

USER GUIDE

Trimble® BD982 GNSS Receiver Module



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Version 4.30
Revision B
April 2011



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Meerheide 45
5521 DZ Eersel, NL



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Introduction

Welcome to the *BD982 GNSS Receiver Module User Guide*. This manual describes how to set up and use the Trimble® BD982 GNSS receiver module. The BD982 receiver uses advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

Even if you have used other Global Positioning System (GPS) products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GPS, visit the Trimble website (www.trimble.com) for an interactive look at Trimble and GPS.

About the BD982 GNSS receiver

The BD982 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 position and heading guidance at a high update rate and low latency.

The BD982 receiver offers centimeter-level accuracy based on RTK solutions and submeter accuracy code-phase solutions.

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

Designed for reliable operation in all environments, the BD982 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.

You can configure the receiver 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.

Technical Support

If you have a problem and cannot find the information you need in the product documentation, contact your local dealer.

Firmware and software updates are available at: www.pacificcrest.com/support.php?page=updates.

Documentation updates are available at: www.pacificcrest.com/resources.php?page=doc_library.

Features and Functions

In this chapter:

- BD982 features
- Use and care
- Radio and radar signals
- COCOM limits

BD982 features

The BD982 receiver provides the following features:

- Position antenna based a on 220-channel Trimble Maxwell™ 6 chip:
 - GPS: Simultaneous L1 C/A, L2E, L2C, L5
 - GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A L2 P
 - SBAS: Simultaneous L1 C/A, L5
 - GIOVE-A: Simultaneous L1 BOC, E5A, E5B, E5AltBOC ¹
 - GIOVE-B: Simultaneous L1 CBOC, E5A, E5B, E5AltBOC ¹
 - GALILEO: Disabled ²
- Vector antenna based on a second 220-channel Maxwell 6 chip:
 - GPS: Simultaneous L1 C/A, L2E, L2C
 - GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A, L2 P
- Advanced Trimble Maxwell 6 Custom Survey GNSS Technology
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 1 USB port
- 1 CAN port
- 1 LAN Ethernet port:
 - Supports links to 10BaseT/100BaseT networks
 - All functions are performed through a single IP address simultaneously—including web interface access and raw data streaming
- Network Protocols supported:
 - HTTP (web GUI)
 - NTP Server
 - NMEA, GSOE, CMR, and so on over TCP/IP or UDP
 - NTripCaster, NTripServer, NTripClient
 - mDNS/UPnP Service discovery
 - Dynamic DNS

¹. Galileo GIOVE-A and GIOVE-B test satellite support uses information that is unrestricted in the public domain and is intended for signal evaluation and test purposes.

². The hardware is compliant with Galileo OS SIS ICD, Draft 1, February 2008. Commercial sale of Galileo technology requires Trimble to acquire a Commercial license from the EU. At the time of writing, there is no process for obtaining a license. Therefore, to comply with the ICD Copyright/IPR terms, all Galileo firmware and hardware functionality is disabled. Depending on the terms of the license, an upgrade to full Galileo (L1 CBOC, E5A, E5B, E5AltBOC) may be offered. This will require an additional fee.

- Email alerts
- Network link to Google Earth
- Support for external modems through PPP
- 4 × RS-232 ports
- 1 Hz, 2 Hz, 5 Hz, 10 Hz, 20, and 50 Hz positioning and heading outputs (depending on the installed option)
- Up to 50 Hz raw measurement and position outputs
- Reference outputs: CMR, CMR+™, RTCM 2.1, 2.2, 2.3, 3.0, 3.1
- Navigation outputs:
 - ASCII: NMEA-0183: GBS; GGA; GGL; GRS; GSA; GST; GSV; HDT; PTNL,AVR; PTNL,BPQ; PTNL,GGK; PTNL,PJK; PTNL,PJT; PTNL,VGK; PTNL,VHD; RMC; ROT; VTG; ZDA.
 - Binary: Trimble GSOF.
- Control software. Web browser:
 - Internet Explorer® internet browser 7.0 or later
 - Mozilla Firefox 3.5 or later
 - Safari 4.0
 - Opera 9
 - Google Chrome
- 1 Pulse Per Second Output
- Event Marker Input Support
- LED drive support

Use and care



CAUTION – Operating or storing the receiver outside the specified temperature range can damage it. For more information, see [Chapter 9, Specifications](#).

Always mount the receiver in a suitable casing.

Radio and radar signals

High-power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits. This does not harm the instrument, but it can prevent the receiver electronics from functioning correctly. Avoid using the receiver within 400 m of

powerful radar, television, or other transmitters. Low-power transmitters such as those used in portable phones and walkie-talkies normally do not interfere with the operation of the receivers.

COCOM limits

The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on this product:

- Immediate access to satellite measurements and navigation results is disabled when the receiver velocity is computed to be greater than 1,000 knots, or its altitude is computed to be above 18,000 meters. The receiver GPS subsystem resets until the COCOM situation clears.

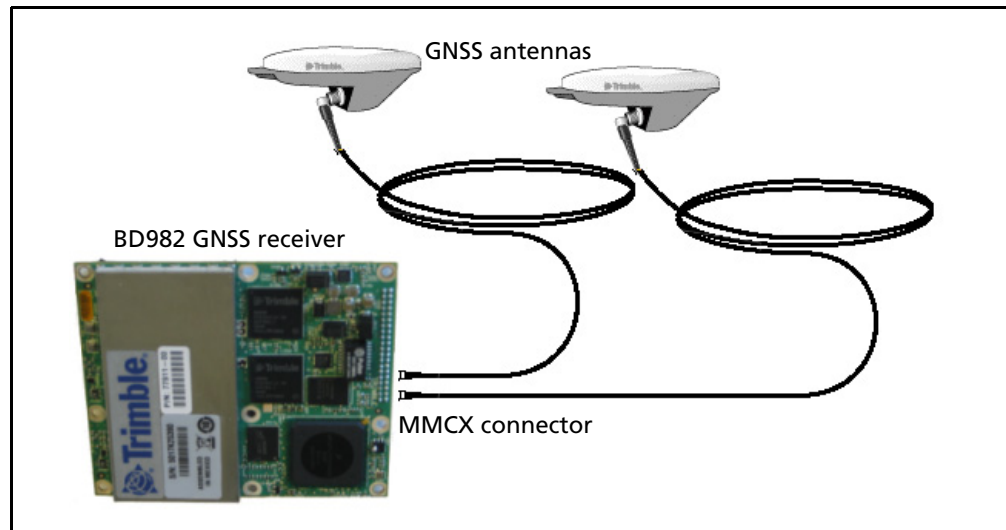
Installation

In this chapter:

- [Setting up the receiver](#)
- [Installing the receiver](#)
- [LED functionality and operation](#)

The Trimble BD982 receiver delivers the highest performance capabilities of a GNSS receiver in a compact form factor. This chapter describes how to set up and install the receiver.

Setting up the receiver



Installing the receiver

Trimble recommends that you read this section *before* installing the BD982 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. This depends 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.

Supported antennas

The receiver tracks multiple GNSS frequencies: The Trimble Zephyr™ II antenna supports these frequencies.

Other antennas may be used. However, ensure that the antenna you choose supports the frequencies you need to track and operates at 5 V with a greater than 39 dB signal gain.

Installation guidelines

The receiver is designed to be standoff mounted. You must use the appropriate hardware and all six mounting holes. Otherwise, you violate the receiver hardware warranty. See [Plan view, page 186](#).

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 (–38 °F)
- Corrosive fluids and gases

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

Mounting the antennas

Choosing the correct location for the antenna is critical to the 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.

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

BD982 interface board

An evaluation kit is available for testing the BD982 receiver. This includes an I/O board that gives access to the following:

- Power input connector
- Power ON/OFF switch
- Four serial ports through DB9 connectors
- Ethernet through a RJ45 connector

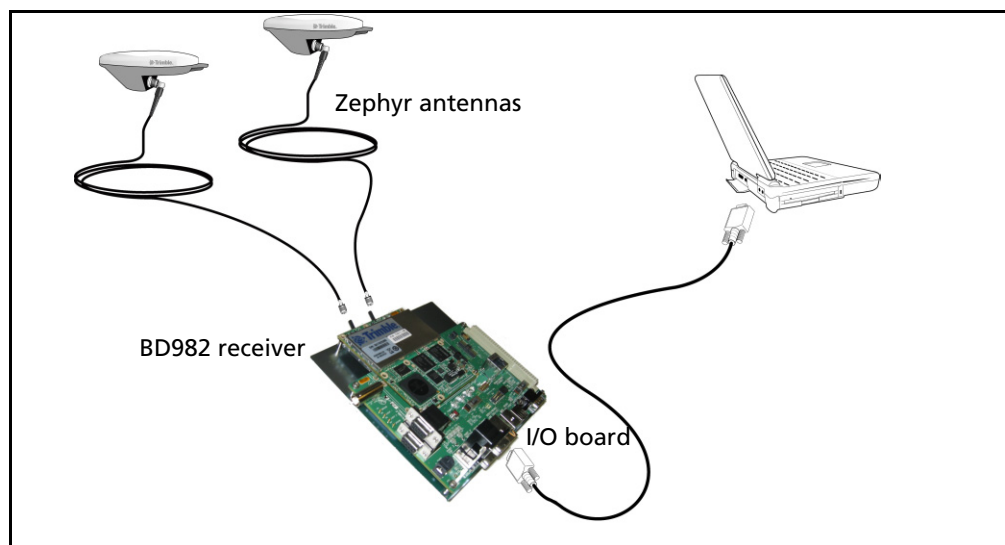
Note – There are separate Ethernet jacks for the BD970 and BD982 boards.

- USB port through USB Type A and B receptacles
- CAN port through a DB9 connector
- Two event input pins
- 1PPS output on BNC connector
- CAN / Serial port 3 switch

Note – To switch between serial port 3 and CAN, you must configure the receiver using the web interface or binary commands. If you do not set an option bit to make CAN the default, the receiver defaults to serial.

- Three LEDs to indicate satellite tracking, receipt of corrections, and power.

The following figure shows a typical I/O board setup:



The computer connection provides a means to set up and configure the receiver.

Included with the BD982 I/O board is a small plastic bag that contains four standoffs. Screw these into the I/O board to coincide with the four corner holes of the receiver when seated on the J3 connector.

Routing and connecting the antenna cable

After mounting the antenna, route the antenna cable from the GPS antenna to the receiver (see the figure on [page 16](#)). 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

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.

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

LED functionality and operation

The BD982 evaluation interface board comes with three LEDs to indicate satellite tracking, RTK receptions, 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:

Power LED	RTK 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 ¹ (5 seconds) followed by high frequency blinking burst ²	The receiver is tracking satellites on both position (primary) and vector (secondary) antennas, but not receiving RTK corrections.
On (continuous)	Off	Blinking at 1 Hz ¹	The receiver is tracking satellites on the position (primary) antenna only. The vector antenna is not tracking.

Power LED	RTK LED	SV Tracking LED	Status
On (continuous)	Off	High frequency blinking burst every 5 seconds ²	The receiver is tracking satellites on the vector (secondary) antenna only. The position antenna is not tracking.
On (continuous)	Blinking at 1 Hz	Blinking at 1 Hz ¹	The receiver is tracking satellites on the position (primary) antenna only (the vector antenna is not tracking) and receiving incoming RTK corrections.
On (continuous)	Blinking at 1 Hz	Blinking at 1 Hz ¹ (5 seconds) followed by high frequency blinking burst ²	The receiver is tracking satellites on both the position (primary) and vector (secondary) antennas and receiving incoming RTK corrections.
On (continuous)	Blinking at 1 Hz	High frequency blinking burst every 5 seconds ²	The receiver is tracking satellites on the vector (secondary) antenna only (the position antenna not tracking), and receiving RTK corrections.
On (continuous)	Blinking at 1 Hz	Off	The receiver is receiving incoming RTK corrections, but not tracking satellites on either antenna.
On (continuous)	Blinking at 1 Hz	On (continuous)	The receiver is in Boot Monitor Mode. Contact technical support.

¹ High frequency rapid flash (blinking) indicates less than five satellites tracked.

² Only available in receivers running firmware version 4.40 or later.

Positioning Modes

In this chapter:

- What is RTK?
- Carrier phase initialization
- Update rate and latency
- Data link
- Moving Baseline RTK positioning
- Critical factors affecting RTK accuracy
- DGPS
- SBAS

The BD982 receiver is designed for high-precision navigation and location. The receiver uses Real-Time Kinematic (RTK) techniques to achieve centimeter-level positioning and heading accuracy. The following section provides background information on terminology and describes the capabilities and limitations of the receiver.

What is 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 GPS carrier phase signals. Carrier phase measurements are like precise tape measures from the base and rover antennas to the satellites. In the BD982 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 BD982 rover has to resolve, or initialize, the carrier phase ambiguities at power-up and every time that 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*, to reflect that no restriction is placed on the motion of the rover receiver throughout the initialization process.

The receiver uses L1 and L2 carrier-phase measurements plus precise code range 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). For the receiver, the maximum update rate is 50 Hz.

Solution latency refers to the lag in time between when the position was valid and when it was displayed. 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 the BD982 receiver, the latency is less than 0.02 seconds.

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 usually results in degraded performance.

Factors to consider when choosing a data link include:

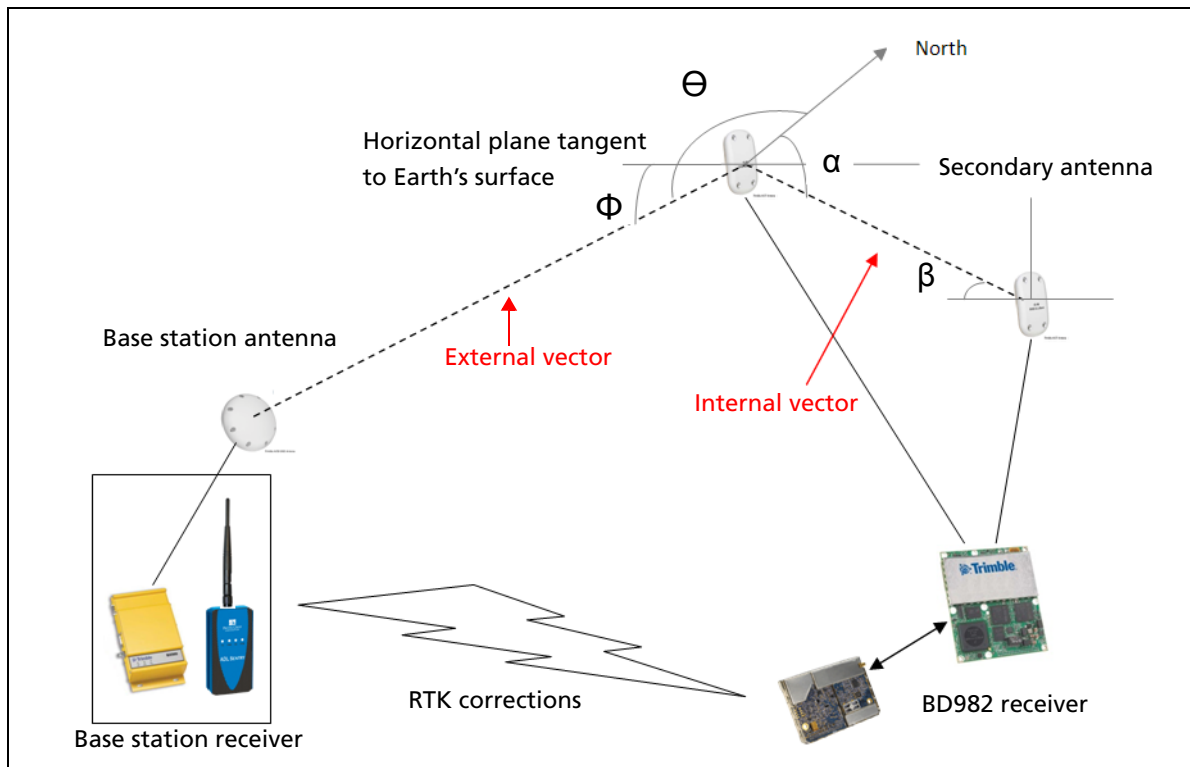
- Throughput capacity
- Range
- Duty cycle
- Error checking/correction
- Power consumption

The data link must support at least 4800 baud, and preferably 9600 baud throughput. Your Trimble representative (see [Technical Support, page 9](#)) 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 50 Hz.

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 (OmniSTAR, DGPS, SBAS, or Autonomous). The following schematic shows an example of moving baseline RTK using the BD982 receiver.



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.

BD982 Moving Base RTK without external base station corrections

A single BD982 receiver without any external reference station acts as a moving base/rover combination that precisely computes a vector between its primary (position) and secondary (vector) antennas. The autonomous absolute position of both antennas has the accuracy of the installed options (such as autonomous, SBAS, OmniSTAR, DGPS). Most users are interested in the precise vector between the antennas, which will be accurate to centimeter level.

The receiver can be configured to output NMEA messages for the position of the position and vector antennas as follows.

Output messages

- **NMEA GPK/GGA** – Position of primary antenna (latitude, longitude, and altitude)
- **NMEA AVR (α, β)** – Yaw angle (α – same as heading), Tilt (β) in degrees and range (meters) between the primary and secondary antennas

The position of the secondary antenna cannot be directly obtained to solve for its position (latitude, longitude and height) using 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 Lat, Lon and Height of the secondary antenna.

BD982 Moving Base RTK with external base station corrections (Chained RTK)

A BD982 receiver that is configured to accept RTK corrections (CMR/RTCM) from an external base station will be computing 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.

As seen in the above figure, 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.

Output messages

- **NMEA G GK/GGA** – Position of primary antenna (latitude, longitude, and altitude).
- **NMEA V GK** – 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. If no external base station is being used to send corrections to the receiver, the vector will be output as 00000.000, 00000.000, 00000.000.
- **NMEA HDT (α)** – Heading of internal vector relative to True North.
- **NMEA AVR (α, β)** – Yaw angle (α – same as heading) and Tilt (β) in degrees.
- **NMEA VHD (Θ, Φ)** – 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 will be 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.

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 BD982 rover. 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 error in the rover location is approximately 5 cm. 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. If the baseline vector is 10 km, then the error in the rover location is approximately 1 cm.

Number of visible satellites

A GNSS position fix is similar to a distance resection. Satellite geometry directly impacts on 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 overdetermined solution is performed and the solution reliability can be measured. The more satellites, 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 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.

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.

DGPS

The receiver supports output and input of differential GPS (DGPS) corrections in the RTCM SC-104 format. This allows position accuracies of less than 1 meter to be achieved using the L1 frequencies of GPS and GLONASS.

SBAS

The receiver supports SBAS (satellite based augmentation systems) that conform to RTCA/DO-229C, such as WAAS, EGONS, or MSAS. The receiver can use the WAAS (Wide Area Augmentation System) set up by the Federal Aviation Administration (FAA). 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 the RTK radio 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 BD982 receiver, exactly like a GPS satellite.

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

Configuring the BD982 Receiver Using Trimble Software Utilities

In this chapter:

- Configuration Toolbox software
- Trimble MS Controller or Winpan software

The Trimble software utilities described in this chapter are available for download from the Support section of the Pacific Crest website, www.PacificCrest.com.

Trimble recommends that you use the receiver Web interface to configure the receiver and monitor its status. Not all receiver functions are supported in the Configuration Toolbox and MS Controller/Winpan software. The Configuration Toolbox is the only utility that can be used to load local datums and coordinate systems into the receiver.

Configuration Toolbox software

The Configuration Toolbox software is a Windows application that provides a graphical user interface to help you configure selected Trimble GPS receivers.

The Configuration Toolbox software lets you:


- create and edit application files
- transfer application files to and from the receiver
- manage application files stored in the receiver

Creating and editing application files

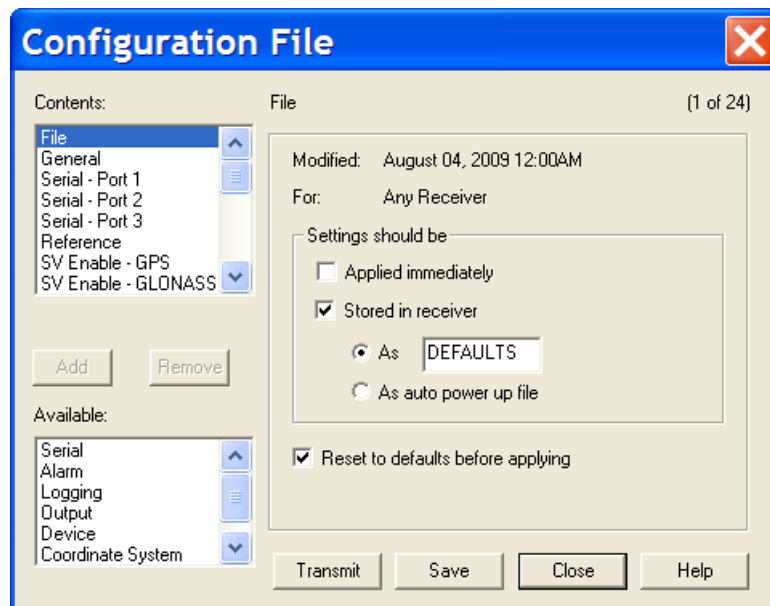
You can create an application file and transfer it to the receiver in several different ways. The general workflow includes the following steps:

1. Create and save the application file in the Configuration Toolbox software.
2. Connect the receiver to the computer and apply power.
3. Open the desired application file in the Configuration Toolbox software.
4. Transfer this application file to the receiver.
5. Check that the receiver is using the transferred application file.

To create and save an application file to the receiver:

1. To start the Configuration Toolbox software, click . Then select *Programs / Trimble / Configuration Toolbox / Configuration Toolbox*.
2. Select *File / New / Any Receiver*.
3. Specify the receiver settings (for more information, refer to the Configuration Toolbox documentation).

4. Use *File / Save As* to save the application file.



To transfer the application file to the receiver:

1. Connect a data cable to any port on the receiver.
2. Connect the other end of the data cable to a serial (COM) port on the computer.
3. Select *File / Open* to open the desired application file.
4. With the file open and the *Configuration File* dialog open, select *Communications / Transmit File*.

A message appears stating that the application file has been successfully transferred. If an error occurs, select *Communications / Transmit File* again. This overrides any incompatibility in baud rates and enables successful communication.

5. To check whether the transfer was successful, close the *Configuration File* dialog and select *Communications / Get File*.

A list of all application files in the receiver appears. If you selected **Apply Immediately** in the application file, the Current application file will contain the settings in the new file.

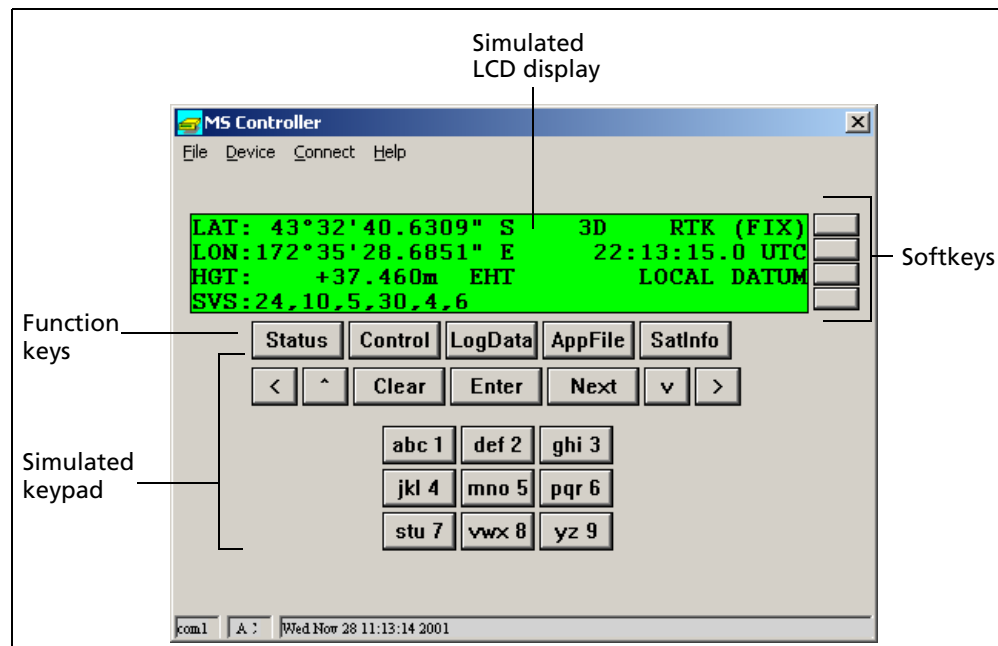
6. To apply a different file, select the file you require from the list and then repeat this procedure.

Trimble MS Controller or Winpan software

The Trimble MS Controller or Winpan software serves as a virtual keypad and display screen for the receiver.

To use the MS Controller or Winpan software, you need to connect one of the receiver's I/O ports to one of the serial ports on a personal computer. The software runs under the Windows operating system and manages the communications link between the computer and the receiver.

The simulated keypad and display for the MS Controller software are shown below:



Simulated LCD display

The simulated LCD display shows data about the current position or survey operation, the satellites tracked by the receiver, the internal status of the receiver, and a variety of other information.

The data shown on the simulated LCD display is called a screen and the various types of data are displayed in fields. Three types of fields are displayed on the simulated screens: Display-only fields, data-entry fields, and carousels. For more information about fields, see [Working with screens and fields, page 34](#).

The simulated LCD display can display four lines of data at once. When more than four lines of data is available for display, double left arrows (⏮) appear in the upper left corner of the display. To display another four lines of data, click the **Next** key.

Some screens appear solely for the purpose of viewing status information. For instance, the *SatInfo* screens show satellite tracking and status information.

Data-entry screens are displayed when you need to configure the operation of the receiver.

Many status and data-entry fields include menu options for displaying additional screens and these screens can contain menus for displaying more screens. Menu options are displayed on the right side of the screen, enclosed within angle brackets.

Softkeys

The four softkeys perform different functions, depending on the menu options displayed on the right side of the simulated display. Menu options (also called softkey options) are displayed on the screen enclosed within left and right angle brackets (< >). One softkey is provided for each of the four lines on the simulated LCD display: The first (top) softkey performs the action described by the menu option on the first line of the display, the second softkey performs the action associated with the menu option on the second screen line, and so on. When a menu option is not displayed on a screen for a specific screen line, the associated softkey performs no action.

In the sample screen below, one menu option (the **<HERE>** softkey) is displayed:

```

BASE STATION (CONTROL)                <HERE>
[CMR]:[OFF      ]      ANT. HT.:00.000 m
LAT: 00°00'0.00000" N NAME: 0000
LON:000°00'00.00000" E HGT:+0000.000 m

```

The menu action associated with a softkey can be executed immediately, or the action can display another screen which might include additional menu options. In the sample screen above, press **<HERE>** to enter the current position as the coordinates for a base station.

Throughout this manual, softkey options are shown enclosed within angle brackets and in bold type.

Simulated keypad

Use the simulated keypad to enter alphanumeric and numeric data, and to select predefined values for data-entry fields:

Key/Symbol	Description
[0] – [9]	The numeric keys let you enter numeric data.
[a] – [z]	The alphabetic keys become active when a field can accept alphabetic data.
[<] – [>]	The side arrow keys let you move the cursor to data-entry fields before entering data or choosing options from carousel fields.
[^] – [v]	The up and down arrow keys let you select options from carousel fields. Alternatively, you can select alphabetic and numeric data where appropriate.
[Next]	Pages through multiple screen lines, softkey options, or predefined field options.

Key/Symbol	Description
Enter	Accepts change entered into data fields. Click Enter from the last data field to accept all changes entered in all fields.
Clear	Returns to the previous screen without saving the changes made in any data fields.

Function keys

The six function keys display screens with options for showing status information and additional screens for controlling receiver functions and options:

Key	Shows...
Status	The <i>Status</i> screen with options for displaying factory configuration information and receiver systems information.
SatInfo	The <i>SatInfo</i> screen with options for displaying satellite tracking and status information.
AppFile	The <i>AppFile</i> screen with options for displaying the application files directory, storing the current parameter settings as an application file, and options for warm booting the receiver.
Control	The <i>Control</i> screen with options for configuring the receiver setup parameters.
LogData	Not applicable.

Working with screens and fields

A summary of the keypad and display operations for the receiver with the MS Controller/Winpan software appears below.

Key/Symbol	Description
Next	Pages through multiple screen lines, softkey options, or carousel data entry fields.
Enter	Accepts / changes data fields. Click Enter on the last data field to accept all changes.
Clear	Returns the screen to the previous menu level without changing the data fields.
[]	Indicates a carousel data field used to select from a limited options list.
Ö	Indicates that additional screen lines are accessible. Click Next .
< >	Indicates a softkey (menu option).
< and >	Moves the cursor between fields on the simulated screen.
^ and v	Selects from carousel data fields, or alphanumeric and numeric data.

Types of field

Three types of field appear on the simulated LCD display:

- Display-only fields
- Data-entry fields

- Carousels

Most fields include two parts—a field description and a reserved area for entering or selecting data.

Display-only fields

Display-only fields can appear on any screen. Some screens are composed entirely of display-only fields. For example, the *SatInfo* screens show satellite status and tracking information. A cursor is not displayed when a screen is composed entirely of display-only fields. If screens contain combinations of data-entry, carousels, and display-only fields, you cannot move the cursor into display-only fields.

Data-entry fields

Data-entry fields accept numeric or alphanumeric input from the keypad. For example, the fields for entering latitude, longitude, and height information accept numeric input from the keypad. Data-entry fields are usually displayed when you configure receiver operating parameters or when you enable receiver functions and options.

Carousels

Whenever square brackets [] appear around an item on the display, you can click the **[Next]** key to change the value to one of a set of options. The square brackets indicate a carousel data entry field.

Click **[Next]** to page through more screen lines. Because the simulated BD982 display has only 4 lines, there are times when additional information needs to be accessed. For example, if you select the **[Control]** menu, four softkeys become active and the double left arrow symbol ⇐ appears in the top left corner of the screen. The double left arrow is the visual cue that selecting **[Next]** allows you to page through more screen information.

Entering data in fields

Carousels let you select from a limited set of options. For example, to choose a port number, you use carousels and **[Next]**. Some data fields involve alphanumeric entry through the keyboard.

Click **[Enter]** to accept the data field and move the cursor to the next input item. To accept all of the selections on the display, click **[Enter]** at the last data field. All of the data selections are ignored if you click **[Clear]** while in a data entry screen. Click **[Clear]** to move back up the menu structure after selections are entered and saved.

Use the < and > keys, on the left and right of the display respectively, to move between data entry fields without changing their values.

Configuring the BD982 Receiver Using a Web Browser

In this chapter:

- Configuring Ethernet settings
- Configuring the receiver using a web browser
- Establishing a PPP connection
- Resetting your username and password

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`

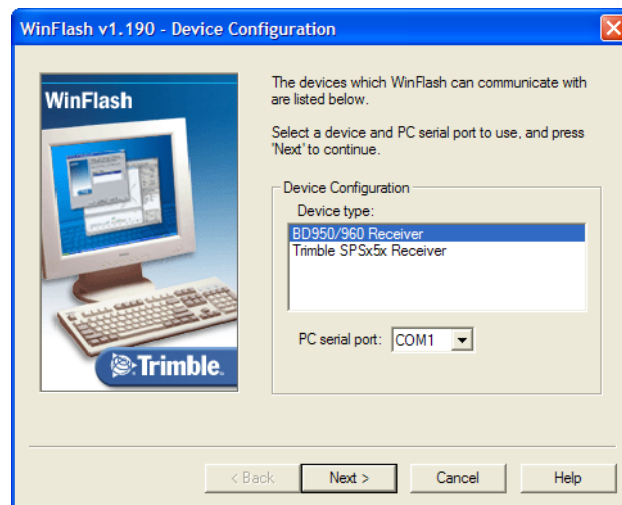
Example of connecting to the receiver using port 4000: `http://169.254.1.0:4000`

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.

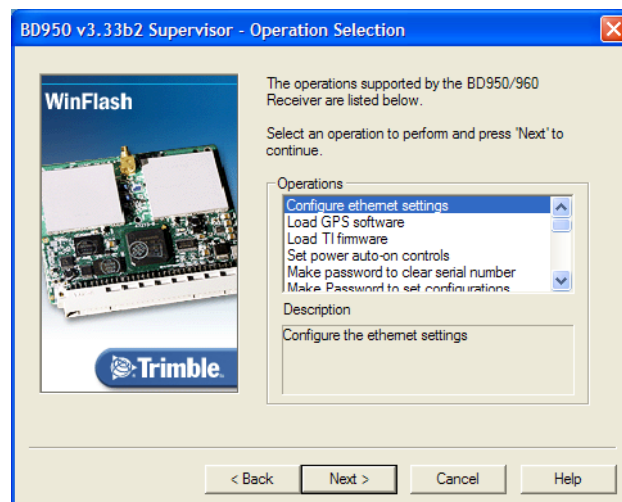
When a receiver is connected to a network using DHCP, the network assigns an IP address to the receiver. To verify the IP address of the receiver, use the WinFlash utility as follows:

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.

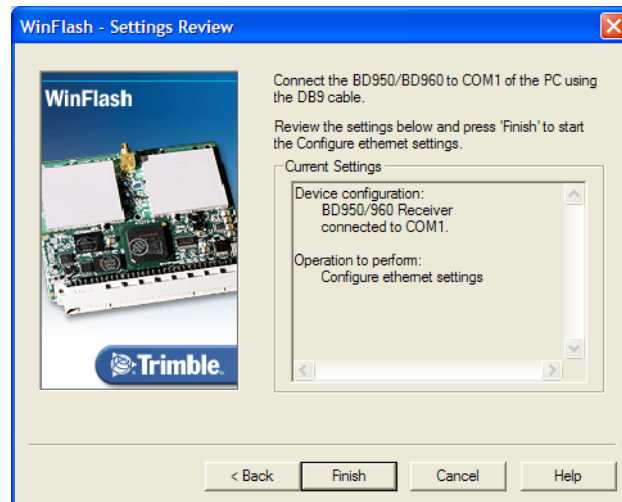
4. From the *Device Configuration* screen, select *BD950/960/BD970/BD982 receiver*. From the *PC serial port* list, select the appropriate PC serial port. Click **Next**:



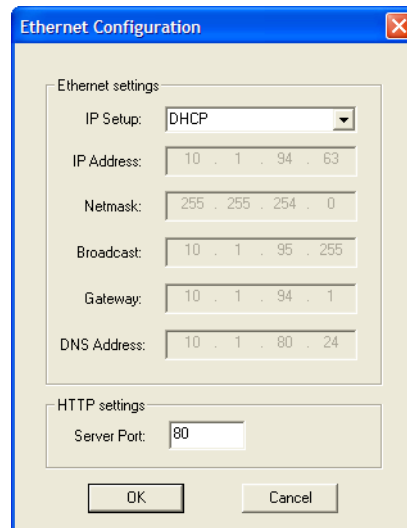
5. From the *Operation Selection* screen, select *Configure ethernet settings* and then click **Next**:



6. From the *Settings Review* screen, click **Finish**:



Note the IP Address displayed 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.

Configuring the receiver using a web browser

This section describes how to set up the receiver using a web browser.

Supported browsers

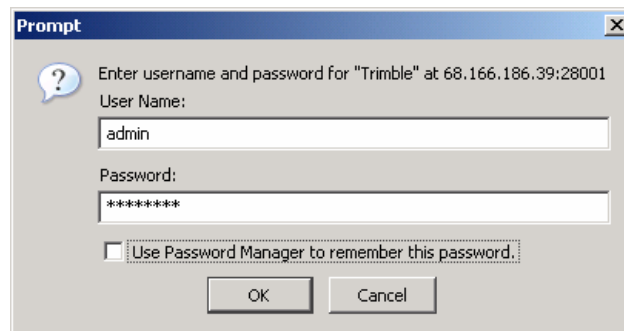
- Mozilla Firefox, version 3.5 or later
- Internet Explorer, version 7.00 or later for Windows operating systems
- Safari 4.0
- Opera 9
- Google Chrome

To connect to the receiver using a web browser:

1. Enter the IP address of the receiver into the address bar of the web browser as shown:



2. If security is enabled on the receiver, the web browser prompts you to enter a username and password:

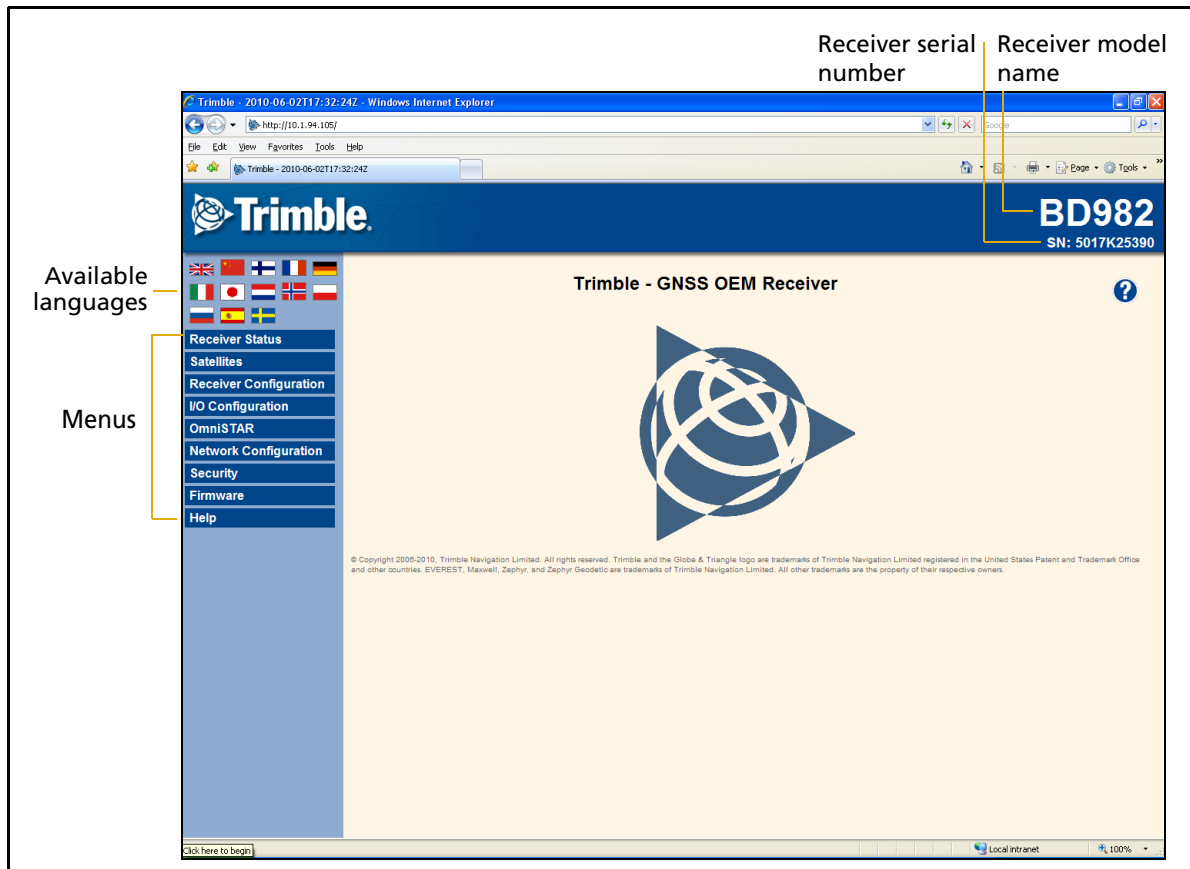


The default login values for the receiver are:

- User Name: admin
- Password: password

If you cannot connect to the receiver, the password for the admin account may have been changed, or a different account may currently be in use. Contact your receiver administrator for the appropriate login information.

Once you are logged in, the welcome web page appears:



Changing the settings

Use the webpage to configure the receiver settings. 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 to monitor receiver performance.

Note – The configuration menus available vary based on the version of the receiver.

A summary of each configuration menu is provided here. For more detailed information about each of the receiver settings, select the *Help* menu. The Help is available whenever your computer is connected to the Internet. It is also available at any time from the Trimble website (www.trimble.com/OEM_ReceiverHelp/V3.60/en/).

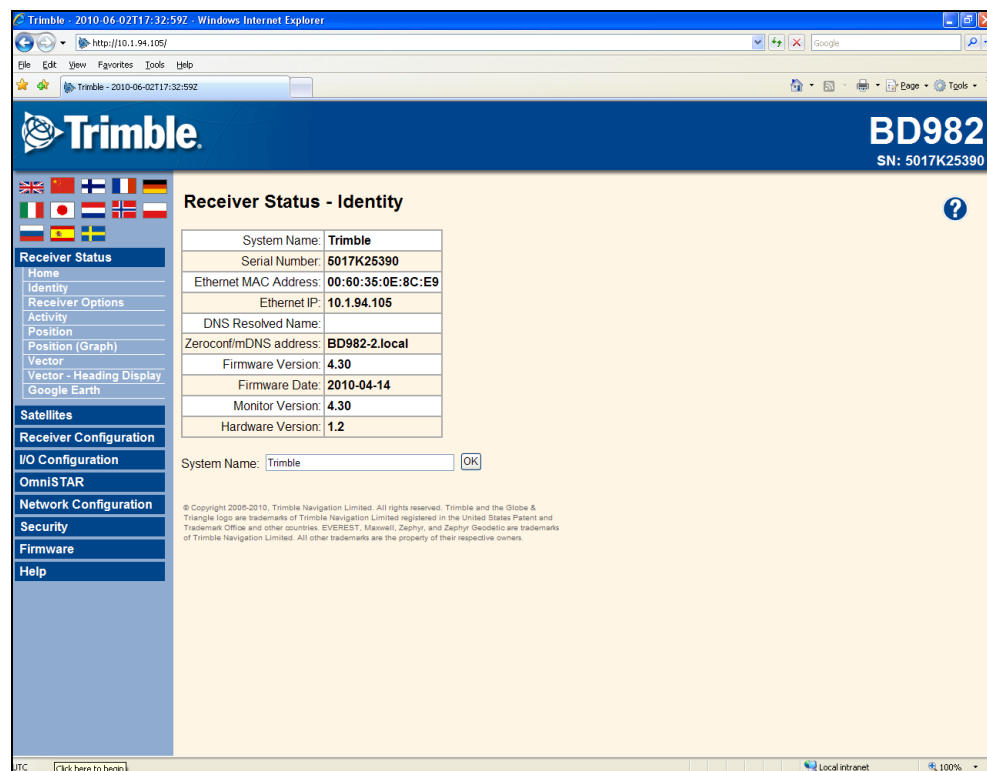
To display the web interface in another language, click the corresponding country flag. The web interface is available in the following languages:

- English (en)
- Chinese (zh)
- Finnish (fi)
- French (fr)
- German (de)
- Italian (it)
- Japanese (ja)
- Russian (ru)
- Spanish (es)
- Swedish (sv)

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.

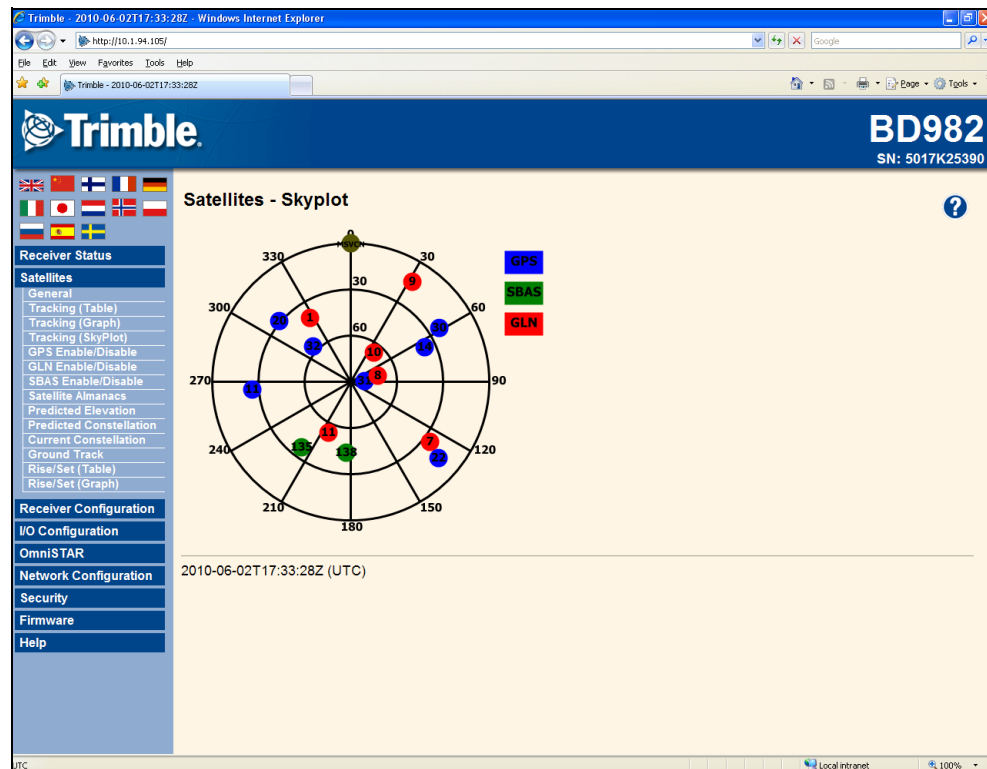
This figure shows an example of the screen that appears when you select *Receiver Status / Identity*:



Satellites menu

Use the *Satellites* menu to view satellite tracking details and enable/disable GPS, GLONASS, and SBAS (WAAS/EGNOS and MSAS) satellites.

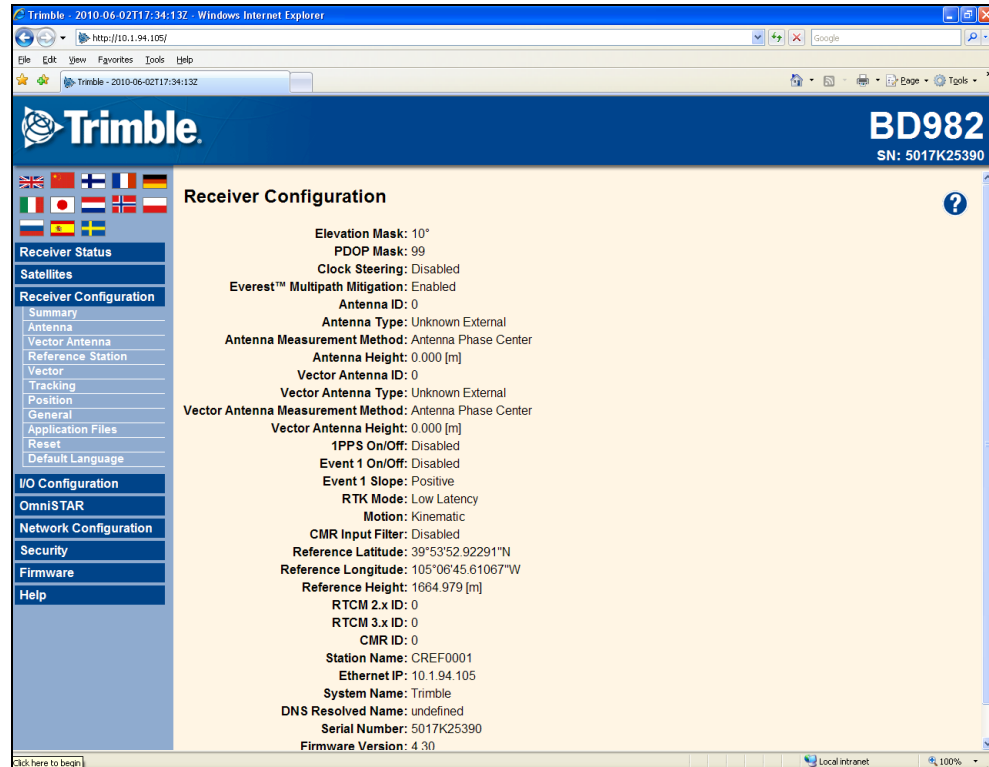
This figure shows an example of the screen that appears when you select *Satellite / Tracking (Sky Plot)*:



Receiver Configuration menu

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

This figure shows an example of the screen that appears when you select *Receiver Configuration / Summary*:



I/O Configuration menu

Use the *I/O Configuration* menu to set up all outputs of the receiver. The receiver can output CMR, RTCM, NMEA, GSOF, RT17, or BINEX messages. These messages can be output on TCP/IP, UDP, or serial ports.

This figure shows an example of the screen that appears when you select *I/O Configuration / Port Summary*:

The screenshot shows the Trimble BD982 web interface in a Windows Internet Explorer browser. The address bar shows the URL <http://10.1.94.105/>. The page title is "Trimble - 2010-06-02T17:35:28Z". The main header displays the Trimble logo and the device model "BD982" with serial number "SN: 5017K25390".

The left sidebar contains a list of navigation links: Receiver Status, Satellites, Receiver Configuration, I/O Configuration (selected), Port Summary, Port Configuration, OmniSTAR, Network Configuration, Security, Firmware, and Help. The I/O Configuration link is highlighted.

The main content area is titled "I/O Configuration" and displays a table of I/O configurations. The table has four columns: Type, Port, Input, and Output. The table is divided into two sections: TCP/IP and NTRIP Client/Server, and Serial/USB.

Type	Port	Input	Output
TCP/IP	10.1.94.73:5018	CMR	-
TCP/IP	5018	-	-
TCP/IP	28001	-	-
TCP/IP	28002	-	-
NTRIP Client	-	-	-
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	-	-	-

The status bar at the bottom shows "UTC" and "Local Intranet" with a zoom level of "100%".

OmniSTAR menu

The receiver can receive OmniSTAR corrections. By default, OmniSTAR tracking is turned on. The receiver must have a valid OmniSTAR subscription. To purchase a subscription for your receiver, contact OmniSTAR at:

www.OmniSTAR.com

North & South America: +1-888-883-8476 or +1-713-785-5850

Europe & Northern Africa, India, Pakistan: +31-70-317-0900

Australia & Asia: +61-8-9322 5295

Southern Africa: +27 21 552 0535

To receive an OmniSTAR activation, the receiver must be switched on, have a clear view to the south, and should be tracking an OmniSTAR satellite. This figure shows an example of the screen that appears when you select *OmniSTAR / Status*:

Trimble **BD982**
SN: 5017K25390

OmniSTAR Status

Receiver Status
Satellites
Receiver Configuration
I/O Configuration
OmniSTAR
Summary
Configuration
Subscription
OmniSTAR Status
Network Configuration
Security
Firmware
Help

OmniSTAR Configuration:
External Data Mode: Auto
Internal Data Mode: Auto
Internal HP/XP Link ID: 110
Internal HP/XP Link Name: Auto
Internal VBS Link ID: 110
Internal VBS Link Name: Auto
Custom Frequency [MHz]: 1551.4890
Custom Bit Rate [Hz]: 1200

HP/XP Library Status:
Internal Library: Not Active
Engine: ---
Subscription Starts At: 1980-01-06
Subscription Expires At: 2010-03-19 [Expired]
Subscribed Engine: HP
Horizontal Precision [m]: 0.30
Vertical Precision [m]: 0.30
Receiver Motion: Kinematic
OmniSTAR Motion: Kinematic
Seed with Last Known Pos: No
Seed with Fixed RTK Pos: No
Seed Quality: Unknown

VBS Library Status:
Internal Library: Not Active
Subscription Starts At: 1980-01-06
Subscription Expires At: 2008-10-04 [Expired]

L-Band Beam Status:
Signal Source: Demodulator
Tracking Mode: Full Tracking
Satellite Link ID: 24
Satellite Link Name: MSVCN
Frequency [MHz]: 1557.8350
Bit Rate [Hz]: 1200
Eb/No [dB]: 5.4
C/No [dBHz]: 39.2

Datum Offset:
Latitude [Deg.]: 0° 0' 0.00000" N
Longitude [Deg.]: 0° 0' 0.00000" E
Height [m]: 0.000
Sigma-E [m]: 0.000
Sigma-N [m]: 0.000
Sigma-U [m]: 0.000

NMEA Encryption:
Mode: Disabled

Last Known Position:
Latitude [Deg.]: 0° 0' 0.00000" N
Longitude [Deg.]: 0° 0' 0.00000" E
Height [m]: 0.000
Sigma-E [m]: 0.000
Sigma-N [m]: 0.000
Sigma-U [m]: 0.000

Note: If the library has no subscription, activating it will have no effect.

2010-06-02T17:44:31Z (UTC)

Network Configuration menu

Use the *Network Configuration* menu to configure Ethernet settings, email alerts, PPP connection, HTTP port, FTP port, and VFD port settings of the receiver. For information on the Ethernet settings, see [Configuring Ethernet settings, page 38](#).

This figure shows an example of the screen that appears when you select *Network Configuration / Ethernet*:

The screenshot shows the Trimble BD982 web interface in Internet Explorer. The browser address bar shows <http://10.1.94.105/>. The page title is "Trimble - 2010-06-02T17:45:39Z". The interface has a blue header with the Trimble logo and "BD982 SN: 5017K25390". A left sidebar contains a menu with options: Receiver Status, Satellites, Receiver Configuration, I/O Configuration, OmniSTAR, Network Configuration (selected), Summary, Ethernet, PPP, Routing Table, E-Mail Client, E-Mail Alerts, HTTP, Proxy, NTP, DDNS Client, Zeroconf/UPnP, Security, Firmware, and Help. The main content area is titled "Ethernet Configuration" and contains two sections: "Stored settings" and "Current settings".

Stored settings

IP Setup: DHCP

IP Address: 10.1.94.105

Netmask: 255.255.254.0

Broadcast: 10.1.95.255

Gateway: 10.1.94.1

Force DNS Address: ☐

DNS Address: 10.1.80.24

DNS Domain: am.trimblecorp.net

Hostname: BD982

MTU: 1500

Current settings

IP Setup: DHCP

IP Address: 10.1.94.105

Netmask: 255.255.254.0

Broadcast: 10.1.95.255

Gateway: 10.1.94.1

Force DNS Address: No

DNS Address: 10.1.80.24

DNS Domain: am.trimblecorp.net

Hostname: BD982

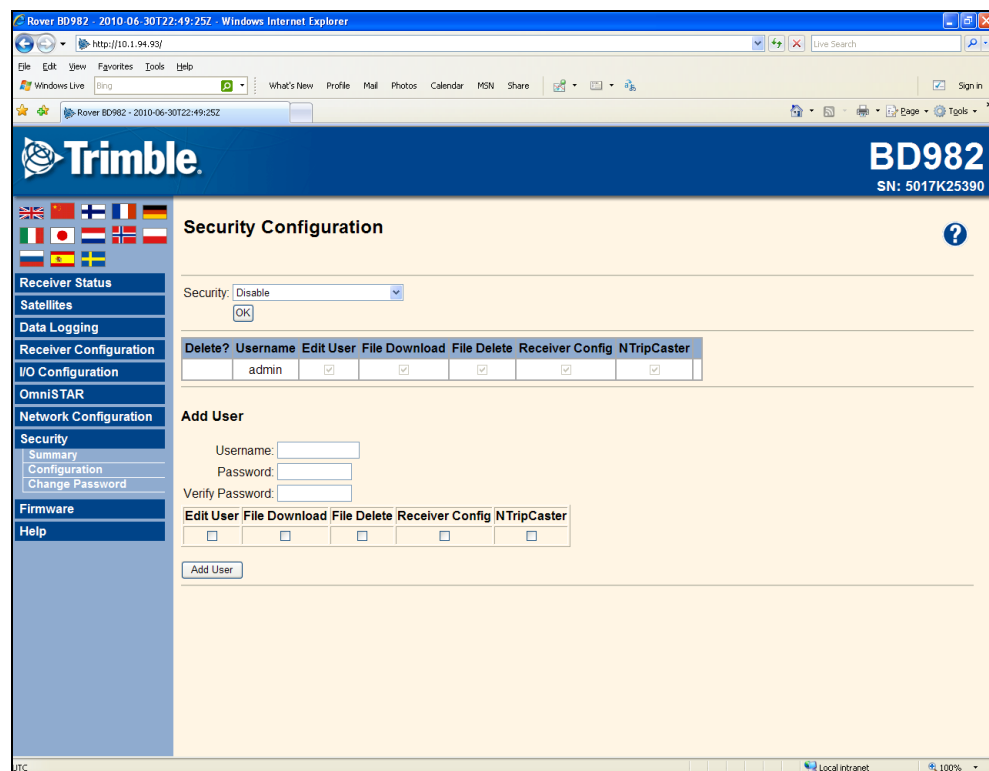
MTU: 1500

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.

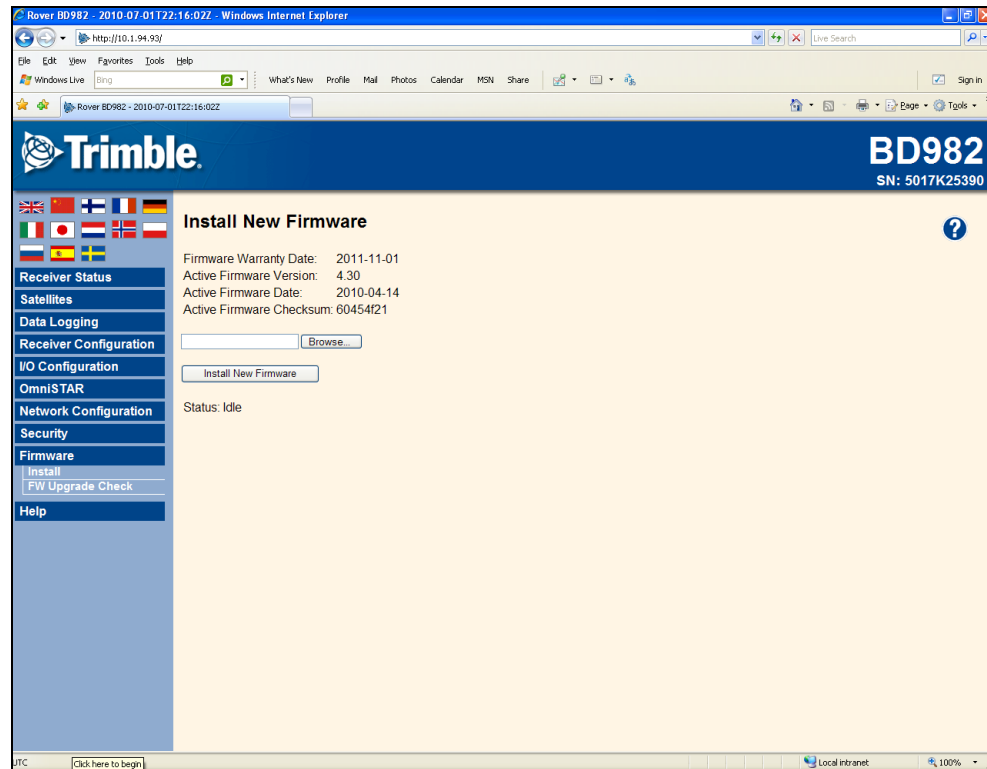
This figure shows an example of the screen that appears when you select *Security / Configuration*:



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.

This figure shows an example of the screen that appears when you select *Firmware*:



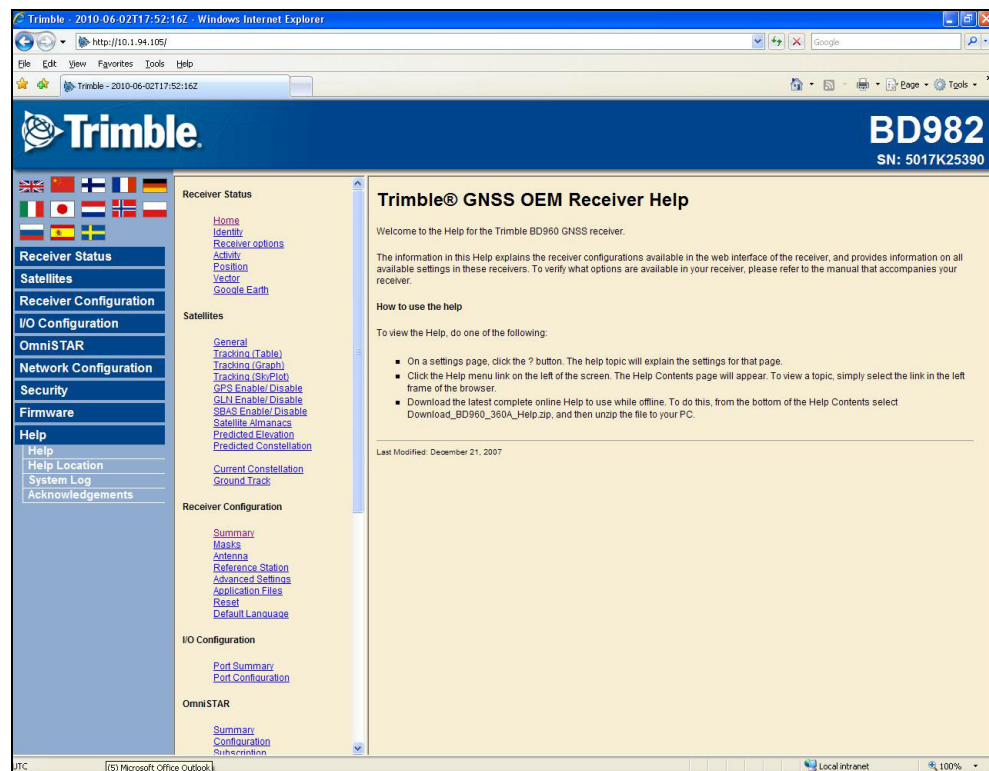
Help menu

The *Help* menu provides information on each of the receiver settings available in a web browser. Selecting the *Help* menu opens new windows. Select the section of the Help that you want to view. The Help files are stored on the Trimble Internet site (www.trimble.com/OEM_ReceiverHelp/V3.60/en/ or www.trimble.com/OEM_ReceiverHelp/V4.30/en/).

Note – For languages other than English, replace **en** with the appropriate two-letter country code, see [page 43](#)

To access the Help, the computer must be connected to the Internet.

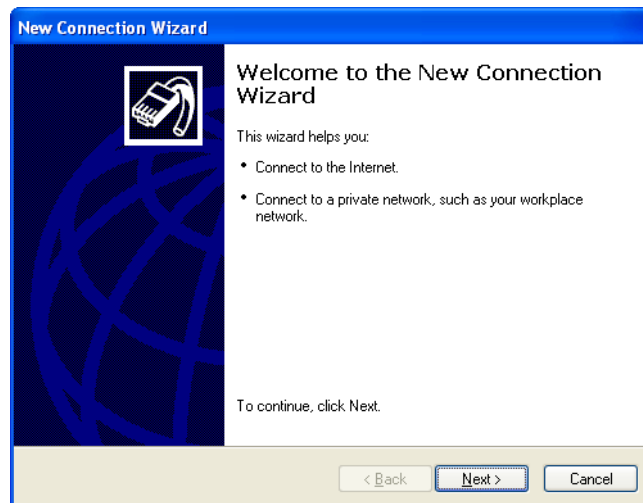
This figure shows an example of the screen that appears when you select *Help*:



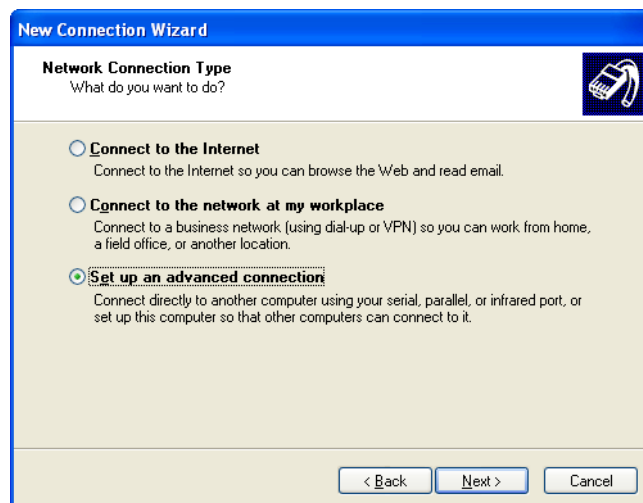
Establishing a PPP connection

This section describes how to establish a PPP connection between a Trimble receiver (the server) and a computer (the client) that is running the Windows XP operating system.

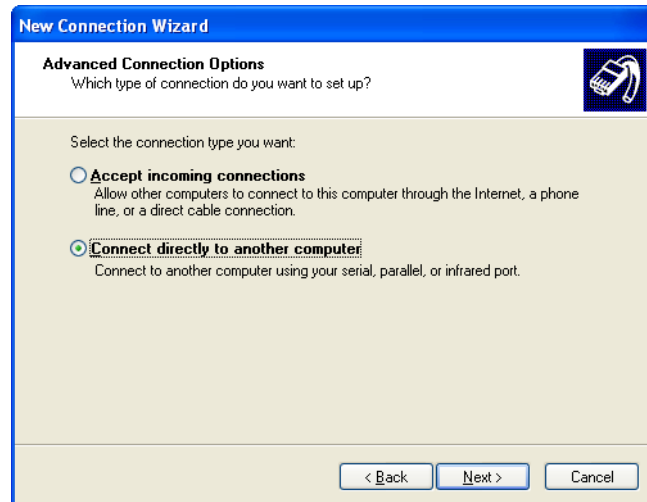
1. On the computer, click *Start / Control Panel / Network Connections*.
2. Click *Create a new connection*:



3. Click **Next**:



4. Select *Set up an advanced connection*. Click **Next**:



5. Select *Connect directly to another computer*. Click **Next**:

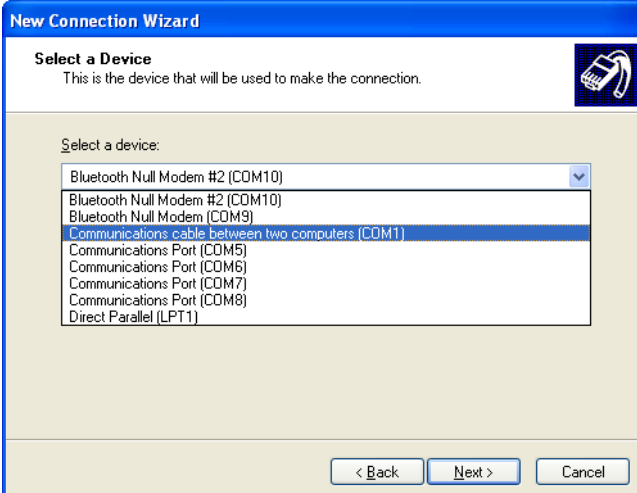


6. Select *Guest*. Click **Next**:



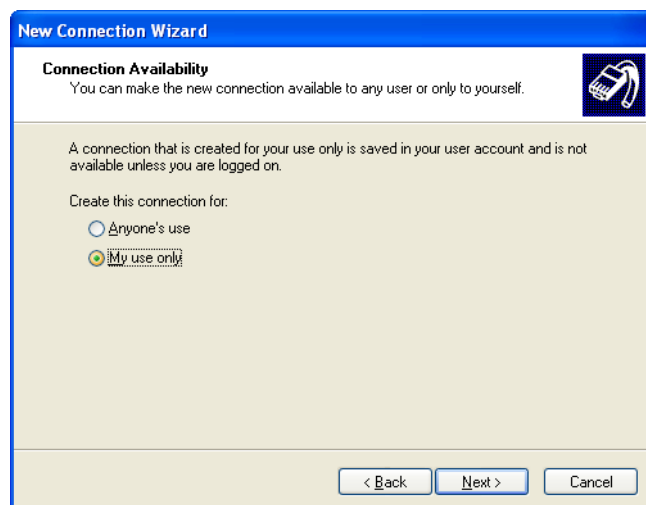
The screenshot shows the 'New Connection Wizard' window with the 'Connection Name' step. The title bar is blue with the text 'New Connection Wizard'. Below the title bar, the section 'Connection Name' is highlighted. The text 'What is the name of the other computer you are connecting to?' is displayed. A small icon of a mobile phone is in the top right corner. The main area has a light beige background with the instruction 'Type the name of the other computer in the following box.' followed by 'Computer Name'. A text input field contains 'PPP to Trimble Receiver'. Below the field, it says 'The name you type here will be the name of the connection you are creating.' At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'.

7. Enter a meaningful name such as **PPP to Trimble Receiver**. Click **Next**:



The screenshot shows the 'New Connection Wizard' window with the 'Select a Device' step. The title bar is blue with the text 'New Connection Wizard'. Below the title bar, the section 'Select a Device' is highlighted. The text 'This is the device that will be used to make the connection.' is displayed. A small icon of a mobile phone is in the top right corner. The main area has a light beige background with the instruction 'Select a device:'. Below this is a list box containing several options: 'Bluetooth Null Modem #2 (COM10)', 'Bluetooth Null Modem #2 (COM10)', 'Bluetooth Null Modem (COM9)', 'Communications cable between two computers (COM1)', 'Communications Port (COM5)', 'Communications Port (COM6)', 'Communications Port (COM7)', 'Communications Port (COM8)', and 'Direct Parallel (LPT1)'. The 'Communications cable between two computers (COM1)' option is selected and highlighted in blue. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'.

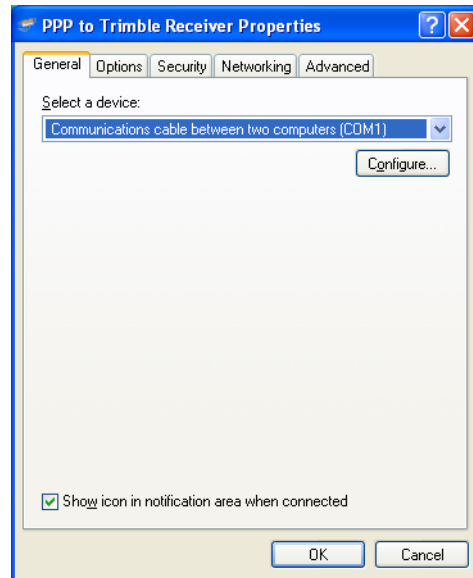
8. Select *Communications cable between two computers (COM1)*. Click **Next**:



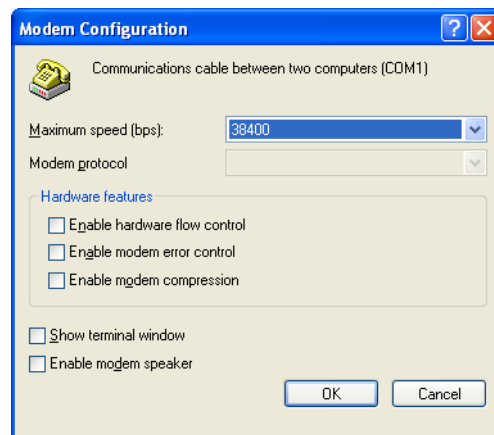
9. Select *My use only*. Click **Next**:
10. Select *Add a shortcut to this connection to my desktop*. Click **Finish**:



11. Click **Properties**:



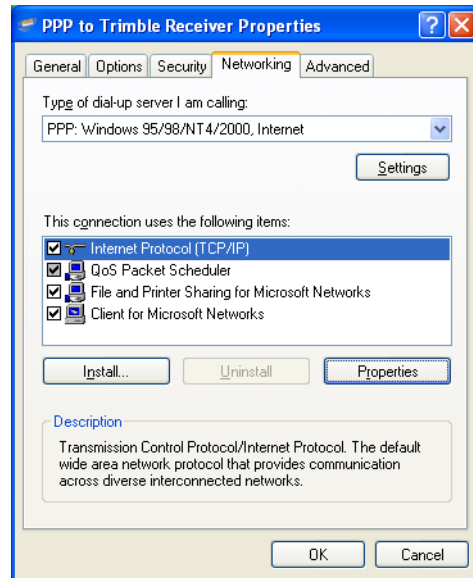
12. Click **Configure**:



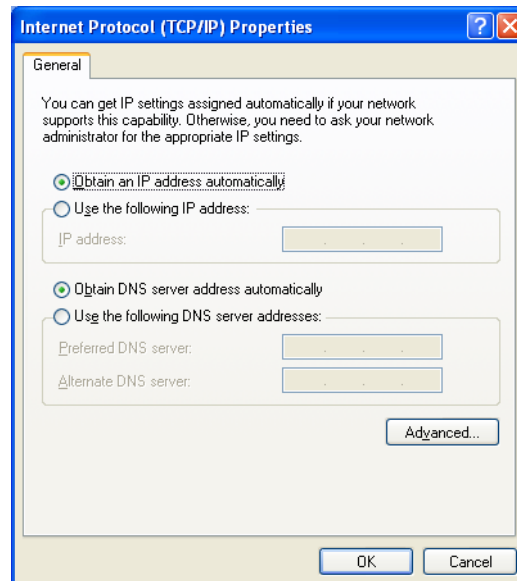
13. Make sure that the Maximum speed (bps) is 38400, and that there is no flow control enabled. Click **OK**. (Or click **Cancel** if you did not make changes.)

Note – By default, Trimble receiver serial ports have baud rate: 38400, data bits: 8, parity: none, stop bits: 1, and flow control: none. If this default was changed on the receiver, this setting should match it.

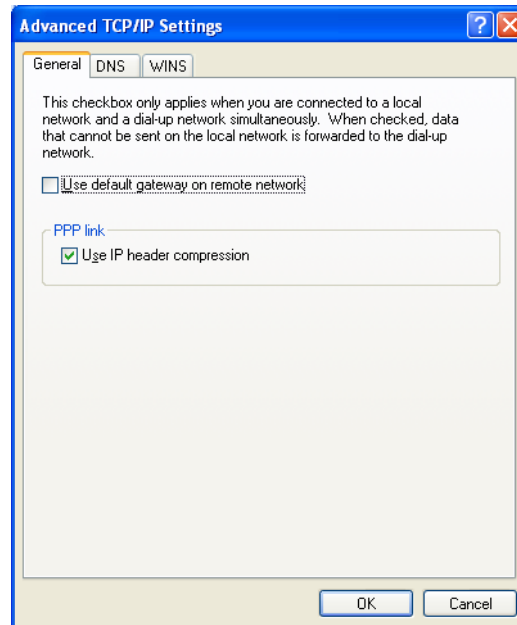
14. In the *PPP Trimble Receiver Properties* dialog, select the *Networking* tab:



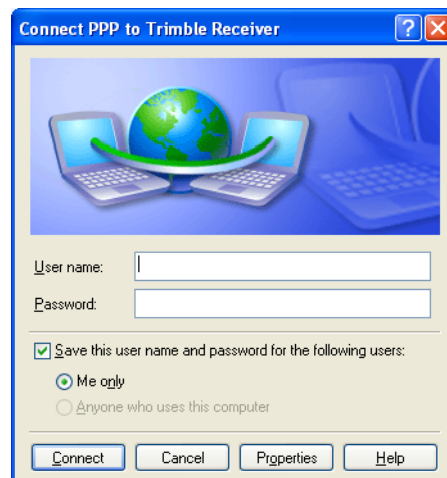
15. Select *Internet Protocol (TCP/IP)* and then click **Properties**:



16. Click **Advanced:**



17. Clear the *Use default gateway on remote network* check box. Click **OK** one or more times until the *Connect PPP to Trimble Receiver* dialog appears:



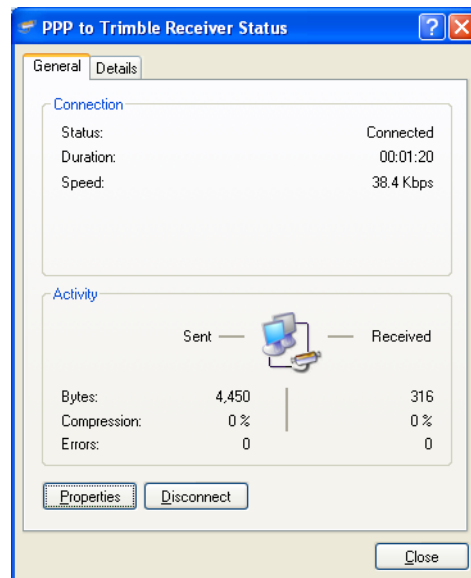
18. If the serial port has a serial cable connected to the receiver, click **Connect**. You do not need to enter a User name or Password.



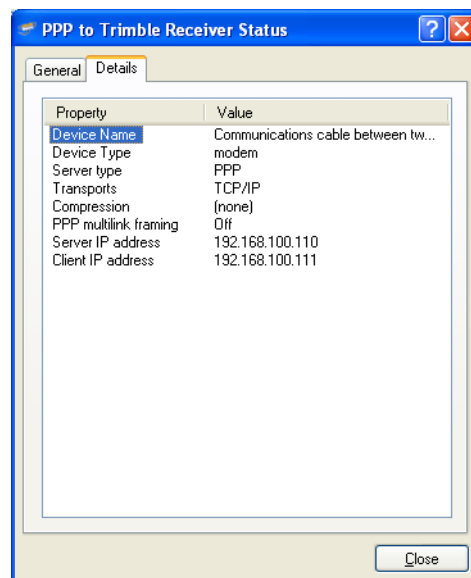
On the bottom right of the computer screen, you will see the PPP to Trimble Receiver network connection icon:



19. Right-click the icon and then select *Status*:

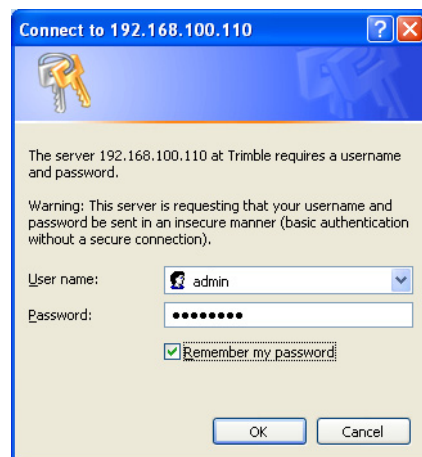


20. Select the *Details* tab:

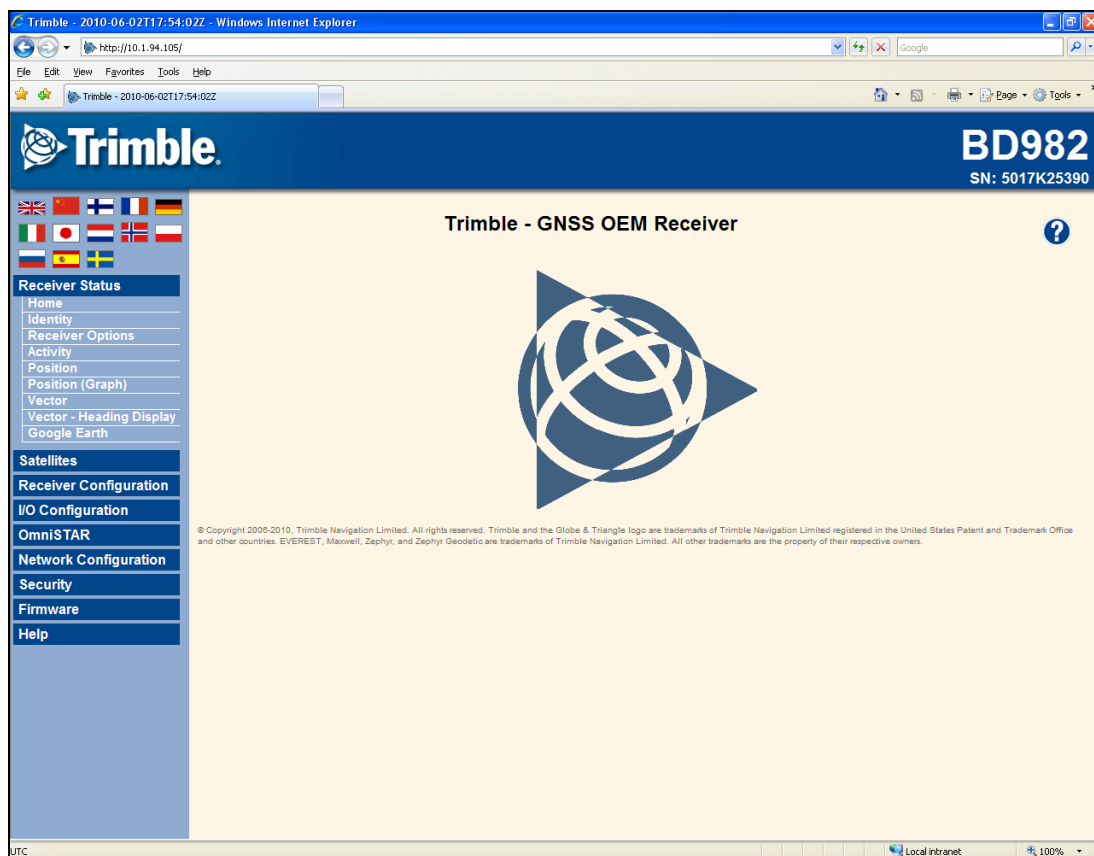


The *Server IP address* (192.168.100.110) is the address to access the receiver.

21. Open a Web browser and then enter the Server IP address in the address field:



22. If security is enabled on the board, enter the default User name: **admin** and Password: **password**. Click **OK**:



The receiver and computer are connected.

Trimble recommends that you run the receiver and the computer at 115 k baud to speed up screen views.

Resetting your username and password

1. Open the Trimble Configuration Toolbox utility.
2. From the menu, select *Communications* and then select *Reset Receiver*.
3. Select the *Erase Battery-backed RAM* and *Erase File System* check boxes.
4. Click **OK**.

The receiver will reset to the default username (admin) and password (password).

Configuring the BD982 Receiver Using Binary Interface Commands

In this chapter:

- RS-232 Serial Interface Specification
- Data Collector Format Command Packets
- Data Collector Format Report Packets

This chapter documents the Data Collector Format packets that are used to configure the receiver settings and outputs.

RS-232 Serial Interface Specification

The RS-232 Serial Interface Specification enables a remote computing device to communicate with a BD982 receiver over an RS-232 connection, using Data Collector Format packets. The RS-232 Serial Interface Specification provides command packets for configuring the BD982 receiver for operation, and report packets for retrieving position and status information from the receiver.

Data Collector Format packets are similar to the data collector format packets which evolved with the Trimble Series 4000 receivers. The set of Data Collector Format command and report packets implemented on the receiver are simplified with a more flexible method for scheduling the output of data. For a detailed explanation of the streamed data output format, see [40h, GENOUT \(General output record reports\), page 98](#).

The receiver is configured for operation using application files. Application files include fields for setting all receiver parameters and functions. The default application file for the receiver includes the factory default values. Multiple application files can be transferred to the receiver for selection with command packets. Application files for specific applications can be developed on one receiver and downloaded to a computer for transfer to other BD982 receivers.

For a general description of application files, see [To send application files to the receiver, use the Trimble Configuration Toolbox software or create the application files with a custom software program., page 74](#). For information about the structure of application files, see [64h, APPFILE \(Application file record command\), page 74](#).

Communications format

Supported data rates are: 2400, 4800, 9600, 19200, 38400, and 57600 baud and 115 kbaud. Any of these data rates *can* be used, however only 4800 baud or higher *should* be used. For example, a 20 Hz GKG string output requires the baud rate to be set to at least 19200. Only an 8-bit word format is supported, with Odd, Even, or No parity, and 1 stop bit. The default communications format for the receiver is 38400 baud, 8 data bits, no parity, and 1 stop bit.

Changes to the serial format parameter settings for all serial ports are stored in EEPROM (Electrically-Erasable Read-Only Memory) and remain in effect across power cycles until you change the parameter settings.

Testing the communications link

To determine whether the receiver can accept RS-232 commands, the protocol request ENQ (05h) is used. The response is either ACK (06h) or NAK (15h).

ENQ/ACK/NAK correspond to “Are you ready?”, “I am ready”, and “I am not ready”. This quick 1-byte test can be sent by the remote device before any other command to make sure that the RS-232 line is clear and operational.

Communication errors

The receiver normally responds to a RS-232 Serial Interface Specification command packet within 500 milliseconds. If the receiver does not respond to the request or command, the external device can send numerous \0 characters (250) to cancel any partially received message before resending the previous message.

Data Collector Format packets

Command packets are sent from the remote device to the BD982 receiver when requesting data, sending commands, or when managing application files. The BD982 receiver acknowledges every command packet sent by the remote device. It does this by sending an associated report packet or by acknowledging the transaction with an ACK (06h) or NAK (15h) from the receiver.

Note – *The return of a NAK sometimes means that the receiver cannot fulfill the request. That is, the requested command is not supported.*

Packets are processed by the receiver on a first-in, first-out (FIFO) basis. External devices can send multiple packets without waiting for a response from each packet. The external device is responsible for matching expected responses with the actual response sent by the receiver.

Each message begins with a 4-byte header, followed by the bytes of data in the packet, and 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.

Data Collector Format packet structure

Every command and report packet, regardless of its source and except for protocol sequences, has the same format as shown in [Table 7.1](#).

Table 7.1 Data Collector Format packet structure

Byte #	Message	Description
<i>Begin packet header</i>		
0	STX (02h)	Start transmission
1	STATUS	Receiver status code (see Table 7.2)
2	PACKET TYPE	Hexadecimal code assigned to the packet
3	LENGTH	Single byte # of data bytes, limits data to 255 bytes
<i>Begin packet data</i>		
4 to length	DATA BYTES	Data bytes
<i>Begin packet trailer</i>		
Length + 4	CHECKSUM	(status + type + length + data bytes) modulo 256
Length + 5	ETX (03h)	End transmission

Data Collector Format packet functions



WARNING – Virtually no range checking is performed by the receiver on the values supplied by the remote device. The remote device must adhere to the exact ranges specified within this document. **Failure to do so can result in a receiver crash and/or loss of data.**

The functions of Data Collector Format command and report packets can be divided into the following categories:

- Information requests (command packets) and replies (report packets)
- Control functions (command packets) and RS-232 acknowledgments (ACK or NAK)
- Application file management

Requests for information, such as the Command Packet 4Ah (GETOPT), can be sent at any time. The expected reply (Report Packet 4Bh, RETOPT) is always sent. Some control functions may result in an RS-232 acknowledgment of NAK (15h) if one of the following conditions exists:

- The request is not supported (invalid) by the receiver (for example, a required option may not be installed on the receiver).
- The receiver cannot process the request.

The receiver STATUS byte

The status byte contains important indicators that usually require immediate attention by the remote device. The receiver never makes a request of the remote device. Each bit of the status byte identifies a particular problem. More than one problem may be indicated by the status byte. [Table 7.2](#) lists the status byte codes.

Table 7.2 Status byte codes

Bit	Bit value	Meaning
Bit 0	1	Reserved
Bit 1	1	Low battery
Bit 2–7	0–63	Reserved

Reading binary values

The receiver stores numbers in Motorola format. The byte order of these numbers is the opposite of what personal computers expect (Intel format). 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. A detailed description of the Motorola format used to store numbers in the receiver is provided in the following sections.

INTEGER data types

The INTEGER data types (CHAR, SHORT, and LONG) can be signed or unsigned. They are unsigned by default. All integer data types use two's complement representation. Table 7.3 lists the integer data types.

Table 7.3 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 = $\langle \text{sign} \rangle 1.\langle \text{fraction field} \rangle \times 2^{(\langle \text{exponent field} \rangle - \text{bias})}$

- **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:

$$0.011 \text{ (binary)} = 2^{-2} + 2^{-3} = 0.25 + 0.125 = 0.375$$

- **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 1.18×10^{-38} to 3.4×10^{38} . The floating-point number is precise to 6 decimal digits.

31	30	23	22	0
S	Exp. + Bias	Fraction		

```

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 1.8×10^{308} . The floating-point number is precise to 15 decimal digits.

63	62	52	51	0
S	Exp. + Bias	Fraction		

```

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

```

Data Collector Format Command Packets

Data Collector Format command packets are sent from the remote device to the receiver to execute receiver commands or to request data reports. The receiver acknowledges all command packets. It does this by sending a corresponding report packet or by acknowledging the completion of an action.

The following sections provide details for each command and report packet. [Table 7.4](#) provides a summary of the command packets.

Table 7.4 Command Packet summary

ID, Command Packet	Action	Page
06h, GETSERIAL (Receiver and antenna information request)	06h, GETSERIAL (Receiver and antenna information request)	74
54h, GETSVDATA (Satellite information request)	54h, GETSVDATA (Satellite information request)	72
56h, GETRAW (Position or real-time survey data request)	56h, GETRAW (Position or real-time survey data request)	73
64h, APPFILE (Application file record command)	64h, APPFILE (Application file record command)	74
65h, GETAPPFILE (Application file request)	65h, GETAPPFILE (Application file request)	88
66h, GETAFDIR (Application file directory listing request)	66h, GETAFDIR (Application file directory listing request)	89
68h, DELAPPFILE (Delete application file data command)	68h, DELAPPFILE (Delete application file data command)	90
6Dh, ACTAPPFILE (Activate application file)	6Dh, ACTAPPFILE (Activate application file)	91
81h, KEYSIM (Key simulator)	81h, KEYSIM (Key simulator)	92
82h, SCR_DUMP (Screen dump request)	82h, SCR_DUMP (Screen dump request)	94

06h, GETSERIAL (Receiver and antenna information request)

Command Packet 06h requests receiver and antenna information. The receiver responds by sending the data in the Report Packet 07h:

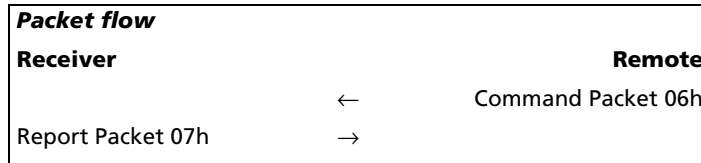


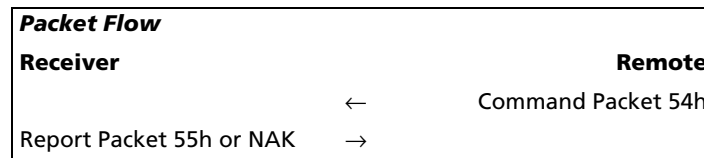
Table 7.5 describes the packet structure.

Table 7.5 Command packet 06h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	06h	Command Packet 06h
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
5	ETX	CHAR	03h	End transmission

54h, GETSVDATA (Satellite information request)

Command Packet 54h requests satellite information. The request may be for an array of flags showing the availability of satellite information such as an ephemeris or almanac. In addition, satellites may be enabled or disabled with this command packet. Table 7.6 shows the packet structure. For additional information, see [Data Collector Format packet structure](#), page 66.



Note – The normal reply to Command Packet 54h is usually Report Packet 55h. However, a NAK is returned if the SV PRN is out of range (except for SV FLAGS), if the DATA SWITCH parameter is out of range, or if the requested data is not available for the designated SV.

Table 7.6 Command packet 54h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	00h	Receiver status code
2	PACKET TYPE	CHAR	54h	Command Packet 54h
3	LENGTH	CHAR	03h	Data byte count
4	DATA SWITCH	CHAR	See Table 7.7, page 72	Selects type of satellite information downloaded from receiver or determines whether a satellite is enabled or disabled
5	SV PRN #	CHAR	01h–20h	Pseudorandom number (1–32) of satellite (ignored if SV Flags or ION/UTC is requested)
6	RESERVED	CHAR	00h	Reserved (set to zero)
7	CHECKSUM	CHAR	See Table 7.2, page 67	Checksum value
8	ETX	CHAR	03h	End transmission

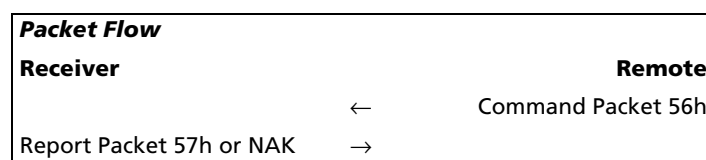
Table 7.7 DATA SWITCH byte values

Byte value		Meaning
Dec	Hex	
0	00h	SV Flags indicating Tracking, Ephemeris and Almanac, Enable/Disable state
1	01h	Ephemeris
2	02h	Almanac
3	03h	ION/UTC data
4	04h	Disable Satellite
5	05h	Enable Satellite

The Enable and Disable Satellite data switch values always result in the transmission of a RETSVDATA message as if the SV Flags are being requested.

56h, GETRAW (Position or real-time survey data request)

Command Packet 56h requests raw satellite data in *.DAT Record 17 format or Concise format. The request may specify if Real-Time attribute information is required. The receiver responds by sending the data in Report Packet 57h. Alternatively, the packet can be used to request receiver position information in *.DAT record 11 format. [Table 7.8](#) describes the packet structure. For additional information, see [57h, RAWDATA \(Position or real-time survey data report\)](#), page 132.



Note – The reply to this command packet is usually a Report Packet 57h. A NAK is returned if the Real-Time Survey Data Option (RT17) is not installed on the receiver.

Table 7.8 Command packet 56h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	56h	Command Packet 56h
3	LENGTH	CHAR	03h	Data byte count
4	TYPE RAW DATA	CHAR	See Table 7.9, page 73	Identifies the requested type of raw data
5	FLAGS	CHAR	See Table 7.10, page 73	Flag bits for requesting raw data
6	RESERVED	CHAR	00h	Reserved; set to zero
7–8	CHECKSUM	SHORT	See Table 7.1, page 66	Checksum value
9	(03h) ETX	CHAR	03h	End transmission

Table 7.9 TYPE RAW DATA values

Byte value		Meaning
Dec	Hex	
0	00h	Real-Time Survey Data Record (Record Type 17)
1	01h	Position Record (Record Type 11)

Table 7.10 FLAGS bit values

Bit	Meaning
0	Raw Data Format 0: Expanded *.DAT Record Type 17 format 1: Concise *.DAT Record Type 17 format
1	Enhanced Record with real-time flags and IODE information 0: Disabled – record data not enhanced 1: Enabled – record data is enhanced
2–7	Reserved (set to zero)

64h, APPFILE (Application file record command)

To send application files to the receiver, use the Trimble Configuration Toolbox software or create the application files with a custom software program.

Application files contain a collection of individual records that fully prescribe the operation of the receiver. Application files are transferred using the standard Data Collector Format packet format.

Each application file can be tailored to meet the requirements of separate and unique applications. Up to 10 application files can be stored within the receiver for activation at a later date.

The two important application files in the receiver are explained in [Table 7.11](#).

Table 7.11 Important application files and their functions

Name	Function
DEFAULT	Permanently stored application file containing the receiver's factory default settings. This application file is used when the receiver is reset to the factory default settings.
CURRENT	Holds the current settings of the receiver.

Individual records within an existing application file can be updated using the software tools included with the receiver. For example, the OUTPUT MESSAGES record in an application file can be updated without affecting the parameter settings in other application file records.

Application files can be started immediately and/or the files can be stored for later use.

Once applications files are transferred into memory, command packets can be used to manage the files. Command packets are available for transferring, selecting, and deleting application files.

If any part of the application record data is invalid, then the receiver ignores the entire record. The receiver reads a record using the embedded length. Any extraneous data is ignored. This allows for backward compatibility when the record length is increased to add new functions.

If you are concerned about application files producing the same results on future receivers, make sure that the application records do not contain extraneous data.

Command Packet 64h is sent to create, replace, or report on an application file. The command packet requests the application file by System File Index.

Packet Flow		
Receiver		Remote
	←	Command Packet 64h
ACK	→	

For detailed information about BD982 Application Files and for guidelines about using application files to control remote devices, see Report Packet [64h, APPFILE \(Application file record report\)](#), page 141.

Packet paging

Since an application file contains a maximum of 2048 bytes (all records are optional) of data and exceeds the byte limit for RS-232 Serial Interface Specification packets, Command Packet 64h is divided into several subpackets called pages. The PAGE INDEX byte (byte 5) identifies the packet page number and the MAXIMUM PAGE INDEX byte (byte 6) indicates the maximum number of pages in the report.

The first and subsequent pages are filled with a maximum of 248 bytes consisting of 3 bytes of page information and 245 bytes of application file data. The application file data is split wherever the 245 byte boundary falls. Therefore the remote device sending the Command Packet pages must construct the application file using the 248 byte pages before sending the file to the receiver.

To prevent data mismatches, each report packet is assigned a Transmission Block Identifier (byte 4) which gives the report pages a unique identity in the data stream. The software on the remote device can identify the pages associated with the report and reassemble the application file using bytes 4–6.

Table 7.12 shows the structure of the report packet containing the application file.

Table 7.12 Command packet 64h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	00h	Receiver status code.
2	PACKET TYPE	CHAR	64h	Command Packet 64h.
3	LENGTH	CHAR	00h	Data byte count.
4	TX BLOCK IDENTIFIER	CHAR	00h–FFh	A Transmission Block Identifier, ranging between 0–255, that must remain the same for all pages of an application file transfer.
5	PAGE INDEX	CHAR	00h–FFh	Index number (0–255) assigned to the current page.
6	MAXIMUM PAGE INDEX	CHAR	00h–FFh	Index number (0–255) assigned to the last page of the packet.
FILE CONTROL INFORMATION BLOCK				
The FILE INFORMATION CONTROL BLOCK must be sent in the first page of the report containing the application file. The second page and consecutive pages must not include a FILE CONTROL INFORMATION BLOCK.				
7	APPLICATION FILE SPECIFICATION VERSION	CHAR	03h	Always 3 for this version of the specification.
8	DEVICE TYPE	CHAR	See Table 7.13, page 79	Unique identifier for every receiver/device type that supports the application file interface.
9	START APPLICATION FILE FLAG	CHAR	See Table 7.14, page 79	Determines whether the application file is activated immediately after records are sent to receiver.
10	FACTORY SETTINGS FLAG	CHAR	See Table 7.15, page 79	Determines whether the receiver is reset to factory default settings before activating the records in the application file.

Table 7.12 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
				Insert Appfile Records here. (See Below)
Length +4	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
Length +5	ETX	CHAR	03h	End transmission.
APPLICATION FILE RECORDS				
The records listed below (for example, FILE STORAGE RECORD, GENERAL CONTROLS RECORD) are subtypes of the FILE CONTROL INFORMATION BLOCK.				
FILE STORAGE RECORD				
The FILE STORAGE RECORD indicates the application file creation date and time and provides identification information required to store the file in memory. When included in the application file, this record must be the first record within the file.				
0	RECORD TYPE	CHAR	00h	File Storage Record.
1	RECORD LENGTH	CHAR	0Dh	Number of bytes in record, excluding bytes 0 and 1.
2–9	APPLICATION FILE NAME	CHARs	ASCII text A...Z, a...z, _ (underscore)	Eight-character name for the application file.
10	YEAR OF CREATION	CHAR	00h–FFh	Year when application file is created, ranging from 00–255 (1900 = 00).
11	MONTH OF CREATION	CHAR	01h–0Ch	Month when application file is created (01–12).
12	DAY OF CREATION	CHAR	00h–1Fh	Day of the month when application file is created (00–31).
13	HOUR OF CREATION	CHAR	00h–17h	Hour of the day when application file is created (00–23).
14	MINUTES OF CREATION	CHAR	00h–3Bh	Minutes of the hour when application file is created (00–59).
GENERAL CONTROLS RECORD				
The GENERAL CONTROLS RECORD sets general GPS operating parameters for the receiver, including the elevation mask, measurement rate, PDOP (Position Dilution of Precision) mask, and the positioning mode.				
0	RECORD TYPE	CHAR	01h	General controls record.
1	RECORD LENGTH	CHAR	08h	Number of bytes in record, excluding bytes 0 and 1.
2	ELEVATION MASK	CHAR	00h–5Ah	Elevation mask in degrees (0–90).
3	MEASUREMENT RATE	CHAR	See Table 7.16, page 80	Frequency rate at which the receiver generates measurements.
4	PDOP MASK	CHAR	00h–FFh	Position Dilution of Precision mask (0–255).
5	RESERVED	CHAR	00h	Reserved (set to zero).
6	RESERVED	CHAR	00h	Reserved (set to zero).
7	RTK POSITIONING MODE	CHAR	See Table 7.20, page 81	Sets the RTK positioning mode.
8	POSITIONING SOLUTION SELECTION	CHAR	See Table 7.17, page 80	Controls use of DGPS and RTK solutions.

Table 7.12 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
9	RESERVED	CHAR	00h	Reserved (set to zero).
SERIAL PORT BAUD/FORMAT RECORD				
The SERIAL PORT BAUD RATE/FORMAT RECORD is used to set the communication parameters for the serial ports. Individual serial ports are identified within the record by the SERIAL PORT INDEX number.				
0	RECORD TYPE	CHAR	02h	Serial Port Baud Rate/Format Record.
1	RECORD LENGTH	CHAR	04h	Number of bytes in the record, excluding bytes 0 and 1.
2	SERIAL PORT INDEX.	CHAR	00h–03h	The number of the serial port to configure.
3	BAUD RATE	CHAR	See Table 7.18, page 80	Data transmission rate.
4	PARITY	CHAR	See Table 7.19, page 80	Sets the parity of data transmitted through the port. The eight data bits and one stop bit are always used, regardless of the parity selection.
5	FLOW CONTROL	CHAR	See Table 7.21, page 81	Flow control.
REFERENCE (BASE) NODE RECORD				
The REFERENCE NODE RECORD is an optional record for providing LLA (Latitude, Longitude, Altitude) coordinates for base station nodes.				
0	RECORD TYPE	CHAR	03h	Reference Node Record.
1	RECORD LENGTH	CHAR	25h	Data bytes in the record, excluding bytes 0 and 1.
2	FLAG	CHAR	00h	Reserved (set to zero).
3	NODE INDEX	CHAR	00h	Reserved (set to zero).
4–11	NAME	CHAR	ASCII text	Eight-character reference node description.
12–19	REFERENCE LATITUDE	DOUBLE	radians	Latitude of reference node, $\pm\pi/2$.
20–27	REFERENCE LONGITUDE	DOUBLE	radians	Longitude of reference node, $\pm\pi$.
28–35	REFERENCE ALTITUDE	DOUBLE	meters	Altitude of reference node, $-9999.999 \leq h \leq +9999.999$.
36–37	STATION ID	SHORT	0000h–03FFh	Reference Node Station ID for RTCM output.
38	RTK STATION	CHAR	00h–1Fh	Reference Station ID for RTK output.
SV ENABLE/DISABLE RECORD				
The SV ENABLE/DISABLE RECORD is used to enable or disable a selection of the 32 GPS satellites. By default, the receiver is configured to use all satellites which are in good health. This record is useful for enabling satellites which are not in good health. Once enabled, the health condition of the satellite(s) is ignored, and the GPS signal transmissions from the satellite(s) are considered when computing position solutions.				
0	RECORD TYPE	CHAR	06h	SV Enable/Disable Record.
1	RECORD LENGTH	CHAR	20h	Number of bytes in record, excluding bytes 0 and 1.
2–33	SV ENABLE/DISABLE STATES	CHARs	See Table 7.22, page 81	Array of Enable/Disable flags for the 32 SVs. The first byte sets the required Enable/Disable status of SV1, the second sets the status of SV2, etc.

Table 7.12 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
OUTPUT MESSAGE RECORD				
The OUTPUT MESSAGE RECORD selects the outputs for a specified serial port, the frequency of message transmissions, the integer second offset from the scheduled output rate, and output specific flags. Bytes 0 through 5 are included in all records, regardless of the output message type. The remaining bytes in the record (byte 6...) are dependent on the output message type.				
0	RECORD TYPE	CHAR	07h	Output Message Record.
1	RECORD LENGTH	CHAR	04h, 05h or 06h	Number of bytes in the record, excluding bytes 0 and 1. The number of bytes is dependent on the number of output specific flags.
2	OUTPUT MESSAGE TYPE	CHAR	See Table 7.23, page 81	Type of message or packet.
3	PORT INDEX	CHAR	00h–03h	Serial port index number.
4	FREQUENCY	CHAR	See Table 7.24, page 83	Frequency of message transmissions.
5	OFFSET	CHAR	00h–FFh	Integer second offset (0–255 seconds) from scheduled output rate. (Only valid when frequency is < 1 Hz or >1 second.)
Note – The remaining bytes depend on the output message type (Byte 2). One or two flag bytes can be sent, but two are always stored in the receiver.				
OUTPUT MESSAGE RECORD TYPE 10 (GSOF)				
6	GSOF SUBMESSAGE TYPE	CHARs	See Table 7.32, page 87	GSOF message number.
7	OFFSET	CHAR	0–255	Integer second offset from scheduled frequency.
OUTPUT MESSAGE RECORD TYPE 2 (RTK-CMR)				
6	CMR MESSAGE TYPE FLAGS	CHAR	See Table 7.25, page 83	CMR message types.
OUTPUT MESSAGE RECORD TYPE 3 (RTCM)				
6	RTCM FLAGS	CHAR	See Table 7.27, page 84	Bit settings for RTCM output flags.
OUTPUT MESSAGE RECORD TYPE 4 (RT17)				
6	REAL-TIME 17 MESSAGE FLAGS	CHAR	See Table 7.26, page 84	RT17 (Real Time 17) flags.
ANTENNA RECORD				
The ANTENNA RECORD identifies the Antenna Type and the true vertical height of antenna above the ground mark.				
0	RECORD TYPE	CHAR	08h	Reference Node record.
1	RECORD LENGTH	CHAR	0Ch	Number of bytes in record, excluding bytes 0 and 1.
2–9	ANTENNA HEIGHT	DOUBLE	meters	Vertical height of antenna, in meters.
10–11	ANTENNA TYPE	SHORT	See Table 7.28, page 85	Defines the type of antenna connected to the receiver.
12	RESERVED	CHAR	00h	Reserved (set to zero).
13	RESERVED	CHAR	00h	Reserved (set to zero).

Table 7.12 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
DEVICE CONTROL RECORD				
The DEVICE CONTROL RECORD contains configuration parameters for controlling some external devices and the operation of some receiver options. The number of bytes contained in the record and the length of the record are determined by the DEVICE TYPE entry. The table subheadings identify different devices				
0	RECORD TYPE	CHAR	09h	Device Control record.
1	RECORD LENGTH	CHAR	02h or 0Dh	Number of bytes in record, excluding bytes 0 and 1.
2	DEVICE TYPE	CHAR	See Table 7.29, page 86	Type of device.
For 1 PPS Output Only				
3	1 PPS CONTROL	CHAR	See Table 7.30, page 86	Enables or disables 1 PPS output; byte 2 is set to 2.
STATIC/KINEMATIC RECORD				
The bytes value in the STATIC/KINEMATIC RECORD determine whether the receiver is operating in Static or Kinematic mode.				
0	RECORD TYPE	CHAR	0Ah	Static/Kinematic record.
1	RECORD LENGTH	CHAR	01h	Number of bytes in record, excluding bytes 0 and 1.
2	STATIC/KINEMATIC MODE	CHAR	See Table 7.31, page 86	Configures receiver for static or kinematic operation.

Table 7.13 DEVICE TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	All Devices
2–5	02h–05h	Reserved
66	42h	BD982 receiver

Table 7.14 START APPLICATION FILE FLAG byte values

Byte value		Meaning
Dec	Hex	
0	00h	Do not apply the application file parameter settings to the active set of parameters when the transfer is complete.
1	01h	Apply application file records immediately.

Table 7.15 FACTORY SETTINGS byte values

Byte value		Meaning
Dec	Hex	
0	00h	Alter receiver parameters only as specified in the application file. Leave unspecified settings alone.
1	01h	Set all controls to factory settings prior to applying the application file.

Table 7.16 MEASUREMENT RATE byte values

Byte value		Meaning
Dec	Hex	
0	00h	1 Hz
1	01h	5 Hz
2	02h	10 Hz

Table 7.17 POSTIONING SOLUTION SELECTION values

Byte value		Meaning
Dec	Hex	
0	00	Use best available solution.
1	01	Produce DGPS and Autonomous solutions.
2	02	Produce DGPS, RTK Float, and Autonomous solutions. On-the-fly RTK initialization is disabled, therefore no RTK Fix solutions are generated.
3	03	Produce RTK Fix, DGPS, and Autonomous solutions (no RTK Float solutions).

Table 7.18 BAUD RATE byte values

Byte value		Meaning
Dec	Hex	
0	00h	9600 baud (default)
1	01h	2400 baud
2	02h	4800 baud
3	03h	9600 baud
4	04h	19.2K baud
5	05h	38.4K baud
6	06h	57.6K baud
7	07h	115.2K baud
8	08h	300 baud
9	09h	600 baud
10	0Ah	1200 baud
11	0Bh	230,000 baud
12	0Ch	460,000 baud

Table 7.19 PARITY byte values

Byte value		Meaning
Dec	Hex	
0	00h	No Parity (10-bit format)
1	01h	Odd Parity (11-bit format)
2	02h	Even Parity (11-bit format)

Table 7.20 RTK POSITIONING MODE byte values

Byte value		Meaning
Dec	Hex	
0	00h	Synchronous positioning
1	01h	Low Latency positioning

Table 7.21 FLOW CONTROL byte values

Byte value		Meaning
Dec	Hex	
0	00h	None
1	01h	CTS

Table 7.22 SV ENABLE/DISABLE STATES flag values

Byte value		Meaning
Dec	Hex	
0	00h	Heed health (default)
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

Table 7.23 OUTPUT MESSAGE TYPE byte values

Byte value	Meaning
0xFF	Turn off all outputs on all ports. Frequency must also be 'Off' for this to work.
0	Turn off all outputs on the given port only. Frequency must be 'Off' for this to work
1	Not used.
2	CMR Output
3	RTCM Output
4	RT17 Output
5	Not used.
6	NMEA_GGA
7	NMEA_GGK
8	NMEA_ZDA
9	Reserved
10	GSOF
11	1PPS
12	NMEA_VTG
13	NMEA_GST
14	NMEA_PJK
15	NMEA_PJT
16	NMEA_VGK

Table 7.23 OUTPUT MESSAGE TYPE byte values (continued)

Byte value	Meaning
17	NMEA_VHD
18	NMEA_GSV
19	NMEA_TSN
20	NMEA_TSS
21	NMEA_PRC
22	NMEA_REF
23	NMEA_GGK_SYNC
24	J1939_VehPos
25	J1939_Time
26	J1939_VehSpd
27	J1939_ImpPos
28	J1939_ImpSpd
29	NMEA_AVR
30	Reserved
31	NMEA_HDT
32	NMEA_ROT
33	NMEA_ADV
34	NMEA_PIO
35	NMEA_BETA
36	Reserved
37	NMEA_VRSGGA
38	NMEA_GSA
39	Binex
40	NMEA_RMC
41	NMEA_BPQ
42	Reserved
43	Reserved
44	NMEA_GLL
45	NMEA_GRS
46	Reserved
47	NMEA_LDG

Table 7.24 FREQUENCY byte values

Byte value		Meaning
Dec	Hex	
0	00h	Off
1	01h	10 Hz
2	02h	5 Hz
3	03h	1 Hz
4	04h	2 seconds
5	05h	5 seconds
6	06h	10 seconds
7	07h	30 seconds
8	08h	60 seconds
9	09h	5 minutes
10	0Ah	10 minutes
11	0Bh	2 Hz
12	0Ch	15 seconds
13	0Dh	20 Hz
15	0Fh	50 Hz
255	FFh	Once only, immediately

Certain message output types may not support >1 Hz output.

Table 7.25 CMR MESSAGE TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	Standard (CMR, CMR+).
1	01h	High speed CMR (5 or 10 Hz).
2	02h	Compatible with Trimble 4000 receivers.

Table 7.26 REAL-TIME 17 MESSAGE bit values

Bit	Meaning
7 (msb)	Reserved (set to zero)
6	Reserved (set to zero)
5	Reserved (set to zero)
4	Position Only 0: Disabled 1: Enabled
3	Streamed Position 0: Disabled 1: Enabled
2	Streamed Ephemeris 0: Disabled 1: Enabled
1	RT (Real-Time) Enhancements 0: Disabled 1: Enabled
0	(lsb) Compact Format 0: Disabled 1: Enabled

Table 7.27 RTCM Flag bit values

Bit	Meaning
0	Invalid value
1	Output RTK RTCM packets (Type 18 & 19)
2	Output DGPS RTCM packets (Type 1)
3	Output RTK and DGPS RTCM packets (Types 1, 18, and 19)
4	Output Type 9 Groups of 3 Bit 3 (Use RTCM version 2.2) 0: Off 1: On (Multiple message bit turned on in Types 18 and 19) Bit 4 (Use RTCM version 2.3) 0: Off 1: On (Output Types 23 & 24)
5–7	Invalid values

If Flags are invalid, the record is not applied. (However, the Appfile may be accepted.)

Table 7.28 ANTENNA TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	Unknown External
1	01h	4000ST Internal
2	02h	4000ST Kinematic Ext
3	03h	Compact Dome
4	04h	4000ST L1 Geodetic
5	05h	4000SST L1 L2 Geodetic
6	06h	4000SLD L1 L2 Square
7	07h	4000SX Helical
8	08h	4000SX Micro Square
9	09h	4000SL Micro Round
10	0Ah	4000SE Attachable
11	0Bh	4000SSE Kinematic L1 L2
12	0Ch	Compact L1 L2 with Groundplane
13	0Dh	Compact L1 L2
14	0Eh	Compact Dome with Init
15	0Fh	L1 L2 Kinematic with Init
16	10h	Compact L1 L2 with Init
17	11h	Compact L1 with Init
18	12h	Compact L1 with Groundplane
19	13h	Compact L1
20	14h	Permanent L1 L2
21	15h	4600LS Internal
22	16h	4000SLD L1 L2 Round
23	17h	Dorne Margolin Model T
24	18h	Ashtech L1 L2 Geodetic L
25	19h	Ashtech Dorne Margolin
26	1Ah	Leica SR299 External
27	1Bh	Trimble Choke Ring
28	1Ch	Dorne Margolin Model R
29	1Dh	Ashtech Geodetic L1 L2 P
30	1Eh	Integrated GPS Beacon
31	1Fh	Mobile GPS Antenna
32	20h	GeoExplorer Internal
33	21h	Topcon Turbo SII
34	22h	Compact L1 L2 with Groundplane with Dome
35	23h	Permanent L1 L2 with Dome
36	24h	Leica SR299/SR399 External Antenna
37	25h	Dorne Margolin Model B

Table 7.28 ANTENNA TYPE byte values (continued)

Byte value		Meaning
Dec	Hex	
38	26h	4800 Internal
39	27h	Micro Centered
40	28h	Micro Centered with Groundplane
47	29h	Rugged Micro Centered with 13-inch Groundplane
85	55	Zephyr (KZ)
86	56	Zephyr Geodetic™ (GZ)

Table 7.29 DEVICE TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	Reserved
1	01h	Reserved
2	02h	1 PPS (Pulse per second) output
3	03h	Reserved
4	04h	Reserved
5	05h	Reserved
6	06h	Reserved
7	07h	Reserved

Table 7.30 1 PPS CONTROL byte values

Byte value		Meaning
Dec	Hex	
0	00h	1 PPS output is off
1	01h	1 PPS output is on

Table 7.31 STATIC/KINEMATIC MODE byte values

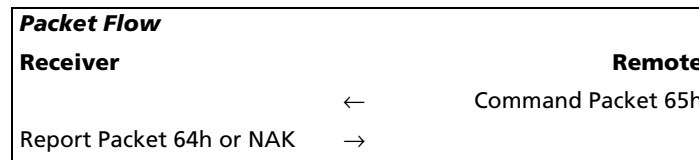
Byte value		Meaning
Dec	Hex	
0	00h	Kinematic
1	01h	Static
2-255	02h-FFh	Reserved

Table 7.32 Output message record type

Record Number	Description
1	POSITION TIME
2	LAT, LONG, HEIGHT
3	ECEF POSITION
4	LOCAL DATUM POSITION
5	LOCAL ZONE POSITION
6	ECEF DELTA
7	TANGENT PLANE DELTA
8	VELOCITY DATA
9	PDOP INFO
10	CLOCK INFO
11	POSITION VCV INFO
12	POSITION SIGMA INFO
13	SV BRIEF INFO
14	SV DETAILED INFO
15	RECEIVER SERIAL NUMBER
16	CURRENT TIME
26	POSITION TIME UTC
27	ATTITUDE INFO*+
41	BASE POSITION AND QUALITY INDICATOR
33	ALL SV BRIEF INFO
34	ALL SV DETAILED INFO
35	RECEIVED BASE INFO

65h, GETAPPFILE (Application file request)

A specific application file can be downloaded from the receiver by sending the Command Packet 65h. If the request is valid, a copy of the application file is downloaded to the remote device in Report Packet 64h.



The receiver can store multiple application files (including a default application file, containing the factory default parameter settings) in the Application File directory. Each application file is assigned a number to give the file a unique identity within the directory. The application file containing the factory default values is assigned a System File Index code of zero (0).

Table 7.33 shows the packet structure. For more information, see [64h, APPFILE \(Application file record report\)](#), page 141.

Table 7.33 Command Packet 65h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status indicator
2	PACKET TYPE	CHAR	65h	Command Packet 65h
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count
4–5	SYSTEM FILE INDEX	SHORT	0–n	Unique number (ID code) assigned to each of the application files stored in the Application File directory
6	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
7	ETX	CHAR	03h	End transmission

66h, GETAFDIR (Application file directory listing request)

Command Packet 66h is used to request a directory listing of the application files stored in receiver memory. The receiver responds by sending the directory listing in Report Packet 67h.

Packet Flow		
Receiver		Remote
	←	Command Packet 66h
Report Packet 67h	→	

Table 7.34 describes the packet structure. For more information, see [67h, RETAFDIR \(Directory listing report\)](#), page 142.

Table 7.34 Command Packet 66h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	66h	Command Packet 66h
3	LENGTH	CHAR	0h	Data byte count
4	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
5	ETX	CHAR	03h	End transmission

68h, DELAPPPFILE (Delete application file data command)

Command Packet 68h deletes the data for a specified application file. The application file is selected by specifying the System File Index assigned to the file.

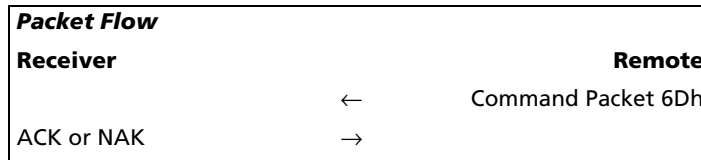


Table 7.35 Command Packet 68h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status indicator.
2	PACKET TYPE	CHAR	68h	Command Packet 68h.
3	LENGTH	CHAR	01h	Data byte count.
4–5	SYSTEM FILE INDEX	SHORT	0– <i>n</i>	Unique number assigned to each of the application files stored in the Application File directory.
6	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum.
7	ETX	CHAR	03h	End transmission.

6Dh, ACTAPPPFILE (Activate application file)

Command Packet 6Dh is used to activate one of the application files stored in the Application File directory. The application file with the specified System File Index is activated.



Each application file is assigned a System File Index. The application file containing the factory default values is assigned a System File Index of zero (0), allowing this command to be used to reset the receiver to the factory default conditions. [Table 7.36](#) describes the packet structure.

Table 7.36 Command Packet 6dh structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status indicator
2	PACKET TYPE	CHAR	6Dh	Command Packet 6Dh
3	LENGTH	CHAR	01h	Data byte count
4–5	SYSTEM FILE INDEX	SHORT	0–n	Unique number assigned to each of the application files stored in the Application File directory
6	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum
7	ETX	CHAR	03h	End transmission

81h, KEYSIM (Key simulator)

Command Packet 81h simulates any front panel key press.

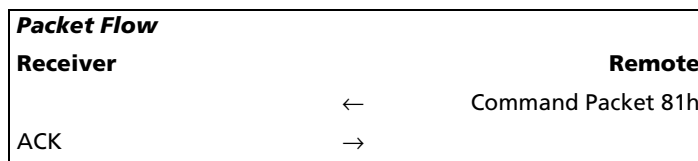


Table 7.37 Command Packet 81h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	81h	Command Packet 81h
3	LENGTH	CHAR	01h	Data byte count
4	KEY ID	CHAR	See Table 7.38, page 92	Key scan code ID
5	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum values
6	ETX	CHAR	03h	End transmission

Table 7.38 Key ID codes

Scan Code	Receiver Key	ASCII Character
7Fh	<input type="button" value="CLEAR"/>	<input type="button" value="Del"/>
0Dh	<input type="button" value="ENTER"/>	<input type="button" value="Enter"/> <carriage return>
41h	Softkey Choice 1	<A>
42h	Softkey Choice 2	
43h	Softkey Choice 3	<C>
44h	Softkey Choice 4	<D>
1Dh	<input type="button" value="←"/>	—
1Ch	<input type="button" value="→"/>	—
30h	<input type="button" value="0"/>	<0>
31h	<input type="button" value="1"/>	<1>
32h	<input type="button" value="2"/>	<2>
33h	<input type="button" value="3"/>	<3>
34h	<input type="button" value="4"/>	<4>
35h	<input type="button" value="5"/>	<5>
36h	<input type="button" value="6"/>	<6>
37h	<input type="button" value="7"/>	<7>
38h	<input type="button" value="8"/>	<8>
39h	<input type="button" value="9"/>	<9>
4Ch	<input type="button" value="STATUS"/>	<L>
4Ah	<input type="button" value="SESSION"/>	<J>
4Bh	<input type="button" value="SAT INFO"/>	<K>
4Fh	<input type="button" value="LOG DATA"/>	<O>

Table 7.38 Key ID codes (continued)

Scan Code	Receiver Key	ASCII Character
4Dh	CONTROL	<M>
50h	ALPHA	<P>
4Eh	MODIFY	<N>
1Bh	POWER	—

82h, SCRDUMP (Screen dump request)

Command Packet 82h has two forms—a command packet and report packet. Both packets are assigned the same hexadecimal code (82h).

Packet Flow		
Receiver		Remote
	←	Command Packet 82h
Report Packet 82h	→	

Command Packet 82h requests an ASCII representation of a BD982 simulated display screen. In response, Report Packet 82h sends the data used that is used to display the screen to the remote device in ASCII format.

[Table 7.39](#) shows the command packet structure. For more information, see [82h, SCRDUMP \(Screen dump\)](#), page 147.

Table 7.39 Command packet 82h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	82h	Command Packet 82h
3	LENGTH	CHAR	0h	Data bytes count
4	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
5	ETX	CHAR	03h	End transmission

Data Collector Format Report Packets

Data Collector Format report packets are usually sent in response to a command packet. The prime exception is Report Packet 40h (GSOF) which streams a selection of data reports to the remote device at intervals defined in the current application file.

Report packets are generated immediately after the request is received. The receiver always responds to requests for reports, even in cases where a report cannot be transmitted for some reason or the transmission of a report is not necessary. In these cases, the receiver sends an ACK or NAK to acknowledge the request.

Report Packet summary

The following sections provide details for each command and report packet. [Table 7.40](#) lists a summary of the report packets.

Table 7.40 Report Packet summary

ID (Hex)	Name	Function	Page
07h	07h, RSERIAL (Receiver and antenna information report)	07h, RSERIAL (Receiver and antenna information report)	96
40h	40h, GENOUT (General output record reports)	40h, GENOUT (General output record reports)	98
55h	55h, RETSVDATA (Satellite information reports)	55h, RETSVDATA (Satellite information reports)	127
57h	57h, RAWDATA (Position or real-time survey data report)	57h, RAWDATA (Position or real-time survey data report)	132
64h	64h, APPFILE (Application file record report)	64h, APPFILE (Application file record command)	141
67h	67h, RETAFDIR (Directory listing report)	67h, RETAFDIR (Directory listing report)	142
6Eh	6Eh, BREAKRET (Break sequence return)	6Eh, BREAKRET (Break sequence return)	144
82h	82h, SCRUMP (Screen dump)	82h, SCRUMP (Screen dump request)	147

07h, RSERIAL (Receiver and antenna information report)

Report Packet 07h is sent in response to the Command Packet 06h. The report returns the receiver and antenna serial number, antenna type, software processor versions, and the number of receiver channels.

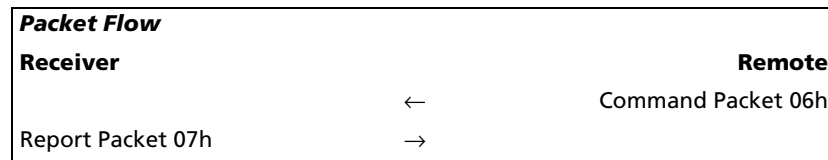


Table 7.41 describes the packet structure. For more information, see [06h, GETSERIAL \(Receiver and antenna information request\)](#), page 71.

Table 7.41 Report Packet 07h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code.
2	PACKET TYPE	CHAR	??h	Report Packet 07h.
3	LENGTH	CHAR	2Dh	Data byte count.
4–11	RECEIVER SERIAL #	CHAR	ASCII text	Receiver serial number.
12–19	RECEIVER TYPE	CHARs	"BD982"	Receiver model designation (padded with three spaces).
20–24	NAV PROCESS VERSION	CHARs	ASCII text	Version number of NAV Processor software.
25–29	SIG PROCESS VERSION	CHARs	ASCII text (00000)	Not applicable.
30–34	BOOT ROM VERSION	CHARs	ASCII text (00000)	Not applicable.
35–42	ANTENNA SERIAL #	CHARs	ASCII text (8 spaces)	Not used.
43–44	ANTENNA TYPE	CHAR	ASCII text (2 spaces)	Not used.
45–46	# CHANNELS	CHAR	12h	There are 18 receiver channels.
47–48	# CHANNELS L1	CHAR	09h	Nine (9) L1 receiver channels.
49 - 58	LONG SERIAL NUMBER	CHARValue	ASCII text (10 spaces)	This is the serial number that should be used for newer receivers like the BD982.
59 - 89	LOCAL LONG ANT SERIAL	CHAR	ASCII text (31 spaces)	Not Applicable
90 - 120	BASE LONG ANT SERIAL	CHAR	ASCII text (31 spaces)	Not Applicable
121 - 151	BASE NGS ANT DESCRIPTOR	CHAR	ASCII text (31 spaces)	Not Applicable
152-153	# USABLE CHANNELS	CHAR		Maximum usable channels with the current option set.
154-155	# PHYSICAL CHANNELS	CHAR		Number of hardware channels.

Table 7.41 Report Packet 07h structure (continued)

Byte #	Item	Type	Value	Meaning
156	# SIMULTANEOUS CHANNELS	CHAR		How many satellites can be tracked at once.
157-161	Reserved	N/A	N/A	N/A
162	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
163	ETX	CHAR	03h	End transmission.

40h, GENOUT (General output record reports)

When scheduled, Report Packet 40h is continuously output at the FREQUENCY specified by the current application file. The GENOUT report contains multiple sub-records as scheduled by the application file (subtype = 10, GSOF).

For information about controlling the record types included in Report Packet 40h, see command packet 64h Appfile.

Packet Flow	
Receiver	Connected computer
(02h) STX	→
(??h) STATUS	→
(40h) TYPE	→
(??h) LENGTH	→
1 (byte) TRANSMISSION NUMBER	→
1 (byte) PAGE INDEX	→
1 (byte) MAX PAGE INDEX	→
Various record types	
1 (byte) OUTPUT RECORD TYPE	→
1 (byte) RECORD LENGTH	→
Various fields dependant on RECORD TYPE.	→
<i>There can be multiple records in one GENOUT packet. There could be multiple GENOUT packets per epoch. Records may be split over two consecutive packets.</i>	
(??h) CHECKSUM	→
(03h) ETX	→

Where:

- TRANSMISSION NUMBER is a unique number assigned to a chapter of pages indicating that the pages are from the same group.
- PAGE INDEX is the page number of this page in a sequence (chapter) of pages and is zero based.
- MAX PAGE INDEX is the index of the last page in the chapter.
- RECORD LENGTH is the length of data in the record (excluding type and size).

Page Numbering – The Page Index and Max Page Index fields are 0-based, so for example the first transmission of a 2-page set will be 0/1 (PAGE/MAX PAGE) and the 2nd (last) page will be 1/1. The total number of pages is MAX PAGE INDEX + 1.

GSOF record types

Table 7.42 GSOF record types

Record number	Description	Page
1	POSITION TIME	100
2	LAT, LONG, HEIGHT	102
3	ECEF POSITION	103
4	LOCAL DATUM POSITION	104
5	LOCAL ZONE POSITION	105
6	ECEF DELTA	106
7	TANGENT PLANE DELTA	107
8	VELOCITY DATA	108
9	PDOP INFO	109
10	CLOCK INFO	110
11	POSITION VCV INFO	111
12	POSITION SIGMA INFO	112
13	SV BRIEF INFO	113
14	SV DETAILED INFO	114
15	RECEIVER SERIAL NUMBER	116
16	CURRENT TIME	117
26	POSITION TIME UTC	118
27	ATTITUDE INFO*+	120
33	ALL SV BRIEF INFO	122
34	ALL SV DETAILED INFO	123
35	RECEIVED BASE INFO	125
41	BASE POSITION AND QUALITY INDICATOR	126

GSOF 1: GSOF 1 (01h) POSITION TIME

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 1	→
1 (byte) RECORD LENGTH	→
4 (long) GPS TIME (ms)	→
2 (int) GPS WEEK NUMBER	→
1 (byte) NUMBER OF SVS USED	→
1 (byte) POSITION FLAGS 1	→
1 (byte) POSITION FLAGS 2	→
1 (byte) INITIALIZATION NUMBER	→

Where:

- OUTPUT RECORD TYPE = 1.
- RECORD LENGTH is the length of this sub-record.
- GPS TIME is in milliseconds of the GPS week.
- GPS WEEK NUMBER is the week count since January 1980.
- NUMBER OF SVS USED is the number of satellites used to determine the position.
- POSITION FLAGS 1 reports position attributes and is defined as follows:
 - bit 0 SET: New Position
 - bit 1 SET: Clock fix calculated this position
 - bit 2 SET: Horizontal coordinates calculated this position
 - bit 3 SET: Height calculated this position
 - bit 4 reserved: Always SET (was "Weighted position")
 - bit 5 SET: Least squares position
 - bit 6 reserved: Always CLEAR (was "Iono-free position")
 - bit 7 SET: Position uses Filtered L1 pseudoranges
- POSITION FLAGS 2 reports position attributes and is defined as follows:
 - bit 0 SET: Position is a differential solution. RESET: Position is autonomous or WAAS solution.
 - bit 1 SET: Differential position is phase including RTK (float, fixed or location), HP or XP Omnistar (VBS is not derived from phase). RESET: Differential position is code.

- bit 2 SET: Differential position is fixed integer phase position (RTK-fixed). Uncorrected position is WAAS (if bit 0 is 0). RESET: Differential position is RTK-float, RTK-location or code phase (DGPS), Uncorrected position is Autonomous (if bit 0 is 0).
 - bit 3 SET: OmniSTAR differential solution (including HP, XP, and VBS.) RESET: Not OmniSTAR solution.
 - bit 4 SET: Position determined with STATIC as a constraint.
 - bit 5 SET: Position is Network RTK solution.
 - bit 6 SET: RTK-Location.
 - bit 7 SET: Beacon DGPS.
- INITIALIZATION NUMBER is a rollover counter to indicate when re-initializations have taken place.

GSOFF 2: GSOFF 2 (02h) LAT, LONG, HEIGHT

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 2	→
1 (byte) RECORD LENGTH	→
8 (double) LATITUDE	→
8 (double) LONGITUDE	→
8 (double) HEIGHT	→

Where:

- OUTPUT RECORD TYPE = 2.
- RECORD LENGTH is the length of this sub-record.
- LATITUDE is the WGS-84 latitude in radians.
- LONGITUDE is the WGS-84 longitude in radians.
- HEIGHT is the WGS-84 height in meters.

GSOF 3: GSOF 3 (03h) ECEF POSITION

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 3	→
1 (byte) RECORD LENGTH	→
8 (double) X	→
8 (double) Y	→
8 (double) Z	→

Where:

- OUTPUT RECORD TYPE = 3.
- RECORD LENGTH is the length of this sub-record.
- X is the earth-centered earth-fixed X axis WGS-84 coordinate of the position in meters.
- Y is the earth-centered earth-fixed Y axis WGS-84 coordinate of the position in meters.
- Z is the earth-centered earth-fixed Z axis WGS-84 coordinate of the position in meters.

GSOF 4: GSOF 4 (04h) LOCAL DATUM POSITION.

Back to: 40h GENOUT

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 4	→
1 (byte) RECORD LENGTH	→
8 (char) LOCAL DATUM ID	→
8 (double) LOCAL DATUM ECEF LATITUDE	→
8 (double) LOCAL DATUM LONGITUDE	→
8 (double) LOCAL DATUM HEIGHT	→
1 (byte) OUTPUT RECORD TYPE = 4	→

Where:

- OUTPUT RECORD TYPE = 4.
- RECORD LENGTH is the length of this sub-record.
- LOCAL DATUM IDENTIFIER is an ASCII string that identifies the coordinate datum.
- LOCAL DATUM LATITUDE is the latitude in the local datum (radians).
- LOCAL DATUM LONGITUDE is the longitude in the local datum (radians).
- LOCAL DATUM HEIGHT is the height in the local datum (meters).

GSO5: GSO5 (05h) LOCAL ZONE POSITION

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 5	→
1 (byte) RECORD LENGTH	→
8 (char) LOCAL DATUM ID	→
8 (char) LOCAL ZONE ID	→
8 (double) LOCAL ZONE NORTH	→
8 (double) LOCAL ZONE EAST	→
8 (double) LOCAL DATUM HEIGHT	→

Where:

- OUTPUT RECORD TYPE = 5.
- RECORD LENGTH is the length of this sub-record.
- LOCAL DATUM IDENTIFIER is an ASCII string that identifies the coordinate datum.
- LOCAL ZONE IDENTIFIER is an ASCII string that identifies the coordinate zone.
- LOCAL ZONE NORTH is the local zone north coordinate (meters).
- LOCAL ZONE EAST is the local zone east coordinate (meters).
- LOCAL DATUM HEIGHT is the height in the local datum (meters).

GSOF 6: GSOF 6 (06h) ECEF DELTA

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 6	→
1 (byte) RECORD LENGTH	→
8 (double) DELTA X	→
8 (double) DELTA Y	→
8 (double) DELTA Z	→

Where:

- OUTPUT RECORD TYPE = 6.
- RECORD LENGTH is the length of this sub-record.
- DELTA X is the ECEF X axis delta between the rover and base positions (rover - base) in meters.
- DELTA Y is the ECEF Y axis delta between the rover and base positions (rover - base) in meters.
- DELTA Z is the ECEF Z axis delta between the rover and base positions (rover - base) in meters.

GSOFF 7: GSOFF 7 (07h) TANGENT PLANE DELTA

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 7	→
1 (byte) RECORD LENGTH	→
8 (double) DELTA EAST	→
8 (double) DELTA NORTH	→
8 (double) DELTA UP	→

Where:

- OUTPUT RECORD TYPE = 7.
- RECORD LENGTH is the length of this sub-record.
- DELTA EAST is the east component of a vector from the base to the rover projected onto a plane tangent to the WGS-84 ellipsoid at the base. Units: meters.
- DELTA NORTH is the north component of the tangent plane vector.
- DELTA UP is the difference between the ellipsoidal height of the tangent plane at the base and a plane parallel to this passing through the rover point.

GSOF 8: GSOF 8 (08h) VELOCITY DATA

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 8	→
1 (byte) RECORD LENGTH	→
1 (byte) VELOCITY FLAGS	→
4 (float) VELOCITY	→
4 (float) HEADING	→
4 (float) VERTICAL VELOCITY	→

Where:

- OUTPUT RECORD TYPE = 8.
- RECORD LENGTH is the length of this sub-record.
- VELOCITY FLAGS indicate attributes of the velocity information. Defined values are:
 - bit 0 SET: Velocity data valid. RESET: Velocity data not valid
 - bit 1 SET: Velocity computed from consecutive measurements. RESET: Velocity computed from Doppler
 - bits 2-7: RESERVED
- VELOCITY is the horizontal velocity in meters per second.
- HEADING is the WGS-84 referenced true north heading in radians.
- VERTICAL VELOCITY is the velocity in the vertical direction in meters per second.

GSOF 9: GSOF 9 (09h) PDOP INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 9	→
1 (byte) RECORD LENGTH	→
4 (float) PDOP	→
4 (float) HDOP	→
4 (float) VDOP	→
4 (float) TDOP	→

Where:

- OUTPUT RECORD TYPE = 9.
- RECORD LENGTH is the length of this sub-record.
- PDOP is the positional dilution of precision.
- HDOP is the horizontal dilution of precision.
- VDOP is the vertical dilution of precision.
- TDOP is the time dilution of precision.

Note – When an RTK system is placed in the Static (measuring) mode, these values become Relative DOP values, and as such tend to diminish with elapsed time spend static.

GSOF 10: GSOF 10 (0Ah) CLOCK INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 10	→
1 (byte) RECORD LENGTH	→
1 (byte) CLOCK FLAGS	→
8 (double) CLOCK OFFSET	→
8 (double) FREQUENCY OFFSET	→

Where:

- OUTPUT RECORD TYPE = 10.
- RECORD LENGTH is the length of this sub-record.
- CLOCK FLAGS indicates information relation of 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
 - bit 3-7: RESERVED
- CLOCK OFFSET is the current clock offset in milliseconds.
- FREQUENCY OFFSET is the offset of the local oscillator from the nominal GPS L1 frequency in parts per million.

GSOF 11: GSOF 11 (0Bh) POSITION VCV INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 11	→
1 (byte) RECORD LENGTH	→
4 (float) POSITION RMS	→
4 (float) VCV xx	→
4 (float) VCV xy	→
4 (float) VCV xz	→
4 (float) VCV yy	→
4 (float) VCV yz	→
4 (float) VCV zz	→
4 (float) UNIT VARIANCE	→
2 (short) NUMBER OF EPOCHS	→

Where:

- OUTPUT RECORD TYPE = 11.
- RECORD LENGTH is the length of this sub-record.
- RANGE RESIDUAL RMS is the square root of (the sum of the squares of the range residuals divided by the number of degrees of freedom in the solution).
- VCVxx .. VCVzz is the variance-covariance matrix. This contains the positional components of the inverted normal matrix of the position solution in a ECEF WGS-84 reference.
- UNIT VARIANCE is the unit variance of the position solution.
- NUMBER OF EPOCHS indicates the number of measurements used to compute the position. It may be greater than 1 for positions subjected to a STATIC constraint.

GSOFF 12: GSOFF 12 (0Ch) POSITION SIGMA INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 12	→
1 (byte) RECORD LENGTH	→
4 (float) POSITION RMS	→
4 (float) SIGMA EAST	→
4 (float) SIGMA NORTH	→
4 (float) COVAR. EAST-NORTH	→
4 (float) SIGMA UP	→
4 (float) SEMI MAJOR AXIS	→
4 (float) SEMI-MINOR AXIS	→
4 (float) ORIENTATION	→
4 (float) UNIT VARIANCE	→
2 (short) NUMBER EPOCHS	→

Where:

- OUTPUT RECORD TYPE = 12.
- RECORD LENGTH is the length of this sub-record.
- RANGE RESIDUAL RMS is the square root of (the sum of the squares of the range residuals divided by the number of degrees of freedom in the solution).
- SIGMA EAST, NORTH, UP are in meters.
- COVARIANCE EAST-NORTH is dimensionless.
- SEMI-MAJOR/MINOR AXES of the error ellipse is in meters.
- ORIENTATION of the semi-major axis is in degrees from clockwise from True North.
- UNIT VARIANCE is valid only for over determined solutions. It should tend towards 1.0. A value less than 1.0 indicates that the apriori variances were too pessimistic.
- NUMBER OF EPOCHS indicates the number of measurements used to compute the position. It may be greater than 1 for positions subjected to a STATIC constraint.

GSOF 13: GSOF 13 (0Dh) SV BRIEF INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 13	→
1 (byte) RECORD LENGTH	→
1 (byte) NUMBER OF SVS	→
repeated for number of sv	
1 (byte) PRN	→
1 (byte) SV FLAGS1	→
1 (byte) SV FLAGS2	→

Where:

- OUTPUT RECORD TYPE = 13.
- RECORD LENGTH is the length of this sub-record.
- NUMBER OF SVS is the number of tracked satellites reported in this record.
- PRN is the PRN number of the satellite which the following flags refer to.
- SV FLAGS1 indicate conditions relating to satellites. Defined values are:
 - bit 0 SET: Above horizon
 - bit 1 SET: Currently assigned to a channel (trying to track)
 - bit 2 SET: Currently tracked on L1 frequency
 - bit 3 SET: Currently tracked on L2 frequency
 - bit 4 SET: Reported at Base on L1 frequency
 - bit 5 SET: Reported at Base on L2 frequency
 - bit 6 SET: Used in Position
 - bit 7 SET: Used in current RTK process (search, propagate, fix solution)
- SV FLAGS2 indicate conditions relating to satellites. Defined values are:
 - bit 0 SET: Tracking P Code on L1
 - bit 1 SET: Tracking P Code on L2
 - bit 2 SET: Tracking CS on L2
 - bits 3-7: RESERVED

GSOF 14: GSOF 14 (0Eh) SV DETAILED INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 14	→
1 (byte) RECORD LENGTH	→
1 (byte) NUMBER OF SVS	→
repeated for number of svcs	
1 (byte) PRN	→
1 (byte) SV FLAGS1	→
1 (byte) SV FLAGS2	→
1 (signed byte) ELEVATION	→
2 (short) AZIMUTH	→
1 (byte) SNR L1*4	→
1 (byte) SNR L2*4	→

Where:

- OUTPUT RECORD TYPE = 14.
- RECORD LENGTH is the length of this sub-record.
- NUMBER OF SVS is the number of tracked satellites reported in this record.
- PRN is the PRN number of the satellite which the following information refers to.
- SV FLAGS1 indicate conditions relating to satellites. Defined values are:
 - bit 0 SET: Above horizon
 - bit 1 SET: Currently assigned to a channel (trying to track)
 - bit 2 SET: Currently tracked on L1 frequency
 - bit 3 SET: Currently tracked on L2 frequency
 - bit 4 SET: Reported at Base on L1 frequency
 - bit 5 SET: Reported at Base on L2 frequency
 - bit 6 SET: Used in Position
 - bit 7 SET: Used in current RTK process (search, propagate, fix solution)
- SV FLAGS2 indicate conditions relating to satellites. Defined values are:
 - bit 0 SET: Tracking P Code on L1
 - bit 1 SET: Tracking P Code on L2
 - bit 2 SET: Tracking CS on L2
 - bits 3-7: RESERVED
- ELEVATION is the angle of the satellite above the horizon in degrees.

- AZIMUTH is the azimuth of the satellite from true north in degrees.
- SNR L1 is the signal-to-noise ratio of the L1 signal (multiplied by 4). 0 for SVs not tracked on this frequency.
- SNR L2 is the signal-to-noise ratio of the L2 signal (multiplied by 4). 0 for SVs not tracked on this frequency.

GSOF 15: GSOF 15 (0Fh) RECEIVER SERIAL NUMBER

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 15	→
1 (byte) RECORD LENGTH	→
4 (long) SERIAL NUMBER	→

Where:

- OUTPUT RECORD TYPE = 15.
- RECORD LENGTH is the length of this sub-record.
- RECEIVER SERIAL NUMBER is the full serial number of the receiver.

GSOF 16: GSOF 16 (10h) CURRENT TIME

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 16	→
1 (byte) RECORD LENGTH	→
4 (long) GPS MILLISEC OF WEEK	→
2 (short) GPS WEEK NUMBER	
2 (short) UTC OFFSET	
1 (byte) FLAGS	

Where:

- OUTPUT RECORD TYPE = 16.
- RECORD LENGTH is the length of this sub-record.
- GPS MILLISECONDS OF WEEK is the time that the message was sent from the receiver.
- GPS WEEK NUMBER is the full week number since start of GPS time.
- UTC OFFSET is the current GPS to UTC time offset in integer seconds.
- FLAGS indicate the validity of the time and UTC offset parameters. Defined values are:
 - bit 0 SET: Time information (week and milliseconds of week) valid
 - bit 1 SET: UTC Offset is valid

GSOF 26: GSOF 26 (1Ah) POSITION TIME UTC

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 26	→
1 (byte) RECORD LENGTH	→
4 (long) MILLISECONDS OF WEEK	→
2 (short) GPS WEEK NUMBER	→
1 (byte) NUMBER OF SVS USED	→
1 (byte) POSITION FLAGS 1	→
1 (byte) POSITION FLAGS 2	→
1 (byte) INITIALIZATION NUMBER	→

Where:

- OUTPUT RECORD TYPE = 26.
- RECORD LENGTH is the length of this sub-record.
- MILLISECONDS OF WEEK is the GPS time since the start of the GPS week.
- GPS WEEK NUMBER is the week count since January 1980.
- NUMBER OF SVS USED is the number of satellites used to determine the position.
- POSITION FLAGS 1 reports position attributes and is defined as follows:
 - bit 0 SET: New Position
 - bit 1 SET: Clock fix calculated this position
 - bit 2 SET: Horizontal coordinates calculated this position
 - bit 3 SET: Height calculated this position
 - bit 4 reserved: Always SET (was "Weighted position")
 - bit 5 SET: Least squares position
 - bit 6 reserved: Always CLEAR (was "Iono-free position")
 - bit 7 SET: Position uses Filtered L1 pseudoranges
- POSITION FLAGS 2 reports position attributes and is defined as follows:
 - bit 0 SET: Position is a differential solution. RESET: Position is autonomous or WAAS solution.
 - bit 1 SET: Differential position is phase (RTK, or HP Omnistar). RESET: Differential position is code.
 - bit 2 SET: Differential position is fixed integer phase position (RTK). Uncorrected position is WAAS (if bit 0 is 0). RESET: Differential position is RTK-float or code phase (DGPS). Uncorrected position is Autonomous (if bit 0 is 0).

- bit 3 SET: HP / Omnistar differential solution. RESET: HP / Omnistar not active.
 - bit 4 SET: Position determined with STATIC as a constraint
 - bit 5 SET: Position is Network RTK solution
 - bits 6-7: RESERVED
- INITIALIZATION NUMBER is a rollover counter to indicate when re-initializations have taken place.

GSOFF 27: GSOFF 27 (1Bh) ATTITUDE INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 27	→
1 (byte) RECORD LENGTH	→
4 (unsigned long) GPS TIME	→
1 (byte) FLAGS	→
1 (byte) NUMBER OF SVS	→
1 (byte) CALCULATION MODE	→
1 (byte) RESERVED	→
8 (double) PITCH	→
8 (double) YAW	→
8 (double) ROLL	→
8 (double) MASTER-SLAVE RANGE	→
2 (word) PDOP	→
Record length = 42, up to and including PDOP (does not include type and length bytes)	
4 (float) PITCH VARIANCE	→
4 (float) YAW VARIANCE	→
4 (float) ROLL VARIANCE	→
4 (float) MASTER-SLAVE RANGE VARIANCE	→
Record length = 70 up to and including Master Slave Range Variance	

Where:

- OUTPUT RECORD TYPE = 27.
- RECORD LENGTH is the length of this sub-record.
- GPS TIME is time of position in milliseconds of GPS week.
- FLAGS indicate the following:
 - bit 0: Calibrated
 - bit 1: Pitch Valid
 - bit 2: Yaw Valid
 - bit 3: Roll Valid
 - bit 4: Scalar Valid
 - bit 5 - Bit 7: Reserved
 - bit 5: Diagnostic Valid

- bit 6: Slave Static
- bit 7: Error Stats valid
- NUMBER OF SVS.
- CALCULATION MODE is one of the following values:
 - 0: None
 - 1: Autonomous
 - 2: RTK/Float
 - 3: RTK/Fix
 - 4: DGPS
- RESERVED is currently unused.
- PITCH is the forward dive/climb angle (radians).
- YAW is the horizontal turn (left or right) (radians).
- ROLL is the side-to-side roll angle (radians).
- MASTER-SLAVE RANGE is the distance between master and slave antennas, in meters.
- PDOP is the current position PDOP in tenths.

Subsequent elements are not implemented in firmware versions prior to GNSS version 4.20. The error stats valid flag is also set when these elements are implemented.

- PITCH VARIANCE is the expected variance of error of the pitch estimate (radians²).
- YAW VARIANCE is the expected variance of error of the yaw estimate (radians²).
- ROLL VARIANCE is the expected variance of error of the roll estimate (radians²).
- PITCH-YAW COVARIANCE is the expected covariance of errors of the pitch and yaw estimates (radians²).
- PITCH-ROLL COVARIANCE is the expected covariance of errors of the pitch and roll estimates (radians²).
- YAW-ROLL COVARIANCE is the expected covariance of errors of the yaw and roll estimates (radians²).
- MASTER-SLAVE RANGE VARIANCE is the expected variance of error of the master-slave range estimate, in meters².

GSOFF 33: GSOFF 33 (21h) ALL SV BRIEF INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 33	→
1 (byte) RECORD LENGTH	→
1 (byte) NUMBER OF SVs	→
Repeated for number of SVs	
1 (byte) PRN	→
1 (byte) SV System	→
1 (byte) SV FLAGS1	→
1 (byte) SV FLAGS2	→

Where:

- OUTPUT RECORD TYPE = 33.
- RECORD LENGTH is the length of this sub-record.
- NUMBER OF SVS is the number of tracked satellites reported in this record.
- PRN is the PRN number of the satellite which the following flags refer to. This will be the ACTUAL PRN number given by the SV (not ranged due to SV system) due to the next field:
- SV System is the system that the SV belongs to.
 - 0 = GPS
 - 1 = SBAS
 - 2 = GLONASS
 - 3 = GALILEO
 - 4 - 255: RESERVED
- SV FLAGS1 indicate 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 3-7: RESERVED
- SV FLAGS2 indicate conditions relating to satellites.
 - bits 0-7: RESERVED

GSOFF 34: GSOFF 34 (22h) ALL SV DETAILED INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 34	→
1 (byte) RECORD LENGTH	→
1 (byte) NUMBER OF SVS	→
Repeated for number of SVs	
1 (byte) PRN	→
1 (byte) SV SYSTEM	→
1 (byte) SV FLAGS1	→
1 (byte) SV FLAGS2	→
1 (signed byte) ELEVATION	→
2 (short) AZIMUTH	→
1 (byte) SNR L1*4	→
1 (byte) SNR L2*4	→
1 (byte) SNR L5*4 OR G1P SNR OR Galileo SNR	→

Where:

- OUTPUT RECORD TYPE = 34.
- RECORD LENGTH is the length of this sub-record.
- NUMBER OF SVS is the number of tracked satellites reported in this record.
- PRN is the PRN number of the satellite which the following flags refer to. This will be the ACTUAL PRN number given by the SV (not ranged due to SV system) due to the next field.
- SV SYSTEM is the system that the SV belongs to.
 - 0: GPS
 - 1: SBAS
 - 2: GLONASS
 - 3 - 9: RESERVED
 - 10: OMNISTAR
 - 11 - 255: RESERVED
- SV FLAGS1 is a bitmap field having the following values:
 - 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 is a bitmap variable having the following values:
 - bit 0 Set: Tracking P-Code on L1/G1
 - bit 1 Set: Tracking P-Code on L2
- IF GPS SV:
 - bit 2 Set: Tracking CS on L2
 - bit 3 Set: Tracking L5 Signal
 - Bits 4-7 are reserved
- If GLONASS SV:
 - bit 2 Set: Glonass SV is “M” SV
 - bit 3 Set: Glonass SV is “K” SV
 - Bits 4-7 are reserved
- ELSE
 - Bits 2-7 are reserved
- ELEVATION is the angle of the satellite above the horizon in degrees.
- AZIMUTH is the azimuth of the satellite from true north in degrees.
- SNR L1 is the signal-to-noise ratio of the L1 signal (multiplied by 4). 0 for SVs not tracked on this frequency.
- SNR L2 is the signal-to-noise ratio of the L2 signal (multiplied by 4). 0 for SVs not tracked on this frequency.
- IF GPS SNR L5 is the signal-to-noise ratio of the L5 signal (multiplied by 4). 0 for SVs not tracked on this frequency.
- IF GLONASS G1P SNR is the signal-to-noise ratio of the G1P signal (multiplied by 4). 0 for SVs not tracked on this frequency.
- IF Galileo, E1 SNR or E5A SNR or E5B SNR or E5AltBOC SNR
- ELSE This last byte is RESERVED.

GSOF 35: GSOF 35 (23h) RECEIVED BASE INFO

Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 35	→
1 (byte) RECORD LENGTH	→
1 (Byte) FLAGS and VERSION OF MESSAGE	→
8 (chars) BASE NAME	→
2 (bytes) BASE ID	→
8 (double) BASE LATITUDE	→
8 (double) BASE LONGITUDE	→
8 (double) BASE HEIGHT	→

Where:

- OUTPUT RECORD TYPE = 35.
- RECORD LENGTH is the length of this sub-record.
- FLAGS specifies a few attributes about the BASE (and ONLY the base, since there are status flags about RTK in other messages). Defined values:
 - Bits 0 - 2 specify a “version number” for this message.
 - Bit 3 if SET specifies that the base info given is valid.
 - Bits 4 - 7 are currently RESERVED.
- BASE NAME is the short base name received from the base. In the case of the base being RTCM (with no base name), the field is set to all 0s.
- BASE ID is the ID# of the base being used. This field is big-endian, so the first byte will always be set to 0 if the base is a CMR base.
- BASE LATITUDE is the WGS-84 latitude of the base in radians.
- BASE LONGITUDE is the WGS-84 longitude of the base in radians.
- BASE HEIGHT is the WGS-84 height of the base in meters.

GSOF 41: GSOF 41 (29h) BASE POSITION AND QUALITY INDICATOR

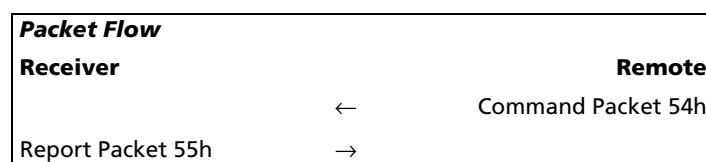
Packet Flow	
Receiver	Connected computer
1 (byte) OUTPUT RECORD TYPE = 41	→
1 (byte) RECORD LENGTH	→
4 (long) GPS TIME (ms)	→
2 (int) GPS WEEK NUMBER	→
8 (double) LATITUDE	→
8 (double) LONGITUDE	→
8 (double) HEIGHT	→
1 (byte) QUALITY INDICATOR	→

Where:

- OUTPUT RECORD TYPE = 41.
- RECORD LENGTH is the length of this sub-record.
- GPS TIME is in milliseconds of the GPS week.
- GPS WEEK NUMBER is the week count since January 1980.
- LATITUDE is the base WGS-84 latitude in radians.
- LONGITUDE is the base WGS-84 longitude in radians.
- HEIGHT is the base WGS-84 height in meters.
- QUALITY INDICATOR shows the quality of the base position:
 - 0 - Fix not available or invalid
 - 1 - Autonomous
 - 2 - Differential, SBAS or OmniSTAR VBS
 - 4 - RTK Fixed
 - 5 - OmniSTAR XP, OmniSTAR HP, RTK Float, or RTK Location

55h, RETSVDATA (Satellite information reports)

Report Packet 55h is sent in response to Command Packet 54h. The report includes either the ephemeris or almanac information for a specific satellite, or ION/UTC data, the Enabled/Disabled state and Heed/Ignore Health state of all satellites, or the condition of satellite status flags for one satellite or all satellites.



Only the satellite information, requested by Command Packet 54h, is sent in the report packet. As a result, several forms of the Report Packet 55h can be requested.

Table 7.43 through Table 7.47 describe the structure of the report packets.

Returns a NAK if the GETSVDATA request meets one of the following criteria:

- SV PRN is out of range 1–32 (except for SV flags)
- Data Switch is out of range
- Data is not available for the requested SV

SV FLAGS report

The SV FLAGS report is sent when Command Packet 54h is used to request the status of the SV Flags for one satellite or all satellites. The Command Packet 54h DATA SWITCH byte (byte 4) is set to zero (0) when requesting the report. Table 7.43 describes the packet structure.

Table 7.43 Report Packet 55h SV flags report structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status.
2	PACKET TYPE	CHAR	55h	Report Packet 55h.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
4	DATA TYPE INDICATOR	CHAR	00h	SV FLAGS Report.
5	SV PRN #	CHAR	00h–20h	Pseudorandom number of satellite (1–32) or zero when requesting flag status of all satellites.
6–9	EPHEMERIS FLAGS	LONG	32 flag bits	For all 32 satellites, the flags show availability of Ephemeris data when set to one. ¹
10–13	ALMANAC FLAGS	LONG	32 flag bits	For all 32 satellites, the flags show availability of Almanac data when set to one. ¹
14–17	SVS DISABLED FLAGS	LONG	32 flag bits	Flags show Enabled or Disabled status of all satellites. When set to one, satellite is disabled. ¹

¹ Bit 0 = PRN 1

Table 7.43 Report Packet 55h SV flags report structure (continued)

Byte #	Item	Type	Value	Meaning
18–21	SVS UNHEALTHY FLAGS	LONG	32 flag bits	Flags show the health of satellites. When set to one, satellite is currently unhealthy. ¹
22–25	TRACKING L1 FLAGS	LONG	32 flag bits	Flags show satellites tracked on L1 when set to one. ¹
26–29	TRACKING L2 FLAGS	LONG	32 flag bits	Flags show satellites tracked on L2 when set to one. ¹
30–33	Y-CODE FLAGS	LONG	32 flag bits	Flags show satellites with Anti-Spoofing turned on when set to one. ¹
34–37	P-CODE ON L1 FLAGS	LONG	32 flag bits	Flags show satellites which are tracking P-code on the L1. Flags are not set for satellites not tracked on L1. ¹
38–41	RESERVED	LONG	32 flag bits	Reserved (set to zero).
42–45	RESERVED	LONG	32 flag bits	Reserved (set to zero).
46–49	RESERVED	LONG	32 flag bits	Reserved (set to zero).
50–53	RESERVED	LONG	32 flag bits	Reserved (set to zero).
54	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
55	ETX	CHAR	03h	End transmission.

¹ Bit 0 = PRN 1

EPHEMERIS report

The EPHEMERIS report is sent when Command Packet 54h is used to request the Ephemeris for one satellite or all satellites. The GETSVDATA DATA SWITCH byte (byte 4) is set to one (1) to request the report. Table 7.44 describes the packet structure.

The Ephemeris data follows the standard defined by GPS ICD-200 except for CUC, CUS, CIS, and CIC. These values need to be multiplied by π to become the units specified in the GPS ICD-200 document. The Ephemeris Flags are described in Table 7.45.

Table 7.44 Report Packet 55h ephemeris report structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status.
2	PACKET TYPE	CHAR	55h	Report Packet 55h.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
4	DATA TYPE INDICATOR	CHAR	01h	Ephemeris report.
5	SV PRN #	CHAR	00h–20h	Pseudorandom number of satellite (1–32) or 0 when data is for all satellites.
6–7	EPH WEEK #	SHORT	GPS ICD-200 ¹	Ephemeris Week Number.
8–9	IODC	SHORT	GPS ICD-200 ¹	
10	RESERVED	CHAR	GPS ICD-200 ¹	Reserved (set to zero).

Table 7.44 Report Packet 55h ephemeris report structure (continued)

Byte #	Item	Type	Value	Meaning
11	IODE	CHAR	GPS ICD-200 ¹	Issue of Data Ephemeris.
12–15	TOW	LONG	GPS ICD-200 ¹	Time of week.
16–19	TOC	LONG	GPS ICD-200 ¹	
20–23	TOE	LONG	GPS ICD-200 ¹	
24–31	TGD	DOUBLE	GPS ICD-200 ¹	
32–39	AF2	DOUBLE	GPS ICD-200 ¹	
40–47	AF1	DOUBLE	GPS ICD-200 ¹	
48–55	AF0	DOUBLE	GPS ICD-200 ¹	
56–63	CRS	DOUBLE	GPS ICD-200 ¹	
64–71	DELTA N	DOUBLE	GPS ICD-200 ¹	
72–79	M SUB 0	DOUBLE	GPS ICD-200 ¹	
80–87	CUC	DOUBLE	GPS ICD-200 ¹	
88–95	ECCENTRICITY	DOUBLE	GPS ICD-200 ¹	
96–103	CUS	DOUBLE	GPS ICD-200 ¹	
104–111	SQRT A	DOUBLE	GPS ICD-200 ¹	
112–119	CIC	DOUBLE	GPS ICD-200 ¹	
120–127	OMEGA SUB 0	DOUBLE	GPS ICD-200 ¹	
128–135	CIS	DOUBLE	GPS ICD-200 ¹	
136–143	I SUB 0	DOUBLE	GPS ICD-200 ¹	
144–151	CRC	DOUBLE	GPS ICD-200 ¹	
152–159	OMEGA	DOUBLE	GPS ICD-200 ¹	
160–167	OMEGA DOT	DOUBLE	GPS ICD-200 ¹	
168–175	I DOT	DOUBLE	GPS ICD-200 ¹	
176–179	FLAGS	LONG	See Table 7.45, page 129	Shows status of Ephemeris Flags.
180	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
181	ETX	CHAR	03h	End transmission.

¹ For detailed information, refer to the U.S. Government document GPS ICD-200.

Table 7.45 Ephemeris flags

Bit(s)	Description	Location
0	Data flag for L2 P-code	Sub 1, word 4, bit 1
1–2	Codes on L2 channel	Sub 1, word 3, bits 11–12
3	Anti-spoof flag: Y-code on: from ephemeris	Sub 1–5, HOW, bit 19
4–9	SV health: from ephemeris	Sub 1, word 3, bits 17–22
10	Fit interval flag	Sub 2, word 10, bit 17
11–14	URA: User Range Accuracy	Sub 1, word 3, bits 13–16
15	URA may be worse than indicated Block I: Momentum Dump flag	Sub 1–5, HOW, bit 18
16–18	SV Configuration: SV is Block I or Block II	Sub 4, page 25, word and bit depends on SV.
19	Anti-spoof flag: Y-code on	Sub 4, page 25, word and bit depends on SV.

ALMANAC report

The ALMANAC report is sent when Command Packet 54h is used to request the Almanac for one satellite or all satellites. The Command Packet 54h DATA SWITCH byte (byte 4) is set to zero (2) when requesting the report. Data follows the format specified by GPS ICD-200.

Table 7.46 describes the packet structure.

Table 7.46 Command Packet 55h almanac report structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status.
2	PACKET TYPE	CHAR	55h	Report Packet 55h.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
4	DATA TYPE INDICATOR	CHAR	02h	Almanac data
5	SV PRN #	CHAR	00h–20h	Pseudorandom number of satellite (1–32) or 0 when data is for all satellites.
6–9	ALM DECODE TIME	LONG		Full GPS seconds from the start of GPS time.
10–11	AWN	SHORT	GPS ICD-200 ¹	
12–15	TOA	LONG	GPS ICD-200 ¹	
16–23	SQRTA	DOUBLE	GPS ICD-200 ¹	
24–31	ECCENT	DOUBLE	GPS ICD-200 ¹	
32–39	ISUBO	DOUBLE	GPS ICD-200 ¹	
40–47	OMEGADOT	DOUBLE	GPS ICD-200 ¹	
48–55	OMEGSUBO	DOUBLE	GPS ICD-200 ¹	
56–63	OMEGA	DOUBLE	GPS ICD-200 ¹	
64–71	MSUBO	DOUBLE	GPS ICD-200 ¹	
72	ALM HEALTH	CHAR	GPS ICD-200 ¹	
73	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
74	ETX	CHAR	03h	End transmission.

¹ For detailed information, refer to the U.S. Government document GPS ICD-200.

RETSVDATA UTC/ION report

The UTC/ION report is sent when Command Packet 54h is used to request the UTC (Universal Time Coordinated) and Ionospheric data. The Command Packet 54h DATA SWITCH byte (byte 4) is set to three (3) when requesting the report.

Data follows the standard defined within GPS ICD-200 except that some parameters are expanded. A NAK is returned if Command Packet 54h DATA SWITCH values is out of range.

Table 7.47 describes the packet structure.

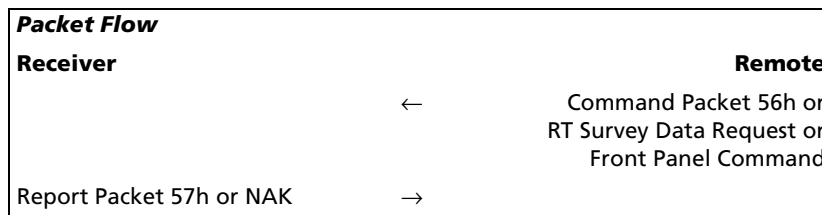
Table 7.47 RETSVDATA UTC/ION packet structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count
4	DATA TYPE INDICATOR	CHAR	03h	UTC/ION Report
5	SV PRN #	CHAR	00h	Data for all satellites
¹ For detailed information, refer to the U.S. Government document GPS ICD-200.				
Begin UTC Data				
6–13	ALPHA 0	DOUBLE	GPS ICD-200 ¹	
14–21	ALPHA 1	DOUBLE	GPS ICD-200 ¹	
22–29	ALPHA 2	DOUBLE	GPS ICD-200 ¹	
30–37	ALPHA 3	DOUBLE	GPS ICD-200 ¹	
38–45	BETA 0	DOUBLE	GPS ICD-200 ¹	
46–53	BETA 1	DOUBLE	GPS ICD-200 ¹	
54–61	BETA 2	DOUBLE	GPS ICD-200 ¹	
62–69	BETA 3	DOUBLE	GPS ICD-200 ¹	
Begin Ionospheric Data				
70–77	ASUB0	DOUBLE	GPS ICD-200 ¹	
78–85	ASUB1	DOUBLE	GPS ICD-200 ¹	
86–93	TSUB0T	DOUBLE	GPS ICD-200 ¹	
94–101	DELTATLS	DOUBLE	GPS ICD-200 ¹	
102–109	DELTATLSF	DOUBLE	GPS ICD-200 ¹	
110–117	IONTIME	DOUBLE	GPS ICD-200 ¹	
118	WNSUBT	CHAR	GPS ICD-200 ¹	
119	WNSUBLSF	CHAR	GPS ICD-200 ¹	
120	DN	CHAR	GPS ICD-200 ¹	
121–126	RESERVED	CHARs	GPS ICD-200 ¹	Reserved (set to zero)
127	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
128	ETX	CHAR	03h	End transmission
¹ For detailed information, refer to the U.S. Government document GPS ICD-200.				

57h, RAWDATA (Position or real-time survey data report)¹

Report Packet 57h is sent in response to one of the following requests:

- Command Packet 56h
- Real-Time Survey Data streaming is enabled in the application file with Command Packet 64h
- A simulated front panel command



A NAK is returned if the Real-Time Survey Data option (RT17) is not installed and the application file is configured to stream real-time survey data.

Report Packet 57h can contain one of the following types of raw data, depending on options selected in Command Packet 56h:

- Expanded Format (*.DAT Record Type 17 style data) raw satellite measurements
- Concise Format (*.DAT Record Type 17 style data) raw satellites measurements
- Position data (*.DAT Record Type 11)

The Expanded and Concise records can also include Enhanced record data, including Real-Time Flags and IODE information if these options are enabled in the application file. For more information, see Report Packet [56h, GETRAW \(Position or real-time survey data request\)](#), page 73.

Packet paging and measurement counting

The Raw satellite data responses follow either the Expanded or the Concise format and usually exceed the byte limit for RS-232 Serial Interface Specification packets. To overcome the packet size limitation, the data is included in several subpackets called pages. The PAGE INDEX byte (Byte 4) identifies the packet page index and the maximum page index included for the measurement epoch (0 of 2, 1 of 2, 2 of 2).

The first and subsequent packet pages are filled with a maximum of 248 bytes consisting of 4 bytes of page and flag information and 244 bytes of raw satellite data. The raw satellite data is split wherever the 244 byte boundary falls, regardless of internal variable boundaries. Therefore the external device receiving the multiple pages must reconstruct the raw satellite record using the 244 byte pages before parsing the data. This format is maintained for the position record, even though it never extends beyond 244 bytes.

¹ This record only contains raw measurement information from the GPS satellites. For raw information from additional constellations (GLONASS and so on), contact Trimble technical support. See [Technical Support](#), page 9.

Determining the LENGTH byte of records

The total length of the Raw Satellite Data (ignoring the protocol framing and the paging bytes) may be computed as follows:

$$\text{Expanded Format: LENGTH} = 17 + N*48 + M*24 + N*J*12$$

$$\text{Concise Format: LENGTH} = 17 + N*27 + M*13 + N*J*3$$

where:

- N is the number of satellites
- M is the number of satellites with L2 data
- J is either 1 if REAL-TIME DATA is ON, or 0 if REAL-TIME DATA is OFF.

Expanded record format

Table 7.48 shows the structure of Report Packet 57h when Expanded Record format is enabled with Command Packet 56h.

Table 7.48 Report Packet 57h structure (expanded format)

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status.
2	PACKET TYPE	CHAR	57h	RAWDATA.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
4	RECORD TYPE	CHAR	See Table 7.50, page 136	Raw data record type.
5	PAGING INFO	CHAR	See Table 7.51, page 136	b7–b4 is the current page number b3–b0 is the total pages in this epoch (1 of 3, 2 of 3, 3 of 3).
6	REPLY #	CHAR	00h–FFh	Roll-over counter which is incremented with every report but remains constant across pages within one report. This value should be checked on the second and subsequent pages to ensure that report pages are not mismatched with those from another report.
7	FLAGS	CHAR	See Table 7.52, page 136	Bit 0 must be set to 0 to enable Expanded Record format.
Begin Expanded Format Record Header (17 bytes)				
8–15	RECEIVE TIME	DOUBLE	msecs	Receive time within the current GPS week (common to code and phase data).
16–23	CLOCK OFFSET	DOUBLE	msecs	Clock offset value. A value of 0.0 indicates that clock offset is not known.
24	# OF SVS IN RECORD	CHAR		Number of SV data blocks included in record.

Table 7.48 Report Packet 57h structure (expanded format) (continued)

Byte #	Item	Type	Value	Meaning
Begin data for first satellite in constellation (repeated for up to n SVs)				
Begin Real-Time Survey Data (48 bytes * n)				
	SV PRN #	CHAR	01h–20h	Pseudorandom number of satellite (1–32).
	FLAGS1	CHAR	See Table 7.53, page 137	First set of status flags.
	FLAGS2	CHAR	See Table 7.54, page 137	Second set of status flags.
	FLAG STATUS	CHAR	See Table 7.55, page 138	Determines whether the bit values for FLAGS1 and FLAGS2 are valid.
	ELEVATION ANGLE	SHORT	degrees	Satellite elevation angle (negative or positive value).
	AZIMUTH	SHORT	degrees	Satellite azimuth.
Begin L1 Data				
	L1 SNR	DOUBLE	<i>dB</i>	Measure of satellite signal strength.
	FULL L1 C/A CODE PSEUDORANGE	DOUBLE	<i>meters</i>	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2).
	L1 CONTINUOUS PHASE	DOUBLE	<i>L1 cycles</i>	L1 Continuous Phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	DOUBLE	<i>Hz</i>	L1 Doppler.
	RESERVED	DOUBLE	0.0	Reserved.
Begin L2 Data (available if bit 0 of FLAGS1 is set to 1) (24 bytes * n)				
	L2 SNR	DOUBLE	<i>dB</i>	Measure of satellite signal strength
	L2 CONTINUOUS PHASE	DOUBLE	<i>L2 cycles</i>	L2 Continuous Phase is in L2 cycles if bit 5 of FLAGS1 = 1
	L2 P-CODE - L1 C/A CODE P-RANGE	DOUBLE	<i>meters</i>	L2 P-Code or L2 Encrypted Code (see bit 1 and bit 2 of FLAGS2) — L1 C/A-Code or P-code (see bit 0 of FLAGS2) pseudorange (valid only if bit 5 of FLAGS1 = 1)
Begin Enhanced Record¹ if bit 1 of the FLAGS byte set to 1 (12 bytes * n)				
	IODE	CHAR	00h–FFh	Issue of Data Ephemeris
	L1 SLIP COUNTER	CHAR	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on L1 carrier phase
	L2 SLIP COUNTER	CHAR	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on the L2 carrier phase. The counter always increments when L2 changes from C/A code to Encrypted code and vice versa.
	RESERVED	CHAR	—	Reserved (set to zero)
	L2 DOPPLER	DOUBLE	<i>Hz</i>	L2 Doppler
<i>Repeat previous bytes for remaining satellites in constellation</i>				
	CHECKSUM	SHORT	See Table 7.1, page 66	Checksum value
	ETX	CHAR	03h	End transmission

¹To be compatible with Trimble software, this data must be stripped off before record 17 is stored in a *.DAT file.

Concise record format

Table 7.49 shows the structure of Report Packet 57h when Concise Record format is enabled with Command Packet 56h.

Table 7.49 Report Packet 57h structure (concise format)

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count
4	RECORD TYPE	CHAR	See Table 7.50, page 136	Raw data record type
5	PAGING INFO	CHAR	See Table 7.51, page 136	b7–b4 is the current page number. b3–b0 is the total pages in this epoch (1 of 3, 2 of 3, 3 of 3).
6	REPLY #	CHAR	00h–FFh	Roll-over counter is incremented with every report but remains constant across pages within one report. This value should be checked on second and subsequent pages to avoid mismatching report pages with those of another report.
7	FLAGS	CHAR	See Table 7.52, page 136	Bit 0 must be set to 1 to enable Concise Record format
Begin Concise Record Header (17 bytes)				
8–15	RECEIVE TIME	DOUBLE	<i>msecs</i>	Receive time within current GPS week (common to code and phase data)
16–23	CLOCK OFFSET	DOUBLE	<i>msecs</i>	Clock offset value. A value of 0.0 indicates that clock offset is not known.
24	# OF SVS IN RECORD	CHAR	<i>blocks</i>	Number of SV data blocks included in record
<i>Begin data for first satellite in constellation (repeated for up to n SVs)</i>				
Begin Real-Time Survey Data (27 bytes * n)				
	SV PRN #	CHAR	01h–20h	Satellite pseudorandom number (1–32)
	FLAGS1	CHAR	See Table 7.53, page 137	First set of satellite status flags
	FLAGS2	CHAR	See Table 7.54, page 137	Second set of satellite status flags
	ELEVATION ANGLE	CHAR	<i>degrees</i>	Satellite elevation angle (negative or positive).
	AZIMUTH	SHORT	<i>degrees</i>	Azimuth of satellite
Begin L1 Data				
	L1 SNR	CHAR	<i>dB * 4</i>	Measure of satellite signal strength. The value needs to be divided by 4.
	FULL L1 C/A CODE PSEUDORANGE	DOUBLE	<i>meters</i>	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2)
	L1 CONTINUOUS PHASE	DOUBLE	<i>L1 cycles</i>	L1 continuous phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	FLOAT	<i>Hz</i>	L1 Doppler

Table 7.49 Report Packet 57h structure (concise format) (continued)

Byte #	Item	Type	Value	Meaning
Begin L2 Data if bit 0 of FLAGS1 set to 1 (13 bytes * n)				
	L2 SNR	CHAR	<i>dB * 4</i>	Measure of satellite signal strength. The value needs to be divided by 4.
	L2 CONTINUOUS PHASE	DOUBLE	<i>L2 cycles</i>	L2 continuous phase is in L2 cycles if bit 5 of FLAGS1 = 1.
	L2 P-CODE ¹ - L1 C/A CODE ² P-RANGE	FLOAT	<i>meters</i>	Valid if bit 5 of FLAGS1 is set to 1.
¹ L2 encrypted. See bit 1 and bit 2 of FLAGS2.				
² P-code. See bit 0 of FLAGS2.				
Begin Enhanced Record¹ if bit 1 of the FLAGS byte is set to 1 (3 bytes * n)				
	IODE	CHAR	00h–FFh	Issue of Data Ephemeris.
	L1 SLIP COUNTER	CHAR	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on L1 carrier phase.
	L2 SLIP COUNTER	CHAR	00h–FFh	Roll-over counter is incremented for each occurrence of detected cycle-slips on the L2 carrier phase. The counter always increments when L2 changes from C/A code to Encrypted code and vice versa.
<i>Repeat previous bytes for remaining satellites in constellation</i>				
	CHECKSUM	SHORT	See Table 7.1, page 66	Checksum value
	ETX	CHAR	03h	End transmission

¹To be compatible with Trimble software, this data must be stripped off before record 17 is stored in a *.DAT file.

Table 7.50 RECORD TYPE byte values

Byte Value		Meaning
Dec	Hex	
0	00h	Real-Time Survey Data
1	01h	Position Data

Table 7.51 PAGE INFO bit values

Bit Value	Meaning
0–3	Total page count
4–7	Current page number

Table 7.52 FLAGS bit values

Bit	Meaning
Real-Time Survey Data	
0	Raw Data Format
	0: Expanded *.DAT Record Type 17 format
	1: Concise *.DAT Record Type 17 format

Table 7.52 FLAGS bit values (continued)

Bit	Meaning
1	Enhanced Record with real-time flags and IODE information 0: Disabled-record data is not enhanced 1: Enabled-record data is enhanced
2–7	Reserved (set to zero)

Table 7.53 FLAGS1 bit values

Bit	Meaning
0	L2 Data Loaded and Phase Valid (also see bit 6) 0: Off 1: On
1	L1 Cycle-slip (since last record 17 write) 0: Off 1: On
2	L2 Cycle-slip (since last record 17 write) 0: Off 1: On
3	L1 Phase Lock Point (redundant, for diagnostics) 0: Off 1: On
4	L1 Phase valid (lock-point valid) 0: Off 1: On
5	L2 Pseudorange (reset = squared - L2 phase) 0: Off (always for the receiver) 1: On
6	L1 Data Valid (non-zero but bytes always present) (also see bit 4), reset = only L2 data loaded (also see FLAG STATUS in Table 7.55, page 138) 0: Off 1: On
7	New Position Computed during this Receiver Cycle 0: Off 1: On

Table 7.54 FLAGS2 bit values

Bit	Meaning
0	L1 Tracking Mode 0: C/A code 1: P-code
1	L2 Tracking Mode 0: C/A code (or encrypted P-code) 1: P-code

Table 7.54 FLAGS2 bit values (continued)

Bit	Meaning
2	L2 Tracking Encryption Code 0: Off 1: On
3	Filtered L1 Band Pseudorange Corrections 0: Off 1: On
4–7	Reserved (bits set to zero)

Table 7.55 FLAG STATUS bit values

Bit	Meaning
0	Validity of FLAGS1 and FLAGS2 Bit Values 0: Bit 6 of FLAGS1 and bit 0–7 of FLAGS2 are undefined 1: Bit 6 of FLAGS1 and bit 0–7 of FLAGS2 are valid (always set for RAWDATA)
2–7	Reserved (bits set to zero)

Position record (Record Type 11)

Table 7.56 shows the structure of Report Packet 57h when the Position Record is enabled with Command Packet 56h.

$$\text{Position Record Length} = 78 + N * 2$$

where N is the number of satellites.

Table 7.56 Position record (record type 11) structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count
4	RECORD TYPE	CHAR	See Table 7.50, page 136	Raw data record type
5	PAGE COUNTER	CHAR	This byte is split into two sections of 4 bits allowing for 15 pages. Bits 0-3 : Page total Bits 4-7 : Current Page number For example, 0x23 indicates page 2 of 3.	Indicates how many pages there are for this epoch and what this page number is (e.g., 1 of 3, 2 of 3, 3 of 3).
6	REPLY NUMBER	CHAR	00h–FFh	Roll-over counter which is incremented with every report but remains constant across pages within one report. This value should be checked on the second and subsequent pages to ensure that report pages are not mismatched with those from another report.
7	Record Interpretation Flags	Char	Real-Time Survey Data: <ul style="list-style-type: none"> • Bit 0: Set Concise format • Bit 1: Set Enhanced Record with real-time flags and IODE information • Bits 2-7: Reserved Position Data, Event Mark, MET3, WAAS, and all other record types: Not Defined	RECORD INTERPRETATION FLAGS indicates special attributes of the record that must be used in parsing values.
Begin Position Record (Record 11) (78 + (nSVs * 2) bytes)				
8–15	LATITUDE	DOUBLE		Latitude in semi-circles
16–23	LONGITUDE	DOUBLE		Longitude in semi-circles
24–31	ALTITUDE	DOUBLE	<i>meters</i>	Altitude
32–39	CLOCK OFFSET	DOUBLE	<i>meters</i>	Clock offset
40–47	FREQUENCY OFFSET	DOUBLE	<i>Hz</i>	Frequency offset from 1536*1.023 MHz
48–55	PDOP	DOUBLE		PDOP (dimensionless)
56–63	LATITUDE RATE	DOUBLE	<i>radians per second</i>	Latitude rate

Table 7.56 Position record (record type 11) structure (continued)

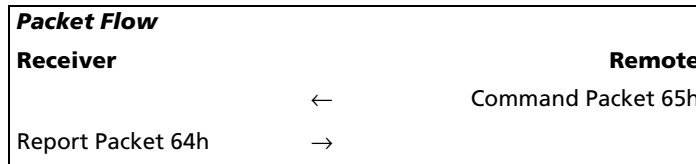
Byte #	Item	Type	Value	Meaning
64–71	LONGITUDE RATE	DOUBLE	<i>radians per second</i>	Longitude rate
72–79	ALTITUDE RATE	DOUBLE	<i>meters per second</i>	Altitude rate
80–83	GPS MSEC OF WEEK	LONG	msecs	Position time tag
84	POSITION FLAGS	CHAR	See Table 7.57, page 140	Position status flags
85	# OF SVS	CHAR	00h–0Ch	Number of satellites used to compute position solution (0–12)
<i>The next 2 bytes are repeated for each satellite used to compute position</i>				
	CHANNEL #	CHAR		Channel used to acquire satellite measurement. Zero is reported for RTK solutions.
	PRN #	CHAR	01–20h	PRN number of satellite (1–32)
	CHECKSUM	SHORT	See Table 7.1, page 66	Checksum value
	ETX	CHAR	03h	End transmission

Table 7.57 POSITION FLAGS bit values

Bit	Meaning
0–2	Position flag and position type definition 0: 0-D position fix (clock-only solution) (1+ SVs) (if # of SVs used is non-zero) 1: 1-D position fix (height only with fixed latitude/longitude) (2+ SVs) 2: 2-D position fix (fixed height and clock) (2+ SVs) 3: 2-D position fix (fixed height) (3+ SVs) 4: 3-D solution (4+ SVs) 5: 3D Solution (4+ SVs) Wide Area/Network RTK
3	RTK Solution: if set, position is fixed RTK, else float RTK 0: Floating integer ambiguity 1: Fixed integer ambiguity
4	DGPS Differential Corrections 0: No DGPS corrections are used in position computation 1: DGPS corrections are used to compute position
5	Reserved (set to zero)
6	RTK Solution: if set, position is from RTK (including Location RTK) 0: False 1: True
7	Position Derived While Static (RTK only) 0: False 1: True
Bit combinations	
<ul style="list-style-type: none"> • Bit 4 and 6 are set if the solution type is SBAS • Bit 5 and 4 are set if the solution type is OmniSTAR HP/XP 	

64h, APPFILE (Application file record report)

Report Packet 64h is sent to the remote device when Command Packet 65h is sent to request a specific application file. Command Packet 65h requests the application file by System File Index.

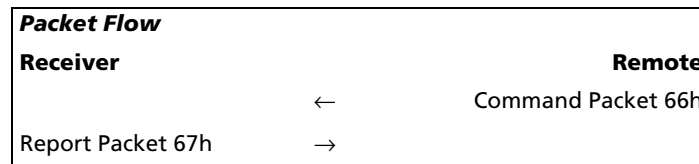


For more information about BD982 Application Files and guidelines for using application files to control remote devices, see Report Packet [64h, APPFILE \(Application file record command\)](#), page 74.

The Application File Record Report format is identical to the format used for Command Packet 64h. For more information, see [Packet paging](#), page 75.

67h, RETAFDIR (Directory listing report)

Report Packet 67h sends a listing of the application files in the application file directory. The report is requested with Command Packet 66h. For more information, see [66h, GETAFDIR \(Application file directory listing request\)](#), page 89.



Report Packet 67h can exceed the maximum data byte limit (248 bytes of data) for RS-232 Serial Interface Specification packets, depending on the number of application files stored in memory. Each application file directory entry occupies 16 bytes. Report Packet 67h is divided into subpackets called pages when the data byte limit is exceeded. The PAGE INDEX and MAXIMUM PAGE INDEX bytes are used to account for the pages included in the report (0 of 2, 1 of 2, 2 of 2).

The TX BLOCK IDENTIFIER uses a roll-over counter to assign a transaction number to the report packet pages. The TX BLOCK IDENTIFIER INDEX number is useful for preventing data mismatches when stream synchronization is lost.

[Table 7.58](#) describes the packet structure.

Table 7.58 Report packet 67h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code.
2	PACKET TYPE	CHAR	67h	Report Packet 67h.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
4	TX BLOCK IDENTIFIER	CHAR	00h–FFh	Unique number assigned to every application file transfer.
5	PAGE INDEX	CHAR	00h–FFh	Page index assigned to packet page.
6	MAXIMUM PAGE INDEX	CHAR	00h–FFh	Page index assigned to the last packet page.
Begin Directory List				
7	# APP FILES		00h–n	Number of application files in directory.
¹ The Date/Time fields should all be relative to UTC.				
First Application File Directory Record				
<i>The following record block (bytes 8–23) is repeated for every application file stored in directory. At least one application file exists (SYSTEM FILE INDEX number 0, the Default Application File). The receiver can store at least 10 user-defined application file records.</i>				
8	SYSTEM FILE INDEX	CHAR	See Table 7.59, page 143	Record number assigned to the file.
9–16	APP FILE NAME	CHARs	ASCII text	Name of application file (8 ASCII characters).
17	CREATION YEAR [†]	CHAR	00h–FFh	Year when file is created. Based on the years since 1900 (1900 = 00).

Table 7.58 Report packet 67h structure (continued)

Byte #	Item	Type	Value	Meaning
18	CREATION MONTH ¹	CHAR	01h–0Ch	Month of the year when file is created (1–12).
19	CREATION DAY ¹	CHAR	01h–1Fh	Day of the month when file is created (1–31).
20	CREATION HOUR ¹	CHAR	00h–17h	Hour when file is created (0–23).
21	CREATION MINUTES ¹	CHAR	00h–3Bh	Minutes of hour when file is created (0–59).
22–23	APP FILE SIZE	SHORT	bytes	Size of file.
<i>Begin Second Application File Record Entry</i>				
.				
.				
.				
<i>End with Last Application File Record Entry</i>				
Length +4	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value.
Length +5	ETX	CHAR	03h	End transmission.

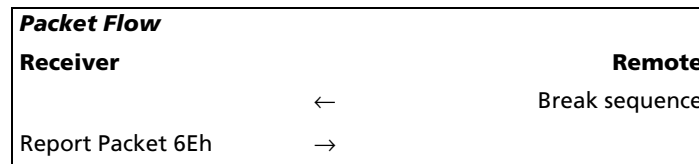
¹ The Date/Time fields should all be relative to UTC.

Table 7.59 SYSTEM FILE INDEX values

Byte Value		Meaning
Dec	Hex	
0	00h	Application file record number of the default application file which contains factory default values.
1–n	01h–nh	Application file record number.

6Eh, BREAKRET (Break sequence return)

Command Packet 6Eh returns the receivers current serial port communication parameters, receiver version numbers and dates, and communication protocol settings when the remote device sends a 250 millisecond (minimum duration) break sequence.



Sending a break sequence

To initiate a break sequence return, the following events need to occur:

1. The remote device sends a break sequence with a minimum duration of 250 milliseconds to the receiver. For example, pressing **Ctrl**+**Break** from an office computer is equivalent to sending a break sequence.
2. The receiver detects the break signal and responds by setting the communication parameters for the serial port to 9600 baud, 8 data bits, no parity, and 1 stop bit.
3. The receiver outputs an Identity Message through the serial port to the remote device (see [Table 7.60](#)).

[Table 7.60](#) describes the structure of Report Packet 6Eh.

Table 7.60 Report packet 6eh structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status indicator.
2	PACKET TYPE	CHAR	6Eh	Report Packet 6Eh.
3	LENGTH	CHAR	See Table 7.1, page 66	Data byte count.
	PRODUCT	CHARs	comma delimited ASCII string	Comma-delimited ASCII string indicating the receiver product family name. For more information, see PRODUCT, page 145 .
	PORT SETTING	CHARs	comma delimited ASCII string	Comma-delimited ASCII string indicating the serial port settings and the break sequence acknowledgment code. For more information, see PORT, page 145 .
	PORT STATUS	CHARs	'FIX' / 'ADJ'	FIX: Port settings cannot be changed. ADJ: Port settings can be changed.
	VERSION	CHARs	comma delimited ASCII string	Comma-delimited ASCII string indicating the software version number and version release date. For more information, see VERSION, page 146 .

Table 7.60 Report packet 6eh structure (continued)

Byte #	Item	Type	Value	Meaning
	COMM PROTOCOL	CHARs	comma delimited ASCII string	Comma-delimited ASCII string indicating the communication protocols supported on serial portm serial number, and Ethernet IP address. For more information, see COMM , page 146. SERIAL: Receiver serial number NOT SET'ETHIP: Receiver Ethernet IP address in xxx.xxx.xxx.xxx format or 0.0.0.0 if not found.
	CHECKSUM	CHAR	See Table 7.1 , page 66	Checksum value.
	ETX	CHAR	03h	End transmission.

Identity message format

The following example shows the structure of an Identity Message:

```
<STX><0><0x6E><93>
PRODUCT,BD982;
PORT,1,38400,38400,8,1,N,F;
VERSION,4.30, 4/14/10,,;
COMM,DCOL,NMEA;
<CHECKSUM><ETX>
```

Note – The previous example shows the strings on separate lines for clarity, but the actual message is one continuous string of characters.

Detailed information about the four parameter strings is described in the following sections.

PRODUCT

For the receiver, the PRODUCT string is always set to BD982. The string always begins with the word PRODUCT, followed by a comma, followed by the word BD982, and terminated with a semicolon as in the following example:

```
PRODUCT,BD982;
```

PORT

The PORT parameter is a comma-delimited string of ASCII characters describing the current input baud rate, output baud rate, data bits, stop bits, parity, and the break sequence status acknowledgment. The syntax of the comma delimited string is shown below:

```
PORT,input baud rate,output baud rate,data bits,stop bits, parity,boolean
acknowledgement;
```

The string always begins with the word PORT, and the end of the string is always terminated with a semicolon character. Commas are used to delimit the other fields within the string.

The input and output protocols can be 2400, 4800, 9600, 19200, 38400, 57600, or 115k baud. The number of data bits is always set to 8, and the number of stop bits is always set to 1. The parity can be O (Odd), E (Even), or N (None). The string always identifies the current communication parameters defined for the port.

The final field in the string contains the boolean (T or F) code used to acknowledge the break sequence. A value of T (True) indicates that the communication parameters for the port are going to be set to 9600,8,N,1 for at least 5 seconds. A value of F (False) indicates that the receiver outputs the identity strings at 9600,8,N,1 and returns to the current port settings.

A sample string is shown below:

PORT,38400,38400,8,1,N,F;

VERSION

The VERSION parameter is a comma-delimited string of ASCII characters with the BD982 firmware and hardware version numbers and release dates. The end of the string is terminated with a semicolon. The syntax of the comma-delimited ASCII string is shown below:

VERSION,*software version number*,*version date*,*hardware version*,*version date*;

The string always begins with the word VERSION, followed by the software version number and date and two commas (,). The slash character (/) is used to separate the month, day, and year in date fields. The string is always terminated with a semicolon character. The following example shows a sample string:

VERSION,2.21,11/21/98,,;

COMM

The COMM parameter is a comma-delimited string of communication protocols supported on the connected serial port. The string has the following syntax:

COMM,*first protocol*,...*last protocol*;

The string always begins with the word COMM and a comma, followed by the comma-delimited list of protocols. The string is terminated with a semicolon character. [Table 7.61](#) identifies the ASCII codes assigned to the various protocols supported by the receiver.

Table 7.61 COMM

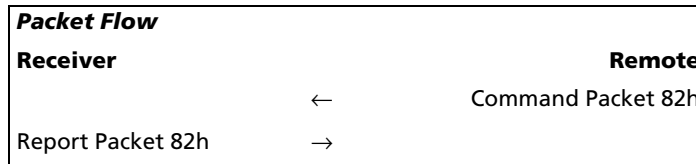
Protocol	Meaning
DCOL	Data Collector Format
NMEA	Outputs a subset of NMEA-0183 messages
RTCM	Radio Technical Commission for Maritime Services protocol specification RTCM SC-104

For example, the comma-delimited ASCII string for the connected serial port which supports DCOL and RTCM is shown below:

COMM,DCOL,RTCM;

82h, SCRDUMP (Screen dump)

Command Packet 82h has two forms—a command packet and report packet. Both packets are assigned the same hexadecimal code (82h). For more information, see [82h, SCRDUMP \(Screen dump request\)](#), page 94.



Report Packet 82h is sent in response to Command Packet 82h. The receiver generates an ASCII representation (a dump) of a BD982 display screen, and sends the dump to the remote device in Report Packet 82h. [Table 7.62](#) shows the packet structure.

Table 7.62 Report packet 82h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See Table 7.2, page 67	Receiver status code
2	PACKET TYPE	CHAR	82h	Report Packet 82h
3	LENGTH	CHAR	A1h	Data byte count
4–163	ASCII DATA	CHARs		ASCII data
164	CURSOR POSITION	CHAR		Position of the cursor
165	CHECKSUM	CHAR	See Table 7.1, page 66	Checksum value
166	ETX	CHAR	03h	End transmission

Default Settings

In this chapter:

- [Default receiver 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.

Default receiver settings

These settings are defined in the default application file.

Function		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 (Height above ellipsoid)
Antenna:	Type	Unknown
	Height (true vertical)	0.00 m
	Measurement method	Antenna Phase Center
1 PPS		Disabled

Specifications

In this chapter:

- Physical specifications
- Performance specifications
- Electrical specifications
- Communication specifications

This chapter details the specifications for the receiver.

Specifications are subject to change without notice.

Physical specifications

Feature	Specification
Dimensions (L x W x H)	100 mm x 84.9 mm x 11.6 mm
Temperature	
Operating	–40 °C to +75 °C (–40 °F to +167 °F)
Storage	–55 °C to +85 °C (–40 °F to +176 °F)
Vibration	MIL810F, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL810D ±40 g operating ±75 g survival
I/O Connector	40-pin header (Samtec TMM-120-03-L-D)
Antenna Connector	2 × MMCX receptacle (Huber-Suhner 82MMCX-50-0-1/111); mating connectors are MMCX plug (Suhner 11MMCX-50-2-1C) or right-angle plug (Suhner 16MMCX-50-2-1C, or 16MMCX-50-2-10)

Performance specifications

Feature	Specification
Measurements	<ul style="list-style-type: none"> Position antenna based on a 220-channel Maxwell 6 chip: <ul style="list-style-type: none"> GPS: Simultaneous L1 C/A, L2E, L2C, L5 GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A (GLONASS M Only), L2 P SBAS: Simultaneous L1 C/A, L5 GIOVE-A: Simultaneous L1 BOC, E5A, E5B, E5AltBOC Footnotes: 1 GIOVE-B: Simultaneous L1 CBOC, E5A, E5B, E5AltBOC Footnotes: 1 GALILEO: Disabled Footnotes: 2 Vector antenna based on a second 220-channel Maxwell 6 chip: <ul style="list-style-type: none"> GPS: Simultaneous L1 C/A, L2E, L2C GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A, L2 P Advanced Trimble Maxwell 6 Custom Survey GNSS Technology High precision multiple correlator for GNSS pseudorange measurements Unfiltered, unsmoothed pseudorange measurements 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 Signal-to-Noise ratios reported in dB-Hz Proven Trimble low elevation tracking technology
Code differential GPS positioning accuracy Footnotes: 3	0.25 m + 1 ppm Horizontal 0.50 m + 1 ppm Vertical
SBAS (WAAS/EGNOS/MSAS) accuracy Footnotes: 4	<5 m 3DRMS

Feature	Specification
RTK positioning accuracy	
Horizontal accuracy	$\pm(8 \text{ mm} + 1 \text{ ppm}) \text{ RMS}$
Vertical accuracy	$\pm(15 \text{ mm} + 1 \text{ ppm}) \text{ RMS}$
Heading accuracy	2 m baseline $<0.09^\circ$ 10 m baseline $<0.05^\circ$
Initialization time	Typically, less than 10 seconds
Initialization reliability	Typically $>99.9\%$

Footnotes: ⁵

Footnotes:

1. *Galileo GloVE-A and GloVE-B test satellite support uses information that is unrestricted in the public domain and is intended for signal evaluation and test purposes.*
2. *The hardware is compliant with Galileo OS SIS ICD, Draft 1, February 2008. Commercial sale of Galileo technology requires Trimble to acquire a Commercial license from the EU. At the time of writing, there is no process for obtaining a license. Therefore, to comply with the ICD Copyright/IPR terms, all Galileo firmware and hardware functionality is disabled. Depending on the terms of the license, an upgrade to full Galileo (L1 CBOC, E5A, E5B, E5AltBOC) may be offered. This will require an additional fee.*
3. *Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended practices.*
4. *Depends on WAAS, EGNOS, and MSAS system performance.*
5. *May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.*

Electrical specifications

Feature	Specification
Power	3.3 V DC $+5\%/-3\%$
Power consumption	Typically, 2.1 W (L1/L2 GPS) Typically, 2.3 W (L1/L2 GPS and G1/G2 GLONASS)

Communication specifications

Feature	Specification
Communications	
1 LAN port	<ul style="list-style-type: none"> • Supports links to 10BaseT/100BaseT networks. • All functions are performed through a single IP address simultaneously—including web interface access and data streaming.
4 x RS-232 ports	Baud rates up to 115,200.
1 USB port	
Receiver position update rate	1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz, and 50 Hz positioning
Correction data input	CMR, CMR+™, RTCM 2.0 (select RTCM 2.1), RTCM 2.1–2.3, RTCM 3.0, 3.1.
Correction data output	CMR, CMR+, RTCM 2.0 DGPS (select RTCM 2.1), RTCM 2.1–2.3, RTCM 3.0, 3.1.
Data outputs	1PPS, NMEA, Binary GSOE, ASCII Time Tags.
Event Marker Input support	

NMEA-0183 Output

In this appendix:

- [NMEA-0183 message overview](#)
- [Common message elements](#)
- [NMEA messages](#)

This appendix describes the formats of the subset of NMEA-0183 messages that are available for output by the receivers. For a copy of the NMEA-0183 Standard, go to the National Marine Electronics Association website at www.nmea.org.

To enable NMEA messages, see the configuration methods described in:

- [Chapter 5, Configuring the BD982 Receiver Using Trimble Software Utilities](#)
- [Chapter 6, Configuring the BD982 Receiver Using a Web Browser](#)
- [Chapter 7, Configuring the BD982 Receiver Using Binary Interface Commands](#)

NMEA-0183 message 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 GPS receiver.

All messages partially 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, and shows the page that contains detailed information about each message.

Message	Function	Page
ADV	Position and Satellite information for RTK network operations	158
GBS	GNSS Satellite Fault Detection	159
GGA	Time, position, and fix related data	161
GLL	Position data	162
GRS	GPS Range Residuals	163
GSA	GPS DOP and active satellites	164
GST	Position error statistics	165
GSV	Number of SVs in view, PRN, elevation, azimuth, and SNR	166
HDT	Heading from True North	167
PTNL,AVR	Time, yaw, tilt, range, mode, PDOP, and number of SVs for Moving Baseline RTK	168
PTNL,BPQ	Base station position and position quality indicator	169
PTNL,GGK	Time, position, position type and DOP values	170
PTNK,PJT	Projection type	171
PTNL,PJK	Local coordinate position output	172
PTNL,VGK	Time, locator vector, type and DOP values	173
PTNL,VHD	Heading Information	174
RMC	Position, Velocity, and Time	175
ROT	Rate of turn	176
VTG	Actual track made good and speed over ground	177
ZDA	UTC day, month, and year, and local time zone offset	178

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

Below is an example of 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
```

Message values

NMEA messages that the receiver generates contains the following values.

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.cc*, where:

- *hh* is hours, from 00 through 23
- *mm* is minutes
- *ss* is seconds
- *cc* is hundredths of seconds

NMEA messages

When NMEA-0183 output is enabled, the following messages can be generated.

ADV Position and Satellite information for RTK network operations

An example of the ADV message string is shown below. [Table A.1](#) and [Table A.2](#) describe the message fields. The messages alternate between subtype 110 and 120.

\$PGPPADV,110,39.88113582,-105.07838455,1614.125*1M

Table A.1 ADV subtype 110 message fields

Field	Meaning
0	Message ID \$PPGPADV
1	Message sub-type 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 *

\$PGPPADV,120,21.76.82,68.51,29,20.66,317.47,28,52.38,276.81,22,42.26,198.96*5D

Table A.2 ADV subtype 120 message fields

Field	Meaning
0	Message ID \$PPGPADV
1	Message sub-type 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
7	Azimuth of second satellite, degrees from True North, 000° through 359°
8	The checksum data, always begins with *

GBS GNSS satellite fault detection

The GBS message supports the Receiver Autonomous Integrity Monitoring (RAIM).

Given that a GNSS receiver tracks enough satellites to perform integrity checks of the positioning quality of the position solution, a message is needed to report the output of this process to other systems to advise the system user. With RAIM in the GNSS receiver, the receiver can isolate faults to individual satellites, and omit them from its position and velocity calculations. In addition, the GNSS receiver can still track the satellite, and easily judge when it is back within tolerance. This message reports this RAIM information.

To perform this integrity function, the GNSS receiver must have at least two observables in addition to the minimum required for navigation. Normally, these observables take the form of additional redundant satellites. If *only* GPS, GLONASS or so on is used for the reported position solution, the talker ID is GP, GL, or as appropriate, and the errors pertain to the individual system. If satellites from multiple systems are used to obtain the reported position solution, the talker ID is GN and the errors pertain to the combined solution.

An example of the GBS message string is shown below. [Table A.3](#) describes the message fields.

```
$GPGBS,015509.00,-0.031,-0.186,0.219,19,0.000,-0.354,6.972*4D
```

Table A.3 GBS message fields

Field	Meaning
0	Message ID \$GBS
1	UTC time of GGA or GNS fix associated with this message
2	Expected error in latitude ¹
3	Expected error in longitude ¹
4	Expected error in altitude ¹
5	ID number ² of most likely failed satellite
6	Probability of missed detection for most likely failed satellite
7	Estimate of bias in meters on most likely failed satellite
8	Standard deviation of bias estimate

Notes –

1. *Expected error, in meters, due to bias, with noise = 0.*
2. *To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention applies:*

Satellite system	ID numbers
GPS	PRN numbers (1-32)
WAAS	33-64
GLONASS	65-96 64+satellite slot number: 1-24 = the full GLONASS constellation of 24 satellites. This gives a range of 65 through 88. 88 through 99 are available if slot numbers above 24 are allocated to on-orbit spares.

GGA Time, Position, and Fix Related Data

An example of the GGA message string is shown below. [Table A.4](#) describes the message fields.

Note – *The following data string exceeds the NMEA standard length.*

```
$GPGGA,172814.0,3723.46587704,N,12202.26957864,W,  
2,6,1.2,18.893,M,-25.669,M,2.0,0031*4F
```

Table A.4 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 4: Real Time Kinematic, fixed integers 5: Real Time Kinematic, float integers
7	Number of SVs in use, range from 00 through 12
8	HDOP
9	Orthometric height (MSL reference)
10	M: unit of measure for orthometric height is meters
11	Geoid separation
12	M: geoid separation is 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, ranging from 0000 through 1023. A null field when any reference station ID is selected and no corrections are received.
15	The checksum data, always begins with *

GLL**Position data: position fix, time of position fix, and status**

An example of the GLL message string is shown below. [Table A.21](#) describes the message fields.

\$GPGSA,A,3,3,6,27,19,9,14,21,22,18,15,,,2.1,1.0,1.8*03

Table A.5 GLL message fields

Field	Meaning
0	Message ID \$GPGLL
1	Latitude in dd mm,mmmm format (0-7 decimal places)
2	Direction of latitude N: North S: South
3	Longitude in ddd mm,mmmm format (0-7 decimal places)
4	Direction of longitude E: East W: West
5	UTC of position in hhmmss.ss format
6	Fixed text "A" shows that data is valid
7	The checksum data always begins with *

GRS**GRS range residuals**

The GRS message is used to support the Receiver Autonomous Integrity Monitoring (RAIM).

Note – *Because the contents of this NMEA message do not change significantly during a one-second interval, the receiver outputs this message at a maximum rate of 1 Hz.*

An example of the GRS message string is shown below. [Table A.21](#) describes the message fields.

\$GPGRS,220320.0,0,-0.8,-0.2,-0.1,-0.2,0.8,0.6,,,,,,*55

Table A.6 GRS message fields

Field	Meaning
0	Message ID \$GPGRS
1	UTC time of GGA position fix
2	Residuals 0: Residuals used to calculate position given in the matching GGA line 1: Residuals recomputed after the GGA position was computed
3-14	Range residuals for satellites used in the navigation solution, in meters

GSA GPS DOP and active satellites

An example of the GSA message string is shown below. [Table A.7](#) describes the message fields.

```
$GPGSA,<1>,<2>,<3>,<3>,,,,,<3>,<3>,<3>,<4>,<5>,<6>*<7><CR><LF>
```

Table A.7 GSA message fields

Field	Meaning
0	Message ID \$GPGSA
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, of satellite used in solution, up to 12 transmitted
4	PDOP-Position dilution of precision, 0.5 through 99.9
5	HDOP-Horizontal dilution of precision, 0.5 through 99.9
6	VDOP-Vertical dilution of precision, 0.5 through 99.9
7	The checksum data, always begins with *

GST **Position Error Statistics**

An example of the GST message string is shown below. [Table A.8](#) describes the message fields.

\$GPGST,172814.0,0.006,0.023,0.020,273.6,0.023,0.020,0.031*6A

Table A.8 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 *

GSV Satellite Information

The GSV message string identifies the number of SVs in view, the PRN numbers, elevations, azimuths, and SNR values. An example of the GSV message string is shown below. [Table A.9](#) describes the message fields.

```
$GPGSV,4,1,13,02,02,213,,03,-3,000,,11,00,121,,14,13,172,05*67
```

Table A.9 GSV message fields

Field	Meaning
0	Message ID \$GPGSV
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, 00–99 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 *

HDT **Heading from True North**

The HDT message outputs the heading calculated between the two antennas of the receiver.

The HDT string is shown below, and [Table A.10](#) describes the message fields.

\$GPHDT,123.456,T*00

Table A.10 Heading from true north 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 *

PTNL,AVR**Time, Yaw, Tilt, Range for Moving Baseline RTK**

The AVR message outputs the attitude vector calculated between the two antennas of the receiver.

The PTNL,AVR message string is shown below, and [Table A.11](#) describes the message fields.

```
$PTNL,AVR,181059.6,+149.4688,Yaw,+0.0134,Tilt,,,60.191,3,2.5,6*00
```

Table A.11 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
6	Reserved
7	Reserved
8	Range in meters
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 *

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, typically the SPS551H.

The PTNL,BPQ message string is shown below, and [Table A.12](#) describes the message fields.

```
$PTNL,BPQ,224445.06,021207,3723.09383914,N,12200.32620132,W,EHT-5.923,
M,5*
```

Table A.12 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 1: Autonomous GPS fix 2: Differential SBAS 4: RTK Fixed 5: OmniSTAR XP, OmniSTAR HP, Float RTK, or Location RTK
11	The checksum data, always begins with *

PTNL,GGK**Time, Position, Position Type, DOP**

An example of the PTNL,GGK message string is shown below. [Table A.13](#) describes the message fields.

```
$PTNL,GGK,172814.00,071296,3723.46587704,N,12202.26957864,W,3,06,1.7,EHT-6.777,M*48
```

Table A.13 PTNL,GGK message fields

Field	Meaning
0	Message ID \$PTNL,GGA
1	UTC of position fix
2	Date
3	Latitude
4	Direction of latitude: N: North S: South
5	Longitude
6	Direction of Longitude: E: East W: West
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 in a Network solution 9: RTK Fixed 2D Network solution 10: OmniSTAR HP/XP solution 11: OmniSTAR VBS solution
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M: ellipsoidal height is measured in meters
12	The checksum data, always begins with *

Note – The PTNL,GGK message is longer than the NMEA-0183 standard of 80 characters.

PTNL,PJT**Projection Type**

An example of the PTNL,PJT message string is shown below. [Table A.14](#) describes the message fields.

\$PTNL,PJT,NAD83(Conus),California Zone 4 0404,*51

Table A.14 PTNL,PJT message fields

Field	Meaning
0	Message ID \$PTNL,PJT
1	Coordinate system name (can include multiple words)
2	Project name (can include multiple words)
3	The checksum data, always begins with *

PTNL,PJK**Local Coordinate Position Output**

An example of the PTNL,PJK message string is shown below. [Table A.15](#) describes the message fields.

```
$PTNL,PJK,010717.00,081796,+732646.511,N,+1731051.091,E,1,05,2.7,EHT-
28.345,M*7C
```

Table A.15 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
8	Number of satellites in fix
9	PDOP of fix
10	Ellipsoidal height of fix
11	M: ellipsoidal 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.

PTNL,VGK**Vector Information**

The VGK message outputs the vector calculated between the external base station and the position antenna of the receiver.

An example of the PTNL,VGK message string is shown below. [Table A.16](#) describes the message fields.

```
$PTNL,VGK,160159.00,010997,-0000.161,00009.985,-0000.002,3,07,1,4,M*0B
```

Table A.16 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
7	Number of satellites if fix solution
8	PDOP of fix
9	M: Vector components are in meters
10	The checksum data, always begins with *

PTNL,VHD

Heading information

The VHD message outputs the vector heading calculated between the external base station and the position antenna of the receiver.

An example of the PTNL,VHD message string is shown below. [Table A.17](#) describes the message fields.

```
$GPRMC,202652.00,A,3953.88199731,N,10506.75992590,W,0.021,1.588,140211,9.0
387,E,D*10
```

Table A.17 PTNL,VHD message fields

Field	Meaning
0	Message ID \$PTNL,VHD
1	UTC of position in hhmmss.ss format
2	Date in mmddyy format
3	Azimuth
4	Δ Azimuth/ Δ Time
5	Vertical Angle
6	Δ Vertical/ Δ Time
7	Range
8	Δ Range/ Δ Time
9	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
10	Number of satellites used in solution
11	PDOP
12	The checksum data, always begins with *

RMC Position, Velocity, and Time

The RMC string is shown below, and [Table A.18](#) describes the message fields.

```
$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W*6A
```

Table A.18 GPRMC message fields

Field	Meaning
0	Message ID \$GPRMC
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 *

ROT Rate and Direction of Turn

The ROT string is shown below, and [Table A.19](#) describes the message fields.

\$GPROT,35.6,A*4E

Table A.19 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 *

VTG Track Made Good and Speed Over Ground

An example of the VTG message string is shown below. [Table A.20](#) describes the message fields.

```
$GPVTG,,T,,M,0.00,N,0.00,K*4E
```

Table A.20 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	The checksum data, always begins with *

ZDA UTC Day, Month, And Year, and Local Time Zone Offset

An example of the ZDA message string is shown below. [Table A.21](#) describes the message fields.

```
$GPZDA,172809,12,07,1996,00,00*45
```

Table A.21 ZDA message fields

Field	Meaning
0	Message ID \$GPZDA
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.

Upgrading the Receiver Firmware

In this appendix:

- [The WinFlash utility](#)
- [Upgrading the receiver firmware](#)

The GPS receiver is supplied with the latest version of the receiver firmware already installed. If a later version of the firmware becomes available, use the WinFlash utility to upgrade the firmware on your receiver.

You can also upgrade the receiver through the web interface (see [Configuring the receiver using a web browser, page 41](#)). If your receiver has access to the Internet, then whenever Trimble releases new firmware your receiver will check and display the new firmware version number in the Web browser. You can then decide to install the newer firmware from the Web browser.

You can download firmware updates from www.pacificcrest.com/support.php?page=updates.

The WinFlash utility

The WinFlash utility communicates with Trimble products to perform various functions including:

- installing software, firmware, and option upgrades
- running diagnostics (for example, retrieving configuration information)
- configuring radios

For more information, online help is also available when using the WinFlash utility.

Note – *The WinFlash utility runs on Microsoft Windows 95, 98, Windows NT®, 2000, Me, or XP operating systems.*

Installing the WinFlash utility

You can install the WinFlash utility from the *Trimble SPS GPS Receiver CD*, or from the Trimble website.

To install the WinFlash utility from the CD:

1. Insert the disk into the CD drive on your computer.
2. From the main menu select *Install individual software packages*.
3. Select *Install WinFlash*.
4. Follow the on-screen instructions.

The WinFlash utility guides you through the firmware upgrade process, as described below. For more information, refer to the WinFlash Help.

Upgrading the receiver firmware

1. Start the WinFlash utility. The *Device Configuration* screen appears.
2. From the *Device type* list, select your receiver.
3. From the *PC serial port* field, select the serial (COM) port on the computer that the receiver is connected to.

4. Click **Next**.

The *Operation Selection* screen appears. The *Operations* list shows all of the supported operations for the selected device. A description of the selected operation is shown in the *Description* field.

5. Select *Load GPS software* and then click **Next**.

The *GPS Software Selection* window appears. This screen prompts you to select the software that you want to install on the receiver.

6. From the *Available Software* list, select the latest version and then click **Next**.

The *Settings Review* window appears. This screen prompts you to connect the receiver, suggests a connection method, and then lists the receiver configuration and selected operation.

7. If all is correct, click **Finish**.

Based on the selections shown above, the *Software Upgrade* window appears and shows the status of the operation (for example, **Establishing communication with <your receiver>**. Please wait.).

8. Click **OK**.

The *Software Upgrade* window appears again and states that the operation was completed successfully.

9. To select another operation, click **Menu**; to quit, click **Exit**.

If you click **Exit**, the system prompts you to confirm.

10. Click **OK**.

Troubleshooting

In this appendix:

- [Receiver issues](#)

Use this appendix to identify and solve common problems that may occur with the receiver.

Please read this section before you contact Technical Support.

Receiver issues

This section describes some possible receiver issues, possible causes, and how to solve them.

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.
	No power to radio.	If the radio has its own power supply, check the charge and connections.
		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.
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).
Communication to the receiver is lost and the LEDs are not behaving normally.	The internal firmware may be corrupt.	With the receiver in the I/O board, apply power while pressing the Boot Monitor button. Reload firmware using the WinFlash utility. See Appendix B, Upgrading the Receiver Firmware.

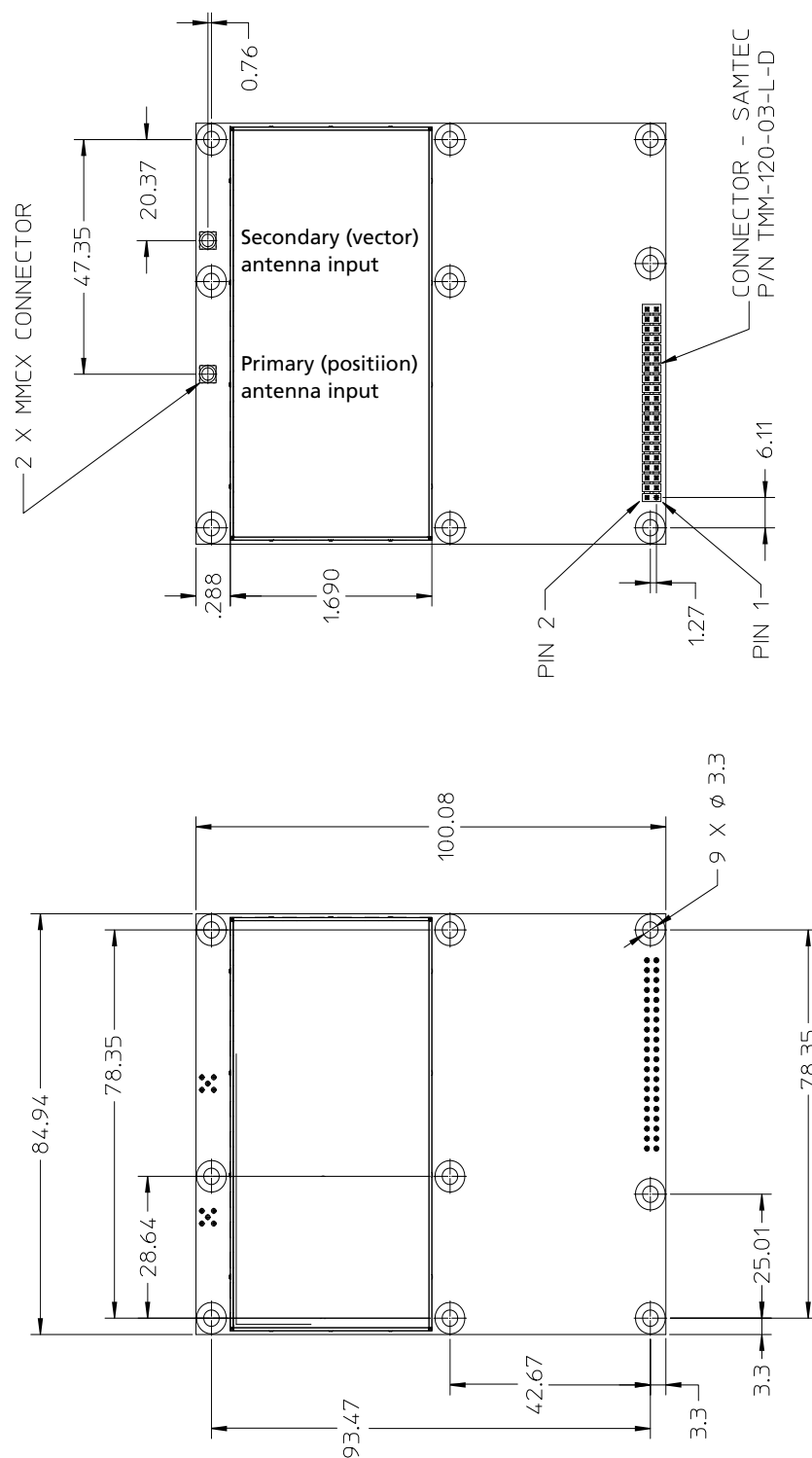
Drawings

In this appendix:

- [Plan view](#)
- [Edge view](#)

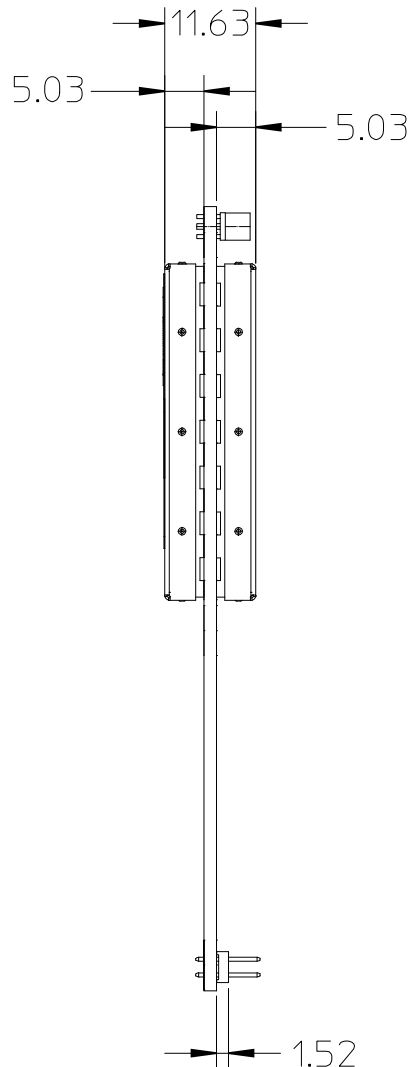
The drawings in this appendix show the dimensions of the receiver. Refer to these drawings if you need to build mounting brackets and housings for the receiver.

Dimensions are shown in millimeters (mm)



Edge view

Dimensions are shown in millimeters (mm)



Electrical Systems Integration

In this appendix:

- Connector pinouts
- 1PPS and ASCII time tag
- ASCII time tag
- Power input
- Antenna power output
- LED control lines
- Power switch and reset
- Event
- Serial port
- CAN
- USB
- Ethernet

Connector pinouts

40-pin header

The 40-pin header (J1) has the following pinouts.

Pin	Signal name	Description	Integration notes
1	GND	Ground Digital ground.	Ground Digital ground.
2	RTK LED	RTK LED. Flashes when an RTK correction is present. This is similar to all BD9xx products, except for the requirement for an external resistor.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4 mA. For LEDs with Vf above 2.7 or current excess of 4 mA, an external buffer is required.
3	POWER_OFF	Powers the unit on and off.	Drive high with a 3.3 V to turn off, leave floating or ground to keep the unit on. Integrators should not drive TTL signals when the unit is not powered.
4	PPS (Pulse per Second)	Pulse per second.	This is 3.3 V TTL level, 4 mA max drive capability. To drive 50 load to ground, an external buffer is required.
5	VCC Input DC Card power	VCC Input DC Card power (3.3 V only).	VCC Input DC Card power (3.3 V only).
6	VCC Input DC Card power	VCC Input DC Card power (3.3 V only).	VCC Input DC Card power (3.3 V only).
7	Event2, CAN1_Rx and COM3_Rx	Event2 – Event input.	MUTUALLY EXCLUSIVE and TTL level.
		CAN1_Rx – CAN Receive line.	Connect Event2 to a TTL level signal to use as Event. Connect CAN1_Rx to RX line of a CAN driver to use as CAN.
		COM3_Rx – COM3 Receive line.	Connect COM3_Rx to a transceiver if RS-232 level is required.
8	Event1	Event1 – Input.	Event1 (must be 3.3 V TTL level).
9	Power LED	POWER Indicator. High when unit is on, low when off. This is similar to all BD9xx products, except for the requirement for an external resistor. This allows the user to use this as a control line.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4 mA. For LEDs with Vf above 2.7 or current excess of 4 mA, an external buffer is required.
10	Satellite LED	Satellite LED. Rapid flash indicates <5 satellites. Slow flash indicates >5 Satellites.	When used to drive an LED, a series resistor with a typical value of 300 Ohms is required. This pin supplies a maximum current of 4mA. For LEDs with Vf above 2.7 or current excess of 4 mA, an external buffer is required.
11	COM2_CTS	COM2 Clear to Send – TTL Level.	Connect COM2_CTS to a transceiver if RS-232 level is required.
12	RESET_IN	RESET_IN – Ground to reset.	Drive low to reset the unit. Otherwise, leave unconnected.
13	COM2_RTS	COM 2 Request to Send.	Request to Send for COM 2 connect to a transceiver if RS-232 level is required.

Pin	Signal name	Description	Integration notes
14	COM2_Rx	COM 2 Receive Data – TTL Level.	Connect COM2_RX to a transceiver if RS-232 level is required.
15	COM1_CTS	COM 1 Clear to Send – RS-232 Level.	–
16	COM2_Tx	COM 2 Transmit Data – TTL Level.	Connect COM2_TX to a transceiver if RS-232 level is required.
17	COM1_RT5	COM 1 Request to Send – RS-232 Level.	
18	COM1_Rx	COM 1 Receive Data – RS-232 Level.	–
19	CAN1_Tx and COM3_Tx	CAN1_Tx – CAN Transmit line.	MUTUALLY EXCLUSIVE and TTL level.
		COM3_Tx – COM3 Transmit line.	Connect CAN1_Tx to TX line of a CAN driver to use as CAN.
			Connect COM3_Tx to a transceiver if RS-232 level is required.
20	COM1_Tx	COM 1 Transmit Data – RS-232 Level.	–
21	USB D (-)	USB D (-) Bi-directional USB interface data (-).	USB data for OTG mode (device and host).
22	USB D (+)	USB D (+) Bi-directional USB interface data (+).	USB data for OTG mode (device and host).
23	GND	Ground Digital Ground.	GND Ground Digital Ground.
24	GND	Ground Digital Ground.	GND Ground Digital Ground.
25	USB ID	USB OTG ID.	Driving a low level puts unit into USB device mode. High level or no-connect puts unit in host mode. Pull-up is on unit and not required for integration.
26	USB Vbus	USB Vbus.	In USB device operation, Vbus is only used for detection. In USB Host mode unit supplies power per USB spec (500 mA at 5 V max).
27	GND	Ground Digital Ground.	GND Ground Digital Ground.
28	GND	Ground Digital Ground.	GND Ground Digital Ground.
29	GND	Ground Digital Ground.	GND Ground Digital Ground.
30	GND	Ground Digital Ground.	GND Ground Digital Ground.
31	GND	Ground Digital Ground.	GND Ground Digital Ground.
32	GND	Ground Digital Ground.	GND Ground Digital Ground.
33	ETH_TD+	Ethernet Transmit. Positive side of differential pair.	Connect straight to Ethernet connector. Magnetics are on-board unit.
34	ETH_RD+	Ethernet Receive. Positive side of differential pair.	Connect straight to Ethernet connector. Magnetics are on-board unit.
35	ETH_TD-	Ethernet Transmit. Negative side of differential pair.	Connect straight to Ethernet connector. Magnetics are on-board unit.
36	ETH_RD-	Ethernet Receive. Negative side of differential pair.	Connect straight to Ethernet connector. Magnetics are on-board unit.

Pin	Signal name	Description	Integration notes
37	COM4_Rx	COM 4 Receive Data – RS-232 Level.	–
38	COM4_Tx	COM 4 Transmit Data – RS-232 Level.	–
39	GND	Ground Digital Ground.	GND Ground Digital Ground.
40	GND	Ground Digital Ground.	GND Ground Digital Ground.

1PPS and ASCII time tag

The receiver can output a 1 pulse-per-second (1PPS) time strobe and an associated time tag message. The time tags are output on a user-selected port.

The leading edge of the pulse coincides with the beginning of each UTC second. The pulse is driven between nominal levels of 0.0 V and 3.3 V (see [Figure E.1](#)). The leading edge is positive (rising from 0 V to 3.3 V). The BD982 PPS out is a 3.3 V TTL level with a maximum source/sink current of 4 mA. If the system requires a voltage level or current source/sink level beyond these levels, you must have an external buffer. This line has ESD protection.

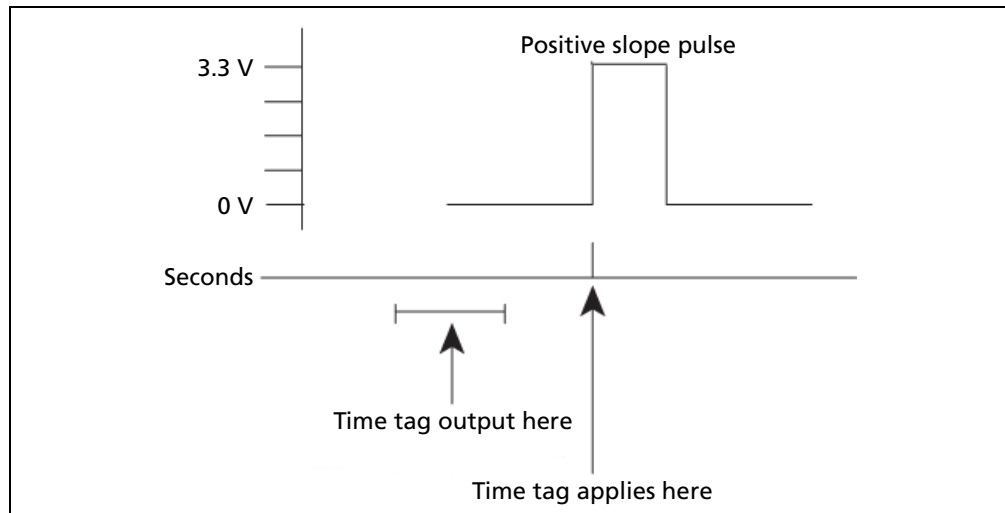


Figure E.1 Time tag relation to 1PPS wave form

The pulse is about 8 microseconds wide, with rise and fall times of about 100 nsec. Resolution is approximately 40 nsec, but the following external factor limits accuracy to approximately ± 1 microsecond:

- Antenna cable length

Each meter of cable adds a delay of about 2 nsec to satellite signals, and a corresponding delay in the 1PPS pulse.

ASCII time tag

Each time tag is output about 0.5 second before the corresponding pulse. Time tags are in ASCII format on a user-selected serial port. The format of a time tag is:

UTC *yy.mm.dd hh:mm:ss ab*

Where:

- UTC is fixed text.
- *yy.mm.dd* is the year, month, and date.
- *hh:mm:ss* is the hour (on a 24-hour clock), minute, and second. The time is in UTC, not GPS.
- *a* is an integer number representing the position-fix type:
 - 1 = time only
 - 2 = 1D & time
 - 3 = currently unused
 - 4 = 2D & time
 - 5 = 3D & time
- *b* is number of GPS satellites being tracked.
- Each time tag is terminated by a *carriage return, line feed* sequence. A typical printout looks like:

UTC 02.12.21 20:21:16 56

UTC 02.12.21 20:21:17 56

UTC 02.12.21 20:21:18 56

Note – *If the receiver is not tracking satellites, the time tag is based on the receiver clock. In this case, *a* and *b* are represented by “?”. The time readings from the receiver clock are less accurate than time readings determined from the satellite signals.*

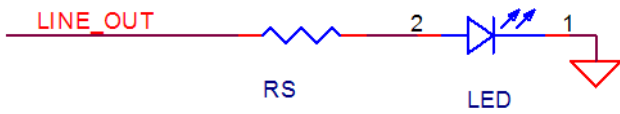
Power input

Power Requirement	<p>The unit operates at 3.3 V +5%/-3%.</p> <p>The 3.3 V should be able to supply 2 A of surge current.</p> <p>Additional Integration Notes –</p> <p>1) To fully protect against the unit resetting while shorting any antenna output, Trimble recommends that the 3.3 V input be rated at least 3.5 A. Power supplies under 3.5 A will lead to the 3.3 V rail drooping, triggering a reset to the system.</p> <p>2) Worst case operation requires a 3 A supply. Worst case operation is defined as: both antennas supplying 5 V at 100 mA, USB supplying 5 V at 250 mA, and actively using all RF bands.</p> <p>The typical power consumption based on band usage is:</p> <ul style="list-style-type: none"> • L1/L2 = 2.08 W • L1/L2/G1/G2 = 2.24 W • L1/L2/G1/G2/SBAS = 2.27 W • L1/L2/G1/G2/SBAS/L5 = 2.54 W • L1/L2/G1/G2/SBAS/L5/Galileo = 2.79 W • L1/L2/G1/G2/SBAS/L5/Galileo + Omnistar = 3.10 W
Power Switch	<p>Pin 3 is an optional power-off pin. When driven high with 3.3 V, the receiver is turned off. This unit can be left floating or ground to keep the unit on. System integrators should not drive TTL signals when the unit is not powered.</p>
Over-voltage Protection	The absolute maximum voltage is 3.6 V.
Under-voltage Protection	The absolute minimum voltage is 3.2 V below nominal.
Reverse Voltage Protection	The unit is protected down to -3.6 V

Antenna power output

Power output specification	The antenna supplies 100mA at 5 V
Short-circuit protection	The unit has an over-current / short circuit protection. Short circuits may cause the unit to reset

LED control lines

Driving LEDs	<p>The receiver outputs are 3.3 V TTL level with a maximum source/sink current of 4mA. An external series resistor must be used to limit the current. The value of the series resistor in Ohms is determined by:</p> $(3.3-V_f)/(I_f) > R_s > (3.3\text{ V} - V_f)/(.004)$ <p>R_s = Series resistor I_f = LED forward current, max typical I_f of the LED should be less than 3mA V_f = LED forward voltage, max typical V_f of the LED should be less than 2.7V</p> <p>Most LEDs can be driven directly as shown in the circuit below:</p>  <p>LEDs that do not meet I_f and V_f specification must be driven with a buffer to ensure proper voltage level and source/sink current.</p>
Power LED	This active-high line indicates that the unit is powered on.
Satellite LED	<p>This active-high line indicates that the unit has acquired satellites.</p> <p>A rapid flash indicates that the unit has less than 5 satellites acquired while a slow flash indicates greater than 5 satellites acquired. This line will stay on if the unit is in monitor mode.</p>
RTK Correction	A slow flash indicates that the unit is receiving correction. This will also flash when the unit is in monitor mode.

Power switch and reset

Power Switch	<p>The integrator may choose to power on or power off the unit. If a 3.3 V level signal is applied to pin 3, Power_Off pin, the unit will disconnect VCC. The system integrator must ensure that other TTL level pins remain unpowered when Power_Off is asserted. Powering TTL-level pins while the unit is powered off will cause excessive leakage current to be sunk by the unit.</p> <p>The integrator may choose to always have the unit powered on. This is accomplished by leaving the Power_Off pin floating or grounded.</p>
Reset Switch	Driving Reset_IN_L, Pin 12, low will cause the unit to reset. The unit will remain reset at least 140mS after the Reset_In_L is deasserted. The unit remains powered while in reset.

Event

Event 1	Pin 8 is dedicated as an Event_In pin. This is a TTL only input, it is not buffered or protected for any inputs outside of 0 V to 3.3V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal prior to connecting to the unit.
Event 2	<p>Event 2 is multiplexed with COM3_RX and CAN_RX. The default setting is to have this line set to COM3_RX. The Event 2 must be enabled in order to use Event2.</p> <p>When using the 63494 Development interface board, the user must not connect anything to Port 3 and the CAN port when using Event 2. The Com3 level selection switch is ignored when Event 2 is selected.</p> <p>This is a TTL only input, it is not buffered or protected for any inputs outside of 0 V to 3.3 V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal prior to connecting to the unit.</p>

Serial port

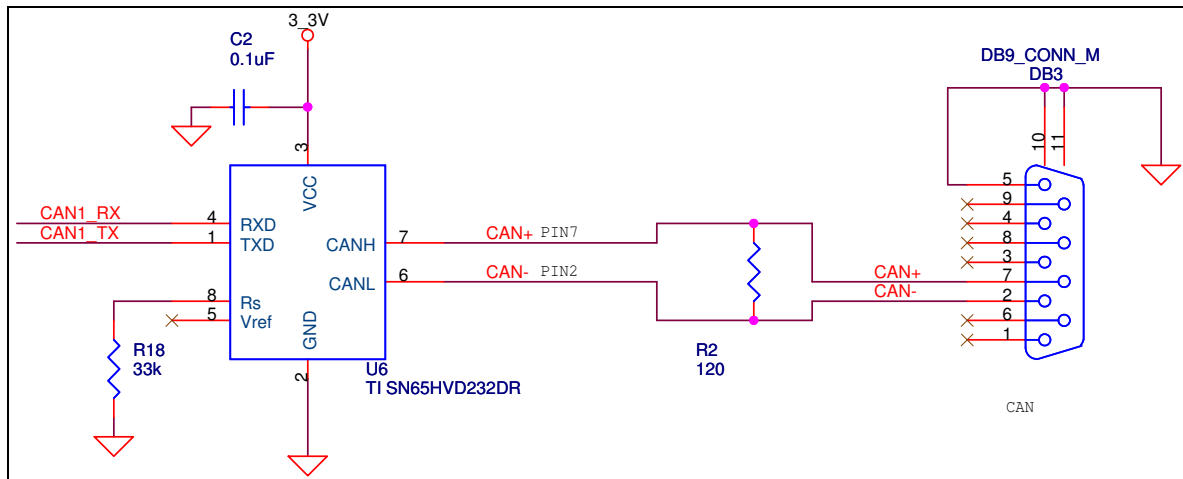
Com 1 RS-232 level with flow control	Com1 is already at RS-232 level and already has 8 kV contact discharge/15 kV air gap discharge ESD Protection. This port has RTS/CTS to support hardware flow control. This is labeled Port 1 on the I/O board.
Com 2 TTL level with flow control	<p>Com 2 is at 0-3.3 V TTL. This port has RTS/CTS to support hardware flow control. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3 V that powers the receiver needs to be added.</p> <p>For development using the I/O board, this Com port is already connected to an RS-232 transceiver. This is labeled Port 2 on the I/O board.</p>
Com 3 TTL level no flow control	<p>Com 3 is at 0-3.3 V TTL and is multiplexed with CAN. The receive line is also multiplexed with Event 2. The integrator must have a BD982 receiver configured to use the serial port in order to use this port as a serial port. The functionality cannot be multiplexed in real time. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3 V that powers the BD982 receiver needs to be added.</p> <p>For development using the I/O board, this com port is already connected to an RS-232 transceiver. This is labeled Port 3 on the I/O board. SW4, labeled BD982 COM3 HW Xceiver Selection, must be set to RS-232. There should not be anything connected to TP5, labeled BD982 Event 2.</p>
Com 4 RS-232 level no flow control	Com4 is on-board level translated to RS-232 voltages, with 8 kV contact discharge/15 kV air gap discharge ESD protection. This is labeled Port 4 on the I/O board.

CAN

Com 3 is at 0-3.3 V TTL and is multiplexed with CAN. The receive line is also multiplexed with Event 2. The integrator must have a BD982 receiver configured to use the CAN port in order to use this port as a serial port. The functionality cannot be multiplexed in real time. The integrator must add a CAN transceiver in order to use the CAN Port.

For development using the I/O board, this com port is already connected to a CAN transceiver. This is labeled BD982 CAN on the I/O board. SW4, labeled BD982 COM3 HW Xceiver Selection, must be set to CAN. There shouldn't be anything connected to TP5, labeled BD982 Event 2.

The following figure shows a typical implementation with a 3.3 V CAN transceiver. It also shows a common mode choke as well as ESD protection. A 5 V CAN Transceiver can be used if proper level translation is added.

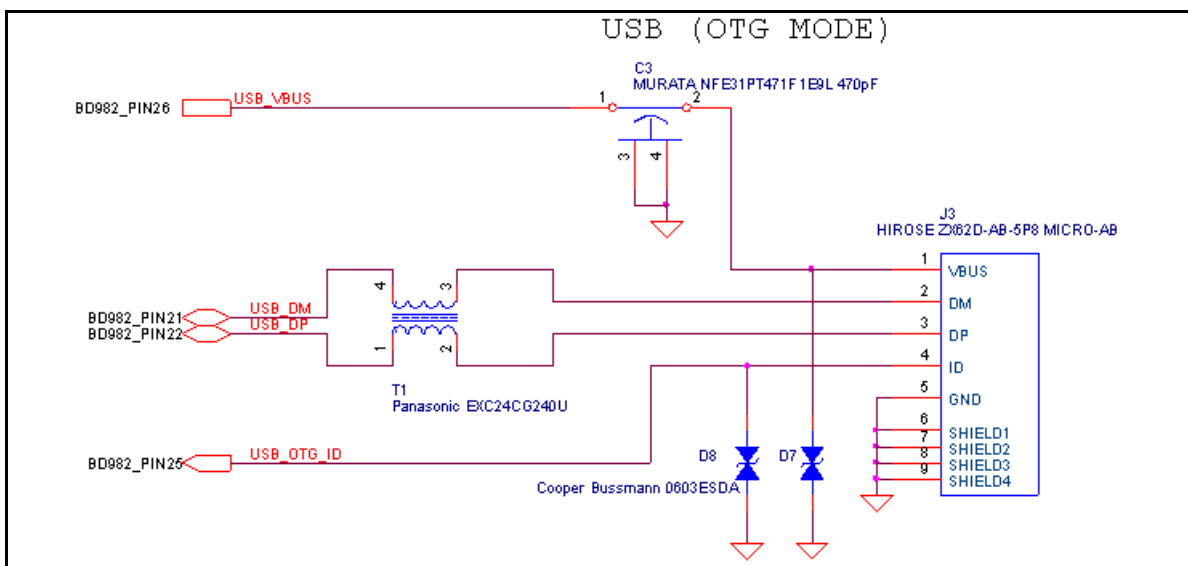


USB

The CPU of the receiver has an integrated PHY that supports both USB 2.0 Device and Host configuration at low speed, full speed, and high speed. In Host mode, the receiver supplies 5 V to a USB device, such as a memory stick. In Device mode, the receiver behaves like an external storage device to a computer.

USB OTG reference design

To be OTG-compliant, the connector must be MICRO AB. An OTG-compliant cable has A and B ends. When the B-side of the cable is inserted, the ID pin is not connected (floating) and the receiver enters Device mode through a pull-up resistor. The A-side of the cable connects the ID pin to ground, which enables Host mode on the receiver.



To reduce EMI, place a USB 2.0 compliant common mode choke on the data lines. To ensure best EMI performance, locate the choke near the USB MICRO AB connector. Trimble recommends that you use an L-C-L type EMI filter for the output power.

For product robustness and protection, place ESD protection diodes on both the USB_VBUS and USB_OTG_ID lines. The receiver has internal high-speed ESD protection on the USB data lines.

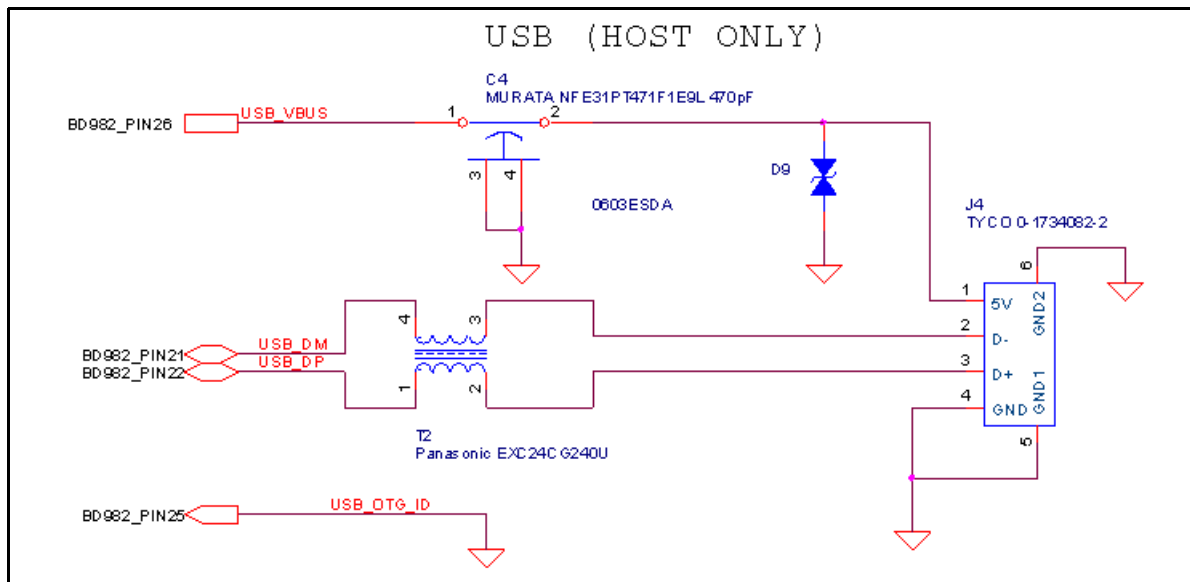
To ensure best USB high-speed performance, carefully consider PCB routing and placement practices:

- Place components so the trace length is minimized.
- Do not have stubs on data lines more than 0.200".
- Route data lines differentially but as parallel as possible.
- Data lines must be controlled to 90 Ohms differential impedance, and 45 Ohms single-ended impedance.
- Route over continuous reference plane (either ground or power).

For more detailed information, refer to the *Intel High Speed USB Platform Design Guidelines*.

USB Host-only reference design

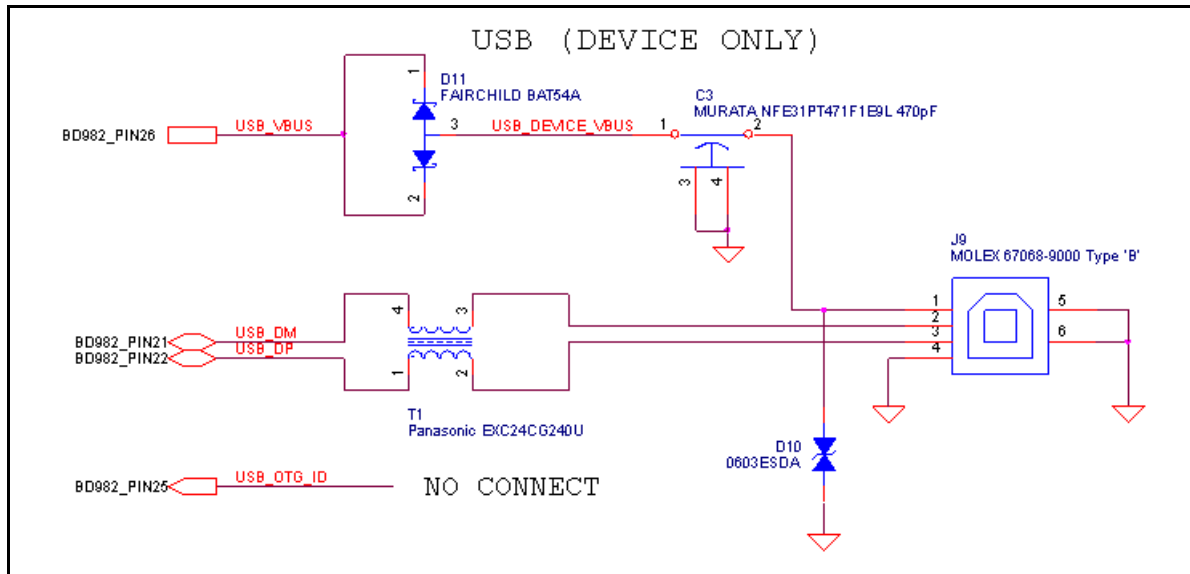
For USB host-only support, a type-A connector is required. Since the receiver does not support dynamic role switching, the ID pin should be grounded on the receiver. In Host mode, the receiver supplies nominal 5 V output at 500 mA to the USB device.



For recommendations about EMI, ESD protection, and layout considerations, see [USB OTG reference design, page 199](#).

USB device-only reference design

For device-only operation, the USB_OTG_ID pin is left floating. For reference, the receiver has an internal 10K Ohm pull-up to 3.3 V. In this mode, the USB_DEVICE_VBUS is used only by receiver to detect if host power is connected.



For recommendations about EMI, ESD protection, and layout considerations, see [USB OTG reference design, page 199](#).

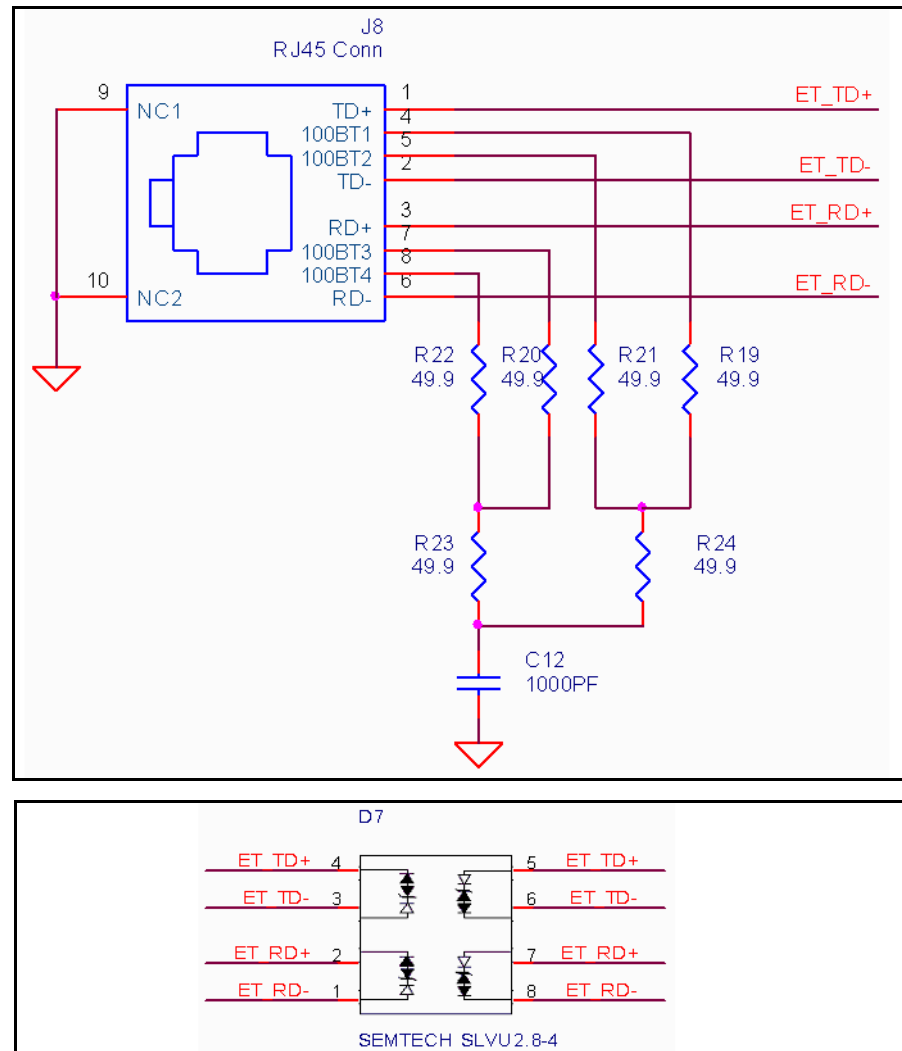
Ethernet

The receiver contains the Ethernet MAC, PHY, and magnetics. The PHY layer is based on the Micrel KSZ8041NLI and is set to default to 100 Mbps, full duplex with auto-negotiation enabled. The receiver has the correct PHY termination on the differential signals as well as Bulk capacitance for the magnetics center tap. The magnetic is implemented using Pulse Engineering HX1188.

Ethernet reference design

- Design using RJ-45 with Integrated Magnetics

Since the magnetics are on-board, the Ethernet interface can be implemented using only a RJ-45 connector, and termination discretes. See design example below.



Ethernet routing

Minimize the distance from the RJ-45 to the receiver main connector to prevent issues with conducted emissions.

The sample routing below shows a four-layer stack up, with dual-side board placement. The routing shown ensures that the differential pairs are routed over solid internal planes.

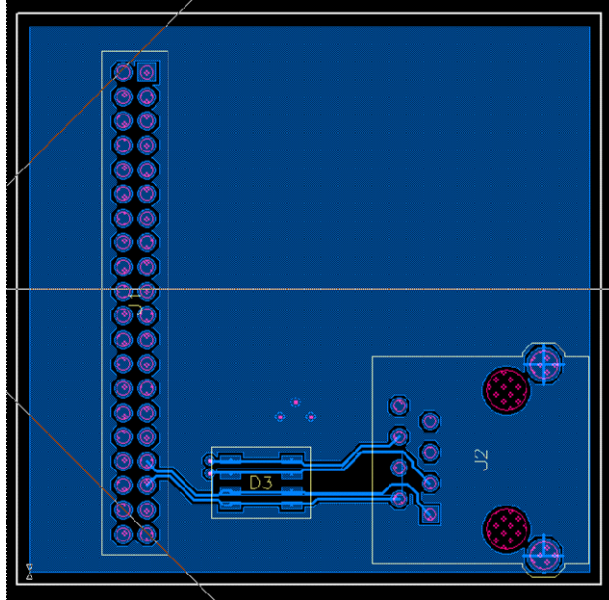


Figure E.2 Top view

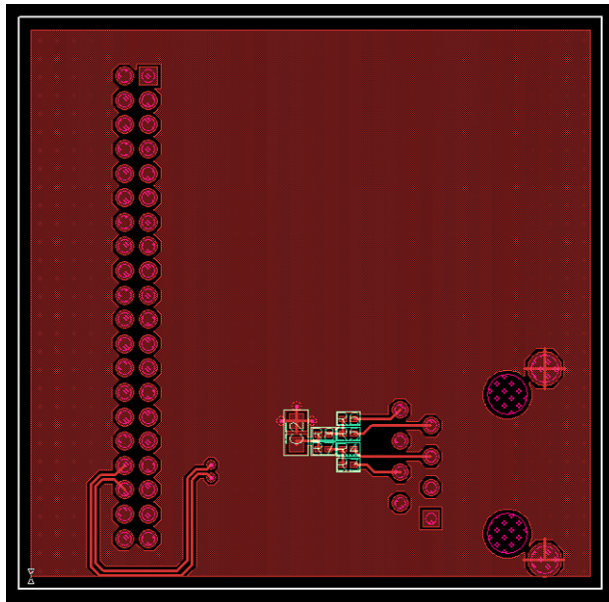


Figure E.3 Bottom view

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	<p>A file that contains orbit information on all the satellites, clock corrections, and atmospheric delay parameters. The almanac is transmitted by a GPS satellite to a GPS receiver, where it facilitates rapid acquisition of GPS signals when you start collecting data, or when you have lost track of satellites and are trying to regain GPS signals.</p> <p>The orbit information is a subset of the ephemeris / ephemerides data.</p>
base station	Also called <i>reference station</i> . A base station in construction, is a receiver placed at a known point on a job site 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 GPS observations are collected over a period of time, for subsequent postprocessing to obtain the most accurate position for the location.
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 adaptor 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.
CMR	Compact Measurement Record. A real-time message format developed by Trimble for broadcasting corrections to other Trimble receivers. CMR is a more efficient
CMR+	alternative to RTCM .
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	<p>Also called <i>geodetic datum</i>. 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.</p> <p>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.</p> <p>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).</p> <p>All GPS coordinates are based on the WGS-84 datum surface.</p>
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	<p>Differential correction is the process of correcting GPS 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.</p> <p>Differential correction can be done in real-time, or after the data has been collected.</p>
differential GPS	See real-time differential GPS .
DOP	<p>Dilution of Precision. A measure of the quality of GPS 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 accuracy is greater. When satellites are close together in the sky, the DOP is higher and GPS positions may contain a greater level of error.</p> <p>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 accuracy of horizontal measurements (latitude and longitude) and vertical measurements respectively. PDOP is related to HDOP and VDOP as follows: $PDOP^2 = HDOP^2 + VDOP^2$.</p>
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 GPS. EGNOS is the European equivalent of WAAS , which is available in the United States.
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.
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 GPS 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/breaklines, or boundaries/areas.
firmware	The program inside the receiver that controls receiver operations and hardware.
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.

GSOF	General Serial Output Format. A Trimble proprietary message format.
HDOP	<p>Horizontal Dilution of Precision. HDOP is a DOP value that indicates the accuracy of horizontal measurements. Other DOP values include VDOP (vertical DOP) and PDOP (Position DOP).</p> <p>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).</p>
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.
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 GPS. 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 GPS 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.
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 GPS receivers can output positions as NMEA strings.
PDOP	<p>Position Dilution of Precision. PDOP is a DOP value that indicates the accuracy of three-dimensional measurements. Other DOP values include VDOP (vertical DOP) and HDOP (Horizontal Dilution of Precision).</p> <p>Using a maximum PDOP value is ideal for situations where both vertical and horizontal precision are important.</p>
real-time differential GPS	<p>Also known as <i>real-time differential correction</i> or <i>DGPS</i>. 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.</p> <p>While DGPS is a generic term, its common interpretation is that it entails the use of single-frequency code phase data sent from a GPS base station to a rover GPS receiver to provide sub-meter position accuracy. The rover receiver can be at a long range (greater than 100 kms (62 miles)) from the base station.</p>
rover	A rover is any mobile GPS receiver that is used to collect or update data in the field, typically at an unknown location.

RTCM	Radio Technical Commission for Maritime Services. A commission established to define a differential data link for the real-time differential correction of roving GPS receivers. There are three versions of RTCM correction messages. All Trimble GPS 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 accuracy.
SBAS	Satellite-Based Augmentation System. SBAS is based on differential GPS, but applies to wide area (WAAS/EGNOS and MSAS) networks of reference stations. Corrections and additional information are broadcast via 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 dBHz.
skyplot	The satellite skyplot confirms reception of a differentially corrected GPS signal and displays the number of satellites tracked by the GPS receiver, as well as their relative positions.
SNR	See signal-to-noise ratio .
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.
WAAS	<p>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 GPS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico.</p> <p>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 GPS receiver, exactly like a GPS satellite.</p> <p>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.</p> <p>The EGNOS service is the European equivalent and MSAS is the Japanese equivalent of WAAS.</p>
WGS-84	<p>World Geodetic System 1984. Since January 1987, WGS-84 has superseded WGS-72 as the datum used by GPS.</p> <p>The WGS-84 datum is based on the ellipsoid of the same name.</p>



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