Series 7400

Operation Manual

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This is the first release of this manual, Series 7400 Operation Manual, Part Number 31463-00, Revision A, November 1996. This manual describes receiver firmware version 2.21.

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Preface

Welcome to the *Series 7400 Operation Manual*. This manual describes the Series 7400 family of GPS receivers and provides guidelines for configuring the receivers for real-time, high-precision applications. The Series 7400 family of GPS receivers use advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

Scope and Audience

Even if you have used other Global Positioning System (GPS) receivers, we recommend that you spend some time reading this manual to learn about the special features of your Series 7400 receiver. The following sections provide you with a guide to this manual, as well as other documentation you have received with this product.

Organization

This manual contains the following chapters and appendices:

- Chapter 1, Overview, describes Series 7400 features and Real-Time Kinematic technique.
- Chapter 2, Using the Simulated Keypad and Display, gives basic instructions for using the simulated keypad and display.

- Chapter 3, Receiver Configuration, shows you how to configure a Series 7400 base station and rover receiver for operation and gives guidelines for verifying proper operation.
- Chapter 4, Receiver Operation, includes step-by-step instructions for operating the Series 7400 receiver.
- Chapter 5, NMEA-0183 Output, describes the basic structure of NMEA-0183 output messages and describes the NMEA output messages supported by the receiver.
- Chapter 6, TrimComm Protocol, describes the structure of the Trimble TrimComm command packets and report packets, and describes the data format of values included in packets. Also included is detailed information about the Application File Interface and guidelines for managing the application files stored on the receiver.
- Chapter 7, TrimComm Command Packets, summarizes the Trimble TrimComm command packets supported by the receiver and provides detailed descriptions of command packet flow and structure.
- Chapter 8, TrimComm Report Packets, summarizes the Trimble TrimComm report packets supported by the receiver and provides detailed descriptions of report packet flow and structure.
- Appendix A, Data and Power Connections, gives guidelines for interfacing the Series 7400 receiver to other devices.
- Appendix B, Specifications, lists the Series 7400 receiver physical and technical specifications.
- Appendix C, Updating Firmware, gives instructions for installing new versions of the Series 7400 receiver firmware.
- Appendix D, Serial Number Form, includes form for recording the serial numbers of your Trimble equipment.
- Appendix E, Hexadecimal Conversion Tables, includes decimal to hexadecimal conversion tables.

- The Bibliography includes a list of suggested reading material about GPS.
- The Glossary includes definitions of the terms used throughout this manual.
- The Index lets you quickly lookup the location of information about specific topics.

Related Information

This manual assumes that you are familiar with the basic procedures for operating your Series 7400 receiver. If you are not yet familiar with the receiver, see the first few chapters of your Series 7400 User Guide. It also 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, we suggest that you read the booklets *GPS, A Guide to the Next Utility* (P/N 16778) and *Differential GPS Explained* (P/N 23036) that are available from Trimble Navigation. For a complete citation to this booklet, see the Bibliography.

Before proceeding to the next chapter, review the following sections for information that will assist you in using this product and communicating with Trimble to receive product updates and other important information.

Update Notes

You will find a Warranty Activation Sheet with your Series 7400 receiver. By sending in your Warranty Activation Sheet, you are automatically sent update notes as they become available. When you receive these packages, read them. They contain important information about software and hardware changes. Contact your local Trimble Dealer for more information about the support agreement contracts for software and firmware, and an extended warranty programs for hardware.

Technical Assistance

If you have problems and cannot find the information you need in this document, call the Trimble Technical Assistance Center (TAC). The phone numbers are:

+1-800-SOS-4TAC (in North America)
+1-408-481-6940 (International)
+1-408-737-6020 (fax)

You can call the Technical Assistance Center phones between 6 AM to 6 PM Pacific Standard Time. A support technician will take your call, help you determine the source of your problem, and provide you with any technical assistance you might need.

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Document Conventions

Italics identify software menus, menu commands, dialog boxes, and the dialog box fields.

SMALL CAPITALS identify DOS commands, directories, file names, and file name extensions.

`Courier` is used to represent what you see printed on the screen by the DOS system or program.

`Courier Bold` represents information that you must type in a software screen or window.

[Return] or [Ctrl] + [C] identifies a hardware function key or key combination that you must press on a PC.

Helvetica Bold represents a software command button.

Notes, Tips, Cautions, and Warnings

Notes, tips, cautions, and warnings are used to emphasize important information.

Note – Notes give additional significant information about the subject to increase your knowledge, or guide your actions. A note can precede or follow the text it references.

Tip – Indicates a shortcut or other time or labor-saving hint that can help you make better use of the receiver.

Caution – Cautions alert you to situations that could cause hardware damage or software error. A caution precedes the text it references.

Warning – Warnings alert you to situations that could cause personal injury or unrecoverable data loss. A warning precedes the text it references.

1 Overview

The Series 7400 receivers addresses a wide range of precise positioning and navigation applications, including construction and mining equipment positioning, robotic equipment control, marine construction, vessel positioning and navigation, and hydrographic surveying and dredging.

The Series 7400 receivers offer 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 (0.1 second) and high update rates (up to 5 Hz) give the response time and accuracy required for precise dynamic applications.

Designed for reliable operation in all environments, the Series 7400 family of GPS receivers feature Trimble's Super-trak technology with multi-bit signal processing. Super-trak technology improves satellite signal acquisition and tracking and offers superior performance in areas of satellite signal blockage as well as providing improved resistance to jamming caused by radio frequency interference.

The Series 7400 receivers provide an interface to a PC, external processing device, or control system. The receiver can be controlled through a serial port using an application file interface. The application file interface allows you to script the Series 7400 operation with a single command. All receiver operations are set using the application file interface or by using the supplied Microsoft Windows Remote Controller software.

The Series 7400 receivers can be configured as an autonomous base station (reference station) or rover receiver (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 Series 7400 receivers also output a one pulse per second strobe signal, allowing remote devices to precisely synchronize time.

1.1 Features

The Series 7400 receivers provides the following available features:

- Centimeter accuracy, real-time positioning with RTK/OTF data, up to 5 Hz position updates and 0.1 second latency
- Submeter accuracy, real-time positioning using pseudorange corrections with a 0.1 second latency
- Automatic OTF (On-the-Fly) initialization while moving
- Super-trak signal processing technology
- 4 serial I/O ports
- Outputs local coordinates direct from receiver
- 1 PPS output
- Remote Controller software
- Rugged, lightweight, and power efficient
- One year hardware warranty

- Quick Plan software for mission planning
- RTK/OTF data input/output in Trimble Format (CMR)
- Supports a subset of NMEA-0183 messages
- RTCM SC-104 Version 2.1 standard data format for code and correction data input
- RTCM SC-104 Version 2.1 standard data format for code and carrier correction data output
- Data Collector Support

1.2 Use and Care

The Series 7400 receivers are designed to withstand the rough treatment typical of equipment used in the field, however, the receivers are high-precision electronic instruments and should be treated with reasonable care. The receivers operates in temperatures ranging from –25°C to 55°C. The enclosure is sealed and buoyant. A waterproof vent allows internal air pressure to adjust to altitude changes.

High-power signals from a near-by radio or radar transmitter can overwhelm the Series 7400 receiver circuits. This does not harm the instrument, but it can prevent the receiver electronics from functioning correctly. To avoid problems, try not to use the receiver within 400 meters 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 Series 7400 operations. For more information, see the Trimble technical note *Using Radio Communication Systems with GPS Surveying Receivers.*

Warning – Operating or storing your Series 7400 receivers outside the specified temperature range can destroy or limit the longevity of the instrument.

1.3 COCOM Limits

The U.S. Department of Commerce COCOM regulations require all exportable GPS products to contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. In accordance, the Series 7400 receivers disable access to satellite measurements and navigation results when the receiver's velocity is greater than 1000 knots, or its altitude is above 18,000 meters. 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 applicable data fields in serial output have zero values. These fields include position and velocity results.

1.4 Real-Time Positioning and Critical Factors Influencing Accuracy

The Series 7400 receivers offer seamless navigation to automatically provide the best possible RTK/DGPS solution given the operating conditions and correction data available. The receivers provide an indication to the user of solution type and quality. This section describes some operational capabilities which are optional features. Please refer to the *User Guide* provided with your Series 7400 receiver for more details. The following sections give you an understanding of the system operating modes and the factors affecting solution type and accuracy.

Many factors contribute to the position accuracy achievable with the Series 7400 receiver. In autonomous (standalone) mode, range measurements to the satellites are used to determine the location of the receiver. Autonomous position accuracy is primarily dictated by satellite geometry and Selective Availability (SA) errors. SA error is an intentional degradation of the satellite signals. A Series 7400 receiver typically achieves 100 meter accuracy in the autonomous (standalone) mode.

DGPS and RTK processing techniques rely on a base station (reference station) receiver and a rover receiver (mobile receiver) simultaneously collecting range measurements from a common set of satellites. Many satellite-related measurement errors are the same for two closely-spaced receivers. By differentiating satellite range measurements, atmospheric and satellite errors are reduced, resulting in position accuracies with two Series 7400 receivers of approximately 50 cm (horizontal) with DGPS and a few centimeters with RTK (fixed). The range at which the receiver automatically switches modes between RTK and DGPS is user definable, the default value is 10.0 Kilometers. The RTK data can be transmitted two different ways—Trimble formatted RTK data message (CMR) or RTCM SC-104, Version 2.1, formatted message Types 18 and 19. DGPS data can be transmitted two different ways—RTCM SC-104, Version 2.1, Type 1 messages or Type 9-3 messages. The mobile receivers can accept RTCM SC-104, Version 2.1, message types 1, 9-3, 18, and 19 messages in one port, simultaneously, or the receiver can accept RTCM SC-104, version 2.1, in one port and the Trimble RTK messages (CMR) on another port.

To achieve centimeter-level accuracy, the rover receiver must operate in the RTK (fixed) mode. To do so, it tracks carrier-phase data and must initialize itself relative to the base station receiver (reference station). The initialization process involves the identification of the correct set of integer carrier phase ambiguities between receivers and satellites. This initialization is performed automatically by the Series 7400 receiver and is normally completed within one or two minutes. Once the base station data is received and at least five common satellites are tracked, the rover receiver attempts to identify the correct ambiguities to initialize the system. If the rover receiver can resolve the integer ambiguities, the receiver solves for a RTK (fixed) solution. Before initializing and computing the RTK (fixed) solution, the Series 7400 receiver computes RTK (float) solutions. RTK (float) solutions are differentially corrected positions relative to the base station. Once initialized, the position mode switches from RTK (float) to RTK (fixed), and the position accuracy changes from the meter level to very accurate centimeter level.

Immediately after satellite acquisition, RTK (float) solutions provide position accuracies comparable with DGPS positioning techniques. However, over time the RTK estimator converges to superior position accuracy for the RTK (float) solutions compared to the DGPS solutions. The time and accuracies achievable are dependent upon the local operating environment and satellite constellation.

If the rover receiver is operating within the range specified by the user in the RTK(1 Hz) mode and the RTK correction data is lost (DGPS data is not available), the receiver produces a DGPS solution for approximately 25 seconds based on the last received base station data which is propagated into pseudorange corrections. After 30 seconds, if the RTK correction data is still lost and no DGPS data is available, the receiver produces an autonomous solution.

If the rover receiver is operating within the range you specify in the RTK(5 Hz) mode, and the RTK correction data is lost (DGPS is not available), the receiver continues to produce RTK solutions for five seconds. After five seconds, a DGPS solution is generated for an additional 25 seconds based on the last received base station data which is propagated into pseudorange corrections. After 30 seconds, if the RTK correction data is still lost and no DGPS data is available, the receiver produces an autonomous solution.

If the range from the base station exceeds the range to automatically switch between RTK and DGPS solutions and RTCM SC-104 DGPS data is available, the rover receiver only computes DGPS solutions, even when a RTK data source is available. The recommended automatic switching threshold between RTK and DGPS solutions should not exceed 10 kilometers. The effective range of the RTK data link could limit this threshold, and the threshold should be adjusted accordingly.

Note – Initialization time is determined by atmospheric properties, satellite constellation, baseline length, and multipath. Try to minimize reflective objects close to the antennas and keep baseline lengths and elevation differences between the base station receiver and rover receiver as small as possible.

Warning – Although initialization in the Series 7400 receivers is very reliable, incorrect initializations can occur. A bad initialization can result in position errors of 1–3 meters. The receiver automatically detects initialization failures, and reports and fixes the problem given suitable satellite geometry information. Bad initializations are generally followed by an increasing solution RMS.

1.4.1 Solution Rates and Processing Techniques

The Series 7400 System uses proprietary techniques to provide highly responsive position updates, many times per second. To achieve a fast update rate and low solution latency (age), a slight degradation in position accuracy is necessary. It is important for you to understand how position accuracy varies depending on the measurement rate of the Series 7400 receiver, the age of the radio correction messages received from the base station, and whether the Series 7400 receiver is computing RTK or DGPS solutions.

There are three modes of operation which determine how the Series 7400 receiver computes solution rates and associated latency and accuracy effects. The three modes are RTK (5 Hz), RTK (1 Hz), and DGPS (1 Hz or 5 Hz). To identify the measurement rate currently used by the Series 7400 receiver, you can display the *CONTROL* screen and choose the **<GENERAL CONTROLS>** softkey. In the RTK (1 Hz) mode, the Series 7400 receiver generates RTK solutions at a rate of once per second with exceptionally high accuracy and slightly higher position solution latency (0.4 seconds). In the RTK (5 Hz) mode, the Series 7400 receiver generates RTK solutions at a rate of five per second with not quite as high position accuracy and lower solution latency (0.1 second). In the DGPS (1 Hz or 5 Hz) mode, the solution latency is 0.1 seconds. You need a good understanding of the existing trade-offs of using the three modes in order to select the appropriate update rate for a given application.

In the RTK (1 Hz) mode, the rover receiver requires synchronized GPS measurement data from the base station once per second, see Figure 1-1.

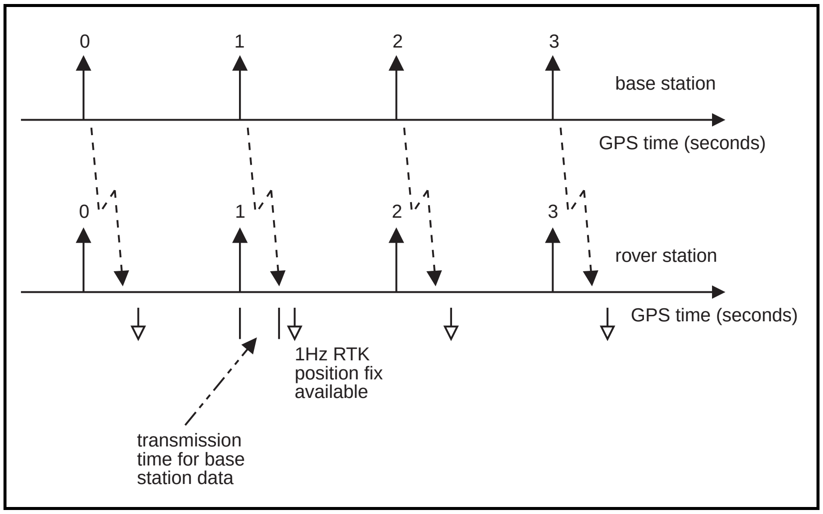

Figure 1-1. RTK (1 Hz) Mode System Timing

Typically, there are noticeable transmission delays of as much as 0.5 seconds incurred when sending measurement data from the base station to the rover receivers over a radio link. The data bandwidth capacity of the radio link dictates the transmission delay time. When the base station data is synchronized with the rover receiver data, a real-time kinematic baseline can be computed. The accuracy of the real-time kinematic baseline is approximately 2 cm. The position latency should be approximately 0.4 seconds when using a pair of Series 7400 receivers (a base station and a rover receiver) with TRIMTALK 900 radio/modems.

RTK (5 Hz) mode is best suited for applications requiring fast update rates, but can tolerate a slight degradation in real-time kinematic accuracy, see Figure 1-2.

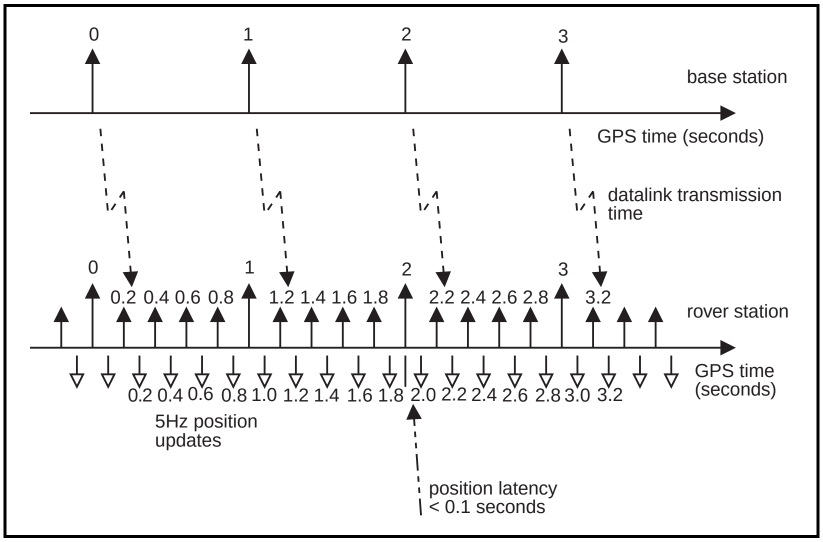

Figure 1-2. RTK (5 Hz) Mode System Timing

In RTK (1 Hz) mode, the radio link delay directly increases the position solution delay. In RTK (5 Hz) mode, the radio link delay does not increase the solution delay, but it does cause position accuracy degradation.

1.4.2 Base Station Receiver Type

The Series 7400 receivers use a state-of-the-art tracking scheme to collect satellite measurements. Maximum real-time performance is achieved when Series 7400 receivers is used as both the base station and as the rover receiver. The Series 7400 receivers are also compatible with the Trimble Series 4000 receivers. A 4000SSE/SSi receiver can be used as the base station with a Series 7400 rover receiver. Similarly, a Series 7400 base station can be used to support 4000SSE/SSi rover receivers. However, a slight degradation in Series 7400 real-time performance occurs when using a 4000SSE/SSi base station.

When using a 4000SSE/SSi base station, the real-time data is received from these receivers later than if you are using a Series 7400 receiver. In RTK (5 Hz) mode, this translates into approximately 2.5 cm of accuracy degradation. In the RTK (1 Hz) mode, the accuracy is the same as if a Series 7400 receiver is used; however, the system latency increases.

1.4.3 Data Link Performance

The transmission speed of correction data sent to the rover receiver can influence system accuracy and solution latency. Figure 1-3 shows the position degradation resulting when RTK data link transmission delays occur. Measurement data, base station coordinates, and base station description messages are sent from the RTK base station over the data link. The measurement data requires less than 2000 bits to transmit information for nine satellites. A 2400 baud radio/modem can support one update per second, however it is preferable to use a much faster transmission rate. Typically, a 9600 baud modem transfers base station data four times faster than a 2400 baud modem.

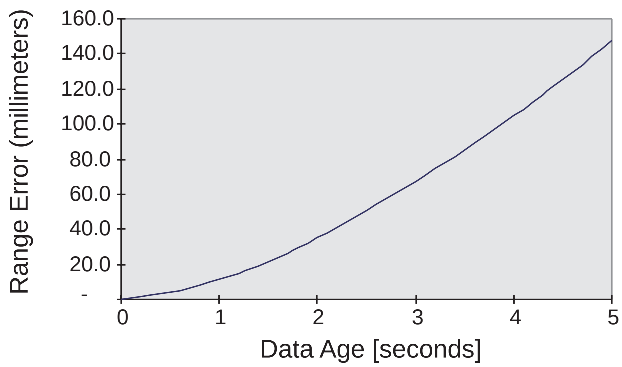

Figure 1-3. Range Error Caused By Old RTK Base Data

Figure 1-3 shows the typical error introduced into the satellite range measurements as a function of the RTK base station correction packet delay. An estimate of the position error induced by range error can be computed by multiplying the graph in Figure 1-3 by the prevailing Position Dilution Of Precision (PDOP).

TRIMTALK radio/modems are designed to support real-time kinematic positioning with Series 7400 receivers. The TRIMTALK units do not require licensing in the U.S. and several other countries around the World. Third-party radio/modems, cellular phones, or satellite communication links can be used to transmit base station data to one or more rover receivers. Factors to consider when choosing an appropriate data link include:

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

The transmission error rate depends on the data link selected and the operating conditions. The Series 7400 receivers are designed to smoothly transition through missed base station data packets. If only one measurement packet is missed, then a small increase in position error may be detected. Longer RTK data outages cause a degradation of the solution as shown in Figure 1-3.

Due to higher data latency with slower radio modems, the position accuracy is degraded relative to the 9600 bps radio modem.

If the rover receiver is operating within the range specified by the user in the RTK(1 Hz) mode, and the RTK correction data is lost (DGPS data is not available), the receiver produces a DGPS solution for approximately 25 seconds based on the last received base station data which is propagated into pseudorange corrections. After 30 seconds, if the RTK correction data is still lost and no DGPS data is available, the receiver produces an autonomous solution.

If the rover receiver is operating within the range that you specify in the RTK(5 Hz) mode, and the RTK correction data is lost (DGPS correction data is not available), the receiver continues to produce RTK solution for five seconds. After five seconds, a DGPS solution is generated for an additional 25 seconds based on the last received base station data which is propagated into pseudorange corrections. After 30 seconds, if the RTK correction data is still lost and no DGPS data is available, the receiver produces an autonomous solution.

If the range from the base station exceeds the range you specify for automatically switching between RTK and DGPS solutions, and there is RTCM SC-104 DGPS data available, the rover receivers only compute a DGPS solution (even if a RTK data source is available). The recommended range for automatically switching between RTK and DGPS solutions should be determined by the RTK data link's effective radio distance and should never exceed 10 kilometers.

1.4.4 Base Station Coordinate Accuracy

The base station coordinates are input by selecting the **<BASE STATION>** softkey from the *CONTROL* screen. The base station coordinates must be known to within 10 meters in the WGS-84 datum for correct system operation. Rover receiver location is computed relative to the base station coordinates. Incorrect or inaccurate base station coordinates cause two problems in the rover receiver position solutions. Every 10 meters of error in the RTK base station coordinates introduces one part per million error in the RTK baseline vector. This means that if the base station coordinates have a height error of 50 meters and the baseline vector is 10 km, then the introduced error in the RTK mobile receiver location is approximately five centimeters.

Note – The **<HERE>** softkey on the *BASE STATION* screen in the *CONTROL* menu, provides an approximate base station position estimate and should not be relied on for precise work.

Base station coordinate errors also impact the precision of RTK (5 Hz) position solutions. Every 10 meters of base station coordinate error introduces as much as 5 cm of error in the RTK (5 Hz) position solutions. If the position error ramps up with increased base station data age (see *PROP*: on the *VECTOR* screen), then there may be a significant error in the base station coordinates.

1.4.5 Number of Visible Satellites

A GPS position solution can be considered a distance resection. The satellite geometry directly impacts the quality of the position solution estimated by the Series 7400 receiver. The Global Positioning System is designed to position at least five satellites above the local horizon at all times. Because the satellites are orbiting, the satellite geometry changes throughout 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 derived. Generally, the more satellites included in the position solution computation, the greater the solution quality and integrity.

A good measure of the satellite geometry quality is the Position Dilution Of Precision (PDOP). The Dilution Of Precision value represents the scale factor used to translate measurement error into position error. If range measurements are accurate to 1.5 meters, then a PDOP value of 2.0 means that the expected position solution error is 3 meters. High DOP values indicate poor satellite geometry, and low DOP values indicate good satellite geometry.

Even though four satellites provide a minimal solution for position and time, real-time kinematic initialization requires at least five common satellites between the base station and rover receiver. RTK initialization can only take place when the base station and rover receivers are tracking L1/L2 carrier-phase data on at lease five common satellites. Once initialized, real-time kinematic solutions can be computed with as few as four satellites, however, five or more satellites are needed for integrity checking.

Warning – Be wary of real-time kinematic solutions derived from only 4 satellites.

1.4.6 Elevation Mask

The Elevation Mask stops the Series 7400 receiver from using satellites that are too low above the horizon to provide accurate data. The previous discussion about the number of tracked satellites concluded that the more satellites tracked, the better the solution quality. This might suggest that to track more satellites, the Elevation Mask should be made as low as possible. Low elevation satellites, however, present problems for a GPS receiver. The amount of atmosphere that the GPS signals must travel through increases for low elevation satellites. The atmosphere corrupts the GPS signals. The GPS antenna gain pattern also causes low elevation satellites to have lower signal-to-noise ratios. Signal multipath also tends to increase for low elevation satellites.

Using an Elevation Mask of greater than 10° for real-time positioning is preferable. The default Elevation Mask of 13° works well for most applications.

1.4.7 Environmental Factors

The environmental factors affecting GPS measurement quality include:

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

Ionospheric Activity

High ionospheric activity can cause rapid changes in GPS signal delay, even between closely spaced receivers. Equatorial and polar regions of the Earth are most effected by ionospheric activity at the middle of the day. Real-time kinematic initialization performance can be degraded in terms of the time required to initialize and also the precision of the results during high ionospheric activity.

Tropospheric Delay

Tropospheric delay is modeled within the Series 7400 receiver. The troposphere delay is caused by the lower part of the atmosphere and varies with weather conditions, height above sea level, and satellite elevation angle. A base receiver located in a sunny valley experiences different tropospheric delays than a rover located at the top of a cloud-covered mountain. Initialization and baseline accuracy are effected by tropospheric delay. If possible, you should try to locate the base station at approximately the same elevation as the rover.

Signal Obstructions and Multipath

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, this effect is on the order of a 1 to 5 centimeters. Multipath effects on the rover receiver antenna are generally transient, while a static base station may experience slowly changing errors. If possible, place the base station in a clear environment with an open view of the sky. If possible use an antenna with a groundplane to minimize multipath.

Radio Interference

The Series 7400 receiver provides good radio interference rejection circuits. 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 mount the base station antenna in a location where radio transmissions can cause interference.

2 Using the Simulated Keypad and Display

The Remote Controller software supplied with the Series 7400 receiver serves as the keypad and display screen for the Series 7400 receiver. This chapter gives you the basic skills necessary to use the Remote Controller software's simulated keypad and display. You can use these skills in latter chapters to verify proper operation of the receiver and to configure receiver operating parameters.

To use the Remote Controller software, you need to connect one of the Series 7400 I/O ports to one of the serial ports on an IBM compatible PC computer. The software runs under Microsoft Windows and manages the communications link between the PC and Series 7400 receiver. This chapter assumes that the Remote Controller software is installed on a PC, and the PC is connected to the Series 7400 receiver. Detailed instructions for installing and using the Remote Controller software are provided in the *Remote Controller Software User's Guide*.

2.1 Remote Controller Software

The Remote Controller software's simulated keypad and display are shown in Figure 2-1.

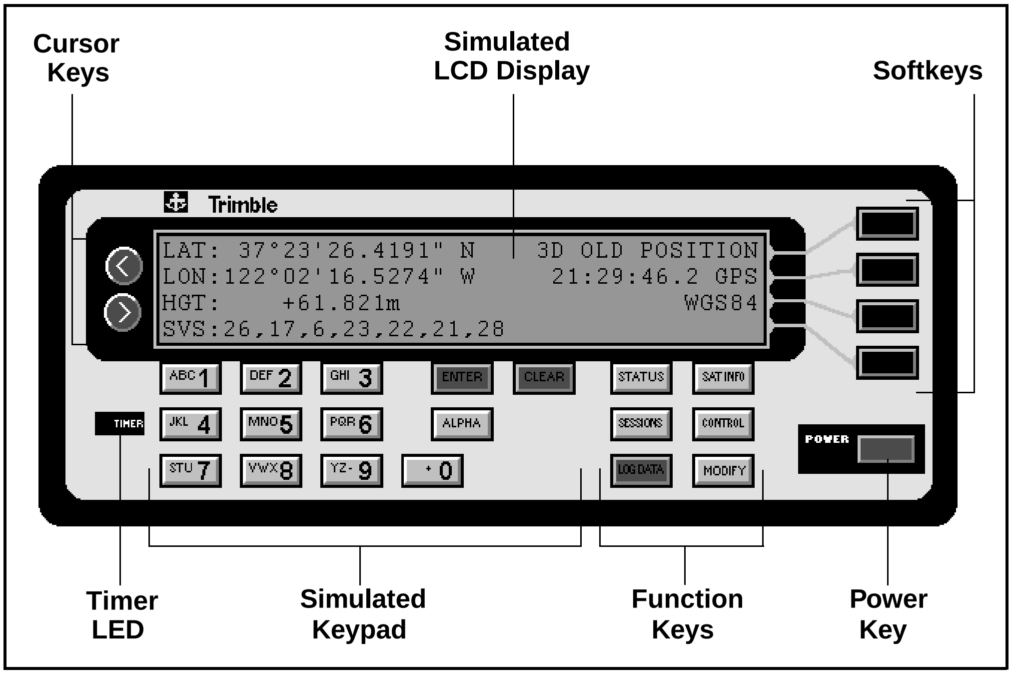

Figure 2-1. Simulated Series 7400 Front Panel

2.1.1 POWER Key

The POWER key can only turn the power off to the Series 7400 receiver. To turn off power, click the POWER key.

2.1.2 Simulated LCD Display

The simulated LCD display displays 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 displayed on the simulated LCD display is called a screen and the various types of data are displayed in fields. Three types of files are displayed on the simulated screens—Display-only fields, Data-entry fields, and Carousels. For detailed information about fields, see Working with Screens and Fields on page 2-7.

The simulated LCD display can display four lines of data at once. When more than four lines of data is available for display, a down arrow (↓) appears in the upper left corner of the display. You can press the ALPHA 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 are displayed solely for the purpose of viewing status information. For instance, the *SAT INFO* 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.

2.1.3 Cursor Keys

The (<) and (>) keys let you move the cursor around the screen. You use the cursor keys to move the cursor to data-entry fields before entering data or choosing options from carousel fields. The (<) and (>) keys are also used to position the cursor within a field when entering numeric or alphanumeric characters. Each time you click on the (<) or (>) key, the cursor moves in the direction of the arrow label on the key.

The (<) key move the cursor to the preceding line when the cursor resides in the first character position within a data entry field. The (>) key moves to the next line when the cursor resides in the last character position within a field.

2.1.4 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:+0000.000m
```

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, the **<HERE>** softkey 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.

2.1.5 Simulated Keypad

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

Table 2-1. 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 is intended to accept alpha data and the ALPHA key is pressed.
ALPHA	Pages through multiple screen lines, softkey options, or predefined field options.
ENTER	Accepts change entered into data fields. Press 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.

2.1.6 Function Keys

The six function keys display screens with options for displaying status information and additional screens for controlling Series 7400 functions and options. Table 2-2 describes the operation of the function keys.

Table 2-2. Function Keys

Key	Description
STATUS	Displays the *STATUS* screen with options for displaying factory configuration information, and receiver systems information.
SAT INFO	Displays the *SAT INFO* screen with options for displaying satellite tracking and status information.
CONTROL	Displays the *CONTROL* screen with options for configuring Series 7400 setup parameters.
MODIFY	Displays the *MODIFY* screens which includes options for adjusting the LCD display. Most of these options are not applicable for the simulated LCD display.
SESSIONS	Displays the *SESSIONS* 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.
LOG DATA	Not applicable.

2.2 Working with Screens and Fields

Table 2-3 gives a summary of the keypad and display operations for the Series 7400 receivers Remote Controller software.

Table 2-3. Keyboard and Display Summary

Key / Symbol	Description
[ALPHA]	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.
[ ]	Indicates a carousel data field used to select from a limited options list.
↓	Indicates additional screen lines are accessible by clicking on [ALPHA].
< >	Indicates a softkey (menu option).
(<) and (>)	Moves the cursor between fields on the simulated screen.

2.2.1 Types of Fields

Three types of fields are displayed 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.

2.2.2 Display-Only Fields

Display-only fields can appear on any screen. Some screens are composed entirely of display-only fields. For example, the SAT INFO 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 are not allowed to move the cursor into display-only fields.

2.2.3 Data-Entry Fields

Data-entry fields accept numeric or alphanumeric input from the keypad. For example, the fields for entering latitude, longitude, and altitude 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.

2.2.4 Carousels

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

ALPHA is also used to page through more screen lines. Because the simulated Series 7400 receivers display only has 4 lines, there are times when additional information needs to be accessed. For example, select the CONTROL menu. Four softkeys become active and the down-arrow symbol ↓ appears in the top left corner of the screen. The down-arrow is the visual cue that selecting ALPHA pages through more screen information.

2.2.5 Entering Data in Fields

Carousels provide a way of selecting from a limited set of options. Choosing a port number or type of output message is performed with the use of carousels and ALPHA. Some data fields involve alphanumeric entry through the keyboard. The CONTROL, **<BASE STATION>**, screen, Figure 2-2, is a good example of both carousel data entry and alphanumeric entry:

```
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:+0000.000m
```

Figure 2-2. Base Station Screen

The CMR field are transmission format and port carousels and can be changed by clicking on ALPHA. Once the appropriate port is selected, click on ENTER to accept the selection. After clicking on ENTER, the cursor moves to the next entry field, ANT. HT. Alphanumeric keys are used to enter the antenna height of the base station. Similarly, latitude, longitude and height values are all entered using the alphanumeric keypad.

The NAME field can consist of numbers and characters. Each alphanumeric key has a dual purpose of selecting either a number or one of three characters. Use ALPHA to choose between a number or letter from the alphanumeric keypad.

Clicking on ENTER accepts the data field and moves the cursor to the next input item. To accept all of the selections on the display, click on ENTER at the last field. All of the data selections are ignored CLEAR is selected while in a data entry screen. CLEAR is also used to move back up the menu structure.

The green ⊲ and ⊳ keys, on the left of the display, are used to move between data entry fields without changing their values.

3 Receiver Configuration

Instructions for verifying the correct operation of the Series 7400 receiver and configuring the receiver as a base station or rover are included in this chapter. A complete operating system, including a base station and rover receiver (mobile receiver), are shown in Figure 3-1.

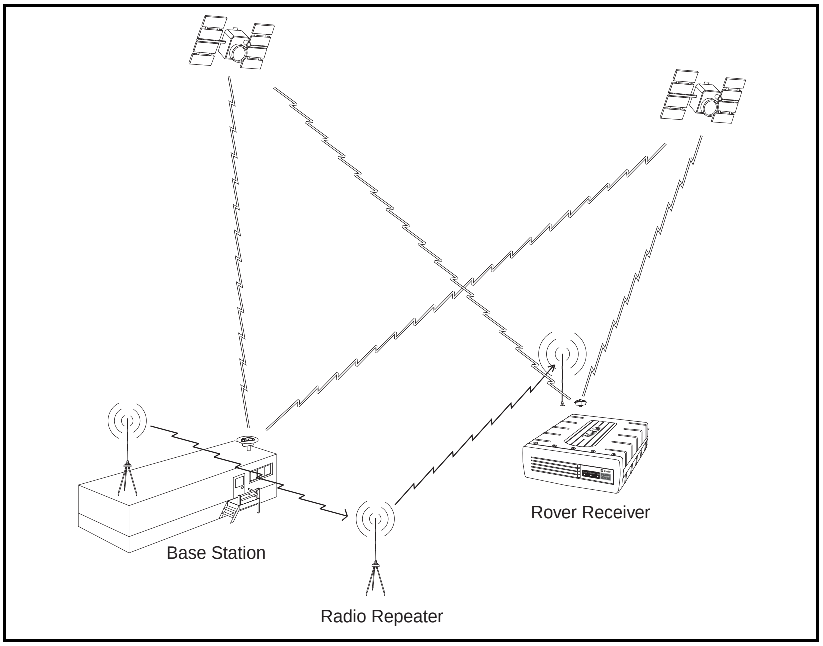

Figure 3-1. Series 7400 System

Although not shown in Figure 3-1, one or more radio repeaters could be installed between the reference station and rover.

3.1 Setup

The Series 7400 receiver is enclosed in a water resistant yellow plastic housing with carry straps. Each receiver has a front panel with soft touch power switch and three LED status lights. Figure 3-2 shows the Series 7400 front panel.

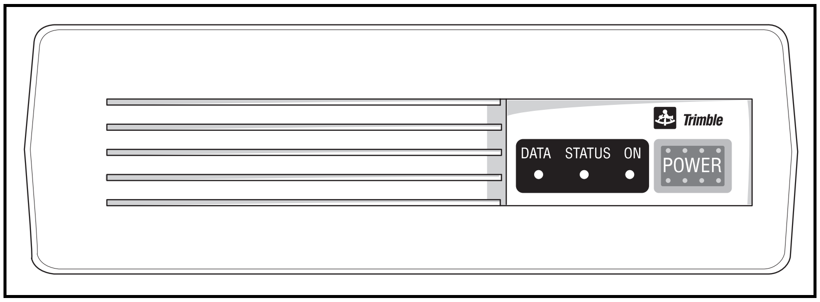

Figure 3-2. Series 7400 Front Panel

The front panel contains a POWER switch and three LEDs. Table 3-1 describes the functions of the three LEDs.

Table 3-1. Front Panel LED Indicators

LED	Color	Description
ON	Solid Green	Illuminates when power is activated on the receiver
STATUS	Flashing Yellow	Flashes when a position fix is computed
DATA	Flashing Red	Flashes when data is received or transmitted by the receiver

The rear panel, shown in Figure 3-3, contains the data, power and antenna connectors. The functions of the connectors are described in Table 3-2.

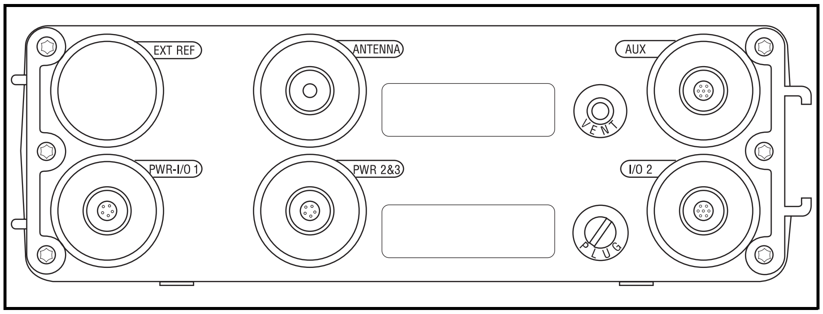

Figure 3-3. Series 7400 Rear Panel

Table 3-2. Series 7400 Rear Panel Connectors

Connector	Function
PWR-I/O 1	Power connection and serial port 1
PWR 2 & 3	Power 2 connection and serial port 3
I/O 2	Serial port 2
AUX	Serial port 4 and 1 PPS
ANTENNA	GPS antenna input
EXT REF	External timebase input (if External Frequency Input Option is installed)

For descriptions of the connector pinouts, see Appendix A, Data and Power Connections.

3.1.1 Powering the Receiver

The Series 7400 receiver is shipped with a fused power and data cable, P/N 27767. This cable provides power input through the PWR-I/O 1 or PWR 2&3 connector. With power supplied to the receiver, the ON (green) LED is lit as soon as the POWER switch is pressed.

3.1.2 Communicating with the Receiver

The Series 7400 receiver has two data cables in addition to the power data cable—a 5-pin Lemo to DE-9 (P/N 18826) and a 7-pin Lemo to DE-9 cable (P/N 18827). The 5-pin Lemo to DE-9 cable is used for the PWR-I/O 1 connection or the PWR 2&3 connection. The 7-pin Lemo to DE-9 cable is used for the I/O2 connection or the AUX connection. These cables are configured for direct connection to PC communication ports.

The default setup parameters for the Series 7400 receiver are:

- Base Station is off with all fields set to 0
- All SVs (satellites) are enabled
- Elevation mask is set to 13°, measurement rate is 5 Hz, and the motion is kinematic
- Power output mode is disabled
- 1 PPS output is enabled but the ASCII time tag is off
- All serial port outputs are disabled
- All serial ports are configured for 9600 baud, 8 data bits, no parity and 1 stop bit.
- No local coordinates are defined

3.1.3 Connecting the GPS Antenna

Place your GPS antenna outside on a level surface, in clear view of the sky.

To connect the GPS antenna:

1. Connect the cable to the antenna using the N-type connection.
2. Connect the Lemo connection end to the Series 7400 receivers ANTENNA connector.

   When power is applied to the Series 7400 receiver, the STATUS (yellow) LED should start flashing after a few minutes. The STATUS LED indicates that the receiver is computing a valid position fix.

Caution – Antennas for Series 7400 receiver and other recent Series 4000 receivers use a lower operating voltage than antennas for earlier receivers (4000A, AX, SX, SL, SD). The Series 7400 receiver does not operate with antennas for earlier receivers. Attaching an old antenna to a newer model of receiver may cause damage. Attaching an antenna made by another manufacturer may also cause damage to the receiver, antenna, or both units.

3.1.4 Connecting the Radio/Modem

Set up the radio link following the instructions in the radio/modem manual. Connect the radio/modem to the radio antenna, and also connect the radio/modem to the GPS receiver.

3.2 Verifying Operation

To verify receiver operation, you need a PC (386 or faster) running DOS, Microsoft Windows 3.1, and the Remote Controller software. The Remote Controller software displays a simulated front panel for the Series 7400 receiver on a computer monitor. Since the Series 7400 receiver does not have these operator controls, this display controls the receiver's operation. The software uses a Microsoft Windows mouse-driven operating environment. All receiver control functions are supported on the PC, except for turning the receiver on and off. For additional information, see the *Remote Controller Software User Guide*. To verify Series 7400 receiver operation perform the following steps.

1. Verify that the Series 7400 receiver is powered on.
2. Connect the Series 7400 receiver to one of the PC's communications ports using the 5- or 7-pin Lemo to RS-232 data cable or the 7-pin Lemo to RS-232 data/power cable if you are powering the Series 7400 receiver using the PWR 2&3 connection.
3. Open Windows and install the Remote Controller software as described in the *Remote Controller Software User's Guide.*
4. When the software is installed, double click on the Remote Controller icon.

   A window displaying a GPS receiver front panel appears.

5. Select *Setup*/ *Comms* to check the communication settings.

   These settings must be the same as the settings of the Series 7400 receivers PWR-I/O 1 port. The default receiver parameters are:

BAUD	:	9600
STOP BITS	:	1
NO PARITY		
NO FLOW CONTROL		

   Make sure that the correct PC COM port is selected (COM1 through COM4).

6. Click on **OK**. The software attempts to connect to the Series 7400 receiver.

7. If the connection is unsuccessful, check the receiver's communication settings again.

8. If the connection is successful the front panel screen lights up and displays two options on the right side of the screen. A prompt appears at the bottom of the screen regarding setting the time.

   If the GPS antenna and cable have been correctly connected to the Series 7400 receiver, the receivers clock is set to GPS time when the receiver is ready for operation and within 15 minutes will be synchronized to UTC.

9. Click on the **<POSITION>** softkey. The black softkeys are located at the right of the simulated screen.

   When you select **<POSITION>** a screen similar to the following appears on the simulated screen.

```
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
```

10. If the display shows OLD POSITION instead of AUTONOMOUS, check the GPS antenna cable connections and verify the antenna has a clear view of the sky.

    When the screen displays AUTONOMOUS, the Series 7400 receiver is getting a standalone position (accurate within 100 meters). In addition, the screen displays latitude, longitude and height, along with the satellites being used (SV's), the time (UTC) and the datum being used (default is WGS-84).

The Series 7400 receiver has now been verified, is operating correctly, and is obtaining valid GPS signals to compute a position.

3.3 Configuring the Series 7400 as a Base Station

To configure the receiver as a base station:

1. Click [CONTROL] to display the *CONTROL* screen, then click on the <**BASE STATION**> softkey.
2. Click [ALPHA] to chose the transmission format. Depending on the options installed on the receiver, the **<CMR>** or **<RTCM>** softkey is displayed.
3. Click [ALPHA] to choose the receiver I/O port required for the transmission of the base station data to your radio/modem.
4. If RTCM is selected as the transmission format, then select the third carousel which contains the different RTCM output message types, and click [ALPHA] to select the different message types.
5. Click [ALPHA] to enter the 3D coordinates of the base station and the antenna height. If you do not have the coordinates of the survey point, click on the **<HERE>** softkey to fill in the position fields with an autonomous GPS position (if available).

   The positions obtained at the rover receiver are accurate relative to the base station position.

Note – Positioning accuracy is directly related to base station coordinate accuracy. For more information, see Real-Time Positioning and Critical Factors Influencing Accuracy on page 1-4.

6. Click ENTER to verify each field on the screen.

Warning – Clicking CLEAR before the fields are verified results in the information being lost.

Note – Improved base station coordinates can be obtained using the averaging capabilities within the receiver. For more information, see BASE STATION Screen on page 4-27.

7. Click CONTROL, click ALPHA, and then click on the **<SERIAL PORT SETUP>** softkey.

   Confirm that the serial port selected for the output has the same serial protocol settings as your radio/modem.

8. Click CLEAR several times to return to the main screen.

   When the receiver is outputting base station data, only the **<POSITION>** softkey is displayed on the *BASE STATION* screen.

9. Click the **<POSITION>** softkey and verify that the GPS position is updating. Your base station should now be transmitting data through the radio/modem.

   These settings should remain fixed, even if the receiver is powered off and on.

The Series 7400 receiver should now automatically wake up as a base station and start transmitting corrections.

3.4 Configuring the Series 7400 as a Rover

To configure the receiver as a rover:

1. Click CONTROL, click ALPHA, and then click on the **<SERIAL PORT SETUP>** softkey.

   Confirm 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 Series 7400 receiver automatically detects which port is used to input corrections. You only have 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 ALPHA, and then click on the **<SERIAL PORT SETUP>** softkey to configure the data output.

   Confirm 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 on the **<SERIAL PORT OUTPUT>** softkey to choose output type.

   For further information on NMEA/ASCII output and streamed output, see NMEA OUTPUT Screen on page 4-37 and STREAMED OUTPUT Screen on page 4-39. For detailed information about data output formats, see Chapter 5, NMEA-0183 Output.

3.5 Installing the Receiver

The Series 7400 receivers are designed to provide the best possible solution in a given environment. To make sure that the solution is as accurate as possible, make sure that the receiver is mounted so that the environmental conditions in which the unit operates do not exceed specified capabilities. Excessive shock and vibration can cause both loss of satellite lock and physical damage to the receiver. The following sections provide information on how the Series 7400 receiver should be installed.

3.5.1 Choosing a Location

The Series 7400 receivers can be installed in any convenient location close to the interface devices (PC and/or radio modem). The interface cable supplied with the Series 7400 receiver is six feet long, but it can be extended if necessary. Choose a location with the following characteristics:

- The LED lights on the front panel are visible
- The POWER switch is accessible
- DC power is available
- Clearance exists for the power, antenna, and interface connections

3.5.2 Environmental Considerations

Although the Series 7400 receiver is enclosed in a splash-proof housing, it should be installed in a dry location. For receiver specifications, see Appendix B, Specifications.

When selecting a location, avoid exposure to extreme environmental conditions, including:

- Frequent exposure to water
- Excessive heat (> 55^{o} C)
- Excessive cold (< -25^{o} C)
- High vibration
- Corrosive fluids and gases

Avoiding these conditions improves the Series 7400 performance and long-term product reliability.

3.5.3 Mounting the Receiver

The Series 7400 receiver can be mounted to a flat surface using 6-32 screws. The receiver should be mounted to the host vehicle using the four threaded mounting holes located on the bottom of the case (see Figure 3-4). The mounting surface must be flat to prevent warping of the receiver case. When positioning the receiver on the mounting surface, allow sufficient clearance behind the Series 7400 receiver for the power, antenna, and interface cables.

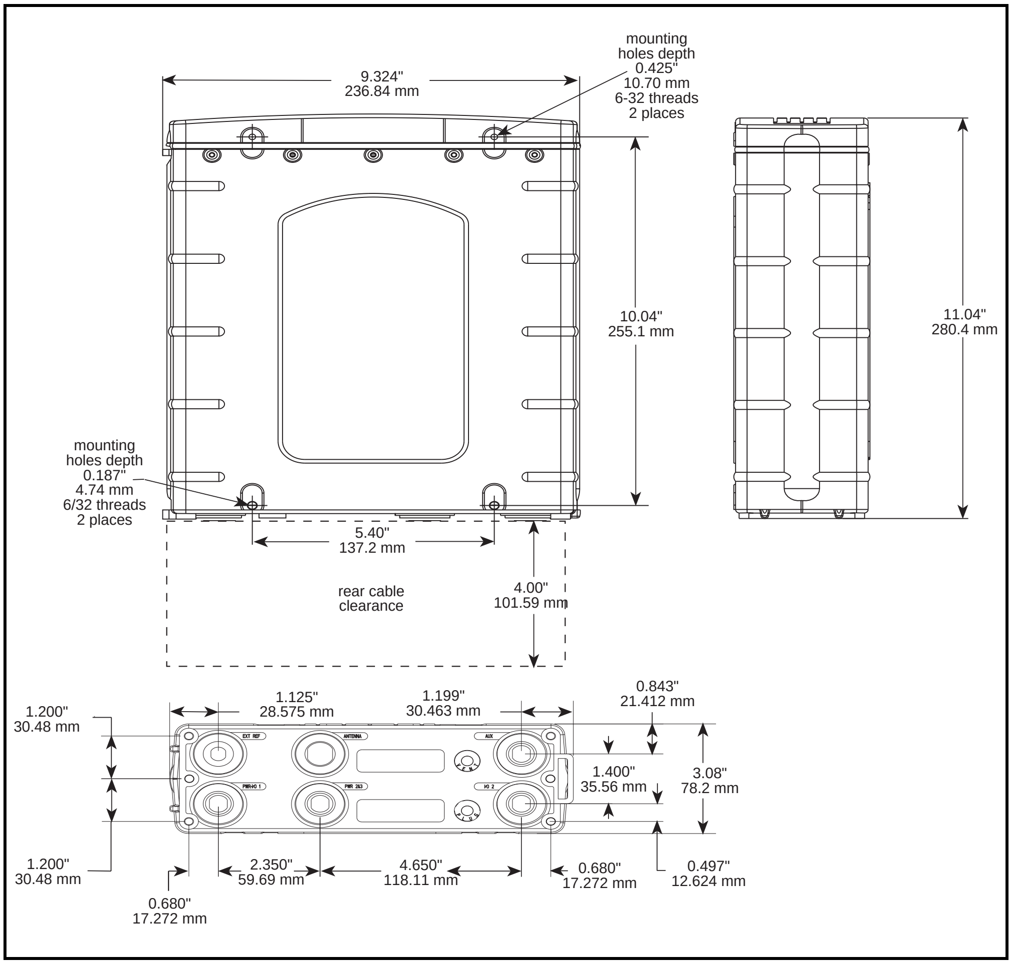

Figure 3-4. Series 7400 Mounting Dimensions

3.6 Connecting the Interface Devices

After installing the Series 7400 receiver and antenna, you can route the interface cables. The cable routing depends on the number and location of the devices connected to the Series 7400 receiver. A connection scheme including both a PC and a radio modem is shown in Figure 3-5.

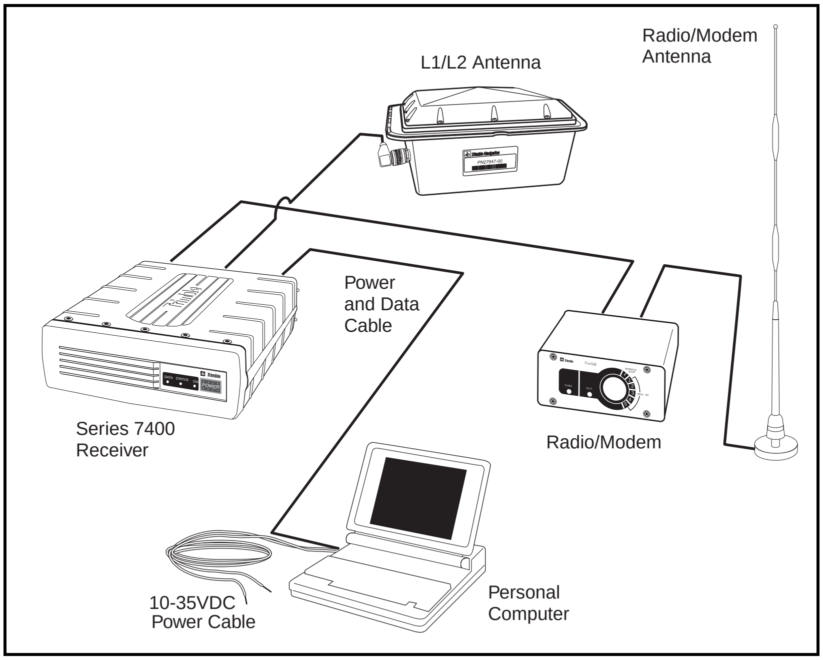

Figure 3-5. Series 7400 Connection Scheme

The Series 7400 receiver can also interface with PCs and modems. For pin-out details about Series 7400 interface ports, see Appendix A, Data and Power Connections.

Note – Many interface devices require special connectors for their interface ports. If the interface device does not include a connector, consult its manual for information on appropriate connectors.

Note – In the pin-out table, (out) indicates an output signal from the Series 7400 receiver and (in) indicates an input signal to the Series 7400 receiver.

3.6.1 Routing the Interface Device Cables

Next, route the cable from the Series 7400 receiver to the interface device. When routing the cable, choose the most direct path to the interface device while avoiding the following hazards:

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

3.6.2 PC and Modem Connections

The interface cable supplied with the Series 7400 receiver is compatible with many PCs and modems. Refer to the documentation included with the PC or modem to identify the correct connector and pin-out requirements for the serial port. Install the appropriate connector on the Series 7400 receivers interface cable, and connect the cable to the PC or modem.

4 Receiver Operation

Series 7400 receivers can be controlled using either of the supplied software packages—the Remote Controller software or the Configuration Toolbox software. To learn about the software features supported by your Series 7400 receiver, refer to the *User Guide* supplied with your receiver.

4.1 Receiver Screens

The Remote Controller software provides a simulated view of the Series 7400 screen system. With the Remote Controller software connected to the Series 7400 receivers, you can monitor and control receiver operation.

The Remote Controller screens are summarized in Table 4-1.

Table 4-1. Remote Controller Screen Summary

Menu Key	Softkey – Level 1	Softkey – Level 2
	<POSITION> Displays the latest position, satellite used, position mode, time of fix, and coordinate system (see page 4-8).	
	<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 4-10).	**<VECTOR AMBIGUITY STATUS>** Displays the ambiguity resolution status and search information for real-time kinematic positioning (see page 4-14). **<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 4-16)

† Softkey is displayed only if option is installed on the receiver.

Table 4-1. Remote Controller Screen Summary (Continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
STATUS	**<FACTORY CONFIGURATION>** Displays the firmware version, installed receiver options, and the memory configuration (see page 4-18).	
	<RECEIVER SYSTEMS> Displays the Series 7400 operating mode, active output messages, power input, and memory availability (see page 4-20).	
	<COORDINATE REFERENCE> Displays the coordinate system, coordinate zone, the datum method, datum, ellipse, projection, site, horizontal plane adjustment, and vertical plane adjustment (see page 4-22).	
SAT INFO	**<SV TRACKING>** Displays the tracking status of the Series 7400 channels, including the satellite number assigned to each channel, the satellite elevation and azimuth, method of code tracking, signal to noise ratio values, issue of data ephemeris, and user range accuracy figures (see page 4-22).	
	<SV STATUS> Displays the list of available, healthy, unhealthy, enabled, and disabled satellites (see page 4-24).	

† Softkey is displayed only if option is installed on the receiver.

Table 4-1. Remote Controller Screen Summary (Continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
SESSIONS	**<DIRECTORY>** Displays the directory listing of the application files stored in memory (see page 4-25).	**<PREV>** Displays the previous application file. **<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 4-26).	
	<USE FACTORY CONTROLS> Restarts the receiver and set all parameters to factory default settings (see page 4-27).	
LOG DATA	Not applicable for Series 7400 receivers.	
MODIFY	**<LCD VIEW ANGLE>** Not applicable because the Series 7400 receivers do not have a display.	

† Softkey is displayed only if option is installed on the receiver.

Table 4-1. Remote 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, antenna name, and the output port for real-time corrections (see page 4-27).	**<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 4-31).	
	<GENERAL CONTROLS> Displays fields for controlling the elevation mask, basic measurement rate, and motion state (see page 4-32).	
	<EXTERNAL FREQUENCY>† Displays fields for selecting the receiver timebase to use the internal Series 7400 clock or a 5 MHz or 10 MHz external timebase (see page 4-34).	
	<POWER CONTROL> Displays a field for controlling Series 7400 power output (see page 4-35).	
	<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 4-36).	

† Softkey is displayed only if option is installed on the receiver.

Table 4-1. Remote Controller Screen Summary (Continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
CONTROL	**<SERIAL PORT OUTPUT>** Displays fields for configuring the communication parameters for the Series 7400 serial ports (see page 4-43).	**<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 4-37). **<STREAMED OUTPUT>** Displays fields for controlling the output of streamed messages (see page 4-39). **<RT17/BINARY OUTPUT>** Displays fields for configuring the output of raw GPS data messages (see page 4-41).

† Softkey is displayed only if option is installed on the receiver.

Table 4-1. Remote Controller Screen Summary (Continued)

Menu Key	Softkey – Level 1	Softkey – Level 2
CONTROL	**<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 4-44).	
	<JX-1100 SETUP> Displays fields for interfacing the Series 7400 receiver to a Clarion JX-1100 radio/modem (see page 4-45).	
	<SET FACTORY DEFAULTS> Resets the Series 7400 receiver to use factory default parameter settings (see page 4-48).	**<ENTER>** Restarts the receiver (see page 4-48).

† Softkey is displayed only if option is installed on the receiver.

4.2 POSITION Screen

The *POSITION* screen displays 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 the **<POSITION>** softkey 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
```

3. Use the field descriptions in Table 4-2 to understand the position information.

Table 4-2. 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.
HGT	Displays the height of the antenna phase center, relative to the selected coordinate system. (EHT = Ellipsoidal Height, GHT = Geoidal Height)
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 reference and rover stations are displayed.

Table 4-2. POSITION Fields (Continued)

Field	Description
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 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 Configuration Toolbox software, you can select a local datum and projection for display and output of local coordinates. Press ALPHA to view the local projected coordinates.

4.3 VECTOR Screen

The *VECTOR* screen lets you display 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 the **<VECTOR>** softkey 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 UNKNOWN
```

3. Use the field descriptions in Table 4-3 to read the status information.

Table 4-3. VECTOR Fields

Field	Description
E	Displays the East component of the vector between the reference station and rover station antenna phase center.
N	Displays the North component of the vector between the reference station and rover station antenna phase center.
U	Displays the Up component of the vector between the reference station and rover station antenna phase center.

Table 4-3. VECTOR Fields (Continued)

Field	Description
R	Displays the Length component of the vector between the reference 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
PROP	Displays the age of the Real-Time Kinematic corrections coming from the reference station. The receiver is designed such that occasional losses of reference station data packets do not cause a loss in position and vector solutions. The PROP time should normally increase from 0.2 seconds to 1.4 seconds. If a 4000SSE/SSi is used as a reference station, the PROP time grows to 2.2 seconds or more.
SVs	Identifies the number of satellites used to compute the solution.

Table 4-3. VECTOR Fields (Continued)

Field	Description
N	Displays the number (N) of continuously initialized epochs. The value increments every time an RTK/FIX solution is computed. Before obtaining a RTK/FIX solution, the receiver estimates the baseline vector in a float mode (RTK/FLOAT), in which case, the value is zero.
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 5.0 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.

Caution – Be suspicious of position and vector information if the DOP is greater than 5.0.

4.3.1 Error Messages

An error message displays to indicate any problems in the Real-Time Kinematic position fix. Table 4-4 lists the possible errors

Table 4-4. 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
SYNC'D DATA	Need synchronized data between reference station and rover receiver
NO REF DATA	Not receiving valid data from the reference station
NEED REF POS	Waiting for valid reference position message from the reference station
COMMON SVS	Less than 4 common satellites between reference station and rover receivers
C/P MISMATCH	Reference 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

4.3.2 VECTOR AMBIGUITY STATUS Screen

The *VECTOR AMBIGUITY STATUS* screen allows you to display 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 the **<VECTOR>** softkey.
3. Click [ALPHA] 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
```

4. Use the field descriptions in Table 4-5 to learn the vector ambiguity status.

Table 4-5. 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
REF SV	Displays the pseudorandom number (PRN) of the satellite used to form double difference measurements.
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.

4.3.3 VECTOR BASE STATION STATUS Screen

The *VECTOR BASE STATION STATUS* screen lets you display the Real-Time Kinematic reference station name, location, satellites tracked at the reference 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 the **<VECTOR>** softkey, and click ALPHA.
3. Click ALPHA again to display:

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

4. Use the field descriptions in Table 4-6 to learn the current status of the vector base station.

Table 4-6. VECTOR BASE STATION STATUS Fields

Field	Description
NAME	Displays the 4-character designation assigned to the reference station.
LAT	Displays the latitude coordinate of the antenna phase center location at the reference station based on the WGS-84 datum.
LON	Displays the longitude coordinate of the antenna phase center location at the reference station based on the WGS-84 datum.
HGT	Displays the height of the antenna phase center location at the reference 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 reference 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 reference station.

4.4 FACTORY CONFIGURATION Screen

The *FACTORY CONFIGURATION* screen allows you to display the firmware version, installed options and memory configuration of the Series 7400 receivers.

To display the receiver configuration and the installed options:

1. Click STATUS to display the *STATUS* menu.
2. Click the **<FACTORY CONFIGURATION>** softkey to display:

```
↓FACTORY CONFIGURATION (STATUS)
7400
FIRMWARE: 2.21 OCT 21 1996
    BOOT: 3.34 FEB 28 1996
 TRIMBLE NAVIGATION
SUNNYVALE CALIFORNIA
  3527A11595
MEMORY: NONE
OTF INIT 1PULSE/SEC NMEA OUTPUT
```

You can click ALPHA to view the rest of the screen.

3. Use the field descriptions in Table 4-7 to identify the receiver configuration and factory installed options.

Table 4-7. FACTORY CONFIGURATION Fields

Field	Description
FIRMWARE	Displays the version number and release date of the firmware.
BOOT	Displays the version number and release date of the Boot ROM code.
Company Name and Address	Displays TRIMBLE NAVIGATION and SUNNYVALE CALIFORNIA.
Serial Number	Displays the receiver serial number.
MEMORY	Displays the amount of memory installed on the receiver. The standard memory configuration is NONE.
Options†	Displays the list of installed receiver options. In the example, the 1 PULSE/SEC, NMEA OUTPUT and OTF INIT is installed.

† To learn about the standard set of options and installable options available for your receivers, refer to the *User Guide* included with the receiver.

4.5 RECEIVER SYSTEMS Screen

The *RECEIVER SYSTEMS* screen lets you list the operating mode of Series 7400 receivers, currently active output messages, power input and memory availability. This screen displays a summary of the Series 7400 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 the **<RECEIVER SYSTEMS>** softkey to display:

```
↓  MODE: ROVER/RTK
OUTPUTS: GGA(3),STREAMED(4),POWER

POWER:*14.71V   0.00V   0.00V
 MEMORY: OFF   508Kb,  99.6% AVAIL.
```

3. Use the field descriptions in Table 4-8 to learn the current status of the receiver.

Table 4-8. 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 – Reference station. Enabled using CONTROL **<BASE STATION>**. • ROVER/RTK – RTK rover which is receiving reference station correction data to compute solutions. • ROVER/DGPS – DGPS rover which is using pseudorange correction data to compute position solutions.

Table 4-8. RECEIVER SYSTEMS Fields (Continued)

Field	Description
OUTPUTS	Lists the currently active outputs and output port index. NMEA GGA strings are being output port 3, while streamed data is being output to port 4 in the example above. 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. Can be Type 1 (DGPS), Type 9-3 (DGPS), Types 18 and 19 (RTK), or Types 1, 18 and 19 (DGPS/RTK) • GGA – NMEA GGA Position Output • GGK – Trimble NMEA string for RTK position output • ZDA – Time tag output message • VTG – Track made good and speed over ground • PJT – Trimble NMEA string for Projection Type • PJK – Trimble NMEA string for local coordinate position output • GST – Position Error Statistics • STREAMED – General Serial Output records • RT17/BINARY – Raw data output • 1 PPS – One Pulse Per Second output • POWER – Power output enabled • CHARGER – Battery charger is enabled
POWER	Displays the power input voltage levels. The active power port is identified with an asterisk (*). The receiver has a sophisticated power system for managing the selection of the most appropriate power source.

4.6 COORDINATE REFERENCE Screen

The *COORDINATE REFERENCE* screen displays the coordinate system, coordinate zone, the datum method, datum, ellipse, projection, site, horizontal plane adjustment, and vertical plane adjustment.

To view the *COORDINATE REFERENCE* screen:

1. Press STATUS.
2. Press **<COORDINATE REFERENCE>** to display the following screen.

```
↓COORD SYSTEM:WGS-84
         ZONE:None
 DATUM METHOD:None
        DATUM:WGS-84
      ELLIPSE:WGS-84
   PROJECTION:None
         SITE:None
  HORIZ PLANE:None
   VERT PLANE:None
```

4.7 SV TRACKING Screen

The *SV TRACKING* screen allows you to list the tracking status of the Series 7400 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 SAT INFO to display the *SAT INFO* menu.

2. Click the **<SV TRACKING>** softkey to display:

```
↓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
  4
  5   5  67/166    C/E   52/28   56   32
  6   4  15/48     C/E   32/10  132   32
  7
  8
  9  20  51/194    C/E   50/29   12   32
```

3. Use the field descriptions in Table 4-9 to learn the SV tracking status of all receiver channels.

Table 4-9. 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 the channels of the 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-Noise ratio of the satellite tracked on the channel.
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.

4.8 SV STATUS Screen

The *SV STATUS* screen allows you to list the available, health, unhealthy and disabled satellites.

To view the current status of all NAVSTAR GPS satellites:

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

```
↓SV STATUS
ACTIVE:
 1,2,4,5,6,7,9,12,14,15,16,17,18,
 19,20,21,22,23,24,25,26,27,28,29
UNHEALTHY:
 24

DISABLED:
 31
```

3. Use the field descriptions in Table 4-10 to learn the status of all satellites.

Table 4-10. SV STATUS Fields

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

4.9 APPLICATION FILE SESSIONS Screen

The *APPLICATION FILE SESSIONS* screen provides a directory listing of the saved application files. An application file can be deleted or started from this screen.

To display the Application File directory on the receiver:

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

```
APP_FILE  (  0 )                        <PREV>
JUN 23 1995 21:12:50.0 UTC
 123 BYTES                            <DELETE>
                                       <START>
```

Table 4-11 describes the *APPLICATION FILE SESSIONS* screen fields.

Table 4-11. 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.

3. Perform any of the following actions:
   - Click the **<PREV>** softkey to scan through the previous list of application files stored in the directory.
   - Click the **<DELETE>** softkey to remove the application file from the directory.
   - Click the **<START>** softkey to apply all of the application file parameters to the receiver.

- Click ALPHA to scan forward through the application file listings stored in the directory.

4.10 STORE APPLICATION FILE Screen

The STORE APPLICATION FILE screen lets you store the current Series 7400 settings into the named application file.

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

1. Click SESSIONS] to display the *APPLICATIONS* menu.
2. Click the **<STORE CURRENT>** softkey to display:

```
STORE APPLICATION FILE

          FILE NAME:APP_FILE
```

Table 4-12 describes the *STORE APPLICATION FILE* screen fields.

Table 4-12. STORE APPLICATION FILE Fields

Field	Description
FILE NAME	Assigns an eight-character name to the application file.
Creation Date / Time	Displays the date and time when the application file is created, in UTC.

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

4.11 USE FACTORY CONTROLS Screen

The *USE FACTORY CONTROL* screen restarts the Series 7400 receivers with the factory default settings.

To restart the receiver and reset the factory default values:

1. Click SESSIONS to display the *APPLICATIONS* menu.
2. Click the **<USE FACTORY CONTROLS>** softkey to restart the receiver and reset the factory default parameters settings.

4.12 BASE STATION Screen

The *BASE STATION* screen lets you specify the reference 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 the **<BASE STATION>** softkey. One of the following two screens is displayed, depending on the transmission format you selected:

```
BASE STATION (CONTROL)              <HERE>
[CMR]:[PORT 1]        ANT. HT.:001.000m
LAT: 37°23'26.00000"[N] NAME: BASE
LON:122°02'16.00000"[W] HT:[+]0006.501m
```

```
BASE STATION (CONTROL)              <HERE>
[RTCM]:[PORT 1][RTK] ANT. HT.:001.000m
LAT: 37°23'26.00000"[N] NAME: BASE
LON:122°02'16.00000"[W] HT:[+]0006.501m
```

3. Set the *BASE STATION* parameters using the information in Table 4-13.

Table 4-13. RTK BASE STATION Fields

Field	Description
TRANSMISSION FORMAT	Select the CMR or RTCM transmission format, depending on the options available on your receiver
PORT	Enables or disables the serial port for transmitting base station data. Possible settings are OFF or 1–4 (serial ports).
RTCM MESSAGE TYPES	This field only appears when the TRANSMISION FORMAT is set to RTCM. • TYPE 1 – Type 1 output at one second rate with Type 3 output at a ten second rate. • 9-3 – Type 9-3 output at one second rate with Type 3 output at a 10 second rate. • RTK – Types 18 and 19 output at a one second rate. • 1 & RTK – Types 1, 18, and 19 output at a one second rate with Type 3 output at a 10 second rate.
ANT. HT.	Identifies the vertical distance between the ground mark to the antenna phase center.
LAT	Identifies the latitude coordinate of the reference station ground mark based on the WGS-84 datum.
LON	Identifies the longitude coordinate of the reference station ground mark based on the WGS-84 datum.
HT	Identifies the height or altitude of the reference station ground mark based on the WGS-84 datum.
NAME	Assigns a four-character designator to the reference station.

4. Click the **<HERE>** softkey to find the approximate location of the reference station. The receiver must be tracking at least 4 satellites with a DOP value less than 3.

Warning – The reference station coordinates must be known to better than 10 meters to achieve utmost RTK accuracy. The position derived from the **<HERE>** softkey is in error by as much as 150 meters and therefore should not be relied on. Use the averaging capabilities within the receiver to obtain more accurate coordinates. For more information, see Base Station Averaging in the next section.

Be careful to get the North/South, East/West indicators correct. If the input reference station coordinates are more than 5 km different from the Series 7400-computed coordinates, no RTK corrections will be output and a warning is issued.

4.12.1 Base Station Averaging

Tests have shown that reference station coordinate accuracies of better than 10 meters can be obtained by averaging autonomous GPS positions over a period of time greater than 30 minutes. The Series 7400 receivers 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 the **<GENERAL CONTROL>** softkey to display the following screen:

```
GENERAL (CONTROL)
ELEV MASK: 13
MEAS RATE: [5 HZ]
MOTION: [KINEMATIC]
```

2. Set the MOTION field to STATIC.
3. Click CONTROL, then click the **<BASE STATION>** softkey to display the following screen:

```
BASE STATION (CONTROL)              <AVG>
[CMR]:[OFF ]       ANT. HT.:001.000m
LAT: 37°23'26.00000"[N] NAME: BASE
LON:122°02'16.00000"[W] HT:[+]0006.501m
```

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

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

   Adjacent to the **<AVG>** softkey 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 the **<AVG>** softkey is clicked, the latest values for averaged position and the length of time used to compute the averaged position solution is displayed on the screen.

4.13 SV ENABLE/DISABLE Screen

The *SV ENABLE/DISABLE* screen allows you to control the Series 7400 tracking of satellites. To display the screen:

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

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

3. Set the *SV ENABLE/DISABLE* parameters using the information in Table 4-14. First, select ALL or enter the pseudorandom number (PRN) of the satellite in the SV field, then select the setting for the STATE field.

Table 4-14. 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.

Warning – Disabling or setting the Series 7400 receivers to override satellite health warnings can adversely effect receiver performance.

4.14 GENERAL CONTROLS Screen

The *GENERAL CONTROLS* screen allows you to control the Series 7400 Elevation Mask, basic positioning rate, and motion state.

To set the *GENERAL CONTROLS* parameters:

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

```
GENERAL (CONTROL)
      ELEV MASK:13  PDOP MASK:07
      MEAS RATE:[5 HZ ]
         MOTION:[KINEMATIC]
```

3. Set the *GENERAL CONTROLS* parameters using the information in Table 4-15.

Table 4-15. GENERAL CONTROLS Fields

Field	Description
ELEV MASK	Selects the Elevation Mask. This is the elevation angle to which satellites are tracked down 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.
MEAS RATE	Assigns the rate for determining how often measurements are collected and used for computing position solutions. In RTK rover mode, the measurement rate controls the accuracy and latency of the solution. • The 1 Hz mode is used for highest precision. • The 5 Hz mode is used where low latency, high updates are needed and some positioning degradation can be tolerated. For a detailed explanation of positioning and the measurement rate, see Real-Time Positioning and Critical Factors Influencing Accuracy on page 1-4.
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 reference station.

Warning – An Elevation Mask of 90° stops the Series 7400 receivers from tracking any satellites. The default Elevation Mask is 13° and should not be changed.

4.15 EXTERNAL FREQUENCY Screen

The *EXTERNAL FREQUENCY* screen lets you setup the external frequency standard. This screen is only available if the external frequency option is installed.

To select the time base frequency source:

1. Click CONTROL to display the *CONTROL* menu.
2. Click the **<EXTERNAL FREQUENCY>** softkey to display:

```
FREQUENCY SOURCE (CONTROL)

     FREQUENCY SOURCE[INTERNAL   ]
```

3. Select time base frequency source based on the field description in Table 4-16.

Table 4-16. EXTERNAL FREQUENCY Fields

Field	Description
FREQUENCY SOURCE	Selects the time base used by the receiver. The default frequency source is the receiver's internal clock. The EXT. 5 MHz setting enables support for an external 5 MHz frequency source and EXT. 10 MHz enables support for an external 10 MHz frequency source.

Warning – Selecting the external frequency setting without a valid input causes the Series 7400 receivers to stop tracking satellites.

4.16 POWER CONTROL Screen

The *POWER CONTROL* screen allows you to control the power output from the Series 7400 receivers.

To control the receiver power output:

1. Click [CONTROL] to display the *CONTROL* menu.
2. Click the **<POWER/CHARGER>** softkey to display:

```
POWER CONTROL (CONTROL)

POWER OUTPUT MODE: [DISABLED        ]
```

3. Set the power output mode, see Table 4-17.

Table 4-17. POWER CONTROL Fields

Field	Description
POWER OUTPUT MODE	Selects one of the following power output modes when powering an externally connected device or charging batteries from an office support module (OSM2): • DISABLED – Power input is PWR-I/O 1 and PWR2. • CHARGER ENABLED – Power input is on PWR I/O 1. Power must be supplied by a Trimble OSM2. Battery charging output is on PWR 2. • POWER OUT – Power input on PWR2 (PWR2&3) sources power output to PWR1 (PWR-I/O 1) and power output on I/O 2. Power output is limited to 0.5 amperes unregulated at the supplied voltage.

Note – The power pins of PWR-I/O 1 and I/O 2 are hardwired together, so that power output is always available through one when power input is provided through the other, regardless of parameter settings.

4.17 1 PPS OUTPUT Screen

The *1 PPS OUTPUT* screen lets you control the output of a one pulse per second signal and the port of an associated ASCII time tag. Details of the 1 PPS output are described in Appendix A, Data and Power Connections.

To enable or disable 1 PPS and ASCII Time Tag output:

1. Click CONTROL to display the *CONTROL* menu.
2. Click ALPHA.
3. Click the **<1 PPS OUTPUT>** softkey to display:

```
1 PPS (CONTROL)

  ENABLE:[ON ]  ASCII TIME TAG:[PORT 2]
```

4. Set the 1 PPS output parameters based on the information in Table 4-18.

Table 4-18. 1 PPS OUTPUT Fields

Field	Description
ENABLE	Enables or disabled 1 PPS output (ON or OFF).
ASCII TIME TAG	Enables or disables the transmission of an ASCII time tag message through a port when NMEA messages are sent. Select OFF or a port number (1–4).

4.18 NMEA OUTPUT Screen

The *NMEA OUTPUT* screen allows you to setup output message type, serial port and the output frequency. The NMEA-0183 (Version 2.1) standard contains messages for integrating GPS information with other systems. The standard is based around ASCII data beginning with the $ and ending with a carriage return, line feed. Null fields still follow a comma (,) delimiter but contain no information.

The checksum value is separated from the last field in an NMEA message by the asterisk (*) delimiter. The checksum is the 8-bit exclusive OR of all characters in the message, including the commas, between but not including the $ and * delimiters. The hexadecimal result is converted to two ASCII characters (0-9, A-F). The most significant character appears first. For information about the subset of NMEA output messages supported by the Series 7400 receivers, see Chapter 5, NMEA-0183 Output.

To control NMEA output:

1. Click CONTROL to display the *CONTROL* menu.
2. Click ALPHA.
3. Click the **<SERIAL PORT OUTPUT>** softkey.
4. Click the **<NMEA/ASCII OUTPUT>** softkey to display:

```
NMEA OUTPUT (CONTROL)

  TYPE:[GGA  ] PORT:[3]  FREQ:[OFF   ]
```

5. Set the NMEA output parameters based on the guidelines in Table 4-19.

Table 4-19. NMEA OUTPUT Fields

Field	Description
TYPE	Selects the NMEA message type: • GGA – Time, position, and fix related data. • GGK – Trimble NMEA string for time and position fix information. • ZDA – UTC day, month, and year and local time. • VTG – Track Made Good and Speed Over Ground. • PJT – Trimble NMEA string for Projection Type. • PJK – Trimble NMEA string for local coordinate position output. • GST – Position error statistics.
PORT	Assigns the serial port for outputting NMEA messages (1–4).
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 Series 7400 ports. For more information, see RECEIVER SYSTEMS Screen on page 4-20.

4.19 STREAMED OUTPUT Screen

The *STREAMED OUTPUT* screen allows you to set up streamed output messages. For information about controlling the streamed output message formats, see Command Packet 4Ah on page 7-7.

To configure the receiver to stream output messages:

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

```
STREAMED OUTPUT (CONTROL)
  PORT:[3]
  TYPE:[POSITION TIME    ]
  FREQ:[OFF    ]     OFFSET (SEC):00
```

Table 4-20 describes the *STREAMED OUTPUT* screen fields.

Table 4-20. STREAMED OUTPUT Fields

Field	Description
PORT	Assigns the serial port used for streamed data output (1–4).
TYPE	Assigns the message type to output on the port: POSITION TIME / DOP INFO LAT, LONG, HT / CLOCK INFO XYZ POSITION / POSITION VCV LOCAL LLH / POSITION SIGMA LOCAL ENU / BRIEF SV INFO DELTA XYZ / DETAIL SV INFO TPLANE ENU / RECEIVER SERIAL VELOCITY / TIME/UTC 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, then the message is output at measurements epochs 2, 7, 12, 17, ...

Note – The *RECEIVER SYSTEMS* screen gives a summary of the messages being output from the Series 7400 ports. For more information, see RECEIVER SYSTEMS Screen on page 4-20.

4.20 RT17/BINARY OUTPUT Screen

The *RT17/BINARY OUTPUT* screen allows you to set up raw GPS data output messages. For additional information, see Command Packet 56h on page 7-10 and Report Packet 56h on page 7-10.

To configure the receiver for raw binary data output:

1. Click CONTROL to display the *CONTROL* menu.
2. Click ALPHA.
3. Click the **<SERIAL PORT OUTPUT>** softkey.
4. Click the **<RT17/BINARY OUTPUT>** softkey to display:

```
RT17/BINARY OUTPUT (CONTROL)
        PORT [3     ]    CONCISE [ON ]
MEASUREMENTS [1 HZ  ]  R-T FLAGS [ON ]
   POSITIONS [1 HZ  ]  EPHEMERIS [ON ]
```

5. Use the field descriptions in Table 4-21 to configure the receiver for raw binary data output.

Table 4-21. RT17/BINARY OUTPUT Fields

Field	Description
PORT	Assigns the serial port (PORT) used for RT17 binary output (1–4).
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 form the Series 7400 ports. For more information, see RECEIVER SYSTEMS Screen on page 4-20.

4.21 SERIAL PORT SETUP Screen

The *SERIAL PORT SETUP* 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 ALPHA.
3. Click the **<SERIAL PORT SETUP>** softkey to display:

```
SERIAL PORT SETUP (CONTROL)

[PORT 2] [9600 ] [8-NONE-1] [NONE     ]
```

4. Use the field descriptions in Table 4-22 to configure one or more serial ports.

Table 4-22. SERIAL PORT SETUP Fields

Field	Description
PORT	Assigns the serial port to configure (1–4).
BAUD	Assigns the baud rate setting in the range: 2400, 4800, 9600, 19.2K, 38.4K.
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 Ports 2 and 4.

4.22 INPUT SETUP Screen

The *INPUT SETUP* 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 ALPHA.
3. Click the **<INPUT SETUP>** softkey to display:

```
INPUT SETUP (CONTROL)
USE RTCM STATION [ONLY]: 0000
RTK/DGPS AUTO SWITCH RANGE: 10.0KM
```

4. Use the field descriptions in Table 4-23 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 4-23. 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 desired RTCM Station, a value ranging from 0–1023.
RTK/DGPS AUTO SWITCH RANGE	Defines the distance used to determine when the Series 7400 receiver automatically switches between the use of RTK and DGPS solutions. The default is 10.0 Km.

4.23 JX-1100 SETUP Screen (Requires Clarion Radio/Modem)

The *JX-1100 SETUP* screen allows you to setup the Series 7400 receivers to operate with a Clarion JX-1100 radio/modem. There are two modes of setup, one for configuring a reference station, the other for configuring a rover. The reference station setup provides the ability for setting a local address, transmission channel and repeater routing. The rover setup contains parameters for both receiving reference station data as well as reporting position information to a central tracking site.

To configure a JX-1100 radio:

1. Click CONTROL to display the *CONTROL* menu.
2. Click ALPHA twice.
3. Click the **<JX-1100 SETUP>** softkey to display:

```
JX-100 SETUP (CONTROL)  [PORT 1]  [OFF]
[ROVER]     LOC ADR: 010 NETWORK:[ON ]
TX CHN: 02 REPEATER:[OFF] PERIOD: 001
RX CHN: 01 DEST ADR: 0002   SLOT: 001
```

Note – You should be familiar with the operation of the Clarion JX-1100 radio/modem before using it with the Series 7400 receivers.

4. Use the field descriptions in Table 4-24 as a guide while configuring the radio parameters.

Table 4-24. JX-1100 SETUP Fields

Field	Description
Port	Assigns the receiver serial port (PORT) connected to the Clarion JX-1100 radio/modem, ports 1–4.
Enable	Switches JX-1100 support ON or OFF for the specified port.
LOC ADR	Assigns the Local Address for the JX-1100 radio/modem connected to the receiver. The Local Address is used to setup a network of JX-1100 nodes, each with a unique address. The value can be any number in the range of 1–255. The Local Address is sent by the JX-1100 with each data packet, identifying the source of each data packet.
NETWORK	Configures position reports for multiple rovers on the same channel. The JX-1100 Radio/Modem supports Time-Division, Multiple Access networking. Each rover can be configured to report back data, such as position, at a specified PERIOD and within a time-slice SLOT.
TX CHAN	Assigns the channel used by the radio when broadcasting data. It may range from 0–62. Only radios using the selected channel receive data transmitted from the reference station.
REPEATER	Configures the number of data packets routed through one radio repeater. The repeater is either OFF or is set to a values ranging from 1–8.
PERIOD	Defines the number of seconds elapsing between reports sent by a rover. The value can range from 1–120 seconds. Selecting a period of 1 second provides 5 SLOTS for reporting. If the PERIOD is set to 2 seconds, 10 slots are available. Each slot is 100 milliseconds long, irrespective of the PERIOD.

Table 4-24. JX-1100 SETUP Fields (Continued)

Field	Description
RX CHAN	Assigns a JX-1100 channel for receiving data. Set the RX CHN on the rover to the same channel as the TX CHN on the reference station. The number of channels ranges from 0–62.
DEST ADR	Assigns a JX-1100 destination address for data sent by the rover. Refers to the JX-1100 address at a remote tracking station.
SLOT	Sets the reporting time slice. SLOT is used in conjunction with PERIOD. There are 5 slots in every 1 second period (see PERIOD).

Note – A radio may define up to 8 separate repeater channels which refer to 8 of the 63 available data channels supported by the JX-1100 radio.

4.24 SET FACTORY DEFAULTS Screen

The *SET FACTORY DEFAULTS* screen sets the Series 7400 receivers to factory default settings.

To reset the receiver operating parameters to the factory default values:

1. Click [CONTROL] to display the *CONTROL* menu.
2. Click [ALPHA], then click [ALPHA] again to display the next selection of softkey options.
3. Click the **<SET FACTORY DEFAULTS>** softkey to display:

```
THE RECEIVER WILL USE THE FACTORY
CONTROLS AFTER THE RESTART.

           PRESS <ENTER> TO CONTINUE
```

4. Click the **<ENTER>** softkey to restart the receiver.

4.25 Cold Booting the Series 7400 Receiver

The Series 7400 receiver can be cold booted by continuously pressing [POWER] for 15 seconds.

Note – Cold booting operations are only possible when the Series 7400 receiver has Boot firmware version 3.34 or higher. You can use the Remote Controller software to check the Boot firmware version by clicking [STATUS], followed by the **<FACTORY CONFIGURATION>** softkey.

5 NMEA-0183 Output

This chapter describes the formats of the subset of NMEA-0183 messages available for output by the Series 7400 receivers.

5.1 NMEA-0183 Outputs

When NMEA-0183 output is enabled, a subset of NMEA-0183 messages can be output to external instruments and equipment interfaced to the Series 7400 ports. These NMEA-0183 messages allow external devices to use selected data collected or computed by the Series 7400 receivers.

All messages conform to the NMEA-0183 Version 2.1 format. All begin with *$* and end with a carriage return and a line feed. Data fields follow comma (,) delimiters and are variable in length. Null fields still follow a comma (,) delimiter but contain no information.

An asterisk (*) delimiter and checksum value follow the last field of data contained in a NMEA-0183 message. The checksum is the 8-bit exclusive OR of all characters in the message, including the commas, between each field, but not including the $ and asterisk delimiters. The hexadecimal result is converted to two ASCII characters (0-9, A-F). The most significant character appears first.

Table 5-1 summarizes the set of NMEA messages supported by the Series 7400 receivers and shows the page number where detailed information about each message is found.

Table 5-1. NMEA Message Summary

Message	Function	Page
GGA	Time, position, and fix related data	5-5
GST	Position error statistics	5-6
PTNL, GGK	Time, position, position type and DOP values	5-7
PTNL, PJT	Projection type	5-8
PTNL, PJK	Local coordinate position output	5-9
VTG	Actual track made good and speed over ground	5-9
ZDA	UTC day, month, and year, and local time zone offset	5-10

The output of individual NMEA messages can be enabled or disabled by selecting the specific messages using the Remote Controller software or by selecting an existing application file with a user-defined selection of enabled messages or by uploading an application file (with an Output Message Record) to overwrite the current NMEA message selection. For more information, see OUTPUT MESSAGE RECORD on page 7-21 and Table 7-24, GSOF SUB-MESSAGE TYPE Byte Values, on page 7-32.

5.2 Common Message Elements

Each message consists of:

- A message ID consisting of *$GP* followed by the message type. For example, the message ID of the GGA message is *$GPGGA*.
- A comma
- A number of fields that depend on message type, separated by commas
- An asterisk
- A checksum

Here is an example of a simple message with a message ID ($GPGGA), followed by 13 fields and checksum value:

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

5.2.1 Message Values

Latitude and Longitude

latitude is represented as *ddmm.mmmm* and longitude is represented as *dddmm.mmmm*, where

- *dd* or *ddd* is degrees
- *mm.mmmm* is minutes and decimal fractions of minutes

Direction

Direction; north, south, east, west; is represented by a single character: *N*, *S*, *E*, or *W*.

Time

Time values are presented in Universal Time Coordinated (UTC) and are represented as *hhmmss.cc*, where:

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

5.3 NMEA Messages

When the NMEA-0183 output is enabled, the following messages can be produced to aid integration with other sensors.

GGA Time, Position, and Fix Related Data

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

Table 5-2 describes the GGA message fields.

Table 5-2. GGA Message Fields

Field	Meaning
1	UTC of position fix
2	Latitude
3	Direction of latitude (N or S)
4	Longitude
5	Direction of longitude (E or W)
6	GPS Quality indicator: 0: Fix not valid 1: GPS fix 2: Differential GPS fix
7	Number of SVs in use, 00 to 12
8	HDOP
9	Antenna height, MSL reference
10	M is fixed text indicating that the unit of measure for altitude is meters
11	Geoidal separation
12	M is fixed text indicating that the unit of measure for geoidal separation is meters
13	Age of differential GPS data record, Type 1 or Type 9. Null when DGPS not used
14	Base station ID, 0000–1023, null when any reference station ID is selected and no corrections are received

GST Position Error Statistics

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

Table 5-3 describes the message fields in the GST message.

Table 5-3. GST Message Fields

Field	Meaning
1	UTC position fix
2	RMS value of the pseudorange residuals (includes carrier phase residuals during periods of RTK (float and RTK (fixed) processing)
3	Error ellipse semi-major axis 1 sigma error (meters)
4	Error ellipse semi-minor axis 1 sigma error (meters)
5	Error ellipse orientation (degrees from true north)
6	Latitude 1 sigma error (meters)
7	Longitude 1 sigma error (meters)
8	Altitude 1 sigma error (meters)

PTNL,GGK Time, Position, Position Type, DOP

```
$PTNL,GGK,172814.00,071296,3723.46587704,N,122
02.26957864,W,3,06,1.7,EHT-6.777,M*48
```

Table 5-4 describes the fields in the PTNL,GGK message.

Table 5-4. PTNL,GGK Message Fields

Field	Meaning
1	UTC of position fix
2	Date
3	Latitude
4	Direction of latitude (N or S)
5	Longitude
6	Direction of Longitude (E or W)
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier phase integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M is fixed text indicating the unit of measure for ellipsoidal height is meters

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

PTNL,PJK Local Coordinate Position Output

```
$PTNL,PJK,010717.00,081796,+732646.511,N,+1731
051.091,E,1,05,2.7,EHT-28.345,M*7C
```

Table 5-5 describes the fields in the PTNL,PJK message.

Table 5-5. PTNL,PJK Message Fields

Field	Meaning
1	UTC of position fix
2	Date
3	Northing (meters)
4	Direction of Northing, will always be N (North)
5	Easting (meters)
6	Direction of Easting, will always be E (East)
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M is fixed text indicating the unit of measure for ellipsoidal height is meters

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

PTNL,PJT Projection Type

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

Table 5-6 describes the fields in the PTNL,PJT message.

Table 5-6. PTNL,PJT Message Fields

Field	Meaning
1	Coordinate system name (can include multiple words)
2	Projection name (can include multiple coordinates)

VTG Actual Track Made Good Over and Speed Over Ground

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

Table 5-7 describes the fields in the PTNL,PJT message.

Table 5-7. VTG Message Fields

Field	Meaning
1	Track made good (degrees true)
2	T is fixed text that indicates that track made good (prior field) is relative to true north
3	Null field
4	M is fixed text
5	Speed (knots)
6	N is fixed text that indicates that speed is in knots
7	Speed over ground in kilometers/hour (KPH)
8	K is fixed text that indicates that speed over ground is in KPH

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

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

Table 5-8 describes the fields in the ZDA message.

Table 5-8. ZDA Message Fields

Field	Meaning
1	Time, in UTC
2	Day, 01 to 31
3	Month, 01 to 12
4	Year
5	Local time zone offset from GMT, 00 to ±13 hours
6	Local time zone offset from, minutes

Fields 5 and 6, together, yield the total offset. For example, if field 5 is –5 and field 6 is –15, local time is 5 hours and 15 minutes earlier than GMT.

6 TrimComm Protocol

TrimComm packets enable a remote computing device to communicate with a Series 7400 receiver over a RS-232 connection. The TrimComm protocol provides command packets for configuring the Series 7400 receiver for operation, and report packets for retrieving position and status information from the receiver.

TrimComm packets are similar to the data collector format packets which evolved with the Trimble Navigation Series 4000 Receivers. The set of TrimComm command and report packets implemented on the Series 7400 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 Report Packet 40h on page 8-10.

The Series 7400 receivers are 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 uploaded 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 Series 7400 receivers.

For a general description of application files, see Application Files on page 6-11. For information about the structure of application files, see Report Packet 64h on page 8-64.

6.1 Communications Format

Supported data rates are: 2400, 4800, 9600, 19200 and 38400 baud. Any of these data rates can be used, however, realistically only 4800 baud or higher should be used. Only an 8-bit word format is supported, with Odd, Even or No parity, and 1 stop bit. The default communications format for the Series 7400 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 until the user explicitly changes the parameter settings.

6.1.1 Testing the Communications Link

To determine whether the Series 7400 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 may be sent by the remote device before any other command to make sure the RS-232 line is clear and operational.

6.1.2 Communication Errors

The receiver normally responds to a TrimComm 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.

6.2 TrimComm Packets

Command packets are sent from the remote device to the Series 7400 receiver when requesting data, sending commands, or when managing application files. The Series 7400 receiver acknowledges every command packet sent by the remote device 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 can never fulfill the request.

Packets are processed by the receiver on a first-in, first-out (FIFO) basis. External devices may 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.

6.2.1 Packet Structure

Every command and report packet, regardless of its source and except for protocol sequences, has the same format as shown in Table 6-1.

Table 6-1. TrimComm Packet Structure

Byte #	Message	Description
Begin Packet Header		
0	STX (02h)	Start transmission
1	STATUS	Receiver status code (see Table 6-2)
2	PACKET TYPE	Hexadecimal code assigned to the packet
3	LENGTH	Single byte # of data bytes, limits data to 255 bytes
Begin Packet Data		
4–*n*	DATA BYTES	From 0–*n* length bytes
Begin Packet Trailer		
Length + 4	CHECKSUM	(status + type + length + data bytes) modulo 256
Length + 5	ETX (03h)	End transmission

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

6.2.2 Packet Functions

The functions of Remote Control 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.

Warning – Virtually no range checking is performed by the Series 7400 receiver on the values supplied by the remote device. It is extremely important for the remote device to adhere to the exact ranges specified within this document. FAILURE TO DO SO MAY RESULT IN A RECEIVER CRASH AND/OR LOSS OF DATA.

6.2.3 The Receiver STATUS Byte

The status byte contains important indicators that usually require immediate attention by the remote device. The Series 7400 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 6-2 lists the status byte codes.

Table 6-2. Status Byte Codes

Bit	Bit Value	Meaning
Bit 0	1	Reserved
Bit 1	1	Low Battery
Bit 2–7	0–63	Reserved

6.3 Reading Binary Values

The Series 7400 receiver stores numbers in Motorola format. The byte order of these numbers is the opposite of what personal computers (PCs) expect (Intel format). In order 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 Series 7400 receiver is provided in the following sections.

6.3.1 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 6-3 lists the integer data types.

Table 6-3. 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 21474883647	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:

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

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

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

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

FLOAT Data Type

The FLOAT data type is stored in the IEEE single-precision format which is 32 bits long. The most significant bit is the sign bit, the next 8 most significant bits are the exponent field, and the remaining 23 bits are the fraction field. The bias of the exponent is 127. The range of single-precision format values is from 1.18 x 10^{-38} to 3.4 x 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 = 0.1
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
```

6.4 TrimComm Packet Summary

Detailed descriptions of the TrimComm command and report packet are provided in Chapter 6 and 7. Table 6-4 summarizes the TrimComm command and report packets, and shows the location in this manual where detailed information about the packet is found.

Table 6-4. TrimComm Packet Summary

ID	Name	Function	Page
06h	Command Packet 06h, GETSERIAL	Receiver and Antenna Information Request	7-3
07h	Report Packet 07h, RSERIAL	Receiver and Antenna Information Report	8-3
08h	Command Packet 08h, GETSTAT1	Receiver Status Request	7-4
09h	Report Packet 09h, RECSTAT1	Receiver Status Report	8-6
1Bh	Command Packet 1Bh, SETANT	Antenna Information Command	7-5
40h	Report Packet 40h, GENOUT	General Output Record Reports	8-10
4Ah	Command Packet 4Ah, GETOPT	Receiver Options Request	7-7
4Bh	Report Packet 4Bh, RETOPT	Receiver Options Parameters Report	8-31
54h	Command Packet 54h, GETSVDATA	Satellite Information Request	7-8
55h	Report Packet 55h, RETSVDATA	Satellite Information Reports	8-36
56h	Command Packet 56h, GETRAW	Position or Real-Time Survey Data Request	7-10
57h	Report Packet 57h, RAWDATA	Position or Real-Time Survey Data Report	8-46
64h	Command Packet 64h, APPFILE	Application File Record Command	7-13
64h	Report Packet 64h, APPFILE	Application File Record Report	8-64
65h	Command Packet 65h, GETAPPFILE	Application File Request	7-37
66h	Command Packet 66h, GETAFDIR	Application File Directory Listing Request	7-39

Table 6-4. TrimComm Packet Summary (Continued)

ID	Name	Function	Page
67h	Report Packet 67h, RETAFDIR	Directory Listing Report	8-88
68h	Command Packet 68h, DELAPPFILE	Delete Application File Data Command	7-40
6Dh	Command Packet 6Dh, ACTAPPFILE	Activate Application File	7-41
6Eh	Report Packet 6Eh, BREAKRET	Break Sequence Return	8-91
81h	Command Packet 81h, KEYSIM	Key Simulator	7-42
82h	Command Packet 82h, SCRDUMP	Screen Dump Request	7-44
82h	Report Packet 82h, SCRDUMP	Screen Dump	8-96

6.5 Application Files

The software tools included with the Series 7400 receiver include software for creating application files and uploading the files to the receiver.

The external device may transfer application files to the receiver using the supplied Configuration Toolbox software (CTOOLBOX) 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 TrimComm packet format.

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

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 uploaded into memory, command packets can be used to manage the files. Command packets are available for downloading application files, selecting application files, and deleting application files.

6.5.1 Application 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
- Base Station Antenna Record
- Device Control Record
- Static/Kinematic Record
- Input Message Record

6.5.2 Application Record Format

The application record data is in the Motorola format described in Reading Binary Values on page 6-6. 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 the user is concerned about application files producing the same results on future receivers, then provisions should be made to assure that the application records do not contain extraneous data.

Table 6-5. Application File Records

Record	Bytes	Description
FILE STORAGE RECORD	15	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	6	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	6	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	36	Provides LLA (Latitude, Longitude, Altitude) coordinates when the receiver is used as a base or reference station.

Table 6-5. Application File Records (Continued)

Record	Bytes	Description
SV ENABLE/ DISABLE RECORD	34	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	6–8	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.
BASE STATION ANTENNA RECORD	10	The Base Station Antenna Record identifies the height of the base station (reference station) antenna.
DEVICE CONTROL RECORD	4–15	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	3	Determines whether the receiver is configured to perform Static or Kinematic surveys.
INPUT MESSAGE RECORD	TBD	Selects the type of GPS correction, serial port, message origin, and input specific settings.

For detailed information about the structure of application files and application file records, see Report Packet 64h on page 8-64.

For information about selecting application files once they are uploaded to the receiver, see Command Packet 6Dh on page 7-41. For information about deleting application files stored in computer memory, see Command Packet 68h on page 7-40. For information about downloading an application file from the receiver, see Command Packet 64h on page 7-13.

For information about requesting a listing of the application files stored on the receiver, see Command Packet 66h on page 7-39 and Report Packet 67h on page 8-88.

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 Report Packet 40h on page 8-10.

7 TrimComm Command Packets

TrimComm 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, by sending a corresponding report packet or by acknowledging the completion of an action.

7.1 Command Packet Summary

The following sections provide details for each command and report packet.

Table 7-1. Command Packet Summary

ID	Command Packet	Action	Page
06h	Command Packet 06h, GETSERIAL	Receiver and Antenna Information Request	7-3
08h	Command Packet 08h, GETSTAT1	Receiver Status Request	7-4
1Bh	Command Packet 1Bh, SETANT	Antenna Information Command	7-5
4Ah	Command Packet 4Ah, GETOPT	Receiver Options Request	7-7
54h	Command Packet 54h, GETSVDATA	Satellite Information Request	7-8
56h	Command Packet 56h, GETRAW	Position or Real-Time Survey Data Request	7-10
64h	Command Packet 64h, APPFILE	Application File Record Command	7-13
65h	Command Packet 65h, GETAPPFILE	Application File Request	7-13
66h	Command Packet 66h, GETAFDIR	Application File Directory Listing Request	7-39
68h	Command Packet 68h, DELAPPFILE	Delete Application File Data Command	7-40
6Dh	Command Packet 6Dh, ACTAPPFILE	Activate Application File	7-41
81h	Command Packet 81h, KEYSIM	Key Simulator	7-42
82h	Command Packet 82h, SCRDUMP	Screen Dump Request	7-44

06h Command Packet 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 7-2 describes the packet structure.

Table 7-2. Command Packet 06h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	06h	Command Packet 06h
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	Table 6-1	Checksum value
5	ETX	CHAR	03h	End transmission

08h

Command Packet 08h, GETSTAT1

Receiver Status Request

Command Packet 08h requests receiver status information regarding position determination, the number of tracked satellites, battery capacity remaining, 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 7-3 describes the packet structure. for additional information, see Report Packet 09h on page 8-6.

Table 7-3. Report Packet 08h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	08h	Command Packet 08h
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	Table 6-1	Checksum value
5	ETX	CHAR	03h	End transmission

1Bh Command Packet 1Bh, SETANT

Antenna Information Command

Command Packet 1Bh is used to identify the type of antenna and the antenna serial number. The receiver responds by sending an ACK to acknowledge the transaction. Table 7-4 describes the packet structure.

Packet Flow		
Receiver:		**Remote:**
	⇦	Command Packet 1Bh
ACK (06h)	⇨	

Table 7-4. Command Packet 1Bh Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	1Bh	Command Packet 1Bh
3	LENGTH	CHAR	0Ah	Data byte count
4–5	TYPE OF ANTENNA	CHARs	Table 7-5	Type of antenna
6–13	ANT SERIAL #	CHARs	*number*	Antenna serial number
14	CHECKSUM	CHAR	Table 6-1	Checksum value
15	ETX	CHAR	03h	End Transmission

Table 7-5. ANTENNA TYPE ID Codes

Antenna Type ID Code			
ASCII	Byte 4	Byte 5	Antenna Type
I_ †	49h	20h	Internal (standard)
IE	49h	45h	Internal Attachable SE
EK	45h	4Bh	External Kinematic (ST, SST: Default for external)
EG	45h	47h	External Geodetic L1 only (ST, SST)
E_ †	45h	20h	External (unknown type)
EH	45h	48h	External Helical (SX, round ground plane)
EX	45h	58h	External Dual Frequency Helical (SX, round ground plane)
EM	45h	4Dh	External Microstrip (SL, square ground plane)
ED	45h	44h	EXTERNAL DUAL FREQUENCY (SL, square ground plane)
EC	45h	43h	External Compact Dome
EF	45h	46h	External SSE/SSi Kinematic Dual Frequency
E2	45h	32h	External Geodetic Dual Frequency (SST, SSE) round ground plane with notches)
G0	47h	30h	Compact L1/L2 with ground plane
K0	4Bh	30h	Compact L1/L2

† Any _ (underline) character indicates a required space character.

The current antenna parameter settings can be checked by sending Command Packet 06h to request Report Packet 07h. For more information, see Command Packet 06h on page 7-3 and Report Packet 07h on page 8-3.

4Ah Command Packet 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 7-6 describes the packet structure. For additional information, see Report Packet 4Bh on page 8-31.

Packet Flow

Receiver:		**Remote:**
	⇦	Command Packet 4Ah
Report Packet 4Bh	⇨	

Table 7-6. Command Packet 4Ah Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	4Ah	Command Packet 4Ah
3	LENGTH	CHAR	00h	Data byte count
4	CHECKSUM	CHAR	Table 6-1	Checksum value
5	ETX	CHAR	03h	End transmission

54h Command Packet 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 7-7 shows the packet structure. For additional information, see Report Packet 4Bh on page 8-33.

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 7-7. Command Packet 54h Structure

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

Table 7-8. DATA SWITCH Byte Values

Byte Value		
Dec	Hex	Meaning
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

Command Packet 56h, GETRAW

Position or Real-Time Survey Data Request

Command Packet 56h requests raw satellite data in *.DAT Record 17 format or Concise format. The request may specify if Real-Time attribute information is required. The receiver responds by sending the data in Report Packet 57h. Alternatively, the packet can be used to request receiver position information in *.DAT record 11 format. Table 7-9 describes the packet structure. For additional information, see Report Packet 57h on page 8-46.

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 7-9. Command Packet 56h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	56h	Command Packet 56h
3	LENGTH	CHAR	03h	Data byte count
4	TYPE RAW DATA	CHAR	Table 7-10	Identifies the requested type of raw data
5	FLAGS	CHAR	Table 7-11	Flag bits for requesting raw data
6	RESERVED	CHAR	00h	Reserved; set to zero
7–8	CHECKSUM	SHORT	Table 6-1	Checksum value
9	(03h) ETX	CHAR	03h	End Transmission

Table 7-10. TYPE RAW DATA Values

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

Table 7-11. 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 Command Packet 64h, APPFILE

Application File Record Command

Command Packet 64h is sent to create or replace 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 Series 7400 Application Files and guidelines for using application files to control remote devices, see Application Files on page 6-11.

Packet Paging

Since an application file contains a maximum of 2048 bytes (all records are optional) of data and exceeds the byte limit for TrimComm 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 where ever 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 text block identifier (byte 4) which gives the report pages a unique identity in the data stream. The software on the remote device can identify the pages associated with the report and reassemble the application file using bytes 4–6.

Table 7-12 shows the structure of the report packet containing the application file.

Table 7-12. Command Packet 64h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	64h	Command Packet 64h
3	LENGTH	CHAR	Table 6-1	Data byte count
4	TX BLOCK IDENTIFIER	CHAR	00h–FFh	A number (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

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. 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	Table 7-13	Unique identifier for every receiver/device type that supports the application file interface
9	START APPLICATION FILE FLAG	CHAR	Table 7-14	Determines whether or not the application file is activated immediately after records are sent to receiver.
10	FACTORY SETTINGS FLAG	CHAR	Table 7-15	Determines whether or not the receiver is reset to factory default settings prior to activating the records in the application file.

† The date and time fields should be relative to UTC (Universal Time Coordinated).
‡ Zero (0) is equal to infinite.

Table 7-12. 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*	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)†

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. 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, Frequency Rate, PDOP (Position Dilution of Precision) Mask, and Frequency Source.				
0	RECORD TYPE	CHAR	01h	General Controls Record
1	RECORD LENGTH	CHAR	04h	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	Table 7-16	Frequency rate at which the receiver generates measurements
4	PDOP MASK	CHAR	00h–FFh‡	Position Dilution of Precision Mask (0–255)
5	FREQUENCY SOURCE	CHAR	Table 7-17	Sets the receiver to use its internal timebase or an external timebase

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. 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	Table 7-18	Data transmission rate
4	PARITY	CHAR	Table 7-19	Sets the parity of data transmitted through the port. Note that the eight data bits and one stop bit are always used, regardless of the parity selection.
5	FLOW CONTROL	CHAR	Table 7-20	Flow control

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. 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	24h	Data bytes in the record, excluding bytes 0 and 1.
2	FLAG	CHAR	00h	Reserved.
3	NODE INDEX	CHAR	00h	Reserved.
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
36–37	STATION ID	SHORT	*0000h–03FFh*	Reference Node Station ID.
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

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
1	RECORD LENGTH	CHAR	20h	Number of bytes in record, excluding bytes 0 and 1
2–33	SV ENABLE/ DISABLE STATES	CHARs	Table 7-21	Array of Enable/Disable flags for the 32 SVs. The first byte sets the desired Enable/Disable status of SV1, the second sets the status of SV2, etc.

† The date and time fields should be relative to UTC (Universal Time Coordinated).
‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
OUTPUT MESSAGE RECORD The OUTPUT MESSAGE RECORD selects the outputs for a specified serial port, the frequency of message transmissions, the integer second offset from the scheduled output rate, and output specific flags. Bytes 0 through 5 are included in all records, regardless of the output message type. The remaining bytes in the record (byte 6...) are dependent on the output message type.				
0	RECORD TYPE	CHAR	07h	Output Message Record
1	RECORD LENGTH	CHAR	04h, 05h or 06h	Number of bytes in the record, excluding bytes 0 and 1. The number of bytes is dependent on the number of output specific flags.
2	OUTPUT MESSAGE TYPE	CHAR	Table 7-22	Type of message or packet
3	PORT INDEX	CHAR	00h–03h	Serial port index number.
4	FREQUENCY	CHAR	Table 7-23	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	GS OF SUBMESSAGE TYPE	CHARs	Table 7-24	GSOF message number.

† The date and time fields should be relative to UTC (Universal Time Coordinated).
‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
7	OFFSET	CHAR	0–255	Integer second offset from scheduled frequency
OUTPUT MESSAGE RECORD TYPE 4 (RT17)				
6	REAL-TIME 17 MESSAGE FLAGS	CHAR	Table 7-25	RT17 (Real Time 17) Flags
OUTPUT MESSAGE RECORD TYPE 3 (RTCM)				
6	RTCM FLAGS	CHAR	Table 7-26	Bit settings for RTCM output flags

† The date and time fields should be relative to UTC (Universal Time Coordinated).
‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
BASE STATION ANTENNA RECORD The BASE STATION ANTENNA RECORD identifies the height of the base station (reference station) antenna.				
0	RECORD TYPE	CHAR	08h	Base Station Antenna Record
1	RECORD LENGTH	CHAR	08h	Number of bytes in record, excluding bytes 0 and 1
2–9	REFERENCE ANTENNA HEIGHT	DOUBLE	*meters*	Height of reference station antenna

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
DEVICE CONTROL RECORD The DEVICE CONTROL RECORD contains configuration parameters for controlling some external devices and the operation of some receiver options. The number of bytes contained in the record and the length of the record are determined by the DEVICE TYPE entry. The table subheadings identify different devices				
0	RECORD TYPE	CHAR	09h	Device Control Record
1	RECORD LENGTH	CHAR	02h or 0Dh	Number of bytes in record, excluding bytes 0 and 1.
2	DEVICE TYPE	CHAR	Table 7-27	Type of device
For Charger/Power Control Only				
3	CHARGER/POWER CONTROL	CHAR	Table 7-28	Disables Charger/Power Control, enables the battery charger feature, or enables power output on the serial port when byte 2 is set to 0.
For 1 PPS Output Only				
3	1 PPS CONTROL	CHAR	Table 7-29	Enables or disables 1 PPS output byte 2 is set to 2

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
For Clarion JX-10 Radio Only				
3	PORT	CHAR	00h–03h	Index number of serial port connected to Clarion JX-10 Radio.
4	JX-10 ENABLE FLAG	CHAR	Table 7-30	Enables or disables the Clarion JX-10 Radio when byte 2 is set to 6.
5	MODE	CHAR	Table 7-31	Sets the JX-10 Radio to operate as a rover radio or base station radio.
6	TRANSMIT CHANNEL	CHAR	00h–3Eh	The JX-10 Radio can be set to transmit data using one of 0–62 channels.
7	RECEIVE CHANNEL	CHAR	00h–3Eh	The JX-10 Radio can be set to receiver data on one of 0–62 channels.
8	LOCAL ADDRESS	CHAR	00–FFh	0–255
9	DESTINATION ADDRESS	CHAR	00–FFh	0–255
10	REPEATER	CHAR	Table 7-32	
11	PERIOD	CHAR	01h–78h	(1–120 seconds)
12–13	SLOT	CHAR		$1 \leq slot \leq 5 * period$
14	TIME DIVISION MULTIPLEXING	CHAR	Table 7-33	
STATIC/KINEMATIC RECORD The bytes value in the STATIC/KINEMATIC RECORD determine whether the receiver is operating in Static or Kinematic mode.				

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
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	Table 7-34	Configures receiver for static or kinematic operation
Length +4	CHECKSUM	CHAR	Table 6-1	Checksum value
Length +5	ETX	CHAR	03h	End transmission

† The date and time fields should be relative to UTC (Universal Time Coordinated).

‡ Zero (0) is equal to infinite.

Table 7-12. 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. If this value is –1, 65535, or FFFFh, any station can be used.

† The date and time fields should be relative to UTC (Universal Time Coordinated).
‡ Zero (0) is equal to infinite.

Table 7-13. DEVICE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	All Devices
1	01h	Series 7400 receiver
2–255	02h–FFh	Reserved

Table 7-14. START APPLICATION FILE FLAG Byte Values

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

Table 7-15. FACTORY SETTINGS Byte Values

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

Table 7-16. MEASUREMENT RATE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	1 Hz
1	01h	5 Hz

Table 7-17. FREQUENCY SOURCE BYTE Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Internal frequency source
1	01h	5 MHz external frequency source
2	02h	10 MHz external frequency source

Table 7-18. BAUD RATE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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

Table 7-19. PARITY Byte Values

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

Table 7-20. FLOW CONTROL Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	None
1	01h	CTS

Table 7-21. SV ENABLE/DISABLE STATES Flag Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Default
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

Table 7-22. OUTPUT MESSAGE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Output Protocol**
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
16–254	10h–FEh	Reserved (future output protocols)
255	FFh	All messages off on the specified port.

Note – The number of supported output protocols could increase in the future.

Table 7-23. FREQUENCY Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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
255	FFh	Once only, immediately

Table 7-24. GSOF SUB-MESSAGE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Switch all GSOF messages off
1	01h	Position and time
2	02h	WGS-84, Lat, Long, Height
3	03h	WGS-84 ECEF (XYZ) Position
4	04h	Local Datum Lat, Long, Height
5	05h	Local Projection East, North, Up
6	06h	Reference → Rover Vector (dx, dy, dz)
7	07h	Reference → Rover Vector (delta East, delta North, delta Up)
8	08h	Velocity and Header information
9	09h	Dilution of Precision (DOP) Values
10	0Ah	Clock data
11	0Bh	Error Covariance Data
12	0Ch	Position Statistics
13	0Dh	Brief satellite information
14	0Eh	Detailed satellite information
15	0Fh	Receiver Serial Number data
16	10h	Current GPS time and UTC offset

Table 7-25. REAL-TIME 17 MESSAGE Bit Values

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

Table 7-26. RTCM Flag Bit Values

Bit	Meaning
0	Output RTK (Type 18 and 19) 0: Off 1: On
1	Output DGPS (Type 1) 0: Off 1: On
2	Output DGPS (Type 9-3) 0: Off 1: On
3–7	Reserved (set to zero).

Table 7-27. DEVICE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Battery Charger/Power output.
1	01h	Reserved
2	02h	1 PPS (Pulse per Second) Output
3	03h	Reserved
4	04h	Reserved
5	05h	Reserved
6	06h	Clarion JX-10 Radio

Table 7-28. CHARGER/POWER CONTROL Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Off
1	01h	Charger On
2	02h	Power output On

Table 7-29. 1 PPS CONTROL Byte Values

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

Table 7-30. JX-10 RADIO ENABLE FLAGS Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disable JX-10 Radio
1	01h	Enable JX-10 Radio

Table 7-31. JX-10 RADIO MODE Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Rover
1	01h	Base Station

Table 7-32. JX-10 RADIO REPEATER Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disabled – radio is not operating as a repeater
1–8	01h–08h	Enabled – radio is operating as a repeater

Table 7-33. JX-10 RADIO TIME DIVISION MULTIPLEXING Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disable (Allow multi-Hz outputs, but limit system to single rover)
1	01h	Enable (Allows for multiple rover receivers, but limits outputs to 1 Hz)

Table 7-34. STATIC/KINEMATIC MODE Byte Values

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

65h Command Packet 65h, GETAPPFILE

Application File Request

A specific application file can be downloaded from the Series 7400 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 an System File Index code of zero (0).

Table 7-35 shows the packet structure. For more information, see Report Packet 64h on page 8-64.

Table 7-35. Command Packet 65h Structure

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

66h Command Packet 66h, GETAFDIR

Application File Directory Listing Request

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

Packet Flow

Receiver:		**Remote:**
	⇦	Command Packet 66h
Report Packet 67h	⇨	

Table 7-36 describes the packet structure. For more information, see Report Packet 67h on page 8-88.

Table 7-36. Command Packet 66h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	66h	Command Packet 66h
3	LENGTH	CHAR	0h	Data byte count
4	CHECKSUM	CHAR	Table 6-1	Checksum value
5	ETX	CHAR	03h	End transmission

68h Command Packet 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 7-37. Command Packet 68h Structure

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

6Dh

Command Packet 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 an System File Index of zero (0), allowing this command to be used to reset the receiver to the factory default conditions. Table 7-38 describes the packet structure.

Table 7-38. Command Packet 6Dh Structure

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

81h Command Packet 81h, KEYSIM

Key Simulator

Command Packet 81h simulates any front panel key press.

Packet Flow		
Receiver:		**Remote:**
	⇦	Command Packet 81h
ACK	⇨	

Table 7-39. Command Packet 81h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	81h	Command Packet 81h
3	LENGTH	CHAR	01h	Data byte count
4	KEY ID	CHAR	Table 7-40	Key scan code ID
5	CHECKSUM	CHAR	Table 6-1	Checksum values
6	ETX	CHAR	03h	End transmission

Table 7-40. Key ID Codes

Scan Code	Receiver Key	ASCII Character
7Fh	CLEAR	Del <del>
0Dh	ENTER	Enter <carriage return>
41h	Softkey Choice 1	A <A>
42h	Softkey Choice 2	B <B>
43h	Softkey Choice 3	<C>
44h	Softkey Choice 4	<D>

Table 7-40. Key ID Codes (Continued)

Scan Code	Receiver Key	ASCII Character
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>
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 Command Packet 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 Series 7400 simulated display screen. In response, Report Packet 82h sends the data used that is used to display the screen to the remote device in ASCII format.

Table 7-41 shows the command packet structure. For more information, see Report Packet 82h on page 8-96.

Table 7-41. Command Packet 82h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	82h	Command Packet 82h
3	LENGTH	CHAR	0h	Data bytes count
4	CHECKSUM	CHAR	Table 6-1	Checksum value
5	ETX	CHAR	03h	End transmission

8 TrimComm Report Packets

TrimComm 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.

8.1 Report Packet Summary

The following sections provide details for each command and report packet.

Table 8-1. Report Packet Summary

ID (Hex)	Name	Function	Page
07h	Report Packet 07h, RSERIAL	Receiver and Antenna Information Report	8-3
09h	Report Packet 09h, RECSTAT1	Receiver Status Report	8-6
40h	Report Packet 40h, GENOUT	General Output Record Reports	8-10
4Bh	Report Packet 4Bh, RETOPT	Receiver Options Parameters Report	8-31
55h	Report Packet 55h, RETSVDATA	Satellite Information Reports	8-36
57h	Report Packet 57h, RAWDATA	Position or Real-Time Survey Data Report	8-46
64h	Report Packet 64h, APPFILE	Application File Record Report	8-64
67h	Report Packet 67h, RETAFDIR	Directory Listing Report	8-88
6Eh	Report Packet 6Eh, BREAKRET	Break Sequence Return	8-91
82h	Report Packet 82h, SCRDUMP	Screen Dump	8-96

07h

Report Packet 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, firmware processor versions, and the number of receiver channels.

Packet Flow		
Receiver:		**Remote:**
	⇦	Command Packet 06h
Report Packet 07h	⇨	

Table 8-2 describes the packet structure. For more information, see Command Packet 06h on page 7-3.

Table 8-2. Report Packet 07h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	07h	Report Packet 07h
3	LENGTH	CHAR	2Dh	Data byte count
4–11	RECEIVER SERIAL #	CHAR	*ASCII text*	Receiver serial number
12–19	RECEIVER TYPE	CHARs	7400(4 spaces)	Identifies the receiver model designation (the number 7400, followed by four space characters)
20–24	NAV PROCESS VERSION	CHARs	*ASCII text*	Version number of NAV Processor firmware

Table 8-2. Report Packet 07h Structure (Continued)

Byte #	Item	Type	Value	Meaning
25–29	SIG PROCESS VERSION	CHARs	*ASCII text*	Version number of SIG Processor firmware
30–34	BOOT ROM VERSION	CHARs	*ASCII text*	Version number of Boot ROM firmware
35–42	ANTENNA SERIAL #	CHARs	*ASCII text*	Serial number of antenna. If no antenna serial number is supplied, the field is filled with spaces.
43–44	ANTENNA TYPE	CHAR	Table 8-3	Identification code for antenna type
45–46	# CHANNELS	CHAR	12h	There are 18 receiver channels.
47–48	# CHANNELS L1	CHAR	09h	Nine (9) L1 receiver channels.
49	CHECKSUM	CHAR	Table 6-1	Checksum value
50	ETX	CHAR	03h	End transmission

Table 8-3. ANTENNA TYPE ID Codes

Antenna Type ID Code			
ASCII	**Byte 43**	**Byte 44**	**Antenna Type**
I_ †	49h	20h	Internal (standard)
IE	49h	45h	Internal Attachable SE
EK	45h	4Bh	External Kinematic (ST, SST: Default for external)
EG	45h	47h	External Geodetic L1 only (ST, SST)
E_ †	45h	20h	External (unknown type)
EH	45h	48h	External Helical (SX, round ground plane)
EX	45h	58h	External Dual Frequency Helical (SX, round ground plane)
EM	45h	4Dh	External Microstrip (SL, square ground plane)
ED	45h	44h	EXTERNAL DUAL FREQUENCY (SL, square ground plane)
EC	45h	43h	External Compact Dome
EF	45h	46h	External SSE/SSi Kinematic Dual Frequency
E2	45h	32h	External Geodetic Dual Frequency (SST, SSE) round ground plane with notches)
G0	47h	30h	Compact L1/L2 with ground plane
K0	4Bh	30h	Compact L1/L2

† Any _ (underline) character indicates a required space character.

Note – The ANTENNA TYPE parameter is set using Command Packet 1Bh. For more information, see Command Packet 1Bh on page 7-5.

09h

Report Packet 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 8-4 describes the packet structure. For more information, see Command Packet 08h on page 7-4.

Table 8-4. Report Packet 09h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status indicator
2	PACKET TYPE	CHAR	09h	Report Packet 09h
3	LENGTH	CHAR	15h	Data byte count
4	POSITION FIX	CHAR	Table 8-5	Current GPS position fix mode
5	MEASUREMENT STATUS	CHAR	Table 8-6	Indicates whether the measurement is new or old
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	00h–65h	The remaining battery time in hours (0–101)
14–18	RESERVED	CHARs		Reserved
19–22	STATUS OF RECEIVER	CHARs	Table 8-7	Current action performed by the receiver
23–24	# L2 CHANNELS OPERATIONAL	CHARs	*channels*	Number of L2 channels selected for taking measurements
25	CHECKSUM	CHAR	Table 6-1	Checksum value
26	ETX	CHAR	03h	End transmission

Table 8-5. POSITION FIX Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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 8-6. MEASUREMENT STATUS Byte Values

Byte Value		
ASCII	**Hex†**	**Meaning**
N	4Eh	New measurement
O	4Fh	Old measurement

† The hexadecimal byte value is derived from the decimal number associated with the upper case ASCII character.

Table 8-7. STATUS OF RECEIVER Byte Values

	Byte Values				
ASCII	**19**	**20**	**21**	**23**	**Meaning**
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

Note – MEASUREMENT STATUS is set to zero (OLD) after this packet is sent. The POSITION FIX STATUS is set to zero (OLD) when the POSITION packet is sent.

40h Report Packet 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 Application Files on page 6-11.

Note – Application files are created and uploaded to the receiver with the software tools included with the receiver. For more information, see Application Files on page 6-11 and Command Packet 64h on page 7-13.

Table 8-8 describes the packet structure. Note that the byte numbers in Table 8-8 are reset to 0 for each sub-record type. To approximate packet size, add the header and footer bytes to the sum of the byte counts for all records included in the packet.

Table 8-8. Report Packet 40h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	40h	Report Packet 40h
3	LENGTH	CHAR	00h–FAh	Data byte count
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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
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	Table 8-9	Reports first set of position attribute flag values
10	POSITION FLAGS 2	CHAR	Table 8-10	Reports second set of position attribute flag values
11	INITIALIZATION NUMBER	CHAR	00h–FFh	Increments with each initialization (modulo 256)

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
ECEF DELTA (Type 6 Record)				
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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
TANGENT PLANE DELTA (Type 7 Record)				
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 Set to zero for satellites which are not tracked on the current frequency (L1 or L2).

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
VELOCITY DATA (Type 8 Record)				
0	OUTPUT RECORD TYPE	CHAR	08h	Velocity Data Output Record
1	RECORD LENGTH	CHAR	0Dh	Bytes in record
2	VELOCITY FLAGS	CHAR	Table 8-11	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
PDOP INFO (Type 9 Record)				
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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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	Table 8-12	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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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 a 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.

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. Report Packet 40h Structure (Continued)

Byte #	Item	Type	Value	Meaning
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.

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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[2]
	The following bytes are repeated for NUMBER OF SVS			
	PRN	CHAR	01h–20h	Pseudorandom number of satellite (1–32)
	SV FLAGS1	CHAR	Table 8-13	First set of satellite status bits
	SV FLAGS2	CHAR	Table 8-14	Second set of satellite status bits

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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		Bytes in record
2	NUMBER OF SVS	CHAR	00h–18h	Number of satellites included in record[2]
	The following bytes are repeated for NUMBER OF SVS			
	PRN	CHAR	01h–20h	Pseudorandom number of satellite (1–32)
	FLAGS1	CHAR	Table 8-13	First set of satellite status bits
	FLAGS2	CHAR	Table 8-14	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).[1]
	SNR L2	CHAR	dB * 4	Signal-to-noise ratio of L2 signal (multiplied by 4).[1]

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-8. 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	Table 8-15	Flag bits indicating validity of Time and UTC offset parameters
Length + 4	CHECKSUM	CHAR	Table 6-1	Checksum value
Length + 5	ETX	CHAR	03h	End transmission

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

2 The number of SVs includes all tracked satellites, all satellites used in position solution, and all satellites in view.

Table 8-9. 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 8-10. 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 8-11. 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 8-12. 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 8-13. 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
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 8-14. SV FLAGS2 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 8-15. 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

4Bh Report Packet 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 firmware 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 8-16 describes the packet structure. For more information, see Command Packet 4Ah on page 7-7.

Table 8-16. Report Packet 4Bh Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	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

Table 8-16. Report Packet 4Bh Structure (Continued)

Byte #	Item	Type	Value	Meaning
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
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	Table 8-17	L1/L2 operating mode
13–21	RESERVED	CHAR	00h	Reserved (set to zero)
22	NMEA-0183 OUTPUTS	CHAR	Table 8-18	NMEA-0183 Output Option installation flag
23	RESERVED	CHAR	00h	Reserved
24	RTCM INPUT	CHAR	Table 8-19	RTCM Input installation flag
25	RESERVED	CHAR	00h	Reserved
26	RTCM OUTPUT	CHAR	Table 8-20	RTCM Output installation flag
27–29	RESERVED	CHAR	00h	Reserved (set to zero)
30	PULSE PER SEC	CHAR	Table 8-21	1 PPS Output Option installation flag
31	EXT TIME INPUT	CHAR	Table 8-22	External Timebase Option installation flags
32	COCOM ALT/ SPEED	CHAR	Table 8-23	COCOM Alt/Speed Option installation flag
33–34	MEMORY INSTALLED	SHORT	*kilobytes*	Kilobytes of memory installed on receiver (modulus 65 MB)
35	% MEMORY USED	CHAR	00h–64h	Percentage of memory used by data (0–100%)
36–42	RESERVED	CHAR	00h	Reserved (set to zero)

Table 8-16. Report Packet 4Bh Structure (Continued)

Byte #	Item	Type	Value	Meaning
43	RESERVED	CHAR	00h	Reserved (set to zero)
44	REAL-TIME SURVEY DATA	CHAR	Table 8-24	Real-Time Survey Data Option installation flag
45	RESERVED	CHAR	00h	
46	SUMMARY OF RTK OPTIONS	CHAR	Table 8-25	RTK option summary flags
47–52	RESERVED	CHAR	00h	Reserved (set to zero)
53	Checksum	CHAR	Table 6-1	Checksum value
54	ETX	CHAR	03h	End transmission

Table 8-17. L1/L2 OPERATION Byte Values

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

Table 8-18. NMEA-0183 OUTPUTS Byte Values

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

Table 8-19. RTCM INPUT

Byte Value		
Dec	Hex	Meaning
0	00h	Not installed

Table 8-19. RTCM INPUT

Byte Value		
Dec	**Hex**	**Meaning**
1	01h	Installed

Table 8-20. RTCM OUTPUT

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

Table 8-21. PULSE PER SEC Byte Values

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

Table 8-22. EXT TIME INPUT Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Internal timebase (receiver's clock) is used
1	01h	External timebase is installed and disabled; internal timebase is currently being used
5	05h	5 MHz external timebase is installed and used in lieu of internal timebase
10	0Ah	10 MHz external timebase is installed and used in lieu of internal timebase

Table 8-23. COCOM ALT/SPEED Byte Values

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

Table 8-24. REAL-TIME SURVEY DATA Byte Values

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

Table 8-25. 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 Report Packet 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 8-26 through Table 8-30 describe the structure of the report packets.

Note – 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 8-26 describes the packet structure.

Table 8-26. Report Packet 55h SV FLAGS Report Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	Table 6-1	Data byte count
4	DATA TYPE INDICATOR	CHAR	00h	SV FLAGS Report
5	SV PRN #	CHAR	00h–20h	Pseudorandom number of satellite (1–32) or zero when requesting flag status of all satellites
6–9	EPHEMERIS FLAGS	LONG	*32 flag bits*	For all 32 satellites, the flags show availability of Ephemeris data when set to one.†
10–13	ALMANAC FLAGS	LONG	*32 flag bits*	For all 32 satellites, the flags show availability of Almanac data when set to one.†
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.†
18–21	SVS UNHEALTHY FLAGS	LONG	*32 flag bits*	Flags show the health of satellites. When set to one, satellite is currently unhealthy.†
22–25	TRACKING L1 FLAGS	LONG	*32 flag bits*	Flags show satellites tracked on L1 when set to one.†

† Bit 0 = PRN 1.

Table 8-26. Report Packet 55h SV FLAGS Report Structure (Continued)

Byte #	Item	Type	Value	Meaning
26–29	TRACKING L2 FLAGS	LONG	*32 flag bits*	Flags show satellites tracked on L2 when set to one.†
30–33	Y-CODE FLAGS	LONG	*32 flag bits*	Flags show satellites with Anti-Spoofing turned on when set to one.†
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.†
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	Table 6-1	Checksum value
55	ETX	CHAR	03h	End transmission

† 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 8-27 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 8-28.

Table 8-27. Report Packet 55h EPHEMERIS Report Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	Table 6-1	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†	Ephemeris Week Number
8–9	IODC	SHORT	GPS ICD-200†	
10	RESERVED	CHAR	GPS ICD-200†	Reserved (set to zero)
11	IODE	CHAR	GPS ICD-200†	Issue of Data Ephemeris
12–15	TOW	LONG	GPS ICD-200†	Time of week

† Refer to the United States Government document GPS ICD-200 for detailed information.

Table 8-27. Report Packet 55h EPHEMERIS Report Structure (Continued)

Byte #	Item	Type	Value	Meaning
16–19	TOC	LONG	GPS ICD-200†	
20–23	TOE	LONG	GPS ICD-200†	
24–31	TGD	DOUBLE	GPS ICD-200†	
32–39	AF2	DOUBLE	GPS ICD-200†	
40–47	AF1	DOUBLE	GPS ICD-200†	
48–55	AF0	DOUBLE	GPS ICD-200†	
56–63	CRS	DOUBLE	GPS ICD-200†	
64–71	DELTA N	DOUBLE	GPS ICD-200†	
72–79	M SUB 0	DOUBLE	GPS ICD-200†	
80–87	CUC	DOUBLE	GPS ICD-200†	
88–95	ECCENTRICITY	DOUBLE	GPS ICD-200†	
96–103	CUS	DOUBLE	GPS ICD-200†	
104–111	SQRT A	DOUBLE	GPS ICD-200†	
112–119	CIC	DOUBLE	GPS ICD-200†	
120–127	OMEGA SUB 0	DOUBLE	GPS ICD-200†	
128–135	CIS	DOUBLE	GPS ICD-200†	
136–143	I SUB 0	DOUBLE	GPS ICD-200†	
144–151	CRC	DOUBLE	GPS ICD-200†	
152–159	OMEGA	DOUBLE	GPS ICD-200†	
160–167	OMEGA DOT	DOUBLE	GPS ICD-200†	
168–175	I DOT	DOUBLE	GPS ICD-200†	
176–179	FLAGS	LONG	Table 8-28	Shows status of Ephemeris Flags
180	CHECKSUM	CHAR	Table 6-1	Checksum value
181	ETX	CHAR	03h	End transmission

† Refer to the United States Government document GPS ICD-200 for detailed information.

Table 8-28. 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 8-29 describes the packet structure.

Table 8-29. Command Packet 55h ALMANAC Report Structure

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

† Refer to the United States Government document GPS ICD-200 for detailed information.

Table 8-29. Command Packet 55h ALMANAC Report Structure (Continued)

Byte #	Item	Type	Value	Meaning
73	CHECKSUM	CHAR	Table 6-1	Checksum value
74	ETX	CHAR	03h	End transmission

† Refer to the United States Government document GPS ICD-200 for detailed information.

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 8-30 describes the packet structure.

Table 8-30. RETSVDATA UTC/ION Packet Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	55h	Report Packet 55h
3	LENGTH	CHAR	Table 6-1	Data byte count
4	DATA TYPE INDICATOR	CHAR	03h	UTC/ION Report
5	SV PRN #	CHAR	00h	Data for all satellites
Begin UTC Data				
6–13	ALPHA 0	DOUBLE	GPS ICD-200†	
14–21	ALPHA 1	DOUBLE	GPS ICD-200†	
22–29	ALPHA 2	DOUBLE	GPS ICD-200†	
30–37	ALPHA 3	DOUBLE	GPS ICD-200†	
38–45	BETA 0	DOUBLE	GPS ICD-200†	
46–53	BETA 1	DOUBLE	GPS ICD-200†	

† Refer to the United States Government document GPS ICD-200 for detailed information.

Table 8-30. RETSVDATA UTC/ION Packet Structure (Continued)

Byte #	Item	Type	Value	Meaning
54–61	BETA 2	DOUBLE	GPS ICD-200†	
62–69	BETA 3	DOUBLE	GPS ICD-200†	
Begin Ionospheric Data				
70–77	ASUB0	DOUBLE	GPS ICD-200†	
78–85	ASUB1	DOUBLE	GPS ICD-200†	
86–93	TSUB0T	DOUBLE	GPS ICD-200†	
94–101	DELTATLS	DOUBLE	GPS ICD-200†	
102–109	DELTATLSF	DOUBLE	GPS ICD-200†	
110–117	IONTIME	DOUBLE	GPS ICD-200†	
118	WNSUBT	CHAR	GPS ICD-200†	
119	WNSUBLSF	CHAR	GPS ICD-200†	
120	DN	CHAR	GPS ICD-200†	
121–126	RESERVED	CHARs	GPS ICD-200†	Reserved (set to zero)
127	CHECKSUM	CHAR	Table 6-1	Checksum value
128	ETX	CHAR	03h	End transmission

† Refer to the United States Government document GPS ICD-200 for detailed information.

57h Report Packet 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 Application Files on page 6-11.

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 (e.g. 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 where ever 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 Format LENGTH = 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 8-31 shows the structure of Report Packet 57h when Expanded Record format is enabled with Command Packet 56h.

Table 8-31. Report Packet 57h Structure (Expanded Format)

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	Table 6-1	Data byte count
4	RECORD TYPE	CHAR	Table 8-33	Raw data record type
5	PAGING INFO	CHAR	Table 8-34	b7–b4 is the current page number. b3–b0 is the total pages in this epoch (e.g. 1 of 3, 2 of 3, 3 of 3).

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

Table 8-31. Report Packet 57h Structure (Expanded Format) (Continued)

Byte #	Item	Type	Value	Meaning
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	Table 8-35	Bit 0 must be set to 0 to enable Expanded Record format.
Begin Expanded Format Record Header *(17 bytes)*				
8–15	RECEIVE TIME	DOUBLE	*msecs*	Receive time within the current GPS week (common to code and phase data).
16–23	CLOCK OFFSET	DOUBLE	*msecs*	Clock offset value. A value of 0.0 indicates that clock offset is not known.
24	# OF SVS IN RECORD	CHAR		Number of SV data blocks included in record.
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	Table 8-36	First set of status flags
	FLAGS2	CHAR	Table 8-37	Second set of status flags

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

Table 8-31. Report Packet 57h Structure (Expanded Format) (Continued)

Byte #	Item	Type	Value	Meaning
	FLAG STATUS	CHAR	Table 8-38	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

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

Table 8-31. 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.

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

Table 8-31. Report Packet 57h Structure (Expanded Format) (Continued)

Byte #	Item	Type	Value	Meaning
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).

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

Table 8-31. Report Packet 57h Structure (Expanded Format) (Continued)

Byte #	Item	Type	Value	Meaning
Begin Enhanced Record† 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	Table 6-1	Checksum value
	ETX	CHAR	03h	End transmission

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

Concise Record Format

Table 8-32 shows the structure of Report Packet 57h when Concise Record format is enabled with Command Packet 56h.

Table 8-32. Report Packet 57h Structure (Concise Format)

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	Table 6-1	Data byte count
4	RECORD TYPE	CHAR	Table 8-33	Raw data record type
5	PAGING INFO	CHAR	Table 8-34	b7–b4 is the current page number. b3–b0 is the total pages in this epoch (e.g. 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	Table 8-35	Bit 0 must be set to 1 to enable Concise Record format.

1 L2 encrypted. See bit 1 and bit 2 of FLAGS2.

2 P-code, see bit 0 of FLAGS2.

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

Table 8-32. Report Packet 57h Structure (Concise Format) (Continued)

Byte #	Item	Type	Value	Meaning
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.
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	Table 8-36	First set of satellite status flags
	FLAGS2	CHAR	Table 8-37	Second set of satellite status flags
	ELEVATION ANGLE	CHAR	*degrees*	Satellite elevation angle (negative or positive).
	AZIMUTH	SHORT	*degrees*	Azimuth of satellite

1 L2 encrypted. See bit 1 and bit 2 of FLAGS2.
2 P-code, see bit 0 of FLAGS2.
3 To be compatible with Trimble software, this data must be stripped off before record 17 is stored in a *.DAT file.

Table 8-32. Report Packet 57h Structure (Concise Format) (Continued)

Byte #	Item	Type	Value	Meaning
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
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.
Begin Enhanced Record[3] if bit 1 of the FLAGS byte is set to 1 *(3 bytes * n)*				
	IODE	CHAR	00h–FFh	Issue of Data Emphemeris

1 L2 encrypted. See bit 1 and bit 2 of FLAGS2.
2 P-code, see bit 0 of FLAGS2.
3 To be compatible with Trimble software, this data must be stripped off before record 17 is stored in a *.DAT file.

Table 8-32. Report Packet 57h Structure (Concise Format) (Continued)

Byte #	Item	Type	Value	Meaning
	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	Table 6-1	Checksum value
	ETX	CHAR	03h	End transmission

1 L2 encrypted. See bit 1 and bit 2 of FLAGS2.

2 P-code, see bit 0 of FLAGS2.

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

Table 8-33. RECORD TYPE Byte Values

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

Table 8-34. PAGE INFO Bit Values

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

Table 8-35. 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 8-36. FLAGS1 Bit Values

Bit	Meaning
0	L2 Data Loaded and Phase Valid (also see bit 6) 0: Off 1: On
1	L1 Cycle-slip (since last record 17 write) 0: Off 1: On
2	L2 Cycle-slip (since last record 17 write) 0: Off 1: On
3	L1 Phase Lock Point (redundant, for diagnostics) 0: Off 1: On
4	L1 Phase valid (lock-point valid) 0: Off 1: On
5	L2 Pseudorange (reset = squared - L2 phase) 0: Off (always for Series 7400 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 8-38) 0: Off 1: On
7	New Position Computed during this Receiver Cycle 0: Off 1: On

Table 8-37. 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
3	Filtered L1 Band Pseudorange Corrections 0: Off 1: On
4–7	Reserved (bits set to zero)

Table 8-38. 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 8-39 shows the structure of Report Packet 57h when the Position Record is enabled with Command Packet 56h.

Position Record Length = 78 + N * 2

where N is the number of satellites.

Table 8-39. Position Record (Record Type 11) Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status
2	PACKET TYPE	CHAR	57h	RAWDATA
3	LENGTH	CHAR	Table 6-1	Data byte count
4	RECORD TYPE	CHAR	Table 8-33	Raw data record type
5	PAGING INFO	CHAR	Table 8-34	b7–b4 is the current page number. b3–b0 is the total pages in this epoch (e.g. 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.

Table 8-39. Position Record (Record Type 11) Structure (Continued)

Byte #	Item	Type	Value	Meaning
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	Table 8-40	Position status flags
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	Table 6-1	Checksum value
	ETX	CHAR	03h	End transmission

Table 8-40. 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; bit set to 0
6	Real-Time Kinematic (RTK) Positions 0: False 1: True
7	Position Derived While Static 0: False 1: True

64h

Report Packet 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 detailed information, about Series 7400 Application Files and guidelines for using application files to control remote devices, see Application Files on page 6-11.

Packet Paging

Since an application file contains a maximum of 2048 bytes (all records are optional) of data and exceeds the byte limit for TrimComm packets, Report 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 where ever the 245 byte boundary falls. Therefore the remote device receiving the report pages must reconstruct the application file using the 248 byte pages before parsing the data.

To prevent data mismatches, each report packet is assigned a text 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 8-41 shows the structure of the report packet containing the application file.

Table 8-41. Command Packet 64h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	64h	Command Packet 64h
3	LENGTH	CHAR	Table 6-1	Data byte count
4	TX BLOCK IDENTIFIER	CHAR	00h–FFh	A number (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

† The date/time fields are relative to UTC.
‡ Zero (0) is equal to infinite.

Table 8-41. 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	Table 8-42	Unique identifier for every receiver/device type that supports the application file interface
9	START APPLICATION FILE FLAG	CHAR	Table 8-43	Determines whether or not the application file is activated immediately after records are sent to receiver.
10	FACTORY SETTINGS FLAG	CHAR	Table 8-44	Determines whether or not the receiver is reset to factory default settings prior to activating the records in the application file.

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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*	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)†

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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, Frequency Rate, PDOP (Position Dilution of Precision) Mask, and Frequency Source.				
0	RECORD TYPE	CHAR	01h	General Controls Record
1	RECORD LENGTH	CHAR	04h	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	Table 8-45	Frequency rate at which the receiver generates measurements
4	PDOP MASK	CHAR	00h–FFh‡	Position Dilution of Precision Mask (0–255)
5	FREQUENCY SOURCE	CHAR	Table 8-46	Sets the receiver to use its internal timebase or an external timebase

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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	Table 8-47	Data transmission rate
4	PARITY	CHAR	Table 8-48	Sets the parity of data transmitted through the port. Note that the eight data bits and one stop bit are always used, regardless of the parity selection.
5	FLOW CONTROL	CHAR	Table 8-49	Flow control

† The date/time fields are relative to UTC.
‡ Zero (0) is equal to infinite.

Table 8-41. 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 (reference) station nodes.				
0	RECORD TYPE	CHAR	03h	Reference Node Record
1	RECORD LENGTH	CHAR	24h	Data bytes in the record, excluding bytes 0 and 1.
2	FLAG	CHAR	00h	Reserved
3	NODE INDEX	CHAR	00h	Reserved
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
36–37	STATION ID	SHORT	0000h–03FFh	Reference Node Station ID.

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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	Table 8-50	Array of Enable/Disable flags for the 32 SVs. The first byte sets the desired Enable/Disable status of SV1, the second sets the status of SV2, etc.

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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	Table 8-51	Type of message or packet
3	PORT INDEX	CHAR	00h–03h	Serial port index number.
4	FREQUENCY	CHAR	Table 8-52	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 SUB-MESSAGE TYPE	CHARs	Table 8-53	GSOF message number.
7	OFFSET	CHAR	0–255	Integer second offset from scheduled frequency
OUTPUT MESSAGE RECORD TYPE 4 (RT17)				

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
6	REAL-TIME 17 MESSAGE FLAGS	CHAR	Table 8-54	RT17 (Real Time 17) Flags
OUTPUT MESSAGE RECORD TYPE 3 (RTCM)				
6	RTCM FLAGS	CHAR	Table 8-55	Bit settings for RTCM output flags

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
BASE STATION ANTENNA RECORD The BASE STATION ANTENNA RECORD identifies the height of the base station (reference station) antenna.				
0	RECORD TYPE	CHAR	08h	Base Station Antenna Record
1	RECORD LENGTH	CHAR	08h	Number of bytes in record, excluding bytes 0 and 1
2–9	REFERENCE ANTENNA HEIGHT	DOUBLE	*meters*	Height of reference station antenna

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. 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	Table 8-56	Type of device
For Charger/Power Control Only				
3	CHARGER/ POWER CONTROL	CHAR	Table 8-57	Disables Charger/Power Control, enables the battery charger feature, or enables power output on the serial port when byte 2 is set to 0.
For 1 PPS Output Only				
3	1 PPS CONTROL	CHAR	Table 8-58	Enables or disables 1 PPS output byte 2 is set to 2

† The date/time fields are relative to UTC.
‡ Zero (0) is equal to infinite.

Table 8-41. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
For Clarion JX-10 Radio Only				
3	PORT	CHAR	00h–03h	Index number of serial port connected to Clarion JX-10 Radio.
4	JX-10 ENABLE FLAG	CHAR	Table 8-59	Enables or disables the Clarion JX-10 Radio when byte 2 is set to 6.
5	MODE	CHAR	Table 8-60	Sets the JX-10 Radio to operate as a rover radio or base station radio.
6	TRANSMIT CHANNEL	CHAR	00h–3Eh	The JX-10 Radio can be set to transmit data using one of 0–62 channels.
7	RECEIVE CHANNEL	CHAR	00h–3Eh	The JX-10 Radio can be set to receiver data on one of 0–62 channels.
8	LOCAL ADDRESS	CHAR	00–FFh	0–255
9	DESTINATION ADDRESS	CHAR	00–FFh	0–255
10	REPEATER	CHAR	Table 8-61	
11	PERIOD	CHAR	01h–78h	(1–120 seconds)
12–13	SLOT	CHAR		$1 \leq slot \leq 5 * period$
14	TIME DIVISION MULTIPLEXING	CHAR	Table 8-62	

† The date/time fields are relative to UTC.
‡ Zero (0) is equal to infinite.

Table 8-41. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
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	Table 8-63	Configures receiver for static or kinematic operation
Length +4	CHECKSUM	CHAR	Table 6-1	Checksum value
Length +5	ETX	CHAR	03h	End transmission

† The date/time fields are relative to UTC.

‡ Zero (0) is equal to infinite.

Table 8-41. Command Packet 64h Structure (Continued)

Byte #	Item	Type	Value	Meaning
RTCM INPUT RECORD The bytes value in the RTCM INPUT RECORD identify the RTK/GPS automatic switch over range and the station ID of 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. If this value is –1, 65535, or FFFFh, any station can be used.

† The date/time fields are relative to UTC.
‡ Zero (0) is equal to infinite.

Table 8-42. DEVICE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	All Devices
1	01h	Series 7400 receiver
2–255	02h–FFh	Reserved

Table 8-43. START APPLICATION FILE FLAG Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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 8-44. FACTORY SETTINGS Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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 8-45. MEASUREMENT RATE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	1 Hz
1	01h	5 Hz

Table 8-46. FREQUENCY SOURCE BYTE Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Internal frequency source
1	01h	5 MHz external frequency source
2	02h	10 MHz external frequency source

Table 8-47. BAUD RATE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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

Table 8-48. PARITY Byte Values

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

Table 8-49. FLOW CONTROL Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	None
1	01h	CTS

Table 8-50. SV ENABLE/DISABLE STATES Flag Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Default
1	01h	Disable the satellite
2	02h	Enable the satellite regardless of whether the satellite is in good or bad health

Table 8-51. OUTPUT MESSAGE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Output Protocol**
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
16–254	10h–FEh	Reserved (future output protocols)
255	FFh	All messages off on the specified port

Note – The number of supported output protocols could increase in the future.

Table 8-52. FREQUENCY Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
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
255	FFh	Once only, immediately

Table 8-53. GSOF SUB-MESSAGE TYPE Byte Values

Byte Value		
Dec	**Hex**	**Meaning**
0	00h	Switch all GSOF messages off
1	01h	Position and time
2	02h	WGS-84, Lat, Long, Height
3	03h	WGS-84 ECEF (XYZ) Position
4	04h	Local Datum Lat, Long, Height
5	05h	Local Projection East, North, Up
6	06h	Reference → Rover Vector (dx, dy, dz)
7	07h	Reference → Rover Vector (delta East, delta North, delta Up)
8	08h	Velocity and Header information
9	09h	Dilution of Precision (DOP) Values
10	0Ah	Clock data
11	0Bh	Error Covariance Data
12	0Ch	Position Statistics
13	0Dh	Brief satellite information
14	0Eh	Detailed satellite information
15	0Fh	Receiver Serial Number data
16	10h	Current GPS time and UTC offset

Table 8-54. 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 8-55. RTCM Flag Bit Values

Bit	Meaning
0	Output RTK (Types 18 and 19) 0: Off 1: On
1	Output DGPS (Type 1) 0: Off 1: On
2	Output DGPS (Type 9-3) 0: Off 1: On
3–7	Reserved (set to zero)

Table 8-56. DEVICE TYPE Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Battery Charger/Power output.
1	01h	Reserved
2	02h	1 PPS (Pulse per Second) Output
3	03h	Reserved
4	04h	Reserved
5	05h	Reserved
6	06h	Clarion JX-10 Radio

Table 8-57. CHARGER/POWER CONTROL Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Off
1	01h	Charger On
2	02h	Power output On

Table 8-58. 1 PPS CONTROL Byte Values

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

Table 8-59. JX-10 RADIO ENABLE FLAGS Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disable JX-10 Radio
1	01h	Enable JX-10 Radio

Table 8-60. JX-10 RADIO MODE Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Rover
1	01h	Base Station

Table 8-61. JX-10 RADIO REPEATER Byte Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disabled – radio is not operating as a repeater
1–8	01h–08h	Enabled – radio is operating as a repeater

Table 8-62. JX-10 RADIO TIME DIVISION MULTIPLEXING Values

Byte Value		
Dec	Hex	Meaning
0	00h	Disable (Allow multi-Hz outputs, but limit system to single rover)
1	01h	Enable (Allows for multiple rover receivers, but limits outputs to 1 Hz)

Table 8-63. STATIC/KINEMATIC MODE Byte Values

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

67h Report Packet 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 Command Packet 66h on page 7-39.

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 (e.g. 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 8-64 describes the packet structure.

Table 8-64. Report Packet 67h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	67h	Report Packet 67h
3	LENGTH	CHAR	Table 6-1	Data byte count
4	TX BLOCK IDENTIFIER	CHAR	00h–FFh	Unique number assigned to every application file transfer.
5	PAGE INDEX	CHAR	00h–FFh	Page index assigned to packet page
6	MAXIMUM PAGE INDEX	CHAR	00h–FFh	Page index assigned to the last packet page
Begin Directory List				
7	# APP FILES		00h–*n*	Number of application files in directory
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	Table 8-65	Record number assigned to the file
9–16	APP FILE NAME	CHARs	*ASCII text*	Name of application file (8 ASCII characters)
17	CREATION YEAR†	CHAR	00h–FFh	Year when file is created. Based on the years since 1900 (1900 = 00)
18	CREATION MONTH†	CHAR	01h–0Ch	Month of the year when file is created (1–12)

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

Table 8-64. Report Packet 67h Structure (Continued)

Byte #	Item	Type	Value	Meaning
19	CREATION DAY†	CHAR	01h–1Fh	Day of the month when file is created (1–31)
20	CREATION HOUR†	CHAR	00h–17h	Hour when file is created (0–23)
21	CREATION MINUTES†	CHAR	00h–3Bh	Minutes of hour when file is created (0–59)
22–23	APP FILE SIZE	SHORT	*bytes*	Size of file.
Begin Second Application File Record Entry . . . *End with Last Application File Record Entry*				
Length +4	CHECKSUM	CHAR	Table 6-1	Checksum value
Length +5	ETX	CHAR	03h	End transmission

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

Table 8-65. SYSTEM FILE INDEX Values

Byte Value		
Dec	Hex	Meaning
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

Report Packet 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 a PC 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 8-66).

Table 8-66 describes the structure of Report Packet 6Eh.

Table 8-66. Report Packet 6Eh Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status indicator
2	PACKET TYPE	CHAR	6Eh	Report Packet 6Eh
3	LENGTH	CHAR	Table 6-1	Data byte count
	PRODUCT	CHARs	*comma delimited ASCII string*	Comma-delimited ASCII string indicating the receiver product family name. For more information, see PRODUCT on page 8-93.
	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 on page 8-93.
	VERSION	CHARs	*comma delimited ASCII string*	Comma-delimited ASCII string indicating the software version number and version release date. For more information, see VERSION on page 8-94.
	COMM	CHARs	*comma delimited ASCII string*	Comma-delimited ASCII string indicating the communication protocols supported on serial port. For more information, see COMM on page 8-95.
	CHECKSUM	CHAR	Table 6-1	Checksum value
	ETX	CHAR	03h	End transmission

Identity Message Format

The following example shows the structure of a Identity Message:

<STX><0><0x6E><93>
PRODUCT,7400;
PORT,1,38400,38400,8,1,N,F;
VERSION,2.21,10/21/96,,;
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 Series 7400 receivers, the PRODUCT string is always set to 7400. The string always begins with the word PRODUCT, followed by a comma, followed by the word 7400, and terminated with a semicolon as in the following example:

PRODUCT,7400;

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, or 38400 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 Series 7400 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,2.21,10/21/96,,;

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 8-67 identifies the ASCII codes assigned to the various protocols supported be the Series 7400 receiver.

Table 8-67. 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

Report Packet 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 Command Packet 82h on page 7-44.

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 Series 7400 display screen, and sends the dump to the remote device in Report Packet 82h. Table 8-68 shows the packet structure.

Table 8-68. Report Packet 82h Structure

Byte #	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission
1	STATUS	CHAR	Table 6-2	Receiver status code
2	PACKET TYPE	CHAR	82h	Report Packet 82h
3	LENGTH	CHAR	A1h	Data byte count
4–163	ASCII DATA	CHARs		ASCII data
164	CURSOR POSITION	CHAR		Position of the cursor.
165	CHECKSUM	CHAR	Table 6-1	Checksum value
166	ETX	CHAR	03h	End transmission

A Data and Power Connections

All data and power connections for the Series 7400 receiver are located on the rear panel, as shown in Figure A-1.

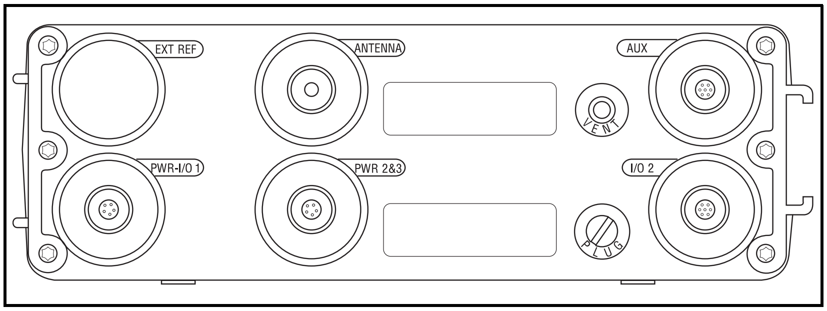

Figure A-1. Series 7400 Rear Panel

Table A-1 lists each of the data and power connectors and describes its function.

Table A-1. Connectors on the Rear Panel

Connector	Function
PWR-I/O 1	Serial port 1, power port 1; 10.75 to 35 VDC input or power output
I/O 2	Serial port 2; power output with direct connection to power lines on PWR-I/O 1, or software selected with power input on PWR 2&3
PWR 2&3	Serial port 3, power port 2; 10.75 to 35 VDC input or battery charging output
AUX	Serial port 4; 1 pulse/second output
ANTENNA	Antenna input
EXT REF	External timebase input (if External Frequency Input Option is installed)

A.1 Power In

The Series 7400 receiver can input power through the PWR-I/O 1 and/or PWR 2&3 connectors. See Figure A-2 and Table A-2. Cable P/N 27767 provides fused power input through PWR-I/O 1 or PWR 2&3. Trimble batteries, adapters, or other special cables can also be used.

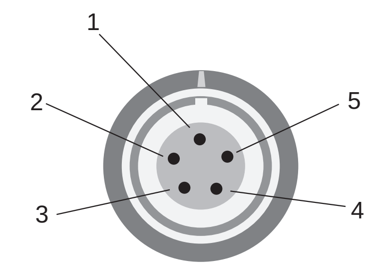

Figure A-2. 5-Pin Power In Port

Table A-2. Power In Pinouts

Pin	PWR 2&3	PWR-I/O 1
1	Battery 2 power in	Power 1 in & out
2	Battery 2 ground	Power 1 ground
3	Serial I/O 3 data in	Serial I/O 1 data in
4	Serial I/O 3 signal ground	Serial I/O 1 signal ground
5	Serial I/O 3 data out	Serial I/O 1 data out

The Series 7400 receiver requires a 1-ampere, 11 to 35 VDC power supply. The receiver switches to an alternative power source when the battery voltage drops below 10.75 VDC, if the alternative source is connected to the Series 7400 power port. If an alternative source is not connected to the receiver power port, the receiver turns itself off.

The power source must be protected by a 3 to 5-ampere load fuse, and must be regulated to eliminate voltage spikes or voids. It must be filtered to within the 11 to 35 volt operating range. Power from an unfiltered automobile battery charger is not acceptable.

Caution – The Series 7400 DC power inputs have no user-serviceable fuses. Any external DC power supply must be fuse-protected by a 3 to 5 ampere load fuse. The Trimble equipment warranty is void if this precaution is not followed. All Trimble battery cables have in-line fuses to protect the receiver.

A.1.1 Selecting a Power Source

If a source of more than 14.7 VDC (such as an OSM2) is attached to any of a Series 7400 power input connectors, the receiver automatically selects that source when turned on. It ordinarily does not change sources while running unless the selected source drops below 10.75 VDC. The Series 7400 switches to the OSM2 if one is plugged in while battery charging is enabled.

If a source of more than 14.7 VDC is not available on a power connector at power-up, the Series 7400 receiver selects the lowest-voltage source available. When that source drops below 10.75 VDC, it automatically selects the next lowest source.

A.2 Power Out

The Series 7400 receiver can supply power output through ports I/O 2 or PWR-I/O 1. This power output will be approximately equal to the supplied voltage and can operate a low-power remote device such as a remote display or a radio modem. The remote device must use a soft-start sequence so that the initial current drain is not too large.

To enable power output:

1. Connect PWR 2 to a power source.
2. Disconnect PWR-I/O 1 from any power source.
3. Connect the remote device to I/O 2 or PWR-I/O 1.
4. Press CONTROL.
5. Click on the <**POWER/CHARGER**> softkey.
6. Press ALPHA to choose POWER OUT and enable the power output.
7. Turn on the remote device.

A.3 Power Supply Options

Table A-3 provides a list of power supply options.

Table A-3. Batteries, Power Sources, and Cables

P/N	Description
13543-00	Rechargeable 6 ampere-hour external battery, with hard case and cable
13542-00	Rechargeable 10 ampere-hour external battery, with soft case and cable
17466	Rechargeable 2.3 ampere-hour external battery (camcorder battery)
23001-00	Office Support Module 2 (OSM2); a 100 to 240 VAC power adapter, data DE-9 connector, and battery charger. Automatically adapts to local line voltage. Includes power cable for U.S style outlets and the *OSM2 Operation Manual.*
11017	SM2 power cord for U.S. style outlets
29148-10	Power Supply, 16VDC, 1.5A, with Lemo 5 pin connector.
28406	Y cable (Lemo 5-pin to Lemo 5-pin and DE-9).
16668-00	General purpose power adapter; attaches the PWR-I/O 1 port to a 12 VDC terminal strip. Also provides a DE9S connector for access to one of the receiver's serial ports.
14555-00	General purpose battery cable; LEMO 5-pin to terminal clips. Suitable for use on PWR-I/O 1 or PWR 2&3.
16474	Fused DC power cable
18939	Dual input fused DC power cable; LEMO 5-pin to pigtails. Suitable for use on PWR 2&3 only.
18294	Dual camcorder battery input cable; LEMO 5-pin to battery clips. Connects one battery to each power port (PWR 2&3).
21184	Quadruple battery input cable; LEMO 5-pin to battery clips. Connects two batteries to each power port (PWR 2&3).
16041-00	Data and power connector adapter; splits the PWR-I/O 1 connector into a LEMO 5-pin connector for power and DE9S connector for serial port 1

When the Series 7400 receiver is connected to an OSM2 or 18 VDC (0–5 ampere) power supply through PWR-I/O 1 port, batteries can be recharged from the receiver's PWR 2&3 port. To enable the Series 7400 battery charging feature:

1. Connect an OSM2 to PWR-I/O 1.
2. Connect one or more batteries to PWR 2&3.
3. Press CONTROL.
4. Click on the <**POWER/CHARGER>** softkey.
5. Press ALPHA to choose CHARGER ENABLED and enable the battery charging function.

A Series 7400 receiver that is not connected to an OSM2 or 18 VDC (0–5 ampere) power supply cannot charge batteries even if the battery charging function is enabled. If an OSM2 is plugged in while the receiver is running and battery charging is enabled, the Series 7400 switches over to the OSM2 and begins charging the battery.

A.4 GPS Antennas and Cables

The antenna that a receiver uses to collect satellite signals is sometimes called a GPS antenna to distinguish it from a radio antenna used for communication between receivers in techniques such as RTK and DGPS.

The Series 7400 receiver is connected to its antenna through the Lemo connector labeled ANTENNA. A coaxial cable with a type N plug at the antenna end is used.

For antenna cable lengths of 35 feet (10 meters) or less, RG-58 cable may be used. For cable lengths over 35 feet, RG-213 cable must be used. For cable lengths over 100 feet (30 meters), an in-line amplifier, semi-rigid coaxial cable, or other low-loss cable assembly must be used. For a list of accessories and spare parts, refer to the *User Guide* included with the receiver.

A.5 Serial Ports

The Series 7400 receiver presents port 1 on the PWR-I/O 1 connector, and port 2 on I/O 2. Port 3 is on PWR 2&3. Port 4 is on AUX. See Figure A-3 and Table A-4.

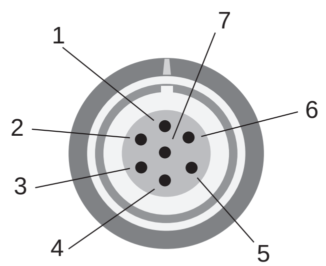

Figure A-3. 7-Pin Serial Port

Table A-4. Serial Port Pinouts

Pin	I/O 2	AUX
1	Signal ground	Signal ground
2	Power 2 ground	1 PPS out
3	Serial I/O 2 data in	Serial I/O 4 data in
4	Serial I/O 2 RTS	Serial I/O 4 RTS
5	Serial I/O 2 CTS	Serial I/O 4 CTS
6	Power 2 out	Event in
7	Serial I/O 2 data out	Serial I/O 4 data out

A.5.1 Baud Rate, Format, and Flow Control

Each serial port's baud rate, format, and flow control can be set independently. Table A-5 shows the combinations for each port.

To change a port's format, baud rate, and/or flow control:

1. From the CONTROL menu, select ALPHA and click on the <**SERIAL PORT SETUP>** softkey.
2. Select the port number, baud rate, and format, and type of flow control.

Table A-5. Serial Port Parameters

	Port 1	**Port 2**	**Port 3**	**Port 4**
Baud Rate	2400, 4800, 9600, 19.2K, 38.4K	2400, 4800, 9600, 19.2K, 38.4K	Same as port 2	Same as port 2
Data Format (data bits, parity, stop bits)	8,None,1 8,Even,1 8,Odd,1	8, None, 1 8, Even, 1 8, Odd, 1	Same as port 2	Same as port 2
Flow Control	NONE	NONE or RTS/CTS	Same as port 1	Same as port 2

A.5.2 Data Cables

The Series 7400 receiver is supplied with three data cables to bring out the data lines to DE9 socket connectors in a DCE configuration. Their descriptions are given in Table A-6, Table A-7, and Table A-8.

Table A-6. Serial Data Cable P/N 18826 Pinout

LEMO 5-Pin	DE9S
1	N/C
2	N/C
3	3
4	5
5	2

Table A-7. Serial Data Cable P/N 18827 Pinout

LEMO 7-pin	DE9S
1	5
2	N/C
3	3
4	7
5	8
6	N/C
7	2

Table A-8. Power Data Cable P/N 27767 Pinout

External Wire	LEMO 5-pin	DE9S
+12 VDC (Red)	1	N/C
GND (Black)	2	N/C
	3	3
	4	5
	5	2

These cables can be connected directly to a computer's RS-232 COM port in DTE configuration (the standard configuration on IBM PCs and PC-compatible computers).

To connect these serial ports to a DCE device such as a modem, connect a null modem cable to the end of the standard cable. The null cable swaps the pin positions of the data lines and the control lines so the one device's transmit line, for example, is attached to the other's receive line. Table A-9 is an example pinout.

Table A-9. Null Modem Cable Pinout

DE9P	DE9P
2	3
3	2
5	5
7	8
8	7

A.5.3 Split Data Cable

A serial port can read and write simultaneously. This makes it possible to split a data cable so that a single serial port on the Series 7400 receiver can simultaneously input data from one device and output data to another. For example, port 1 can simultaneously input RTK corrections and output position reports.

Figure A-4 shows a suitable design for a split cable attached to a portable receiver's PWR-I/O 1 port. Data Source inputs data to port 1. Data Sink receives the output data from port 1.

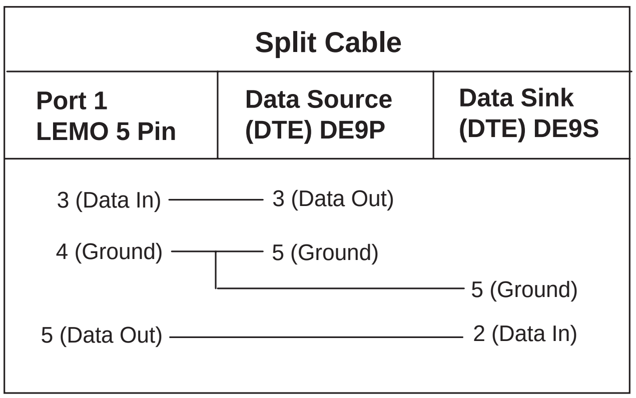

Figure A-4. Split Cable Design

You can design split cables for the other ports as well. For ports 2 and 4, remember to wire the CTS and RTS lines if CTS/RTS flow control can be used.

A.6 1 PPS Time Strobe and Time Tag

The Series 7400 receiver can output a 1 pulse/second (1 PPS) time strobe and an associated time tag. The receiver outputs the pulse on the AUX connector, Figure A-5, using the pinouts shown in Table A-10. The time tags are output on a user-selected serial port.

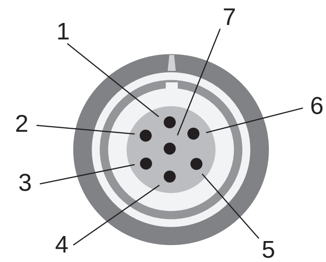

Figure A-5. 7-Pin AUX Port

Table A-10. AUX Pinout

Pin	Function
1	Signal ground
2	1 PPS out
3	Serial I/O 4 data in
4	Serial I/O 4 RTS
5	Serial I/O 4 CTS
6	Event in
7	Serial I/O 4 data out

The leading edge of the pulse coincides with the beginning of each UTC second. The pulse is driven by an RS-422 driver between nominal levels of 0.0V and 4.0V. The leading edge is positive (rising from 0V to 4V).

The pulse is about 1 µsec wide, with rise and fall times of about 100 nsec. Resolution is approximately 40 nsec, but several external factors limit accuracy to approximately ±1 µsec:

- Selective Availability: When in effect, introduces errors of up to 30 meters (100 nsec) in satellite signals, with corresponding errors in the 1 PPS pulse.
- antenna cable length: Each meter of cable adds a delay of about 2 nsec. to satellite signals, and a corresponding delay in the 1 PPS pulse.

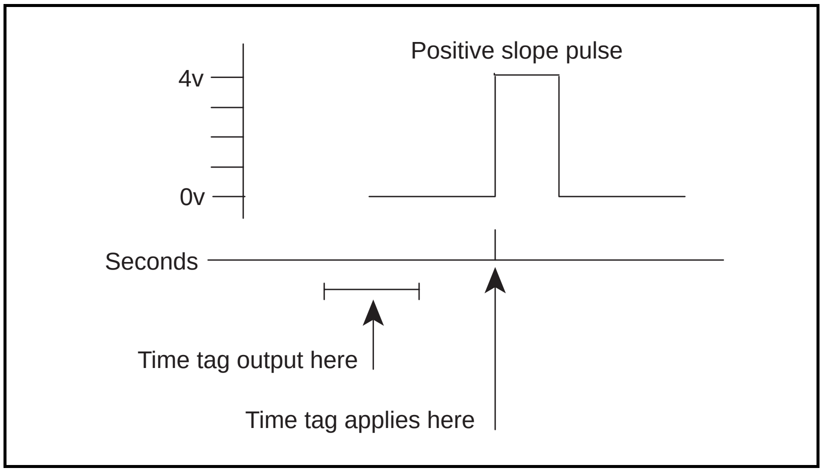

Figure A-6. Time Tag Relation to 1 PPS Wave Form

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

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

Where:

- UTC is fixed text.
- *yy.mm.dd* is the year, month, and date.
- *hh:mm:ss* is the hour (on a 24-hour clock), minute, and second. Note that the time is in UTC, not GPS.
- *a* is the position-fix type:
  1 = time only
  2 = 1D & time
  3 is currently unused
  4 = 2D & time
  5 = 3D & time
- *b* is number of satellites being tracked: 1 to 9.
- Each time tag is terminated by a *carriage return, line feed* sequence.

A typical printout looks like:

```
UTC 93.12.21 20:21:16 56
UTC 93.12.21 20:21:17 56
UTC 93.12.21 20:21:18 56
```

a and *b* may be ??, meaning that the time is based on the Series 7400 clock because the receiver is not tracking satellites. The receiver clock is less accurate than time readings extracted from satellite signals.

B Specifications

Table B-1 and Table B-2 contain physical and technical specifications for the Series 7400 receiver.

Table B-1. Series 7400 Physical Specifications

Size	24 cm (W) x 8 cm (H) x 28 cm (D) 9.4" (W) x 3.1" (H) x 11.0" (D)
Weight	2.8 kg (6.2 lbs.)
Power	9 watts typical, 10.5 to 35 VDC
Operating Temperature	-25°C to +55°C (-40°F to +158°F)
Storage Temperature	-30°C to +75°C (-40°F to +185°F)
Humidity	100% fully sealed
Casing	Dust proof, splash proof, water proof and shock resistant

Table B-2. Series 7400 Technical Specifications

Tracking	9 channels L1 C/A code, L1/L2 full cycle carrier. Fully operational during P-code encryption.		
Signal Processing	Maxwell architecture; very low-noise C/A code processing; multipath suppression		
Start-up	<2 minutes from power on (cold start) <30 seconds with recent ephemeris (warm start)		
Positioning RTK (OTF)	**Mode**	**Latency**	**Accuracy[1,2]**
	1 Hz	0.4 sec	1 cm + 2 ppm (times baseline length) Horizontal 2 cm + 2 ppm (times baseline length) Vertical
	5 Hz	0.1 sec	3 cm + 2 ppm (times baseline length) Horizontal 5 cm + 2 ppm (times baseline length) Vertical
	Initialization		Automatic while moving or static
	Time Required		Typically <1 minute to initialize
	Range		Up to 10 km
Positioning (L1 C/A Code Phase)	**Mode**	**Latency**	**Accuracy[1,2]**
	1 Hz/5 Hz	0.1 sec	Horizontal – 50 cm Vertical – 75 cm
Communications	4 x RS-232 ports. Baud rates up to 38,400		
Configuration	Configuration of receiver via user definable application files		
Remote Control	Full control and display of receiver operations via graphical user interface software running remotely under Microsoft Windows		
Output Formats	NMEA-0183: GGK, GGA, ZDA, VTG, GST, PJT, PJK Trimble Binary Streamed Output		

1 Depends on radio link latency.
2 One sigma figure of merit, varies with S/A errors and satellite geometry.

C Updating Firmware

Trimble distributes firmware upgrades on disk, or, if you have a modem, you can download the upgrade file from the Trimble Bulletin Board (refer to the Preface).

The disk contains an encrypted security file (LOADER.BIN) of serial numbers entitled to use the update. If you receive an error message, view file SERIALS.*, this contains an ASCII text file of serials contained in LOADER.BIN. If your serial number (last four or five digits only) is not in this file contact Trimble Service for assistance.

Do the following to update the Series 7400 firmware:

1. Connect a serial port of your PC to the PWR-I/O 1 port on the Series 7400 receiver.
2. If the connection from step 1 does not provide power to the Series 7400 receiver, connect a battery or OSM to the PWR 2&3 port on the receiver.
3. Power up the Series 7400 receiver.
4. Run the UPDATE batch file and select the Baud Rate and Serial Communications Port as follows:
   - To update at 38400 baud using COMM PORT 1, type UPDATE 1 and press Enter.
   - To update at 9600 baud using COMM PORT 1, type UPDATE_S 1 and press Enter.
   - To update at 38400 baud using COMM PORT 2, type UPDATE 2 and press Enter.

- To update at 9600 baud using COMM PORT 2, type UPDATE_S 2 and press [Enter].

Note – At 38400 baud, the update takes approximately 3 minutes. This is the recommended speed. If your PC does not run reliably at 38400 baud, try the option at 9600 baud. At this baud rate the update takes approximately 12 minutes.

5. The program finds the baud rate of the instrument, sets the baud rate to either 38400 or 9600, depending on whether the operator typed update or update_s, extracts the serial number of the Series 7400 receiver, checks to see if that serial number has a current firmware support registration, and then proceeds to perform the update. When completed, the program instructs the receiver to reboot.

6. From the [STATUS] menu, click on the **<FACTORY CONFIGURATION>** softkey to verify the version number that loaded.

D Serial Number Form

Fill out this form when you unpack your receiver(s). Copy or remove the form and store it in a safe place. You may need the serial numbers if the equipment is lost, stolen, or damaged.

Table D-1. Receiver Information

Description	Serial Number	Part Number

Table D-2. Antenna Information (Optional)

Description	Serial Number	Part Number

Table D-3. Power Source Information (Optional)

Description	Serial Number	Part Number

Table D-4. Battery Information (Optional)

Description	Serial Number	Part Number

E Hexadecimal Conversion Tables

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	

Dec	Hex	ASCII
28	1Ch	
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

Dec	Hex	ASCII
56	38h	8
57	39h	9
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

Dec	Hex	ASCII
84	54h	T
85	55h	U
86	56h	V
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

Dec	Hex	ASCII
112	70h	p
113	71h	q
114	72h	r
115	73h	s
116	74h	t
117	75h	u
118	76h	v
119	77h	x
120	78h	y
121	79h	z
122	7Ah	{
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	

Dec	Hex	ASCII
140	8Ch	
141	8Dh	
142	8Eh	
143	8Fh	
144	90h	
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	

Dec	Hex	ASCII
168	A8h	
169	A9h	
170	AAh	
171	ABh	
172	ACh	
173	ADh	
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	

Dec	Hex	ASCII
196	C4h	
197	C5h	
198	C6h	
199	C7h	
200	C8h	
201	C9h	
202	CAh	
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	

Dec	Hex	ASCII
224	E0h	
225	E1h	
226	E2h	
227	E3h	
228	E4h	
229	E5h	
230	E6h	
231	E7h	
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	

Dec	Hex	ASCII
252	FCh	
253	FDh	
254	FEh	
255	FFh	

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SS-GPS-300B

System Specification for the NAVSTAR Global Positioning System

ICD-GPS-200

see: NAVSTAR GPS Space Segment/Navigation User Interfaces

Differential GPS Explained, Trimble P/N 23036 (1993)

A companion to *GPS, A Guide to the Next Utility*, explaining the topic of differential GPS (DGPS).

GPS, A Guide to the Next Utility, Trimble P/N 18239 (1992)

A short, non-technical introduction to GPS/ Explains what GPS does, how it works, and what its capabilities and limitations are.

Guide to GPS Positioning, David Wells (editor), Canadian GPS Associates (1986).

A comprehensive introduction to the principles and applications of GPS. While this book's perspective and terminology are outdated, it remains a standard work in the field. The papers cover a spectrum from highly conceptual to highly technical.

NAVSTAR GPS Space Segment: Navigation User Interfaces, drawing number ICD-GPS-200 (3 July 1991).

The official definition of the data formats used in NAVSTAR GPS satellite signals. The document is published in two versions: a public release version that excludes classified information about P-code, and a controlled release version that includes the classified information. The public release version is distributed by the United States Coast Guard. Write or call:

Commanding Officer
USCG ONSCEN
7323 Telegraph Road
Alexandria, VA 22310
(703) 313-5900

Proceedings of the Institute of Navigation, Washington DC

A series of 3 abstracts published between 1980 & 1986 of papers from the Journal of the Institute of Navigation. Essential source material for any system designer.

RTCM Recommended Standards for Differential GPS Service. RTCM Paper 194-93 / SC104-STD (January 3, 1994), Trimble P/N 19454.

Defines Version 2.1 of the RTCM message protocol.

TRIMTALK 900 Operation Manual, Trimble P/N 27608-00

User manual for the TRIMTALK 900, a short-range radio intended for linking receivers for RTK surveying or DGPS applications.

Using Radio Communication Systems with GPS Surveying Receivers, a Trimble Navigation Application & Technical Note (no part number).

This brief document suggests some measures you can take to deal with interference when using GPS receivers with radio links.

Glossary

This section defines technical terms and abbreviations used in Trimble documentation. These definitions are oriented to the needs of Series 7400 receiver users. Many have been simplified to exclude details that are not relevant to the Series 7400 receiver, or to reduce the amount of technical background required to understand them.

absolute positioning
The process of computing a position fix from satellite data alone, without reference to corrections supplied by a reference station.

acquisition
The process of locking onto a satellite's C/A code and P-code. A receiver acquires all available satellites when it is powered up, and acquires additional satellites as they become available. Once a receiver acquires a satellite, it tracks that satellite until the satellite's signal becomes unavailable.

almanac
Information about NAVSTAR satellite orbits, Keplerian elements, clock corrections, atmospheric delay parameters, and health status transmitted by each satellite. GPS receivers use this information for satellite acquisition and postprocessing.

AH
Ampere hour(s), a measure of a battery's capacity to deliver current over time. A 10 AH battery can deliver 1 ampere for 10 hours, 2 amperes for 5 hours, and so on.

Anti-Spoofing (AS)
A feature that allows the U.S. Department of Defense to transmit an encrypted Y-code in place of P-code. Y-code is intended to be useful only to authorized (primarily military) users. Anti-Spoofing is used with Selective Availability to deny the full precision of the NAVSTAR GPS system to civilian users.

application
A class of tasks that a GPS receiver can be used to accomplish. Control surveying, topographic surveying, and navigation are examples of applications.

autonomous positioning
A mode of operation in which a GPS receiver computes position fixes in real time from satellite data alone, without reference to data supplied by a base station. Autonomous positioning is the least precise positioning procedure a GPS receiver can perform, yielding position fixes that are precise to ±100 meters horizontal RMS when Selective Availability is in effect, and to ±10--20 meters when it is not. Also known as *absolute positioning.*

base station
(1) A receiver that observes satellite data from a known, fixed location during a survey or other GPS procedure, together with its antenna, tripod, etc. (2) The site at which such a receiver operates. Also known as a *reference station*.

baseline
The three-dimensional vector distance between a pair of stations, computed from simultaneously collected GPS data by means of carrier-phase processing. This technique is used in surveying applications. It yields the most accurate GPS results.

baseline surveying
A class of procedures in which observations are used to develop a network of vectors of high accuracy and precision. The applications popularly classed as surveying use baseline surveying procedures.

broadcast ephemeris A set of data that describes the predicted positions of a GPS satellite through the near future. Each GPS satellite periodically transmits its own broadcast ephemeris, which is uploaded to the satellite by the Control Segment. See also *ephemeris.*

carrier beat phase The difference between the carrier signal generated by a receiver's internal oscillator and the carrier signal received from a satellite.

code phase difference The phase difference between received C/A or P-code and the same code generated internally by the receiver. Used to determine the range to a satellite.

Coarse/ Acquisition code (C/A code) A pseudorandom noise code (PRN) modulated onto a GPS satellite's L1 signal. This code helps the receiver compute its distance from the satellite.

continuous kinematic surveying A variety of kinematic surveying in which the roving receiver makes carrier phase observations while in motion. Continuous kinematic surveying is useful for aerial surveying, topographic surveying, and vehicle tracking.

control mark A mark on the earth whose coordinates are known and accepted, or are being surveyed, for use as a reference in other surveys. Also known as a control point or control station.

Control Segment That part of a GPS system that monitors the satellites (the Space Segment) and feeds information to them. The NAVSTAR system's Control Segment consists of monitor stations, upload stations, and a master control station. See also *Space Segment, User Segment.*

control surveying A type of baseline surveying in which the relationships among selected points in a region of interest are measured with high, repeatable precision. These points are often used as reference marks in a topographic survey of the same area. Because control surveying requires more precision than topographic surveying and covers fewer points, it generally uses procedures that are slower but more accurate. See also *baseline surveying, topographic surveying.*

cycle (1) One complete wave of a radio signal; 360º of phase shift. (2) Occasionally, a synonym for *epoch*, the length of each period in which a GPS receiver makes one set of satellite measurements.

cycleslip An interruption in a receiver's lock on a satellite's radio signals. Some surveying procedures require an observation to be restarted if a cycleslip temporarily reduces the number of satellites tracked to less than the minimum required.

datum A model of the earth consisting of an ellipsoid and an origin. Positions are described by a latitude and longitude relative to specified point on the surface. The ellipsoid and origin are chosen to yield that most accurate and convenient approximation of the surface of the earth for mapping in a particular region. See also *local datum*, *WGS-84.*

DOP Dilution of precision, a class of measures of the magnitude of error in GPS position fixes due to the orientation of the GPS satellites with respect to the GPS receiver. There are several DOPs to measure different components of the error. See also *GDOP, HDOP, PDOP, TDOP, VDOP.*

DOY Day of the year, a number from 1 to 365 (366 in leap years). Also known as a *Julian day.*

dual-frequency Using both the L1 and L2 signals from GPS satellites. Used to describe Series 7400 receivers, antennas, procedures, and so on. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions by measuring and compensating for ionospheric delay errors. See also *single-frequency.*

earth-centered earth-fixed (ECEF) A Cartesian coordinate system used for satellite positioning. The ECEF coordinate system's origin is at the earth's center of mass. The *z* axis is coincident with the mean rotational axis of the earth, with positive values to the north. The *x* axis passes through 0° N, 0° E, with positive values in that direction. The *y* axis is perpendicular to the plane of the *x* and *z* axes, with positive values to the direction of 0° N, 90° W. The WGS-84 datum is defined with reference to the ECEF coordinate system.

ELEV Elevation; the angle from the horizon to the observed position of a satellite.

elevation mask A parameter that specifies a minimum elevation at which the receiver will track a satellite.

ellipsoid A mathematical figure generated by rotating an ellipse on its minor axis. Geodetic surveying operations use an ellipsoid as a model of the surface of the earth; the minor axis represents the earth's axis of rotation. See also *Reference ellipsoid.*

ephemeris A set of data that describes the position of a celestial object as a function of time. The plural is ephemerides. Each GPS satellite periodically transmits a *broadcast ephemeris* describing its predicted positions through the near future, uploaded by the Control Segment. Postprocessing programs can also use a *precise ephemeris* which describes the exact positions of a satellite at relevant times in the past.

epoch	The measurement interval used by a GPS receiver; also called a *cycle.* Satellite measurements, position fix computations, and most cycle printouts are produced once per epoch.
flow control	A means of coordinating two communicating devices so that one transmits data only when the other is prepared to receive it. The Series 7400 also supports CTS/RTS flow control on ports 2 and 4 (if installed).
GDOP	Geometric dilution of precision, an overall measure of the magnitude of DOP errors in GPS position fixes. PDOP and TDOP are components of GDOP. See also *DOP.*
geodetic position	The coordinates of a mark, measured with reference to a defined ellipsoid.
geoid	The gravity-equipotential surface that best approximates mean sea level over the entire surface of the earth.
GIS data acquisition	An application in which a receiver collects position data for a geographic information system (GIS) database. GIS data acquisition is similar to logging position fixes, except that the receiver also collects attribute information about points of interest (such as identification numbers or street names) as well as coordinates.
GMT	Greenwich Mean Time.
GPS	Global Positioning System; the navigation/positioning system consisting of NAVSTAR satellites, their ground stations, and GPS receivers such as the Series 7400 receiver.
GPS time	A measure of time used internally by the NAVSTAR GPS system. GPS time is based on UTC, but does not add periodic leap seconds to correct for changes in the Earth's period of rotation.

GRS-80 Geodetic Reference System of 1980; an oblate ellipsoid, or ellipsoid of revolution, on which the North American Datum of 1983 (NAD83) is based. This datum has the same semi-major and semi-minor axis as WGS-84 (the reference ellipsoid for GPS) and differs slightly only in the flattening (1/f).

HDOP Horizontal dilution of precision; a measure of the magnitude of DOP errors in latitude and longitude. See also *DOP*.

HI The height of a GPS antenna above a point of interest. HI is pronounced antenna height. It was originally an abbreviation for height of instrument.

HVEL Horizontal velocity.

Issue of data ephemeris (IODE) A value identifying a version of an ephemeris.

Julian date A date expressed as a year and the number of the day within the year. For example, January 1, 1994 expressed as a Julian date is 94001; February 1, 1994 is 94032. The day is known as a Julian day, or day of year (DOY).

L1 The primary L-band carrier used by GPS satellites to transmit satellite data. Its frequency is 1575.42 MHz. It is modulated by C/A code, P-code, and a 50 bit/second Navigation Message.

L2 The secondary L-band carrier used by GPS satellites to transmit satellite data. Its frequency is 1227.6 MHz. It is modulated by P-code and a 50 bit/second Navigation Message.

latitude (LAT) The north/south component of the coordinate of a point on the surface of the earth; expressed as an angular measurement from the plane of the equator to a line from the center of the earth to the point of interest.

latitude/longitude/ height (LLH) A method of describing a position by its latitude and longitude on a datum. See also *northing/easting/height*.

LED Light-emitting diode.

local datum A datum that is designed for accuracy and convenience in surveying in a particular locality. In Series 4000 documentation, any datum other than the WGS-84 datum is considered a local datum.

local zone A projection of a local datum onto a plane, with positions expressed as northings and eastings from a specified origin on the plane; also, the region in which such a projection is considered meaningful. See also *projection coordinates*.

lock The state in which a GPS receiver receives and recognizes a satellite's signals. If the signals are interrupted, the receiver experiences loss of lock, a common cause of interruption in a kinematic or RTK survey.

longitude (LON) The east/west component of the coordinate of a point on the surface of the earth; expressed as an angular measurement from the plane that passes through the earth's axis of rotation and the 0º meridian and the plan that passes through the axis of rotation and the point of interest.

mean sea level (MSL) A model of the earth's surface that represents sea level averaged over time at each point; or, the height of the surface of that model at a given latitude and longitude.

multipath interference	Interference created when a receiver simultaneously detects signals received directly from a transmitter and signals reflected off other objects, such as the ground. Multipath interference is the usual cause of ghosts in a television picture. See also *multipath error*.
multipath error	An error in the position fixes computed by a GPS receiver, caused by multipath interference with satellite signals.
NAD-83	A reference system often used for precise coordinates in North America and near-by locations. The term is a contraction of North American Datum, 1983. Throughout North America, NAD-83 is essentially equivalent to WGS-84; its predecessor, NAD-27, is not.
navigation	An application in which a receiver provides information about a vehicle's location and course, helping the operator to guide the vehicle to its destination. Navigation may be done on water or land, or in the air.
NAVSTAR	The name of the satellites used in the Global Positioning System (GPS). It is an acronym for **Nav**igation **S**ystem with **T**ime **a**nd **R**anging.
NGS	The United States National Geodetic Survey, the geodetic surveying agency of the United States government.
NMEA-0183	A standard established by the National Marine Electronics Association (NMEA) that defines electrical signals, data transmission protocol, timing, and sentence formats for communicating navigation data among marine navigation instruments.
northing/easting/ height (NEH)	A method of describing a position by its distance north and east of the origin in a local zone. The height is the same as on the datum associated with the zone.

observation	A set of measurements made at a mark (or, in dynamic procedures, while moving between marks). GPS receivers perform observations by tracking and analyzing satellite signals.
OSM2	Office Support Module 2, a power supply, battery charger, and interface device used with Trimble's portable receivers.
P-code	Precise code or protected code; a pseudorandom code transmitted by a NAVSTAR satellite. Each satellite has a unique code that it modulates onto the L1 and L2 signals. P-code is replaced by an encrypted Y-code when Anti-Spoofing is active; Y-code is intended to be available only to authorized (primarily military) users. See also *Coarse/Acquisition code, Anti-Spoofing,* and *Y-code.*
PDOP	Position dilution of precision, a measure of the magnitude of DOP errors in the *x, y,* and *z* coordinates. See also *DOP.*
PDOP mask	A receiver parameter specifying a maximum PDOP value for positioning. When the geometric orientation of the satellites yields a PDOP greater than the mask value, the receiver will stop computing position fixes and/or logging satellite measurements.
point ID	An eight-character code used to identify a mark in a kinematic survey; equivalent to a mark ID in a FastStatic survey.
precise positioning service (PPS)	The most precise level of dynamic position service provided by GPS, based on the use of dual-frequency P-code. This service is subject to encryption, and when encrypted it is available only to United States military agencies and other authorized users. See also *standard positioning service.*

precision positioning — A type of GPS application in which the receiver's position must be determined precisely, epoch by epoch. Precision positioning may be used to track the position of a vehicle (such as a crop dusting aircraft) or to control servomechanisms that maintain the position of a mobile object (such as a marine oil exploration platform).

PRN — Pseudorandom noise, a sequence of binary digits that appears to be randomly distributed but can be exactly reproduced. Identical PRN sequences have a low auto-correlation value except when they are exactly coincident. Each GPS satellite transmits a unique PRN in both C/A and P-code. GPS receivers use PRNs to identify and lock onto satellites and to compute their pseudoranges.

projection — A mapping of a set of coordinates from a datum to a plane; or a set of mathematical rules for performing such a translation. Projections are used to create flat maps that represent the surface of the earth or parts of it. A Series 7400 receiver uses the definition of a projection to translate position fixes from the local datum to the local zone.

pseudorange — The apparent distance from a satellite to the phase center of a GPS receiver's antenna, computed as the product of apparent signal propagation time and the speed of light. Differences between pseudorange and real range are caused by offsets between the satellite and receiver clocks, by propagation delays, and by other errors.

Real-Time Kinematic (RTK) — A surveying or positioning procedure that yields very accurate position fixes in real time. It is similar to the kinematic surveying procedure, but uses a radio link between the base station and the rover(s) to allow the rovers to compute position fixes in real time. Like kinematic surveying, it is sensitive to high PDOP and loss of satellite lock.

receiver	As used in this manual, receiver refers to a Series 7400 GPS receiver. References to other types of receivers are qualified when confusion is possible, for example, communications receiver.
reference ellipsoid	In geodesy, any ellipsoid whose minor axis is defined as the Earth's axis, and whose major axis is defined as being in the equatorial plane. Many global coordinate systems are based on a reference ellipsoid as a model of the Earth's surface. See also *WGS-84*.
reference mark or point	A mark whose coordinates are known with sufficient accuracy for a given purpose. Also, the physical sign (stake, chalk mark, etc.) used to indicate the position of a mark. Many GPS procedures require one or more receivers to occupy reference marks. Also known in some procedures as a *reference point* or *reference station*.
reference position	The accepted coordinates of a mark over which a receiver's GPS antenna is set up. The reference position may be entered manually or may be derived from a receiver's computed position.
reference station	See *base station*.
RF	Radio frequency.
rover	A receiver that collects satellite data at survey marks, whose coordinates are to be determined. The term *rover* usually refers to the receiver's antenna, rangepole or other support, cables, etc, as well as the receiver itself. Also known as a survey receiver or differential station in some procedures.
RTK/OTF	Real-Time Kinematic/On-The-Fly

satellite data The data transmitted by a GPS satellite. Also used to denote the data that a receiver logs in a file; this includes data that is processed or originated in the receiver as well as data received from satellites.

satellite geometry The relative positions of available GPS satellites at a given time, from the viewpoint of a GPS receiver. The set of positions that result in a high (or low) PDOP are often described as poor (or good) satellite geometry.

schedule plot A one-shot printout that plots satellite visibility against time for all known satellites over any UTC day.

Selective Availability (SA) A U.S. Department of Defense program to limit the accuracy of autonomous position fixes computed by unprivileged (civilian) receivers. Selective Availability works by introducing controlled errors to the GPS satellites' C/A codes. When Selective Availability is in effect, the horizontal coordinates of autonomous position fixes exhibit errors of up to 100 meters 2D RMS. See also *Anti-Spoofing.*

single-frequency Using only the L1 carrier phase signal from GPS satellites. Used to describe receivers, antennas, procedures, and so on. See also *dual-frequency.*

Signal to Noise Ratio (SNR) A measure of a satellite's signal strength, expressed in arbitrary units.

Space Segment The part of the NAVSTAR GPS system that operates in space, the satellites. See also *Control Segment, User Segment.*

standard positioning service (SPS) The level of positioning precision provided by GPS to civilian users, based on the use of single-frequency C/A code. The precision of standard positioning service is limited by Selective Availability. See also *precise positioning service.*

station	(1) A receiver being used to perform a GPS procedure, together with its antenna, tripod or rangepole, and so on. Usually used in phrases like *base station.* (2) The site where a receiver is set up. (3) Any of 30 locations whose coordinates can be stored in a receiver's memory and used to specify the location of a receiver in the static and RTK surveying procedures. (4) A synonym for *mark* in certain procedures.
SV	Space vehicle; specifically, a GPS satellite.
sync time	A receiver parameter that determines the length of a cycle.
TDOP	Time dilution of precision, a measure of the magnitude of DOP errors in position fixes due to user clock offset from GPS time. See also *DOP.*
timebase	A receiver's source of internal time measurement. All Series 7400 receivers have an internal quartz oscillator timebase. A receiver with the External Frequency Input Option can also accept signals from a high-precision external timebase such as an atomic clock.
topographic surveying	An application that determines the relative coordinates of points in a region of interest for mapping and three-dimensional modeling applications. See also *control surveying.*
TOW	Time of week; time measured in seconds from midnight Sunday UTC.
tribrach	A centering and leveling device often used for mounting a GPS antenna or other surveying instrument on a tripod.

tracking Receiving and recognizing signals from a satellite. For example, a receiver might be described as tracking six satellites. A receiver does not necessarily use the signals from all of the satellites it is tracking; for example, signals from a satellite below the elevation mask may be tracked but will not be used.

User Range Accuracy (URA) A measure of the errors that may be introduced by satellite problems and Selective Availability if a particular SV is used. A URA of 32 meters indicates that Selective Availability is enabled. The URA value is set by the Control Segment and is broadcast by the satellites.

User Segment A collective name for the GPS receivers that make use of GPS satellite signals. The world's entire population of GPS receiver's constitute the User Segment. See also *Control Segment*, *Space Segment.*

Universal Time Coordinated (UTC) A time standard maintained by the United States Naval observatory, based on local solar mean time at the Greenwich meridian. Equivalent to Greenwich Mean Time (GMT). See also *GPS time.*

VDOP Vertical dilution of precision, a measure of the magnitude of DOP errors in the height component of a position fix. See also *DOP.*

VVEL Vertical velocity.

WGS-84 World Geodetic System 1984, the current standard datum for global positioning and surveying. The WGS-84 datum is based on the GRS-80 ellipsoid. For Series 4000 receivers, any datum other than WGS-84 is known as a local datum.

Y-code An encrypted form of the information contained in P-code, which satellites transmit in place of P-code at times when Anti-Spoofing is in effect.

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Series 7400 Operation Manual **November 1996**
P/N: 31463-00 **Revision A**

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