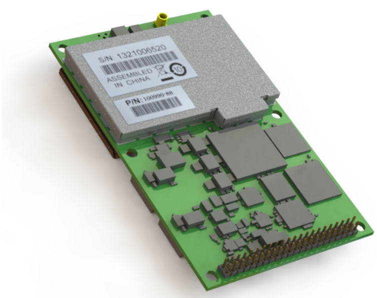
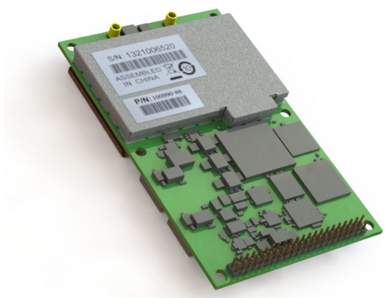
BD990/BD992/BD992-INS/BX992

GNSS and Inertial Receiver Modules

USER GUIDE



BD990



BD992/BD992_INS

BX992

Version 5.32
Revision C
April 2018

TRANSFORMING THE WAY THE WORLD WORKS

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Legal Notices

Support for Galileo is developed under a license of the European Union and the European Space Agency (BD910/BD920/BD930/BD935/BD940/BD970/BD982/BX935/BX982).

Release Notice

This is the April 2018 release (Revision C) of the BD99x Series and BX992 GNSS Receiver Module User Guide. It applies to version 5.32 of the receiver firmware.

Contents

1

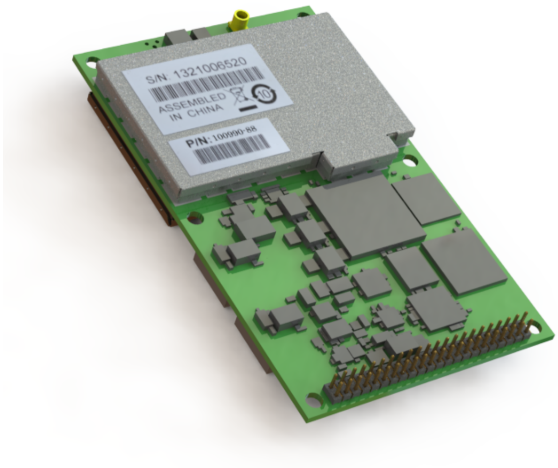
Introduction

This manual describes how to set up, configure, and use the Trimble® BD992, BD992-INS, and BX992 GNSS receiver module. The receiver uses advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

About the BD990 GNSS receiver

The Trimble BD990 receiver is part of a family of receivers that support advanced functionality. In the same mechanical footprint and pin-out as the Trimble BD970, industry professionals trust Trimble embedded positioning technologies as the core of their precision applications. Moving the industry forward, the Trimble BD990 redefines high-performance positioning.

This receiver is used for a wide range of precise positioning and navigation applications. These uses include unmanned vehicles and port and terminal equipment automation, and any other application requiring reliable, centimeter-level positioning at a high update rate and low latency.



The receiver offers centimeter-level accuracy based on carrier phase RTK and submeter accuracy code-based solutions.

Automatic initialization and switching between positioning modes allow for the best position solutions possible. Low latency (less than 20 ms) and high update rates give the response time and accuracy required for precise dynamic applications.

The receiver can be configured as an autonomous base station (sometimes called a reference station) or as a rover receiver (sometimes called a mobile receiver). Streamed outputs from the receiver provide detailed information, including the time, position, heading, quality assurance (figure of merit) numbers, and the number of tracked satellites. The receiver also outputs a one pulse-per-second (1 PPS) strobe signal which lets remote devices precisely synchronize time.

Designed for reliable operation in all environments, the receiver provides a positioning interface to an office computer, external processing device, or control system. The receiver can be controlled through a serial, ethernet, USB, or CAN port using binary interface commands or the web interface.

About the BD992 GNSS receiver

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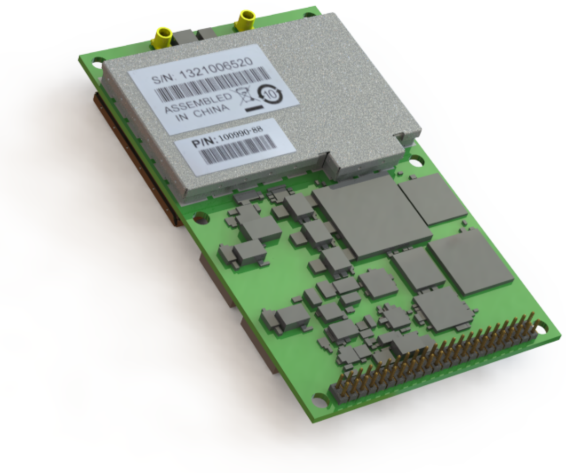

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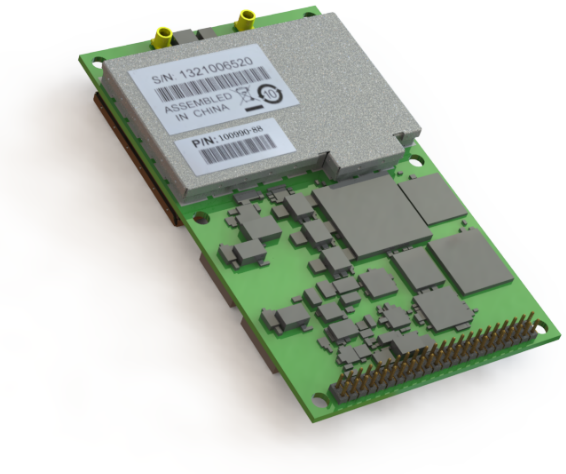
Designed for reliable operation in all environments, the receiver provides a positioning interface to an office computer, external processing device, or control system. The receiver can be controlled through a serial, ethernet, USB, or CAN port using binary interface commands or the web interface.

About the BD992-INS GNSS receiver

The Trimble® BD992-INS receiver contains a powerful multi-constellation, multi-frequency GNSS receiver with on-board integrated inertial sensors. Taking advantage of Trimble's expertize in both GNSS and Inertial technology the BD992-INS receiver has been designed for applications requiring continuous centimeter accuracy in a compact package. By integrating inertial sensors on the same module, robust high accuracy positions are produced in all environments. A simple intuitive web interface and interface protocol allows a variety of dynamic models to be supported.



The GNSS components are fully shielded. This design ensures that the high quality signals are protected from the sources of EMI on the host platform.

The BD992-INS supports both the triple frequency for the GPS and GLONASS constellations, and the dual frequency from BeiDou and Galileo. As the number of satellites in the constellations grows, the BD992-INS is ready to take advantage of the additional signals. This delivers the quickest and most reliable RTK initializations for 1 to 2 centimeter positioning. For applications that do not require centimeter accuracy, the BD992-INS integrated GNSS-Inertial engine delivers high accuracy GNSS/DGNSS positions in the most challenging environments such as urban canyons.

Different configurations are available. These include everything from a DGPS L1 unit through to a four-constellation triple-frequency RTK unit. Choose the configuration that suits your requirements. All features are password-upgradeable, allowing functionality to be upgraded as your requirements change.

The receiver also supports Fault Detection and Exclusion (FDE) and Receiver, and Autonomous Integrity Monitoring (RAIM) for safety-critical applications.

Key features include:

- High update rate position and orientation solutions
- Continuous positioning in GNSS denied environments
- Lever arm calculation from antenna to navigation point of interest
- Robust Moving Baseline RTK for precision landing on moving platforms
- Single antenna heading not influenced by magnetic field variations

About the BX992 receiver

The BX992 receiver enclosure allows OEM and system integrator customers to rapidly integrate high accuracy GNSS into their applications. The single-board BX992 is ideal as either a base station or a rover. The two-board model (the BX960-2) is suited for applications that require precise heading in addition to positions.

The receiver provides reliable operation in all environments, and a positioning interface to an office computer, external processing device, or control system. You can control the receiver through a serial or Ethernet port using binary interface commands or web interface.

About the Trimble Maxwell 7 technology

The Trimble BD990/BD992 GNSS products and the INS variant supports triple-frequency for the GPS, GLONASS, BeiDou and Galileo constellations. As the number of satellites in the constellations grows the receiver is ready to take advantage of the additional signals. This delivers the quickest and most reliable RTK initializations for centimeter positioning. With the latest Trimble Maxwell™ 7 Technology, the receivers provide:

- 336 tracking channels
- Trimble EVEREST™ Plus multipath mitigation
- Advanced RF Spectrum Monitoring and Analysis
- Proven low-elevation tracking technology

With the option of utilizing OmniSTAR or RTX services, the GNSS receivers delivers varying levels of performance down to centimeter level without the use of a base station.

Flexible interfacing

The BD990 and BD992 GNSS products are designed for easy integration and rugged dependability. Customers benefit from the Ethernet connectivity available on the board, allowing high speed data transfer and configuration via standard web browsers. USB and RS-232 are also supported. Just like other Trimble embedded technologies; easy to use software commands simplify integration and reduce development times.

Different configurations of the module are available. These include everything from a DGPS L1 unit all the way to a four-constellation triple-frequency RTK unit. All features are password-upgradeable, allowing functionality to be upgraded as your requirements change.

Typical applications

The receiver can be used in a multitude of applications that require robust high precision positioning. The receiver can be used within systems being developed for:

- Precision agriculture
- Autonomous vehicles
- Unmanned aircrafts
- Field robotics
- Machine guidance and control
- Timing

- Construction
- GNSS heading and attitude measurements for marine equipment

The receiver can be set up and installed as:

- an on-board GNSS rover in SBAS DGPS mode.
- an on-board GNSS rover connected to an external communication device (radio, GPRS, CDMA) and used in DGPS, Flying RTK or RTK mode.
- a low-cost solution for vector determination applications.
- a relative positioning combined with an absolute RTK position (machine guidance and control).
- a relative movement monitoring, heave compensation, wing deformation, and so forth.

Features

The following features are applicable to these receivers.

Technical specifications

- Trimble Maxwell™ 7 technology
- On-board Advanced MEMS inertial sensors (applicable to BD992-INS and BX992 only)
- 336 tracking channels
  - GPS: L1 C/A, L2E, L2C, L5
  - BeiDou: B1, B2
  - GLONASS: L1 and L2 C/A, L3 CDMA13
  - Galileo2: E1, E5A, E5B, E5AltBOC
  - IRNSS L5
  - QZSS: L1 C/A, L1 SAIF, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-Band: OmniSTAR, Trimble RTX
- High precision multiple correlator for GNSS pseudorange measurements
- Trimble EVEREST™ Plus multipath mitigation
- Advanced RF Spectrum Monitoring and Analysis
- Unfiltered, unsmoothed pseudorange measurement data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- Reference outputs/inputs: CMR, CMR+™, sCMRx, RTCM 2.1, 2.2, 2.3, 2.4, 3.0, 3.112, 3.2.

  NOTE – The functionality to input or output any of these corrections depends on the installed options.

  NOTE – Different manufacturers may have established different packet structures for their correction messages. Thus, the receiver may not receive corrections from another manufacturer's receiver, and another manufacturer's receiver may not be able to receive corrections from the receiver.

- Navigation outputs:
  - ASCII: NMEA-0183: GBS; GGA; GLL; GNS; GRS; GSA; GST; GSV; HDT; LLQ; AVR; GDP; DTM; BPQ; GGK; PJK; PJT; VGK; VHD; RMC; ROT; VTG; ZDA.
  - Binary: Trimble GSOF, NMEA 2000

  NOTE – Galileo support is developed under a license of the European Union and the European Space Agency.

  NOTE – There is no public GLONASS L3 CDMA ICD. The current capability in the receivers is based on publicly available information. As such, Trimble cannot guarantee that these receivers will be fully compatible.
- 1 pulse-per-second (1PPS) output
- Event Marker Input support
- Supports Fault Detection and Exclusion (FDE), Receiver Autonomous Integrity Monitoring (RAIM)

Communication

- 1 USB 2.0 device port
- 1 LAN Ethernet port
- All functions are performed through a single IP address simultaneously—including web interface access and raw data streaming
- Network protocols supported:
  - HTTP (web interface)
  - NTP Server
  - NMEA, GSOF, CMR over TCP/IP or UDP
  - NTripCaster, NTripServer, NTripClient
  - mDNS/uPnP Service discovery
  - Dynamic DNS
  - eMail alerts
  - Network link to Google Earth
  - Support for external modems through PPP
  - RDNIS support
- 2 x RS-232 ports (baud rates up to 460,800)
- 1 x CAN port

- Control Software: HTML web browser, Internet Explorer, Firefox, Safari, Opera, Google Chrome

Default settings

All settings are stored in application files. The default application file, Default.cfg, is stored permanently in the receiver, and contains the factory default settings. Whenever the receiver is reset to its factory defaults, the current settings (stored in the current application file, Current.cfg) are reset to the values in the default application file.

These settings are defined in the default application file.

Function	Settings	Factory default
SV Enable	-	All SVs enabled
General Controls	Elevation mask	10°
	PDOP mask	99
	RTK positioning mode	Low Latency
	Motion	Kinematic
Ports	Baud rate	38,400
	Format	8-None-1
	Flow control	None
Input Setup	Station	Any
NMEA/ASCII (all supported messages)		All ports Off
Streamed Output		All types Off
		Offset=00
RT17/Binary		All ports Off
Reference Position	Latitude	0°
	Longitude	0°
	Altitude	0.00 m HAE
Antenna	Type	Unknown
	Height (true vertical)	0.00 m
	Measurement method	Antenna Phase Center
1PPS		Disabled
Event Ports		Disabled

If a factory reset is performed, the above defaults are applied to the receiver. The receiver also returns to a DHCP mode, and security is enabled (with a default login of admin and the password of password). To perform a factory reset:

- From the web interface, select Receiver Configuration / Reset and then clear the Clear All Receiver Settings option.
- Send the Command 58h with a 03h reset value.
- Use the Configuration Toolbox utility and from the Communications menu, select Reset Receiver. Select both the Erase Battery-Backed RAM and Erase File System options.

BD990 and BD992 flavors

All the flavors are configured to output at 20 Hz. 50 Hz or 100 HZ are available as an upgrade.

											RTK	
BD990	BD992	Heading	MSS	GPS	GLONASS	Galileo	Beidou	L1	L2	L5	Base	Rover
100990-01 [1]	100992-01 [1]											
100990-02 [2]	100992-02 [2]		✓	✓				✓				
100990-03 [3]	100992-03 [3]		✓	✓				✓			✓	✓
100990-04 [4]	100992-04 [4]		✓	✓				✓			✓	✓
100990-05 [5]	100992-05 [5]		✓	✓				✓	✓	✓		✓
100990-06 [6]	100992-06 [6]		✓	✓				✓	✓	✓		✓
100990-07 [4]	100992-07 [4]		✓	✓				✓	✓	✓		✓
100990-08 [4]	1009902-08 [4]		✓	✓				✓	✓	✓	✓	✓
100990-22 [2]			✓	✓	✓			✓				
100990-23 [3]			✓	✓	✓			✓			✓	✓
100990-24 [4]			✓	✓	✓			✓	✓	✓	✓	✓
100990-25 [5]			✓	✓	✓			✓	✓	✓		✓

[1] Unconfigured

[2] Autonomous/SBAS

[3] DGPS

[4] RTK 1 cm

[5] 30 cm limit

[6] 10 cm limit

BD992-INS and BX992 flavors

All the flavors are configured to output at 20 Hz. 50 Hz or 100 HZ are available as an upgrade.

											RTK	
BD990	BD992	Heading	MSS	GPS	GLONASS	Galileo	Beidou	L1	L2	L5	Base	Rover
100990-01 [1]	100992-01 [1]											
100990-02 [2]	100992-02 [2]		✓	✓				✓				
100990-03 [3]	100992-03 [3]		✓	✓				✓			✓	✓
100990-04 [4]	100992-04 [4]		✓	✓				✓			✓	✓
100990-05 [5]	100992-05 [5]		✓	✓				✓	✓	✓		✓
100990-06 [6]	100992-06 [6]		✓	✓				✓	✓	✓		✓
100990-07 [4]	100992-07 [4]		✓	✓				✓	✓	✓		✓
100990-08 [4]	1009902-08 [4]		✓	✓				✓	✓	✓	✓	✓
100990-22 [2]			✓	✓	✓			✓				
100990-23 [3]			✓	✓	✓			✓			✓	✓
100990-24 [4]			✓	✓	✓			✓	✓	✓	✓	✓
100990-25 [5]			✓	✓	✓			✓	✓	✓		✓

[1] Unconfigured

[2] Autonomous/SBAS

[3] DGPS

[4] RTK 1 cm

[5] 30 cm limit

[6] 10 cm limit

Receiver hardware and accessories

The following support hardware and accessories can be ordered for the BD990, BD992, and BD992-INS:

Part number	Description
112076-00	Trimble BD99x Evaluation Kit (receiver not included)
105679-00-B	Trimble BD99x Interface board
A02503	18 V Power Supply, 3 Ah
A02584	CBL ASSY TNC-MMCX

The following support hardware and accessories can be ordered for the BX992:

Part number	Description
A02503	18 V Power Supply, 3 Ah
57168-INT	DB26 to DB9, Ethernet and Power adapter
77070-00-INT	Cable DB26 to Power, 1PPS, DB9F, DB9M, USB, RJ45M

Evaluation kit

For system integrators/evaluators, Trimble offers an evaluation kit for the BD990, BD992, and BD992-INS receivers. This kit comes with a specially designed board that can mate with the receiver. Once mated, the evaluation board provides the integrator or tester with a platform to gain an in-depth understanding of the receiver. It also allows for development of custom applications that can effectively implement the precision GNSS information that the receiver is capable of outputting. The evaluation board gives access to the following;

- Power connector
- Four serial ports through 2 × DB9 and 2 × USB Type-B connectors
- Ethernet through 1 × RJ45 connector
- Three USB ports through 2 × Type-A and 1 × Type-B receptacles
- Three LEDs to indicate satellite tracking, receipt of corrections and power

For more information, see Evaluation Board, page 44.

Upgrade options

The following support hardware and accessories apply to all the receivers.

Part number	Description
106781-01	Trimble BD990 Configuration Field Upgrade 1
106782	50 Hz Output Rate Field Upgrade
106783	100 Hz Output Rate Field Upgrade (applicable only to BD992-INS and BX992)
106784	GLONASS Field Upgrade
106785	Galileo Field Upgrade
106786	BeiDou Field Upgrade

For details about ordering these upgrades for your receiver, please email GNSSOEMSales@trimble.com. Your regional sales manager would be happy to assist you in upgrading your receiver with the options of your choice.

Compatible antennas

It is always recommended that a Trimble tested and compatible Trimble antenna is used with the receivers. You may use other antennas but ensure that these antennas support the correct frequencies enabled on the receiver. Furthermore, be aware of the minimum LNA gain on the receivers is 31 dB.

The following list shows a list of recommended antennas and their part numbers.

P/N	Description
105000-50-INT	Zephyr™ Model 3, L1/L2/L5 Rover
115000-50-INT	Zephyr Model 3 L1/L3/L5 Base
C02817	L1/L2 Aviation Antenna (TSO Certified)
C02992	Trimble AV59 L1/L2/L5/G1/G2/L-Band Aviation Antenna (Not TSO Certified)
C03167	Trimble LV59 L1/L2/L5/G1/G2/ L-Band Antenna (Not TSO Certified) 5/8 Mount
105728	Trimble AV39 L1/L2/L5/G1/G2/ L-Band Aviation Antenna Antenna (TSO Certified/US sales)
105728-10	Trimble AV39 L1/L2/L5/G1/G2/ L-Band Aviation Antenna Antenna (TSO Certified/Non US sales)
112735	Trimble AV28 L1/L2/L5 L-band Aviation Antenna
83553	Trimble AV33 L1/G1 Aviation Antenna
86362	Trimble AV34 L1/L2/G1/G2 Aviation Antenna
99038-00-INT	Trimble AG25 L1/L2/L5/G1/G2/ L-Band Antenna
99810-30-INT	Trimble GA810 GNSS L-Band Antenna
44830-00-INT	Trimble GA830 GNSS L-Band Antenna

The following cables and accessories may be purchased with the antenna:

P/N	Description
58957-05-INT	5 m TNC-TNC Antenna Cable
A02500	10 m TNC-TNC Antenna Cable 1
92296-10-INT	10 m TNC-TNC LMR400 Antenna Cable
A02501	30 m TNC-TNC Antenna Cable
A02584	CBL ASSY TNC-MMCX
F00922	Zephyr Mounting Bracket
84902	AV33/34 Antenna Bracket
86693	Mag mount with 5/8" x 11 bolt

Technical support

If you have a problem and cannot find the information you need in the product documentation, send an email to GNSSOEMSupport@trimble.com.

Documentation, firmware, and software updates are available at: www.intech.trimble.com/support/oem_gnss/receivers/trimble.

2

Specifications

This chapter details the specifications for the receiver.

Specifications are subject to change without notice.

Positioning specifications

NOTE – The following specifications are provided at 1 sigma level when using a Trimble Zephyr 2 antenna. These specifications may be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

BD990/BD992

Feature		Specification	
Initialization time		Typically <8 seconds	
Initialization accuracy		>99.9%	
Mode	**Accuracy**	**Latency (at max. output rate)**	**Maximum Rate**
Single Baseline RTK (<30 km)	0.008 m + 1 ppm horizontal	<20 ms	50 Hz
	0.015 m + 1 ppm vertical		
DGPS	0.25 m + 1 ppm horizontal	<20 ms	50 Hz
	0.5 m + 1 ppm vertical		
SBAS[1]	0.5 m horizontal	<20 ms	50 Hz
	0.85 m vertical		
Autonomous	1.00 m horizontal	<20 ms	50 Hz
	1.5 m vertical		

[1] GPS only and depends on SBAS system performance. FAA WAAS accuracy specifications are <5m 3DRMS.

Performance specifications

NOTE – The Time to First Fix specifications are typical observed values. A cold start is when the receiver has no previous satellite (ephemerides/almanac) or position (approximate position or time) information. A warm start is when the ephemerides and last used position is known.

BD990 and BD992

Feature	Specification	
Time to First Fix (TFF)	Cold Start	<45 seconds
	Warm Start	<30 seconds
	Signal Re-acquisition	<2 seconds
Velocity Accuracy[1]	Horizontal	0.007 m/sec
	Vertical	0.020 m/sec
Maximum Operating Limits[2]	Velocity	515 m/sec
	Altitude	18,000 m
Acceleration	11 g	
RTK initialization time	Typically <8 seconds	
RTK initialization reliability	>99%	
Position latency	<20 ms	
Maximum position/attitude update rate	50 Hz	

[1] 1 sigma level when using a Trimble Zephyr 2 antenna. These specifications may be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

[2] As required by the US Department of Commerce to comply with export licensing restrictions.

BD992-INS and BX992

Feature	Specification		
Initialization time	Typically <8 seconds		
Initialization accuracy	>99.9%		
Mode	**Accuracy**	**Latency (at max. output rate)**	**Maximum rate**
Single Baseline RTK (<30 km)	0.008 m + 1 ppm horizontal	<20 ms	50 Hz
	0.15 m + 1 ppm vertical		
DGPS	0.25 m + 1 ppm horizontal	<20 ms	50 Hz
	0.5 m + 1 ppm vertical		
	0.5° True Heading		
SBAS[1]	0.5 m horizontal	<20 ms	50 Hz
	0.85 m vertical		
Autonomous	1.00 m horizontal	<20 ms	50 Hz
	1.50 m vertical		
INS-Autonomous	1.00 m horizontal	<20 ms	50 Hz
	1.50 m vertical		
	roll/pitch	0.1°	
	Heading 2 m Baseline	0.09°	
INS-SBAS	0.50 m horizontal	<20 ms	50 Hz
	0.85 m vertical		
	roll/pitch	0.1°	
	Heading 2 m Baseline	0.09°	

[1] As required by the US Department of Commerce to comply with export licensing restrictions.

Feature	Specification		
INS-DGNSS	0.40 m horizontal	<20 ms	50 Hz
	0.60 m vertical		
	roll/pitch	0.1°	
	Heading 2 m Baseline	0.09°	
INS-RTK	0.05 m horizontal	<20 ms	50 Hz
	0.03 m vertical		
	roll/pitch	0.1°	
	Heading 2 m Baseline	0.09°	

Physical and electrical characteristics

<table>
<tr><th>Feature</th><th>BD990</th><th>BD992/BD992-INS</th><th>BX992</th></tr>
<tr><td>Dimensions (L × W × H)</td><td colspan="2">100 mm × 60 mm × 11.6 mm</td><td>185 mm × 93 mm × 43 mm</td></tr>
<tr><td>Power</td><td colspan="2">3.3 V DC +5%/–3%
Typically, 1.45 W (L1/L2 GPS)
Typically, 1.55 W (L1/L2 GPS and G1/G2 GLONASS)
Typically, 2.35 W (L1/L2/L5 GPS, G1/G2 GLONASS, B1/B2 BeiDou, L1/E5 Galileo)</td><td>9 V to 30 V DC external power input with over-voltage protection
Maximum 4.1 W (with both antennas connected)</td></tr>
<tr><td>Weight</td><td>54 grams</td><td>62 grams</td><td>.75 kg</td></tr>
<tr><td>Connectors - I/O</td><td colspan="2">44-pin Header</td><td>2 × DB9
1 × DB26</td></tr>
<tr><td>Connectors - Antenna</td><td>1 × MMCX receptacle</td><td>2 × MMCX receptacles</td><td>TNC Female</td></tr>
<tr><td>Antenna LNA Power Output</td><td colspan="3">Input voltage: 3.3 to 5 V DC
Maximum current: 400 mA</td></tr>
<tr><td>Minimum required LNA gain</td><td colspan="3">32 dB
NOTE – This receiver is designed to operate with the Zephyr Model 2 antenna which has a gain of 50 dB. Higher-gain antennas have not been tested.</td></tr>
</table>

Environmental specifications

Feature	Specification
Temperature	Operating: -40 °C to 75 °C (-40 °F to 167 °F)
	Storage: -55 °C to 85 °C (-67 °F to 185 °F)
Vibration	MIL810F, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL810D +/- 40 g operating +/- 75 g survival
Operating humidity	5% to 95% R.H. non-condensing, at +60 °C (140 °F)

Communication specifications

Feature	Specification
Communications	1 LAN port Supports links to 10BaseT/100BaseT networks. All functions are performed through a single IP address simultaneously including web interface access and data streaming.
	2 × RS-232 ports Baud rates up to 460,800 1 USB 2.0 port
Receiver position update rate	1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz, and 50 Hz positioning
Correction data input	CMR, CMR+™, sCMRx, RTCM 2.0–2.4, RTCM 3.x, 3.2
Correction data output	CMR, CMR+, sCMRx, RTCM 2.0 DGPS (select RTCM 2.1), RTCM 2.1–2.4, RTCM 3.x, 3.2
Data outputs	1PPS, NMEA, Binary GSOF, ASCII Time Tags

Receiver pinout information

BD990/BD992/BD992-INS 44-pinout connector

Pin	Usage	Integration notes
1	GND	
2	RTK LED	
3	Power Switch ***	Low = on, High = off, 1 Mohm pulldown
4	PPS Out	
5	Power In	3.3 VDC
6	Power In	3.3 VDC
7	COM3 RX or CAN RX or EVENT 1	3.3 V level, multiplexed
8	EVENT 0	
9	Power LED	
10	Satellite LED	
11	COM2 CTS	3.3 V level
12	RESET IN ***	Low = reset, NC = normal function, 100 k pullup
13	COM2 RTS	3.3 V level
14	COM2 RX	3.3 V level
15	COM1 CTS RS232	RS-232 level
16	COM2 TX	3.3 V level
17	COM1 RTS RS232	RS-232 level
18	COM1 RX RS232	RS-232 level
19	COM3 TX or CAN TX	3.3 V level, multiplexed
20	COM1 TX RS232	RS-232 level
21	USB DM	
22	USB DP	

Pin	Usage	Integration notes
23	GND	
24	GND	
25	RESERVED	USB ID
26	RESERVED	USB VBUS
27	ETHERNET RD-	
28	ETHERNET RD+	
29	NC	
30	ETHERNET TD+	
31	ETHERNET TD-	
32	NC	
33	VOUT	3.3 VDC
34	NC	
35	RESERVED	I2C SCL
36	RESERVED	I2C SDA
37	DMI1	
38	DMI2	
39	GND	
40	GND	
41	10 MHz in	
42	Enable external 10 MHZ	High = external enabled, low or NC = internal TCXO enabled. 10 k pulldown
43	IMU LED	
44	GND	

44-pin connector details

MFG: SAMTEC

P/N: TMM-122-03-S-D

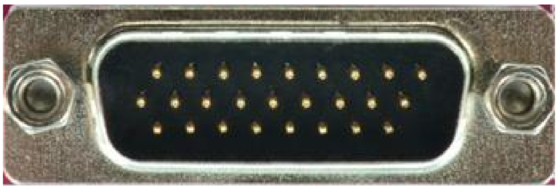
Recommended mating connector

MFG: SAMTEC

P/N: SQW-122-01-L-D

BX992 connectors

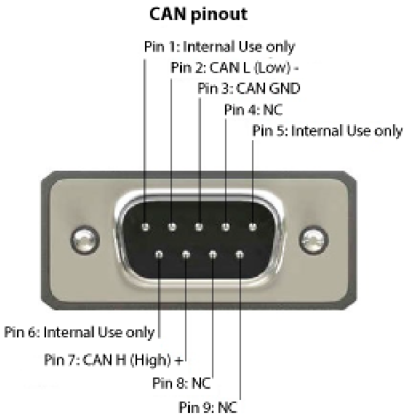
DB26 pin out connector



Pin	Usage
1	Power OFF (disconnected)
2	Clear to send (CTS) input for COM Port 2
3	Event 0 input
4	Event 1 input
5	Not connected
6	Common ground
7	Transmit data for COM Port 1
8	Receiver data for COM Port 1
9	USB +
10	Ethernet ground (ET GND RJ45 Pin 4)
11	Ready to send (RTS) output for COM Port 2
12	Transmit data for COM Port 2
13	Ethernet spare (ET GND RJ45 Pin 5)
14	Ethernet spare (ET GND RJ45 Pin 8)
15	USB ID
16	Ethernet receive data- (RD- RJ45 Pin 6)
17	Ethernet transmit data- (TD- RJ45 Pin 2)

Pin	Usage
18	USB D-
19	USB Power
20	1PPS
21	Receive data for COM Port 2
22	Ethernet ground (ET GND RJ45 Pin 7)
23	Common ground
24	DC power in, 9–28 V DC (Ground is Shell)
25	Ethernet receive data+ (RD+ RJ45 Pin 3)
26	Ethernet transmit data+ (TD+ RJ45 Pin 1)

DB9 pin out connector



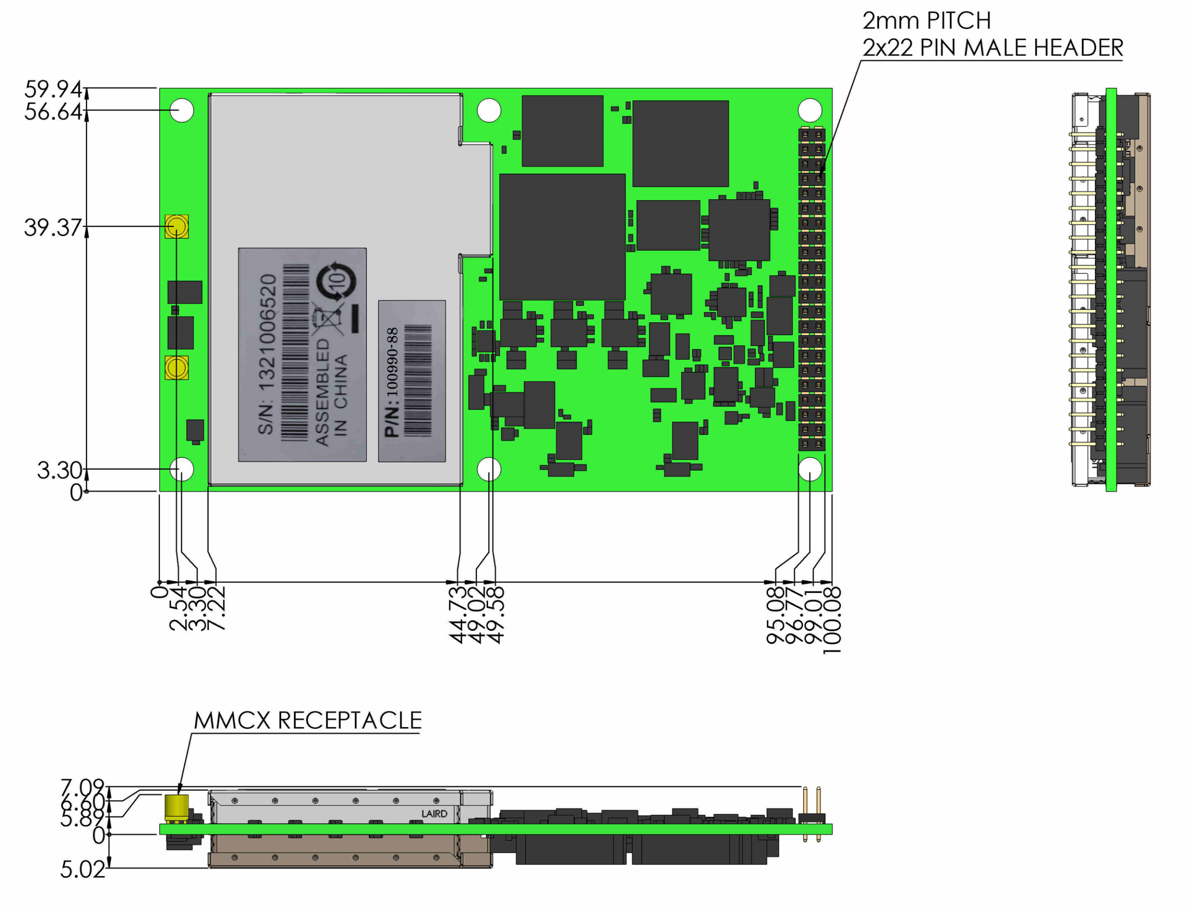
NOTE – The DB9 port on the BX992 is not mutliplexed to output RS-232 OR CAN. This port can only output CAN.

Mechanical specifications

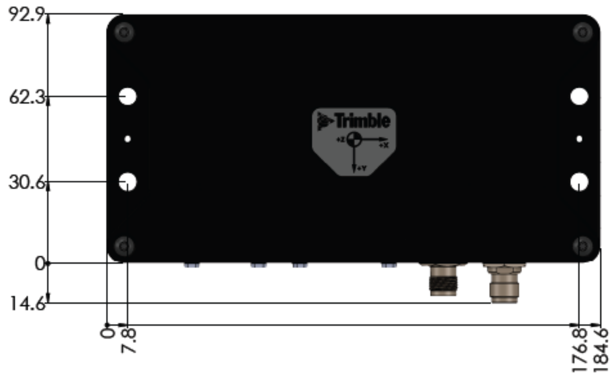
If you require a 3D CAD model of the module, please send a request to GNSSOEMSupport@trimble.com.

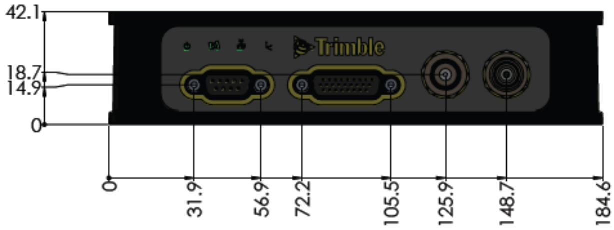
Board dimensions are similar between the BD990 and the BD992/BD992-INS. The key difference between the three receivers is the lack of a second MMCX receptacle on the BD990.

Below is an overview of key dimensions on the BD990/BD992/BD992-INS.



Below is an overview of key dimensions on the BX992.





Power input

Item	Description
Power requirement	The unit, excluding the antenna, operates at 3.3 V +5%/-3%. The 3.3 V should be able to supply 2.0 A of surge current. The typical power consumption based on band usage is: • L1/L2 GPS + GLONASS = 2.0 W • L1/L2/L5 GPS + GLONASS + BeiDou + Galileo = 2.5 W

3

Installation

Follow the guidelines in this chapter for installing and mounting the receiver.

Unpacking and inspecting the shipment

Visually inspect the shipping cartons for any signs of damage or mishandling before unpacking the receiver. Immediately report any damage to the shipping carrier.

Shipment carton contents

The shipment will include one or more cartons depending on the number of optional accessories ordered. Open the shipping cartons and make sure that all of the components indicated on the bill of lading are present.

Reporting shipping problems

Report any problems discovered after you unpack the shipping cartons to both Trimble Customer Support and the shipping carrier.

Trimble's customer support for the GNSS receiver can be reached at GNSSOEMsupport@trimble.com.

Installation guidelines

In order for the receivers to perform optimally, the following precautions should be taken or followed.

Considering environmental conditions

Install the receiver in a location situated in a dry environment. Avoid exposure to extreme environmental conditions. This includes:

- Water or excessive moisture
- Excessive heat greater than 75 °C (167 °F)
- Excessive cold less than –40 °C (–40 °F)
- Corrosive fluids and gases

Avoiding these conditions improves the receiver's performance and long-term product reliability.

Sources of electrical interference

Avoid the following sources of electrical and magnetic noise:

- Gasoline engines (spark plugs)
- Television and computer monitors
- Alternators and generators
- Electric motors
- Propeller shafts
- Equipment with DC-to-AC converters
- Fluorescent lights
- Switching power supplies

Mounting the antennas

Choosing the correct location for the antenna is critical for a high quality installation. Poor or incorrect placement of the antenna can influence accuracy and reliability and may result in damage during normal operation. Follow these guidelines to select the antenna location:

- If the application is mobile, place the antenna on a flat surface along the centerline of the vehicle.
- Choose an area with clear view to the sky above metallic objects.

- *Avoid* areas with high vibration, excessive heat, electrical interference, and strong magnetic fields.
- *Avoid* mounting the antenna close to stays, electrical cables, metal masts, and other antennas.
- *Avoid* mounting the antenna near transmitting antennas, radar arrays, or satellite communication equipment.

Connecting the antenna cable

1. After mounting the antenna, route the antenna cable from the GPS antenna to the receiver.

   Avoid the following hazards when routing the antenna cable:

   - Sharp ends or kinks in the cable
   - Hot surfaces (such as exhaust manifolds or stacks)
   - Rotating or reciprocating equipment
   - Sharp or abrasive surfaces
   - Door and window jams
   - Corrosive fluids or gases

2. After routing the cable, connect it to the receiver. Use tie-wraps to secure the cable at several points along the route. For example, to provide strain relief for the antenna cable connection, use a tie-wrap to secure the cable near the base of the antenna.

   NOTE – When securing the cable, start at the antenna and work towards the receiver.

3. When the cable is secured, coil any slack. Secure the coil with a tie-wrap and tuck it in a safe place.

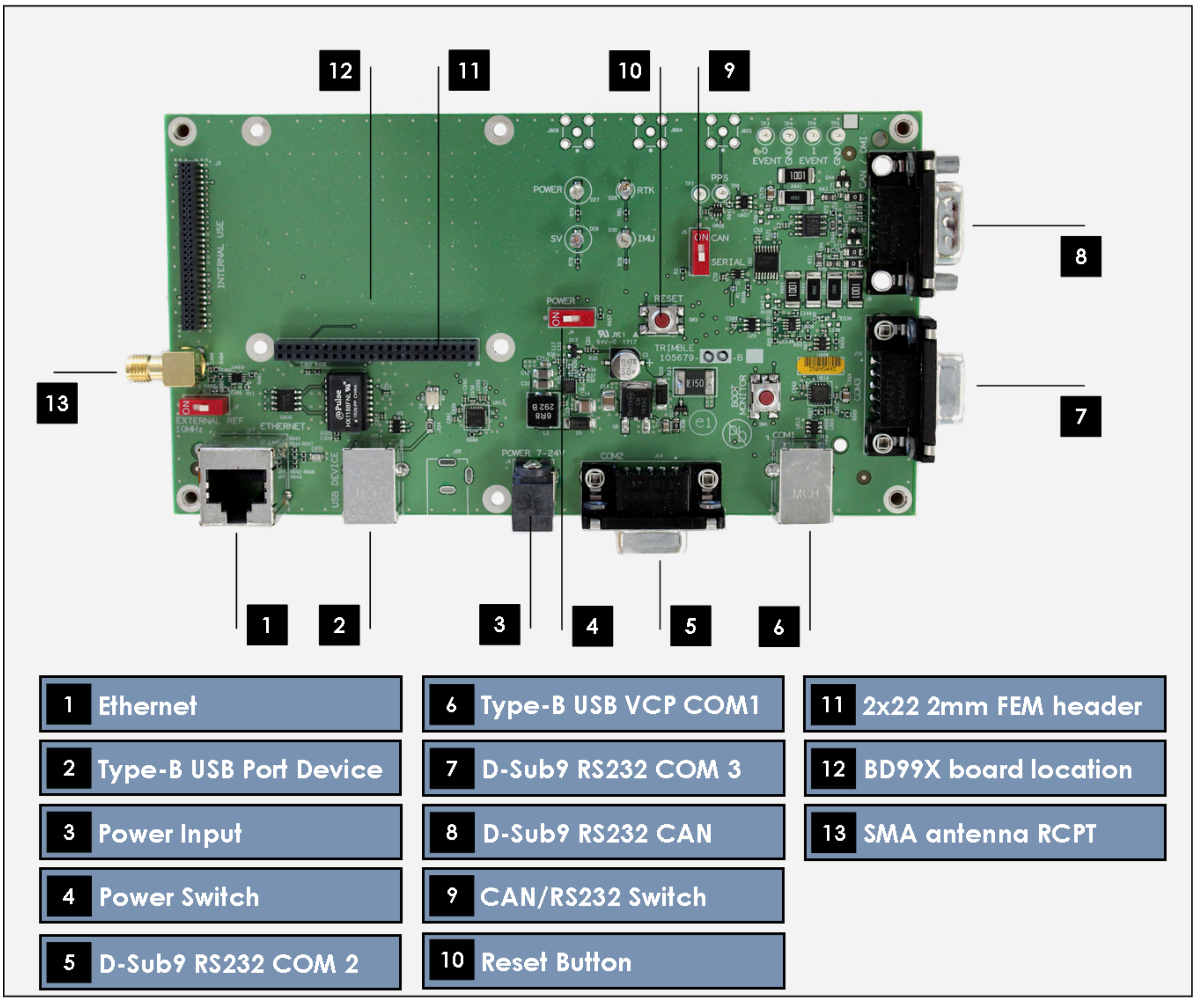
4

Evaluation Board

This chapter provides an overview of the evaluation board. An evaluation kit is available for testing the receiver. The evaluation board has three LEDs to indicate satellite tracking, RTK receptions, and power. The evaluation board also has a unique configuration to control the voltage sent to the antenna.

BD990/BD992/BD992-INS evaluation board layout

Current or prospective customers can obtain schematic drawings of the evaluation I/O board by contacting GNSSOEMSupport@trimble.com.



LED functionality and operation

The evaluation interface board comes with three LEDs to indicate satellite tracking, RTK reception, and power. The initial boot-up sequence for a receiver lights all the three LEDs for about three seconds followed by a brief duration where all three LEDs are off. Thereafter, use the following table to confirm tracking of satellite signals or for basic troubleshooting.

For single antenna configurations, the following LED patterns apply:

Power LED	RTK Corrections LED	SV Tracking LED	Status
On (continuous)	Off	Off	The receiver is turned on, but not tracking satellites.
On (continuous)	Off	Blinking at 1 Hz	The receiver is tracking satellites, but no incoming RTK corrections are being received.
On (continuous)	Blinking at 1 Hz	Blinking at 1 Hz	The receiver is tracking satellites and receiving incoming RTK corrections.
On (continuous)	Off or Blinking (receiving corrections)	Blinking at 5 Hz for a short while	Occurs after a power boot sequence when the receiver is tracking less than 5 satellites and searching for more satellites.
On (continuous)	Blinking at 1 Hz	Off	The receiver is receiving incoming RTK corrections, but not tracking satellites.
On (continuous)	Blinking at 5 Hz	Blinking at 1 Hz	The receiver is receiving Moving Base RTK corrections at 5 Hz.
On (continuous)	On (continuous)	Blinking at 1 Hz	The receiver is receiving Moving Base RTK corrections at 10 or 20 Hz (the RTK LED turns off for 100 ms if a correction is lost).
On (continuous)	On, Blinking off briefly at 1 Hz	Blinking at 1 Hz	The receiver is in a base station mode, tracking satellites and transmitting RTK corrections.
On	Blinking at 1 Hz	On	The receiver is in Boot Monitor

Power LED	RTK Corrections LED	SV Tracking LED	Status
(continuous)		(continuous)	Mode. Use the WinFlash utility to reload application firmware onto the board. For more information, contact technical support.

BD992-INS IMU LED

The BD992-INS evaluation board has an additional LED that functions only when a BD992-INS is plugged in. This blue led shows the IMU status. The following table shows the different modes of this LED:

IMU navigation status	LED behavior
Signal status unknown or no GNSS/INSS solution	LED is off
Coarse leveling	LED blinks at 5 Hz
Degraded solution	LED blinks at 2 Hz
Aligned solution	LED blinks at 1 Hz

5

GNSS and RTK Basics

In order to understand how to set up Trimble's GNSS and inertial systems, this chapter describes the basics of the different protocols, various terminologies, and concepts that are used.

Autonomous GNSS

Autonomous or standalone GNSS operation uses radio signals from GNSS satellites alone. No other sources of augmentation or correction are used in the position computation. While this is theoretically the poorest accuracy mode of GNSS, recent improvements in satellite orbits and receiver performance result in positions close to one meter in accuracy. Autonomous GNSS provides robust positioning as it is does not rely on the reception of data from secondary data links.

SBAS

The receiver supports SBAS (Satellite Based Augmentation Systems) that conform to RTCA/DO-229C, such as WAAS, EGNOS, or MSAS. The receiver can use the WAAS (Wide Area Augmentation System) set up by the FAA (Federal Aviation Administration). WAAS was established for flight and approach navigation for civil aviation. WAAS improves the accuracy, integrity, and availability of the basic GPS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico.

SBAS can be used in surveying applications to improve single point positioning when starting a reference station, or when an RTK radio corrections link is down. SBAS corrections should be used to obtain greater accuracy than autonomous positioning, not as an alternative to RTK positioning.

The SBAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is then broadcast on the L1 frequency, and is tracked using a channel on the BD9xx receiver, exactly like a GPS satellite.

For more information on WAAS, refer to the FAA home page at http://gps.faa.gov.

The receiver also contains an SBAS+ mode which allows it to use pseudoranges of satellites for which SBAS corrections are present as well as pseudoranges from uncorrected satellites in the position solution. The SBAS+ solution can minimize occurrences of the solution mode switching back and forth between SBAS and Autonomous solution modes; however, the SBAS+ position solution may perform more poorly at times because uncorrected satellites have an influence in the position solution.

NOTE – To receive SBAS corrections, you must be within the official service volume of that SBAS service. Receiver manufacturers often set SBAS correction volumes to be slightly larger than the ones specified by the respective SBAS service but this may depend on each receiver manufacturer. For example, Trimble receivers situated in the MSAS correction zones can use MSAS corrections between the latitudes 20 and 60 degrees North and between longitudes 110 and 150 degrees East. Hence, *receivers situated within this window will track and use MSAS while a receiver situated outside this window may track but not use MSAS corrections.*

DGPS/DGNSS

Differential GPS/GNSS encompasses a series of techniques that improves the relative accuracy of GNSS by referencing to a single or network of stations. In its most common form a fixed reference station broadcasts the difference between the measured satellite pseudorange and the calculated pseudorange. These differences or corrections are applied to the rover receiver pseudoranges to calculate a more accurate position. Accuracies at the decimeter level can be achieved.

RTK

Real-Time Kinematic (RTK) positioning is positioning that is based on at least two GPS receivers—a base receiver and one or more rover receivers. The base receiver takes measurements from satellites in view and then broadcasts them, together with its location, to the rover receiver(s). The rover receiver also collects measurements to the satellites in view and processes them with the base station data. The rover then estimates its location relative to the base.

The key to achieving centimeter-level positioning accuracy with RTK is the use of the satellite carrier phase signals. Carrier phase measurements are like precise tape measures from the base and rover antennas to the satellites. In the receiver, carrier phase measurements are made with millimeter-precision. Although carrier phase measurements are highly precise, they contain an unknown bias, termed the *integer cycle ambiguity*, or *carrier phase ambiguity*. The rover has to resolve, or initialize, the carrier phase ambiguities at power-up and each time the satellite signals are interrupted.

Carrier phase initialization

The receiver can automatically initialize the carrier phase ambiguities as long as at least five common satellites are being tracked at base and rover sites. *Automatic initialization* is sometimes termed *On-The-Fly (OTF)* or *On-The-Move (OTM)*, to reflect that no restriction is placed on the motion of the rover receiver throughout the initialization process.

The receiver uses L1 (or for dual-frequency receivers L1 and L2) carrier-phase measurements plus precise code-phase measurements to the satellites to automatically initialize the ambiguities. The initialization process generally takes a few seconds.

As long as at least four common satellites are continuously tracked after a successful initialization, the ambiguity initialization process does not have to be repeated.

TIP – Initialization time depends on baseline length, multipath, and prevailing atmospheric errors. To minimize the initialization time, keep reflective objects away from the antennas, and make sure that baseline lengths and differences in elevation between the base and rover sites are as small as possible.

Update rate and latency

The number of position fixes delivered by an RTK system per second also defines how closely the trajectory of the rover can be represented and the ease with which position navigation can be accomplished. The number of RTK position fixes generated per second defines the *update rate*. Update rate is quoted in Hertz (Hz). The maximum update rate will vary based on the receiver used and the options purchased, and will range between 5 Hz and 50 Hz.

Solution latency refers to the lag in time between when the satellite measurements were made and when the position was displayed or output. For precise navigation, it is important to have prompt position estimates, not values from 2 seconds ago. Solution latency is particularly important when guiding a moving vehicle. For example, a vehicle traveling at 25 km/h moves approximately 7 m/s. Thus, to navigate to within 1 m, the solution latency must be less than 1/7 (= 0.14) seconds. For BD9xx receivers, the latency is less than 0.03 seconds in low-latency mode.

With low-latency positioning, the rover receiver uses the last received base measurement and extrapolates this correction for up to 20 seconds. The receivers can also be put in synchronized mode where the rover waits until the base measurements have been received before it computes a position. This mode results in a slightly more accurate position, however the latency is higher due to the delay in receiving the base measurement.

Data link

The base-to-rover data link serves an essential role in an RTK system. The data link must transfer the base receiver carrier phase, code measurements, plus the location and description of the base station, to the rover.

The receiver supports two data transmission standards for RTK positioning: the Compact Measurement Record (CMR) format and the RTCM/RTK messages. The CMR format was designed by Trimble and is supported across all Trimble RTK products.

⚠ CAUTION – Mixing RTK systems from different manufacturers can result in degraded performance.

Factors to consider when choosing a data link include:

- Throughput capacity
- Range
- Duty cycle
- Error checking/correction
- Power consumption

The data link must support at least 4800 baud, and preferably 9600 baud throughput. Your Trimble representative can assist with questions regarding data link options.

Moving baseline RTK positioning

In most RTK applications, the reference receiver remains stationary at a known location, and the rover receiver moves. However, Moving Baseline RTK is an RTK positioning technique in which both reference and rover receivers can move. The receiver uses the Moving Baseline RTK technique to determine the heading vector between its two antennas. Internally raw code and carrier measurements from GPS and GLONASS satellites are processed at a rate up to 20 Hz when linking two independent receivers. The BD982 and BX982 can produce 50Hz moving baseline solutions.

Moving baseline RTK can be used in applications where the relative vector between two antennas is precisely known to centimeter level, while the absolute position of the antennas will depend on the accuracy of the positioning service it uses (RTK, OmniSTAR, RTX, DGPS, SBAS, or Autonomous).

Critical factors affecting RTK accuracy

The following sections present system limitations and potential problems that could be encountered during RTK operation.

Base station receiver type

⚠ CAUTION – Trimble recommends that you always use a Trimble base station with a BD9xx roving receiver. Using a non-Trimble base receiver can result in suboptimal initialization reliability and RTK performance.

The receiver uses a state-of-the-art tracking scheme to collect satellite measurements. The receiver is compatible with all other Trimble RTK-capable systems.

Base station coordinate accuracy

The base station coordinates should be known to within 10 m in the WGS-84 datum for optimal system operation. Incorrect or inaccurate base station coordinates degrade the rover position solution. It is estimated that every 10 m of error in the base station coordinates introduces one part per million error in the baseline vector. This means that if the base station coordinates have a height error of 50 m, and the baseline vector is 10 km, then the additional error in the rover location is approximately 5 cm, in addition to the typical specified error. One second of latitude represents approximately 31 m on the earth surface; therefore, a latitude error of 0.3 seconds equals a 10 m error on the earth's surface. The same part per million error applies to inaccuracies of the base station's latitude and longitude coordinates.

Number of visible satellites

A GNSS position fix is similar to a distance resection. Satellite geometry directly impacts the quality of the position solution estimated by the receiver. The Global Positioning System is designed so that at least 5 satellites are above the local horizon at all times. For many times throughout the day, as many as 8 or more satellites might be above the horizon. Because the satellites are orbiting, satellite geometry changes during the day, but repeats from day-to-day.

A minimum of 4 satellites are required to estimate user location and time. If more than 4 satellites are tracked, then an over-determined solution is performed and the solution reliability can be measured. The more satellites used, the greater the solution quality and integrity.

The Position Dilution Of Precision (PDOP) provides a measure of the prevailing satellite geometry. Low PDOP values, in the range of 4.0 or less, indicate good satellite geometry, whereas a PDOP greater than 7.0 indicates that satellite geometry is weak.

Even though only 4 satellites are needed to form a three-dimensional position fix, RTK initialization demands that at least 5 common satellites must be tracked at base and rover sites. Furthermore, L1 (and L2, for dual-frequency RTK) carrier phase data must be tracked on the 5 common satellites for successful RTK initialization. Once initialization has been gained, a minimum of 4 continuously tracked satellites must be maintained to produce an RTK solution.

When additional constellations such as GLONASS are tracked, one of the satellites will be used to resolve the timing offsets between that constellation and the GPS constellation. Tracking additional satellites will aid in the RTK solution.

Elevation mask

The elevation mask stops the receiver from using satellites that are low on the horizon. Atmospheric errors and signal multipath are largest for low elevation satellites. Rather than attempting to use all satellites in view, the receiver uses a default elevation mask of 10 degrees. By using a lower elevation mask, system performance may be degraded.

Environmental factors

Environmental factors that impact GPS measurement quality include:

- Ionospheric activity
- Tropospheric activity
- Signal obstructions
- Multipath
- Radio interference

High ionospheric activity can cause rapid changes in the GPS signal delay, even between receivers a few kilometers apart. Equatorial and polar regions of the earth can be affected by ionospheric activity. Periods of high solar activity can therefore have a significant effect on RTK initialization times and RTK availability.

The region of the atmosphere up to about 50 km is called the troposphere. The troposphere causes a delay in the GPS signals which varies with height above sea level, prevailing weather conditions, and satellite elevation angle. The receiver includes a tropospheric model which attempts to reduce the impact of the tropospheric error. If possible, try to locate the base station at approximately the same elevation as the rover.

Signal obstructions limit the number of visible satellites and can also induce signal multipath. Flat metallic objects located near the antenna can cause signal reflection before reception at the GPS antenna. For phase measurements and RTK positioning, multipath errors are about 1 to 5 cm. Multipath errors tend to average out when the roving antenna is moving while a static base station may experience very slowly changing biases. If possible, locate the base station in a clear environment with an open view of the sky. If possible use an antenna with a ground plane to help minimize multipath.

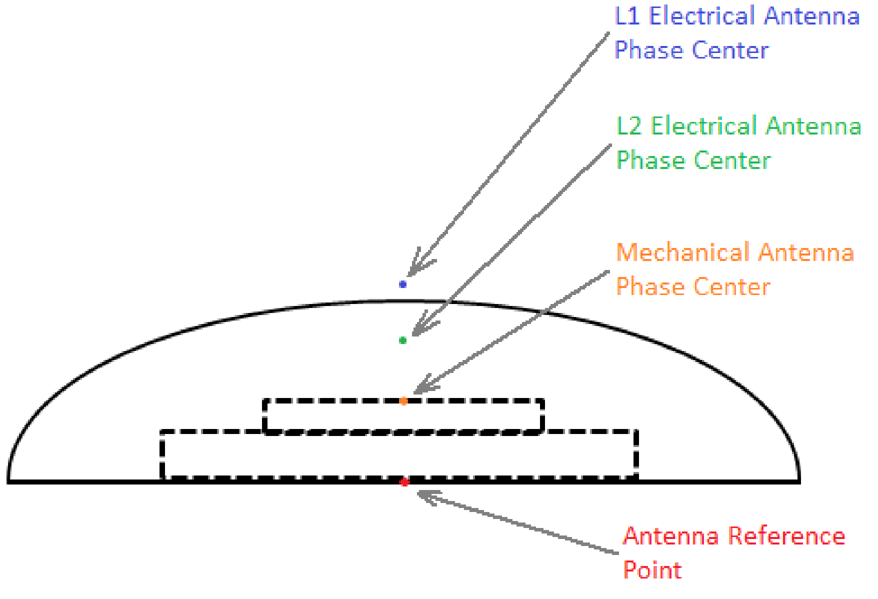
The receiver provides good radio interference rejection. However, a radio or radar emission directed at the GPS antenna can cause serious degradation in signal quality or complete loss of signal tracking. Do not locate the base station in an area where radio transmission interference can become a problem.

Operating range

Operating range refers to the maximum separation between base and rover sites. Often the characteristics of the data link determine the RTK operating range. There is no maximum limit on the baseline length for RTK with the receiver, but accuracy degrades and initialization time increases with range from the base. Specifications given for receivers specify the distance within which those specifications are valid, and specifications are not given beyond that range.

Antenna Phase Centers

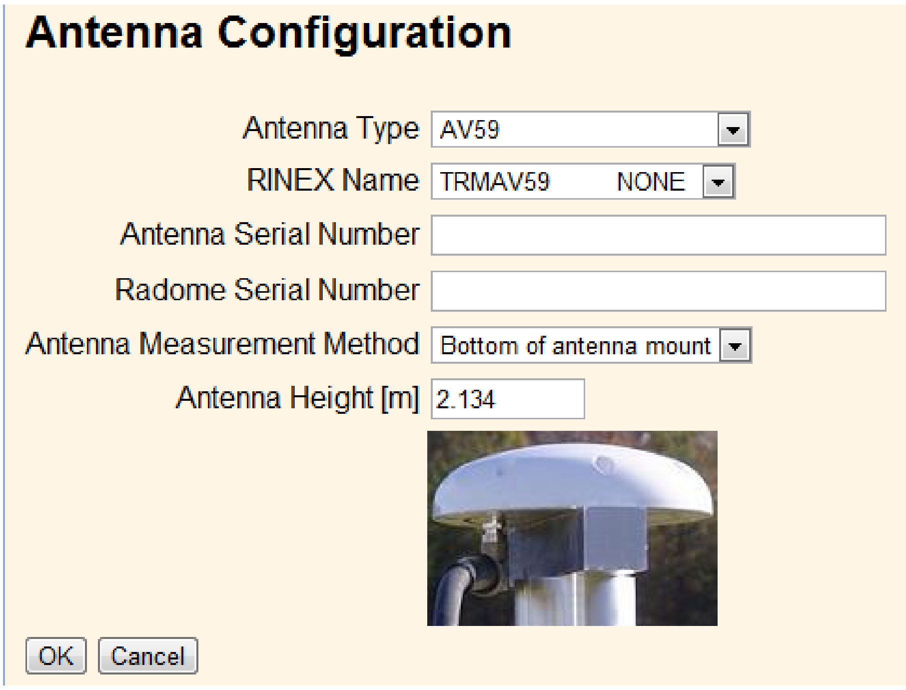
To understand Antenna Phase Centers (APC) and Antenna Reference Points (ARP), let's begin with a diagram of an antenna:



The ARP is typically the point on the centerline of the antenna at the mounting surface. Above the ARP is the Mechanical Antenna Phase Center, this is the physical point on the surface of the antenna element where the Antenna Phase Center electronics reside. The actual Antenna Phase Centers for L1 and L2 frequencies are points (or clouds) in space, typically above the Mechanical Antenna Phase Center.

The GNSS receiver reduces all of the measurements at the L1 and L2 Antenna Phase Centers to the Mechanical Antenna Phase Center. The GNSS receiver outputs the coordinates for the Mechanical Antenna Phase Center in all of its output measurements. If you wish to further reduce the output coordinates (for example, reduce them to the ARP), you must do this reduction in your software applications, taking into account factors such as tilt of the antenna.

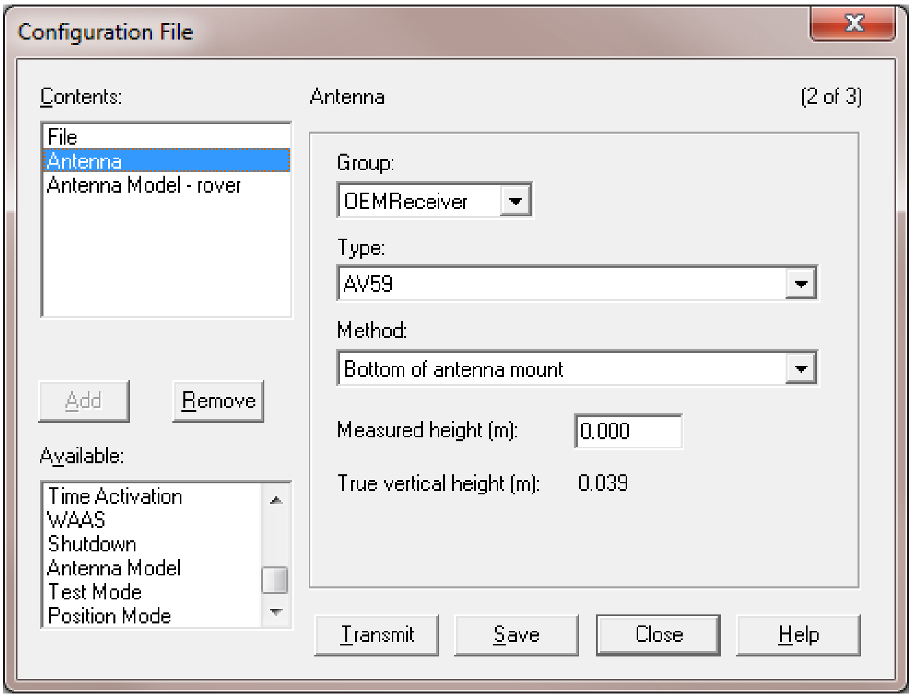
The GNSS receiver has an interface to setup the antenna type, antenna height, and antenna measurement method. The entered antenna height and antenna measurement method values are only applied when setting the GNSS receiver up as a base station, since the CMR or RTCM correction message outputs the coordinate of the base stations' Mechanical Antenna Phase Center. However, typically only the coordinates of the ground station which the antenna is setup over are known. Entering the antenna height and antenna measurement method enables the software to calculate the height of the Mechanical Antenna Phase Center above the ground station.



When the **Antenna Type** field is set, the value of the **RINEX Name** field is automatically set, and vice-versa.

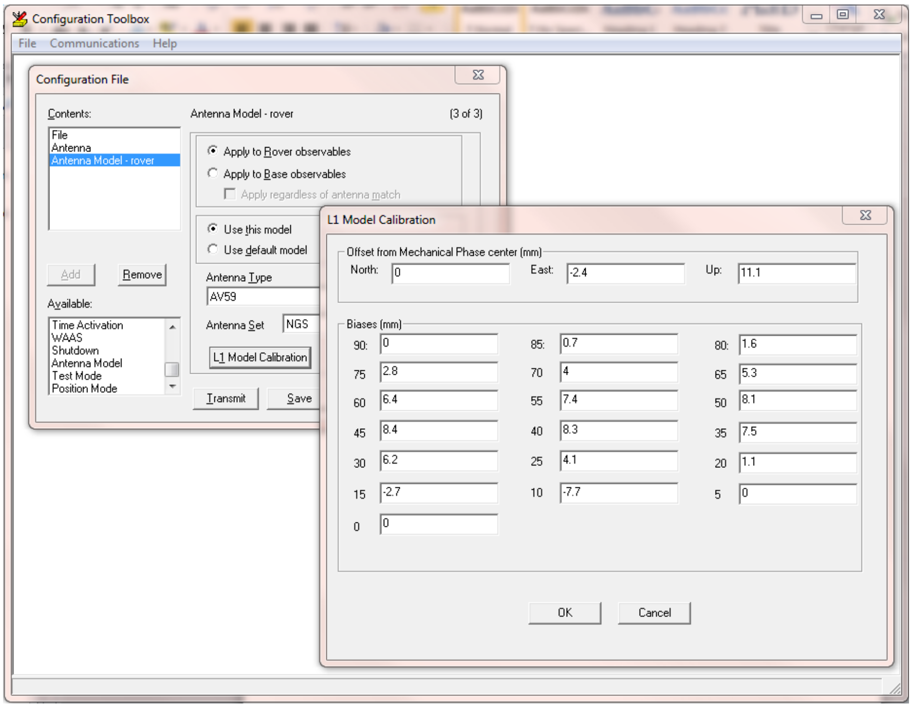
Setting the proper antenna type slightly improves the accuracy of the GNSS receiver, since the L1 and L2 Antenna Phase Center offsets are known and accounted for. In addition, the antenna model accounts for elevation-dependent biases of the antenna, so that the satellite tracking is corrected at various elevation angles.

If you want to know the offsets between the Antenna Reference Point and the various Antenna Phase Centers, Trimble recommends using the Configuration Toolbox software. In the Configuration Toolbox software, you can add the **Antenna** page and then select the antenna type:



If you select "Bottom of antenna mount" in the **Method** field, the **True vertical height** field shows the distance between the Antenna Reference Point and the Mechanical Antenna Phase Center.

If you want to understand the location of the L1 and L2 Antenna Phase Centers with respect to the Mechanical Antenna Phase Center, add the **Antenna Model** page and then select the antenna type. Click the **L1 Model Calibration** or **L2 Model Calibration** button to view the offsets and the elevation-dependent tracking biases:



These antenna calibrations are automatically used by the receiver when the correct antenna type is selected. You only need to add the **Antenna Model** page if you want to over-ride the antenna models. Trimble recommends using the default antenna models.

To download the most recent antenna models, go to http://www.trimble.com/trimbleconfiguration_ts.asp.

6

Quick Setup Guides

This section describes how to configure the receiver using the web interface and/or the Binary TrimComm commands.

It comprises the following sections:

1. Configuring the receiver as a base station
2. Configuring the receiver as a rover
3. Configuring the receiver as a moving base
4. Setting up input/output on Ethernet ports:
   - Using the AEh command to get the Ethernet configuration
   - Using the AEh command to get the virtual IP ports
   - Using the AEh command to get details on or set a virtual IP port

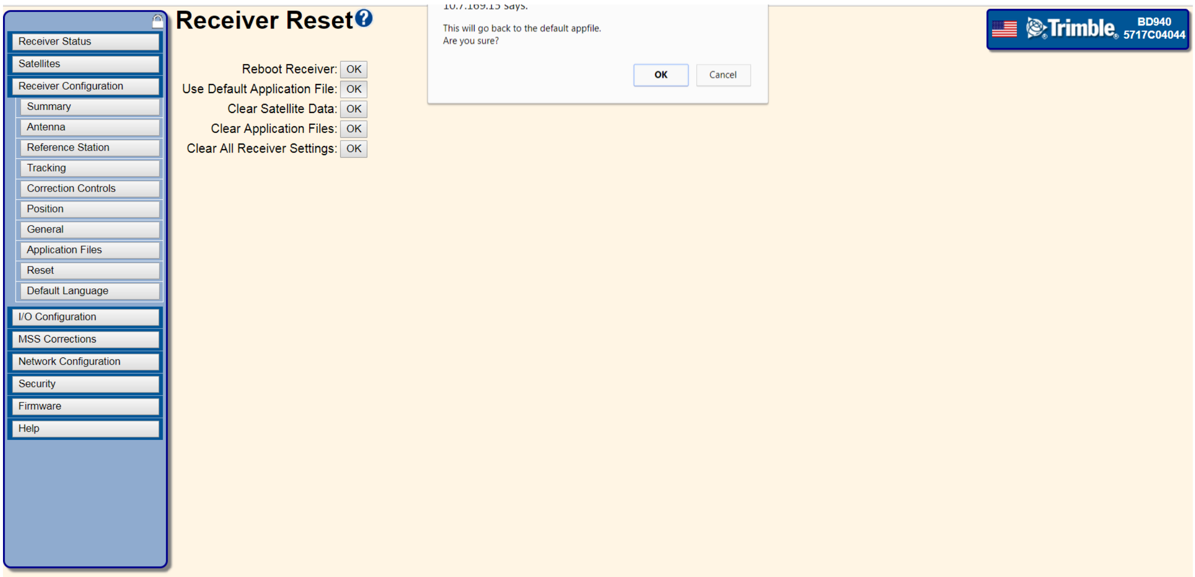
Related Sections:

- For a description of the web user interface, see the Receiver Web Interface, page 83.
- For the Binary Interface Control Document, refer to the *OEM GNSS Integrators Guide*.

Configuring the receiver as a base station

When setting up the base station, Trimble recommends the following steps:

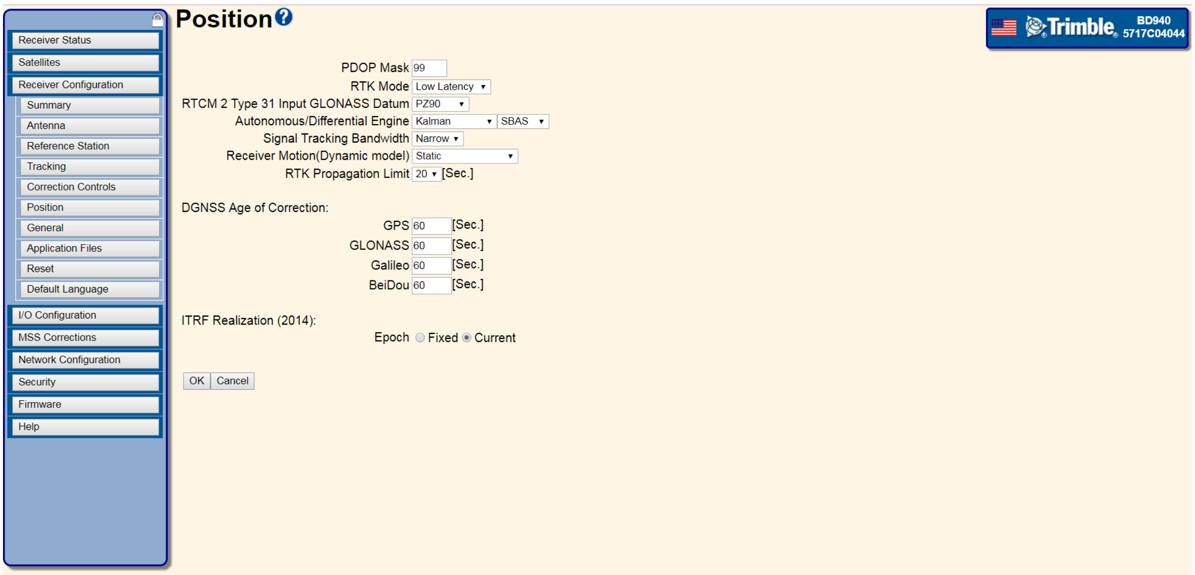
1. Reset the unit to use the default application file:



2. Once the receiver is reset itself, the web page will update itself to show a message that the reset is complete.

3. Set the **Operation Mode** field to Base and set the **1 PPS On/Off** field to Disable. Click **OK** to save the settings:

4. Set the **Receiver Motion** field to Static:



The 64h command to reset the receiver to defaults and put the unit into static mode is:

`02 00 64 0A 00 00 00 03 00 01 01 0A 01 01 7F 03`

Where:

`RECORD BYTES: 0A 01 01`

Decode as:

`RECORD TYPE: 10 (0Ah (10) Static Kinematic)`

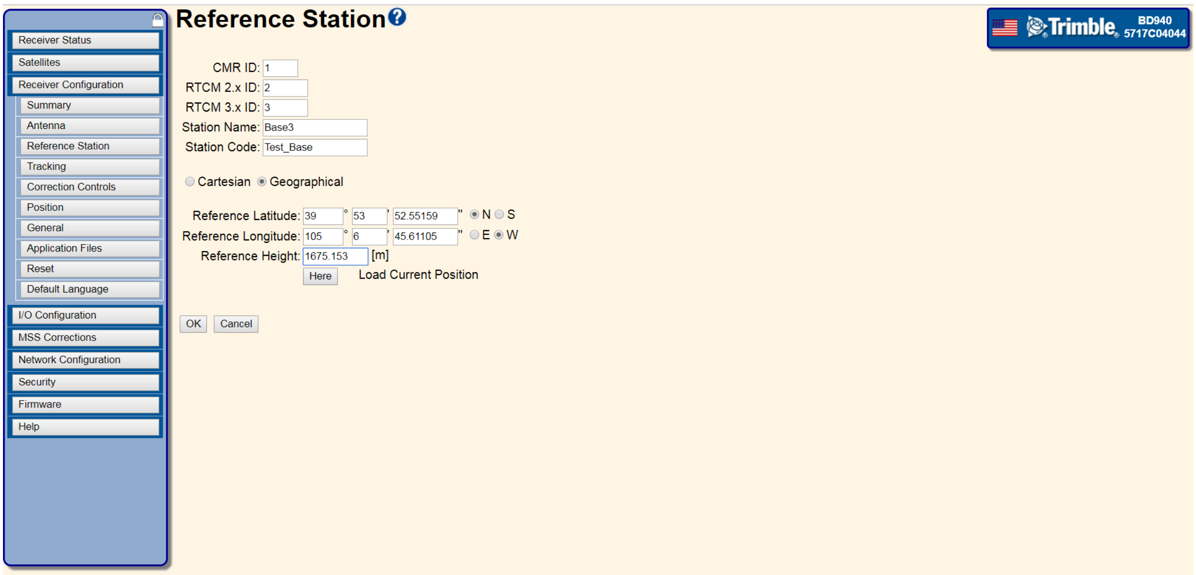
`RECORD LENGTH: 1`

`Static/Kinematic Mode: 1 (Static)`

NOTE – The highlighted bit is set to 01 only in this command (since it resets the unit to defaults). In the following steps this bit is set to 00 since a reset at that point would reset all of the settings that have already been configured.

5. Set the CMR and RTCM ID values, station names and codes, and the reference position of the base station:

   NOTE – A warning message will pop up if the coordinates input into the fields is far away from what the receiver is seeing.



The 64h command to set these base parameters is:

```
02 00 64 62 00 00 00 03 00 01 00 03 59 00 00 42 41 53 45 20 20
20 20 3F E6 48 80 57 7F A2 1F BF FD 5A 5D DD 52 DF 68 40 9A 04
9C AC 08 31 27 00 02 01 40 41 42 41 53 45 20 20 20 20 20 20 20
20 20 20 20 20 20 20 20 20 42 74 65 73 74 5F 62 61 73 65 20 20
20 20 20 20 20 44 41 4E 4D 43 34 20 20 20 20 40 00 03 89 03
```

Where:

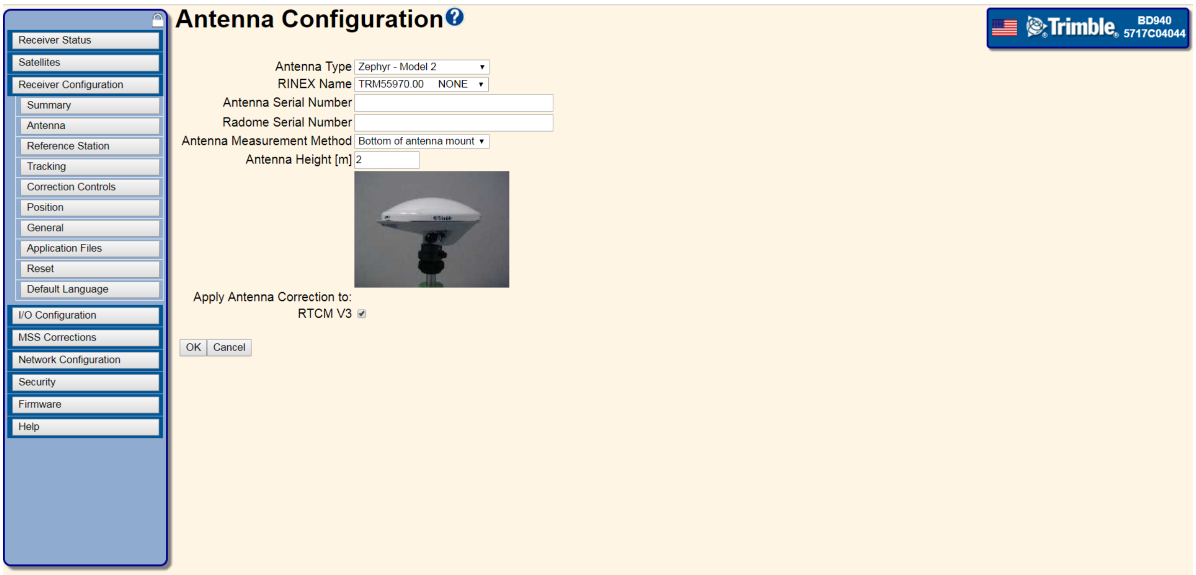
```
RECORD BYTES: 03 59 00 00 42 41 53 45 20 20 20 20 3F E6 48 80
57 7F A2 1F BF FD 5A 5D DD 52 DF 68 40 9A 04 9C AC 08 31 27 00
02 01 40 41 42 41 53 45 20 20 20 20 20 20 20 20 20 20 20 20 20
20 20 20 42 74 65 73 74 5F 62 61 73 65 20 20 20 20 20 20 20 44
41 4E 4D 43 34 20 20 20 20 40 00 03
```

Decode as:

```
RECORD TYPE: 3 (03h Reference Node)

RECORD LENGTH: 89

Flag (Reserved - set to 0x00): 0x00 (0)

Node Index (Reserved - set to 0x00): 0x00 (0)

Name: BASE

Reference Latitude (radians): 0.696350260635

Reference Longitude (radians): -1.834562172457

Reference Altitude (meters): 1665.1530

RTCM v2.x Station ID: 2

CMR Station ID: 1
```

```
Frame Character (@): @
Station ID indicator: A
Station Point ID: BASE
Feature Code indicator: B
Feature Code: test_base
Epoch Rate indicator: D
Base quality indicator: A
Base point class indicator: N
Tracking indicator: 01001101
Antenna Type: 184
Flag (Reserved - set to 0x20): 0x20 (32)
Protocol Indicator (set to 0x20): 0x20 (32)
Flag (Reserved - set to 0x20): 0x20 (32)
Flag (Reserved - set to 0x20): 0x20 (32)
Frame Character (@): @
RTCM v3.x Station ID: 3
```

6. Set the antenna type, antenna height, and the measurement method:



The 64h command to set these base parameters is:

```
02 00 64 15 00 00 00 03 00 01 00 08 0C 40 00 AC A5 7A 00 00 00
00 B8 00 00 54 03
```

Where:

```
RECORD BYTES: 08 0C 40 00 AC A5 7A 00 00 00 00 B8 00 00
```

Decode as:

```
RECORD TYPE: 8 (08h (8) Antenna)
RECORD LENGTH: 12
Antenna Height (meters): 2.0843
Antenna Type: 184
(Reserved - set to 0x00): 0
(Reserved - set to 0x00): 0
```

NOTE – In this example, because the bottom of antenna mount (the ARP) was selected, the antenna height accounts for the distance between the antenna phase center (APC) and the ARP. However, the output messages are always given for the position of the APC.

7. Configure the CMR or RTCM correction output. You can configure bandwidth limiting if required:

The 64h command to set these base parameters is:

```
02 00 64 1B 00 00 00 03 00 01 00 02 04 01 05 00 00 07 0C 02 00
03 00 00 00 00 DC 00 00 00 00 83 03
```

Where:

```
RECORD BYTES: 02 04 01 05 00 00
```

Decode as:

```
RECORD TYPE: 2 (02h (2) Serial Port Baud Format)
RECORD LENGTH: 4
PORT INDEX (zero based): 1 (Serial port 2)
BAUD RATE: 5 (38.4K baud (default))
```

```
PARITY: 0 (No Parity)
FLOW CONTROL: 0 (None)
```

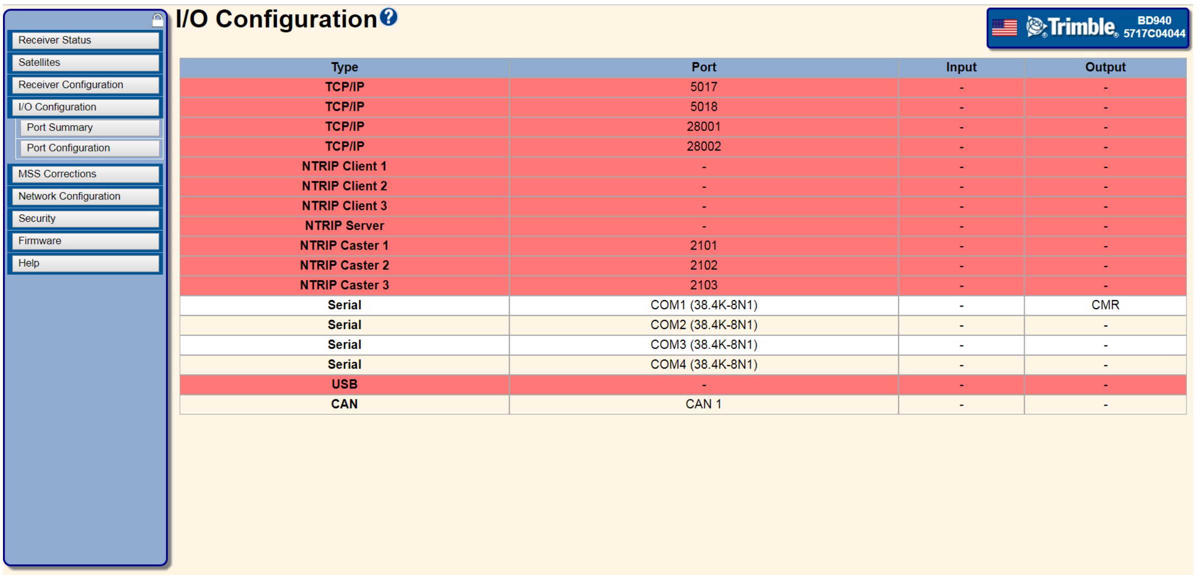
Where:

```
RECORD BYTES: 07 0C 02 00 03 00 00 00 00 DC 00 00 00 00
```

Decode as:

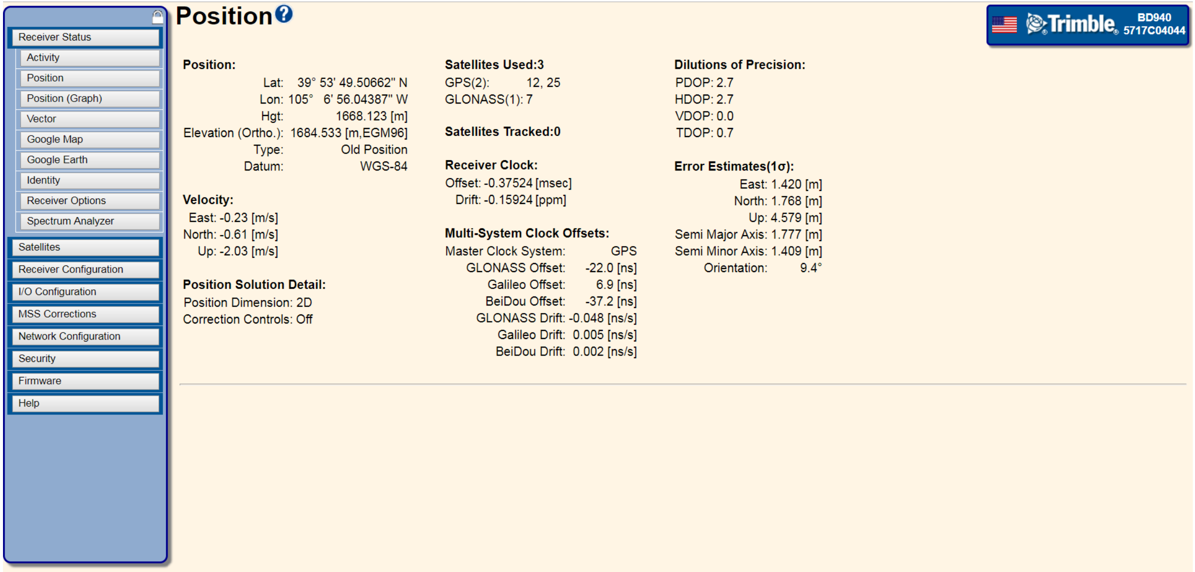
```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 12
OUTPUT MESSAGE TYPE: 2 (CMR Output)
PORT INDEX (zero based): 0 (Serial port 1)
FREQUENCY: 3 (1 Hz)
OFFSET: 0
CMR Flag 1: 0 (CMR+)
CMR Flag 2: 0x00
BANDWIDTH LIMIT: 220
EXTRA BYTE1: 0x00
EXTRA BYTE2: 0x00
EXTRA BYTE3: 0x00
EXTRA BYTE4: 0x00
```

8. In the **I/O Configuration** / **Port Summary** page, verify that the CMR outputs are configured. In this example, Serial1/COM1 shows CMR as its output.



Type	Port	Input	Output
TCP/IP	5017	-	-
TCP/IP	5018	-	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client 1	-	-	-
NTRIP Client 2	-	-	-
NTRIP Client 3	-	-	-
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	COM1 (38.4K-8N1)	-	CMR
Serial	COM2 (38.4K-8N1)	-	-
Serial	COM3 (38.4K-8N1)	-	-
Serial	COM4 (38.4K-8N1)	-	-
USB	-	-	-
CAN	CAN 1	-	-

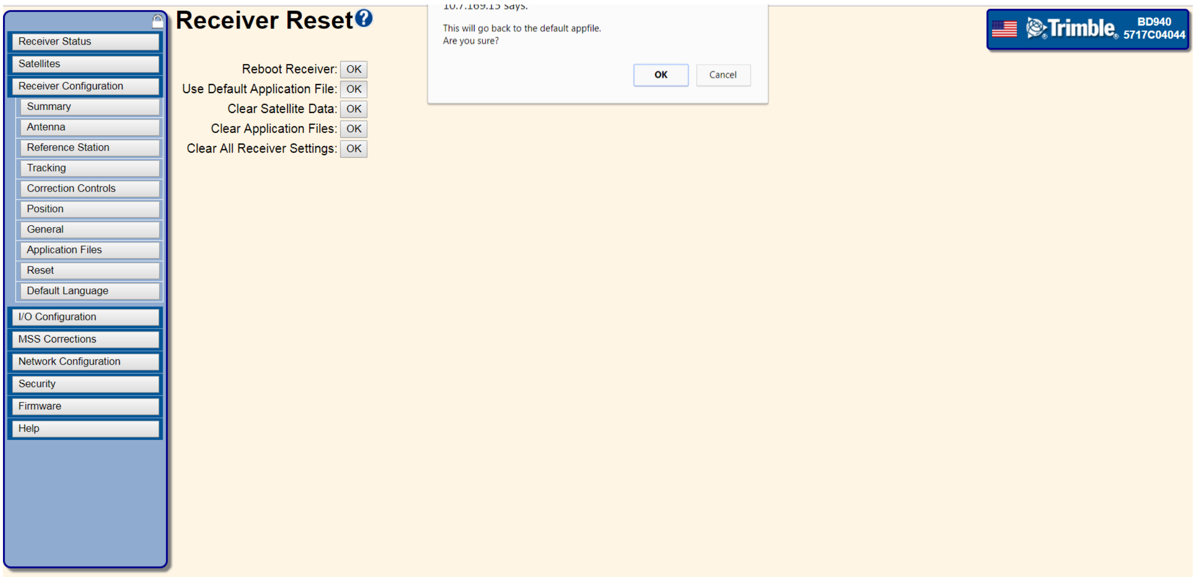
9. In the **Receiver Status** / **Position** page, verify that the base station is tracking satellites and positioning:



Configuring the receiver as a rover

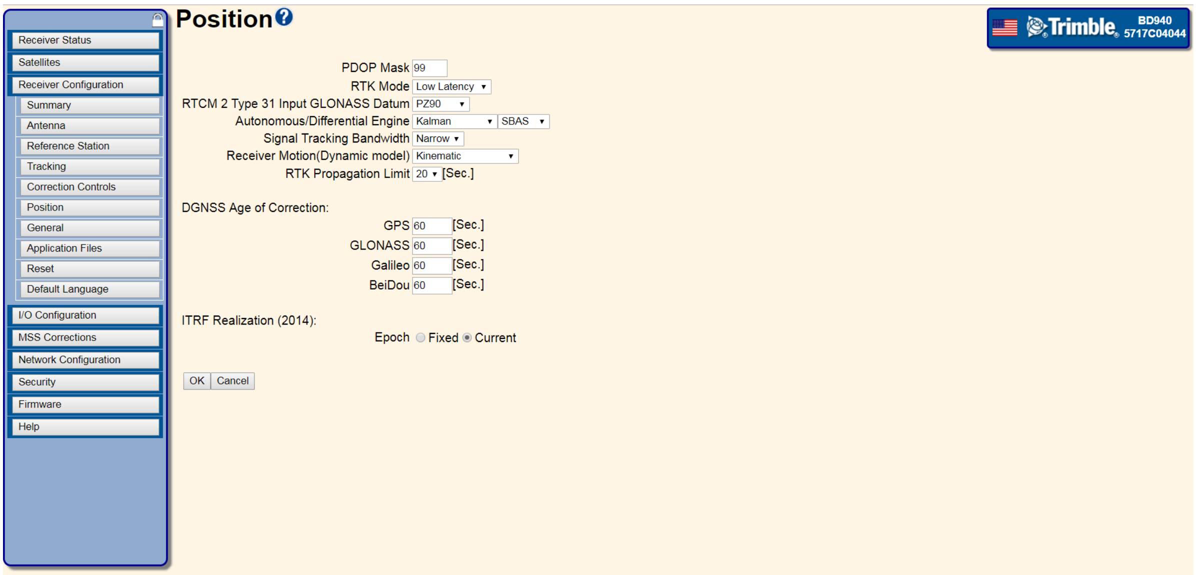
When setting up a rover, Trimble recommends the following steps:

1. Reset the unit to use the default application file:



2. Set the Operation Mode to Rover:

3. Set the RTK Motion to Kinematic:



The 64h command to reset the receiver to defaults and put the unit into a kinematic mode is:

`02 00 64 0A 00 00 00 03 00 01 01 0A 01 00 7E 03`

Where:

`RECORD BYTES: 0A 01 00`

Decode as:

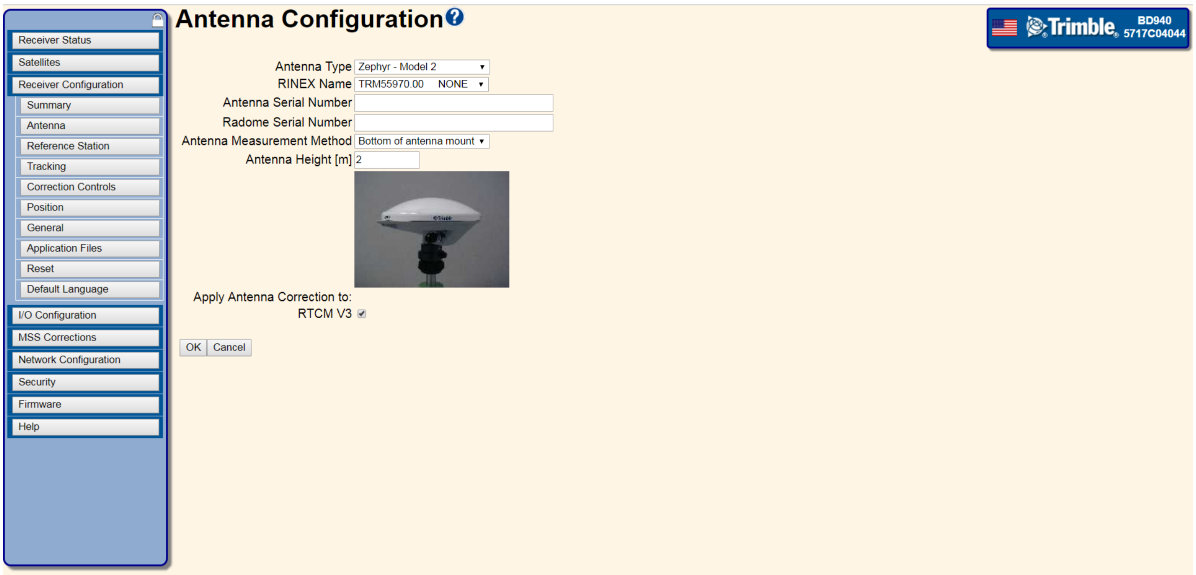
`RECORD TYPE: 10 (0Ah (10) Static Kinematic)`

`RECORD LENGTH: 1`

`Static/Kinematic Mode: 0 (Kinematic)`

NOTE – The highlighted bit is set to 01 only in this command (since it resets the unit to defaults). In the following steps this bit is set to 00 since a reset at that point would reset all of the settings that have already been configured.

4. Set the antenna type, antenna height, and the measurement method:



The 64h command to set these base parameters is:

```
02 00 64 15 00 00 00 03 00 01 00 08 0C 3F B5 94 AF 40 00 00 00
00 B8 00 00 C0 03
```

Where:

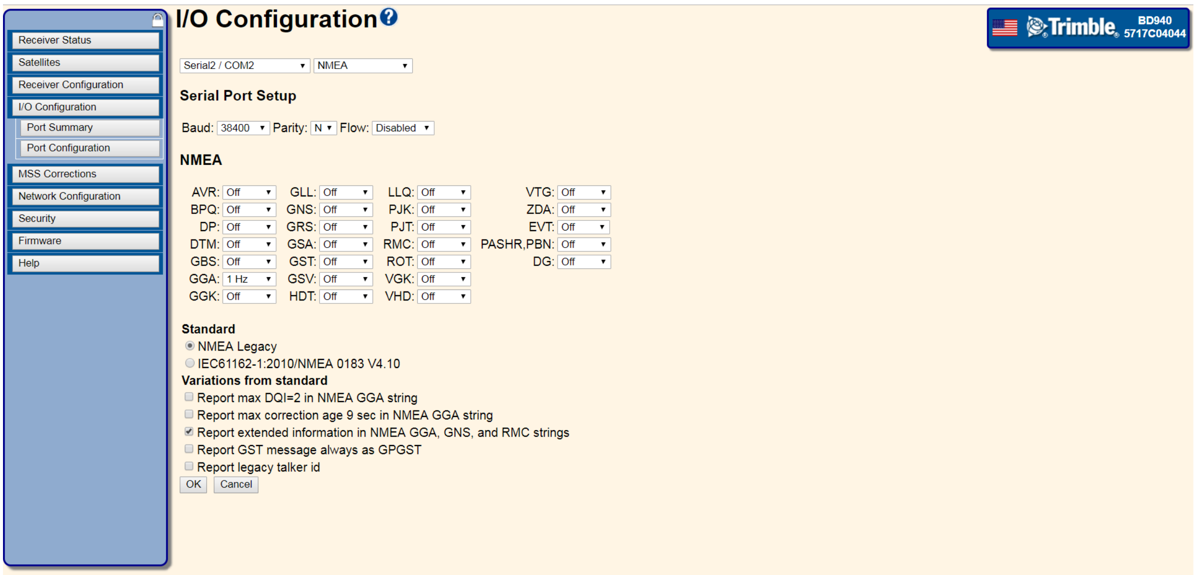
```
RECORD BYTES: 3F B5 94 AF 40 00 00 00 00 B8 00 00
```

Decode as:

```
RECORD TYPE: 8 (08h (8) Antenna)
RECORD LENGTH: 12
Antenna Height (meters): 0.0843
Antenna Type: 184
(Reserved - set to 0x00): 0
(Reserved - set to 0x00): 0
```

NOTE – In this example, because the bottom of antenna mount (the ARP) was selected, the antenna height accounts for the distance between the antenna phase center (APC) and the ARP. However, the output messages are always given for the position of the APC.

5. Configure any output messages:



The 64h command to set these base parameters is:

```
02 00 64 19 00 00 00 03 00 01 00 02 04 01 05 00 00 07 04 06 01
03 00 07 04 0D 01 03 00 BE 03
```

Where:

```
RECORD BYTES: 02 04 01 05 00 00
```

Decode as:

```
RECORD TYPE: 2 (02h (2) Serial Port Baud Format)
RECORD LENGTH: 4
PORT INDEX (zero based): 1 (Serial port 2)
BAUD RATE: 5 (38.4K baud (default))
PARITY: 0 (No Parity)
FLOW CONTROL: 0 (None)
```

Where:

```
RECORD BYTES: 07 04 06 01 03 00
```

Decode as:

```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 4
OUTPUT MESSAGE TYPE: 6 (NMEA_GGA)
PORT INDEX (zero based): 1 (Serial port 2)
FREQUENCY: 3 (1 Hz)
```

```
OFFSET: 0
```

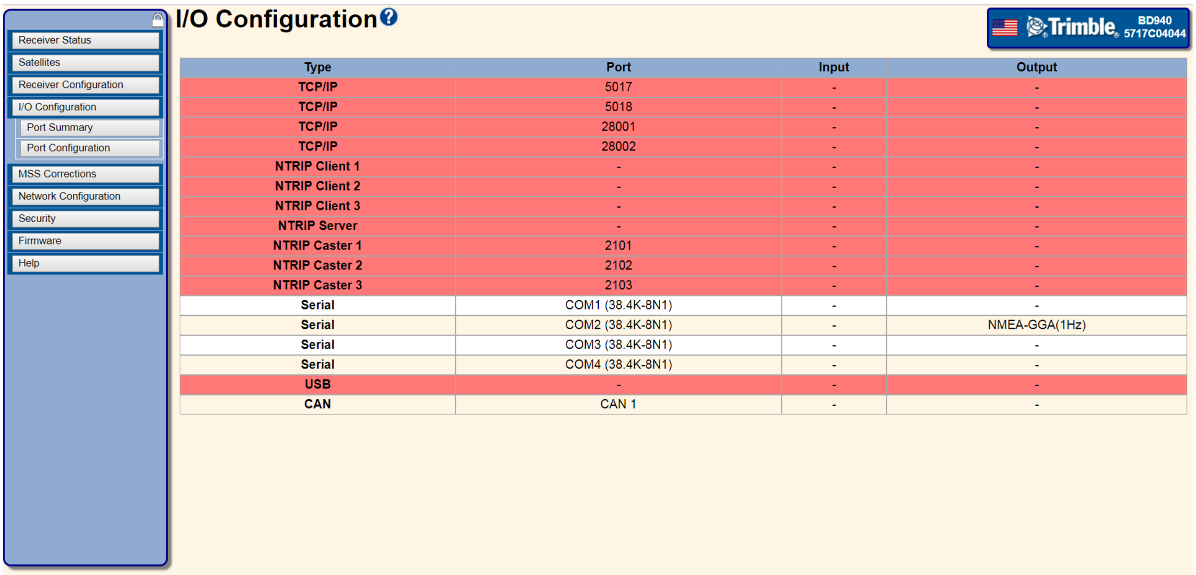
Where:

```
RECORD BYTES: 07 04 0D 01 03 00
```

Decode as:

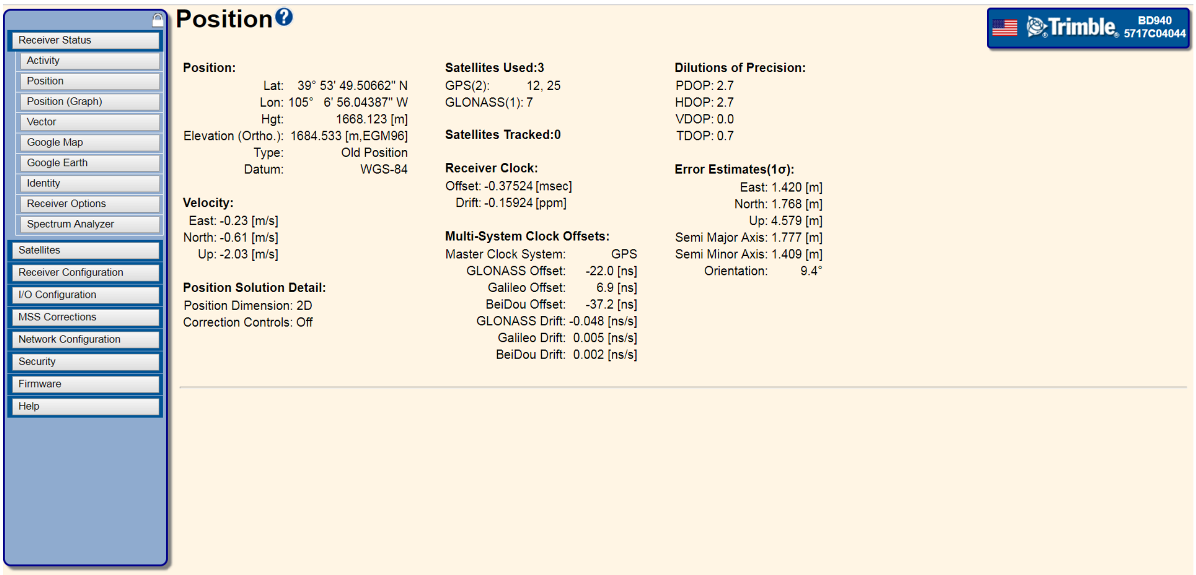
```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 4
OUTPUT MESSAGE TYPE: 13 (NMEA_GST)
PORT INDEX (zero based): 1 (Serial port 2)
FREQUENCY: 3 (1 Hz)
OFFSET: 0
```

6. In the **I/O Configuration / Port Summary** page, verify that the CMR corrections are inputs (if the text is bold then these corrections are being used in the position solution) and verify the output messages:



Type	Port	Input	Output
TCP/IP	5017	-	-
TCP/IP	5018	-	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client 1	-	-	-
NTRIP Client 2	-	-	-
NTRIP Client 3	-	-	-
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	COM1 (38.4K-8N1)	-	-
Serial	COM2 (38.4K-8N1)	-	NMEA-GGA(1Hz)
Serial	COM3 (38.4K-8N1)	-	-
Serial	COM4 (38.4K-8N1)	-	-
USB	-	-	-
CAN	CAN 1	-	-

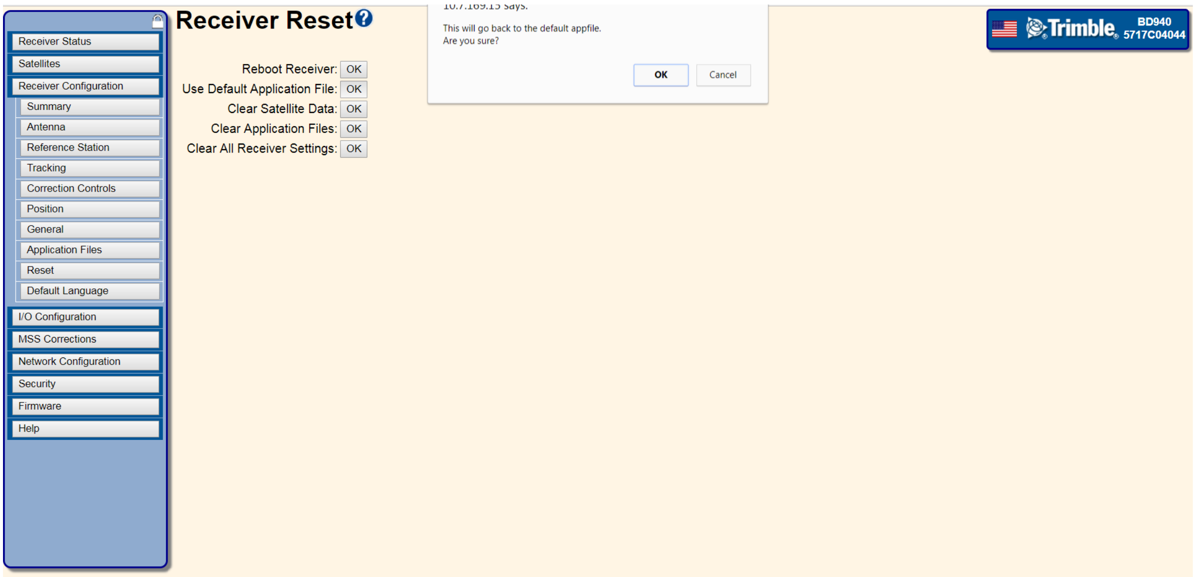
7. In the **Receiver Status** / **Position** page, verify that the rover is tracking satellites and positioning using the input corrections from the base station:



Configuring the receiver as a moving base

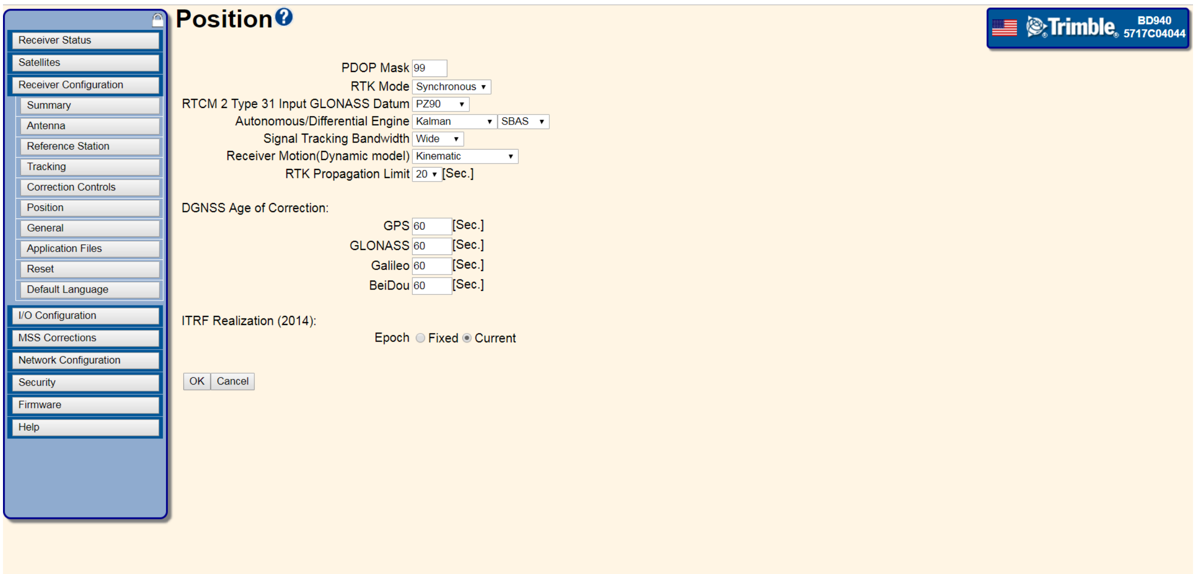
When setting up a moving base, Trimble recommends the following steps:

1. Reset the unit to use the default application file:



2. Set the Operation Mode to Moving Base:

3. Set the RTK Motion to Kinematic and the **RTK Mode** field to Synchronous:



The 64h command to reset the receiver to defaults and put the unit into a kinematic mode is:

```
02 00 64 14 00 00 00 03 00 01 01 0A 01 00 01 08 0A 02 63 00 00
00 00 00 00 03
```

Where:

```
RECORD BYTES: 0A 01 00
```

Decode as:

```
RECORD TYPE: 10 (0Ah (10) Static Kinematic)
RECORD LENGTH: 1
Static/Kinematic Mode: 0 (Kinematic)
```

Where:

```
RECORD BYTES: 01 08 0A 02 63 00 00 00 00 00
```

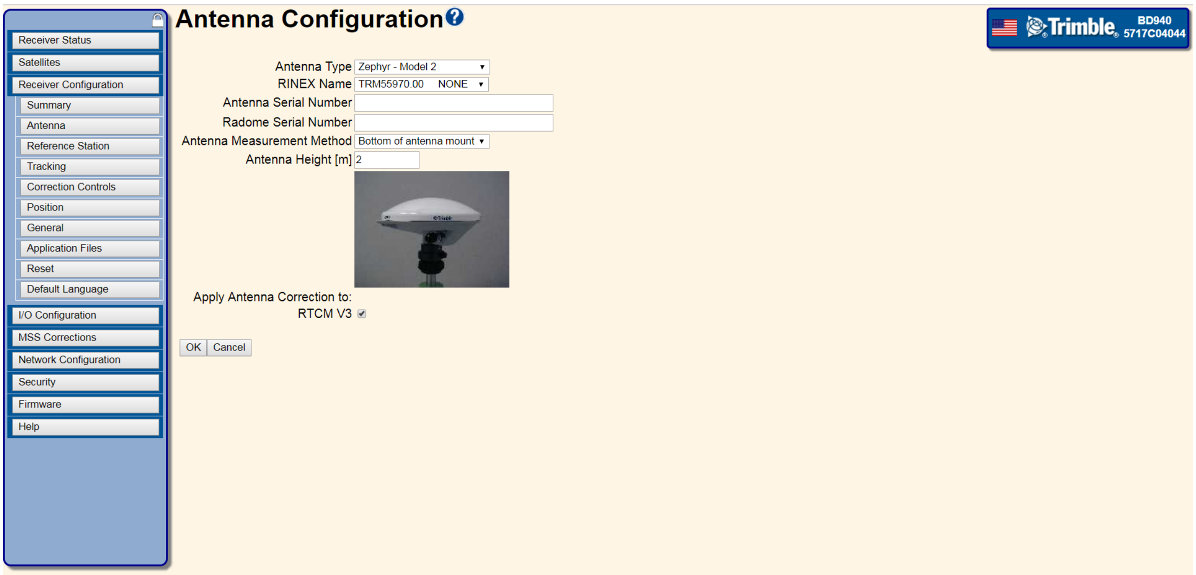
Decode as:

```
RECORD TYPE: 1 (01h (1) General Controls)
RECORD LENGTH: 9
Elevation Mask: 10
Meas Rate (OBSOLETE): 2 (10Hz)
PDOP Mask: 99
Frequency Source (RESERVED - set to 0x00): 0
Position Source (OBSOLETE - set to 0x00): 0
```

```
RTK POSITIONING MODE: 0 (Synchronous positioning)
POSITIONING SOLUTION SELECTION: 0 (Use best available solution)
RESERVED - set to 0x00: 0
```

NOTE – The highlighted bit is set to 01 only in this command (since it resets the unit to defaults). In the following steps this bit is set to 00 since a reset at that point would reset all of the settings that have already been configured.

4. Set the antenna type, antenna height, and the measurement method:



The 64h command to set these base parameters is:

```
02 00 64 15 00 00 00 03 00 01 00 08 0C 3F B5 94 AF 40 00 00 00
00 B8 00 00 C0 03
```

Where:

```
RECORD BYTES: 3F B5 94 AF 40 00 00 00 00 B8 00 00
```

Decode as:

```
RECORD TYPE: 8 (08h (8) Antenna)
RECORD LENGTH: 12
Antenna Height (meters): 0.0843
Antenna Type: 184
(Reserved - set to 0x00): 0
(Reserved - set to 0x00): 0
```

NOTE – In this example, because the bottom of antenna mount (the ARP) was selected, the antenna height accounts for the distance between the antenna phase center (APC) and the ARP. However, the output messages are always given for the position of the APC.

5. Configure the **Moving Base CMR** output:

The 64h command to set these base parameters is:

```
02 00 64 1B 00 00 00 03 00 01 00 02 04 02 05 00 00 07 0C 02 02
0D 00 01 00 00 00 00 00 00 00 B5 03
```

Where:

```
RECORD BYTES: 02 04 02 05 00 00
```

Decode as:

```
RECORD TYPE: 2 (02h (2) Serial Port Baud Format)
RECORD LENGTH: 4
PORT INDEX (zero based): 2 (Serial port 3)
BAUD RATE: 5 (38.4K baud (default))
PARITY: 0 (No Parity (10-bit format))
FLOW CONTROL: 0 (None)
```

Where:

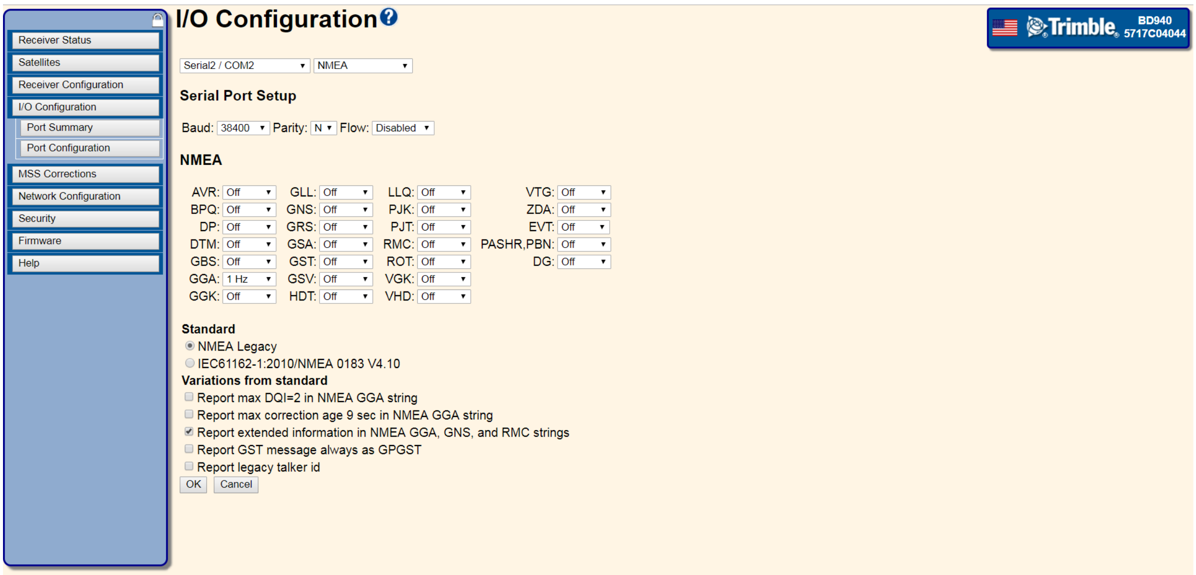
```
RECORD BYTES: 07 0C 02 02 0D 00 01 00 00 00 00 00 00 00
```

Decode as:

```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 12
OUTPUT MESSAGE TYPE: 2 (CMR Output)
PORT INDEX (zero based): 2 (Serial port 3)
FREQUENCY: 13 (20 Hz)
```

```
OFFSET: 0
CMR Flag 1: 1 (High speed CMR (5, 10, or 20 Hz))
CMR Flag 2: 00000000
BANDWIDTH LIMIT: 0
EXTRA BYTE1: 0x00 (0)
EXTRA BYTE2: 0x00 (0)
EXTRA BYTE3: 0x00 (0)
EXTRA BYTE4: 0x00 (0)
```

6. Configure any output messages:



The 64h command to set these base parameters is:

```
02 00 64 19 00 00 00 03 00 01 00 02 04 01 05 00 00 07 04 06 01
03 00 07 04 0D 01 03 00 BE 03
```

Where:

```
RECORD BYTES: 02 04 01 05 00 00
```

Decode as:

```
RECORD TYPE: 2 (02h (2) Serial Port Baud Format)
RECORD LENGTH: 4
PORT INDEX (zero based): 1 (Serial port 2)
BAUD RATE: 5 (38.4K baud (default))
PARITY: 0 (No Parity)
FLOW CONTROL: 0 (None)
```

Where:

```
RECORD BYTES: 07 04 06 01 03 00
```

Decode as:

```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 4
OUTPUT MESSAGE TYPE: 6 (NMEA_GGA)
PORT INDEX (zero based): 1 (Serial port 2)
FREQUENCY: 3 (1 Hz)
OFFSET: 0
```

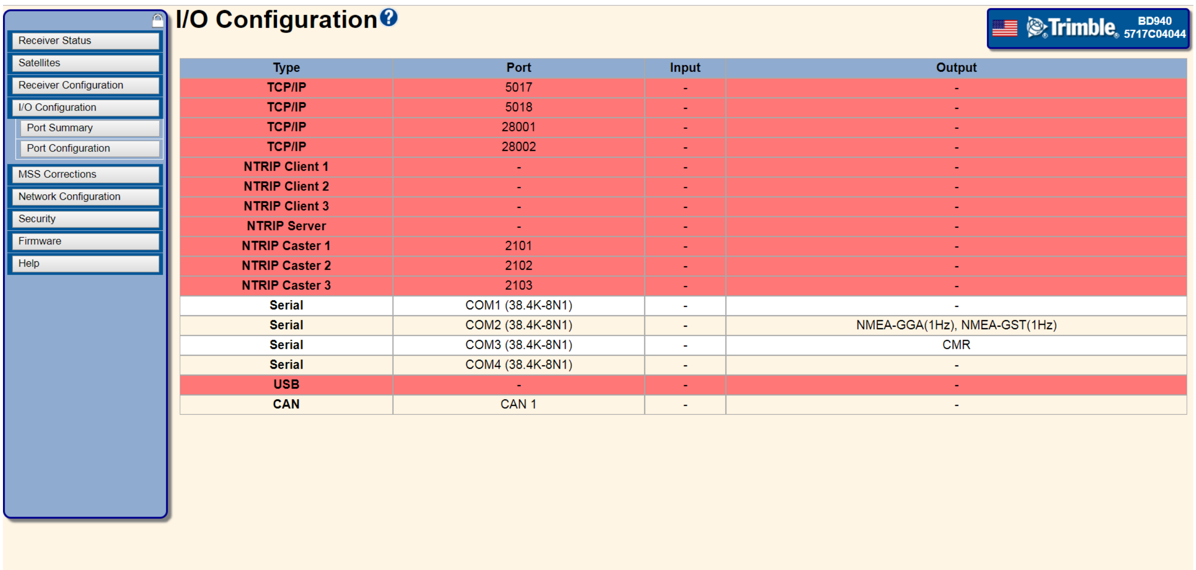
Where:

```
RECORD BYTES: 07 04 0D 01 03 00
```

Decode as:

```
RECORD TYPE: 7 (07h (7) Output Message)
RECORD LENGTH: 4
OUTPUT MESSAGE TYPE: 13 (NMEA_GST)
PORT INDEX (zero based): 1 (Serial port 2)
FREQUENCY: 3 (1 Hz)
OFFSET: 0
```

7. In the **I/O Configuration** / **Port Summary** page, verify that the CMR corrections are inputs (if the text is **bold** then these corrections are being used in the position solution) and verify the output messages:



Type	Port	Input	Output
TCP/IP	5017	-	-
TCP/IP	5018	-	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client 1	-	-	-
NTRIP Client 2	-	-	-
NTRIP Client 3	-	-	-
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	COM1 (38.4K-8N1)	-	-
Serial	COM2 (38.4K-8N1)	-	NMEA-GGA(1Hz), NMEA-GST(1Hz)
Serial	COM3 (38.4K-8N1)	-	CMR
Serial	COM4 (38.4K-8N1)	-	-
USB	-	-	-
CAN	CAN 1	-	-

Setting up input/output on Ethernet ports

Configure the TCP or UDP ports to send data the same way as with the serial ports. When configuring the TCP or UDP ports to receive data, they must be put into a client mode and the source/server must be specified:

Using the AEh command to get the Ethernet configuration

When working with the receivers using TrimComm commands, the IP address of the receiver can be found by sending the AEh ETHERNET CFG subtype 00h command, for example:

```
02 00 AE 01 00 AF 03
```

The receiver responds with the AEh ETHERNET CFG subtype 01h response, like this:

```
02 28 AE 16 01 00 0A 01 5E F2 FF FF FE 00 0A 01 5F FF 0A 01 5E 01
0A 01 50 18 8A 03
```

Which decodes as:

```
DHCP ACTIVE: 0
IP Address byte 1: 10
IP Address byte 2: 1
IP Address byte 3: 94
IP Address byte 4: 242
NETMASK byte 1: 255
NETMASK byte 2: 255
NETMASK byte 3: 254
NETMASK byte 4: 0
BROADCAST ADDRESS byte 1: 10
BROADCAST ADDRESS byte 2: 1
BROADCAST ADDRESS byte 3: 95
BROADCAST ADDRESS byte 4: 255
GATEWAY byte 1: 10
GATEWAY byte 2: 1
GATEWAY byte 3: 94
GATEWAY byte 4: 1
DNS SERVER ADDRESS byte 1: 10
DNS SERVER ADDRESS byte 2: 1
DNS SERVER ADDRESS byte 3: 80
DNS SERVER ADDRESS byte 4: 24
```

The AEh ETHERNET CFG subtype 02h command can be used to set these parameters.

Using the AEh command to get the virtual IP ports

The receiver uses a "virtual port" for the IP ports which allows a single byte to identify the port. To find the available virtual ports for the TCP and UDP ports on the IP stack, send the AEh ETHERNET CFG subtype 0Ch command, for example:

```
02 00 AE 01 0C BB 03
```

The receiver responds with the AEh ETHERNET CFG subtype 0Dh response, like this:

```
02 E8 AE 08 0D 15 1E 04 15 16 17 18 3C 03
```

Which decodes as:

```
FIRST VIRTUAL PORT (1-based): 0x15 (21)
LAST VIRTUAL PORT (1-based): 0x1E (30)
No. ACTIVE VPORTS: 4
ACTIVE VPORTS (1-based): 0x15 (21)
ACTIVE VPORTS (1-based): 0x16 (22)
ACTIVE VPORTS (1-based): 0x17 (23)
ACTIVE VPORTS (1-based): 0x18 (24)
```

These are the port addresses that must be used in the 64h commands for sending output messages from a TCP or UDP port.

Using the AEh command to get details on or set a virtual IP port

To find details about a specific port, send the AEh ETHERNET CFG subtype 0Eh command, for example (on port 16h):

```
02 00 AE 02 0E 16 D4 03
```

The receiver responds with the AEh ETHERNET CFG subtype 0Fh response, like this:

```
02 E8 AE 1F 0F 16 01 13 9A 00 3C 00 00 01 13 9B 00 00 00 00 00 00
00 0B 31 30 2E 31 2E 39 34 2E 32 33 35 A1 03
```

Which decodes as:

```
VIRTUAL PORT (1-based): 0x16 (22)

ACTIVE: 1

IP Port: 5018

Mode: 0

UDP TIMEOUT: 60

OUTPUT ONLY: 0

AUTHENTICATE: 0

INITIATE CONNECTION: 1

REMOTE IP PORT: 5019

AUTHENTICATION KEY:

REMOTE IP ADDR LENGTH: 11

REMOTE IP ADDRESS: 10.1.94.235
```

In this case you can see that the port is configured in a client mode, connected to 10.1.94.235. The AEh ETHERNET CFG subtype 10h command can be used to set these parameters.

7

Receiver Web Interface

This section of the user guide provides a detailed overview of the web interface.

- BD990
- BD992
- BX992

For BD992-INS and BX992 Inertial products, additional screens appear in the web interface that enables configuration of the INS features. For details on the inertial portion of these GNSS products, please see Reference Frames and Offset Measurements, page 1.

Receivers can also be configured using the Application File packets described in the Binary Interface Control Document.

Web interface menus

Use the web interface to configure the receiver settings.

Supported languages

The web interface is available in the following languages:

- English (en)
- Chinese (zh)
- Dutch (nl)
- Finnish (fi)
- French (fr)
- German (de)
- Italian (it)
- Japanese (ja)
- Norwegian (n)

- Polish (pl)
- Portuguese (pt)
- Russian (ru)
- Spanish (es)
- Swedish (sv)

Use the **Receiver Configuration** / **Default Language** setting to select the default language for your use.

The web interface shows the configuration menus on the left of the browser window, and the settings on the right. Each configuration menu contains related submenus to configure the receiver and monitor receiver performance.

NOTE – The menus and options available depend on the type of receiver you have.

Supported browsers

For PCs and laptops, current versions of these HTML browsers are supported:

- Google Chrome (recommended)
- Mozilla Firefox
- Microsoft Internet Explorer for Windows operating systems
- Opera
- Apple Safari

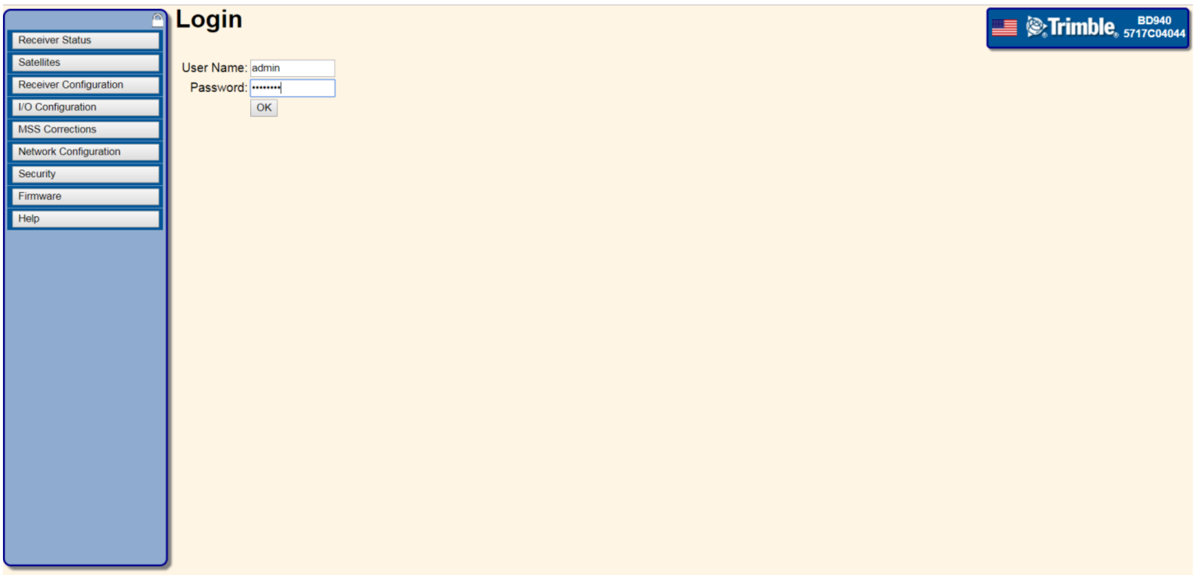
NOTE – Trimble seeks to support and operate properly with all web browsers, however no guarantee can be made since Trimble does not develop these browsers. These browsers are regularly updated by their developers, and the behavior of each browser is affected by the various internal settings that can be customized by the user.

Log in

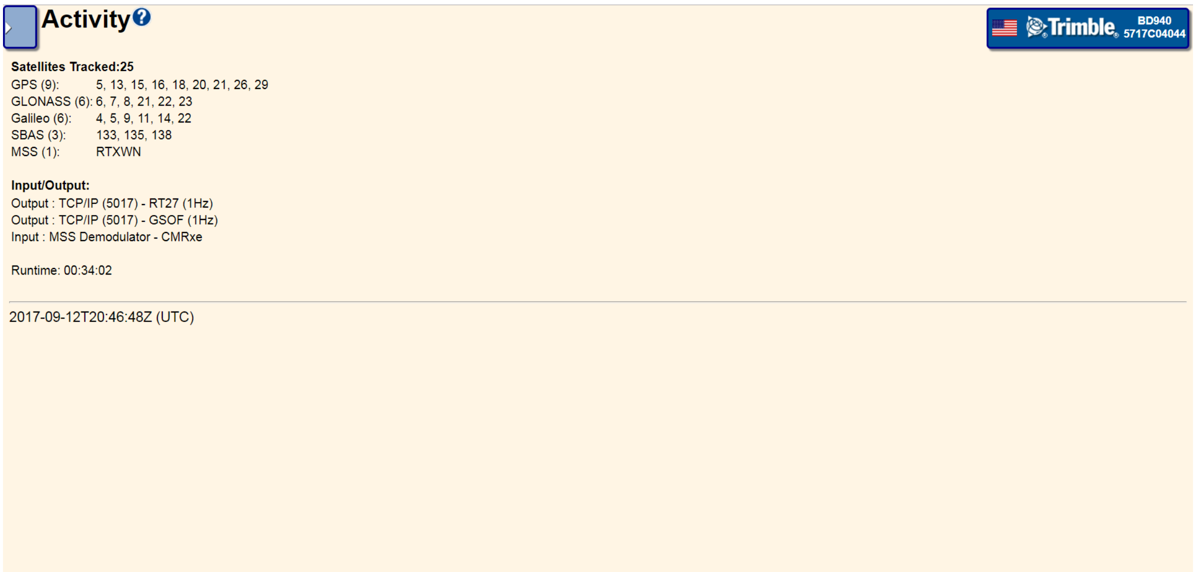
Enables you to log in to the receiver. Select the **Log in** field and when prompted enter a username and password. To log out, return to this menu and click **Log out**.

The default username is **admin**.

The default password is **password**.



To the left of the screen you will see a blue bar with a list of menu options. This user guide describes the function of each menu. At the top right of the blue menu bar you will see a Lock symbol. Clicking on the lock screen enables you to hide the menu bar and enlarge the information screen. The following figure shows the web page with the menu bar unlocked and collapsed to the top left corner of the screen;



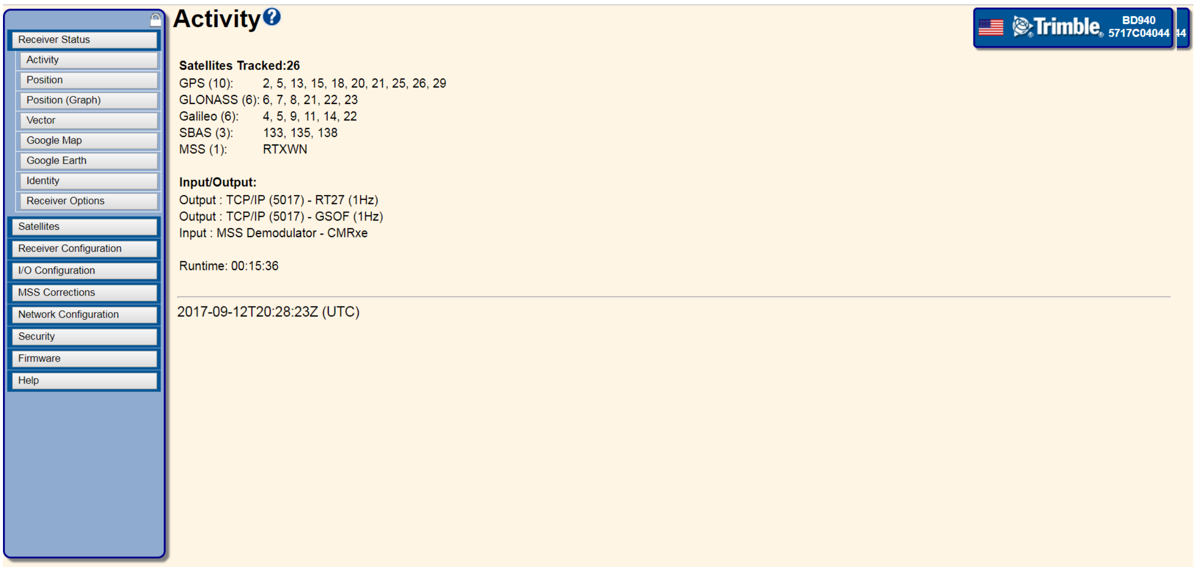
To bring the menu bar back into view, click on the blue box in the top left corner. To prevent the menu bar from hiding itself once the mouse pointer leaves its boundaries, click on the lock icon to lock the menu bar in place.

Receiver Status menu

The **Receiver Status** menu provides a quick link to review the receiver's available options, current firmware version, IP address, temperature, runtime, satellites tracked, current outputs, available memory, position information, and more.

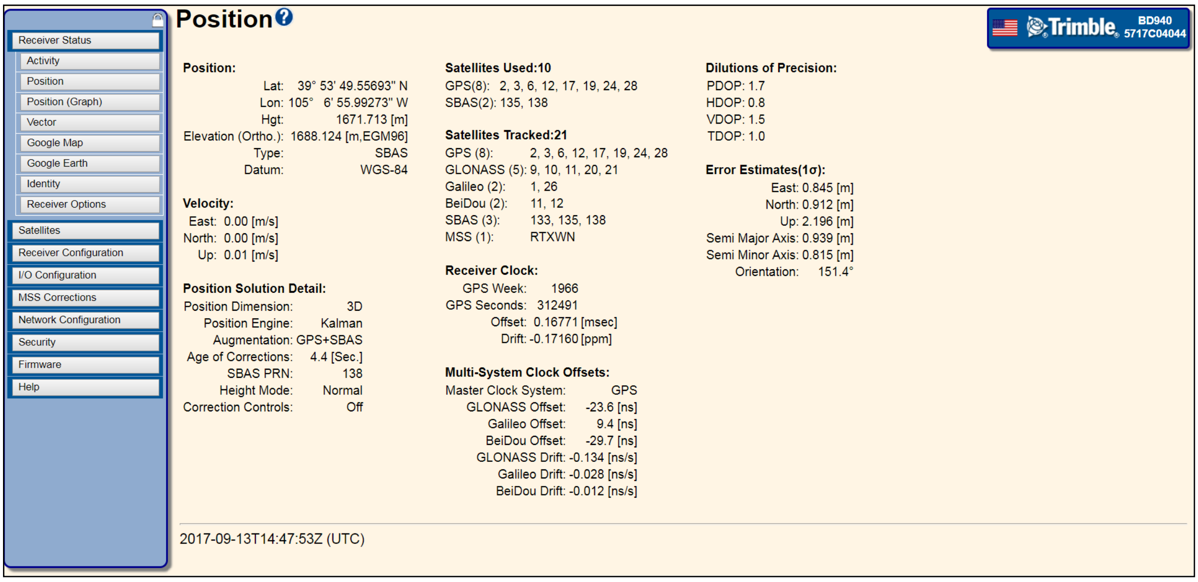
Receiver Status – Activity

This page lists information such as number of satellites tracked and available inputs and outputs.



Position and Position Graph

This page shows information such as current coordinates of the receiver, elevation, velocity, clock and other key GNSS information:



Position – Shows the current position solution.

- Lat – Latitude in degrees, minutes, and seconds.
- Lon – Longitude in degrees, minutes, and seconds.
- Hgt – Height above the ellipsoid to the Antenna Phase Center in meters.

> CAUTION – The position output by the receiver is the Antenna Phase Center position. You may want to reduce this position to a reference position elsewhere. If so, you should account for any tilt of the antenna in such a reduction. The settings for the Antenna Measurement Method and Antenna Height are not applied to this output.

- Elevation (Ortho.) – xxx.xxx is annotated [m, EGM96] in meters. This field displays the Orthometric height, Elevation, from the global EGM96 Geoid. If the receiver has a coordinate system loaded, then
  - the Elevation is annotated [m,SlopePln]
  - or [m,Subgridname] where Subgridname is the first 8 characters of the uploaded subgridded Geoid name.
  - In all cases when a coordinate system is installed AND a subgrid is used AND the Lat/Long position is outside the subgrid zone, then the receiver adds * to the

annotation like [m,name*] to warn the user.

NOTE – From firmware version 4.70 onward, the global EGM96 geoid is the default geoid in the receiver. The EGM96 geoid is a more precise estimation of the Mean Sea Level than the older DMA geoid model in the receiver prior to version 4.70 firmware.

NOTE – From firmware version 4.70 and later, the global EGM96 geoid is the default geoid in receivers with sufficient memory to store this geoid model. Receivers without sufficient memory to store the EGM96 geoid will continue to use the DMA WGS-84 geoid. The EGM96 geoid is a more precise estimation of the Mean Sea Level than the older DMA WGS84 geoid model.

- Type – Current position type.
  - Old – No updated position available.
  - Autonomous – Position has no satellite corrections applied.
  - Code Diff – Code differential solution – typically a single-frequency solution.
  - Phase Diff – Carrier phase differential solution (also known as Real-Time Kinematic (RTK) solution), typically a dual-frequency solution.
  - Beacon DGPS – Code phase differential solution using RTCM correction from an internal IALA MSK beacon receiver.
  - OmniSTAR VBS – Position using OmniSTAR VBS satellite-based correction service.
  - OmniSTAR XP – Position using OmniSTAR XP satellite-based correction service.
  - OmniSTAR HP – Position using OmniSTAR HP satellite-based correction service.
  - OmniSTAR HP+G2 – Position using OmniSTAR HP and G2 satellite-based correction service.
  - CDGP – Position using the Canadian DGPS corrections.
  - SBAS+ – Position using the SBAS Plus corrections.
  - SBAS – Position using SBAS corrections.
  - GVBS – Position using the clocks and orbits information from RTX corrections to augment the autonomous solution.
  - RTK and RTK Location – Carrier phase double difference position correction service.
  - RTX – Position using Trimble CenterPoint RTX satellite-based or IP correction service.
  - xFill – Position using Trimble xFill RTK augmentation service (5 minute duration limit).

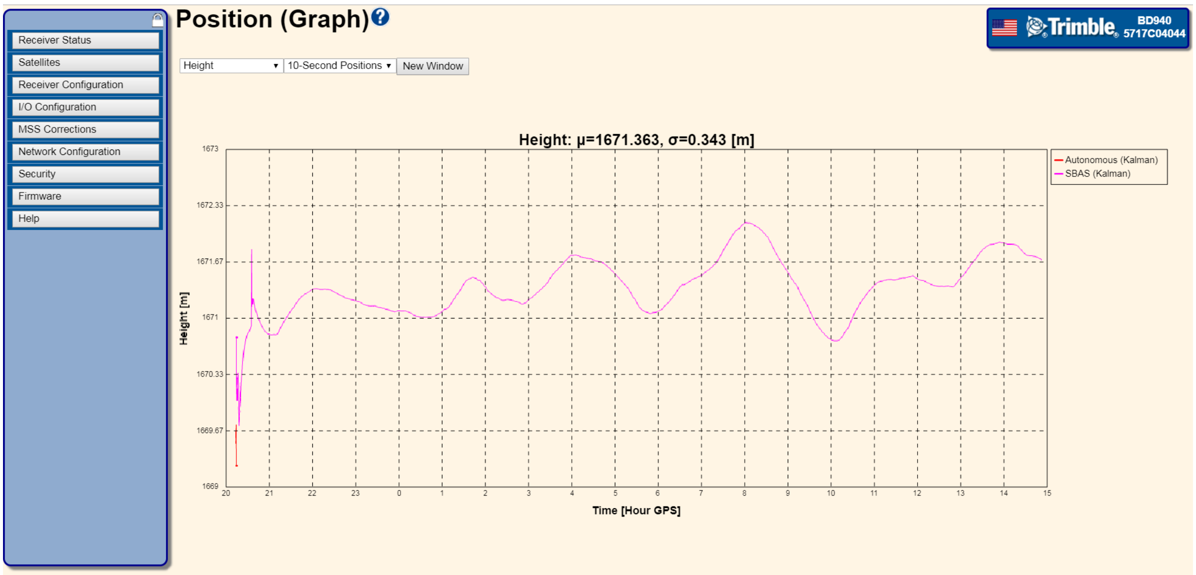
  - **xFill-RTX** – Position using Trimble xFill RTK augmentation service with unlimited duration. Service requires a CenterPoint RTX subscription.
- **Precision** – Displays the precision capability of the receiver.
- **Datum** – Displays the datum that the position is referenced to.

Position Graph

The Position Graph page lays out data such as height (in meters) against time (GPS hour). This information is not restricted to just height but more graphs can be generated for data sources such as PDOP/SVs, East, North, Horizontal, etc. To generate different graphs for the available data sources, select a data source from the menus on the top left corner of the Position Graph page.

To view this page correctly, you will need the latest Adobe Flash player installed and enabled in your browser.

You can also switch between a '10 second position' and also 'high rate positions'.



- **10 Second Positions** – The "10 Second" buffer contains data for up to the last 24 hours at 10 second intervals. The graphs displayed update every 10 seconds as new data is sent from the receiver to the browser.
- **High Rate Positions** – The "High Rate" buffer is 5,000 elements long and contains the last 5,000 positions the receiver computed. The time-span depends on the position rate of the receiver. Once the graph is drawn, data is sent from the receiver to the browser at the position rate, so the graphs update in real time only, subject to network and browser latencies.

NOTE – Both data source buffers are volatile. A reset of the graph is needed if the receiver is restarted.

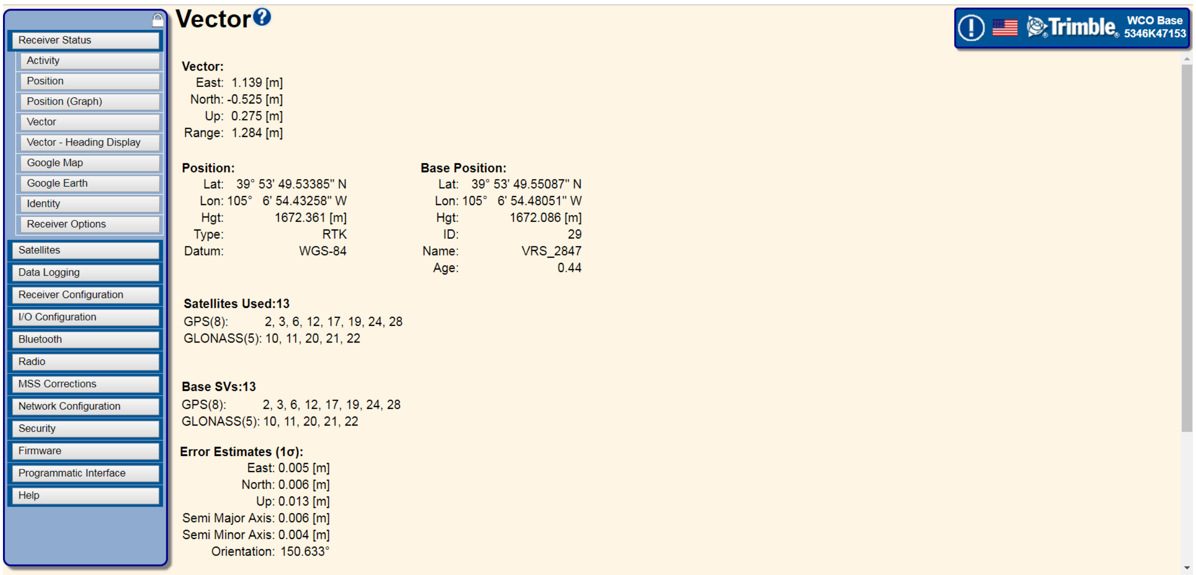
Right-clicking on the graph also shows more options that enables you to manipulate the graph. You can zoom in or out, print the graph or save it as a PNG file.

Vector page

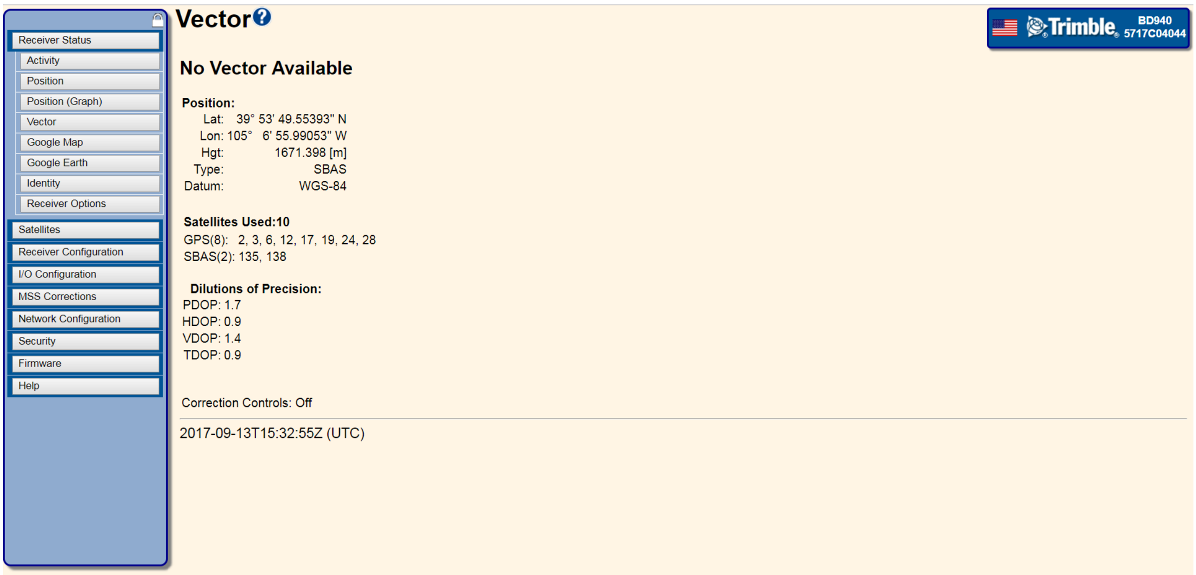
This page shows the RTK vector information. The RTK vector information is available only when the Trimble receiver is receiving RTK corrections from a static or moving RTK base. The vector information includes:

Vector – The RTK vector between the base and rover antennas. The RTK information is only displayed if the receiver is receiving valid RTK correction data.

The following screen shows the information displayed when valid RTK correction data is available to the receiver.



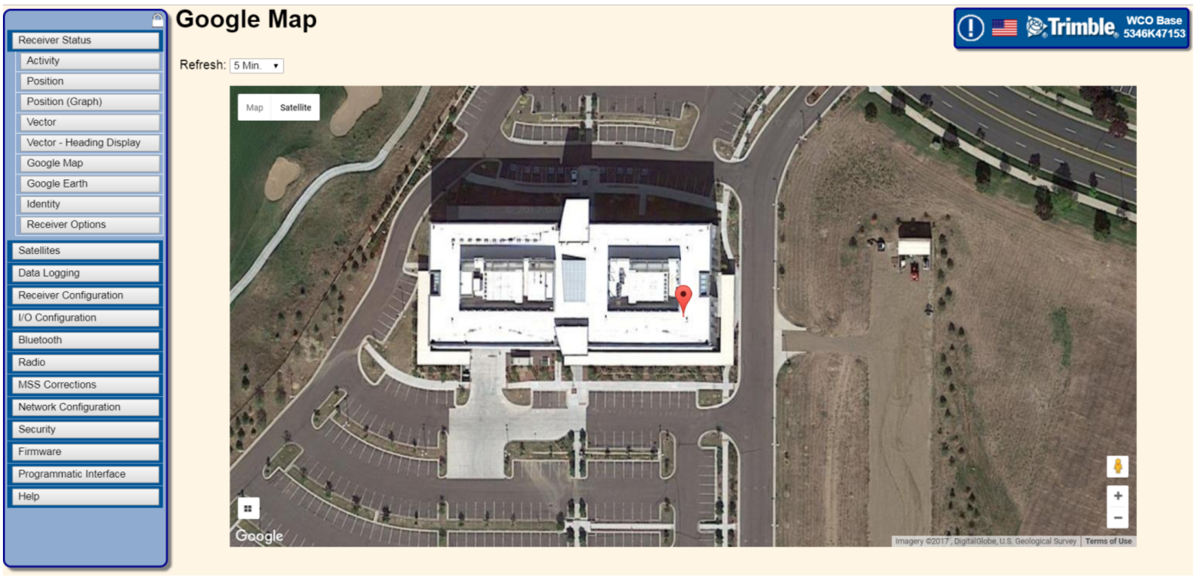
The following screen shows that there are no RTK corrections available:



Google Map and Google Earth

This page shows the current position of the receiver plotted on Google Maps.

Refresh Interval – Sets the refresh rate of the map, which is useful if the receiver is moving and you want to track its location. The refresh rate can be set to Off, 10 seconds, 20 seconds, 30 seconds, 1 minute, and 5 minutes.



The receiver also provides you with an option to export positional data to Google Earth. To use this feature, you must have Google Earth 4.1 or later installed. To download Google Earth, go to http://earth.google.com/download-earth.html. For more information, see Google Earth, page 94.

Google Earth

To use this feature, you must have Google Earth 4.1 or later installed. To download Google Earth, go to http://earth.google.com/download-earth.html.

Use the Google Earth menu to open Google Earth through a link in the receiver. This sets up a network link between the receiver and Google Earth. Google Earth shows the current position of the receiver; this is refreshed every 30 seconds.

To open Google Earth, click and then click **OK**. When Google Earth opens, you will see a placemarker showing the current position of the receiver.

NOTE – If you have security enabled, enter your username and password for the receiver's web interface into the Google Earth login box.

Once the data has loaded into Google Earth, it should look similar to the following screen. The point name shown is the serial number of the receiver:

Every 30 seconds, the position of the placemarker updates with the current position of the receiver. Click the placemarker in Google Earth to view information about the current position and the number of satellites tracked.

The receiver provides you with the option of sending up to approximately 200 bytes of HTML to the placemarker (shown when you click the placemarker). This information must be well-formed HTML and can be used to provide links to other web pages and/or an image of the receiver.

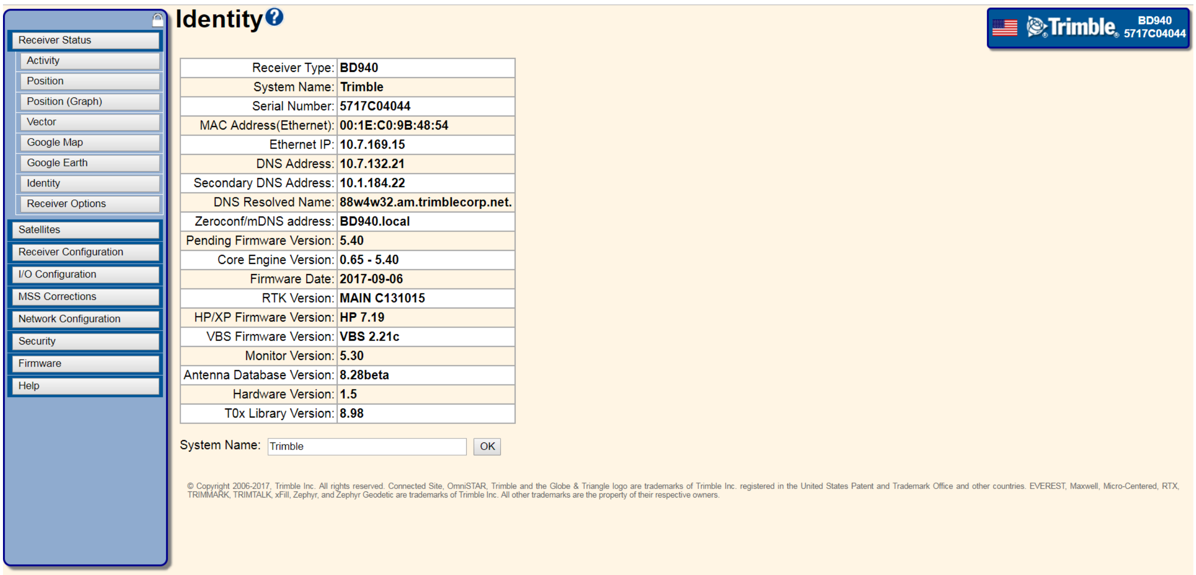
NOTE – Version 4.10 of Google Earth does not allow you to use iframes. An example is shown of what could be added to the HTML field in the receiver, where "myServer" is a web server:

<img width="500" src='http://myServer/AntennaLocation.png'></img>

Then, when you click the placemarker it also downloads and shows "AntennaLocation.png", as shown in the following graphic. Approximately every 30 seconds the placemarker disappears as Google Earth refreshes to show the receiver's position.

Identity

This page shows information detailed information about the GNSS receiver such as IP address, MAC address, and Firmware versions.



Some of the information shown is described in further detail below:

System Name – Provides a way to distinguish between receivers. In the System Name field at the bottom of the screen, enter a logical name to identify the receiver such as "WorkSite AlphaRxr". To help recognize the receiver when using the Zero Configuration service discovery, enter a name that is clear and obvious. This name is visible when on a computer that is on the same subnet as the receiver. Plan the assignment of system names, especially in large networks, to help network administration.

Zeroconf/mDNS address – Shows the address used for the hardware when Zero Configuration service discovery (mDNS/DNS-SD) is enabled and in use.

Firmware Version – Identifies the current software version running on the Trimble receiver. Usually this will be the same as the Core Engine version unless some additional functionality has been added that is independent of the core receiver operation.

Core Engine Version – Identifies the current core software running on the Trimble receiver. This information is used to determine if more recent firmware is available from Trimble, and also to identify the firmware if you need to contact Trimble Support. Receiver firmware is loaded using the Install New Firmware menu.

Firmware Date – Identifies the date that the current software running on the Trimble receiver was released.

RTK Version – Identifies the current version of the RTK engine. Used for troubleshooting with technical support

RTX Version – Identifies the current version of the RTX engine. Used for troubleshooting with technical support.

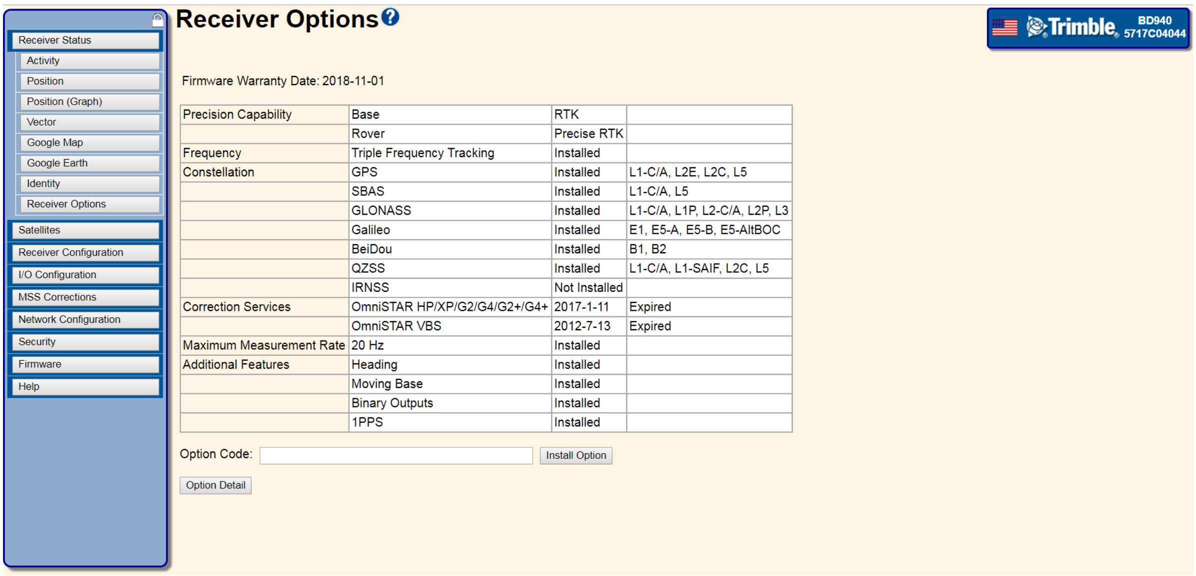
Monitor Version – Identifies the current monitor version on the Trimble receiver.

Antenna Database Version – Identifies the current Antenna database version installed on the Trimble receiver.

Hardware Version – Identifies the hardware version of the receiver.

Receiver Options

This page shows which functionality the Trimble receiver has enabled.



Precision Capability	Base	RTK	
	Rover	Precise RTK	
Frequency	Triple Frequency Tracking	Installed	
Constellation	GPS	Installed	L1-C/A, L2E, L2C, L5
	SBAS	Installed	L1-C/A, L5
	GLONASS	Installed	L1-C/A, L1P, L2-C/A, L2P, L3
	Galileo	Installed	E1, E5-A, E5-B, E5-AltBOC
	BeiDou	Installed	B1, B2
	QZSS	Installed	L1-C/A, L1-SAIF, L2C, L5
	IRNSS	Not Installed	
Correction Services	OmniSTAR HP/XP/G2/G4/G2+/G4+	2017-1-11	Expired
	OmniSTAR VBS	2012-7-13	Expired
Maximum Measurement Rate	20 Hz	Installed	
Additional Features	Heading	Installed	
	Moving Base	Installed	
	Binary Outputs	Installed	
	1PPS	Installed	

Firmware Warranty Date – The date on which support for this receiver expires. Any firmware that is dated earlier than this may be installed on the receiver. For firmware patches, the Firmware Warranty Date may be earlier than the Firmware Date. To purchase an extended warranty for the receiver, contact your local Trimble dealer.

Precision Capability – Defines the precision capabilities of the receiver in Base mode and Rover mode.

- Not Activated – The receiver needs to be activated using an upgrade code. This is usually completed by the Trimble Dealer or SITECH before delivery to the customer.
- Off – The receiver does not have this function installed. Ask your dealer if an upgrade is available.
- Base – RTK – The base receiver can transmit CMR/RTCM corrections.
- Rover – Precise RTK – The rover receiver is capable of positioning at survey precisions (sub-centimeter).
- Rover – Limited – The rover receiver is capable of positioning to the installed precision, e.g., 10/10 indicates it can position to 10 cm (RMS) horizontal and 10 cm (RMS) vertical. The actual precision depends on the correction source used.

Frequency

The total number of frequencies the receiver is capable of tracking. GNSS satellite constellations are capable of transmitting at three frequencies.

Single Frequency Tracking – The receiver can track a single frequency.

Dual Frequency Tracking – The receiver can track dual frequencies.

Triple Frequency Tracking – The receiver can track triple frequencies.

Constellation

Lists the GNSS satellite constellations tracking capability installed/enabled on the receiver.

Correction Services

Commercial GNSS augmentation services available for use on the receiver. Most of these services require a paid subscription through Trimble Positioning Services.

- RTX – The receiver can track Trimble CenterPoint RTX correction services. A CenterPoint RTX subscription is required to perform RTX surveying or to use unlimited xFill services. The table displays the date of expiry of your subscription. A date in the past represents there is not a valid subscription installed.
- xFill – When On, the receiver is capable of using the Trimble xFill RTK extension service. To use this service, you must have version 3.20 or later of the SCS900 software.
- OmniSTAR HP/XP – The receiver can track OmniSTAR-HP and OmniSTAR-XP signals.
- OmniSTAR HP – The receiver can track the RTX, OmniSTAR-HP, OmniSTAR-XP, and OmniSTAR VBS signals. To use RTX, the CMRx option must also be enabled via an RTK Location 30/30 or higher upgrade.
- OmniSTAR VBS – The receiver can track OmniSTAR VBS signals.

Maximum Measurement Rate

The maximum rate at which observable data (measurements) can be logged.

Communication

The available wireless communications installed on the receiver.

- Bluetooth – The receiver can use Bluetooth wireless technology for communications.
- Internal Radio – The internal UHF or VHF radio is installed. Also shown is the current radio bandwidth and country code.
- GSM/GPRS – The receiver can support a GSM/GPRS cellular modem.
- Wi-Fi – Indicates the receiver supports Wi-Fi in Access Point (AP) mode and Client modes.

Additional Features

- Binary Outputs – Enables the receiver to output raw GPS and optional GLONASS data in a Trimble proprietary format for use with datalogging.

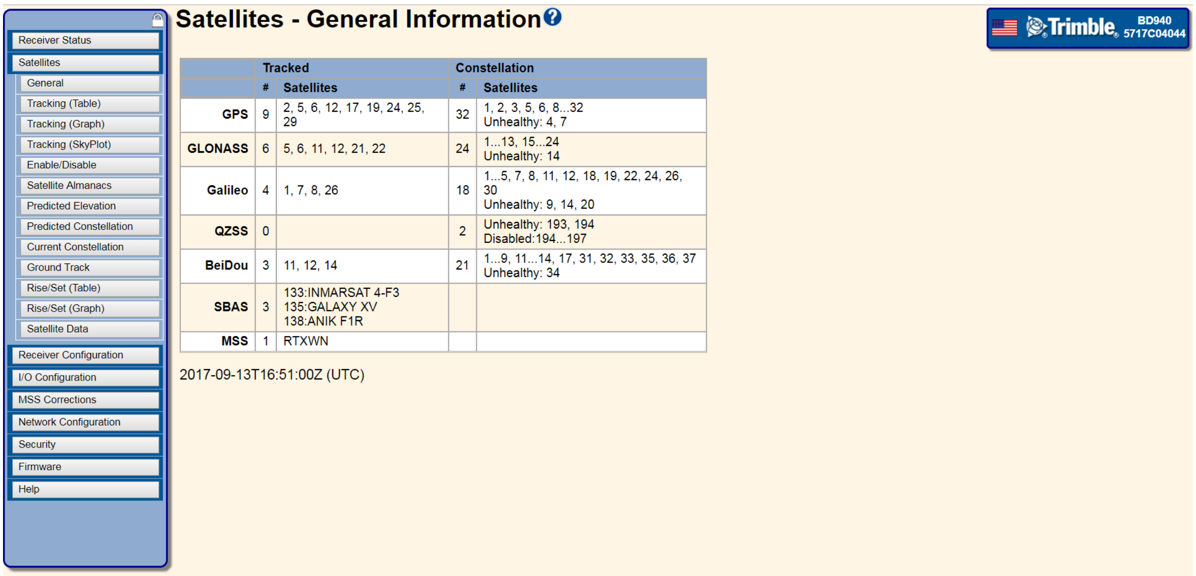
- **Data Logging** – The receiver can log raw GNSS data to internal memory. Also displayed is the total available memory in the receiver.
- **High Accuracy NMEA** – The receiver can output high accuracy (any position type other than Autonomous and SBAS) positions in NMEA messages to non-Trimble applications.
- **Option Code** – Enter an option code supplied by Trimble and then click **Install Option**. Option codes are used to enable new functionality in the receiver.

Satellites menu

Use the **Satellites** menu to view satellite tracking details and enable/disable GNSS and SBAS satellites.

Satellites – General Information

This page shows overview information about the satellites being tracked and the overall satellite constellation. The information on this display is updated every five seconds.



	Tracked		Constellation	
	#	Satellites	#	Satellites
GPS	9	2, 5, 6, 12, 17, 19, 24, 25, 29	32	1, 2, 3, 5, 6, 8...32 Unhealthy: 4, 7
GLONASS	6	5, 6, 11, 12, 21, 22	24	1...13, 15...24 Unhealthy: 14
Galileo	4	1, 7, 8, 26	18	1...5, 7, 8, 11, 12, 18, 19, 22, 24, 26, 30 Unhealthy: 9, 14, 20
QZSS	0		2	Unhealthy: 193, 194 Disabled:194...197
BeiDou	3	11, 12, 14	21	1...9, 11...14, 17, 31, 32, 33, 35, 36, 37 Unhealthy: 34
SBAS	3	133:INMARSAT 4-F3 135:GALAXY XV 138:ANIK F1R		
MSS	1	RTXWN		

Tracked – Shows the total count and PRN numbers of the satellites currently being tracked; the display includes GPS, QZSS, SBAS, RTX/OmniSTAR, and the optional GLONASS, Galileo, or BeiDou systems.

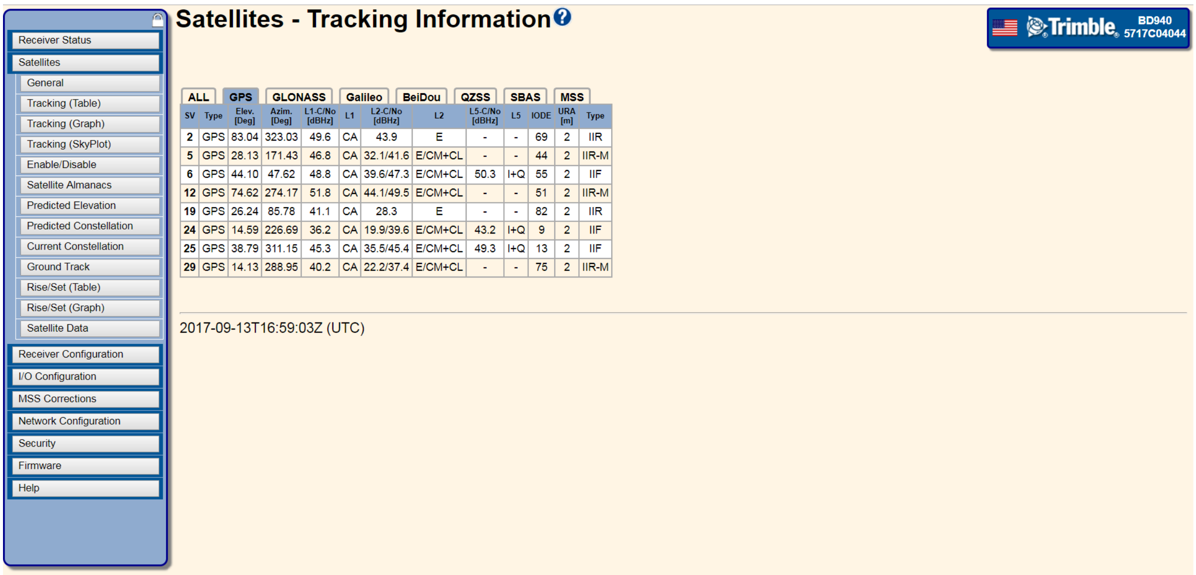
Constellation – Shows how many satellites are currently in orbit for the named constellation, and which, if any, are Unhealthy. This information comes from the most recent data transmitted in satellite almanacs.

Ignore Health – Shows how many satellites have been selected by the user to be tracked even if they are currently thought to be unhealthy. Typically, unhealthy satellites will not be tracked, measured, or used in position calculations.

Trimble has a free GNSS Planning Online tool at www.trimble.com/GNSSPlanningOnline.

Satellites – Tracking (Table)

This table shows information about the satellites that are currently being tracked. To sort the table based on column values, click the header at the top of the column.



The table is organized into tabs for each constellation for ease of viewing or can be viewed together using the **ALL** tab.

If the background color of a given satellite is red, the satellite is unhealthy. Data from unhealthy satellites is logged but is not used in the position solution.

If the background color of a given satellite on the table is orange, the receiver's RAIM (Receiver Autonomous Integrity Monitoring) algorithm has either detected a problem with the satellite or, if you are tracking SBAS, the corrections indicate there is an integrity problem with the satellite. In either case, the satellite is not used in the position solution.

If the background color of a given satellite on the table is blue, the satellite is tracked, but not yet fully phase locked, so it is not yet available for use in RTK. This typically occurs very briefly when a satellite is first acquired or when the environment is hostile to GNSS.

SV – The numeric identifier of the satellite tracked on the channel.

Type – Indicates if the satellite is GPS, GLONASS, Galileo, BeiDou, QZSS, SBAS (WAAS, EGNOS, MSAS) or MSS (OmniSTAR).

Elev [Deg] – The elevation of the satellite, in degrees above the horizon.

Azim [Deg] – The azimuth (direction) of the satellite, in degrees clockwise from True North.

L1-C/No [dB-Hz] / L2-C/No [dB-Hz] / L5-C/No [dB-Hz] – The signal-to-noise ratio of the satellite on either the L1, L2, or L5 frequency. Scaled to a 1 Hertz bandwidth. The SNRs are available for both Position antenna 1 (POS) and Vector antenna 2 (VECT) for dual-antenna systems.

L1 – The signal being tracked in the L1 frequency band (1525 to 1614 MHz for each satellite.

L2 – The signal being tracked in the L2 frequency band (1217 to 1257 MHz) for each satellite.

L5 – The signal being tracked in the L5 frequency band (1164 to 1214 MHz) for each satellite.

IODE (Issue of Data Ephemeris) – The numeric identifier for the latest ephemeris data collected from this satellite.

URA [m] (User Range Accuracy) – The satellite's estimate of the accuracy of its ranging signals, in meters.

Type – Indicates which satellite model or generation is being tracked (if known).

Satellites – Tracking (Graph)

This graph shows information about the satellites that are currently tracked.

To view the graphs, you need Scalable Vector Graphic (SVG) support. SVG is available for download from ADOBE as a browser plug-in. Download and install the Adobe SVG plug-in from the Adobe website (www.adobe.com/svg/viewer/install/) if it is not enabled in your browser.

The graph can be sorted based on the ***satellite ID*** or the ***elevation angle***. To change the ordering sequence, click Order by below the graph.

Type – Apply a filter by selecting or deselecting the type of satellite and tracked signal displayed. For dual-antenna systems, you can select both the position and vector antenna frequencies.

SV – The numeric identifier of the satellite tracked on the channel with a prefix to identify the constellation.

C/No – The SNR of the satellite on the selected frequencies; scaled to a 1 Hz bandwidth.

Elev [Deg] – The elevation of the satellite, in degrees above the horizon is shown on the horizontal scale below the SV.

Satellites – Tracking (Skyplot)

This plot shows the locations of the satellites that are currently being tracked centered on the receiver's antenna location.

To view the graphs, you need Scalable Vector Graphic (SVG) support. SVG is available for download from ADOBE as a browser plug-in. Download and install the Adobe SVG plug-in from the Adobe website (www.adobe.com/svg/viewer/install/) if it is not enabled in your browser.

The numbers on the outermost circle indicate the azimuth angle values.

The numbers on each of the inner circles indicate the elevation angle values.

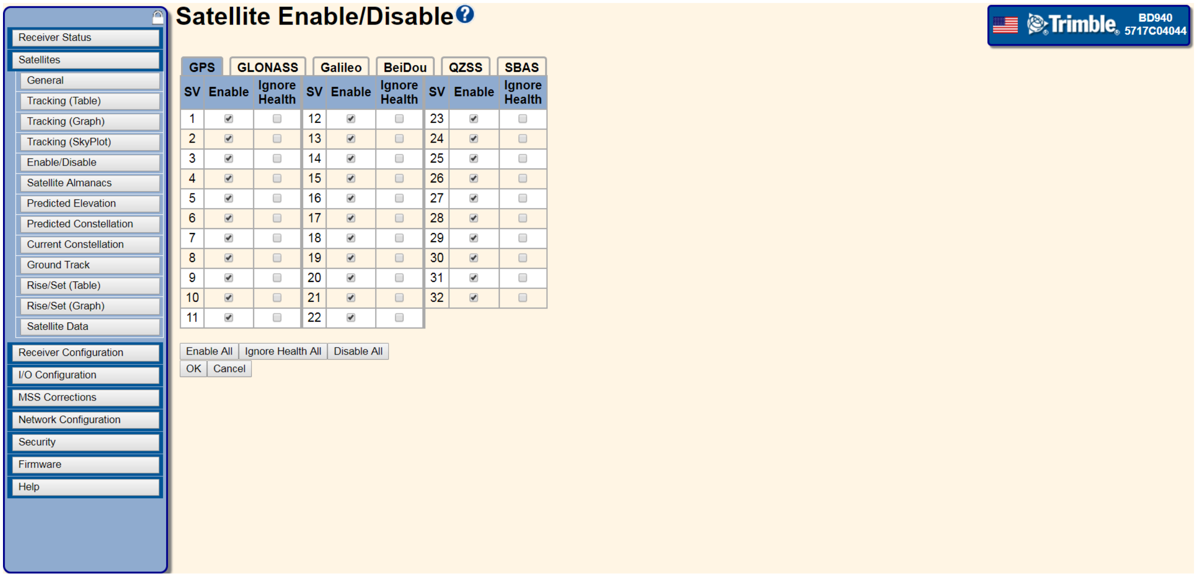
The color of the satellites signify its tracked constellation:

- Blue – Tracking GPS satellite
- Red – Tracking GLONASS
- Dark Green – Tracking an QZSS satellite
- Light Blue – Tracking an MSS (OmniSTAR/RTX) satellite
- Green – Tracking SBAS satellite
- Yellow – Tracking GIOVE or Galileo satellites
- Purple – Tracking BeiDou GNSS Satellites
- Gray – Satellite is above elevation mask but it is not yet being tracked

A bold pink ring around the satellite indicates it is being used in the current position solution.

Constellation tabs

A separate tab is available for each tracked constellation.



Use these settings to show and to control which satellites are enabled or are set to ignore bad health status. Each satellite has two check boxes associated with it. These check boxes control how the receiver treats each satellite.

An overall option to turn all tracking for each constellation on or off is available on the Receiver Configuration - Tracking page.

SV – The numeric identifier of the satellite.

Enable – If the Enable check box is selected, the receiver uses the satellite in positioning and places the measurements from that satellite in logged data files, as long as the satellite is reported to be healthy, or as long as the Ignore Health check box is checked.

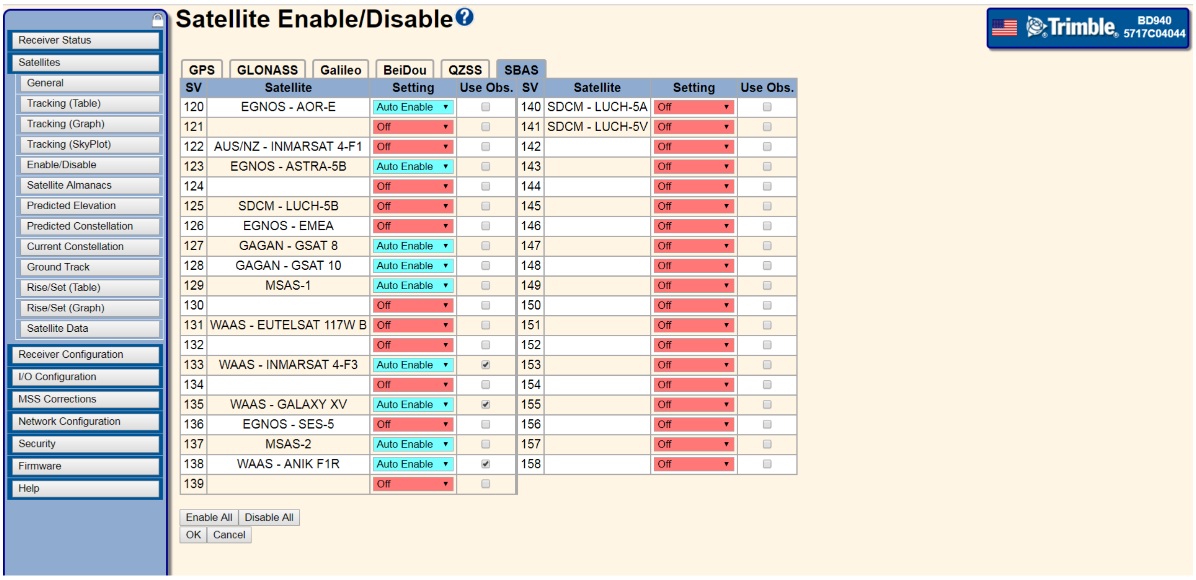
If the Enable check box is not selected, the receiver does not use the satellite in positioning, and does not place the measurements in logged data files, regardless of the reported health or the state of the Ignore Health check box. It is not recommended that satellites be explicitly disabled.

Ignore Health – The receiver does not normally track satellites that are considered unhealthy. However, if the Ignore Health check box is selected for a satellite, then the receiver tracks that satellite *even* if it is considered unhealthy. Measurements from that satellite are used in all outputs such as logged measurements, logged ephemeris files, and in any other output that gives raw measurement values. Regardless of this setting, unhealthy satellites are never used to calculate the position of the receiver. Trimble recommends that you *do not* track unhealthy satellites in normal (non-scientific) applications.

Use the **Enable All** and **Disable All** buttons as a quick way to turn on or off the use of all satellites if several have been disabled.

SBAS Satellite Enable/Disable

Use these settings to show and to control which Satellite-Based Augmentation System (SBAS) satellites are enabled or are set to ignore bad health status. An overall option is available to turn all SBAS tracking on or off. In addition, each SBAS satellite has a setting list associated with it so you can select how the receiver treats each satellite.



An overall option to turn all SBAS tracking on or off is available on the Tracking page.

SV – Shows the satellite ID.

Satellite – Displays the SBAS type and satellite identifier.

Setting –

- Off – The individual satellite is not tracked even if SBAS Tracking is set to Enabled on the Tracking page.
- Enable – The receiver uses the satellite in positioning as long as the satellite is reported to be healthy. For the selected satellites to be tracked, you must set global SBAS Tracking to Enable SBAS tracking on the Tracking page.
- Ignore Health – The receiver does not normally track satellites that are considered unhealthy. However, if the Ignore Health check box is selected for a satellite, then the receiver tracks that satellite *even* if it is considered unhealthy. Measurements from that satellite will also be used in all outputs such as logged measurements. Regardless of this setting, unhealthy satellites are never used to calculate the position of the receiver. Trimble recommends that you *do not* track unhealthy satellites in normal (non-scientific) applications.

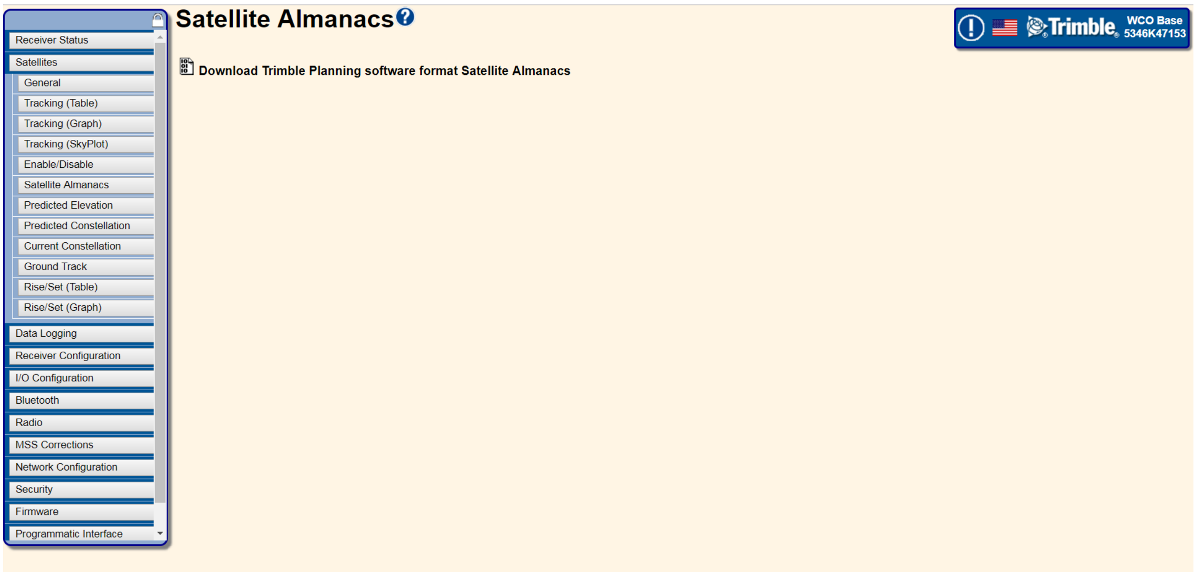
- Auto Enable – The WAAS/EGNOS/MSAS satellites are associated with a region of operation. The receiver detects the region of operation based on its location and uses only those satellites associated with it. To override this setting, set the satellite to Enable to track the satellite irrespective of location; the receiver attempts to use the data.

  TIP – To view the current status of the EGNOS system, go to www.egnos-pro.esa.int/index.html.

- Use Obs – The receiver uses the pseudorange in the SBAS corrected position solution. The receiver does not use it in any other position solution type.

Satellite Almanacs

This page enables you to download the current receiver almanac. Click on the Download link. The file can then be imported into the Trimble Planning software.

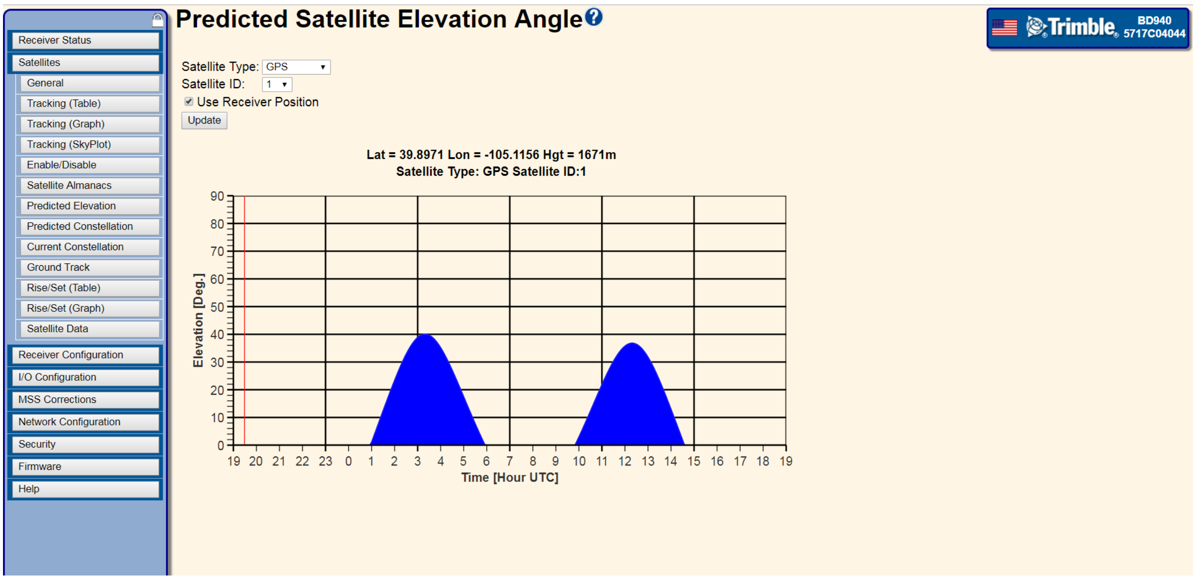


This software is available as a free download from www.trimble.com/GNSSPlanningOnline/#/Settings.

Predicted Satellite Elevation Angle

Use this page to view the predicted elevation angle of a particular satellite.

To view the graphs, you need Scalable Vector Graphic (SVG) support. SVG is available for download from ADOBE as a browser plug-in. Download and install the Adobe SVG plug-in from the Adobe website (www.adobe.com/svg/viewer/install/) if it is not enabled in your browser.



Satellite Type and Satellite ID – Select a satellite that you want to view:

- The GPS selection is available for all receivers.
- The other constellations are available only if the receiver is tracking them.
- Satellite numbers shown in red are unhealthy satellites.

For more information, see GPS Satellite Enable/Disable.

Use Receiver Position – Select this check box to view the elevation angle of the predicted satellite for the receiver's current position.

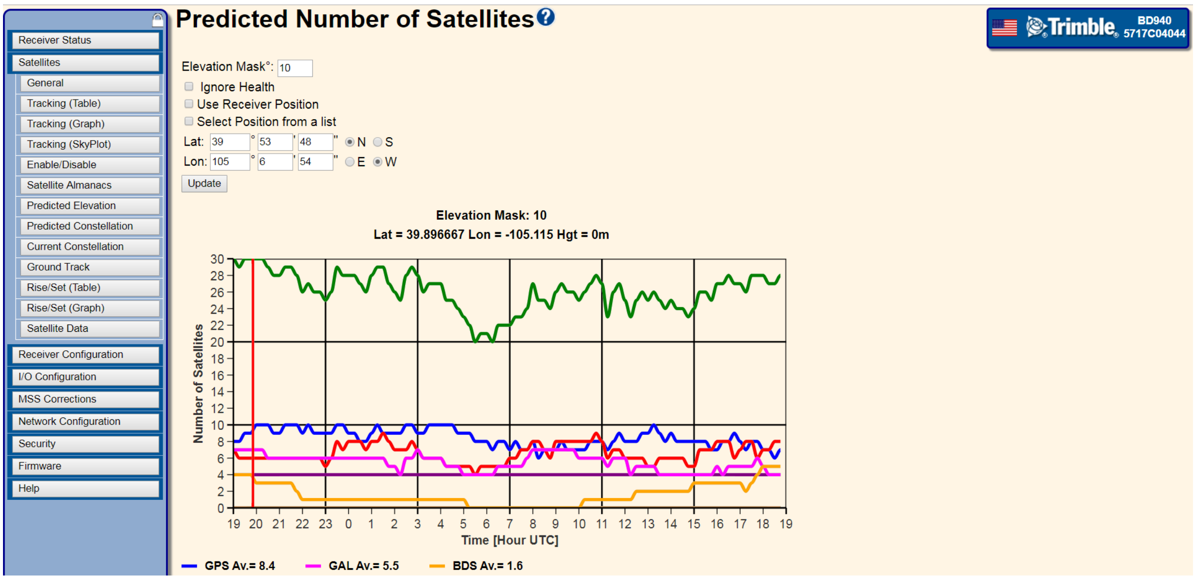
Select Position from a list – This option becomes available once you clear the **Use Receiver Position** check box. This enables you to select a major city from the list. To view the predicted satellite elevation angle for a particular location, clear the check box. Fields then appear where you can enter the location's latitude and longitude.

Select position using Latitude and Longitude – To view the predicted satellite elevation angle for a particular location, clear the check box. Fields then appear where you can enter the location's latitude and longitude.

Predicted Number of Satellites

Use this page to view the predicted number of satellites available per constellation from a specific location for the next 24 hour period.

To view the graphs, you need Scalable Vector Graphic (SVG) support. SVG is available for download from ADOBE as a browser plug-in. Download and install the Adobe SVG plug-in from the Adobe website (www.adobe.com/svg/viewer/install/) if it is not enabled in your browser.



Ignore Health – Select this check box to view both healthy and unhealthy satellites. By default, this check box is cleared as the receiver does not normally track satellites that are considered unhealthy. For more information, see Satellite Enable/DisableSatellite Enable/Disable.

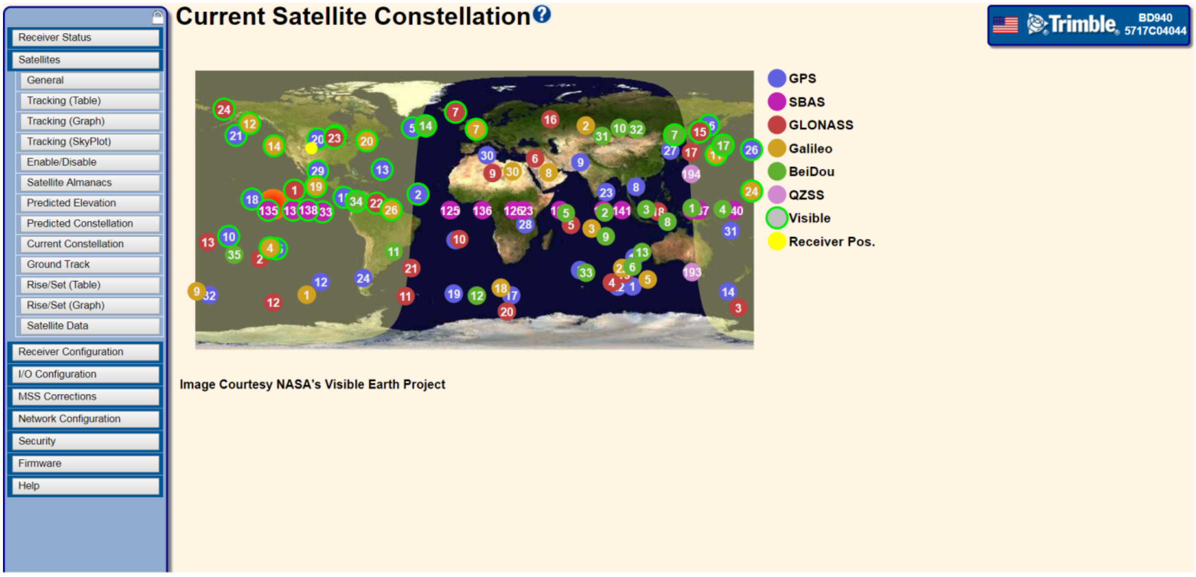
Elevation Mask – Select this check box to view the predicted satellite constellation for the elevation angle mask at the receiver's current position.

Use Receiver Position – Select this check box to view the satellite constellation for the receiver's current position.

Select Position from a list – This option becomes available once you clear the **Use Receiver Position** check box. This enables you to select a major city from the list. To view the predicted satellite constellation for a particular location, clear the check box. Fields then appear where you can enter the location's latitude and longitude.

Current Satellite Constellation

Use this page to view the current position of the entire constellation of satellites. The labels show the point on the earth directly beneath the satellite.

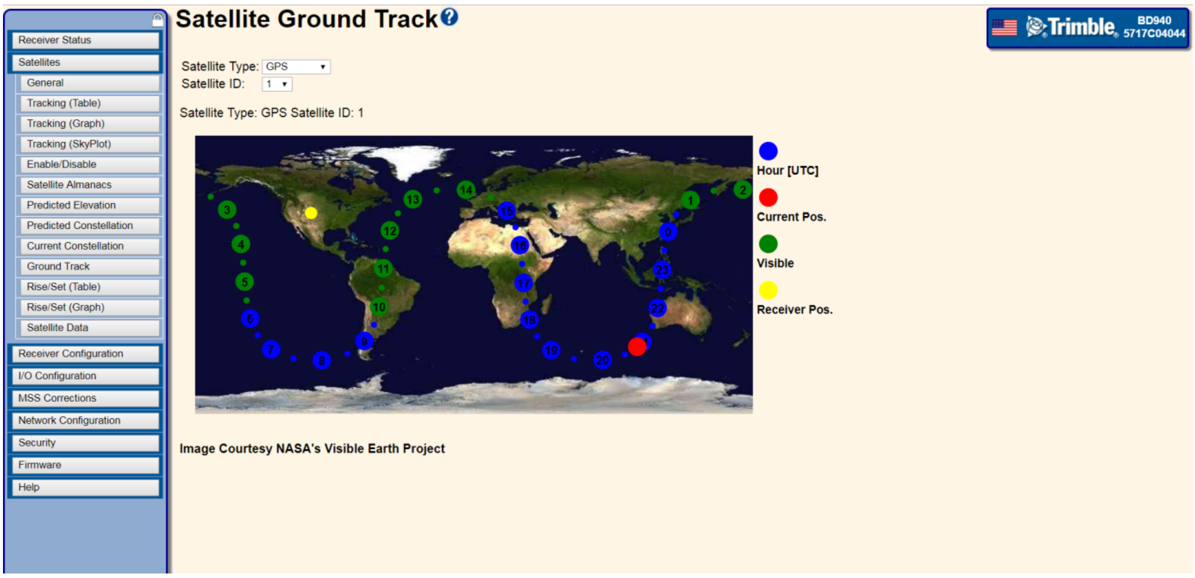


To view the graph, you need SVG support.

- Blue – GPS satellites
- Red – GLONASS satellites
- Magenta – Galileo satellites
- Brown – QZSS satellites
- Orange – BeiDou satellites
- Green circles – Visible satellites
- Yellow dot – Current receiver position

Satellite Ground Track

Use this page to view an orbit of a given satellite projected onto the earth. The graph shows the current position of the satellite and the time (in UTC format) that it will pass over various locations.



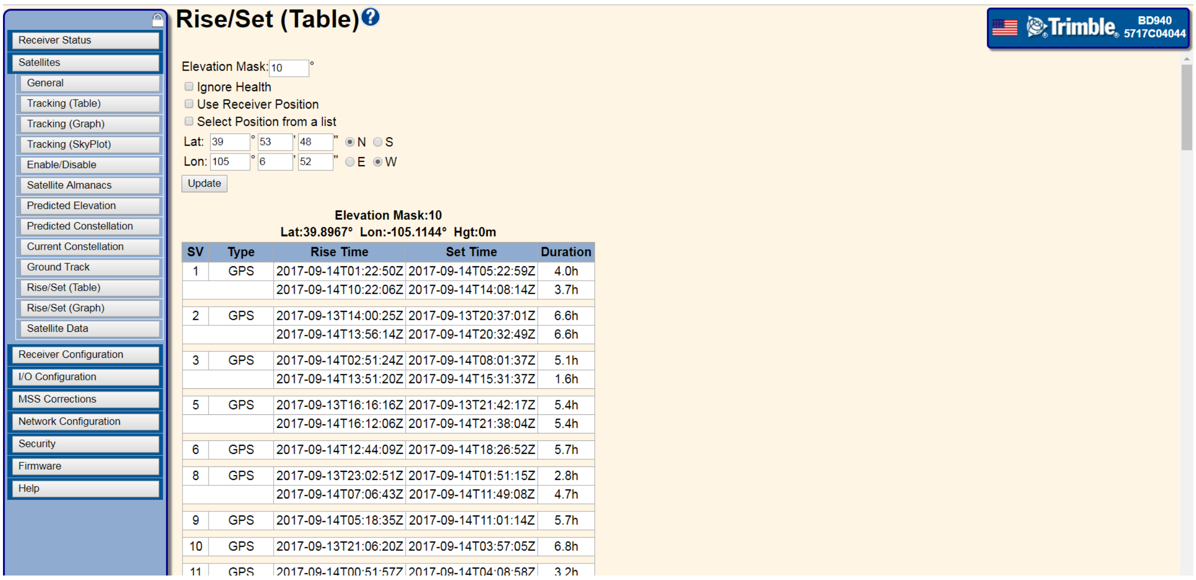
To view the graph, you need SVG support.

Select the Satellite Type from the list of available constellations and the satellite ID:

- The current location of the selected satellite above the earth is shown by in red.
- The UTC hour is shown for each location along the orbit.
- The current Receiver position is shown as a yellow dot.
- The satellite is visible from the Receiver position when the orbit is green.
- The satellite is not visible from the Receiver position when the orbit is blue.

Rise/Set (Table)

This table provides the UTC time at which the satellites currently being tracked by the receiver will rise above and set below the selected elevation mask at the selected location.



SV	Type	Rise Time	Set Time	Duration
1	GPS	2017-09-14T01:22:50Z	2017-09-14T05:22:59Z	4.0h
		2017-09-14T10:22:06Z	2017-09-14T14:08:14Z	3.7h
2	GPS	2017-09-13T14:00:25Z	2017-09-13T20:37:01Z	6.6h
		2017-09-14T13:56:14Z	2017-09-14T20:32:49Z	6.6h
3	GPS	2017-09-14T02:51:24Z	2017-09-14T08:01:37Z	5.1h
		2017-09-14T13:51:20Z	2017-09-14T15:31:37Z	1.6h
5	GPS	2017-09-13T16:16:16Z	2017-09-13T21:42:17Z	5.4h
		2017-09-14T16:12:06Z	2017-09-14T21:38:04Z	5.4h
6	GPS	2017-09-14T12:44:09Z	2017-09-14T18:26:52Z	5.7h
8	GPS	2017-09-13T23:02:51Z	2017-09-14T01:51:15Z	2.8h
		2017-09-14T07:06:43Z	2017-09-14T11:49:08Z	4.7h
9	GPS	2017-09-14T05:18:35Z	2017-09-14T11:01:14Z	5.7h
10	GPS	2017-09-13T21:06:20Z	2017-09-14T03:57:05Z	6.8h
11	GPS	2017-09-14T00:51:57Z	2017-09-14T04:08:58Z	3.2h

Ignore Health – Select this check box to view both healthy and unhealthy satellites in the predictions.

Elevation Mask – Enter the minimum elevation that you want to compute the satellites rise/set times. The rise and set times are based on when the satellites meets this criteria.

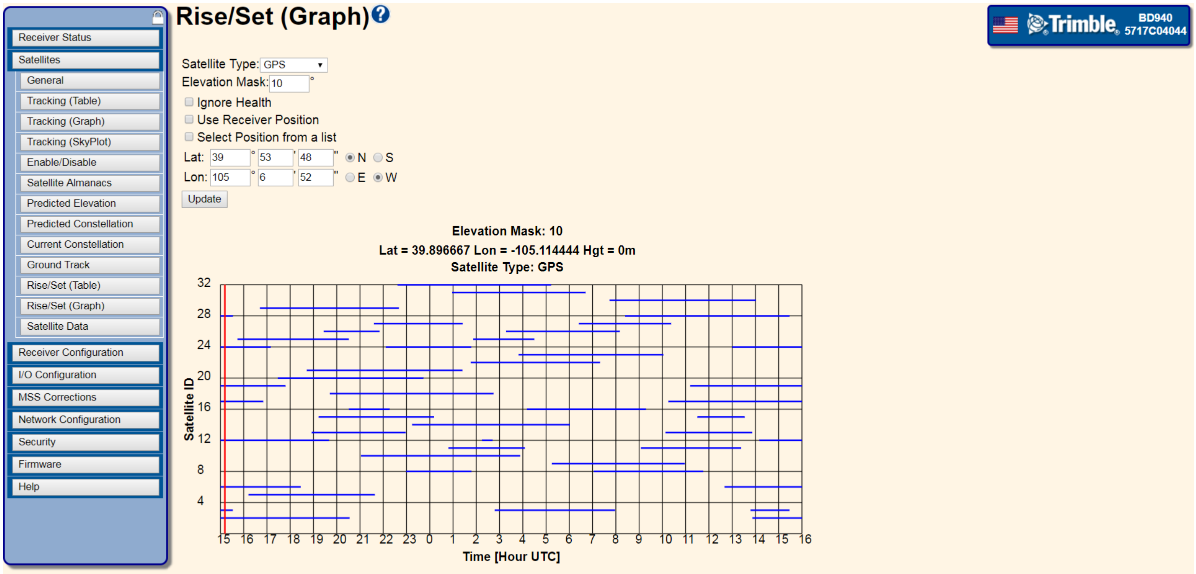
Use Receiver Position – Select this check box to use the current receiver latitude/longitude to compute rise/set times.

Select Position from a list – This option becomes available once you clear the **Use Receiver Position** check box. This enables you to select a major city from the list. To view the rise/set times for a particular location, clear the check box. Fields then appear where you can enter the location's latitude and longitude.

Click **Update** to show the predictions based on the data selected.

Rise/Set (Graph)

This graphic provides the UTC time at which the satellites currently being tracked by the receiver will rise above and set below the selected elevation mask at the selected location.



Satellite Type – Select the type of satellites to view the rise and set times from.

Ignore Health – Select this check box to view both healthy and unhealthy satellites in the predictions.

Elevation Mask – Enter the preferred minimum elevation to compute the satellites rise/set times. The rise and set times are based on when the satellites meets this criteria.

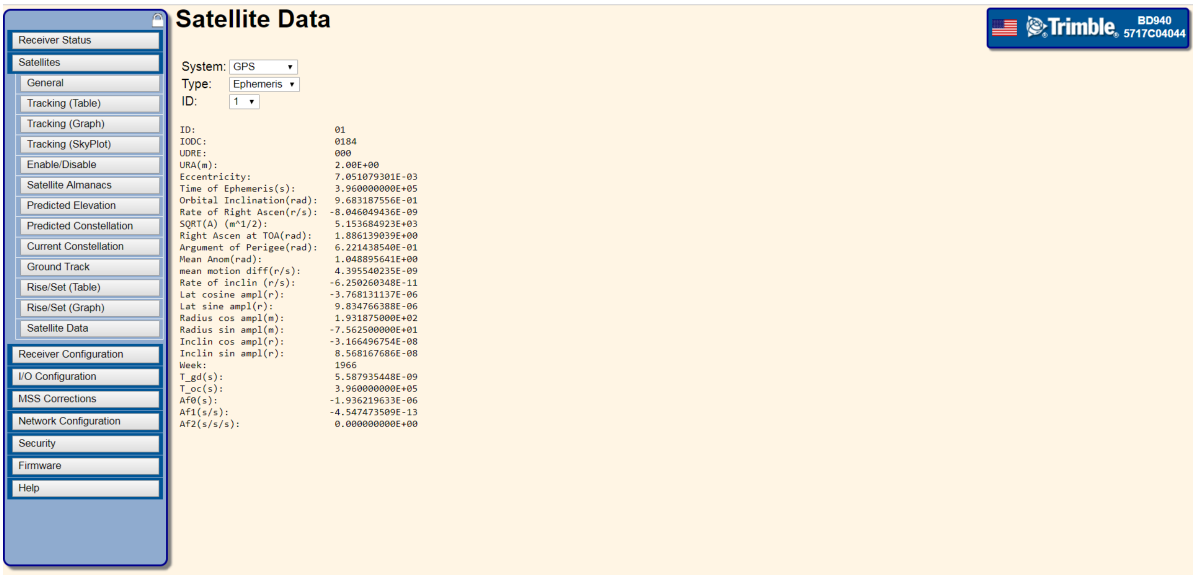
Use Receiver Position – Select this check box to use the current receiver latitude/longitude to compute rise/set times.

Select Position from a List – Select this check box to select positions from the main cities. Clear this check box to enter a latitude and longitude of the preferred position to get predictions from.

Update – Click **Update** to show the predictions based on the data selected.

Satellite Data

On this page you can view detailed information such as IODC (Issue of Data, Ephemeris), UDRE (User differential Range Error), Time of Ephemeris, Eccentricity, and rate of accent, for every satellite that is in view. You can view each satellite's detailed information by selecting the constellation, the type of data that you want to view, and the ID of the satellite. This screen shows Ephemeris information for Satellite ID:2 in the GPS constellation.

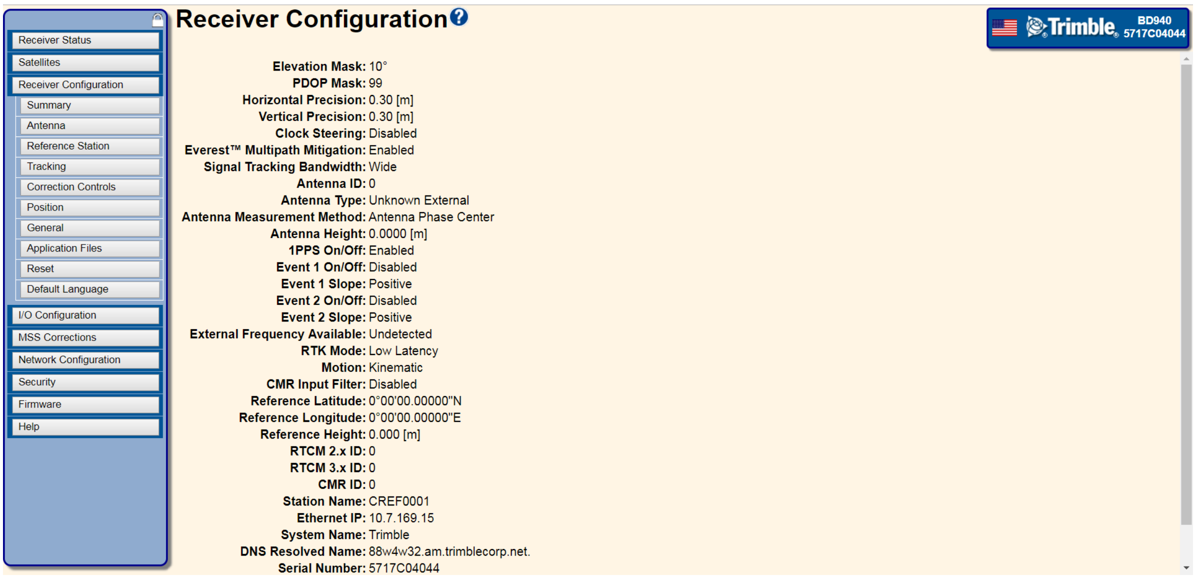


Receiver Configuration menu

Use the **Receiver Configuration** menu to configure such settings as elevation mask and PDOP mask, and the reference station position.

Receiver Configuration – Summary

This page displays the current settings of the receiver.



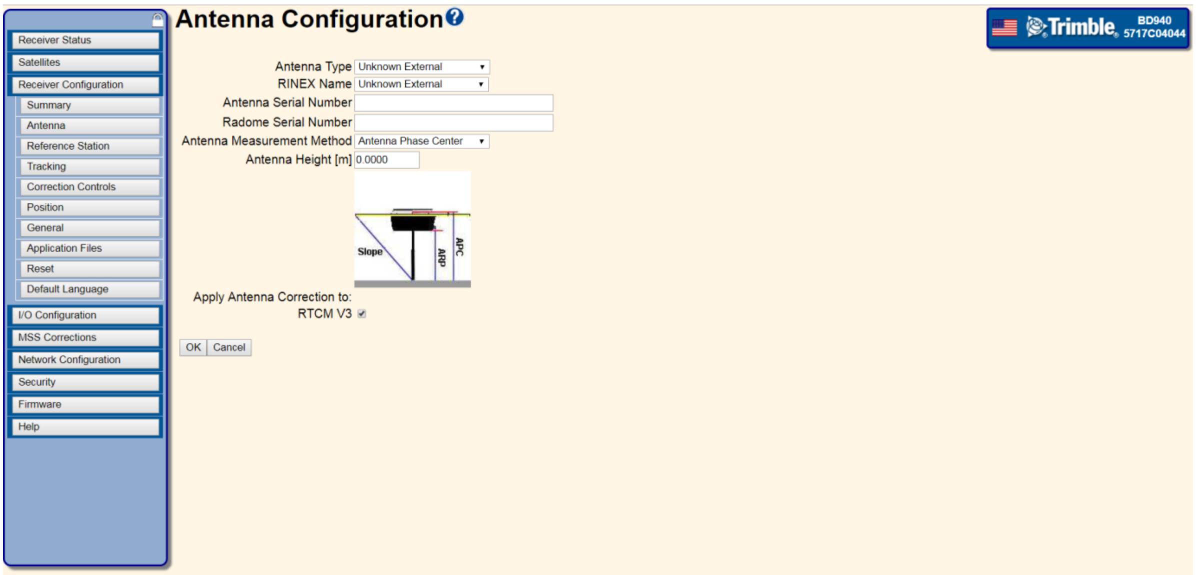
Select **Receiver Configuration** / **Summary**.

Receiver Configuration – Antenna

Use these settings to define the antenna being used by the receiver.

For dual-antenna systems, this is the Position antenna. You can also use these settings to define the Vector antenna deployed with the receiver.

NOTE – The receiver uses two antennas. All data relating to position references the Position (POS) antenna. The Vector (VECT) antenna is used to provide vector information only, such as the heading and attitude.



Antenna Type – Select the type of antenna being used with the receiver. The antenna serial number is automatically shown for the GNSS smart antenna.

RINEX Name – Allows the selection of the type of antenna being used with the receiver using the RINEX name of the antenna rather than the Trimble name for the antenna. Setting this field will automatically set the antenna type in the preceding field.

Antenna Serial Number – Enter the serial number of the antenna being used.

Antenna Measurement Method – Select how the antenna height is being measured.

Antenna Height [m] – Enter the measured height of the antenna. This is typically measured from a ground marker or the mounting point of the antenna.

Gain Amplification – Enable Gain Amplification if the sum of the antenna gain and the total cable loss is less than 38 dB. For example, if the antenna gain is 30 dB and the cable loss is 8 dB, then the sum is 30-8=22 dB (cable loss is negative) of gain. In this case, enable the Gain Amplification. Trimble antennas have an antenna gain of 50 dB and a maximum suggested cable loss of 12 dB for a total of 38 dB system gain, so the Gain Amplification should be set to Disabled. If a Trimble antenna is used with a very long cable run that has, for example, a 20 dB loss, then the system gain is only 30 dB, so Gain Amplification should be Enabled.

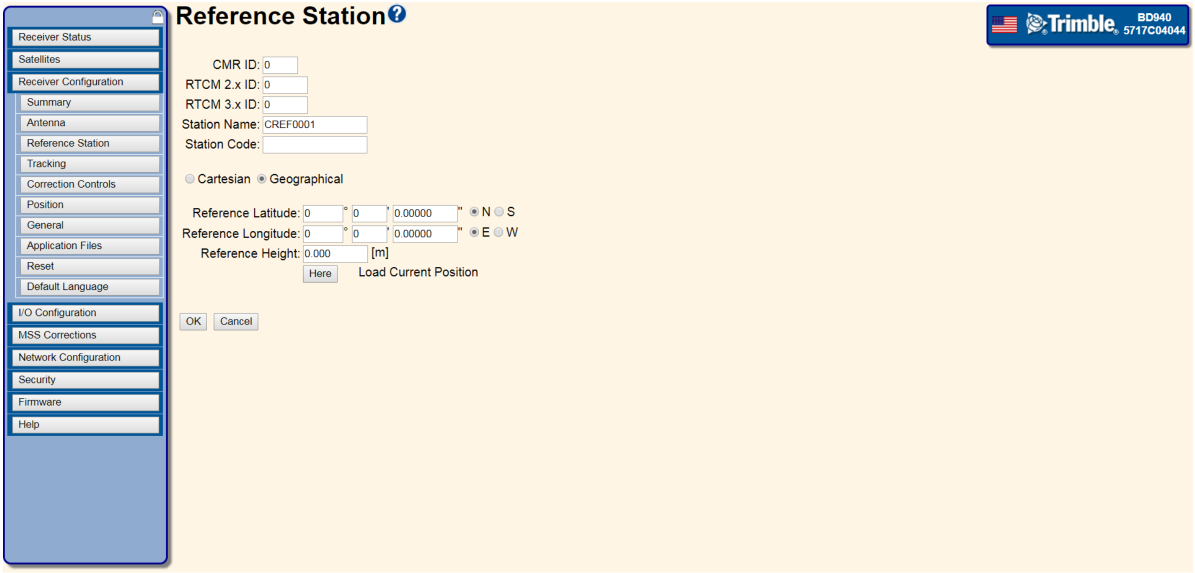
Apply Antenna Correction to – When the RTCM V3 check box is selected, the Base antenna is set to a "Null Antenna" and no antenna model parameters are sent to the rover receiver. When using Trimble receivers exclusively, Trimble recommends that you select the check box. In some case, when using a third-party rover receiver, the check box should be left cleared and the antenna model parameters are sent to the rover. To determine the settings for this parameter, check with the third-party manufacturer.

NOTE – If available, an image of the selected antenna is displayed, so that you can confirm that you have selected the correct antenna.

Receiver Configuration – Reference Station

Use these settings to set the position of the receiver and the ID of the data for use in RTCM and CMR output.

Select **Receiver Configuration / Reference Station**.



CMR ID – Enter a station ID for CMR corrections generated by the receiver (0 through 31).

RTCM 2.x ID – Enter a station ID for RTCM 2.x corrections generated by the receiver (0 through 1023).

RTCM 3.x ID – Enter a station ID for RTCM 3 corrections generated by the receiver (0 through 4095).

Station Name – Enter a name for the reference station (up to 16 characters).

This name is also used as the IBSS Base Station name.

Station Code – Enter a description for the reference station (up to 16 characters).

Reference Station Coordinate Type – Select a coordinate type using the *Cartesian* or *Geographical* options.

- **Cartesian (ECEF)** – An XYZ Cartesian Earth Centered Earth Fixed (ECEF) coordinate system is a coordinate system with the origin at the center of the Earth (as defined by a reference ellipsoid). The Z-axis coincides with the minor axis of the reference ellipsoid. The X-axis runs from the origin through a point on the equatorial plane at the zero meridian. The Y-axis is perpendicular to the X-axis on the equatorial plane. The coordinate of your reference station is defined in the plane of the X, Y and Z axis.
- **Geographical** – The "latitude" (abbreviation: Lat., φ, or phi) of a point on the Earth's surface is the angle between the equatorial plane and the straight line that passes

through that point and is normal to the surface of a reference ellipsoid that approximates the shape of the Earth. This line passes a few kilometers away from the center of the Earth except at the poles and the equator where it passes through the center of the Earth. Lines joining points of the same latitude trace circles on the surface of the Earth called parallels, as they are parallel to the equator and to each other. The north pole is 90° N; the south pole is 90° S. The 0° parallel of latitude is designated the equator, the fundamental plane of all geographic coordinate systems. The equator divides the globe into Northern and Southern hemispheres.

The "longitude" (abbreviation: Long., λ, or lambda) of a point on the Earth's surface is the angle east or west from a reference meridian to another meridian that passes through that point. All meridians are halves of great ellipses (often improperly called great circles), which converge at the North and South Poles.

A line, which was intended to pass through the Royal Observatory, Greenwich (a suburb of London, UK), was chosen as the international zero-longitude reference line, the *prime meridian*. Places to the east are in the Eastern hemisphere, and places to the west are in the Western hemisphere.

Reference Station Coordinates – Enter the reference station coordinate using the coordinate type selected.

- Cartesian –
  - Reference X – Enter the X coordinate of the reference station in meters (+/-). Enter using the WGS-84 reference frame only.
  - Reference Y – Enter the Y coordinate of the reference station in meters (+/-). Enter using the WGS-84 reference frame only.
  - Reference Z – Enter the Z coordinate of the reference station in meters (+/-). Enter using the WGS-84 reference frame only.
- Geographical –
  - Reference Latitude – Enter the latitude of the reference station in degrees, minutes, seconds, and north or south hemisphere. Enter a WGS-84 position only.
  - Reference Longitude – Enter the longitude of the reference station in degrees, minutes, seconds, and east or west hemisphere. Enter a WGS-84 position only.
  - Reference Height – Enter the ellipsoidal height of the reference station in meters. Enter a WGS-84 height only. The Antenna Phase Center must be directly vertically above the station.

Here – Click Here to load the current position of the receiver as the reference station position.

Average – Click Average to load the average position of the receiver as the reference station position. The average position can be displayed in Cartesian (Earth Centered, Earth Fixed – XYZ coordinates) or Geographic (latitude, longitude, height) coordinates. The averaging time is also displayed.

Position Averaging – Select either Cartesian or Geographical reference frame.

- Current Position – The current position in the selected reference frame.
- Average Position – The average position in the selected reference frame.

Reset Average – Click to reset the position averaging to zero and restart.

Auto Average – Select this check box to set the averaging time (between 20 and 600 seconds), then click OK to begin auto averaging. An error message warning that the current reference position is "far away from current position" appears; accept this (click OK) since the auto average position will be loaded as the reference station position when the auto average operation is complete.

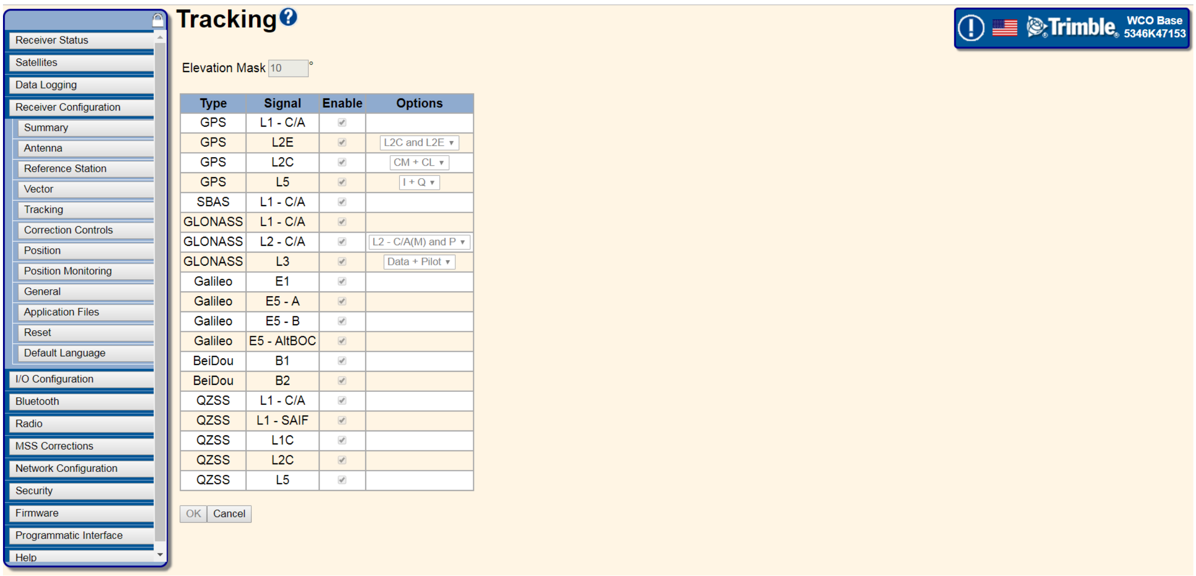
When performing an "auto-average", if the receiver position solution type changes, the auto-average starts from the beginning of the defined time period.

If the auto-average feature is running, the Here, Average, and Reset Average buttons are grayed out until the auto-average is complete. The auto-average can be canceled at any time.

The Auto Average feature is only available in the Web interface.

Tracking

On this page you can enter the elevation, in degrees, below which the receiver will not track satellites.



Receiver Configuration – Correction Controls

Select **Receiver Configuration** / **Correction Controls**.

Use these settings to manage the use of incoming RTK and DGNSS correction streams. If the receiver is receiving more than one correction stream or the same stream on different channels (such as radio, serial port, and Ethernet), predetermined criteria can be entered to set the preferred correction stream. Additional user-defined fallback settings can also be added.

The receiver always attempts to use the most precise positioning solution by using the following correction types in order:

1. RTK.
2. xFill.
3. RTX.
4. OmniSTAR XP/HP/G2.
5. Differential (DGPS, DGNSS).
6. OmniSTAR VBS.
7. Beacon DGPS.
8. SBAS.
9. Autonomous.

The correction streams are grouped into three categories according to how they will be processed:

- RTK
- DGNSS
- OmniSTAR

If there are multiple correction streams within any one of the three categories, the selection is made by the following rules in order:

1. Use the CMR Input Filter and RTCM Input Filter.
2. Use the user-defined Correction Controls.
3. If the category is RTK, use CMRx over CMR+™ over RTCM 3 over RTCM 2 (RTK).
4. If streams are of the same types, use the lowest Reference Station ID.
5. If the sources are identical, remain with the currently used channel.

CMR Input Filter – Select this check box to use CMR corrections from a single specific base station. In the ID field, enter a base station ID between 0 through 31.

RTCM Input Filter – Select this check box to use RTCM corrections from a single specific base station. In the ID field, enter a base station ID between 0 through 1023.

RTK – Use this control to use the rules manager to select which RTK service will be used based on user-defined criteria. By default, it is set to Any Channel with the option to Reject All Channels instead.

To select a channel based on user-defined criteria, click the Add Channel button (+). To add additional fallback channels and criteria, click the Add Channel button (+) next to the Else field.

Use the Change Channel drop-down list to select an I/O port as the primary correction source, and the Else field to select either the Any Channel or Reject All Channels option if the primary source is unavailable (or does not meet the specified criteria).

Once the you have selected a primary correction source, click the Add Qualifier button (+ on the right of the source) to select the Choose Qualifier option to specify when the primary source will be rejected.

Qualifiers can be set either by:

- Correction Age (user-specified period in seconds after the selected channel stops getting a valid correction stream before switching to the next source). Note: This is not the same as the DGNSS Age of corrections.)
- Base ID (user-specified from 0 through 9999)

To remove rules for channels and qualifiers, click the red X button next to the item to remove.

For example:

> Serial 2 / Modem 1 where Correction Age ≤ 20 seconds
> Else
> Radio where Base ID = 37
> Else
> Reject All Channels

DGNSS – Use this control to use the rules manager to select which DGNSS service will be used based on user-defined criteria in the same manner as RTK (see above).

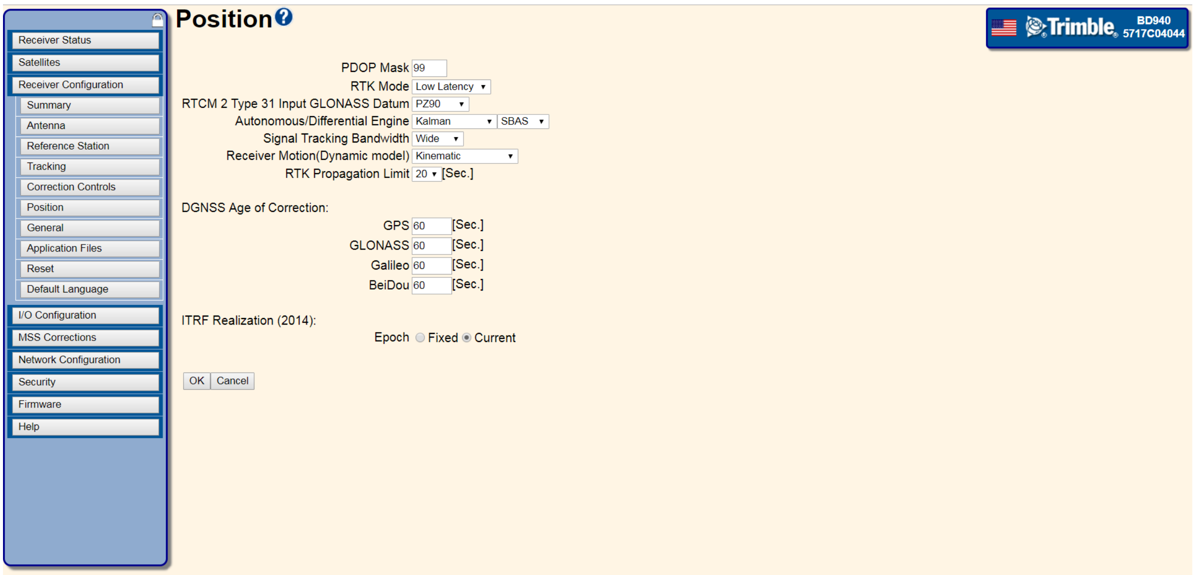
RTX Controls – Controls the enabling and disabling of the RTX-based functions in the receiver.

- Disable RTX – Disables any use of CenterPoint RTX, if the receiver has a current subscription.
- Disable xFill – Disables the use of xFill to 'fill in' for up to 5 minutes when RTK corrections drop out.
- Disable GVBS– Disables the use of clock and orbit information from the RTX corrections to augment the autonomous solution.

Receiver Configuration – Position

Use this page to set receiver position-related settings.

Select **Receiver Configuration** / **Position**.



PDOP Mask – Use the PDOP mask to enter the value for PDOP above which the calculation of new positions is suspended until the PDOP falls below the mask value again.

NOTE – This applies only to the calculation of position solutions. It does not affect the logging or streaming of GNSS measurements.

RTK Mode – Set the RTK Mode to Synchronous or Low Latency.

- **Synchronous** – The rover receiver must wait until the base station measurements are received before computing a baseline vector. Therefore, the latency of the synchronous position depends on the data link delay. A synchronous RTK solution yields the highest precision possible but is subject to latency. This mode is suitable for static and low-dynamic positioning.
- **Low Latency**– Provides a slightly lower precision solution than Synchronous mode but with a constant low latency, typically 20 msec. This mode is ideal for high-dynamic positioning where latency is an issue.

Signal Tracking Bandwidth – Allows for a DSP (Digital Signal Processor) selection for Wide or Narrow band tracking.

- **Wide** – This is the default setting and can be used for most field applications.
- **Narrow** – This allows less noise to pass through the filter, which can improve accuracy in certain conditions.

Receiver Motion – Set to operate as a static or kinematic receiver. This mode determines if the receiver is Static or Moving for base station applications and OmniSTAR initialization. For the BD935-INS, it is recommended to use the default setting, **Automotive**.

RTCM 2 Type 31 Input GLONASS Datum – If receiving RTCM 2 corrections from a GLONASS source, you can select the datum (PZ90 or PZ90.02) that they are based on.

Autonomous/Differential Engine – By default, the Kalman filter is on and results in higher quality position solution for autonomous or DGPS solutions when compared with a Least Squares solution. The Kalman selection works substantially better than a Least Squares solution in a mobile vehicle when there are frequent satellite signal dropouts around bridges or high buildings, and gives improved performance around forested areas.

A Kalman solution uses the time history of the position and velocity it has created, whereas a Least Squares option does not use the time history. Trimble recommends using the Kalman filter for most operations. Select Least Squares for non linear movement such as on a suction cutter dredge.

Signal Tracking Bandwidth – Allows for a DSP (Digital Signal Processor) selection for Wide or Narrow band tracking. The default is Wide band.

- **Wide** – Used for high dynamic applications to allow the signal tracking to compensate for a higher rate of change in the Doppler frequency caused by antenna movement.
- **Narrow** – Used in low dynamic applications where only relatively small changes in Doppler frequency are expected from antenna movement. Narrow bandwidth signal tracking allows less noise to pass through the filter to improve low dynamic positioning with better accuracy.

Receiver Motion (Dynamic Model) – As an aid to the Autonomous/Differential engine, you can select a dynamic model which best describes the dynamic environment for positioning.

Select Marine Dynamics when:

- Using a dual-antenna system outputting Rate of Turn to an application as this gives improved accuracy for that data. See NMEA-0183 message: ROT, page 234.
- Whenever a vessel is underway with a constant velocity.
- When a vessel is alongside with zero velocity. See NMEA-0183 message: VTG.

Horizontal Precision – The required horizontal precision that you set to determine when the horizontal quality indicator on the receiver display switches from flashing (precision threshold not met) to not flashing (precision threshold met). It also determines when an OmniSTAR solution has initialized.

Vertical Precision – The required vertical precision that you set. This threshold determines when the vertical quality indicator on the receiver display switches from flashing (precision threshold not met) to not flashing (precision threshold met).

DGNSS Age of corrections – Defines the maximum age of the DGPS corrections, in seconds, for each constellation. When this maximum age is exceeded, the corrections are not used in the position solution.

Position Output Source – Only available when the receiver is in Heading operation mode.

- Derived – By default, the receiver outputs the position derived from the Moving Base receiver position plus the Moving Base vector.
- Native – The Heading receiver outputs a position that is not derived from the incoming Moving Base CMR corrections, but the next most accurate position such as OmniSTAR or an SBAS or autonomous position.

For RTX capable receivers, the following menu items are available:

ITRF Realization (2014) –

Epoch – The default is Fixed. Fixed means ITRF2014 (2005.0 Epoch). If Current is selected, then the Latitude, Longitude and Height are determined on the ITRF2014 reference frame for the current date. For example, 31 January 2017 will be the 2017.08 Epoch. Up until 23 March 2017, the RTX was on ITRF2008.

Apply ITRF Transformation to – RTX selection is the default setting. If None is selected, the RTX position is still computed on the ITRF2014.

ITRF Epoch – This field cannot be edited and shows you that when Fixed Epoch is selected, then the 2005.0 Epoch is used.

Tectonic Plate – When the Fixed Epoch default setting is used, the receiver uses its position and automatically determines which tectonic plate it is on. The Auto setting is default. If the drop-down menu is opened, the selected plate and the four closest plates to the receiver position are listed. The Fixed epoch allows you to select another adjacent tectonic plate.

Recalculate – Click this button to force the current position of the receiver to be used to recalculate the selection of the correct tectonic plate. This button can be used when the Tectonic Plate is set to Auto. Other than at receiver power on, the receiver firmware does not continuously update the Plate selection if Auto is selected.

Click OK to apply the changed settings to the receiver.

Receiver Configuration – General

Use this page to set the general receiver settings.

Enable Shared Port – Sets the shared port on the receiver to be an additional serial port, a CAN bus, or a second Event Marker.

Event 1 On/Off – Enable or disable the first event marker function of the receiver.

Event 1 Slope – Sets the first event marker to have a Positive (rising) slope or Negative (falling) slope.

Event 2 On/Off – Enable or disable the second event marker function of the receiver.

Event 2 Slope – Sets the second event marker to have a Positive (rising) slope or Negative (falling) slope.

Autobase – Enable with Warning or disable the AutoBase function of the receiver.

- Disable – When a receiver is turned on, it automatically installs the CURRENT Application file and starts running, applying all previous settings.
- Enable with Warning – After the receiver has a stable position; it uses that position to search for a base position in the stored Application files in the receiver. If there is no base position within the AutoBase search distance (20 m 2D) of the current position in any of the stored application files, then AUTOBASE FAILED warning appears on the modular receivers that have the 2-line display so you can intervene and fix the problem. The receiver continues to use the CURRENT Application file, until you update the configuration or set up a new reference base setting. If corrections are turned ON in the previously mentioned CURRENT Application file, the receiver continues sending corrections with the previous base position in the CURRENT Application file. If the

CURRENT Application file does not have any corrections set up, then there will not be any transmissions.

Operation Mode – Choose between Base, Rover, Moving Base, and Heading modes.

- **Base** – Provides base station functionality. The Motion is set to Static.
- **Rover** – Provides rover functionality. The Motion is set to Kinematic.
- **Moving Base** – Provides Moving Base functionality. The Motion is set to Kinematic and a CMR output is configured on Serial 3. To reconfigure this, select **I/O Configuration** / **Port Configuration**. The RTK Mode is set to Low Latency to allow for the use of static CMR or RTCM corrections. However, you can change it to Synchronous if you use Moving Base CMR corrections from another Moving Base receiver.

  NOTE – The internal radio does not support transport of Moving Base CMR corrections.

- **Heading** – Provides Heading functionality. Requires CMR input from a Moving Base receiver. The Motion is set to Kinematic and the RTK Mode is set to Synchronous. If CMR corrections are available from a Moving Base receiver, the Heading (True North) is displayed on the receiver front panel.

Automatic MBase output – When enabled, the MBase CMR output is automatically configured to output on Serial 3 when Operation mode is set to Moving Base.

1PPS On/Off – Enable or disable the 1PPS (one pulse-per-second) output regardless of whether or not the clock has been set, and to continue to output even after the clock is believed to have degraded.

WARNING – Setting 1PPS may yield inaccurate results when the receiver is not tracking enough satellites to set time.

Receiver Configuration – Application Files

Use these settings to configure and activate application files for the receiver.

The receiver can generate application files, which you can then download.

You can configure and activate Clone files, which include the information included in Application files as well as the optional IP (Internet, Network) and Ephemeris settings. The application files are typically used to duplicate the settings from a master receiver to multiple receivers in the field.

NOTE – Installing a Clone file on a receiver with I/O settings configured, ***does not*** *disable or replace the I/O settings currently in the receiver. A Clone file only adds I/O configurations; it does not disable or replace them.*

Calibration and Projection information in the Trimble DC or CAL files can be imported to enable the receiver to output site or map projection coordinates in the relevant output messages such as NMEA PJK.

Executing App. File Name – The display box at the top of this page shows which application file is currently running, for example:

Executing App. File Name ALPHA1

Operation – Select one of the following:

- Start Now – Select an application file and then click OK to start the application file.
- Enable Timer – Prompts you for a date and time, in UTC format, to start the selected application file.
  - Repeat – Enables you to define how often the application file is reapplied.

For example, create an application file called START so that CMR output start at 7 am, and repeats every 24 hours. Also create an application file called STOP so that CMR outputs are not sent after 7 pm, and repeat this every 24 hours.

NOTE – Enter the date and time in UTC format.

- Disable Timer – Disables the presently enabled Timer function for application files.
- Delete File – Deletes the application file that was selected from the Filename list.
- Download File – Exports the application file from the receiver to an external directory. It prompts you to name the file.
- Upload File – Imports an application file from an external directory to the receiver. It prompts you to browse for the file and, if required, rename it.
- Store Current File – Stores the current application file receiver settings to the non-volatile RAM of the receiver. It prompts you to name the file.
- Start Default Now – Activates the factory default application file immediately.
- Generate Clone File – Generates an XML file. When you select this option, a filename field appears. Enter the preferred name to assign to the clone file. There are also prompts to generate various settings that are not included in application files.
- Install Clone File – Prompts you to install a clone file from a list of XML files.
- Upload Clone File – Imports a clone file from an external folder to the receiver. It prompts you to browse for the file and, if required, rename it.
- Download Clone File – Exports the application file from the receiver to an external folder with an option to compress it with GZIP.
- Delete Clone File – Deletes the clone file that was selected in the Filename list.
- Upload & Install clone file – Imports and installs a clone file from an external folder to the receiver. It prompts you to browse for the file and, if required, rename it before installation. In addition, an option to install a static address from the clone file is available.
- Upload & Apply Projection and Calibration file – Select this when there is a preferred DC or CAL file to upload into the receiver. The DC or CAL files are available from the SCS900 Trimble Business Center software and other Trimble devices and utilities. When they are loaded into the receiver, map projection or site coordinates can be output in the form of North, Easting, and Elevation values.

For example, if a valid DC or Projection file is loaded, the NMEA PJK message outputs NEE.

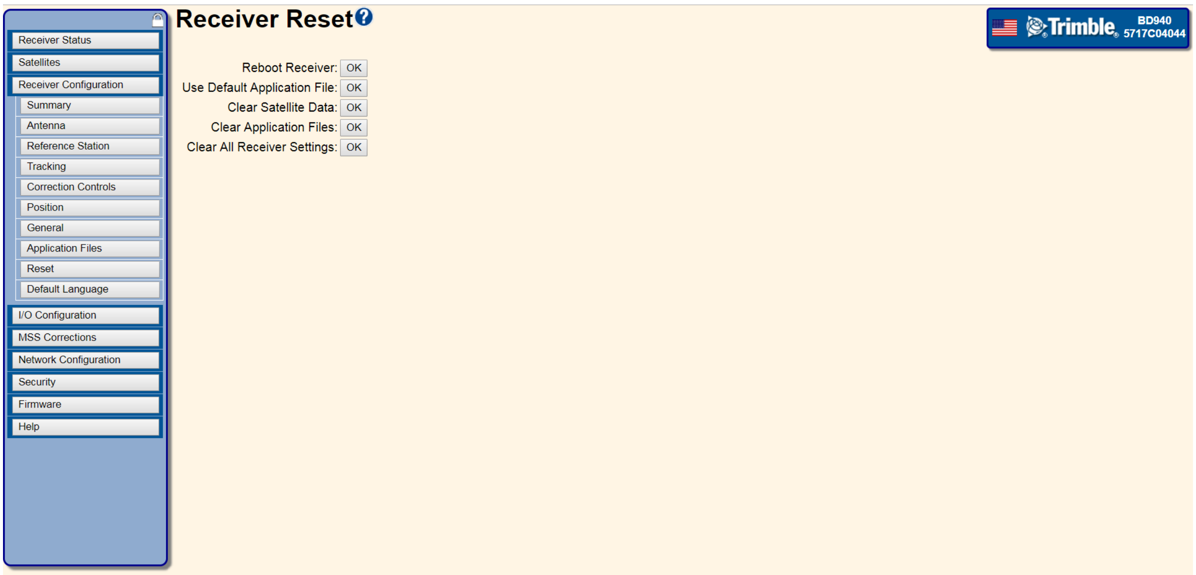
Once this item is selected, the Select File menu prompts you to browse for a file with a DC or CAL file extension. Click OK to load the selected file.

- View & Apply Projection and Calibration file – Select this and the file that was previously loaded into the receiver. The map projection and calibration data (if in the file) appear. Click OK.
- Delete Projection and Calibration file – Select this and the adjacent file to remove the file and its parameters from the receiver. Once you click OK, any NEE outputs using this data will no longer output NEE values.

Filename – Select the application file on which to apply the operation. It is recommended that you use a name that clearly defines what the application file is to be used for.

Current Timer Setting – Displays Enabled or Disabled to reflect current timer setting configured in the Operation field above.

Receiver Configuration – Reset



Reboot Receiver – Select this option to restart the receiver. All data and settings are kept.

Use Default Application file – Select this option to reset the receiver to its factory default settings. The satellite ephemeris and almanac data and all logged data files are kept. The receiver does not restart.

Clear Satellite Data – The satellite ephemeris and almanac data is cleared, and the receiver restarts.

Clear Application Files – Select this option for the receiver to perform the two operations above and also clear any application files resident in non-volatile memory. The receiver restarts. All Ethernet network settings are kept.

Clear All Receiver Settings – Select this option for the receiver to perform the three operations above and also clear all Ethernet network settings. The receiver restarts.

Receiver Configuration – Default Language

Use this menu to select the default language of the web interface. The receiver language setting is contained in the web browser cache. To see the language change, clear the browser cache or open a new browser.

Select **Receiver Configuration** / **Default Language**.

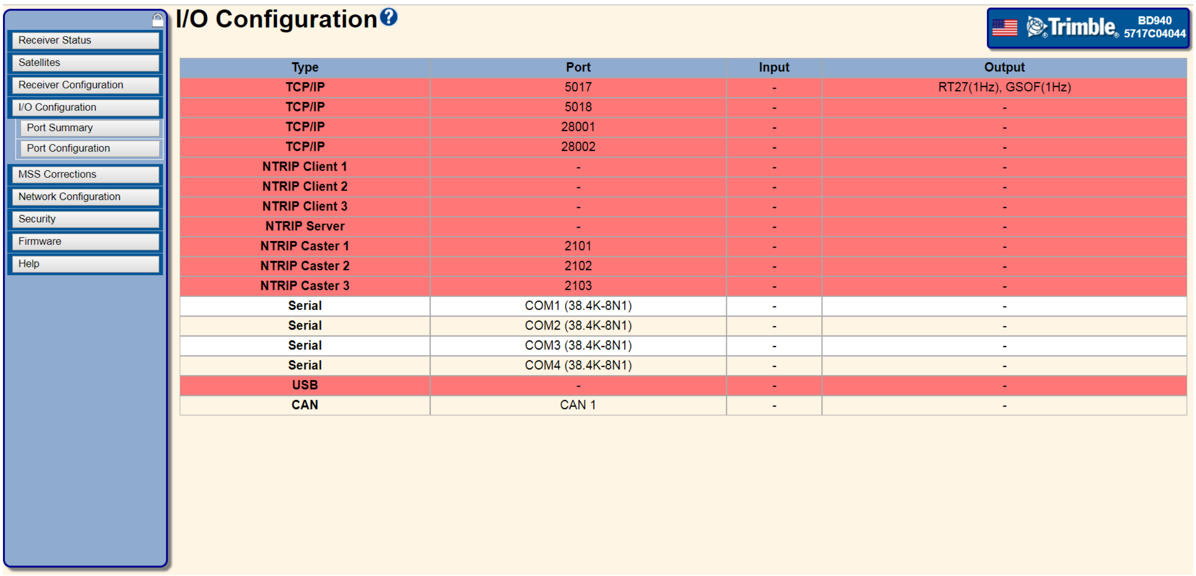
To change the language, click the option next to the corresponding country flag.

I/O Configuration menu

Use the **I/O Configuration** menu to set up all outputs of the receiver. Depending on the receiver's specification it may output CMR, RTCM, RTCM-REPEAT, RT17/RT27, NMEA, GSOF messages on a variety of ports including TCP/IP, NTRIP, UDP, serial ports.

I/O Configuration – Port Summary

This page provides a summary of input and output ports available to the receiver.



Type	Port	Input	Output
TCP/IP	5017	-	RT27(1Hz), GSOF(1Hz)
TCP/IP	5018	-	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client 1	-	-	-
NTRIP Client 2	-	-	-
NTRIP Client 3	-	-	-
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	COM1 (38.4K-8N1)	-	-
Serial	COM2 (38.4K-8N1)	-	-
Serial	COM3 (38.4K-8N1)	-	-
Serial	COM4 (38.4K-8N1)	-	-
USB	-	-	-
CAN	CAN 1	-	-

To edit the settings, click on the port type. The opens where you can edit the configuration settings for that port.

Type – Indicates what types of inputs/outputs are available.

- **TCP/IP** (Transmission Control Protocol/Internet Protocol) – A connection over an IP network.
- **UDP** (User Datagram Protocol) – A connection over an IP network.
- **IBSS/NTRIP Client 1, 2, 3** – A connection to IBSS or an NTRIP Caster for receiving correction data.
- **IBSS/NTRIP Server 1, 2, 3** – A connection to IBSS or an NTRIP Caster for sending correction data.
- **NTRIP Caster 1, 2, 3** – Allows up to ten users (NTRIP Clients) per port to request single base correction data.
- **Serial** – An RS-232 connection.
- **USB** (Universal Serial Bus) – A connection over USB.

NOTE – NTRIP is Networked Transport of RTCM via Internet Protocol. IBSS is Internet Base Station Service.

Port – Which port the input/output is being transferred on.

- TCP/IP or UDP – The port number will be displayed.
- IBSS/NTRIP Client – The type of the service and the name of the base station or Mountpoint it is connected to.
- IBSS/NTRIP Server – The type of the service and the name of the base station or Mountpoint being sent to the NTRIP Caster.
- Serial – Serial ports will indicate the receiver connector, baud rate, data bits, parity, and stop bits settings of the port.
- USB – No port will be displayed.

Input – The type of input that is received on the port. The correction stream input currently being used in the position solution will be shown in bold text.

Output – The type of output that is sent on the port.

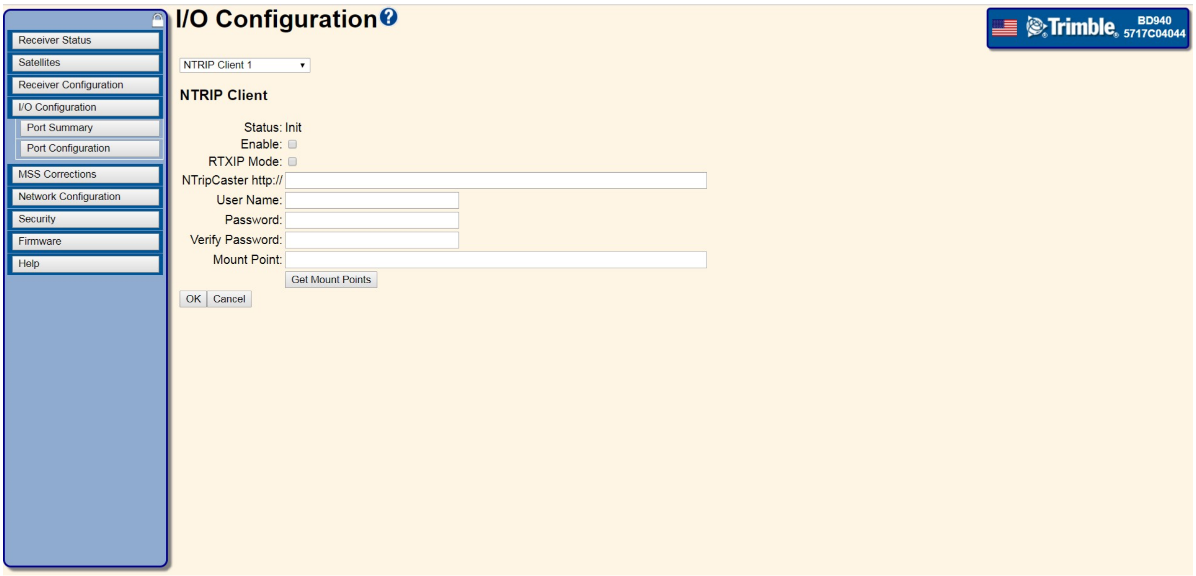
Connection Colors – The color of the connection provides additional status information.

- Green – Indicates an active connection from another device on that port.
- Yellow – Indicates a connection is having problems or is not functioning properly.
- Red – Indicates no connection from another device on that port.
- No highlight – The serial port connections are not highlighted since it is not possible to distinguish if there is a connection from another device.
- Bold – Indicates that this correction stream input is currently being used for the position solution.

Settings for the type of ports can be edited by clicking on the port type. A Port Configuration page opens and you can edit the configuration settings for that port. For example, clicking on NTRIP Client 1 opens a new web page that shows fields for setting up the NTRIP feed:

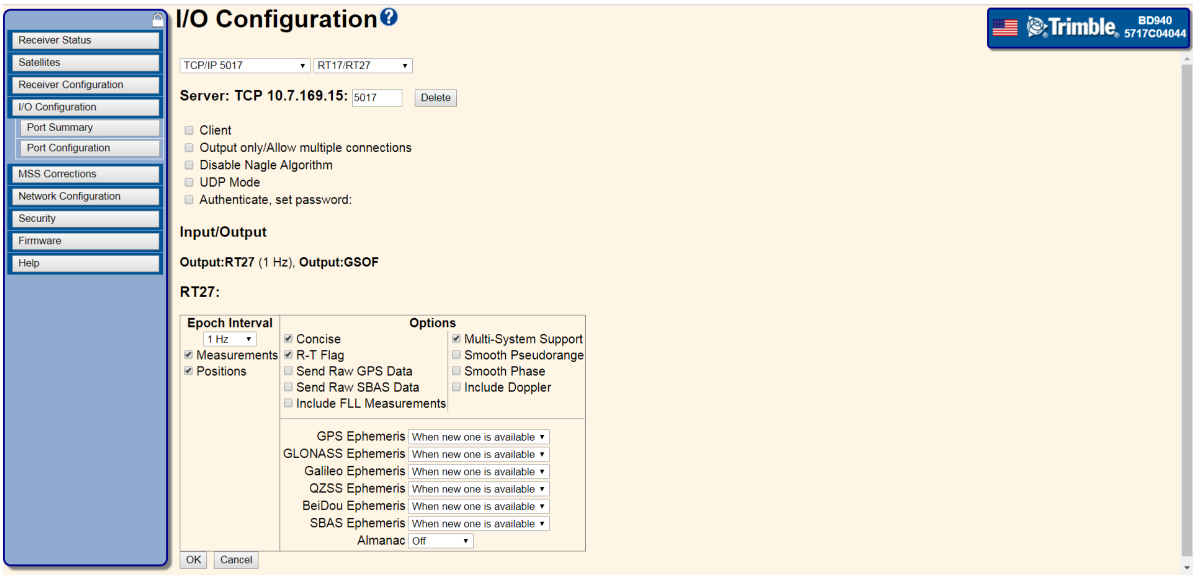
- Status
- Enable
- RTXIP Mode
- NTRIP CASter http://
- User Name
- Password

- Verify Password
- Mount Point



I/O Configuration – Port Configuration

Use these settings to set up the receiver inputs and outputs.



Port Selection

- Port – The first drop-down list displays which type of port is available for configuration.
- Output Type – The second drop-down list displays which output type is sent out of each port.

One of the following output groups appears with configuration settings, depending on the option that you select in the drop-down list at the top of the page:

- CMR
- RTCM
- REPEAT-RTCM
- NMEA
- RT17/RT27
- BINEX
- GSOF
- OMNISTAR
- 1PPS

Select one of the following options:

- TCP/IP 5017
- TCP/IP 5018

- Add TCP/IP or UDP Port
- IBSS/NTRIP Client
- IBSS/NTRIP Server
- NTRIP Caster 1
- NTRIP Caster 2
- NTRIP Caster 3
- USB

TCP/IP 5017 and TCP/IP 5018. TCP/IP:28001 and TCP/IP:28002

By default, these ports are available. However, these can be changed to add or remove other ports.

Client – Select this check box to enter a Remote IP and port. This enables the receiver to initiate a connection to the remote server. This can be used when the receiver is behind a network firewall or has a dynamic IP address.

Output Only/ Allow Multiple TCP/IP Connections – Select this check box to configure the receiver so that it can broadcast to multiple simultaneous remotes. The remotes are unable to send data back to the receiver. Trimble strongly recommends this setting for all ports without a two-way data requirement. If this is not enabled, remotes can reconfigure the receiver.

UDP Mode – Select this check box to use UDP (User Datagram Protocol) instead of TCP. You can edit a UDP timeout. By default, it is set to 60 seconds.

- UDP Broadcast Transmit – Selecting this option will allow the broadcast of data (e.g., CMRx) to any devices on the same local network by using the IP broadcast address of 255.255.255.255.
- UDP Broadcast Receive – Selecting this option will allow the receipt of data (e.g., CMRx) from a UDP Broadcast Transmit device on the same local network.

Authenticate, set password – Select this check box so that all incoming connections are required to enter a password to authenticate the connection. This is not NTRIP authentication.

Add TCP/IP or UDP Port

Select this option to add a new TCP/IP port to the receiver.

UDP Mode – Select this check box to use UDP (User Datagram Protocol) instead of TCP.

Local Port# – Select the port number that is to be used and then click Add to create the configuration.

Depending on the option that you select in the drop-down list at the top of the page, the options for configuration changes:

- CMR
- RTCM
- REPEAT-RTCM
- NMEA
- RT17/RT27
- BINEX
- GSOF
- OMNISTAR
- 1PPS

IBSS/NTRIP Client

<does IBSS apply to the BD receivers?>>

This option allows correction data to be received securely from an NTRIP Caster. The NTRIP source may be:

- A Trimble VRS Network
- A Trimble NTRIP Caster
- The Trimble Internet Base Station Service (IBSS)
- Another NTRIP compliant correction source

NTRIP version 2 is supported in firmware version 4.14 and later.

Status – Indicates the current status of the NTRIP connection:

Status	Meaning
Init	NTRIP Client disabled.
Up and Connected	NTRIP Client is connected to a source of corrections and receiving data.
Invalid Mountpoint	NTRIP error 404 returned from NTRIP Caster.
Invalid Username or Password	NTRIP error 401 returned from NTRIP Caster.
Failed to connect to remote NTRIP Caster	Connection failed due to an Internet-related issue.

Status	Meaning
No GNSS data from Caster	NTRIP error 503 returned from NTRIP Caster. No data available from the NTRIP Caster.
Unexpected internal error	NTRIP Caster internal error.
Incorrect NTRIP Caster response	NTRIP error 602 returned from NTRIP Caster.
No output stream is configured	NTRIP error 604 returned from NTRIP Caster.
Connection in progress	The NTRIP Client is in the process of connecting to the NTRIP Caster.
Unknown Ntrip Status	The status is not one of those listed above.

Enable – Select to enable NTRIP Client.

IBSS Mode – Checking this mode provides a simplified interface for IBSS:

- TCC Organization – Enter the TCC Organization name.
- TCC Device ID – The Device ID is generated by the receiver.
- TCC Password – Enter the TCC password provided by your Organization's TCC administrator.
- Base Name – Enter the name of the base station preferred as the source of your corrections if known, or select from the list using the Get Base Name list button.
- Get Base Name List – Use this button to obtain a list of available IBSS base stations for selection. The list is ordered with the closest at the top of the list and includes the distance from your current location in km.

NTRIP Caster HTTP:// – The address and port of the NTRIP Caster that the receiver will connect to in order to receive correction data.

Username – Enter the username required to log on to the server.

Password – Enter the password required to log on to the server.

Verify Password – Re-enter the password required to log on to the server.

Mount Point – Enter name of the correction stream to which you are connecting on the NTRIP Caster if known, or select from the list using the Get Mount Points button.

Get Mount Points – Use this button to obtain a list of available IBSS base stations for selection. The list is ordered with the closest at the top of the list and includes the distance from the receiver's current position in km.

IBSS/NTRIP Server

This option enables the receiver to connect to IBSS or an NTRIP Caster to send correction data securely across the internet.

Status – Indicates the current status of the NTRIP connection:

Status	Meaning
Init	NTRIP Server disabled.
Up and Connected	NTRIP Server is connected to an NTRIP Caster and sending correction data.
Invalid Mountpoint	NTRIP error 404 returned from NTRIP Caster.
Invalid Username or Password	NTRIP error 401 returned from NTRIP Caster.
Failed to connect to remote NTRIP Caster	Connection failed due to an Internet-related issue.
No GNSS data from Caster	NTRIP error 503 returned from NTRIP Caster. No data available from the NTRIP Caster.
Unexpected internal error	NTRIP Caster internal error.
Incorrect NTRIP Caster response	NTRIP error 602 returned from NTRIP Caster.
Rejected by remote Caster due to mount point in use	NTRIP error 603 returned from NTRIP Caster.
No output stream is configured	NTRIP error 604 returned from NTRIP Caster.
Connection in progress	The NTRIP Server is in the process of connecting to the NTRIP Caster.
Unknown Ntrip Status	The status is not one of those listed above.

Enable – Select this check box to enable NTRIP Server.

NTRIP Version – NTRIP Server supports either NTRIP version 1 or 2.

NTRIP Caster http:// – The address and port of the NTRIP Caster that the receiver will connect to in order to send or receive data.

Mount Point – The name of the correction stream the receiver is supplying to the NTRIP Caster.

Username – Enter the username required to log on to the server.

Password – Enter the password required to log on to the server.

Verify Password – Re-enter the password required to log on to the server.

Identifier – The unique identifier for the receiver (NTRIP Server) supplying the correction stream.

Country – An optional identifier to help distinguish which country the NTRIP Server is in.

Network – An optional identifier to help distinguish which network the NTRIP Server is a part of.

Select the correction type to output:

- CMR
- RTCM
- OMNISTAR

NTRIP Caster

There are three NTRIP Caster ports available. For each port, a maximum of 10 users can request data, which means that a total of 30 users can simultaneously request data.

Enable – Select this check box to enable this NTRIP Caster port.

Port – Source Port number of the caster host.

Country – Enter the character country code, for example USA, DE.

Identifier – The unique identifier for the NTRIP Caster.

Mount Point – Enter the name of the output stream, such as its type. Users must enter this name to connect to the port.

Authentication – This is set to Basic so you will require a login username and password.

Generator – Set to Trimble.

Fee – Set to no fee per connection. There is no billing model in this receiver.

NMEA Required – Set to No as this is a single base solution.

Mount Point – Enter the name of the receiver, such as its location. This name is required by the users.

Select one source of corrections:

When the factory defaults are applied the three NTRIP Caster ports will be automatically configured to output CMRx on port 2101, CMR on port 2102 and RTCMv2.1 on port 2103.

- CMR
- RTCM
- RT17/RT27
- OMNISTAR

Serial 1 / COM1, Serial2 / COM2, Serial3 / COM3, Serial4 / COM4

The BD99x series and BX992 has two serial ports. Port 1 DOES NOT have flow control. Flow control is ENABLED on Port 2.

Serial Port Setup – Set the appropriate baud rate, parity, and flow control for the port.

One of the following groups appears, depending on the option that you select in the drop-down list at the top of the page:

- CMR
- RTCM
- NMEA
- RT17/RT27
- GSOF
- OMNISTAR

USB

USB Port – Data can be streamed over an available USB connection.

NOTE – Adapter (P/N 57167) is not supplied.

Depending on the option selected in the drop-down list at the top of the page, the options for configuration changes:

- CMR
- RTCM
- NMEA
- RT17/RT27
- GSOF
- OMNISTAR

CAN 0

CAN – CMR, NMEA, or GSOF data can be streamed over this port.

For more detail on the format of these messages and cabling, contact Trimble.

One of the following groups appears, depending on the option selected in the drop-down list at the top of the page:

- CMR
- NMEA
- GSOF

CMR

The following fields appear when CMR is selected from the list at the top of the page.

CMR – Select which CMR corrections will be output on this port. If transmitting CMRx messages, ensure that all rovers and machines have firmware that will accept CMRx. CMRx was introduced in receiver firmware version 4.0.

Moving Base CMR – The Moving Base CMR corrections are available when in ***Moving Base*** operation mode and are used in conjunction with a second receiver in ***Heading*** operation mode.

Delay – Select the time delay for the CMR output. This is used in multi-base applications.

Bandwidth Limit – Enable this only when using radios in a two-way data radio network. This is only required when GLONASS records are included in the CMR message. If transmitting with CMRx format, there is no need to bandwidth limit as all signals can be transmitted over the radios.

REPEAT-RTCM

This feature allows an external source of RTCM corrections to be repeated to another port. The external source can be OmniSTAR VBS (if installed).

The following fields appear when you select REPEAT - RTCM from the list at the top of the page.

Use VBS as source – Select this check box to use the decoded OmniSTAR VBS service to populate an RTCM DGPS correction stream. The RTCM DGPS correction stream can be output on Ethernet, Serial, or USB ports. This output is available when the receiver is in any operating mode and can also be selected from the front panel Port menu. Only available when a valid OmniSTAR VBS subscription is loaded in receiver that supports OmniSTAR.

RTCM

The following fields appear when you select RTCM from the list at the top of the page.

Enable/Disable – Select if RTCM output is to be enabled on this port.

Version – Select which version of RTCM message will be output on this port. (Use version 2.X to transmit a version of RTCM that is compatible when multiple rovers are being used and they are not all compatible with the same version of RTCM message. That is, one rover might only support version 2.1 and the other requires version 2.3.)

RTCM version 3 is available when the base station is used by a mixed fleet of RTK receivers from a number of manufacturers. RTCM version 3 is more efficient, handles GLONASS, and is more suitable for networked RTK than version 2.x. If the GLONASS option is installed in the base station (receiver firmware version 4.13 and later), then both GPS and GLONASS measurements are output.

Bandwidth limit – This option is available once RTCM version 3 is selected. If the radio link used has a known maximum data throughput rate, then enter that value into this field in bytes per second. The receiver will then logically reduce the number of satellite messages so that maximum rate is not exceeded.

Type – Select which type of RTCM message will be output on this port.

NMEA

The following fields appear when NMEA is selected from the list at the top of the page.

NMEA Messages – Select which NMEA messages will be output on this port.

Standard – Select which standard to use for the compliant messages.

- *NMEA* – Output messages comply the National Marine Electronics Association (NMEA) 0183 Standard for Interfacing Marine Electronic Devices, Version 4.0, November 1, 2008. This is the default selection.
- *IEC61162-1:2010/NMEA 0183 V4.10* – Output messages will comply with the International Electrotechnical Commission (IEC) 61162-1, Edition 4 2010-11

Report max DQI=2 NMEA GGA string – When enabled, the Quality Indicator field in the GGA output message will never be greater than 2 (Differential GPS). Use this only with legacy systems that do not fully support the NMEA standard.

Report max correction age 9 sec in NMEA GGA string – When enabled, the Age of differential data field in the GGA message will never be greater than 9 sec. Use this only with legacy systems that do not fully support the NMEA standard.

Report extended information in NMEA GGA and RMC strings – By default, this check box is enabled to provide high precision position data in the NMEA messages. Clear this check box to conform to the NMEA standard message length of 82 characters.

Report GST message always as GPGST – When enabled, the NMEA talker ID will always be $GP for the GST message no matter what constellation is being tracked. This is required for some legacy systems using this NMEA output which have not yet been updated to follow the NMEA standard. By default this will be disabled.

Report legacy talker ID – When enabled, this forces the following sentences to always use “GP” as the talker ID: GGA, MSS, DTM, GLL, HDT, RMC, ROT, VTG, and ZDA.

RT17/RT27

The RT17/RT27 option is only available when the Binary Outputs option is installed in the receiver.

The following fields appear when RT17/RT27 is selected from the list at the top of the page.

Epoch Interval – This defines the rate at which the RT17/RT27 messages are output. Check boxes are provided to enable the output of measurements and/or positions.

Measurements – Select this check box to output raw observables.

Positions – Select this check box to output position measurements.

Concise – Select this check box to output a more compact message containing the raw observables. This should always be enabled.

R-T Flag – Select this check box to output IODE values and cycle-slip counts.

Ephemeris – Select this check box to output the satellite ephemeris when received.

Send Raw GPS Data – Select this check box to output the raw data extracted from the satellites.

Multi-System Support – Select this check box to output the GPS L5 and GLONASS observables.

Smooth Pseudorange – Enable Pseudorange smoothing.

Smooth Phase – Enable Phase smoothing.

Send Raw WAAS Data – Select this box to output the raw data extracted from the SBAS satellites.

NOTE – If interfacing to a BD9xx receiver that is running version 3.30 firmware or later and is using binary commands, it is important to note that the receiver does not support binary command and control interfacing unless login authentication (through a serial port) is carried out.

BINEX

The following fields appear when you select BINEX from the list at the top of the page.

Observable Rate – Select the output rate for the raw observables.

Smooth Pseudorange – Enable Pseudorange smoothing.

Smooth Phase – Enable Phase smoothing.

GSOF

The following fields appear when you select GSOF (General Survey Output Format) message from the list at the top of the page.

GSOF Messages – Select which GSOF messages will be output on this port.

NOTE – If you are interfacing to a BD9xx receiver that is running version 3.30 firmware or later and is using binary commands, it is important to note that the receiver does not support binary command and control interfacing unless login authentication (through a serial port) is carried out by the application.

OmniSTAR

Only available when a valid OmniSTAR subscription is loaded in a BD9xx receiver that supports OmniSTAR.

DATA for OmniSTAR – Enables the demodulated OmniSTAR data output on this port. This output can then be used as an External OmniSTAR input on a non-Trimble OmniSTAR-capable receiver that has a valid and appropriate OmniSTAR subscription.

DATA for Trimble – Enables the demodulated OmniSTAR data output on this port. This output is the same raw data as above with a TRIMCOMM wrapper (0xC4) to support use as an External OmniSTAR input on a Trimble receiver. The receiver must have a valid and appropriate OmniSTAR subscription.

DEBUG – Enables/Disables DEBUG OmniSTAR output on this port.

1PPS Time Tag

The following fields appear when you select 1PPS Time Tag from the list at the top of the page.

1PPS Time Tag – Enables the ASCII Time tags. The time tag provides the UTC time of the 1PPS pulse and is output approximately 800 milliseconds before the pulse.

To enable the 1PPS pulse, see Receiver Configuration – General, page 130.

Met-Tilt

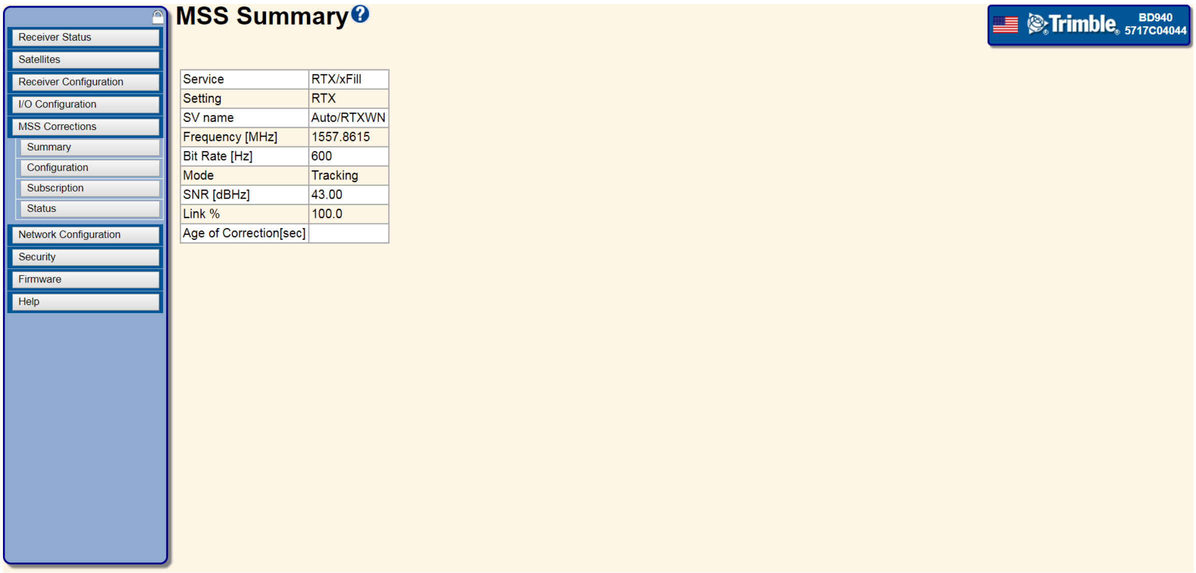
These settings are used to support meteorological and tilt sensors.

MSS Corrections menu

For information on OmniSTAR services or to contact support, go to www.omnistar.com.

MSS – Summary

This page provides a summary of the Mobile Satellite Services (MSS) information.



Service – Displays the Mobile Satellite service currently being used.

Setting – Displays the Mobile Satellite service setting currently being used.

SV name – Displays the name of the RTX/OmniSTAR satellite currently being tracked. "Auto" indicates that the satellite was selected based on geographical location.

Frequency (MHz) – Displays the frequency that the RTX/OmniSTAR satellite that is currently tracked is broadcasting on.

Bit rate (Hz) – Display the rate at which the tracked RTX/OmniSTAR data is modulated to the carrier wave.

Mode – Indicates if the internal demodulator is currently tracking an RTX/OmniSTAR satellite, or if external OmniSTAR data is being received from another source.

SNR [dB-Hz] – Displays the signal-to-noise ratio of the signal being tracked.

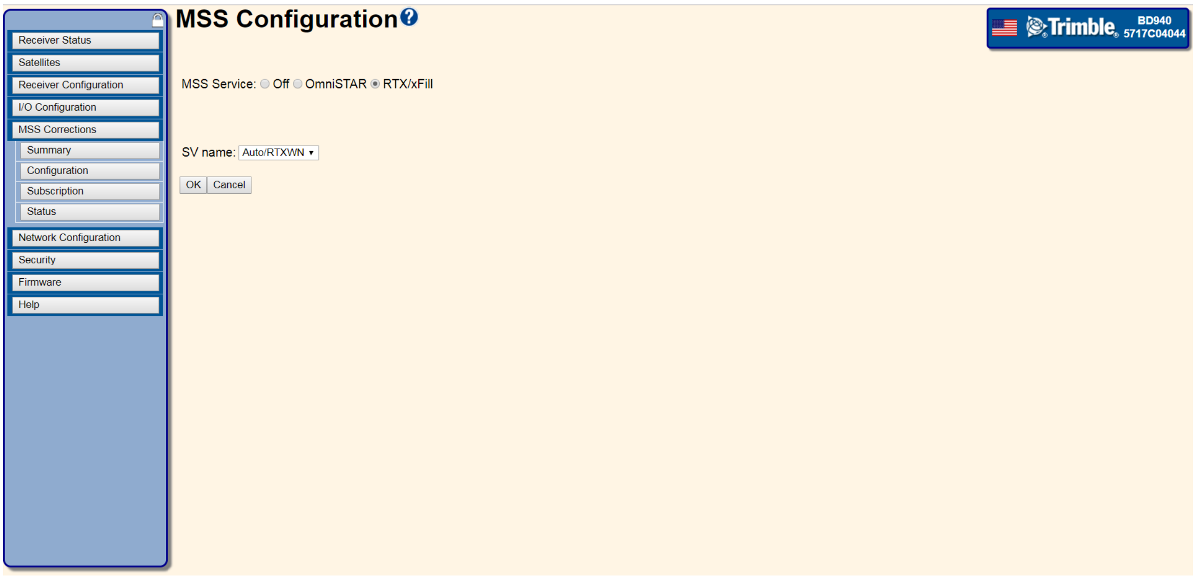
Link % – Displays the packet success rate. 100% indicates that no packets have been dropped

Age of Corrections [sec] – Displays the age of corrections in seconds.

MSS Configuration

Use this page to configure the receiver to track MSS (RTX/OmniSTAR) satellites.

NOTE – There must be a valid subscription on the receiver before it can use RTX/OmniSTAR data for positioning.



MSS Service – Select either Off, RTX/xFill, or OmniSTAR.

If RTX/xFill is selected, the following options are available:

SV name – Select which RTX satellite is to be tracked by the receiver. If you do not know the appropriate satellite name, select Auto so that the receiver scans for the satellite whose spot beam is closest to your current location. If the required SV Name does not appear in the list, select Custom and then enter the Frequency and Bit rate of the required satellite.

NOTE – When RTX/xFill has been selected, the default datum will be ITRF2014 (fixed on 2005.0 Epoch). This can be changed to either the Fixed (2005 Epoch) or a Current epoch in the Receiver Configuration – Position menu.

If OmniSTAR is selected, the following options are available:

Preferred Source of Data – When the OmniSTAR service has been selected, then select either External or Internal. If the receiver is configured below to use both internal and external data, it uses the preferred source when both are available:

- Internal – The OmniSTAR data is derived from the L-Band signal received via an appropriate antenna (for example, GA810).

- External – The OmniSTAR data is derived from an external source such as an NTRIP Client over an Internet connection.

External OmniSTAR Data – Set the receiver to use an external OmniSTAR data stream if available on an Ethernet, NTRIP, serial, Bluetooth, or USB port and then use one of the following modes:

- Don't Use – Do not use an external source of OmniSTAR data.
- Auto – Tracking is enabled and, if more than one external OmniSTAR service is available, the most precise mode is used.
- Selecting specific services – The following specific services are available for selection if the receiver has an appropriate valid subscription. Selecting one of these modes restricts the receiver from using other external OmniSTAR services:
  - HP Only
  - G2 Only
  - HP+G2
  - HP+XP
  - XP Only
  - VBS Only

Internal OmniSTAR Demodulator – Set the internal OmniSTAR demodulator to the required mode.

- Off – OmniSTAR tracking is disabled.
- Auto – Provides the best solution based on the error estimates. This delays the transition to OmniSTAR HP until the HP solution reports it is better than the VBS solution.

  NOTE – Be careful how you treat VBS; in some locations it is in NAD-83. By default, the receiver provides NAD-83 VBS (in the USA) positions and ITRF2014 for HP. However, you can configure the receiver to transform the NAD-83 VBS positions to ITRF by selecting the following check box.
- Selecting specific services – The following specific services are available if the receiver has an appropriate valid subscription. Selecting one of these modes restricts the receiver from using other internal OmniSTAR services:
  - HP Only
  - G2 Only
  - HP+G2
  - HP+XP

- XP Only
- VBS Only

SV Name – Select which OmniSTAR satellite is to be tracked by the receiver. If you do not know the appropriate OmniSTAR satellite name, select Auto so that the receiver scans for the OmniSTAR satellite whose spot beam is closest to your current location. If the required SV Name does not appear in the list, select Custom and then enter the Frequency and Bit rate of the required satellite.

NOTE – The SV Name list is automatically updated by OmniSTAR broadcasts, which contain the satellite name and ID, and coverage area. If this information is not currently available from OmniSTAR, the list may be incomplete or out of date. If this occurs, the SV Name Auto option may not select the most appropriate spot beam; instead you should select the Custom option.

Max Data Outage – This setting applies only to OmniSTAR corrections (not RTX corrections). If the OmniSTAR signal has been lost for the amount of time set in this field, the receiver discards the HP/XP/G2 position or the VBS correction. For OmniSTAR VBS, even though it discards the correction, the firmware still generates VBS positions until the time set in the DGNSS Age of Correction field also expires.

Seed with RTK – Select this option if the primary positioning mode is RTK and you need to use the OmniSTAR solution for short RTK outages. The OmniSTAR engine is seeded with the current RTK Fixed position at a 1 Hz rate. If an RTK Fixed position solution becomes unavailable, the OmniSTAR HP position solution will be used until it is restored. The RTK position is transformed into the OmniSTAR HP datum by using the Datum Offset parameters.

NAD83 - ITRF Transformation – In North America, the OmniSTAR VBS datum is NAD-83, all other OmniSTAR services use the ITRF datum. Enable this feature to transform the VBS positions from NAD-83 to ITRF datum.

NOTE – When CenterPoint RTX has been selected as the Internal OmniSTAR Demodulator, the default datum will be ITRF2014 (fixed on 2005.0 Epoch), so the NAD83 – ITRF Transformation feature is unavailable. However, for CenterPoint RTX, either the Fixed (2005 Epoch) or a Current epoch can be selected in the Receiver Configuration – Position, page 127 menu.

RTX or OmniSTAR – MSS Subscription

This page provides information about the MSS (RTX, xFill, OmniSTAR) subscription.

If the receiver is connected to an MSS-capable antenna with RTX or OmniSTAR reception, then subscriptions can be activated remotely.

If RTX/xFill was selected in the **MSS Configuration** page, then the following subscription information is displayed:

RTX Subscription – The start and end date of any current subscription.

xFill Subscription – The start and end date of any current subscription.

RTX Version – The currently installed version of RTX.

Serial Number – The serial number required when applying for an RTX subscription.

If OmniSTAR was selected in the **MSS Configuration** page, then the following subscription information is displayed:

HP/XP or VBS Expiration Date UTC – Shows when the current OmniSTAR subscriptions will expire. The receivers do not ship with an active subscription. Contact OmniSTAR for a subscription activation.

HP/XP Engine Mode – When the receiver has a valid subscription, the engine mode indicates which services are available.

HP/XP or VBS Firmware Version – Displays the current version of the OmniSTAR firmware that is loaded in the receiver.

Serial Number – The serial number is either a 7-digit or a 10-digit number, for example, 1475389 or 1010012017.

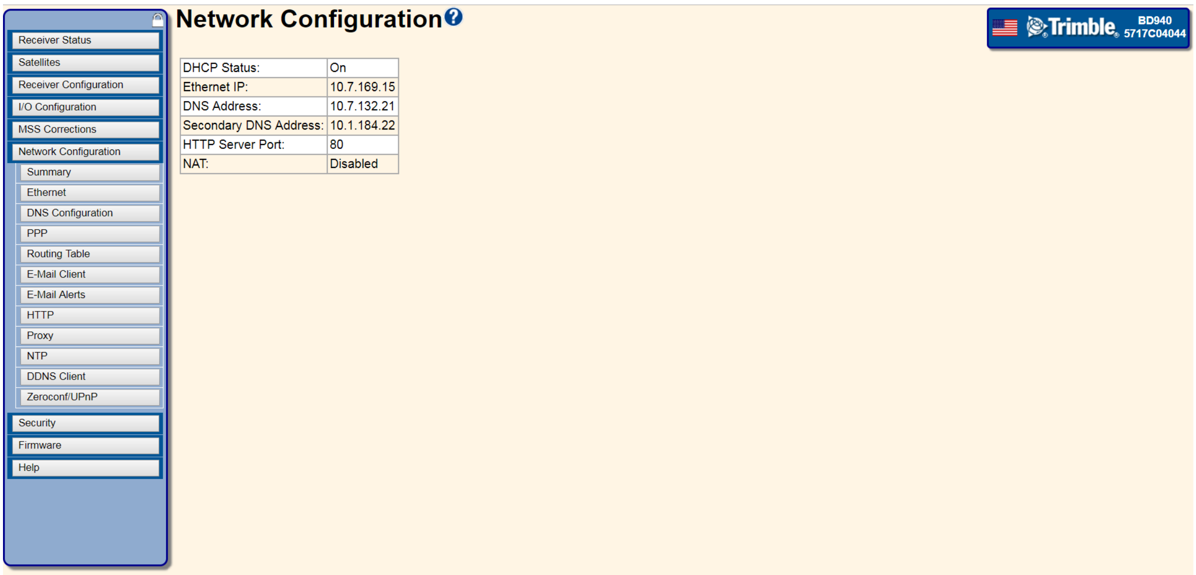
NOTE – When ordering a subscription from OmniSTAR, you must refer to this serial number. Please do not send the serial number (for example, 5221F12345) of the actual receiver.

Network Configuration menu

Use the **Network Configuration** menu to configure Ethernet settings, email alerts, PPP connection, HTTP port, and FTP port settings of the receiver. For more information, see Configuring Ethernet settings.

Network Configuration – Summary

These settings display the current receiver Internet configuration.



DHCP Status – Indicates if DHCP is on or off. If DHCP is on, the receiver is automatically assigned an IP address from the network.

The receiver can recover its IP address when in DHCP mode whenever it is connected to a DHCP server that is temporarily unavailable. If the receiver is connected to a DHCP server which is then not available and its "lease" has expired, the receiver switches to IP address 169.254.1.XXX. Every 60 seconds, the receiver tries to reconnect to the DHCP server to obtain a new IP address. This is useful when the receiver "drops off" the DHCP server and does not require a manual power cycle.

Ethernet IP – Displays the current Ethernet IP address of the receiver.

DNS Address – Displays the IP address of the current Domain Name Server.

Secondary DNS Address – Displays the IP address of the Secondary Domain Name Server

FTP Push – Indicates if FTP Push is on or off.

HTTP Server Port – Displays the port on which the web server is currently running. The default HTTP port is 80.

Network Address Translation – Displays whether NAT is Enabled or Disabled.

If PPP is enabled, the following information is displayed:

PPP Port – Displays the port on which the PPP connection is established.

PPP State – Indicates if a PPP connection is currently established.

PPP Local Address – Displays the IP address of the receiver on the PPP connection.

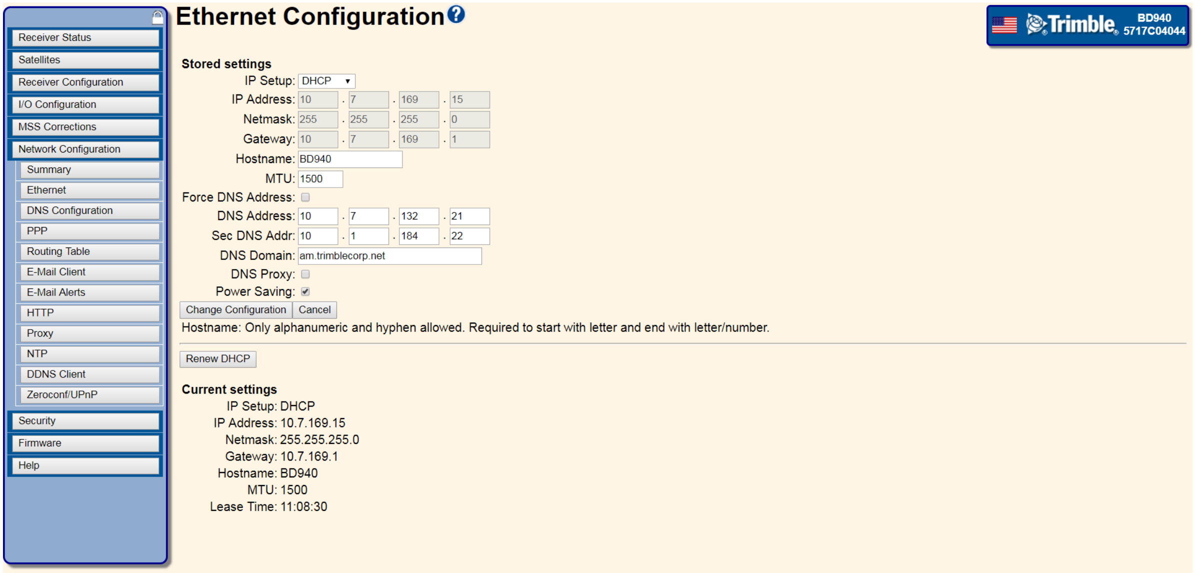
PPP Remote Address – Displays the IP address of the device that the receiver is connected to on the PPP connection. The receiver assigns this address to the connecting device on connection.

If Data Logging and FTP Push are both enabled, the following information is displayed:

FTP Push Server – Displays the server address that files will be pushed to.

Network Configuration – Ethernet Configuration

Use these settings to change the Ethernet configuration of the receiver.



IP Setup – Set the receiver to obtain an IP address using DHCP (Dynamic Host Configuration Protocol) or a Static IP.

IP Address – Enter a static IP address for the receiver to use when connected to a network. This field cannot be edited when using DHCP.

Netmask – Enter the netmask for the network that the receiver will be connected to. This field cannot be edited when using DHCP.

Broadcast – The broadcast address is for informational purposes. This address allows packets to be sent to all devices on a network. This field cannot be edited when using DHCP.

Gateway – Enter the Gateway IP address for the network that the receiver will be connected to. This is typically the Local Area Network IP address of the router that links the receiver to the Internet. This field cannot be edited when using DHCP.

Hostname – Enter a name for the device. This name can be used to connect to the receiver over a network when DHCP is enabled and the IP address of the receiver is unknown.

MTU – Maximum Transmission Unit. The greatest amount of data or "packet" size that can be transferred in one physical frame on a network. The default is 1,500 bytes and is common for Ethernet and dial-up links.

NOTE – The suggested smallest MTU is 576. When MTU is set a value less than 576, networking activity is not guaranteed to work.

Change Configuration – Click to view the stored settings and reset the receiver any changes to take effect. If you do not want to change the current settings, click any other page.

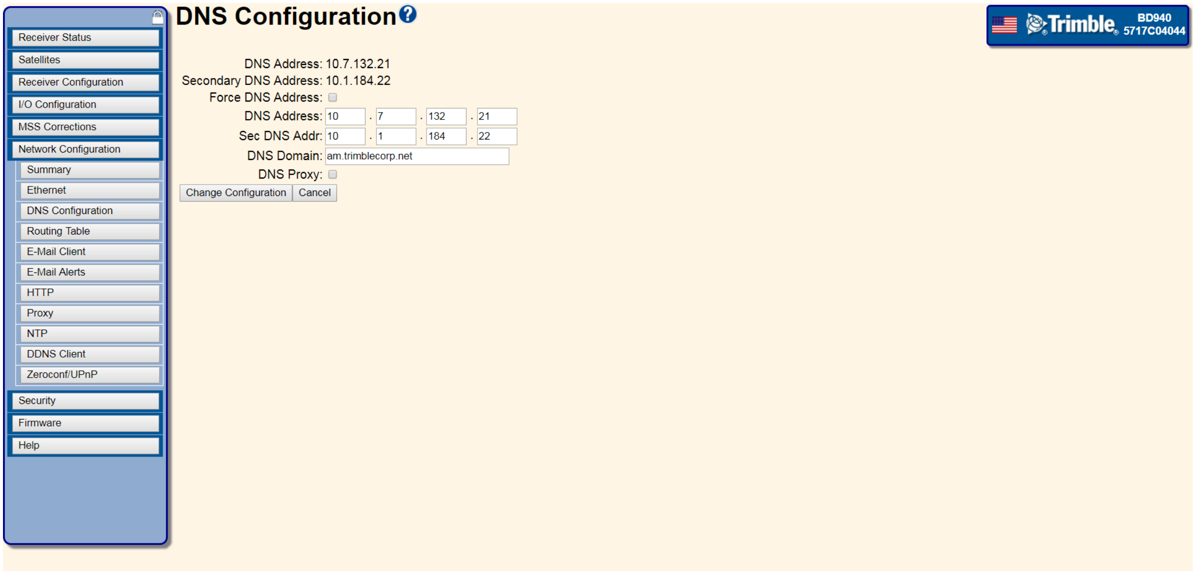
Renew DHCP – DHCP renew is automatically done, but you can also do it manually by clicking this button. Also, click this button to renew the DHCP settings if the server has restarted.

Current Settings – Displays the current network configuration.

Lease time – Lease time is assigned by the DHCP server; you cannot change it. This is for information only to let you know how long before the lease is due to expire. The receiver system automatically renews the lease before its expiration.

Network Configuration – DNS Configuration

Use this page if you need to set your special DNS IP address.



If the receiver I/O configuration is using any domain name (such as “ntrip1.trimblehh.com”), the receiver needs to resolve the domain name string to an IP address; the DNS server serves that purpose. Many systems, such as the Microsoft Windows operating system, have two DNS IP addresses; primary DNS and secondary DNS. If the primary DNS cannot be reached, the secondary DNS is used. If the secondary DNS also fails, then the domain name cannot be resolved and the system cannot reach the specified address.

Usually when a receiver is configured in DHCP mode, the DHCP server assigns an IP address to the receiver along with a DNS IP address (both primary and secondary DNS). By default, the receiver uses the DHCP assigned DNS address. You do not have to do anything on this settings page unless you do not want to use the assigned DNS IP address.

If the receiver is configured as static mode, you must configure the DNS address in addition to the Ethernet Configuration page where you configure the IP address, Netmask, Broadcast, Gateway, hostname, and MTU settings.

The DNS address will be changed accordingly when the default interface is changed. For example, when using PPP over internal/external GPRS modem, the default interface is set to PPP over GPRS modem, and the PPP server will assign its special DNS address to the connection. The system will obtain a DNS address from the PPP connection unless it is “forced”. When PPP is disconnected, the DNS address will be changed back to the Ethernet DNS address. The priority of DNS addresses and default route is:

1. PPP over GPRS connection.
2. Ethernet.

3. Other PPPs.
4. Wi-Fi connection.

DNS Address – Displays the current DNS address.

Secondary DNS Address – Displays the secondary DNS address.

Force DNS Address – When you select this check box, you can enter a specific DNS Server IP address and DNS Domain Name. After you click Change Configuration, this DNS IP address and DNS Domain Name is used in the system. If this check box is selected, the system uses the supplied DNS address and ignores any DNS address assigned by an DHCP server or PPP server. Whether you have Ethernet or PPP, the DNS IP address is forced.

DNS Address – Enter the DNS (Domain Name Server) address for the network that the receiver will connect to. This field cannot be edited when using DHCP. In DHCP mode, the DNS Address is sent to the receiver and is unique for each customer's LAN. If you require a static IP setup, this DNS address will have to be obtained by an system administrator.

Sec DNS Addr – Enter the Secondary DNS (Domain Name Server) address for the network that the receiver will connect to.

DNS Domain – Enter the DNS domain for the network that the receiver will connect to. This field cannot be edited when using DHCP. The DNS Domain name also comes from the DHCP server and is mainly used by mDNS and UPnP.

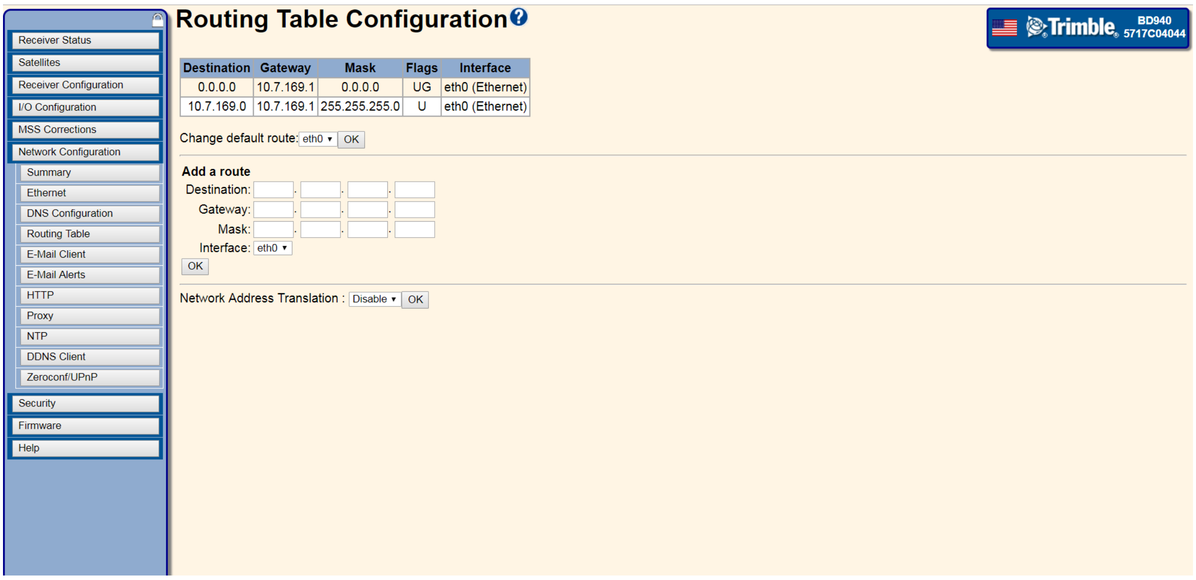
DNS Proxy – The ability to enable/disable the DNS proxy provides better network security when a client is connecting to the Internet using an SPS GNSS receiver over PPP or Wi-Fi. As a guideline this should be enabled in the following circumstances, but depends on your network:

1. 1. If the system is in Wi-Fi AP mode and has any Wi-Fi client connected and has upstream DNS available.
1. 2. If the receiver is a PPP server and has upstream DNS available.

Change Configuration – When this is pressed these new settings will be applied for the static configuration. Any static settings will be over written if the system goes to factory defaults (DHCP). If "Force DNS Address" is not selected and "Change Configuration" is pressed, then the provided DNS will be set to the system once, but it will not be forced and in the DHCP case the next DHCP renew will overwrite the DNS addresses that you just set.

Network Configuration – Routing Table

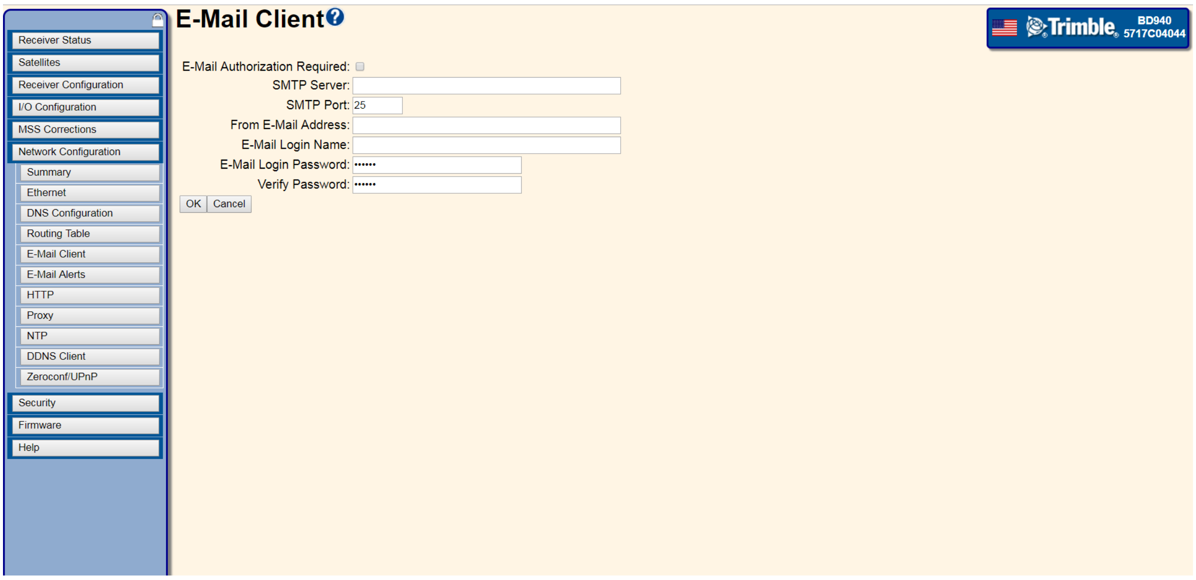
Use these settings to connect to a sub-network, such as behind a gateway, or to add static routes to a network. This page is for advanced users.



Network Configuration – E-Mail Client

Use these settings to configure the receiver to use a specific email client which can be used to send E-Mail Alerts regarding the status of the receiver.

NOTE – The email server needs to support SMTP without encryption.



E-Mail Authorization Required – Select this check box if the e-mail server requires authorization.

SMTP Server – Enter the SMTP (outgoing mail server) address that the e-mail will be sent from.

SMTP Port – Enter the SMTP port that the receiver connects to on the e-mail server. The most common SMTP Port is 25.

From E-Mail Address – Enter an address from which the e-mail will be sent.

E-Mail Login Name – Enter the login name (if required) that is required to send an e-mail on the SMTP server listed above.

E-Mail Login Password – Enter the login password (if required) that is required to send an e-mail on the SMTP server listed above.

Verify Password – Re-enter the login password.

Network Configuration – E-Mail Alerts

Use these settings to configure the receiver to send e-mail to a specified address with detailed information regarding the state of the receiver.

NOTE – You must first configure the E-Mail Client.

Enable – Select this check box to enable e-mail alerts.

To E-Mail Address – Enter the address that the email will be sent to. (Only one email address is supported).

Selection Boxes – Select which events will cause the receiver to send an email.

NOTE – To check if all e-mail alert settings are correct and to send a test e-mail, click ***Test***.

Network Configuration – HTTP

Use this setting to configure the HTTP Server Port on which the web server will run.

HTTP Server Port – Enter the port number for the HTTP server. The default is port 80.

HTTP Secure Enable – Enter the port number for the HTTPS server. The default is 443.

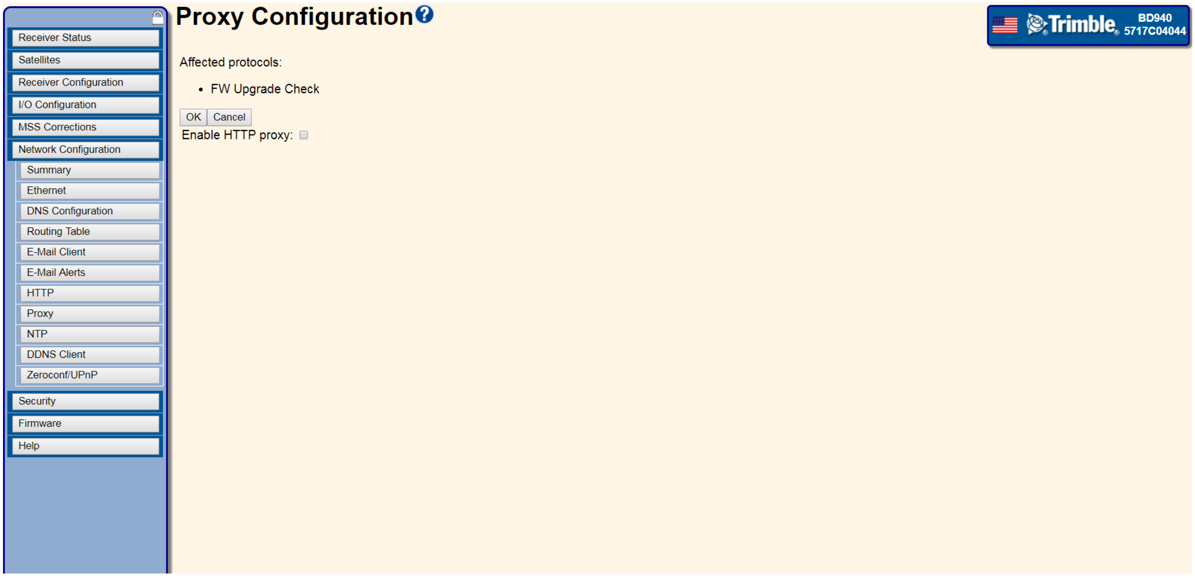
These settings are only available if the HTTPS option is installed.

The receiver can support a secure HTTP link, with encryption limited to a 56-bit encryption.

NOTE – By default, Mozilla Firefox does not support this low grade encryption. Turn on the security.ssl3.rsa_1024_rc4_56_sha option by going to about:config in Firefox.

Network Configuration – Proxy

Use these settings to configure the proxy settings for the receiver.



Enable HTTP proxy – If the receiver is on a network that uses a proxy server, or if you find the NTRIP service or the Firmware Upgrade Check feature is not functioning, then select this check box.

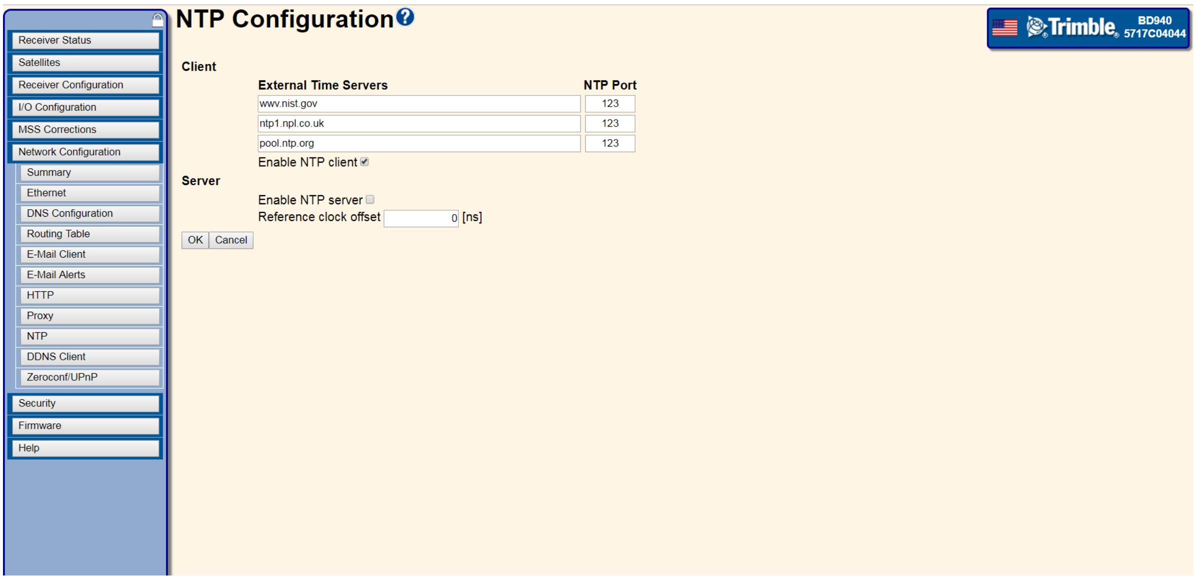
HTTP proxy – Contact your network administrator to get this value.

HTTP proxy port – Contact your network administrator to get this value.

NOTE – Enter the server name and IP address without adding the protocol in front. That is, enter /companyx.com, not http://companyx.com.

NTP Configuration

Use these settings to configure the NTP (Network Time Protocol) Client settings for the receiver.



Client

External Time Servers – Enter the IP address or DNS address and port of the NTP server that the receiver will connect to. This allows the receiver to synchronize the internal receiver clock to an Internet time source, which can improve satellite acquisition if the receiver was powered off for a long period of time. The receiver is preconfigured with three default time servers.

Enable NTP Client – Select this check box if you require the receiver to be an NTP client. Use this feature to synchronize the receiver time using an external time source.

Server

Enable NTP server – Select this check box if you require the receiver to be an NTP server. Use this feature to synchronize devices on a network, for example, other computers. This is useful on an offshore installation when an external NTP time server is not available and other devices on the network cannot access the 1PPS, but they are on a local network (wired or wireless) and require time synchronization.

Reference clock offset – If an accurate absolute time service is required, then the delay caused by the length of the antenna cable needs to be determined and entered as nanoseconds delay.

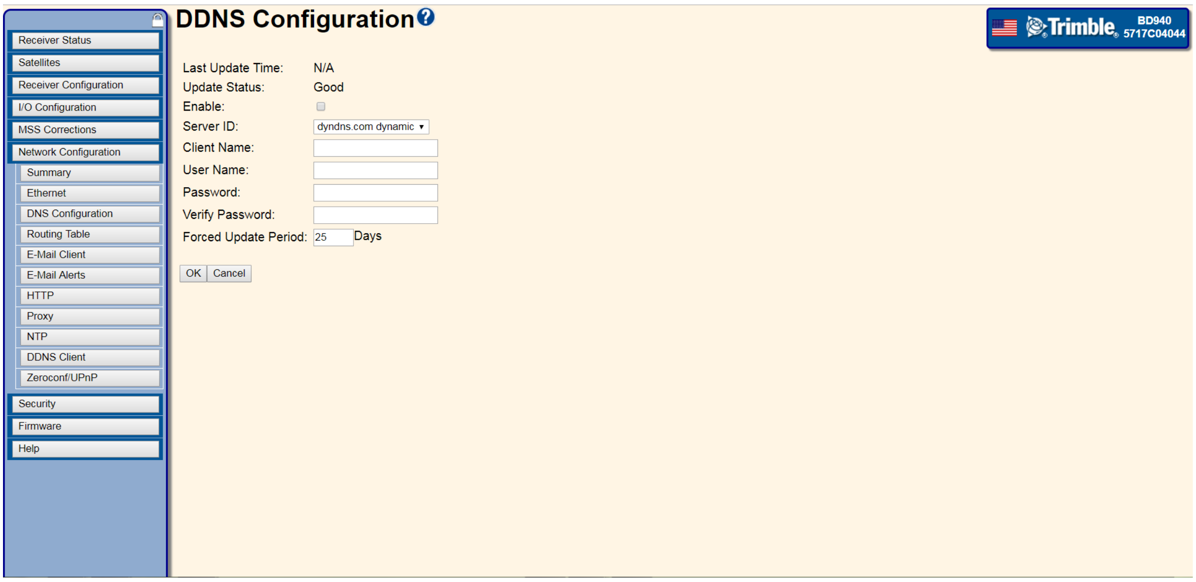
DDNS Configuration

Use these settings to set up a Dynamic DNS (DDNS) Client in the receiver.

The main reason for setting up a DDSN Client is to solve the problem of the base station using the NTRIP Caster function to make a correction stream available directly from its router, or a cell phone changing its IP address as determined by the service provider. When this occurs, rover systems can no longer connect to and use this source of Internet corrections. This DDNS feature can be used when your router does not have an inbuilt DDNS Client or when you are using a cell phone at the base station in which the IP address is randomly changing.

DDNS is often used in conjunction with NTrip Caster in the role of an Internet-capable base station. Before setting up the DDNS, do the following:

- Set up the base station NTrip Caster parameters.
- Set up an account on a free DDNS Server such as at DynDNS (www.dyndns.com).



Last Update Time – The time period since the last successful update was made. The format is dd (days) hh (hours) mm (minutes) ss (seconds). The field is updated every 5 seconds and starts again after a “forced update period” occurs.

Update Status – This field shows one of the following:

Status Message	Meaning
Good	The update was successful.
Invalid Remote Address	The DDNS Server IP address cannot be resolved.

Status Message	Meaning
TCP/IP connect() failed	The connect() due to the device is behind a NAT (Network Address Translation or Network Address Translator) or a firewall.
TCP/IP send() or rcv () failed	The send or receive failed.
Invalid Response from IP Check Server	The response from the IP Check Server is not expected.
Invalid Response from DNS Server	The response from the DNS server is not expected.
Internet error	Other errors occurred in the implementation.

Enable – Select this check box to enable the DDNS feature.

Server ID – Select from a list of common DDNS servers, for example, www.dyndns.com. The dyndns.org dynamic setting is used when your Internet connection has a public routable IP address. This is probably the most common setting. For information about the Custom setting, go to www.dyndns.com.

The receiver supports the following DDNS servers:

- dyndns.com
- freedns.afraid.org
- zoneedit.com
- no-ip.com

Client Name – Enter an existing URL, for example, SiteAlphaBase.dyndns.org.

User Name and Password – Enter the name and password that you chose when you set up your DDNS Server account.

Forced Update Period – The receiver automatically updates the DNS information within 120 seconds (2 minutes) of the IP address changing. You can also specify a time frequency for the receiver to update DNS information at, even if the information has not changed. This is the "Forced Update Period". The minimum Forced Update Period is 5 minutes; the default is 40320 minutes (28 days).

Click **OK** to apply the changed settings to the receiver.

TIP – You can set up an alert, so that an email is sent to you if the DDNS update process fails. Select **Network Configuration / E-Mail Alerts** and then select the *Alert when DDNS update failed* check box.

Zero Configuration / Universal Plug and Play

This feature enables a computer on the same subnet as the receiver to discover the IP address of the receiver and then discover what services and ports the receiver has enabled. The computer client can then access data files, configure the receiver, connect to NMEA/CMR streams, send CMR streams to the receiver, and so on.

It enables users with no networking experience to connect directly to the receiver without having to know or enter an IP address.

Use Bonjour or uPnP on your local computer.

Enable Zeroconf service discovery (mDNS/DNS-SD) – This is enabled, by default, and enables computers on the subnet using Bonjour to discover this receiver.

For Windows, download Bonjour For Windows (http://support.apple.com/downloads/Bonjour_for_Windows). When you open Internet Explorer or Safari, a new icon appears that lets you browse for devices. Click on the Bonjour devices; it scans the network and shows all the GNSS devices on the subnet.

The local name string applied to the receiver is the following:

Product Name, Serial Number: System Name

Where:

> Product Name is the name of the product.
>
> Serial Number is the Trimble 10-character serial number.
>
> System Name - Entered using either the WinFlash utility or the web interface.

For other browsers and operating systems:

- *After* installing Bonjour for Windows, you can install BonjourFoxy for Firefox browser support.
- For Linux, install avahi and do "avahi-browse -a".
- In Mac OSX, Bonjour is installed as standard.

Bonjour also enables the receiver to advertise other services it has today. Trimble advertises HTTP and FTP, if the services are enabled.

Enable UPnP service discovery – By default, this check box is selected. It enables computers on the subnet using Universal Plug and Play to discover this receiver.

A similar technology to Bonjour is UPnP, however it does not provide as much functionality as Bonjour (you cannot advertise FTP, NTP, and so forth, but you can advertise that the receiver is a web server).

While Microsoft has included this as part of their Windows operating systems, it is not integrated as cleanly into Internet Explorer as it is in Bonjour; there are also no known Firefox plugins that support UPnP. However, the Microsoft Windows API does give programmatic access to UPnP (search the MSDN documentation). From version 4.12 firmware, the receiver implements UPnP. To connect to the receiver, without knowing the IP address, using this technology under Windows XP open "My Network Places". If you have UPnP discovery enabled, you see a list of receivers. If you do not see the list, and you know there are receivers with this functionality enabled on your subnet, make sure that you have select the Show UPnP ... option.

Forward HTTP – The Forward options relate to UPnP and routers/firewalls.

Use these options if you place a receiver behind your router/firewall at a site office and you need to access the receiver from another location (anywhere besides the site office). If you select this check box, then the receivers performs a UPnP search for a router and automatically tries to forward the HTTP port externally. If it succeeds, you should be able to point your web browser to the IP address listed next to the "Internet Gateway Device IP".

NOTE – You must have UPnP enabled on your site office firewall/router. By default, some routers are UPnP enabled. However, some require you to enable it using the router web interface.

<<this webpage contains scrambled text when I view it in IE and Chrome>>. For a diagram of a setup that might want port forwarding, see www.knoxscape.com/Upnp/NAT.htm. The article also shows how to manually configure port forwarding on a LinkSys router (Note – The configuration differs between routers.)

Forward FTP – Is the same as the Forward HTTP check box except for your FTP port.

Forward IO – Select one of the following options:

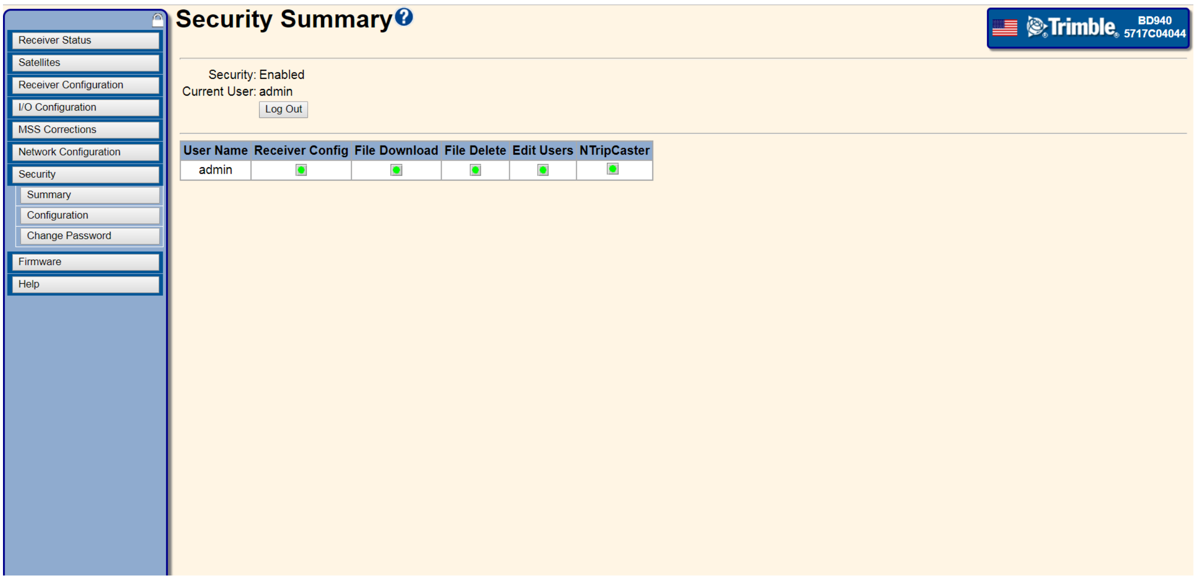
- **None** – Do not forward any I/O ports through the local firewall/router.
- **Output-only** – Forward all server I/O ports marked "Output only/Allow multiple connections" and NTRIP caster ports.
- **All** – Forward all server I/O ports and NTRIP caster ports.

Security menu

Use the **Security** menu to configure the login accounts for all users who will be permitted to configure the receiver using a web browser. Each account consists of a username, password, and permissions. Administrators can use this feature to limit access to other users. Security can be disabled for a receiver. However, Trimble discourages this as it makes the receiver susceptible to unauthorized configuration changes.

Security Summary

Use this page to review the current security settings of the receiver. The table on the page provides a summary of all users and their security privileges.

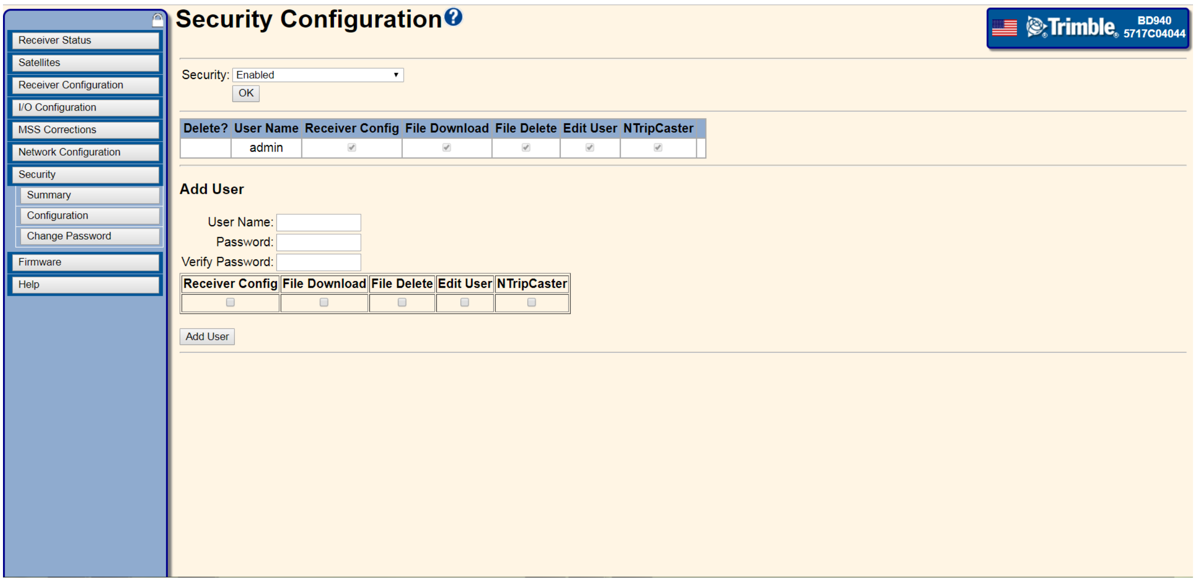


Security – There are three different types of security access for the receiver:

- Enabled
- Enabled with Anonymous Access
- Disabled

Security Configuration

Use these settings to configure the security settings of the Trimble receiver.



Security

- **Enable** – Requires all users to log in to access the receiver.
- **Enable with Anonymous Access** – Any user can access the receiver without logging in. If enabled, Anonymous users can be permitted to download and delete files. Users are required to log in when attempting to change any of the receiver settings.
- **Disable** – Any user can gain access to the receiver without logging in. All users have complete control of the receiver.

User Summary Table – The table provides a summary of all users and their security privileges. The privileges of the admin user cannot be changed and the admin user cannot be deleted. Only the password of the admin user can be changed.

Add User – Enter a username and password for a new user. To enable the privileges for the user, select the appropriate check boxes. To create a new user, click **Add User**.

Change Password

Use these settings to change the password for an existing user.

Username – Enter the existing username for which the password is to be changed.

New Password – Enter the new password for the user.

Verify New Password – Re-enter the new password for the user.

Firmware menu

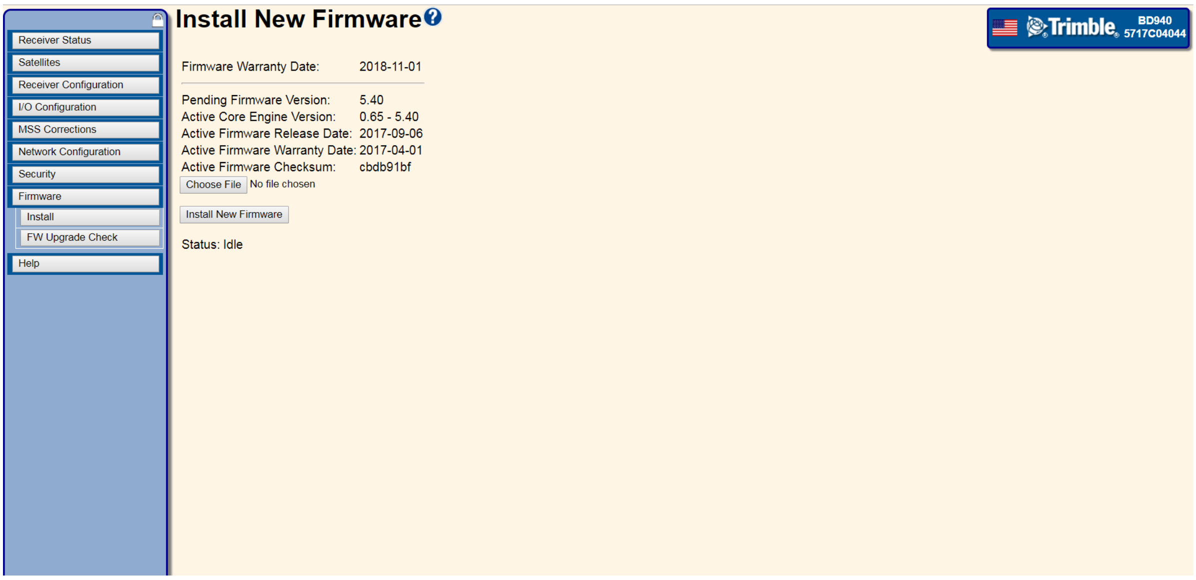
Use the **Firmware** menu to verify the current firmware and load new firmware to the receiver. You can upgrade firmware across a network or from a remote location without having to connect to the receiver with a serial cable.

Install new firmware

This page provides a summary of the firmware currently installed on the Trimble receiver. You can also use it to install new firmware on the receiver.

CAUTION – All data files are deleted when you install new firmware. Before you install the new firmware, ensure that you first download any data files to your computer.

*NOTE – When you upload firmware version 3.70 or later using the web interface, and the receiver's firmware warranty has expired, the message **Corrupt Firmware Image** may appear when you select **Firmware / Install**. To confirm the expiry date, check the **Firmware Warranty Date** on this menu. To resolve this problem, contact your Trimble Dealer to order an extended 12 month firmware warranty to enable new firmware to be loaded.*



Firmware Warranty Date – Indicates when the firmware support for the receiver will expire. Once the date shown has passed, the receiver will not install new firmware. Before new firmware is loaded to the receiver, an Extended Warranty must be purchased from Trimble and the receiver must be updated.

Active Firmware Version – Shows the version of firmware that is currently installed on the receiver.

Active Core Engine Version – Shows the core firmware version. Use this when reporting problems or issues to Trimble Support.

Active Firmware Release Date – Shows the date that the firmware currently installed on the receiver was produced.

Active Firmware Warranty Date – Shows the warranty date for the firmware currently installed on the receiver. This can be different to the Active Firmware Release Date. The firmware will only load into the receiver if this date is prior to the Firmware Warranty Date set in the receiver.

Active Firmware Checksum – Used by Trimble support to verify that the current firmware of the receiver is correctly installed.

Choose File – Click Choose File to locate new firmware on your computer to install on the receiver.

Install New Firmware – Begins the installation of the newly uploaded firmware to the receiver. Status updates are given at the bottom of the page during a new firmware installation.

Check for Firmware Upgrades

The receiver can automatically check for firmware upgrades from the Trimble website if this option is enabled (by default it is enabled).

If your network requires that you pass through a proxy server, you can configure the IP address of the server and the port through which the Internet is accessed from Network Configuration - Proxy.

Update Available – This field is visible if there is a more recent firmware version than the receiver has installed. If the receiver is under warranty support, select the **Firmware / Install** option to open the Install New Firmware page.

8

Configuring the Receiver

The receivers have an Ethernet port so that the receiver can connect to an Ethernet network. You can use the Ethernet network to access, configure, and monitor the receiver.

You can also configure the receiver using the Trimble Binary Interface over RS-232, USB, or Ethernet connections. The binary interface enables you to send commands to the receiver to set configurations, query the receiver for current status, and return current satellite tracking and positioning data.

Configuring Ethernet settings

The receiver has an Ethernet port so that the receiver can connect to an Ethernet network. You can use the Ethernet network to access, configure, and monitor the receiver. No serial cable connection to the receiver is necessary.

The receiver requires the following Ethernet settings:

- IP setup: Static or DHCP
- IP address
- Netmask
- Broadcast
- Gateway
- DNS address
- HTTP port

The default setting for the HTTP port is 80. The HTTP port is not assigned by the network. HTTP port 80 is the standard port for web servers. This allows you to connect to the receiver by entering only the IP address of the receiver in a web browser. If the receiver is set up to use a port other than 80, you will need to enter the IP address followed by the port number in a web browser.

Example of connecting to the receiver using port 80: http://169.254.1.0

Example of connecting to the receiver using port 4000: http://169.254.1.0:4000

If prompted (and the defaults are in affect), the default username is **admin**. The default password is **password**. If the default username and password are not being used and you have forgotten your password, see Change Password, page 175.

The default setting of the receiver is to use DHCP. Using DHCP enables the receiver to automatically obtain the IP address, Netmask, Broadcast, Gateway, and DNS address from the network.

When a receiver is connected to a network using DHCP, the network assigns an IP address to the receiver. To verify the IP address of the receiver, use the WinFlash utility as follows:

1. Connect the receiver to a computer running the WinFlash utility using the serial cable provided with the receiver.
2. Turn on the receiver.
3. On the computer, start the WinFlash utility.

4. From the **Device Configuration** screen, select **BD9xx receiver**. From the **PC serial port** list, select the appropriate PC serial port. Click **Next**.
5. From the **Operation Selection** screen, select **Configure ethernet settings** and then click **Next.**
6. From the **Settings Review** screen, click **Finish**.

   The IP address appears in the **Ethernet Configuration** dialog.
7. If your network installation requires the receiver to be configured with a static IP address, you can select a Static IP address and enter the settings given by your network administrator. The **Broadcast** setting is the IP address that is used to broadcast to all devices on the subnet. This is usually the highest address (usually 255) in the subnet.

Resetting your user name and password

Resetting your user name and password can be carried out over a serial port or USB as follows:

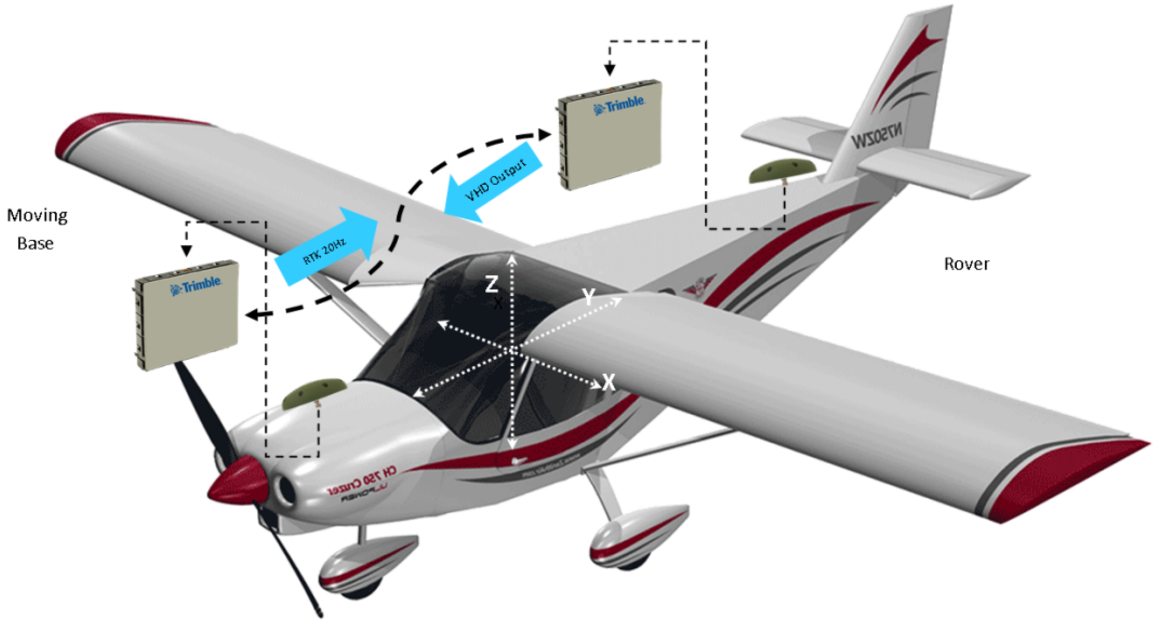
1. Open the Trimble Configuration Toolbox utility.
2. From the menu, select **Communications** and then select the desired **Port** which is connected to the receiver.
3. From the menu, select **Communications** and then select **Reset Receiver**.
4. Select the **Erase Battery-backed RAM** and **Erase File System** check boxes.
5. Click **OK**.

The receiver will reset to the default username (**admin**) and password (**password**).

Configuring BD990 for attitude and inertial applications

Attitude measurement using single antenna modules

The Trimble BD990 high performance GNSS module can be used to obtain vehicle orientation using the moving base RTK technique and concept of chained RTK measurements.

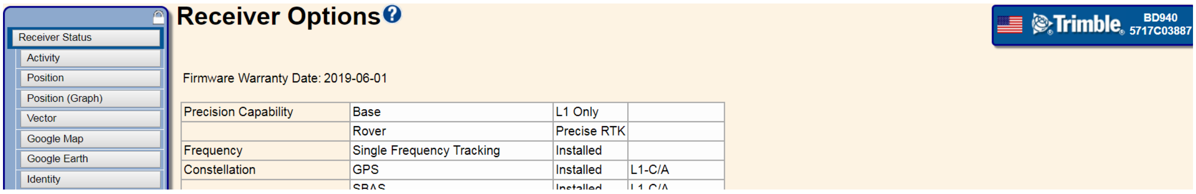


NOTE – The module shown above is the BD940 receiver.

In the above figure, the aircraft could have two BD990 receiver modules installed at both ends. One of the modules has its antenna installed towards the nose of the aircraft and the second module has its antenna installed at the tail of the aircraft. The BD/BX module connected to the nose antenna is setup as a moving base receiver while the module connected to the tail antenna is setup as a rover. The below configuration procedure shows the basic steps to follow in order to setup this layout on a BD940. It is similar on the BD990.

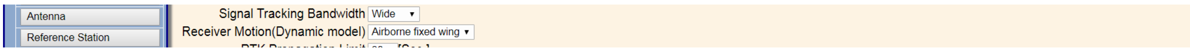
1. Device 1 Setup: BD940 reference/moving base receiver

1. Required options: Moving base RTK, RTK output corrections.

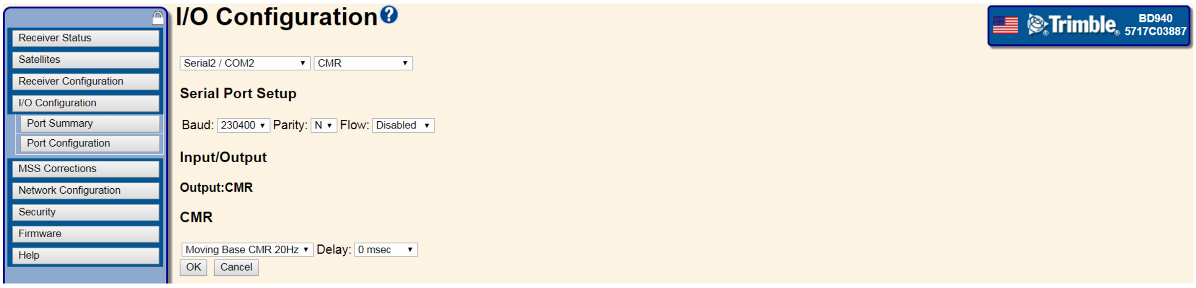


2. In **Receiver Configuration** / **General**, set the **Operation Mode** field to Moving Base.

3. In **Receiver Configuration** / **Position** page, ensure that the correct model is selected under **Receiver Motion (dynamic model)** list. In this case, “airborne fixed wing” is used.

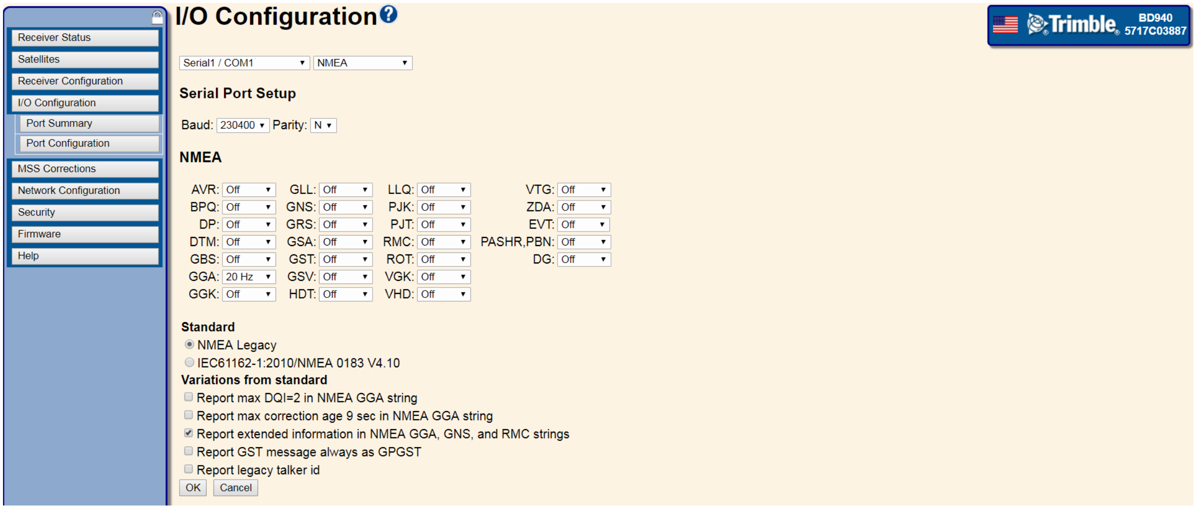


4. The following figure shows the **I/O Configuration** page where outputs can be setup. We need to set up one output to feed corrections data from the Base to the Rover. In this case, we have set up COM 2 to output CMR Moving base 20 Hz corrections at a serial baud rate of 230400 bps.



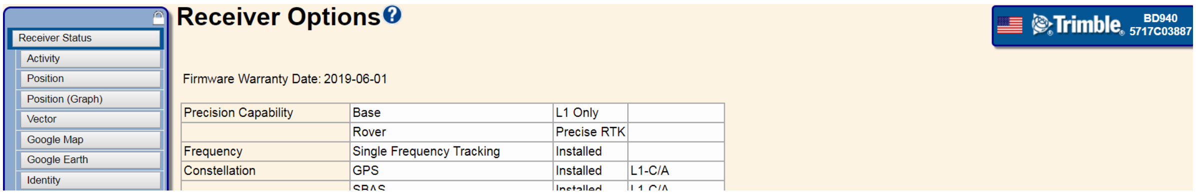
5. We may also set another serial port to output NMEA data to the aircraft’s navigational system. Therefore, if the moving base position and time information is needed, NMEA

GGA or GSOF POSITION/TIME messages (records 1,2) can be set up as outputs.

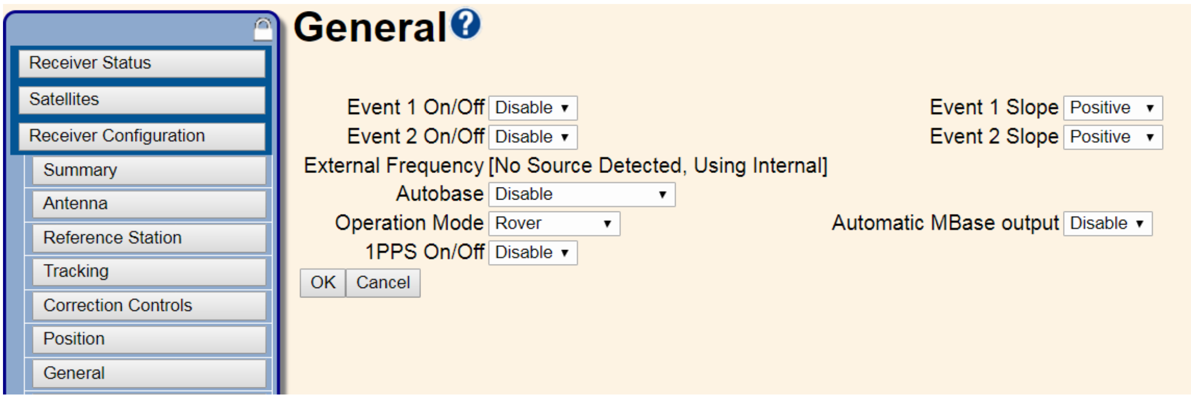


2. Device 2 Setup: BD940 rover receiver (mounted along the direction of primary vehicle motion)

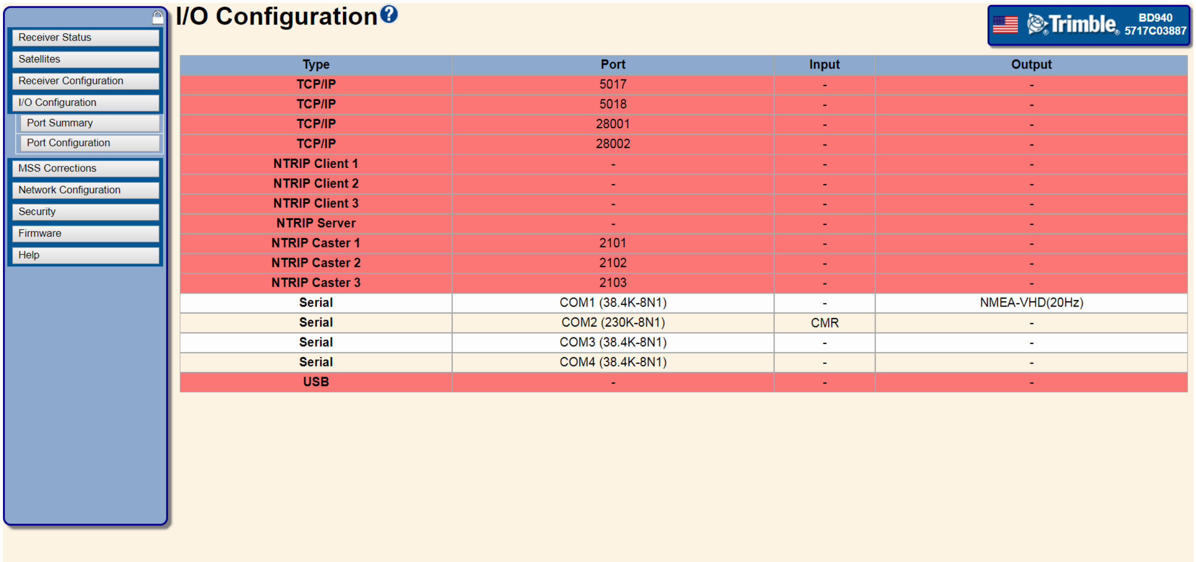
1. Required options: RTK correction input capability.



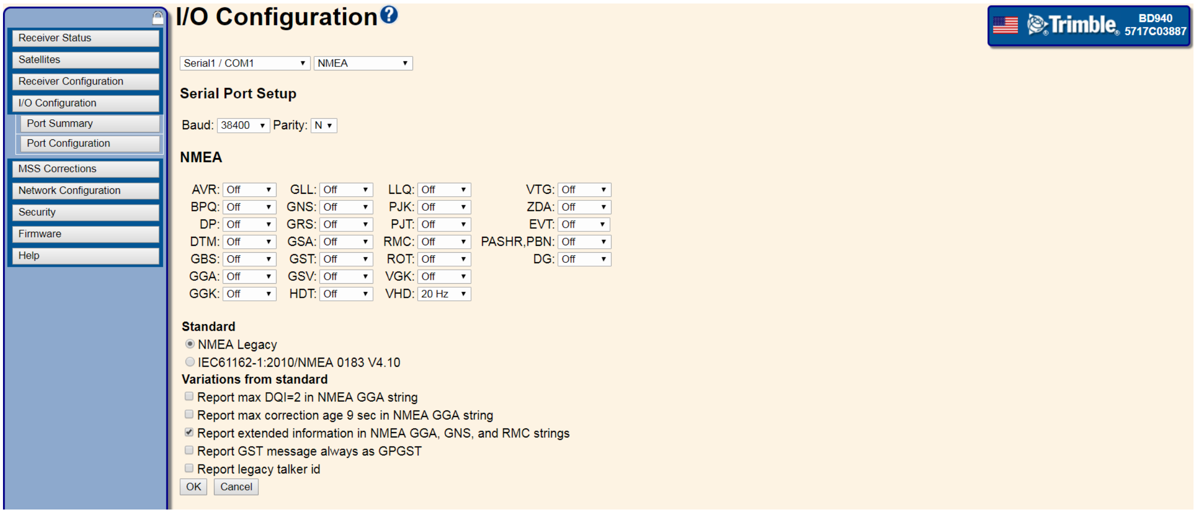
2. In **Receiver Configuration** / **General**, set the receiver **Operation Mode** field to Rover.



3. Input messages: RTK corrections input need to be provided from the Base to the Rover. Therefore, in this case we have connected COM2 of the Rover modules to COM2 of the Base.



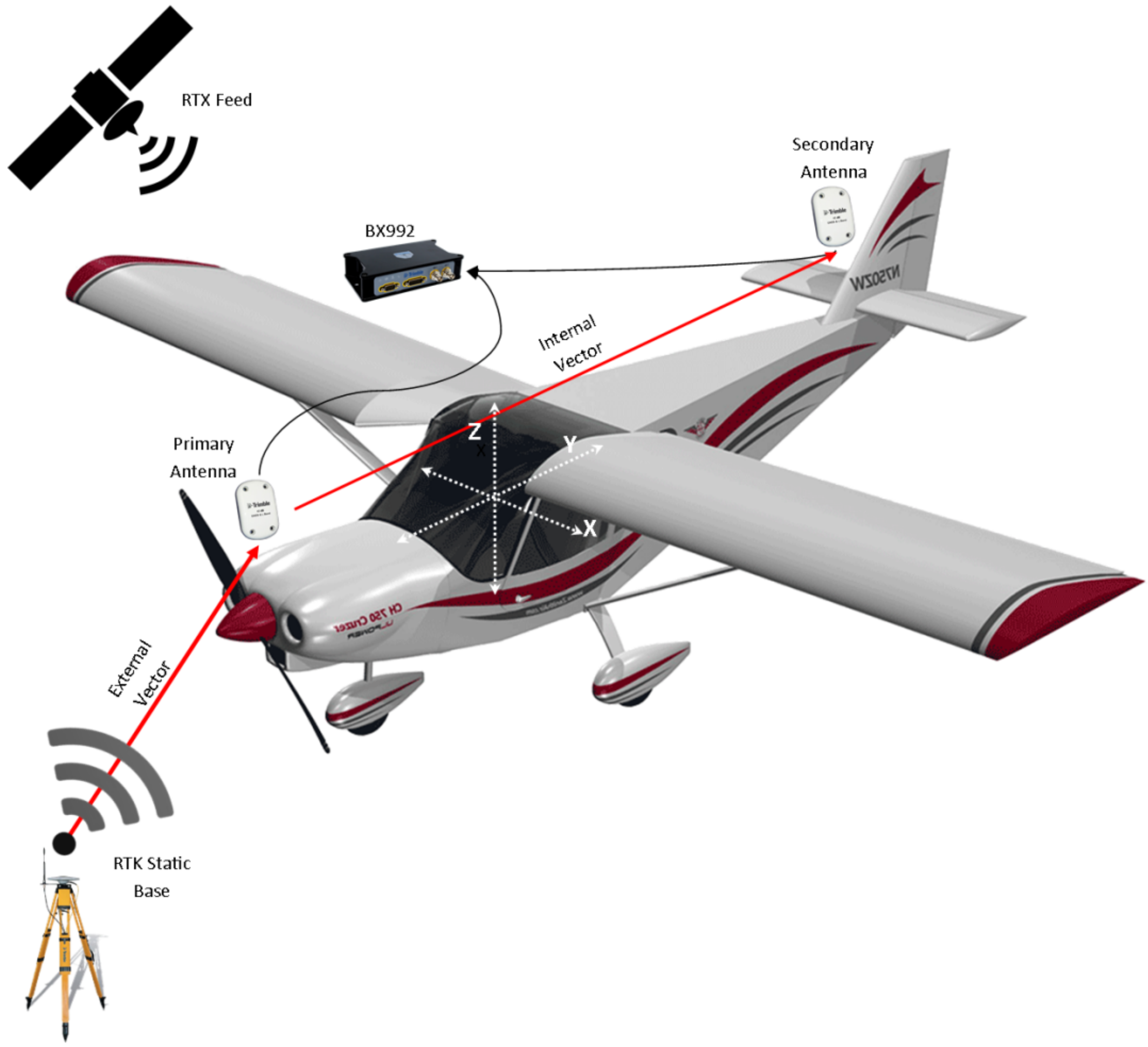
4. The Rover needs to also be setup to output messages such as NMEA VHD or GSOF Attitude Info message (record 27) for heading and attitude (5, 10, or 20 Hz). These messages are fed to the Base.



Configuring BD992/BD992-INS and BX992 receivers

Attitude measurement using Trimble OEM dual-antenna systems

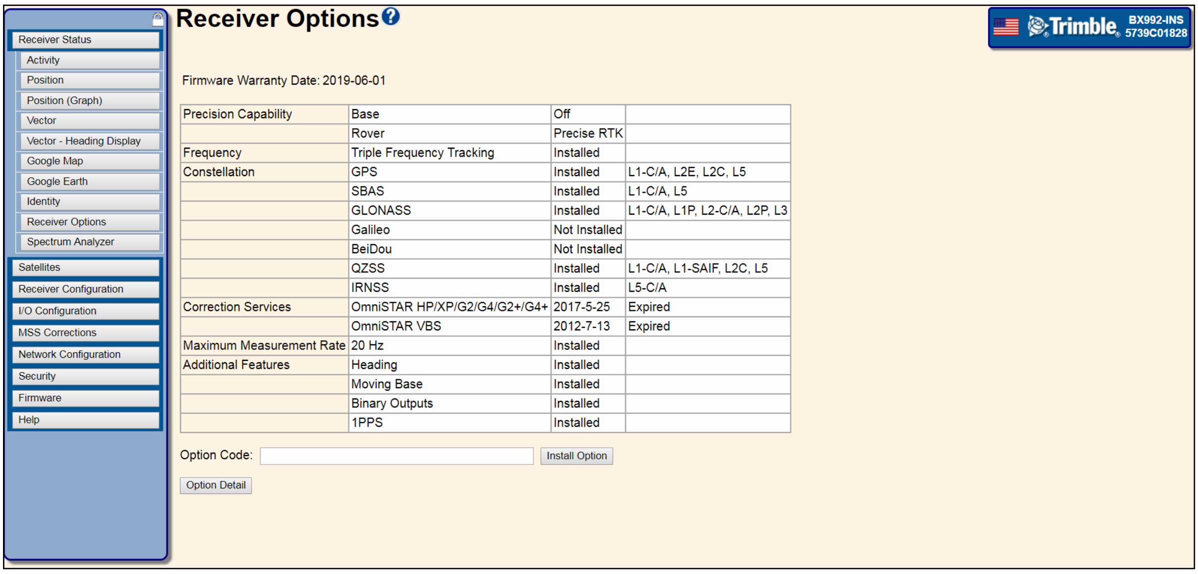
The Trimble BD992 or BD992 receiver is a dual antenna receiver which can be used to compute a two-attitude orientation set (such as roll and pitch / roll and yaw (heading) / pitch and yaw (heading), for example) for a dynamic platform based on the placement of antennas with respect to the vehicular body frame.



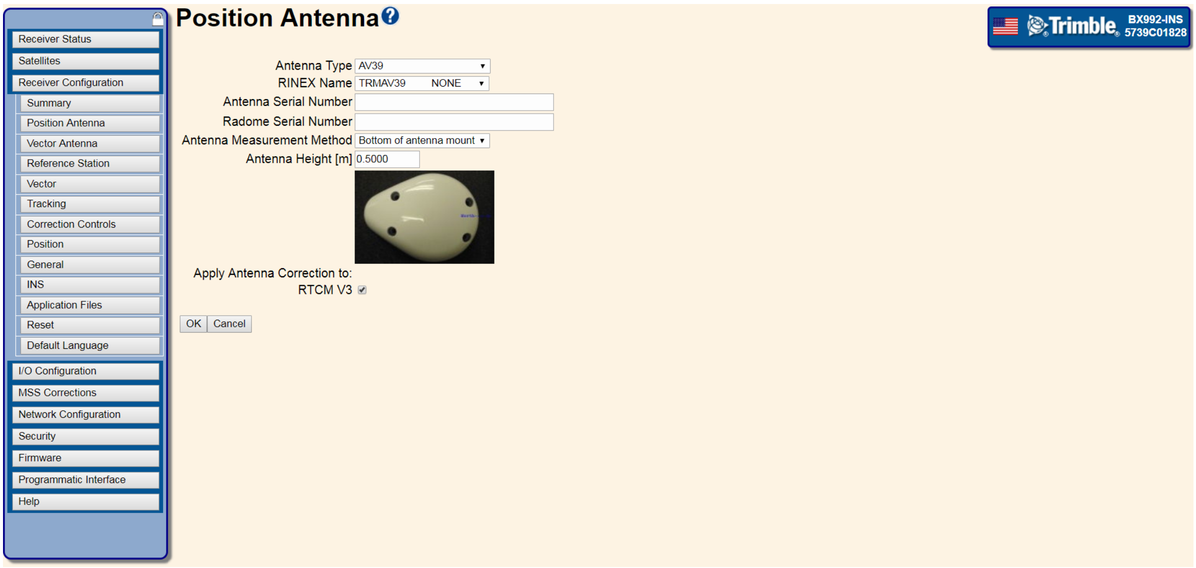
The BD/BX992 receiver uses the moving baseline RTK technique to determine the heading vector between its two antennas. Internally, raw code and carrier measurements from GPS and GLONASS satellites are processed at a rate up to 50 Hz. The receiver's primary (position) antenna acts as a moving base antenna, while the secondary (vector) antenna acts as a rover antenna for the receiver as it computes the internal vector between its two antennas.

1. BD992/BX992 Setup: Primary Antenna moving base

1. Required options: Moving base RTK, RTK output corrections:



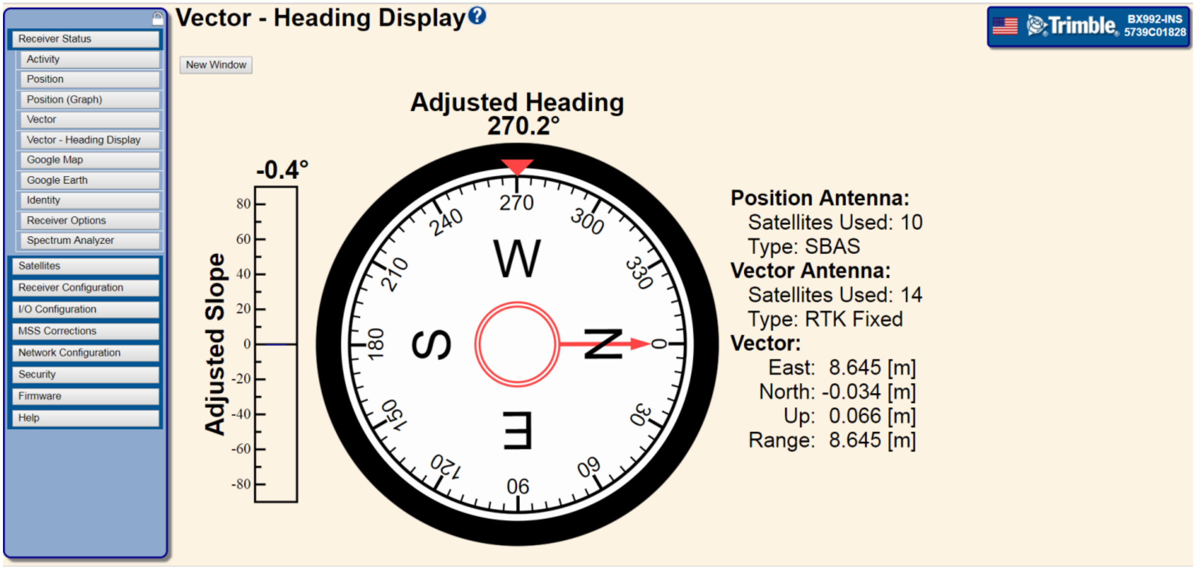
2. Go to **Receiver Configuration** / **Position Antenna** and set the details of the antenna type and height:



2. BD992/BX992 Setup: Secondary Antenna Rover Setup

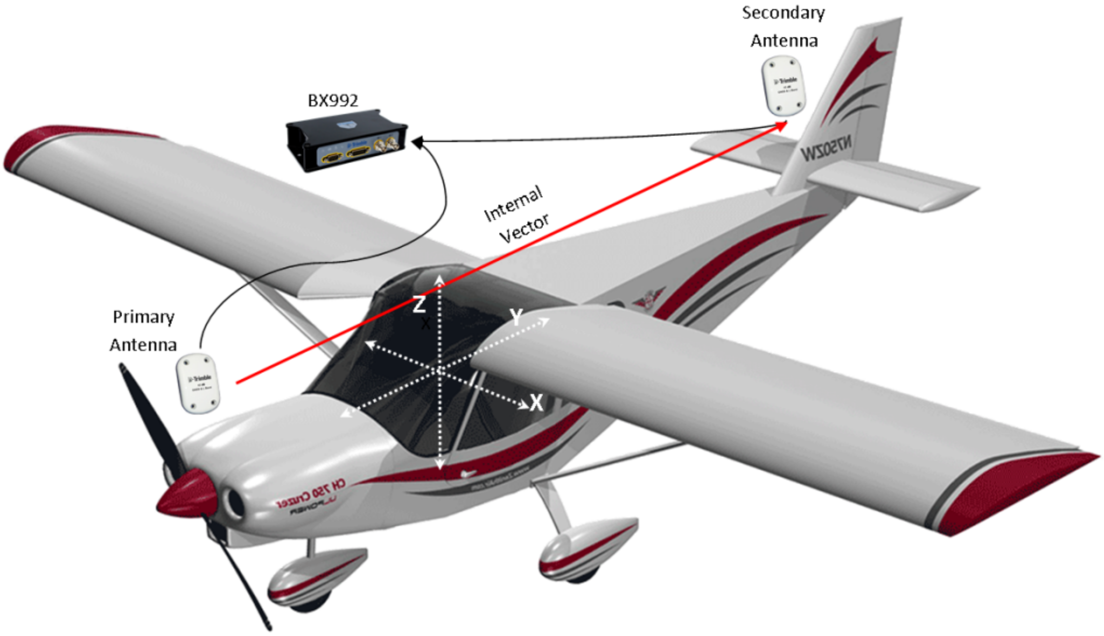
1. In **Receiver Configuration / Vector Antenna**, set the details of the second antenna and its height:

2. Results of the configuration will update in the **Receiver Configuration / Vector** or **Vector Heading Display** page:



Moving base RTK without external base station corrections

A single BD992 or BX992 receiver without any external reference station can be setup to act as a moving base/rover combination. This capability allows for precisely computing a vector between its primary (position) and secondary (vector) antennas. Most users are interested in the precise vector between the antennas, which is accurate to centimeter level.



The receiver can be configured to output NMEA messages for the position of the primary (position) and secondary (vector) antennas as follows:

1. NMEA GGK/GGA or GSOF POSITION/TIME messages (records 1,2)
   a. Position of primary antenna (latitude, longitude, and altitude) and receiver time.
2. NMEA AVR (α,β) or GSOF Attitude Info message (record 27)
   a. Yaw angle (α – same as heading), Tilt (β) in degrees and range (meters) between the primary and secondary antennas.
3. NMEA HDT (α) or GSOF Velocity Data message (record 8)
   a. Heading of internal vector relative to True North.

The position (latitude, longitude and height) of the secondary antenna is not directly output in an NMEA message. However, using the NMEA AVR message which gives the range in meters between the two antennas and the directional angles for the range vector, one can solve for the range projections in the East-North-Up frame relative to the primary antenna and further use coordinate transformations to obtain the Latitude, Longitude and Height of the secondary antenna.

Moving base RTK with external base station corrections (chained RTK)

A BD99x receiver that is configured to accept RTK corrections (CMR/RTCM) from an external base station computes RTK grade vectors between both its internal antennas (the receiver's primary and secondary antennas) as well as between the antennas of the external base station and the receiver's primary position antenna. A two-parameter attitude set can be obtained from the receiver for both the internal and external vectors. The following NMEA-0183 messages can be used to output the vector attitudes.

1. NMEA GGK/GGA or GSOF POSITION/TIME messages (records 1,2)
   a. Position of primary antenna (latitude, longitude, and altitude).
2. NMEA VGK or GSOF Tangent Plane Delta Message (record 7)
   a. Vector between the external base station antenna and the primary (position) antenna of the receiver as expressed in the East-North-Up (ENU) reference frame.

      NOTE – If no external base station is used to send corrections to the rover receiver, this vector (external vector) is output as 00000.000, 00000.000, 00000.000.
3. NMEA HDT (α) or GSOF Velocity Data Message (record 8)
   a. Heading of internal vector relative to True North.
4. NMEA AVR (α, β) or GSOF Attitude Info message (record 27)
   a. Output message giving Yaw angle (α – same as heading) and Tilt (β – pitch or roll depending on antenna placement) in degrees.
5. NMEA VHD (Θ ,Φ) or GSOF Attitude Info message (record 27)
   a. Output message giving Azimuth (Θ) and Elevation (Φ) in degrees.

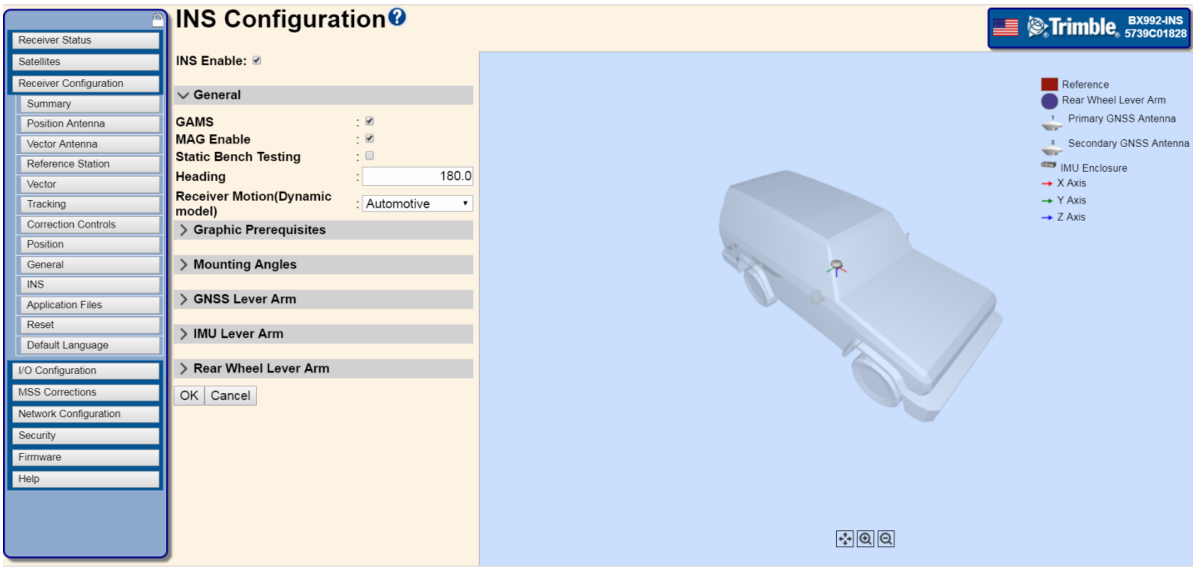
The above configuration can be used for “chained” RTK positioning, which implies that if the external base station is set up at a fixed and surveyed location, the external and internal vectors are accurate to within the given specification (<1 cm horizontally) and the absolute position of the receiver's primary and secondary antennas in space can be determined to an accuracy similar to the external base station position. With the two vectors known precisely, you can use vector addition with known base station coordinates to find a rover's antenna location in space.

Dual-antenna inertial setup for an automotive application

The following procedure shows the process that needs to be followed for setting up the BD992-INS or BX992 for an inertial application. This application is specific to a dual antenna inertial receiver.

General Config

The following screenshot shows the **General** section on the **INS Configuration** page:



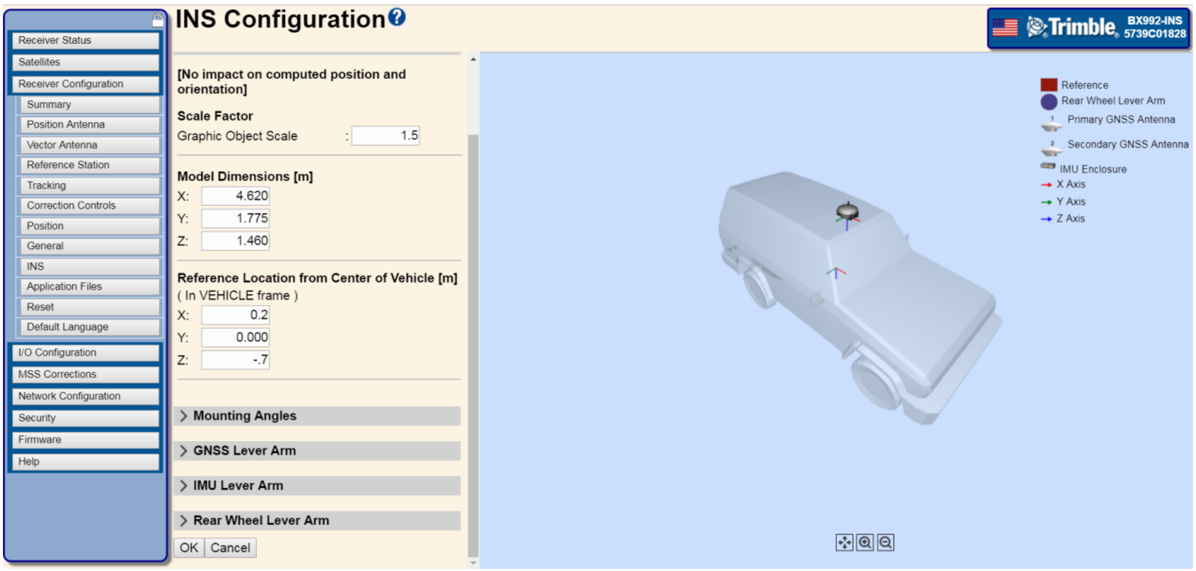
Verify that the following selections are made on this page.

- **INS Enable** check box is selected.
- **MAG Enabled** check box is selected.
- **GAMS** check box is selected.

  NOTE – Ensure that Calibration is conducted on the vehicle under test before exercising the system.
- **Static Bench Testing** is NOT SELECTED.
- From the **Receiver Motion** list, select Automotive.

Graphic Prerequisites

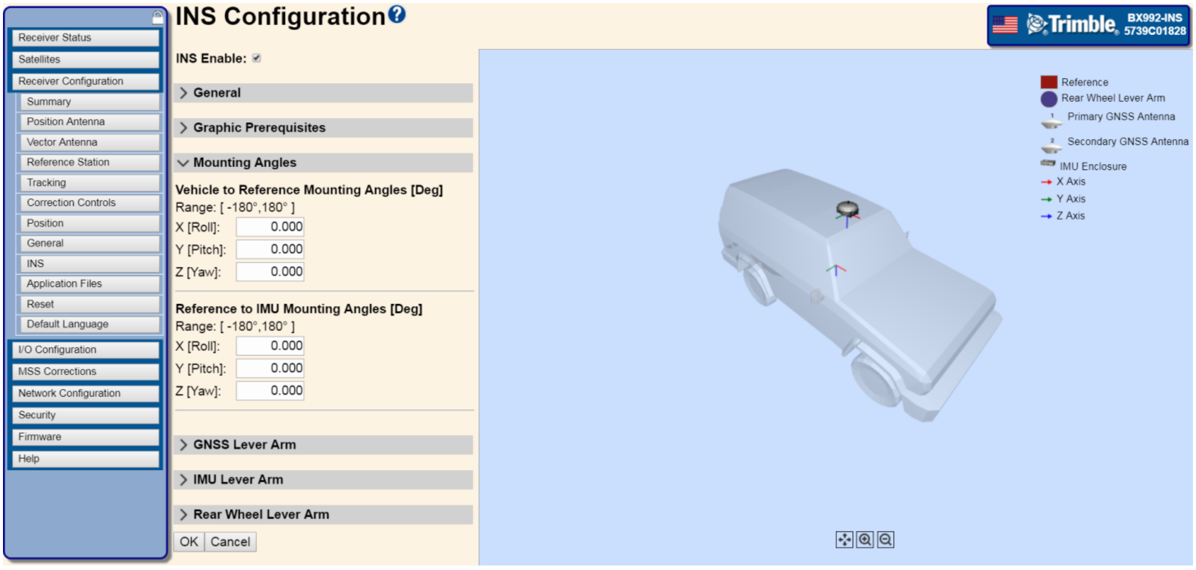
Under the **Graphics Prerequisites** section, select the following options to configure the web representation of the inertial installation:



1. Select **IMU shown as enclosure** checkbox if applicable. This option is not available for the BX992-INS.
2. Under **Scale Factor**, select the appropriate scale of the graphical image. Changing this number will reduce or enlarge the IMU or antenna graphical image.
3. Enter the **Model Dimensions**.
4. Enter the **X**, **Y**, and **Z** values of the reference location to where the primary antenna will be mounted within the vehicle frame

Mounting Angles

Under the **Mounting Angles** section, enter the reference and IMU mounting angles. In this configuration example, there are no rotations or different direction of travel. Therefore, the values for Pitch, Roll, Yaw for the reference antennas and IMU are left at 0°.

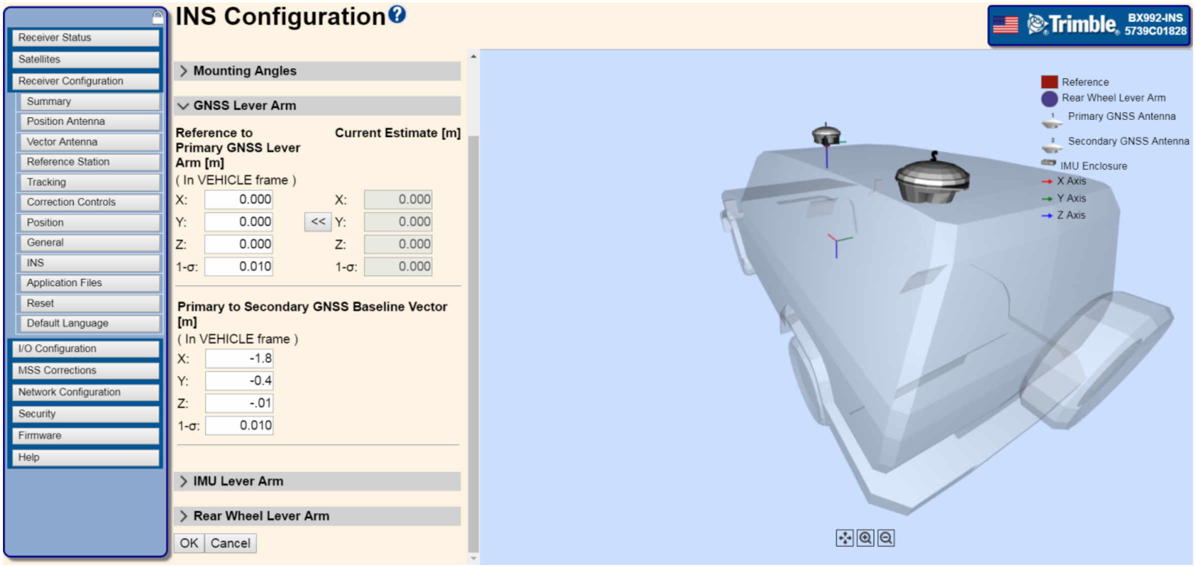


- **Vehicle to Reference Mounting Angles** are left at 0.
- **Reference to IMU Mounting Angles** are left at 0.

GNSS Lever Arm

For this configuration example, the values for the GNSS lever arm can be left at 0 which is the default.

NOTE – Reference to Primary GNSS Lever Arm is not required if the Reference is the Antenna Phase Center (APC).



The secondary antenna is located to rear of the vehicle and so the vector information was entered between the primary antenna and the secondary antenna. For this case, the values were:

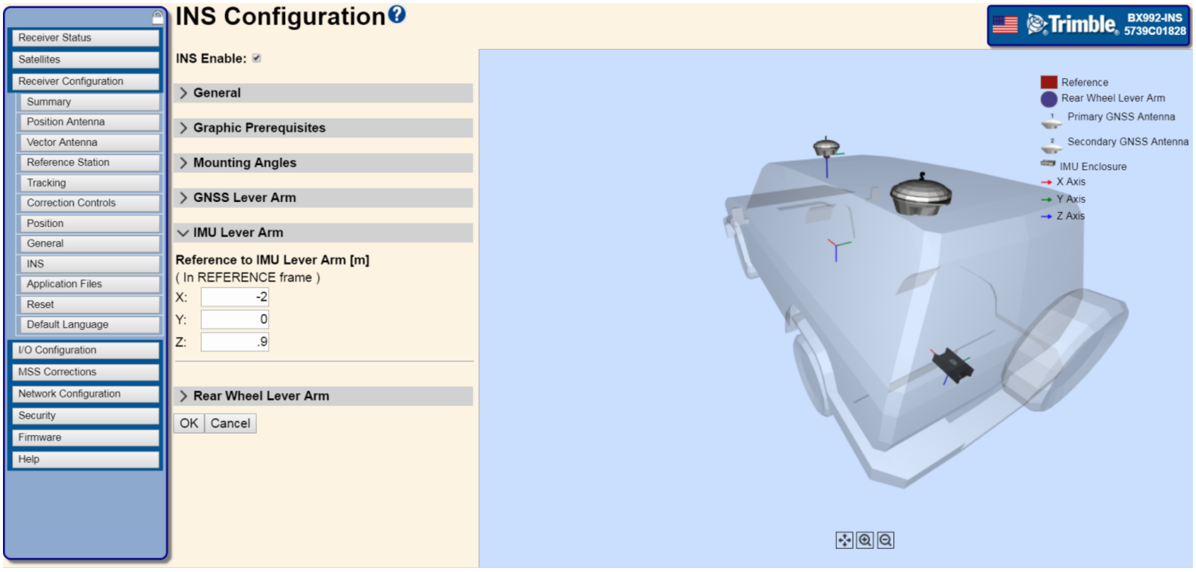
1. X: -1.8
2. Y: -0.4
3. Z: -0.01

As seen in the figure, the secondary antenna has now moved from to rear left of the vehicle.

IMU Lever Arm

In the **IMU level arm** section, using the APC simplifies setup measurements. Simply enter your measurement uncertainty from the **Primary Reference** to the **IMU Lever Arm** for the GNSS Lever Arm uncertainty.

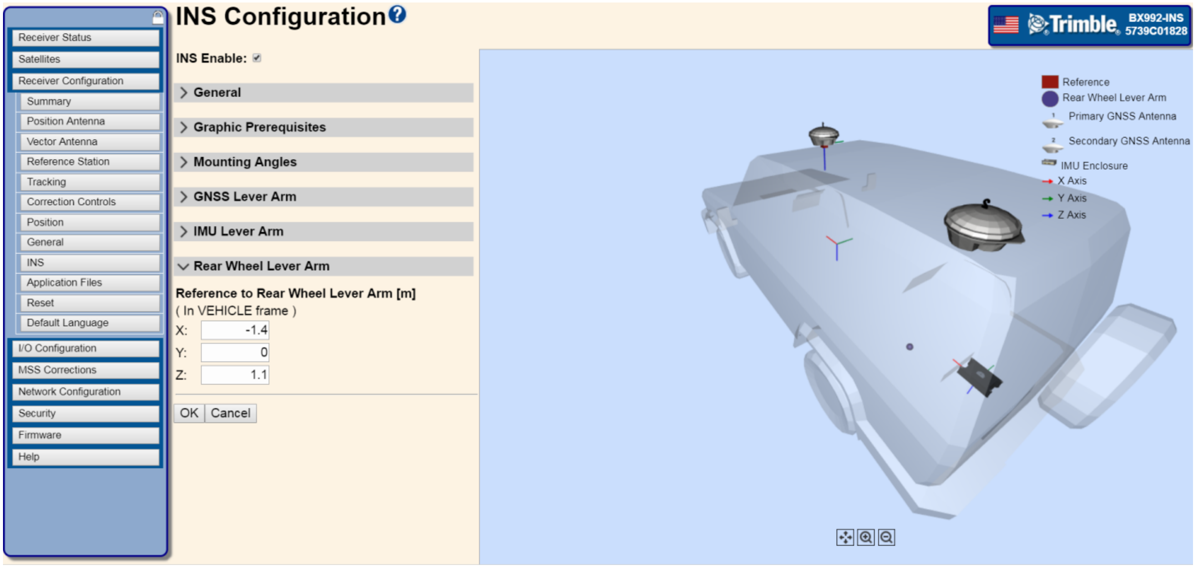
In this example, we are placing the IMU towards the rear of the vehicle on the floor pan. The distances from the IMU to the primary antenna are measured and inserted into the X, Y and Z fields of the IMU Lever arm section as shown below.



- X = -2.000 (m)
- Y = 0.000 (m)
- Z = 0.900 (m)

Rear Wheel Lever Arm

In the **Rear Wheel Lever Arm** section, enter the distance measured from the primary reference to the rear wheel of the vehicle. This Lever Arm is used to minimize the Cross Track Error. This example assumes no lateral wheel slippage.



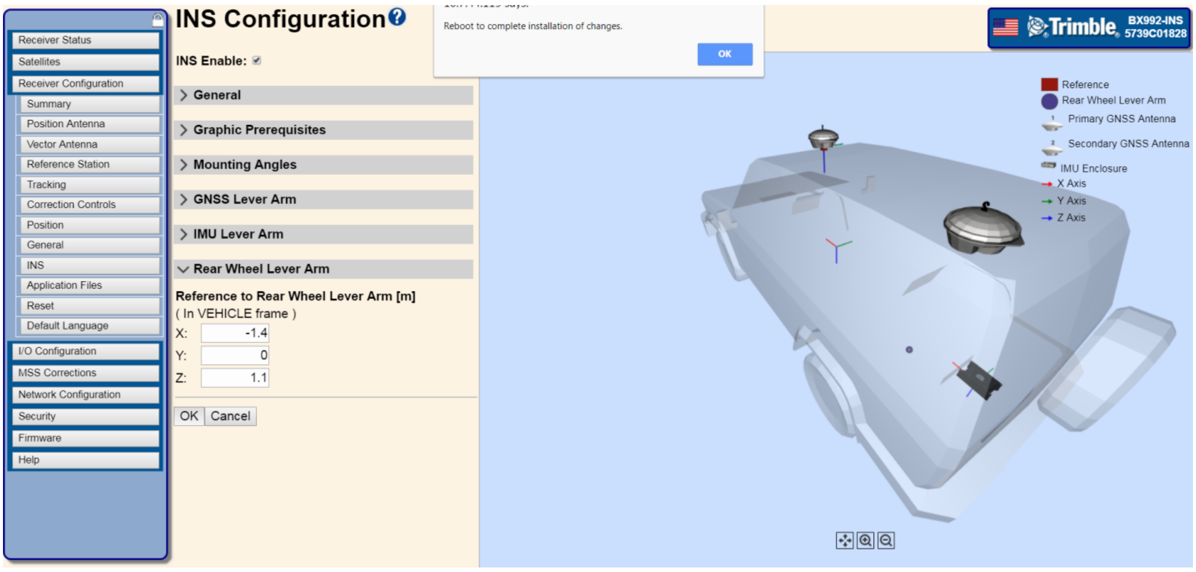
- X = -1.400 (m)
- Y = 0.000 (m)
- Z = 1.100 (m)

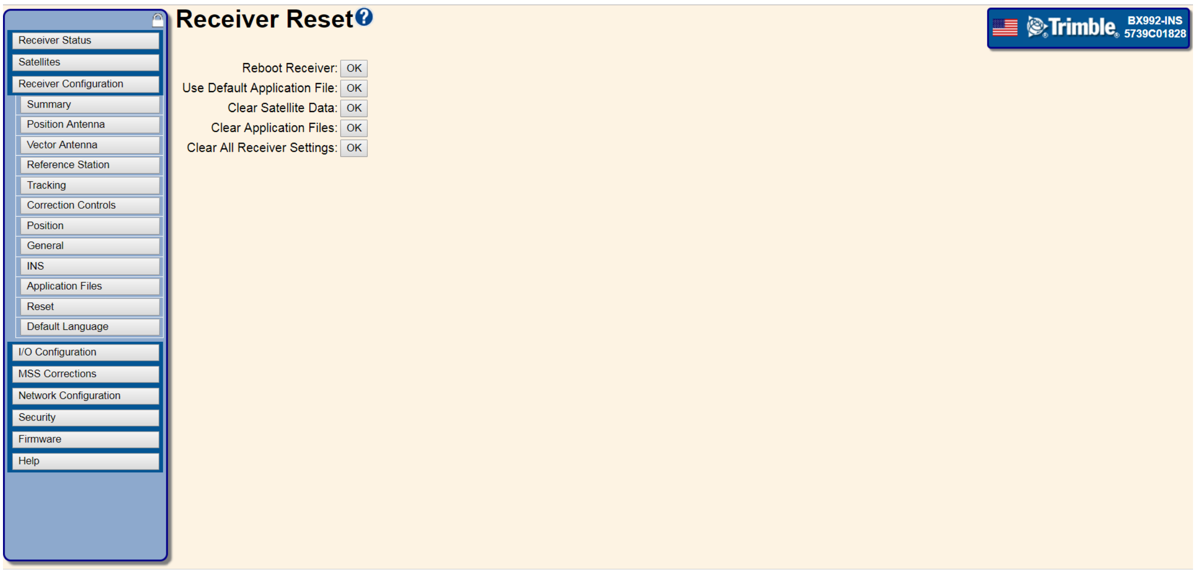
The benefits of using the Rear Wheel Lever Arm are:

- For when the system is using degraded GNSS SV Input (Carrier or Code Phase) for 3 or Less SVs
- For Dead Reckoning Navigation States using the Magnetometer for Position and Heading updates

Reboot receiver

After all the settings have been set, click **OK** at the bottom of the **INS** menu to save the changes. Click **OK** in the message that pops up. Doing so will redirect the web page to the **Receiver Reset** web page. Click **OK** next to the reboot receiver line to reboot the receiver.





Configuring the receiver using the binary interface

The Trimble Binary Interface allows configuration of the receiver over RS-232, USB, or Ethernet connections. The binary interface allows users to send commands to the receiver to set configurations, query the receiver for current status, and return current satellite tracking and positioning data.

For more information, refer to the Binary Interface Control section in the *BD9XX Integrator Guide*.

Accessing the web interface of the receiver via RNDIS

The Trimble GNSS receivers running firmware version 5.30 and later have implemented the protocol of Remote Network Driver Interface Specification (RNDIS). Using the USB cable connection, you can access the web pages of these receivers via RNDIS from Microsoft Windows 7, 8, or 10 on a computer. If that computer is on a company network, multiple users on your network can access the web pages of the receiver. This is useful for remote support and training.

Step 1: The Hardware Setup

The only hardware setup requirement is connecting the receiver to the PC via a USB cable. The receiver needs to be powered up before any attempt to connect to the web interface.

Step 2: The USB Driver Installation

Trimble USB driver installation is only required on a Microsoft Windows 7 or 8 PC. You do not need to run the Trimble USB driver installer on a Microsoft Windows 10 PC. If it has already been installed on a Windows 7 PC, you do not need to install it again. The driver is available from www.trimble.com/Support/Support_AZ.aspx / Support pages (Search under Downloads).

Step 3: The Network Settings Setup

The network setup is required for Microsoft Windows 7, 8, and 10. Follow these steps:

1. From the Windows Start menu, type **cmd**. The Windows command console pops up on the screen.
2. Right-click on the words **cmd.exe** and select **Run as administrator**. The Administrator: command prompt will be launched:
3. Type in the following command from the prompt:

   netsh interface portproxy add v4tov4 listenport=8080 listenaddress=0.0.0.0 connectport=80 connectaddress=169.254.0.10

   This is a single command. If the command console wraps the text, it is fine. This command needs to be run only once on success. You can run it multiple times if you want to add another listenport as such as 8081, but for majority users, it is not needed. This command will be executed successfully only when the "command prompt" console is launched as an administrator.

Step 4: Launch the Browsers

Once the steps are completed, any of the modern browsers can be used to open the receiver web pages. Step 2 and Step 3 only need to be done once.

The tests have been done on Google Chrome, Internet Explorer, and Mozilla Firefox. To access the webpage to the receiver that connected to the local PC, type http://localhost:8080 on the browser's URL like this:

To access the web page of a receiver that is connected to another PC on the network, type in the IP address of the remote PC, followed by the listen port number, like this:

In this case, a receiver connected to Windows 10 PC via RNDIS, the IP address for that Windows 10 PC is 10.1.150.56.

Step 5: Troubleshooting Tips

If the web page cannot be launched, the following can be used to troubleshoot the problem:

1. If this is Windows 7 PC, make sure the Trimble USB driver has been installed. You can use Windows Device Manager can be used to check if the driver has been properly installed. Sometimes Trimble devices do not connect well via the superspeed USB (SS-USB). In this case, try the regular USB.
2. Using Ping to test the connection. From the command prompt, type “ping 169.254.0.10”. If connection is good, a reply should be returned. Otherwise, check the cable connection.
3. If the “localhost:8080” URL does not connect, use http://localhost:8080.
4. Make sure the netsh in Step 3 is executed successfully under a command prompt with the “administrator” privilege.

9

Output Messages

This section includes information regarding output messages. The ASCII NMEA messages are detailed along with the binary GSOF messages.

If you are not familiar with GSOF messages, you may find the GSOF Message Parsing and Decoding section in the *BD9XX Integrator Guide* useful.

You may also wish to refer to the Binary Interface Control Document and the Command Packet and Report Packet Summary to understand other commands that can be used to return data from the receiver. In particular, the Application File packets can be used to retrieve the current configuration, or any stored configurations, from the receiver.

NMEA-0183 messages: Overview

When NMEA-0183 output is enabled, a subset of NMEA-0183 messages can be output to external instruments and equipment connected to the receiver serial ports. These NMEA-0183 messages let external devices use selected data collected or computed by the GNSS receiver.

All messages conform to the NMEA-0183 version 3.01 format. All begin with $ and end with a carriage return and a line feed. Data fields follow comma (,) delimiters and are variable in length. Null fields still follow comma (,) delimiters, but contain no information.

An asterisk (*) delimiter and checksum value follow the last field of data contained in an NMEA-0183 message. The checksum is the 8-bit exclusive of all characters in the message, including the commas between fields, but not including the $ and asterisk delimiters. The hexadecimal result is converted to two ASCII characters (0–9, A–F). The most significant character appears first.

The following table summarizes the set of NMEA messages supported by the receiver.

Message	Function
ADV	Position and satellite information for RTK network operations
DTM	Datum reference information
GBS	GNSS satellite fault detection (RAIM support)
GGA	Time, position, and fix related data
GLL	Position data: position fix, time of position fix, and status
GNS	GNS Fix data
GRS	GRS range residuals
GSA	GPS DOP and active satellites
GST	Position error statistics
GSV	Number of SVs in view, PRN, elevation, azimuth, and SNR
HDT	Heading from True North
LLQ	Leica local position and quality
PASHR	RT300 proprietary roll and pitch sentence
PFUGDP	A proprietary message containing information about the type of positioning system, position, number of satellites and position statistics

Message	Function
PTNL,AVR	Time, yaw, tilt, range, mode, PDOP, and number of SVs for Moving Baseline RTK
PTNL,BPQ	Base station position and position quality indicator
PTNL,DG	L-band corrections and beacon signal strength and related information
PTNL,GGK	Time, position, position type, and DOP values
PTNL,PJK	Time, position, position type, and DOP values
PTNL,PJT	Projection type
PTNL,VGK	Time, locator vector, type, and DOP values
PTNL,VHD	Heading Information
RMC	Position, Velocity, and Time
ROT	Rate of turn
VTG	Actual track made good and speed over ground
ZDA	UTC day, month, and year, and local time zone offset

To enable or disable the output of individual NMEA messages, do one of the following:

- Create an application file in the Configuration Toolbox software that contains NMEA output settings and then send the file to the receiver.
- Add NMEA outputs in the **Serial outputs** tab of the GPS Configurator software and then apply the settings.

NOTE – The position output by the receiver is the Antenna Phase Center position. You may want to reduce this position to a reference position elsewhere. If so, you should account for any tilt of the antenna in such a reduction. The settings for the Antenna Measurement Method and Antenna Height are not applied to the position outputs.

For a copy of the NMEA-0183 Standard, go to the National Marine Electronics Association website at www.nmea.org.

NMEA-0183 messages: Common message elements

Each message contains:

- a message ID consisting of $GP followed by the message type. For example, the message ID of the GGA message is $GPGGA.
- a comma.
- a number of fields, depending on the message type, separated by commas.
- an asterisk.
- a checksum value.

The following example shows a simple message with a message ID ($GPGGA), followed by 13 fields and a checksum value:

$GPGGA,172814.0,3723.46587704,N,12202.26957864,W,2,6,1.2,18.893,M,-25.669,M,2.0,0031*4F

NMEA Message values

NMEA messages that the receiver generates contains the following values:

Value	Description
Latitude and Longitude	Latitude is represented as ddmm.mmmm and longitude is represented as dddmm.mmmm, where: • dd or ddd is degrees • mm.mmmm is minutes and decimal fractions of minutes
Direction	Direction (north, south, east, or west) is represented by a single character: N , S , E , or W.
Time	Time values are presented in Universal Time Coordinated (UTC) and are represented as hhmmss.ss, where: • hh is hours, from 00 through 23 • mm is minutes • ss.ss is seconds with variable length decimal-fraction of seconds

NMEA-0183 message: ADV

Position and satellite information for RTK network operations

The messages alternate between subtype 110 and 120.

ADV subtype 110 message fields

An example of the ADV subtype 110 message string is:

$PGPPADV,110,39.88113582,-105.07838455,1614.125*1M

Field	Meaning
0	Message ID $PGPPADV
1	Message subtype 110
2	Latitude
3	Longitude
4	Ellipsoid height
6	Elevation of second satellite, in degrees, 90° maximum
7	Azimuth of second satellite, degrees from True North, 000° through 359°
8	The checksum data, always begins with *

ADV subtype 120 message fields

An example of the ADV subtype 120 message string is:

$PGPPADV,120,21,76.82,68.51,29,20.66,317.47,28,52.38,276.81,22,42.26,198.96*5D

Field	Meaning
0	Message ID $PGPPADV
1	Message subtype 120
2	First SV PRN number
3	Elevation of first satellite, in degrees, 90° maximum
4	Azimuth of first satellite, degrees from True North, 000° through 359°
5	Second SV PRN number
6	Elevation of second satellite, in degrees, 90° maximum

Field	Meaning
7	Azimuth of second satellite, degrees from True North, 000° through 359°
8	The checksum data, always begins with *

NMEA-0183 message: DTM

The DTM message identifies the local geodetic datum and datum offsets from a reference datum. This sentence is used to define the datum to which a position location, and geographic locations in subsequent sentences, is referenced.

An example of the DTM message string is:

$GPDTM,W84,,0.0,N,0.0,W,0.0,W84*7D

DTM message fields

Field	Meaning
0	Message ID $GPDTM
1	Local datum code (CCC): W84 – WGS-84 W72 – WGS-72 S85 – SGS85 P90 – PE90 999 – User-defined IHO datum code
2	Local datum subdivision code (x)
3	Latitude offset, in minutes (x.x)
4	N/S (x)
5	Longitude offset, in minutes (x.x)
6	E/W (x)
7	Altitude offset, in meters (x.x)
8	Reference datum code (CCC): W84 – WGS-84 W72 – WGS-72 S85 – SGS85 P90 – PE90

NMEA-0183 message: GBS

GNSS satellite fault detection (RAIM support)

An example of the GBS message string is:

$GPGBS,015509.00,-0.031,-0.186,0.219,19,0.000,-0.354,6.972*4D

GBS message fields

Field	Meaning
0	Message ID $--GBS. Talker ID can be: GA: Galileo GB: Beidou GP: GPS. To provide information specific to the GPS constellation when more than one constellation is used for the differential position fix. GL: GLONASS. To provide information specific to the GLONASS constellation when more than one constellation is used for the differential position fix. GN: Combined GNSS position. GNSS position fix from more than one constellation, for example, GPS and GLONASS. GQ: QZSS
1	UTC of position fix
2	Expected error in latitude, in meters, due to bias, with noise = 0
3	Expected error in longitude, in meters, due to bias, with noise = 0
4	Expected error in altitude, in meters, due to bias, with noise = 0
5	ID number of most likely failed satellite
6	Probability of missed detection of most likely failed satellite
7	Estimate of bias, in meters, on the most likely failed satellite
8	Standard deviation of bias estimate
9	The checksum data, always begins with *

If NMEA-0183 version 4.10 is selected, the 9th, 10th, and 11th fields become:

Field	Meaning	
9	System ID based on:	
	GPS	1
	GLONASS	2
	Galileo	3
	Beidou	4
	QZSS	0
10	Signal ID based on:	
	GPS	1
	GLONASS	1
	Galileo	7
	Beidou	Null
	QZSS	Null
11	The checksum data, always begins with *	

NMEA-0183 message: GNS

GNSS fix data

GNSS capable receivers will always output this message with the GN talker ID

GNSS capable receivers will also output this message with other talker ID's when using more than one constellation for the position fix

An example of the GNS message output from a GNSS capable receiver is:

$GNGNS,014035.00,4332.69262,S,17235.48549,E,RR,13,0.9,25.63,11.24,,*70<CR><LF>

$GPGNS,014035.00,,,,,,8,,,,1.0,23*76<CR><LF>

$GLGNS,014035.00,,,,,,5,,,,1.0,23*67<CR><LF>

GNS message fields

Field	Meaning
0	Message ID $--GNS Talker ID can be: GA: Galileo GB: Beidou GP: GPS GL: GLONASS. When more than one constellation is used. GN: Combined GNSS position, for example, GPS and GLONASS. GQ: QZSS
1	UTC of position fix
2	Latitude
3	Direction of latitude: N: North S: South
4	Longitude
5	Direction of longitude: E: East W: West

<table>
<tr><th>Field</th><th>Meaning</th></tr>
<tr><td>6</td><td>Mode indicator:
Variable character field with one character for each supported constellation.
First character is for GPS.
Second character is for GLONASS.
Third character is Galileo.
Fourth character is for Beidou.
Fifth character is for QZSS.
Subsequent characters will be added for new constellations.
Each character will be one of the following:

N = No fix. Satellite system not used in position fix, or fix not valid

A = Autonomous. Satellite system used in non-differential mode in position fix

D = Differential (including all OmniSTAR services). Satellite system used in differential mode in position fix

P = Precise. Satellite system used in precision mode. Precision mode is defined as: no deliberate degradation (such as Selective Availability) and higher resolution code (P-code) is used to compute position fix

R = Real Time Kinematic. Satellite system used in RTK mode with fixed integers

F = Float RTK. Satellite system used in real-time kinematic mode with floating integers

E = Estimated (dead reckoning) Mode

M = Manual Input Mode

S = Simulator Mode</td></tr>
<tr><td>7</td><td>Number of SVs in use, range 00–99</td></tr>
<tr><td>8</td><td>HDOP calculated using all the satellites (GPS, GLONASS, and any future satellites) used in computing the solution reported in each GNS sentence.</td></tr>
<tr><td>9</td><td>Orthometric height in meters (MSL reference)</td></tr>
<tr><td>10</td><td>Geoidal separation in meters – The difference between the earth ellipsoid surface and mean-sea-level (geoid) surface defined by the reference datum used in the position solution.

“-” = mean-sea-level surface below ellipsoid.</td></tr>
</table>

Field	Meaning
11	Age of differential data – Null if talker ID is GN, additional GNS messages follow with Age of differential data.
12	Reference station ID[1], range 0000-4095 – Null if Talker ID is GN. Additional GNS messages follow with Reference station ID.
13	The checksum data, always begins with *

***NOTE –** If a user-defined geoid model, or an inclined plane is loaded into the receiver, then the height output in the NMEA GNS string is always the orthometric height (height above a geoid). The orthometric height is output even if no user-defined geoid is loaded (there is a default geoid in the receiver), or if a user-defined geoid is loaded, or if an inclined plane is used.*

1

When using OmniSTAR services, the Reference Station ID indicates the following services:

VBS 100=VBS; 1000=HP; 1001 = HP/XP (Orbits) ; 1002 = HP/G2 (Orbits); 1008 = XP (GPS); 1012 = G2 (GPS); 1013 = G2 (GPS/GLONASS); 1014 = G2 (GLONASS); 1016 = HP/XP (GPS); 1020 = HP/G2 (GPS) ; 1021 = HP/G2 (GPS/GLONASS).

NMEA-0183 message: GGA

Time, position, and fix related data

An example of the GBS message string is:

$GPGGA,172814.0,3723.46587704,N,12202.26957864,W,2,6,1.2,18.893,M,-25.669,M,2.0
0031*4F

NOTE – The data string exceeds the NMEA standard length.

GGA message fields

Field	Meaning
0	Message ID $GPGGA
1	UTC of position fix
2	Latitude
3	Direction of latitude: N: North S: South
4	Longitude
5	Direction of longitude: E: East W: West
6	GPS Quality indicator: 0: Fix not valid 1: GPS fix 2: Differential GPS fix (DGNSS), SBAS, OmniSTAR VBS, Beacon, RTX in GVBS mode 3: Not applicable 4: RTK Fixed, xFill 5: RTK Float, OmniSTAR XP/HP, Location RTK, RTX 6: INS Dead reckoning
7	Number of SVs in use, range from 00 through to 24+
8	HDOP

Field	Meaning
9	Orthometric height (MSL reference)
10	M: unit of measure for orthometric height is meters
11	Geoid separation
12	M: geoid separation measured in meters
13	Age of differential GPS data record, Type 1 or Type 9. Null field when DGPS is not used.
14	Reference station ID, range 0000-4095. A null field when any reference station ID is selected and no corrections are received. See table below for a description of the field values.
15	The checksum data, always begins with *

NOTE – If a user-defined geoid model, or an inclined plane is loaded into the receiver, then the height output in the NMEA GGA string is always the orthometric height (height above a geoid). The orthometric height is output even if no user-defined geoid is loaded (there is a simplified default geoid in the receiver), or if a user-defined geoid is loaded, or if an inclined plane is used.

When using one of the MSS (Mobile Satellite Services), the **Reference Station ID** field indicates the following services:

Reference Station ID	Service
0002	CenterPoint or ViewPoint RTX
0005	RangePoint RTX
0006	FieldPoint RTX
0100	VBS
1000	HP
1001	HP/XP (Orbits)
1002	HP/G2 (Orbits)
1008	XP (GPS)
1012	G2 (GPS)
1013	G2 (GPS/GLONASS)
1014	G2 (GLONASS)

Reference Station ID	Service
1016	HP/XP (GPS)
1020	HP/G2 (GPS)
1021	HP/G2 (GPS/GLONASS)

NMEA-0183 message: GSA

GPS DOP and active satellites

An example of the GSA message string is:

$GNGSA,A,3,21,5,29,25,12,10,26,2,,,,,1.2,0.7,1.0*27

$GNGSA,A,3,65,67,80,81,82,88,66,,,,,,1.2,0.7,1.0*20

GSA message fields

Field	Meaning
0	Message ID $GNGSA
1	Mode 1, M = manual, A = automatic
2	Mode 2, Fix type, 1 = not available, 2 = 2D, 3 = 3D
3	PRN number, 01 through 32 for GPS, 33 through 64 for SBAS, 64+ for GLONASS
4	PDOP: 0.5 through 99.9
5	HDOP: 0.5 through 99.9
6	VDOP: 0.5 through 99.9
7	The checksum data, always begins with *

If NMEA-0183 version 4.10 is selected, the 7th and 8th fields become:

Field	Meaning	
7	System ID based on:	
	GPS	1
	GLONASS	2
	Galileo	3
	Beidou	4
	QZSS	0
8	The checksum data, always begins with *	

NMEA-0183 message: GST

Position error statistics

An example of the GST message string is:

$GPGST,172814.0,0.006,0.023,0.020,273.6,0.023,0.020,0.031*6A

The Talker ID ($--) will vary depending on the satellite system used for the position solution:

- $GP - GPS only
- $GL - GLONASS only
- $GN - Combined

GST message fields

Field	Meaning
0	Message ID $GPGST
1	UTC of position fix
2	RMS value of the pseudorange residuals; includes carrier phase residuals during periods of RTK (float) and RTK (fixed) processing
3	Error ellipse semi-major axis 1 sigma error, in meters
4	Error ellipse semi-minor axis 1 sigma error, in meters
5	Error ellipse orientation, degrees from true north
6	Latitude 1 sigma error, in meters
7	Longitude 1 sigma error, in meters
8	Height 1 sigma error, in meters
9	The checksum data, always begins with *

NMEA-0183 message: GSV

Satellite information

The GSV message string identifies the number of SVs in view, the PRN numbers, elevations, azimuths, and SNR values. Example GSV message strings are:

$GPGSV,8,1,25,21,44,141,47,15,14,049,44,6,31,255,46,3,25,280,44*75

$GPGSV,8,2,25,18,61,057,48,22,68,320,52,27,34,268,47,24,32,076,45*76

$GPGSV,8,3,25,14,51,214,49,19,23,308,46*7E

$GPGSV,8,4,25,51,44,183,49,46,41,169,43,48,36,220,45*47

$GLGSV,8,5,25,82,49,219,52,76,22,051,41,83,37,316,51,67,57,010,51*6C

$GLGSV,8,6,25,77,24,108,44,81,10,181,46,78,1,152,34,66,18,060,45*50

$GLGSV,8,7,25,68,37,284,50*5C

$GBGSV,8,8,25,111,35,221,47,112,4,179,39,114,48,290,48*11

GSV message fields

Field	Meaning
0	Message ID
1	Total number of messages of this type in this cycle
2	Message number
3	Total number of SVs visible
4	SV PRN number
5	Elevation, in degrees, 90° maximum
6	Azimuth, degrees from True North, 000° through 359°
7	SNR, 00 through 99 dB (null when not tracking)
8–11	Information about second SV, same format as fields 4 through 7
12–15	Information about third SV, same format as fields 4 through 7
16–19	Information about fourth SV, same format as fields 4 through 7
20	The checksum data, always begins with *

NOTE –

$GPGSV indicates GPS and SBAS satellites. If the PRN is greater than 32, this indicates an SBAS PRN, 87 should be added to the GSV PRN number to determine the SBAS PRN number.

$GLGSV indicates GLONASS satellites. 64 should be subtracted from the GSV PRN number to determine the GLONASS PRN number.

$GBGSV indicates BeiDou satellites. 100 should be subtracted from the GSV PRN number to determine the BeiDou PRN number.

$GAGSV indicates Galileo satellites.

$GQGSV indicates QZSS satellites.

NMEA-0183 message: HDT

Heading from True North

NOTE – The heading computation in this message is computed from the moving baseline vector, which requires a two-antenna system.

An example of the HDT string is:

$GPHDT,123.456,T*00

Heading from true north message fields

Field	Meaning
0	Message ID $GPHDT
1	Heading in degrees
2	T: Indicates heading relative to True North
3	The checksum data, always begins with *

NMEA-0183 message: LLQ

Leica local position and quality

An example of the LLQ message string is:

$GPLLQ,034137.00,210712,,M,,M,3,15,0.011,,M*15

Field	Meaning
0	Message ID $GPLLQ
1	hhmmss.ss – UTC time of position
2	ddmmyy – UTC date
3	xxx.xxx – Grid easting (meters)
4	M – Meter, fixed text
5	xxxx.xxxx – Grid northing (meters)
6	M – Meter, fixed text
7	x – GPS quality. 0 = not valid. 1 = GPS Nav Fix. 2 = DGPS Fix. 3 = RTK Fix.
8	x – Number of satellites used in computation
9	xx.xx – Position quality (meters)
10	xxxx.xxxx – Height (meters)
11	M – Meter, fixed text
	*hh – checksum
	<CR> – carriage return
	<LF> – Line feed

NMEA-0183 message: PTNL,AVR

Time, yaw, tilt/roll, range for moving baseline RTK

NOTE – The heading computation in this message is computed from the moving baseline vector, which requires a two-antenna system.

An example of the PTNL,AVR message string is:

$PTNL,AVR,212405.20,+52.1531,Yaw,-0.0806,Tilt,,,12.575,3,1.4,16*39

$PTNL,AVR,212604.30,+52.1800,Yaw,,,-0.0807,Roll,12.579,3,1.4,16*21

AVR message fields

Field	Meaning
0	Message ID $PTNL,AVR
1	UTC of vector fix
2	Yaw angle, in degrees
3	Yaw
4	Tilt angle, in degrees
5	Tilt
8	Range, in meters (between antennas)
9	GPS quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential carrier phase solution RTK (Float) 3: Differential carrier phase solution RTK (Fix) 4: Differential code-based solution, DGPS
10	PDOP
11	Number of satellites used in solution
12	The checksum data, always begins with *

NMEA-0183 message: PTNL,BPQ

Base station position and quality indicator

This message describes the base station position and its quality. It is used when the moving base antenna position and quality are required on one serial port (along with a heading message) from a receiver in heading mode.

An example of the PTNL,BPQ message string is:

$PTNL,BPQ,224445.06,021207,3723.09383914,N,12200.32620132,W,EHT-5.923,M,5*

BPQ message fields

Field	Meaning
0	Talker ID
1	BPQ
2	UTC time of position fix, in hhmmss.ss format. Hours must be two numbers, so may be padded, for example, 7 is shown as 07.
3	UTC date of position fix, in ddmmyy format. Day must be two numbers, so may be padded, for example, 8 is shown as 08.
4	Latitude, in degrees and decimal minutes (ddmm.mmmmmmm)
5	Direction of latitude: N: North S: South
6	Longitude, in degrees and decimal minutes (dddmm.mmmmmmm). Should contain 3 digits of ddd.
7	Direction of longitude: E: East W: West
8	Height Ellipsoidal height of fix (antenna height above ellipsoid). Must start with EHT.
9	M: ellipsoidal height is measured in meters
10	GPS quality indicator: 0: Fix not available or invalid

Field	Meaning
	1: Autonomous GPS fix 2: Differential SBAS, or OmniSTAR VBS 4: RTK Fixed 5: OmniSTAR XP, OmniSTAR HP, CenterPoint RTX, Float RTK, or Location RTK
11	The checksum data, always begins with *

NMEA-0183 message: PTNL,DG

L-band corrections and beacon signal strength and related information

This message, $PTNLDG, is a Trimble-created message. It outputs the L-band and beacon signal strength and other information.

Examples of the PTNL,DG message string are:

For beacon DG message: $PTNLDG,44.0,33.0,287.0,100,0,4,1,0,,,*3E

For L-band DG message: $PTNLDG,124.0,10.5,1557855.0,1200,2,4,0,3,,,*3C

DG message fields

Field	Meaning
0	Talker ID
1	Signal strength
2	SNR in db
3	Signal frequency in kHz
4	Bit rate
5	Channel number. For a beacon message, the system locks only to the primary channel. As a result, there is not more than one beacon message. The channel for beacon is 0 (so it matches the DSM 232 family of GPS receivers). For L-band messages, the channel number is 2 (so it matches the DSM 232 family of GPS receivers).
6	Tracking status: 0: Channel idle. 1: Wideband FFT search. 2: Searching for signal. 3: Channel has acquired signal. 4: Channel has locked onto signal. For beacon, this means valid RTCM has been received. For L-band, this means good data has been decoded. 5: Channel disabled.
8	Channel tracking performance indicator. For beacon, this is the word error rate, which is in percentage. For L-band, this is the time since the last sync, in tenths of seconds ranging from 0 through 255.

NMEA-0183 message: PTNL,GGK

Time, position, position type, DOP

An example of the PTNL,GGK message string is:

$PTNL,GGK,102939.00,051910,5000.97323841,N,00827.62010742,E,5,09,1.9,EHT150.790,M*73

PTNL,GGK message fields

Field	Meaning
0	Talker ID $PTNL
1	Message ID GGK
2	UTC time of position fix, in hhmmmss.ss format. Hours must be two numbers, so may be padded. For example, 7 is shown as 07.
3	UTC date of position fix, in ddmmyy format. Day must be two numbers, so may be padded. For example, 8 is shown as 08.
4	Latitude, in degrees and decimal minutes (dddmm.mmmmmmm)
5	Direction of latitude: N: North S: South
6	Longitude, in degrees and decimal minutes (dddmm.mmmmmmm). Should contain three digits of ddd.
7	Direction of longitude: E: East W: West
8	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: RTK float solution 3: RTK fix solution 4: Differential, code phase only solution (DGPS) 5: SBAS solution – WAAS/EGNOS/MSAS

Field	Meaning
	6: RTK float or RTK location 3D Network solution 7: RTK fixed 3D Network solution 8: RTK float or RTK location 2D in a Network solution 9: RTK fixed 2D Network solution 10: OmniSTAR HP/XP solution 11: OmniSTAR VBS solution 12: Location RTK solution 13: Beacon DGPS 14: CenterPoint RTX 15: xFill
9	Number of satellites in fix
10	Dilution of Precision of fix (DOP)
11	Ellipsoidal height of fix (antenna height above ellipsoid). Must start with EHT.
12	M: ellipsoidal height is measured in meters
13	The checksum data, always begins with *

NOTE – The PTNL,GGK message is longer than the NMEA-0183 standard of 80 characters.

NOTE – Even if a user-defined geoid model, or an inclined plane is loaded into the receiver, then the height output in the NMEA GGK string is always an ellipsoid height, for example, EHT24.123.

NMEA-0183 message: PTNL,PJK

Local coordinate position output

Some examples of the PTNL,PJK message string are:

$PTNL,PJK,202831.50,011112,+805083.350,N,+388997.346,E,10,09,1.5,GHT+25.478,M*77

$PTNL,PJK,010717.00,081796,+732646.511,N,+1731051.091,E,1,05,2.7,EHT+28.345,M*7C

PTNL,PJK message fields

Field	Meaning
0	Message ID $PTNL,PJK
1	UTC of position fix
2	Date
3	Northing, in meters
4	Direction of Northing will always be N (North)
5	Easting, in meters
6	Direction of Easting will always be E (East)
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: RTK float solution 3: RTK fix solution 4: Differential, code phase only solution (DGPS) 5: SBAS solution – WAAS/EGNOS/MSAS 6: RTK Float 3D network solution 7: RTK Fixed 3D network solution 8: RTK Float 2D network solution 9: RTK Fixed 2D network solution 10: OmniSTAR HP/XP solution 11: OmniSTAR VBS solution 12: Location RTK

Field	Meaning
	13: Beacon DGPS 14: CenterPoint RTX 15: xFill
8	Number of satellites in fix
9	DOP of fix
10	Height of Antenna Phase Center (see Note below)
11	M: height is measured in meters
12	The checksum data, always begins with *

NOTE – The PTNL,PJK message is longer than the NMEA-0183 standard of 80 characters.

NOTE – If a user-defined geoid model, or an inclined plane is loaded into the receiver, then the NMEA PJK string will always report the orthometric height (the field starts with the letters GHT). If the latitude/longitude of the receiver is outside the user-defined geoid model bounds, then the height is shown as ellipsoidal height (the field starts with the letters EHT).

NOTE – If the receiver does not have an application file, this string returns nothing in fields 3, 4, 5, 6, or 10.

NMEA-0183 message: PTNL,VGK

Vector information

An example of the PTNL,VGK message string is:

$PTNL,VGK,160159.00,010997,-0000.161,00009.985,-0000.002,3,07,1,4,M*0B

PTNL,VGK message fields

Field	Meaning
0	Message ID $PTNL,VGK
1	UTC of vector in hhmmss.ss format
2	Date in mmddyy format
3	East component of vector, in meters
4	North component of vector, in meters
5	Up component of vector, in meters
6	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: RTK float solution 3: RTK fix solution 4: Differential, code phase only solution (DGPS) 5: SBAS solution – WAAS/EGNOS/MSAS 6: RTK Float 3D network solution 7: RTK Fixed 3D network solution 8: RTK Float 2D network solution 9: RTK Fixed 2D network solution 10: OmniSTAR HP/XP solution 11: OmniSTAR VBS solution 12: Location RTK 13: Beacon DGPS 14: CenterPoint RTX

Field	Meaning
	15: xFill
7	Number of satellites if fix solution
8	DOP of fix
9	M: Vector components are in meters
10	The checksum data, always begins with *

NMEA-0183 message: PTNL,VHD

Heading information

NOTE – The heading computation in this message is computed from the moving baseline vector, which requires a two-antenna system.

An example of the PTNL,VHD message string is:

$PTNL,VHD,030556.00,093098,187.718,-22.138,-76.929,-5.015,0.033,0.006,3,07,2.4,M*22

PTNL,VHD message fields

Field	Meaning
0	Message ID $PTNL
1	VHD
2	UTC of position in hhmmss.ss format
3	Date in mmddyy format
4	Azimuth
5	Rate of change of azimuth = azimuth/time
6	Vertical angle
7	Rate of change of vertical angle = vertical/time
8	Range
9	Rate of change of range between antenna = range/time
10	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: RTK float solution 3: RTK fix solution 4: Differential, code phase only solution (DGPS) 5: SBAS solution – WAAS/EGNOS/MSAS 6: RTK Float 3D network solution 7: RTK Fixed 3D network solution 8: RTK Float 2D network solution

Field	Meaning
	9: RTK Fixed 2D network solution 10: OmniSTAR HP/XP solution 11: OmniSTAR VBS solution 12: Location RTK 13: Beacon DGPS 14: CenterPoint RTX 15: xFill
11	Number of satellites used in solution
12	PDOP
13	M
14	The checksum data, always begins with *

NMEA-0183 message: RMC

Position, velocity, and time

NOTE – The heading computation in this message is derived from consecutive positions. For heading using a moving baseline system, see NMEA-0183 message: PTNL,AVR, page 221.

The RMC string is:

$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W*6A

GPRMC message fields

Field	Meaning
0	Message ID $--RMC Talker ID can be: GP: GPS only GN: More than one constellation
1	UTC of position fix
2	Status A=active or V=void
3	Latitude
4	Longitude
5	Speed over the ground in knots
6	Track angle in degrees (True)
7	Date
8	Magnetic variation, in degrees
9	The checksum data, always begins with *

NMEA-0183 message: ROT

Rate and direction of turn

NOTE – The heading computation in this message is derived from consecutive positions. For heading using a moving baseline system, see *NMEA-0183 message: PTNL,AVR, page 221*.

An example of the ROT string is:

$GPROT,35.6,A*4E

ROT message fields

Field	Meaning
0	Message ID $GPROT
1	Rate of turn, degrees/minutes, "–" indicates bow turns to port
2	A: Valid data V: Invalid data
3	The checksum data, always begins with *

NMEA-0183 message: VTG

Track made good and speed over ground

NOTE – The heading computation in this message is derived from consecutive positions. For heading using a moving baseline system, see *NMEA-0183 message: PTNL,AVR, page 221*.

An example of the VTG message string is:

$GPVTG,140.88,T,,M,8.04,N,14.89,K,D*05

VTG message fields

Field	Meaning
0	Message ID $GPVTG
1	Track made good (degrees true)
2	T: track made good is relative to true north
3	Track made good (degrees magnetic)
4	M: track made good is relative to magnetic north
5	Speed, in knots
6	N: speed is measured in knots
7	Speed over ground in kilometers/hour (kph)
8	K: speed over ground is measured in kph
9	Mode indicator: A: Autonomous mode D: Differential mode E: Estimated (dead reckoning) mode M: Manual Input mode S: Simulator mode N: Data not valid
10	The checksum data, always begins with *

NMEA-0183 message: ZDA

UTC day, month, and year, and local time zone offset

An example of the ZDA message string is:

$GPZDA,172809.456,12,07,1996,00,00*45

ZDA message fields

Field	Meaning
0	Message ID $--ZDA Talker ID can be: GP: GPS only GN: More than one constellation
1	UTC
2	Day, ranging between 01 and 31
3	Month, ranging between 01 and 12
4	Year
5	Local time zone offset from GMT, ranging from 00 through ±13 hours
6	Local time zone offset from GMT, ranging from 00 through 59 minutes
7	The checksum data, always begins with *

Fields 5 and 6 together yield the total offset. For example, if field 5 is -5 and field 6 is +15, local time is 5 hours and 15 minutes earlier than GMT.

GSOF Messages: Overview

These topics provide information on the General Serial Output Format (GSOF) messages. GSOF messages are a Trimble proprietary format and can be used to send information such as position and status to a third-party device.

This table summarizes the GSOF messages that the receiver supports. When GSOF output is enabled, the following messages can be generated:

Message	Function
Attitude Info	Attitude info
Base Position and Quality	Base station position and its quality
Battery/Memory Info	Receiver battery and memory status
Brief All SV Info	SV brief info (all satellite systems)
Brief SV Info	GPS SV brief info
Clock Info	Clock info
Current Time UTC	Current UTC time
Delta ECEF	Earth-Centered, Earth-Fixed Delta position
Detail All SV	SV detailed info (all satellite systems)
Detail SV Info	GPS SV detailed info
DOP Info	PDOP info
INS Full Navigation Info	INS Navigation Info
INS RMS Info	INS RMS Info
Lat, Long, Ht	Latitude, longitude, height
Local ENU	Local zone north, east, and height - projection/calibration based
Local LLH	Local datum position
Position Sigma	Position sigma info
Position Time	Position time
Position VCV	Position VCV info

Message	Function
Received Base	Received info about the base
Receiver Serial	Receiver serial number
Position Type Information	Position Type Information
TPlane ENU	Tangent Plane Delta
Velocity	Velocity data
ECEF Position	ECEF Position
Multiple Page Detail All SV	Multiple Page All SV Detailed Info
L-Band Status Info	L-Band status info

NOTE – The receiver allows a maximum of 10 GSOF messages to be output.

NOTE – The position output by the receiver is the Antenna Phase Center position. You may want to reduce this position to a reference position elsewhere. If so, you should account for any tilt of the antenna in such a reduction. The settings for the Antenna Measurement Method and Antenna Height are not applied to the position outputs.

GSOF messages: General Serial Output Format

Report packet 40h structure (GENOUT)

Byte	Item	Type	Value	Meaning
0	STX	Char	02h	Start transmission
1	STATUS	Char	See Receiver status code	Receiver status code
2	PACKET TYPE	Char	40h	Report Packet 40h (GENOUT)
3	LENGTH	Char	00h–FAh	Data byte count
4	TRANSMISSION NUMBER	Char		Unique number assigned to a group of record packet pages. Prevents page mismatches when multiple sets of record packets exist in output stream.
5	PAGE INDEX	Char	00h–FFh	Index of current packet page.
6	MAX PAGE INDEX	Char	00h–FFh	Maximum index of last packet in one group of records.
One or more GSOF messages				
	Output record type	Char	01h	For example, Time (Type 1 Record)
	Record length	Char	0Ah	Bytes in record
Various fields depending on Output record type. There can be various records in one GENOUT packet. There could be multiple GENOUT packets per epoch. Records may be split over two consecutive packets.				
Length + 4	CHECKSUM	–	–	(Status + type + length + data bytes) modulo 256
Length + 5	ETX		03h	End transmission

Each message begins with a 4-byte header, followed by the bytes of data in each packet. The packet ends with a 2-byte trailer. Byte 3 is set to 0 (00h) when the packet contains no data. Most data is transmitted between the receiver and remote device in binary format.

Receiver Status code

Byte number	Description
Bit 0	Reserved
Bit 1	If set, low battery at the base station
Bit 2	Reserved
Bit 3	If set, receiver's kinematic state is currently set to 'Roving', otherwise 'static'
Bit 4–7	Reserved

GSOF messages: Reading binary values (Motorola format)

The receivers store numbers in Motorola format. The byte order of these numbers is the opposite of what personal computers (Intel format) expect. To supply or interpret binary numbers (8-byte DOUBLES, 4-byte LONGS, and 2-byte INTEGERS), the byte order of these values must be reversed. This section contains a detailed description of the Motorola format.

INTEGER data types

The INTEGER data types (CHAR, SHORT, and LONG) can be signed or unsigned. By default, they are unsigned. All integer data types use two's complement representation. The following table lists the integer data types:

Type	# of bits	Range of values (Signed)	Unsigned
Char	8	-128 to 127	0 to 255
Short	16	-32768 to 32767	0 to 65535
Long	32	–2147483648 to 2147483647	0 to 4294967295

FLOATING-POINT data types

Floating-point data types are stored in the IEEE SINGLE and DOUBLE precision formats. Both formats have a sign bit field, an exponent field, and a fraction field. The fields represent floating-point numbers in the following manner:

Floating-Point Number = <sign> 1.<fraction field> x 2(<exponent field> - bias)

Sign bit field

The sign bit field is the most significant bit of the floating-point number. The sign bit is 0 for positive numbers and 1 for negative numbers.

Fraction field

The fraction field contains the fractional part of a normalized number. Normalized numbers are greater than or equal to 1 and less than 2. Since all normalized numbers are of the form 1.XXXXXXXX, the 1 becomes implicit and is not stored in memory. The bits in the fraction field are the bits to the right of the binary point, and they represent negative powers of 2. For example:

0.011 (binary) = 2-2 + 2-3 = 0.25 + 0.125 = 0.375

Exponent field

The exponent field contains a biased exponent; that is, a constant bias is subtracted from the number in the exponent field to yield the actual exponent. (The bias makes negative exponents possible.)

If both the exponent field and the fraction field are zero, the floating-point number is zero.

NaN

A NaN (Not a Number) is a special value that is used when the result of an operation is undefined. For example, adding positive infinity to negative infinity results in a NaN.

FLOAT data type

The FLOAT data type is stored in the IEEE single-precision format which is 32 bits long. The most significant bit is the sign bit, the next 8 most significant bits are the exponent field, and the remaining 23 bits are the fraction field. The bias of the exponent is 127. The range of single-precision format values is from 1.18 x 10–38 to 3.4 x 1038. The floating-point number is precise to 6 decimal digits.

0 000 0000 0 000 0000 0000 0000 0000 0000 = 0.0
0 011 1111 1 000 0000 0000 0000 0000 0000 = 1.0
1 011 1111 1 011 0000 0000 0000 0000 0000 = -1.375
1 111 1111 1 111 1111 1111 1111 1111 1111 = NaN

DOUBLE

The DOUBLE data type is stored in the IEEE double-precision format which is 64 bits long. The most significant bit is the sign bit, the next 11 most significant bits are the exponent field, and the remaining 52 bits are the fractional field. The bias of the exponent is 1023. The range of single precision format values is from 2.23 × 10–308 to 1.8 × 10308. The floating-point number is precise to 15 decimal digits.

0 000 0000 0000 0000 0000 ... 0000 0000 0000 = 0.0
0 011 1111 1111 0000 0000 ... 0000 0000 0000 = 1.0
1 011 1111 1110 0110 0000 ... 0000 0000 0000 = -0.6875
1 111 1111 1111 1111 1111 ... 1111 1111 1111 = NaN

GSOF message: Attitude

This message describes attitude information relating to the vector between the Heading antenna and the Moving Base antenna. It contains the following data:

- Tilt or vertical angle, in radians, from the Heading antenna to the Moving Base antenna relative to a horizontal plane through the Heading antenna
- Heading or yaw, in radians, relative to True North
- Range or slope distance between the Heading antenna and the Moving Base antenna

NOTE – The heading computation in this message is computed from the moving baseline vector, which requires a two-antenna system.

Attitude (Type 27 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	1Bh	Attitude information
1	Record length	Char		Bytes in record
2–5	GPS time	Long	msecs	GPS time in milliseconds of GPS week
6	Flags	Char	See Attitude flags	Flag bits indicating validity of attitude components
7	Number of SVs used	Char		Number of satellites used to calculate attitude
8	Calculation mode	Char	See Attitude calculation flags	Positioning mode
9	Reserved			Reserved (unused)
10–17	Pitch	Double	radians	The forward dive/climb angle
18–25	Yaw	Double	radians	Rotation about the vertical axis relative to True North (i.e. horizontal turn left or right)
26–33	Roll	Double	radians	Side-to-side roll angle
34–41	Master-Slave Range	Double	meters	Distance between master and slave antennas
42–43	PDOP	Short	0.1	Position Dilution of Precision of current

Field	Item	Type	Value	Meaning
				position
44-47	Pitch variance	Float	$radians^2$	Expected variance of error of the pitch estimate
48-51	Yaw variance	Float	$radians^2$	Expected variance of error of the yaw estimate
52-55	Roll Variance	Float	$radians^2$	Expected variance of error of the roll estimate
56-59	Pitch-Yaw Covariance	Float	$radians^2$	Expected covariance of errors of the pitch and yaw estimates
60-63	Pitch-Roll Covariance	Float	$radians^2$	Expected covariance of errors of the pitch and roll estimates
64-67	Yaw-Roll Covariance	Float	$radians^2$	Expected covariance of errors of the yaw and roll estimates
68-71	Master-Slave Range Variance	Float	$meters^2$	Expected variance of error of the master-slave range estimat

Subsequent elements are not implemented in firmware versions prior to GNSS version 4.20 firmware. The error stats valid flag is ***not*** set when these elements are implemented, because the error stats flag refers to specific position statistics, and not to the attitude statistics provided here. The presence of these additional elements should be detected based on the record length.

GSOF message: BASE POSITION AND QUALITY INDICATOR

This message describes the base station position and its quality. It is used when the moving base antenna position and quality are required on one serial port (along with a heading message) from a receiver in Heading mode.

Base position and quality indicator (Type 41 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	01h	Position time output record
1	Record length	Char		Bytes in record
2–5	GPS time (ms)	Long	msecs	GPS time, in milliseconds, of GPS week
6–7	GPS week number	Short	number	GPS week count since January 1980
8–15	Latitude	Double	radians	The WGS-84 latitude, in radians, of the moving base antenna
16–23	Longitude	Double	radians	The WGS-84 longitude, in radians, of the moving base antenna
24–31	Height	Double	meters	The WGS-84 height, in meters, of the moving base antenna
32	Quality indicator	Char	number	The quality of the base station position: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential SBAS or OmniSTAR VBS 4: RTK Fixed, xFill 5: OmniSTAR XP, OmniSTAR HP, CenterPoint RTX, Float RTK, or Location RTK

GSOF message: Batt/Mem

This message provides information relating to the receiver battery and memory. It contains the following data:

- Remaining battery power
- Remaining memory

Batt/Mem (Type 37 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	25h	
1	Record length	Char	0Ah	Bytes in record
2–3	Battery capacity	Unsigned short	percentage	Remaining battery capacity in percentage
4–11	Remaining memory	Double	hours	Estimated remaining data logging time in hours

GSOF message: GPS SV Brief

This message contains brief satellite information. It contains the following data:

- Number of satellites tracked
- The PRN number of each satellite
- Flags indicating satellite status

All SV brief (Type 13 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Dh	Brief satellite information output record
1	Record length	Char		Bytes in record
2	Number of SVs	Float	00h–18h	Number of satellites included in record. *NOTE – Includes all tracked satellites, all satellites used in the position solution, and all satellites in view.*
The following bytes are repeated for the number of SVs:				
	PRN	Char	01h–20h	Pseudorandom number of satellites (–32)
	SV Flags 1	Char	See SV flags: 1-bit values	First set of satellite status bits
	SV Flags 2	Char	See SV flags: 2-bit values	Second set of satellite status bits

GSOF message: All SV Detail

This message describes detailed satellite information for all tracked satellites in all tracked satellite systems. It contains the following data:

- Number of satellites tracked
- The PRN number of each satellite
- The satellite system that the satellite belongs to
- Flags indicating satellite status
- Elevation above horizon, in degrees
- Azimuth from True North, in degrees
- Signal-to-noise ratio (SNR) of first frequency
- Signal-to-noise ratio (SNR) of second frequency
- Signal-to-noise ratio (SNR) of third frequency

All SV detail (Type 34 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	22h	Detailed satellite information for all satellite systems output record.
1	Record length	Char	1 + 8 (number of SVs)	Bytes in record. This record will not exceed 255 bytes; satellites may be dropped from the output message if the length exceeds this. To ensure that output for all satellites is output, use the GSOF 30h "Multiple Page All SV Detail" message.
2	Number of SVs	Char		Number of satellites included in record. *NOTE – Includes all tracked satellites, all satellites used in the position solution, and all satellites in view.*
The following bytes are repeated for each SV:				
	PRN	Char		The PRN number of the satellite which the following flags refer to. This is the actual PRN number given by the SV (not ranged due to the SV system).
	SV System			The system that the SV belongs to. Valid values are: 0: GPS

Field	Item	Type	Value	Meaning
				1: SBAS 2: GLONASS 3: Galileo 4: QZSS 5: BeiDou 6–255: Reserved
	SV Flags1	Char		SV Flags 1 indicates conditions relating to satellites: bit 0 Set: Above horizon bit 1 Set: Currently assigned to a channel (trying to track) bit 2 Set: Currently tracked on L1/G1 frequency bit 3 Set: Currently tracked on L2/G2 frequency bit 4 Set: Reported at base on L1/G1 frequency bit 5 Set: Reported at base on L2/G2 frequency bit 6 Set: Used in current position bit 7 Set: Used in the current RTK solution
	SV Flags2	Char		SV Flags 2 is a bitmap variable that has the following values: If SV SYSTEM is GPS: bit 0 Set: Tracking P Code on L1/G1 bit 1 Set: Tracking P Code on L2 bit 2 Set: Tracking CS on L2 bit 3 Set: Tracking on L5 bits 4–7: RESERVED If SV SYSTEM is GLONASS: bit 0 Set: Tracking P Code on L1/G1 bit 1 Set: Tracking P Code on L2 bit 2 Set: GLONASS SV is "M" SV bit 3 Set: GLONASS SV is "K" SV

Field	Item	Type	Value	Meaning
				bits 4–7: RESERVED If SV SYSTEM is Galileo: bit 0 Set: Tracking E1 bit 1 Set: Tracking E5A bit 2 Set: Tracking E5B bit 3 Set: Tracking E5AltBOC bits 4–7: RESERVED If SV SYSTEM is QZSS: bit 0 Set: Tracking L1 C/A bit 1 Set: Tracking L1C BOC bit 2 Set: Tracking L1SAIF bit 3 Set: Tracking L2C bit 4 Set: Tracking L5 bits 5–7: RESERVED If SV SYSTEM is BeiDou: bit 0 Set: Tracking B1 bit 1 Set: Tracking B2 bit 2 Set: Tracking B3 bits 3–7: RESERVED else: bits 0–7: RESERVED
	Elevation	Char	Degrees	Angle of satellite above the horizon.
	Azimuth	Short	Degrees	Azimuth of satellite from True North.
	SNR first frequency	Char	dB * 4	Signal-to-noise ratio of first frequency (multiplied by 4)1 If GPS: L1 C/A SNR If GLONASS: G1C or G1P SNR

Field	Item	Type	Value	Meaning
				If Galileo: E1 SNR If BeiDou: B1 SNR
	SNR second frequency	Char	dB * 4	Signal-to-noise ratio of second frequency (multiplied by 4)1 If GPS: L2C or L2P SNR If GLONASS: G2C or G2P SNR If Galileo: E5 AltBoc SNR If BeiDou: B2 SNR
	SNR third frequency	Char	dB * 4	Signal-to-noise ratio of third frequency (multiplied by 4)1 If GPS: L5 SNR If GLONASS: G3 SNR If Galileo: E5A SNR if available, else E5B SNR if available If BeiDou: B3 SNR

GSOF message: Clock Info

This message describes the clock information. It contains the following data:

- Clock offset
- Frequency offset

Clock information (Type 10 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Ah	Clock information output record
1	Record length	Char		Bytes in record
2	Clock flags	Char	0, 1, or 2	Provides information related to the clock fix process. Defined values are: bit 0 SET: clock offset is valid bit 1 SET: frequency offset is valid bit 2 SET: receiver is in anywhere fix mode
3–10	Clock offset	Double	milliseconds	The current clock offset in milliseconds
11–18	Frequency offset	Double	ppm	The offset of the local oscillator from the nominal GPS L1 frequency in parts per million

GSOF message: UTC

This message describes current time information. It contains the following data:

- GPS time, in milliseconds of GPS week
- GPS week number
- GPS to UTC time offset, in seconds

UTC (Type 16 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	10h	
1	Record length	Char	09h	Bytes in record
2–5	GPS millisecond of week	Long	msecs	Time when packet is sent from the receiver, in GPS milliseconds of week
6–7	GPS week number	Short	number	Week number since the start of GPS time
8–9	UTC offset	Short	seconds	GPS to UTC time offset
10	Flags	Char	See Flags: Bit values	Flag bits indicating validity of Time and UTC offsets

GSOF message: ECEF DELTA

This message describes the ECEF Delta position. It contains the following data:

- Earth-Centered, Earth-Fixed X, Y, Z deltas between the rover and base position, in meters

ECEF Delta (Type 6 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	06h	Earth-Centered, Earth-Fixed (ECEF) Delta output record
1	Record length	Char	18h	Bytes in record
2–9	Delta X	Double	meters	ECEF X-axis delta between rover and basis station positions
10–17	Delta Y	Double	meters	ECEF Y-axis delta between rover and basis station positions
18–25	Delta Z	Double	meters	ECEF Z-axis delta between rover and basis station positions

GSOF message: DOP

This message describes the DOP information. It contains the following data:

- PDOP
- HDOP
- VDOP
- TDOP

DOP (Type 9 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	09h	DOP information output record
1	Record length	Char	10h	Bytes in record
2–5	PDOP	Float		Positional Dilution of Precision
6–9	HDOP	Float		Horizontal Dilution of Precision
10–13	VDOP	Float		Vertical Dilution of Precision
14–17	TDOP	Float		Time Dilution of Precision

GSOF message: LLH

This message describes latitude, longitude, and height. It contains the following data:

- WGS-84 latitude and longitude, in radians
- WGS-84 height, in meters

Latitude, longitude, height (Type 2 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	02h	Latitude, longitude, and height output record
1	Record length	Char	18h	Bytes in record
2–9	Latitude	Double	radians	Latitude from WGS-84 datum
10–17	Longitude	Double	radians	Longitude from WGS-84 datum
18–25	Height	Double	meters	Height from WGS-84 datum

GSOF message: Position SIGMA

This message describes the Position Sigma information. It contains the following data:

- Position RMS
- Sigma east, in meters
- Sigma north, in meters
- Sigma up, in meters
- Covariance east-north
- Error Ellipse Semi-major axis, in meters
- Error Ellipse Semi-minor axis, in meters
- Orientation of Semi-major axis in degrees from True North
- Unit variance
- Number of epochs

NOTE – The Configuration Toolbox software incorrectly identifies this message subtype as “Error Covariance data”.

Sigma (Type 12 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Ch	Position sigma information output record
1	Record length	Char	26h	Bytes in record
2–5	Position RMS	Float		Root mean square of position error calculated for over-determined positions
6–9	Sigma east	Float	meters	
10–13	Sigma north	Float	meters	
14–17	Covar. east-north	Float	number	Covariance east-north (dimensionless)
18–21	Sigma up	Float	meters	
22–25	Semi-major	Float	meters	Semi-major axis of error ellipse

Field	Item	Type	Value	Meaning
	axis			
26–29	Semi-minor axis	Float	meters	Semi-minor axis of error ellipse
30–33	Orientation	Float	degrees	Orientation of semi-minor axis, clockwise from True North
34–37	Unit variance	Float		Valid only for over-determined solutions. Unit variance should approach 1.0 value. A value of less than 1.0 indicates that apriori variances are too pessimistic.
38–39	Number of epochs	Short	count	Number of measurement epochs used to compute the position. Could be greater than 1 for positions subjected to static constraint. Always 1 for kinematic.

GSOF message: Position TIME

This message describes position time information. It contains the following data:

- GPS time, in milliseconds of GPS week
- GPS week number
- Number of satellites used
- Initialization counter

Time (Type 1 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	01h	Position time output record
1	Record length	Char	0Ah	Bytes in record
2–5	GPS time (ms)	Long	msecs	GPS time, in milliseconds, of GPS week
6–7	GPS week number	Short	number	GPS week count since January 1980
8	Number of SVs used	Char	number	Number of satellites used to determine the position
9	Position Flags 1	Char	See Position flags: 1-bit values	Reports first set of position attribute flag values
10	Position Flags 2	Char	See Position flags: 2-bit values	Reports second set of position attribute flag values
11	Initialized number	Char	00h–FFh	Increments with each initialization (modulo 256)

GSOF message: TPlane ENU

This message contains Tangent Plane Delta information. It contains the following data:

- North, East, and Up deltas of the vector from the base to the rover (in meters) projected onto a plane tangent to the WGS-84 ellipsoid at the base receiver.

NOTE – These records are output only if a valid DGPS/RTK solution is computed.

TPlane ENU (Type 7 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	07h	Tangent Plane Delta output record.
1	Record length	Char	18h	Bytes in record.
2–9	Delta east	Double	meters	East component of the vector from base station to rover, projected onto a plane tangent to the WGS-84 ellipsoid at the base station.
10–17	Delta north	Double	meters	North component of the vector from base station to rover, projected onto a plane tangent to the WGS-84 ellipsoid at the base station.
18–25	Delta up	Double	meters	Difference between ellipsoidal height of tangent plane at base station and a parallel plane passing through rover point.

GSOF message: Velocity

This message describes velocity information. It contains the following data:

- Horizontal velocity, in meters per second
- Vertical velocity, in meters per second
- Heading, in radians, referenced to WGS-84 True North

NOTE – The heading computation in this message is derived from consecutive positions. For heading using a moving baseline system, see *GSOF message: Attitude, page 243**.*

Velocity (Type 8 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	08h	Velocity data output record
1	Record length	Char	0Dh, 11D	Bytes in record
2	Velocity flags	Char	See Velocity flags: bit values	Velocity status flags
3–6	Speed	Float	Meters per second	Horizontal speed
7–10	Heading	Float	Radians	True north heading in the WGS-84 datum
11–14	Vertical velocity	Float	Meters per second	Vertical velocity

GSOF message: L-Band Status Information

This message describes the L-band status information.

L-Band status information (Type 40 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char		L-band status information record
1	Record length	Char		Bytes in record
2	Satellite name	Char	string	The name of the L-band satellite the receiver is trying to track. There are two tracking modes: • In Auto mode, the receiver automatically picks a satellite to track and this field shows the name of the selected satellite. • In Custom mode, the first 5 characters of "Custom" is reported i.e., "Custo".
3	Satellite frequency	Char	MHz	The frequency of the tracked satellite, in MHz
4	Satellite bit rate	Char	Hz	The bit rate of the tracked satellite, in Hz
5	SNR	Char	dB-Hz	The SNR (C/No dB-Hz) value of the tracked satellite
6	HP/XP subscribed engine	Char		The subscribed engine in the HP/XP library: 0: XP 1: HP 2: G2 3: HP + G2 4: HP + XP 0xFF: Unknown
7	HP/XP library mode	Char		0: Library is inactive 1: Library is active.

Field	Item	Type	Value	Meaning
8	VBS library mode	Char		0: Library is inactive 1: Library is active.
9	Beam mode	Char		The mode of the L-band beam: 0: Off 1: FFT initializing 2: FFT running 3: Search initializing 4: Search running 5: Track initializing 6: Track searching 7: Tracking
10	OmniSTAR motion	Char		The motion state reported by the OmniSTAR library: 0: Dynamic 1: Static 2: OmniSTAR is not ready 0xFF: Unknown
11	3-sigma horizontal precision threshold	Char		Shows the configured 3-sigma horizontal precision threshold
12	3-sigma vertical precision threshold	Char		Shows the configured 3-sigma vertical precision threshold
13	NMEA encryption state	Char		0: Encryption is not applied to NMEA 1: Encryption is applied to NMEA
14	I/Q ratio	Char		Mean power in I and mean power in Q
15	Estimated bit error rate			
16	Total unique			Total unique words since the last search

Field	Item	Type	Value	Meaning
	words			
17	Total unique words with 1 or more bit errors			Total unique words with 1 or more bit errors since the last search
18	Total bad unique word bits			Total bad unique word bits since the last search
19	Total # of viterbi symbols			Total number of viterbi symbols since the last search. When the count reaches FFFFFF00 the count resets to 0.
20	# of corrected viterbi symbols			Number of corrected viterbi symbols since the last search. This count is reset along with the number of viterbi symbols.
21	# of bad messages			Number of bad messages since the last search. A bad message has a non-0 flush byte.
22	MEAS frequency valid flag			0: The MEAS frequency could be out by a significant amount 1: The MEAS frequency is accurate
23	MEAS frequency			Measured satellite frequency in Hz.

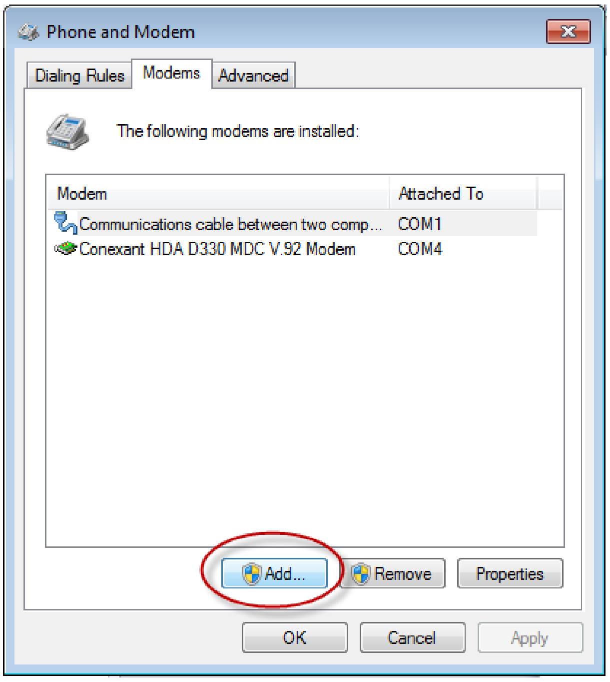
A

Establishing a PPP Connection under Windows 7

To establish a PPP connection between a Trimble receiver (the server) and a computer (the client) that is running the Windows7 operating system, you need to install the direct cable connection as a modem device using the modem setup procedure:

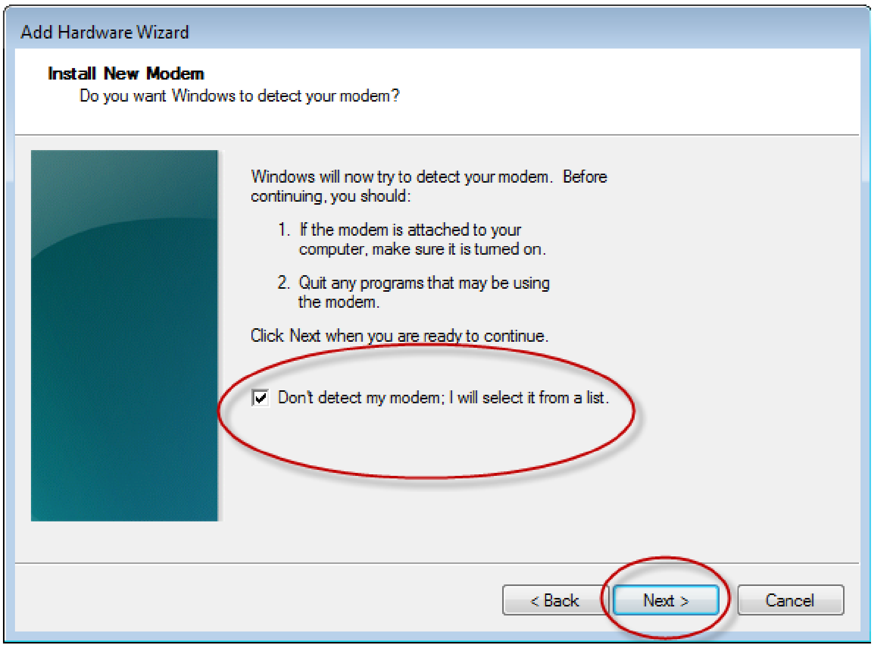
1. On the computer, click **Start** / **Control Panel** / **Phone and Modem**. The **Phone and Modem** dialog appears.
2. Select the **Modems** tab and then click **Add**.

   NOTE – Administrator's rights are needed to do this correctly.

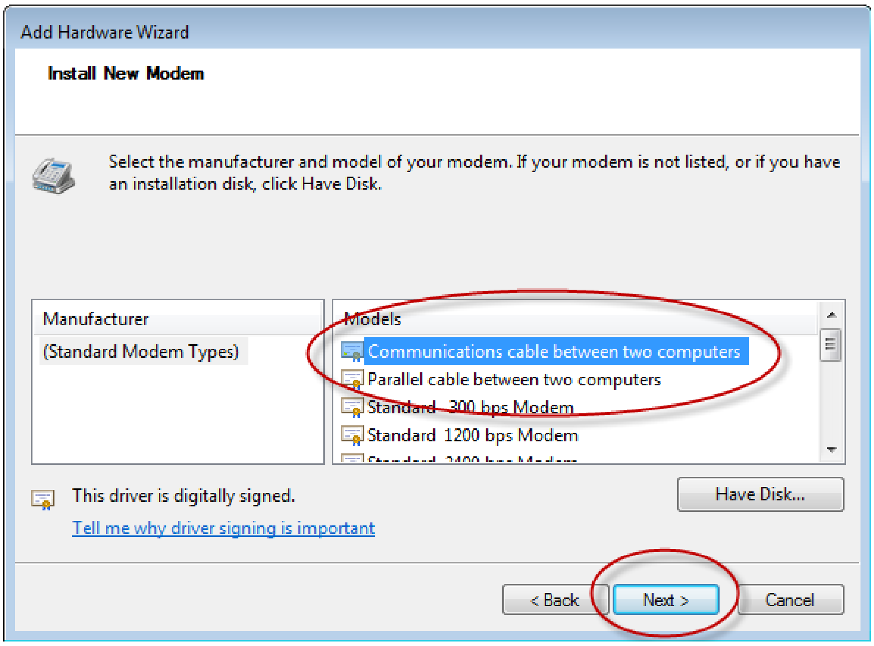
   

   The **Add Hardware** wizard appears.
3. Select the **Don't detect my modem. I will select it from a list.** check box and then click

Next.

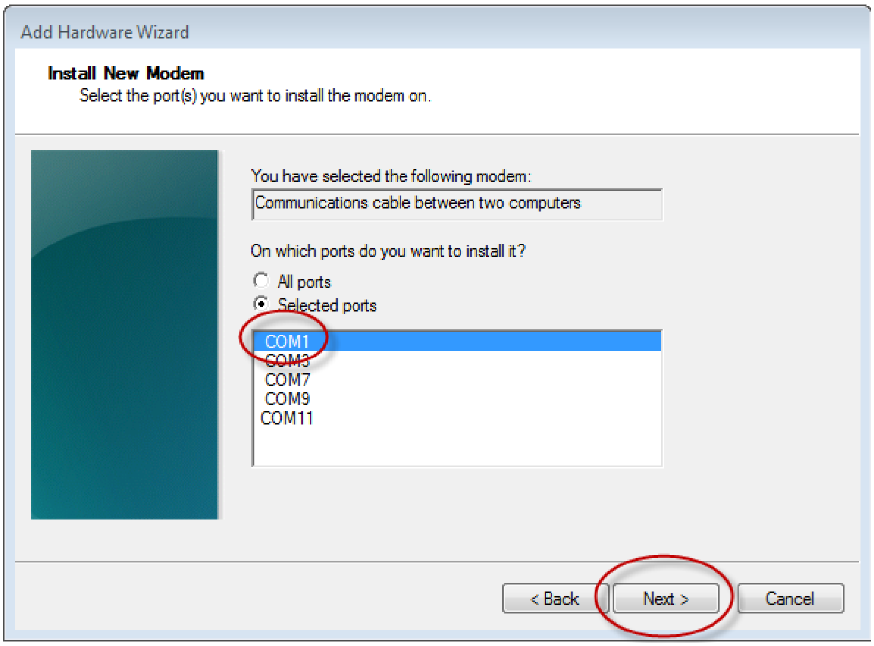


4. Select the **Communications cable between two computers** option and then click **Next**.

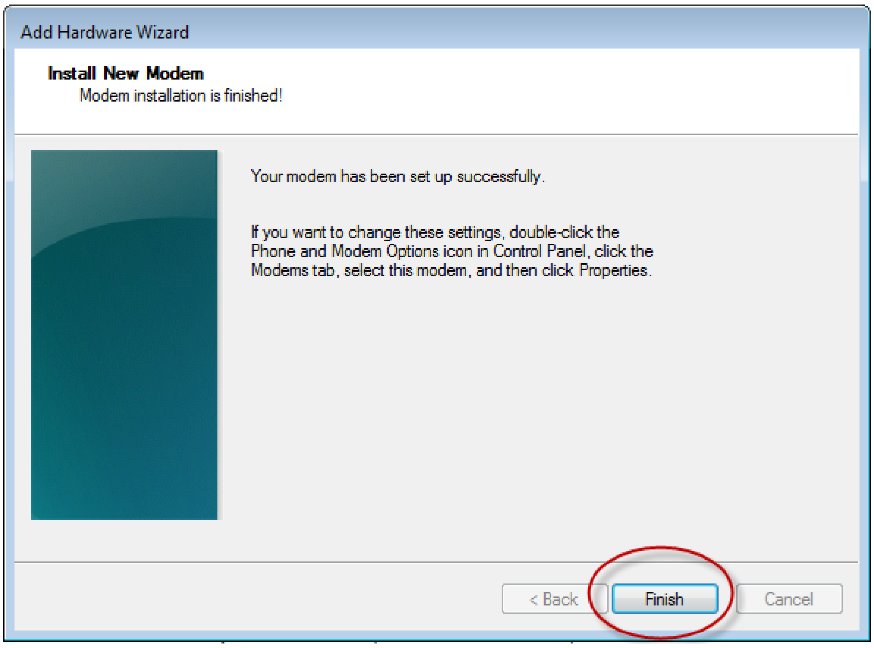


5. Select the **Selected ports** option and then select the serial com port (COM 1). Click **Next**.

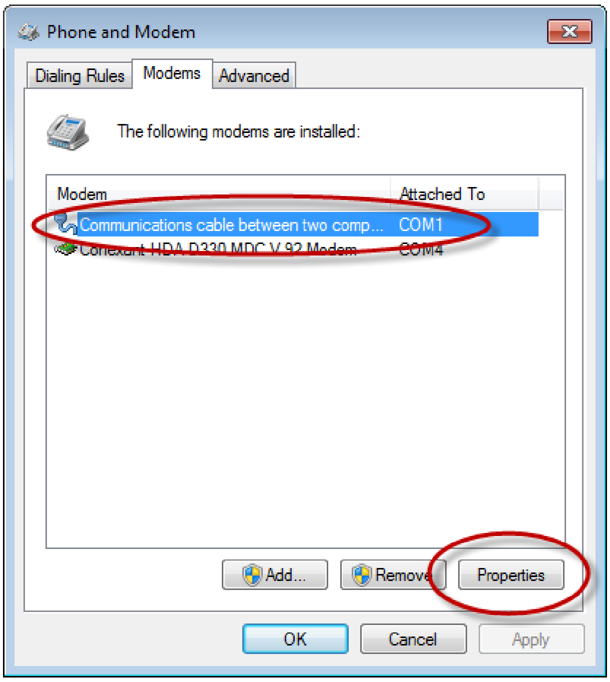
NOTE – A null cable is required for this connection.



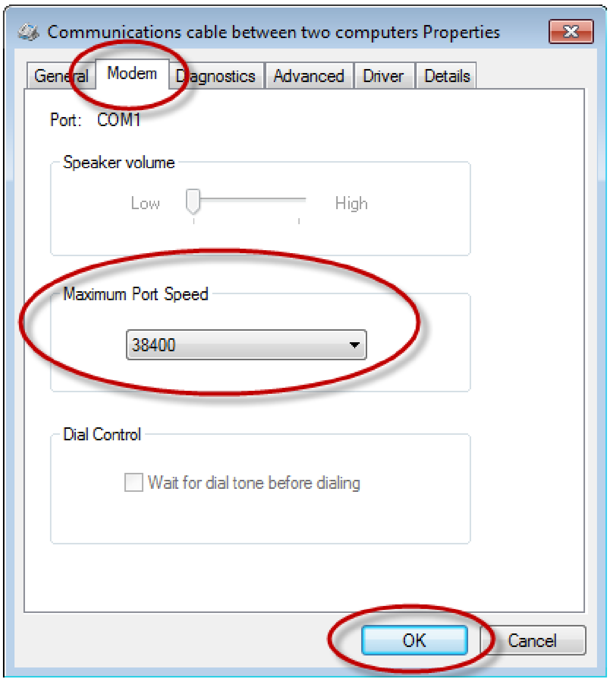
6. Click **Finish**.



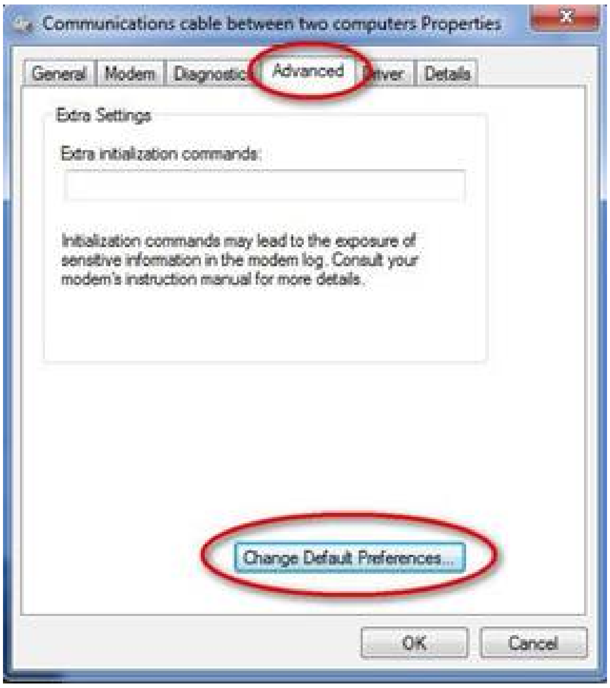
7. In the **Modems** tab of the **Phone and Modem** dialog, select the new COM1 connection and then click **Properties**.



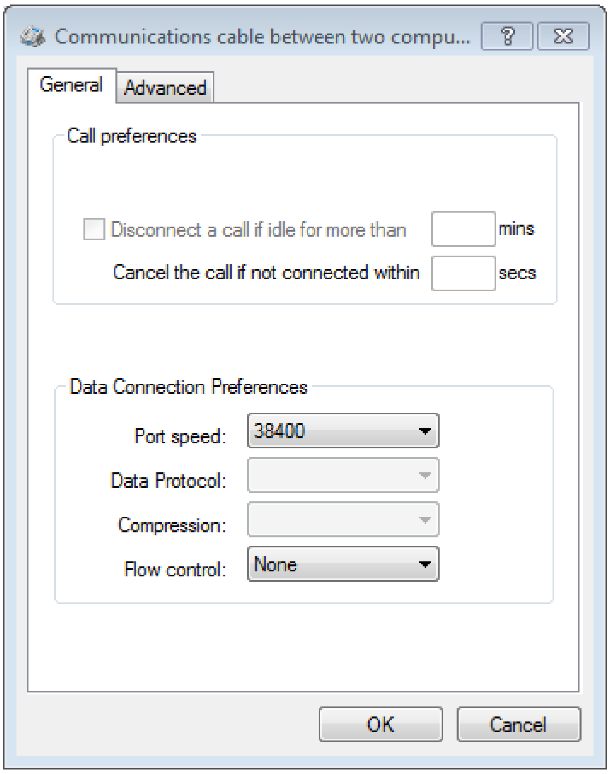
8. In the **Properties** dialog for the connection, select the **Modem** and then change the **Maximum Port Speed** field to 38400. Click **OK**.



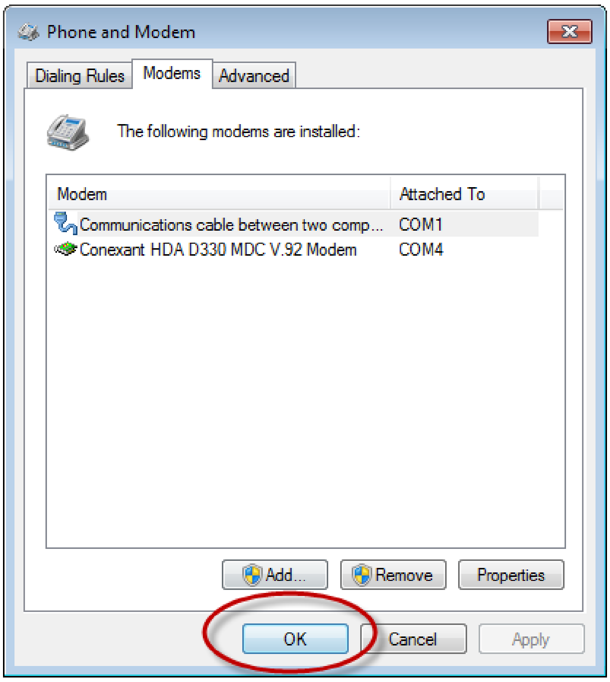
9. Select the **Advanced** tab and then click **Change Default Preferences**.



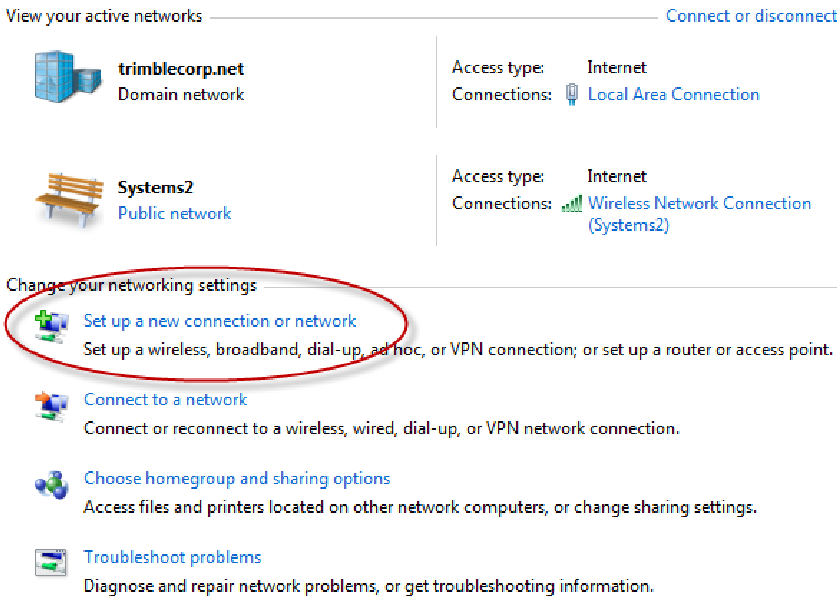
10. In the **Flow control** field, select *None* and then click **OK**.



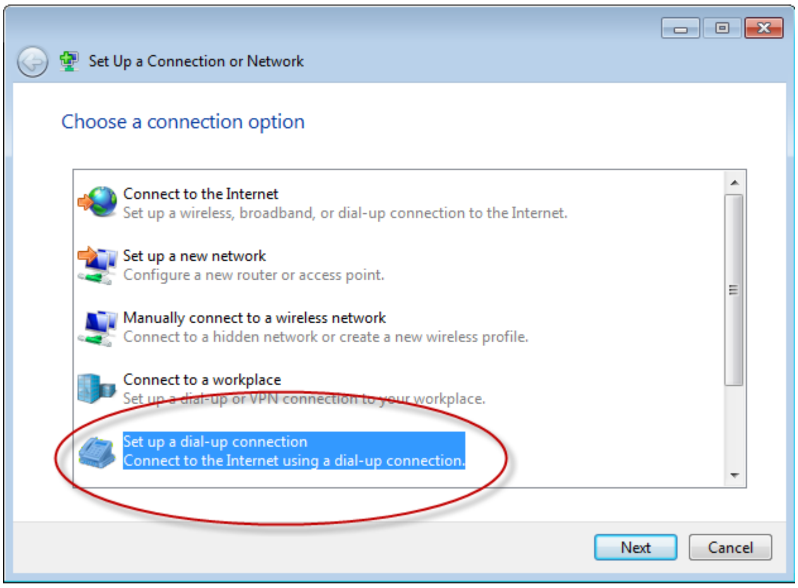
11. Click **OK** to close the **Properties** dialog for the connection.
12. In the **Modems** tab of the **Phone and Modem** dialog, click **OK** to save your changes.



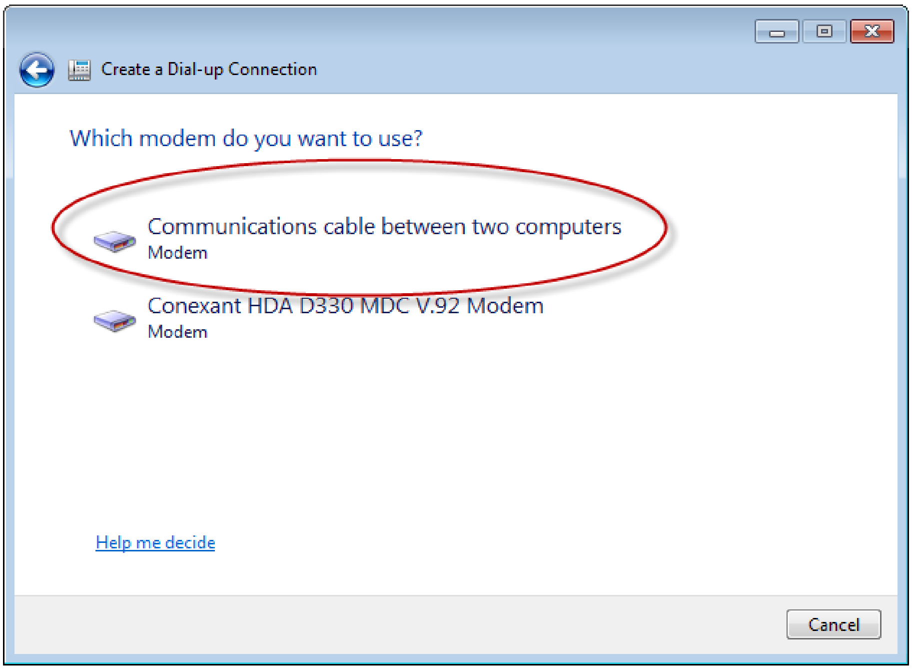
13. On the computer, click **Start** / **Control Panel** / **Network and Sharing Center** and then select **Set up a new connection or network**.



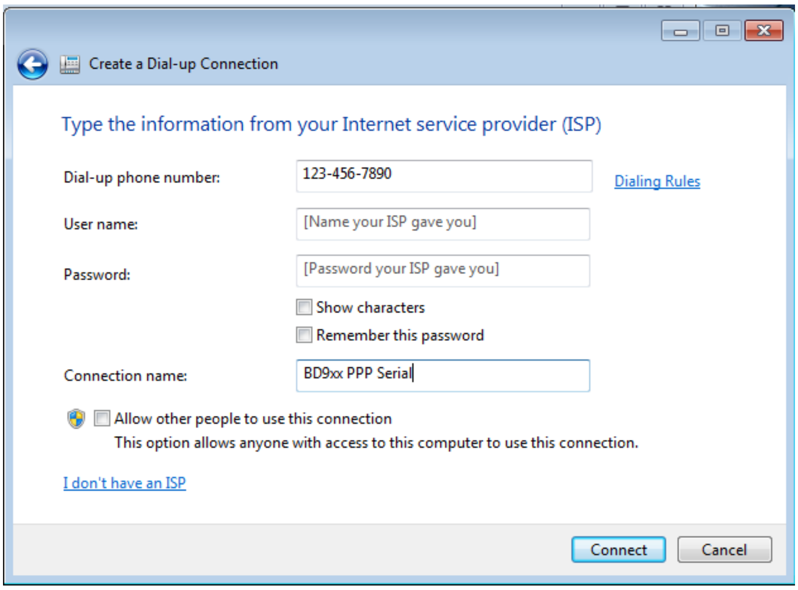
14. Select the **Set up a dial-up connection** option and then click **Next**.



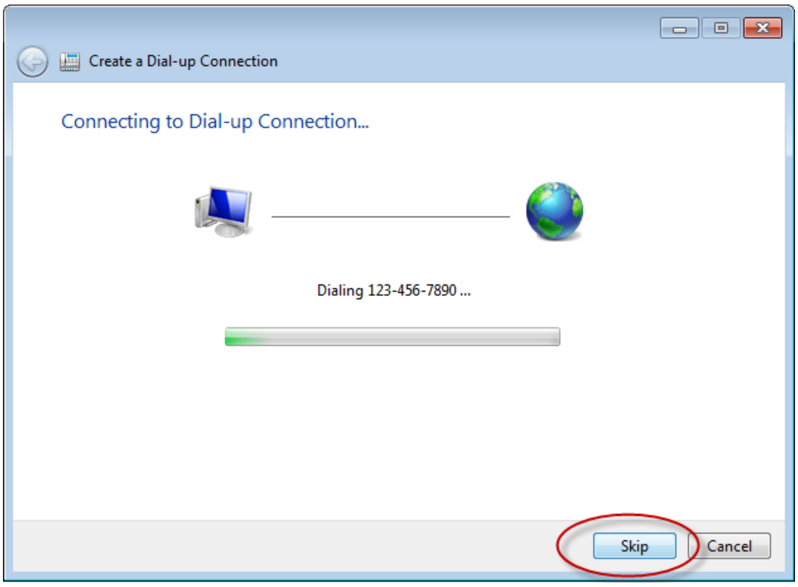
15. If you have created more than one modem device on your computer, you are prompted to select the modem to use. Select the **Communications cable between two computers** modem.



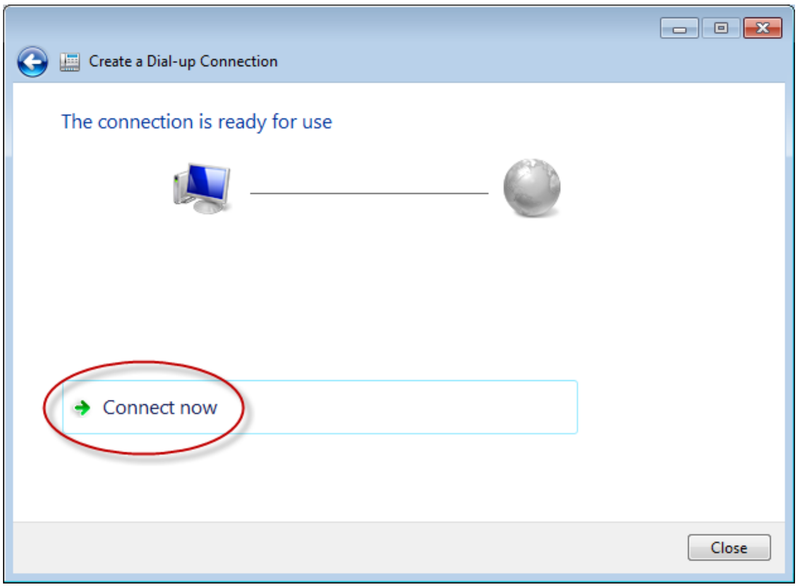
16. Enter the appropriate information from your ISP. You must enter a phone number, so if necessary enter a fictitious one. In the **Connection name** field, enter a unique name so that you can easily identify your new PPP connection. Click **Connect**.



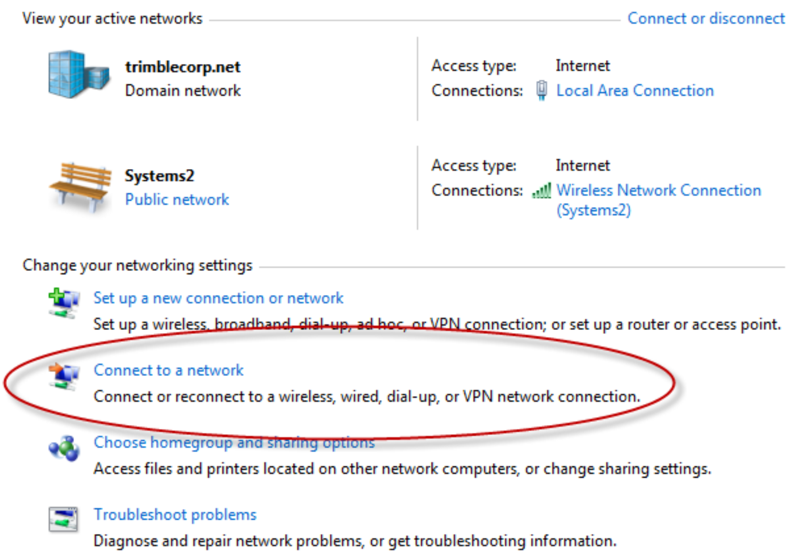
17. To skip the connection test, click **Skip**.



18. A message confirms that the connection is ready for use. Click **Close**.

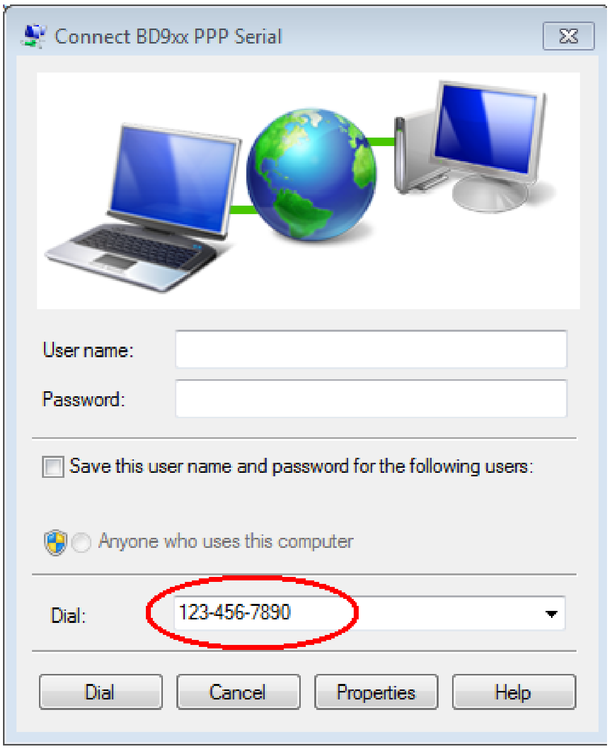


19. On the computer, click **Start** / **Control Panel** / **Network and Sharing Center** and then select **Connect to a network**.



20. A list of available connections appears on the computer. Select the PPP connection you created and then click **Connect**.

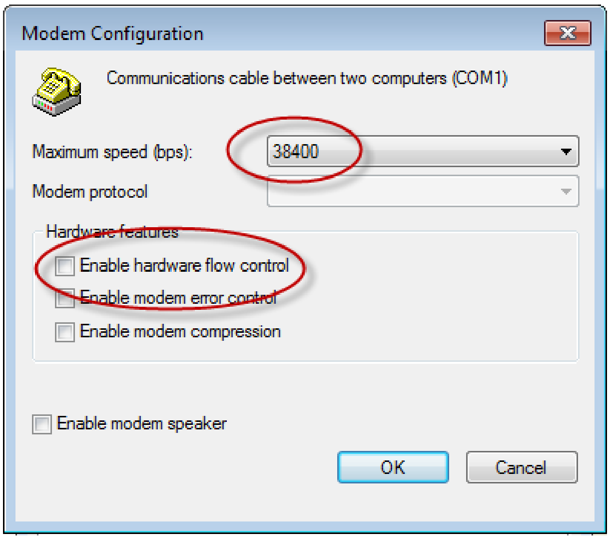
21. The **Connect** dialog appears. Click **Properties**.



22. In the **Properties** dialog, select the **General** tab and then click **Configure**.

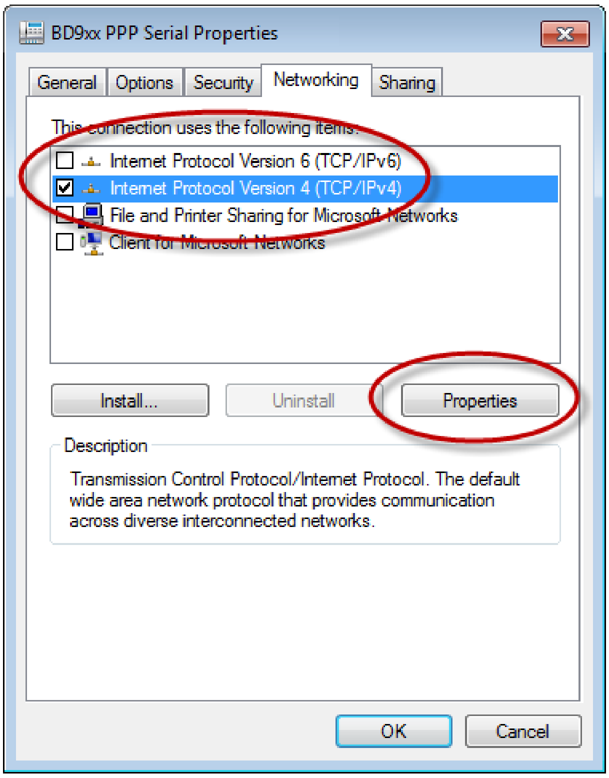
23. In the **Modem Configuration** dialog, change the value in the **Maximum speed** field to 38400. Make sure the **Enable hardware flow control** check box is *clear* and then click

OK.

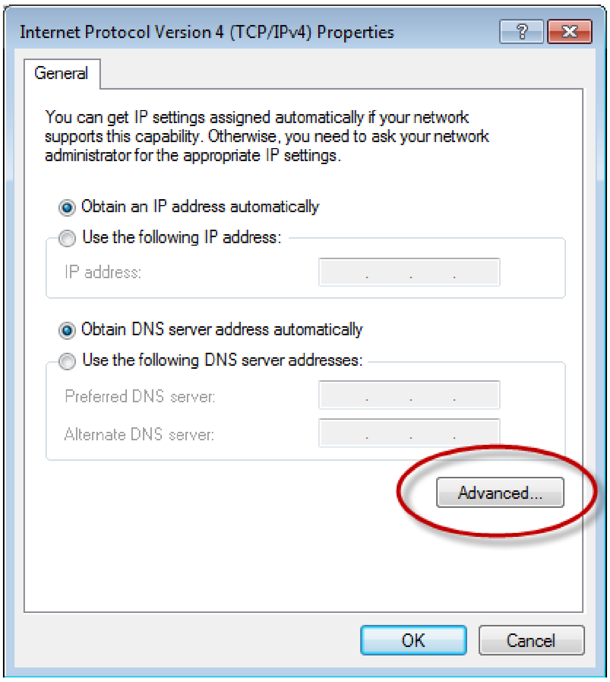


24. Return to the **Properties** dialog and select the **Networking** tab.

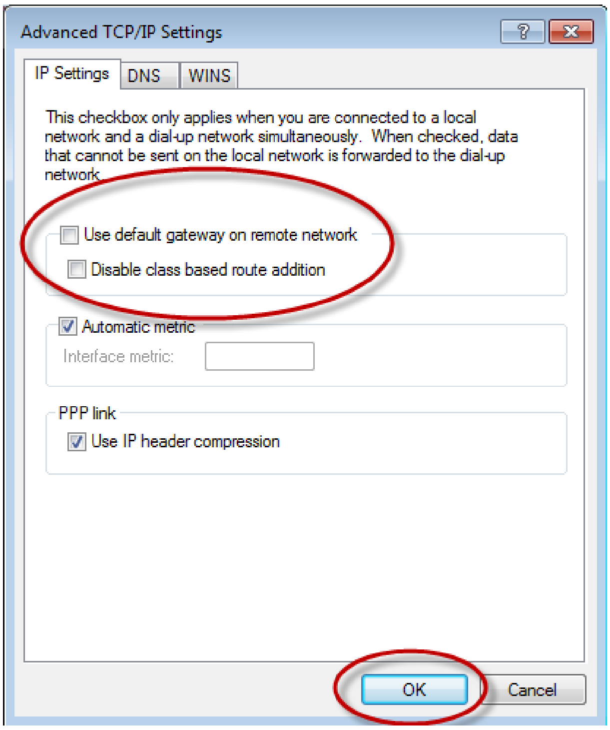
25. Clear the **Internet Protocol Version 6** check box and select the **Internet Protocol Version 4** check box. Click **Properties**.



26. In the **Internet Protocol Version 4** dialog, click **Advanced**.

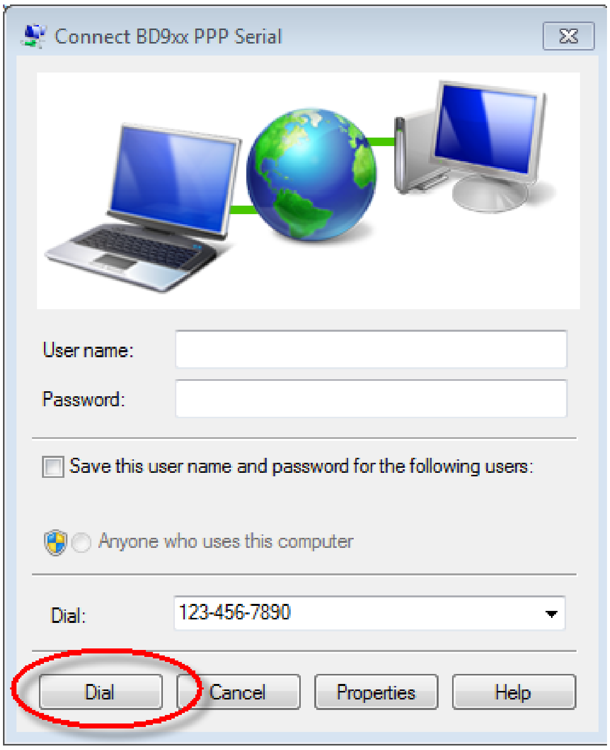


27. In the **IP Settings** tab, clear the **Use default gateway on remote network** check box. Click **OK**.



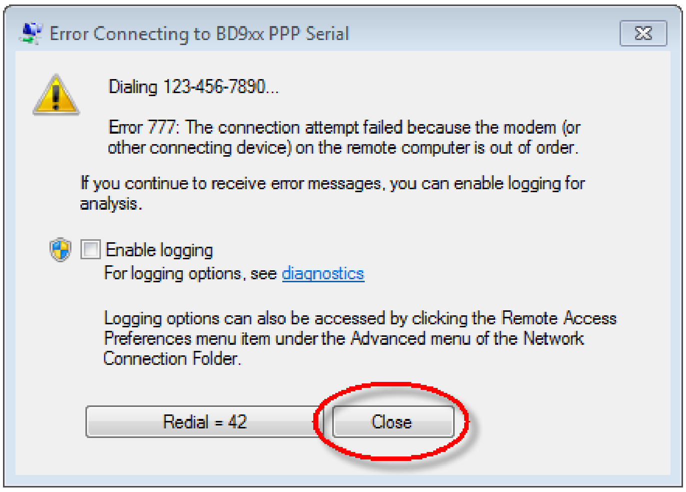
28. Click **OK** to return to the **Properties** dialog for the PPP connection.
29. Connect the receiver to the computer's COM1 port using a null modem serial cable.

You do not need to enter a user name and password. Click **Dial**.



A dialing message appears.

If you receive a connection error similar to the one shown the issue may be a Microsoft driver issue:

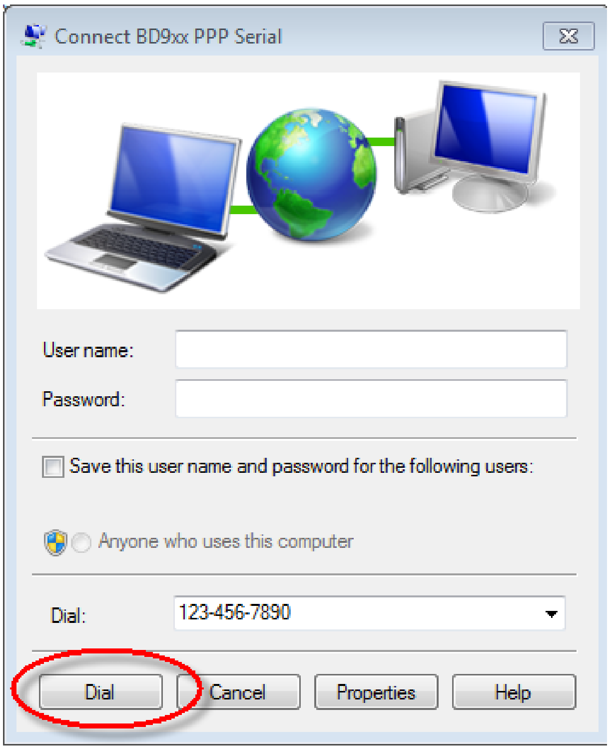


30. If this message does not appear, skip to step 33. If this message appears, do the following:
    1. click **Close** .
    2. Restart the computer.

3. Once restarted, try the connection again. To do this, return to the Network and Sharing Center in the computer's Control Panel and click Connect to a network.

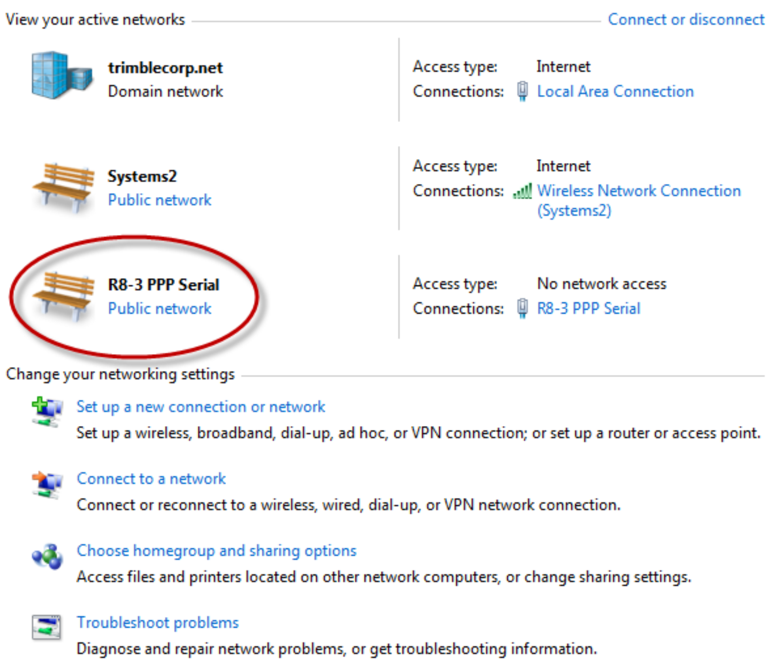
31. From the connections list on the computer, select the PPP connection and then select Connect.

32. Connect the receiver to the computer at COM1 using a null modem serial cable. Click Dial. (No user name and password is required.)

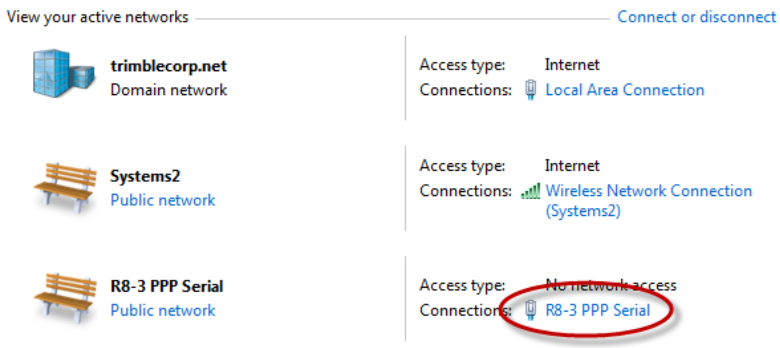


A connection window appears, showing Dialing.

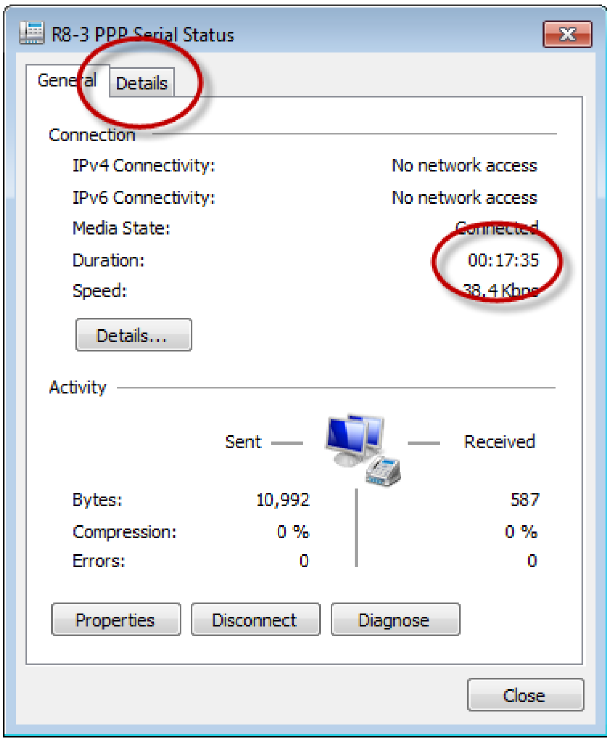
33. Once connected, return In the **View Active Networks** area. Your PPP connection appears:



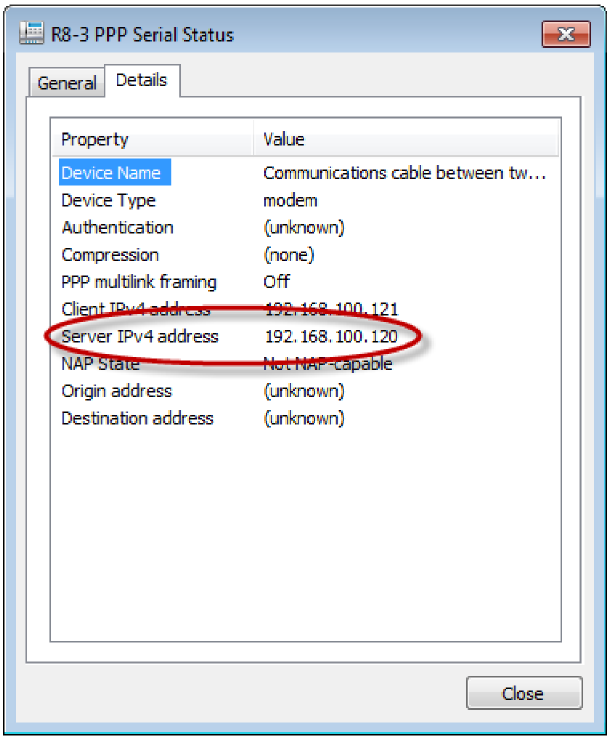
34. To verify the connection is active, click the **Connections** link for the PPP connection:



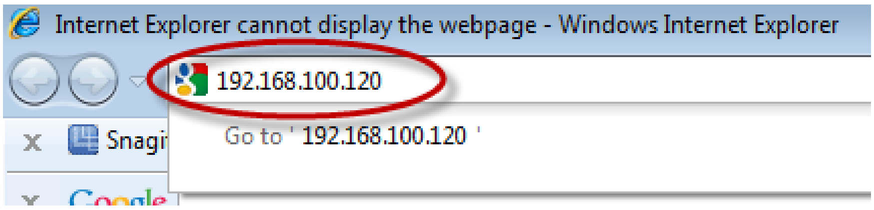
35. In the **Status** window, check the time duration and then select the **Details** tab.



36. In the **Details** tab, note down the information in the **Server IPv4 address** field:



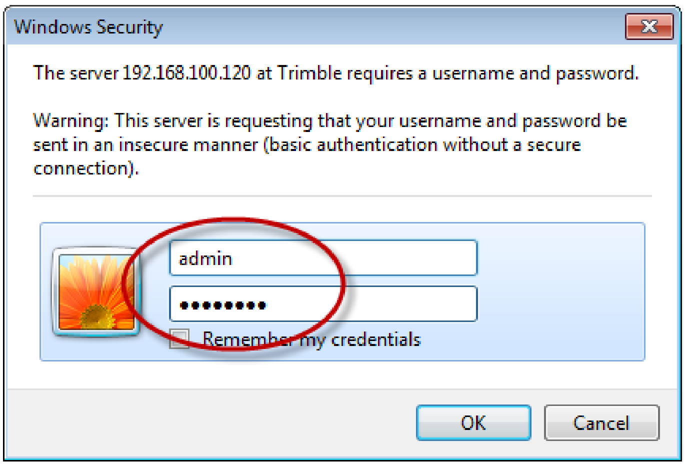
37. Open an Internet browser window and enter the Server IP address in the address line:



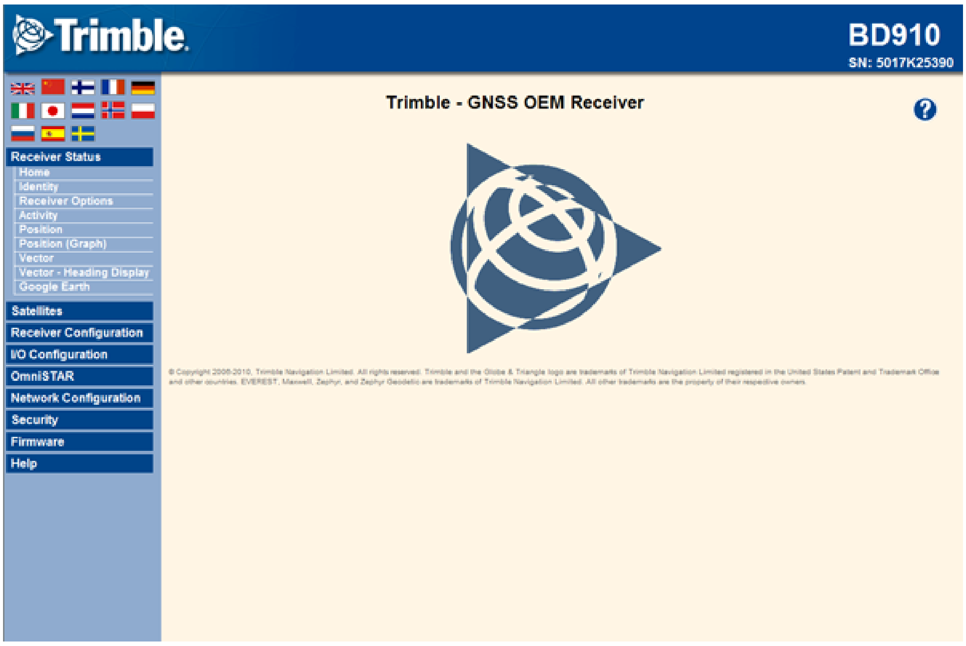
38. A **Windows Security** dialog appears. Enter the following information:

    user name: **Admin**

    password: **password**



Once connected successfully, a web page similar to the one below appears:



B

Troubleshooting Receiver Issues

This section describes some possible receiver issues, possible causes, and how to solve them. Please read this section before you contact Technical Support.

If after attempting the listed steps does not resolve your issue, please contact Technical Support at GNSSOEMSupport@trimble.com.

Issue	Possible cause	Solution
The receiver does not turn on.	External power is too low.	Check that the input voltage is within limits.
The base station receiver is not broadcasting.	Port settings between reference receiver and radio are incorrect.	Check the settings on the radio and the receiver.
	Faulty cable between receiver and radio.	Try a different cable.
		Examine the ports for missing pins.
		Use a multimeter to check pinouts.
Rover receiver is not receiving radio.	The base station receiver is not broadcasting.	See the issue "The base station receiver is not broadcasting" above.
	Incorrect over air baud rates between reference and rover.	Connect to the rover receiver radio, and make sure that it has the same setting as the reference receiver.
	Incorrect port settings between roving external radio and receiver.	If the radio is receiving data and the receiver is not getting radio communications, check that the port settings are correct.

Issue	Possible cause	Solution
The receiver is not receiving satellite signals.	The GPS antenna cable is loose.	Make sure that the GPS antenna cable is tightly seated in the GPS antenna connection on the GPS antenna.
	The cable is damaged.	Check the cable for any signs of damage. A damaged cable can inhibit signal detection from the antenna at the receiver.
	The GPS antenna is not in clear line of sight to the sky.	Make sure that the GPS antenna is located with a clear view of the sky.
		Restart the receiver as a last resort (turn off and then turn it on again).

C

Correction Transmission Troubleshooting

This chapter describes how to troubleshoot correction transmission when using a GNSS base station that is passing corrections (typically some variant of CMR or RTCM) to a GNSS rover via a communications link. The communications link could be a serial cable, Ethernet cable, UHF radio, 900 MHz spread spectrum radio, Internet connection (including cellular modems and Wi-Fi links), and so forth.

It comprises the following sections:

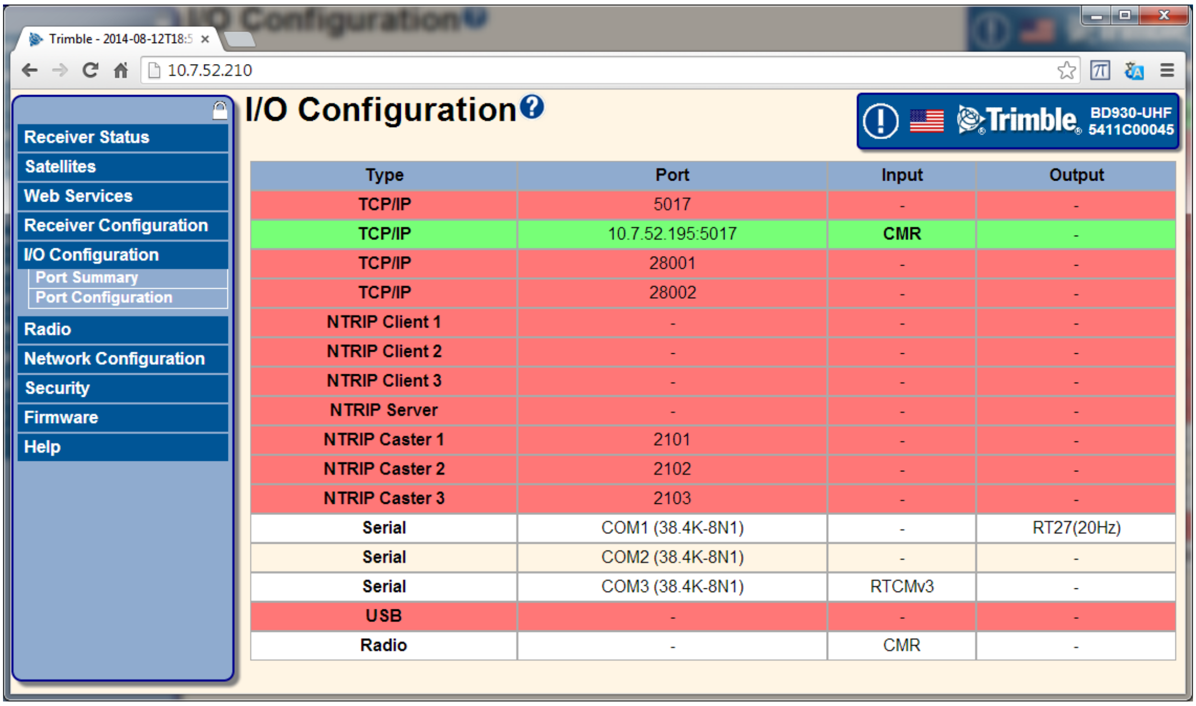
BD9xx base station setup

When setting up a Trimble GNSS base station to transmit RTK corrections, corrections can be output in the following formats: CMR, CMR+, sCMRx, RTCM 2.0 DGPS (select RTCM 2.1), RTCM 2.1–2.3, RTCM 3.0.

Note that Trimble GNSS receivers will output the CMR and CMR+ GLONASS message in a different format than other manufactures have used for the GLONASS message. It is not believed that non-Trimble GNSS rovers will be able to decode the Trimble GLONASS packet. However, Trimble GNSS rovers will in most cases decode the GLONASS CMR/CMR+ packet from non-Trimble base stations.

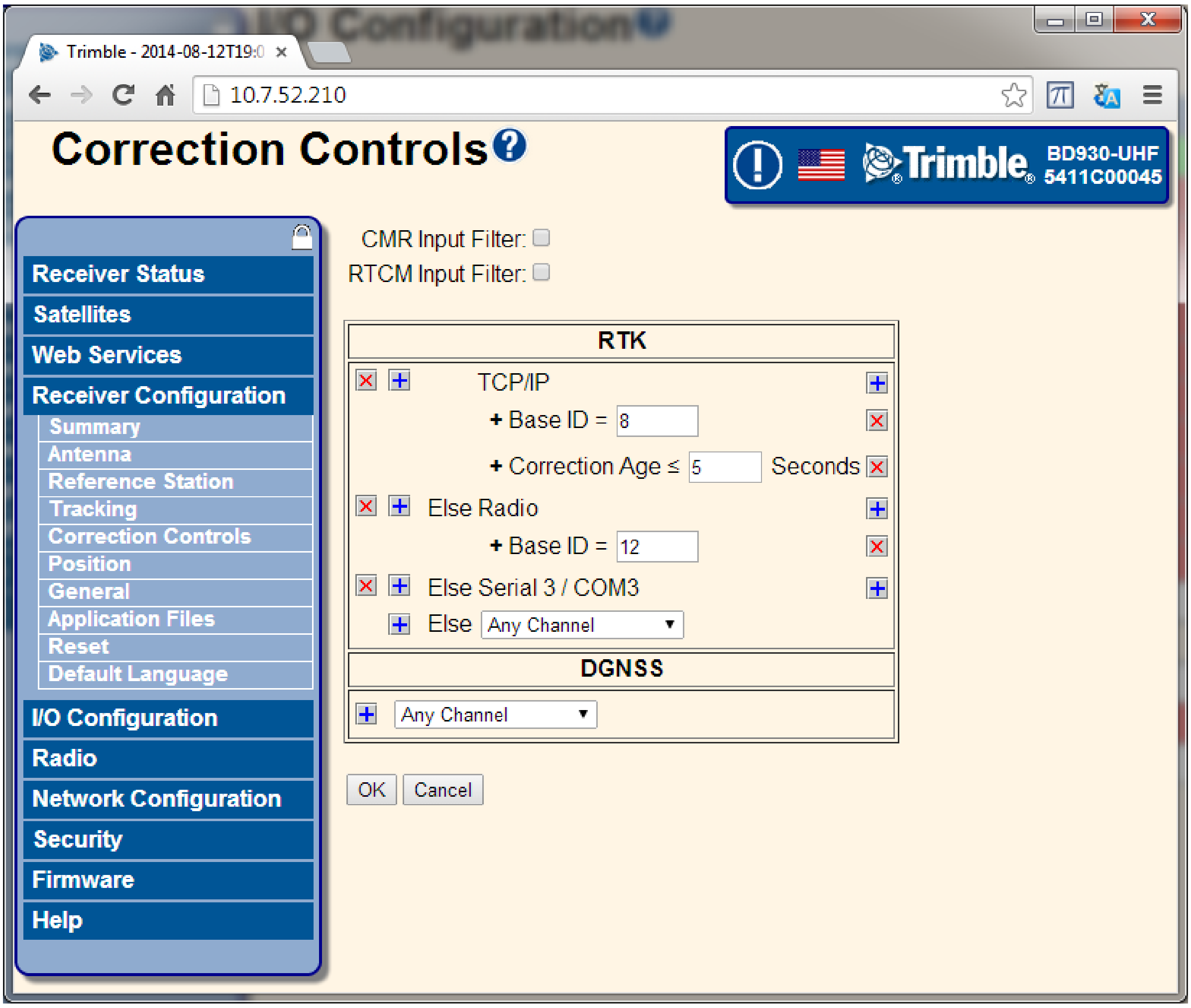
Checking correction reception at the rover

When checking the receptions of corrections at the GNSS rover, the I/O Configuration page of the receiver will indicate which ports are receiving valid correction messages. If multiple corrections inputs are received, the input in bold is the correction input that is currently being used. The rover will automatically identify correction streams that are input, no configuration is required.

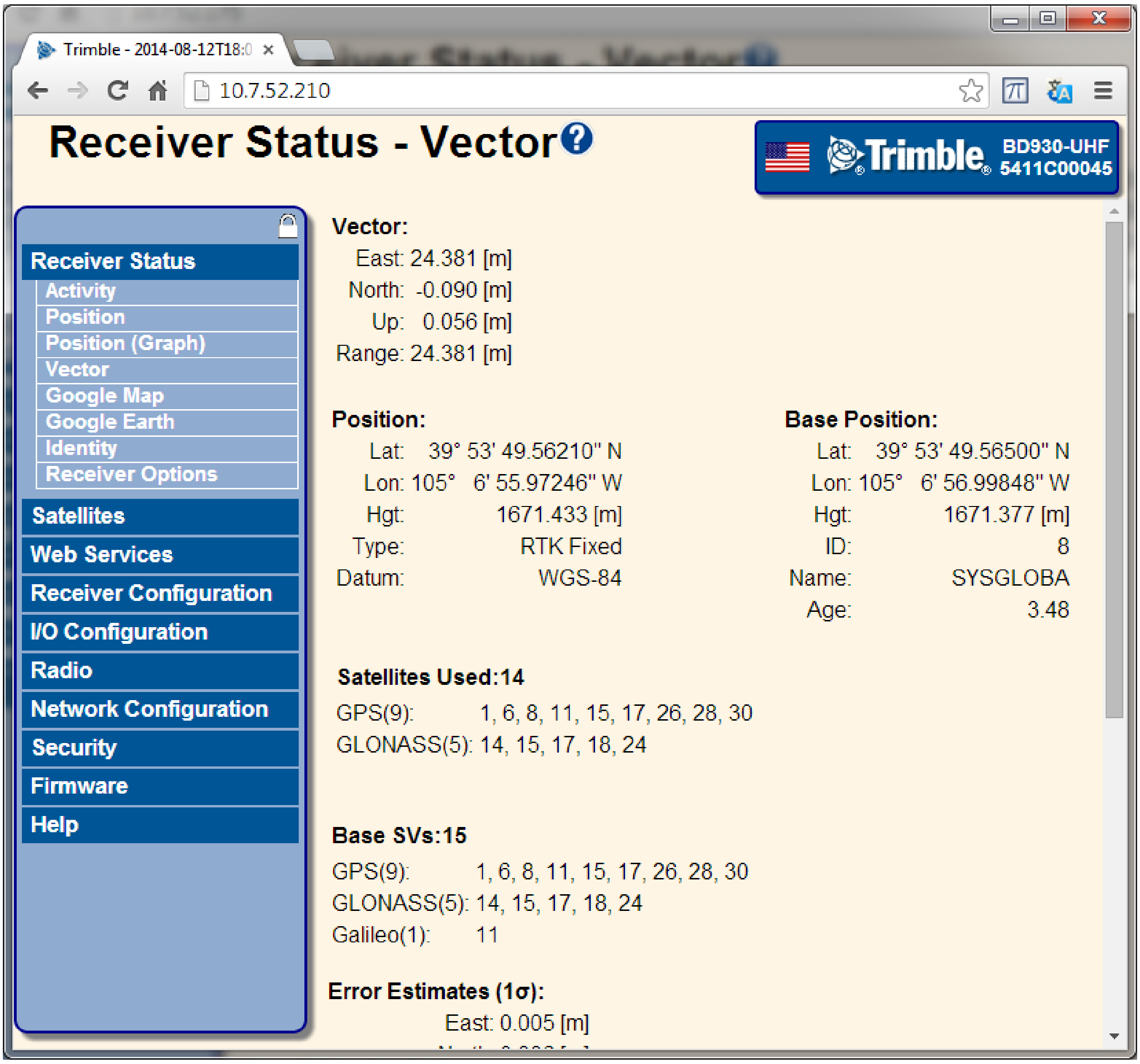


Type	Port	Input	Output
TCP/IP	5017	-	-
TCP/IP	10.7.52.195:5017	**CMR**	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client 1	-	-	-
NTRIP Client 2	-	-	-
NTRIP Client 3	-	-	-
NTRIP Server	-	-	-
NTRIP Caster 1	2101	-	-
NTRIP Caster 2	2102	-	-
NTRIP Caster 3	2103	-	-
Serial	COM1 (38.4K-8N1)	-	RT27(20Hz)
Serial	COM2 (38.4K-8N1)	-	-
Serial	COM3 (38.4K-8N1)	RTCMv3	-
USB	-	-	-
Radio	-	CMR	-

In the case of multiple correction inputs, the Correction Controls can be used to define the criteria for which correction input will be used.



When a valid correction stream is received, the Vector screen can be used to verify the base station position, age of corrections, ID & name of the station, and satellites for which the base station is sending corrections.



Using the CSGTestSuite to check transmission of corrections

CSGTestSuite is a PC software utility for validating the CMR protocol over a wireless network both in a lab environment as well as in the field. The software can be configured for communication over a RS-232 port or a TCP/UDP IP port. CSGTestSuite is available under the product Support tab for each BD9xx product at www.trimble.com/gnss-inertial/GNSS-Positioning-and-Heading-Systems.aspx. When using CSGTestSuite to troubleshoot correction transmission problems, Trimble recommends that you:

1. Start by plugging the computer running CSGTestSuite into the port on the GNSS base station that is outputting corrections. Verify with CSGTestSuite that the expected

corrections are being output from the GNSS base station. If no correction messages are received:

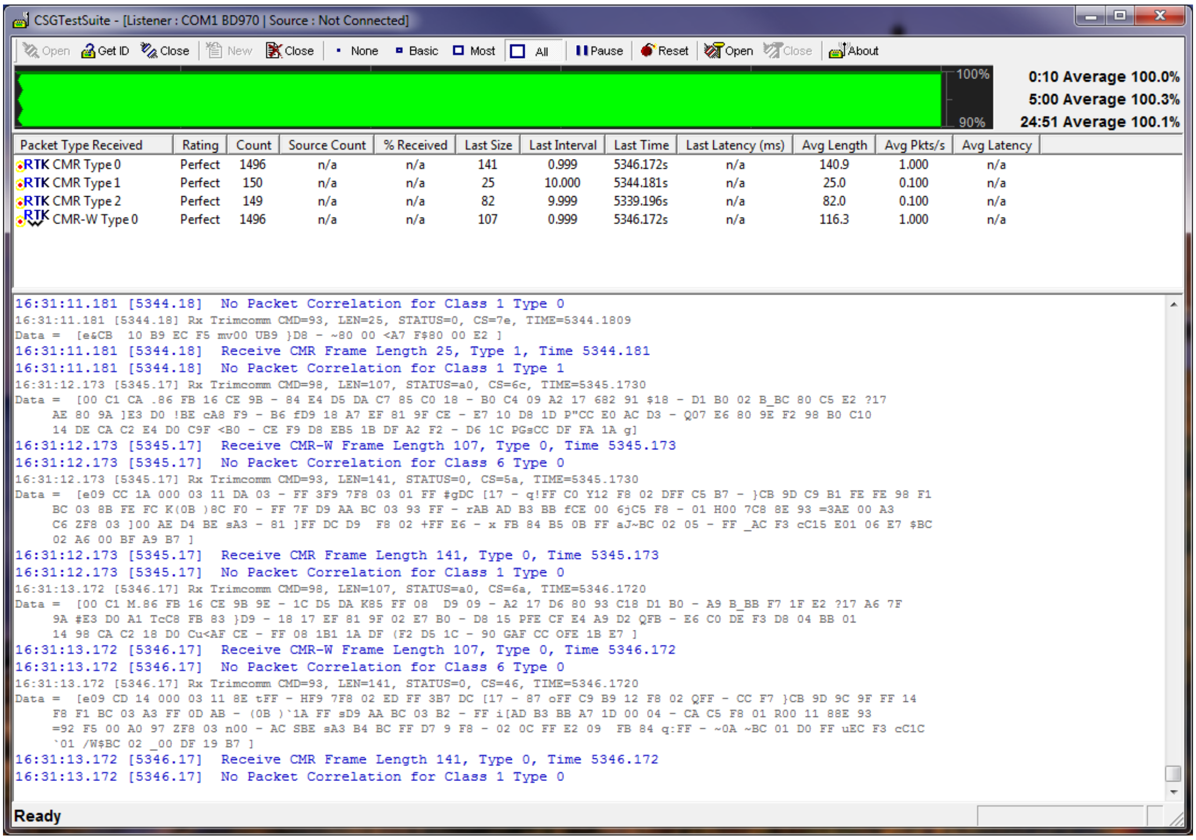
   a. Verify that the expected outputs are enabled.
   b. If applicable, verify the port baud rate and parity.
   c. If applicable, verify cables, are null modems required?

2. When complete, reconnect the GNSS base station to the base station radio. If the base station radio has a display to indicate that it is receiving correction messages, verify. If such an indicator exists and does not indicate that corrections are received:
   a. If applicable, verify the port baud rate and parity matches between the GNSS base station and the base station radio.
   b. If applicable, verify cables, are null modems required?
   c. If applicable, is hardware flow control required?
3. Go to the rover radio and plug the computer running CSGTestSuite into the radio port that is outputting the correction data. Verify with CSGTestSuite that the same correction messages are being output at the rover radio that were output from the GNSS base station. If no correction messages are received:
   a. If applicable, verify the port baud rate and parity.
   b. If applicable, verify cables, are null modems required?
   c. If applicable, is hardware flow control required?
   d. If only some of the messages from the base station are received, does the radio have enough bandwidth to support the number of data bytes transmitted? If not, bandwidth limiting should be setup at the base station to limit correction messages to the number of bytes that the radio can support.
4. Reconnect the rover radio to the GNSS rover and verify on the GNSS rover that corrections are received (see the previous section). If corrections are received at the rover radio but not by the GNSS rover:
   a. If applicable, verify the port baud rate and parity matches between the rover radio and the GNSS rover.
   b. If applicable, verify cables, are null modems required?
   c. If applicable, is hardware flow control required?

Understanding the CSGTestSuite displays

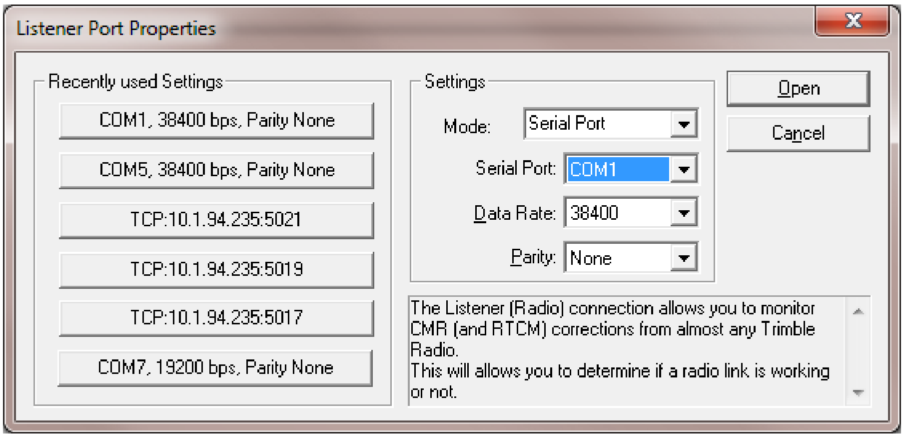
Once open, the CSGTestSuite displays at the top a list of the message types received with some information regarding the size and rate at which these are being received. The estimated "Rating" of the quality of the reception of these corrections is based on typical data rates (1 Hz). When other data rates are used (that is, RTCM 2 Seconds, Moving Base CMR 10 Hz, and so forth) these indicators will not be valid, instead fields like the "Avg Pkts/s" should be used for analysis.

The lower portion of the CSGTestSuite display shows the continuous reception of data. To change the logging level, use the **None**, **Basic**, **Most**, and **All** buttons at the top of the display. This data can also be recorded to an ASCII file using the "**New** button at the top. The **Close** button will end the logging of the file.

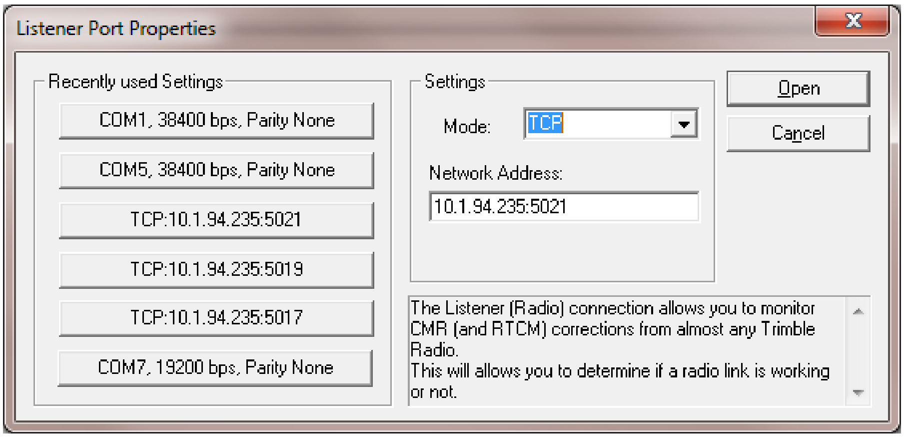


Connecting with the CSGTestSuite software

To connect the CSGTestSuite to the RS-232 port of SNB900 rover radio, use a NULL modem DB9 cable. Click on the Connect icon **Open** to open the following dialog:



Or, when connecting to a TCP or UDP socket, enter the IP address and port:



Select the required serial port. The default port speed on the SNB900 radio is 38400 bits/sec. and Parity “None”.

CSGTestSuite display of CMR and Ag Scrambled CMR

The CSGTestSuite software shows the CMR output from the SNB900 rover radio RS-232 port. The expected CMR protocol should be, highlighted in yellow:

CMR Type 0: - GPS Base Station Measurements @ 1 Hz (unless otherwise configured).

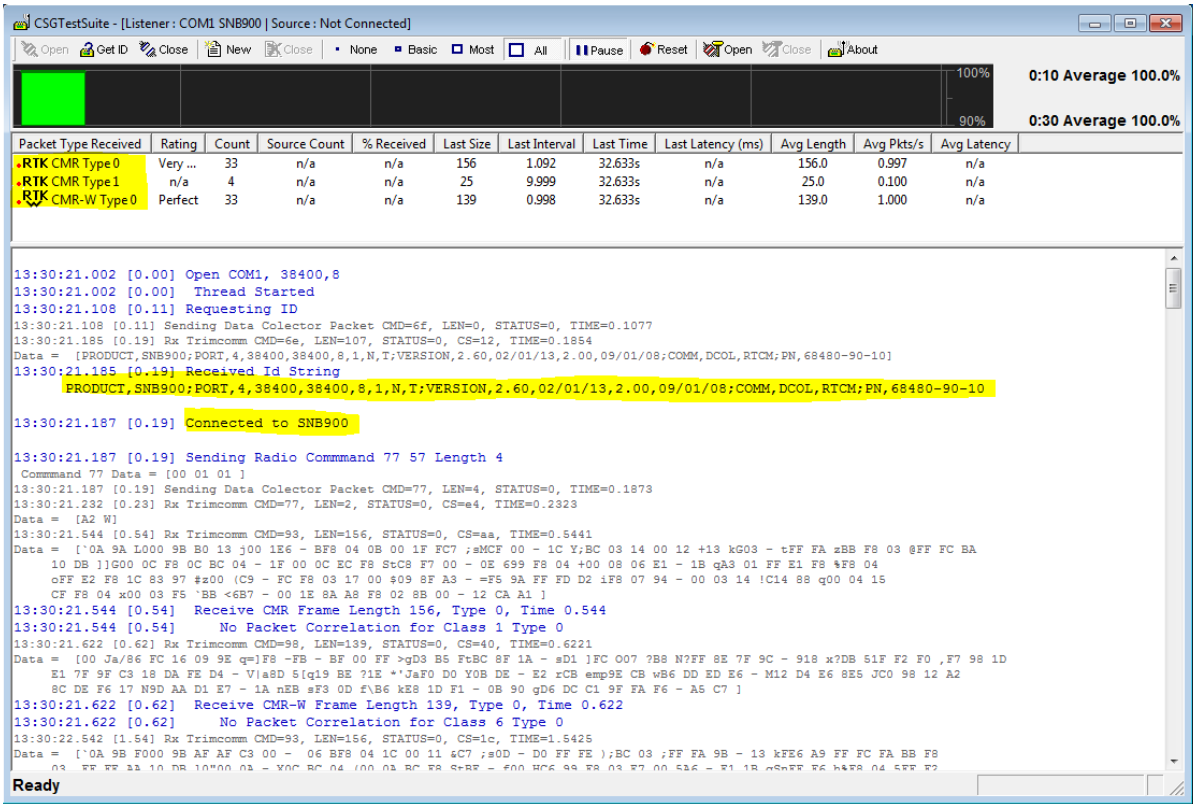
CMR Type 1: - Base Station Location (typically @ 10 seconds intervals).

CMR Type 2 (optional): - Base Station Description (typically @ 10 seconds intervals).

CMR-W Type 0: - GLONASS Base Station Measurements @ 1 Hz (unless otherwise configured).

CMR-W Type 1 (optional): - Time Synchronization Message @ 1 Hz.

In some cases a CMR-W Type 1 message may also be output. The time synchronization message may slightly improve satellite acquisition time on networks with low latency. Current firmware on the SNB900 will intentionally drop this message to free up the limited bandwidth for satellite correction data.



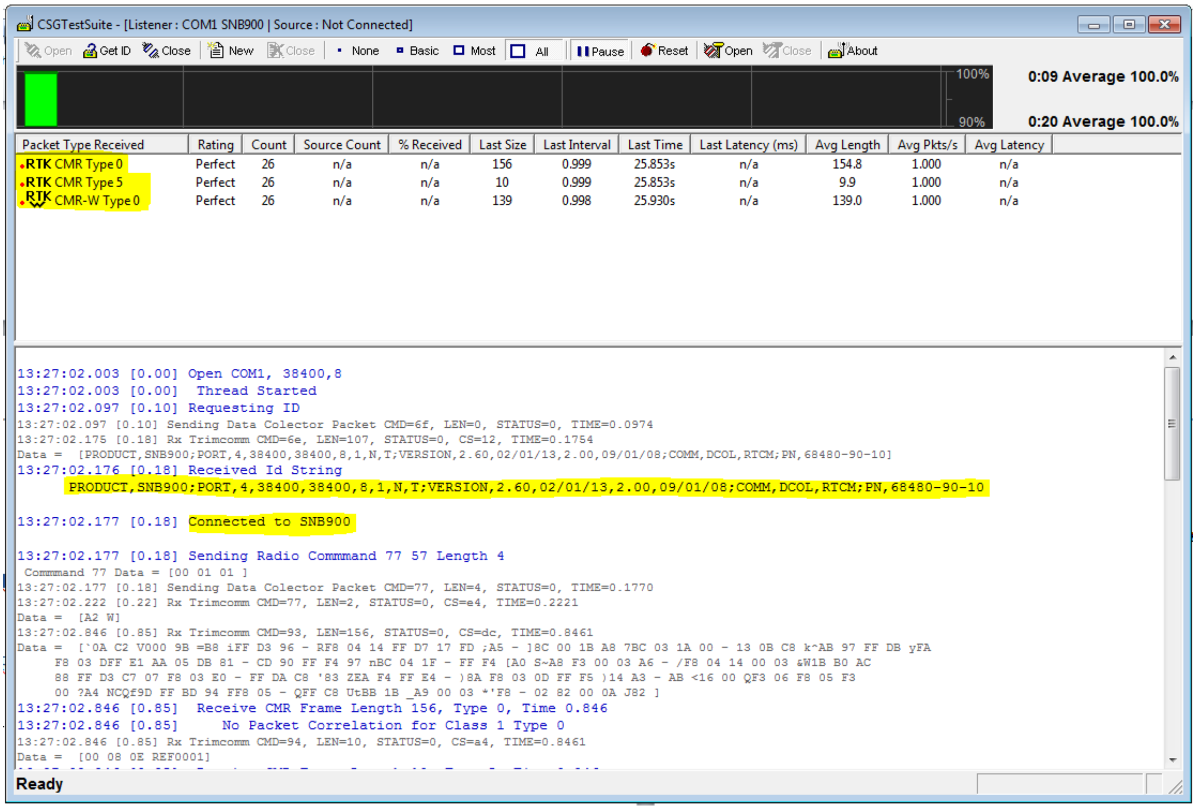
CSGTestSuite display of CMR+ and Ag Scrambled CMR+

The expected CMR+ (plus) Protocol should be, highlighted in yellow:

```
CMR Type 0: - GPS Base Station Measurements @ 1 Hz (unless otherwise configured).
```

```
CMR Type 5: - Types 1 and 2 streamed together @ 1Hz, typically the entire message will be streamed in 15 seconds.
```

```
CMR-W Type: 0 - GLONASS Base Station Measurements @ 1 Hz (unless otherwise configured).
```



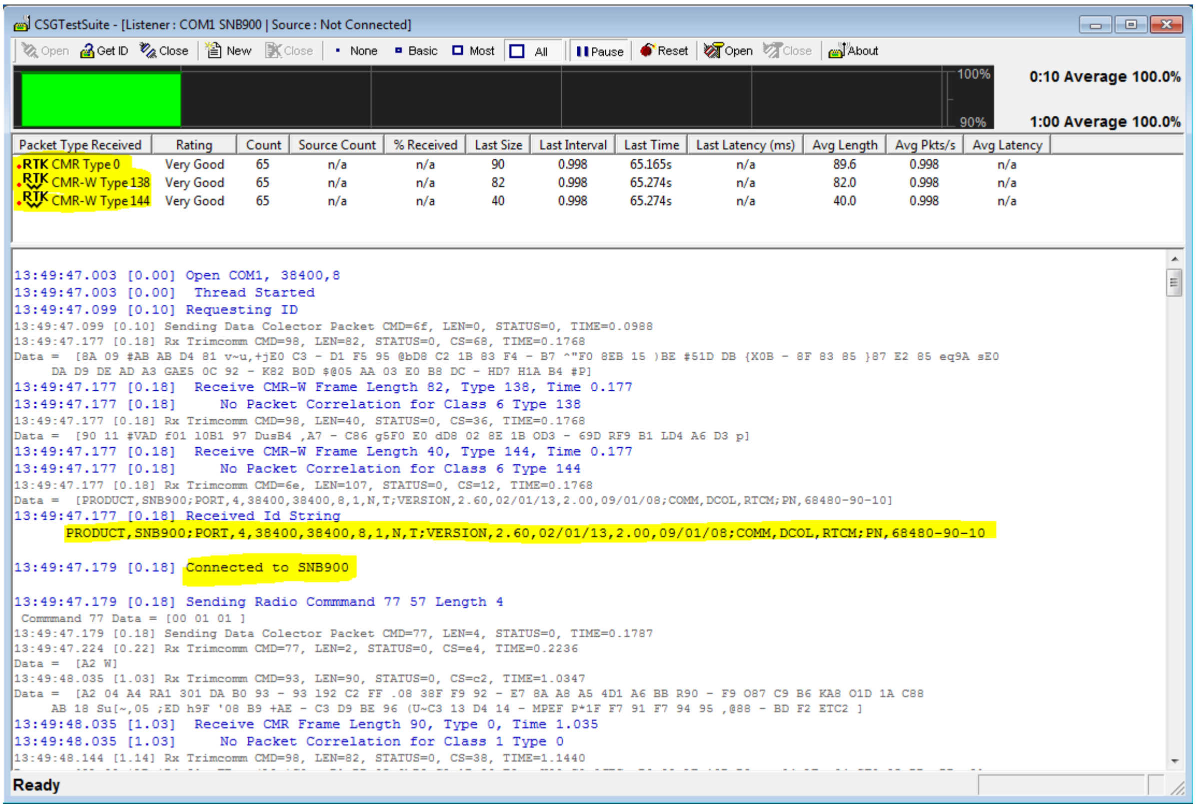
CSGTestSuite display of sCMRx

The expected sCMRx protocol should be, highlighted in yellow:

`CMR Type 0: – GPS Base Station Measurements @ 1 Hz (unless otherwise configured).`

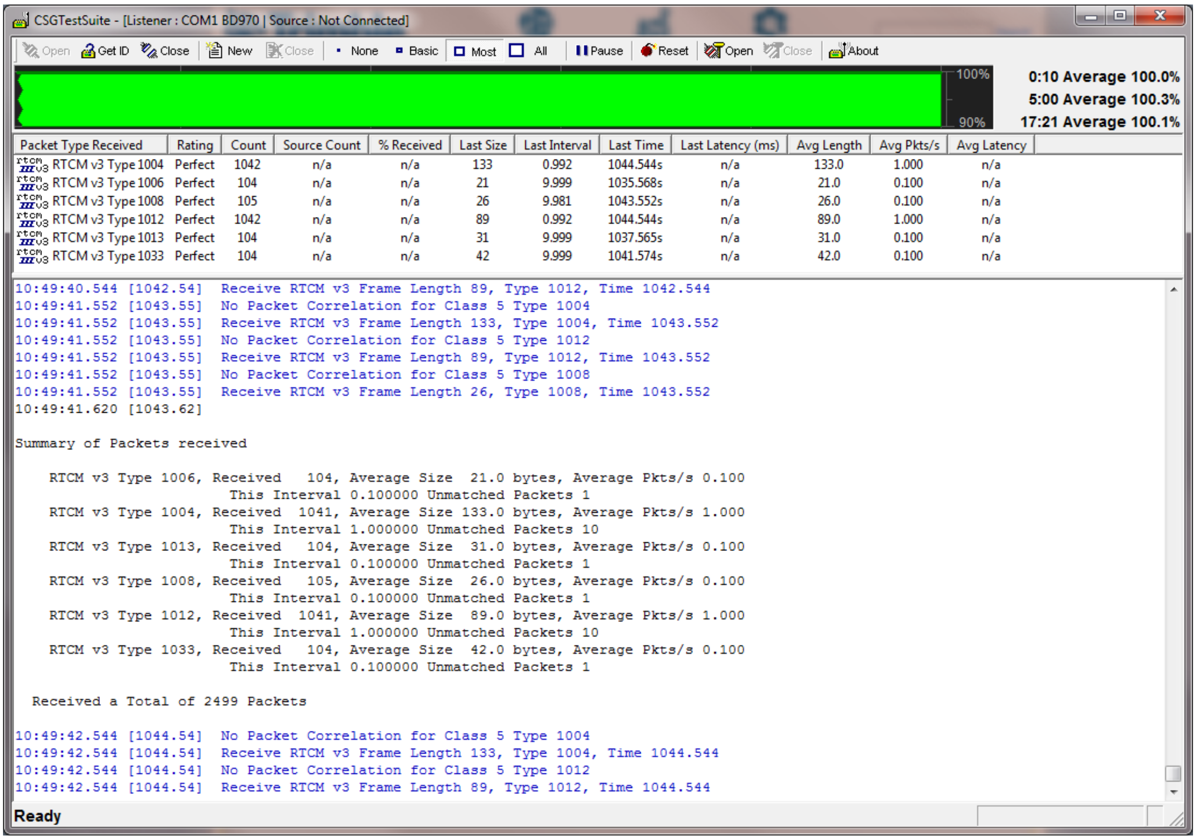
`CMR Type 138 – Base Station Information @ 1seconds intervals.`

`CMR-W Type: 144 – GLONASS Base Station Measurements @ 1 Hz (unless otherwise configured).` Note: if BeiDou or Galileo are enabled on the Base receiver these measurements will be included in the CMR-W Type 144.



CSGTestSuite display of RTCM version 3

The messages transmitted in RTCM version 3 vary based on the receiver manufacturer, firmware versions, configuration settings, constellations tracking, and so forth. An example of what you could view when receiving RTCM v3 corrections would be:



SNB900 Front Panel Display Setup

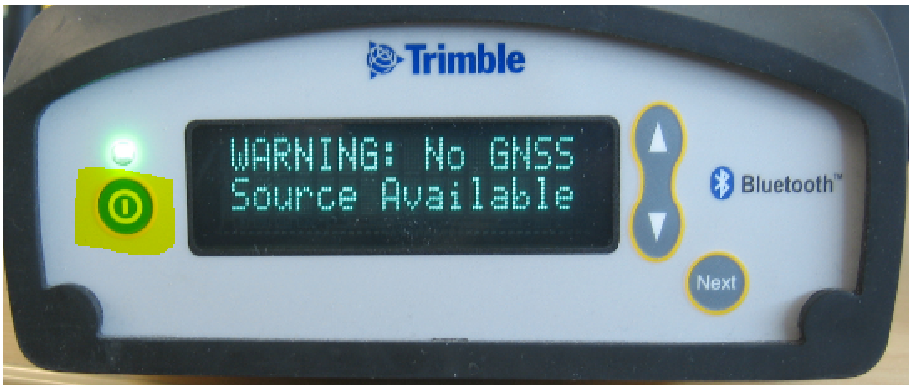
This section describes the use of the Trimble SNB900, a 900 MHz spread spectrum radio which can serve as a base or rover radio. The radios are in this example are loaded with firmware version 2.60. The interface and functionality may differ if other versions of firmware are used. These radios do not require a FCC license. The use case described is for the Transmitting and Receiving following protocols:

- CMR/CMR+ for GPS and GLONASS
- sCMRx for GPS, GLONASS and BeiDou
- Ag Scrambled CMR/CMR+ (scrambled CMR/CMR+)

This section describes the SNB900 front panel display setup for both base and rover 900 MHz radio using the default 38400 bits/sec. baud on the RS-232 port. The default RS-232 port settings on the BD9XX GNSS OEM receiver are 38400 bits/sec. baud. For more information, refer to the SNB900 User Guide.

Turn on the base receiver

Power up the base receiver, pressing the Power button  on the left side of the panel:



Set the base protocol to CMR

Press the Next button until "Protocol" is displayed. Use the up and down arrow keys to select "CMR":

Set the Base mode

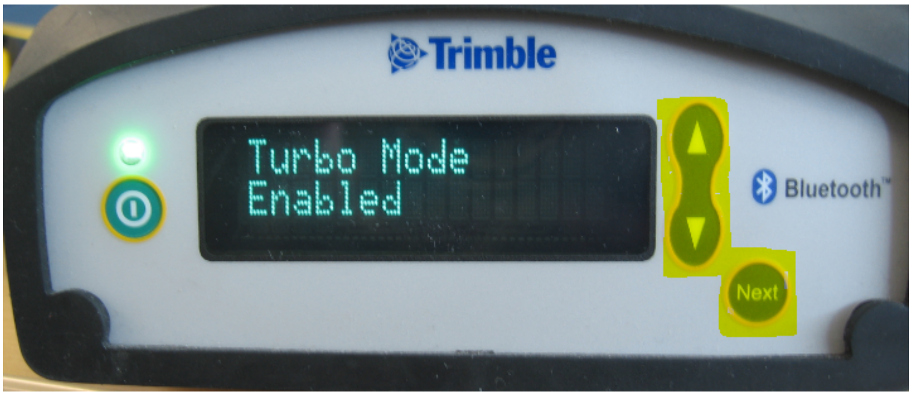
Press until "Mode" is displayed. Use the up and down arrow keys to select "Base":

Set the Base network

Press until "Network" is displayed. Use the up and down arrow keys to select the required network. In this case Network #10 is selected:

Enable the Base Turbo Mode

Press until "Turbo Mode" is displayed. Use the up and down arrow keys to "Enable" the mode.



Base connected to BD9XX RS-232 transmitting CMR protocol

The Front panel display shows the CMR (CMRG) transmitting GPS and GLONASS:

Turn on the rover

Power up the rover receiver, pressing the Power button on the left side of the panel:

Set the Rover protocol to CMR

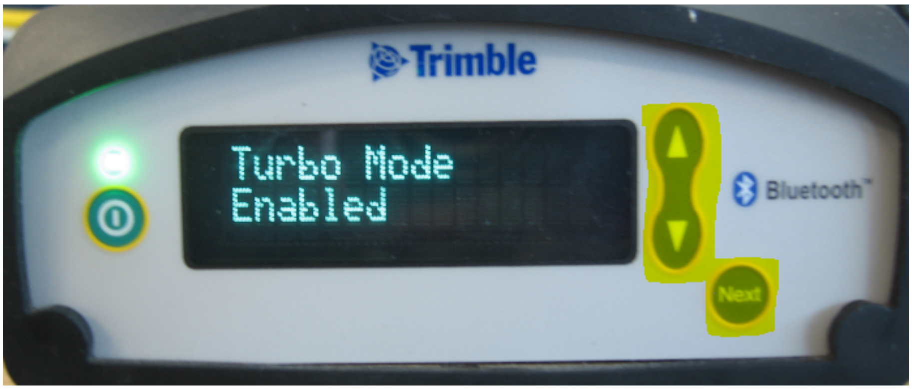
Press until "Protocol" is displayed. Use the up and down arrow keys to select "CMR":

Set the Rover Mode

Press Next until “Mode” is displayed. Use the up and down arrow keys to select “Rover”:

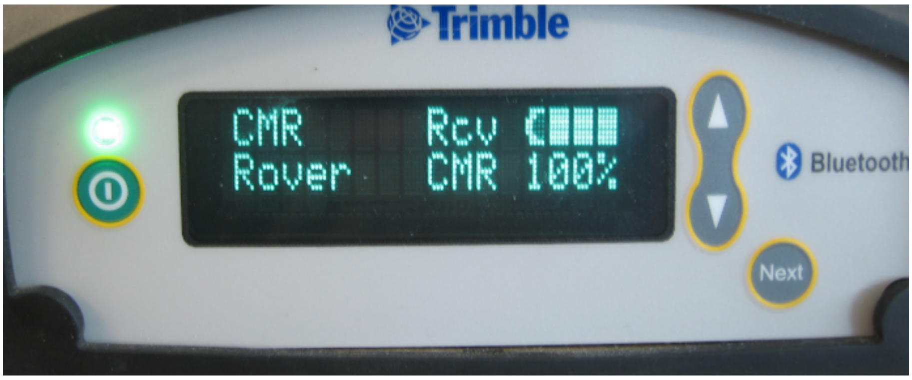
Set the rover network

Press Next until “Network” is displayed. Use the up and down arrow keys to select the required network. In this case Network #10 was selected on the SNB900 base. Select Network #10 setting, which was set on the base receiver:



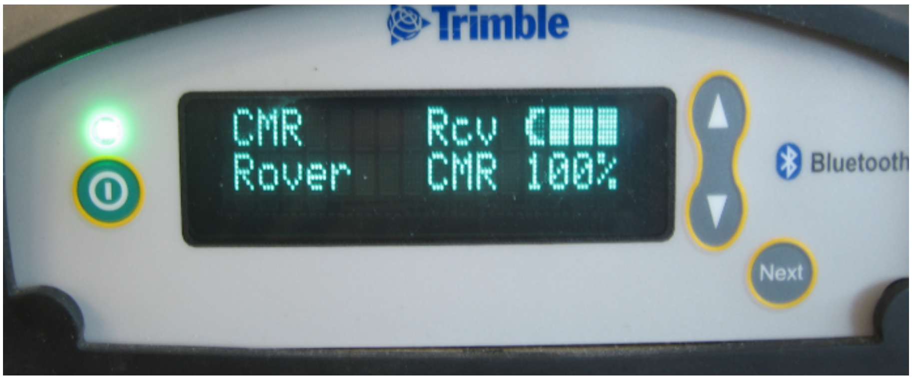
Enable the Rover Turbo mode

Press Next until "Turbo Mode" is displayed. Use the up and down arrow keys to "Enable" the mode:



Rover receiving the CMR protocol

The Front panel display shows the SNB900 rover receiving (Rcv) the CMR Protocol at 100% (No dropped message types):



Glossary

1PPS	Pulse-per-second. Used in hardware timing. A pulse is generated in conjunction with a time stamp. This defines the instant when the time stamp is applicable.
Almanac	A file that contains orbit information on all the satellites, clock corrections, and atmospheric delay parameters. The almanac is transmitted by a GNSS satellite to a GNSS receiver, where it facilitates rapid acquisition of GNSS signals when you start collecting data, or when you have lost track of satellites and are trying to regain GNSS signals. The orbit information is a subset of the ephemeris/ephemerides data.
Base station	Also called *reference station*. In construction, a base station is a receiver placed at a known point on a jobsite that tracks the same satellites as an RTK rover, and provides a real-time differential correction message stream through radio to the rover, to obtain centimeter level positions on a continuous real-time basis. A base station can also be a part of a virtual reference station network, or a location at which GNSS observations are collected over a period of time, for subsequent postprocessing to obtain the most accurate position for the location.
BeiDou	The BeiDou Navigation Satellite System (also known as BDS) is a Chinese satellite navigation system. The first BeiDou system (known as BeiDou-1), consists of four satellites and has limited coverage and applications. It has been offering navigation services mainly for customers in China and from neighboring regions since 2000. The second generation of the system (known as BeiDou-2) consists of satellites in a combination of geostationary, inclined geosynchronous, and medium earth orbit configurations. It became operational with coverage of China in December 2011. However, the complete Interface Control Document (which specifies the satellite messages) was not released until

	December 2012. BeiDou-2 is a regional navigation service which offers services to customers in the Asia-Pacific region. A third generation of the BeiDou system is planned, which will expand coverage globally. This generation is currently scheduled to be completed by 2020.
BINEX	BInary EXchange format. BINEX is an operational binary format standard for GPS/GLONASS/SBAS research purposes. It is designed to grow and allow encapsulation of all (or most) of the information currently allowed for in a range of other formats.
Broadcast server	An Internet server that manages authentication and password control for a network of VRS servers, and relays VRS corrections from the VRS server that you select.
Carrier	A radio wave having at least one characteristic (such as frequency, amplitude, or phase) that can be varied from a known reference value by modulation.
Carrier frequency	The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz.
Carrier phase	Is the cumulative phase count of the GPS or GLONASS carrier signal at a given time.
Cellular modems	A wireless adapter that connects a laptop computer to a cellular phone system for data transfer. Cellular modems, which contain their own antennas, plug into a PC Card slot or into the USB port of the computer and are available for a variety of wireless data services such as GPRS.
Clock steering	When enabled, the receiver clock is steered to GPS system time rather than periodically introducing 1 ms steps and constraining the clock to ± 0.5 ms. Disabled by default; this setting does not affect performance.
CMR/CMR+	Compact Measurement Record. A real-time message format developed by Trimble for broadcasting corrections to other Trimble receivers. CMR is a more efficient alternative to RTCM.
CMRx	A real-time message format developed by Trimble for transmitting more satellite corrections resulting from more satellite signals, more constellations, and more satellites. Its

	compactness means more repeaters can be used on a site.
CMR ID	A unique identifier for the CMR message. It can be any value between 0 through 31.
CMR input filter	Shows whether or not CMR corrections are being used from a specific base station.
Code Diff	Code differential solution. Typically a single-frequency solution.
Constrained height	An external height constraint for the antenna position. The receiver will produce a height value within the constraints provided by the external application.
Covariance	A statistical measure of the variance of two random variables that are observed or measured in the same mean time period. This measure is equal to the product of the deviations of corresponding values of the two variables from their respective means.
Datum	Also called *geodetic datum*. A mathematical model designed to best fit the geoid, defined by the relationship between an ellipsoid and, a point on the topographic surface, established as the origin of the datum. World geodetic datums are typically defined by the size and shape of an ellipsoid and the relationship between the center of the ellipsoid and the center of the earth. Because the earth is not a perfect ellipsoid, any single datum will provide a better model in some locations than in others. Therefore, various datums have been established to suit particular regions. For example, maps in Europe are often based on the European datum of 1950 (ED-50). Maps in the United States are often based on the North American datum of 1927 (NAD-27) or 1983 (NAD-83). All GPS coordinates are based on the WGS-84 datum surface.
Deep discharge	Withdrawal of all electrical energy to the end-point voltage before the cell or battery is recharged.
DGPS	See real-time differential GPS.
Differential correction	Differential correction is the process of correcting GNSS data collected on a rover with data collected simultaneously at a

	base station. Because the base station is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the rover data. Differential correction can be done in real-time, or after the data is collected by postprocessing.
Differential GPS	See real-time differential GPS.
DOP	Dilution of Precision. A measure of the quality of GNSS positions, based on the geometry of the satellites used to compute the positions. When satellites are widely spaced relative to each other, the DOP value is lower, and position precision is greater. When satellites are close together in the sky, the DOP is higher and GNSS positions may contain a greater level of error. PDOP (Position DOP) indicates the three-dimensional geometry of the satellites. Other DOP values include HDOP (Horizontal DOP) and VDOP (Vertical DOP), which indicate the precision of horizontal measurements (latitude and longitude) and vertical measurements respectively. PDOP is related to HDOP and VDOP as follows: $PDOP^2 = HDOP^2 + VDOP^2$.
Dual-frequency GPS	A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.
EGNOS	European Geostationary Navigation Overlay Service. A Satellite-Based Augmentation System (SBAS) that provides a free-to-air differential correction service for GNSS. EGNOS is the European equivalent of WAAS, which is available in the United States.
Elevation	The vertical distance from a geoid such as EGM96 to the antenna phase center. The geoid is sometimes referred to as Mean Sea Level.
Elevation mask	The angle below which the receiver will not track satellites. Normally set to 10 degrees to avoid interference problems caused by buildings and trees, atmospheric issues, and multipath errors.

Ellipsoid	An ellipsoid is the three-dimensional shape that is used as the basis for mathematically modeling the earth's surface. The ellipsoid is defined by the lengths of the minor and major axes. The earth's minor axis is the polar axis and the major axis is the equatorial axis.
EHT	Height above ellipsoid.
Ephemeris/ephemerides	A list of predicted (accurate) positions or locations of satellites as a function of time. A set of numerical parameters that can be used to determine a satellite's position. Available as broadcast ephemeris or as postprocessed precise ephemeris.
Epoch	The measurement interval of a GNSS receiver. The epoch varies according to the measurement type: for real-time measurement it is set at one second; for postprocessed measurement it can be set to a rate of between one second and one minute. For example, if data is measured every 15 seconds, loading data using 30-second epochs means loading every alternate measurement.
Feature	A feature is a physical object or event that has a location in the real world, which you want to collect position and/or descriptive information (attributes) about. Features can be classified as surface or non-surface features, and again as points, lines/break lines, or boundaries/areas.
Firmware	The program inside the receiver that controls receiver operations and hardware.
GAGAN	GPS Aided Geo Augmented Navigation. A Satellite Based Augmentation System (SBAS) for the Indian Airspace.
Galileo	Galileo is a GNSS system built by the European Union and the European Space Agency. It is complimentary to GPS and GLONASS.
Geoid	The geoid is the equipotential surface that would coincide with the mean ocean surface of the Earth. For a small site this can be approximated as an inclined plane above the Ellipsoid.
GHT	Height above geoid.
GIOVE	Galileo In-Orbit Validation Element. The name of each satellite for the European Space Agency to test the Galileo positioning system.

GLONASS	Global Orbiting Navigation Satellite System. GLONASS is a Soviet space-based navigation system comparable to the American GPS system. The operational system consists of 21 operational and 3 non-operational satellites in 3 orbit planes.
GNSS	Global Navigation Satellite System.
GPS	Global Positioning System. GPS is a space-based satellite navigation system, owned by the United States government, consisting of multiple satellites in six orbit planes.
GSOF	General Serial Output Format. A Trimble proprietary message format.
HDOP	Horizontal Dilution of Precision. HDOP is a DOP value that indicates the precision of horizontal measurements. Other DOP values include VDOP (vertical DOP) and PDOP (Position DOP). Using a maximum HDOP is ideal for situations where vertical precision is not particularly important, and your position yield would be decreased by the vertical component of the PDOP (for example, if you are collecting data under canopy).
Height	The vertical distance above the ellipsoid. The classic ellipsoid used in GPS is WGS-84.
IBSS	Internet Base Station Service. This Trimble service makes the setup of an Internet-capable receiver as simple as possible. The base station can be connected to the Internet (cable or wirelessly). To access the distribution server, the user enters a password into the receiver. To use the server, the user must have a Trimble Connected Community site license.
IRNSS	The Indian Regional Navigation Satellite System (IRNSS) with an operational name of NAVIC ("sailor" or "navigator" in Sanskrit, Hindi and many other Indian languages, which also stands for NAVigation with Indian Constellation) is an autonomous regional satellite navigation system that provides accurate real-time positioning and timing services
L1	The primary L-band carrier used by GPS and GLONASS satellites to transmit satellite data.
L2	The secondary L-band carrier used by GPS and GLONASS satellites to transmit satellite data.

L2C	A modernized code that allows significantly better ability to track the L2 frequency.
L5	The third L-band carrier used by GPS satellites to transmit satellite data. L5 will provide a higher power level than the other carriers. As a result, acquiring and tracking weak signals will be easier.
Location RTK	Some applications such as vehicular-mounted site supervisor systems do not require Precision RTK accuracy. Location RTK is a mode in which, once initialized, the receiver will operate either in 10 cm horizontal and 10 cm vertical accuracy, or in 10 cm horizontal and 2 cm vertical accuracy.
Mountpoint	Every single Ntrip Source needs a unique mountpoint on an Ntrip Caster. Before transmitting GNSS data to the Ntrip Caster, the Ntrip Server sends an assignment of the mountpoint.
Moving Base	Moving Base is an RTK positioning technique in which both reference and rover receivers are mobile. Corrections are sent from a “base” receiver to a “rover” receiver and the resultant baseline (vector) has centimeter-level accuracy.
MSAS	MTSAT Satellite-Based Augmentation System. A Satellite-Based Augmentation System (SBAS) that provides a free-to-air differential correction service for GNSS. MSAS is the Japanese equivalent of WAAS, which is available in the United States.
Multipath	Interference, similar to ghosts on an analog television screen that occurs when GNSS signals arrive at an antenna having traversed different paths. The signal traversing the longer path yields a larger pseudorange estimate and increases the error. Multiple paths can arise from reflections off the ground or off structures near the antenna.
NavIC (IRNSS)	Navigation with Indian Constellation. Previously the Indian Regional Navigation Satellite System. An autonomous regional satellite navigation system that covers India and surrounding areas.
NMEA	National Marine Electronics Association. NMEA 0183 defines the standard for interfacing marine electronic navigational devices. This standard defines a number of 'strings' referred to as NMEA strings that contain navigational details such as

	positions. Most Trimble GNSS receivers can output positions as NMEA strings.
Ntrip Protocol	Networked Transport of RTCM via Internet Protocol (Ntrip) is an application-level protocol that supports streaming Global Navigation Satellite System (GNSS) data over the Internet. Ntrip is a generic, stateless protocol based on the Hypertext Transfer Protocol (HTTP). The HTTP objects are extended to GNSS data streams.
Ntrip Caster	The Ntrip Caster is basically an HTTP server supporting a subset of HTTP request/response messages and adjusted to low-bandwidth streaming data. The Ntrip Caster accepts request messages on a single port from either the Ntrip Server or the Ntrip Client. Depending on these messages, the Ntrip Caster decides whether there is streaming data to receive or to send. Trimble Ntrip Caster integrates the Ntrip Server and the Ntrip Caster. This port is used only to accept requests from Ntrip Clients.
Ntrip Client	An Ntrip Client will be accepted by and receive data from an Ntrip Caster, if the Ntrip Client sends the correct request message (TCP/UDP connection to the specified Ntrip Caster IP and listening port).
Ntrip Server	The Ntrip Server is used to transfer GNSS data of an Ntrip Source to the Ntrip Caster. An Ntrip Server in its simplest setup is a computer program running on a PC that sends correction data of an Ntrip Source (for example, as received through the serial communication port from a GNSS receiver) to the Ntrip Caster. The Ntrip Server - Ntrip Caster communication extends HTTP by additional message formats and status codes.
Ntrip Source	The Ntrip Sources provide continuous GNSS data (for example, RTCM-104 corrections) as streaming data. A single source represents GNSS data referring to a specific location. Source description parameters are compiled in the source-table.
OmniSTAR	The OmniSTAR HP/XP service allows the use of new generation dual-frequency receivers with the OmniSTAR service. The

	HP/XP service does not rely on local reference stations for its signal, but utilizes a global satellite monitoring network. Additionally, while most current dual-frequency GNSS systems are accurate to within a meter or so, OmniSTAR with XP is accurate in 3D to better than 30 cm.
Orthometric elevation	The Orthometric Elevation is the height above the geoid (often termed the height above the 'Mean Sea Level').
PDOP	Position Dilution of Precision. PDOP is a DOP value that indicates the precision of three-dimensional measurements. Other DOP values include VDOP (vertical DOP) and HDOP (Horizontal Dilution of Precision). Using a maximum PDOP value is ideal for situations where both vertical and horizontal precision are important.
Postprocessing	Postprocessing is the processing of satellite data after it is collected, in order to eliminate error. This involves using computer software to compare data from the rover with data collected at the base station.
QZSS	Quasi-Zenith Satellite System. A Japanese regional GNSS, eventually consisting of three geosynchronous satellites over Japan.
Real-time differential GPS	Also known as *real-time differential correction* or *DGPS*. Real-time differential GPS is the process of correcting GPS data as you collect it. Corrections are calculated at a base station and then sent to the receiver through a radio link. As the rover receives the position it applies the corrections to give you a very accurate position in the field. Most real-time differential correction methods apply corrections to code phase positions. While DGPS is a generic term, its common interpretation is that it entails the use of single-frequency code phase data sent from a GNSS base station to a rover GNSS receiver to provide submeter position . The rover receiver can be at a long range (greater than 100 kms (62 miles)) from the base station.
Rover	A rover is any mobile GNSS receiver that is used to collect or update data in the field, typically at an unknown location.
Roving mode	Roving mode applies to the use of a rover receiver to collect

	data, stakeout, or control machinery in real time using RTK techniques.
RTCM	Radio Technical Commission for Maritime Services. A commission established to define a differential data link for the real-time differential correction of roving GNSS receivers. There are three versions of RTCM correction messages. All Trimble GNSS receivers use Version 2 protocol for single-frequency DGPS type corrections. Carrier phase corrections are available on Version 2, or on the newer Version 3 RTCM protocol, which is available on certain Trimble dual-frequency receivers. The Version 3 RTCM protocol is more compact but is not as widely supported as Version 2.
RTK	Real-time kinematic. A real-time differential GPS method that uses carrier phase measurements for greater .
SBAS	Satellite-Based Augmentation System. SBAS is based on differential GPS, but applies to wide area (WAAS, EGNOS, MSAS, and GAGAN) networks of reference stations. Corrections and additional information are broadcast using geostationary satellites.
Signal-to-noise ratio	SNR. The signal strength of a satellite is a measure of the information content of the signal, relative to the signal's noise. The typical SNR of a satellite at 30° elevation is between 47 and 50 dB-Hz.
skyplot	The satellite skyplot confirms reception of a differentially corrected GNSS signal and displays the number of satellites tracked by the GNSS receiver, as well as their relative positions.
SNR	See signal-to-noise ratio.
Source-table	The Ntrip Caster maintains a source-table containing information on available Ntrip Sources, networks of Ntrip Sources, and Ntrip Casters, to be sent to an Ntrip Client on request. Source-table records are dedicated to one of the following: • data STReams (record type STR) • CASters (record type CAS) • NETworks of data streams (record type NET) All Ntrip Clients must be able to decode record type STR.

	Decoding types CAS and NET is an optional feature. All data fields in the source-table records are separated using the semicolon character.
Triple frequency GPS	A type of receiver that uses three carrier phase measurements (L1, L2, and L5).
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian.
xFill	Trimble xFill® is a service that extends RTK positioning for several minutes when the RTK correction stream is temporarily unavailable. The Trimble xFill service improves field productivity by reducing downtime waiting to re-establish RTK corrections in black spots. It can even expand productivity by allowing short excursions into valleys and other locations where continuous correction messages were not previously possible. Proprietary Trimble xFill corrections are broadcast by satellite and are generally available globally where the GNSS constellations are also visible. It applies to any positioning task being performed with a single-base, Trimble Internet Base Station Service (IBSS), or VRS RTK correction source.
VRS	Virtual Reference Station. A VRS system consists of GNSS hardware, software, and communication links. It uses data from a network of base stations to provide corrections to each rover that are more accurate than corrections from a single base station. To start using VRS corrections, the rover sends its position to the VRS server. The VRS server uses the base station data to model systematic errors (such as ionospheric noise) at the rover position. It then sends RTCM correction messages back to the rover.
WAAS	Wide Area Augmentation System. WAAS was established by the Federal Aviation Administration (FAA) for flight and approach navigation for civil aviation. WAAS improves the accuracy and availability of the basic GNSS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico. The WAAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is

then broadcast on the L1 frequency, and is tracked using a channel on the GNSS receiver, exactly like a GNSS satellite.

Use WAAS when other correction sources are unavailable, to obtain greater accuracy than autonomous positions. For more information on WAAS, refer to the FAA website at http://gps.faa.gov.

The EGNOS service is the European equivalent and MSAS is the Japanese equivalent of WAAS.

WGS-84	World Geodetic System 1984. Since January 1987, WGS-84 has superseded WGS-72 as the datum used by GPS. The WGS-84 datum is based on the ellipsoid of the same name.