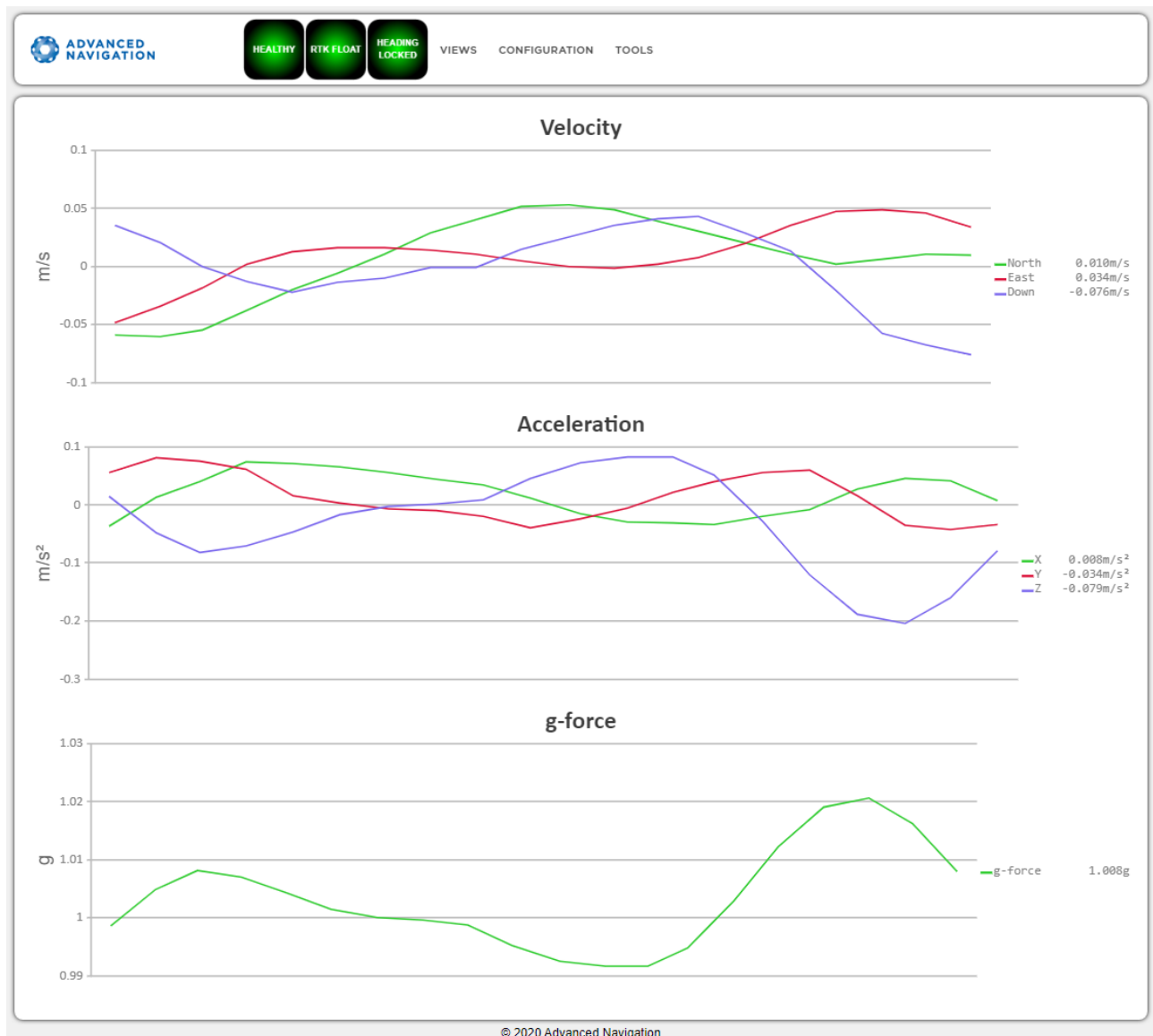


Figure 31: Certus Web UI Velocity and Acceleration Page

8.1.2.10 GNSS Receiver Information

This page shows information about the GNSS receiver fitted to Certus.

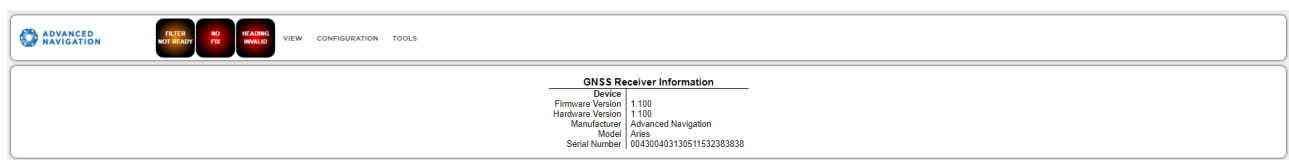


Figure 32: Certus Web UI GNSS Receiver Information Page

8.1.2.11 Heave

This page displays the heave at up to 4 reference points.

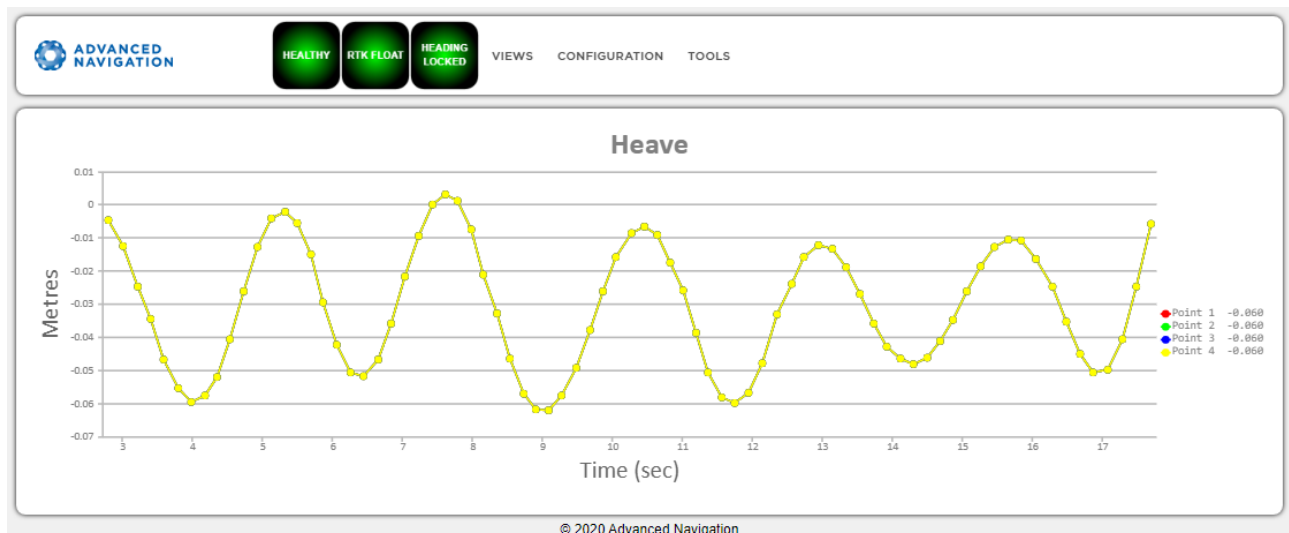


Figure 33: Certus Web UI Heave Page

8.1.3 Configuration Menu

These menus contain the set of configuration settings for Certus.

8.1.3.1 Sensor Ranges

Note: The sensor range can only be modified for Certus. Certus Evo only offers a fixed sensor range. See [5.1 Navigation Specifications](#) for sensor range specifications.

The 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.

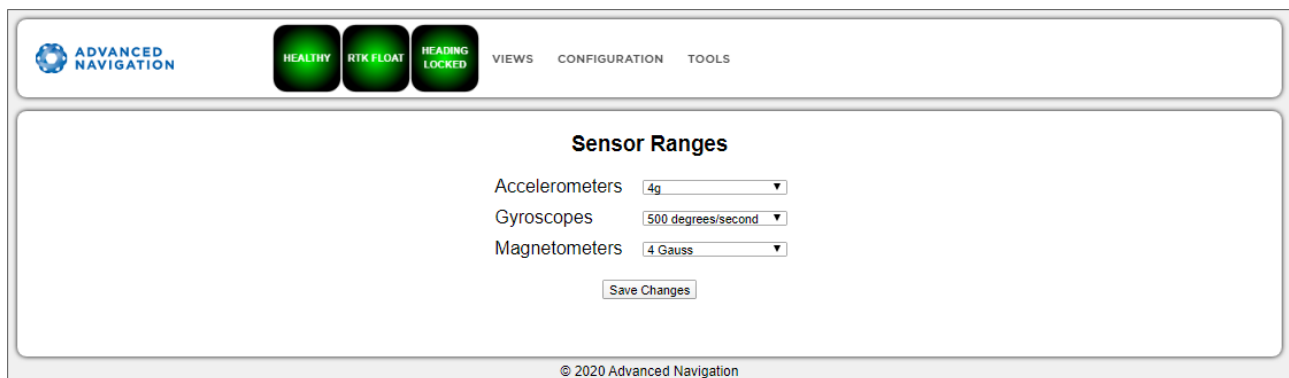


Figure 34: Certus Web UI Sensor Ranges Page

8.1.3.2 Filter Options

Ensure that the Vehicle Type filter option is selected for all applications. For most standard applications, the other filter options can be left as their defaults.

The Magnetic Heading Enabled and Automatic Magnetic Calibration Enabled options can be used if you are using external magnetometers.

See [7.1 Filter Initialisation](#) for more information on these specific settings. If you require assistance, contact support@advancednavigation.com.

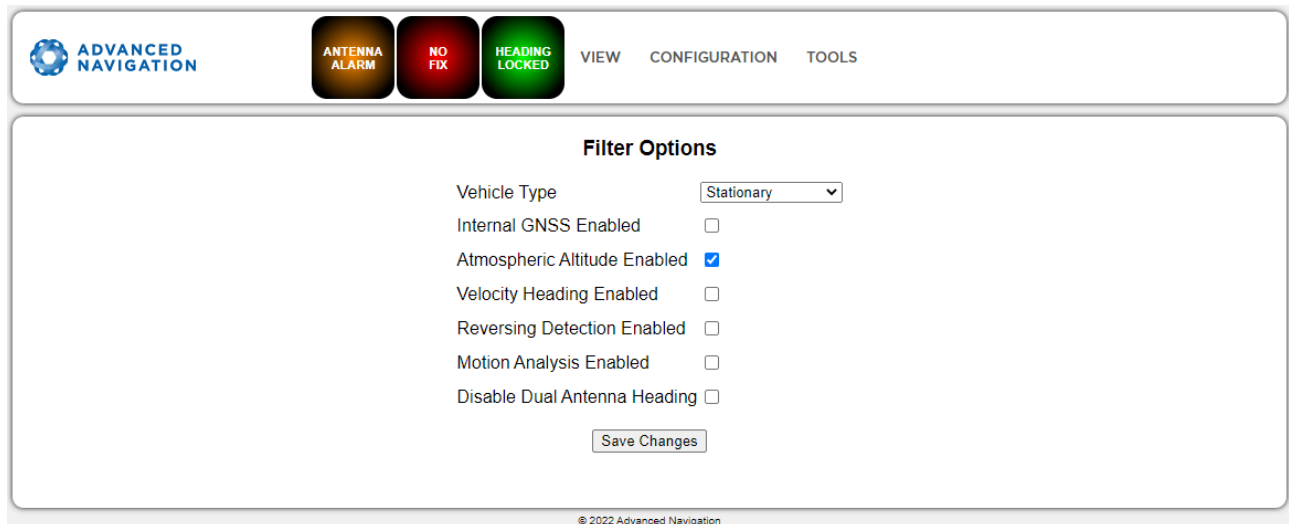


Figure 35: Certus Web UI Filter Options Page

8.1.3.3 Data Ports

The Data Ports page allows you to specify which data packets or messages are output on a periodic basis and at what rate via a range of serial and Ethernet ports.

Note: The GPIOs and auxiliary port are configured in the Data Ports page only if they are being used as serial transmit and receive lines. To configure GPIOs as digital or frequency inputs or outputs, use the [8.1.3.6 GPIO](#) page.

The default ANPP format 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. Other ANPP format state packets can be enabled as required.

Other data formats available include NMEA0183, GNSS, TSS1, SIMRAD and other formats. For more information see [9.1.2 Ethernet Functions](#) and [9.2 Serial Interface](#).

HEALTHY

RTK FLOAT

HEADING LOCKED

VIEWS CONFIGURATION TOOLS

Data Ports

Primary

Output

ANPP

Add Packet Rate

Packet: System State (20)

Period: 50 ms

Frequency: 20.00hz

Remove

Packet: Raw Sensors (28)

Period: 50 ms

Frequency: 20.00hz

Remove

Auxiliary

Output

GNSS Passthru

Input

GNSS Passthru

GPIO

Output

None

Input

None

Ethernet 1

Output

None

Input

None

Mode: TCP Server

Port: 0

Ethernet 2

Output

None

Input

None

Mode: TCP Server

Port: 0

Ethernet 3

Output

None

Input

None

Mode: TCP Server

Port: 0

Ethernet 4

Output

None

Input

None

Mode: TCP Server

Port: 0

Logging

Output

None

Save Changes

Figure 36: Certus Web UI Data Ports Page

8.1.3.4 Alignment

The Alignment page is used to set the alignment offsets of the system installation. It is important to set the values on this page correctly to avoid degrading performance.

Figure 37: Certus Web UI Alignment Page

Alignment Offset

If Certus 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 that this will only correct for roll and pitch offsets, the Heading offset must be entered manually and saved after using this function.

Primary GNSS Antenna Offset

The primary GNSS antenna offset is measured from the centre of the Certus unit to the phase centre of the primary GNSS antenna in [11.3 The Body Co-ordinate Frame](#) (X positive forward, Z positive down).

External Data Offset

These values are only required for speciality applications operating with an external source of velocity and position data. Please contact support@advancednavigation.com for assistance.

8.1.3.5 Baud Rates

This page 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: The primary and auxiliary ports on Certus OEM are UART only, and cannot be changed to RS232 or RS422. An appropriate adapter/interface is required to connect to a computer.

ADVANCED NAVIGATION

HEALTHY RTK FLOAT HEADING LOCKED

VIEWS CONFIGURATION TOOLS

Baud Rates

Primary 115200 Mode RS232

GPIO 1/2 115200 Mode RS232

Auxiliary 115200 Mode RS232

Save Changes

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Figure 38: Certus Web UI Baud Rates Page

8.1.3.6 GPIO

This page allows the user to select 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.

ADVANCED NAVIGATION

HEALTHY RTK FLOAT HEADING LOCKED

VIEWS CONFIGURATION TOOLS

GPIO Configuration

GPIO1 Function Inactive

GPIO2 Function Inactive

Auxillary Transmit Function GNSS Receiver Passthrough

Auxillary Receive Function GNSS Receiver Passthrough

Save Changes

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Figure 39: Certus Web UI GPIO Configuration Page

8.1.3.7 Odometer

The Odometer page allows the user to configure the odometer pulse length and offset. See [6.9 Odometer](#) and [7.10 Odometer Pulse Length](#) for more information on the use of odometers.

Figure 40: Certus Web UI Odometer Configuration Page

8.1.3.8 Reset

The Reset button causes the system to perform a power cycle. No configuration settings or state data are lost.

The Cold Start button clears all filters, and connections are reset and must re-established. No configuration settings are lost.

The Factory Reset button resets all Certus settings back to their factory defaults, including state data and all configuration settings. It also erases the hot start data so that the system is forced to perform a cold start.

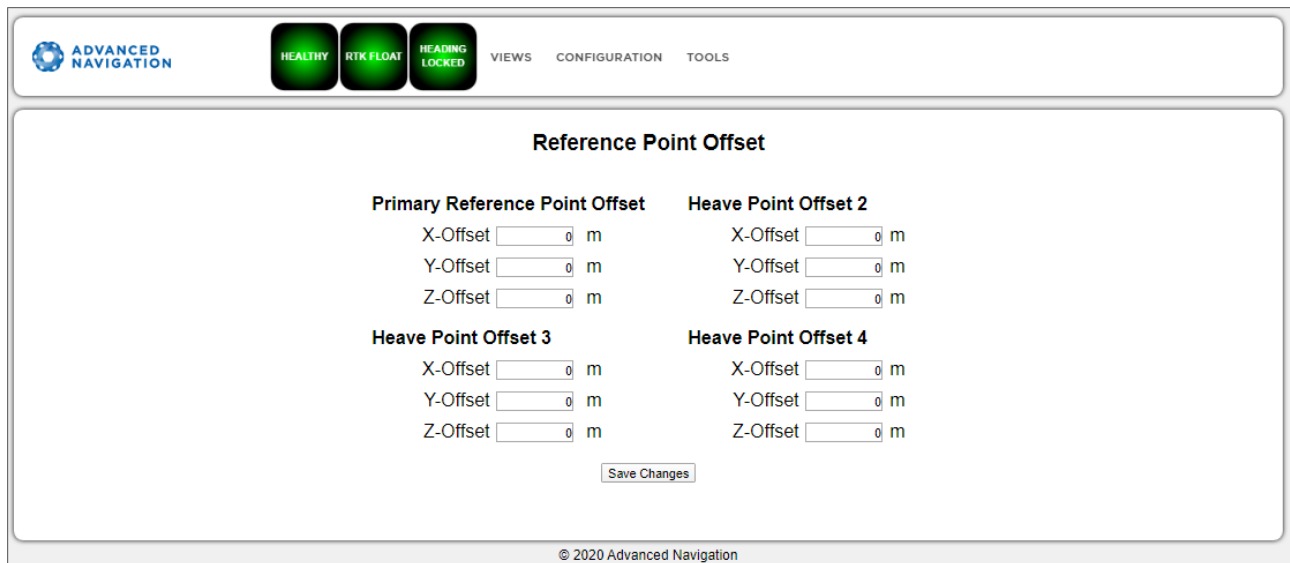
Note: A Factory Reset will re-enable the DHCP Client and lose any static IP address settings.

Figure 41: Certus Web UI Reset Page

8.1.3.9 Reference Point Offsets

The Reference Point Offsets page allows the user to set measurement points away from its default position at the physical centre of the Certus 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.

The Heave Points 2 to 4 allow the user to offset reference points for the heave values 2 to 4 in the [10.4.37 Heave Packet](#).

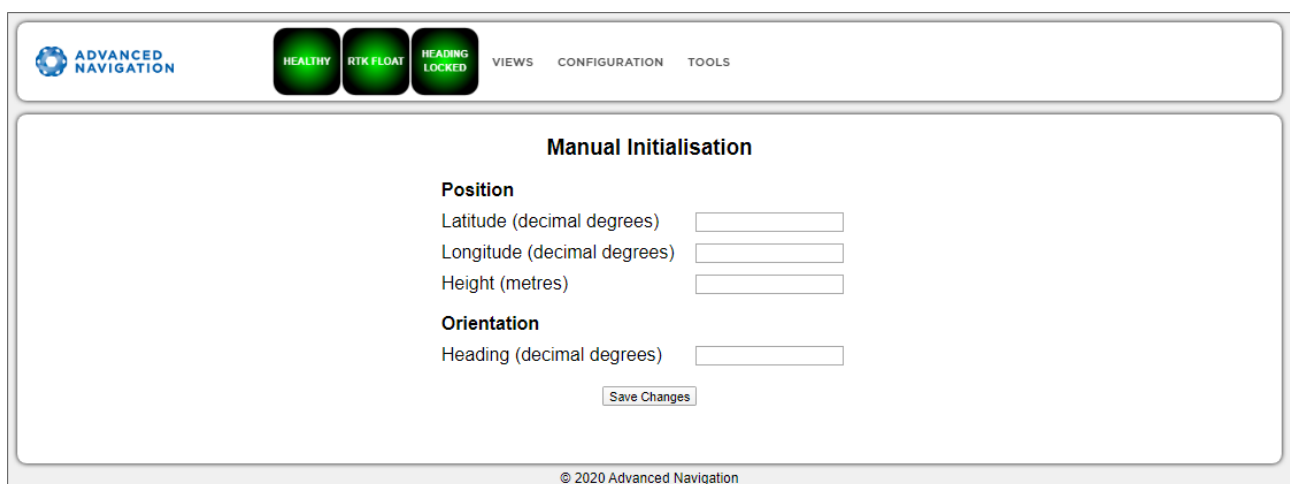


The screenshot shows the 'Reference Point Offset' dialog in the Certus Web UI. At the top, there's a status bar with 'ADVANCED NAVIGATION' logo, three green status buttons labeled 'HEALTHY', 'RTK FLOAT', and 'HEADING LOCKED', and navigation tabs for 'VIEWS', 'CONFIGURATION', and 'TOOLS'. The main content area is titled 'Reference Point Offset' and contains four sections for setting offsets: 'Primary Reference Point Offset', 'Heave Point Offset 2', 'Heave Point Offset 3', and 'Heave Point Offset 4'. Each section has input fields for X-Offset, Y-Offset, and Z-Offset, each followed by a unit 'm'. A 'Save Changes' button is located at the bottom center of the dialog. The footer of the dialog shows '© 2020 Advanced Navigation'.

Figure 42: Certus Web UI Reference Point Offsets Dialogue

8.1.3.10 Manual Initialisation

This page can be used to manually initialise Certus when a GNSS fix is not available. Setting the position will initialise the navigation filter. Setting the heading will also initialise the heading filter.



The screenshot shows the 'Manual Initialisation' page in the Certus Web UI. It has the same top status bar and navigation tabs as Figure 42. The main content area is titled 'Manual Initialisation' and is divided into two sections: 'Position' and 'Orientation'. The 'Position' section has input fields for 'Latitude (decimal degrees)', 'Longitude (decimal degrees)', and 'Height (metres)'. The 'Orientation' section has an input field for 'Heading (decimal degrees)'. A 'Save Changes' button is at the bottom center. The footer shows '© 2020 Advanced Navigation'.

Figure 43: Certus Web UI Manual Initialisation Page

8.1.3.11 Dual Antenna

The Dual Antenna configuration page is only used if the primary and secondary GNSS antennas are not installed in their recommended and default positions of primary front and secondary rear, at the same height.

If it is not practical to mount the antennas in the recommended alignment, the alternate alignments must be entered into this page. It is recommended to try and use one of the automatic offsets where possible, where the antennas must be installed in one of four different automatic offset orientations aligned on an axis.

If it is not possible to use one of the automatic offsets, the antennas can be installed in any configuration and a manual offset should be entered. The manual offset is measured from the central base of the secondary antenna to the central base of the primary antenna in the body co-ordinate frame (X+ forward, Z+ down). If using a manual offset, be careful to measure the offset accurately, as even small offset errors can result in relatively large heading errors e.g. 2 cm error = 1.15 degrees heading error with a 1 metre separation.

When using an automatic offset, the manual offset values are ignored.

When using a manual offset, the automatic offset selection is ignored.

When using automatic offset, the manual offset values will show the distance that Certus has automatically measured.

The screenshot shows the 'Dual Antenna Configuration' page in the Certus Web UI. At the top, there is a status bar with the 'ADVANCED NAVIGATION' logo, three green status indicators labeled 'HEALTHY', 'RTK FLOAT', and 'HEADING LOCKED', and navigation links for 'VIEWS', 'CONFIGURATION', and 'TOOLS'. The main content area is titled 'Dual Antenna Configuration' and contains the following settings: 'Offset Orientation Mode' set to 'Automatic, Primary Left Secondary Right' (with a dropdown arrow), 'Manual Offset X Metres' set to 0, 'Manual Offset Y Metres' set to 0, and 'Manual Offset Z Metres' set to 0. A 'Save Changes' button is located at the bottom of the configuration area. The footer of the page displays '© 2020 Advanced Navigation'.

Figure 44: Certus Web UI Dual Antenna Page

8.1.3.12 Ethernet Settings

The Ethernet Settings page allows you to enable or disable the DHCP Client. When the DHCP Client is disabled you need to enter the TCP/IP settings if you wish to access the web UI.

If you are only connecting to Certus via the primary port these settings can be ignored.

The default is for the Ethernet mode to be set to DHCP.

The screenshot shows the 'Ethernet Settings' page in the Certus Web UI. The top status bar is identical to the previous page. The main content area is titled 'Ethernet Settings' and contains the following settings: 'Ethernet Mode' set to 'DHCP' (with a dropdown arrow), 'Automatic DNS' checked with a checkbox, 'IP Address' set to 0.0.0.0, 'Netmask' set to 0.0.0.0, 'Gateway' set to 0.0.0.0, and 'DNS Server' set to 0.0.0.0. A 'Save Changes' button is located at the bottom of the configuration area. The footer of the page displays '© 2020 Advanced Navigation'.

Figure 45: Certus Web UI Ethernet Settings page

8.1.3.13 NTRIP Client

The NTRIP client built into Certus can be used to connect to a network DGPS (Differential GPS, a older standard for GNSS corrections of lower performance than RTK) or RTK service to stream correction data to Certus for DGPS or RTK. The NTRIP client requires that Certus 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.

These steps are required:

1. Select Enabled.
2. For Host/Server, enter the NTRIP Caster address.
3. For Port, enter the NTRIP Caster port number. This is usually 2101.
4. Click Save.
5. Click Get Mountpoints.
6. Select your mountpoint from the Mountpoint drop down list, being mindful that the distance should not exceed 50km.
7. Enter your username in the Username box.
8. Enter your password in the Password box.
9. Click Save.

To disconnect from the NTRIP Caster unselect Enabled and click Save.

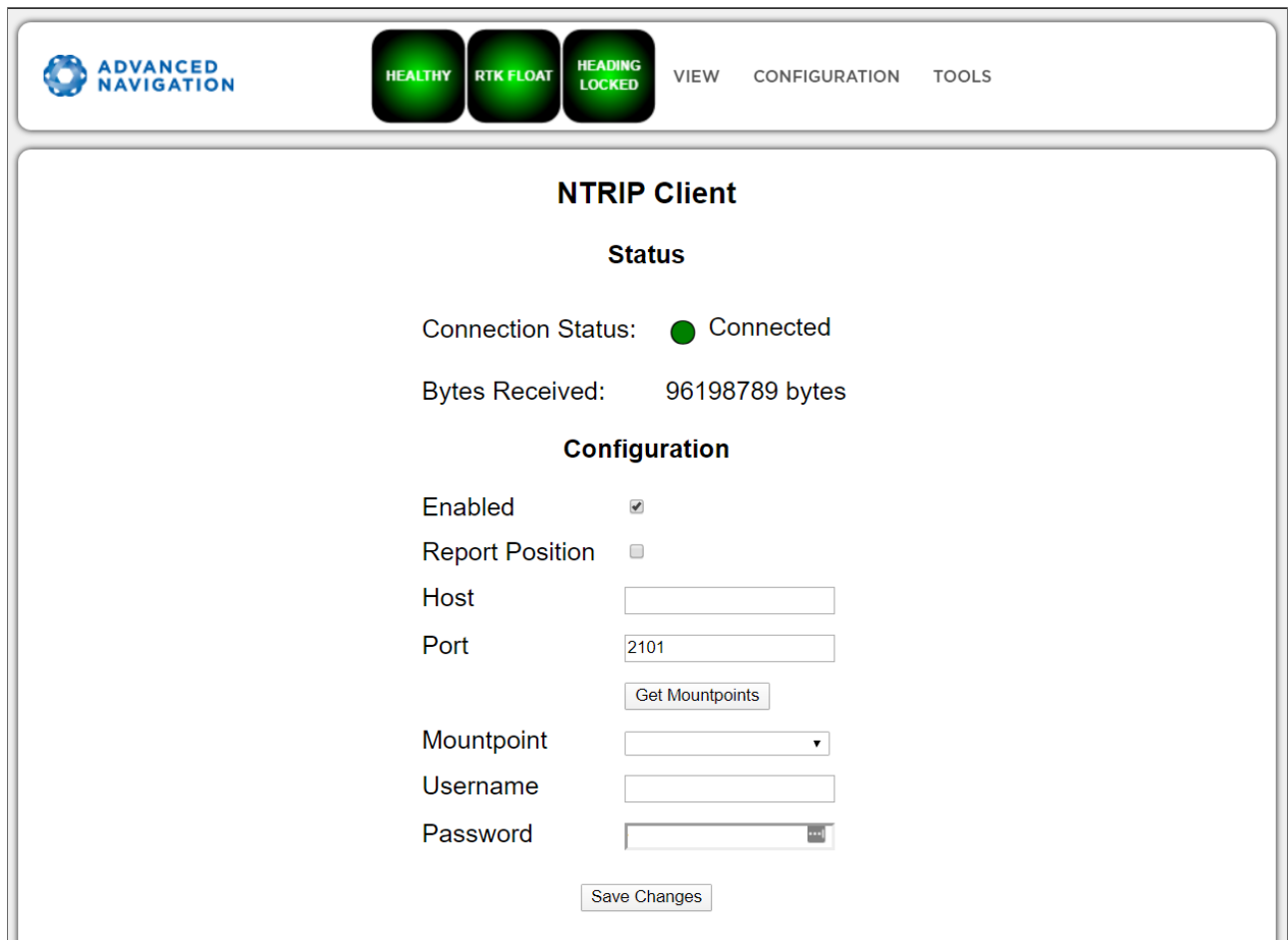
Troubleshooting NTRIP Caster Connections


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

If you cannot get the list of mountpoints, 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.

Contact support@advancednavigation.com for further assistance with network DGPS or RTK.




**ADVANCED
NAVIGATION**

HEALTHY

RTK FLOAT

HEADING LOCKED

VIEW CONFIGURATION TOOLS

NTRIP Client

Status

Connection Status: ● Connected

Bytes Received: 96198789 bytes

Configuration

Enabled ☒

Report Position ☐

Host

Port

Mountpoint

Username

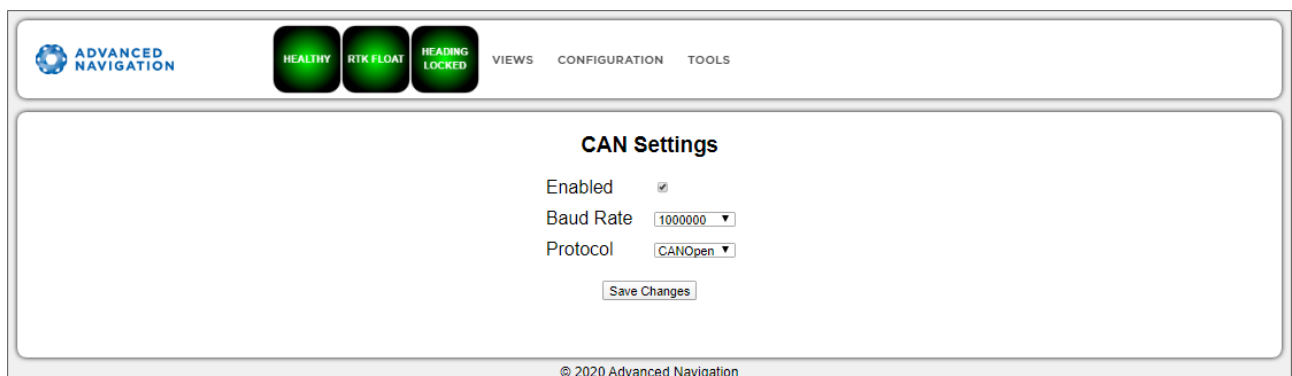
Password


Figure 46: Certus Web UI NTRIP Client Page

8.1.3.14 CAN Settings

The CAN Settings page allows you to enable or disable the CAN functionality. If you are only connecting to Certus via the primary port then these settings can be ignored.

The default for CAN is Enabled at 1,000,000 baud rate. A CANOpen EDS file is available. Contact Support for a copy of this file.




**ADVANCED
NAVIGATION**

HEALTHY

RTK FLOAT

HEADING LOCKED

VIEW CONFIGURATION TOOLS

CAN Settings

Enabled ☒

Baud Rate

Protocol

© 2020 Advanced Navigation

Figure 47: Certus Web UI CAN Settings Page

8.1.3.15 Advanced

The 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.

Advanced

GPIO 1 & 2 / 1PPS working voltage:

NTRIP Disable position reporting: ☐

CANopen Packet Rates

System State	<input type="text" value="50"/>	ms
Raw Sensors	<input type="text" value="50"/>	ms
Raw GNSS	<input type="text" value="50"/>	ms
Odometer State	<input type="text" value="50"/>	ms
Body Velocity	<input type="text" value="50"/>	ms

CANopen TXPDO

TXPDO Index	Function Code (decimal)	Node ID (decimal)	COB-ID (hexadecimal)
0	<input type="text" value="3"/>	<input type="text" value="1"/>	<input type="text" value="0x181"/>
1	<input type="text" value="3"/>	<input type="text" value="2"/>	<input type="text" value="0x182"/>
2	<input type="text" value="3"/>	<input type="text" value="3"/>	<input type="text" value="0x183"/>

Figure 48: Certus Web UI Advanced Page

8.1.3.16 GNSS Configuration

The GNSS Configuration page 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 dialogue.

Aries GNSS Receiver

When using an Aries 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.
- SBAS and QZSS correction services can also be enabled for all constellation configurations, except when using GPS, Galileo and BeiDou together.

Refer to the table below for a list of supported constellation configurations.

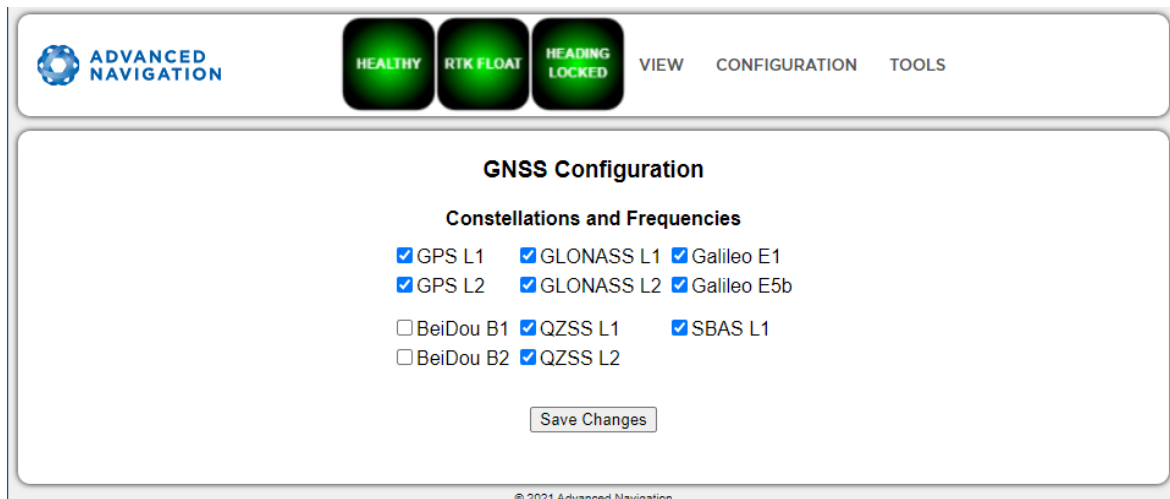


Figure 49: Certus Web UI Aries GNSS Configuration Page

The table below lists the supported constellations and the corresponding GNSS sample period depending upon the number of constellations selected. When setting the [8.1.3.3 Data Ports](#), the packet rate of the [10.4.10 Raw GNSS Packet](#) and [10.4.38 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	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)	GPS Galileo GLONASS BeiDou
2	80 ms	1 ms - 159 ms = 80 ms = 12.5 Hz 160 ms - 239 ms = 160 ms (6.25 Hz)	GPS & Galileo GPS & GLONASS GPS & BeiDou
3	100 ms	1 ms - 199 ms = 100 ms (10 Hz) 200 ms - 299 ms = 200 ms (5 Hz)	GPS, GLONASS & Galileo GPS, GLONASS & BeiDou (no correction services)
4	125 ms	1 ms - 249 ms = 125 ms (8 Hz) 250 ms - 374 ms = 250 ms (4 Hz)	GPS, Galileo, GLONASS & BeiDou

Table 20: Aries Supported GNSS Constellation Configurations

8.1.4 Tools Menu

The Tools menu contains tools for performing certain procedures with Certus.

8.1.4.1 Firmware Update

This page is used to update the Certus device firmware, Advanced Navigation device firmware files have the extension .anfw.

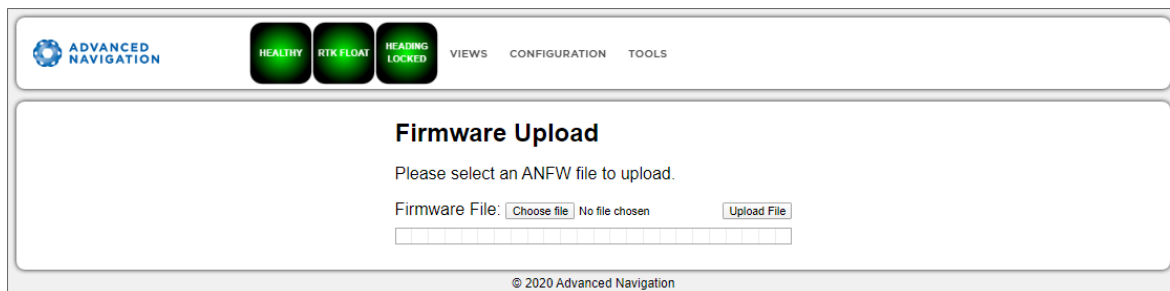


Figure 50: Certus Web UI Firmware Update Page

Certus contains firmware which is regularly updated to improve performance and add features. 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 cause problems with units. Check the [Certus](#) product page of the Advanced Navigation website periodically for updates.

Follow these steps:

1. Navigate to the Firmware Update page under the **Tools** menu.
2. Click **Choose File** and select the firmware file.
3. Click **Upload File**.
4. Wait for the system to restart.

8.1.4.2 Logs

Certus features an onboard 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 Logging section on the [8.1.3.3 Data Ports](#) page (in the [8.1.3 Configuration Menu](#)).

If any log files exist on the Certus they will appear on this page in a list, with the most recent at the top. The log file name includes the date and time the log file recording commenced, using UTC time, in the format CertusLog_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 that Certus does not have a GNSS fix and has therefore not yet determined the correct time.

Note that the logging configuration and recorded log files can only be accessed by the web UI. You cannot use the serial port interfaces.

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 Certus 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 Certus device configuration. If logging is currently not enabled, this button will not do anything.

8.1.4.3 Viewing Logged Data

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 Certus Manager, see section [8.2.8.4 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.

8.2 Using Certus Manager

Certus Manager is a software tool provided by Advanced Navigation for logging, testing, display and configuration of Certus. It is designed to be simple and easy to use. It should run on most Windows, MacOS and Linux computers.

Certus Manager is only available for systems with x64 architecture.

Note: Java 11 is required to run Certus Manager. Adoptium JRE 11 is the recommended Java installer to be used on all platforms. Install the latest version of Java 11 from [Adoptium](#), selecting the correct operating system and architecture for your computer.

Note: The primary and auxiliary ports on Certus OEM are UART only, therefore an appropriate adapter/interface is required to connect to a computer.

Certus Manager contains almost identical functionality to the web UI. This section will only include the areas that are different or absent from the web UI. Refer to the documentation for [8.1 Using the Web User Interface](#) as required.

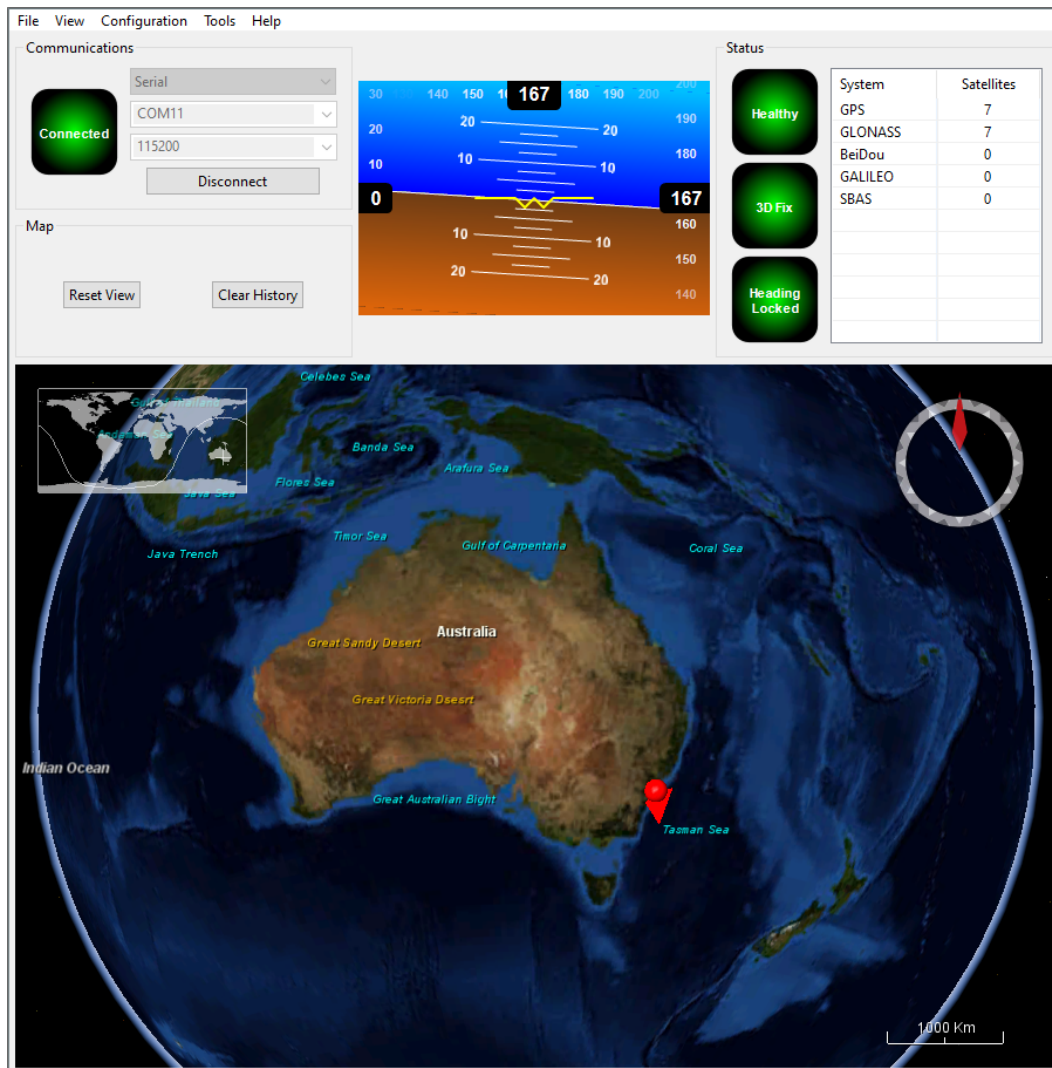


Figure 51: Screenshot of Certus Manager

8.2.1 Software Changelog

Version	Date	Changes
7.0	13 February 2023	<p>Updated from JDK8 to JDK11. JRE11/JDK11 required to run this release</p> <p>Refresh Port Mode information on reconnection</p> <p>Refresh Packet Rates information on reconnection</p> <p>Fixed Ethernet Settings Static IP setting</p> <p>Improved reliability of firmware update</p> <p>Changed Low Voltage label to Internal Data Logging Error to support newer firmware</p> <p>Fixed issue with NTRIP client streaming from some servers</p> <p>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</p> <p>Overwrite/clear existing packet rates on import of configuration</p> <p>Added Disable Dual Antenna Heading option</p> <p>Updated Seastar frequencies for Trimble receivers</p>

Version	Date	Changes
		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	10 October 2022	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 "Rover Fix Type" Added GPIO voltage selection Removed of SBAS corrections option when SBAS is not supported on the device Various bug fixes
6.1	18 February 2022	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
5.9	28 June 2021	Add ability to disable logging Add ability to control log file location Add GNSS configuration page, support BD992 and Aries 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

Version	Date	Changes
		Support new style GPIO output packet Fix GPIO output configuration window not working Fix NTRIP NMEA Message Output at Irregular Periods Various bug fixes
5.7	23 September 2020	Added support for Certus Evo Configuration Export and Import
5.3	30 June 2020	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	20 May 2020	Initial Release

Table 21: Certus Manager Software Changelog

8.2.2 System Requirements

Certus Manager is only available for systems with x64 architecture.

Certus Manager includes a 3D mapping display which requires an internet connection. If your machine does not meet the graphics requirements the mapping view will only show space without a globe.

Note, when Certus is running at very high output rates e.g. 1000 Hz, Certus Manager can consume significant system resources handling the large quantity of data.

8.2.3 Installation and Starting

The latest version of Certus Manager can be downloaded from the [Certus](#) product page of the Advanced Navigation website. Installation notes are as follows:

- **Java 11 is required** to run Certus Manager.
Adoptium JRE 11 is the recommended Java installer to be used on all platforms. Install the latest version of Java 11 from [Adoptium](#), selecting the correct operating system and architecture for your computer.
- Certus Manager does not need to be installed and on a Windows system it can be run from any directory by simply double clicking on it. To open the program on some systems it may be necessary to right click and select open with → Java Runtime Environment.
- On MacOS systems it may be necessary to run the application from a terminal window:
`java -jar XstartOnFirstThread CertusManager.jar`
- On Linux systems it may be necessary to run the application from a terminal window:
`java -jar CertusManager.jar`

The Certus Evaluation Kit includes an FTDI USB to RS232 / RS422 adaptor cable. The drivers are normally installed automatically, but if not they are available for download from www.ftdichip.com/Drivers/VCP.htm.

8.2.4 Troubleshooting

If the application will not start, the most common reason is that you have 32-bit Java installed on a 64-bit operating system. Uninstall Java and reinstall the 64-bit version.

If the globe does not appear in the 3D map area, this indicates that either your graphics card is not powerful enough, your graphics card driver is out of date, or you have no internet connection.

- Ensure the RS232 / RS422 switch is in the correct mode. The Certus factory default mode is RS232.
- Ensure you select the correct COM port. This can be easily identified by unplugging and re-plugging in the USB connector.

- Ensure you have the correct baud rate selected in Certus Manager. The factory default value for the baud rate is 115200 bps for the Primary, GPIO and Auxiliary ports.

Contact [Support](#) if you are having issues.

8.2.4.1 Windows

There is a well known problem with USB serial devices under Windows known as “crazy mouse”. The problem occurs when the system mistakenly installs the USB serial device as a mouse. Unfortunately Microsoft has not fixed this problem in over 15 years, so it probably won't be fixed. If you experience this problem, often a restart will resolve it. Otherwise there is a tool available at <http://www.stentec.com/anonftp/pub/wingps/pnpblockersetup.exe> that can fix the issue.

If the serial port does not show up when you plug in the FTDI USB to RS232/RS422 adaptor cable, you may need to install the drivers from www.ftdichip.com/Drivers/VCP.htm.

When operating Certus on Windows at a high data rate, data can be lost due to the latency of the FTDI driver. To resolve this problem the latency of the driver should be reduced to 1 ms:

1. Start the Windows Device Manager (1) and find the Ports section (2).
2. Identify the specific COM port being used (3) by dis-connecting and re-connecting the USB to RS232 / RS422 adaptor cable.
3. Right click on the identified COM port and select Properties. Select the Port Settings tab (4) and select Advanced (5).
4. Change the Latency Timer value (6) to 1 msec then press OK (7), and OK again for the previous window.

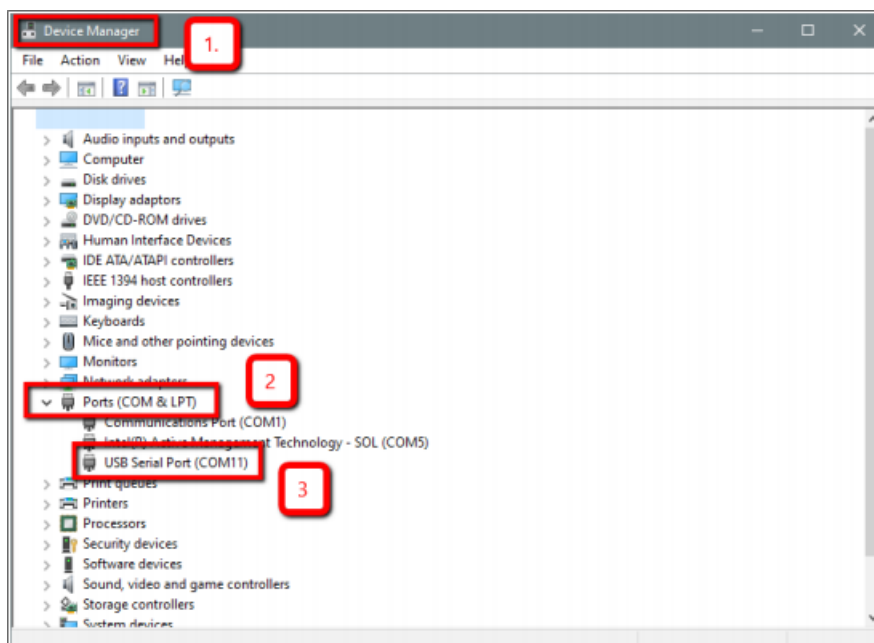


Figure 52: Setting the Windows Port Latency Value - 1

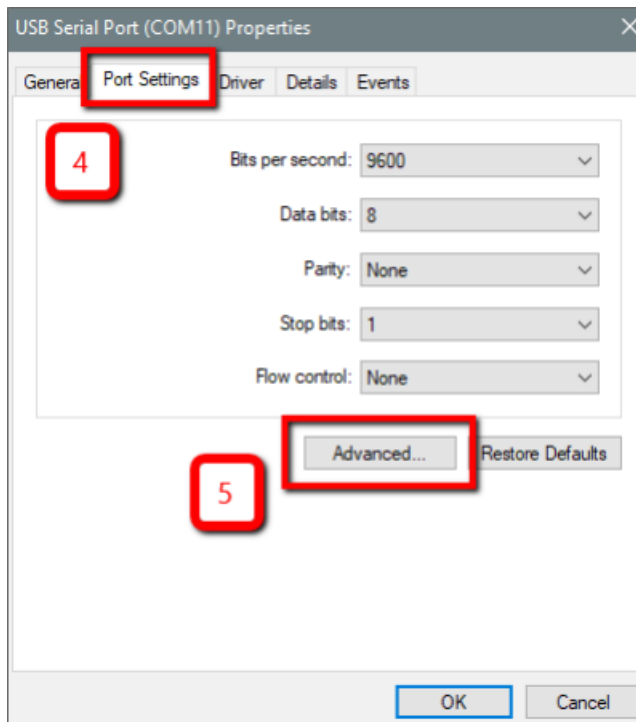


Figure 53: Setting the Windows Port Latency Value - 2

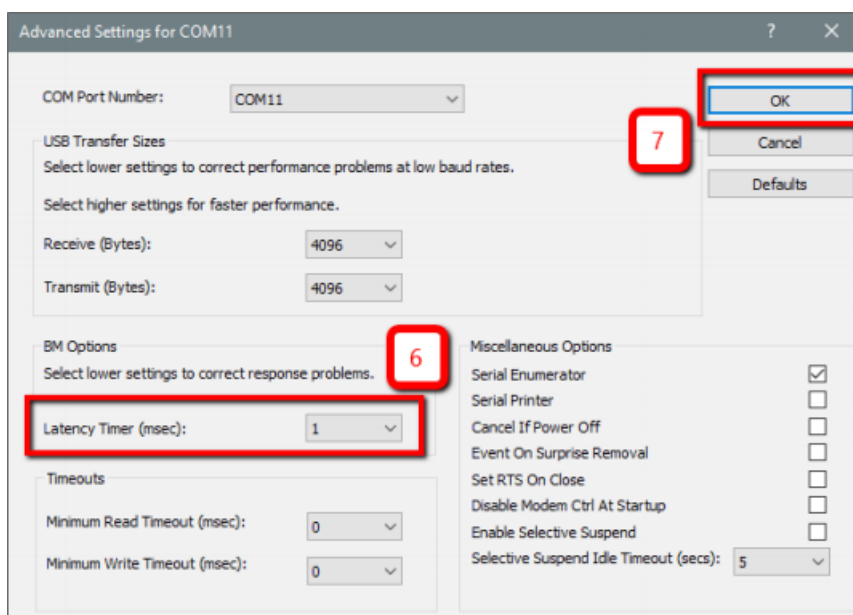


Figure 54: Setting the Windows Port Latency Value - 3

8.2.4.2 Linux

If serial ports do not show up, the typical reason is a lack of permissions. The user should add themselves to the dialout group with the command:

```
sudo adduser username dialout
```

Compiz causes issues with the 3D mapping. If you are experiencing problems it is recommended to turn off Compiz.

Modemmanager can also sometimes cause problems on Linux installations. If you are not using a modem, it is recommended to remove modemmanager with the command:

```
sudo apt-get remove modemmanager
```

8.2.5 Main View

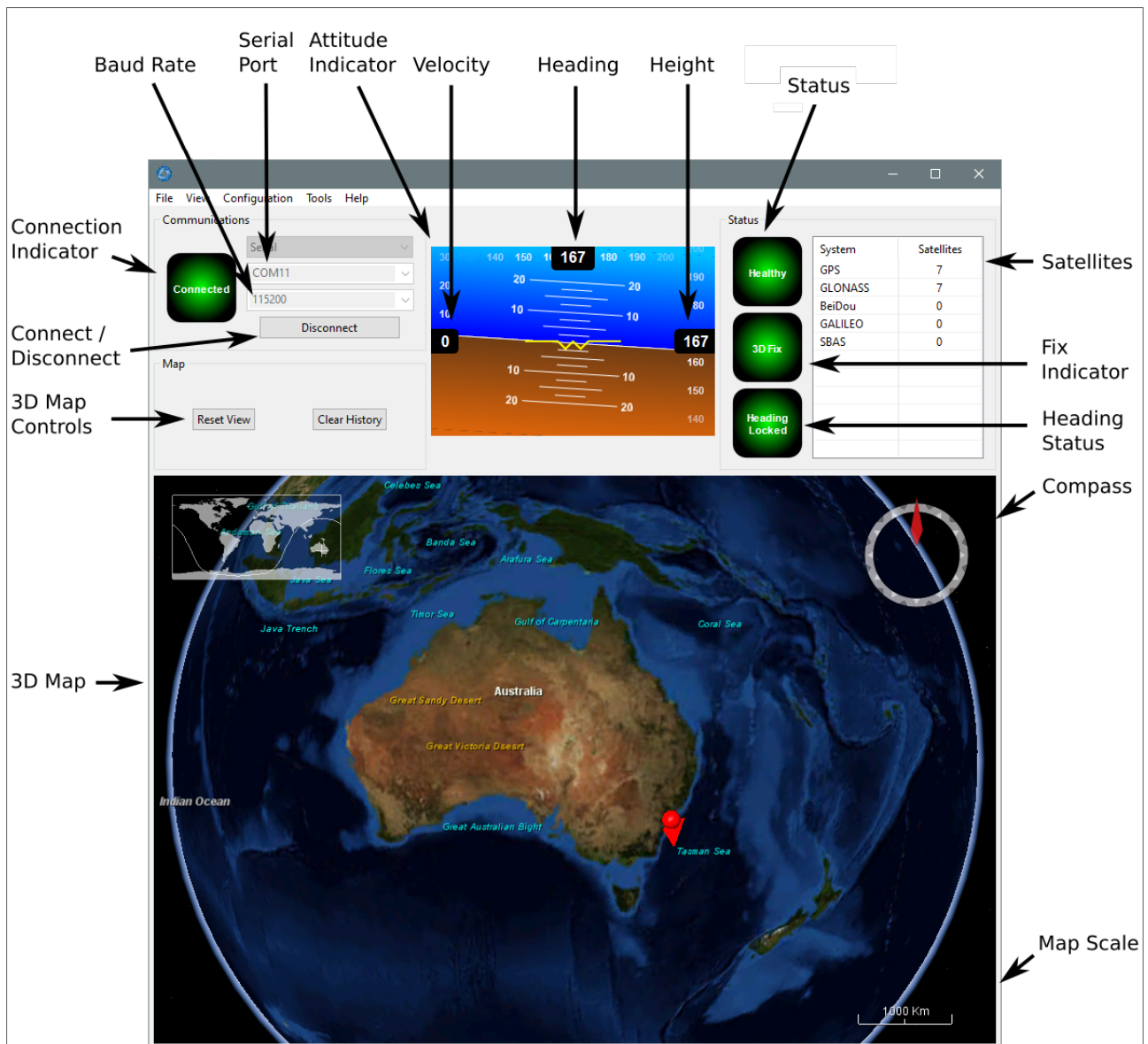


Figure 55: Certus Manager Main View

8.2.5.1 Serial Port

The Serial Port dialogue is used to connect to Certus. Select the serial port and baud rate and click **Connect**. The default baud rate of Certus is 115200. The Connection Indicator displays whether there is communication with a Certus unit.

8.2.5.2 Baud Rate

This displays the current and available baud rates options for the serial connection.

8.2.5.3 Connect / Disconnect

This button allows the serial connection to be enabled or disabled.

8.2.5.4 3D Map

The 3D map shows the Certus position on the Earth as well as a red trail of position history. When the filter initialises the map will automatically reset the view to the Certus position. To move the camera click and drag on the map. To zoom in and out use the mouse scroll wheel. To change the camera view right click and drag or shift click and drag.

8.2.6 View Menu

8.2.6.1 Communications

This dialogue shows statistics on the data packets received from Certus and can be useful in diagnosing signal integrity problems.

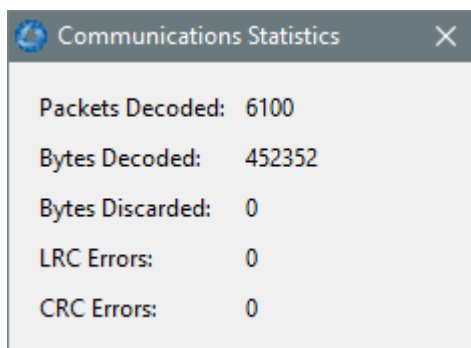


Figure 56: Certus Manager Communications Dialogue

8.2.7 Configuration Menu

8.2.7.1 Configuration Export

The Configuration Export dialogue can be used to export all the Certus settings to a file. This file can be imported at a later date or on other units. This is useful to restore a unit to a preset configuration at a later date or for batch configuration of multiple units.

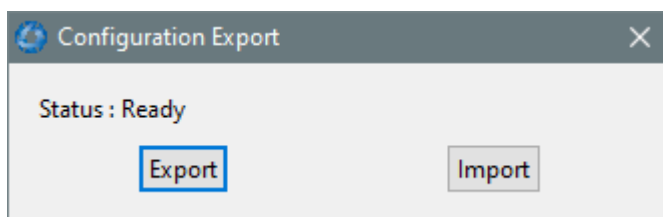


Figure 57: Certus Manager Configuration Export Dialogue

8.2.7.2 Alignment

The Alignment dialogue is used to set the alignment offsets of the system installation. It is important to set the values in this dialogue correctly for 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.

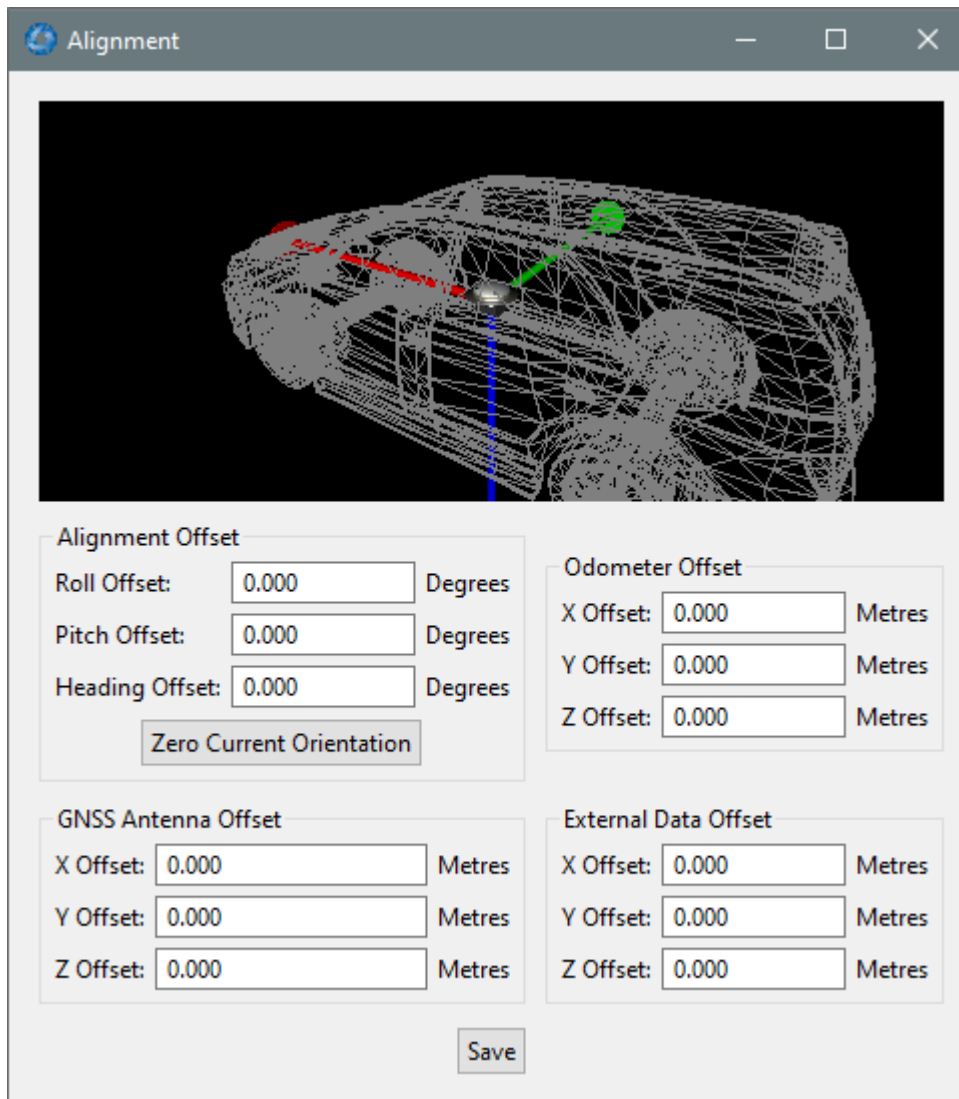


Figure 58: Certus Manager Alignment Dialogue

Alignment Offset

If Certus 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 pressing the Zero Current Orientation button.

Note: This will only correct for roll and pitch offsets, the Heading offset must be entered manually and saved before using this function.

All the other offsets will be measured in the realigned body co-ordinate frame (X positive forward, Z positive down) after being corrected for any alignment offset entered.

GNSS Antenna Offset

The GNSS antenna offset is measured from the centre of the Certus unit to the centre of the antenna in the body co-ordinate frame (X positive forward, Z positive down).

Odometer Offset

The odometer offset is measured from the centre of the Certus 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 data. Contact support@advancednavigation.com for assistance with these values.

8.2.7.3 Port Mode and Baud Rates

When changing baud rates, some Microsoft Windows machines are unable to function at the higher baud rates. It is recommended to test the baud rate first without selecting 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.

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

Note: The primary and auxiliary ports on CertusOEM are UART only, and cannot be changed to RS232 or RS422. An appropriate adapter/interface is required to connect to a computer.

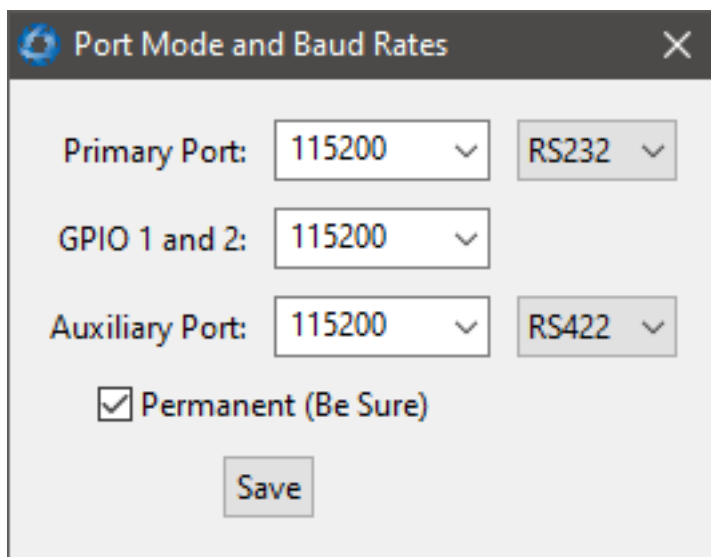


Figure 59: Certus Manager Baud Rates Dialogue

8.2.7.4 GPIO

This allows the user to set the functionality of the GPIO and auxiliary ports.

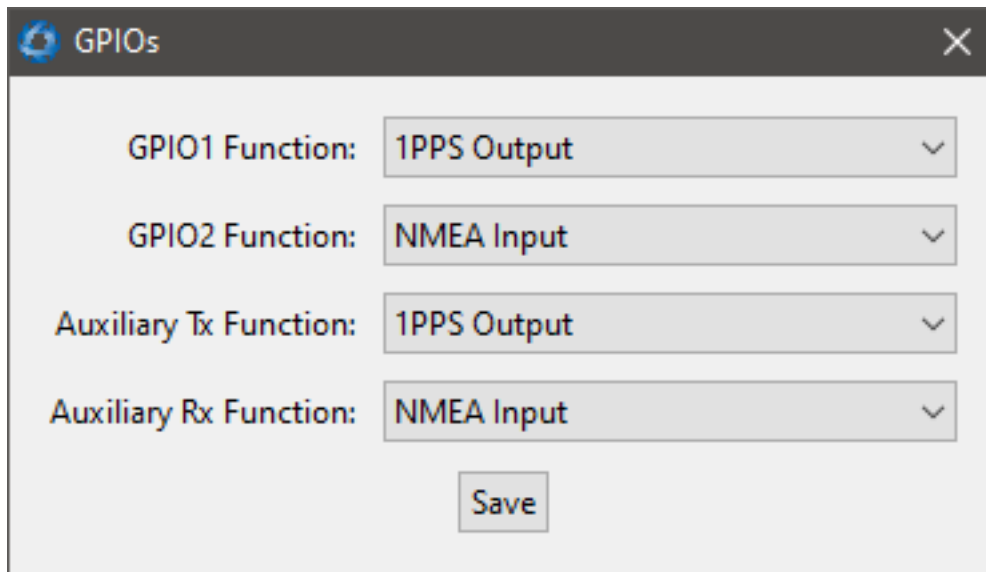


Figure 60: Certus Manager GPIO configuration Dialogue

8.2.7.5 Odometer

The Odometer dialogue allows the user to configure the odometer pulse length and view the real time odometer data to verify correct operation.

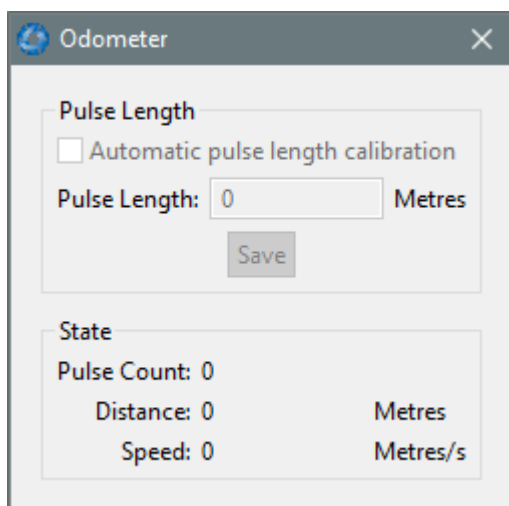


Figure 61: Certus Manager Odometer Dialogue

8.2.7.6 GPIO Output

The GPIO output configuration dialogue allows the user to configure the output rates for the GPIO and Auxiliary RS232/RS422 data functions NMEA, TSS and PASHR.

GPIO Output

NMEA

Fix Mode: Normal

GPIO1 Rate

Auxiliary Tx Rate

GPZDA Rate: Disabled

Disabled

GPZDA Rate: Disabled

Disabled

GPVGA Rate: Disabled

Disabled

GPVGA Rate: Disabled

Disabled

GPVTG Rate: Disabled

Disabled

GPVTG Rate: Disabled

Disabled

GPRMC Rate: Disabled

Disabled

GPRMC Rate: Disabled

Disabled

GPHDT Rate: Disabled

Disabled

GPHDT Rate: Disabled

Disabled

GPGLL Rate: Disabled

Disabled

GPGLL Rate: Disabled

Disabled

PASHR Rate: Disabled

Disabled

PASHR Rate: Disabled

Disabled

GPROT Rate: Disabled

Disabled

GPROT Rate: Disabled

Disabled

GPHEV Rate: Disabled

Disabled

GPHEV Rate: Disabled

Disabled

GPGSV Rate: Disabled

Disabled

GPGSV Rate: Disabled

Disabled

PFECAAtt Rate: Disabled

Disabled

PFECAAtt Rate: Disabled

Disabled

PFECHve Rate: Disabled

Disabled

PFECHve Rate: Disabled

Disabled

GPGST Rate: Disabled

Disabled

GPGST Rate: Disabled

Disabled

TSS

GPIO1 Rate

Auxiliary Tx Rate

Disabled

Disabled

Simrad

GPIO1 Rate

Auxiliary Tx Rate

Disabled

Disabled

Save

Figure 62: Certus Manager GPIO Output Dialogue

8.2.7.7 Gimbal

The Gimbal configuration dialogue is only used in speciality gimbal applications. Contact [Support](#) for more information on using Certus inside a gimbal.

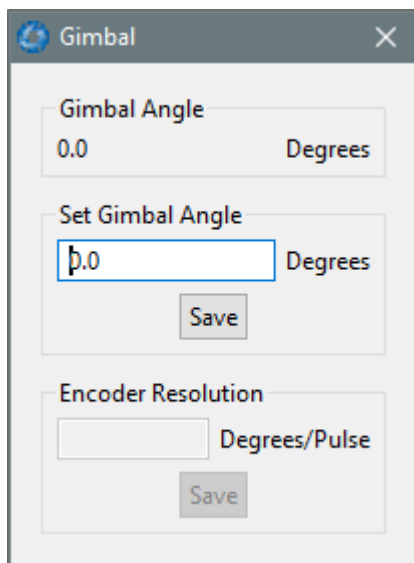


Figure 63: Certus Manager Gimbal Dialogue

8.2.8 Tools Menu

The **Tools** menu contains tools for performing certain procedures with Certus.

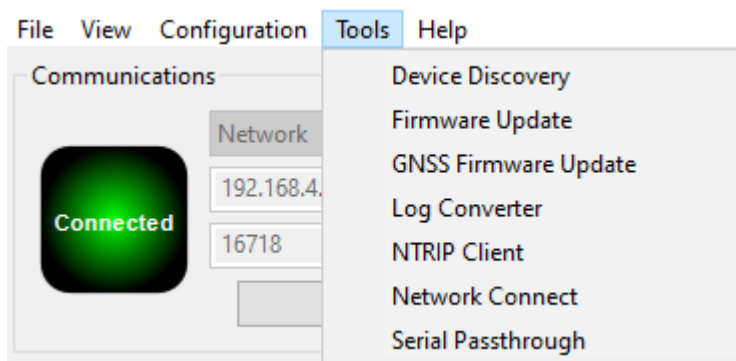


Figure 64: Certus Manager Tools Menu

8.2.8.1 Device Discovery

Device discovery allows network discovery and reconfiguration of devices on the local network regardless of network settings.

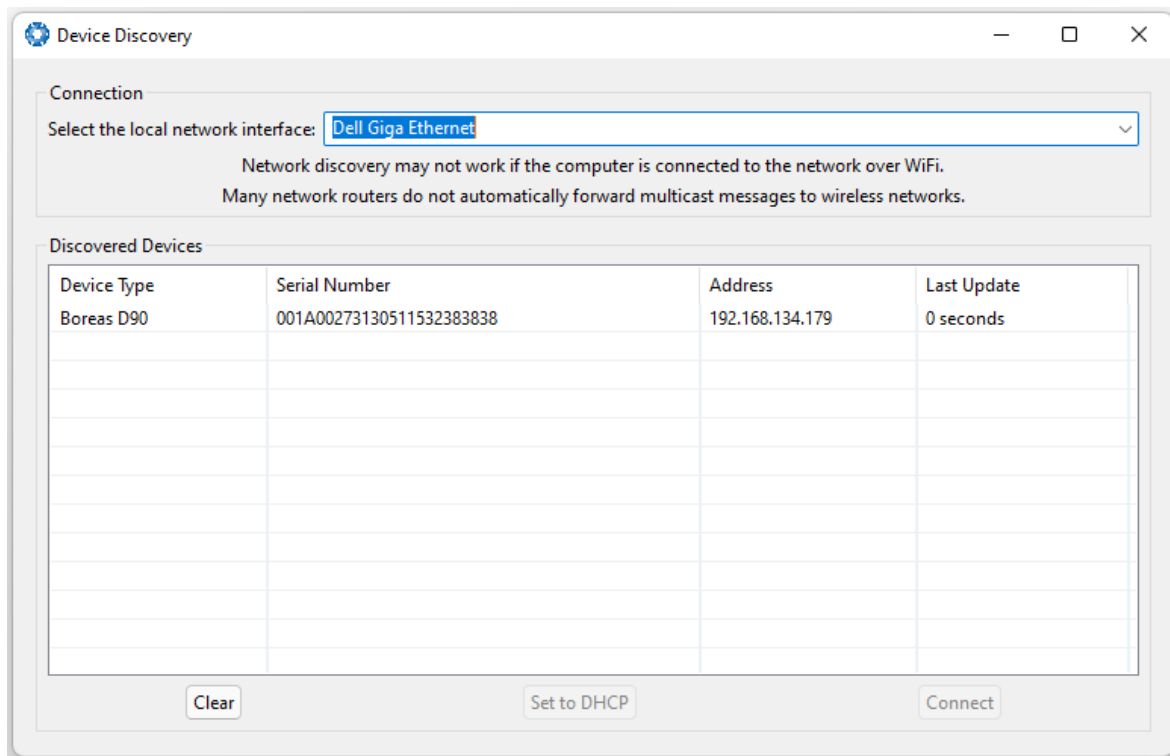


Figure 65: Device Discovery window

Set to DHCP

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

8.2.8.2 Magnetic Calibration

The Magnetic Calibration dialogue allows the user to perform magnetic calibration as well as view and modify the magnetic calibration values. The actual magnetic calibration is performed inside the Spatial unit. This dialogue does not have any smarts, it is just a control and display interface.

Magnetic Calibration

Calibration Process

Status: 3D Calibration Completed

Progress:

Error: 4 %

Start 2D Calibration Start 3D Calibration

Cancel Reset

Calibration Values

	Hard Iron:	Soft Iron:		
X:	-150.008	1.057	0.013	0.005
Y:	-48.334	0.013	1.078	-0.018
Z:	30.307	0.005	-0.018	0.991

World Magnetic Model Local Field

X: 241.765 mG	Declination: 12.545 Degrees
Y: 53.797 mG	Inclination: -64.826 Degrees
Z: -514.378 mG	

Save

Figure 66: Certus Manager Magnetic Calibration Dialogue

8.2.8.3 Firmware Update

This page is used to update the Certus device firmware, Advanced Navigation device firmware files have the extension .anfw.

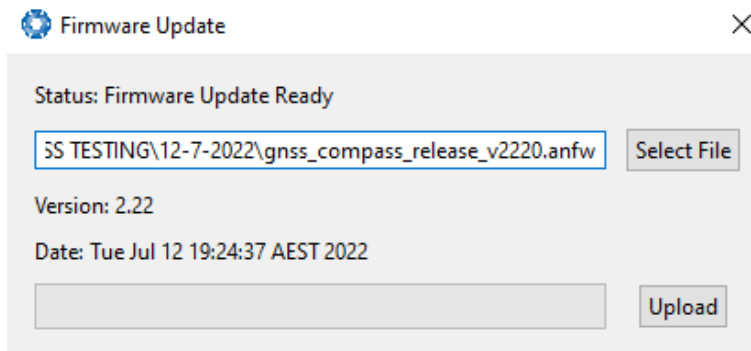


Figure 67: Certus Manager Firmware Update Page

Certus contains firmware which is regularly updated to improve performance and add features. 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 cause problems with units. Check the [Certus](#) product page of the Advanced Navigation website periodically for updates.

Follow these steps:

1. Navigate to the Firmware Update page under the **Tools** menu.
2. Click **Choose File** and select the firmware file.
3. Click **Upload File**.
4. Wait for the system to restart.

8.2.8.4 Log Converter

This tool allows the user to convert Certus log files into various standard formats that are readable by many programs. The offset is used to project the exported position to a point other than the centre of the Certus unit. For most users these values should be left at zero.

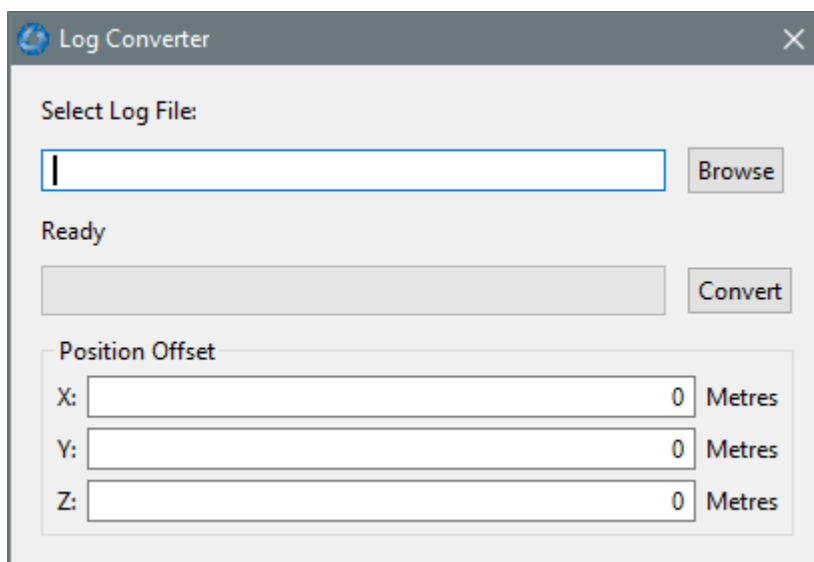


Figure 68: Certus Manager Log Converter Dialogue

To configure the Log path, navigate to *Settings*, under the File menu.

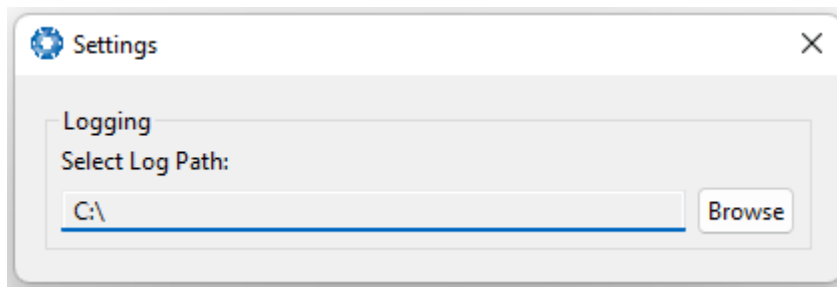


Figure 69: Settings menu for configuring Log Path

8.2.8.5 NTRIP Client

The NTRIP client can be used to connect to a network DGPS or RTK service to stream correction data to Certus for DGPS or RTK. The NTRIP client requires an internet connection to function. Contact [Support](#) for guidance on getting set up with network DGPS or RTK.

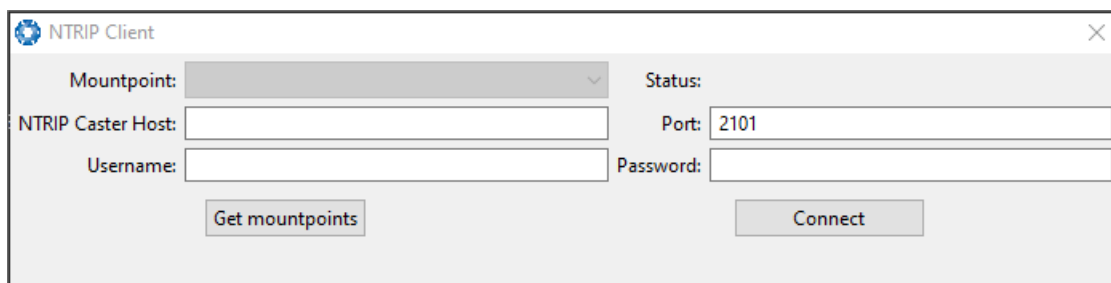


Figure 70: Certus Manager NTRIP Client Dialogue

Note: These settings refer to the NTRIP Client built into the Certus Manager application. It is not possible to configure the NTRIP Client built into Certus using Certus Manager. You need to use the web UI for this.

8.2.8.6 Network Connect

The network connect dialogue allows Certus Manager to make a connection to Certus over a TCP/IP network rather than the primary serial port connection.

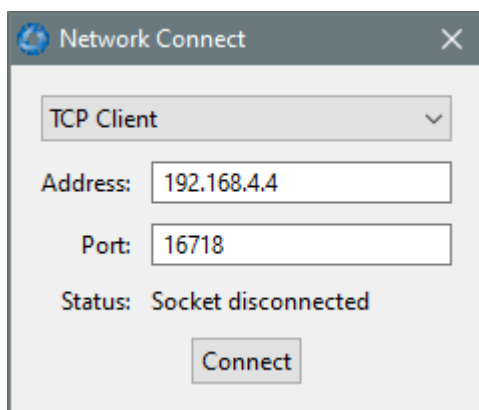


Figure 71: Certus Manager Network Connect Dialogue

8.2.8.7 Serial Passthrough

This function allows pass-through communication through either GPIO 1 and 2 or the Auxiliary port.

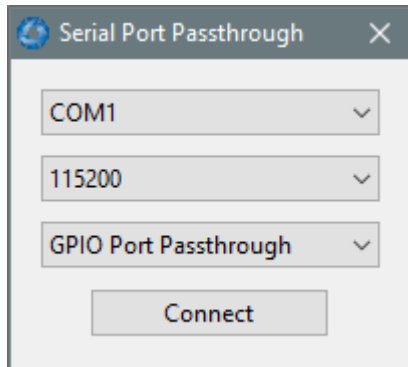


Figure 72: Certus Manager Serial Port Passthrough Dialogue

8.2.9 Logging

Certus Manager features a fully automatic logging system. Every time the serial port **Connect** button is clicked Certus Manager starts a new log file in the current directory. The log file is given the file name CertusLog_date_time.anpp and contains all of the raw data received from Certus in the AN packet protocol. The log files are closed when the serial port is disconnected.

To convert these log files into easily accessible formats, the [8.2.8.4 Log Converter](#) dialogue in the **Tools** menu can be used. The Log Converter creates a folder if no Log Path is set and generates files in the CSV (comma separated values) format that can be easily opened with Microsoft Excel, Matlab, LibreOffice and most other data analysis programs. It also creates a GPX file and a KML file that are designed to be opened with [Google Earth Pro](#).

Name	Date modified	Type	Size
DeviceInformation.txt	4/11/2019 4:55 PM	TXT File	1 KB
Configuration.txt	4/11/2019 4:55 PM	TXT File	6 KB
Status.csv	4/11/2019 4:55 PM	Microsoft Excel Comma Separated Values File	24 KB
State.csv	4/11/2019 4:55 PM	Microsoft Excel Comma Separated Values File	16,322 KB
Satellites.csv	4/11/2019 4:55 PM	Microsoft Excel Comma Separated Values File	17 KB
RawSensors.csv	4/11/2019 4:55 PM	Microsoft Excel Comma Separated Values File	8,170 KB
GoogleEarthTrack.kml	4/11/2019 4:55 PM	KML	897 KB
GoogleEarthTrack.gpx	4/11/2019 4:55 PM	gpx_auto_file	236 KB

Figure 73: Files Generated by the Log Converter

Note: This data logging is performed by the Certus Manager application and is separate from the Certus inbuilt logging functionality accessible via the web UI.

8.3 Using the Android App

The Spatial Manager Android app provides logging and visualisation functions for Android phones and tablets. It is particularly useful for field testing purposes. You can use this app to connect to your Certus via Bluetooth and:

- Monitor position and orientation in real time
- Log real-time data for later analysis and review
- Configure NTRIP stream corrections
- Configure device alignment offsets and manual initialisation

You will require a Serial to Bluetooth adaptor with Bluetooth v2.0 support connected to the primary serial port.

The app can be found by searching the Google Play store for "Advanced Navigation Spatial Manager". Refer to the in-app Quick Start guide for more information. Contact [Support](#) if you have any questions about the Android app.

8.4 Using ANPP

Certus 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 at no extra charge to assist you when developing your own applications. It contains example code in a number of programming languages, ready to compile and test. This is available from the Certus [product page](#).

9 Interfacing

Communication with Certus is possible on the following ports:

- [Ethernet](#)
- [9.2 Serial Interface](#)
- [CAN](#)
- [9.3 1PPS Signal](#)
- [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 22: Ethernet Data Port Modes

9.1.2 Ethernet Functions

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

Table 23: 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 GPGGA, GPVTG and GPZDA with optional messages GPGSV and GPGSA.

Message ID	Description
GPGGA	3D position
GPGLL	2D position
GPRMC	2D position, 2D velocity and coarse time
GPVTG	2D velocity
GPHDT	Heading
GNHDT	
HEHDT	
GPGSV	Satellites
GPGSA	Dilution of Precision
GPZDA	Time
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 24: 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 ANPP Input

Description: This function accepts data in the ANPP format as specified in [10 Advanced Navigation Packet Protocol](#).

9.1.2.5 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.

9.1.2.6 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.

9.1.2.7 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.

9.1.2.8 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.

9.1.2.9 Teledyne DVL Input

Description: This function accepts DVL data from a Teledyne DVL. For assistance with configuration, contact [Support](#).

9.1.2.10 Trittech USBL Input

Description: This function accepts USBL data from a Trittech USBL. For assistance with configuration, contact [Support](#).

9.1.2.11 Linkquest DVL Input

Description: This function accepts DVL data from a Linkquest DVL. The DVL should be configured to output in NQ1 format. For assistance with configuration, contact [Support](#).

9.1.2.12 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.

9.1.2.13 NMEA Output

Description: This function outputs a configurable combination of the NMEA messages GPZDA, GPGGA, GPVTG, GPRMC, GPHDT, PASHR, GPROT, GPHEV, GPGSV, PFECGPAtt, and PFECGPHe at up to 50 Hz. The messages output and the output rate can be configured using the web UI or Certus 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,0.0,89.2,070513,12.5,W,E*02
$GPHDT,89.2,T*06
$PASHR,031644.460,089.19,T,-00.01,-00.47,-00.00,,,,0,0*2E
```

9.1.2.14 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.

9.1.2.15 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.

9.1.2.16 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 [8.1.3.3 Data Ports](#) page in the [8.1 Using the Web User Interface](#).

9.1.2.17 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 [8.1.3.3 Data Ports](#) page in the [8.1 Using the Web User Interface](#).

9.1.2.18 Serial Port Passthrough

Description: This function allows passthrough communication through either GPIO 1 and 2 or the Auxiliary port. To transmit data use the [10.3.7 Serial Port Passthrough Packet](#). When data is received it will be sent back using the same [10.3.7 Serial Port Passthrough Packet](#).

9.1.2.19 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	ANPP only over UART. No dynamic pin functions	ANPP over UART, 9.6.1 Dynamic Pin Functions	ANPP over RS232, 9.6.1 Dynamic Pin Functions

Table 25: I/O Ports Available

9.2.1 Baud Rate

The default baud rate of Certus is 115,200. The primary and auxiliary port baud rate can be set anywhere from 4800 to 4,000,000 baud and can be modified using the Baud Rates page in the web UI or Certus Manager. The GPIO port baud rate can be set anywhere from 4800 to 250,000 baud. 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 115200, the data rate is 11520 bytes per second. If the selected data rate is insufficient, data may be lost without a warning.

The Support team can provide a baud rate calculator if it is required. For more information, contact Support at support@advancednavigation.com.

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 [5.7 Connector Pin-out](#). It can be set to either 0 to 5 V or 0 to 3.3 V. See the [8.1.3.15 Advanced](#) section of the Configuration Menu for information on changing this setting.

The 1PPS signal reference ground is the GPIO ground domain. See [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.

A CANopen EDS file is available. Contact the Advanced Navigation support team at support@advancednavigation.com for a copy of this.

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
10.4.25 External Position Packet
10.4.26 External Velocity Packet
10.4.27 External Body Velocity Packet
10.4.28 External Heading Packet
10.4.32 External Time Packet
10.4.33 External Depth Packet
10.4.40 External Odometer Packet
10.4.41 External Air Data Packet
10.4.46 External Magnetometers Packet

Table 26: 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 [10.5.3.1 Supported Baud Rate](#). Changes to these baud rates can be made by using the Baud Rates page in the [web UI](#) or [Certus 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 function at 0 to 5 V (or 0 to 3.3 V) levels for digital input, digital output, frequency input and frequency output, but when a serial data function is selected that GPIO pin automatically switches to RS232 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
	9.6.1.32 ANPP Input
	9.6.1.33 RTCM Differential GNSS Corrections Input
	9.6.1.34 Trimble GNSS Input
	9.6.1.35 u-blox GNSS Input
	9.6.1.36 Hemisphere GNSS Input
	9.6.1.37 Teledyne DVL Input
	9.6.1.38 Trittech USBL Input
	9.6.1.39 Linkquest DVL Input
	9.6.1.40 Linkquest USBL Input
	9.6.1.41 Nortek DVL Input
Serial Transmit	9.6.1.42 NMEA Output
	9.6.1.43 ANPP Output
	9.6.1.44 TSS1 Output
	9.6.1.45 Simrad 1000 Output
	9.6.1.46 Simrad 3000 Output
Serial	9.6.1.47 Serial Port Passthrough
	9.6.1.48 GNSS Receiver Passthrough

Table 27: 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	-5V to 5V	Falling Edge
GPIO	0V to 5V	Rising Edge

Figure 74: 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 its 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 is the recommended 1PPS signal to use as it comes direct from the internal GNSS receiver rather than the internal microprocessor. 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 10.5.5 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 de-bouncing 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. Contact Advanced Navigation support for help integrating with your speed sensor.

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

Table 28: 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. Contact Advanced Navigation support@advancednavigation.com for help integrating with a pitot tube.

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. Contact Advanced Navigation support@advancednavigation.com for help integrating with your speed sensor.

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

Table 29: 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 GPGGA, GPVTG and GPZDA with optional messages GPGSV and GPGSA.

Message ID	Description
GPGGA GNGGA	3D position
GPGLL GNGLL	2D position
GPRMC GNRMC	2D position, 2D velocity and coarse time
GPVTG GNVTG	2D velocity
GPHDT GNHDT HEHDT	Heading
GPGSV GNGSV	Satellites
GPGSA GNGSA	Dilution of Precision
GPZDA GNZDA	Time
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 30: 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 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.

9.6.1.31 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 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.

9.6.1.33 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.

9.6.1.34 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 (20Hz recommended) and optional records 9 and 34 at 1 to 2Hz.

9.6.1.35 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 1Hz.

9.6.1.36 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 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.

9.6.1.37 Teledyne DVL Input

Type:	Serial Receive
GPIO Port:	2
Auxiliary:	Receive
Description:	This function accepts DVL data from a Teledyne DVL. For assistance with configuration, contact support@advancednavigation.com .

9.6.1.38 Trittech USBL Input

Type:	Serial Receive
GPIO Port:	2
Auxiliary:	Receive
Description:	This function accepts USBL data from a Trittech USBL. For assistance with configuration, contact support@advancednavigation.com .

9.6.1.39 Linkquest DVL Input

Type:	Serial Receive
GPIO Port:	2
Auxiliary:	Receive
Description:	This function accepts DVL data from a Linkquest DVL. For assistance with configuration, contact support@advancednavigation.com .

9.6.1.40 Linkquest USBL Input

Type:	Serial Receive
GPIO Port:	2
Auxiliary:	Receive
Description:	This function accepts USBL data from a Linkquest USBL. For assistance with configuration, contact support@advancednavigation.com .

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 8Hz.

9.6.1.42 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 Certus 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
```

9.6.1.43 ANPP Output

Type:	Serial Transmit
GPIO Port:	1
Auxiliary:	Transmit
Description:	<p>This function outputs data in the ANPP format as specified in 10 Advanced Navigation Packet Protocol. This function is for ANPP peripheral devices only.</p> <p>When this function is enabled, the GPIO and auxiliary ports function the same as the primary port, with one exception:</p> <ul style="list-style-type: none"> 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.

9.6.1.44 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.

9.6.1.45 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 page in the 8.1 Using the Web User Interface .

9.6.1.46 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 page in the 8.1 Using the Web User Interface .

9.6.1.47 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 10.3.7 Serial Port Passthrough Packet . When data is received it will be sent back using the same 10.3.7 Serial Port Passthrough Packet .

9.6.1.48 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 well defined specification and is very flexible. It is used across all Advanced Navigation products. A packet type can be identified by its unique Packet ID. For more information about packets, see [10.1 About Packets](#).

The following packet types are available:

- [10.3 System Packets](#) - These packets have ID values of less than 20.
- [10.4 State Packets](#) - These packets have ID values between 20 and 179.
- [10.5 Configuration Packets](#) - These packets have IDs greater than 179.

The following table lists Advanced Navigation packets by type.

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
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
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

Packet ID	Name	Length	R/W
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	10.4.25 External Position Packet	36	R/W
46	10.4.26 External Velocity Packet	24	R/W
47	10.4.27 External Body Velocity Packet	16 or 24	R/W
48	10.4.28 External Heading Packet	8	R/W
49	10.4.29 Running Time Packet	8	R
50	10.4.30 Local Magnetic Field Packet	12	R
51	10.4.31 Odometer State Packet	20	R
52	10.4.32 External Time Packet	8	R
53	10.4.33 External Depth Packet	8	R/W
54	10.4.34 Geoid Height Packet	4	R
55	10.4.35 RTCM Corrections Packet	Varies	W
57	10.4.36 Wind Packet	12	R/W
58	10.4.37 Heave Packet	16	R
60	10.4.38 Raw Satellite Data Packet	Varies	R
61	10.4.39 Raw Satellite Ephemeris Packet	Varies	R
67	10.4.40 External Odometer Packet	13	W
68	10.4.41 External Air Data Packet	25	R/W
69	10.4.42 GNSS Receiver Information Packet	Varies	R
70	10.4.43 Raw DVL Data Packet	60	R
72	10.4.44 Gimbal State Packet	8	R/W
73	10.4.45 Automotive Packet	24	R

Packet ID	Name	Length	R/W
75	10.4.46 External Magnetometers Packet	17	R/W
80	10.4.47 Basestation Packet	45	R
83	10.4.48 Zero Angular Velocity Packet	8	W
84	10.4.49 Extended Satellites Packet	Varies	R
85	10.4.50 Sensor Temperature Packet	32	R
Packet ID	Name	Length	R/W
Configuration Packets			
180	10.5.1 Packet Timer Period Packet	4	R/W
181	10.5.2 Packets Period Packet	Varies	R/W
182	10.5.3 Baud Rates Packet	17	R/W
184	10.5.4 Sensor Ranges Packet	4	R/W
185	10.5.5 Installation Alignment Packet	73	R/W
186	10.5.6 Filter Options Packet	17	R/W
188	10.5.7 GPIO Configuration Packet	13	R/W
189	10.5.8 Magnetic Calibration Values Packet	49	R/W
190	10.5.9 Magnetic Calibration Configuration Packet	1	W
191	10.5.10 Magnetic Calibration Status Packet	3	R
192	10.5.11 Odometer Configuration Packet	8	R/W
193	10.5.12 Set Zero Orientation Alignment Packet	5	W
194	10.5.13 Reference Point Offsets Packet	49	R/W
195	10.5.14 GPIO Output Configuration Packet	183	R/W
196	10.5.15 Dual Antenna Configuration Packet	17	R/W
197	10.5.16 GNSS Configuration Packet	85	R/W
198	10.5.17 User Data Packet	64	R/W
199	10.5.18 GPIO Input Configuration Packet	65	R/W
202	10.5.19 IP Dataports Configuration Packet	30	R/W
203	10.5.20 CAN Configuration Packet	30	R/W

Table 31: Advanced Navigation 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 multiple languages via the SDK, available from the [Certus](#) product page of the Advanced Navigation website.

Header				
Header LRC	Packet ID	Packet Length	CRC16	Packet Data

Table 32: 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 33: 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:

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

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 [10.3.2 Request Packet](#).

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 [10.3.1 Acknowledge Packet](#).

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 Certus Manager or through the [10.5.2 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 11 = 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 34: 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 35: 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 36: 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 37: 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 38: Boot Mode Packet

10.3.3.1 Boot Mode Types

Value	Description
0	Bootloader
1	Main Program

Table 39: 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 40: 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
14	Subsonus
16	Spatial FOG Dual
17	Motus
19	GNSS Compass
21	Subsonus Tag
22	Poseidon
26	Certus
27	Aries
28	Boreas D90
41	Boreas D70

Table 41: 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 42: 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 43: Reset Packet

10.3.6.1 Verification Sequence Values

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

Table 44: 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 Routes
2	1			Passthrough Data

Table 45: Serial Port Passthrough Packet

10.3.7.1 Passthrough Routes

Value	Description
1	GPIO 1 and 2
2	Auxiliary

Table 46: Passthrough Routes

10.3.8 IP Configuration Packet

IP Configuration Packet				
Packet ID			11	
Length			30	
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 47: 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 48: DHCP Mode

10.3.8.2 Link Mode Index

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

Table 49: 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	
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	u8[8]	8	Reserved

Table 50: 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 51: Device Sub-type's

10.3.10 Subcomponent Information Packet

Only Advanced Navigation sub-components will be shown here, for GNSS Receiver see [10.4.42 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 52: Subcomponent Information Packet

10.3.10.1 Subcomponent Device ID

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

Table 53: Subcomponent Device IDs

10.4 State Packets

Certus supports a ANPP number of packets providing extensive functionality. However for the majority of users the easiest approach is to configure Certus using the web UI or Certus Manager software and then support only the single system state packet shown in [10.4.1 System State Packet](#). Advanced functionality can be added as required through the other packets.

This section covers the following topics:

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
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	10.4.25 External Position Packet	36	R/W
46	10.4.26 External Velocity Packet	24	R/W

Packet ID	Name	Length	R/W
47	10.4.27 External Body Velocity Packet	16 or 24	R/W
48	10.4.28 External Heading Packet	8	R/W
49	10.4.29 Running Time Packet	8	R
50	10.4.30 Local Magnetic Field Packet	12	R
51	10.4.31 Odometer State Packet	20	R
52	10.4.32 External Time Packet	8	R
53	10.4.33 External Depth Packet	8	R/W
54	10.4.34 Geoid Height Packet	4	R
55	10.4.35 RTCM Corrections Packet	Varies	W
57	10.4.36 Wind Packet	12	R/W
58	10.4.37 Heave Packet	16	R
60	10.4.38 Raw Satellite Data Packet	Varies	R
61	10.4.39 Raw Satellite Ephemeris Packet	Varies	R
67	10.4.40 External Odometer Packet	13	W
68	10.4.41 External Air Data Packet	25	R/W
69	10.4.42 GNSS Receiver Information Packet	Varies	R
70	10.4.43 Raw DVL Data Packet	60	R
72	10.4.44 Gimbal State Packet	8	R/W
73	10.4.45 Automotive Packet	24	R
75	10.4.46 External Magnetometers Packet	17	R/W
80	10.4.47 Basestation Packet	45	R
83	10.4.48 Zero Angular Velocity Packet	8	W
84	10.4.49 Extended Satellites Packet	Varies	R
85	10.4.50 Sensor Temperature Packet	32	R

Table 54: 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)
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 55: 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 56: 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 57: Filter Status

10.4.1.3 GNSS Fix Status

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

Table 58: GNSS Fix Status

10.4.1.4 Unix Time Seconds

This field provides UTC time in seconds since January 1, 1970, including leap seconds.

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 59: 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 60: 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 61: 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 62: 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 63: 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 64: 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 65: Quaternion Orientation Standard Deviation Packet

10.4.9 Raw Sensors Packet

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 66: Raw Sensors Packet

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.

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 67: Raw GNSS Packet

10.4.10.1 Raw GNSS Status

Bit	Description
0	GNSS Fix Status
1	
2	
3	Doppler velocity valid
4	Time valid
5	External GNSS
6	Tilt valid

Bit	Description
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 68: 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 69: 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 70: 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 71: 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 72: 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 73: 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 74: 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 75: 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 76: 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 77: 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 78: 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 79: 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 80: 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 81: 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 82: External Position and Velocity Packet

10.4.25 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)
5	28	fp32	4	Longitude standard deviation (m)
6	32	fp32	4	Height standard deviation (m)

Table 83: External Position Packet

10.4.26 External Velocity Packet

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

10.4.27 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 85: External Body Velocity Packet

10.4.28 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 86: External Heading Packet

10.4.29 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 87: Running Time Packet

10.4.30 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 88: Local Magnetic Field Packet

10.4.31 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

Table 89: Odometer State Packet

10.4.32 External Time Packet

External Time Packet				
Packet ID			52	
Length			8	
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

Table 90: External Time Packet

10.4.33 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 91: External Depth Packet

10.4.34 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 92: Geoid Height Packet

10.4.35 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 93: RTCM Corrections Packet

10.4.36 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 [10.4.41 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 94: Wind Packet

10.4.37 Heave 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 95: Heave Packet

10.4.38 Raw Satellite Data Packet

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

Note: Once this packet is enabled, Packet 61 ([10.4.39 Raw Satellite Ephemeris Packet](#)) will also be enabled automatically.

Raw Satellite Data Packet				
Packet ID		60		
Length		16 + Satellites * (6 + Frequencies * 26)		
Read / Write		Read		
Field #	Bytes Offset	Data Type	Size	Description

Raw Satellite Data Packet				
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 96: Raw Satellite Data Packet

10.4.38.1 Satellite Systems

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

Table 97: Satellite Systems

10.4.38.2 Satellite Frequencies

Value	GPS	GLONASS	Galileo	BeiDou	SBAS	QZSS
0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
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
9			E5 b			
10			E5 a+b			

Table 98: Satellite Frequencies

10.4.38.3 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 99: Tracking Status

10.4.39 Raw Satellite Ephemeris Packet

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

Note: This packet is enabled automatically when packet 60 ([10.4.38 Raw Satellite Data Packet](#)) is enabled. This packet cannot be enabled independently of Packet 60.

Raw Satellite Ephemeris Packet	
Packet ID	61
Length	Varies

Raw Satellite Ephemeris Packet				
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)
15	46	fp64	8	Eccentricity [e]
16	54	fp32	4	Cus (rad)
17	58	fp64	8	\sqrt{A} (\sqrt{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	10.4.39.1 GPS Flags
For GLONASS satellites (94 Bytes)				
5	6	fp32	4	Satellite clock bias (s)

Raw Satellite Ephemeris Packet				
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	u8	1	Reserved

Table 100: Raw Satellite Ephemeris Packet

10.4.39.1 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 101: GPS Flags

10.4.40 External Odometer Packet

External Odometer Packet				
Packet ID			67	
Length			13	
Read / Write			Write	
Field #	Bytes Offset	Data Type	Size	Description

External Odometer Packet				
1	0	fp32	4	Estimated delay (s)
2	4	fp32	4	Speed (m/s)
3	8	fp32	4	Reserved (set to zero)
4	12	u8	1	Odometer flags

Table 102: External Odometer Packet

10.4.40.1 Odometer Flags

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

Table 103: Odometer Flags

10.4.41 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)
2	8	fp32	4	Barometric altitude (m)
3	12	fp32	4	Airspeed (m/s)
4	16	fp32	4	Barometric altitude standard deviation (m)
5	20	fp32	4	Airspeed standard deviation (m/s)
6	24	u8	1	Flags

Table 104: External Air Data Packet

10.4.41.1 External Air Data Flags

Bit	Description
0	Barometric altitude set and valid
1	Airspeed set and valid
2	Barometric altitude reference reset

Table 105: 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.

10.4.42 GNSS Receiver Information Packet

10.4.42.1 Aries GNSS Receiver

Aries 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 106: Aries GNSS Receiver Information Packet

10.4.42.2 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
		1	Trimble BD920
		2	Trimble BD930
		3	Trimble BD982
		4	Trimble MB-One
		5	Trimble MB-Two
		6	Trimble BD940
		7	Trimble BD992
3	Advanced Navigation	0	GNSS Receiver Model Unknown
		1	Aries
		2	Aries GC2

Table 107: GNSS Manufacturer IDs and Receiver Models

10.4.42.3 Omnistar Engine Modes

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

Table 108: Omnistar Engine Modes

10.4.42.4 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 109: RTK Software License Accuracies

10.4.43 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 Certus 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 10.4.43.1 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)

Raw DVL Data Packet				
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 110: Raw DVL Data Packet

10.4.43.1 Raw DVL Data Flags

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

Table 111: Raw DVL Data Flags

10.4.44 Gimbal State Packet

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 112: Gimbal State Packet

10.4.45 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

Automotive Packet				
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 113: Automotive Packet

10.4.46 External Magnetometers Packet

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 114: External Magnetometers Packet

10.4.46.1 External Magnetometers Flags

Bit	Description
0	Magnetometers failure
1	Magnetometers over-range

Table 115: External magnetometers Flags

10.4.47 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	10.4.47.1 GNSS Fix Status

Table 116: Basestation packet

10.4.47.1 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 117: GNSS Fix Status

10.4.48 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 10.4.48.1 Zero Angular Velocity Dur-

Zero Angular Velocity Packet				
				ation
2	4		4	Reserved (set to zero)

Table 118: Zero Angular Velocity Packet

10.4.48.1 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.

10.4.49 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)
5	4	s8	1	10.4.49.3 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 119: 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.

10.4.49.1

10.4.49.2 Satellite Systems

Value	System
0	Unknown
1	GPS
2	GLONASS

Value	System
3	BeiDou
4	Galileo
5	SBAS
6	QZSS
7	Reserved
8	Reserved
9	Reserved

Table 120: Satellite Systems

10.4.49.3 Satellite Frequencies

Value	GPS	GLONASS	Galileo	BeiDou	SBAS	QZSS
0	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
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
9			E5 b			
10			E5 a+b			

Table 121: Satellite Frequencies

10.4.49.4 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 122: Extended Satellites Flags

10.4.50 Sensor Temperature Packet

Sensor Temperatures Packet	
Packet ID	85

Sensor Temperatures Packet				
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 123: Sensor temperature packet

10.5 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).

This section covers the following topics:

Packet ID	Name	Length	R/W
Configuration Packets			
180	10.5.1 Packet Timer Period Packet	4	R/W
181	10.5.2 Packets Period Packet	Varies	R/W
182	10.5.3 Baud Rates Packet	17	R/W
184	10.5.4 Sensor Ranges Packet	4	R/W
185	10.5.5 Installation Alignment Packet	73	R/W
186	10.5.6 Filter Options Packet	17	R/W
188	10.5.7 GPIO Configuration Packet	13	R/W
189	10.5.8 Magnetic Calibration Values Packet	49	R/W
190	10.5.9 Magnetic Calibration Configuration Packet	1	W
191	10.5.10 Magnetic Calibration Status Packet	3	R
192	10.5.11 Odometer Configuration Packet	8	R/W
193	10.5.12 Set Zero Orientation Alignment Packet	5	W
194	10.5.13 Reference Point Offsets Packet	49	R/W
195	10.5.14 GPIO Output Configuration Packet	183	R/W
196	10.5.15 Dual Antenna Configuration Packet	17	R/W
197	10.5.16 GNSS Configuration Packet	85	R/W
198	10.5.17 User Data Packet	64	R/W
199	10.5.18 GPIO Input Configuration Packet	65	R/W
202	10.5.19 IP Dataports Configuration Packet	30	R/W
203	10.5.20 CAN Configuration Packet	30	R/W

10.5.1 Packet Timer Period Packet

Packet Timer Period Packet				
Packet ID			180	
Length			4	
Read / Write			Read / Write	
Field #	Bytes Offset	Data Type	Size	Description
1	0	u8	1	Permanent
2	1	u8	1	10.5.1.1 UTC Synchronisation
3	2	u16	2	10.5.1.2 Packet Timer Period

Table 124: Packet Timer Period Packet

10.5.1.1 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 = $1000000/(\text{Packet Timer Period})$ Hz

10.5.1.2 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 65535 (65.535 ms) or 15.30 Hz.

10.5.2 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 125: Packets Period Packet

10.5.2.1 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.

10.5.2.2 Packet Period

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

Packet Rate = $1000000 / (\text{Packet Period} \times \text{Packet Timer Period})$ 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 = $1000000 / (50 \times 1000)$

Packet 20 Rate = 20 Hz

10.5.3 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 baud rate (4800 to 4000000) bit #31: 0 = RS232, 1 = RS422
3	5	u32	4	GPIO 1 & 2 baud rate (4800 to 250000)
4	9	u32	4	Auxiliary RS232 Baud Rate (4800 to 4000000) bit #31: 0 = RS232, 1 = RS422
5	13		4	Reserved (set to zero)

Table 126: Baud Rates Packet

The highest bit (bit #31) of fields #2 and #4 are used to set the port mode of the primary and auxiliary ports. A zero indicates RS232 mode, a one indicates RS422 mode.

10.5.3.1 Supported Baud Rate

Supported Baud Rates
4800
9600
19200
38400
57600
115200
230400
250000
460800
500000
800000
921600
1000000
1250000
2000000
4000000

Table 127: Supported Baud Rates

10.5.4 Sensor Ranges Packet

Note: The Sensor Ranges Packet is only valid for Certus OEM units. This packet is not applicable for Certus Evo OEM 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	10.5.4.1 Accelerometers Range
3	2	u8	1	10.5.4.2 Gyroscopes Range
4	3	u8	1	10.5.4.3 Magnetometers Range

Table 128: Sensor Ranges Packet

10.5.4.1 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 129: Accelerometers Range

10.5.4.2 Gyroscopes Range

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

Table 130: Gyroscopes Range

10.5.4.3 Magnetometers Range

Value	Description
0	2 Gauss
1	4 Gauss
2	8 Gauss

Table 131: Magnetometers Range

10.5.5 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	37	fp32	4	GNSS antenna offset X (m)
12	41	fp32	4	GNSS antenna offset Y (m)
13	45	fp32	4	GNSS antenna offset Z (m)
14	49	fp32	4	Odometer offset X (m)
15	53	fp32	4	Odometer offset Y (m)
16	57	fp32	4	Odometer offset Z (m)
17	61	fp32	4	External data offset X (m)
18	65	fp32	4	External data offset Y (m)
19	69	fp32	4	External data offset Z (m)

Table 132: Installation Alignment Packet

10.5.5.1 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.

$$\text{DCM}[0][0] = \cos(\text{heading}) * \cos(\text{pitch})$$

$$\text{DCM}[0][1] = \sin(\text{heading}) * \cos(\text{pitch})$$

$$\text{DCM}[0][2] = -\sin(\text{pitch})$$

$$\text{DCM}[1][0] = -\sin(\text{heading}) * \cos(\text{roll}) + \cos(\text{heading}) * \sin(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[1][1] = \cos(\text{heading}) * \cos(\text{roll}) + \sin(\text{heading}) * \sin(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[1][2] = \cos(\text{pitch}) * \sin(\text{roll})$$

$$\text{DCM}[2][0] = \sin(\text{heading}) * \sin(\text{roll}) + \cos(\text{heading}) * \sin(\text{pitch}) * \cos(\text{roll})$$

$$\text{DCM}[2][1] = -\cos(\text{heading}) * \sin(\text{roll}) + \sin(\text{heading}) * \sin(\text{pitch}) * \cos(\text{roll})$$

$$\text{DCM}[2][2] = \cos(\text{pitch}) * \cos(\text{roll})$$

10.5.6 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	10.5.6.1 Vehicle Types
3	2	u8	1	Internal GNSS enabled (boolean)
4	3	u8	1	Magnetic Heading enabled (boolean)
5	4	u8	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	u8	1	Automatic magnetic calibration enabled (boolean)
10	9	u8	1	Dual antenna disabled
11	10		7	Reserved (set to zero)

Table 133: Filter Options Packet

10.5.6.1 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	ANPP Ship
11	Stationary
12	Stunt Plane
13	Race Car

Table 134: Vehicle Types

10.5.7 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 10.5.7.1 GPIO Functions
3	2	u8	1	GPIO2 function. See 10.5.7.1 GPIO Functions
4	3	u8	1	Auxiliary RS232 transmit function. See 10.5.7.2 Auxiliary Functions
5	4	u8	1	Auxiliary RS232 receive function. See 10.5.7.2 Auxiliary Functions
6	5	u8	1	10.5.7.3 GPIO Voltage Selection
7	6		7	Reserved (set to zero)

Table 135: GPIO Configuration Packet

10.5.7.1 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	
16	Set Zero Orientation Alignment	
17	System State Packet Trigger	
18	Raw Sensors Packet Trigger	GPIO2
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	

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	
35	Linkquest USBL Input	GPIO2
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	GPIO2
51	Nortek DVL Input	
53	Reverse Alignment, Forward Low	
54	Reverse Alignment, Forward High	
55	Zero Angular Velocity Input	GPIO1, GPIO2

Table 136: GPIO functions

10.5.7.2 Auxiliary Functions

Value	Description	Auxiliary Function Type
0	Inactive	Transmit, Receive
1	1PPS Output	Transmit
2	GNSS Fix Output	
3	Odometer Input	Receive
4	Zero Velocity Input	
5	Pitot Tube Input	
6	NMEA Input	

Value	Description	Auxiliary Function Type
7	NMEA Output	Transmit
8	Novatel GNSS Input	Receive
9	Topcon GNSS Input	
11	ANPP Input	
12	ANPP Output	Transmit
13		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	
42	Serial Port Passthrough	Transmit, receive

Value	Description	Auxiliary Function Type
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	

Table 137: Auxiliary Functions

10.5.7.3 GPIO Voltage Selection

Value	Description
0	5V
1	3.3V
2	Power Disabled

Table 138: GPIO Voltage Selection

10.5.8 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
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

Magnetic Calibration Values Packet				
13	45	fp32	4	Soft iron transformation ZZ

Table 139: Magnetic Calibration Values Packet

10.5.9 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	10.5.9.1 Magnetic Calibration Actions

Table 140: Magnetic Calibration Configuration Packet

10.5.9.1 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 141: Magnetic Calibration Actions

10.5.10 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	10.5.10.1 Magnetic Calibration Status
2	1	u8	1	Magnetic calibration progress (%)
3	2	u8	1	Local magnetic error (%)

Table 142: Magnetic Calibration Status Packet

10.5.10.1 Magnetic Calibration Status

Value	Description
0	Magnetic calibration not completed
1	2D magnetic calibration completed
2	3D magnetic calibration completed

Value	Description
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 143: Magnetic Calibration Status

10.5.11 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 144: Odometer Configuration Packet

10.5.12 Set Zero Orientation Alignment Packet

Set Zero Orientation Alignment Packet				
Packet ID		193		
Length		5		
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 145: Set Zero Orientation Alignment Packet

10.5.13 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 [10.4.37 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 146: Reference Point Offsets Packet

10.5.14 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 10.5.14.1 Port Input Modes
3	2	u8	1	Auxiliary port Output Mode. See 10.5.14.2 Port Output Modes
4	3	u8	1	Auxiliary port NMEA fix behaviour. See 10.5.14.3 NMEA Fix Behaviour
5	4	u8	1	Auxiliary port GPZDA Rates. See 10.5.14.4 Port Output Rates
6	5	u8	1	Auxiliary port GPGGA Rates. See 10.5.14.4 Port Output Rates
7	6	u8	1	Auxiliary port GPVTG Rates. See 10.5.14.4 Port Output Rates
8	7	u8	1	Auxiliary port GPRMC Rates. See 10.5.14.4 Port Output Rates
9	8	u8	1	Auxiliary port GPHDT Rates. See 10.5.14.4 Port Output Rates
10	9	u8	1	Auxiliary port GPGLL Rates. See 10.5.14.4 Port Output Rates
11	10	u8	1	Auxiliary port PASHR Rates. See 10.5.14.4 Port Output Rates
12	11	u8	1	Auxiliary port TSS1 Rates. See 10.5.14.4 Port Output Rates
13	12	u8	1	Auxiliary port Simrad Rates. See 10.5.14.4 Port Output Rates
14	13	u8	1	Auxiliary port GPROT Rates. See 10.5.14.4 Port Output Rates
15	14	u8	1	Auxiliary port GPHEV Rates. See 10.5.14.4 Port Output Rates
16	15	u8	1	Auxiliary port GPGSV Rates. See 10.5.14.4 Port Output Rates
17	16	u8	1	Auxiliary port PFECAtt Rates. See 10.5.14.4 Port Output Rates
18	17	u8	1	Auxiliary port PFECHe Rates. See 10.5.14.4 Port Output Rates

GPIO Output Configuration Packet				
				put Rates
19	18	u8	1	Auxiliary port GPGST Rates. See 10.5.14.4 Port Output Rates
20	19	u8[8]	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 147: GPIO Output Configuration Packet

10.5.14.1 Port Input Modes

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

Table 148: Port Input Modes

10.5.14.2 Port Output Modes

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

Table 149: 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.

10.5.14.3 NMEA Fix Behaviour

Value	Description
0	Normal
1	Always indicate 3D fix when the navigation filter is ini-

Value	Description
	tialised

Table 150: NMEA Fix Behaviour

10.5.14.4 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

Table 151: Port Output Rates

10.5.15 Dual Antenna Configuration Packet

By default the system uses automatic offset with primary front and secondary rear.

When using an automatic offset:

- There are four available configurations, listed in the Automatic Offset Orientations table below.
- Manual offset values will be ignored and should be set to zero.
- The manual offset values will be populated with the automatically calculated offset values.

If your antenna configuration does not match one of the four available automatic offset configurations you must use a manual offset. These values are measured from the secondary antenna to the primary antenna in the body co-ordinate frame.

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	Offset type
3	3	u8	1	Automatic offset orientation
4	4	u8	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 152: Dual Antenna Configuration Packet

10.5.15.1 Offset Types

Value	Description
0	Manual offset
1	Automatic offset

Table 153: Offset Types

10.5.15.2 Automatic Offset Orientations

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 154: Automatic Offset Orientations

10.5.16 GNSS Configuration Packet

10.5.16.1 Aries GNSS Receiver

Aries GNSS Receiver Configuration Packet				
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 10.5.16.3 GNSS Frequency Bitfields .
3	9		76	Reserved (set to 0)

Table 155: Aries GNSS Receiver Configuration Packet

10.5.16.2 Trimble BD992 GNSS Receiver

Trimble BD992 GNSS Receiver Configuration Packet	
Packet ID	197
Length	85

Trimble BD992 GNSS Receiver Configuration Packet				
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 10.5.16.3 GNSS Frequency Bitfields .
3	9	fp32	4	PDOP threshold - the Position Dilution of Precision to achieve a fix
4	13	fp32	4	TDOP threshold - The Time dilution of Precision to achieve a fix
5	17	u8	1	Elevation mask (degrees) - Minimum elevation of the satellite that will be used when calculating fix
6	18	u8	1	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	SBAS corrections enabled
8	20	u8	1	10.5.16.4 L Band Modes
9	21	u32	4	L band frequency (Hz)
10	25	u32	4	L band baud rate
11	29	u32	4	Primary antenna type
12	33	u32	4	Secondary antenna type
13	37	u8	1	10.5.16.5 L Band Satellite IDs - this refers to the satellite name
14	38		47	Reserved

Table 156: Trimble BD992 GNSS Receiver Configuration Packet

10.5.16.3 GNSS Frequency Bitfields

Each GNSS frequency is a field that contains 8 bits that indicate whether a particular frequency is enabled for a constellation. These are boolean fields with a zero indicating false and a one indicating true. The table below provides a description of each bit, which is a combination of a constellation name and its frequency.

Bit	Description
0	GPS L1CA
1	GPS L1C
2	GPS L1P
3	GPS L2C
4	GPS L2P
5	GPS L2M

Bit	Description
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
17	BEIDOU B1
18	BEIDOU B2
19	BEIDOU B3
20	GALILEO E1
20	GALILEO E5A
22	GALILEO E5B
23	GALILEO E5AB
24	GALILEO E6
25	QZSS L1CA
25	QZSS L1SAIF
26	QZSS L1C
27	QZSS L2C
28	QZSS L5
29	QZSS LEX
30	SBAS L1CA

10.5.16.4 L Band Modes

L Band Mode	L Band Mode Name
0	Disabled
2	Omnistar Auto
3	Omnistar HP
4	Omnistar XP
5	Omnistar VBS

L Band Mode	L Band Mode Name
8	Omnistar G2
9	Omnistar HP+G2
10	Omnistar HP+XP
11	Trimble RTX
13	Omnistar L1 Only
14	Omnistar G4 Only
15	Omnistar G2+ Only
16	Omnistar G4+ Only

Table 157: L Band Modes

10.5.16.5 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 158: L Band Satellite IDs

10.5.17 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

User Data Packet				
Field #	Bytes Offset	Data Type	Size	Description
1	0		64	User Data

Table 159: User Data Packet

10.5.18 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 160: GPIO Input Configuration Packet

10.5.19 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
2	2	u32	4	TCP/UDP IP Address
3	6	u16	2	TCP/UDP Port
4	8	u8	1	10.5.19.1 IP Dataport Mode
+				Fields 2-4 Repeat 3 times (a total of 4 copies) for each of the 4 data ports

Table 161: IP Dataports Configuration Packet

10.5.19.1 IP Dataport Mode

Value	Description
0	MODE_NONE
1	Reserved
2	MODE_TCP_SERVER
3	MODE_TCP_CLIENT
4	MODE_UDP

Table 162: IP Dataport Mode

10.5.20 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	u8	4	Reserved (set to zero)

Table 163: CAN Configuration Packet

10.5.20.1 CAN Protocol

Value	Description
0	CANopen

Table 164: CAN Protocol

11 Reference Information

This chapter is a learning reference that briefly covers knowledge essential to understanding Certus and INS generally. It explains the following concepts in simple terms so that people unfamiliar with the technology may understand it:

- [11.1 Technology Overview](#), including Global Navigation Satellite System (GNSS) , Inertial Navigation System (INS) and Attitude and Heading Reference System (AHRS)
- [11.2 The Sensor Co-ordinate Frame](#)
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11.1 Technology Overview

11.1.1 GNSS

GNSS stands for Global Navigation Satellite System. A GNSS consists of a set of satellites in medium Earth orbit that broadcast navigation signals with a common operator. These navigation signals can be picked up by a GNSS receiver on the earth to estimate that receiver's position and velocity. For a long time the only operational GNSS was the United States GPS. However, the Russian GLONASS, the Chinese BeiDou GNSS, and the European Union's Galileo GNSS are fully operational.

GNSS provides a fairly accurate absolute position (down to 1.2 metres without assistance and as low as 8 mm with) and velocity (as low as 0.007 metres/second). The main drawback of GNSS is that the receiver must have a clear signal from at least 4 satellites to function. GNSS signals are very weak and struggle to penetrate through buildings, trees and other objects obstructing an uninterrupted view of the sky. GNSS can also occasionally drop out due to disturbances in the upper atmosphere, or the presence of jammers.

11.1.2 AHRS

AHRS stands for Attitude and Heading Reference System. An AHRS uses accelerometers, magnetometer data and gyroscopes combined in a mathematical algorithm to provide orientation. Orientation consists of the three body angles roll, pitch and heading.

11.1.3 INS

INS stands for Inertial Navigation System. An inertial navigation system can provide position and velocity similar to GNSS but with some major differences. The principle of inertial navigation is the measurement of acceleration, which is then integrated into velocity. The velocity is then further integrated to estimate position. Due to noise in the measurement and the compounding of that noise through the integration steps, inertial navigation has an error that increases exponentially over time. Inertial navigation systems have a very low relative error over short time periods but over long time periods the error can increase enormously.

11.1.4 GNSS/INS

By combining GNSS and INS together in a mathematical algorithm, it is possible to take advantage of the benefits of the long-term precision of GNSS and the short-term accuracy of inertial sensors. This provides an

enhanced position and velocity solution that can withstand GNSS drop outs.

11.2 The Sensor Co-ordinate Frame

Inertial sensors have 3 different axes: X, Y and Z and these determine the references around which angles and accelerations are measured. It is very important to align these axes correctly in installation, otherwise the system won't work correctly.

These axes are marked on the top of the device as shown in [Figure 75: Certus Axes](#) below, with the X axis pointing in the direction of the connectors, the Z axis pointing down through the base of the unit and the Y axis pointing off to the right.

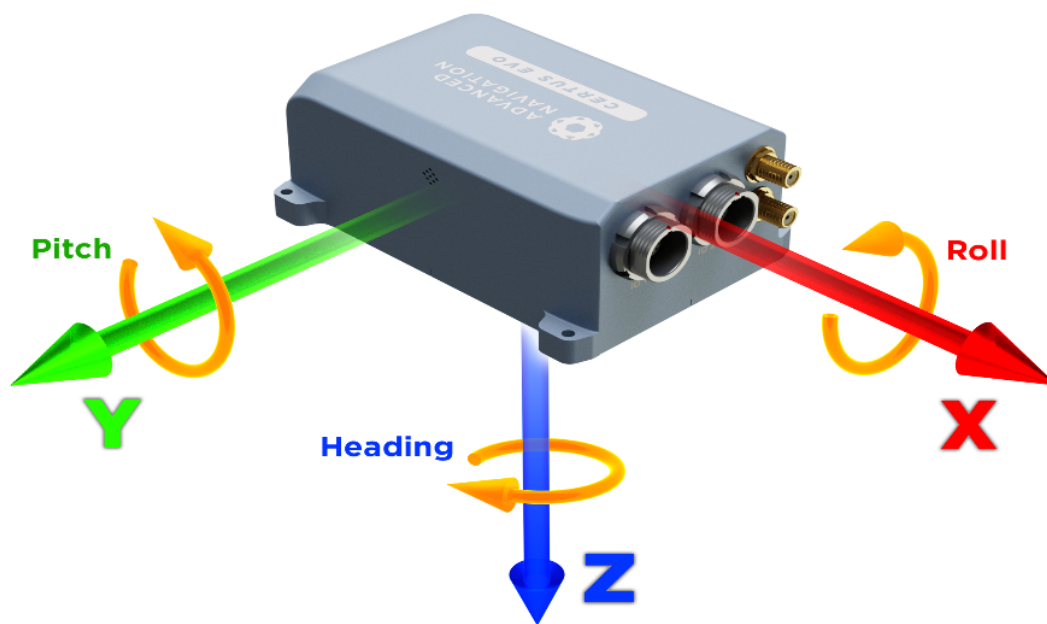


Figure 75: Certus Axes

11.2.1 Right Hand Rule

When installed in an application the X axis should be aligned such that it points forwards and the Z axis aligned so that it points down when the system is level. A good way to remember the sensor axes is the right hand rule, which is visualised in [Figure 76: First Right-hand Rule](#).

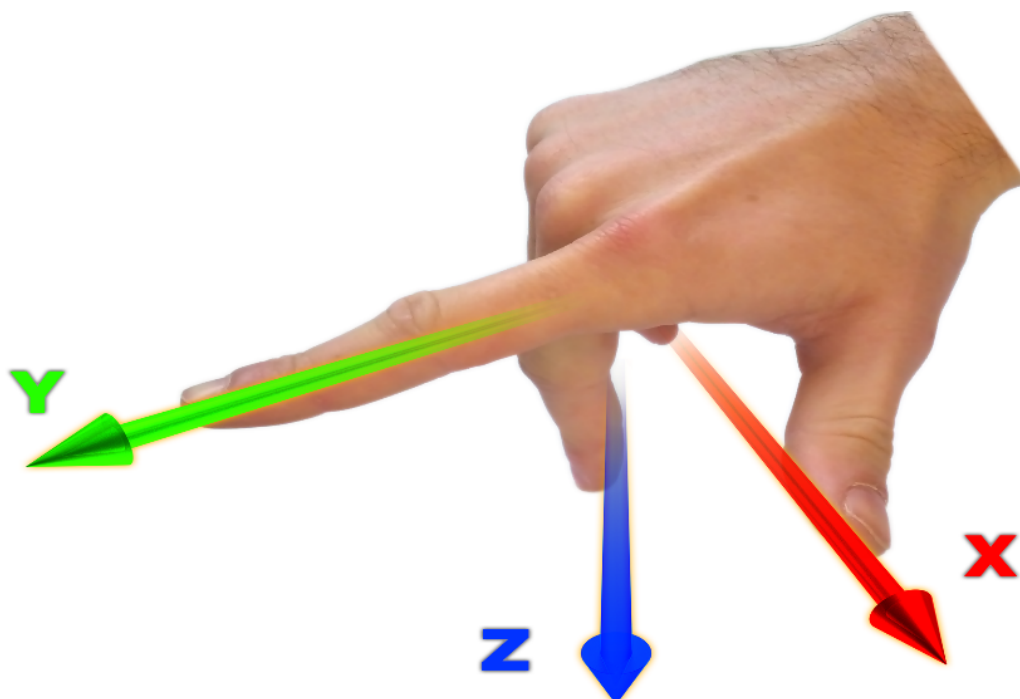


Figure 76: First Right-hand Rule

You take your right hand and extend your thumb, index and middle. Your thumb then denotes the positive X axis, your index denotes the positive Y axis and your middle denotes the positive Z axis.

11.3 The Body Co-ordinate Frame

Also known as the vehicle co-ordinate (reference) frame, this can be described most easily using a car (the body or vehicle) as an example. The forward direction of travel for a car is the positive X axis, out to the right of the car is the positive Y axis, and down is the positive Z axis. The distinction between the sensor co-ordinate frame and the body co-ordinate frame becomes important when the INS device is not mounted with its axes aligned to the vehicle axes, for example when the INS is mounted with a 90 degree heading rotation. Offset measurements, which are described later in this document, will always be in the body co-ordinate frame to remove any INS alignment variations. Generally any data output by the INS using the X, Y and Z axes will be using the body co-ordinate frame.

11.4 Roll, Pitch and Heading

Orientation can be described by the three angles roll, pitch and heading: these are known as the Euler angles. The rotation axes of roll, pitch and heading are shown visually in [Figure 75: Certus Axes](#). The arrow indicates the positive rotation direction.

Roll is the angle around the X axis and is zero when the unit is level. Pitch is the angle around the Y axis and is zero when the unit is level. Heading is the angle around the Z axis and is zero when the positive X axis is pointing to true north.

11.4.1 Second Right Hand Rule

The two right hand rules are often the best way to memorise the sensor axes and directions of positive rotation. The first right hand rule gives the positive axis directions and is described in [11.2 The Sensor Co-ordinate Frame](#). The second right hand rule shown in the figure below provides the direction of positive rotation. To use

it, point your thumb in the positive direction of that axis, then the direction that your fingers curl over shows the positive rotation on that axis.

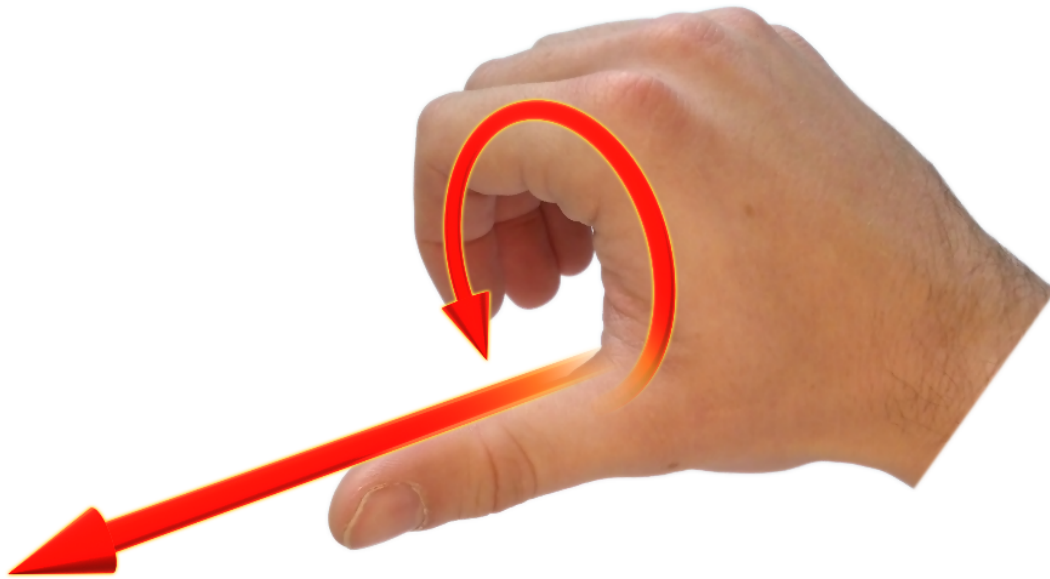


Figure 77: Second right Hand Rule

11.4.2 Rotation Order

When multiple axes are rotated, to imagine the final orientation the three rotations must be performed in the order heading first, then pitch and then roll. To deduce the final orientation the unit should first be considered level with the X axis pointing north and the Z axis pointing down. Heading is applied first, then pitch is applied and finally roll is applied to give the final orientation. This can be hard for some people to grasp at first and is often best learned experimentally by rotating Certus with your hand whilst watching the orientation plot in real time on the computer.

11.5 Geodetic Co-ordinate System

The geodetic co-ordinate system is the most popular way of describing an absolute position on the Earth. It is made up of two angles, latitude and longitude, combined with a height relative to an ellipsoid.

11.5.1 Latitude and Longitude

Latitude is the angle that specifies the north to south position of a point on the Earth's surface, reported as $\pm 90^\circ$. Longitude is the angle that specifies the east to west position of a point on the Earth's surface, reported as $\pm 180^\circ$. The line of zero latitude is the equator, and the line of zero longitude is the prime meridian. See [Figure 78: Latitude and longitude represented visually to describe a position on an ellipsoid](#).

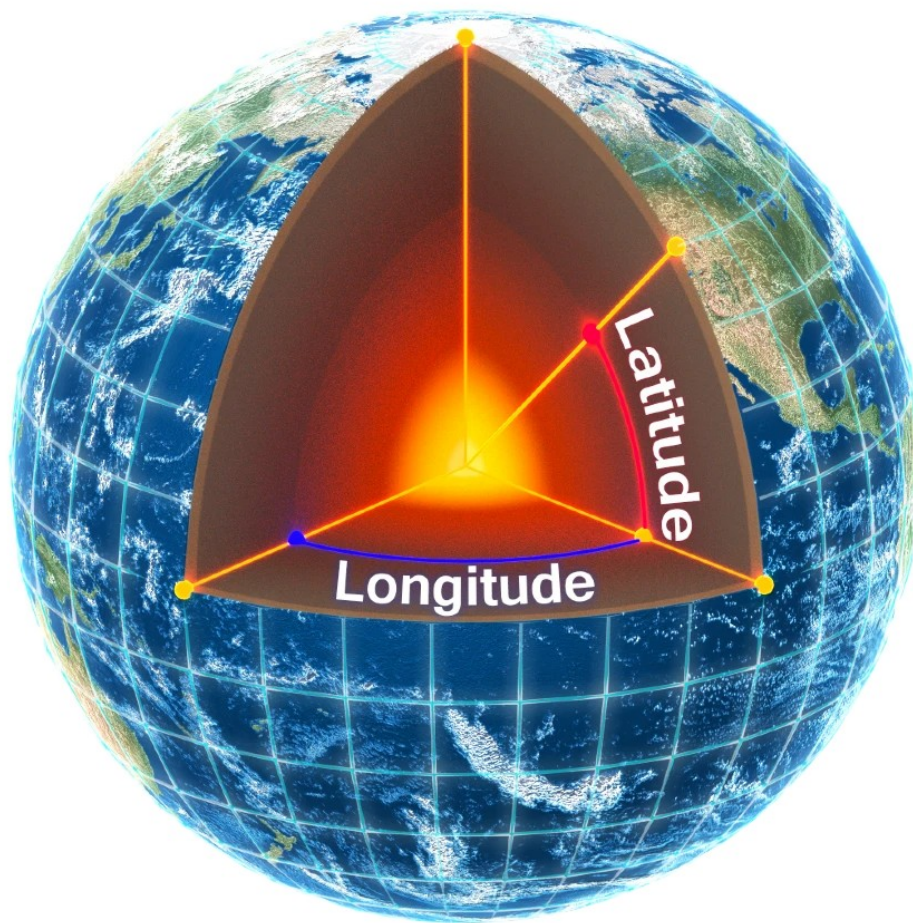


Figure 78: Latitude and longitude represented visually to describe a position on an ellipsoid

The figure below shows latitude and longitude on a map of the world, represented with a standard Mercator projection.

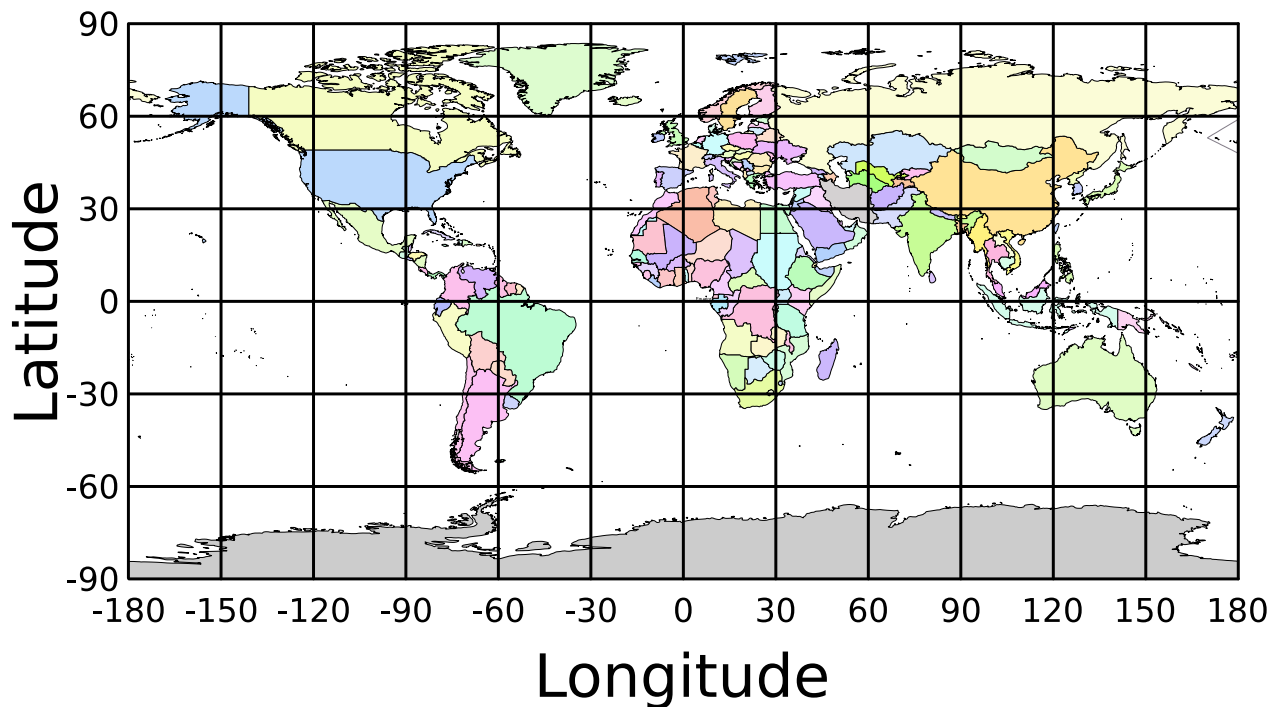


Figure 79: World map showing latitudes and longitudes

Latitude and longitude give the 2D point on the surface of the Earth. These are combined with height to give the 3D position on the Earth.

11.5.2 Height

Any height data output by Advanced Navigation devices is the height referenced the WGS84 reference ellipsoid. The WGS84 reference ellipsoid is a smooth mathematical model that approximates the form of the surface of the earth. The ellipsoid height (as used by GNSS) is not referenced to mean sea level; the height from the EGM96 geoid (orthometric height) approximates the height above mean sea level (MSL).

See [Figure 80: Orthometric, ellipsoid and geoid height diagram](#) below for a visual representation of geoid height, ellipsoid height and orthometric height (height above mean sea level).

Note:

Ellipsoid height refers to the height of a point of interest referenced to the WGS84 reference ellipsoid.
Geoid height refers to the height of the EGM96 geoid referenced to the WGS84 reference ellipsoid at a point of interest.

Orthometric height is the height at a point of interest referenced to the EGM96 geoid.

All heights can be either positive or negative dependant upon direction from the reference surface.

$$H = h - N$$



Figure 80: Orthometric, ellipsoid and geoid height diagram

The value required to convert the WGS84 ellipsoid height to orthometric height can be found in the geoid height packet, see [10.4.34 Geoid Height Packet](#).

11.6 NED Co-ordinate Frame

The NED (North East Down) co-ordinate frame is used to express velocities and relative positions. The origin of the co-ordinate frame is the current position. From that origin, the north axis points true north and parallel to the line of latitude at that point. The east axis points perpendicular to the north axis and parallel to the line of longitude at that point. The down axis points directly down towards the centre of the Earth. See the figure below for a graphical representation of the NED co-ordinate frame at a position on the Earth.

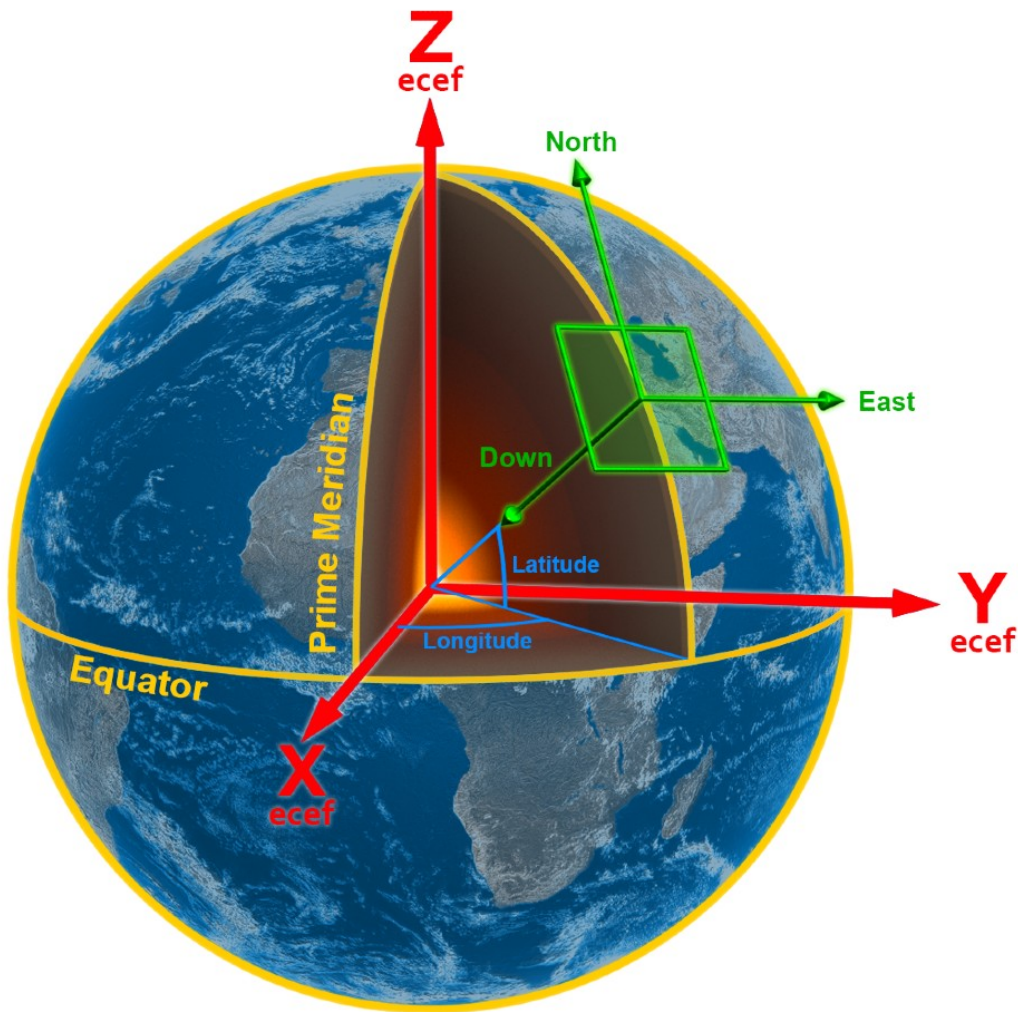


Figure 81: Graphic Showing Geodetic, NED and ECEF Co-ordinates

11.7 ECEF Co-ordinate Frame

The ECEF (Earth-centred earth-fixed) co-ordinate frame is a Cartesian co-ordinate frame used to represent absolute positions on the Earth. Its origin is at the centre of the Earth. ECEF is an alternative to the geodetic co-ordinate frame. It is represented by the three axes X, Y and Z which are presented graphically in [Figure 81: Graphic Showing Geodetic, NED and ECEF Co-ordinates](#). ECEF positions can be retrieved from Advanced Navigation products, however the geodetic system is used as the default.