BD950™

Reference Manual

Trimble®

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CHAPTER

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Introduction

In this chapter:

- Welcome
- About the BD950 receiver
- COCOM limits
- About this manual

Welcome

Welcome to the *BD950 Reference Manual*. This manual describes the BD950™ receiver and provides guidelines for configuring the receiver for real-time, high-precision applications. The BD950 receiver uses advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

About the BD950 receiver

The BD950 receiver is used for a wide range of precise positioning and navigation applications. These uses include: construction, mining, and agriculture equipment positioning; robotic equipment control; hydrographic surveying; and any other application requiring reliable, centimeter-level, guidance at a high update rate and low latency.

The BD950 receiver offers centimeter-level accuracy based on RTK/OTF (Real-Time Kinematic/On-the-Fly) solutions and submeter accuracy based on L1 C/A (Coarse/Acquisition) 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 (up to 20 Hz) give the response time and accuracy required for precise dynamic applications.

Designed for reliable operation in all environments, the BD950 receiver provides a positioning interface to an office computer, external processing device, or control system. The receiver can be controlled through a serial port using an application file interface. The application file interface lets you script the BD950 receiver operation with a single command. Receiver operations are set using the application file interface through the Trimble® Configuration Toolbox™ software. Alternatively, you can use the Trimble MS Controller software to handle receiver configuration and status.

You can configure the BD950 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, quality assurance (figure of merit) numbers, and the number of tracked satellites. The receivers also output a one pulse per second (1 PPS) strobe signal which lets remote devices precisely synchronize time.

Features of the receiver

A BD950 receiver provides the following features:

- Centimeter accuracy, real-time positioning with RTK/OTF data, up to 20 Hz position updates and around 20 millisecond (msec) latency
- Submeter accuracy, real-time positioning using pseudorange corrections with < 20 msec latency
- Automatic OTF (On-the-Fly) initialization while moving
- Local coordinates output direct from receiver
- 1 PPS output
- Four RS-232 serial ports suitable for:
  - NMEA output
  - RTCM SC-104 input and output
  - Trimble format (CMR) input and output
- WAAS (Wide Area Augmentation System) compatible
- External frequency input
- Event marker input
- LED support

The receiver comes with a one year hardware warranty.

Use and care of the receiver

The BD950 receiver should always be mounted in a suitable casing.

Warning – Operating or storing a BD950 receiver at temperatures outside the specified temperature range can destroy the instrument, or shorten the life of the instrument. For more information, see Chapter 10, Specifications.

Radio and radar signals

High-power signals from a nearby radio or radar transmitter can overwhelm the BD950 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. For more information, see the Trimble Support Note *Using Radio Communication Systems with GPS Surveying Receivers*.

COCOM Limits

The U.S. Department of Commerce COCOM regulations require all exportable GPS products to contain performance limitations, preventing their use in a manner threatening the security of the United States. In accordance with this requirement, the BD950 receiver disables access to satellite measurements and navigation results when the receiver’s velocity is greater than 1000 knots, or its altitude is above 18,000 m. Access is restored when both limits are no longer exceeded.

During the violation period, all displays of position and velocity related quantities are blanked, and all access to those quantities through the serial ports is disabled. All data outputs stop, including position and velocity results.

About this Manual

This manual describes how to set up and use the BD950 receiver.

This manual assumes that you are familiar with the principles of the Global Positioning System (GPS), and with the terminology used to discuss it. For example, you should understand such terms as space vehicle (SV), elevation mask, and Dilution of Precision (DOP).

If you are not familiar with GPS, visit Trimble's website (www.trimble.com) for an interactive look at Trimble and GPS.

Trimble assumes that you are familiar with Microsoft Windows and know how to use a mouse, select options from menus and dialogs, make selections from lists, and refer to online help.

Related information

Other sources of related information are:

- www.trimble.com/support – for additional information such as support notes, service bulletins, and FAQs. You can also download software patches, firmware, and utility programs.
- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, visit the Trimble website at www.trimble.com/support.

Technical assistance

If you have a problem and cannot find the information you need in the product documentation, *contact your local Distributor.* Alternatively, do one of the following:

- Request technical support using the Trimble website at www.trimble.com/support/support.htm
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CHAPTER

2

Real-Time Kinematic Positioning

In this chapter:

- Introduction
- What is RTK?
- Carrier phase initialization
- Update rate and latency
- Data link
- RTK positioning modes
- Critical factors affecting RTK accuracy
- Further reading

Introduction

The BD950 receiver is designed for high-precision navigation and location. The receiver uses Real-Time Kinematic (RTK) techniques to achieve centimeter-level positioning accuracy. The following section provides background information on terminology and describes the capabilities and limitations of the BD950 receiver. For a list of references to learn more about the topics covered in this section, see page 27.

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. Typically, base and rover receivers take measurements at regular 1 second epochs (events in time) and produce position solutions at the same rate.

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 BD950, 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 BD950 rover has to resolve, or initialize, the carrier phase ambiguities at power-up and every time the satellite signals are interrupted.

Carrier Phase Initialization

Warning – Although initialization in the BD950 receiver is very reliable, incorrect initializations can occur. A bad initialization can result in position errors of 1 to 3 m. The receiver automatically detects initialization failures, and reports and fixes the problem. Bad initialization detection may take 1 to 4 minutes, depending on the number of satellites being tracked. Generally, a bad initialization is followed by an increasing solution RMS.

The BD950 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 BD950 receiver uses L1 and L2 carrier phase measurements plus precise code range measurements to the satellites to automatically initialize the ambiguities. The initialization process takes between 10 seconds and a few minutes. While the receiver is initializing the ambiguities it generates a *float* solution with meter-level accuracy. The float solution is reflected in the position display and outputs. When the initialization process is complete, the solution mode switches from *float* to *fix*, and the precision changes from meter-level to centimeter-level accuracy.

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 BD950 receiver, the maximum update rate is 20 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.

Figure 2.1 contains a summary of the factors contributing to the latency in the synchronized RTK solution.

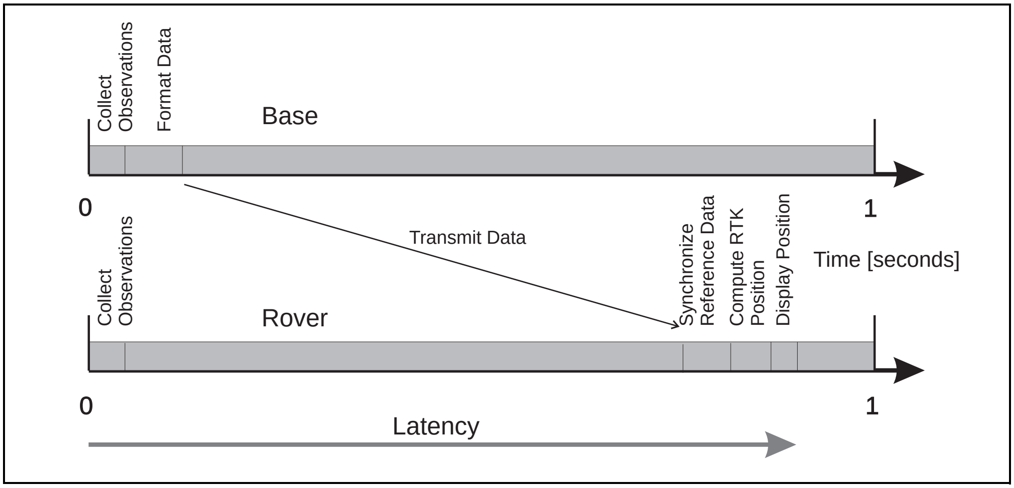


Figure 2.1 Factors contributing to RTK latency

The accumulation of the following parameters can result in a maximum latency of 0.5 to 2 seconds in the BD950 RTK solution:

- Base receiver observation collection time
- Reference data formatting
- Data transmission
- Synchronization of base and rover data
- Position calculation
- Solution display/output

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 BD950 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.

For a detailed description of this standard, see Talbot [1996] and Talbot [1997] in Further Reading, page 27.

The Radio Technical Commission for Maritime Services (RTCM) developed RTK messages as part of their Version 2.2 standard. For more information, see RTCM [1998] in Further Reading, page 27.

RTCM/RTK messages 18 to 21 were aimed at forming an industry standard for mixing and matching RTK base and rover systems from different manufacturers.

Industry acceptance of the RTCM/RTK messages has been limited, because the messages require at least a 4800 baud data link, compared with a 2400 baud data link for the CMR format. Furthermore, antenna and receiver compatibility issues have not been completely resolved between RTK manufacturers. Use caution when trying to mix RTK systems from different manufacturers; degraded performance nearly always results.

Not all RTK positioning modes are supported when the RTCM/RTK format is used. Use the CMR format for all Trimble RTK positioning applications.

SiteNet™ 900 radio-modems are designed for BD950 RTK operation. Similarly, SiteNet 450 and TRIMTALK™ 450 radio-modems are customized for RTK applications. The SiteNet 900 system does not require licensing in the United States of America and several other countries. Third-party radio-modems, cellular phones, or satellite communication links can transmit base station data to one or more rover sites.

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 dealer (see Technical assistance, page 5) can assist with questions regarding data link options.

RTK Positioning Modes

The BD950 receiver incorporates four positioning modes to support a broad spectrum of user applications. The following section highlights the differences and requirements for each positioning mode.

Synchronized RTK (1 Hz)

Synchronized RTK is the most widely used technique to achieve centimeter-level position estimates between a fixed base station and a roving receiver. Typically, the update rate for Synchronized RTK is once per second (1 Hz). With Synchronized RTK, the rover receiver must wait until the base station measurements are received before computing a baseline vector. The latency of the synchronized position fixes is dominated by the data link delay (see Figure 2.1). Given a 4800 baud data link, the latency of the Synchronized RTK fixes will approach 0.5 seconds. The solution latency could be reduced by using a 9600 baud, or higher bandwidth data link.

The Synchronized RTK solution yields the highest precision possible and suits low dynamic applications such as human-mounted guidance. Airborne applications such as photogrammetry, or aircraft landing system calibration, demand update rates in excess of 1 Hz, to sample the platform trajectory. Data postprocessing can generate the results of the mission back in the office. However, this would require raw GPS data to be stored and postprocessed. Postprocessing presents data management problems, particularly for large data sets collected at 5 or 10 Hz. The BD950 receiver includes a positioning mode—termed *Fast Update Synchronized RTK*—which addresses high speed positioning applications.

Fast Update Synchronized RTK (5 or 10 Hz)

The Fast Update Synchronized RTK scheme has the same latency and precision as the 1 Hz synchronized approach. However, position solutions are generated 5 or 10 times per second (5 or 10 Hz), see Figure 2.2.

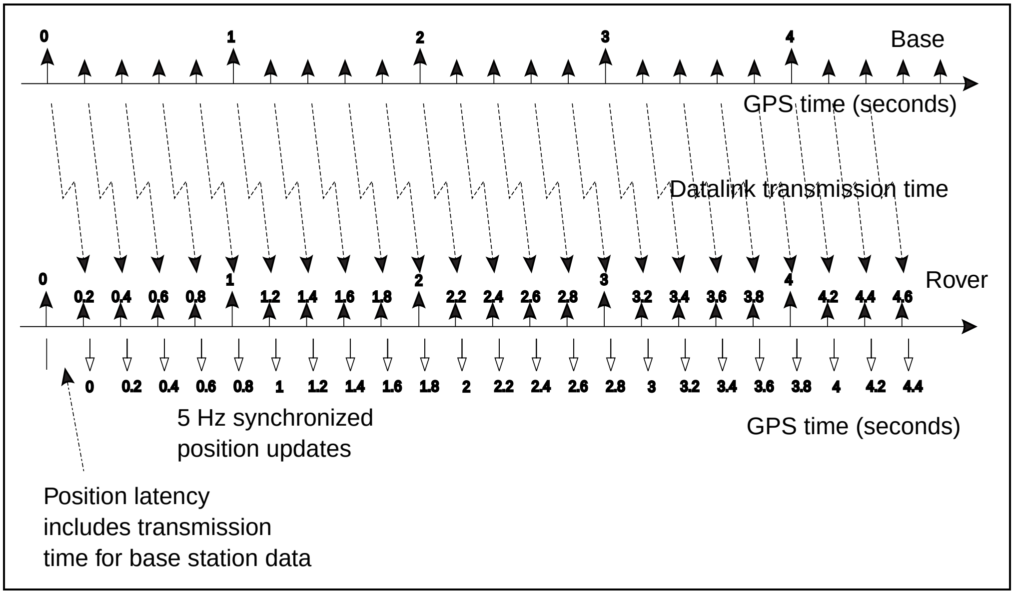


Figure 2.2 Fast update rate synchronized RTK (5 Hz)

The BD950 base station must be configured to output CMR data in either the 5 Hz or 10 Hz CMR Mode. In the Fast Output Mode, the BD950 base receiver interleaves the 1 Hz CMR measurement data with highly compressed information at the x.2, x.4, x.6 and x.8 second epochs for 5 Hz output. At the 10 Hz CMR output rate, packets are sent at x.1, x.2, x.3,..., x.9 seconds between the x.0 epochs. The total data throughput requirement for the Fast Mode is less than 9600 bps for 9 satellites.

The BD950 rover synchronizes its own 5 or 10 Hz measurements with those received from the base. Results are then generated and can be output at 5 or 10 Hz. The data link throughput is critical to the operation of the Fast Update Synchronized RTK scheme. Use at least a 9600 baud data link to achieve satisfactory results.

Note – *The Fast Update Synchronized RTK mode is only supported through the CMR format. The RTCM messages cannot be output at 5 or 10 Hz.*

Low Latency RTK

A large part of the solution latency in Synchronized RTK processing is due to the data formatting and transmission of the base station data to the rover (see Figure 2.1 on page 10). The BD950 receiver includes a Low Latency positioning mode for applications that demand centimeter-level accuracy almost instantaneously. The Low Latency positioning mode delivers 20 Hz position fixes with around 20 msec latency with a precision that is only slightly less accurate than Synchronized RTK positioning.

The Low Latency positioning scheme relies on the predictability of the base station phase data. Phase measurements observed at a fixed base receiver generally exhibit a smooth trend. Variations in the carrier phase are caused by:

- Cycle slips
- Satellite motion
- Receiver and satellite clock variations
- Atmospheric delay

Given a brief history of base station phase measurements, the BD950 receiver is able to accurately predict what they will be in the next few seconds. Instead of waiting for base station carrier phase measurements to arrive, the BD950 rover predicts or projects what the base carrier phase measurements will be for the current epoch. A baseline solution is then generated using the projected base station carrier phase measurements and the observed rover receiver carrier phase. The latency of the position solution derived from projected carrier phase is around 20 milliseconds for the BD950 receiver.

With the Low Latency positioning scheme, accuracy is traded for timeliness. An increase in the data link delay relates to an increase in the projection time of the base station phase data. This leads to an increase in the uncertainty of the RTK solution. Figure 2.3 presents an empirically derived model for the base receiver phase projection errors as a function of data link delay.

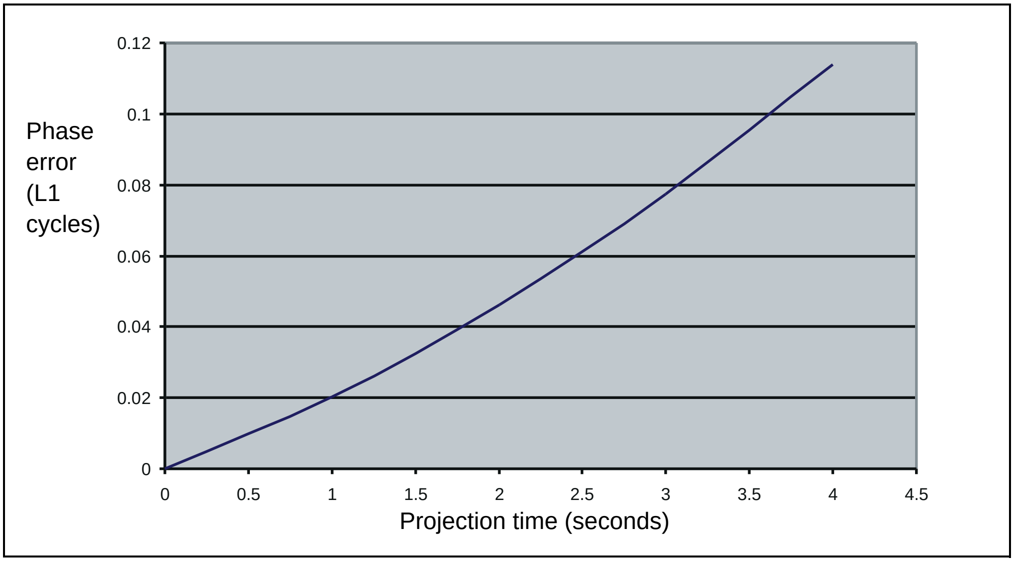


Figure 2.3 Phase projection for the low latency RTK solution

The base phase prediction errors are governed by:

- Unmodeled Selective Availability errors
- Short term instabilities in the receiver and satellite clocks
- Unmodeled satellite orbit variations

A data link latency of 1 second would result in phase projection errors approaching 0.02 cycles (0.004 m). Multiplying the phase projection errors by a PDOP of 3.0 would yield an increase in noise for the Low Latency RTK solution of 3.0 × 0.004 = 0.012 m over the Synchronized RTK solution. In many applications the slight noise increase in the Low Latency Solution is tolerable.

Moving Baseline RTK

In most RTK applications, the base station remains stationary at a known location, while the rover moves. A method of RTK positioning, called *Moving Baseline RTK*, is implemented in the BD950. Both the base and rover receivers move. The Moving Baseline RTK technique can be used for vehicle orientation applications (see Figure 2.4), and precise relative displacement tracking of two moving vehicles.

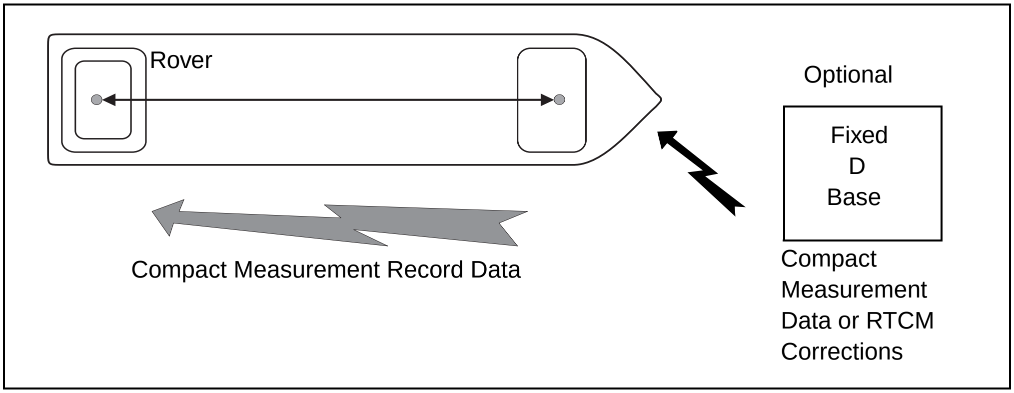


Figure 2.4 Moving baseline RTK applied to ship heading estimation

With the Moving Baseline RTK technique, the base receiver broadcasts CMR measurement and station location data every epoch and the rover receiver performs a synchronized baseline solution at 1, 5, or 10 Hz. The resultant baseline solution is accurate to centimeter-level, while the absolute location of the base–rover space vector is only accurate to 100 m. The accuracy of the derived baseline vector is somewhat dictated by the knowledge of the moving base location. For this reason, the base–rover separation should be less than 1 km to ensure optimal results.

Enhancing Moving Baseline RTK

Although the Moving Baseline RTK mode provides centimeter-level vector components between moving base and rover, the absolute coordinates of the base and rover are only generally known to 100 m. The BD950 receiver is capable of performing DGPS or RTK while acting as the moving base station.

Moving base positions are estimated relative to a fixed base to, say, meter-level with DGPS, or centimeter-level with RTK. This technique is best explained with an example. Figure 2.5 shows an example of an application.

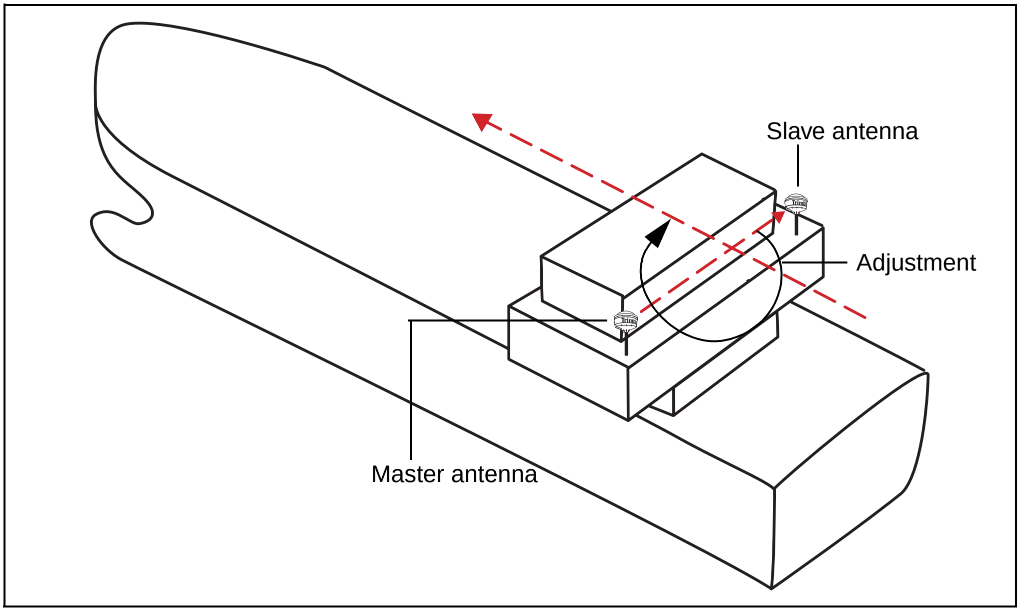


Figure 2.5 Vessel heading from moving baseline RTK

In this example, if the master receiver broadcasts CMR measurement and station location data every epoch, while the slave receiver performs a synchronized baseline solution at, say, 10 Hz, the resultant baseline solution has centimeter-level accuracy while the absolute location of the master/slave space vector is only accurate to 15 m.

The accuracy of the derived baseline vector is restricted to knowing the moving receiver's reference location. For this reason, the reference/rover separation must be less than 1 km.

Similarly, in the example shown in Figure 2.4 on page 17, a shore-based (fixed) base station sends either RTCM or CMR data to the moving base station on a ship.

The moving base station receives differential corrections from the shore-based base station and generates position solutions. The moving base station can be operated in either Low Latency mode or Synchronized mode. CMR data is output by the moving base station to the rover at either 1, 5, or 10 Hz by using the Standard or Fast CMR output modes, respectively.

The rover accepts CMR data from the moving base station and generates an RTK vector solution at the same rate as moving base CMR transmissions. The rover must be configured in the Synchronized mode. The BD950 receiver will automatically force the unit into the Synchronized mode if the Low Latency mode is currently active.

When the roving base station is differentially corrected, both the vector displacement and absolute location of the moving baseline are derived.

The moving Baseline RTK mode can *chain* together multiple moving base receivers. Chained-RTK is best explained with an example. Consider a static base station (receiver 1) sending out CMR data at 10 Hz. A moving BD950 receiver (receiver 2) receives the CMR data from the static base and estimates its location and then outputs CMR data at a 10 Hz rate. Another moving BD950 receiver (receiver 3) receives the CMR data from receiver 2 and performs a synchronized RTK solution. Receiver 3 then generates CMR data for transmission to yet another BD950 receiver and so on. The solution latency for the last receiver is the summation of the transmission delays of the previous links in the chain. The technique is therefore limited by the data link throughput. The Chained RTK mode can determine the location and orientation of large structures such as bridge elements as they are being moved into position.

Summary of RTK positioning modes

Table 2.1 provides a summary of the RTK positioning modes available in the BD950 receiver.

Table 2.1 Characterization of RTK positioning modes

RTK mode	Update rate (Hz)	Latency (seconds)	Data link requirement[1] (Baud)	Accuracy[2]
Synchronized	1	0.5 – 2.5[3]	2400	Horizontal: 1 cm + 2 ppm Vertical: 2 cm + 2 ppm
Fast Update Synchronized	5 or 10	0.5 – 2.5[3]	9600	Horizontal: 1 cm + 2 ppm Vertical: 2 cm + 2 ppm
Low Latency	20 (max)	0.02	2400	Horizontal: 2 cm + 2 ppm[4] Vertical: 3 cm + 2 ppm
Moving Baseline RTK	1, 5, 10	0.5 – 2.5[3]	4800, 9600	Horizontal: 1 cm[5] Vertical: 2 cm

1 Minimum bandwidth requirement – higher bandwidths provide increased performance
2 Accuracy figures are 1 sigma
3 Latency is dependent on data link throughput
4 Accuracy figures assume a 1 second data link delay
5 Assumes that base – rover separation is less than 1 km

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 BD950 rover. Using a non-Trimble base receiver can result in suboptimal initialization reliability and RTK performance.

The BD950 receiver uses a state-of-the-art tracking scheme to collect satellite measurements. Optimal RTK performance is achieved when using BD950 receivers at base and rover sites. The BD950 receiver is compatible with all other Trimble RTK-capable systems. However, not all RTK positioning modes are supported with mixed receiver operation. Table 2.2 lists the compatibility of various Trimble RTK base stations with the positioning modes of the BD950 receiver.

Table 2.2 Summary of RTK functionality supported by different RTK base stations

Base receiver type	Synchronized RTK (1 Hz)	Fast Update Synchronized RTK (5 or 10 Hz)	Low Latency RTK	Moving Baseline RTK
BD950	✔	✔	✔	✔
MS Series receivers	✔	✔	✔	✔
5700	✔	✔	✔	
4800	✔		✔	
4700	✔		✔	
4600LS	✔			

Base station coordinate accuracy

The base station coordinates used for RTK positioning are set through the *Base Station Control* menu. 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.

The second effect of base station coordinate errors is on the low latency RTK solutions. With low latency positioning, the baseline vector errors will ramp up with increased data link age.

For Moving Baseline RTK, the base station coordinates are only determined with 10–20 m accuracy with selective availability (S/A) turned off. For this reason, Moving Baseline RTK works best when base-to-rover separation is less than 1 km.

Number of visible satellites

A GPS position fix is similar to a distance resection. Satellite geometry directly impacts on the quality of the position solution estimated by the BD950. 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 BD950 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 BD950 receiver uses a default elevation mask of 13 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 BD950 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 BD950 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. The initialization performance of the BD950 receiver is optimized for an operating range up to 20 km. Degraded initialization time and reliability are likely to result if RTK is attempted beyond the 20 km operating range specification.

SBAS

The BD950 supports SBAS (satellite based augmentation systems) that conform to RTCA/DO-229B, such as WAAS and EGNOS. The BD950 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.

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

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 BD950 receiver, exactly like a GPS satellite.

For more information on WAAS, refer to the FAA home page at http://gps.faa.gov. Use the Trimble Configuration Toolbox software to enable WAAS support in the BD950 receiver.

For more information, refer to the *Trimble Configuration Toolbox User Guide* or the Configuration Toolbox Help.

Note – *At the time this manual went to print, the WAAS system was operational, but had not been enabled by the FAA for general use. To use WAAS corrections while the system is disabled, configure the BD950 receiver to ignore WAAS health messages.*

Further Reading

RTCM, 1998. RTCM Recommended Standards for Differential GNSS Service, Version 2.2, RTCM Paper 11-98/SC104-STD, January 15.

Talbot, N.C. 1996. Compact Data Transmission Standard for High-Precision GPS, ION-GPS-96, Kansas City, Missouri, September 17–20, pages 861–871.

Talbot, N.C. 1997. Improvements in the Compact Measurement Record Format, Trimble Conference Proceedings, San Jose, California. pages 322–337.

CHAPTER

3

Installation

In this chapter:

- Introduction
- Installing the BD950 receiver

Introduction

The Trimble BD950 receiver delivers the highest performance capabilities of a dual-frequency receiver in a compact Eurocard form factor (see Figure 3.1). This chapter gives instructions for installing and operating the BD950 receiver.

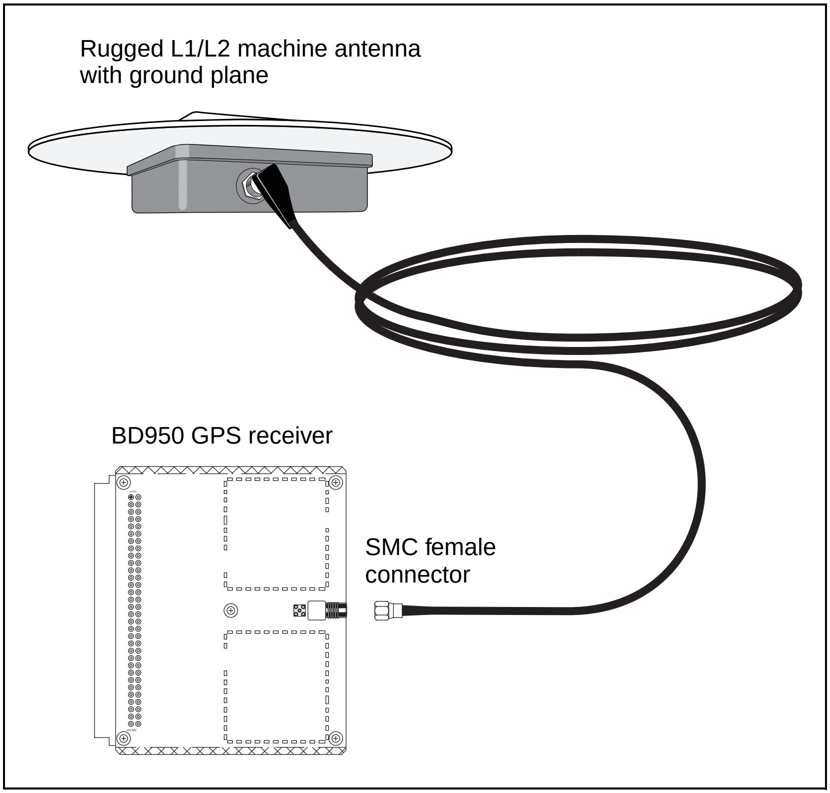


Figure 3.1 BD950 receiver on Eurocard PC board

Installing the BD950 Receiver

Trimble recommends that you read this section ***before*** attempting to install the BD950 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. Table 3.1 identifies the standard components included with the BD950 receiver starter kit.

Table 3.1 BD950 starter kit (49500-05) components

Item	Qty	Part number
BD950 GPS receiver	1	49500-10
Test I/O board	1	47415-10
CD, BD950 Support software	1	49505-00
Power supply	1	30413

Supported antennas

The BD950 supports both Micro Centered and Zephyr antennas from Trimble.

You can also use other antennas that operate with a 7.2 volt input and supply greater than 40dB signal at the board antenna port.

Reporting shipping problems

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

Installation guidelines

The BD950 receiver is designed to be either rail mounted or standoff mounted. Use the appropriate hardware and the five mounting holes that are provided. See Figure 3.2 and Figure 3.3.

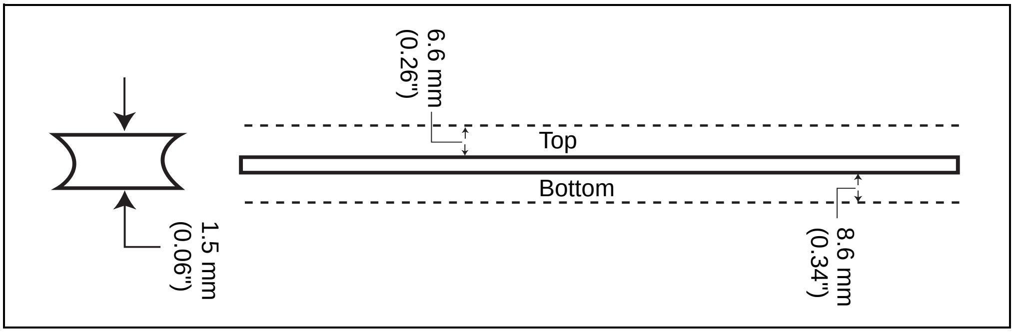


Figure 3.2 BD950 edge view

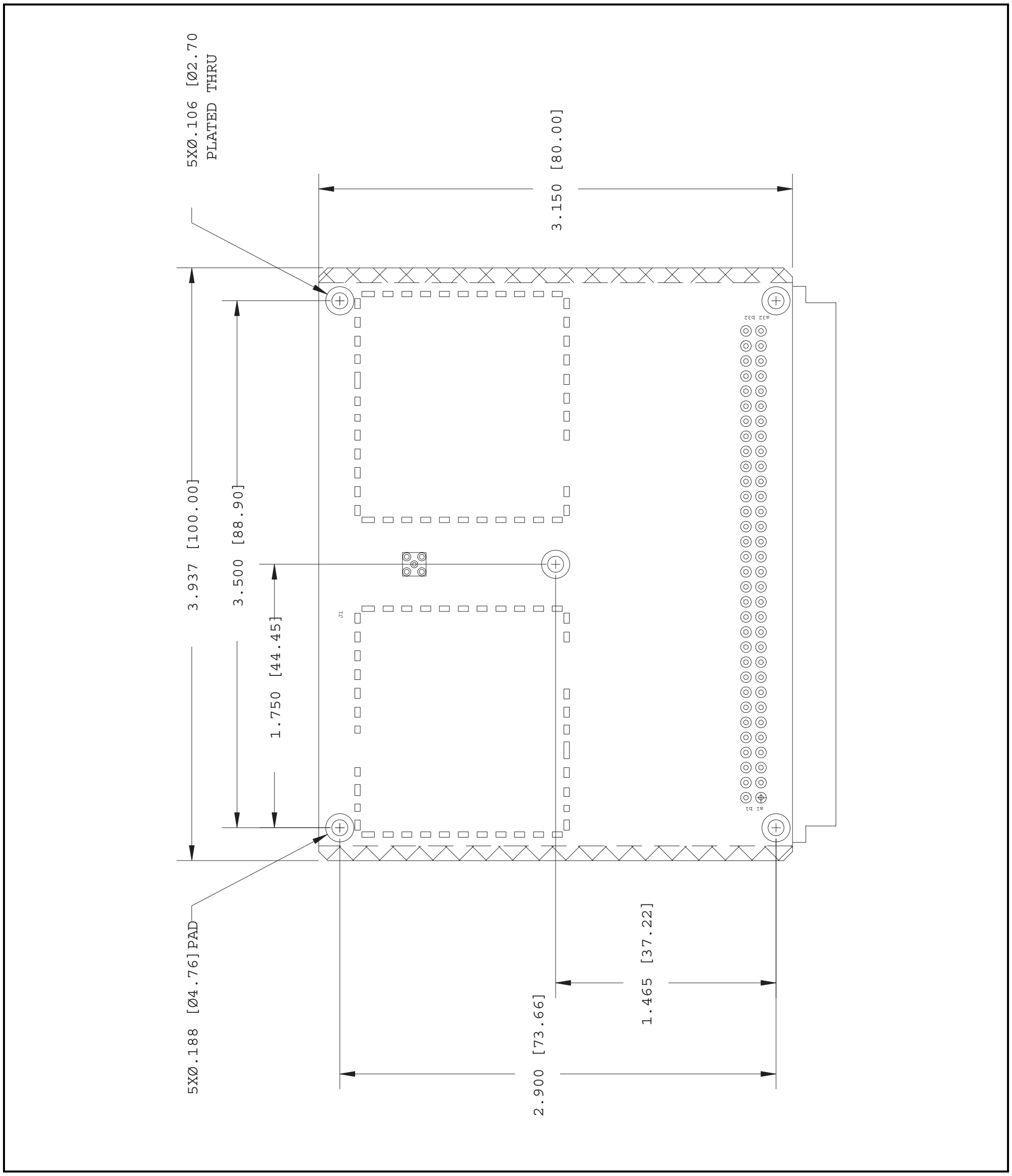


Figure 3.3 BD950 dimensions outline

Considering environmental conditions

Install the BD950 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 BD950 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:

- Place the antenna on a flat surface along the centerline of the vehicle, if the application is mobile.
- 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
- florescent lights
- switching power supplies

BD950 connections

The BD950 starter kit (PN 49500-05) contains a test I/O board and cabling to provide power and signal interface to the receiver.

Figure 3.4 shows the BD950 receiver and the connection scheme with the I/O board and other components.

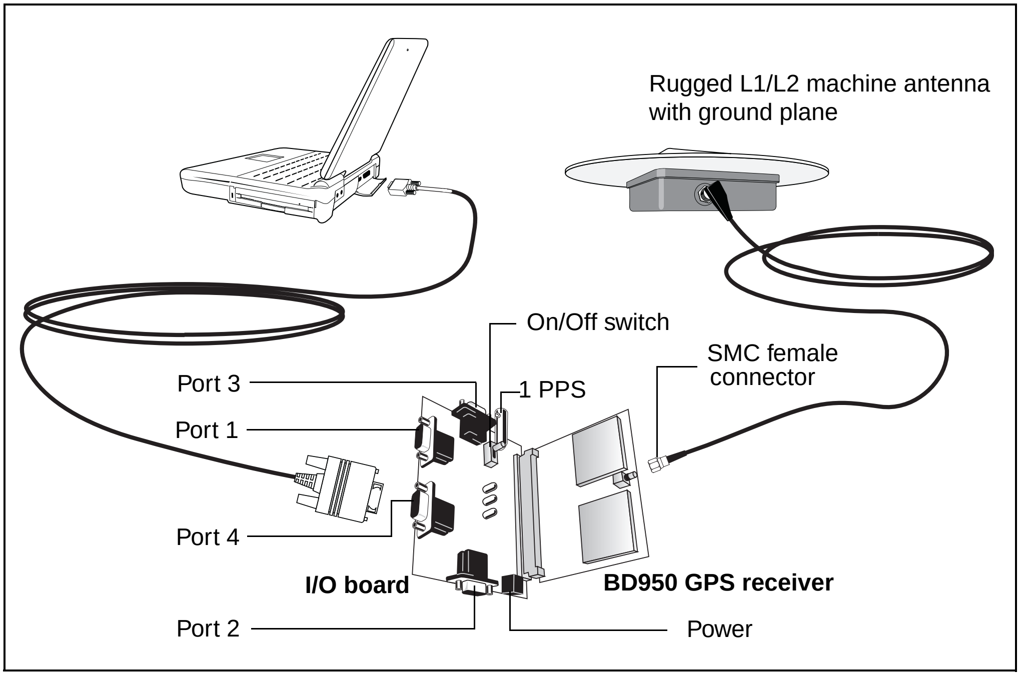


Figure 3.4 Typical BD950 setup

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

Routing and connecting the antenna cable

After mounting the antenna, route the antenna cable from the GPS antenna to the BD950 receiver (see Figure 3.1). 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 BD950 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 BD950 receiver.*

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

On/Off switch

The I/O board contains an On/Off switch. Use this switch to activate the external On/Off control (Pin A32) of the BD950 power supply.

When jumper J3 is in place on the BD950 (the default setting), the board automatically powers up. The On/Off switch has no effect.

If jumper J3 is removed, then the BD950 will power up when the switch is set to On, or when pin A32 is connected to ground.

CHAPTER

4

Using the Simulated Keypad and Display

In this chapter:

- Introduction
- Trimble MS Controller software
- Working with screens and fields
- Receiver operation
- Streamed output screen
- Input setup screen

Introduction

The Trimble MS Controller software supplied with the BD950 receiver serves as a virtual keypad and display screen for the receiver.

To use the MS Controller software, you need to connect one of the receiver's I/O ports to one of the serial ports on an IBM compatible office computer. The software runs under Microsoft Windows and manages the communications link between the computer and the BD950 receiver. This chapter assumes that the MS Controller software is installed on the computer, and that the computer is connected to a BD950 receiver. It gives you the basic skills necessary to use the MS Controller software's simulated keypad and display. For details of how to install the MS Controller software, see page 88.

Trimble MS Controller Software

The simulated keypad and display for the MS Controller software are shown in Figure 4.1.

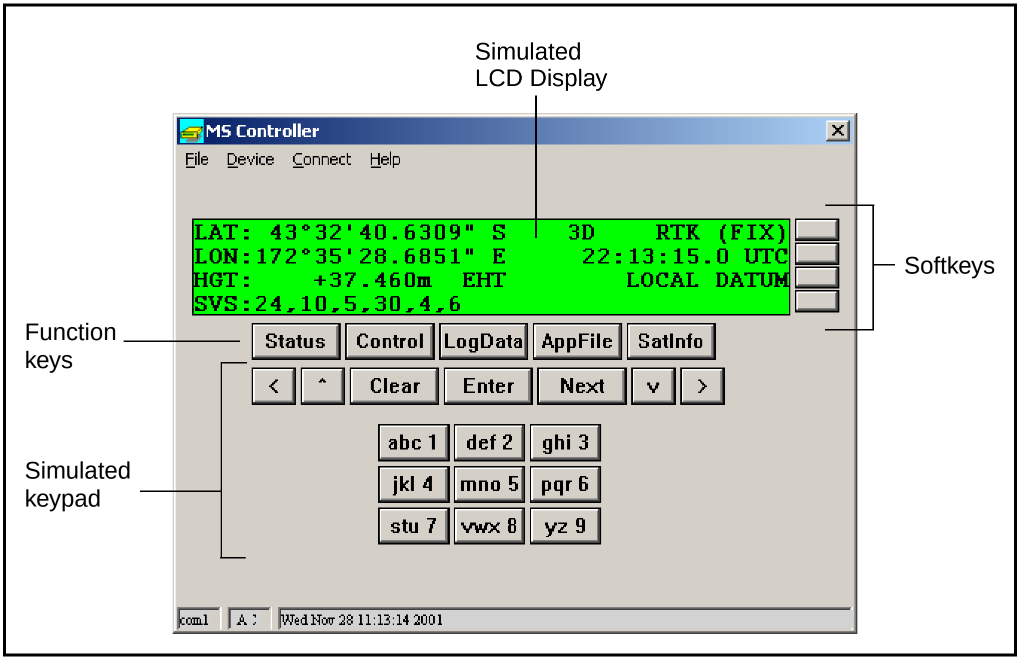


Figure 4.1 Simulated BD950 receiver front panel

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 44.

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. You can click the Next key to display another four lines of data. The sample screens in this manual show all of the lines of data associated with a screen without displaying the arrow symbol.

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 could be executed immediately, or the action could display another screen which might include additional menu options. In the sample screen above, **<HERE>** enters the current position as the coordinates for a base station.

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

Simulated keypad

Use the simulated keypad to enter alphanumeric and numeric data, and to select predefined values for data-entry fields. Table 4.1 describes the operation of the simulated keypad.

Table 4.1 Keypad functions

Key/Symbol	Description
[0] – [9]	The numeric keys let you enter numeric data.
[a] – [z]	The alpha keys become active when a field can accept alpha 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 alpha and numeric data where appropriate.
[Next]	Pages through multiple screen lines, softkey options, or predefined field options.
[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 BD950 receiver functions and options. Table 4.2 describes the operation of the function keys.

Table 4.2 Function keys

Key	Shows ...
Status	The *Status* screen with options for displaying factory configuration information, and receiver systems information.
SatInfo	The *SatInfo* screen with options for displaying satellite tracking and status information.
AppFile	The *AppFile* 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 *Control* screen with options for configuring the receiver setup parameters.
LogData	Not applicable.

Working with Screens and Fields

Table 4.3 gives a summary of the keypad and display operations for the BD950 receiver with the MS Controller software.

Table 4.3 Keypad and display summary

Key/Symbol	Description
Next	Pages through multiple screen lines, softkey options, or carousel data entry fields.
Enter	Accepts / changes data fields. Press Enter on the last data field to accept all changes.
Clear	Returns the screen to the previous menu level without changing the data fields.

Table 4.3 Keypad and display summary (continued)

Key/Symbol	Description
[ ]	Indicates a carousel data field used to select from a limited options list.
Õ	Indicates additional screen lines are accessible by clicking on Next.
< >	Indicates a softkey (menu option).
< and >	Moves the cursor between fields on the simulated screen.
^ and v	Selects from carousel data fields, or alpha 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. For screens containing 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.

Use Next to page through more screen lines. Because the simulated BD950 display has only 4 lines, there are times when additional information needs to be accessed. For example, 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 pages 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 select Clear while in a data entry screen. Use 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.

Receiver Operation

This section describes the screens provided for use in configuring parameters for the BD950.

***Note –** Other screens may be made available with firmware upgrades.*

Receiver screens

The MS Controller software provides a simulated view of the BD950 screen system. With the MS Controller software connected to the BD950 receiver, you can monitor and control receiver operation. Table 4.4 gives a summary of the MS Controller screens.

Table 4.4 MS Controller screen summary

Menu Key	Softkey – Level 1	Softkey – Level 2
	<POSITION> Displays the latest position, satellites used, position mode, time of fix, and coordinate system (see page 51).	
	<VELOCITY> Displays the latest directional velocities, satellites used, position mode, time of fix, and coordinate system (see page 53).	
	<ATTITUDE> This softkey is displayed only if the option is installed on the receiver. Displays tilt, yaw, distance, # of satellites used, position mode, time of fix, PDOP, delta time (current minus fix) of moving baseline calculated vector (see page 53).	

Table 4.4 MS Controller screen summary (continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
	<VECTOR> Displays the latest real-time kinematic vector information, the solution RMS, age of corrections, fix mode, number of continuously initialized epochs, solution DOP (Dilution of Precision), and any fault messages (see page 54).	**<VECTOR AMBIGUITY STATUS>** Displays the ambiguity resolution status and search information for real-time kinematic positioning (see page 58). **<VECTOR BASE STATION STATUS>** Displays the real-time kinematic reference station name, location, satellites tracked at the reference station, and the age of RTK corrections (see page 59).
Status	**<FACTORY CONFIGURATION>** Displays the software version, installed receiver options, and the memory configuration (see page 62).	
	<RECEIVER SYSTEMS> Displays the BD950 operating mode, active input and output messages (see page 63).	
	<COORDINATE REFERENCE> Displays the coordinate system, coordinate zone, the datum method, datum, ellipse, projection, site, horizontal plane adjustment, and vertical plane adjustment (see page 65).	

Table 4.4 MS Controller screen summary (continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
SatInfo	**<SV TRACKING>** Displays the tracking status of the BD950 channels, including the satellite number assigned to each channel, satellite elevation and azimuth, method of code tracking, signal to noise ratio values, issue of data ephemeris, user range accuracy figures (see page 66).	
	<SV STATUS> Displays the list of available, healthy, unhealthy, enabled, and disabled satellites (see page 68).	
	<DELETE ALM/EPHS> Deletes the current almanac and ephemeris settings (see page 69).	
AppFile	**<DIRECTORY>** Displays the directory listing of the application files stored in memory (see page 70).	**<PREV>** Displays the previous application file. **<TIMER>** Allows files to be started at a specific time. **<DELETE>** Deletes the current application file. **<START>** Starts a new application file.
	<STORE CURRENT> Accepts the file name used for storing the current operating parameters as an application file (see page 71).	
	<CLEAR ALL> Erases all application files and defaults all settings.	
LogData	Not applicable.	

Table 4.4 MS Controller screen summary (continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
Control	**<BASE STATION>** Displays data-entry fields for specifying the reference station location, antenna height, and antenna name (see page 72).	**<HERE>** Applies the most recent position as the base station location. **<AVG>** Applies the cumulative average position as the base station location.
	<SV ENABLE/DISABLE> Displays fields for enabling and disabling satellites (see page 74).	
	<GENERAL CONTROLS> Displays fields for controlling the elevation mask, PDOP mask, RTK mode, and motion state (see page 76).	
	<1 PPS OUTPUT> Displays fields for enabling or disabling 1 PPS output and specifying the port number used for outputting ASCII time tags (see page 77).	
Control	**<SERIAL PORT OUTPUT>** Displays fields for configuring the communication parameters for the BD950 serial ports (see page 84).	**<NMEA OUTPUT>** Displays fields and softkey options for setting up the NMEA-0183 message type, serial port for outputting NMEA messages, and the message output frequency (see page 78). **<STREAMED OUTPUT>** Displays fields for controlling the output of streamed messages (see page 79). **<RT17/BINARY OUTPUT>** Displays fields for configuring the output of raw GPS data messages (see page 80). **<CMR/RTCM OUTPUT>** Displays fields for configuring CMR and RTCM (see page 82).

Table 4.4 MS Controller screen summary (continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
	<SERIAL PORT SETUP> Displays softkey options for setting up the serial ports.	
	<INPUT SETUP> Displays fields for selecting an RTCM reference station and setting the range used for switching between DGPS and RTK (see page 85).	

POSITION screen

This screen shows the latest position, satellites used, position mode, time of fix, and coordinate system.

To display the *POSITION* screen:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<POSITION>** to display:

```
LAT: 37°23'26.0070" N     3D     RTK (FIX)
LON:122°02'15.9993" W      22:00:34.2 UTC
HGT:     -0.026 m EHT              WGS-84
SVS:20,24,9,7,4,12,5
```

Use the field descriptions in Table 4.5 to understand the position information.

Table 4.5 POSITION fields

Field	Description
LAT	Displays the latitude coordinate of the antenna phase center, relative to the selected coordinate system.
LON	Displays the longitude coordinate of the antenna phase center, relative to the selected coordinate system.

Table 4.5 POSITION fields (continued)

Field	Description
HGT	Displays the height of the antenna phase center, relative to the selected coordinate system. EHT = Ellipsoidal Height (with no datum selected) and GHT = Geoidal Height (if coordinate system defined).
SVS	Identifies the satellites used to compute the position solution. The satellites displayed can be a subset of the total satellites tracked by the receiver. In RTK mode, the common satellites tracked by the base and rover stations are shown.
Fix Mode	Identifies the method used to compute position solutions: OLD POSITION – No position computed 2D AUTONOMOUS – Stand-alone horizontal solution with constrained height 3D AUTONOMOUS – Stand-alone horizontal and vertical solution 3D RTK (FLOAT) – Real-Time Kinematic, differential position solution with float ambiguities 3D RTK (FIX) – Real-Time Kinematic, differential position solution with fixed ambiguities DGPS – Differential GPS solution using pseudorange correction data
Fix Time	Displays the time when the position fix is computed. The fix time always lags behind the current time. The displayed time is given in terms of Universal Time Coordinated (UTC), which is different from GPS time by an integer number of seconds.
Coordinate System	Displays the coordinate system. The receiver performs all calculations in terms of the GPS coordinate system, WGS-84. Using the Trimble Configuration Toolbox software, you can select a local datum and projection for display and output of local coordinates. Click Next to view the local projected coordinates.

VELOCITY screen

This screen shows the East, North, and Up velocities of the solution.

To display the *VELOCITY* screen:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<VELOCITY>** to display:

```
  E: -0.156kph      3D   RTK (FIX)
 N: +0.542kph     20:04:58.0 UTC
 U: +2.034kph             WGS-84
SVS:18,19,16,1,27,13,3
```

Use the field descriptions in Table 4.6 to read the status information.

Table 4.6 VELOCITY Fields

Field	Description
E	Displays velocity in the East direction.
N	Displays velocity in the North direction.
U	Displays velocity in the Up direction.

ATTITUDE screen

This screen shows the tilt, yaw, distance, number of satellites used, position mode, time of fix, PDOP, and delta time of the moving baseline calculated.

Note – *This screen is only applicable in a BD950 setup with Moving Base option enabled for Moving Base RTK operation with either NMEA AVR messages or ATTITUDE INFO messages switched on.*

To display the *ATTITUDE* screen:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<ATTITUDE>** to display:

```
TILT:    +0.20 deg              RTK (FIX)
 YAW: +180.03 deg     22:30:44.6 UTC
DIST:   +2.421m
 SVs: 7      PDOP: 2.2  dT:0.21
```

Use the field descriptions in Table 4.7 to read the status information.

Table 4.7 ATTITUDE fields

Field	Description
TILT	Displays vertical angle in degrees between master and slave antenna. Tilt is zero when both are on same horizontal plane. Tilt is positive when slave is above master.
YAW	Displays horizontal angle in degrees between master and slave antenna, with respect to local zone's North axis.
DIST	Displays distance between master and slave antenna.
SVs	Displays number of satellites used in the moving baseline.
PDOP	Displays Position Dilution of Precision of the position fix.
dT	Displays delta time between moving baseline solution and current time. This indicates latency of output attitude information.

VECTOR screen

This screen shows the latest Real-Time Kinematic vector information, the solution RMS, age of corrections, fix mode, number of continuously initialized epochs, solution Dilution Of Precision and any faults.

Note – *Vector information is not displayed for a DGPS solution.*

To display the *VECTOR* screen:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<VECTOR>** to display:

```
«E: +1287.312  RMS:  0.024 RTK/FIX
 N:  -504.791 PROP:    0.8 SVS:5
 U:   +10.026    N:   3247
 R:  1382.782  DOP:    1.8
```

Use the field descriptions in Table 4.8 to read the status information.

Table 4.8 VECTOR fields

Field	Description
E	Displays the East component of the vector between the base station and rover station antenna phase center.
N	Displays the North component of the vector between the base station and rover station antenna phase center.
U	Displays the Up component of the vector between the base station and rover station antenna phase center.
R	Displays the Length component of the vector between the base station and rover station antenna phase center.
RMS	Displays the root mean square (RMS) error of the measurement residuals in units of L1 cycles. For fixed-ambiguity (RTK/FIX) solutions, the RMS value should be less than 0.100 cycles. In a float-ambiguity (RTK/FLOAT) mode, the RMS value is generally less than 10 cycles.
Fix Mode	Displays the method used to compute position solutions: N/A – Stand-alone position or no position computed RTK/FLOAT – Real-Time Kinematic, differential position solution with float ambiguities RTK/FIX – Real-Time Kinematic, differential position solution with fixed ambiguities

Table 4.8 VECTOR fields (continued)

Field	Description
PROP	Displays the age of the Real-Time Kinematic corrections coming from the base station. The receiver is designed such that occasional losses of base station data packets do not cause a loss in position and vector solutions. The "normal" PROP time (0.2 seconds to 1.4 seconds) may increase if corrections are received through one or more repeaters. If a Trimble 4000SSE/SSi™ is used as a base station, the PROP time grows to 2.2 seconds or more.
SVs	Identifies the number of satellites used to compute the solution.
N	Displays the number (N) of seconds the receiver has been in the current mode (Fix/Float).
DOP	Displays the Dilution Of Precision of the position fix. The DOP value gives an indication of the satellite geometry quality. Low DOP values indicate strong measurement geometry, while values greater than 7.0 indicate weak geometry. When the receiver is put in a STATIC mode using the general controls, the DOP value decreases over time. The DOP value displayed while STATIC is Relative Dilution Of Precision, and when KINEMATIC, is the Geometric Dilution Of Precision.

***Note –** Be cautious of position and vector information if the DOP is greater than 5.0.*

Error messages

An error message displays to indicate any problems in the Real-Time Kinematic position fix. Table 4.9 lists the possible errors.

Table 4.9 RTK position fix errors

Error message	Description
UNKNOWN	Unknown error condition.
< MIN SVS	Need more satellites to compute a position fix.
HIGH DOP	Dilution Of Precision exceeds mask value.

Table 4.9 RTK position fix errors (continued)

Error message	Description
SYNC'D DATA	Need synchronized data between base station and rover receiver.
NO REF DATA	Not receiving valid data from the base station.
NEED REF POS	Waiting for valid reference position message from the base station.
COMMON SVS	Fewer than 4 common satellites between base station and rover receivers.
C/P MISMATCH	Base and rover receivers are tracking different types of code measurements.
DIFF PDOP	Differential DOP value exceeds mask value.
NO L2 PHASE	Need L2 phase data to start ambiguity search process.
POOR RMS	RMS figure is considered too high.
NO SEARCH	Ambiguity search has not been started.
VERIFY FAIL	Ambiguities failed the verification process.
# SVS < MIN	Need at least 5 common satellites to start search.
SUSPECT LINE	Known baseline entered could be incorrect.
HIGH RMS	Search cancelled due to high RMS.
LOW RATIO	Search cancelled due to low ratio.
PROP CANCEL	Search cancelled because it took too long.
HIGH SRH DOP	Search satellites have poor geometry – cannot resolve.

VECTOR AMBIGUITY STATUS screen

This screen shows the ambiguity resolution status and search information for Real-Time Kinematic positioning.

To display the *VECTOR AMBIGUITY STATUS* data:

1. Click [Clear] several times until the *MAIN* screen appears.
2. Click **<VECTOR>**.
3. Click [Next] to display:

```
«SV: 02 07 09 04 05 24 26 xx
 L1: R  R  R  R  S  S  F
 L2: -  -  -  -  -  -  -
 REF SV:12 RATIO:  128.19  RMS: 0.024
```

Use the field descriptions in Table 4.10 to learn the vector ambiguity status.

Table 4.10 VECTOR AMBIGUITY STATUS fields

Field	Description
SV	Displays the satellites (SVs) used for the RTK vector.
L1,L2	Displays a list of the L1 and L2 ambiguity resolution status codes for each satellite. The search process is automatically handled by the receiver. The ambiguity search process involves: F – Estimation of float ambiguities S – Search the ambiguities V – Verify that ambiguities are valid R – Resolve ambiguities (normal code for a fixed solution)
REF SV	Displays the pseudorandom number (PRN) of the satellite used to form double difference measurements.

Table 4.10 VECTOR AMBIGUITY STATUS fields (continued)

Field	Description
RATIO	Displays the separation between the best ambiguity candidate and the next best. A large ratio (>10) indicates that the best candidate is significantly better than the next best. Once the ambiguities are resolved, the ratio value is retained.
RMS	Displays the root mean square (RMS) error of the best ambiguity search candidate. The RMS value at resolution is retained. The RMS is displayed in meters.

VECTOR BASE STATION STATUS screen

This screen shows the Real-Time Kinematic base station name, location, satellites tracked at the base station, and the age of the RTK corrections. This display is used for RTK positioning at the rover receiver.

To view the status of the vector base station:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<VECTOR>**, and click Next.
3. Click Next again to display:

```
«BASE STATION          NAME: BASE
LAT: 37°23'26.0000" N  HGT:      +0.000 m
LON:122°02'16.0000" W  AGE:      1.2
SVS:20,6,12,9,5,4
```

Use the field descriptions in Table 4.11 to learn the current status of the vector base station.

Table 4.11 VECTOR BASE STATION STATUS fields

Field	Description
NAME	Displays the 8-character designation assigned to the base station.
LAT	Displays the latitude coordinate of the antenna phase center location at the base station based on the WGS-84 datum.
LON	Displays the longitude coordinate of the antenna phase center location at the base station based on the WGS-84 datum.
HGT	Displays the height of the antenna phase center location at the base station based on the WGS-84 datum.
AGE	Displays the age of the Real-Time Kinematic measurement correction data. Under normal operation, the age does not exceed 2 seconds. If, however, the radio link between base and rover stations is intermittent, then the age field could exceed 3 seconds.
SVS	Displays the pseudorandom numbers (PRNs) of the satellites (SVs) tracked by the base station.

VECTOR AVAILABLE RADIO LINKS STATUS screen

This screen shows the available base station IDs (radio links) on the radio frequency. The screen also shows the associated qualities of the corrections being received.

To view the status of the radio links:

1. Click Clear several times until the *MAIN* screen appears.
2. Click **<VECTOR>**, and click Next twice.
3. Click Next again to display:

```
«AVAILABLE RADIO LINKS
ID:       22    0    0    0    0    0
QUALITY:100%   0%   0%   0%   0%   0%
```

Use the field descriptions in Table 4.12 learn the current status of the vector radio links.

Table 4.12 VECTOR RADIO LINKS STATUS fields

Field	Description
ID	Displays the ID of the base station.
QUALITY	Shows as a percentage the quality of the corrections received.

FACTORY CONFIGURATION screen

This screen shows the software version, installed options, and memory configuration of the BD950 receiver.

To display the receiver configuration and the installed options:

1. Click [Status] to display the *STATUS* menu.
2. Click **<FACTORY CONFIGURATION>** to display:

```
«FACTORY CONFIGURATION (STATUS)
BD950
FIRMWARE: 1.40 MAR 2 2002
 SERIAL: 220154564
```

3. Click [Next] to view installed options. The options in your receiver may differ.

```
«FACTORY CONFIGURATION (STATUS)
CMR INPUT CMR OUTPUT RTCM INPUT
RTCM OUTPUT JX-1100   TSC1/TDC1
GSOF, RT17   20 Hz
```

Use the field descriptions in Table 4.13 to identify the receiver configuration and factory installed options.

Table 4.13 FACTORY CONFIGURATION fields

Field	Description
Firmware	Displays the version number and release date of the firmware.
Serial number	Displays the receiver serial number.
Options	Displays the list of installed receiver options.

RECEIVER SYSTEMS screen

This screen lists the operating mode of the BD950 receiver, and currently active output and input messages. It shows a summary of the receiver's operation without having to page through the *CONTROL* screens.

To view the status the receiver:

1. Click Status to display the *STATUS* menu.
2. Click **<RECEIVER SYSTEMS>** to display:

```
«  MODE: ROVER/RTK
OUTPUTS: GGA(1),STREAMED(2)

INPUTS : CMR(3)
```

Use the field descriptions in Table 4.14 to learn the current status of the receiver.

Table 4.14 RECEIVER SYSTEMS fields

Field	Description
MODE	Displays the receiver positioning mode: AUTONOMOUS – Stand-alone positioning mode. Activated automatically by receiver at power-up. BASE STATION – Base station. Enabled using Control. **<SERIAL PORT OUTPUT>**,**<CMR/RTCM OUTPUT>** ROVER/RTK – RTK rover which is receiving base station correction data to compute solutions ROVER/DGPS – DGPS rover which is using pseudorange correction data to compute position solutions
OUTPUTS	Lists the currently active outputs and output port index. NMEA GGA strings are being output port 1, while streamed data is being output to port 2 in the example on page 63. A list of receiver output messages follows: No Outputs – No data is currently being output CMR – Trimble-formatted RTK data output RTCM – RTCM SC-104 formatted correction data NMEA – ASCII messages STREAMED – General Serial Output format RT17/BINARY – Raw data output 1 PPS – One Pulse Per Second output
INPUTS	Lists the currently active inputs and input port index. CMR messages are received on port 3 in the example above. Receiver input messages include: CMR – Trimble-formatted RTK data input RTCM – RTCM SC-104 formatted correction data

COORDINATE REFERENCE screen

This screen shows the coordinate system, coordinate zone, datum method, datum, ellipse, projection, site, horizontal plane adjustment, and vertical plane adjustment.

To view the *COORDINATE REFERENCE* screen:

1. Click Status.
2. Click **<COORDINATE REFERENCE>** to display the following screens:

```
«         DATUM:WGS-84
  COORD SYSTEM:WGS-84
          ZONE:None
  DATUM TRANS:None
```

```
«       ELLIPSE:WGS-84
   PROJECTION:None
          SITE:None
  HORIZ PLANE:None
```

```
«    VERT PLANE:None
```

SV TRACKING screen

This screen lists the tracking status of the BD950 channels. The satellite PRN number assigned to each channel is shown with elevation/azimuth, method of code tracking, signal-to-noise ratio values, ephemeris issue of data, and the user range accuracy figure.

To view the SV tracking status of all receiver channels:

1. Click [SatInfo] to display the *SAT INFO* menu.
2. Click **<SV TRACKING>** to display the following screens:

```
«CH  SV  EL/AZ    CODE  SNR/L2  IOD  URA
  1   6  37/297    C/E   49/27  127   32
  2   9  63/301    C/E   55/25  101   32
  3  16  41/124    C/E   51/29  197   32
```

```
«CH  SV  EL/AZ    CODE  SNR/L2  IOD  URA
  4
  5   5  67/166    C/E   52/28   56   32
  6   4  15/48     C/E   32/10  132   32
```

```
«CH  SV  EL/AZ    CODE  SNR/L2  IOD  URA
  7
  8
  9  20  51/194    C/E   50/29  12    32
```

Use the field descriptions in Table 4.15 to learn the SV tracking status of all receiver channels.

Table 4.15 SV TRACKING fields

Field	Description
CH	Displays the receiver channel number (1–9).
SV	Displays the pseudorandom number (PRN) of the satellite tracked on the channel (1–32).
EL/AZ	Displays the elevation and azimuth of the satellite.
CODE	Displays the type of code measurements tracked on the channel. The channels of L1 always indicate C (C/A code). For the L2 channels, a Trimble proprietary tracking scheme is used and is designated with E (E-code).
SNR/L2	Displays the Signal-to-Noises ratio of the satellite tracked on the channel, for L1 and L2.
IOD	Displays the Issue Of Data number transmitted by the satellite tracked on the channel. Changes in the IOD number indicate a change to a new ephemeris.
URA	Displays the User Range Accuracy, in meters. URA is a figure of merit value used to measure the quality of the broadcast satellite ephemeris.

SV STATUS screen

This screen lists the active, unhealthy, and disabled satellites.

To view the current status of all NAVSTAR GPS satellites:

1. Click SatInfo to display the *SAT INFO* menu.
2. Click **<SV STATUS>** to display the following screens:

```
«SV STATUS
ACTIVE:
1,2,3,4,5,6,7,8,9,10,12,13,14,15,16,17,18,19,2
0,21,22,23,24,25,26,27,29,30
```

```
«UNHEALTHY:
 24
```

```
«DISABLED:
 31
```

Use the field descriptions in Table 4.16 to learn the status of all satellites.

Table 4.16 SV STATUS fields

Field	Description
ACTIVE	Displays the list of active satellites that have been launched and considered part of the GPS constellation.

Table 4.16 SV STATUS fields (continued)

Field	Description
UNHEALTHY	Displays the list of satellites deemed unhealthy by the GPS ground segment. By default, the receiver does not use unhealthy satellites in position solutions. Satellite health is derived from the broadcast ephemeris or satellite almanac.
DISABLED	Identifies the satellites which are manually disabled for the receiver. Use CONTROL **<SV ENABLE/ DISABLE>** to disable a satellite.

DELETE ALM/EPH screen

This screen enables the deletion of the current almanac and ephemeris stored in the .

To delete the current almanac and ephemeris settings:

1. Click SatInfo to display the *SAT INFO* menu.
2. Click **<DELETE ALM/EPH>** to display the following screen:

```
THE RECEIVER WILL DELETE THE CURRENT
ALMANAC AND EPHEMERIS SETTINGS

       PRESS <ENTER> TO CONTINUE
```

3. Click Enter to delete the current almanac and ephemeris settings.

APPLICATION FILE SESSIONS screen

This screen provides a directory listing of the saved application files. An application file can be deleted or started from this screen.

To show the Application File directory on the receiver:

1. Click AppFile to display the *APPLICATIONS* menu.
2. Click **<DIRECTORY>** to display:

```
APP_FILE  (  0 )                        <PREV>
FEB 8 2002 02:36:55.0 UTC                <TIMER>
1208 BYTES                               <DELETE>
                                        <START>
```

3. Perform any of the following actions:
   - To scan through the previous list of application files stored in the directory, click **<PREV>**.
   - To set a time in the future when an application file will be started, click **<TIMER>**.
   - To remove the application file from the directory, click **<DELETE>**.
   - To apply all of the application file parameters to the receiver, click **<START>**.
   - To scan forward through the application file listings stored in the directory, click Next.

Table 4.17 describes the *APPLICATION FILE SESSIONS* screen fields.

Table 4.17 APPLICATION FILE SESSIONS fields

Field	Description
Application File Name/Index	Displays the file name or index number assigned to the application file.
Creation Date/ Time	Displays the date and time when the application file is created, in UTC.
File Size	Displays the size of the application file, in bytes.

STORE CURRENT screen

This screen lets you store the current BD950 receiver settings into the named application file.

To store the current receiver parameter settings in an application file:

1. Click AppFile to display the *APPLICATIONS* menu.
2. Click **<STORE CURRENT>** to display:

```
STORE APPLICATION FILE

          FILE NAME:
```

3. Enter an eight-character name for the application file. The software stores the creation date and time with the file.

CLEAR ALL screen

This screen lets you erase all application files and reset to factory settings.

***Note –** Step 2 below erases the ephemeris stored in the receiver. If only a reset of defaults is required, see APPLICATION FILE SESSIONS screen, page 70 for a procedure to start the default application file.*

To erase all files and reset the factory default values:

1. Click AppFile to display the *APPLICATIONS* menu.
2. Click **<CLEAR ALL>**.

BASE STATION screen

Warning – The base station coordinates must be known to better than 10 meters (m) to achieve utmost RTK accuracy. The position derived from **<HERE>** is in error by 10–20 m. Use the averaging capabilities within the receiver to obtain more accurate coordinates. For more information, see Base Station Averaging in the next section.
Make sure that you correctly set the North/South, East/West indicators correct. If the input base station coordinates are more than 300 m different from the BD950-computed coordinates, no RTK corrections will be output and a warning is issued.

This screen lets you specify the base station location, antenna height, name, and output port for real-time corrections.

To set the *BASE STATION* parameters:

1. Click Control to display the *CONTROL* menu.
2. Click **<BASE STATION>** to display: BD950

3. Set the *BASE STATION* parameters using the information in Table 4.18.

Table 4.18 RTK BASE STATION fields

Field	Description
LAT	Identifies the latitude coordinate of the base station ground mark based on the WGS-84 datum.
LON	Identifies the longitude coordinate of the base station ground mark based on the WGS-84 datum.
HGT	Identifies the height or altitude of the base station ground mark based on the WGS-84 datum.
ANT. HT.	Identifies the vertical distance between the ground mark to the antenna phase center.

4. If known coordinates are not available, click **<HERE>** to find the approximate location of the base station. The receiver must be tracking at least 4 satellites with a DOP value less than 3.

Base station averaging

Tests have shown that base station coordinate accuracies of better than 10 m can be obtained by averaging autonomous GPS positions over a period of time greater than 30 minutes. The BD950 receiver can compute cumulative position averages.

Note – *The receiver must be doing autonomous GPS solutions, not RTK (fixed) or RTK (float), or DGPS solutions.*

To implement base station averaging:

1. Click Control, then click **<GENERAL CONTROLS>** to display:

```
GENERAL (CONTROL)
ELEV MASK: 13      PDOP MASK: 07
RTK MODE: [LOW LATENCY]
MOTION: [KINEMATIC]
```

2. Set the *MOTION* field to *STATIC*.

3. Click Control, then click **<BASE STATION>** to display:

```
BASE STATION (CONTROL)              <AVG>
LAT: 37°23'29.35788"[N]
LON:122°02'13.80337"[W]
HGT:[+]0140.350 m   ANT. HT.:000.000 m
```

   The **<HERE>** softkey is now replaced with the **<AVG>** softkey.

4. Click **<AVG>** to enter the current averaged position in the coordinate fields.

   Adjacent to **<AVG>** is the display of the hours, minutes, and seconds elapsing since the start of the computation of averaged position. The time begins when the ***MOTION*** field is set to *STATIC*. Each time **<AVG>** is clicked, the latest values for averaged position and the length of time used to compute the averaged position solution appears on the screen.

SV ENABLE/DISABLE screen

Warning – Disabling or setting the BD950 receiver to override satellite health warnings can adversely affect receiver performance.

This screen lets you control the BD950 receiver's tracking of satellites. To display the screen:

1. Click Control to display the *CONTROL* menu.
2. Click **<SV ENABLE/DISABLE>** to display:

```
SV CONTROL
 SV:[ALL] STATE:[ENABLE   ]
```

3. Set the *SV ENABLE/DISABLE* parameters using the information in Table 4.19. To do this, do one of the following:
   - Select ALL
   - Enter the pseudorandom number (PRN) of the satellite in the *SV* field
4. Select the setting for the *STATE* field using the information in Table 4.19.

Table 4.19 SV ENABLE/DISABLE fields

Field	Description
SV	Selects ALL satellites or accepts the pseudorandom number (PRN) of a specific satellite (1–32). The ENABLE/ DISABLE state of each satellite can be set individually.
STATE	Assigns the ENABLE/DISABLE state to the satellite or all satellites. ENABLE – Enables tracking for the specified satellite(s) DISABLE – Do not track the specified satellite(s) or use it in a position solution FORCE USE – Override health status of the satellite(s) and use the satellite(s) in solution

GENERAL CONTROLS screen

Warning – An elevation mask of 90° stops the BD950 receiver from tracking any satellites. The default elevation mask is 13° and should ***not*** be changed.

This screen lets you control the BD950 elevation mask, PDOP mask, RTK mode, and motion state.

To set the *GENERAL CONTROLS* parameters:

1. Click Control to display the *CONTROL* menu.
2. Click **<GENERAL CONTROLS>** to display:

```
GENERAL (CONTROL)
ELEV MASK: 13      PDOP MASK: 07
RTK MODE: [LOW LATENCY]
MOTION: [KINEMATIC]
```

3. Set the *GENERAL CONTROLS* parameters using the information in Table 4.20.

Table 4.20 GENERAL CONTROLS fields

Field	Description
ELEV MASK	Selects the elevation mask. This is the elevation angle from which satellites are tracked above the horizon. The elevation mask is measured from the local horizon towards the zenith, 0–90°. The default is 13°.
PDOP MASK	Position Dilution of Precision mask. The default is 7.

Table 4.20 GENERAL CONTROLS fields (continued)

Field	Description
RTK MODE	Two modes of operation are available for RTK operation: Low Latency mode and Synchronized mode. Low Latency mode delivers low latency positions at rates up to 20 Hz with a small degradation in accuracy. Synchronized mode delivers the highest accuracy position at a maximum update rate of 10 Hz and increased latency. For more information, see Chapter 2, Real-Time Kinematic Positioning.
MOTION	Sets the motion state of the receiver to KINEMATIC or STATIC. Select Kinematic when the receiver is moving. The STATIC mode causes averaging of the computed position. STATIC mode is automatically selected by the receiver if the receiver is configured as an RTK or DGPS base station.

1 PPS OUTPUT screen

This screen lets you control the output of a one pulse per second (1 PPS) signal and the port of an associated ASCII time tag. To enable or disable 1 PPS and ASCII Time Tag output:

1. Click Control to display the *CONTROL* menu.
2. Click **<1 PPS OUTPUT>** to display:

```
1 PPS (CONTROL)

  1 PPS:[ON ]  ASCII TIME TAG PORT: 1
```

3. Set the 1 PPS output parameters based on the information in Table 4.21.

Table 4.21 1 PPS OUTPUT fields

Field	Description
1 PPS	Enables or disables 1 PPS output (ON or OFF).
ASCII TIME TAG PORT	Enables or disables the transmission of an ASCII time tag message through a port. Select OFF or a port designation.

NMEA/ASCII OUTPUT screen

This screen lets you set up output message type, serial port, and the output frequency. The NMEA-0183 (Version 2.3) standard contains messages for integrating GPS information with other systems. The standard is based around ASCII data beginning with the $ character and ending with a carriage return and line feed. Null fields still follow a comma (,) delimiter but contain no information.

To control NMEA output:

1. Click [Control] to display the *CONTROL* menu.
2. Click [Next].
3. Click **<SERIAL PORT OUTPUT>**.
4. Click **<NMEA/ASCII OUTPUT>** to display:

```
NMEA OUTPUT <CONTROL>

  TYPE:[GGA  ] PORT:[1]  FREQ:[OFF    ]
```

5. Set the NMEA output parameters based on the guidelines in Table 4.22.

Table 4.22 NMEA OUTPUT fields

Field	Description
TYPE	Selects the NMEA message type.
PORT	Assigns the serial port for outputting NMEA messages.
FREQ	Assigns a frequency for outputting NMEA messages in either Hz, seconds, or minutes.

Note – *The RECEIVER SYSTEMS screen gives a summary of the messages being output from the BD950 ports. For more information, see RECEIVER SYSTEMS screen, page 63.*

STREAMED OUTPUT screen

This screen lets you set up streamed output messages. For information about controlling the streamed output message formats, see Command Packet 4Ah GETOPT (Receiver options request), page 119.

To configure the receiver to stream output messages:

1. Click Control to display the *CONTROL* menu.
2. Click Next.
3. Click **<SERIAL PORT OUTPUT>**.
4. Click **<STREAMED OUTPUT>** to display:

```
STREAMED OUTPUT (CONTROL)
  PORT:[1]
  TYPE:[POSITION TIME     ]
  FREQ:[OFF    ]     OFFSET (SEC):00
```

Table 4.23 describes the *STREAMED OUTPUT* screen fields.

Table 4.23 STREAMED OUTPUT fields

Field	Description
PORT	Assigns the serial port used for streamed data output.
TYPE	Assigns the message type to output on the port: POSITION TIMEDOP INFO LAT, LONG, HTCLOCK INFO XYZ POSITIONPOSITION VCV LOCAL LLHPOSITION SIGMA LOCAL ENUBRIEF SV INFO DELTA XYZDETAIL SV INFO TPLANE ENURECEIVER SERIAL VELOCITYTIME/UTC INFO ATTITUDE INFO
FREQ	Assigns a frequency for outputting messages in either Hz, seconds, or minutes.
OFFSET	Assigns an offset value for the number of seconds elapsing while messages are output relative to the frequency (FREQ). If the frequency is 5 seconds and the offset is 2 seconds, the message is output at measurement epochs 2, 7, 12, 17, ...

Note – *The RECEIVER SYSTEMS screen gives a summary of the messages being output from the BD950 ports. For more information, see RECEIVER SYSTEMS screen, page 63.*

RT17/BINARY OUTPUT screen

This screen lets you set up raw GPS data output messages. For more information, see 56h, GETRAW (Position or real-time survey data request), page 122 and 57h, RAWDATA (Position or real-time survey data report), page 192.

To configure the receiver for raw binary data output:

1. Click [Control] to display the *CONTROL* menu.
2. Click [Next].

3. Click **<SERIAL PORT OUTPUT>**.
4. Click **<RT17/BINARY OUTPUT>** to display:

```
RT17/BINARY OUTPUT (CONTROL)
        PORT [1      ]       CONCISE [ON ]
MEASUREMENTS [1 HZ   ]     R-T FLAGS [ON ]
   POSITIONS [1 HZ   ]   EPHEMERIS   [ON ]
```

5. Use the field descriptions in Table 4.24 to configure the receiver for raw binary data output.

Table 4.24 RT17/BINARY OUTPUT fields

Field	Description
PORT	Assigns the serial port (PORT) used for RT17 binary output.
CONCISE	Selects between Concise and Expanded measurement output formats.
MEASUREMENTS	Sets the raw GPS measurement output rate.
R-T FLAGS	Provides Real-Time Flags for enabling and disabling enhanced measurement records with IODE information and cycle slip counters for each satellite. This data can be useful to computer programs processing data for real-time applications.
POSITIONS	Sets the output rate for position measurements.
EPHEMERIS	Determines whether or not the ephemeris is automatically formatted and transmitted whenever a new IODE (Issue of Data Ephemeris) becomes available.

***Note –** The RECEIVER SYSTEMS screen gives a summary of the messages being output from the BD950 ports. For more information, see RECEIVER SYSTEMS screen, page 63.*

CMR/RTCM OUTPUT screen

This screen lets you configure CMR and RTCM base station output settings.

To configure the receiver CMR/RTCM output:

1. Click Control to display the *CONTROL* menu.
2. Click Next.
3. Click **<SERIAL PORT OUTPUT>**.
4. Click **<CMR/RTCM OUTPUT>** to display:

```
CMR/RTCM (CONTROL) RTCM VERSION [2.1]
 RTCM PORT [OFF]      TYPE [RTK]   ID 0000
  CMR PORT [1]        NAME CREF0001 ID 0000
  CMR TYPE [CMR+]  BASE [STATIC]
```

5. Use the field descriptions in Table 4.25 to configure one or more serial ports.

Table 4.25 CMR/RTCM OUTPUT fields

Field	Description
RTCM VERSION	Selects version of RTCM to output.
RTCM PORT	Assigns the serial port for RTCM output.
TYPE	Sets the required RTCM types: Type 1 – DGPS corrections Type 9-3 – DGPS corrections Type RTK – RTK data only (Type 18, 19) Type RTK & 1 – RTK and DGPS corrections (Type 1, 18, 19)
ID	Allows input of a station ID.
CMR PORT	Assigns the serial port for CMR output.
NAME	Assigns a 4-character designator to the base station.

Table 4.25 CMR/RTCM OUTPUT fields (continued)

Field	Description
ID	Allows input of a station ID.
CMR TYPE	Sets the required CMR types: CMR+ – Outputs base data at a 1 Hz rate for RTK application CMR 5Hz – Required for 5 Hz Synchronized RTK and higher accuracy Low Latency positioning CMR 10Hz – Required for 10 Hz Synchronized RTK and higher accuracy Low Latency positioning CMR – Required for applications where roving receivers include Trimble 4000 Series receivers
BASE	Sets the motion state of the base station. Set to MOVING if base is part of a Moving Base RTK configuration.

SERIAL PORT SETUP screen

This screen lets you configure the serial port baud, data bits, parity, stop bits, and flow control settings.

To configure the serial communication parameters for a port:

1. Click Control to display the *CONTROL* menu.
2. Click Next.
3. Click **<SERIAL PORT SETUP>** to display:

```
SERIAL PORT SETUP (CONTROL)

[PORT 1] [38400 ] [8-NONE-1] [NONE     ]
```

4. Use the field descriptions in Table 4.26 to configure one or more serial ports.

Table 4.26 SERIAL PORT SETUP fields

Field	Description
PORT	Assigns which serial port is to be configured.
BAUD	Assigns the baud rate setting in the range: 2400, 4800, 9600, 19.2K, 38.4K, 57.6K, 115K.
DATA	Assigns the data, parity, and stop bit settings: 8 – NONE – 1 eight data bits, no parity, and one stop bit (default) 8 – ODD – 1 eight data bits, odd parity, and one stop bit 8 – EVEN – 1 eight data bits, even parity, and one stop bit
FLOW CONTROL	Enables or disables CTS/RTS (Clear To Send / Request To Send) flow control negotiation for port 1.

INPUT SETUP Screen

This screen lets you allow the receiver to automatically select an RTCM station or to manually specify a RTCM Station ID, and specify the distance used by the receiver to switch between the use of RTK and DGPS correction processing techniques.

To configure the input setup parameters:

1. Click Control to display the *CONTROL* menu.
2. Click Next.
3. Click **<INPUT SETUP>** to display:

```
INPUT SETUP (CONTROL)
USE RTCM STATION [ONLY]: 0000
RTK/DGPS AUTO SWITCH RANGE: 200.0 KM
```

4. Use the field descriptions in Table 4.27 to configure which RTCM base station the rover receiver is using to calculate solutions and the range that the receiver automatically switches between RTK or DGPS corrections.

Table 4.27 INPUT SETUP fields

Field	Description
USE RTCM STATION	Assigns the identification number of the RTCM Station used for receiving RTCM corrections. You can choose ANY or ONLY. If you choose ANY, the receiver selects any RTCM station for receiving RTCM corrections. If you choose ONLY, you must manually enter the number of the required RTCM Station, a value ranging from 0–1023.
RTK/DGPS AUTO SWITCH RANGE	Defines the distance used to determine when the BD950 receiver automatically switches between the use of RTK and DGPS solutions. The default is 200.0 km.

CHAPTER

5

Software Utilities

In this chapter:

- Introduction
- MS Controller software
- Configuration Toolbox software
- WinFlash software

Introduction

This chapter provides information on the software utilities that you can use with the BD950 receiver.

MS Controller Software

The MS Controller software is a Windows application that you can use to configure selected Trimble GPS receivers. The MS Controller software lets you:

- check current receiver settings and operation
- change receiver settings in real time

Installing the MS Controller software

To install the MS Controller software:

1. Turn on the computer and start Microsoft Windows.
2. Place the BD950 Support software CD in the CD drive of your computer.
3. When the BD950 Support Software window opens, click on *Install MS Controller.*

   Note – *If the BD950 Support Software window does not open, under My Computer double click on the computer drive that the BD950 Support Software CD is in.*
4. Follow the InstallShield wizard which will guide you through the installation of MS Controller on your computer.

Using the MS Controller software

The MS Controller software supplied with the BD950 receiver serves as a virtual keypad and display screen for receivers. For more information about how to use the MS Controller software, refer to Chapter 4, Using the Simulated Keypad and Display.

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

Installing the Configuration Toolbox software

A copy of the Configuration Toolbox software is included on the BD950 Support software CD.

To install the software:

1. Insert the CD-ROM into the CD drive on your computer.
2. Using Windows Explorer, navigate to the CD drive.
3. Double-click the file called Setup.exe.
4. Follow the onscreen instructions.

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:

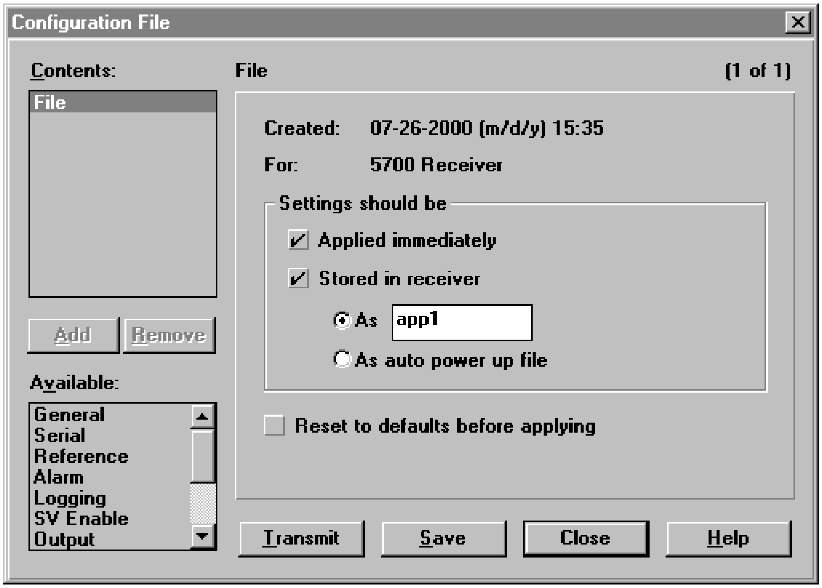
1. Create and save the application file in the Configuration Toolbox software.
2. Connect the receiver to the computer and apply power.
3. Open the desired application file in the Configuration Toolbox software.
4. Transfer this application file to the receiver.

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 specific 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 BD950 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 informing you 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 BD950 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 select *Communications* / *Activate File*.

WinFlash Software

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

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

If additional information is needed, online help is also available when using the WinFlash software.

Note – *The WinFlash software is a 32-bit application, so the local computer's operating system must be Windows 95, 98, NT, 2000, or ME. It does not run under earlier versions of Windows.*

Installing the WinFlash software

The WinFlash software can be installed from the BD950 Support software CD, or from the Trimble website. Refer to one of the following sections for the installation procedure you need.

WInFLASH from the BD950 Support software CD

A copy of the WinFlash software is included on the BD950 Support software CD.

To install the WinFlash software from the CD:

1. Insert the disk into the CD drive on your computer.
2. Using Windows Explorer, navigate to the CD drive.
3. Double-click the file called Setup.exe.
4. Follow the onscreen instructions.

WinFlash from the Internet

To install the WinFlash software from the Trimble website:

1. Go to http://www.trimble.com/support.
2. From the list, select BD950.
3. Click the **Downloads** link.
4. Click the link for the latest version of the firmware. The file that contains the firmware includes the WinFlash software.
5. Follow the prompts provided by the File Download wizard.

Upgrading firmware

Your BD950 receiver is supplied with the latest version of receiver firmware installed. If a later version becomes available, upgrade the firmware installed on your receiver.

The WinFlash software guides you through the firmware upgrade process. The steps required are described below. For more information, refer to the WinFlash Help.

To upgrade the BD950 receiver firmware:

1. Start the WinFlash software.

   The *Device Configuration* screen appears.
2. From the *Device type* list select BD950 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 GPS software upgrade and click **Next**.

The *GPS Software Selection* window appears. This screen prompts you to select the software that you want to install on the BD950 receiver.

6. Select the latest version from the *Available Software* list and 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 the BD950. Please wait.).

8. Click **OK**.

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

9. Click **Menu** to select another operation, or click **Exit** to quit the WinFlash software.

10. If you click **Exit**, another screen appears asking you to confirm that you want to quit the WinFlash software. Click **OK**.

CHAPTER

6

Configuration

In this chapter:

- Introduction
- Communicating with the receiver
- Configuring the BD950 as a static base station
- Configuring the BD950 as a rover

Introduction

The BD950 receiver can be set up to operate in either of two ways:

- as a static base station
- as an RTK or DGPS rover relative to a base station.

Trimble recommends you read Chapter 4, Using the Simulated Keypad and Display first, to become familiar with the status screens and configuration of the receiver.

Communicating with the Receiver

Connect the computer to a serial port on the test I/O board, using a serial cable (such as part number 14284). To run the MS Controller software, refer to the instructions about Trimble MS Controller Software, page 40.

Note – *The BD950 receiver can also be configured using Trimble's Configuration Toolbox software, or using the Data Collector Format serial interface.*

The main default settings for the BD950 receiver are:

- All serial port outputs are disabled.
- All serial ports are set for 38400 baud, 8 data bits, no parity, and 1 stop bit.
- No local coordinates defined.

Configuring the BD950 as a Static Base Station

Warning – Do ***not*** click Clear until all fields intended to be entered have been verified. Otherwise, the information will be lost.

To configure the BD950 receiver as a base station:

1. Click Control to display the *Control* screen, and then click **<BASE STATION>**.
2. Enter the 3D coordinates of the base station. If the coordinates of the survey point are unknown, click **<HERE>**.

   Note – *For more information about base station setup, see Base station averaging, page 73.*
3. From the *Control* screen click Next, and then click **<SERIAL PORT OUTPUT>**.
4. Click **<CMR/RTCM OUTPUT>**. Enable either CMR or RTCM message outputs using the instructions for *CMR/RTCM OUTPUT* screen on page 82.
5. Click Clear several times to return to the *Main* screen. To verify the outputs are switched on, click Status then **<RECEIVER SYSTEMS>**. The mode field should show *Base Station*.

Configuring the BD950 as a Rover

To configure the receiver as a rover:

1. Click Control, click Next, and then click **<SERIAL PORT SETUP>**.

   Make sure that the serial settings of the receiver’s I/O port being used for the correction input are the same as those selected for the radio-modem.

   Note – *The BD950 receiver automatically detects the port used to input corrections. You need to verify that the serial settings are correct.*

2. Click [Clear] several times to return to the *Main* screen.
3. Click **<POSITION>** and confirm the position type to be RTK or DGPS, depending on the type of correction data you selected as input for the system.

To enable the output of position and other data strings from the receiver:

1. Click [Control], click [Next], and then click **<SERIAL PORT SETUP>** to configure the data output.

   Make sure that the serial parameters of the receiver I/O ports match the communications parameters selected for the interface device.

2. Click [Clear], and then click **<SERIAL PORT OUTPUT>** to choose output type.

For further information on NMEA / ASCII output and streamed output, see page 78 and page 79.

For detailed information about data output formats, see Chapter 9, Data Collector Format Report Packets.

CHAPTER

7

RS-232 Serial Interface Specification

In this chapter:

- Introduction
- Communications format
- Data collector format packets
- Reading binary values
- Data collector format packet summary
- Application files

Introduction

The RS-232 Serial Interface Specification enables a remote computing device to communicate with a BD950 receiver over an RS-232 connection, using Data Collector Format packets. The RS-232 Serial Interface Specification provides command packets for configuring the BD950 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 BD950 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 161.

The BD950 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 BD950 receivers.

For a general description of application files, see Application Files, page 110. For information about the structure of application files, see 64h, APPFILE (Application file record report), page 206.

Communications Format

Supported data rates are: 2400, 4800, 9600, 19200, 38400, 57600, and 115k baud. Any of these data rates can be used, however only 4800 baud or higher should be used. For example, a 20 Hz GGK 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 BD950 receiver is 9600 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 BD950 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 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 BD950 receiver when requesting data, sending commands, or when managing application files. The BD950 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
Begin packet header		
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

Table 7.1 Data Collector Format packet structure (continued)

Byte #	Message	Description
Begin packet data		
4 – Length 3	DATA BYTES	Data bytes
Begin packet trailer		
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 BD950 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 BD950 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 BD950 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 BD950 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 = <sign> 1.<fraction
field> x 2(<exponent field> - bias)
```

- **Sign bit field**

  The sign bit field is the most significant bit of the floating-point number. The sign bit is 0 for positive numbers and 1 for negative numbers.

- **Fraction field**

  The fraction field contains the fractional part of a normalized number. Normalized numbers are greater than or equal to 1 and less than 2. Since all normalized numbers are of the form 1.XXXXXXXX, the 1 becomes implicit and is not stored in memory. The bits in the fraction field are the bits to the right of the binary point, and they represent negative powers of 2.

  For example:

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

- **Exponent field**

  The exponent field contains a biased exponent; that is, a constant bias is subtracted from the number in the exponent field to yield the actual exponent. (The bias makes negative exponents possible.)

  If both the exponent field and the fraction field are zero, the floating-point number is zero.

- **NaN**

  A NaN (Not a Number) is a special value that is used when the result of an operation is undefined. For example, adding positive infinity to negative infinity results in a NaN.

FLOAT data type

The FLOAT data type is stored in the IEEE single-precision format which is 32 bits long. The most significant bit is the sign bit, the next 8 most significant bits are the exponent field, and the remaining 23 bits are the fraction field. The bias of the exponent is 127. The range of single-precision format values is from 1.18×10^{-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 x 10^{-308} to 1.8 x 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 Packet Summary

Detailed descriptions of the Data Collector Format are provided in Appendix 8, Data Collector Format Command Packets and Appendix 9, Data Collector Format Report Packets. Table 7.4 summarizes the Data Collector Format command and report packets, and shows the location in this manual where detailed information about the packet is found.

Table 7.4 Data Collector Format packet summary

ID	Name	Function	Page
06h	06h, GETSERIAL (Receiver and antenna information request)	Receiver and antenna information request	117
07h	07h, RSERIAL (Receiver and antenna information report)	Receiver and antenna information report	157
08h	08h, GETSTAT1 (Receiver status request)	Receiver status request	118
09h	09h, RECSTAT1 (Receiver status report)	Receiver status report	158
40h	40h, GENOUT (General output record reports)	General output record reports	161
4Ah	4Ah GETOPT (Receiver options request)	Receiver options request	119
4Bh	4Bh, RETOPT (Receiver options parameters report)	Receiver options parameters report	179
54h	54h, GETSVDATA (Satellite information request)	Satellite information request	120
55h	55h, RETSVDATA (Satellite information reports)	Satellite information reports	183
56h	56h, GETRAW (Position or real-time survey data request)	Position or real-time survey data request	122

Table 7.4 Data Collector Format packet summary (continued)

ID	Name	Function	Page
57h	57h, RAWDATA (Position or real-time survey data report)	Position or real-time survey data report	192
64h	64h, APPFILE (Application file record command)	Application file record command	124
64h	64h, APPFILE (Application file record report)	Application file record report	206
65h	65h, GETAPPFILE (Application file request)	Application file request	146
66h	66h, GETAFDIR (Application file directory listing request)	Application file directory listing request	147
67h	67h, RETAFDIR (Directory listing report)	Directory listing report	207
68h	68h, DELAPPFILE (Delete application file data command)	Delete application file data command	148
6Dh	6Dh, ACTAPPFILE (Activate application file)	Activate application file	149
6Eh	6Eh, BREAKRET (Break sequence return)	Break sequence return	209
81h	81h, KEYSIM (Key simulator)	Key simulator	150
82h	82h, SCRDUMP (Screen dump request)	Screen dump request	152
82h	82h, SCRDUMP (Screen dump)	Screen dump	214

Application Files

The software tools included with the BD950 receiver include software for creating application files and transferring the files to the receiver.

The external device can transfer application files to the receiver using Trimble's Configuration Toolbox software or by creating 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.

There are three very important application files in the BD950. These are explained in Table 7.5.

Table 7.5 Important application files and their functionality

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 BD950 receiver's current settings.
POWER_UP	Any user-defined application file that is named POWER_UP will be invoked every time the receiver is powered on.

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.

Application file records

Application files can include the following records:

- File Storage Record
- General Controls Record
- Serial Port Baud/Format Record
- Reference Node Record
- SV Enable/Disable Record
- Output Message Record
- Antenna Record
- Device Control Record
- Static/Kinematic Record
- Input Message Record
- Coordinate System

Application file record format

The application record data is in the Motorola format described in Reading Binary Values, page 104. 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, then make sure that the application records do not contain extraneous data. Table 7.6 describes the application file records.

Table 7.6 Application file records

Record	Description
FILE STORAGE RECORD	When present, this record forces the application file to be stored in the receiver's database/file system. When included in an application file, the file storage record must be the first record in the application file.
GENERAL CONTROLS RECORD	The General Controls Record is used to set general GPS operating parameters for the receiver, including the elevation mask, frequency rate, PDOP (Position Dilution of Precision) mask, and frequency source.
SERIAL PORT BAUD/FORMAT RECORD	The Serial Port Baud Rate/Format Record is used to set the communication parameters for a selected serial port. The selected serial port is determined by the Serial Port Index (Byte 2), a number ranging from 0 (zero) to 3 (three).
REFERENCE NODE RECORD	Provides LLA (Latitude, Longitude, Altitude) coordinates when the receiver is used as a base or reference station.
SV ENABLE/ DISABLE RECORD	The SV Enable/Disable Record is used to enable or disable a selection of the 32 GPS satellites, regardless of whether the satellites are in good health or not. By default, the reciever 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.
OUTPUT MESSAGE RECORD	The Output Message Record selects the output protocol supported by a specified serial port, the frequency of message transmissions, the integer second offset from the scheduled output rate, and output specific flags.

Table 7.6 Application file records (continued)

Record	Description
ANTENNA RECORD	The Antenna Record identifies the height of the base station (reference station) antenna.
DEVICE CONTROL RECORD	The number of bytes contained in the record and the length of the record are determined by the Device Type (Byte 2).
STATIC/ KINEMATIC RECORD	Determines whether the receiver is configured to perform Static or Kinematic surveys.
INPUT MESSAGE RECORD	Selects the type of GPS correction, serial port, message origin, and input specific settings.

For more information about the structure of application files and application file records, see 64h, APPFILE (Application file record report), page 206.

For more information about selecting application files once they are transferred to the receiver, see 6Dh, ACTAPPFILE (Activate application file), page 149. For information about deleting application files stored in computer memory, see 68h, DELAPPFILE (Delete application file data command), page 148. For information about downloading an application file from the receiver, see Command Packet 64h, APPFILE (Application file record command), page 124.

For more information about requesting a listing of the application files stored on the receiver, see 66h, GETAFDIR (Application file directory listing request), page 147 and 67h, RETAFDIR (Directory listing report), page 207.

The parameter settings in the Output Messages Record of an application file determine which output messages are streamed to the remote device. For more information, see 40h, GENOUT (General output record reports), page 161.

CHAPTER

8

Data Collector Format Command Packets

In this chapter:

- Introduction
- Command packet summary

Introduction

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.

Command Packet Summary

The following sections provide details for each command and report packet. Table 8.1 provides a summary of the command packets.

Table 8.1 Command packet summary

ID, Command Packet	Action	Page
06h, GETSERIAL (Receiver and antenna information request)	06h, GETSERIAL (Receiver and antenna information request)	117
08h, GETSTAT1 (Receiver status request)	08h, GETSTAT1 (Receiver status request)	118
4Ah GETOPT (Receiver options request)	4Ah GETOPT (Receiver options request)	119
54h, GETSVDATA (Satellite information request)	54h, GETSVDATA (Satellite information request)	120
56h, GETRAW (Position or real-time survey data request)	56h, GETRAW (Position or real-time survey data request)	122
64h, APPFILE (Application file record command)	64h, APPFILE (Application file record command)	124
65h, GETAPPFILE (Application file request)	65h, GETAPPFILE (Application file request)	146
66h, GETAFDIR (Application file directory listing request)	66h, GETAFDIR (Application file directory listing request)	147

Table 8.1 Command packet summary (continued)

ID, Command Packet	Action	Page
68h, DELAPPFILE (Delete application file data command)	68h, DELAPPFILE (Delete application file data command)	148
6Dh, ACTAPPFILE (Activate application file)	6Dh, ACTAPPFILE (Activate application file)	149
81h, KEYSIM (Key simulator)	81h, KEYSIM (Key simulator)	150
82h, SCRDUMP (Screen dump request)	82h, SCRDUMP (Screen dump request)	152

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.

Packet Flow

Receiver:		Remote:
	←	Command Packet 06h
Report Packet 07h	→	

Table 8.2 describes the packet structure.

Table 8.2 Command packet 06h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	06h	Command Packet 06h

Table 8.2 Command packet 06h structure (continued)

Byte #	Item	Type	Value	Meaning
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
5	ETX	CHAR	03h	End transmission

08h, GETSTAT1 (Receiver status request)

Command Packet 08h requests receiver status information regarding position determination, the number of tracked satellites, battery capacity remaining, and the remaining memory. The receiver responds by sending the data in Report Packet 09h.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 08h
Report Packet 09h	→	

Table 8.3 describes the packet structure. For additional information, see 09h, RECSTAT1 (Receiver status report), page 158.

Table 8.3 Report packet 08h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	08h	Command Packet 08h
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
5	ETX	CHAR	03h	End transmission

To check the current antenna parameter settings, send Command Packet 06h to request Report Packet 07h. For more information, see 06h, GETSERIAL (Receiver and antenna information request), page 117 and Report Packet 07h, RSERIAL (Receiver and antenna information report), page 157.

4Ah GETOPT (Receiver options request)

Command Packet 4Ah requests the list of receiver options installed on the receiver. The receiver responds by sending the data in Report Packet 4Bh. Table 8.4 describes the packet structure. For additional information, see 4Bh, RETOPT (Receiver options parameters report), page 179.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 4Ah
Report Packet 4Bh	→	

Table 8.4 Command packet 4ah structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	4Ah	Command Packet 4Ah
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
5	ETX	CHAR	03h	End transmission

54h, GETSVDATA (Satellite information request)

Command Packet 54h requests satellite information. 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 8.5 shows the packet structure. For additional information, see 4Bh, RETOPT (Receiver options parameters report), page 179.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 54h
Report Packet 55h or NAK	→	

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 8.5 Command packet 54h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	54h	Command Packet 54h
3	LENGTH	CHAR	03h	Data byte count
4	DATA SWITCH	CHAR	See table 8.6, page 121	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)

Table 8.5 Command packet 54h structure (continued)

Byte #	Item	Type	Value	Meaning
6	RESERVED	CHAR	00h	Reserved (set to zero)
7	CHECKSUM	CHAR	See table 7.2, page 104	Checksum value
8	ETX	CHAR	03h	End transmission

Table 8.6 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 8.7 describes the packet structure. For additional information, see 57h, RAWDATA (Position or real-time survey data report), page 192.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 56h
Report Packet 57h or NAK	→	

***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 8.7 Command packet 56h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	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 8.8, page 123	Identifies the requested type of raw data
5	FLAGS	CHAR	See table 8.9, page 123	Flag bits for requesting raw data

Table 8.7 Command packet 56h structure (continued)

Byte #	Item	Type	Value	Meaning
6	RESERVED	CHAR	00h	Reserved; set to zero
7–8	CHECKSUM	SHORT	See table 7.1, page 102	Checksum value
9	(03h) ETX	CHAR	03h	End Transmission

Table 8.8 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 8.9 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)

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 BD950 Application Files and guidelines for using application files to control remote devices, see Report Packet 07h, RSERIAL (Receiver and antenna information report), page 157.

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 8.10 shows the structure of the report packet containing the application file.

Table 8.10 Command packet 64h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	64h	Command Packet 64h
3	LENGTH	CHAR	See table 7.2, page 104	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

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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 8.11, page 136	Unique identifier for every receiver/device type that supports the application file interface
9	START APPLICATION FILE FLAG	CHAR	See table 8.12, page 136	Determines whether the application file is activated immediately after records are sent to receiver
10	FACTORY SETTINGS FLAG	CHAR	See table 8.13, page 136	Determines whether the receiver is reset to factory default settings prior to activating the records in the application file

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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)

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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 8.14, page 136	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 8.18, page 138	Sets the RTK positioning mode
8	POSITIONING SOLUTION SELECTION	CHAR	See table 8.15, page 137	Controls use of DGPS and RTK solutions
9	RESERVED	CHAR	00h	Reserved (set to zero)

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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 8.16, page 137	Data transmission rate
4	PARITY	CHAR	See table 8.17, page 138	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 8.19, page 138	Flow control

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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, $-9999.999 \le h \le +9999.999$
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

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
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 8.20, page 138	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 8.10 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 8.21, page 139	Type of message or packet
3	PORT INDEX	CHAR	00h–03h	Serial port index number
4	FREQUENCY	CHAR	See table 8.22, page 140	Frequency of message transmissions
5	OFFSET	CHAR	00h–FFh	Integer second offset (0–255 seconds) from scheduled output rate. (Only valid when frequency, < 1 Hz or > 1 second).
OUTPUT MESSAGE RECORD TYPE 10 (GSOF)				
6	GSOF SUBMESSAGE TYPE	CHARs	See table 8.23, page 141	GSOF message number
7	OFFSET	CHAR	0–255	Integer second offset from scheduled frequency

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
OUTPUT MESSAGE RECORD TYPE 2 (RTK-CMR)				
6	CMR MESSAGE TYPE FLAGS	CHAR	See table 8.23, page 141	CMR message types
OUTPUT MESSAGE RECORD TYPE 3 (RTCM)				
6	RTCM FLAGS	CHAR	See table 8.25, page 142	Bit settings for RTCM output flags
OUTPUT MESSAGE RECORD TYPE 4 (RT17)				
6	REAL-TIME 17 MESSAGE FLAGS	CHAR	See table 8.24, page 141	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 8.26, page 142	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 8.10 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 8.27, page 144	Type of device
For 1 PPS Output Only				
3	1 PPS CONTROL	CHAR	See table 8.28, page 145	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 8.29, page 145	Configures receiver for static or kinematic operation

Table 8.10 Command packet 64h structure (continued)

Byte #	Item	Type	Value	Meaning
RTCM INPUT RECORD				
The bytes of the RTCM INPUT RECORD set the RTK/DGPS switch over range and identify the RTCM base station used for RTK/DGPS corrections.				
0	RECORD TYPE	CHAR	10h	RTCM Input Record
1	RECORD LENGTH	CHAR	06h	Number of bytes in record, excluding bytes 0 and 1
2–5	RANGE	LONG	meters	RTK/DGPS automatic switch over range
6–7	STATION ID	SHORT		Station ID of the RTCM base station that is used for RTK/ DGPS corrections. Valid station IDs range between 1–1023 (0000h–03FFh). If –1, 65535, or FFFFh is set, any station ID is used.
Length +4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
Length +5	ETX	CHAR	03h	End transmission

Table 8.11 DEVICE TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	All Devices
2–5	02h–05h	Reserved
6	06h	BD950 receiver

Table 8.12 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 8.13 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 8.14 MEASUREMENT RATE byte values

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

Table 8.15 Positioning 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 8.16 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

Table 8.17 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 8.18 RTK POSITIONING MODE byte values

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

Table 8.19 FLOW CONTROL byte values

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

Table 8.20 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 8.21 OUTPUT MESSAGE TYPE byte values

Byte value		Meaning
Dec	Hex	
0	00h	All messages (OFF on all ports)
1	01h	Reserved
2	02h	RTK Correction CMR output
3	03h	RTCM output
4	04h	Real-Time 17 output
5	05h	Reserved
6	06h	NMEA – GGA output
7	07h	NMEA – GGK output
8	08h	NMEA – ZDA output
9	09h	Reserved
10	0Ah	GSOF
11	0Bh	1 PPS (ASCII)
12	0Ch	NMEA – VTG output
13	0Dh	NMEA – GST output
14	0Eh	NMEA – PJK output
15	0Fh	NMEA – PJT output
16	10h	NMEA – VGK output
17	11h	NMEA – VHD output
18	12h	NMEA – GSV output
19–22	13h–16h	Reserved (future output protocols)
23	17h	NMEA – GGK_SNC output
24–28	18h–1Ch	Reserved (future output protocols)
29	1Dh	NMEA – AVR
30	1Eh	Reserved
31	1Fh	NMEA – HDT

Table 8.21 OUTPUT MESSAGE TYPE byte values

Byte value		Meaning
Dec	Hex	
32	20h	NMEA – ROT
33–254	21h–FEh	Reserved (future output protocols)
255	FFh	All messages (OFF on the specified port)
The number of supported output protocols could increase in the future.		

Table 8.22 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
255	FFh	Once only, immediately
Certain message output types may not support >1 Hz output.		

Table 8.23 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	4000 compatible

Table 8.24 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 8.25 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 & 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 8.26 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

Table 8.26 ANTENNA TYPE byte values (continued)

Byte value		Meaning
Dec	Hex	
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

Table 8.26 ANTENNA TYPE byte values (continued)

Byte value		Meaning
Dec	**Hex**	
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
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 8.27 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

Table 8.27 DEVICE TYPE byte values (continued)

Byte value		Meaning
Dec	Hex	
6	06h	Reserved
7	07h	Reserved

Table 8.28 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 8.29 STATIC/KINEMATIC MODE byte values

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

65h, GETAPPFILE (Application file request)

A specific application file can be downloaded from the BD950 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.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 65h
Report Packet 64h or NAK	→	

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 8.30 shows the packet structure. For more information, see 64h, APPFILE (Application file record report), page 206.

Table 8.30 Command packet 65h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status indicator
2	PACKET TYPE	CHAR	65h	Command Packet 65h
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count

Table 8.30 Command packet 65h structure (continued)

Byte #	Item	Type	Value	Meaning
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 102	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 8.31 describes the packet structure. For more information, see 67h, RETAFDIR (Directory listing report), page 207.

Table 8.31 Command packet 66h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	66h	Command Packet 66h

Table 8.31 Command packet 66h structure (continued)

Byte #	Item	Type	Value	Meaning
3	LENGTH	CHAR	0h	Data byte count
4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
5	ETX	CHAR	03h	End transmission

68h, DELAPPFILE (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.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 68h
ACK or NAK	→	

Table 8.32 Command packet 68h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status indicator
2	PACKET TYPE	CHAR	68h	Command Packet 68h
3	LENGTH	CHAR	01h	Data byte count

Table 8.32 Command packet 68h structure (continued)

Byte #	Item	Type	Value	Meaning
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 102	Checksum
7	ETX	CHAR	03h	End transmission

6Dh, ACTAPPFILE (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.

Packet Flow

Receiver:		Remote:
	←	Command Packet 6Dh
ACK or NAK	→	

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 8.33 describes the packet structure.

Table 8.33 Command packet 6dh structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status indicator
2	PACKET TYPE	CHAR	6Dh	Command Packet 6Dh

Table 8.33 Command packet 6dh structure (continued)

Byte #	Item	Type	Value	Meaning
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 102	Checksum
7	ETX	CHAR	03h	End transmission

81h, KEYSIM (Key simulator)

Command Packet 81h simulates any front panel key press.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 81h
ACK	→	

Table 8.34 Command packet 81h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	81h	Command Packet 81h
3	LENGTH	CHAR	01h	Data byte count

Table 8.34 Command packet 81h structure (continued)

Byte #	Item	Type	Value	Meaning
4	KEY ID	CHAR	See table 8.35, page 151	Key scan code ID
5	CHECKSUM	CHAR	See table 7.1, page 102	Checksum values
6	ETX	CHAR	03h	End transmission

Table 8.35 Key ID codes

Scan Code	Receiver Key	ASCII Character
7Fh	CLEAR	Del <del>
0Dh	ENTER	Enter <carriage return>
41h	Softkey Choice 1	<A>
42h	Softkey Choice 2	<B>
43h	Softkey Choice 3	<C>
44h	Softkey Choice 4	<D>
1Dh	<	—
1Ch	>	—
30h	0	<0>
31h	1	<1>
32h	2	<2>
33h	3	<3>
34h	4	<4>
35h	5	<5>
36h	6	<6>
37h	7	<7>
38h	8	<8>

Table 8.35 Key ID codes (continued)

Scan Code	Receiver Key	ASCII Character
39h	9	<9>
4Ch	STATUS	<L>
4Ah	SESSION	<J>
4Bh	SAT INFO	<K>
4Fh	LOG DATA	<O>
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 BD950 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 8.36 shows the command packet structure. For more information, see 82h, SCRDUMP (Screen dump request), page 152.

Table 8.36 Command packet 82h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	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 102	Checksum value
5	ETX	CHAR	03h	End transmission

CHAPTER

9

Data Collector Format Report Packets

In this chapter:

- Introduction
- Report packet summary

Introduction

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 9.1 lists a summary of the report packets.

Table 9.1 Report packet summary

ID (Hex)	Name	Function	Page
07h	07h, RSERIAL (Receiver and antenna information report)	07h, RSERIAL (Receiver and antenna information report)	157
09h	09h, RECSTAT1 (Receiver status report)	09h, RECSTAT1 (Receiver status report)	158
40h	40h, GENOUT (General output record reports)	40h, GENOUT (General output record reports)	161
4Bh	4Bh, RETOPT (Receiver options parameters report)	4Bh, RETOPT (Receiver options parameters report)	179
55h	55h, RETSVDATA (Satellite information reports)	55h, RETSVDATA (Satellite information reports)	183
57h	57h, RAWDATA (Position or real-time survey data report)	57h, RAWDATA (Position or real-time survey data report)	192
64h	64h, APPFILE (Application file record report)	64h, APPFILE (Application file record report)	206

Table 9.1 Report packet summary (continued)

ID (Hex)	Name	Function	Page
67h	67h, RETAFDIR (Directory listing report)	67h, RETAFDIR (Directory listing report)	207
6Eh	6Eh, BREAKRET (Break sequence return)	6Eh, BREAKRET (Break sequence return)	209
82h	82h, SCRDUMP (Screen dump)	82h, SCRDUMP (Screen dump)	214

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.

Packet Flow		
Receiver:		**Remote:**
	←	Command Packet 06h
Report Packet 07h	→	

Table 9.2 describes the packet structure. For more information, see 06h, GETSERIAL (Receiver and antenna information request), page 117.

Table 9.2 Report packet 07h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	07h	Report Packet 07h
3	LENGTH	CHAR	2Dh	Data byte count

Table 9.2 Report packet 07h structure (continued)

Byte #	Item	Type	Value	Meaning
4–11	RECEIVER SERIAL #	CHAR	ASCII text	Receiver serial number
12–19	RECEIVER TYPE	CHARs	"BD950 "	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	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
50	ETX	CHAR	03h	End transmission

09h, RECSTAT1 (Receiver status report)

Report Packet 09h is sent in response to Command Packet 08h. The report packet returns receiver status information regarding position determination, the number of tracked satellites, the remaining battery capacity, and the remaining memory.

Packet Flow

Receiver:		**Remote:**
	←	Command Packet 08h
Report Packet 09h	→	

Table 9.3 describes the packet structure. For more information, see 08h, GETSTAT1 (Receiver status request), page 118.

Table 9.3 Report packet 09h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status indicator
2	PACKET TYPE	CHAR	09h	Report Packet 09h
3	LENGTH	CHAR	15h	Data byte count
4	POSITION FIX	CHAR	See table 9.4, page 160	Current GPS position fix mode
5	MEASUREMENT STATUS	CHAR	4Fh	Measurement Status is always set to "0" (4Fh) to indicate old measurements
6–7	# SVS LOCKED	CHAR	00h–18h	Number of tracked satellites in the current constellation
8–10	# MEAS TO GO	CHARs	00h	Used with a type of kinematic survey which is beyond the scope of this manual
11–13	% BATTERY REMAINING	CHARs	64h	Battery time always set
14–18	RESERVED	CHARs		Reserved
19–22	STATUS OF RECEIVER	CHARs	See table 9.5, page 160	Current action performed by the receiver
23–24	# L2 CHANNELS OPERATIONAL	CHARs	channels	Number of L2 channels selected for taking measurements
25	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
26	ETX	CHAR	03h	End transmission

Table 9.4 POSITION FIX byte values

Byte Value		Meaning
Dec	**Hex**	
0	00h	Position is not determined, or position has not changed since last request
1	01h	0-D Position Fix (time only; 1 or more SVs required)
2	02h	1-D Position Fix (height only; 1 or more SVs required)
3	03h	2-D Position Fix (includes current latitude and longitude coordinates, height and time are fixed; 2 or more SVs required)
4	04h	2-D Position Fix (includes current latitude, longitude, and time; height is fixed; 3 or more SVs required)
5	05h	3-D Position Fix (includes current latitude, longitude, altitude, and time; 4 or more SVs required)

Table 9.5 STATUS OF RECEIVER byte values

ASCII	Byte Values				Meaning
	19	**20**	**21**	**23**	
SETT	53h	45h	54h	54h	Setting time
GETD	47h	45h	54h	44h	Updating ION/UTC/Health data
CAL1	43h	41h	4Ch	31h	Calibrating
MEAS	4Dh	45h	41h	53h	Static Survey Measurements
KINE	4Bh	49h	4Eh	45h	Kinematic Survey

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).

Packet Flow		
Receiver:		**Remote:**
Report Packet 40h	→	

For information about controlling the record types included in Report Packet 40h, see Report Packet 07h, RSERIAL (Receiver and antenna information report), page 157.

Note – *Application files are created and transferred to the receiver using software tools that are included with the receiver. For more information, see Report Packet 07h, RSERIAL (Receiver and antenna information report), page 157, and Command Packet 64h, APPFILE (Application file record command), page 124.*

Table 9.6 describes the packet structure. The byte numbers in this table are reset to 0 for each sub-record type. To approximate the packet size, add the header and footer bytes to the sum of the byte counts for all records included in the packet.

Table 9.6 Report packet 40h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	40h	Report Packet 40h
3	LENGTH	CHAR	00h–FAh	Data byte count

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
4	TRANSMISSION NUMBER	CHAR		Unique number assigned to a group record packet pages. Prevents page mismatches when multiple sets of record packets exist in output stream
5	PAGE INDEX	CHAR	00h–FFh	Index of current packet page
6	MAX PAGE INDEX	CHAR	00h–FFh	Maximum index of last packet in one group of records
POSITION TIME (Type 1 Record)				
0	OUTPUT RECORD TYPE	CHAR	01h	Position Time Output Record
1	RECORD LENGTH	CHAR	0Ah	Bytes in record
2–5	GPS TIME (ms)	LONG	msecs	GPS time, in milliseconds of GPS week
6–7	GPS WEEK NUMBER	SHORT	number	GPS week count since January 1980
8	NUMBER OF SVS USED	CHAR	00h–0Ch	Number of satellites used to determine the position (0–12)
9	POSITION FLAGS 1	CHAR	See table 9.7, page 174	Reports first set of position attribute flag values
10	POSITION FLAGS 2	CHAR	See table 9.8, page 175	Reports second set of position attribute flag values
11	INITIALIZATION NUMBER	CHAR	00h–FFh	Increments with each initialization (modulo 256)

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
LAT, LONG, HEIGHT (Type 2 Record)				
0	OUTPUT RECORD TYPE	CHAR	02h	Latitude, Longitude, and Height Output Record
1	RECORD LENGTH	CHAR	18h	Bytes in record
2–9	LATITUDE	DOUBLE	radians	Latitude from WGS-84 datum
10–17	LONGITUDE	DOUBLE	radians	Longitude from WGS-84 datum
18–25	HEIGHT	DOUBLE	meters	Height from WGS-84 datum
ECEF POSITION (Type 3 Record)				
0	OUTPUT RECORD TYPE	CHAR	03h	Earth-Centered, Earth-Fixed (ECEF) Position Output Record
1	RECORD LENGTH	CHAR	18h	Bytes in record
2–9	X	DOUBLE	meters	WGS-84 ECEF X-axis coordinate
10–17	Y	DOUBLE	meters	WGS-84 ECEF Y-axis coordinate
18–25	Z	DOUBLE	meters	WGS-84 ECEF Z-axis coordinate

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
LOCAL DATUM POSITION (Type 4 Record)				
0	OUTPUT RECORD TYPE	CHAR	04h	Local Datum Position Output Record
1	RECORD LENGTH	CHAR	20h	Bytes in record
2–9	LOCAL DATUM ID	CHARs	ASCII text	Identification name or code assigned to local datum
10–17	LOCAL DATUM LATITUDE	DOUBLE	radians	Latitude in the local datum
18–25	LOCAL DATUM LONGITUDE	DOUBLE	radians	Longitude in the local datum
26–33	LOCAL DATUM HEIGHT	DOUBLE	meters	Height in the local datum
LOCAL ZONE POSITION (Type 5 Record)				
0	OUTPUT RECORD TYPE	CHAR	05h	Local Zone Position Output Record
1	RECORD LENGTH	CHAR	28h	Bytes in record
2–9	LOCAL DATUM ID	CHARs	ASCII text	Identification code or name assigned to coordinate datum
10–17	LOCAL ZONE ID	CHARs	ASCII text	Identification code or name assigned to coordinate zone
18–25	LOCAL ZONE EAST	DOUBLE	meters	East coordinate of local zone
26–33	LOCAL ZONE NORTH	DOUBLE	meters	North coordinate of local zone
34–41	LOCAL DATUM HEIGHT	DOUBLE	meters	Height in the Local datum

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
ECEF DELTA (Type 6 Record) [1]				
0	OUTPUT RECORD TYPE	CHAR	06h	Earth-Centered, Earth-Fixed Delta Output Record
1	RECORD LENGTH	CHAR	18h	Bytes in record
2–9	DELTA X	DOUBLE	meters	ECEF X axis delta between rover and base station positions
10–17	DELTA Y	DOUBLE	meters	ECEF Y axis delta between rover and base station positions
18–25	DELTA Z	DOUBLE	meters	ECEF Z axis delta between rover and base station positions
TANGENT PLANE DELTA (Type 7 Record) [1]				
0	OUTPUT RECORD TYPE	CHAR	07h	Tangent Plane Delta Output Record
1	RECORD LENGTH	CHAR	18h	Bytes in record
2–9	DELTA EAST	DOUBLE	meters	East component of vector from base station to rover, projected onto a plane tangent to the WGS-84 ellipsoid at the base station
10–17	DELTA NORTH	DOUBLE	meters	North component of tangent plane vector
18–25	DELTA UP	DOUBLE	meters	Difference between ellipsoidal height of tangent plane at base station and a parallel plane passing through rover point

[1] These records are only output if a valid DGPS/RTK solution is computed.

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
VELOCITY DATA (Type 8 Record) [1]				
0	OUTPUT RECORD TYPE	CHAR	08h	Velocity Data Output Record
1	RECORD LENGTH	CHAR	0Dh	Bytes in record
2	VELOCITY FLAGS	CHAR	See table 9.9, page 175	Velocity status flags
3–6	SPEED	FLOAT	meters per second	Horizontal speed
7–10	HEADING	FLOAT	radians	True north heading in the WGS-84 datum
11–14	VERTICAL VELOCITY	FLOAT	meters per second	Vertical velocity
15-18[1]	LOCAL HEADING (See note)	FLOAT	radian	Heading in local datum
[1] Local heading field is only present if local coordinate system is loaded.				
PDOP INFO (Type 9 Record) [1]				
0	OUTPUT RECORD TYPE	CHAR	09h	PDOP Information Output Record
1	RECORD LENGTH	CHAR	10h	Bytes in record
2–5	PDOP	FLOAT		Positional Dilution Of Precision
6–9	HDOP	FLOAT		Horizontal Dilution Of Precision
10–13	VDOP	FLOAT		Vertical Dilution Of Precision
14–17	TDOP	FLOAT		Time Dilution Of Precision

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
CLOCK INFO (Type 10 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Ah	Clock Information Output Record
1	RECORD LENGTH	CHAR	11h	Bytes in record
2	CLOCK FLAGS	CHAR	See table 9.10, page 176	Clock status flags
3–10	CLOCK OFFSET	DOUBLE	msecs	Current clock offset
11–18	FREQUENCY OFFSET	DOUBLE	parts per million	Offset of local oscillator from nominal GPS L1 frequency

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
POSITION VCV INFO (Type 11 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Bh	Position VCV Information Output Record
1	RECORD LENGTH	CHAR	22h	Bytes in record
2–5	POSITION RMS	FLOAT		Root means square of the error of the position calculated for overdetermined positions
6–9	VCV xx	FLOAT		The variance-covariance matrix contains the positional components of the inverted normal matrix of the position solution based on an ECEF WGS-84 reference
10–13	VCV xy	FLOAT		
14–17	VCV xz	FLOAT		
18–21	VCV yy	FLOAT		
22–25	VCV yz	FLOAT		
26–29	VCV zz	FLOAT		
30–33	UNIT VARIANCE	FLOAT		Unit variance of the position solution
34–35	NUMBER OF EPOCHS	SHORT	count	Number of measurement epochs used to compute the position. Could be greater than 1 for positions subjected to STATIC constraint. Always 1 for Kinematic.

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
POSITION SIGMA INFO (Type 12 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Ch	Position Sigma Information Output Record
1	RECORD LENGTH	CHAR	26h	Bytes in record
2–5	POSITION RMS	FLOAT		Root means square of position error calculated for overdetermined positions
6–9	SIGMA EAST	FLOAT	meters	
10–13	SIGMA NORTH	FLOAT	meters	
14–17	COVAR. EAST-NORTH	FLOAT	number	Covariance East-North (dimensionless)
18–21	SIGMA UP	FLOAT	meters	
22–25	SEMI MAJOR AXIS	FLOAT	meters	Semi-major axis of error ellipse
26–29	SEMI-MINOR AXIS	FLOAT	meters	Semi-minor axis of error ellipse
30–33	ORIENTATION	FLOAT	degrees	Orientation of semi-major axis, clockwise from True North
34–37	UNIT VARIANCE	FLOAT		Valid only for over determined solutions. Unit variance should approach 1.0. A value of less than 1.0 indicates that apriori variances are too pessimistic.
38–39	NUMBER OF EPOCHS	SHORT	count	Number of measurement epochs used to compute the position. Could be greater than 1 for positions subjected to STATIC constraint. Always 1 for Kinematic.

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
SV BRIEF INFO (Type 13 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Dh	Brief Satellite Information Output Record
1	RECORD LENGTH	CHAR		Bytes in record
2	NUMBER OF SVS	CHAR	00h–18h	Number of satellites included in record[1]
	The following bytes are repeated for NUMBER OF SVS			
	PRN	CHAR	01h–20h	Pseudorandom number of satellite (1–32)
	SV FLAGS1	CHAR	See table 9.11, page 176	First set of satellite status bits
	SV FLAGS2	CHAR	See table 9.12, page 177	Second set of satellite status bits

[1] The number of SVs includes all tracked satellites, all satellites used in the position solution, and all satellites in view.

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
SV DETAILED INFO (Type 14 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Eh	Detailed Satellite Information Output Record
1	RECORD LENGTH	CHAR	1 + 8x (number of SVs)	Bytes in record
2	NUMBER OF SVS	CHAR	00h–18h	Number of satellites included in record[1]
	The following bytes are repeated for NUMBER OF SVS			
	PRN	CHAR	01h–20h	Pseudorandom number of satellite (1–32)
	SVFLAGS1	CHAR	See table 9.11, page 176	First set of satellite status bits
	SVFLAGS2	CHAR	See table 9.12, page 177	Second set of satellite status bits
	ELEVATION	CHAR	degrees	Angle of satellite above horizon
	AZIMUTH	SHORT	degrees	Azimuth of satellite from true North
	SNR L1	CHAR	dB * 4	Signal-to-noise ratio of L1 signal (multiplied by 4)[2]
	SNR L2	CHAR	dB * 4	Signal-to-noise ratio of L2 signal (multiplied by 4)[2]

[1] The number of SVs includes all tracked satellites, all satellites used in the position solution, and all satellites in view.

[2] Set to zero for satellites which are not tracked on the current frequency (L1 or L2).

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
RECEIVER SERIAL NUMBER (Type 15 Record)				
0	OUTPUT RECORD TYPE	CHAR	0Fh	Receiver Serial Number Output Record
1	RECORD LENGTH	CHAR	04h	Bytes in record
2–5	SERIAL NUMBER	LONG	number	Receiver serial number
CURRENT TIME (Type 16 Record)				
0	OUTPUT RECORD TYPE	CHAR	10h	Current Time Output Record
1	RECORD LENGTH	CHAR	09h	Bytes in record
2–5	GPS MILLISEC OF WEEK	LONG	msecs	Time when packet is sent from receiver, in GPS milliseconds of week
6–7	GPS WEEK NUMBER	SHORT	number	Week number since start of GPS time
8–9	UTC OFFSET	SHORT	seconds	GPS-to-UTC time offset
10	FLAGS	CHAR	See table 9.13, page 177	Flag bits indicating validity of Time and UTC offset parameters
Length + 4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
Length + 5	ETX	CHAR	03h	End transmission

Table 9.6 Report packet 40h structure (continued)

Byte #	Item	Type	Value	Meaning
ATTITUDE INFO (Type 27 Record)				
0	OUTPUT RECORD TYPE	CHAR	1Bh	Attitude Information
1	RECORD LENGTH	CHAR	2A	Bytes in record
2-5	GPS TIME	LONG	msecs	GPS time in milliseconds of GPS week
6	FLAGS	CHAR	See table 9.14, page 178	Flag bits indicating validity of attitude components
7	NUMBER OF SATELLITES USED	CHAR	00h-0ch	Number of satellites used to calculate attitude
8	CALCULATION MODE	CHAR	See table 9.15, page 178	Positioning mode
9	RESERVED			Reserved
10–17	TILT	DOUBLE	radians	Tilt relative to horizontal plane
18–25	YAW	DOUBLE	radians	Rotation about the vertical axis
26–33	RESERVED			Reserved
34–41	RANGE	DOUBLE	meters	Distance between master and slave antennas
42–43	PDOP	SHORT	0.1	Position Dilution of Precision

Table 9.7 POSITION FLAGS 1 bit values

Bit	Meaning
0	New Position 0: No 1: Yes
1	Clock Fix Calculated for Current Position 0: No 1: Yes
2	Horizontal Coordinates Calculated this Position 0: No 1: Yes
3	Height Calculated this Position 0: No 1: Yes
4	Weighted Position 0: No 1: Yes
5	Overdetermined Position 0: No 1: Yes
6	Ionosphere-Free Position 0: No 1: Yes
7	Position Uses Filtered L1 Pseudoranges 0: No 1: Yes

Table 9.8 POSITION FLAGS 2 bit values

Bit	Meaning
0	Differential Position 0: No 1: Yes
1	Differential Position Method 0: RTCM 1: RTK
2	Differential Position Type 0: Differential position is code (RTCM) or a float position (RTK) 1: Differential position is fixed integer phase position (RTK)
3	Narrowlane or Widelane Data 0: Differential position uses L1, L2, or Narrowlane data 1: Differential position uses Widelane data
4	Position Determined with STATIC as a Constraint 0: No 1: Yes
5–7	Reserved (set to zero)

Table 9.9 VELOCITY FLAGS bit values

Bit	Meaning
0	Velocity Data Validity 0: Not valid 1: Valid
1	Velocity Computation 0: Computed from Doppler 1: Computed from consecutive measurements
2–7	Reserved (set to zero)

Table 9.10 CLOCK FLAGS bit values

Bit	Meaning
0	Clock Offset Validity 0: Not valid 1: Valid
1	Frequency Offset Validity 0: Not valid 1: Valid
2	Receiver in Anywhere Fix Mode 0: No 1: Yes
3–7	Reserved (set to zero)

Table 9.11 SV FLAGS 1 bit values

Bit	Meaning
0	Satellite Above Horizon 0: No 1: Yes
1	Satellite Currently Assigned to a Channel (trying to track) 0: No 1: Yes
2	Satellite Currently Tracked on L1 Frequency 0: No 1: Yes
3	Satellite Currently Tracked on L2 Frequency 0: No 1: Yes
4	Satellite Reported at Base on L1 Frequency 0: No 1: Yes
5	Satellite Reported at Base on L2 Frequency 0: No 1: Yes

Table 9.11 SV FLAGS 1 bit values (continued)

Bit	Meaning
6	Satellite Used in Position 0: No 1: Yes
7	Satellite Used in Current RTK Process (Search, Propagate, Fix Solution) 0: No 1: Yes

Table 9.12 SV FLAGS 2 bit values

Bit	Meaning
0	Satellite Tracking P-Code on L1 Band 0: No 1: Yes
1	Satellite Tracking P-Code on L2 Band 0: No 1: Yes
2–7	Reserved (set to zero)

Table 9.13 FLAGS bit values

Bit	Meaning
0	Time Information (week and milliseconds of week) Validity 0: Not valid 1: Valid
1	UTC Offset Validity 0: Not valid 1: Valid

Table 9.14 Attitude flags

Bit	Meaning
0	Calibrated 0: No 1: Yes
1	Tilt Valid 0: No 1: Yes
2	Yaw Valid 0: No 1: Yes
3	Reserved
4	Range Valid 0: No 1: Yes
5	Reserved
6	Reserved
7	Reserved

Table 9.15 Attitude calculation mode

Value	Meaning
0	No position
1	Autonomous position
2	RTK/Float position
3	RTK/Fix position
4	DGPS position

4Bh, RETOPT (Receiver options parameters report)

Report Packet 4Bh is sent in response to Command Packet 4Ah. The report contains a listing of the optional hardware and software installed on the receiver at the factory. Also included are the current parameter settings for elevation mask, PDOP mask, and synchronization time.

Packet Flow		
Receiver:		**Remote:**
	←	Report Packet 4Ah
Report Packet 4Bh	→	

Table 9.16 describes the packet structure. For more information, see Report Packet 4Ah GETOPT (Receiver options request), page 119.

Table 9.16 Report packet 4bh structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	4Bh	Report Packet 4Bh
3	LENGTH	CHAR	31h	Data byte count
4	ELEVATION MASK	CHAR	00h–5Ah	Elevation mask setting in degrees (0–90 degrees)
5	PDOP MASK	CHAR	00h–FFh	PDOP mask setting. The PDOP mask has a scale of 0.1 and values range from 0 (00.0) to 255 (25.5). If the PDOP mask is greater than 25.5, 255 is returned
6–7	SYNC TIME	SHORT	01h–0Ah	Synchronization time, in 0.1 second units, ranging from 0.1 to 1.0 seconds (range = 1–10)
8–9	FASTEST MEAS RATE	SHORT	0.0–6553.5	Fastest measurement rate, in 0.1 second units

Table 9.16 Report packet 4bh structure (continued)

Byte #	Item	Type	Value	Meaning
10	CURRENT PORT ID	CHAR	01h–04h	ID code assigned to the current port (port 1–4)
11	PORTS AVAILABLE	CHAR	01h–04h	Number of receiver ports (1–4) installed
12	L1/L2 OPERATION	CHAR	See table 9.17, page 181	L1/L2 operating mode. Always set to 2 for the BD950 receiver.
13–21	RESERVED	CHAR	00h	Reserved (set to zero)
22	NMEA-0183 OUTPUTS	CHAR	See table 9.18, page 181	NMEA-0183 Output Option installation flag
23	RESERVED	CHAR	00h	Reserved
24	RTCM INPUT	CHAR	See table 9.19, page 182	RTCM Input installation flag
25	RESERVED	CHAR	00h	Reserved
26	RTCM OUTPUT	CHAR	See table 9.20, page 182	RTCM Output installation flag
27–29	RESERVED	CHAR	00h	Reserved (set to zero)
30	PULSE PER SEC	CHAR	See table 9.21, page 182	1 PPS Output Option installation flag
31	RESERVED	CHAR	00h	Reserved (set to zero)
32	COCOM ALT/ SPEED	CHAR	See table 9.22, page 182	COCOM Alt/Speed Option installation flag
33–34	MEMORY INSTALLED	SHORT	kilobytes	Always set to zero for BD950 receiver
35	% MEMORY USED	CHAR	00h	Always set to zero for BD950 receiver
36–42	RESERVED	CHAR	00h	Reserved (set to zero)

Table 9.16 Report packet 4bh structure (continued)

Byte #	Item	Type	Value	Meaning
43	RESERVED	CHAR	00h	Reserved (set to zero)
44	REAL-TIME SURVEY DATA	CHAR	See table 9.23, page 182	Real-Time Survey Data Option installation flag
45	RESERVED	CHAR	00h	
46	SUMMARY OF RTK OPTIONS	CHAR	See table 9.24, page 183	RTK option summary flags
47–52	RESERVED	CHAR	00h	Reserved (set to zero)
53	Checksum	CHAR	See table 7.1, page 102	Checksum value
54	ETX	CHAR	03h	End transmission

Table 9.17 L1/L2 OPERATION byte values

Byte Value		Meaning
Dec	Hex	
1	01h	L1 only
2	02h	L1 and L2

Table 9.18 NMEA-0183 OUTPUTS byte values

Byte Value		Meaning
Dec	Hex	
0	00h	Not installed
1	01h	Installed

Table 9.19

Byte Value		Meaning
Dec	**Hex**	
0	00h	Not installed
1	01h	Installed

Table 9.20 RTCM OUTPUT

Byte Value		Meaning
Dec	**Hex**	
0	00h	Not installed
1	01h	Installed

Table 9.21 PULSE PER SEC byte values

Byte Value		Meaning
Dec	**Hex**	
0	00h	Unavailable
1	01h	Installed
2	02h	Installed, but 1 PPS Output is disabled

Table 9.22 COCOM ALT/SPEED byte values

Byte Value		Meaning
Dec	**Hex**	
0	00h	Not installed
1	01h	Installed

Table 9.23 REAL-TIME SURVEY DATA byte values

Value		Meaning
Dec	**Hex**	
0	00h	Not installed
1	01h	Installed

Table 9.24 SUMMARY OF RTK OPTIONS flag bits

Bit	Meaning
0–1	Reserved (set to zero)
2	RTK Fast Static 0: Not Installed 1: Installed
3	RTK OTF 0: Not installed 1: Installed
4	Reserved (set to zero)
5	CMR Input 0: Not installed 1: Installed
6	CMR Output 0: Not installed 1: Installed
7	Reserved (set to zero)

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.

Packet Flow

Receiver:		Remote:
	←	Command Packet 54h
Report Packet 55h	→	

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 9.25 through Table 9.29 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 9.25 describes the packet structure.

Table 9.25 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 104	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	See table 7.1, page 102	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
[1] Bit 0 = PRN 1				

Table 9.25 Report packet 55h SV flags report structure (continued)

Byte #	Item	Type	Value	Meaning
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]
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 102	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 9.26 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 9.27.

Table 9.26 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 104	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	See table 7.1, page 102	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)
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]	

Table 9.26 Report packet 55h ephemeris report structure (continued)

Byte #	Item	Type	Value	Meaning
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 9.27, page 188	Shows status of Ephemeris Flags
180	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
181	ETX	CHAR	03h	End transmission

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

Table 9.27 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 9.28 describes the packet structure.

Table 9.28 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 104	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count

Table 9.28 Command packet 55h almanac report structure (continued)

Byte #	Item	Type	Value	Meaning
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 102	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 meets one of the following criteria:

- SV PRN out of range (not 1–32)
- Command Packet 54h DATA SWITCH value is out of range
- Data is not available for requested SV

Table 9.29 describes the packet structure.

Table 9.29 RETSVDATA UTC/ION packet structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	See table 7.1, page 102	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.

Table 9.29 RETSVDATA UTC/ION packet structure (continued)

Byte #	Item	Type	Value	Meaning
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 102	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)

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

Packet Flow

Receiver:		Remote:
	←	Command Packet 56h or RT Survey Data Request or Front Panel Command
Report Packet 57h or NAK	→	

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 07h, RSERIAL (Receiver and antenna information report), page 157.

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 TrimComm 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.

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:

Expanded FormatLENGTH = 17 + N*48 + M*24 + N*J*12

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

Table 9.30 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 104	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count
4	RECORD TYPE	CHAR	See table 9.32, page 201	Raw data record type
5	PAGING INFO	CHAR	See table 9.33, page 201	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 9.34, page 201	Bit 0 must be set to 0 to enable Expanded Record format

Table 9.30 Report packet 57h structure (expanded format) (continued)

Byte #	Item	Type	Value	Meaning
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
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 9.35, page 201	First set of status flags
	FLAGS2	CHAR	See table 9.36, page 202	Second set of status flags
	FLAG STATUS	CHAR	See table 9.37, page 203	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

Table 9.30 Report packet 57h structure (expanded format) (continued)

Byte #	Item	Type	Value	Meaning
Begin L1 Data				
	L1 SNR	DOUBLE	dB	Measure of satellite signal strength
	FULL L1 C/A CODE PSEUDORANGE	DOUBLE	meters	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2)
	L1 CONTINUOUS PHASE	DOUBLE	L1 cycles	L1 Continuous Phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	DOUBLE	Hz	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	dB	Measure of satellite signal strength
	L2 CONTINUOUS PHASE	DOUBLE	L2 cycles	L2 Continuous Phase is in L2 cycles if bit 5 of FLAGS1 = 1
	L2 P-CODE - L1 C/A CODE P-RANGE	DOUBLE	meters	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)

Table 9.30 Report packet 57h structure (expanded format) (continued)

Byte #	Item	Type	Value	Meaning
Begin Enhanced Record[1] 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	Hz	L2 Doppler
Repeat previous bytes for remaining satellites in constellation				
	CHECKSUM	SHORT	See table 7.1, page 102	Checksum value
	ETX	CHAR	03h	End transmission

Concise record format

Table 9.31 shows the structure of Report Packet 57h when Concise Record format is enabled with Command Packet 56h.

Table 9.31 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 104	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA

Table 9.31 Report packet 57h structure (concise format) (continued)

Byte #	Item	Type	Value	Meaning
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count
4	RECORD TYPE	CHAR	See table 9.32, page 201	Raw data record type
5	PAGING INFO	CHAR	See table 9.33, page 201	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 9.34, page 201	Bit 0 must be set to 1 to enable Concise Record format
Begin Concise Record Header (17 bytes)				
8–15	RECEIVE TIME	DOUBLE	msecs	Receive time within 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	blocks	Number of SV data blocks included in record

Table 9.31 Report packet 57h structure (concise 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 (27 bytes * n)				
	SV PRN #	CHAR	01h–20h	Satellite pseudorandom number (1–32)
	FLAGS1	CHAR	See table 9.35, page 201	First set of satellite status flags
	FLAGS2	CHAR	See table 9.36, page 202	Second set of satellite status flags
	ELEVATION ANGLE	CHAR	degrees	Satellite elevation angle (negative or positive).
	AZIMUTH	SHORT	degrees	Azimuth of satellite
Begin L1 Data				
	L1 SNR	CHAR	dB * 4	Measure of satellite signal strength. The value needs to be divided by 4.
	FULL L1 C/A CODE PSEUDORANGE	DOUBLE	meters	Full L1 C/A code or P-code pseudorange (see bit 0 of FLAGS2)
	L1 CONTINUOUS PHASE	DOUBLE	L1 cycles	L1 continuous phase. Range-Rate sign convention: When pseudorange is increasing, the phase is decreasing and the Doppler is negative.
	L1 DOPPLER	FLOAT	Hz	L1 Doppler

Table 9.31 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	dB * 4	Measure of satellite signal strength. The value needs to be divided by 4.
	L2 CONTINUOUS PHASE	DOUBLE	L2 cycles	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	meters	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 Record[1] if bit 1 of the FLAGS byte is set to 1 (3 bytes * n)				
	IODE	CHAR	00h–FFh	Issue of Data Emphemeris
	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
Repeat previous bytes for remaining satellites in constellation				
	CHECKSUM	SHORT	See table 7.1, page 102	Checksum value
	ETX	CHAR	03h	End transmission
[1] To be compatible with Trimble software, this data must be stripped off before record 17 is stored in a *.DAT file.				

Table 9.32 RECORD TYPE byte values

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

Table 9.33 PAGE INFO bit values

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

Table 9.34 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
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 9.35 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

Table 9.35 FLAGS1 bit values (continued)

Bit	Meaning
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 BD950 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 9.37, page 203) 0: Off 1: On
7	New Position Computed during this Receiver Cycle 0: Off 1: On

Table 9.36 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
2	L2 Tracking Encryption Code 0: Off 1: On

Table 9.36 FLAGS2 bit values (continued)

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

Table 9.37 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 9.38 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 9.38 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 104	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count
4	RECORD TYPE	CHAR	See table 9.32, page 201	Raw data record type

Table 9.38 Position record (record type 11) structure (continued)

Byte #	Item	Type	Value	Meaning
5	PAGING INFO	CHAR	See table 9.33, page 201	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.
Begin Position Record (Record 11) (78 + (nSVs * 2) bytes)				
7–14	LATITUDE	DOUBLE		Latitude in semi-circles
15–22	LONGITUDE	DOUBLE		Longitude in semi-circles
23–30	ALTITUDE	DOUBLE	meters	Altitude
31–38	CLOCK OFFSET	DOUBLE	meters	Clock offset
39–46	FREQUENCY OFFSET	DOUBLE	Hz	Frequency offset from 1536*1.023 MHz
47–54	PDOP	DOUBLE		PDOP (dimensionless)
55–62	LATITUDE RATE	DOUBLE	radians per second	Latitude rate
63–70	LONGITUDE RATE	DOUBLE	radians per second	Longitude rate
71–78	ALTITUDE RATE	DOUBLE	meters per second	Altitude rate
79–82	GPS MSEC OF WEEK	LONG	msecs	Position time tag
83	POSITION FLAGS	CHAR	See table 9.39, page 205	Position status flags

Table 9.38 Position record (record type 11) structure (continued)

Byte #	Item	Type	Value	Meaning
84	# OF SVS	CHAR	00h–0Ch	Number of satellites used to compute position solution (0–12)
	The next 2 bytes are repeated for each satellite used to compute position			
	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 102	Checksum value
	ETX	CHAR	03h	End transmission

Table 9.39 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)
3	RTK Solution 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)

Table 9.39 POSITION FLAGS bit values (continued)

Bit	Meaning
6	Real-Time Kinematic (RTK) Positions 0: False 1: True
7	Position Derived While Static 0: False 1: True

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.

Packet Flow

Receiver:		Remote:
	←	Command Packet 65h
Report Packet 64h	→	

For more information about BD950 Application Files and guidelines for using application files to control remote devices, see Report Packet 07h, RSERIAL (Receiver and antenna information report), page 157.

The Application File Record Report format is identical to the format used for Command Packet 64h. For more information, see Packet paging, page 124.

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 147.

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

Report Packet 67h can exceed the maximum data byte limit (248 bytes of data) for TrimComm 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 9.40 describes the packet structure.

Table 9.40 Report packet 67h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status code
2	PACKET TYPE	CHAR	67h	Report Packet 67h
3	LENGTH	CHAR	See table 7.1, page 102	Data byte count

Table 9.40 Report packet 67h structure (continued)

Byte #	Item	Type	Value	Meaning
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 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.				
8	SYSTEM FILE INDEX	CHAR	See table 9.41, page 209	Record number assigned to the file
9–16	APP FILE NAME	CHARs	ASCII text	Name of application file (8 ASCII characters)
17	CREATION YEAR[1]	CHAR	00h–FFh	Year when file is created. Based on the years since 1900 (1900 = 00)
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

Table 9.40 Report packet 67h structure (continued)

Byte #	Item	Type	Value	Meaning
Begin Second Application File Record Entry . . . End with Last Application File Record Entry				
Length +4	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
Length +5	ETX	CHAR	03h	End transmission
[1] The Date/Time fields should all be relative to UTC.				

Table 9.41 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–*n*h	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.

Packet Flow		
Receiver:		**Remote:**
	←	Break Sequence
Report Packet 6Eh	→	

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 9.42).

Table 9.42 describes the structure of Report Packet 6Eh.

Table 9.42 Report packet 6eh structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	Receiver status indicator
2	PACKET TYPE	CHAR	6Eh	Report Packet 6Eh
3	LENGTH	CHAR	See table 7.1, page 102	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 212.
	PORT	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 212.

Table 9.42 Report packet 6eh structure (continued)

Byte #	Item	Type	Value	Meaning
	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 213.
	COMM	CHARs	comma delimited ASCII string	Comma-delimited ASCII string indicating the communication protocols supported on serial port. For more information, see COMM, page 213.
	CHECKSUM	CHAR	See table 7.1, page 102	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,BD950;
PORT,1,38400,38400,8,1,N,F;
VERSION,2.21,11/21/98,,;
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 BD950 receiver, the PRODUCT string is always set to BD950. The string always begins with the word PRODUCT, followed by a comma, followed by the word BD950, and terminated with a semicolon as in the following example:

PRODUCT,BD950;

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 BD950 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 9.43 identifies the ASCII codes assigned to the various protocols supported by the BD950 receiver.

Table 9.43 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 152.

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

Report Packet 82h is sent in response to Command Packet 82h. The receiver generates an ASCII representation (a dump) of a BD950 display screen, and sends the dump to the remote device in Report Packet 82h. Table 9.44 shows the packet structure.

Table 9.44 Report packet 82h structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	See table 7.2, page 104	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

Table 9.44 Report packet 82h structure (continued)

Byte #	Item	Type	Value	Meaning
164	CURSOR POSITION	CHAR		Position of the cursor
165	CHECKSUM	CHAR	See table 7.1, page 102	Checksum value
166	ETX	CHAR	03h	End transmission

CHAPTER

10

Specifications

In this chapter:

- Introduction
- Physical characteristics
- Pinouts
- Technical specifications
- Positioning specifications

Introduction

This chapter provides technical information about the BD950 receiver. Please check the release notes for any updates to these specifications. They are subject to change.

Physical Characteristics

Table 10.1 Physical characteristics

Item	Characteristic
Size	100 mm x 80 mm x 17 mm
Power	+4.75 VDC to +32 VDC Typical 1.0 W at 5 VDC (L1 only) Typical 1.5 W at 5 VDC (L1/L2 + RTK)
Connector details	64-pin connector DIN41612
Operating temperature	–40°C to +75°C
Storage temperature	–55°C to +85°C
Vibration	MIL 810 D, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL 810 D ±40 g operating ±75 g survival

Pinouts

Table 10.2 64-Pin connector pinout

Pin #	Trimble BDEURO	Comment
A1	GND	
A2	+4.5 V to +33.0 V input	
A3	Factory use	Factory use – boot monitor, ground to force into monitor
A4	GND	
A5	LED 1	Tracking SV
A6	LED 2	CMR received
A7	GND	
A8		
A9	Serial Port 2 TXD	
A10	Serial Port 2 RXD	
A11	Serial Port 1 TXD	
A12	Serial Port 1 RXD	
A13	Serial Port 4 TXD	
A14	Serial Port 4 RXD	
A15	GND	
A16		
A17	Serial Port 3 TXD	
A18	Serial Port 3 RXD	
A19		
A20		
A21		
A22	GND	
A23	GND	
A24	GND	

Table 10.2 64-Pin connector pinout (continued)

Pin #	Trimble BDEURO	Comment
A25	GND	
A26		
A27		
A28	GND	
A29	GND	
A30		
A31		
A32	ONOFFSW*	Connect input to GND to power up board or insert jumper JP3 for automatic turn on when external power is applied
B1	GND	
B2	+4.5 V to +33.0 V input	
B3		
B4		
B5	LED 3	Power
B6		
B7	Factory use	
B8	Factory use	
B9	Serial Port 2 CTS	
B10	Serial Port 2 RTS	
B11		
B12		
B13		
B14		
B15	Factory use	
B16	Factory use	
B17	Serial Port 3 CTS	

Table 10.2 64-Pin connector pinout (continued)

Pin #	Trimble BDEURO	Comment
B18	Serial Port 3 RTS	
B19		
B20		
B21		
B22	1 PPS output	7.2 V 50 ohm pulse
B23		
B24	Event input	0–12 V input, default rising edge, software reconfigure to falling edge
B25		
B26	Factory use	
B27	Factory use	
B28	Manual Reset input	
B29		
B30	Factory use	
B31	Factory use	
B32		
RF Connector	SMA	
External Frequency Connector	SSMC	

Technical Specifications

Table 10.3 Technical specifications

Item	Specification
Tracking	12 channels L1 C/A code, L1/L2 full cycle carrier Fully operational during P-code encryption
Signal Processing	Advanced Maxwell 4 Custom Survey GPS chip
Startup	<90 seconds from power on to positioning <30 seconds with recent ephemeris
Initialization	Automatic OTF (on-the-fly) while moving
Time Required	Typically <1 minute
Range	Up to 20 km for RTK
Communications	4× RS-232 ports Baud rates up to 115,200
Configuration	Configuration Toolbox, MS Controller Software, or user definable application files
Output Formats	NMEA-0183: GGK, GGA, ZDA, VTG, GST, PJT and PJK Trimble Binary Streamed Output

Positioning Specifications

Table 10.4 Positioning specifications

Positioning Mode	Accuracy[1]	Latency[2]	Max Rate
Synchronized RTK	1 cm + 2 ppm horizontal 2 cm + 2 ppm vertical	300 msec[3]	10 Hz
Low Latency	2 cm + 2 ppm horizontal[4] 3 cm + 2 ppm vertical	<20 msec	20 Hz
DGPS	<1 m	<20 msec	20 Hz
WAAS[5]	<5 m	V20 msec	

[1] 1 sigma level
[2] At maximum output rate
[3] Depends on data link throughput
[4] Assumes 1 second data link delay
[5] Depends on WAAS system performance

APPENDIX

A

Hexadecimal Conversion Table

The table in this appendix is useful for converting decimal numbers and the decimal numbers assigned to ASCII characters to hexadecimal format.

Dec	Hex	ASCII
0	00h	
1	01h	
2	02h	
3	03h	
4	04h	
5	05h	
6	06h	
7	07h	
8	08h	
9	09h	
10	0Ah	
11	0Bh	
12	0Ch	
13	0Dh	
14	0Eh	
15	0Fh	
16	10h	
17	11h	
18	12h	
19	13h	
20	14h	
21	15h	
22	16h	
23	17h	
24	18h	
25	19h	
26	1Ah	
27	1Bh	
28	1Ch	

Dec	Hex	ASCII
29	1Dh	
30	1Eh	
31	1Fh	
32	20h	Space
33	21h	!
34	22h	“
35	23h	#
36	24h	$
37	25h	%
38	26h	&
39	27h	‘
40	28h	(
41	29h	)
42	2Ah	*
43	2Bh	+
44	2Ch	,
45	2Dh	-
46	2Eh	.
47	2Fh	/
48	30h	0
49	31h	1
50	32h	2
51	33h	3
52	34h	4
53	35h	5
54	36h	6
55	37h	7
56	38h	8
57	39h	9

Dec	Hex	ASCII
58	3Ah	:
59	3Bh	;
60	3Ch	<
61	3Dh	=
62	3Eh	>
63	3Fh	?
64	40h	@
65	41h	A
66	42h	B
67	43h	C
68	44h	D
69	45h	E
70	46h	F
71	47h	G
72	48h	H
73	49h	I
74	4Ah	J
75	4Bh	K
76	4Ch	L
77	4Dh	M
78	4Eh	N
79	4Fh	O
80	50h	P
81	51h	Q
82	52h	R
83	53h	S
84	54h	T
85	55h	U
86	56h	V

Dec	Hex	ASCII
87	57h	W
88	58h	X
89	59h	Y
90	5Ah	Z
91	5Bh	[
92	5Ch	\
93	5Dh	]
94	5Eh	^
95	5Fh	_
96	60h	‘
97	61h	a
98	62h	b
99	63h	c
100	64h	d
101	65h	e
102	66h	f
103	67h	g
104	68h	h
105	69h	i
106	6Ah	j
107	6Bh	k
108	6Ch	l
109	6Dh	m
110	6Eh	n
111	6Fh	o
112	70h	p
113	71h	q
114	72h	r
115	73h	s

Dec	Hex	ASCII
116	74h	t
117	75h	u
118	76h	v
119	77h	w
120	78h	x
121	79h	y
122	7Ah	z
123	7Bh	{
124	7Ch	|
125	7Dh	}
126	7Eh	~
127	7Fh	
128	80h	
129	81h	
130	82h	
131	83h	
132	84h	
133	85h	
134	86h	
135	87h	
136	88h	
137	89h	
138	8Ah	
139	8Bh	
140	8Ch	
141	8Dh	
142	8Eh	
143	8Fh	
144	90h	

Dec	Hex	ASCII
145	91h	
146	92h	
147	93h	
148	94h	
149	95h	
150	96h	
151	97h	
152	98h	
153	99h	
154	9Ah	
155	9Bh	
156	9Ch	
157	9Dh	
158	9Eh	
159	9Fh	
160	A0h	
161	A1h	
162	A2h	
163	A3h	
164	A4h	
165	A5h	
166	A6h	
167	A7h	
168	A8h	
169	A9h	
170	AAh	
171	ABh	
172	ACh	
173	ADh	

Dec	Hex	ASCII
174	AEh	
175	AFh	
176	B0h	
177	B1h	
178	B2h	
179	B3h	
180	B4h	
181	B5h	
182	B6h	
183	B7h	
184	B8h	
185	B9h	
186	BAh	
187	BBh	
188	BCh	
189	BDh	
190	BEh	
191	BFh	
192	C0h	
193	C1h	
194	C2h	
195	C3h	
196	C4h	
197	C5h	
198	C6h	
199	C7h	
200	C8h	
201	C9h	
202	CAh	

Dec	Hex	ASCII
203	CBh	
204	CCh	
205	CDh	
206	CEh	
207	CFh	
208	D0h	
209	D1h	
210	D2h	
211	D3h	
212	D4h	
213	D5h	
214	D6h	
215	D7h	
216	D8h	
217	D9h	
218	DAh	
219	DBh	
220	DCh	
221	DDh	
222	DEh	
223	DFh	
224	E0h	
225	E1h	
226	E2h	
227	E3h	
228	E4h	
229	E5h	
230	E6h	
231	E7h	

Dec	Hex	ASCII
232	E8h	
233	E9h	
234	EAh	
235	EBh	
236	ECh	
237	EDh	
238	EEh	
239	EFh	
240	F0h	
241	F1h	
242	F2h	
243	F3h	
244	F4h	
245	F5h	
246	F6h	
247	F7h	
248	F8h	
249	F9h	
250	FAh	
251	FBh	
252	FCh	
253	FDh	
254	FEh	
255	FFh	

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Reader Comment Form

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Revision A

We appreciate your comments and suggestions for improving this publication.

Which Trimble product do you use? ______________________________

What do you use your Trimble product for? ______________________________

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Please circle a response for each of the statements below:

1 = strongly agree   2 = agree   3 = neutral   4 = disagree   5 = strongly disagree

The manual is well organized.	1	2	3	4	5
I can find the information I want.	1	2	3	4	5
The information in the manual is accurate.	1	2	3	4	5
I can easily understand the instructions.	1	2	3	4	5
The manual contains enough examples.	1	2	3	4	5
The examples are appropriate and helpful.	1	2	3	4	5
The layout and format are attractive and useful.	1	2	3	4	5
The illustrations are clear and helpful.	1	2	3	4	5
The manual is:	too long		just right		too short

Please answer the following questions:

Which sections do you use the most? ______________________________

What do you like best about the manual? ______________________________

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What do you like least about the manual? ______________________________

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Optional:

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