Series 4000

Receiver Reference

Part Number: 27250-00

Revision: B

Date: February 1996

Trimble Navigation Limited
Surveying & Mapping Division
645 North Mary Avenue
Post Office Box 3642
Sunnyvale, CA 94088-3642
U.S.A.
+1-800-827-8000 in North America
+1-408-481-8000 International
FAX: +1-408-481-8214

Trimble Navigation Europe Ltd.
Trimble House
Meridian Office Park
Osborn Way, Hook
Hampshire RG27 9HX England
+44-256-760-150
FAX: +44-256-760-148

Trimble Navigation Singapore Pte Ltd.
300 Beach Road #34-05
The Concourse
Singapore 0719
Singapore
+65-296-2700
FAX: +65-296-8033

Trimble Navigation Japan
Believe Mita Building 11th Floor
Shiba 3-43-16, Minato-ku
Tokyo 105
Japan
+81-3-5476-0880
FAX: +81-3-5476-4353

Trimble Navigation New Zealand
76 Chester Street East
P.O. Box 13-547 Armagh
Christchurch, New Zealand
+64-3-3713-400
FAX: +64-3-3713-417

Copyrights

Printed in the United States of America. Printed on recycled paper.

Revision Notice

This is the second release of the Series 4000 Receiver Reference, Part Number 27250-00, Revision B, February 1996. This document describes receiver firmware version 7.10.

Trademarks

Disclaimer of Warranty

Except as indicated in “Limited Warranty” herein, Trimble Hardware, Software, Firmware and documentation is provided “as is” and without express or limited warranty of any kind by either Trimble or anyone who has been involved in its creation, production, or distribution including but not limited to the implied warranties of merchantability and fitness for a particular purpose. The entire risk, as to the quality and performance of the Trimble Hardware, Software, Firmware and documentation, is with you. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you.

Limitation of Liability

Because the Software is inherently complex and may not be completely free of errors, you are advised to verify your work. In no event will Trimble or any person involved in the creation, production, or distribution of the Trimble Software be liable to you on account of any claim for any damages, including any lost profits, lost savings, or other special, incidental, consequential, or exemplary damages, including but not limited to any damages assessed against or paid by you to any third party, rising out of the use, liability to use, quality or performance of such Trimble Software and documentation, even if Trimble or any such person or entity has been advised of the possibility of damages, or for any claim by any other party. Some states do not allow the limitation or exclusion of liability for incidental or consequential damages so, the above limitations may not apply to you.

Software and Firmware Limited Warranty

Trimble warrants that Software and Firmware products will substantially conform to the published specifications provided it is used with the Trimble products, computer products, and operating system for which it was designed. For a period of ninety (90) days, commencing thirty (30) days after shipment from Trimble, Trimble also warrants that the magnetic media on which Software and Firmware are distributed and the documentation are free from defects in materials and workmanship. During the ninety (90) day warranty period, Trimble will replace defective media or documentation, or correct substantial program errors at no charge. If Trimble is unable to replace defective media or documentation, or correct program errors, Trimble will refund the price paid for The Software. These are your sole remedies for any breach in warranty.

Hardware Limited Warranty

Trimble Navigation Limited products are warranted against defects in material and workmanship for a period of one year. The warranty period shall commence thirty (30) days after shipment from Trimble's factory. Warranty service will be provided at a designated Trimble Service Center. Trimble will at its option either repair or replace products that prove to be defective. The Customer shall pay all shipping charges for products returned to Trimble for warranty service. Trimble shall pay all shipping charges for the return of products to the Customer.

The above warranty shall not apply to defects resulting from:

1. Improper or inadequate maintenance by the buyer
2. Buyer-supplied software or interfacing
3. Unauthorized modification or misuse
4. Operation outside of the environmental specifications of the product
5. Improper installation, where applicable
6. Lightning or other electrical discharge
7. Fresh or salt water immersion or spray
8. Normal wear and tear on consumable parts (for example, batteries)

No other warranty is expressed or implied. Trimble Navigation Limited specifically disclaims the implied warranties of fitness for a particular purpose and merchantability.

Table of Contents I

7 The Sessions Screens

8 The Log Data Screens

A Features and Accessories

List of Figures

List of Tables

Preface

Welcome to the Series 4000 Receiver Reference manual. This manual describes all current models in the Trimble Series 4000 group of GPS receivers. These receivers are designed for a variety of applications in the areas of surveying, positioning, and navigation, but they share many hardware and firmware components, and they behave alike in many respects.

Scope and Audience

Even if you have used other Global Positioning System (GPS) receivers we recommend that you spend some time reading this manual. This manual provides detailed reference information about members of Series 4000 GPS receivers. It assumes that you already are familiar with the basic procedures for operating your receiver. If you are not yet familiar with the receiver, see the first few chapters of its *User Guide.*

This manual also assumes that you understand the application for which you intend to use your receiver.

You should be familiar with the principles of the NAVSTAR Global Positioning System (GPS), and with the terminology that is 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 the NAVSTAR GPS, we suggest that you read Trimble's booklet *GPS, A Guide to the Next Utility.* You can find a complete citation to that publication in the Bibliography at the end of this manual.

To download and postprocess logged data, you should know how to use personal computers running the IBM DOS or MS-DOS operating system. You should be able to run programs, create and use directories, and use common DOS commands for copying, renaming, and deleting files.

The following section provides you with a guide to this manual, as well as to other documentation included with this product.

Notes on Terminology

Series 4000 receivers are used in several different applications that have developed independently of each other, and this has led to a certain amount of inconsistent terminology. For example, in static surveying the point that a receiver's GPS antenna occupies during a satellite observation has traditionally been called a *station;* in FastStatic surveying it has been called a *mark,* and in kinematic surveying it has been called a *point.*

Trimble's documentation has adopted a consistent set of terms as far as it is practical to do so. For the present, this will lead to some inconsistency between documentation and equipment. For example, documentation consistently uses the term *mark* for a point whose coordinates are to be determined, but the static surveying procedure's receiver screens continue to say *station.* Future releases of software will reduce or eliminate these inconsistencies.

The first chapter of the *Series 4000 Application Guide* summarizes the major changes in terminology. These terms and others are defined in the Glossary near the end of this manual.

How to Use the Series 4000 Manuals

Each Series 4000 GPS receiver is accompanied by several pieces of documentation:

- A *User Guide* introduces the receiver and describes those of its features that are not shared by other members of the Series 4000.
- The *Series 4000 Receiver Reference* (this document) describes all features found in Series 4000 receivers, in complete detail. It is useful when you need to know exactly how a particular key or data display works, or you need technical information about a receiver's power requirements, inputs, or outputs.
- The *Series 4000 Application Guide* explains the applications that Series 4000 receivers may be used for, such as FastStatic surveying, navigation, and real-time positioning with differential GPS. It discusses the purpose of each procedure, explains how to perform the procedure, and gives suggestions for planning the procedure and configuring the receiver.
- Once you are familiar with the basics of using a receiver, the *Application Guide* and the *Quick Reference* (below) should ordinarily be the only pieces of documentation you need to take into the field.
- A set of *Series 4000 Quick References* summarize the procedures most often performed with each receiver. They are much less detailed than the *Application Guide,* but their compact format makes them very convenient to carry in your shirt pocket or backpack.

Series 4000 Receiver Reference Organization

The major divisions of the text in the *Series 4000 Receiver Reference* are:

- Chapter 1, Introduction (this chapter), briefly describes Series 4000 GPS receivers and documentation that supports them.
- Chapter 2, The Keypad and Display, shows you how to use the receiver's keypad and LCD display. (This information is also presented in Chapter 2 of each *User Guide*.)
- Chapter 3, The *Status* Screens, describes receiver functions you can use by pressing the STATUS key. These functions display information about the status and configuration of the receiver. They also provide many of the receiver's navigation functions.
- Chapter 4, The *Sat Info* Screens, describes receiver functions you can use by pressing the SAT INFO key. These functions display and print information about satellites and the receiver.
- Chapter 5, The *Control* Screens, describes receiver functions you can use by pressing the CONTROL key. These functions let you control aspects of the receiver's GPS data handling, such as which satellites to track, what data to input and output, and what input/output data formats to use.
- Chapter 6, The *Modify* Screens, describes receiver functions you can use by pressing the MODIFY key. These functions let you control certain aspects of the receiver's internal operation, such as LCD viewing angle and backlight, battery use, beeper volume, and displayed units.
- Chapter 7, The *Sessions* Screens, describes receiver functions you can use by pressing the SESSIONS key. The functions are used to define sessions, stations, and parameters for data logging

- Chapter 8, The *Log Data* Screens, describes receiver functions you can use by pressing the LOG DATA key. These functions let you start and stop data logging to record measurement data for later processing.
- Appendix A, Features and Accessories, summarizes the features of Series 4000 receivers and the supplies and accessories you can use with them. It summarizes receiver parameters and lists their default settings. It discusses issues related to connecting a Series 4000 receiver to another device: pinouts and electrical characteristics of the receiver's connectors, appropriate use of Trimble cables, and procedures for interfacing the receiver to computers, navigation displays, power sources, etc.
- Appendix B, Data Output Formats, describes the formats of the messages and printouts the receiver can produce.
- The Glossary defines technical terms used in this manual and other Series 4000 documentation.
- The Bibliography lists manuals, papers, and books that contain additional information about GPS, Trimble products, and applications.
- The Index provides an easy way to find particular topics in the manual.

Related Information

This manual contains system-wide, general information about the Series 4000 receivers. The following sections discuss other sources of information.

Update Notes

You will find a Warranty Activation Sheet with your 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.

Trimble Bulletin Board Service

If you have a modem, check the Trimble Surveying and Mapping Bulletin Board Service (BBS) on a regular basis for application notes, new software release notices, and other information. The phone numbers are:

+1-408-732-6717
+1-408-732-8936   high-speed modem

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)
+1-408-737-9142 (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.

FaxBack

FaxBack is a completely automated fax response system for selecting documents and catalogs (lists of available documents) to be faxed back to a fax machine. Call from a tone-dialing phone and FaxBack guides you through the call by playing a pre-recorded voice message.

The FaxBack system is available 24 hours a day, seven days a week. You can order a variety of documents, including; data sheets, application notes, technical documentation, configuration guides, assembly drawings, and general information.

To call the FaxBack service, dial +1-408-481-7704 and follow the instructions received.

Reader Comment Form

A reader comment form is provided at the end of this guide. If this form is not available, comments and suggestions can be sent to Trimble Navigation Limited, 645 North Mary Avenue, Post Office Box 3642, Sunnyvale, CA 94088-3642. All comments and suggestions become the property of Trimble Navigation Limited.

Document Conventions

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

SMALL CAPITALS identify DOS commands, directories, filenames, and filename 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.

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 Series 4000 receivers.

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 The Series 4000 Receivers

All current members of the Series 4000 share these features:

- Track GPS satellites on nine or more L1 or L1/L2 channels.
- Can measure carrier phase to compute very high-precision vectors between two stations.
- Make low-noise C/A code measurements with carrier aided filtering and smoothing.
- Automatically calculate overdetermined position solutions when enough satellites are available.
- Can automatically compute 3D or 2D position fixes depending on the number of satellites being tracked.
- Can output all raw and computed data through bi-directional RS-232 ports for transmission by radio modem, logging on a computer, or input to navigation instruments.
- Can resume last operation after power-down / power-up cycles.
- Present data on a 4-line, 40-character front-panel display.

The following sections briefly describe the receivers discussed in this manual. For more detailed descriptions of an individual receiver, see that receiver's *User Guide.*

1.1 “Maxwell” Technology

The latest generation of Series 4000 receivers feature Trimble's proprietary Maxwell technology, which provides more precise position measurements by means of very low-noise C/A code processing. In differential GPS (DGPS) applications, Maxwell technology increases the precision of position fixes from ±2–5 meters RMS horizontal to better than ±1 meter. Also, the precision of carrier phase measurement has been increased nearly to its theoretical limit.

The following model descriptions tell which receivers use Maxwell technology.

1.2 Super-trak™ Technology

4000SSi series receivers feature Trimble’s Super-trak technology. Super-trak enables acquiring low power satellite signals, maintaining better lock on signals once acquired and tracking under conditions of high RF interference. Super-trak is a combination of hardware and firmware technology, including true multibit signal processing. Performance tests show significantly improved jamming immunity over lesser equipped receivers. Another system benefit is measurement of the L2 range during P-code encryption. Receivers with the SSi designation use Super-trak technology.

1.3 Dual-Frequency Surveying Receivers

Dual-frequency receivers (those equipped with the Dual Frequency Option) observe satellite measurements on both the L1 and the L2 frequencies. They thus can perform FastStatic surveys and RTK surveys (with the RTK Functions Option), as well as static and kinematic surveys.

By measuring transmission time differences between the two frequencies, dual-frequency receivers can compensate for measurement errors due to atmospheric delay. They also produce cleaner, lower-noise measurements than single-frequency receivers. These features make them particularly useful for control surveying and other applications that demand very accurate results over long distances. Dual-frequency receivers also can operate under more difficult conditions, such as interference caused by high ionospheric activity.

The *4000SSE Site Surveyor* is a Maxwell-based receiver. It provides 9 channels of L1 P-code and carrier phase, and 9 channels of L2 P-code and carrier phase. During periods when Anti-spoofing is active, it uses L1/L2 cross-correlation to derive information from the encrypted P-code. This receiver is capable of performing real-time surveys. The system provides centimeter accuracy positions in real time. It is suitable for short range control (up to 10 km), topographic surveys and stake out operations. Real-time kinematic firmware is a standard feature.

The *4000SSE Land Surveyor IID* is a Maxwell-based receiver. It provides carrier phase measurement on both L1 and L2, and P-code measurement on L2 only. During periods when the Department of Defense's Anti-Spoofing mode is active, it uses half-wave L2 processing to derive information from the L2 signal. It provides economical dual-frequency measurement for surveying applications that do not require more sophisticated features.

The *4000SSE Geodetic Surveyor* is similar to the Land Surveyor IID, but offers substantially more functions in an economical package. It receives and makes measurements on P-code on both L1 and L2. During periods when Anti-Spoofing is active, it uses L1/L2 cross-correlation (6th Observable technology) to derive information from the encrypted P-code. This technique replaces the earlier half-wave L2 measurement technique.

The *4000SSE Geodetic System Surveyor* is similar to the Geodetic Surveyor, but provides several features that are useful for integrating the receiver together with other pieces of equipment into a system. These features include NMEA-0183 output for communication with other NMEA-0183 compatible devices; RTCM-104 input for computing corrected position fixes in real time; 1 pulse/second output to provide a precise timing signal for synchronization with other devices; and event marker input for recording time-tagged data about events that occur during data logging. It also provides an extended navigation facility, including the ability to define up to 99 waypoints and use them to navigate complex courses.

The *Site Surveyor SSi* is a Maxwell-based receiver that includes Super-trak technology. It provides 9 channels of L1 P-code and carrier phase, and 9 channels of L2 P-code and carrier phase. During periods when Anti-Spoofing is active, it uses Super-trak technology to measure the L2 range. This receiver is capable of performing real-time surveys. The system provides centimeter accuracy positions in real time. It is suitable for short range control (up to 10 km), topographic surveys and stake out operations. Real-time kinematic firmware is a standard feature.

The *Geodetic Surveyor SSi* is a Maxwell-based receiver that includes Super-trak technology. Like the Site Surveyor SSi, the Geodetic Surveyor SSi provides 9 channels of L1 P-code and carrier phase, and 9 channels of L2 P-code and carrier phase. During periods when Anti-Spoofing is active, it uses Super-trak technology to measure the L2 range. This receiver is capable of performing static, FastStatic, and kinematic surveys. It can record 26 hours of 5-satellite L1/L2 data at a 15 second measurement time.

The *Geodetic System Surveyor SSi* is a Maxwell-based receiver that includes Super-trak technology. The Geodetic System Surveyor SSi is similar to the Geodetic Surveyor SSi, but provides several features that are useful for integrating the receiver with other pieces of equipment in the system. These features include NMEA-0183 output for communication with other NMEA-0183 compatible devices; RTCM input for computing corrected position fixes in real time; 1 pulse/second output to provide a precise timing signal for synchronization with other devices; and event marker input for recording time-tagged data about events that occur during data logging. It also provides an extended navigation facility including the ability to define up to 99 waypoints and use them to navigate complex courses. It can record 65 hours of 5-satellite L1/L2 data at a 15 second measurement time.

1.4 Single-Frequency Surveying Receivers

Single-frequency receivers measure C/A code on the L1 frequency only; they do not receive the L2 frequency, and do not measure P-code. They are designed primarily for surveying applications over distances of up to 15 or 20 Km.

The *4000SE Land Surveyor II* is an economical Maxwell-based receiver for surveying applications that require centimeter accuracy. In addition to the Maxwell processor, its basic configuration provides more memory than the Land Surveyor (1 MB instead of 0.5 MB) and more serial ports (two instead of one).

The *4000SE System Surveyor II* is similar to the Land Surveyor II, but provides features for integrating the receiver together with other equipment into a system. These features are essentially the same ones that distinguish the Geodetic System Surveyor from the Geodetic Surveyor (see Dual-Frequency Surveying Receivers,” above).

4000SSi series receivers feature Trimble's Super-trak technology. Super-trak enables acquiring low power satellite signals, maintaining better lock on signals once acquired and tracking under conditions of high RF interference. Super-trak is a combination of hardware and firmware technology, including true multibit signal processing. Performance tests show significantly improved jamming immunity over lesser equipped receivers. Another system benefit is measurement of the L2 range during P-code encryption. Receivers with the SSi designation use Super-trak technology (see the section Super-trak™ Technology, above).

The *Site Surveyor SE* is a Maxwell-based receiver with a 9 L1 channel (C/A code and carrier tracking) capable of performing real-time kinematic surveys. The system provides centimeter accuracy positions in real time. It is suitable for topographic surveys and stake out operations. Standard features include real-time kinematic firmware and 0 MB memory.

1.5 Single-Frequency Positioning Receivers

The *4000RS Reference Surveyor* is a Maxwell-based receiver that is oriented toward precision positioning applications. It is intended for use as a DGPS base station, generating RTCM-104 corrections which a DGPS rover (like the 4000DS, below) can use to compute very accurate position fixes.

The *4000DS Differential Surveyor* is similar to the 4000RS, but is intended for use as a DGPS rover. That is, it can apply RTCM-104 corrections to the satellite data it receives in order to generate very accurate position fixes in real time.

The *4000RSR* and *4000DSR* are identical to the 4000RS and 4000DS except for their enclosures; they are packaged in a rack-mounted enclosure instead of a waterproof portable enclosure.

1.6 Dual-Frequency Positioning Receivers

The *4000MSK DGPS Reference Receiver* is a Maxwell-based, rack-mounted unit that can provide a modulated carrier wave directly to a radiobeacon transmitting system.

1.7 Single-Frequency Mapping Receivers

The *GIS Surveyor* is oriented toward GIS data-acquisition applications, which require the ability to enter attribute data (street names, asset descriptions, etc.) along with position data. It is similar to the 4000SE System Surveyor II, but lacks the Carrier Phase Option. Its standard features include 1 MB of memory.

1.8 Receivers Not Discussed in This Manual

All of the receivers described in this manual have similar hardware and firmware. They differ in the presence or absence of Maxwell technology, Super-trak technology, and of various features that adapt a receiver to one class of applications or another.

The Series 4000 includes several earlier models that have substantially different hardware and firmware. These receivers are discussed only in individual *Operation Manuals* that predate the current Series 4000 documentation set. These earlier models are:

- Series 4000AX
- Series 4000S, SL, and SLD
- Series 4000ST and SST
- Series 4000SX
- Series 4000SE Static Land Surveyor, Kinematic Land Surveyor, Land Surveyor, and System Surveyor
- Series 4000RL-II, RL-IIR, DL-II, and DL-IIR

2 The Keypad and Display

Figure 2-1 shows the ones that appear on rack-mounted receivers. Figure 2-2 shows the keypad and display that appear on portable receivers.

The two keypads contain the same set of keys; only the arrangement of the keys is different.

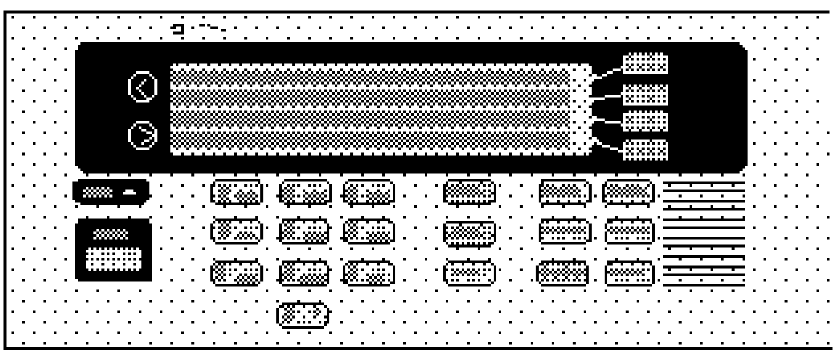


Figure 2-1. A Rack-Mounted Receiver's Front Panel

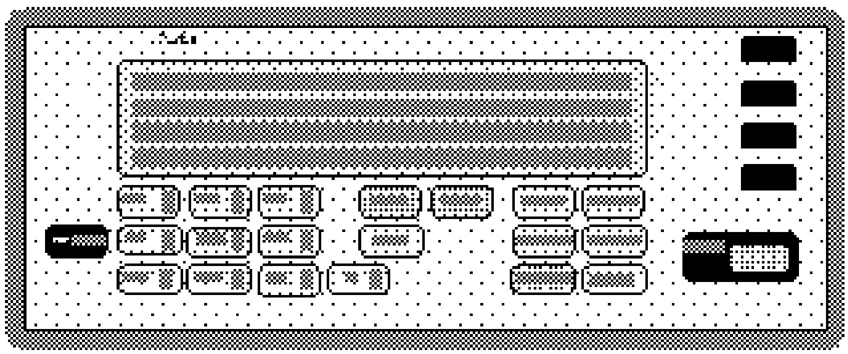


Figure 2-2. A Portable Reciever's Front Panel

2.1 Screen Control Keys

The keys to the left and right of the LCD (Figure 2-1 or Figure 2-2, upper half) are closely tied to the operation of the LCD display itself.

The < and > keys move the underline cursor left or right on the display. Press one of these keys briefly to move the cursor one position, or hold it down for fast repeat movement.

The four *softkeys* to the right of the display perform different functions at different times. The function labels for the softkeys are displayed on the right side of the LCD. For example, the following screen shows labels for the first, second, and fourth softkeys. (In this example the third softkey has no function.)

```
LAT: 37°23.4660’ N     PDOP: 1.8|NAVIGATE
LON:122°02.2470’ W     HDOP: 0.9|VELOCITY
HGT: +0020.8 m         VDOP: 1.6|
                       TDOP: 1.0|   STATS
```

2.2 The Main Keypad

The main keypad, shown in the lower halves of Figure 2-1 and Figure 2-2, is used to control the receiver's display, serial ports, and general operation.

The POWER key controls the receiver's power. To turn the unit on, press this key briefly and release it. To turn the unit off, you must press the key and hold it down for a few seconds. This method of operation protects you from turning the receiver off accidentally.

The six *primary function keys* near the right side of the keypad invoke groups of screens that operate the receiver's major functions:

- STATUS displays current information about the status and configuration of the receiver and the satellites being tracked. When data logging is under way, it shows data logging status: number of measurements, SVs being tracked, and so on. It also invokes many of the receiver's navigation functions, such as displaying and editing waypoint data.
- SAT INFO displays information about the satellites and the receiver, and prints plots and printouts (reports).
- CONTROL displays screens that control various aspects of the receiver's GPS data handling, such as which satellites to track, what data to input and output through the serial ports, and what input/output data formats to use.

- SESSIONS displays screens that let you define, edit, and delete data logging stations and sessions. (Station and session parameters determine what data is to be logged, and when.) It is active only on receivers that have the Memory Option.
- LOG DATA displays screens that let you perform surveys and other procedures that involve data logging. This key is function only on receivers that have the Memory Option.
- MODIFY displays screens that let you control several aspects of the receiver's internal operation, such as LCD viewing angle and backlight, power input selection, beeper volume, and units of measure in displays.

The ENTER and CLEAR keys control the acceptance of entered or displayed data. ENTER saves the contents of the current field or screen into memory. CLEAR erases changes keyed into a screen and returns the screen to its previous values. These keys are also used to return the display to previously displayed screens. (See the section Entering Data and Moving from Field to Field, for more details.)

The numeric keypad is used to enter data. ALPHA toggles the receiver between numeric mode and alphanumeric mode. (See the section Alphanumeric Fields, for more information.)

TIMER is a red LED which shows the status of the Auto Survey Timer (a feature that can be used to save power and memory between preplanned surveying sessions). When the Auto Survey Timer is enabled, the TIMER light flashes. This feature is available only on receivers that have the Memory Option.

2.3 How the Receiver Uses Screens

The receiver uses its LCD to display a variety of information about its location, its internal status, the satellites it is tracking, and so on. Each kind of display is called a *screen*. Typically the left side of a screen presents data and messages. The right side presents menus of choices that you can select with the softkeys to the right of the LCD.

Each of the six primary function keys, STATUS, SAT INFO, SESSIONS, CONTROL, LOG DATA, and MODIFY, displays a screen that controls one of the receiver's major functions. These screens are named after the keys that invoke them: they are called the *Status* screen, the *Sat Info* screen, and so on.

Each of these screens heads a group of screens with related functions. For example, the *Status* screen heads a group of screens that let you inspect the status of receiver and the satellite data it is receiving.

Most of these groups of screens are hierarchic. This means that you may imagine the screens as a group of boxes on an organization chart. From a particular top-level screen you typically can display any of several second-level screens, from each of which you can display several third-level screens, and so on. Figure 2-3 illustrates the hierarchic relationships among the first few screens in two groups, *Status* and *Control*.

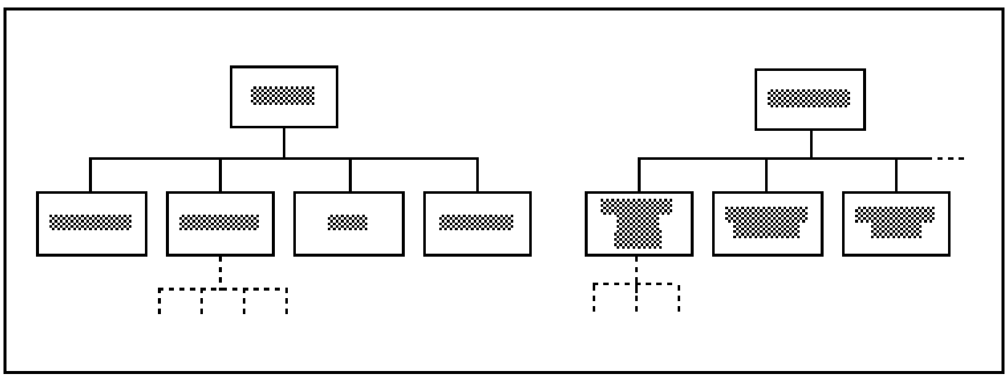


Figure 2-3. A Part of the Receiver's Screen Hierarchy

The screen hierarchy controls your movement from screen to screen both going down the hierarchy and coming back up. For example, if from the *Status* screen you can display either the ELEV/AZM screen or the POSITION screen, then from the ELEV/AZM or POSITION screen you return to the *Status* screen. Also, if you want to go from the ELEV/AZM screen to the POSITION screen, you must first return to the *Status* screen.

This manual refers often to the hierarchic nature of the receiver's screens. For example, it speaks of returning from one screen to “the next higher screen.” This means the next screen up in the hierarchy. In the case of the three screens we have been discussing, the *Status* screen is the next higher screen relative to both the ELEV/AZM screen and the POSITION screen.

The six primary function keys override the screen hierarchy. That is, each primary function key takes you directly to its main screen, regardless of what screen was displayed before.

2.3.1 An Example

Press the [STATUS] key, then the POSITION softkey, to display the receiver's POSITION screen:

```
LAT: 37×23.4660' N    PDOP: 1.8|NAVIGATE
LON:122×02.2470' W    HDOP: 0.9|VELOCITY
HGT: +0020.8 m        VDOP: 1.6|
                      TDOP: 1.0|   STATS
```

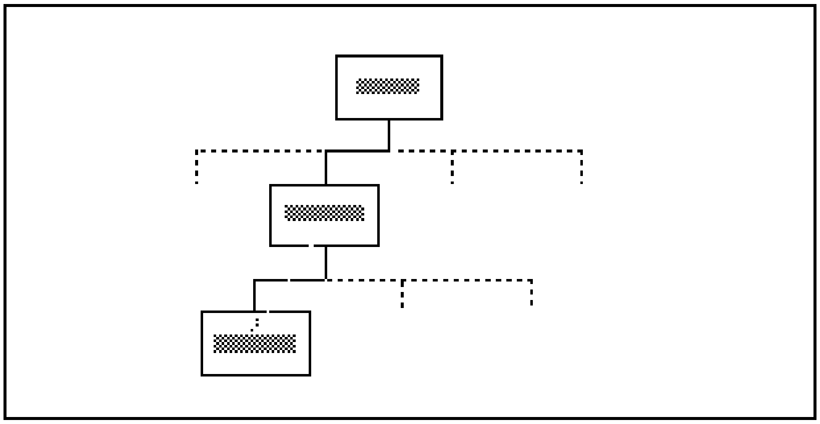
Press the NAVIGATE softkey. The receiver displays a screen similar to this (if your receiver has the Navigation Package Option):

```
   FROM: 00  TO: 01        |   SELECT LEG
BEARING:       181× TRUE   |CHANGE FORMAT
  RANGE:       228 m       | EDIT WAYPNTS
    XTE:         2 m LEFT  |    SET UNITS
```

. . .or this (if it does not):

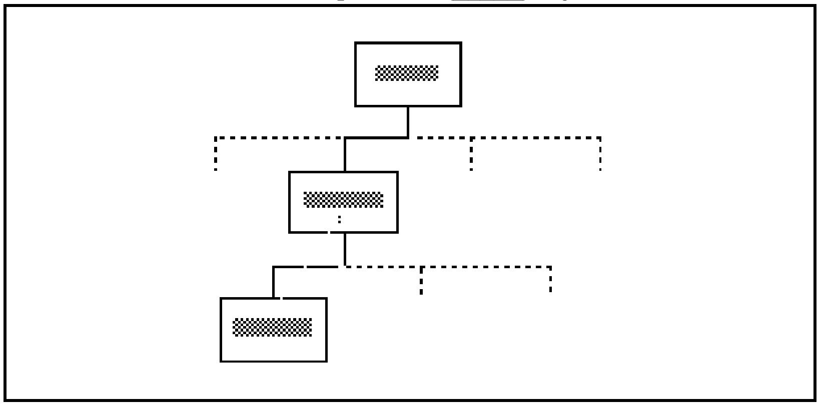
```
   BEARING: 181× TRUE          |WAYPOINT
     RANGE:     228 m          |
HEAD SOUTH:       2 m          |
    & EAST:     228 m          |   UNITS
```

You have moved down one level in the hierarchy from the POSITION screen to the NAVIGATE screen.



The NAVIGATE screen displays information that would be useful for finding your way to a specified destination. By pressing appropriate softkeys, you could proceed down the hierarchy to other screens that let you perform various navigation functions.

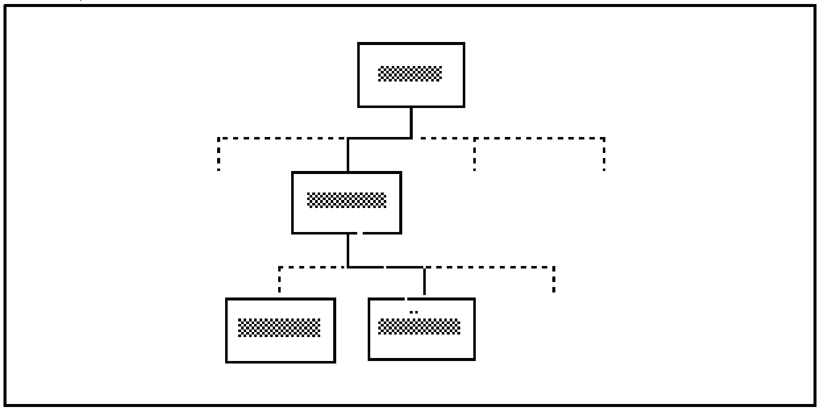
At this point, though, let us travel back up the hierarchy to the POSITION screen. To do so, press the CLEAR key.



Now press the VELOCITY softkey. The receiver displays a screen similar to this one:

```
  VELOCITY:                   |   UNITS
HORIZONTAL:   0.78 km/h @ 146×|POSITION
  VERTICAL:  +0.09 km/h       |
                              |
```

This screen shows the horizontal and vertical components of the receiver's velocity. (If the receiver is not moving, any apparent velocity is a by-product of Selective Availability and measurement errors.)



Press the CONTROL key to display the *Control* screen.

```
RECEIVER CONTROL:     | LOGGED DATA FILES
(1 of 6)              |   RTCM-104 OUTPUT
                      |    RTCM-104 INPUT
                      |              MORE
```

Now press CLEAR. The receiver displays the *Status* screen again. That screen is the receiver's "*main* main screen," at the top of the hierarchy. Press CLEAR enough times and you will return to this screen from any other screen the receiver displays.

2.3.2 About Menus

Most of the receiver's main screens (main *Status* screen, main *Control* screen, and so on) are essentially *menus*. That is, they are lists of functions that you can choose by pressing a softkey.

Menus that have more than four choices are displayed in segments. For example, the *Modify* screen displays this menu:

```
RECEIVER MODIFY:        |        VIEW ANGLE
(1 of 3)                |         BACKLIGHT
                        |             POWER
                        |              MORE
```

You may press VIEW ANGLE to adjust the LCD's optimum viewing angle, BACKLIGHT to adjust its backlight intensity, or POWER to select the port to be used as a power source. Or, you can press MORE to display the next group of menu items:

```
RECEIVER MODIFY:        |  UNITS OF MEASURE
(2 of 3)                |     BEEPER VOLUME
                        |ALTITUDE REFERENCE
                        |              MORE
```

Again, you can select one of the three listed items, or press MORE to see the last group:

```
RECEIVER MODIFY:        |  INTEGRITY ALARMS
(3 of 3)                |
                        |
                        |              MORE
```

From the last screen of a menu, the MORE softkey returns you to the first.

For the sake of clarity, this manual shows menus in a single box with as many lines as necessary, like this:

```
RECEIVER MODIFY:      |        VIEW ANGLE
                      |         BACKLIGHT
                      |             POWER
                      |  UNITS OF MEASURE
                      |     BEEPER VOLUME
                      |ALTITUDE REFERENCE
                      |  INTEGRITY ALARMS
```

Note – Some menu items are present only if corresponding options are installed. Be aware that your receiver's menus may not show all of the items that appear in this manual.

2.4 Entering Data and Moving from Field to Field

You can use the receiver's keypad to enter data into the screens, make corrections, and shift from field to field.

2.4.1 Moving from Field to Field

On screens that have more than one user-enterable field, the ENTER key moves the cursor from one field to the next.

To see how the ENTER key works, press the *Status* screen's POSITION softkey, then the NAVIGATE softkey, then the EDIT WAYPNTS softkey. The receiver displays this screen, which lets you define and change waypoints (the points where one leg of a course meets the next) for navigation.

```
SELECT WAYPOINT -> 1           |    NEXT
 LAT   00×00.0000' N           |PREVIOUS
 LON   00×00.0000' W           |
                               |
```

Notice that the cursor, represented above by an underscore, is in the first position of the first field. Press ENTER to move the cursor to the first position of the second field, then the third. Notice that the softkeys change as the cursor moves from field to field.

```
  EDIT WAYPOINT -> 01          |    HERE
 LAT   0×00.0000'  N           |  DELETE
 LON   00×00.0000' W           |   SOUTH
                               |  ACCEPT
```

```
  EDIT WAYPOINT -> 01          |    HERE
 LAT   00×00.0000' N           |  DELETE
 LON   0×00.0000'  W           |    EAST
                               |  ACCEPT
```

When the cursor is in a screen's last field, the ENTER key may either

- move it back to the first field, or
- make the receiver accept the data you have entered and return to the preceding screen.

In the screen we are looking at, ENTER has the first function. Press ENTER now to return the cursor to the first field.

The CLEAR key moves the cursor the other way:

- From the interior of a field to the beginning of the field.
- From the beginning of a field to the beginning of the preceding field.
- From the beginning of the screen's first field to a higher screen—usually, but not always, the screen one level up the hierarchy.

The < and > keys move the underline cursor left and right within a field. In some screens they also move it across the boundary between consecutive fields. Press one of these keys briefly to move the cursor one position, or hold it down for fast repeat movement.

2.4.2 Multiple-Choice Fields

Most multiple-choice fields are controlled by softkeys. To choose a value, simply press the corresponding softkey until the value you want is displayed.

To see how a softkey can change a field's value, return the cursor to the EDIT WAYPNTS screen's first field, if it is not already there.

```
SELECT WAYPOINT -> 01          |    NEXT
 LAT   00×00.0000' N           |PREVIOUS
 LON   00×00.0000' W           |
                               |
```

The NEXT and PREVIOUS softkeys increase and decrease the value of the waypoint number. Press NEXT a few times and watch the waypoint number increase. If waypoints are defined on your receiver, the receiver shows each waypoint's coordinates along with its number.

```
SELECT WAYPOINT -> 03            |    NEXT
 LAT   37×23.3448' N             |PREVIOUS
 LON  122×05.2487' W             |
                                 |
```

2.4.3 Numeric Fields

Some fields require you to enter numeric values. All of the fields in the screen shown above are examples.

To enter a numeric value, simply enter the numerals through the keypad. To enter the value 122° 05.2487' in the LON field, for example, you would press 1 2 2 0 5 2 4 8 7.

The cursor skips over the degree and minute signs and the decimal point, which the keyboard does not change. Therefore, to enter a value with leading zeros you must enter the zeros. To enter 15° 25.4400', for example, press 0 1 5 2 5... .

When you enter a numeral in the last digit of a numeric field, the cursor automatically moves to the next field. In the last field the cursor stays in place, though, and the receiver waits for you to accept or discard the information you have entered in the screen.

You can move the cursor within a field by pressing the < and > keys. For example, suppose you want to change 122° 05.2487' to 122° 06.0000'. Move the cursor to the beginning of the LON field, if necessary, and press > four times to advance the cursor to the ‘5’. Then press 6 0 0 0 0. The receiver replaces the ‘5’ with a ‘6’, the ‘2’ with a ‘0’, and so on.

If you make a mistake, press < to make the cursor move backward. For example, suppose you accidentally press 9 instead of 6. To correct the error, press < to move the cursor left one position; then press 6.

In some cases you can make the receiver discard all the changes you have made to a field by leaving that field with the CLEAR key. In the EDIT WAYPNTS screen, the receiver discards changes to both LAT and LON when you use CLEAR to return from LAT to the waypoint number.

Try entering values in the LAT and LON fields now. Practice correcting errors and moving the cursor forward and backward within and between fields.

Note that some fields allow you to enter letters as well as numbers. The section Alphanumeric Fields, explains how.

2.4.4 Combination Fields

Some fields allow either multiple-choice or numeric entry. The waypoint number in the EDIT WAYPNTS field is one example; you can change it either by pressing the NEXT and PREV softkeys, or by entering a new value with the numeral keys.

Other fields allow only numeric entry or only multiple-choice entry. The LAT and LON fields, for example, allow only numeric entry. The direction fields that follow LAT and LON allow only multiple-choice entry; you can only change the direction of LAT by pressing the NORTH/SOUTH softkey, and of LON by pressing the EAST/WEST softkey. (Try this now.)

2.4.5 Accepting and Discarding Changes to a Screen

There are two ways to make the receiver accept information that you have entered on a screen and return to a higher screen.

- If an ACCEPT softkey is defined, press that key.
- Press ENTER as many times as necessary to move the cursor to the last field, then once more. This will make the receiver accept the information you have entered *whether it returns to a higher screen or not.*

Press ACCEPT now to make the receiver leave the EDIT WAYPNTS screen and accept the waypoints you have entered.

To make the receiver discard information you have entered, press CLEAR. To return to a higher screen, press CLEAR as many times as necessary to back up the cursor to the start of the current field, then up to the first field on the screen; then press it once more.

Try this now. Select EDIT WAYPNTS again and change the value of the LAT field. Then press CLEAR once to return to the start of the LAT field, if necessary, then again to return to the waypoint number, then again to leave the screen. Select EDIT WAYPNTS again. The value of LAT has not changed; when you pressed CLEAR, the receiver discarded it.

Note that CLEAR *only* affects information you entered through the numeric keypad. When you change a multiple-choice value with a softkey such as CHANGE, the change takes effect immediately, and pressing CLEAR will not make the receiver discard it.

2.4.6 Alphanumeric Fields

Some character fields require you to enter alphanumeric data. In such fields you can enter numerals, letters, spaces, and some punctuation marks.

The TIME ZONE IDENTIFIER field in the ADJUST LOCAL TIME screen is an alphanumeric field. To see this field, press CONTROL, then press MORE until the ADJUST LOCAL TIME softkey appears; then press that key. The receiver displays this screen:

```
ADJUST LOCAL TIME:                  | FORWARD
  (APPROXIMATE)   FRI 10:50 AM |BACKWARD
TIME OFFSET(LOC-UTC): -7:00     |
 TIME ZONE IDENTIFIER= LOC      |
```

In an alphanumeric field, each numeral key represents a numeral and three other characters:

- The 1 key represents ‘1’, ‘A’, ‘B’, and ‘C’. The 2 key represents ‘2’, ‘D’, ‘E’, and ‘F’, and so on.
- The 9 key represents ‘9’, ‘Y’, ‘Z’, and ‘-’ (a hyphen).
- In most cases the 0 key represents ‘0’ (zero), space, ‘+’ (plus), and ‘.’ (period or decimal point).

  In a few cases the 0 key represents ‘0’ (zero),’_’ (underscore), ‘#’ (pound sign), and ‘%’ (percent sign).

Entry Method 1.

When you press a numeral key in an alphanumeric field, the receiver not only puts that numeral in the character position at the cursor; it also displays a softkey menu listing the four characters that the numeral key represents. Pressing 2, for example, both puts a ‘2’ in the field and displays a softkey menu with the characters ‘2,’ ‘D’, ‘E’, and ‘F’. Press one of the softkeys to enter a character and move the cursor to the next position.

For example, suppose you are in the ADJUST LOCAL TIME screen, and the cursor is in the first position. (The underscore represents the cursor.) You want to replace the current field value with ‘GMT’.

```
ADJUST LOCAL TIME:                | FORWARD
  (APPROXIMATE)   FRI 10:50 AM |BACKWARD
TIME OFFSET(LOC-UTC): -7:00       |
 TIME ZONE IDENTIFIER= LOC        |
```

You press 3. The receiver displays a ‘3’ in the field, and on the right, a menu of characters represented by the 3 key.

```
ADJUST LOCAL TIME:                    | "3"
  (APPROXIMATE)   FRI 10:50 AM        | "G"
TIME OFFSET(LOC-UTC): -7:00           | "H"
 TIME ZONE IDENTIFIER= LOC            | "I"
```

XX

You press the second softkey, entering a ‘G’.

```
ADJUST LOCAL TIME:                    | "3"
  (APPROXIMATE)   FRI 10:50 AM        | "G"
TIME OFFSET(LOC-UTC): -7:00           | "H"
 TIME ZONE IDENTIFIER= GOC            | "I"
```

Notice that the cursor has moved to the second position in the field, but the softkey menu remains on the screen. If you want to enter another character from the same menu, you can simply press the appropriate softkey. This is very convenient for entering the same character repeatedly; for example, to erase the last part of a field by entering a string of spaces.

To enter characters from a different numeral key, simply press that numeral key. The numeric character appears in the field, and the appropriate menu appears by the softkeys. To finish entering ‘GMT’, for example, press [5], making the receiver display this screen:

```
ADJUST LOCAL TIME:                    | "5"
  (APPROXIMATE)   FRI 10:50 AM        | "M"
TIME OFFSET(LOC-UTC): -7:00           | "N"
 TIME ZONE IDENTIFIER= G5C            | "O"
```

Then press the second softkey to enter an ‘M’:

```
ADJUST LOCAL TIME:                    | "5"
  (APPROXIMATE)   FRI 10:50 AM        | "M"
TIME OFFSET(LOC-UTC): -7:00           | "N"
 TIME ZONE IDENTIFIER= GMC            | "O"
```

Finally, press the [7] key, then the third softkey, to enter a ‘T’:

```
ADJUST LOCAL TIME:                    | "7"
  (APPROXIMATE)   FRI 10:50 AM        | "S"
TIME OFFSET(LOC-UTC): -7:00           | "T"
 TIME ZONE IDENTIFIER= GMT            | "U"
```

Entry Method 2.

Some users find this method of entering alphanumeric data more convenient.

Press a numeral key to insert that numeral in the field and display the corresponding softkey menu. If the numeral is the character you want, press [>] to move the cursor to the next position in the field. If the numeral is not the character you want, *just press the same numeral key again* to select the second of that key's four characters, again to select the third, and again to select the fourth. Then press [>] to move the cursor on to the next position.

To enter a 'G', for example, you could press [3]:

```
ADJUST LOCAL TIME:                      | "3"
  (APPROXIMATE)   FRI 10:50 AM          | "G"
TIME OFFSET(LOC-UTC): -7:00             | "H"
 TIME ZONE IDENTIFIER= 3OC              | "I"
```

Then press [3] once more:

```
ADJUST LOCAL TIME:                      | "3"
  (APPROXIMATE)   FRI 10:50 AM          | "G"
TIME OFFSET(LOC-UTC): -7:00             | "H"
 TIME ZONE IDENTIFIER= GOC              | "I"
```

Then press [>]:

```
ADJUST LOCAL TIME:                      | "3"
  (APPROXIMATE)   FRI 10:50 AM          | "G"
TIME OFFSET(LOC-UTC): -7:00             | "H"
 TIME ZONE IDENTIFIER= GOC              | "I"
```

2.4.7 Numeric/Alphanumeric Fields

Some fields allow you to enter numeric *or* alphanumeric data. The TYPE 16 MESSAGE field under the *Control* menu's RTCM-104 OUTPUT item is one example. (Note that your receiver can display this field only if it is has the RTCM-104 Output Option.)

To display this field, press CONTROL, then press the MORE softkey until the RTCM-104 OUTPUT softkey appears; then press that softkey. Press MORE and the receiver displays this screen:

```
RTCM-104 REFERENCE STATION      <-   MORE
       PRINTOUT [    OFF     ]  <- CHANGE
 CTS->XMT DELAY [  0.0 SEC   ]  <- CHANGE
TYPE 16 MESSAGE [    OFF     ]  <- CHANGE
```

Press the TYPE 16 MESSAGE... CHANGE softkey. The receiver displays this screen:

```
"_"                                 |  ALPHA
                                    |
                                    | ACCEPT
TYPE 16 MESSAGE [    OFF     ]   <-CHANGE
```

The cursor is in the first position of an empty field that accepts either numeric or alphanumeric data.

Notice the first softkey, labeled ALPHA. This label implies that the field is now accepting *numeric data*; you can press the ALPHA softkey to *make it start accepting* alphanumeric data. Conversely, when the softkey is labeled NUMERIC, the field is accepting *alphanumeric data*; you can press the softkey to make it start accepting numeric data.

```
"_"                                         |NUMERIC
                                            |
                                            | ACCEPT
TYPE 16 MESSAGE [     OFF     ]            <-CHANGE
```

When the field is accepting alphanumeric data, it works just like an ordinary alphanumeric field. Press the 3 key, for example, and you will see this:

```
"3"                                            | "3"
                                               | "G"
                                               | "H"
TYPE 16 MESSAGE [     OFF     ]                | "I"
```

Now press the second softkey and you will see this:

```
"G_"                                           | "3"
                                               | "G"
                                               | "H"
TYPE 16 MESSAGE [     OFF     ]                | "I"
```

You can accept the information you have entered by pressing ENTER, or discard it by pressing CLEAR, just as you can when you enter numeric data. Since the field uses all four softkeys for the character menu, though, the softkeys' usual functions are inaccessible. To select one of those functions you must leave alphanumeric mode by pressing the ALPHA key. Then you can press the CHANGE softkey to toggle Type 16 message generation on and off.

In general, the ALPHA key has the same effect as the ALPHA/NUMERIC softkey: it toggles the field between alphanumeric and numeric data entry whenever that is possible.

3 The *Status* Screens

The *Status* screens, shown on the preceding page, present the information you need to carry out positioning operations, navigation, and surveying. They show:

- Position and velocity data.
- Navigation data.
- Dilution of precision values (PDOP, HDOP, VDOP, and TDOP).
- Position statistics (only if QA/QC Option is installed).
- Position and status of satellites tracked.
- Date and time data.
- RTCM differential correction status.
- Status of NAV BEACON XL (if connected).
- Installed options, firmware versions, and receiver model and serial number.
- Status of data logging (if Memory Option is installed and data logging is enabled).
- RTK status (if RTK Functions Option is installed).

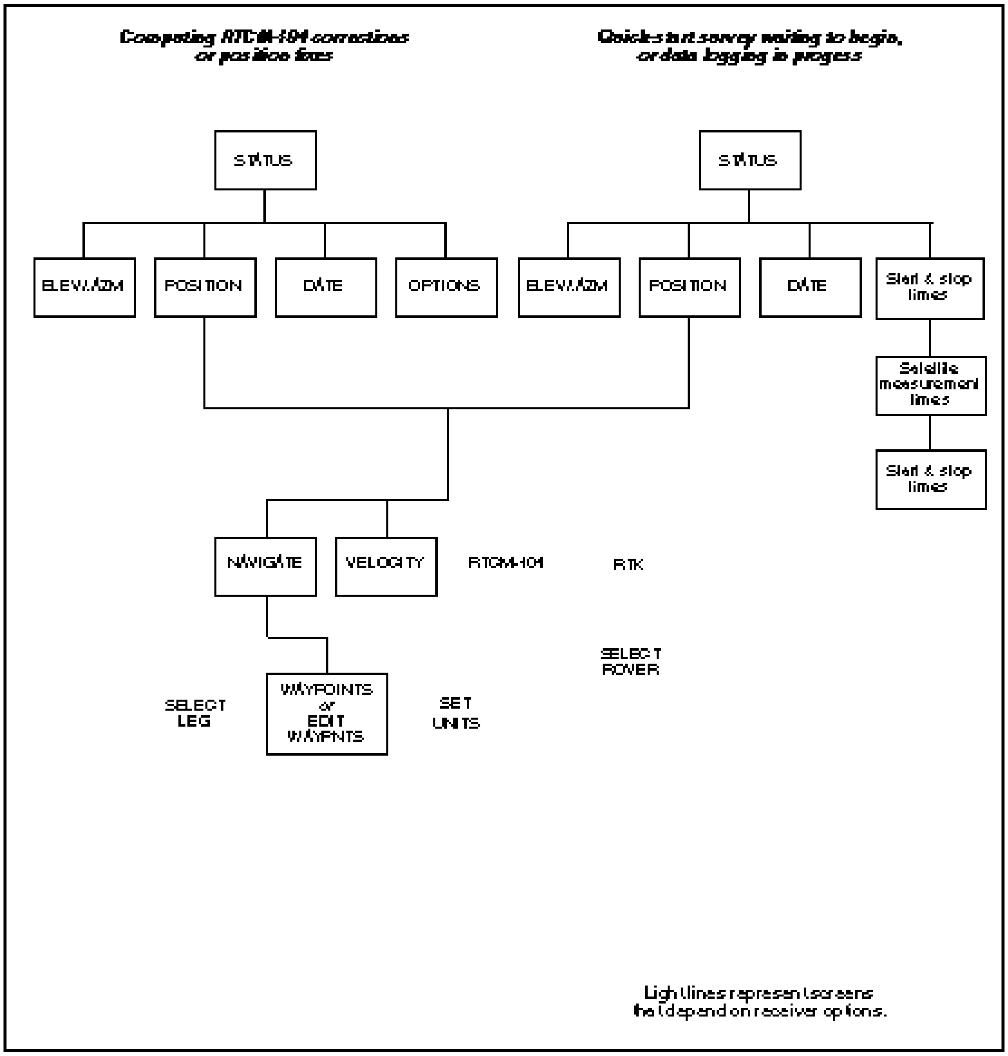


Figure 3-1. Hierarchy of *Status* Screens

3.1 The *Status* Screens

Display basic information about the receiver's status.

The “main *Status* screen” is actually a group of screens; the receiver's status determines which screen appears. Some of these screens are followed by additional status screens. This section describes the first screen, and the following sub-sections describe the others.

To display the first screen. Press the STATUS key, or press the CLEAR key repeatedly until the display stops changing. The receiver displays a screen similar to one of these:

- If a static survey is in progress, or a quickstart static survey is waiting to begin:

```
0492-137-0  LOGGING FOR  0:01  |ELEV/AZM
APPROX. MEMORY LEFT:  94 HR    |POSITION
SV 02,19[06,18]                |    DATE
PWR2+[■■■■■] Þ 2:05:03 PST/24 |    MORE
```

- If no survey is in progress and the receiver is computing RTCM-104 corrections:

```
RTCM-104 REFERENCE STATION     |ELEV/AZM
GENERATING CORRECTIONS FOR     |POSITION
 SV12,13,20,24                 |    DATE
PWR1+[■■■■■] Þ 00:24:14 UTC   | OPTIONS
```

- If no survey is in progress and the receiver is computing corrected or uncorrected position fixes:

```
POSITIONING -  AUTO SV SELECT  |ELEV/AZM
POSITION FIX: LAT/LON, FIX HGT |POSITION
 SV12,13,20,24                 |    DATE
PWR1+[■■■■■]CÞ 00:23:26 UTC    | OPTIONS
```

To read. The four lines of the first screen show:

1. The receiver's current status. Possible statuses and their meanings are shown in Table 3-1.

   If a quickstart survey is waiting to begin or data logging is in progress, this line also shows the name of the active data file and the time, in hours and minutes, that the receiver has been logging data.

2. Additional information about the mode.

   If the receiver is logging data, the approximate capacity of the remaining free memory, expressed in hours of logging with the current parameters.

   If the receiver is computing RTCM-104 corrections, the fixed text GENERATING CORRECTIONS FOR. Note that this is possible only with RTCM-104 Output Option.

   If the receiver is computing position fixes, the type of fixes.

3. SV numbers of the satellites from which data is currently being logged or used. Satellites that are being tracked but not used are not shown.

   During a static surveying session, satellites whose measurements are *not* being logged are displayed in square brackets. Such satellites may still be used for positioning, depending on the value of the positioning elevation mask.

Table 3-1. Receiver Status on Main *Status* Screen 1

Type of Operation	Status	Meaning
Logging Data	WAITING FOR START	A preplanned session's start time has not arrived yet.
	WAIT: *n* SVs >= MASK	Receiver is acquiring satellites. It must find *n* healthy satellites above the session's elevation mask to begin logging data.
	PRE-SURVEY POSITION	Receiver is taking a position fix at the start of data logging as part of its record keeping.
	STARTED SURVEY	Data logging has started.
	LOGGING FOR *h:mm*	Receiver has been logging data for *h* hours and *mm* minutes.
Differential GPS base station	RTCM-104 REFERENCE STATION (*or* REFERENCE SURVEYOR)	Receiver is generating RTCM-104 corrections for use in differential GPS.
Differential GPS rover, or autonomous operation	POSITIONING -- AUTO SV SELECT	Receiver is computing position fixes, and is automatically selecting and tracking the most appropriate SVs.

4. The current power source, power gauge, antenna symbol, time, and time zone identifier.

   The power gauge shows five blocks when an AC power supply or a fully charged battery is in use. As a battery's charge decreases, portions of the blocks progressively disappear.

Note – The power gauge is not linear; most of its scale represents the last stage of a battery's usefulness, when the charge is decreasing rapidly. When the gauge starts going down, plan to change batteries in the near future.

A ‘C’ or ‘P’ appears after the power indicator if the battery charger (C) or power output (P) feature is enabled.

The antenna symbol, ‘Þ’, appears if an antenna is detected on the ANTENNA port.

The time display does not show seconds if the receiver has not tracked satellites since power-up or has been running without tracking satellites for several hours.

To use. The softkeys are:

- ELEV/AZM: Displays signal-to-noise ratios (SNRs), elevations, azimuths, and User Range Accuracies (URAs) of satellites currently being tracked.
- POSITION: Displays current position and DOP values or position statistics. Additional softkeys lead to navigation features and velocity display.
- DATE: Displays current date and time, and lets you change the time's display format.
- MORE and PREV: Display the next and previous screen in a sequence of main *Status* screens. The following sections describe these screens.
- OPTIONS: Displays the receiver's model, serial number, firmware version numbers, list of features installed, and enabled/disabled status of certain important features.

3.1.1 Main *Status* Screen 2

If a quickstart survey is waiting to begin, or data logging is in progress, the first main *Status* screen displays a MORE softkey. Pressing that key displays a second screen in the main *Status* sequence, showing when the survey started or will start, and when it will stop. The following paragraphs show what main *Status* screen 2 looks like.

- Quickstart survey or manual preplanned survey waiting to begin:

```
START WHEN:  SVs RISE ABOVE          |
             ELEVATION MASK          |
STOP WHEN:  SVs FALL BELOW           |
    ELEVATION MASK OR USER END       |MORE
```

- Quickstart survey or manual preplanned survey in progress:

```
STARTED AT:                          |PREV
   TUE 25-JAN-95  13:28 PDT/24       |
STOP WHEN:  SVs FALL BELOW           |
    ELEVATION MASK OR USER END       |MORE
```

- “At specified time” preplanned survey in progress:

```
START AT:                        |ELEV/AZM
            17:55 UTC            |POSITION
STOP AT:                         |    DATE
            19:35 UTC            |    MORE
```

Press the MORE softkey again to display screens that describe satellite tracking status and data logging status (described below).

To read. The lines of the screen show:

1–2. The time or condition at which data logging began, or will begin.

3–4. The time or condition at which data logging will end.

To use. The softkeys are the same as for the first main *Status* screen, above.

3.1.2 Main *Status* Screen 3

The third main *Status* screen looks like this for a dual-frequency receiver that is tracking satellites on both frequencies:

```
             SV02  SV19  SV26  SV27 |PREV
CONT-L1        36    79    80    80 |
CONT-L2        36    79    80    80 |
TOTAL-L1       80    80    80    80 |MORE
```

It looks like this for a receiver that is tracking satellites on the L1 frequency only:

```
             SV02  SV19  SV26  SV27 |PREV
CONTINUOUS     36    79    80    80 |
TOTAL MEAS.    80    80    80    80 |
                                    |MORE
```

To read. The screen shows the number of measurements that have been made from each satellite being tracked. If the receiver is tracking too many satellites to describe on one screen, it displays additional screens to show the rest.

CONT-L1 or CONTINUOUS is the number of measurements made on the L1 channel since the receiver started logging data to the current file or since measurements were interrupted, whichever happened later. The count will be reset if a cycleslip occurs.

Similarly, CONT-L2 is the number of measurements made on the L2 channel.

TOTAL MEAS. is the total number of L1 measurements made since the receiver started logging data to the current file.

To use. The NEXT and PREV softkeys display the next and previous main *Status* screens.

3.1.3 Main *Status* Screen 4

The fourth main *Status* screen looks like this:

```
LOGGING ELEV MASK:  +15°            |PREV
 LOGGING INTERVAL:  15.0 SEC        |
 MINIMUM NUM. SVs:   3              |
    LAST EVENT ID: 00000            |MORE
```

To read. The screen shows the parameter values being used to log data: the survey elevation mask, logging interval, minimum number of SVs required to log data, and the last event ID recorded in this data file.

To use. The PREV softkey displays the previous main *Status* screen. The NEXT softkey returns to the first main *Status* screen.

3.2 ELEV/AZM

Shows satellite tracking data.

To display. From the *Status* screen, select ELEV/AZM. The receiver displays a screen similar to this (for a single-frequency receiver or a dual-frequency receiver with L2 tracking disabled):

```
CH1-4  SV26  SV28  SV03u SV21 |MORE CHAN
ELEV    22°   31°   42°   77° |      URA
AZMTH  061°  316°  113°  240° |
SNR      8     7    11    11  |
```

...or this (for a dual-frequency receiver with L2 tracking enabled):

```
CH1-4  SV26  SV28  SV03  SV21 |MORE CHAN
ELEV    22°   31°   42°   77° |      URA
L2 SNR   8p    7p   11p   11p |  AZIMUTH
L1 SNR   8p    7p   11p   11p |
```

To read. Each display is grouped into columns, each column representing an SV on one receiver channel. For each channel, the four lines show:

1. Which SV the channel is currently tracking or searching for.

   A ‘u’ after an SV number indicates that the SV is unhealthy.

2. The SV's elevation or its broadcast URA value. To toggle between the two displays, press the URA/ELEV softkey.

   URA (User Range Accuracy) is a measure of the errors that may be introduced by Selective Availability and satellite health problems. Each SV's URA is set by the NAVSTAR system's ground support (the Control Segment). The larger the number, the larger the errors that are likely to occur when that satellite is used to compute positions autonomously. A URA of 32 indicates that Selective Availability is enabled.

3–4. In the first display, line 3 shows the satellite's azimuth and line 4 shows its signal-to-noise ratio (SNR).

   In the second display, line 3 shows the satellite's azimuth or L2 SNR, and line 4 shows its L1 SNR. To toggle line 3 between the L2 SNR and the azimuth, press the AZIMUTH/L2 SNR softkey (whose label changes each time it is pressed).

To read: notes on SNRs.

A signal-to-noise ratio (SNR) indicates a signal's strength. The larger the value, the stronger the signal. A value in the 20's is very strong. If no value is displayed, the receiver is still searching for the SV.

SNRs appear only when satellites are being tracked. If a satellite is visible but the receiver is not tracking it, it may appear with an azimuth and elevation, but its SNR(s) will be blank. This is usually because the satellite is below the user-specified elevation mask.

If an SNR value is followed by a ‘p’, the receiver is tracking P-code on that frequency (L1 or L2) from that satellite. If an SNR value is followed by an ‘x’, the receiver is doing cross-correlation processing on that satellite's signals. In the 4000 SSi receivers, the SNR value is followed by an ‘e’ indicating the P-code signal is encrypted and Super-trak technology is being used to derive the L2 ranges.

To use. The softkeys are:

- MORE CHAN: Display the next set of channels.
- URA/ELEV: Toggle line 2 of the display between satellite elevation and URA values.
- AZIMUTH/L2 SNR: Toggle line 3 of the display between L2 SNR and azimuth (only on dual-frequency receivers with Carrier Phase Option present and L2 tracking enabled).

3.3 POSITION

Displays current position and dilution of precision (DOP) values. Additional softkeys lead to navigation features and displays of velocity, accuracy statistics, and the status of RTCM, RTK, and the NAV BEACON XL.

To display. From the *Status* screen, select POSITION.

- The initial display shows dilution of precision (DOP) values in one of these screens:

```
LAT: 37°23.6410' N*   PDOP: 2.2|NAVIGATE
LON:122°02.2318' W*   HDOP: 2.2|VELOCITY
HGT: -0001.0 m (MSL)  VDOP: 0.0|RTCM-104
 [DIFF/FIXED HEIGHT]  TDOP: 0.8|   STATS
```

```
LAT: 37°23.6410' N    PDOP: 2.2|NAVIGATE
LON:122°02.2318' W    HDOP: 2.2|VELOCITY
HGT: -0001.0 m (MSL)  VDOP: 0.0|     RTK
  [FIXED HEIGHT]      TDOP: 0.8|   STATS
```

- The STATS/DOPS softkey toggles the screen between DOP calculations and position statistics. This softkey and screen are available only if the QA/QC Option is installed:

```
LAT: 37°23.4586' N    SIGMA N:23.9m
LON:122°02.2737' W    SIGMA E:12.5m
HGT: -0016.3 m (MSL)  SIGMA U:51.2m
  [FIXED HEIGHT]         UNIT: 0.86|DOPS
```

To read: Position. On the left, the four lines display:

1–3. Latitude, longitude, and height.

The latitude and longitude normally are displayed in the WGS-84 datum. Their format is controlled by the *Modify* menu's UNITS OF MEASURE item. It can be either degrees, minutes, and decimals, or in degrees, minutes, seconds, and decimals.

Height is in meters. ‘MSL’ means that height is measured from mean sea level; if it is not shown, height is measured from the WGS-84 reference ellipsoid. This is controlled by the *Modify* menu's ALTITUDE REFERENCE item.

When RTCM-104 output is enabled (that is, when the receiver is functioning as a differential GPS base station), the receiver does not calculate position fixes. This screen will always show the positioning reference position.

4. Type of position fix. If the value is:

   – DIFFERENTIAL: Position is 3D, based on current differential corrections.

   – DIFF/FIXED HEIGHT: Position is 2D, based on current differential corrections.

   – DIFF/FIXED LAT/LON: Position is 1D (height only), based on current differential corrections.

   – OLD POSITION: The receiver is not currently calculating position fixes; the position is the last one calculated.

   When the receiver is calculating FIXED HEIGHT (2D) positions, the height value is the last computed height, or the height from the reference position if LAT and LON are non-zero. When the receiver is calculating FIXED LAT/LON (1D) positions, LAT and LON are the last computed values, or the values from the reference position if it is non-zero.

   Blank: Position is 3D autonomous (uncorrected).

   FIXED LAT/LON: Position is 1D autonomous.

   FIXED HEIGHT: Position is 2D autonomous.

To read: DOP values. The DOP values represent position (PDOP), horizontal (HDOP), vertical (VDOP), and time (TDOP) dilution of precision. The smaller a DOP value, the better the precision of the position.

A 3D position fix's maximum probable error, in meters, is approximated by the product of the PDOP and the URA. As a rule of thumb, PDOP values under 4.0 yield excellent position fixes; values between 4.0 and 7.0 yield acceptable fixes; values over 7.0 yield poor fixes.

HDOP and VDOP are components of the PDOP, and never exceed it.

Asterisks ('*'s) before the PDOP and HDOP indicate that the receiver is computing unweighted positions. This is controlled by the WEIGHTED SOLUTION ENABLED parameter in the *Control* menu's POSITIONING MODES screen.

To read: Sigma values (only with QA/QC Option). Each sigma value is the square root of the error covariance matrix term representing error in one of the three coordinates. Sigma values are computed using the constellation geometry and the error estimate for each satellite. They are expressed in meters.

- SIGMA N: Latitude error.
- SIGMA E: Longitude error.
- SIGMA U: Height error.
- UNIT: An *a posteriori* estimate of the relationship of the sigma values to the actual error. Computed only for overdetermined solutions, *i.e.*, when more satellites are used than are necessary for the type of solution being computed.

  UNIT = 1.0: The sigma values roughly correspond to the actual errors.

  UNIT < 1.0: The sigma values probably overestimate the actual errors.

  UNIT > 1.0: The sigma values probably underestimate the actual errors.

To read: Local datum or zone selected. In this configuration the first POSITION screen may resemble one of these:

```
LAT: 37°23.6410' N    PDOP: 2.2|NAVIGATE
LON:122°02.2318' W    HDOP: 2.2|VELOCITY
HGT: -0001.0 m (MSL)  VDOP: 0.0|RTCM-104
  [FIXED HEIGHT]       NAD 83  |   STATS
```

```
NORTH:+0600050.224 m  PDOP: 2.2|NAVIGATE
EAST :+1863807.380 m  HDOP: 2.2|VELOCITY
HGT: -0001.0 m (MSL)  VDOP: 0.0|RTCM-104
  [FIXED HEIGHT]       CA3     |   STATS
```

When LOCAL LLH (a local datum) is selected, lines 1 and 2 show latitude and longitude in the appropriate local datum. Line 4 shows the short name of the local datum being used.

When LOCAL NEH (a local zone) is selected, lines 1 and 2 show northing and easting, in meters, relative to the origin of the projection. Line 4 shows the short name of the zone. However, if the receiver determines that the position is outside the zone, lines 1 and 2 say ‘Check Zone’.

When a local datum *or* a local zone is selected, line 4 shows the short name of the datum or zone. Otherwise, it shows the type of position fix and TDOP, as shown at the start of this section.

To use. The softkeys are:

- NAVIGATE: Displays a screen that gives you access to the receiver's navigation functions.
- VELOCITY: Displays a screen showing the receiver's velocity.

- RTCM-104: Leads to a group of screens that show the actual correction data that is being received or generated.
- This softkey is present only if RTCM message input or output is installed and enabled.
- RTK: Leads to a group of screens that show the status of RTK (Real-Time Kinematic) rover operations. This softkey is present only if RTK rover control is installed and enabled.
- STATS/DOPS: Toggles this screen between DOP values and sigma values. This softkey is present only if the QA/QC Option is installed.

3.3.1 NAVIGATE: General Information

The navigation screens can be used to steer a vehicle from one location to another by defining and following a course consisting of some number of straight lines (legs).

These screens appear in two versions: a simple version on receivers without the Navigation Package Option, and a more extensive version on receivers with that option.

The navigation functions use corrected positions if the RTCM-104 Input Option is installed and operating, and use RTK positions if the RTK Functions Option is installed and operating. Otherwise they use uncorrected (autonomous) positions.

3.3.2 NAVIGATE without Navigation Package Option

On receivers that do not have the Navigation Package Option, the NAVIGATION screens let you define a destination, called a *waypoint*, and display information about your position relative to the waypoint as you travel toward it.

To display. From the *Status* screen, select POSITION, then NAVIGATE.

```
   BEARING: 181° TRUE          |WAYPOINT
     RANGE:     228 m          |
HEAD SOUTH:       2 m          |
    & EAST:     228 m          |   UNITS
```

To read. The four lines show:

1. Bearing from your current position to the waypoint.
2. Range from the current position to the waypoint.
3. North/south heading and range to the waypoint.
4. East/west heading and range to the waypoint.

To use. The softkeys are:

- WAYPOINT: Displays a screen that lets you set the coordinates of the waypoint.
- UNITS: Changes the units of measurement that the NAVIGATION screen uses to express distances. The basic units you can select are miles (mi), nautical miles (nm), meters (m), and feet (ft). When the units are meters, large values are displayed in kilometers (km) or megameters (Mm).

WAYPOINT

Available only if the Navigation Package Option is *not* installed.

Display and change the coordinates of the waypoint.

This screen appears only on receivers that *do not* have the Navigation Package Option. On receivers that have that option, it is replaced by a group of screens that let you select, display, and change any of 99 different waypoints.

To display. From the NAVIGATE screen, select WAYPOINT.

```
ENTER DESTINATION WAYPOINT:    |   NORTH
 LAT   37°23.3448' N           |   SOUTH
 LON  122°02.2487' W           |    HERE
                               |  ACCEPT
```

To read. The lines on the screen show:

1. ENTER DESTINATION WAYPOINT: Fixed text.

2–3. The waypoint's position.

To use. Enter the latitude and longitude of the waypoint. Use the NORTH and SOUTH or EAST and WEST softkeys to toggle the direction of whichever coordinate you are entering.

When you have finished defining the waypoint, press either ENTER or ACCEPT to save it. The receiver redisplays the NAVIGATE screen.

The softkeys are:

- NORTH/EAST: Toggle the latitude's direction from SOUTH to NORTH, or the longitude's direction from WEST to EAST.
- SOUTH/WEST: Toggle the latitude's direction from NORTH to SOUTH, or the longitude's direction from EAST to WEST.
- HERE: Set the waypoint to the receiver's current position. This is useful if you will need to return to the current position from another, possibly unknown place.
- ACCEPT: Accept the waypoint definition and return to the NAVIGATE screen.

3.3.3 NAVIGATE with Navigation Package Option

On receivers that have the Navigation Package Option, the NAVIGATION screens let you define and use up to 99 *waypoints,* numbered from 01 to 99. A waypoint is a position which represents the beginning or end of a course, or some intermediate point. The part of a course between two waypoints is called a *leg* or *leg line.*

You can follow a complex course by defining an appropriate set of waypoints, then selecting the leg lines that trace out the course, one at a time, as you proceed. When you select each leg line, the receiver displays information about your position relative to the waypoint at its end.

To display. From the *Status* screen, select POSITION, then NAVIGATE.

You can select one of three navigation data display formats with the CHANGE FORMAT softkey.

- The cross-track error (XTE) display:

```
   FROM: 00  TO: 01        |   SELECT LEG
BEARING:      181° TRUE    |CHANGE FORMAT
  RANGE:      228 m        | EDIT WAYPNTS
    XTE:        2 m LEFT   |    SET UNITS
```

- The range-and-bearing display:

```
   FROM: 00  TO: 01        |   SELECT LEG
RNG/BRG:      248 m 182°   |CHANGE FORMAT
  SOUTH:      248 m        | EDIT WAYPNTS
   WEST:       11 m        |    SET UNITS
```

- The steering direction display:

```
   FROM: 00  TO: 01        |   SELECT LEG
BEARING:      183° TRUE    |CHANGE FORMAT
  RANGE:      253 m        | EDIT WAYPNTS
  STEER: >>>>>>>>■--------|    SET UNITS
```

To read. The four lines show:

1. The numbers of the waypoints at the beginning and end of the leg displayed.

2–4. Information about the path from the current position to the end of the leg:

  - BEARING or BRG: Bearing from the current position to the end of the leg, in degrees relative to true north.
  - RANGE or RNG: Range from the current position to the end of the leg.
  - XTE: Cross-track error, that is, the direction and shortest distance from the current position to the leg.
  - STEER: An arrow that represents the direction to steer to intersect the leg from the current position. The number of arrowheads on the arrow increases with the distance from the current position to the nearest point on the course. The distance that each arrowhead represents is adjustable with the SET UNITS softkey.
  - NORTH/SOUTH and EAST/WEST: Directions and distances from the current position to the destination with respect to true north.

To use. The softkeys are:

- SELECT LEG: Displays a screen that lets you select the waypoints at the start and end of the leg.

- CHANGE FORMAT: Cycles this screen's display format among the three variations shown above.
- EDIT WAYPNTS: Displays a screen that lets you inspect and change the coordinates of waypoints.
- SET UNITS: Displays a screen that lets you change the units used to express distances, and the distance represented by one arrow in the STEER display.

SELECT LEG

Available only with the Navigation Package Option.

Lets you select a course leg that begins and ends at any specified pair of waypoints.

To display. From the NAVIGATE screen, choose SELECT LEG.

```
  FROM: 00  TO: 01              |    NEXT
                                |    PREV
                                |    HERE
                                |  ACCEPT
```

To read. FROM and TO are the waypoints at the start and end of the leg.

To use. You can enter numbers into the FROM and TO fields, or select a pair of waypoints with the NEXT and PREV softkeys.

Note that the waypoints at the start and end of the leg need not have consecutive numbers. If you commonly travel among certain fixed locations, you may enter their positions as waypoints; then you may select the corresponding waypoints to navigate directly from any one location to any other.

For the purpose of data entry, FROM and TO act like a single field. You can move from one to the other by pressing the < and > keys.

Do not try to use [ENTER] and [CLEAR] for this purpose; they will return you directly to the NAVIGATE screen.

- NEXT: Makes the new FROM waypoint the same as the TO waypoint, then increments the TO waypoint number by 1. For example, if FROM is 14 and TO is 05, pressing NEXT will set FROM to 05 and TO to 06.
- PREV: Makes the new TO waypoint the same as the FROM waypoint, then decrements the FROM waypoint number by 1. For example, if FROM is 14 and TO is 05, pressing PREV will set FROM to 13 and TO to 14.
- HERE: Sets the FROM waypoint number to 00 and stores the receiver's current position in waypoint 00. This offers a convenient way of defining a one-leg course from your current location to any point.
- ACCEPT: Makes the receiver return to the NAVIGATE screen and display information about the leg you have selected.

EDIT WAYPNTS

Available only with the Navigation Package Option.

Defines or modifies the locations of waypoints.

To display. From the NAVIGATE screen, select EDIT WAYPNTS.

The screen has two forms, depending on whether you are selecting a waypoint to be defined, or defining it.

- The initial display, used to select a waypoint:

```
SELECT WAYPOINT -> 01          |    NEXT
 LAT   37×23.3448' N           |PREVIOUS
 LON  122×02.2487' W           |
                               |
```

- The display used to define the selected waypoint:

```
EDIT WAYPOINT -> 01                |    HERE
 LAT   37°23.3448' N               |  DELETE
 LON  122°02.2487' W               |   SOUTH
                                   |  ACCEPT
```

To read. The lines on the screen show:

1. The waypoint number.

2–3. The waypoint's position.

To use. Enter a waypoint number, or press NEXT and PREVIOUS until the number you want is displayed. Then press ENTER. The receiver displays the second form of the screen, with the cursor at the beginning of LAT.

Enter the latitude and longitude of the waypoint. Use the NORTH/SOUTH/EAST/WEST softkey to toggle the direction of whichever coordinate you are entering.

When you have finished defining a waypoint, press either ENTER or ACCEPT to save it. The receiver displays the first form of this screen and moves the cursor back to the waypoint number. You may then repeat this procedure to enter another waypoint.

When you are done defining waypoints, press CLEAR to return to the NAVIGATE screen.

The softkeys are:

- NEXT: Display the definition of the next waypoint number.
- PREVIOUS: Display the definition of the previous waypoint number.
- HERE: Set this waypoint to the receiver's current position.
- DELETE: Set this waypoint to 00½ 00' latitude and 000½ 00' longitude.

- NORTH/SOUTH: Toggle the latitude's direction (when you are entering the latitude).
- EAST/WEST: Toggle the longitude's direction (when you are entering the longitude).
- ACCEPT: Accept this waypoint definition. Display the first form of this screen, allowing you to select and define another waypoint.

SET UNITS

Available only with the Navigation Package Option.

Units in Navigation Package OptionChanges the units of measure that the NAVIGATION screen uses to express distances, and the distance that one arrowhead represents in the steering direction display.

- The initial form of the screen, used to change range units:

```
    RANGE UNITS = METERS      <-- CHANGE

     XTE ARROWS = [000025] m  <-- CHANGE
                                PREVIOUS
```

- The form used to change the scale of the cross-track arrows, displayed when you press the XTE ARROWS. . . CHANGE softkey:

```
    RANGE UNITS = METERS      |
                              |
     XTE ARROWS = [000025] m  |
                              |   ACCEPT
```

To read. The lines on the screen show:

1. Units used to measure distances on the NAVIGATION screen.
3. Distance represented by one arrowhead in the steering direction display. For example, a value of 10 m means that each arrowhead in the steering direction display represents 10 meters of cross-track error.

To use.

- RANGE UNITS... CHANGE: Cycles through available units: miles, nautical miles, feet, meters, or kilometers.
- XTE ARROWS... CHANGE: Moves the cursor into the field that defines the distance represented by one steering direction arrow. Edit the value and press ENTER or ACCEPT to save your changes.

  Note that the scale of XTE ARROWS is expressed in meters when the range units are metric, and in feet when the range units are English.
- PREVIOUS: Returns to the NAVIGATION screen. Equivalent to ENTER or CLEAR.

3.3.4 VELOCITY

Velocity of receiverDisplays the receiver's current velocity, computed from Doppler shifts observed in the SV signals.

To display. From the main POSITION screen, select VELOCITY.

```
VELOCITY:                          |   UNITS
 HORIZONTAL:   0.78 km/h @ 146°|POSITION
   VERTICAL:  +0.09 km/h           |
                                   |
```

To read. The lines in the screen show:

1. VELOCITY (fixed text).

2. Magnitude and direction of the horizontal component of velocity. Direction is given relative to true north.

3. Magnitude of the vertical component of velocity.

Note that even a stationary receiver will show some velocity (as in the example above) due to Selective Availability and measurement errors. Selective Availability typically causes an apparent velocity of about 1 knot; measurement errors cause a velocity of about 0.1 to 0.2 knots. Applying corrections from a base station will reduce these errors to relatively small values.

To use. The softkeys are:

- UNITS: Cycles through the available units for velocity: miles/hour horizontal and vertical; kilometers/hour horizontal and vertical; meters/second horizontal and vertical; knots horizontal, feet/minute vertical; or knots horizontal and vertical.
- POSITION: Returns to the POSITION screen (one level up).
- CLEAR: Returns directly to the *Status* screen (two levels up).

3.3.5 RTCM-104

Available only with the RTCM-104 Input Option or RTCM-104 Output Option.

This screen shows the status of the receiver's RTCM-104 message processing. It is available only if the receiver has the RTCM-104 Input Option or Output Option, *and* the option is enabled; that is, when the receiver either is computing corrected position fixes or is generating RTCM-104 corrections.

To display. From the *Status* screen's POSITION function, press the RTCM-104 softkey.

- If RTCM-104 input is enabled, the receiver displays this screen:

```
            DISPLAY NAVBEACON STATUS --->
                 DISPLAY RTCM STATUS --->
             DISPLAY RTCM RTK STATUS --->
```

The `DISPLAY RTCM RTK STATUS` softkey is only displayed if RTK is enabled.

If you press the DISPLAY NAV BEACON STATUS softkey, the receiver displays the first of a group of screens that display the status of a Trimble NAVBEACON XL that is attached to the receiver. These screens are described in the next section.

If you press the DISPLAY RTCM STATUS softkey, the receiver displays the first of the following series of screens. Press the MORE softkey to cycle through the screens.

```
RTCM-104 INPUT STATUS:            | MORE
  LAST MESSAGE FROM STATION 0
 TYPE 1 (REV2) 16 WORDS
RECEIVED 1 SECONDS AGO
```

```
RTCM-104 INPUT STATUS:            | MORE
TYPE 16 MESSAGE:
""
```

```
RTCM-104 INPUT STATUS:            | MORE
TYPE 3 RECEIVED 7 SECONDS AGO
 37°23.4628' N  122°02.2493' W
            +0018.0 m MSL
```

```
RTCM CORRECTION FOR SV27:+27.311m | MORE
 IODE:219   AGE:  1sec  UDRE:0
 219: PRC+27.240m   RRC+0.158m/s
 214:dPRC -0.020m  dRRC+0.000m/s
```

- If RTCM output is enabled, the receiver displays the first of these screens:

```
RTCM REFERENCE STATION STATUS:    | MORE
 GENERATING CORRECTIONS FOR 05 SVS
```

```
RTCM CORRECTION FOR SV27:         | MORE
IODE UDRE:0
219: PRC+27.240m   RRC+0.158m/s
214:dPRC -0.020m  dRRC+0.000m/s
```

To read. The lines on the input status screens show:

- *Screen 1:* Station ID of the base station which generated the last message received; type, RTCM version, and length of the message; and age of the message.
- *Screen 2:* Contents of the last Type 16 (Special Message) message received.
- *Screen 3:* Contents and age of the last Type 3 (Reference Station Parameters) message received.
- *Screen 4:* Contents and age of the last Type 1 and Type 2 (Correction) messages received. (The receiver displays multiple copies of this screen, one for each SV from which corrections are being received.)
  - IODE identifies the *issue of data ephemeris*, that is, the current version of the ephemeris. It is derived from the satellite signal, and is set by the NAVSTAR system's control segment about once per hour.
  - UDRE is the *User Differential Range Error.* For RTCM-104 Version 2.0, the range of values is 0 to 3. For Version 1.0, the range is 0 to 7. For the meanings of specific values, see the document that defines the appropriate version of RTCM-104; the documents are listed in the Bibliography.
  - PRC is the *pseudorange correction:* The correction term for this satellite.
  - dPRC is the *delta pseudorange correction:* The difference in the correction term from the previous IODE. It allows rovers that have not acquired the new ephemeris to continue using the corrections.
  - RRC is the *range rate correction:* The rate of change in the PRC over time.
  - dRRC is the *delta range rate correction,* the difference in RRC from the previous IODE. This allows rovers that have not acquired the new ephemeris to continue using the corrections.

The lines on the output status screens show:

- *Screen 1:* Number of SVs for which the receiver is generating corrections.
- *Screen 2:* Contents of last Type 1 and Type 2 (Correction) messages generated. (The receiver displays multiple copies of this screen, one for each SV for which corrections are being generated.)

DISPLAY NAV BEACON STATUS

Available only with the RTCM-104 Input Option.

Displays the status of an attached NAV BEACON XL communications receiver and lets you change its receiving frequency.

To display. From the main POSITION screen, press the RTCM-104 softkey. From the resulting menu, press the DISPLAY NAV BEACON STATUS softkey.

```
NAVBEACON XL STATUS:  TRACKING     |MORE
 FREQ: 300.0 kHz    LEVEL:+67.0 dBuV/m
 BAUD: 100 b/sec    SNR  :+21.0 dB
 ERRORS IN LAST 256 WORDS:   0
```

```
NAVBEACON XL STATUS:  TRACKING     |MORE
   CARRIER OFFSET:  +1.5 Hz
    SYMBOL OFFSET: 100.0 Hz
   FREQUENCY MODE: AUTOMATIC  <-- CHANGE
```

```
NAVBEACON XL #0000023076 22-DEC-92 |MORE
   BOOT VERSION:  01.00  12-NOV-1992
   PROG VERSION:  01.00  14-DEC-1992
    SIG VERSION:  01.00  16-NOV-1992
```

Screen 2's CHANGE softkey displays one of these screens, depending on whether the receiver's automatic frequency selection is enabled:

```
SELECT FREQUENCY MODE:             INCREASE
                                   DECREASE
      FREQUENCY [ 300.0 kHz ]          AUTO
                                     ACCEPT
```

```
SELECT FREQUENCY MODE:

      FREQUENCY [ AUTOMATIC ]        MANUAL
                                     ACCEPT
```

To read. The lines on screen 1 show:

1. The NAV BEACON XL's current status: TRACKING, SEARCHING, etc.
2. Its current frequency and signal strength.
3. Its data rate for the RTCM data being received from a radio, and its signal-to-noise ratio.
4. The number of errors in the last 256 words of data received.

The lines on the screen 2 show:

1. Status (same as in first screen).
2. Carrier offset: The offset of the received carrier's frequency from the selected carrier's frequency.
3. Symbol offset: Observed bit rate of the received data.
4. Frequency mode: AUTOMATIC (the NAV BEACON XL selects a base station's transmission automatically) or MANUAL (it uses a specified fixed frequency).

The lines on the screen 3 show:

1. The NAV BEACON XL's serial number and date of manufacture.

2–4. The version numbers and release dates of its boot, program, and signal firmware.

The SELECT FREQUENCY MODE screens display the NAV BEACON XL's frequency setting.

To use. The softkeys are:

- MORE: Cycles through the three status screens.
- INCREASE and DECREASE: Increase and decrease the receiver's frequency setting. (You can also enter a new frequency with the numeral keys.)
- AUTO: Enable automatic frequency selection and display the second form of the SELECT FREQUENCY MODE screen.
- MANUAL: Disable automatic frequency selection and display the first form of the SELECT FREQUENCY MODE screen.
- ACCEPT: Accept settings and return to the RTCM status screen; equivalent to ENTER.

For information about appropriate NAV BEACON XL frequency settings, refer to the NAV BEACON XL manual.

3.3.6 RTK

Available only with the RTK Functions Option.

This screen displays the status of RTK rover operations. It is available only if the RTK Functions Option is installed and RTK rover control is enabled.

Note – This section describes only the RTK screens available on a receiver. You must have a Trimble Data Collector to access the full functionality of RTK.

To display. From the *Status* screen's POSITION function, press the RTK softkey. The receiver displays the first of the following screens. Press the MORE softkey to cycle through the screens. (These screens will not all appear in order; see the following description.)

```
dE:     +35.570 m   RMS: 5957 mc   | MORE
dN:      +1.382 m  RDOP:  0.11     | ROVE
dU:      -0.841 m  ROVE-FLOAT/L1   |  ZBL
 R:      35.607 m  [NEED REF POS]  | INIT
```

```
RTK REFERENCE STATUS  cref (31)

  NEED REF STATION COORDINATES
```

```
RTK REFERENCE STATUS: cref (31) |   MORE
   REF LAT   37½23.473615' N    |
   REF LON  122½02.264807' W    | ACCEPT
   REF ALT   +0008.723 m        |
```

```
RTK REFERENCE STATUS: cref (31)    |MORE
         SV20   SV03   SV12   SV2  |
CYCLES:  1934   1934   1934   1230 |
   SNR:     4     10     18     28 |
```

To read. The contents of the screens are:

- *Screen 1:* In the left column, the distance between the base station and the rover. dE, dN, and dU are the east/west, north/south, and vertical components. R is the range.

  In the right column, the rover's survey mode and status.

  Possible modes are:

  – STATIC: The rover is in *Static* mode. Precision is approximately 2 cm + 2 ppm as long as the antenna remains stationary. If the antenna moves, results are invalid and the survey may have to be reinitialized.

  – ROVE–FLOAT/L1: The rover is computing *Float* solutions in *Rove* mode. Solutions are precise to better than ±1 meter if the rover and base station both use Maxwell technology, and to ±2–5 meters in other cases.

  – ROVE–FIXED/L1: The rover is computing *Fixed* solutions in *Rove* mode. Solutions are precise to between 2 and 5 cm.

When the receiver is initialized it operates in *Static* mode, or in *Rove* mode with *Fixed* solutions, at the user's option. When the receiver is uninitialized it operates only in *Rove* mode with *Float* solutions.

Possible status messages are:

– NEED REF POS: The rover has not received and accepted a reference position over the radio link since it was activated.

– NEED SV DATA: Either the rover or the base station does not have any SV data.

– RF LINK DOWN: No valid data is being received from the base station. The base station may not be operating, or the radio link may be out of order.

– NEED 2-D FIX: A 2D fix is needed for a good estimate of the clock offset.

– NEED 4 SVS: RTK cannot function because the rover and the base station do not have at least four satellites in common.

– INIT FAILED: The rover's specified position relative to the base could not be determined to an accuracy of ±5 cm, causing the initialization procedure to fail. Reinitialize with a different reference mark or initializer.

– SUSPECT RMS: A problem has caused the fixes to become less reliable. This typically is caused by moving the rangepole during the observation, or by a cycleslip on one or more satellites.

– HIGH PDOP: The PDOP of the common SVs is greater than the positioning PDOP mask. This message may appear while the rover is in *Rove* mode.

– HIGH RPDOP: The relative PDOP (or RDOP) of the common SVs is greater than the PDOP mask. This message may appear while the rover is in *Static* mode; the RTK firmware takes advantage of the fact that the receiver is static to compute RPDOP, which is essentially PDOP averaged over time.

- *Screen 2:* This screen appears after screen 1 if you press the MORE softkey when a base station position has not yet been received over the radio. Press any key to return to the POSITION screen.
- *Screen 3:* This screen appears after screen 1 if you press the MORE softkey when a base station position has been received over the radio. The first line shows the base station's station index number (by default, 31) and ID (always ‘cref’, for “control/reference,” if the index is 31). The second through fourth lines show the base station's reference position.

  RTK's use of indexes and station IDs is explained in the section RTK OUTPUT CONTROL in Chapter 5.

  If the reference position is correct (if it gives the accepted coordinates of the proper base station), press ACCEPT. If not, verify that all of the equipment—both base station and rover—is set up correctly.
- *Screen 4:* This screen appears after screen 3. It shows information received from the base station, which shows the base station's status: the satellite IDs of the SVs being used, with the continuous measurement count and the signal/noise ratio for each. If more than four SVs are being used, the receiver displays them on additional screens.

To use. The softkeys are:

- ROVE or STATIC: Change this station's mode from *Static* to *Rove* or *vice versa.* When the station is in *Rove* mode, the STATIC key appears; in *Static* mode, the ROVE key appears.

  In *Static* mode the receiver computes more precise position fixes by averaging measurements over time to dilute the effects of noise. In *Rove* mode it does not do averaging; this reduces its precision but lets it compute position fixes even while moving.

These keys are available only when the receiver is receiving signals from an RTK base station, and has been initialized.

- ZBL: Perform zero baseline initialization. This function is intended for software testing only, and is not useful for conducting surveys.
- INIT or UNINIT: INIT displays the SELECT ROVER STATION screen, described below, to initialize the rover. Once initialized, the rover computes *Fixed* solutions. UNINIT returns the rover to the uninitialized state, making it resume computing *Float* solutions, which are less precise than *Fixed* solutions.

  INIT is available when the rover has accepted the base station coordinates but has not yet been initialized, or has been uninitialized. UNINIT is available when the rover has accepted base station coordinates and has been initialized.

  Note that the ZBL and INIT softkeys appear only when the rover and base station are tracking at least four common SVs and the rover has received a base station position via radio link.
- ACCEPT or REJECT: ACCEPT allows the receiver use the base station coordinates displayed on screen 3. This lets the rover begin computing solutions.

  REJECT makes the rover discard previously accepted reference coordinates and stop computing solutions.

  ACCEPT is available when base station coordinates have been received but not yet accepted (or REJECT has been pressed). REJECT is available when base station coordinates have been accepted; that is, when the rover is computing solutions.

SELECT ROVER STATION

Enables you to initialize or re-initialize an RTK receiver as a rover at a specified station.

Note – You cannot enter antenna heights or survey mark feature codes from the receiver's screens. Also, stakeout functions are not easily accessible. For these reasons, the rover should be controlled from an Survey Controller or Seismic Controller for surveying operations.

To display. From the first POSITION...RTK screen, press the INIT softkey.

```
SELECT ROVER STATION:       (31)|    NEXT
  LAT   37°23.468839' N         |    PREV
  LON  122°02.262386' W         |
  HGT  -0005.098 m              |  ACCEPT
```

To read. The lines on the screen show:

1. Fixed text. The number in parentheses is the index of the selected station. (RTK's use of station IDs is explained in the section RTK OUTPUT CONTROL in Chapter 5.)

2–4. The latitude, longitude, and height of the station.

To use. Select and accept the station whose reference position corresponds to the rover's initial location.

The softkeys are:

- NEXT or PREV: Select the next or previous station.
- ACCEPT: Accept the station index selection and return to the RTK rover status screen. (You may also press ENTER to do this.)

3.4 DATE

Displays the current date and time, and lets you change the time's display format.

The date and time are derived from the SV signals, and cannot be changed.

To display. From the *Status* screen, select DATE.

```
WED 25-JAN-95  00:47:13 UTC     |   UNITS
JULIAN DAY: 25                  |
  GPS WEEK: 785                 |
TIME OFFSET(GMT-UTC): +0:00     |
```

To read. The four lines display:

1. Day of week, date, time, and time zone identifier.
2. Julian day (day of year, counting from January 1).
3. GPS week (a count of weeks from Sunday, January 6, 1980). Each GPS week starts on Sunday.
4. Time offset from GMT to the local time zone.

To use. The softkeys are:

- UNITS: Toggles the time display between 24-hour format and 12-hour format with AM/PM indicator.

3.5 OPTIONS

Displays the receiver's model, serial number, firmware version numbers, list of options installed, and enabled/disabled status of certain important features.

To display. From the *Status* screen, select OPTIONS. This displays the first of a series of screens that list information about the receiver:

```
RECEIVER CONFIGURATION:   (1 of n) |
                                   |
 TRIMBLE NAVIGATION                |
SUNNYVALE CALIFORNIA               |MORE
```

```
RECEIVER CONFIGURATION:   (2 of n) |
MODEL:    GEODETIC SYSTEM SURVEYOR |
SERIAL NUMBER:          3144A00270 |
TOTAL NUMBER OF CHANNELS:        9 |MORE
```

```
RECEIVER CONFIGURATION:   (3 of n) |
  NAV VERSION: 7.00  15-FEB-95     |
  SIG VERSION: 3.00  24-JAN-95     |
 BOOT VERSION: 3.33  26-APR-94     |MORE
```

```
RECEIVER CONFIGURATION:   (m of n) |
SINGLE FREQ (L1)         INSTALLED |
MAX EPOCHS @ 8 SVs,15 SEC:   10946 |
NUMBER OF RS-232 PORTS:        4   |
POSITION STATISTICS       INSTALLED|
CARRIER PHASE PROCESSING  INSTALLED|
REMOTE DOWNLOAD           INSTALLED|
RT SURVEY DATA            INSTALLED|
EXTERNAL TIMEBASE   OFF & INSTALLED|
EVENT MARKER        -ON & INSTALLED|
1 PPS OUTPUT        OFF & INSTALLED|
LOCAL DATUM/ZONES         INSTALLED|
RS-232 FIRMWARE UPDATE    INSTALLED|
RTCM-104 V1.0/V2.0 INPUTS INSTALLED|
RTCM-104 V1.0/V2.0 OUTPUT INSTALLED|
FAST MEASUREMENT RATE     INSTALLED|
NMEA-0183 OUTPUTS         INSTALLED|
NAVIGATION PACKAGE        INSTALLED|
KINEMATIC MODE            INSTALLED|
RTK1 OPERATION            INSTALLED|
COCOM ALT/SPEED LIMITS    INSTALLED|
```

To read. Screen 1 identifies the receiver as a Trimble product.

Screen 2 identifies the receiver's model number, serial number, and number of channels.

Screen 3 shows the version numbers and creation dates of the receiver's firmware components. NAV processes data and manages the keypad and LCD. SIG monitors satellite signals. BOOT does power-up testing.

The remaining screens display information about receiver features and installed options. The number and contents of the screens depend on the options installed on your receiver. The long “screen” above lists all of the lines that can appear in these screens. The individual lines are:

- SINGLE FREQ: The receiver tracks satellite signals only through C/A code on the L1 frequency.

  SINGLE+CARRIER: The receiver has the Carrier Phase Option; it can track satellite signals through L1 C/A code and carrier phase analysis.

  DUAL FREQ (L1/L2+P): The receiver has the Dual-Frequency Option, Carrier Phase Option, and L2 P-Code Option. It can track satellite signals through L1 C/A code and L2 P-code when P-code is not encrypted, and through L1 C/A code and carrier phase analysis when Anti-Spoofing is active.

  DUAL FREQ (L1/L2)P: The receiver has the Dual-Frequency Option, Carrier Phase Option, and L1/L2 P-Code Option. It can track satellite signals through L1 and L2 P-code when P-code is not encrypted, and through L1 C/A code and carrier phase analysis when Anti-Spoofing is active.

- MAX EPOCHS: The approximate number of epochs of data that could be stored in available free memory.
- NUMBER OF RS-232 PORTS: number of serial ports available; 1, 2, or 4, depending on receiver model and installed options.
- The remaining items show whether various options are installed, and in appropriate cases, whether they are enabled. For details about options, see the option descriptions in your receiver's *User Guide.*

To use. These screens are for inspection only. Use them to confirm that option(s) are installed and are enabled or disabled, as appropriate. Press the MORE softkey to cycle through the screens.

4 The *Sat Info* Screens

The *Sat Info* screens (shown on the preceding page) present the information about the health and predicted availability of SVs. Printouts of the data are also available through a serial port.

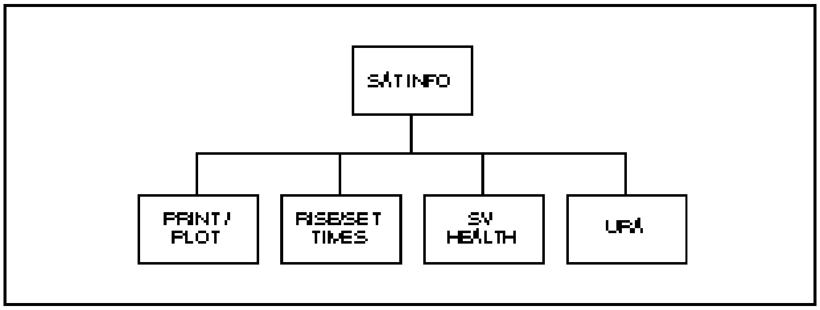


Figure 4-1. Hierarchy of *Sat Info* Screens

4.1 The *Sat Info* Screen

Displays information about the satellites that are visible (above the horizon) according to the receiver's current ephemeris. This screen is useful for checking reception problems, since it shows all of the satellites that *should* be visible, even if they are below the elevation mask or some problem prevents the receiver from tracking them.

To display. Press the SAT INFO key. The receiver displays one of these screens:

```
     5 SVs IN VIEW          |    PRINT/PLOT
SV   02   11   16   18   19 |RISE/SET TIMES
EL°  35   26   24   52   65 |     SV HEALTH
                            |           URA
```

```
SV   02 03 11 14 16 18      |    PRINT/PLOT
EL°  02 -3 00 13 06 82      |RISE/SET TIMES
SV   19 22                  |     SV HEALTH
EL°  61 09                  |           URA
```

To read. The first screen appears if one to five satellites are visible. The lines on the screen show:

1. The number of satellites now visible.

2–3. The satellite numbers and elevations of the visible satellites.

The second screen appears if six or more satellites are visible. The lines on the screen show:

1–2. The satellite numbers and elevations of the first six visible satellites.

3–4. The satellite numbers and elevations of up to six additional satellites. A '+' appears at the end of the last line if more than 12 satellites are visible, but the receiver does not display more than 12.

Elevations are computed relative to the last position fix, or to the reference position if the receiver is generating RTCM-104 corrections or is not tracking satellites.

To use. The softkeys are:

- PRINT/PLOT: Produces printouts about satellites and the receiver setup, including satellite visibility plots.
- RISE/SET TIMES: Displays satellite rise/set times.
- SV HEALTH: Displays information about satellite health.
- URA: Displays information about user range accuracy (URA) values.

4.1.1 PRINT/PLOT

Prints information about satellites and the receiver setup.

To display. From the *Sat Info* menu, select PRINT/PLOT.

```
PRINT/PLOT:    ON PORT [ 2 ]  <-- CHANGE
              BROADCAST DATA  <-- CHANGE
                   FOR SV01   <--NEXT SV
                               **PRINT**
```

To read. The screen shows:

1. The serial port on which information will be printed.
2. The type of information that will be printed (see the softkey descriptions below).
3. The number of the satellite the information will describe (if applicable).

To use. The softkeys are:

- ON PORT... CHANGE: Cycles through the available serial ports.
- BROADCAST DATA... CHANGE: Cycles through the available types of information:
  - BROADCAST DATA: Broadcast data from the selected SV.

- – IONOSPHERIC & UTC DATA: Ionospheric & UTC (time) data.
- – SATELLITE ELEVATION PLOT: Satellite elevation plots for all SVs.
- – SCHEDULE PLOT FOR ALL SATS: Schedule plot for all satellites.
- – RECEIVER SETUP INFO: Receiver configuration.

- NEXT SV: Cycles through the available SVs.
- PRINT: Prints one batch of the selected type of information on the specified port.

To read the printouts. The printout formats are described in the section Single-Shot Printouts in Appendix B.

4.1.2 RISE/SET TIMES

Shows the predicted rise and set times for a specified SV on the current UTC day.

To display. From the *Sat Info* screen or the SV HEALTH screen, select RISE/SET TIMES.

```
 10× MASK    RISE/SET FOR SV01 | NEXT SV
 37×23'N       19:30 to 22:00  | PREV SV
122×02'W       02:45 to 10:45  |
THU 25-FEB-93  14:29 PST/24    |   UNITS
```

To read. The lines on the screen show:

1. The positioning elevation mask and the satellite number.

2–3. On the left, the position from which rise and set times are calculated. If the receiver is operating as a base station and is tracking SVs, this is the last position fix; otherwise it is the positioning reference position.

On the right, the satellite's rise and set times for passes starting on this day.

Note that the rise and set times may contain substantial errors if the receiver has not tracked satellites for a few months.

4. The current date and time, time zone identifier, and time format.

To use. The softkeys are:

- NEXT SV and PREV SV: Cycle through satellite numbers. The screen displays rise and set times for the selected satellite.

  You can also enter a satellite number with the numeral keys.

- UNITS: Cycles the time format between UTC and 24-hour local time.

4.1.3 SV HEALTH

Shows a list of the healthy or unhealthy satellites as decoded from SV broadcast data.

To display. From the *Sat Info* screen, select SV HEALTH.

- The initial display shows healthy satellites.

```
21 HEALTHY SVs:                 |  IN VIEW
  01  02  03  11  12  13  14  | RISE/SET
  15  16  17  18  19  20  21  |UNHEALTHY
  23  24  25  26  27  28  29  |      URA
```

- Press UNHEALTHY to see the unhealthy satellites.

```
1 UNHEALTHY SVs:            |  IN VIEW
 22                         | RISE/SET
                            |SV HEALTH
                            |      URA
```

To read. The first line shows the number of healthy or unhealthy satellites.

The remaining lines list the satellites' numbers.

If the receiver is not currently tracking satellites, the information in the screens is derived from data stored when it last did so. The actual health of the satellites may then be different from that displayed.

To use. The softkeys are:

- IN VIEW: Goes directly to the *Sat Info* screen (above), showing what satellites are now visible.
- RISE/SET: Goes directly to the RISE/SET screen (above).
- UNHEALTHY/SV HEALTH: Toggles the display between healthy and unhealthy satellites.
- URA: Goes directly to the URA screen (below).

4.1.4 URA

Displays User Range Accuracy (URA), a measure of the accuracy of range measurements to a specific satellite. URA is always measured in meters. A satellite's URA value is computed by the GPS Control Segment, uploaded to the satellite, and transmitted as part of the satellite's ephemeris.

A given satellite's URA is updated only when that satellite is tracked, so it will become obsolete if the SV is not tracked and the Control Segment updates the satellite's URA.

To display. From the *Sat Info* screen or the SV HEALTH screen (above), select URA.

```
URA 2.8 SV: 03 11 15                    |MORE
URA   4 SV: 13 20 22                    |
URA 5.7 SV: 12                          |
                                        |
```

To read. Each line lists the satellites that share a specified URA value. For example, the screen above shows that satellites 03, 11, and 15 all have a URA of 2.8 meters.

If there is more URA information than will fit on one screen, the MORE softkey is displayed. Press it to cycle through additional screens of URA values.

A URA of 32 meters indicates that Selective Availability is active for the affected satellite. SA can be activated only on Block II satellites.

To use. This screen is for inspection only; the MORE softkey is the only one defined.

5 The *Control* Screens

The *Control* screens (shown on the preceding page) let you inspect and change parameter settings that control most aspects of the receiver's satellite tracking and information processing.

Parameter values are stored in RAM with battery powered backup, so any changes you make will normally be preserved even when the receiver is turned off. (the Power-Up Control section, describes an exception.)

5.1 The *Control* Screen

Displays a multi-screen menu whose menu items represent groups of parameters you can inspect and change.

To display. Press the CONTROL key.

The number of screens in the *Control* menu and the menu items that appear on each will vary, depending on what options are installed in your receiver. The following “screen” lists all of the options that may appear.

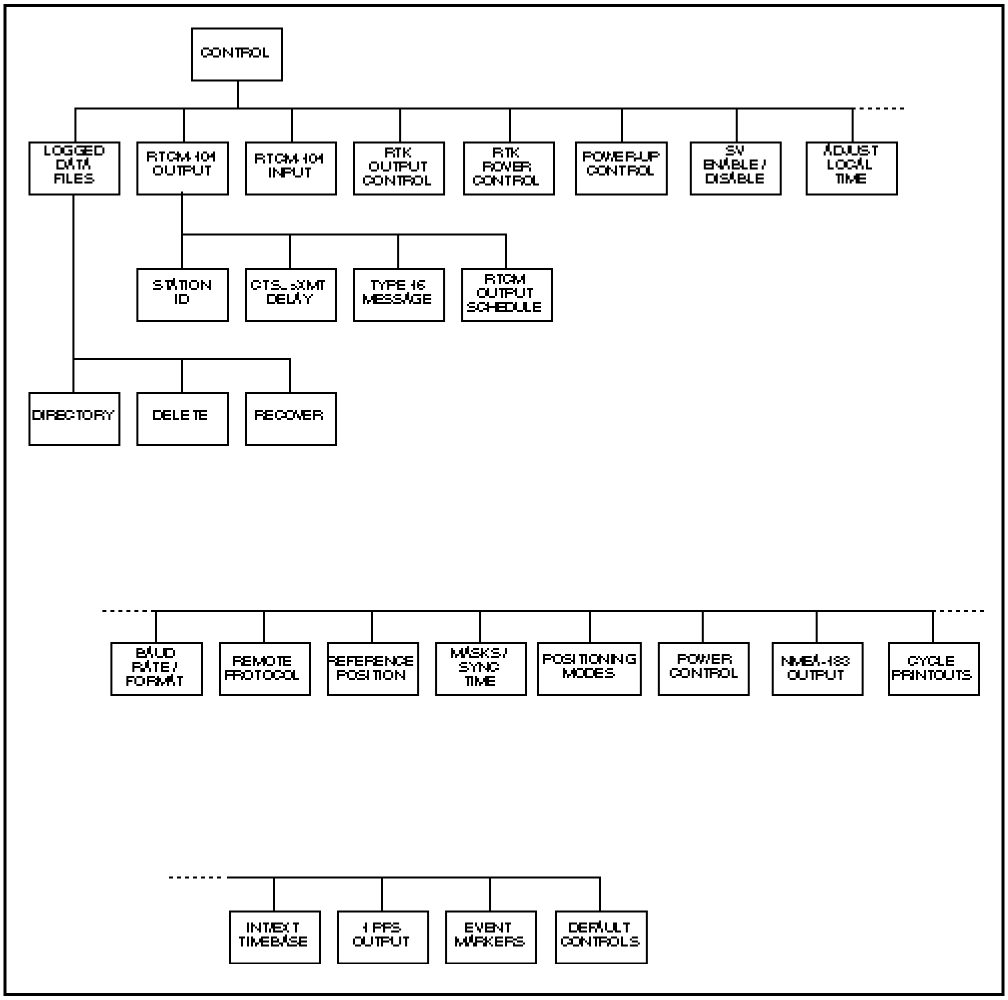


Figure 5-1. Hierarchy of *Control* Screens

```
RECEIVER CONTROL:     | LOGGED DATA FILES
(m of n)              |   RTCM-104 OUTPUT
                      |    RTCM-104 INPUT
                      |RTK OUTPUT CONTROL
                      | RTK ROVER CONTROL
                      |  POWER-UP CONTROL
                      | SV ENABLE/DISABLE
                      | ADJUST LOCAL TIME
                      |  BAUD RATE/FORMAT
                      |   REMOTE PROTOCOL
                      |REFERENCE POSITION
                      |   MASKS/SYNC TIME
                      | POSITIONING MODES
                      |     POWER CONTROL
                      |       DATA FORMAT
                      |   L1/L2 OPERATION
                      |   NMEA-183 OUTPUT
                      |   CYCLE PRINTOUTS
                      |  INT/EXT TIMEBASE
                      |      1 PPS OUTPUT
                      |     EVENT MARKERS
                      |  DEFAULT CONTROLS
```

To use. To advance from one *Control* screen to the next, press the MORE softkey (the last one on each screen). From the last screen, MORE cycles back to the first screen.

5.2 LOGGED DATA FILES

Available only with the Memory Option.

The Memory Option provides random access memory (RAM) in which the receiver can log *data files* of position fixes, satellite data, and carrier phase measurements.

The LOGGED DATA FILES screen displays the amount of memory available, and lets you review, delete, and recover stored files.

To display. From the *Control* menu, select LOGGED DATA FILES.

```
SURVEY DATA FILES:              |DIRECTORY
  7 FILES USED:26.1% OF MEMORY|   DELETE
 6 FILES RECOVERABLE            |  RECOVER
2.8 HOURS LEFT @ 6svs, 1 sec   |
```

To read. The lines of the screen show:

1. SURVEY DATA FILES: Fixed text.
2. The number of files in memory and the percentage of memory used.
3. The number of files that have been deleted from memory, but are still recoverable. (See the Recover section for more information about recovering files.)
4. The estimated data logging time left at the displayed parameter settings.

To use. The softkeys are:

- DIRECTORY: List files stored in memory.
- DELETE: Delete files stored in memory.
- RECOVER: Recover (undelete) files that have been deleted from memory.

5.2.1 DIRECTORY

Displays a list of active (undeleted) files stored in memory.

To display. From the *Control* menu, select LOGGED DATA FILES, then select DIRECTORY.

```
FILE: 1234-056-1   INDEX:15   |NEXT FILE
CREATED:    01:04 PM PST      |PREV FILE
        THU 25-02(FEB)-93     |
   1 KBYTES        4 RECORDS  |
```

To read. The screen summarizes one file at a time. To inspect other files, press the NEXT FILE and PREV FILE softkeys.

The lines on the screen show:

1. The file's name and index. The name consists of a four-digit station ID, a three-digit session ID, and a one-digit sequence number. The index is an integer assigned by the receiver when the file is created.

   Each data file you create normally has a unique name, but if a session is interrupted the receiver will start a new data file when it resumes logging data, and each such file will have the same name. In this case you must combine the identically named files after downloading them to the computer for postprocessing.

   A file's index is meaningful only as long as the file is stored in the receiver. The index uniquely identifies each file that is stored in the receiver *at a given time*, but files stored in the receiver at different times may have the same index.

2. The file's creation time.
3. The file's creation date.

4. The size of the file in thousands of kilobytes (units of 1024 bytes), and the number of records in the file. Both values are updated on the screen as data logging progresses if the active file's directory entry is being displayed.

To use. The softkeys are:

- NEXT FILE: Display the next file in memory.
- PREV FILE: Display the previous file in memory.

5.2.2 DELETE

Deletes one or more files from memory. A deleted file does not appear in the directory display, but actually remains in memory until the space it occupies is needed to log new data. Up to that time it can be recovered.

To display. From the *Control* menu, select LOGGED DATA FILES, then select DELETE.

```
FILE: 1234-056-1    INDEX: 16 |NEXT FILE
CREATED:    10:14 AM PST      |PREV FILE
        THU 25-02(FEB)-93     |
    1 KBYTES        5 RECORDS |DELETE IT
```

To read. The first screen summarizes one file. It shows the same information as the DIRECTORY screen, above. To inspect other files, press the NEXT FILE and PREV FILE softkeys.

To use. The first screen's softkeys are:

- NEXT FILE: Display the next file in memory.
- PREV FILE: Display the previous file in memory.
- DELETE IT: Delete the file now displayed.

When you delete a file, the receiver displays the next undeleted file in the directory. You can delete more files by pressing the appropriate softkeys.

When you are done deleting files, press the CLEAR key to leave the screen.

Conditions that disable DELETE. If the file directory is empty, this screen appears:

```
         FILE DIRECTORY IS EMPTY


           ** PRESS ANY KEY **
```

Similarly, if data logging is in progress, this screen appears:

```
          - SURVEY IN PROGRESS -
          FILE ACCESS LOCKED OUT

           ** PRESS ANY KEY **
```

Both screens indicate that the *Delete* function is disabled. Press any key to leave the screen.

5.2.3 RECOVER

Displays and reactivates deleted data files. (See the notes below about the limitations of RECOVER.)

To display. From the *Control* menu, select LOGGED DATA FILES, then select RECOVER.

```
FILE: 2142-103-2   INDEX: 14 | NEXT FILE
CREATED:    10:37 AM LOC     | PREV FILE
        TUE 13-04(APR)-93    |
  12 KBYTES      101 RECORDS |RECOVER IT
```

To read. The screen displays information about one deleted file at a time. It shows the same information as the DIRECTORY screen, above. To inspect other files, press the NEXT FILE and PREV FILE softkeys.

To use. The softkeys are:

- NEXT FILE: Display the next deleted file in memory.
- PREV FILE: Display the previous deleted file in memory.
- RECOVER IT: Recover the deleted file now displayed.

When you recover a file, the receiver displays the next deleted file in the directory. You can recover more files by pressing the appropriate softkeys.

When you are done recovering files, press the CLEAR key to leave the screen.

Limitations of RECOVER. The RECOVER function works because DELETE does not actually remove files from memory—it only marks them as “deleted.” When new data is logged to memory, though, it may overwrite deleted files. The deleted files then become unrecoverable.

Thus, if no data has been logged to memory since you deleted a file, you can be certain of recovering the file. If the receiver runs out of free memory while logging new data, it reuses the space occupied by the oldest deleted file, and then the space occupied by more and more recent ones. Thus, the more data has been logged to memory, the greater the chance that a deleted file is unrecoverable.

If memory contains no recoverable deleted files, RECOVER displays this screen:

```
NO RECOVERABLE FILES


** PRESS ANY KEY **
```

Press any key to exit the *Recover* function.

5.3 RTCM-104 Output

Available only with the RTCM-104 Output Option.

Controls the receiver's generation of RTCM-104 messages for use in differential GPS (DGPS) operations.

When RTCM-104 output is enabled, the receiver functions as a *base station*, or *reference station.* It generates corrections which can be broadcast to receivers that have the RTCM-104 Input Option. Those receivers can then operate as *rovers*, using the corrections to compute corrected position fixes in real time. A more complete description of this process appears in the *Application Guide.*

To display. From the *Control* menu, select RTCM-104 OUTPUT.

The receiver displays the first of a series of four screens. Press the MORE softkey to cycle through the screens.

```
RTCM-104 REFERENCE STATION     <-   MORE
         ENABLE [  PORT 1   ]  <- CHANGE
     STATION ID [   0000    ]  <- CHANGE
         FORMAT [ VERSION 2 ]  <- CHANGE
```

```
RTCM-104 REFERENCE STATION     <-   MORE
       PRINTOUT [    OFF    ]  <- CHANGE
MESSAGE SCHEDULE[  DEFAULT  ]  <- CHANGE
TYPE 16 MESSAGE [    OFF    ]  <- CHANGE
```

```
RTCM-104 REFERENCE STATION     <-   MORE
 CARRIAGE RETURN[    ON     ]  <- CHANGE
   RTCM_BIT_RATE[    OFF    ]  <- CHANGE
    SV ISOLATION[           ]  <- CHANGE
```

```
RTCM-104 REFERENCE STATION     <-   MORE
 ANTENNA HEIGHT (m)[  0.000 ]  <- CHANGE
```

To read. The screens show the status of the RTCM-104 output parameters.

In the first screen:

- ENABLE: Shows which port is being used to write RTCM-104 output. OFF means that RTCM-104 output is disabled.
- STATION ID: Shows the station ID of this station. The station ID is transmitted with the corrections, allowing a rover to identify the source of the data.
- FORMAT: Shows the format of the RTCM-104 messages generated. Currently supported values are VERSION 1, VERSION 2, VERSION 2.1, USCG (9-1), and USCG (9-3). The last two values produce Version 2.0 output using Type 9 messages. Type 9-1 provides for 1 satellite per message. Type 9-3 provides for 3 satellites per message.

The 4000 Series firmware version 7.00 and later supports real time RTCM Reference Station formats: RTCM+RTK and RTK ONLY. RTCM+RTK format results in message Types 18 and 19 being transmitted every epoch. Also transmitted are the usual RTCM messages using either the default or a user defined schedule. See the section titled *RTK USING RTCM*, later in this chapter.

In the second screen:

- PRINTOUT: Shows whether the receiver is sending copies of generated RTCM messages to an alternate serial port. In this manner they can be printed on a serial printer or logged on a computer at the same time they were being transmitted to the rovers.

  Possible values are OFF, ASCII PORT 1 through ASCII PORT 4, and RAW PORT 1 through RAW PORT 4. (The port selected by the ENABLE parameter is excluded.)

  The ASCII PORT settings write messages in formatted, ASCII form. The format is described in the RTCM-104 Input/Output in Appendix B.

  The RAW PORT settings write the original (raw) correction data. The format is described in *RTCM Recommended Standards for Differential NAVSTAR GPS Service;* see the Bibliography for a complete citation.

- MESSAGE SCHEDULE: Shows the output schedule for the various types of messages in the RTCM message stream. The Type 1 message schedule is determined by the sync time (one message per epoch). The other message types' schedules are proportional to the Type 1 schedule: one message of each type per *n* Type 1 messages.

  DEFAULT means that the factory default message schedule is in effect. USER means that at least one of the message types' schedule parameters has been changed.

- TYPE 16 MESSAGE: Shows whether the receiver is generating Type 16 messages. (RTCM Type 16 is used to send ASCII messages to the remote users.)

In the third screen:

- CARRIAGE RETURN: Shows whether or not the receiver writes a carriage return character after each correction message.
- RTCM BIT RATE: Shows the RTCM output stream's data rate in RTCM data bits per second. (Note that each byte of serial data contains only six RTCM data bits.) Possible values are OFF, 25.0, 27.3, 30.0, 33.3, 37.5, 42.9, 50.0, 60.0, 75.0, 100.0, and 150.0.

  The standard value is OFF, requiring the receiver to send RTCM messages at the port baud rate, once per epoch. Other values are for use in special data link applications.

  If this parameter is set to a value other than OFF, the time required to transmit a cycle of RTCM messages may be increased, increasing the minimum safe value for SYNC TIME. For more information on this topic, see the discussion of sync time in the section on DGPS in the *Application Guide.*

  SV ISOLUTION: ?????

- ANTENNA HEIGHT: Allows the user to specify the location of a station mark as the reference position and thenuse the antyennal height to determine the APC coordinates.

  Series 4000 receivers generate these types of RTCM-104 messages:

  – Type 1: Pseudorange and range rate corrections.

  – Type 2: Pseudorange and range rate correction differences between current ephemeris and a previous one. This message is used only when there is an ephemeris issue mismatch between stations. The differences enable to rover to its own values to the ones the base station is using.

– Type 3: Base station coordinates.

– Type 6: Null messages.

– Type 16: ASCII messages.

For more information about RTCM messages, see *RTCM Recommended Standards for Differential NAVSTAR GPS Service*, described in the Bibliography.

To use: General information. Press the CHANGE softkey next to the parameter you want to change.

Most of the parameters simply cycle through a set of possible values. A few display lower level screens, as described below.

To use: STATION ID. The CHANGE softkey displays this screen:

```
RTCM-104 REFERENCE STATION      |
                                |
     STATION ID [   0000    ]   |
                                | ACCEPT
```

Enter a new ID between 0000 and 1023, then press ACCEPT or ENTER to accept the new ID and return to the RTCM-104 OUTPUT screen.

To use: MESSAGE SCHEDULE. The CHANGE softkey displays this screen:

```
RTCM OUTPUT SCHEDULE (TYPE1 MSGS PER...)
    TYPE  2:15    TYPE  3:30
    TYPE  6:00    TYPE 16:30
    TYPE 15:15    Type  5:00    DEFAULTS
                                  ACCEPT
```

This example shows that one Type 2 message is sent for every 15 Type 1 messages. One Type 3 message and one Type 16 is sent for every 30 Type 1s. The ‘00’ value for Type 6 means that this message type is sent only when necessary.

To reset all of the message schedules to their defaults, press the DEFAULTS softkey.

To change any message schedule, enter a number after the colon. For example, to send one Type 3 message for every 10 Type 1's, change the ‘30’ after ‘TYPE 3:’ to ‘10’.

To accept the schedule displayed on the screen and return to the RTCM-104 OUTPUT menu, press the ACCEPT softkey.

To use: TYPE 16 MESSAGE. The CHANGE softkey displays this screen:

```
"-"                                |NUMERIC
                                   |
                                   | ACCEPT
TYPE 16 MESSAGE [ OFF  ]          <-CHANGE
```

The first three lines show the text of the message, a string of up to 64 characters.

You can edit the message with the keypad. (To enter alphanumeric messages, see the Alphanumeric Fields section in Chapter 2.)

Press the ALPHA/NUMERIC softkey to toggle to keypad between alphanumeric mode and numeric mode. Remember that when the softkey is labeled NUMERIC, the keypad is in *alphanumeric* mode; pressing the softkey would *change* it to numeric mode.

Press the CHANGE softkey to toggle Type 16 message generation on and off.

Press the ENTER key or the ACCEPT softkey to accept the changes you have made and return to the RTCM-104 OUTPUT screen. (If the keypad is in alphanumeric mode the ACCEPT softkey is not available; press the ALPHA key to return the keypad to numeric mode and display ACCEPT.)

Notes on simultaneous RTCM-104 input/output and static survey. On receivers that have the RTCM-104 Input Option or the RTCM-104 Output Option, it is possible to use DGPS and run a static survey simultaneously. The two procedures interact in several ways:

- **Reference position.** If you selected AUTOMATIC for the survey reference position, the survey uses the positioning parameters' reference position. If the positioning reference position is not defined, it takes a position fix autonomously.
- **Elevation mask.** When RTCM-104 output is enabled during a survey, the receiver uses the static survey elevation mask for positioning (and DGPS). The positioning elevation mask is ignored for the duration of the surveying session.
- **Sync time.** If either the positioning sync time or the static survey sync time is a decimal fraction, the static survey sync time is applied to positioning (and DGPS). The positioning sync time parameter is actually set equal to the current value of the static survey sync time; it is not changed back at the end of the surveying session, and you cannot change it to a fractional value during the session.

5.4 RTCM-104 Input

Available only with the RTCM-104 Input Option.

Controls the receiver's use of RTCM-104 messages.

When RTCM-104 input is enabled, the receiver functions as a DGPS rover. It computes position fixes using corrections generated by a base station.

Note – RTCM-104 input and output cannot be enabled at the same time. When you enable one, the receiver automatically disables the other.

To display. From the *Control* menu, select RTCM-104 INPUT.

The receiver displays the first of a series of three screens. Press the MORE softkey to cycle through the screens.

```
DIFFERENTIAL STATION             <-- MORE
RTCM-104 INPUTS [    OFF     ] <-- CHANGE
    PORT SELECT [    OFF     ] <-- CHANGE
         FORMAT [ VERSION 2 ] <-- CHANGE
```

```
DIFFERENTIAL STATION             <-- MORE
 ASCII PRINTOUT [    OFF     ] <-- CHANGE
         BEEPER [    OFF     ] <-- CHANGE
 STATION SELECT [    ANY     ] <-- CHANGE
```

```
DIFFERENTIAL STATION             <-- MORE
      AGE LIMIT [100 SECONDS] <-- CHANGE
 INTEGRETY MONITOR [  OFF    ] <-- CHANGE
```

To read. Each screen shows the status of three of the RTCM-104 input parameters:

- RTCM-104 INPUTS: Shows the status of RTCM-104 input processing. Possible values are OFF, ON, and ON/AUTO.

  OFF makes the receiver operate only autonomously, that is, without applying differential corrections. This drastically reduces the accuracy of real-time position fixes.

  ON lets the receiver operate only in differential mode. If no corrections are received or the last message exceeds the AGE LIMIT parameter, the receiver stops generating new position fixes.

  ON/AUTO lets the receiver operate either autonomously or in differential mode. As long as valid corrections are received, the receiver uses them to operate in differential mode. If no corrections are received, or none are received for a time exceeding the AGE LIMIT parameter, the receiver automatically falls back to autonomous positioning.

  This parameter is automatically turned off when RTCM output is turned on.

- PORT SELECT: Shows which port is used to receive corrections. Possible values are PORT 1 through PORT 4. (Ports 3 and 4 are available only if the Four-Port Option is installed.)

Note – When the receiver is configured to read RTCM-104 input on a certain port, all other input on that port is ignored.

- FORMAT: Shows the message format that the receiver expects incoming RTCM messages to use. It must match the format being sent by the base station. Possible values are VERSION 1.0 (for compatibility with older equipment that cannot generate Version 2.0), VERSION 2.0 (the current standard) and USCG (similar to Version 2.0, but expects input to include type 9-1 and/or type 9-3 records).

- ASCII PRINTOUT: Shows whether the receiver is outputting incoming correction messages to a serial port in ASCII format. Such output could be sent to a serial printer or recorded on a computer for later use. Possible values are OFF and PORT 1 through PORT 4. (Ports 3 and 4 are available only if the Four Serial Port Option is installed.)

  For a description of RTCM-104 output format, see “RTCM-104 Input/Output” on page 273.

- BEEPER: Shows the receiver's use of its beeper. Possible values are ON (the receiver beeps when a valid RTCM message is received on the selected port, even from a base station with a different station ID than the one selected) and OFF (the receiver does not beep).

- STATION SELECT: Shows the station ID of the base station whose corrections the receiver should use. ANY allows the receiver to accept corrections from any base station.

- AGE LIMIT: Shows the period for which the last received correction is considered good. Possible values are 5, 10, 20, 30, 50, and 100 seconds. The default value is 100 seconds.

  When the age limit is exceeded, the receiver stops generating new position fixes (if INPUTS is set to ON) or falls back to autonomous positioning (if INPUTS is set to ON/AUTO).

To use: General information. Press the CHANGE softkey next to the parameter whose value you want to change.

Most of the parameters simply cycle through a set of possible values. The only exception is STATION SELECT.

Base station:DGPS**To use: STATION SELECT.** The CHANGE softkey displays one of these screens:

- If STATION SELECT is currently set to ANY:

```
RTCM-104 STATION SELECT
  ACCEPT CORRECTIONS FROM:
                         ANY STATION  <*
           ONLY ONE SPECIFIC STATION  --
```

- If STATION SELECT is currently set to a station ID:

```
RTCM-104 STATION SELECT
  ACCEPT CORRECTIONS FROM:
                         ANY STATION  --
                   ONLY STATION 0000  <*
```

To set STATION SELECT to ANY, press the ANY STATION softkey. The receiver automatically returns to the RTCM-104 INPUT screen.

Note that if more than one base station signal is available, ANY will let the receiver switch among them randomly. This is generally undesirable, although it can be useful in a fringe reception area where no one station is continuously available.

To set a station ID, press the ONLY STATION softkey. The receiver displays the second form of the screen. Enter the desired station ID, then press ENTER to return to the RTCM-104 INPUT screen.

5.5 RTK USING RTCM

The RTCM SC-104 Version 2.1 specifies a set of messages to support RTK positioning. These include RTCM message types 18 and 19, raw pseudorange and phase measurements. Receivers equipped with the RTCM and RTK options are capable of generating an RTK solution based upon the information coded within. Specifically a 4000 Series configured as an RTCM base station can be setup in a mode which broadcasts these messages every epoch. Furthermore a 4000 Series configured as an RTCM Rover can be set in a mode which uses these messages to generate an RTK solution.

5.5.1 Reference Station

The 4000 Series using firmware version 7.00 has two real time RTCM Reference Station formats: RTCM+RTK and RTK ONLY. RTCM+RTK format results in message Types 18 and 19 being transmitted every epoch. Also transmitted are the usual RTCM messages using either the default or a user defined schedule. Both RTCM Differential users and RTK users may operate from this Base Station simultaneously. Also in the event that an RTK solution is not possible, for example when tracking only 3 SV's or when the radio link is interrupted, the RTK rover can still generate an RTCM differential solution.

If the user has limited radio bandwidth and requires RTK using RTCM the selection of RTK ONLY on the base station limits the transmissions to those messages required for the RTK solution. Note that in this case there is no RTCM Differential solution available from this Reference Station.

5.5.2 Rover

At the Rover, under the RTCM-104 INPUTS selection the user can configure the DIFFERENTIAL STATION as RTK-L1 or RTK-L1/ L2. From the user's perspective there is virtually no difference between these modes and the L1 ONLY and L1/L2 modes found under the RTK ROVER CONTROL menu. However under the POSITION softkey on the STATUS display the user will find the RTCM-104 softkey, not an RTK softkey. The position displayed on this screen will be either an RTK solution or an RTCM DIFFERENTIAL solution or simply an unaided GPS solution and is labeled accordingly. The solution type will depend upon the information received from the Reference Station.

Under the RTCM-104 softkey there is a DISPLAY RTCM RTK STATUS selection which takes the user to the familiar RTK status displays. On the RTK REFERENCE STATUS page of these displays the user will note that the name given to the Reference Station is RTCM. Trimble's RTK System permits a user-programmable label to be transmitted from the Reference Station however RTCM does not support this facility. The RTCM Reference Station ID number is displayed along side of the RTCM label in parentheses though.

5.5.3 Graceful Degradation

When using RTCM 2.1 if the Reference Station is in the RTCM+RTK mode a rover in one of the two RTCM RTK Rover modes will perform an RTCM DGPS solution when it cannot generate an RTK solution and will continue to degrade performing a DGPS Fixed or Constrained Height Solution or an Autonomous solution depending upon the operating conditions.

5.6 RTK OUTPUT CONTROL

Available only with the RTK Functions Option.

This section and the next one document the RTK control screens that appear on the receiver itself.

Note that the receiver screens are primarily for testing. RTK surveys should normally be performed with the aid of a handheld Trimble Survey Controller™ or Seismic Controller. For a full discussion of RTK principles and procedures, see the *TDC1 Survey Controller Operation Manual.*

For descriptions of the receiver's RTK test screens, see the RTK section in Chapter 3. For information about using Trimble's TRIMTALK 900 radio to link RTK stations, see the *TRIMTALK 900 Operation Manual.*

Base station:RTKThe RTK OUTPUT CONTROL screen controls the RTK functions of a receiver that is being used as an RTK base station. (Note that an RTK base station need not have the RTCM-104 Output Option; the base station firmware for RTK is entirely different from the corresponding firmware for differential GPS.)

To display. From the *Control* menu, select RTK OUTPUT CONTROL.

```
      RTK OUTPUTS [   OFF   ] <- CHANGE
      APPLICATION [BASE-L1  ] <- CHANGE
          STATION [ DEFAULT ] <- CHANGE
ANTENNA HEIGHT(m) [  +0.000 ] <- CHANGE
```

To read. The lines on the screen show:

1. The serial port on which the receiver is producing reference output. Possible values are the names of the available serial ports, and OFF.
2. The type of application for which the receiver is producing reference output. For RTK procedures the parameter must be set to BASE-L1.
3. Shows the station ID that specifies the coordinates of the base station's location.

   Possible values are 1 through 30 and DEFAULT. A base station's index is initially set to DEFAULT, which represents the reference position defined by the *Control* menu's REFERENCE POSITION screen. In some other RTK screens, this index is shown as ‘31’.

   Station indexes 1 through 30 represent the 30 stations that can be defined with a data collector, or with the *Sessions* process described in Chapter 7.
4. Shows the height of the receiver's GPS antenna above the mark in meters.

To use. The softkeys are:

- RTK OUTPUTS... CHANGE: Selects the serial port used for reference output; cycles through the available serial ports and OFF (disabled).

  The receiver will start producing RTK reference output as soon as an output port is selected.

- APPLICATION... CHANGE: Cycles through the available types of reference output. For RTK procedures, select the value BASE-L1. (As of firmware release 5.72, the softkey has no function because no other values are supported.)
- STATION... CHANGE: Display the REFERENCE STATION screen (below), which lets you select the station at which the base station is operating.
- ANTENNA HEIGHT... CHANGE: Displays the ENTER ANTENNA HEIGHT screen (below), which lets you enter the height of the base station antenna above the mark.

5.6.1 Reference Station

The REFERENCE STATION screen lets you select the station index that represents the position of the base station.

To display. From the RTK OUTPUT CONTROL screen (above), press the STATION...CHANGE softkey.

```
SELECT REF STATION:        (31)|    NEXT
  LAT   37×23.500000' N        |    PREV
  LON  122×02.500000' W        |
  HGT  -0005.098 m             |  ACCEPT
```

To read. The lines on the screen show:

1. Fixed text. The number in parentheses is the index of the selected station, whose reference position identifies the location of the base station.

2–4. The latitude, longitude, and height of the station relative to the WGS-84 ellipsoid.

To use. The softkeys are:

- NEXT or PREV: Select the next or previous station. Station 31 represents the positioning reference position, defined by the *Control* menu's REFERENCE POSITION screen. Stations 1 through 30 can be defined with the Survey Controller or Seismic Controller or with the *Sessions* process described in Chapter 7.

  For a base station, the station index defaults to 31.

- ACCEPT: Accept the station index shown and return to the RTK OUTPUT CONTROL screen. (You may also press ENTER to do this.)

5.6.2 Enter Antenna Height

The ENTER ANTENNA HEIGHT screen lets you enter the measured height of the base station's GPS antenna above the survey mark. The measured height must be a corrected (true vertical) height. (You can enter a corrected or uncorrected height from the Survey Controller or Seismic Controller.)

To display. From the RTK OUTPUT CONTROL screen (above), press the ANTENNA HEIGHT... CHANGE softkey.

```
ENTER ANTENNA HEIGHT (METERS)

                        [   0.000 ]    ACCEPT
```

To read. The lines on the screen show:

1. Fixed text. Note that the unit used to express antenna height is always METERS.
4. Antenna height.

To use. Enter the antenna's corrected height on the fourth line.

The softkeys are:

- ACCEPT: Accept the antenna height now displayed and return to the RTK OUTPUT CONTROL screen.

5.7 RTK ROVER CONTROL

Available only with the RTK Functions and Carrier Phase Options.

This screen controls the RTK functions of a receiver that is being used as an RTK rover.

For important information about the RTK Functions Option, see the first few paragraphs in the RTK OUTPUT CONTROLsection.

To display. From the *Control* menu, select RTK ROVER CONTROL.

```
RTK ROVER CONTROLS:
            ENABLE [   OFF   ] <- CHANGE
```

To read. The lines on the screen show:

1. Fixed text.
2. The current status of RTK rover control: OFF (disabled) or L1 ONLY (enabled) or L1/L2 if dual frequency.

To use. The softkeys are:

- ENABLE... CHANGE: Toggles RTK rover control on and off.

Note that an RTK rover cannot deliver very precise position fixes until it has been initialized. See the RTK section in Chapter 3.

5.8 POWER-UP CONTROL

Controls whether the receiver will automatically reset the values of certain parameters (the power-up parameters) to their factory default values at every power-up. The default settings of these parameter groups (and others) are listed in Factory Default Settings in Appendix A.

The power-up parameters are:

CYCLE PRINTOUT parameters
MASKS/SYNC TIME parameters
NMEA-183 OUTPUT parameters
1 PPS OUTPUT
POSITIONING MODES (position fix mode only)
POWER CONTROL
REMOTE PROTOCOL
RTCM-104 INPUT parameters
RTK OUTPUT CONTROL
RTK ROVER CONTROL
SV ENABLE/DISABLE

Note that the following parameters are *always* reset at power-up, regardless of how POWER-UP CONTROL is set:

BACKLIGHT TIMEOUT
L1 TRACKING (applies only to receivers with the L2 P-Code Option)

To display. From the *Control* menu, select POWER-UP CONTROL.

```
POWER-UP INITIALIZATION CONTROL

  [    DEFAULT CONTROLS     ] <-- CHANGE
         AT POWER UP
```

To read. The screen shows what the receiver will do at power-up. Possible actions are DEFAULT CONTROLS (reset power-up parameters to factory default values) and DO NOT DEFAULT CONTROLS (do not reset the parameters).

To use. Press the CHANGE softkey to toggle the parameter setting.

You can also use the *Control* menu's DEFAULT CONTROLS item to reset the power-up parameters to their factory default values and restart the receiver (as at power-up) immediately.

5.9 SV ENABLE/DISABLE

Controls the rules that the receiver uses to decide whether to track and use each satellite vehicle's data, based on that satellite's health status.

To display. From the *Control* menu, select SV ENABLE/DISABLE. The receiver displays the first of these screens.

```
IGNORE HEALTH (SURVEYING):    |MORE MODES
NONE                          |
                              |
                              | SET MODES
```

```
DISABLED MODE:                 |MORE MODES
NONE                           |
                               |
                               | SET MODES
```

```
ENABLED MODE:                  |MORE MODES
SV01,02,03,11,12,13,14,15,16,|
  17,18,19,20,21,22,23,24,25,|
  26,27,28,29                  | SET MODES
```

To read. The lines on the screen show:

1. The current mode of treating a satellite's health status. Possible values are:

   – IGNORE HEALTH(POSITION): The receiver will attempt to use this SV for positioning and data logging regardless of its health status.

   – IGNORE HEALTH(SURVEY ONLY): The receiver will attempt to log carrier phase data from this SV regardless of its health status. It will not use the SV for positioning. The data can be evaluated later, in postprocessing.

   – DISABLED: The receiver will not attempt to use the SV regardless of its health.

   – ENABLED: The receiver will attempt to use the SV if it is healthy, and will not use it if it is unhealthy.

   Ignoring the health of an SV is generally not recommended, since data from an unhealthy satellite can ruin a survey.

2–4, A list of satellites that the receiver is treating according to this health status mode's rules.

The receiver determines the health of a satellite from the data broadcast by the satellite itself, or from the other satellites. The NAVSTAR system's Control Segment sets a satellite's health status to "unhealthy" if its performance is known or suspected to be bad.

To use. The softkeys are:

- MORE MODES: Cycle through the available modes.
- SET MODES: Change a satellite's mode. The receiver displays this screen:

```
ENABLE/DISABLE MODE:   SV01 |     NEXT SV
                            |     PREV SV
 CURRENT MODE:              |
              ENABLED       |CHANGE MODE
```

Enter the satellite's ID, or use the NEXT SV and PREV SV softkeys to select the proper ID. Then press the CHANGE MODE softkey to select the desired mode for that satellite. Press ENTER to accept the change and return to the *Control* menu's SV ENABLE/DISABLE screen.

5.10 ADJUST LOCAL TIME

Displays and lets you change the offset from UTC to local time, and the time zone identifier displayed with local time values.

Note that this screen controls only the *display* of the time. The receiver's clock is synchronized with GPS time from the SV signals, and cannot be set by the user.

To display. From the *Control* menu, select ADJUST LOCAL TIME.

```
ADJUST LOCAL TIME:                | FORWARD
  (APPROXIMATE)   WED 10:56 AM |BACKWARD
TIME OFFSET(PST-UTC): -8:00     |
 TIME ZONE IDENTIFIER= PST      |
```

To read. The lines on the screen show:

1. ADJUST LOCAL TIME: Fixed text.
2. The current day of week and time.

   APPROXIMATE means that the time shown is derived from the receiver's internal clock only. When the receiver is tracking one or more satellites its internal clock is synchronized with GPS time, and APPROXIMATE does not appear.
3. The difference between the local (displayed) time and UTC.
4. The time zone identifier.

To use. The softkeys are:

- FORWARD: Advance the local (displayed) time in 15-minute increments.
- BACKWARD: Back up the local (displayed) time in 15-minute increments.

Use the keypad to change the time zone identifier (up to three characters). The time zone identifier is always entered in alphanumeric mode. Press ENTER to accept any changes you have made and leave the screen.

5.11 BAUD RATE/FORMAT

Show and change each serial port's baud rate, data format, and flow control. Each port must be set to values that match those used by whatever device it is communicating with.

To display. From the *Control* menu, select BAUD RATE/FORMAT.

The receiver displays different versions of the BAUD RATE/FORMAT screen for different ports.

```
SERIAL PORT 1 SETTINGS                  MORE
       BAUD RATE [    9600  ] <-- CHANGE
          FORMAT [ 8-ODD--1 ] <-- CHANGE
    FLOW CONTROL [ XON/XOFF ] <-- CHANGE
```

To read. The lines on the screen show:

1. Which serial port is being displayed.
2. The port's baud rate.
3. The port's data format.
4. Serial port:Flow controlStatus of flow control.

The settings and their possible values are described in “Baud Rate, Format, and Flow Control,” on page 230.

To use. To change a port's settings, display that port's settings, then change the baud rate, format, and/or flow control. You may then leave the screen by pressing ENTER or CLEAR.

The softkeys are:

- MORE: Cycles through the available serial ports.
- BAUD RATE... CHANGE: Cycles through the available baud rates.
- FORMAT... CHANGE: Cycles through the available data formats.

- FLOW CONTROL... CHANGE: Selects type of flow control.

5.12 REMOTE PROTOCOL

Selects an interface protocol that remote devices may use to control the receiver or request information from it through one of its serial ports.

To display. From the *Control* menu, select REMOTE PROTOCOL.

```
REMOTE INTERFACE PROTOCOL

[ DATA COLLECTOR COMPATIBLE ] <-- CHANGE
  (STX,DATA,CHECKSUM,ETX)
```

To read. The screen shows the type of interface protocol being used. Possible values are:

- DATA COLLECTOR COMPATIBLE: Used with Trimble Data Collectors and receiver firmware update software. For information about this protocol, see the *4000SE/SSE RS-232 Interface Data Collector Format Specifications Manual*.
- 4000 A/S COMPATIBLE: A protocol used by older Trimble application software. See the *Model 4000 Remote Control Interface Manual*.

To use. Press the CHANGE softkey to toggle the selected protocol.

Caution – When using the 4000A/S compatible remote protocol, do not attach a device to a serial port until you have configured baud rate and data format on the device and the receiver port. If you ignore this rule the receiver may misinterpret incoming data as a command, which could corrupt the receiver's internal database.

If you do make this error and the receiver locks up or behaves oddly, turn the receiver off and back on. If that does not help, reset the receiver's parameters to their factory default values. If the problem still does not go away, call the Trimble Assistance Center.

5.13 REFERENCE POSITION

Display and set the receiver's reference position.

A differential GPS base station uses its reference position as a basis for computing corrections. Any error in the reference position will affect the accuracy of the corrections, and thus the accuracy of the position fixes computed with those corrections.

A DGPS rover may use its reference position to set the antenna height in 2D (fixed height) positioning mode. Thus, any error in the antenna height may lead to horizontal position errors when the receiver operates in 2D position mode.

You can set the positioning reference position to a point other than the actual position of the receiver's antenna to calculate SV rise and set times at that point (with the *Sat Info* menu's RISE/SET TIMES screen) or to calculate range and bearing from that point to a waypoint (with the *Status* menu's POSITION/NAVIGATE function). For these functions the reference position does not have to be exact. The antenna should be disconnected so that the receiver cannot compute new position fixes, forcing it to use the reference position you have entered.

To display. From the *Control* menu, press the REFERENCE POSITION softkey.

```
ENTER REFERENCE POSITION:        |   NORTH
 LAT   37×23.4727805' N          |   SOUTH
 LON  122×02.2437615' W          |    HERE
 HGT  -0007.430 m       FIXED    |  ACCEPT
```

To read. The lines on screen show:

1. “Enter Reference Position”: Fixed text.
2. The reference position's latitude.
3. The reference position's longitude.
4. The reference position's height.

To use. Enter the reference position's latitude, longitude, and height with the numeral keys and the direction softkeys.

A reference position must be entered in the WGS-84 datum. (In North America the NAD-83 datum is close enough to WGS-84 to be used for most purposes. The NAD-27 datum is not.) Height can be entered as either height above the ellipsoid (HAE) or height above mean sea level (MSL).

You may also enter the receiver's current position (from the latest position fix) by pressing the HERE softkey.

To accept the reference position you have entered and return to the *Control* menu, press the ENTER key or the ACCEPT softkey.

The softkeys are:

- NORTH and SOUTH: Set the latitude's direction. Visible only when the cursor is in the LAT field.
- EAST and WEST: Set the longitude's direction. Visible only when the cursor is in the LON field.

- PLUS and MINUS: Set the height's direction (above or below zero). Visible only when the cursor is in the HGT field.
- MSL/WGS84: Select the reference point for height: mean sea level or the WGS-84 datum. Visible only when the cursor is in the HGT field.
- HERE: Set the latitude, longitude, and height to the receiver's current position (from the latest position fix). Visible only when the cursor is in the LAT or LON field.

  Remember that an uncorrected position fix may contain errors of up to 100 meters in any direction due to Selective Availability.
- ACCEPT: Accept the reference position you have entered and return to the *Control* menu; equivalent to ENTER.

5.14 MASKS/SYNC TIME

Displays and changes parameters that the receiver uses to qualify satellite data for use in computing position fixes or conducting static surveys.

The receiver maintains several sets of elevation masks and sync time parameters for use in different types of procedures. This screen controls the positioning parameters, which are used for computing position fixes autonomously or with the DGPS procedure. When a static survey is in progress, it can also change the parameters being used to log measurement data.

To display. From the *Control* menu, select MASKS/SYNC TIME.

- If a static survey is in progress, the receiver displays this screen:

```
      MODIFY SURVEY SYNCS/MASKS    -->

 MODIFY POSITION SYNCS/MASKS       -->
```

Press the appropriate softkey to display the static survey's parameters (MODIFY SURVEY...) or the positioning parameters (MODIFY POSITION...). The receiver displays one of these screens:

```
  SURVEYING MASKS/SYNC TIME:    |
    ELEVATION MASK = +15×       | MINUS
         PDOP MASK =  07.0      |
      SV SYNC TIME =  015.0 SEC | ACCEPT
```

```
POSITIONING MASKS/SYNC TIME:    |
    ELEVATION MASK = +09×       | MINUS
         PDOP MASK =  07.0      |
      SV SYNC TIME =  005.0 SEC | ACCEPT
```

- If no static survey is in progress, the receiver displays the POSITION MASKS/SYNC TIME screen immediately when you select MASKS/SYNC TIME.

To read. The lines on both of the parameter screens show:

1. SURVEYING [or POSITIONING] MASKS/SYNC TIME: Fixed text.
2. ELEVATION MASK: The receiver only uses the SVs that are at an elevation equal to or greater than this value. SV elevation is calculated with respect to the current latitude and longitude and zero height. The range of values is –9× to +90×.
3. PDOP MASK: The receiver calculates positions only when the PDOP is equal to or less than this value. The range of values is 0.0 to 99.9.

   PDOP values of 7 or less should yield accurate positions. Use satellite visibility software such as Trimble's Plan or QuickPlan to predict low PDOP periods for a particular location.

   Note that unlike the other parameters on this screen, a PDOP mask does not apply to a single procedure; the same value applies to positioning and static surveying, and a change in one screen will affect the value shown in the other.
4. SYNC TIME: Controls the length of an epoch. The receiver generates one correction message, computes one position fix, or log one set of measurement data per epoch. Cycle printouts (if available and enabled) are generated once per positioning epoch.

Warning – Changing the static survey sync time while a surveying session is under way may render the logged data unusable. In surveying applications, all data will be unusable except that recorded at multiples of the greatest common denominator of the sync times. For example, if you change the sync time from 3 to 5 seconds, only data recorded at 15-second intervals will be useable.

To use. Change numeric values with the numeral keys. Use the PLUS/MINUS softkey to change the sign of the field at the cursor. Press the ENTER key or the ACCEPT softkey to accept changes and return to the *Control* menu.

The softkeys are:

- PLUS/MINUS: Change the current field's sign. Displayed only when the cursor is in a field whose value may be positive or negative.
- ACCEPT: Accept the mask and sync time parameter values you have entered and return to the *Control* menu; equivalent to ENTER.

5.15 POSITIONING MODES

Displays and controls the procedure that the receiver uses to compute position fixes from satellite data and corrections. You can select the positioning mode that gives the most accurate results for a particular application.

To display. From the *Control* menu, select POSITIONING MODES.

To view and set the positioning mode, press the POSITIONING MODE softkey. The receiver displays this screen:

```
POSITIONING MODES:
    WEIGHTED SOLUTION ENABLED <-- CHANGE
    LAT/LON OR LAT/LON/HEIGHT <-- CHANGE
```

To read. The lines on the screen show:

1. POSITIONING MODES: Fixed text.
2. Shows whether or not the receiver will compute weighted positions. Possible values are ENABLED (compute weighted positions; the default) and DISABLED (compute non-weighted positions).
3. Shows the current position fix mode, which determines the number of SVs the receiver must track to compute position fixes, and the type of fixes it will compute. Possible values are:
   - LAT/LON OR LAT/LON/HEIGHT: Auto 3D/2D mode; the default. The receiver performs 3D positioning when four or more SVs are available, and 2D positioning when only three SVs are available.
   - LAT/LON (FIXED HEIGHT): 2D mode. The receiver computes 2D position fixes if three or more SVs are available, and otherwise does not compute fixes.

     In this mode the receiver assumes a fixed height. It uses the positioning reference position's height unless its latitude and longitude are both zero, in which case it uses the last calculated 3D height.
   - HEIGHT (FIXED LAT/LON): 1D mode. The receiver computes 1D position fixes (heights) if two or more SVs are available, and otherwise does not compute fixes.

     In this mode the receiver assumes a fixed latitude and longitude. It uses the positioning reference position's latitude and longitude unless both are zero, in which case it uses the last calculated latitude and longitude.
   - LAT/LON/HEIGHT ALWAYS: 3D mode. The receiver computes 3D position fixes if four or more SVs are available, and otherwise does not compute fixes.

A receiver must track four healthy SVs to generate 3D positions; three to generate 2D positions; and two to generate 1D positions. If more SVs are visible than the selected mode requires, the receiver can use the extra information to generate a more accurate over-determined position.

Warning – The kinematic, FastStatic, and quickstart static surveying procedures force the receiver into auto 3D/2D mode. Once this change has been made, it persists until you change it explicitly. If you need some other setting, always check the parameter at the start of a surveying session to be sure it has not been changed.

To use. The softkeys are:

- WEIGHTED SOLUTION... CHANGE: Toggles the parameter between ENABLED and DISABLED. When WEIGHTED SOLUTION is enabled, the receiver gives more weight to satellites with higher quality signals in computing overdetermined position fixes.
- *Position fix mode*... CHANGE: Cycles position fix mode through the available modes, listed above.

5.16 POWER CONTROL

Available only on portable receivers (not rack-mounted receivers).

Portable receivers can supply power to low-wattage external equipment while operating, or can charge Trimble batteries while operating from an OSM2. The maximum power the receiver can provide is 6 watts (0.5 ampere at 12 volts).

Rack-mounted receivers display the POWER CONTROL screen, but cannot power equipment or charge batteries.

To display. From the *Control* menu, select POWER CONTROL.

```
POWER PORT:
CHARGER & PWR OUTPUT DISABLED <-- CHANGE
```

To read. The lines of the screen show:

- POWER PORT: Fixed text.
- The power control parameter's setting. Possible values are:
  - CHARGER & PWR OUTPUT DISABLED: Power input is on PWR I/O 1 and PWR 2&3.
  - BATTERY CHARGE ENABLED: Power input is on PWR I/O 1. Power must be supplied by a Trimble OSM or OSM2. Battery charging output is on PWR 2&3.

    The *Status* screen displays a 'C' after the power indicator.

    The battery charger feature is meant to be an overnight charger. It fast-charges a 3.5 AH camcorder battery to about a 90% of capacity in 3 hours. Trimble 6 AH and 10 AH batteries take longer. If two batteries are connected, one is fast-charged before the other. After each battery has been fast-charged, both are float-charged to full power.
  - POWER OUTPUT ENABLED: Power input is on PWR 2&3. Power output is on PWR I/O 1 and I/O 2; power output is limited to 0.5 amperes unregulated at the supplied voltage.

    The *Status* screen displays a 'P' after the power indicator.

    Note that 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.

To use: General instructions. Press the CHANGE softkey until the desired parameter setting is displayed. Press ENTER or CLEAR to leave the screen.

To use: Charging one or more batteries.

1. Connect the OSM2 to power port 1.
2. Connect camcorder batteries or Trimble battery packs to power ports 2 and/or 3.
3. Set the POWER CONTROL parameter to BATTERY CHARGER ENABLED.

Warning – Enable and use the battery charger function only with Trimble's Office Support Module (OSM or OSM2). The charging feature's design depends on the output current limits of the OSM2; using another power supply could damage the receiver and/or the power supply.

To use: Supplying power to external equipment.

1. Connect batteries or an Office Support Module to PWR 2&3.
2. Connect the remote equipment to PWR I/O 1 and/or I/O 2.
3. Set the POWER CONTROL parameter to POWER OUTPUT ENABLED.

5.17 DATA FORMAT

Available on 4000SE Land Surveyor only.

This screen controls the receiver's data logging format.

Each model in the Series 4000 line logs data in either *standard format* or *compact format*. Early models use compact format if equipped with the Kinematic Functions Option, and otherwise use standard format. More recent models, including all models discussed in this manual, use compact format. The 4000SE Land Surveyor can be configured to use either format.

Some postprocessing programs are compatible with only one format or the other. The programs that postprocess kinematic data accept only compact data; so does GPSurvey.

To display. From the *Control* menu, select DATA FORMAT.

```
DATA FORMAT:
                              STANDARD FORMAT --
                               COMPACT FORMAT <*
```

The ‘<*’ symbol indicates the format currently selected.

To use. Press the appropriate softkey to change the data logging format.

5.18 L1/L2 OPERATION

Available only with the dual-frequency option.

This screen controls the receiver's use of the L1 and L2 channels. For most survey applications, it is not necessary to access these controls. Disabling L2 may be desired for single frequency applications to reduce the volume of stored data.

To display. From the *Control* menu, select L1/L2 OPERATION.

```
L1/L2 TRACKING P,C/A CODE |L1 TRACKING
                 P,E-CODE |L2 TRACKING
                          |
                          |
```

To read. The lines of the screen show:

1. Type of tracking on the L1 frequency: P-CODE and C/A-CODE, or C/A-CODE only (P-CODE disabled).
2. Type of tracking on the L2 frequency: P-CODE or E-CODE, or E-CODE only (P-CODE disable).

3–4. A warning message if L2 TRACKING is set to E-CODE only or DISABLED; otherwise empty.

Note – The above tracking types refer to the 4000SSi. For the 4000SSE receivers, E-CODE is substituted with X-CODE, which indicates cross-correlation (see below).

To use. The softkeys are:

- L1 TRACKING: Toggles the type of tracking on the L1 frequency.
- L2 TRACKING: Toggles the type of tracking on the L2 frequency.

  When L2 TRACKING is set to DISABLED, L1 TRACKING automatically defaults to P-CODE and C/A-CODE.

  When L2 TRACKING is set to E-CODE (X-CODE in the 4000SSE), L1 TRACKING automatically defaults to C/A-CODE only, and cannot be changed.

About cross-correlation. The 4000SSE receiver supports cross-correlation, and the 4000SSi utilizes a proprietary Super-trak technique. These techniques make use of encrypted P-code during periods when Anti-Spoofing is active. Although P-code is encrypted, cross-correlation and Super-trak techniques allow the receiver to obtain satellite measurements and derive the L2 ranges.

Receivers that support cross-correlation or Super-trak activate it automatically when required. When the receiver detects encrypted P-code on a channel, it automatically enables encrypted P-code tracking on that channel. That is, for the 4000SSi it changes the channel's tracking mode from *"L1 P-code and C/A-code, L2 P-code and E-code"* (the default) to *"L1 C/A-code only, L2 E-code only"*. The receiver switches the channel back to the default tracking mode if encryption is turned off, or if the channel is assigned to a different (unencrypted) satellite or to no satellite.

The L2 TRACKING softkey's E-CODE (or X-CODE) setting forces the receiver to disable L2 P-code on all channels. It is not a normal mode of operation, and should only be used when suggested by the Trimble Assistance Center.

5.19 NMEA-183 Output

Displays and selects the types of NMEA-0183 messages that are written to output.

To display. From the *Control* menu, select NMEA-183 OUTPUTS. The receiver displays a multi-screen menu that shows the status of each NMEA-0183 output message type. For descriptions of the message types, see the NMEA-0183 section in Appendix B.

```
NMEA-183          ENABLE[ OFF ] <- CHANGE
OUTPUT CONTROL       ALM[ OFF ] <- CHANGE
                     BWC[ OFF ] <- CHANGE
                     GBA[ OFF ] <- CHANGE
                     GGA[ OFF ] <- CHANGE
                     GLL[ OFF ] <- CHANGE
                     GRS[ OFF ] <- CHANGE
                     GSA[ OFF ] <- CHANGE
                     GST[ OFF ] <- CHANGE
                     GSV[ OFF ] <- CHANGE
                PTNL,DOP[ OFF ] <- CHANGE
                PTNL,TSN[ OFF ] <- CHANGE
                PTNL,TSS[ OFF ] <- CHANGE
                     RMB[ OFF ] <- CHANGE
                     RMC[ OFF ] <- CHANGE
                     VTG[ OFF ] <- CHANGE
                     WPL[ OFF ] <- CHANGE
                     XTE[ OFF ] <- CHANGE
                     ZDA[ OFF ] <- CHANGE
```

To read. The first line of the first screen, ENABLE, shows the serial port to which NMEA-0183 output is written. Possible values are PORT1 through PORT4 (subject to the number of available ports) and OFF.

The remaining parameters show the status of each supported record type: ON or OFF. Each type of record is written to the output port if the corresponding parameter is ON.

Note that some of the parameters shown above are displayed only if certain associated options are installed.

To use. To toggle or cycle one of the parameters, press the corresponding CHANGE softkey. When you are done, press ENTER or CLEAR to return to the *Control* menu.

To disable all message types, set ENABLE to OFF. The receiver automatically sets all of the individual message types to OFF. To re-enable message types, set ENABLE to a port number, then toggle the appropriate message types to ON.

5.20 CYCLE PRINTOUTS

Available only with the Two or Four Serial Port Option.

Controls the production of cycle printouts.

A cycle printout is a real-time log of some aspect of the receiver's operation. An example of a cycle printout is *Position Calculations;* when this printout is enabled, the receiver outputs a message containing time, position, velocity, and other useful data. Cycle printout data is generated at well-defined intervals: for most types of cycle printouts, once per cycle (per epoch).

In practice, cycle printouts are rarely printed. More often they are recorded by a computer for later use, or are fed to an external device such as a navigation/positioning system.

To display. From the *Control* menu, select CYCLE PRINTOUTS.

```
OUTPUT EVERY RECEIVER CYCLE
       POSITION CALCULATIONS  <-- NEXT
           FORMAT [ ASCII  ]  <-- CHANGE
           ENABLE [  OFF   ]  <-- CHANGE
```

To read. The screen displays the status of one type of cycle printout. For most types of cycle printouts lines on the screen show:

1. OUTPUT EVERY RECEIVER CYCLE: Fixed text. (“Cycle” refers to the positioning cycle time.)
2. The type of cycle printout, in this example POSITION CALCULATIONS. The possible types of cycle printouts are:

   Position Calculations
   Navigation Calculations
   Raw Measurements
   Nav Display Unit
   Compact Measurements
   Eph/Ion/UTC Data
   Position Quality Stats
   Raw L1 Data Message
   Position Type 2
   Navigation Type 2
   Local Datum/Zone Pos
   RT Survey Data

   The cycle printouts are described in the Cycle Printouts section in Appendix B.
3. The format of the printout: ASCII (suitable for printing or display) or BINARY (suitable for transfer to a computer for additional processing). For some printout types this line is blank; that means output is provided in only one format.

4. Where printout is produced: PORT 1 through PORT 4 or OFF (disabled).

To step through the different types of cycle printouts, press the NEXT softkey.

To use. For most of the cycle printouts, the softkeys are:

- NEXT: Display the status of the next type of cycle printout.
- FORMAT... CHANGE: Toggle the format of this type of cycle printout between ASCII and BINARY.
- ENABLE... CHANGE: Change the place where the cycle printout is produced from PORT 1 through PORT 4 to OFF. Output begins as soon as the cycle printout is enabled.

Press the CLEAR key to leave the screen.

Be sure that the receiver's and remote device's baud rates and data formats are the same. Remember to disable the printout when you are finished, because it is not disabled automatically when the receiver is turned off.

For information about the format and contents of each cycle printout, see the Cycle Printouts section in Appendix B.

Exception: *RT Survey Data.* This cycle printout is an exception to the rules described above, because it has more parameters than the two normally displayed on lines 3 and 4. Its screen looks like this:

```
OUTPUT EVERY RECEIVER CYCLE
               RT SURVEY DATA <-- NEXT
              PORT SELECTION  <-- NEXT
           ENABLE [  OFF   ]  <-- CHANGE
```

Line 3 displays the name of a parameter; line 4 displays that parameter's value. You can select a parameter by pressing the NEXT softkey on line 3, and then set that parameter's value by pressing the CHANGE softkey on line 4.

The parameters and their possible values are:

- PORT SELECTION: Controls the place where the cycle printout is produced. Possible values are PORT 1 through PORT 4 and OFF. Output begins as soon as the parameter is set to a port.
- Concise format for RT Survey Data cycle printoutCONCISE FORMAT: Controls whether output is produced in standard format (ENABLE... OFF, the default) or concise format (ENABLE... ON).
- ADD RT FLAGS: Controls whether the output will include IODE values and carrier phase cycleslip counters. This data may be useful to computer programs processing the data in real-time applications.
- OUTPUT EPHEMERIS: Controls whether output includes ephemeris data (ENABLE... ON) or does not include it (ENABLE... OFF, the default).
- OUTPUT POSITIONS: Controls whether output includes position data (ENABLE... ON) or does not (ENABLE... OFF, the default).

Note – Cycle printouts can also be controlled by a remote device such as a computer through the Data Collector Compatible Protocol. See the 4000SE/SSE RS-232 Interface Data Collector Format Specifications Manual for details.

5.21 INT/EXT TIMEBASE

Available only with the External Frequency Input Option.

Controls the source of the reference signal that controls the receiver's timebase.

To display. From the *Control* menu, select INT/EXT TIMEBASE.

```
TIMEBASE CONTROL:
                             INTERNAL <*
                       5 MHz EXTERNAL --
                      10 MHz EXTERNAL --
```

To read. The symbol '<*' indicates the current source of the reference signal. The possible sources are:

- INTERNAL: The receiver's internal quartz oscillator.
- 5 MHz EXTERNAL: A 5 MHz external signal on the EXT REF port.
- 10 MHz EXTERNAL: A 10 MHz external signal on the EXT REF port.

To use. Press the softkey that corresponds to the reference signal source you want to use. Then press ENTER or CLEAR.

A high-precision external reference signal is useful for very precise geodetic survey measurements, and for position fix measurements when less than 4 SVs are available.

Warning – Do not select EXTERNAL unless an external reference signal is actually available. Doing so may cause the receiver to function incorrectly or cease functioning at all.

5.22 1 PPS OUTPUT

Available only with the 1 PPS Output Option.

Controls the production of a 1 pulse/second (1 PPS) time strobe and associated time tags. The leading edge of each pulse marks the beginning of a second.

To display. From the *Control* menu, select 1 PPS OUTPUT.

```
   1 PPS OUTPUT: [ DISABLED ] <-- CHANGE
          SLOPE: [ POSITIVE ] <-- CHANGE
ASCII TIME TAGS: [   NONE   ] <-- CHANGE
```

To read. The lines on the screen show:

1. Status of 1 PPS output: ENABLED or DISABLED.
2. The polarity of the pulse. POSITIVE makes the leading edge of the pulse rise from 0.0V to 4.0V; NEGATIVE makes it fall from 4.0V to 0.0V .
3. Where time tags are written. Time tags may be written to PORT 1 through PORT 4, or to NONE (meaning that time tags are disabled).

To use. To change any of the parameters, press the corresponding CHANGE softkey. Press ENTER or CLEAR to return to the *Control* menu.

The time tag is issued approximately 0.5 second prior to the arrival of the pulse. Electrical characteristics of the pulse are described in the 1 PPS and Time Tag section in Appendix A.

5.23 EVENT MARKERS

Available only with the Event Marker Input and Memory Options.

Controls the use of event marker input.

The event marker feature is used to log a precise GPS time tag and sequential ID number in the current data file for an externally generated pulse, such as the shutter a photogrammetric camera's shutter opening pulse. The information can be extracted from the data file by TRIMVEC Plus; for further information, see the TRIMVEC Plus documentation.

To display. From the *Control* menu, select EVENT MARKERS.

```
EVENT MARKERS: [  ENABLED ]   <-- CHANGE

        SLOPE: [ NEGATIVE ]   <-- CHANGE
   EVENT BEEP: [ DISABLED ]   <-- CHANGE
```

To read. The lines on the screen show:

1. EVENT MARKERS: ENABLED (event markers will be processed and events will be logged) or DISABLED (event markers will not be processed).
2. Empty line.
3. SLOPE: Shows the slow of the leading edge of an event marker signal. POSITIVE means the leading edge has rising voltage; NEGATIVE means it has falling voltage.
4. EVENT BEEP: Shows whether the instrument will beep when an event marker arrives. Possible values are ALWAYS (always beep), SURVEY ONLY (beep only when logging data), and DISABLED (never beep). The event beep is useful for testing a setup intended to generate event markers, and for confirmation that events are being recorded.

To use. Press the softkeys to select the desired parameter settings. Press ENTER or CLEAR to return to the *Control* menu.

About the event marker signal. The event marker input's electrical characteristics are described in the Event Mark Input section in Appendix A.

About user-entered events and notes. When data logging is under way, the user can generate an event mark from the *Log Data* menu by selecting USER INPUT, then MARK EVENT NOW. This does not put a pulse into the connector, but writes the same type of message to memory.

At any time, the user can add notes to a specified event mark from the *Log Data* menu by selecting USER INPUT, then MARK COMMENTS.

Both of these operations are described in the USER INPUT: Enter Notes and Event Marks section in Chapter 8.

5.24 DEFAULT CONTROLS

Resets the power-up parameters to their factory default values and restarts the receiver as if it were powered down and back up.

To display. From the *Control* menu, select DEFAULT CONTROLS.

```
INITIALIZE ALL CONTROLS TO DEFAULT |
   SETTINGS AND RESTART RECEIVER   |
                                   |  NO
                  ARE YOU SURE ? | YES
```

To use. To reset the power-up parameters and restart the receiver, press the YES softkey. To cancel the operation, press the NO softkey, ENTER, or CLEAR.

The power-up parameters and their default settings are shown in the section Factory Default Settings section in Appendix A.

Note that you can also use the *Control* menu's POWER-UP CONTROL item to determine whether the receiver will reset the power-up parameters every time it is powered up.

6 The *Modify* Screens

The *Modify* screens (shown on the preceding page) let you inspect and change parameter settings that control certain aspects of the receiver's internal operation: LCD viewing angle and backlight, battery use, beeper volume, and displayed units of measure.

6.1 The *Modify* Screen

Displays a multi-screen menu whose menu items represent groups of parameters you can inspect and change.

To display. Press the MODIFY key.

The receiver displays the first of a series of screens that present the *Modify* menu. Press the MORE softkey to cycle through the screens.

The items that can appear in the *Modify* menu are:

```
                   |         VIEW ANGLE
                   |          BACKLIGHT
                   |              POWER
                   |   UNITS OF MEASURE
                   |      BEEPER VOLUME
                   |ALTITUDE REFERENCE
                   |  KINEMATIC ALARMS
                   |  INTEGRITY ALARMS
                   |         MODEM SETUP
```

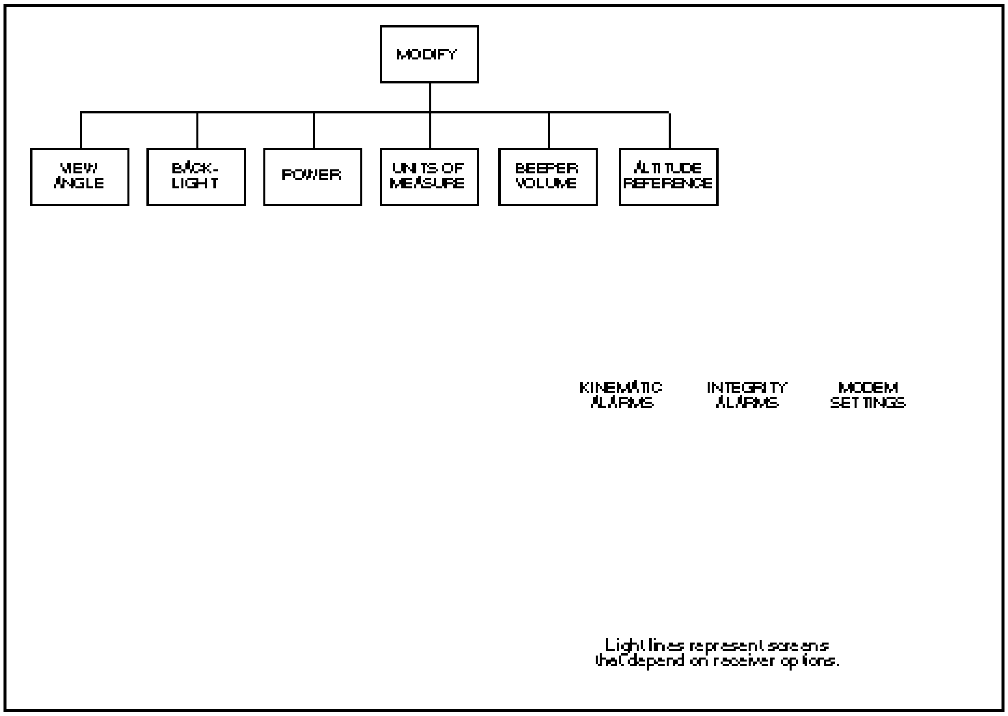


Figure 6-1. Hierarchy of *Modify* Screens

6.2 VIEW ANGLE

Displays and changes the LCD screen's optimum viewing angle.

To display. From the *Modify* menu, select VIEW ANGLE.

```
DISPLAY VIEW ANGLE:
                                /--  UP
          DOWN[    •    ]UP -------- DOWN
```

To use. Press the UP or DOWN softkey to adjust the optimum viewing angle for best visibility.

6.3 BACKLIGHT

Displays and changes the screen backlight's brightness and timeout interval (the time after which the receiver turns the backlight off to save power if no keys have been pressed).

To display. From the *Modify* menu, select BACKLIGHT.

```
DISPLAY BACKLIGHT:
                            /-- INCREASE
     BRIGHTNESS [••••••••]----- DECREASE
        TIMEOUT = 001 MINUTES
```

To use. Press the INCREASE or DECREASE softkey to adjust the display's brightness for best visibility. If you are running the receiver from batteries, remember that brightening the LCD will shorten the time you can run on a battery charge.

Use the cursor and numeral keys to change the timeout interval. Note that the timeout is always reset to the default value (1 minute) at power-up.

To return to the *Modify* screen, press ENTER.

How the backlight is controlled. The backlight has several modes of operation:

- At moderate temperatures, the backlight is normally on. If the receiver is operating on battery power, it turns the backlight and display off to save power whenever the timeout interval passes without any keypresses; it turns them back on when a key is pressed. If the receiver is using line power the timeout interval is ignored.
- At high temperatures, the backlight is turned off to avoid adding heat to the unit.
- At very low temperatures (roughly below 0×C), the backlight is turned on at maximum brightness to warm up the display and improve LCD performance. The BRIGHTNESS and TIMEOUT parameters are both ignored. Note that this mode of operation increases power consumption, and decreases the time the receiver can operate on a battery charge.

6.4 POWER

Displays the voltage of any battery or OSM2 connected to the receiver, and the status of the internal battery charger (if enabled).

To display. From the *Modify* menu, select POWER.

```
POWER STATUS/SELECT (CHARGER ENABLED)
        PWR-I/O 1:  *** NOT DETECTED***
            PWR 2:   12.84V         <----
            PWR 3:   12.36V
```

To read. The display shows the voltage detected (if any) on each power port. The arrow identifies the power port currently in use.

The notation CHARGER ENABLED or POWER OUT ENABLED on the first line indicates that the battery charger feature is enabled or the power out feature is enabled. (Only one of these can be enabled at a time.)

PWR 2 and PWR 3 refer to the power ports 2 and 3 on the connector labeled PWR 2&3. (See the illustration of the portable receiver back panel in Appendix A.)

The voltage displays have a maximum value of 14.7 VDC. The OSM2 or another source of more than 14.7 VDC is displayed as ‘>14.70V’.

To use. To select a power source manually, press the corresponding softkey. You may notice a slight change in screen backlight intensity when you change power sources. Press [ENTER] or [CLEAR] to return to the *Modify* menu.

If you enable the battery charger feature and an OSM2 is connected, the receiver automatically selects the power port connected to the OSM2. If you select another port, the receiver will switch to that port but then will immediately switch back.

The receiver will not let you switch to a port that does not have enough voltage to operate it.

For details about the receiver's rules for automatically selecting a power source, see the How the receiver selects a power source section in Appendix A.

6.5 UNITS OF MEASURE

Displays and changes the units which the receiver uses to display latitudes and longitudes, antenna height, and time.

To display. From the *Modify* menu, select UNITS OF MEASURE.

```
UNITS: LAT-LON = deg-min-sec  <-- CHANGE
   ANTENNA HGT = meters       <-- CHANGE
          TIME = 12 hr local  <-- CHANGE
      POSITION = WGS84 LLH    <-- CHANGE
```

To read. The lines on the screen show:

1. Format of latitude and longitude. Possible formats are:
   - Degrees, minutes, and seconds; for example, 35½ 25' 30.5000".
   - Degrees and minutes; for example, 35½ 25.5083'.
2. Antenna height units: meters, centimeters, feet, or inches.
3. Time format: 24-hour UTC, 12-hour local, or 24-hour local.
4. Position display format.

   The value identifies the selected coordinate system (the one that the receiver is using to display position fixes). Possible values are:
   - WGS84 LLH: Positions are displayed in the WGS-84 datum (the receiver's standard datum) as a latitude, longitude, and height.
   - Local LLH: Positions are transformed into the local datum, and are displayed as a latitude, longitude, and height.
   - Local NEH: Positions are transformed into the local datum and projected onto the plane defined by the local zone, and are displayed as a northing and easting from the origin of the zone. The displayed height is the local datum height.

The local datum is intended to define the datum that is customarily used for local surveying in the region where you are working. The local zone is intended to define the customary projection of the local datum.

A receiver can hold definitions of only one local datum and one local zone at a time. To change them, you must connect the receiver to a computer and run the DATM4000 program.

When you select a different coordinate system, the change affects the *Status* menu's POSITION screen and the positions in the *Local Datum/Zone Pos* cycle printout. It *does not* affect any other receiver outputs, such as position fixes logged to a file or the contents of other cycle printouts. These always use the standard datum, WGS84 LLH.

For more information about local datums and zones and the DATM4000 program, see *Local Datum and Zones Option: Software Release Notes.*

Select the desired units or datum by pressing the appropriate CHANGE softkey(s). Then press ENTER or CLEAR to return to the *Modify* menu.

6.6 BEEPER VOLUME

Controls the volume of the keypress beep (which sounds whenever a key is pressed) and the cycle beep (which sounds once per measurement cycle).

To display. From the *Modify* menu, select BEEPER VOLUME.

```
BEEPER VOLUME:                 /-------  UP
    KEYPRESS BEEP [•     ]---------- DOWN
                                   /---  UP
       CYCLE BEEP [   OFF   ]------ DOWN
```

To read. The volume of each type of beep is indicated by the length of the bar between the square brackets. If the beep is turned off, the word OFF is displayed.

To use. To adjust each beep's volume, press the corresponding UP and DOWN softkeys. To turn a beep off, press the DOWN softkey until OFF appears.

Press ENTER or CLEAR to return to the *Modify* menu

6.7 ALTITUDE REFERENCE

Displays and changes the reference system for height (altitude) measurements.

To display. From the *Modify* menu, select ALTITUDE REFERENCE.

```
ALTITUDE REFERENCE

   HEIGHT ABOVE [ ELLIPSOID ] <-- CHANGE
```

To read. The HEIGHT ABOVE... line indicates the height reference. Possible values are ELLIPSOID (the WGS-84 reference ellipsoid) and M.S.L. (mean sea level). The mean sea level is defined by the average of observations at selected points around the continental United States over a period of years (OSU 84).

To use. Press the CHANGE softkey to toggle the height reference.

6.8 KINEMATIC ALARMS

Available only with the Kinematic Functions Option.

Displays and changes volume settings for special alarms used in kinematic surveys.

To display. From the *Modify* menu, select KINEMATIC ALARMS.

```
KINEMATIC ALARM VOLUME:         /---  UP
      POOR PDOP ALARM [•••  ]------ DOWN
                                /---  UP
 RETURN TO MARK ALARM [•••  ]------ DOWN
```

To read. The volume of each type of alarm is indicated by the length of the bar between the square brackets. If the alarm is turned off, the word OFF is displayed.

To use. To adjust each alarm's volume, press the corresponding UP and DOWN softkeys. To turn an alarm off, press the DOWN softkey until OFF appears.

Press ENTER or CLEAR to return to the *Modify* menu

6.9 INTEGRITY ALARMS

Available only with the QA/QC Option.

Integrity alarms warn the user when one of the sigma values exceeds a selected threshold. The possible thresholds are 5, 10, and 20 meters.

To display. From the *Modify* menu, select INTEGRITY ALARMS. The receiver displays this screen:

```
POSITION INTEGRITY ALARMS:
      HORIZONTAL ALARM [ 20m ] <- CHANGE
        VERTICAL ALARM [ 10m ] <- CHANGE
                                 ACCEPT
```

To use. Press the HORIZONTAL... CHANGE softkey to change the horizontal alarm threshold, and the VERTICAL... CHANGE softkey to change the vertical alarm threshold.

6.10 MODEM SETUP

Available only with Remote Download option.

Use the modem setup string to reinitialize a modem if it ceases to function. The receiver sends this string to the modem after five minutes without incoming or outgoing data, and every five minutes thereafter until the modem responds.

To display. From the *Modify* menu, select MODEM SETUP. The receiver displays this screen:

```
MODEM SETUP STRING [ PORT 1 ] <-- CHANGE
(SCHEDULED EVERY 5 MINS WHEN IDLE)
```

To read. Line 1 shows the port to which the modem setup string will be written. DISABLED indicates that the modem setup string will not be written to any port.

Lines 3 and 4 form a single field that shows the current modem setup string. If both lines are empty, the modem setup string is null.

To use. Press the CHANGE softkey to select the port that is connected to the modem. If no modem is connected, select DISABLED. Enter or edit data on lines 3 and 4 to change the string.

What value to set. The modem setup string should re-configure the modem to its normal operating state. Consult the modem's user documentation for specifics.

At a minimum, the modem setup string should put the modem in an on-hook state and should set flow control to match the configuration of the receiver's serial port. It may also have to disable automatic baud rate selection and set the baud rate to match the receiver's serial port. Automatic baud rate selection may select the wrong setting if it observes unusual data patterns coming from the receiver or the line.

Alphanumeric data entry in modem setup string**Extended softkey functions for modem setup string.** The modem setup string provides a special, extended technique for entering alpanumeric data. This technique enables you to enter several symbols that are useful in modem command strings.

When you press the [0] key the receiver displays a softkey menu of four alphanumeric characters, as usual:

```
MODEM SETUP STRING [ PORT 1 ]       | '0'
(SCHEDULED EVERY 5 MINS WHEN IDLE) | '_'
AT0                                 | '#'
                                    | '%'
```

If you press [0] a second time, though, the receiver displays a second menu of additional alphanumeric characters:

```
MODEM SETUP STRING [ PORT 1 ]       | '0'
(SCHEDULED EVERY 5 MINS WHEN IDLE) | ''
AT0                                 | '&'
                                    | '='
```

If you press [0] a third and a fourth time, the receiver displays a third and fourth menu of additional characters:

```
MODEM SETUP STRING [ PORT 1 ]       | '0'
(SCHEDULED EVERY 5 MINS WHEN IDLE) | '\'
AT0                                 | ')'
                                    | '*'
```

```
MODEM SETUP STRING [ PORT 1 ]       | '0'
(SCHEDULED EVERY 5 MINS WHEN IDLE) | ' '
AT0                                 | '+'
                                    | '.'
```

If you press [0] a fifth time it redisplays the first softkey menu.

7 The *Sessions* Screens

The SESSIONS key leads to a series of screens that let you define and modify plans for static surveys and other data logging sessions. This key is functional only if the Memory Option is installed.

Note – Preplanned sessions may be used for both static surveying and for non-survey applications such as precision positioning. Many of the Sessions and Log Data screens refer only to “surveys.” Remember that these screens apply to non-survey applications as well.

Sessions defined with the SESSIONS key are called *preplanned static surveying sessions*, or simply *preplanned sessions.* (A static surveying session is the only type of survey that can be preplanned.) They stand in contrast to *quickstart static surveying sessions* (or simply *quickstart sessions*), which do not require pre-planning. Quickstart sessions are described in Chapter 8, “The *Log Data* Screens.”

This chapter describes the individual *Sessions* screens. Topics such as how to plan a surveying session and how to choose appropriate values for the *Sessions* parameters are covered in the *Application Guide.*

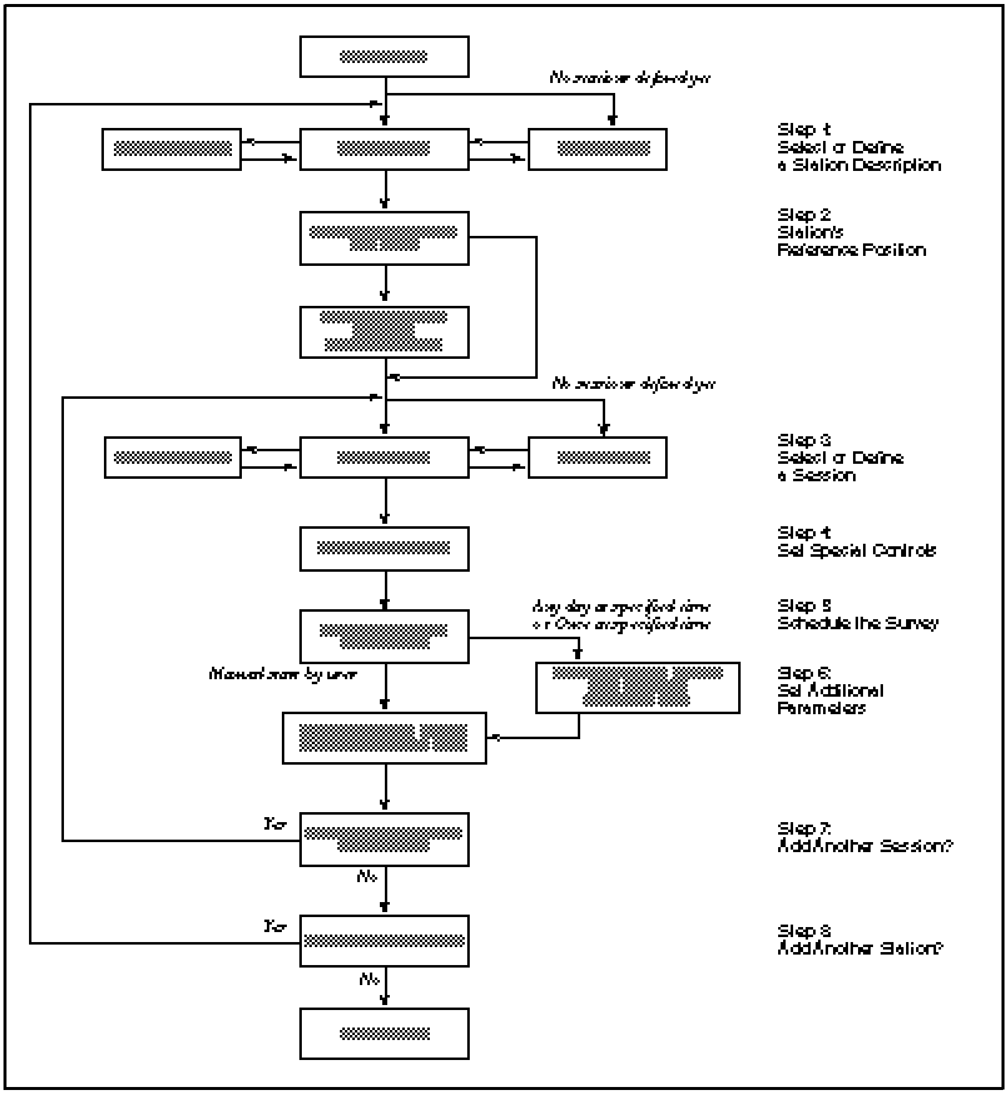


Figure 7-1. Procedure for Using *Sessions* Screens

Sessions **screens are sequential.** Unlike most of the Series 4000's other groups of screens, the *Sessions* screens are sequential, not hierarchic. That is, the SESSIONS screens lead you through a process that has an inherent order, and the receiver insists that you use the screens in the proper order. The major sections of this chapter correspond to the steps in the *Sessions* process. The CLEAR key generally moves you back one step in the process.

Uses in other procedures. The preplanned static surveying procedure is useful in several types of surveying in addition to static surveying.

In the RTK procedure, rovers are initialized and reinitialized at *stations* with known coordinates. (The *Sessions* process may be used to define these stations.) For a description of how RTK uses stations, see the Select Rover Station section in Chapter 3.

FastStatic and kinematic postprocessing software can accept base station data logged with the static surveying procedure. Thus, the base station in a FastStatic or kinematic survey can be set up to log data in a preplanned static surveying session.

7.1 Step 1: Select or Define a Station Description

In this context, a *station* is a position at which a stationary receiver logs data, or a mobile receiver begins logging data.

In a preplanned session, the user must select a station description that specifies the position at which the session is conducted. In an RTK survey, the rover must select one or more station descriptions that define the position(s) from which the rover begins moving.

Each station description consists of:

- A numeric *index* which uniquely identifies the station in the receiver's memory. A receiver can hold up to 30 station descriptions, with indexes from 1 to 30. When you enter a station description you cannot choose its index, but the

Sessions screens show what index it has been assigned. The RTK screens refer to a station description's index.

- A four-character *station ID*, chosen by you. When you define a session description later in the *Sessions* process, you must refer to a station description by specifying its station ID.
- A name up to 50 characters long, chosen by you. The name identifies the station in postprocessor screens and reports.

To display. Press the SESSIONS key. The receiver displays one of these screens.

- If no station descriptions are defined in the receiver's memory:

```
 NEW STATION:   0000            |  ALPHA
                                |
                                |
                                | ACCEPT
```

- If any station descriptions are defined in the receiver's memory:

```
EDIT STATION:   1111  ID:01|NEXT STATION
NAME:                      |PREV STATION
                           | NEW STATION
                           |   DELETE IT
```

To read. The NEW STATION screen displays no information.

The EDIT STATION screen displays one station description. To display other station descriptions, press the NEXT STATION and PREV STATION softkeys.

To use: General information. The softkeys are:

- ALPHA/NUMERIC: Toggle the receiver between alphanumeric and numeric mode; equivalent to the ALPHA key.

- ACCEPT: Accept the station ID you have entered in the NEW STATION screen; display it in the EDIT STATION screen.
- NEXT STATION or PREV STATION: Display the next or previous station description in the receiver's memory.
- NEW STATION: Display the NEW STATION screen, allowing you to define a new station description.
- DELETE IT: Delete this station description from the receiver's memory.

Selecting an existing station description with softkeys. Press the NEXT STATION or PREV STATION softkey until the receiver displays the station description you want. Then press ENTER.

The cursor moves to the NAME field. Change the station description's name, if appropriate; then press ENTER again. Go on to step 2.

Selecting an existing station description with the keypad. You can also select a station description by entering its station ID in the EDIT STATION field. When you enter the first character of the station ID, the receiver displays this screen:

```
SEARCH STATION: 1000            |  ALPHA
                                |
                                |
                                | ACCEPT
```

When the station ID is complete, press ENTER.

If the receiver finds the station ID in memory it returns to the EDIT STATION screen and displays the corresponding station description. If the receiver does not find the station ID in memory it displays the message STATION NOT FOUND at the bottom of the screen. Press CLEAR or SESSIONS to clear the error message; then correct the station ID and press ENTER again.

In either case, when you have successfully selected a station description the cursor moves to the NAME field. Change the station description's name, if appropriate; then press ENTER again. Go on to step 2.

Defining a new station description. If the EDIT STATION screen is displayed, press the NEW STATION softkey to go to the NEW STATION screen.

Enter the station's ID and press the ENTER key or the ACCEPT softkey.

The receiver displays the station ID you have entered in the EDIT STATION screen and moves the cursor to the NAME field. Enter the station description's name, then press ENTER again. Go on to step 2.

Deleting a station description. To delete a station description, display the description as in “Selecting an Existing Station Description,” above. Then press the DELETE IT softkey. The receiver deletes the station description and displays the preceding description (if any).

Now you may delete another station description, select an existing one, define a new one, or press CLEAR to return to the *Status* screen.

7.2 Step 2: Enter Station's Reference Position

The *reference position* gives the accepted coordinates of the mark at which you will conduct a session that refers to this station description. For surveying applications, this is the position of the base station.

7.2.1 Select Automatic or Manual Entry

When you leave step 1 of the *Sessions* process, the receiver displays this screen:

```
REFERENCE POSITION FOR:  1234
                            AUTOMATIC <*

                               MANUAL --
```

To read. Line 1 displays the station ID you selected.

To use: Automatic entry. This choice is appropriate for a station to be used in static surveys, where only an approximate position for the survey site is needed to get the survey started.

Press the AUTOMATIC softkey or the ENTER key. When the session begins, the receiver will use the reference position defined in the positioning parameters; if there is none, it will perform a position fix. It will store the resulting position with the logged data for use in postprocessing. It will not use this reference position as a basis for RTCM corrections.

Go on to step 3.

To use: Manual entry. This choice is appropriate for a station to be used in an RTK survey or on a rover in a kinematic survey, where accurate coordinates are needed to ensure accurate survey results. It may also be used for static surveys.

Press the MANUAL softkey. The receiver displays this screen:

```
ENTER REFERENCE POSITION:      |   NORTH
 LAT   37×23.4727805' N        |   SOUTH
 LON  122×02.2437615' W        |    HERE
 HGT  -0007.430 m              |  ACCEPT
```

Enter the reference position's coordinates in the WGS-84 datum. The softkeys are:

- NORTH and SOUTH: Set the latitude's direction. Visible only when the cursor is in the LAT field.
- EAST and WEST: Set the longitude's direction. Visible only when the cursor is in the LON field.
- PLUS and MINUS: Set the height's direction (above or below zero). Visible only when the cursor is in the HGT field.
- MSL/WGS84: Select the reference point for height measurements: mean sea level or the WGS-84 datum. Visible only when the cursor is in the HGT field.
- HERE: Set the latitude, longitude, and height to the receiver's current position (from the latest position fix). Visible only when the cursor is in the LAT or LON field.
- ACCEPT: Accept the reference position you have entered. Go on to step 3.

7.3 Step 3: Select or Define a Session

Next you must select a session from the receiver's memory or define a new session.

To display. When you finish entering the reference position, the receiver displays one of these screens.

- If no sessions are defined in the receiver's memory:

```
 NEW SESSION:   000-0              |  ALPHA
STATION: 1234                      |
NAME:                              |
                                   | ACCEPT
```

- If any sessions are defined in the receiver's memory:

```
EDIT SESSION:   000-0       |NEXT SESSION
STATION: 1234               |PREV SESSION
NAME: TNL                   | NEW SESSION
                            |   DELETE IT
```

To read. The NEW SESSION screen displays no information.

The EDIT SESSION screen displays one session description. The lines on the screen show:

1. EDIT SESSION or NEW SESSION (fixed text), followed by the session ID.

   The session ID normally consists of the session's Julian day (the day of year) followed by a sequence number. For example, the first session conducted on February 1 would customarily be named 032-1 (because February 1 is the 32nd day of the year); the second session on that date would be 032-2; and so on.

   You can see today's Julian day by pressing STATUS, then selecting DATE.

2–3 The station ID and station name associated with the session.

To display other session descriptions, press the NEXT SESSION and PREV SESSION softkeys.

To use: General information. The softkeys are:

- ALPHA/NUMERIC: Toggle the receiver between alphanumeric and numeric mode; equivalent to the ALPHA key.
- ACCEPT: Accept the session ID you have entered in the NEW SESSION screen; display it in the EDIT SESSION screen.
- NEXT SESSION or PREV SESSION: Display the next or previous session description in the receiver's memory.

- NEW SESSION: Display the NEW SESSION screen, allowing you to define a new session description.
- DELETE IT: Delete this session description from the receiver's memory.

Selecting an existing session description with softkeys. Press the NEXT SESSION or PREV SESSION softkey until the receiver displays the session description you want. Then press ENTER.

The cursor moves to the session ID on the first line. Enter the session number; then press ENTER again. Go on to step 4.

Selecting an existing session description with the keypad. You can also select a session description by entering its session ID on the first line. When you enter the first character of the station ID, the receiver displays this screen:

```
SEARCH SESSION: 100-0                |  ALPHA
STATION:                             |
NAME:                                |
                                     | ACCEPT
```

When the session ID is complete, press ENTER.

If the receiver finds the session ID in memory it returns to the EDIT SESSION screen and displays the corresponding session description. If the receiver does not find the session ID in memory it displays the message SESSION NOT FOUND at the bottom of the screen. Press CLEAR or SESSIONS to clear the error message; then correct the station ID and press ENTER again.

In either case, when you have successfully selected a session description, go on to step 4.

Defining a new session description. If the EDIT SESSION screen is displayed, press the NEW SESSION softkey to go to the NEW SESSION screen.

Enter the session's ID and press the ENTER key or the ACCEPT softkey. Go on to step 4.

Deleting a session description. To delete a session description, display the description as in “Selecting an Existing Session Description,” above. Then press the DELETE IT softkey. The receiver deletes the session description and displays the preceding description (if any).

Now you may delete another session description, select an existing one, define a new one, or press CLEAR to return to the reference position screens.

7.4 Step 4: Set Special Controls

The SPECIAL CONTROLS screen sets parameters that affect the receiver's logging of position data.

To display. The receiver displays this screen when you finish defining the session:

```
SESSION 123-1 SPECIAL CONTROLS
               USE SPECIAL CONTROLS   --

              USE RECEIVER DEFAULTS   <*
```

To read. The first line displays the session ID.

To use. The softkeys are:

- USE SPECIAL CONTROLS: Displays a screen that lets you set the special controls parameters to non-standard values. This screen is described below.

- USE RECEIVER DEFAULTS: Sets the special controls parameters to standard values (shown in the illustration of the menu in the next section) and displays the next screen in the *Sessions* process. Go on to step 5.

7.4.1 Setting Special Controls Values

To display. If you press the USE SPECIAL CONTROLS softkey in the SPECIAL CONTROLS screen, the receiver displays a multi-screen menu with these items:

```
SESSION 123-1 SPECIAL CONTROLS
 POSITION LOGGED [  NORMALLY ] <- CHANGE
  OVER DETERMINE [   ENABLE  ] <- CHANGE
   LOG SMOOTH PR [  DISABLE  ] <- CHANGE
   POSITION TYPE [   3D/2D   ] <- CHANGE
   HEIGHT SOURCE [   AUTO    ] <- CHANGE
```

To read. The parameters are:

- POSITION LOGGED: Controls the type of data that is logged and frequency of logging. Possible values are:
  - NORMALLY: Log satellite data once per epoch, and a position fix once every five minutes. This is appropriate for most surveying applications.
  - EVERY CYCLE: Log satellite data and a position fix once per epoch. This is appropriate for applications that require both real-time position fixes and postprocessing.
  - EXCLUSIVELY: Do not log satellite data. Log a position once per epoch. This is appropriate for applications that require real-time position fixes only.

Satellite data consumes considerably more storage space than position fixes alone. In applications where postprocessing is not required, recording position fixes EXCLUSIVELY will substantially increase the receiver's data logging capacity.

- OVER DETERMINE: Controls whether the receiver will compute overdetermined solutions if it is tracking enough satellites to do so. Possible values are ENABLE and DISABLE. Overdetermined solutions use all available satellites. Solutions that are not overdetermined use the minimum number required to compute the required type of position; the receiver chooses the best available satellites for this purpose, considering DOP values, satellite health, etc.
- LOG SMOOTH PR: Controls logging of smoothed pseudoranges. Possible values are ENABLED (log smoothed pseudoranges) and DISABLED (log raw pseudoranges).
- POSITION TYPE: Controls the type of position fixes the receiver will compute. This parameter overrides the positioning mode set from the control menu. Possible values are:
  - 3D/2D: Auto 3D/2D mode. The receiver switches between 3D and 2D positioning depending on the number of SVs available.
  - 3D ONLY: The receiver computes 3D position fixes if four or more SVs are available, and otherwise does not compute fixes.
  - 2D ONLY: The receiver computes 2D position fixes if three or more SVs are available, and otherwise does not compute fixes. The height is determined by the HEIGHT SOURCE parameter.
- HEIGHT SOURCE: Controls the source of height information for computing 2D position fixes during the session. Possible values are:

- AUTO: Compute height from satellite data if possible; otherwise use the reference position's height.
- USER: Use an operator-specified height.

To use: General information. Press the CHANGE softkeys to cycle through each parameter's possible values. When all of the parameters are set, press ENTER to display the next screen. Go on to step 5.

To use: HEIGHT SOURCE. When you cycle the value to USER, the receiver displays this screen:

```
SESSION 123-1 SPECIAL CONTROLS      PLUS
ENTER USER HEIGHT (WGS-84):        MINUS
         +0000.0 meters
                                  ACCEPT
```

The screen shows the height that will be used to compute position fixes.

Use the numeral keys to change the height. Press the PLUS and MINUS softkeys to change the sign. When the data is entered, press the ACCEPT softkey to return to the SPECIAL CONTROLS parameter menu.

7.5 Step 5: Schedule the Session

To display. The next step is to define the preplanned session's start time and frequency. The receiver displays this screen:

```
SELECT SCHEDULE FOR: 1234-043-1
                 MANUAL START BY USER <*
            ANY DAY AT SPECIFIED TIME --
      ONCE AT SPECIFIED DATE AND TIME --
```

To read. The first line shows the station number (in this case, 1234) followed by the session number (043-1). The other lines present softkey labels.

To use. Select the type of preplanned session you want. The softkeys are:

- MANUAL START BY USER: The session will be started and stopped by the user.

  When you select this choice, the receiver goes directly to the next step of the *Sessions* process. Go to step 6.

- Any Day at Specified Time session ANY DAY AT SPECIFIED TIME: If started with the START PREPLANNED procedure, the session will be run once, at the next occurrence of a specified time of day.

  If started with the ENABLE AUTO-SURVEY TIMER procedure, the session will be run *every* day, at the specified time, until the auto-survey timer is canceled.

  The procedure for specifying the time is similar to the one shown below for ONCE AT SPECIFIED DATE AND TIME, except you are not prompted to enter a date.

- ONCE AT SPECIFIED DATE AND TIME: The session will be run once, at a specified time on a specified day, whether started with START PREPLANNED or ENABLE AUTO-SURVEY TIMER.

  When you select this choice, the receiver displays the following screen:

```
STATION/SESSION: 1234-044-1
START TIME/DATE:  10:58 AM PST
              TUE 31-01 (JAN)-95
OBSERVATION TIME: 01:15 (hh:mm)   ACCEPT
```

The screen shows the scheduled start time and date and the observation time. Change the values as appropriate and press the ENTER key or the ACCEPT softkey. Go on to step 6.

7.6 Step 6: Set Additional Parameters

To display. Next, the receiver displays this screen:

```
STATION/SESSION: 1234-043-1       |
RECEIVER DEFAULTS IN USE          |
ELEVATION MASK:+15×  MIN SVs: 03 | MINUS
MEAS SYNC TIME: 015.0 SEC        |ACCEPT
```

This screen lets you set the static surveying parameters for this session. Note that it does not affect positioning parameters.

To read. The lines on the screen show:

1. The station number followed by the session number. In this example the station number is 1234 and the session number is 043-1.
2. RECEIVER DEFAULTS IN USE if all of the special controls have their default values, or SPECIAL CONTROLS IN USE if one or more of them have been changed.
3. The elevation mask that will be used to screen satellites for the session, and the minimum number of healthy SVs that the receiver must track in order to log data.
4. The measurement sync time, that is, the interval at which the receiver should log position fixes and/or raw measurements.

To use. The softkeys are:

- PLUS/MINUS: Change the sign of the elevation mask. Displayed only when the cursor is in the ELEVATION MASK field.

Caution – Negative elevation masks allow the receiver to accept data from satellites below 0½ elevation. Note that such elevations are meaningless unless the receiver is located substantially above ground level!

- ACCEPT: Accept the parameter values entered and go on to the next step.

See the parameters and then press the ENTER key or the ACCEPT softkey. Go on to step 7.

7.7 Step 7: Add Another Session

The next screen asks if you want to select and schedule another session for the same station:

```
      ADD ANOTHER SESSION FOR      | YES
          STATION:  1234 ?         |
                                   |
       ** 47 SESSIONS FREE **      |  NO
```

To schedule another session, press the YES softkey. Return to step 3.

If you do not want to schedule another session, press the NO softkey. Go on to step 8.

7.8 Step 8: Add Another Station

The next screen asks if you want to select and schedule sessions for another station:

```
        ADD ANOTHER STATION ?       | YES
                                    |
       ** 27 STATIONS FREE **       |
       ** 47 SESSIONS FREE **       |  NO
```

To select another station, press the YES softkey. Return to step 1.

If you do not want to schedule sessions for another station, press the NO softkey. The receiver displays the *Log Data* menu.

If you want to start a session now, see Chapter 8, “The *Log Data* Screens,” for directions.

8 The *Log Data* Screens

The LOG DATA key, shown on the preceding pages, leads to a group of screens that let you:

- Set survey control parameters for quickstart static, FastStatic, and kinematic surveys.
- Start and control preplanned static surveys.
- Conduct quickstart static, FastStatic, and kinematic surveys.
- Conduct non-survey data logging sessions (using the same procedures as for preplanned or quickstart static surveys).

This chapter gives detailed descriptions of the *Log Data* screens. The procedures that use these screens are described in the *Application Guide.* How to log data to a computer's disk, and how to download logged data for postprocessing, are explained in the *Receiver Reference.*

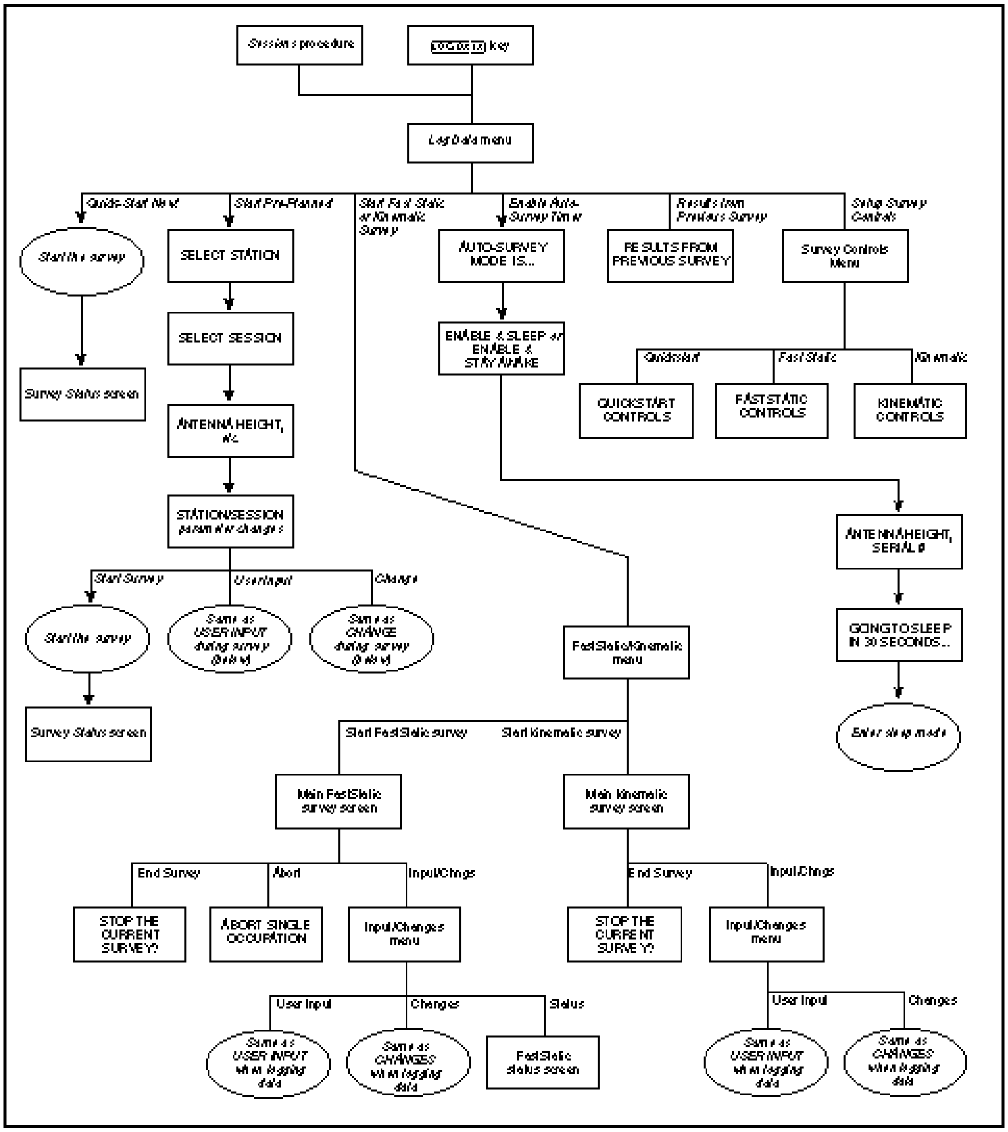


Figure 8-1. Procedure for Using Log Data Screens (Not Logging Data)

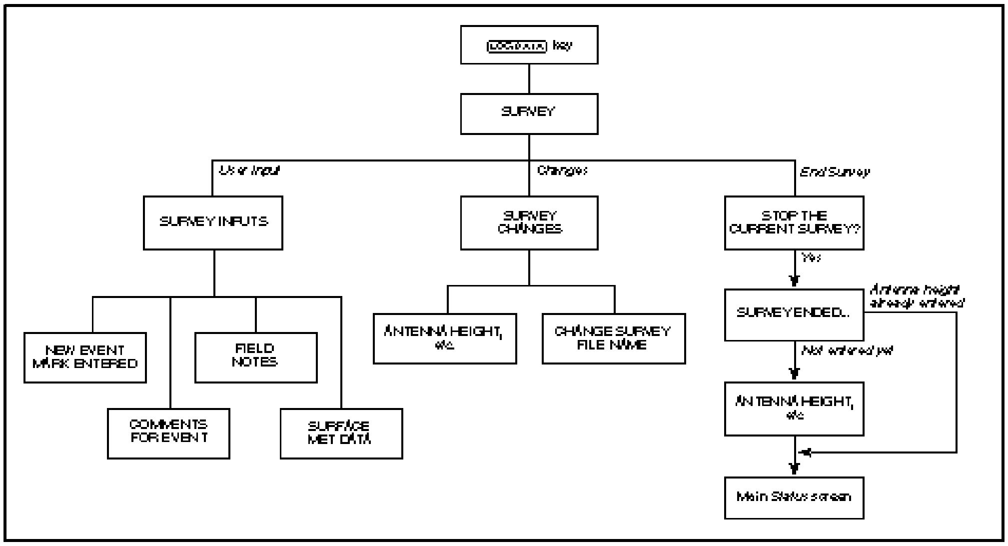


Figure 8-2. Procedure for Using *Log Data* Screens (Logging Data)

Note – The LOG DATA key is functional only on receivers that have the Memory Option.

8.1 *Log Data* Screens and Surveying Procedures

Because there is not a one-to-one correspondence between selections on the *Log Data* menu and the types of procedures a receiver can perform, it is important to understand which menu selections do what.

Static surveys are performed by QUICK-START NOW! and START PRE-PLANNED; the latter with the aid of a preplanned session description, the former without it.

FastStatic and kinematic surveys are performed by START FAST STATIC OR KINEMATIC SURVEY. This selection leads to a secondary menu that lets you choose the type of survey you want. Static procedures may also be used to log reference data (but not rover data) for these types of surveys.

Non-survey data logging for procedures such as differential GPS and RTK are done with the preplanned or quickstart static procedure.

Note – From the receiver's perspective, there is no essential difference between conducting a static survey and logging data in a non-survey application. This chapter uses the term “session” to refer to both.

8.2 The *Log Data* Screen

To display. Press the LOG DATA key.

The receiver displays different *Log Data* screens when it is not logging data and when it is conducting a quickstart or preplanned data logging session. (Other procedures that log data do not allow you to range freely through the receiver's screens, and so give you no chance to display the *Log Data* screen.)

- If the receiver is not logging data, it displays a multi-screen menu of selections for planning and starting data logging operations:

```
    QUICK-START NOW! (SINGLE SURVEY) --
   START PRE-PLANNED (SINGLE SURVEY) --
START FAST STATIC OR KINEMATIC SURVEY --
             ENABLE AUTO-SURVEY TIMER --
         RESULTS FROM PREVIOUS SURVEY --
                SETUP SURVEY CONTROLS --
```

The receiver also displays this menu when you power it up or restart it, and at the end of the session programming process.

The menu selections are described in the following sections.

- If the receiver is conducting a quickstart or preplanned data logging session, it displays a menu of selections for managing and stopping the session:

```
SURVEY:                       |USER INPUT
                              |   CHANGES
                              |
                              |END SURVEY
```

This screen is described in the Controlling a Session section.

Note – The main Status screen provides a convenient indicator of whether the receiver is conducting a session. Press STATUS and look at line 1 of the screen. If it says LOGGING FOR..., a survey is running.

8.2.1 QUICK-START NOW

This selection starts a quickstart session. It is "quick" in the sense that it lets you start data logging without scheduling a session first.

When you select QUICK-START NOW, the receiver waits for the minimum number of satellites to be available above the elevation mask, then displays the static survey status screen and begins logging data. It takes the elevation mask, minimum number of satellites, and measurement rate from parameters set with the *Log Data* menu's SETUP SURVEY CONTROLS item before the start of the session. It takes the reference position from the most recent position fix. (Since this reference position is computed autonomously, it is not accurate enough for most survey applications, but is adequate for many differential GPS applications that do not require precise absolute positioning.) It forces the positioning mode to Auto 3D/2D.

Under normal conditions (no power failure or loss of satellite lock, etc.), a quickstart session continues until you stop it, or until the required minimum number of satellites cannot be tracked.

For information about how to stop a quickstart session, see “Controlling a Session,” on page 193.

8.2.2 START PRE-PLANNED

The station and session descriptions that you program into the receiver with the SESSIONS key can be used to start *preplanned* data logging sessions.

The following sections explain how to start a preplanned session. For information about defining a session, see Chapter 8, “The *Sessions* Screens.” For information about stopping a session, see the Controlling a Session section.

A similar, somewhat briefer section in the *Application Guide* explains specifically how to conduct a preplanned static survey.

Step 1: Select Station

Select the station description to use for data logging.

To display. From the *Log Data* menu, select START PRE-PLANNED. The receiver displays this screen:

```
SELECT STATION: 1234 ID:02 |NEXT STATION
NAME:                      |PREV STATION
                           |
                           |      ACCEPT
```

To read. The screen displays one station's ID, index, and name.

To use. The softkeys are:

- NEXT STATION or PREV STATION: Select the next or previous station description stored in memory.
- ACCEPT: Accepts the station description now displayed and goes on to select a session.

Select a station description by pressing the NEXT STATION or PREV STATION key, or by entering the station ID and pressing ENTER or ACCEPT. Go on to step 2.

Step 2: Select Session

Select the session description to use for this session. It must be a session description that has been defined for the selected station in the *Sessions* process.

To display. After you select a station, the receiver displays this screen:

```
SELECT SESSION: 093-1       |NEXT SESSION
STATION:  1234              |PREV SESSION
NAME:                       |
                            |      ACCEPT
```

To read. The screen displays one session's session ID, the station ID you selected in step 1, and the station's name (on two lines).

To use. The softkeys are:

- NEXT SESSION or PREV SESSION: Select the next or previous session description stored in memory.
- ACCEPT: Accepts the session description now displayed and goes on to prompt you for session parameters.

Select a session description by pressing the NEXT SESSION or PREV SESSION key, or by entering the session ID and pressing ENTER or ACCEPT. Go on to step 3.

Step 3: Enter Antenna Information

To display. After you select a session, the receiver displays this screen:

```
ANT HEIGHT: 0000.0000 INCHES     | UNITS
 MEAS TYPE: UNCORRECTED          |  NEXT
  ANT TYPE: EXTERNAL (UNKNOWN)   |  NEXT
ANT SERIAL: 000000               |ACCEPT
```

To read. The lines on the screen display:

1. Antenna height.
2. Type of antenna height measurement (corrected or uncorrected).
3. Antenna type.
4. Antenna serial number.

A postprocessing program must know the antenna type to compute the true vertical antenna height (distance from the phase center of the antenna to the point on the ground directly below it) from the uncorrected height (distance from a specified part of the antenna to the same point).

The antenna serial number is helpful in troubleshooting. If postprocessing reveals that a survey was conducted with a defective antenna, you can use the logged serial number to identify the antenna that is at fault.

To use. The softkeys are:

- UNITS: Cycles through the units of measure for antenna height: INCHES, FEET, METERS, and CENTIMETERS.
- MEAS TYPE... NEXT: Toggles the measurement type. Possible values are UNCORRECTED and TRUE VERTICAL.
- ANT TYPE... NEXT: Cycles through the possible antenna types. Possible values and their meanings are shown in Table 8-1.
- ACCEPT: Accepts the values selected and entered, and goes on to prompt you to start the session.

Use the numeral keys and softkeys to enter and select an appropriate value for each parameter. Then press ENTER or ACCEPT. Go on to step 4.

If you want to start the session quickly you may ignore ANT HEIGHT now, and set it while running the session. (If no value is entered before the session ends, the receiver will prompt you for it at that time.)

Table 8-1. ANT TYPE Parameter Values

ANT TYPE Value	Antenna
EXTERNAL (UNKNOWN)	Unsupported or unknown
COMPACT L1/2 W/GRND P	Compact L1/L2 Antenna with groundplane
COMPACT L1/2	Compact L1/L2 Antenna without groundplane
COMPACT L1 W/GRND P	Compact L1 Antenna with groundplane
COMPACT L1	Compact L1 Antenna without groundplane
PERMANENT L1/L2	Permanent Reference Station L1/L2 Geodetic Antenna
INTERNAL (ST)	4000ST Integral Antenna (not applicable to receivers described in this manual)
ATTACHABLE (SE)	Modular Antenna
EXT COMPACT DOME	Compact Dome Antenna
EXT KIN (ST,SST)	4000ST and SST Kinematic Antenna
EXT L1/2 GEOD (SST/E)	L1/L2 Geodetic Antenna
EXT L1/2 KIN (SSE, SSi)	L1/L2 Kinematic Antenna
EXT GEOD L1 (ST,SST)	L1 Geodetic Antenna

Step 4: Start the Session

To display. After you enter antenna information, the receiver displays this screen:

```
STATION/SESSION: 2345-093-1|START SURVEY
APPROX. MEMORY LEFT: 8.4 HR|  USER INPUT
                           |     CHANGES
PWR1+[*****] 2:01:59 PM PST|ABORT SURVEY
```

To read. The lines on the screen show:

1. The name of the file that will be used to store measurements from this session. The file name is composed of the station ID (2345 in this example) and the session ID (093-1).
2. The approximate amount of memory left for logging data, expressed as a number of hours of operation with the current parameter settings.
3. An empty line.
4. Power status; battery charging and antenna indicators; current time and time zone identifier. For details, see the The *Status* Screens section in Chapter 3.

To use. The softkeys are:

- START SURVEY: Starts the session. The receiver displays the data logging status screen. This ends the procedure for starting a preplanned session.
- USER INPUT: Displays a screen that lets you enter information about the session. This information is stored in memory along with the logged data. The screen is described in the USER INPUT: Enter Notes And Event Marks saection.
- CHANGES: Lets you correct the antenna height and change the name of the data file used to log the data. The screen is described in the Changes section.

To start data logging, press the START SURVEY softkey.

What happens next depends on the starting mode specified by the session description:

- *Manual Start by User:* The session starts as soon as the required number of satellites is available above the elevation mask.
- *Any Day at Specified Time:* The receiver will run the session at the next occurrence of the specified time.
- *Once at Specified Date and Time:* The receiver will run the session at the specified date and time.

If a session's scheduled start time is past but its scheduled duration has not expired, the receiver starts the session immediately and runs it until it would have ended if started on time . For example, if a session is scheduled to start at 1500 hours and run for one hour, and it is started at 1545 hours, it will start immediately and run for 15 minutes.

8.2.3 START FAST STATIC OR KINEMATIC SURVEY

Required options. Kinematic surveying requires the Memory Option, as do all surveying procedures. FastStatic surveying requires the Memory Option and the Carrier Phase Option.

To use. If the receiver supports FastStatic surveying, select START FAST STATIC OR KINEMATIC SURVEY from the *Log Data* menu. The receiver will display this screen:

```
              START FAST STATIC SURVEY --

              START  KINEMATIC  SURVEY --
```

Press the START FAST STATIC SURVEY or START KINEMATIC SURVEY softkey to display the main screen for the desired type of survey.

If the receiver does not support FastStatic surveying, select START KINEMATIC SURVEY from the *Log Data* menu. The receiver displays the main kinematic survey screen.

Main FastStatic Screen

To display. Press the LOG DATA key to display the *Log Data* menu. From that menu, select START FAST STATIC OR KINEMATIC SURVEY. From the following menu, select START FAST STATIC SURVEY.

The screen displays different information at different points in the FastStatic survey procedure. These examples cover the major variations.

- Waiting to start an observation:

```
FAST STATIC: MOVE TO MARK   |      START
                            |
      TRACKING 5 SVs        |INPUT/CHNGS
 *** PRESS START AT NEW MARK| END SURVEY
```

- During an observation, before sufficient data for the observation has been collected:

```
FAST STATIC: COLLECTING DATA|
                            |      ABORT
MARK  ID: ____0001    5 SVs |INPUT/CHNGS
TIME REMAINING: 14:59       | END SURVEY
```

- During an observation, after sufficient data for the observation has been collected:

```
FAST STATIC: COLLECTING DATA|       MOVE
                            |      ABORT
MARK  ID: FLDC0001    5 SVs |INPUT/CHNGS
** PRESS MOVE BEFORE MOVING | END SURVEY
```

To read. The lines on the screen show:

1. The fixed text FAST STATIC, followed by a description of the FastStatic survey procedure's current status. Possible statuses are:

   – MOVE TO MARK: The receiver is waiting for you set up the antenna at the first (next) survey mark. When the antenna is set up, connected, centered, and leveled, press the START softkey to start an observation.

   – WAIT FOR DATA: The receiver is initializing itself to perform a FastStatic survey. This status appears briefly at the beginning of the first observation in each session.

   – COLLECTING DATA: The receiver is collecting measurement data, or cannot collect sufficient data to ensure a valid observation because it cannot track the minimum required number of satellites.

   – SUFFICIENT DATA: The receiver has collected sufficient data to ensure a valid observation, and cannot collect more because it is tracking fewer than two satellites.

3. The ID of the mark currently occupied (if any) and the number of satellites being tracked.

4. Contents depends on the mark's data collection status.

   Before enough data has been collected to ensure a valid observation, line 4 shows the predicted data collection time remaining, in minutes and seconds. If the receiver cannot track the minimum number of satellites required by the FastStatic data logging parameters, line 4 still displays the words TIME REMAINING, but the time value is replaced by a message like NEED 5 SVs (“need 5 satellites”).

At most other times, line 4 shows a scrolling message describing the next action you must take. When such a message is displayed, you can redisplay it from the beginning by pressing the CLEAR key. If the number of available satellites drops below 2 (the minimum required to form a double-difference) *after* the receiver has collected sufficient data for a valid observation, the scrolling message on line 4 does not change, but the procedure's status on line 1 changes to SUFFICIENT DATA. In this case you may terminate the observation by pressing the ABORT softkey, and on the resulting screen pressing the DATA OK softkey. Then you may go on to the next mark. (See the Aborting an Observation section for details.)

To use. The softkeys are:

- START: Start an observation. Press this softkey after setting up, centering, leveling, and attaching the antenna.
- MOVE: End an observation. This softkey is available only when the receiver has collected enough data for a complete observation.

  You must press MOVE before moving or disconnecting the antenna, or the data you have collected at the current mark will be corrupted.
- ABORT: Abort the current observation. The receiver displays a menu that lets you specify the reason for aborting the observation.
- INPUT/CHNGS: Displays a menu that lets you enter antenna parameters and notes, and change the data file's name.
- END SURVEY: Displays a screen that prompts you to confirm that you want to end the survey. Press the YES softkey to end the survey and return to the *Log Data* menu; press NO to continue running the survey.

If the receiver is collecting data, ending the survey will automatically end the current observation if the receiver has collected enough data, or abort the observation if it has not.

Enter mark ID. At some time during the observation at each mark, you must enter a mark ID. The mark ID field is eight characters long; it consists of a four-character identifier which you must enter, followed by a four-character sequence number which the receiver fills in.

The sequence number is reset to 0001 for the first observation at each mark. If an observation is aborted and repeated, the receiver ordinarily increments the sequence number by 1. You also can change the sequence number manually if necessary.

Time remaining may increase or decrease. The observation time remaining, displayed on the fourth line, is a prediction based on the settings of the FastStatic data logging parameters and the current observation conditions. It may increase or decrease during the observation if conditions change. In any case, you can be sure that the receiver has collected enough data for a valid observation when the time remaining reaches zero.

Main Kinematic Screen

To display. Press the LOG DATA key to display the *Log Data* menu. From that menu, select START FAST STATIC OR KINEMATIC SURVEY. From the following menu, select START KINEMATIC SURVEY.

The screen displays different information at different points in the kinematic survey procedure. These examples cover the major variations.

- Waiting to start an observation:

```
KINEMATIC MODE: ROVING       |     STATIC
DATA SET: 1          SVs: 7 |
POINT ID: 11110001          |INPUT/CHNGS
4SV EPOCHS:0                | END SURVEY
```

- During an observation, before sufficient data for the observation has been collected:

```
KINEMATIC MODE: STATIC WAIT |
DATA SET: 2          SVs: 7 |      ABORT
POINT ID: 11110001          |INPUT/CHNGS
4SV EPOCHS:0                | END SURVEY
```

- During an observation, after sufficient data for the observation has been collected:

```
KINEMATIC MODE: STATIC      |       ROVE
DATA SET: 2          SVs: 7 |      ABORT
POINT ID: 11110001          |INPUT/CHNGS
4SV EPOCHS:5                | END SURVEY
```

To read. The lines on the screen show:

1. The fixed text KINEMATIC MODE, followed by a description of the kinematic survey procedure's current status. Possible statuses are:
   - ROVING: The receiver and antenna may be moved to the next survey mark. When the antenna is set up, connected, centered, and leveled, press the STATIC softkey to start an observation.

  - STATIC WAIT: The receiver is collecting measurement data.
  - STATIC: The receiver has collected sufficient data to ensure a valid observation, but will continue collecting data until you press the ROVE softkey.
2. The number of the current data set (the current observation) and the number of satellites being tracked.
3. The ID of the mark currently or most recently occupied.
4. The number of epochs of data that have been collected at the current mark, without interruption and with the minimum number of satellites available.

To use. The softkeys are:

- STATIC: Start an observation. Press this softkey after positioning the antenna over a mark.
- ROVE: End an observation. This softkey is available only when the receiver has collected enough data for a complete observation.

  In a stop-and-go survey you must press ROVE before moving the antenna, or the data you have collected at the current mark will be corrupted.
- ABORT: Abort the current observation. The receiver displays a menu that lets you specify the reason for aborting the observation. (See Aborting an Observation.)
- INPUT/CHNGS: Displays a menu that lets you enter antenna parameters and notes, and change the data file's name.
- END SURVEY: Displays a screen that prompts you to confirm that you want to end the survey. Press the YES softkey to end the survey and return to the *Log Data* menu; press NO to continue running the survey.

  If the receiver is collecting data, ending the survey will automatically end the current observation if the receiver has collected enough data, or abort the observation if it has not.

Enter point ID. At some time during the observation at each mark, you must enter a point ID. The point ID field consists of a four-character identifier followed by a four-character sequence number. The receiver automatically increments the trailing numeric part of the sequence number for each observation, so you usually need only press ENTER to accept the point ID displayed. You can change the sequence number manually if necessary, though.

INPUT/CHNGS Menu: Input Data or Change Parameters

To display. From the main FastStatic or kinematic menu, press the INPUT/CHNGS softkey.

```
FAST STATIC:                |
                            |USER INPUT
                            |   CHANGES
                            |ANTENNA HEIGHT
                            |    STATUS
```

To use. The softkeys are:

- USER INPUT: Displays a menu that lets you enter field notes, event marks, event mark comments, and surface meteorological data. See the USER INPUT: Enter Notes and Event Marks.
- CHANGES: Displays a menu that lets you enter antenna parameters, change the data file's name, and change the volume of the beep that the receiver makes when it has collected enough data to ensure a valid observation at a mark. See the CHANGES section.

  You must use CHANGES to enter antenna parameters. If you are using a tripod you must use CHANGES once per occupation, since the antenna's height will change each time it is moved.

- STATUS: Available only during a FastStatic survey; displays a screen that shows the status of the satellite observations. See the description below.

STATUS

To display. From the main FastStatic screen, press the CLEAR key or the INPUT/CHNGS softkey, then the STATUS softkey.

```
CONTINUOUS TRACKING TIMES:        |
          [4]     5      6   SVs|
REQUIRE: __:__  15:00   8:00    |CURRENT
   BEST: 10:16  10:16   2:00    | RETURN
```

To read. The lines on the screen show:

1. CONTINUOUS TRACKING TIMES: fixed text.

2-3. The minimum measurement times required for four, five, and six or more satellites by the FastStatic data logging parameters. (For information about setting these parameters, see Setup Survey Controls.) In this example, the value for four satellites was entered as 0:00, disabling the corresponding minimum observation time. The ‘4’ on line 2 is enclosed in brackets, and the value on line 3 is blank.

Pressing the CURRENT softkey makes line 3 display the current continuous measurement times for four, five, and six or more satellites.

4. The durations of the best (longest) continuous measurement times. If any of the values on line 4 is greater than the corresponding value on line 3, the MOVE softkey is available on the main FastStatic screen.

To use. The softkeys are:

- CURRENT/REQUIRE: Toggles the display on line 3 between the continuous measurement times required to complete an observation (the initial display), and the current continuous measurement times.
- RETURN: Return to the main FastStatic screen. Equivalent to CLEAR.

Multiple Data Files for One FastStatic Survey

The FastStatic surveying procedure normally creates a single data file for all of the observations in a survey. This simplifies the task of file management.

It is also possible to create a separate file for each survey mark. Simply start each observation by performing the procedure for starting a survey, and end it by pressing the END SURVEY softkey. Each data file will have the same filename in the receiver (unless the UTC day happens to change during the survey). When you download the files, you must combine them or give them distinct DOS file names.

8.2.4 Turning Power Off Between FastStatic Survey Marks

If a FastStatic survey's marks are far apart, you may want to turn off the receiver's power while moving to preserve the battery charge. Before you turn off the receiver you should end the session by pressing the END SURVEY softkey. When you turn the receiver back on, it will start a new session (and a new data file) as described in “Multiple Data Files for One FastStatic Survey,” above.

Since it is possible to resume a survey after a power failure, it is theoretically possible to turn the power off between marks by pressing the MOVE softkey, then powering off. The receiver will restart in the *Move* mode when powered on. This technique is not recommended, though, except as a means of recovering from an *accidental* loss of power. It still produces multiple data files, but it does not put a header in each file; thus you must concatenate the files after downloading them in order to postprocess them.

8.3 ENABLE AUTO-SURVEY TIMER

The ENABLE AUTO-SURVEY TIMER selection schedules *all* sessions that have been defined to start “Any Day at Specified Time” or “Once at Specified Date and Time.”

In addition, the ENABLE AUTO-SURVEY TIMER selection makes the receiver “sleep” until the time when the first session is scheduled to start. Five minutes before the session will start, the receiver wakes up and attempts to acquire SVs. It then starts the session automatically. When the session ends, the receiver may remain awake or go back to sleep until the next session is scheduled to be run. When there are no more scheduled sessions, the receiver turns itself off.

The auto-survey timer is useful for unattended base station operation. You can use it to schedule a series of data logging sessions to coincide with times when you are conducting surveys with a rover. By not logging data between sessions, you conserve the base station's memory and increase its effective data logging capacity.

The auto-survey timer also conserves battery power, since battery drain is very low when the receiver is asleep. A fully charged 2.3 ampere-hour battery can power a receiver for about 3.5 hours when it is awake, or for more than a week when it is asleep.

When you use the auto-survey timer, take care not to schedule overlapping sessions; the earlier session will “cover” a later one, which thus will be unable to start until the earlier session ends.

To display. From the *Log Data* menu, select ENABLE AUTO-SURVEY TIMER. The receiver displays this screen:

```
AUTO-SURVEY MODE IS OFF           | ENABLE
SCHEDULED SESSIONS:               |
  1 EVERYDAY SESSION              |
 NO ONCE-ONLY SESSIONS            |
```

To read. The first line shows whether the auto-survey timer is enabled. The other lines show the number of "Any Day at Specified Time" and "Once at Specified Date and Time" sessions that will be scheduled.

To use. Press the ENABLE softkey to display this screen:

```
       ENABLE & SLEEP BETWEEN SURVEYS --
  ENABLE & STAY AWAKE BETWEEN SURVEYS --

                               CANCEL --
```

Press one of the ENABLE... softkeys to enable the auto-survey timer. ENABLE & SLEEP... makes the receiver go back to sleep after each session; ENABLE & STAY AWAKE... makes it stay awake after waking up for the first session.

The TIMER indicator to the left of the keypad lights up, showing that the auto-survey timer is enabled but the receiver is not yet asleep. The receiver displays this screen:

```
AUTO-SURVEY MODE ENABLED          | CANCEL
DEFAULT ANTENNA HEIGHT:           |  UNITS
           0000.0000 INCHES       |
 SERIAL #:  000000                | ACCEPT
```

This screen gives you one more chance to change the antenna height and serial number. If you enter values, they will apply to all of the scheduled sessions. When you are done changing these values, if necessary, press the ACCEPT softkey. The receiver displays this screen:

```
AUTO-SURVEY MODE ENABLED          |CANCEL
                                  |
GOING TO SLEEP IN 30 SECONDS      |

UNTIL:TUE 12-JUL-94 15:25 PST/24 |
```

The last line shows the date and time when the receiver will wake up for the first scheduled session. The GOING TO SLEEP... line counts down to zero, then the receiver goes to sleep.

While the receiver is asleep, the SLEEP indicator flashes every few seconds to show that the receiver is not turned off.

When scheduled sessions are run. “Schedules all sessions” means that the receiver will run each session at the scheduled time without further intervention. Any sessions defined to start “Any Day at Specified Time” will be run *every day* until the auto-survey timer is canceled.

If a session's scheduled start time is past but its scheduled duration has not expired, the receiver starts the session immediately and runs it until it would have ended if started on schedule. For example, if a session is scheduled to start at 1500 hours and run for one hour, and the auto-survey timer is enabled at 1545 hours, the session will start immediately and run for 15 minutes.

Canceling the Auto-Survey Timer

You can cancel the auto-survey timer, if necessary, at any time. Canceling the auto-survey timer terminates the current surveying session if any; deschedules any other scheduled sessions; and turns off the timer.

Note – If you end a survey manually (with the survey status screen's END SURVEY softkey) while the auto-survey timer is enabled, the receiver will disable the timer. No other preplanned surveys will run until the timer is enabled again.

If the receiver is awake: You can use most functions *without* canceling the auto-survey timer. For example, you can download logged data and delete old data files. In this respect, running a session with the auto-survey timer is just like running a session manually, except that the receiver logs data only when a scheduled session is actually running.

If you must cancel the auto-survey timer:

1. Press [LOG DATA]. The *Log Data* menu will appear.
2. From the *Log Data* menu, press the END SURVEY softkey. (See End Survey for more detailed instructions.)

If the receiver is asleep:

1. Press the [POWER] key to wake the receiver up. It will perform its power-up tests, then display this screen:

```
AUTO-SURVEY MODE ENABLED         |CANCEL
SLEEP INTERRUPTED                |
GOING TO SLEEP IN  30 SECONDS    |
UNTIL:THU 31-MAR-94   7:15 AM PST|
```

2. To prevent the receiver from going back to sleep, press the CANCEL softkey within the 30 second countdown period. The *Log Data* menu will appear.

8.3.1 RESULTS FROM PREVIOUS SURVEY

You can review the results from the most recent completed static survey or other data logging session.

To display. From the *Log Data* menu, select RESULTS FROM PREVIOUS SURVEY. The receiver displays the first of these screens:

```
LAST SURVEY: 0270-139-0             |PREV
BEGAN: WED 18-MAY-94  17:50 PDT/24 |
LOGGED DATA FOR   2 HR 31 MIN       |
ENDED BY USER                       |MORE
```

```
            SV03  SV12  SV16  SV20 |PREV
CONTINUOUS     7     7     7     7 |
TOTAL MEAS.    7     7     7     7 |
                                   |MORE
```

To read: first screen. The lines on the screen show:

1. The station ID and session ID of the most recent completed session.
2. The date and time when the session began.
3. The duration of the session.
4. How the session was ended: by expiration of the observation time, by the user, etc.

To read: second screen. Each column gives measurement counts for one satellite that was tracked during the session. The lines on the screen show:

1. Satellite number.
2. CONTINUOUS: The number of measurements made since the receiver started logging data to the current file or since measurements were interrupted, whichever happened later.
3. TOTAL MEAS: The total number of measurements made since the receiver started logging data to the current file.

If the session used too many satellites to display in one screen, the receiver displays additional screens in the same format as the second one.

To use. The softkeys are:

- PREV: Cycle backward through the screens.
- MORE: Cycle forward through the screens.

8.3.2 SETUP SURVEY CONTROLS

This screen lets you view and set a group of parameters that affect the way a quickstart static, FastStatic, or kinematic survey is performed.

To display. From the *Log Data* menu, select SETUP SURVEY CONTROLS. The receiver displays a menu similar to this one:

```
          MODIFY QUICKSTART  CONTROLS --
          MODIFY FAST STATIC CONTROLS --
          MODIFY KINEMATIC   CONTROLS --
```

Press the appropriate softkey to select the group of survey controls you want to set up:

```
QUICKSTART CONTROLS                  |MORE
STORE POSITION:   NORMALLY           |CHANGE
ELEVATION MASK:+15×  MIN SVs: 03     |MINUS
MEAS SYNC TIME: 015.0 SEC            |ACCEPT
```

```
FAST STATIC SURVEY ELV MASK:+15×|DEFAULT
                     4  5  6 SVS|  MINUS
MINIMUM MEAS TIMES: 20 15 08 MIN|
   MEAS SYNC TIME : 15.0     SEC| ACCEPT
```

```
KINEMATIC CONTROLS                   |
STORE POSITION:   NORMALLY           |CHANGE
ELEVATION MASK:+15×  MIN SVs: 04     |MINUS
MEAS SYNC TIME: 015.0 SEC            |ACCEPT
```

To read: quickstart controls. The lines on the screen show:

1. QUICKSTART CONTROLS: Fixed text.
2. STORE POSITION: The mode of logging data. Possible values are described in Setting Special Controls Values.
3. ELEVATION MASK and MIN SVs: The elevation mask to use for a quickstart session, and the minimum number of healthy satellites that must be available above the elevation mask.
4. MEAS SYNC TIME: The interval at which the receiver logs satellite measurements.

To read: FastStatic controls . The lines on the screen show:

1. FAST STATIC SURVEY: Fixed text.

   ELV MASK: The elevation mask to use for FastStatic surveys.

2-3. SVS... MIN: Each column shows the minimum measurement time with continuous tracking that the receiver will need to complete an observation with a specified number of SVs. For example, the screen above shows that the receiver will require 20 minutes with 4 SVs, 15 minutes with 5 SVs, or 8 minutes with 6 SVs.

4. MEAS SYNC TIME: The interval at which to log measurements.

To read: Kinematic controls. The lines on the screen show:

1. KINEMATIC CONTROLS: Fixed text.
2. STORE POSITION: The mode of logging data. Possible values are described in Setting Special Controls Values.
3. ELEVATION MASK and MIN SVs: The elevation mask to use for a kinematic survey, and the minimum number of healthy satellites that must be available above the elevation mask.
4. MEAS SYNC TIME: The interval at which to log data.

To use. The softkeys are:

- CHANGE: Cycle the STORE POSITION parameter through its possible values.
- PLUS/MINUS: Visible only when the cursor is in the elevation mask field; toggles the sign of the elevation mask between '+' and-'.
- ACCEPT: Accept the parameter values shown and return to the *Log Data* menu.

8.4 Performing Other Receiver Operations During a Session

Most of the receiver's functions work the same way when it is running a static survey or other data logging session as when it is in positioning mode (not logging data). There are a few exceptions. During a session:

- The STATUS key displays the data logging status screen instead of the positioning mode status screen. If you press the CLEAR key enough times to rise to the top of the screen hierarchy, you will also see the data logging status screen instead of the positioning status screen.
- The LOG DATA key displays the SURVEY screen instead of the *Log Data* menu. (See Controlling a Session, below.)
- The SESSIONS key is locked out, and the *Control* menu's LOGGED DATA FILES item is locked out to protect files from accidental change.

The data may be compromised if you change most *Control* parameters while logging data. The only *Control* parameters it is safe to change are the antenna parameters described in Enter Antenna Information.

8.5 Controlling a Session

The receiver can display several screens that let you control and stop surveys of various types.

8.5.1 Static Surveys: The SURVEY Screen

This screen lets you stop a static survey, enter supplementary data, and change the data file name and antenna information parameters.

To display. While a static survey is running, the LOG DATA key displays this screen.

```
SURVEY:                          |USER INPUT
                                 |   CHANGES
                                 |
                                 |END SURVEY
```

To use. The softkeys are:

- USER INPUT: Displays a screen that lets you enter supplementary data about a session. This data is logged along with the session's measurement data and/or position fixes.
- CHANGES: Displays a screen that lets you view and change the data file name and antenna parameters.
- END SURVEY: Ends the session. If the auto-survey timer is enabled, this cancels the timer (and with it, any sessions scheduled to be run).

8.5.2 FastStatic Surveys

While a FastStatic survey is running, the receiver displays the FastStatic survey main screen:

```
FAST STATIC: COLLECTING DATA|       MOVE
                            |      ABORT
MARK  ID: FLDC0001    5 SVs |INPUT/CHNGS
** PRESS MOVE BEFORE MOVING | END SURVEY
```

To read. The lines of the display show:

1. The survey's current status:
   - COLLECTING DATA: The receiver is conducting an observation.
   - SUFFICIENT DATA: The receiver is conducting an observation, but has collected enough data to make the observation valid.
2. The mark ID of the mark being observed (which you must enter during the observation) and the number of satellites being tracked.
3. TIME REMAINING: During an incomplete observation, shows the predicted time remaining to collect sufficient data. A message like “TIME REMAINING: NEED 5 SVs” indicates that the observation has been suspended due to insufficient available satellites.

   At other times, this line shows a scrolling message that tells you what to do next.

To use. The softkeys are:

- MOVE or STATIC: Shifts the receiver's mode. MOVE is available when the receiver is making an observation, and has collected sufficient data. STATIC is available when the receiver is in *Move* mode (after you press MOVE).
- ABORT: Aborts the current observation; displays a menu that lets you specify the disposition of the aborted observation.
- INPUT/CHNGS: Displays a menu that lets you enter supplementary data and change survey parameters.
- END SURVEY: Ends the survey.

8.5.3 Kinematic Surveys

While a kinematic survey is running, the receiver displays the kinematic survey main screen:

```
KINEMATIC MODE: STATIC      |       ROVE
DATA SET:  1         SVs: 4 |      ABORT
POINT ID: 00001111          |INPUT/CHNGS
4SV EPOCHS:1                | END SURVEY
```

To read. The lines on the screen are:

1. Shows the fixed text KINEMATIC MODE, followed by the kinematic surveying procedure's current status:
   - ROVING: In *Rove* mode; the receiver is ready to move.
   - STATIC WAIT: In *Static* mode; the receiver is collecting data.
   - STATIC: In *Static* mode; the receiver is collecting data, but has collected enough to ensure a valid observation. Press the ROVE softkey to go to *Rove* mode before moving the antenna.
2. The fixed text NOT LOGGING indicates that the receiver is acquiring satellites and calibrating itself. This process requires a few seconds at the beginning of each survey.

   For the rest of the surveying session, this line shows the number of observations that have been made in this survey and the number of satellites being tracked.
3. The point ID of the mark currently or most recently occupied.
4. Minimum number of satellites required for data collection, and number of epochs of data collected.

If the receiver was unable to maintain its lock on the minimum required number of satellites, this line shows the message RETURN TO A PREVIOUS MARK.

To use. The softkeys are:

- ROVE or STATIC: Shifts the receiver's mode. ROVE is available when the receiver is making an observation, and has collected sufficient data. STATIC is available when the receiver is in *Rove* mode (after you press ROVE).
- ABORT: Aborts the current observation; places the receiver in *Rove* mode.
- INPUT/CHNGS: Displays a menu that lets you enter supplementary data and change survey parameters.
- END SURVEY: Ends the survey.

8.5.4 USER INPUT: Enter Notes and Event Marks

To display. While a static survey or non-survey data logging session is underway, press LOG DATA to display the SURVEY screen. Then select USER INPUT.

You can also display this screen while starting a static survey (see Step 4: Start the Session); from the *Start the Session* screen select USER INPUT.

To display this screen while running a FastStatic or kinematic survey, select INPUT/CHNGS; from the resulting menu, select USER INPUT.

```
SURVEY INPUTS:      |    MARK EVENT NOW!
                    |EVENT MARK COMMENTS
                    |        FIELD NOTES
                    |   SURFACE MET DATA
```

To use. The softkeys are:

- MARK EVENT NOW: Logs a serial-numbered, time-stamped event mark.

  The receiver displays a screen that says NEW EVENT MARK ENTERED and shows the event mark's serial number. Press the CLEAR key to return to the USER INPUT menu.

  The effect is the same as that of an event pulse on the AUX or EVENT MARKER port. (See Event Markers.)

- EVENT MARK COMMENTS: Lets you enter or edit an alphanumeric note associated with an event mark. See the description below.

- FIELD NOTES: Lets you enter up to three lines of field notes concerning the session or survey as a whole. See the description below.

- SURFACE MET DATA: Lets you enter values describing surface meteorological conditions at the time and location of the session or survey. See the description below.

8.5.5 EVENT MARK COMMENTS

This screen lets you enter and edit a note associated with an event mark. It applies both to event marks entered from the USER INPUT menu and event marks entered by a pulse on the AUX or EVENT MARKER port.

To display. From the USER INPUT menu, select EVENT MARK COMMENTS. The receiver displays the first of these screens:

```
COMMENTS FOR EVENT: 0003        |NEXT ID
                                |PREV ID
                                |
                                |
```

```
COMMENTS FOR EVENT:                |  ALPHA
                                   |
                                   |
                                   | ACCEPT
```

To read. The first screen lets you select an event by ID. The second lets you view and edit the selected event's comments.

To use. The softkeys are:

- NEXT ID or PREV ID: Displays the next or previous event mark's ID.
- ALPHA/NUMERIC: Toggles the keypad between alphanumeric mode and numeric mode. This softkey has the same effect as the ALPHA key.
- ACCEPT: Accepts the comment as now displayed on the screen. The receiver returns to the USER INPUT menu.

Select the event mark you want to edit by pressing the NEXT ID or PREV ID key, or enter its number with the numeral keys. Then press ENTER. The receiver displays the second screen shown above. Enter or edit the note; then press ENTER or ACCEPT.

FIELD NOTES

This screen lets you enter notes associated with the current session or survey as a whole.

To display. From the USER INPUT menu, select FIELD NOTES.

```
FIELD NOTES:                     |  ALPHA
                                 |
                                 |
                                 | ACCEPT
```

To use. The softkeys are:

- ALPHA/NUMERIC: Toggles the keypad between alphanumeric mode and numeric mode. Equivalent to the ALPHA key.
- ACCEPT: Accepts the note as now displayed on the screen. The receiver returns to the USER INPUT menu.

Enter the note; then press ENTER or ACCEPT.

Each time you display the FIELD NOTES screen it prompts you to enter a new note. Thus you can enter any number of notes for a session or survey, but once you have entered a note you cannot change it or delete it on the receiver.

SURFACE MET DATA

This screen lets you enter information about surface meteorological conditions at the time and place of the session or survey. This information is for your use only; it is not used in calculations.

To display. From the USER INPUT menu, select SURFACE MET DATA.

```
SURFACE MET DATA:                  |
TEMP: (DRY)+020.0 (WET)+000.0 ×C | UNITS
PRES: 1013 millibars               |
  RH: 50 %   WEATHER CODE: 99999 |
```

To read. The lines on the screen show:

1. SURFACE MET DATA: Fixed text.
2. Dry and wet temperatures.
3. Atmospheric pressure.
4. Relative humidity and NGS standard weather code.

To use. The softkeys are:

- UNITS: Toggles the display between metric units (temperatures in Celsius, pressure in millibars) and English units (temperatures in Fahrenheit, pressure in inches of mercury).

Enter appropriate values in each field. To leave the screen, press ENTER until the cursor is at the last field, then press ENTER once more.

You can change the sign of the wet or dry temperature by placing the cursor at the sign and pressing the YZ-9 key (for “minus”) or the +0 key (for “plus”). Note that this is different from most other signed fields, which expect you to press a PLUS/MINUS softkey.

8.5.6 Changes

This screen lets you enter or change the antenna information parameters and the name of the current data file.

To display: For a quickstart or preplanned (static) session. Before you have started the session, select CHANGES from the “Start the Session” screen. (See the Step 4: Start The Session section.) After you have started the session, press LOG DATA to display the SURVEY screen. Then select CHANGES.

To display: For a FastStatic or kinematic survey. Select INPUT/CHNGS; from the resulting menu, select USER INPUT.

```
SURVEY CHANGES:      |      ANTENNA HEIGHT
                     |           FILE NAME
                     |
                     |
```

To use. The softkeys are:

- ANTENNA HEIGHT: Displays a screen that lets you change the antenna height and other antenna information. See the description below.
- FILE NAME: Displays a screen that lets you change the name of the data file. See the description below.

ANTENNA HEIGHT

This screen lets you change a session's antenna information parameters while data is being logged.

To display. While data is being logged, press LOG DATA to display the SURVEY screen. Then select CHANGES, then ANTENNA HEIGHT.

```
ANT HEIGHT: 0000.0000 INCHES     | UNITS
 MEAS TYPE: UNCORRECTED          |  NEXT
  ANT TYPE: EXTERNAL (UNKNOWN)   |  NEXT
ANT SERIAL: 000000               |ACCEPT
```

To read and use. See Enter Antenna Information. The screen described there is identical to this one.

FILE NAME

This screen lets you change the name of the file being used to log data. It renames the file without disturbing its contents.

To display. While data is being logged, press LOG DATA to display the SURVEY screen. Select CHANGES; then select FILE NAME.

```
CHANGE SURVEY FILE NAME:          |  ALPHA
          OLD: 0492-137-0         |
          NEW: 0492-137-0         |
                                  | ACCEPT
```

To read. OLD shows the file's current name. NEW initially contains the same name.

To use. The softkeys are:

- ALPHA/NUMERIC: Toggles the keypad between alphanumeric mode and numeric mode. Equivalent to the ALPHA key.
- ACCEPT: Accepts the new file name as displayed, and return to the CHANGES menu. Equivalent to the ENTER key.

Edit the NEW field with the keypad, then press ENTER or ACCEPT.

To discard any changes you have made, press CLEAR.

8.5.7 END SURVEY

This selection ends the current surveying session. If the auto-survey timer is enabled, it also disables the timer.

To display: static survey. If the receiver is in sleep mode, press the POWER key to wake it up; then press the CANCEL softkey to return to the original survey selection menu.

Press the LOG DATA key to display the SURVEY screen, then select END SURVEY.

To display: FastStatic or kinematic survey. From the survey status screen, select END SURVEY.

In either case, the receiver displays a screen like this one:

```
                                   | YES
STOP THE CURRENT SURVEY ?          |
                                   |
                                   | NO
```

To use. Select YES. The receiver stops logging data.

If you have not yet entered antenna parameters, the receiver now prompts you to do so:

```
ANT HEIGHT: 0000.0000 INCHES     | UNITS
 MEAS TYPE: UNCORRECTED          |  NEXT
  ANT TYPE: EXTERNAL (UNKNOWN)   |  NEXT
ANT SERIAL: 000000               |ACCEPT
```

Enter an appropriate value in each field, then press the ENTER key or the ACCEPT softkey. (For details, see Enter Antenna Information.)

The receiver returns to the positioning mode's main *Status* screen.

8.6 Aborting an Observation

You can abort a FastStatic or kinematic observation by pressing the ABORT softkey from the survey status screen.

This section describes the FastStatic ABORT screen. The kinematic procedure has no ABORT screen; the ABORT softkey simply aborts an observation and places the receiver in *Rove* mode.

To display (FastStatic procedure only). From the FastStatic status screen, press the ABORT softkey. The receiver displays a screen similar to this one:

```
ABORT SINGLE OCCUPATION |       DATA BAD
                        |        DATA OK
                        | REOBSERVE MARK
                        |   CANCEL ABORT
```

Press one of the softkeys:

- DATA BAD flags the data as suspect and increments the mark ID. This is the appropriate choice if the antenna has been disturbed.
- DATA OK flags the data as processable and increments the mark ID. This is an appropriate choice only if the MOVE softkey has not yet appeared *and* the antenna has not been moved.
- REOBSERVE MARK is equivalent to DATA BAD, but does not increment the mark ID. If you accidentally press REOBSERVE MARK instead of DATA BAD, you should increment the mark ID manually.
- CANCEL ABORT redisplays the main FastStatic screen and allows the observation to continue undisturbed.

An observation is also aborted if you press the END SURVEY softkey before sufficient data is collected for a valid observation (before the MOVE softkey has appeared). This is equivalent to pressing DATA OK, except that it ends the survey as well as aborting the observation.

8.7 How the Receiver Names Data Files

When the receiver creates a data file it assigns the file an eight-character name in the form *ssss-nnn-d.* An example of a data file name is 0005-137-0.

For a preplanned static survey, the parts of the name are:

- The four-character station ID of the station where the survey is being performed.
- The three-character session ID of the session for which the survey is being performed.
- A one-character numeric sequence number.

For any other type of survey, the parts of the name are:

- The last four digits of the receiver's serial number.
- The Julian date on which the survey was started.
- The one-digit sequence number.

To rename the current data file. Display the CHANGES menu and select FILE NAME. (See Changes.)

8.8 Interruptions in Data Logging, and Recovery

If the receiver's power fails during a survey or session, data logged before the power failure is preserved in the data file. The file records the fact that the session was ended by a power failure.

Data logging also is interrupted when the receiver's memory is filled, or when any condition occurs that reduces the number of available satellites below the minimum required by the procedure being used and the receiver's parameter settings.

The receiver always returns to the state it was in when the failure occurred: static (collecting data) or moving (waiting for the user to press START). The best continuous measurement information is retained. If the receiver was in a “ready to move” static state when power failed (that is, if it had collected sufficient data for a valid observation), then it will still be “ready to move” when power is restored.

Data logging will resume when the condition that caused the interruption is corrected: that is, when power is reapplied, free memory becomes available, or the required number of satellites becomes available.

When the receiver resumes an interrupted survey, it creates a new data file with the same name as the original one. When you download the data files, you must combine them or give them distinct DOS file names. Use the COPY command with the /B (binary) option; see your DOS user's manual for details.

8.8.1 Recovery: Auto-Survey Timer Not Enabled

To restart the survey or session:

1. Restore power to the receiver.
2. After the receiver completes its power-up test, the survey restarts automatically. The receiver displays this screen:

```
SURVEY RESTARTED

AFTER POWER FAIL
** PRESS ANY KEY **
```

3. Press any key to display the status screen.

Data from the restarted session is logged to a file with the same name as the original file. (The receiver, unlike most computers, allows duplicate file names.)

8.8.2 Recovery: Auto-Survey Timer Enabled

To restart the survey or session:

1. Restore power to the receiver.
2. After the receiver completes its power-up test, the session restarts automatically. The receiver displays this screen:

```
AUTO-SURVEY MODE ENABLED
      POWER FAIL?
STARTING SESSION:  1234-111-0
      IN 30 SECONDS
```

When the countdown reaches zero, the session is restarted. Data is logged to a new file with the same name as the original file. (The files may be distinguished by their start times.)

When Trimble's software downloads the data files to a computer, it renames the second file to avoid a naming conflict. The files should be merged after the download is complete.

A Features and Accessories

A.1 Factory Default Settings

Table A-1lists the Series 4000 factory default parameter settings.

Note that some of these parameters do not exist on particular models, depending on what options are installed. The table shows which parameters are dependent on options.

Table A-1. Factory Default Parameter Settings

Screen	• Power-Up Parameter ✻ Resets at power up regardless of power-up mode	Parameter Name	Default Value
***Sat Info* screens**			
PRINT/PLOT		ON PORT	1
***Control* screens**			
RTCM-104 OUTPUT		ENABLE	OFF
Requires RTCM-104		STATION ID	0000
Output Option.		FORMAT	Version 1.0
		PRINTOUT	OFF
		CTS→XMT DELAY	0.0 seconds
		TYPE 16 MESSAGES	OFF
		CARRIAGE RETURN	ON
		RTCM BIT RATE	OFF (use serial port's baud rate)
		MESSAGE SCHEDULE	DEFAULT
RTCM-104 INPUT	•	RTCM-104 INPUTS	OFF
Requires RTCM-104	•	PORT SELECT	OFF
Input Option.		FORMAT	Version 1.0.
		ASCII PRINTOUT	OFF
		BEEPER	OFF
		STATION SELECT	ANY
		AGE LIMIT	100 seconds
POWER-UP CONTROL		Power-up control	DO NOT DEFAULT CONTROLS AT POWER UP
SV ENABLE/DISABLE	•	List of SVs in each mode	All SVs enabled in IGNORE HEALTH (POSITIONING) mode

Table A-1. Factory Default Parameter Settings (Continued)

Screen	• Power-Up Parameter ✻ Resets at power up regardless of power-up mode	Parameter Name	Default Value
***Control* screens (continued)**			
ADJUST LOCAL TIME		TIME OFFSET	0:00
		TIME ZONE IDENTIFIER	GMT
BAUD RATE/FORMAT		BAUD RATE	9600
		FORMAT	8 data bits, parity odd, 1 stop bit.
		CTS CONTROL (ports 2 & 4 only)	DISABLE
REMOTE PROTOCOL	•	Remote interface protocol	DATA COLLECTOR COMPATIBLE
REFERENCE POSITION		LAT, LON, HGT	All zero
MASKS/SYNC TIME	•	ELEVATION MASK	10×
	•	PDOP MASK	7.0
	•	SV SYNC TIME	1.0 second
POSITIONING MODES		Type of solution	WEIGHTED SOLUTION ENABLED
		Ionospheric Model used	L1 IONO
	•	Position fix mode	LAT/LON OR LAT/LON/ HEIGHT
RTK OUTPUT CONTROL	•	RTK OUTPUTS	OFF
Requires RTK Functions		APPLICATION	BASE-L1
Option.		STATION	DEFAULT
RTK ROVER CONTROL Requires RTK Functions Option.	•	ENABLE	OFF
POWER CONTROL Portable receivers only.	•	Charger/power output	CHARGER & PWR OUTPUT DISABLED

Table A-1. Factory Default Parameter Settings (Continued)

Screen	• Power-Up Parameter ✻ Resets at power up regardless of power-up mode	Parameter Name	Default Value
		***Control* screens (continued)**	
DATA FORMAT 4000SE Land Surveyor only.		DATA FORMAT (Standard or Compact)	COMPACT
L1/L2 TRACKING Requires Cross-Correlation Option or Super-trak technology.	✻	L1 TRACKING	P-CODE
	✻	L2 TRACKING	P-CODE
NMEA-183 OUTPUT	•	ENABLE	OFF
	•	ALM, BWC, GGA, etc.	All message types: OFF
CYCLE PRINTOUTS	•	FORMAT (for printouts with more than one format)	ASCII for printouts that have ASCII as an option; otherwise BINARY.
	•	ENABLE	OFF
INT/EXT TIMEBASE Requires External Frequency Input Option.		Timebase control	INTERNAL
1 PPS OUTPUT Requires 1 PPS Option.	•	1 PPS OUTPUT	DISABLED
	•	SLOPE	POSITIVE
	•	ASCII TIME TAGS	NONE
EVENT MARKERS		EVENT MARKERS	ENABLED
		SLOPE	NEGATIVE
		EVENT BEEP	DISABLED
		***Modify* screens**	
VIEW ANGLE		Viewing angle	Center position
BACKLIGHT		BRIGHTNESS	Maximum
	✻	TIMEOUT	1 minute

Table A-1. Factory Default Parameter Settings (Continued)

Screen	• Power-Up Parameter ✻ Resets at power up regardless of power-up mode	Parameter Name	Default Value
***Modify* screens (continued)**			
POWER		PWR -- I/O 1	none
		PWR 2	none
		PWR 3	none
UNITS OF MEASURE		LAT and LON	Degrees and minutes
		Antenna height units	INCHES
		TIME	UTC (Universal Time Coordinated)
BEEPER VOLUME		KEYPRESS BEEP	20% of maximum (1 bar)
		CYCLE BEEP	OFF
ALTITUDE REFERENCE		Coordinate system used	ELLIPSOID
		RETURN TO MARK ALARM	3 bars
INTEGRITY ALARMS		HORIZONTAL	OFF
		VERTICAL	OFF
MODEM SETUP		Enabled/disabled	DISABLED
		Modem setup string	none
***Sessions* screens**			
SPECIAL CONTROLS		POSITION LOGGED	NORMALLY
Requires Memory		OVERDETERMINE	ENABLE
Option.		LOG SMOOTH PR	DISABLE
		POSITION TYPE	3D/2D
		HEIGHT SOURCE	AUTO

Table A-1. Factory Default Parameter Settings (Continued)

Screen	• Power-Up Parameter ✻ Resets at power up regardless of power-up mode	Parameter Name	Default Value
***Log Data* screens**			
SETUP SURVEY CONTROLS Requires Memory Option.		STORE POSITION	NORMALLY
		ELEVATION MASK	All types of surveys: 15×
		MIN SVS	Quickstart surveys: 3 FastStatic surveys: 4 Kinematic surveys: 4
		MEAS SYNC TIME	All types of surveys: 15 seconds
ENABLE AUTO-SURVEY TIMER		AUTO-SURVEY MODE IS	OFF
RESULTS FROM PREVIOUS SURVEY		List of available results	All results are deleted.

A.2 Receiver Options

This section describes options that Series 4000 models may have.

The availability of options varies from model to model. Thus, some options may be standard features on your receiver; others may not be available at all. Your receiver's *User Guide* states which features are standard features, which are truly optional, and which are not available.

A.2.1 Signal Preprocessing Options

These options affect the types of information that a receiver can extract from satellite signals.

All receivers are capable of tracking C/A code on L1; therefore this capability is not considered an option.

12-Channel Option.

Enables a receiver to track twelve satellites instead of the standard nine.

Dual-Frequency Option.

Enables a receiver to track both the L1 and L2 carriers. A receiver without this option can track only the L1 carrier, and so cannot compensate for the effects of ionospheric propagation delay.

A receiver with the Dual-Frequency Option can conduct FastStatic surveys and dual-frequency static surveys. These techniques offer better range and precision than the single-frequency alternatives by compensating for ionospheric effects.

This option is unusual in that it is not truly optional on any current model. Each model either has dual-frequency capability as a standard feature, or does not support it at all.

The rest of the signal preprocessing options are available only if the Dual-Frequency Option is installed.

L2 P-Code Option.

Enables a receiver to measure satellite range from the offset between the L2 P-code received from the satellite and a replica that the receiver generates internally. This option is generally accompanied by the Carrier Phase Option, which may be used as a fallback technique when Anti-Spoofing is active.

L1/L2 P-Code Option.

Similar to the L2 P-Code Option, but can measure P-code on both the L1 and L2 channels, increasing range and precision.

Carrier Phase Option.

Enables a receiver to measure satellite range by observing (among other things) the phase difference between the L1 and L2 carriers. This option is less precise than the L2 P-Code Option, but it is not affected by Anti-Spoofing. It may be used as a less sophisticated alternative to the L2 P-Code Option, or as a fallback when Anti-Spoofing is active.

Cross-Correlation Option.

Enables a receiver to compensate for the effects of ionospheric delay by measuring the offset between the L1 and L2 P-code signals. This technique improves the precision of all measurements. It is not vulnerable to Anti-Spoofing, since the depends only on the offset between two P-code signals transmitted by a satellite, and those are identical whether they are encrypted or not.

Half-Wave L2 Option.

A technique for correcting ionospheric delay errors without the use of P-code; replaced in recent dual-frequency receivers by the more accurate Cross-Correlation Option.

Super-trak Option.

Super-trak enables acquiring low power satellite signals, maintaining better lock on signals once acquired and tracking under conditions of high RF interference. Super-trak is a combination of hardware and firmware technology, including true multibit signal processing. Performance tests show significantly improved jamming immunity over lesser equipped receivers. Another system benefit is measurement of the L2 range during P-code encryption. Receivers with the SSi designation use Super-trak technology.

A.2.2 Memory Option

The Memory Option provides battery-backed memory in which a receiver can log satellite measurements, position fixes, and related data. Such data can later be downloaded to a computer for postprocessing.

Receivers that lack this option cannot perform any of the surveying procedures that require data logging. They can only compute position fixes in real time, and output satellite measurements and position fixes in real time to be captured by a computer.

Each Series 4000 model actually accepts a number of memory options with different amounts of memory. When other factors remain constant, more memory allows a receiver to log data for a longer period of time before downloading it. Most receivers can be equipped with only one Memory Option, although you can upgrade a receiver by replacing a smaller Memory Option with a larger one.

A.2.3 Input/Output Options

These options affect the types of electronic connections you can use to move data into and out of a receiver.

Two Serial Port Option.

Provides two serial (RS-232) ports. Each port may be used for a variety of purposes, such as: outputting one-shot printouts and cycle printouts; inputting and outputting RTCM-104 corrections; outputting NMEA-0183 messages; uploading logged data; controlling the receiver from a computer or other external device; controlling an external device such as a NAV BEACON XL from the receiver; and downloading firmware updates to the receiver. In many cases a single port may be used to input one kind of data and output another, making the ports even more useful.

Four Serial Port Option.

Provides four serial (RS-232) ports.

RTCM-104 Input Option.

Enables a receiver to serve as a DGPS differential station (a rover) by inputting RTCM-104 corrections through a serial port from a digital radio receiver.

RTCM-104 Output Option.

Enables a receiver to function as a DGPS reference station (a base station) by outputting RTCM-104 corrections through a serial port to a digital radio transmitter.

NMEA-0183 Output Option.

Enables a receiver to output several types of NMEA-0183 messages through a serial port. Other devices can use these messages for navigation and similar functions. This option is used primarily in marine applications.

1 PPS Output Option.

Provides a port through which the receiver can output a very precise one pulse/second strobe, based on timing information in the satellite signals. Other devices can use this strobe as a timing signal.

Event Marker Input Option.

Enables a receiver to log a time-stamped record whenever an event (an electrical pulse) is detected on a special connector. You can record alphanumeric messages associated with particular events; you can also generate events from the receiver's keypad.

External Frequency Input Option.

Enables a receiver to substitute a very precise external oscillator, such as an atomic clock, for its internal quartz-crystal oscillator.

A.2.4 Other Options

Kinematic Functions Option.

Enables a receiver to perform kinematic surveys.

RTK Functions Option.

Enables a receiver to perform RTK (Real-Time Kinematic) surveys.

Navigation Package Option.

Provides an extended set of navigation functions, including a cross-track error display and the ability to define and use up to 99 waypoints.

QA/QC Option.

Enables a receiver to compute the probable error (“sigma”) in its real-time position fixes.

Remote Download Option.

Enables a computer equipped with a modem to download data files from an unattended receiver.

A.3 Data and Power Connections

Series 4000 receivers have two different rear panels. Portable receivers use the panel shown in Figure A-1. Rack-mounted receivers use the panel shown in Figure A-2.

All of the connectors are described in Table A-2.

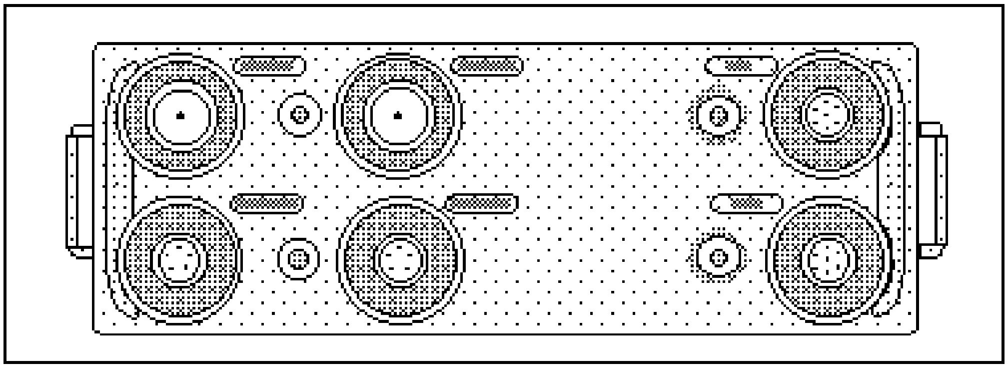


Figure A-1. Portable Receiver Rear Panel

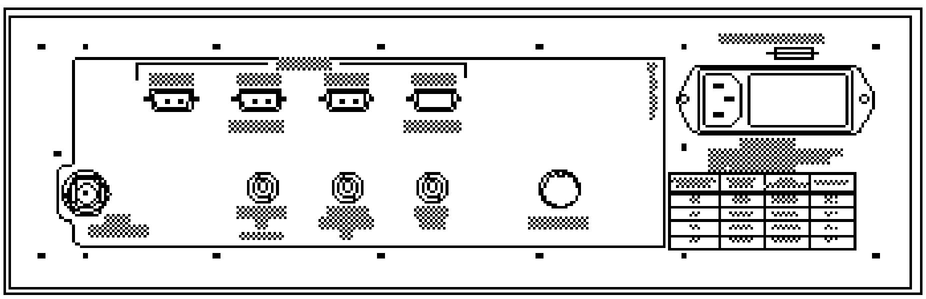


Figure A-2. Rack-Mounted Receiver Rear Panel

Table A-2. Connectors on the Rear Panel

Portable Receivers	Rack-Mounted Receivers	Function
—	AC INPUT	AC power input: 100/120/220/240 volts at 47-63 Hz.
PWR I/O 1	—	Serial port 1. Power port 1; 10.75-35 VDC input or 12 VDC output.
I/O 2	—	Serial port 2 (if Two or Four Serial Port Option is installed). Power output with direct connection to power lines on PWR I/O 1.
PWR 2&3 (POWER on some older receivers)	—	Serial port 3 (if Four Serial Port Option is installed). Power ports 2 &3; 10.75-35 VDC input or 12 VDC output on each port.
AUX	—	Serial port 4 (if Four Serial Port Option is installed). Event marker input (if Event Marker Input Option is installed). 1 pulse/second output (if 1 PPS Option is installed).
—	12 VDC IN	11 to 35 VDC power input.
—	DATA I/O PORT 1 DATA I/O PORT 2	Serial ports 1 & 2 (if Two Serial Port Option is installed).
—	DATA I/O PORT 3 DATA I/O PORT 4	Serial ports 3 & 4 (if Four Serial Port Option is installed).
—	EVENT MARKER	Event marker input (if option is installed).
—	1 PPS OUT	1 pulse/second output (if option is installed).
ANTENNA	GPS ANTENNA	Antenna input.
EXT REF	EXT REF	External timebase input (if External Frequency Input Option is installed).

A.3.1 Power In

Portable Receiver Power.

A receiver can input power through the PWR-I/O 1 and PWR 2&3 connectors. See Figure A-3 and Table A-3. Cable P/N 18939 provides dual fused power input through PWR 2&3. Trimble batteries, adapters, or other special cables may also be used.

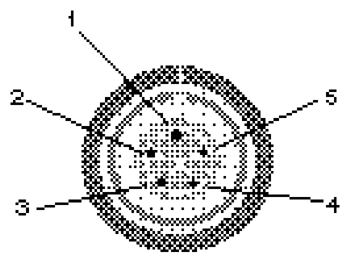


Figure A-3. 5-Pin Power In Port

Table A-3. Power In Pinouts

Pin	PWR 2&3 PWR 2&3 Pinout Function		PWR-I/O 1 Pinout Function
	Four-Port Option Installed	Four-Port Option Not Installed	
1	Battery 2 power in	Battery 2 power in	Power 1 in & out
2	Battery 2 ground	Battery 2 & 3 ground	Power 1 ground
3	Serial I/O 3 data in	—	Serial I/O 1 data in
4	Serial I/O 3 signal ground	Battery 3 power in	Serial I/O 1 signal ground
5	Serial I/O 3 data out	—	Serial I/O 1 data out

A receiver requires a 1-ampere, 11 to 35 VDC power supply. The receiver will turn itself off if the voltage drops below 10.75 VDC. 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 11-35 volt operating range; power from an unfiltered automobile battery charger is not acceptable.

Caution – The receiver's DC power inputs have no user-serviceable fuses. Any external DC power supply must be fuse-protected. The Trimble equipment warranty will be voided if this precaution is not followed.

The DC power cable, P/N 16474, has two pairs of wires, one red-and-black pair and one white-and-black pair. Each pair can be connected to a DC voltage source. The red and white wires are positive leads and the black wires are ground leads. One pair goes to the "PWR 2" part of the PWR 2&3 port, and the other to the "PWR 3" part.

Rack-mounted receiver power.

Rack-mounted receivers can accept DC through the 12 VDC IN connector, or line power through the AC INPUT connector. Power requirements are the same as for the portable receiver (above).

Line power must be 100, 120, 220, or 240 VAC at 47 to 63 Hz, supplied from a grounded source. To select the AC voltage level:

1. Disconnect the power.
2. Remove the fuse holder/cover adjacent to the AC INPUT connector.
3. Remove the selector board from the cover.
4. Move the selector board's white selector tab to the desired voltage.
5. Reinstall the board with the tab pointing outward.

6. Orient the fuse holder plate on the inside of the cover to match the voltage level.

   For 100 and 120-volt operation, the side of the plate with one fuse and one jumper wire must face away from the cover. (This side will face into the receiver when the cover is reinstalled.)

   For 220 and 240-volt operation, the side of the plate with two fuses must face away from the cover.

   To change the fuse holder plate's orientation, loosen the screw that fastens the fuse holder to the cover. Remove the fuse holder, rotate it, and replace it. Tighten the screw.

7. Replace the fuse holder/cover.

8. Reconnect the power.

How the Receiver Selects a Power Source.

If a source of more than 14.7 VDC (such as an OSM2) is attached to any of a receiver's power input connectors, the receiver automatically selects that source when turned on. It ordinarily will not change sources while running unless the selected source drops below 10.75 VDC, but it will switch to the OSM2 if one is plugged in while battery charging is enabled. (See “About Batteries” on page 226.)

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

A.3.2 Power Out

Note – Available only on portable (not rack-mounted) receivers.

Portable receivers can supply 12 VDC at 0.5 ampere through ports I/O 2 (with the Two or Four Serial Port Option only) or PWR - I/O 1. This power output can be used to 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&3 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. From the *Control* menu, select *POWER CONTROL*. Press the *CHANGE* softkey to enable the power output.
5. Turn on the remote device.

Rack-mounted receivers can display the POWER CONTROL screen, but do not provide power output.

A.3.3 The Office Support Module 2

Note – Available only on portable (not rack-mounted) receivers.

The Office Support Module 2 (OSM2) performs three functions for a portable receiver: AC to DC power conversion, battery charging, and serial I/O through a DE9S connector. The OSM2 accepts power at all widely used voltages and frequencies, including 100, 120, 220, and 240 VAC at 50 and 60 Hertz. It has four slots for charging video camera batteries and a LEMO connector for charging external batteries.

The OSM2's serial output is connected to serial port 1 if the OSM2 is plugged into PWR - I/O 1. It is connected to serial port 3 if the Four Serial Port Option is installed and the OSM2 is plugged into PWR 2&3.

LEDs indicate the OSM2's status. The orange PWR light indicates that AC voltage is applied. The orange FAST CHARGE light indicates that batteries are being bulk charged. The green FLOAT CHARGE light indicates that the batteries are at least 90% charged and are being trickle-charged.

About Batteries

Note – Available only on portable receivers (not rack-mounted receivers).

Trimble produces a variety of batteries for different kinds of applications. The batteries are described in a table of accessories and spare parts that appears in the *User Guide* for each model of receiver. (See the list of tables near the end of the Table of Contents.)

Batteries are standard equipment with certain portable receivers. See your receiver's *User Guide* for specifics.

You can use Trimble's OSM2 to recharge batteries. Simply plug a camcorder battery into one of the OSM2's battery slots, or plug an external battery's standard cable into the OSM2's 5-pin LEMO connector.

An external battery can be bulk-charged to approximately 90% of capacity in about eight hours. At that point the OSM2's red FAST CHARGE LED goes off and the green FLOAT CHARGE LED goes on. The battery may need another eight hours to trickle-charge up to 100% of capacity. It is safe to leave the battery plugged in indefinitely.

When the receiver is connected to the OSM2 through PWR -I/O 1 port, batteries may be recharged from the receiver's PWR 2&3 port. To enable the receiver's battery charging feature:

1. Connect an OSM2 to PWR I/O 1.
2. Connect one or more batteries to PWR 2&3.
3. Press the CONTROL key. From the *Control* menu, select POWER CONTROL. Press the CHANGE softkey to enable the battery charging function.

A receiver that is not connected to an OSM2 will not 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 receiver will switch over to the OSM2 and begin charging the battery.

Note that rack-mounted receivers also display the POWER CONTROL screen, but do not have the connectors or circuitry needed to charge batteries.

A.3.4 GPS Antennas

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 procedures such as RTK and DGPS.

Caution – The receivers described in this manual will not operate with the earlier Trimble 4000A, AX, SX, or SL antennas. Also, the newer antennas will be damaged if used with those earlier receivers, or with receivers from another manufacturer.

Connection to the Receiver.

A portable receiver is connected to its antenna through the LEMO connector labeled ANTENNA. A rack-mounted receiver is connected through the type N connector labeled GPS ANTENNA. Both use a coaxial cable with a type N plug at the antenna end.

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. See the table of accessories and spare parts in your receiver's *User Guide* for specifics.

Use and Care.

The *Application Guide* describes the types of antennas that may be used with Series 4000 receivers. It explains which procedures each antenna may be used for, and discusses each antenna's use and care.

A.3.5 Serial Ports

Series 4000 receivers have one or two standard serial ports, depending on the model. They may be upgraded to two and/or four serial ports, depending on the model. See your model's *User Guide* for specifics.

On multi-port receivers, all ports are electrically identical except for baud rate and flow control. On port 1, baud rates range from 110 to 57,600; on ports 2 through 4, they range from 50 to 57,600. Ports 1 and 3 can provide XON/XOFF flow control only; ports 2 and 4 can provide either XON/XOFF or CTS/RTS flow control.

Portable Receiver Connectors.

Portable receivers present port 1 on the PWR -I/O 1 connector, and port 2 (if available) on I/O 2. Port 3 (if available) is on PWR 2&3. Port 4 (if available) is on AUX; some of the pins on AUX have different assignments depending on whether port 4 is available or not.

Table A-3 shows pinouts for PWR -I/O 1and PWR 2&3. Table A-8, on page 234, shows pinouts for AUX. Table A-4 and Figure A-4 show the pinouts for the other serial port connectors.

Table A-4. Pinouts for I/O 2 (Portable Receivers Only

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

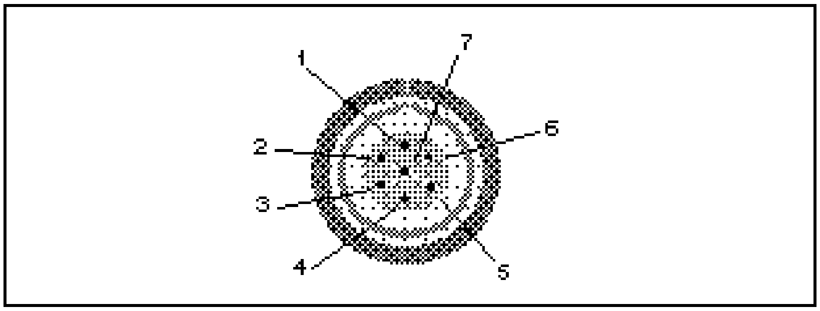


Figure A-4. I/O 2 Serial Port Connector

Rack-Mounted Receiver Connectors.

Rack-mounted receivers present the serial ports on four dedicated connectors, DATA I/O PORT 1 through DATA I/O PORT 4. See Table A-5. All four connectors are present on the rear panel whether or not they are active. All four connectors are DE9S's in a standard DCE configuration.

Table A-5. Pinouts for DATA I/O PORTS 1 to 4 (Rack-Mounted Receivers Only)

Pin	Ports 1 & 3	Ports 2 & 4
1	—	—
2	Data out	Data out
3	Data in	Data in
4	—	—
5	Signal ground	Signal ground
6	—	—
7	—	RTS
8	—	CTS
9	—	—

Baud Rate, Format, and Flow Control

Each serial port's baud rate, format, and flow control can be set independently. Table A-7 shows the combinations that can be set for each port.

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

1. Press the CONTROL key.
2. From the *Control* menu, select BAUD RATE/FORMAT.
3. Press the MORE softkey, if necessary, to display the settings of the port you want to change.
4. Select the port number, baud rate, and format, and type of flow control.

Table A-6. Serial Port Parameters

	Port 1	Port 2	Port 3	Port 4
Baud Rate	110, 300, 600, 1200, 2400, 4800, 9600, 19,200, 38,400, 57,600	50, 110, 300, 600, 1200, 2400, 4800, 9600, 19,200, 38,400, 57,600	Same as port 2	Same as port 2
Data Format (data bits, parity, stop bits)	8,None,18,Even,1 8,Odd,18,None,2 7,Even,17,Odd,1	Any combination of 7 or 8 data bits; even, odd, or no parity; 1 or 2 stop bits	Same as port 2	Same as port 2
Flow Control	XON/XOFF or NONE	XON/XOFF, CTS/RTS, or NONE	Same as port 1	Same as port 2

Each time a serial port's format is changed (each time a CHANGE softkey is pressed), the receiver sends a message on the affected port, in the new format. The message consists of 46 characters followed by a carriage return/line feed, and describes the new format like this:

BAUD RATE [19200] FORMAT [8-NONE-1]

XON/XOFF flow control uses the control characters 11H (XON) and 13H (XOFF). The external device can send an XOFF to stop the receiver output and an XON to start the output again. If XON is not received within 60 seconds the receiver will restart the data flow automatically.

CTS/RTS flow control uses the CTS/RTS lines as specified by the RS-232 standard. That is, the receiver, as a DCE device, asserts CTS when it is ready to send data.

Data Cables

Trimble produces two data cables to bring out the data lines to DE9 socket connectors in a DCE configuration. Their descriptions are given in Table A-7 and Table A-8.

Table A-7. 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-8. 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

Both 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 simply 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.

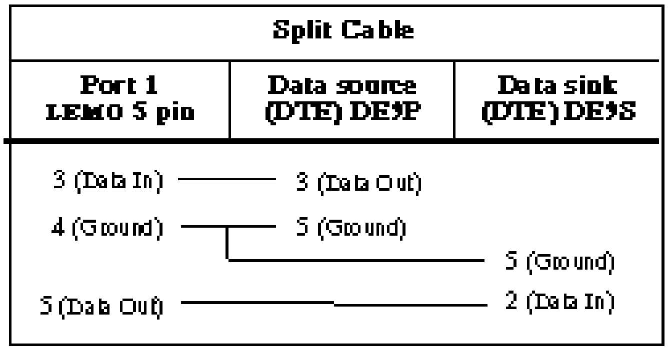
Table A-9. Null Modem Cable Pinout

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

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 receiver can simultaneously input data from one device and output data to another. For example, port 1 can simultaneously input RTCM corrections and output position printouts.

The following diagram 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.



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 may be used.

A.3.6 1 PPS and Time Tag

The receiver can output a 1 pulse/second (1 PPS) time strobe and an associated time tag. Portable receivers output the pulse on the AUX connector, using the pinouts shown in Figure A-5 and Table A-10; rack-mounted receivers output it on the 1 PPS BNC connector. Both types output the time tags on a user-selected serial port.

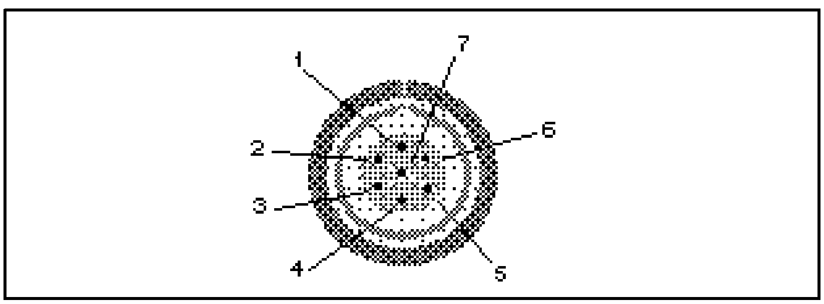


Figure A-5. 7-Pin AUX Port

Table A-10. AUX Pinout

Pin	Function (Four Serial Port Option installed)	Function (Four Serial Port Option not installed)
1	Signal ground	Signal ground
2	1 PPS out	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	Event in
7	Serial I/O 4 data out	—

The leading edge of the pulse coincides with the beginning of each UTC second. (See Figure A-6). The pulse is driven by an RS-422 driver between nominal levels of 0.0V and 4.0V. The leading edge may be positive (rising from 0V to 4V) or negative (falling from 4V to 0V), under user control.

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:

- Position errors (especially if a user-entered reference position is used): Each meter of error can result in 3 nsec. of error in the 1 PPS pulse.
- 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.

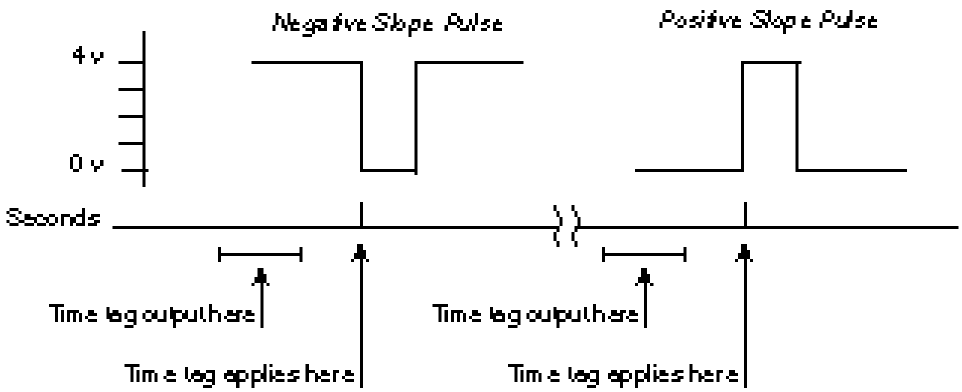


Figure A-6. Time Tag Relation to 1 PPS Wave Form

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, ‘:’ (for 10), ‘;’ (for 11), or ‘<’ (for 12).
- Each time tag is terminated by a *carriage return, line feed* sequence.

A typical printout looks like this:

```
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 receiver clock because the receiver is not tracking satellites. (The receiver clock is less accurate than time readings extracted from satellite signals.)

A.3.7 Event Mark Input

Note – Available only with the Event Marker Input and Memory Options.

Event mark input is used to log a precise GPS time tag on receipt of an externally generated pulse, such as a shutter closing pulse from a photogrammetric camera. Portable receivers input the pulse on the AUX port; for pinouts see Table A-10. Rack-mounted receivers input the pulse on the EVENT MARKER connector, a BNC connector.

The event marker input is pulled up to +5V through a 1 kΩ impedance. The pulse should be TTL level (low < 1.0V, high > 2.5V) with rise and fall times less than 100 nsec. The leading edge may be positive (rising) or negative (falling), under user control. The time tag recorded for an event is accurate to about 1 µsec.

An event mark can also be generated manually from the front panel with the *Log Data* screens. (See the section USER INPUT: Enter Notes And Event Marks in Chapter 8.) This does not put a pulse into the rear panel, but does log the same type of message.

A.3.8 INT/EXT Timebase

Note – Available only with the External Frequency Input Option.

The INT/EXT TIMEBASE control lets you drive the receiver's timebase from an external frequency source, such as a high-stability atomic standard clock, instead of the receiver's internal quartz-crystal oscillator. The external frequency source may run at either 5 or

The external frequency source is input through the EXT REF connector (a BNC connector) on the rear panel. The connector is AC terminated through a 50Ω load. The signal must be 1.0V to 6.0V peak-to-peak with a stability of 2 ppm of the specified value (for example, 5 MHz ± 10 Hz).

Note – The external reference runs the receiver's timebase directly. If the receiver is in one of the external timebase modes and an appropriate external frequency source is unavailable, or the signal is interrupted, the receiver will not function properly.

B Data Output Formats

Series 4000 receivers can generate two classes of printouts (reports): single-shot printouts and cycle printouts. Single-shot printouts are available on all receivers. Cycle printouts are available only on receivers that have the Two Serial Port Option or the Four Serial Port Option.

Single-shot printouts are produced once only, on request. They may be captured by a computer or written directly to a printer.

Each type of cycle printout is produced one entry at a time, in most cases one entry per receiver measurement cycle. The term “printout” is misleading, because cycle printouts are most often captured by a computer to keep records of the receiver's operation. You can produce them with the *Control* menu's CYCLE PRINTOUT selection.

The receiver produces three other types of output on a per-cycle basis, but from other parts of the menu system. They are RTCM-104 output, RTCM-104 input, and NMEA-0183 output, all controlled by separate, appropriately named items on the *Control* menu.

All of the printouts are written to the serial ports. Note that these ports must be properly configured at both the transmitting end (the Series 4000 receiver) and the receiving end (the computer, printer, or other device). For information about configuring serial ports, see the section Baud Rate, Format, and Flow Control in Appendix A.

B.1 Single-Shot Printouts

The receiver can produce the following types of single-shot ASCII printouts:

- *Broadcast Data:* The most recently decoded ephemeris and almanac for a specific satellite.
- *Ionospheric & UTC Data:* The most recently decoded parameters for the basic ionospheric delay model, and for the conversion from GPS system time to Universal Coordinated Time (UTC).
- *Satellite Elevation Plot:* A graph showing the elevation and azimuth of a selected satellite versus time for any selected UTC day.
- *Schedule Plot For All Sats:* A graph of visibility for all known satellites over any selected UTC day.
- *Receiver Setup Info:* A description of the receiver, its characteristics, its control settings, etc.

All of the single-shot printouts are produced with the SAT INFO key's PRINT/PLOT screen.

```
PRINT/PLOT:    ON PORT [ 2 ]  <-- CHANGE
              BROADCAST DATA  <-- CHANGE
                   FOR SV01   <--NEXT SV
                                **PRINT**
```

For an explanation of how to use the screen, see the section Print/Plot in Chapter 4.

The following sections describe each type of printout.

B.1.1 Broadcast Data

Prints the most recently decoded ephemeris and almanac data for a specific satellite.

To use. At the PRINT/PLOT screen, press the type-of-printout CHANGE softkey until BROADCAST DATA appears.

```
PRINT/PLOT:    ON PORT [ 2 ]  <-- CHANGE
              BROADCAST DATA  <-- CHANGE
                    FOR SV01  <--NEXT SV
                               **PRINT**
```

Press the NEXT SV softkey until the ID of the desired satellite appears. Then press the PRINT softkey.

The first section of the printout contains ephemeris data for the satellite, plus a few other items. The second section contains almanac data. Most of the items are labeled with names derived from the GPS system specifications and use the same units. (See *NAVSTAR GPS Space Segment*, listed in the Bibliography.)

Figure B-1 shows a sample printout and Table B-1defines the notes found in the printout.

```
BROADCAST EPHEMERIS DATA
PRN.... 01
WN..... 697  DECODED FRI 141 21-MAY-93 11:59:52
TOW.... 475200
IODC... +2.30000000000E+01
TOC.... +4.78304000000E+05
AF0.... -3.24859283864E-05
AF1.... -3.06954461848E-12
AF2.... +0.00000000000E+00
TGD.... +1.39698386192E-09
IODE... +2.30000000000E+01
TOE.... +4.78304000000E+05
SQRT A. +5.15359688377E+03
DELTA N +1.42733824759E-09
E...... +3.85188730433E-03
M SUB O -6.49030800443E-01
I SUB O +3.04505839012E-01
I DOT.. -1.71326064446E-10
OMEGA.. -3.57246696483E-01
OMEGA O -1.05691832024E-01
OMG DOT -2.49644926952E-09
CRS.... +2.73125000000E+01
CRC.... +1.67843750000E+02
CUS.... +3.47912760847E-06
CUC.... +4.39337688800E-07
CIS.... -4.15028855816E-09
CIC.... -3.14236133689E-08
CONFIG. 1
URA.... 7
ALERT.. 0
FITINVL 0
HEALTH. 000
H TIME. FRI 141 21-MAY-93 11:59:52
LASTUSE FRI 141 21-MAY-93 12:09:00



ALMANAC
AWN.... 698  DECODED FRI 141 21-MAY-93 15:25:23
TOA.... +1.18784000000E+05
SQRT A. +5.15353662109E+03
E...... +3.86285781860E-03
M SUB O +7.39949941635E-01
I SUB O +3.04470825195E-01
OMEGA.. -3.57763051986E-01
OMEGA O -1.44639611244E-01
OMG DOT -2.48837750405E-09
MESSAGE "                       "
```

Figure B-1. A Broadcast Data Printout

Table B-1. Broadcast Data Printout, Notes

Field	Description
TOW	Time of week of the start of the ephemeris transmission, in seconds, derived from the Z-count.
CUS, CUC, CIC, CIS	All are measured in semicircles, not radians.
HEALTH	Most recently decoded health data from any source.
H TIME	Time that the last health data was collected.
LASTUSE	Time that the receiver last locked on this satellite.
MESSAGE	Most recently decoded ASCII special message from any satellite.

B.1.2 Ionospheric & UTC Data

Prints the most recently decoded parameters for the basic ionospheric delay model, and for the conversion from GPS system time to Universal Time Coordinated (UTC). The record format is similar to that of the *Eph/Ion/UTC Data* printout; see the *Model 4000 Remote Control Interface* for a description of that printout's record format. Refer to *NAVSTAR GPS Space Segment* (ICD-GPS-200) for detailed description of the ionospheric and UTC parameters and their uses.

To use. At the PRINT/PLOT screen, press the type-of-printout CHANGE softkey until IONOSPHERIC & UTC DATA appears.

```
PRINT/PLOT:    ON PORT [ 1 ]  <-- CHANGE
      IONOSPHERIC & UTC DATA  <-- CHANGE

                               **PRINT**
```

Press the PRINT softkey.

Figure B-2 shows a sample printout.

```
IONOSPHERIC AND UTC DATA
AWN..... 0698  DECODED FRI 141 21-MAY-93 15:21:22
ALPHA0. +1.02445483207E-08
ALPHA1. +2.23517417907E-08
ALPHA2. -5.96046447753E-08
ALPHA3. -1.19209289550E-07
BETA0.. +9.62560000000E+04
BETA1.. +1.31072000000E+05
BETA2.. -6.55360000000E+04
BETA3.. -5.89824000000E+05

A0..... -1.58324837684E-08
A1..... +1.86517468137E-14
T SUBOT +1.18784000000E+05
D TLS.. +08
D TLSF. +09
WN SUBT 186
WN LSF. 191
DAY NUM 4
```

Figure B-2. An Ionospheric and UTC Data Printout

B.1.3 Satellite Elevation Plot

Prints a graph of the elevation and azimuth of a selected satellite versus time for any UTC day.

To use. At the PRINT/PLOT screen, press the type-of-printout CHANGE softkey until SATELLITE ELEVATION PLOT appears.

```
PRINT/PLOT:    ON PORT [ 2 ]  <-- CHANGE
    SATELLITE ELEVATION PLOT  <-- CHANGE
    04-05(MAY)-93   FOR SV01  <--NEXT SV
                               **PRINT**
```

Enter the date for which a printout is wanted.

- The format of the date is *day*--*month*--*year.*
- The default is today's UTC date.

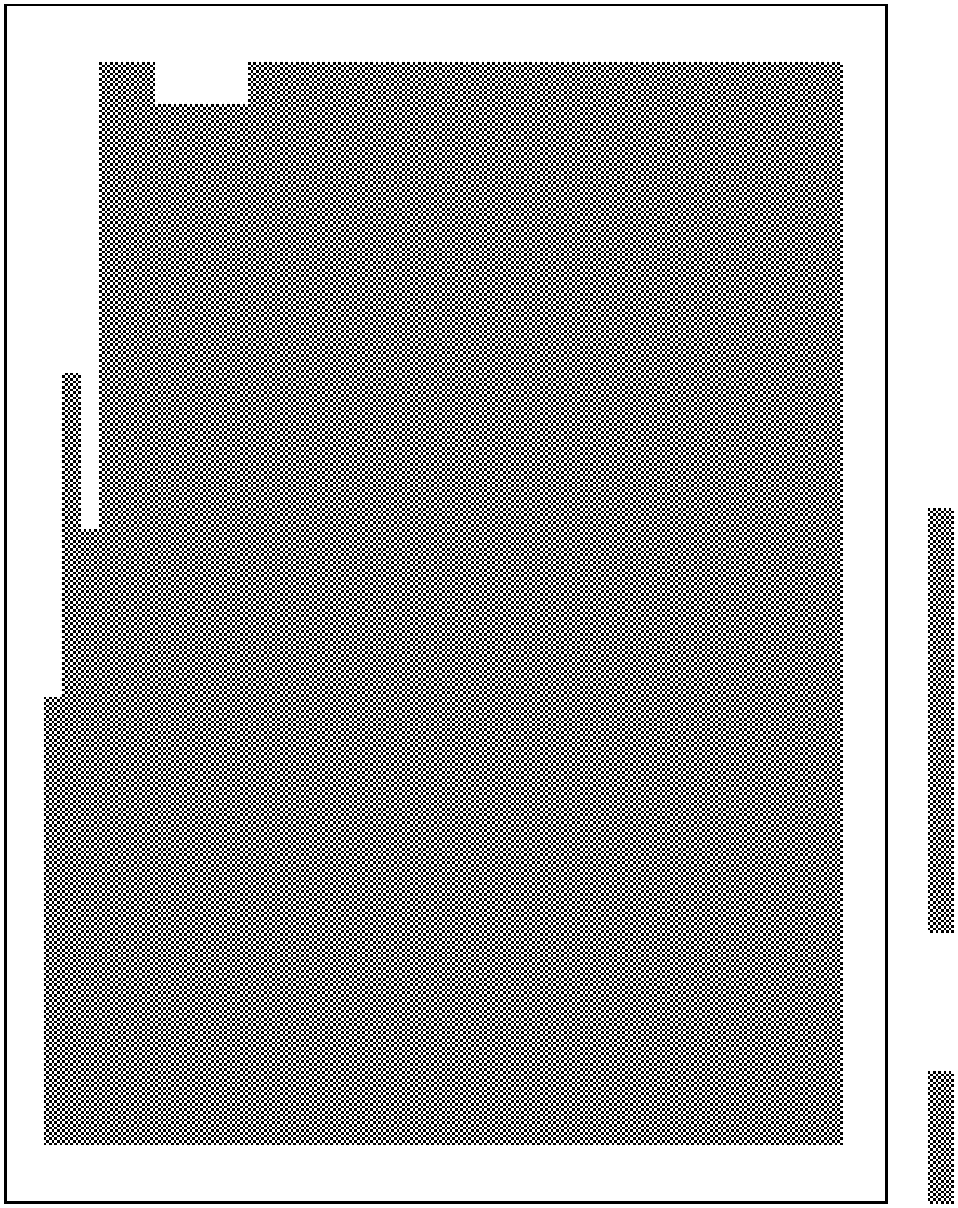
- Calculations for dates in the distant past or future are based on the most recently received orbital descriptions, and do not take into account any orbit shifts or degradations.

Press the NEXT SV softkey until the ID of the desired satellite appears. Then press the PRINT softkey.

Changing the viewing location. The receiver uses its most recently determined position as the location for which the plot is produced. This is the same as the position displayed by the Status menu's POSITION screen.

To produce a printout for a different location, enter the location as the positioning reference position. Disconnect the antenna before changing the reference position to make the receiver use the reference position instead of its own position fix. Remember to reconnect the antenna after producing the printout.

The plot's time axis is labeled in both UTC time and in local time as defined by the *Control* menu's ADJUST LOCAL TIME item. The resolution is four points per hour. At each point where the satellite is above the horizon, it is plotted with an asterisk (a '*') marking elevation in degrees, and a three-digit azimuth value. A dotted line corresponds to the currently set elevation mask.



B.1.4 Schedule Plot for All Satellites

Prints a graph of satellite visibility versus time for all known satellites over any UTC day.

To use. At the PRINT/PLOT screen, press the type-of-printout CHANGE softkey until SCHEDULE PLOT FOR ALL SATS appears.

```
PRINT/PLOT:    ON PORT [ 1 ]  <-- CHANGE
  SCHEDULE PLOT FOR ALL SATS  <-- CHANGE
    04-05(MAY)-93
                               **PRINT**
```

Enter the date for which a printout is wanted. All of the comments for the date in the Satellite Elevation Plot, above, apply here.

Press the PRINT softkey to produce the printout.

Changing the viewing location. The receiver uses its most recently determined position as the location for which the plot is produced. As for the Satellite Elevation Plot, the positioning reference position may also be used.

Changing the elevation mask. To change the elevation mask, use the *Control* menu's MASKS/SYNC TIME screen. For more information, see the section Masks/Sync Time in Chapter 5. Remember that a change to the elevation mask affects all of the receiver's operations, not just this printout.

The plot's time axis is labeled in both UTC and local time as defined by the *Control* menu's ADJUST LOCAL TIME item. The time resolution is four points per hour. Each column represents one satellite.

For each time interval, every satellite's elevation is checked. If a satellite is above the elevation mask, its two-digit PRN number is printed in the appropriate column. If the satellite is below the mask but above the horizon, four dots (‘ :: ’) are printed. If the satellite is below the horizon, the satellite's column is blank.

```
      |SCHEDULE PLOT
L   U |LAT 37:23.5054N  LON 122:02.2763W  ELEVATION MASK  +05 degrees
O   T |JULIAN DAY 140 - THU/20/MAY/1993 - GPS WEEK 0697
C   C |
17  00|-------03----12-13-------16----------20----------24------------------
      |       03    12 13       16          20          24 ::
      |       03    12 13       16          20          24 ::
      |       03    12 ::       16 ::       20          24 ::
18  01|-------03----12-::-------16-::-------20----------24-::---------------
      |       03    12 ::       16 17       20          24 25
      |       03    12          16 17       20          24 25
      |       03    ::          16 17       20          24 25
19  02|-------03----::----------16-17-------20----------24-25---------------
      |       03                16 17       20          24 25 ::
      |       03                16 17       20    :: :: 24 :: ::
      |       03                16 17       20    :: :: :: :: ::
20  03|-------03----------------16-17-------20----::-::-::-::-::------------
      |       03                16 17       20    :: 23    :: ::
      |       03                16 17       20    :: 23       26
      |       03                16 17       20 :: 22 23       26
21  04|-------03----------------16-17-------::-::-22-23-------26------------
      |       03                :: 17       :: 21 22 23       26    ::
      |       03                :: 17       :: 21 22 23       26    ::
      |       03                   17          21 22 23       26    ::
22  05|-------03-------------------17----------21-22-23-------26----28------
      |       03                   17          21 22 23       26    28
      | ::    03                   17          21 22 23       26    28
      | ::    03                   17          21 :: 23       26    28    ::
23  06|-01----03-::----------------17----------21-::-23-------::----28----::
      | 01    03 ::                17          21 :: 23       ::    28    ::
      | 01    03 ::                17          21 :: 23       ::    28    31
      | 01    03 11                17          21 :: 23       ::    28    31
00  07|-01----::-11-::-------------17----------21----23-------------28----31
      | 01    :: 11 ::             17          21    23             28    31
      | 01       11 12             17          21    23             28    31
      | 01       11 12       ::    17          21    23    ::       28    31
01  08|-01-------11-12-------::----17----------21----23----::-------28----31
      | 01       11 12       15    17          21    23    25       28    31
```

Figure B-4. A Part of a Schedule Plot for All Satellites

B.1.5 Receiver Setup Info

Prints a description of the receiver, its characteristics, its control settings, etc.

To use. At the *PRINT/PLOT* screen, press the type-of-printout CHANGE softkey until RECEIVER SETUP INFO appears.

```
PRINT/PLOT:    ON PORT [ 1 ]  <-- CHANGE
          RECEIVER SETUP INFO  <-- CHANGE

                                **PRINT**
```

Then press the PRINT softkey.

The receiver also produces this printout one time when you enable the POSITION CALCULATIONS or POSITION TYPE 2 cycle printout in ASCII format.

```
TRIMBLE NAVIGATION 4000 RS -  SERIAL NUMBER    3252A02142
  TRIMBLE NAVIGATION
 SUNNYVALE CALIFORNIA
SOFTWARE REVS: NAV-5.66 23/JUL/93  SIG-1.23 24/FEB/93  BOOT-3.30 14/JUL/92
CHANNELS INSTALLED: 09 L1 ONLY    INTERNAL MEMORY: 0512 KBYTES

NUMBER OF RS232 PORTS: 2
CARRIER PHASE PROCESSING: INSTALLED
KINEMATIC MODE: UNAVAILABLE
NMEA OUTPUTS: INSTALLED
RTCM 104 VERSION 1 INPUTS: INSTALLED
RTCM 104 VERSION 2 INPUTS: INSTALLED
RTCM 104 VERSION 1 OUTPUTS: INSTALLED
RTCM 104 VERSION 2 OUTPUTS: INSTALLED
NAVIGATION OPTION: INSTALLED
RTCM NETWORK OPERATION:UNAVAILABLE
POSITION STATISTICS:INSTALLED
TAILBUOY OPERATION:UNAVAILABLE
RTK1 OPERATION:INSTALLED
IONO-FREE POSITIONING:UNAVAILABLE
FASTEST MEASUREMENT RATE: .5 SECONDS
FIRMWARE UPGRADES: UNAVAILABLE
EVENT MARKER INPUT: INSTALLED
ONE PULSE PER SECOND OUTPUT: INSTALLED
EXTERNAL TIMEBASE: INSTALLED AND OFF
COCOM ALTITUDE/SPEED LIMITS: INSTALLED
REMOTE DOWNLOAD: UNAVAILABLE

REFERENCE POSITION: 37:23.5314587N 122:02.2666514W +0128 meters
ELEVATION MASK: +00 degrees   PDOP mask: 07.0    SYNC TIME: 001.0 secs
DISABLED SVS: NONE
IGNORE HEALTH (POSITIONING) SVS: NONE
IGNORE HEALTH (SURVEY) SVS: NONE
POSITION FIX MODES:
    LAT/LON/HEIGHT
    LAT/LON USING FIXED HEIGHT

JULIAN DAY 140 - THU/20/MAY/1993 - GPS WEEK 0697
```

Figure B-5. A Receiver Setup Info Printout

B.2 Cycle Printouts

Note – Available only with the Two or Four Serial Port Option.

The *Control* menu's CYCLE PRINTOUTS screen controls the generation of the following types of cycle printouts. For details about how to use this screen, see the section Cycle Printouts in Chapter 5.

- *Position Calculations:* Information about the position fixes that a differential or autonomous station produces every measurement cycle.
- *Navigation Calculations* (ASCII format only): Information about the results of the navigation calculations for the selected waypoints.
- *Raw Measurements:* Unprocessed satellite data.
- *Nav Display Unit* (ASCII format only): Data required to drive a Trimble Navigation Display Unit. The format and contents are the same as for the Position Calculations.
- *Compact Measurements* (binary format only): Satellite data in a compact format for efficient transfer to a computer.
- *Eph/Ion/UTC Data:* The ephemeris, ionospheric, and UTC data transmitted from the SVs.
- *Position Quality Stats:* Sigma values; estimates of error in position fixes. Available only with QA/QC Option.
- *Raw L1 Data Message* (binary format only): Raw L1 measurement data for each SV.
- *Position Type 2:* Very similar to *Position Calculations:* Unneeded characters are omitted to make room for higher precision coordinates.

- *Navigation Type 2* (ASCII format only): Very similar to *Navigation Calculations*. Unneeded characters are omitted to make room for higher precision coordinates.
- *Local Datum/Zone Pos* (ASCII format only): Position fixes computed with the local datum.
- *RT Survey Data* (binary format only): Survey data, in the same format as a downloaded .DAT file.

Two formats for cycle printouts. Many of the cycle printouts can be produced in either of two formats, ASCII and BINARY.

- ASCII format is suitable for printing on a 128-column printer, or for input to computer programs that can only handle printable data. Each line of the printout is terminated by a *carriage return, linefeed* sequence. The following sections illustrate and explain each cycle printout's ASCII format.
- Binary format is meant to send data to a computer or data storage device in a compact form. For specific information about binary formats, see the *Model 4000 Remote Control Interface.*

Note – Some of the cycle printouts produce very long records. The examples wrap such records onto two or more lines, like this:

```
[00 SUN 150 30-MAY-93 21:38:24 37:21.4235N
   122:01.6311W -0007 03.3 462910 +000.00 000.38
   194.4 -3.7709E-07 0050 3 12,13,24]
[00 SUN 150 30-MAY-93 21:38:25 37:21.4234N
   122:01.6312W -0007 03.3 462533 +000.00 000.36
   190.0 -3.7734E-07 0051 3 12,13,24]
```

An indented line in an example is a continuation of the preceding line.

B.2.1 How to Read the Format Tables

Each ASCII format printout is described in a table with two columns, *Field Name* and *Description.* These should be self-explanatory.

Each binary format printout is described in a table with three columns, *Field Name, Format, and Description.* The *Field Name* and *Description* columns should be self explanatory. The *Format* column contains a letter and a number, such as 'N 4'. The letter specifies the type of data in the field, and the number is the field's length in bytes. The letter may be:

- B: Code or bit field.
- C: Character (alphanumeric) data.
- F: Floating point number in IEEE-754 format. To convert to the format used in DOS programs, see the *Model 4000 Remote Control Interface Operation Manual.*
- I: Signed integer in Motorola format (high-order byte first). To convert to Intel format (used in DOS programs), reverse the order of the bytes.
- N: Unsigned integer in Motorola format.
- *None:* Entry represents a group of fields. See the *Description* column for details.

A *Format* like '8 * N 4' means, "eight fields with format N 4."

lsb, meaning ofIn the description of an integer field, the abbreviation *lsb* means "least significant bit." The text identifies the units that apply to the value. For example, "lsb = 1 cm" means "the least significant bit of the value represents 1 cm." In other words, a value of 1 represents 1 cm, 2 represents 2 cm, etc. For another example, "lsb = 0.2 cm" means "the least significant bit represents 0.2 cm." In other words, a value of 1 represents 0.2 cm, 2 represents 0.4 cm, etc.

B.2.2 Position Calculations

Contains information about the position fixes that a differential or autonomous station produces every measurement cycle.

When you enable this cycle printout the receiver produces a setup printout that describes how the receiver is configured and how the controls are set. The receiver then begins generating the cycle printout.

Figure B-6 shows an example of a *Position Calculations* printout in ASCII format. The printout contains two types of record groups: position records and satellite status records. The printout presents a group of ten position records (representing position fixes from ten consecutive cycles), then a group of satellite status records containing one record for each satellite being tracked, then another group of ten position records, and so forth. Each group of records is preceded by a title line that describes the columns in that group.

Each position record is enclosed in square brackets ('[' and ']'). A computer program can use the brackets to identify position records. Between the brackets are the fields described in Table B-2.

The format of a satellite status record in ASCII format is described in Table B-3.

The format of the printout in binary format is described in the *Model 4000 Remote Control Interface Operation Manual.*

```
TRIMBLE NAVIGATION 4000 RS GEODETIC SURVEYOR -  SERIAL NUMBER    3252A02146
  TRIMBLE NAVIGATION
 SUNNYVALE CALIFORNIA
SOFTWARE REVS: NAV-5.66 23/JUL/93  SIG-1.23 24/FEB/93  BOOT-3.30 14/JUL/92
CHANNELS INSTALLED: 09 L1 ONLY    INTERNAL MEMORY: 0512 KBYTES

NUMBER OF RS232 PORTS: 4
CARRIER PHASE PROCESSING: INSTALLED
KINEMATIC MODE: INSTALLED
NMEA OUTPUTS: INSTALLED
RTCM 104 VERSION 1 INPUTS: INSTALLED
RTCM 104 VERSION 2 INPUTS: INSTALLED
RTCM 104 VERSION 1 OUTPUTS: INSTALLED
RTCM 104 VERSION 2 OUTPUTS: INSTALLED
NAVIGATION OPTION: INSTALLED
RTCM NETWORK OPERATION:UNAVAILABLE
POSITION STATISTICS:INSTALLED
TAILBUOY OPERATION:UNAVAILABLE
DGPS+ OPERATION:UNAVAILABLE
IONO-FREE POSITIONING:UNAVAILABLE
FASTEST MEASUREMENT RATE: .5 SECONDS
FIRMWARE UPGRADES: INSTALLED
EVENT MARKER INPUT: UNAVAILABLE
ONE PULSE PER SECOND OUTPUT: INSTALLED
EXTERNAL TIMEBASE: UNAVAILABLE
COCOM ALTITUDE/SPEED LIMITS: INSTALLED
REMOTE DOWNLOAD: UNAVAILABLE

REFERENCE POSITION: 37:23.4727805N 122:02.2437615W -0007 meters
ELEVATION MASK: +00 degrees    PDOP MASK: 07.0    SYNC TIME: 001.0 secs
DISABLED SVS: NONE
IGNORE HEALTH (POSITIONING) SVS: NONE
IGNORE HEALTH (SURVEY) SVS: NONE
POSITION FIX MODES:
    LAT/LON/HEIGHT
    LAT/LON USING FIXED HEIGHT

JULIAN DAY 150 - SUN/30/MAY/1993 - GPS WEEK 0699

 ID DAY DOY   DATE      TIME    LATITUDE    LONGITUDE    HGT  PDOP CLOCK
V.VEL  H.VEL   HDG  FREQ.OFFSET CONT S  SVS
[00 SUN 150 30-MAY-93 21:38:24 37:21.4235N 122:01.6311W -0007 03.3 462910
+000.00 000.38 194.4 -3.7709E-07 0050 3 12,13,24]
[00 SUN 150 30-MAY-93 21:38:25 37:21.4234N 122:01.6312W -0007 03.3 462533
+000.00 000.36 190.0 -3.7734E-07 0051 3 12,13,24]
[00 SUN 150 30-MAY-93 21:38:34 37:21.4225N 122:01.6313W -0007 03.3 459134
+000.00 000.43 189.1 -3.7815E-07 0059 3 12,13,24]
SV EL AZM SN IODC CONT  GPS.TIME
07 57 036 11 0018 0059 +077922.000
24 47 171 11 0421 0059 +077922.000
```

Figure B-6. A Position Calculations Cycle Printout

Table B-2. *Position Calculations* Position Record, ASCII Format

Field Name	Description
ID	Dummy two-digit field, included for compatibility with earlier 4000A/S receivers. Always sent as ‘00’.
DAY DOY DATE TIME	Date and time when the position fix was made. DAY is day of week. DOY is the Julian day of year. DATE is the date in *dd*-*mm*-*yy* format. TIME is the time of day in *hh*:*mm*:*ss* format. Note that if it is not possible to do a position fix the receiver will continue to print once per cycle, although the position and the time fields will not change. If a “clock-only fix” is possible, then the *clock* and FREQ. OFFSET values will change.
d	A single character appears between the TIME and LATITUDE fields to indicate the type of positions being computed. There is no space on either side of the letter. Possible values are: d: The receiver is operating as a DGPS rover, and is receiving and applying RTCM differential corrections. f: The receiver is operating as an RTK rover, and is computing *Float* solutions. i: The receiver is operating as an RTK rover, and is computing *Fixed* (integer) solutions. *blank:* The receiver is computing autonomous positions.
LATITUDE LONGITUDE HGT	Results of the most recent position fix. LATITUDE and LONGITUDE are formatted in degrees, minutes, and decimal fractions of minutes, regardless of how the receiver is configured to format coordinates in screens. HGT is height in meters above the WGS-84 ellipsoid.
PDOP	Position dilution of precision, associated with the most recent position.

Table B-2. *Position Calculations* Position Record, ASCII Format

Field Name	Description
CLOCK	Clock offset in nanoseconds; the difference between the receiver's internal clock and the calculated GPS system clock. The range is 0 to 999,999. There is no “correct” value. The number will drift from measurement to measurement at a rate that depends on the accuracy of the receiver's timebase.
V.VEL H.VEL HDG	The receiver's vertical velocity and horizontal velocity in knots, and its surface heading in degrees relative to true north.
FREQ. OFFSET	The calculated relative error in the receiver's timebase. 1.0000E-6 implies that the receiver's clock is 1 ppm low.
CONT S SVS	Information about the type of position fix, which satellites were used, and how much smoothing the integrated Doppler system did. CONT is the minimum number of cycles (over all satellites used in the position fix) that have passed without a loss of lock. S indicates the type of position fix: 4 = lat/lon/height/clock (full solution).1 = height/clock with fixed lat/lon. 3 = lat/lon/clock with fixed height.0 = clock with fixed lat/lon/height. 2 = lat/lon with fixed height and clock. SVS shows the PRN numbers of the satellites which were used in the position fix. Note that since the receiver computes overdetermined solutions, more than four PRN numbers may appear. If SVS > 6, the CONT and S fields are suppressed to allow room for the satellite numbers. In this case, CONT can be deduced from the individual satellite data that is printed every tenth cycle. S can be deduced from the fact that with more than six satellites the receiver will use the most complete type of fix. In general, this implies S=4 (lat/lon/height/clock) unless the types of fix have been manually limited.

Table B-3. *Position Calculations* Satellite Status Record, ASCII Format

Field Name	Description
SV	The satellite's PRN number.
EL AZM	The satellite's current elevation and azimuth.
SN	The satellite's signal-to-noise ratio. The value's range is 4 to 40. 4-9 Weak signal. 10-19 Moderately strong signal. 20-29 Strong signal. 30-40 Very strong signal.
IODC	Issue of Data Clock of the most recently decoded ephemeris data from a satellite.
CONT	The number of continuous measurement cycles during which no loss of lock has occurred.
GPS.TIME	The time at which the most recent measurement on this satellite was made. The values should be the same for all satellites.

B.2.3 Navigation Calculations

Note – Available only with the Navigation Package Option.

Contains information about the results of the navigation calculations.

Figure B-7 shows an example of a *Navigation Calculations* printout in ASCII format (the only format available).

The printout contains just one type of record, shown in Table B-4. The title line is repeated after every ten records.

```
 DATE     TIME    LATITUDE    LONGITUDE  HEIGHT SPEED HDG CLMB    LEG    RANGE BRG  XTE
21MAY93 15:24:19d37:23.4564N 122:02.2692W -43.4 000.0 359 +0.0 WP00>WP01 0.238 163 0.003R
21MAY93 15:24:20d37:23.4564N 122:02.2692W -43.5 000.0 000 -0.0 WP00>WP01 0.238 163 0.003R
21MAY93 15:24:21d37:23.4564N 122:02.2693W -43.5 000.0 330 -0.0 WP00>WP01 0.238 163 0.003R
21MAY93 15:24:22d37:23.4564N 122:02.2692W -43.6 000.0 270 -0.0 WP00>WP01 0.238 163 0.003R
21MAY93 15:24:23d37:23.4564N 122:02.2692W -43.6 000.0 021 -0.0 WP00>WP01 0.238 163 0.003R
21MAY93 15:24:24d37:23.4565N 122:02.2692W -43.6 000.0 321 +0.0 WP00>WP01 0.238 163 0.003R
```

Figure B-7. A Navigation Calculations Cycle Printout

Table B-4. *Navigation Calculations* Record, ASCII Format

Field Name	Description
DATE TIME	Date and time when the navigation results were calculated.
d, *, *or* blank	This character appears between the TIME and LATITUDE columns. ‘d’ indicates that the current position was produced using RTCM-104 differential corrections. ‘*’ indicates that the receiver was unable to produce a position fix, and the position data therefore is old. A blank indicates that the position fix is current, but was produced without RTCM-104 corrections.
LATITUDE LONGITUDE HEIGHT	The position of the receiver. Coordinates are in degrees, minutes, and a decimal fraction of minutes. HEIGHT is in meters. The format of HEIGHT may change to fit the value into the five-character field.
SPEED HDG CLMB	The receiver's horizontal speed in meters per second, heading in degrees relative to true north, and rate of climb in meters per second. If the value of CLMB is greater than 9.9, the format will change to fit the value in a three-character field.
LEG	The course leg now being navigated, shown as an origin and a destination waypoint number. For example, ‘WP05>WP03’ represents a course leg from waypoint 05 to waypoint 03.
RANGE BRG XTE	Range from position to end of leg in kilometers, bearing in degrees relative to true north, and cross-track error in kilometers. XTE is followed by an ‘L’ or an ‘R’ to indicate that the position is left or right of the leg. The formats of RANGE and XTE may change to fit the value in a five-character field.

B.2.4 Raw Measurements

Contains unprocessed satellite position data.

This "printout" is not suitable for printing, even in ASCII format, because the records are too long to fit on a line and there is no visual separation between fields. Therefore the record format is not shown or described here. See the description of the PRINT MEAS printout in the *Model 4000 Remote Control Interface* manual for details.

NAV Display Unit

Provides information to a Trimble Navigation Display Unit (NDU). An NDU attached to your receiver can display comprehensive navigation data, including waypoints, steering direction display, navigation alarms, distance and bearing calculations, etc.

This printout is available only in ASCII format. Its format is identical to that of the *Position Calculations* printout.

The NDU is no longer available; the message is provided for compatibility with existing units. The EchoXL Remote Display replaces the NDU, but it uses the NMEA-0183 messages for information.

B.2.5 Compact Measurements

Contains satellite data, including raw phase, raw code lane, Doppler shift, integrated Doppler, integrated Doppler epochs, SNR, and time tags.

This printout is intended to transfer measurement records to a computer or recording device in a minimum number of bytes. It is available only in binary format.

Each record has two primary components: framing information and satellite data. The format of a record is shown in Table B-5.

Table B-5. *Compact Measurements* Record, Binary Format

<table>
<tr><th>Field Names</th><th>Format</th><th>Description</th></tr>
<tr><td>STX</td><td>B1</td><td>"Start of tramsmission" code (0x02).</td></tr>
<tr><td></td><td>N1</td><td>Length of the code epoch and measurement data block, in bytes.</td></tr>
<tr><td>Message Tag</td><td>N1</td><td>Fixed value (0x01).</td></tr>
<tr><td>Code epoch</td><td>S4</td><td>lsb = 1 millisecond.</td></tr>
<tr><td>Measurement data block</td><td>s*17</td><td>Repeated s times for s satellites. The format of each block is:</td></tr>
<tr><td colspan="3">
<table>
<tr><th>Field Name</th><th>Format</th><th>Description</th></tr>
<tr><td>SV pseudorandom noise (PRN) number.</td><td>N 1</td><td></td></tr>
<tr><td>Code phase</td><td>N 3</td><td>lsb = 2 cm; e.g., 10 represents 20 cm. Range of values is 0-33,553,330 cm.</td></tr>
<tr><td>Code lane</td><td>N 1</td><td>lsb = 1 light-millisecond.</td></tr>
<tr><td>Doppler</td><td>I 3</td><td>lsb = 0.001 Hz; e.g., 10 represents 0.010 Hz.</td></tr>
<tr><td>Integrated Carrier</td><td>I 4</td><td>lsb = 0.5 cm; e.g., 10 represents 5.0 cm.</td></tr>
<tr><td>Continuous code epoch count</td><td>N 4</td><td></td></tr>
<tr><td>Signal-to-noise ratio (SNR)</td><td>N 1</td><td></td></tr>
</table>
</td></tr>
<tr><td>Checksum</td><td>N1</td><td>The two’s complement of the byte-wide sum of the message tag byte and measurement data block.</td></tr>
<tr><td>ETX</td><td>B1</td><td>"End of transmission" code (0x03).</td></tr>
</table>

B.2.6 Eph/Ion/UTC Data

Contains the ephemeris, ionospheric, and UTC data transmitted from the SVs.

This cycle printout is produced every five minutes rather than once per cycle. Its record format is very long, and so is not described here. It is identical to the *Raw Measurements* printout (see the description of the PRINT MEAS printout in the *Model 4000 Remote Control Interface Operation Manual*), except that it omits the last two sections of each message: the measurement and position data blocks.

B.2.7 Position Quality Stats

Note – Available only with the QA/QC Option.

Contains sigma values, which estimate the error in position fixes.

In ASCII format, this cycle printout uses the same basic layout as an NMEA-0183 message. It omits the asterisk (‘*’) and checksum customarily found at the end of an NMEA-0183 message.

Each record consists of a fixed number of fields separated by commas. One or more spaces may appear after each comma. The fields are described in Table B-6.

Here is an example of a record:

```
$PTNL,QA,152545, 0.41, 0.45, 0.81, 0.00,3.47, 0.45,
0.41,179.80,1,1
```

Table B-6. Position Quality Stats Record, ASCII Format

Field	Description
1	Fixed text '$PTNL' identifies type of record. (Position Quality Stats follows the format of an NMEA-0183 record.)
2	UTC time of position fix in hours, minutes, & seconds.
3-5	Sigma values for longitude (east is positive, west is negative), latitude (north is positive, south is negative), and height. All values are in meters, with range 0 to 999.9.
6	Covariance between sigma values for longitude (field 4) and latitude (field 3); range −999.9 to +999.9.
7	The value of UNIT, a measure of the probable relationship between the sigma values and the actual error; range 0 to 999.9. Meaningful only if field 11 is non-zero. For more information, see "Position," on page 43.
8-9	Semi-major and semi-minor axes of error ellipse, in meters.
10	Orientation of semimajor axis of error ellipse, in degrees clockwise from true north.
11	1: Position solution is overdetermined; UNIT (field 7) is meaningful. 0: Position solution is not overdetermined.
12	0: Position determined by absolute positioning. 1: Position determined by differential correction.

This message's binary format is described in Table B-7.

Table B-7. Position Quality Stats Record, Binary Format

Field Name	Format	Description
STX	B 1	"Start of transmission" code (0x02).
Status	N 1	Receiver status indicator; value is not significant.
Message ID	B 1	Fixed (0x47).
Length	N 1	Number of bytes from the next field through the end of the last data block. Equal to 27+6*s,* where *s* is the number of satellites in this message.
GPS time tag	N 4	lsb = 1 second.
	B 1	Starting with the most significant bit:

Field Name	Bit	Description
	7	Reserved.
	6	set → Position solution was weighted.
	5	set → Differential correction in use.
	4	set → Overdetermined solution.
	0-3	Number of satellites in use (an unsigned number).

Field Name	Format	Description
PDOP	N 2	lsb = 0.1; *e.g.,* 56 represents a PDOP of 5.6.
HDOP	N 2	lsb = 0.1.
VDOP	N 2	lsb = 0.1.
Longitude sigma	N 2	lsb = 10 cm; *e.g.,* 10 represents 1 meter.
Latitude sigma	N 2	lsb = 10 cm.
Height sigma	N 2	lsb = 10 cm.
	N 2	Semi-major axis of error ellipse, lsb = 1 meter.
	N 2	Semi-minor axis of error ellipse, lsb = 1 meter.
	N 2	Orientation of semimajor axis of error ellipse; lsb = 0.1×, measured clockwise from true north; *e.g.,* 900 represents due east (90×).

Table B-7. Position Quality Stats Record, Binary Format (Continued)

Field Name	Format	Description
SV data block	*s* * 6	One block for each satellite in the message. At present the data blocks contain no meaningful data.
Checksum	N 1	The sum of the bytes from *Status* through the end of the last SV data block, modulo 256.
ETX	B 1	“End of transmission” code (0x03).

B.2.8 Raw L1 Data Message

Contains the raw L1 measurement data for each SV.

This cycle printout is available in binary format only. The format is shown in Table B-8.

Table B-8. Raw L1 Data Record, Binary Format

Field Name	Format	Description
STX	B 1	“Start of transmission” code (0x02).
Status	N 1	Receiver status indicator.
Message ID	B 1	Fixed (0xB0).
Length	N 1	Number of bytes from time of week through last SV data block. Equal to 9+20*s,* where *s* is the number of satellites in this message.
Time of week	N 4	lsb = 1 millisecond.
Clock offset	N 4	lsb = 2^{-7} meter; *e.g.,* 128 (2^{7}) represents 1 meter (2^{7} Þ 2^{-7} m = 1 m).
SVs	N 1	Number of satellites in this message (the value of *s*).
SV data blocks	s*20	Repeated *s* times for *s* satellites. See Table B-9 for details.
Checksum	N 1	The sum of the bytes from *Status* through the end of the last SV data block, modulo 256.
ETX	B 1	“End of transmission” code (0x03).

Table B-9. Raw L1 Data Record's SV Data Block, Binary Format

Field Name	Format	Description
SV ID	N 1	Satellite ID.
FLAG1	B 1	Starting with the most significant bit:
	Field Name	**Bit** — **Description**
	7	set → New position computed in this receiver cycle.
	6	set → L1 data loaded.
	5	Reserved.
	4	set → L1 phase valid (lock point valid).
	2-3	Reserved.
	1	set → L1 cycleslip since last message.
	0	Reserved.
FLAG2	1	Starting with the most significant bit:
	Field Name	**Bit** — Description
	4-7	Reserved.
	3	set → Filtered L1 pseudorange.
	1-2	Reserved.
	0	clear → L1 tracking C/A code.
Signal-to-noise ration (SNR)	N 1	lsb = 2^{-2}; *e.g.,* 16 represents 4 ($16x2^{-2} = 16/4 = 4$).
L1 C/A range	N 4	lsb = 2^{-7} meter; *e.g.,* 128 (2^7) represents 1 m (2^7x2^{-7} m = 1 m).
L1 Phase	F 8	lsb = one L1 wavelength; *e.g.,* 0.01 represents 1/100 of the length of an L1 wave.
Doppler	N 4	SV signal's Doppler shift. lsb = 2^{-6} Hz; *e.g.,* 64 represents 1 Hz (64×2^{-6} Hz = 1 Hz).

B.2.9 Position Type 2

Contains essentially the same information as *Position Calculations*. In ASCII format the position record layout is slightly different; unneeded characters are omitted to make room for higher-precision positioning information and more satellite IDs. The ASCII format setup and satellite information messages are the same as in the the Position Calculations printout, as are the binary formats for all messages.

Here is an example of the printout header and a position record:

```
  DATE     TIME      LATITUDE      LONGITUDE      HEIGHT   PDOP...
21MAY93 15:26:07d37:23.454333N 122:02.269493W -00046.453 01.6
  ...CLOCK   V.VEL  H.VEL   HDG  FREQ.OFFSET CONT S SVS
     447984 -000.05 000.00 000.0 -5.1645E-07 0868 4 19,28,14,18,27
```

B.2.10Navigation Type 2

Contains nearly the same information as a *Navigation Calculations* record with a slight difference in the record format. Unneeded characters are omitted to make room for higher-precision positioning information.

Like *Navigation Calculations,* the *Navigation Type 2* cycle printout available only in ASCII format.

Here is an example of the printout header and a record:

```
DATE      TIME      LATITUDE      LONGITUDE      HEIGHT   SPEED HDG
    CLMB       LEG      RANGE BRG      XTE
21MAY93 15:26:44d37:23.454705N 122:02.269520W -00044.956 000.0 000
         -000.0 WP00>WP01 0.235 162 0.004R
```

B.2.11 Local Datum/Zone Pos

Contains position fixes computed with the local datum.

Each epoch of data consists of a group of five records, which contain:

1. *Time:* GPS time, PDOP, and related information.
2. *WGS84 Position:* LLH (latitude/longitude/height) position fix in the WGS-84 datum (the receiver's standard datum).
3. *Local Datum Position:* LLH position fix in the local datum.
4. *Local Zone Position:* NEH (northing/easting/height) position fix in the projection of the local datum.
5. Blank (a zero-length record); a visual separator between groups.

This cycle printout's records consist of unnamed, comma-delimited fields. Fields may be preceded and/or followed by spaces, which have no significance.

The formats of the non-blank records are shown in Table B-10. Following is an example of one set of records.

```
$PTNL,PJ0, Time, 19OCT93, 01:19:26.000, 177575.000, 719, 05.1, 000.23, 220.6
$PTNL,PJ1, Raw,   WGS84,  037:23'29.1295",N,122:02'17.2360",W, +00031.9,  SPH
$PTNL,PJ2, Datum, NAD 83, 037:23'29.1295",N,122:02'17.2360",W, +00031.9,  SPH
$PTNL,PJ3, Projn, CA 3,    N, +0600050.225,   E, +1863807.380, +00031.9,  SPH
```

Table B-10. Local Datum/Zone Pos, ASCII Format

Field number	Description
Initial Fields: All Records	
1	The fixed text '$PTNL'.
2	The fixed text 'PJ*n*', where *n* is the record type number: 1 (Time), 2 (WGS-84 Position), 3 (Local Datum Position), or 4 (Local Zone Position).
3	Type of record: 'Time' (1), 'Raw' (2), 'Datum' (3), or 'Zone' (4).
Data Fields: Time Record	
4-5	GPS date, in the form *ddmmmyy;* GPS time of day, in the form *hh:mm:ss.ttt.* (*ttt* represents thousandths of seconds, and is always 000.)
6-7	GPS time of week, in seconds; GPS week number.
8	PDOP.
9-10	Speed, in meters/second; true heading, in degrees.
Data Fields: WGS-84 Position Record and Local Datum Position Record	
4	Coordinate system name. For a WGS-84 Position record, 'WGS-84'. For a Local Datum Position record, the short name of the local datum.
5-6	Latitude in "degrees/minutes/seconds" format, and hemisphere ('N' or 'S'). See note on precision, below.
7-8	Longitude and hemisphere ('E' or 'W'). See note on precision.
9	Height in meters, always preceded by a sign. See note on precision.
10	Altitude reference: 'SPH' (ellipsoid) or 'MSL' (Mean Sea Level).
Note on precision: For positions computed autonomously, latitude and longitude are given to two decimal places of seconds, and height to one decimal place (±0.1 m). For positions computed with differential GPS or RTK, latitude and longitude are given to four decimal places of seconds, and height to three decimal places (±0.001 m).	

Table B-10. Local Datum/Zone Pos, ASCII Format (Continued)

Field number	Description
	Data Fields: Local Zone Position Record (if position is in zone)
4	Name of the local projection.
5-6	Direction ('N', for northing); northing in meters, always preceded by a sign. See note on precision, below
7-8	Direction ('E', for easting); easting in meters, always preceded by a sign. See note on precision.
9	Height in meters, always preceded by a sign. See note on precision.
10	Altitude reference: 'SPH' (ellipsoid) or 'MSL' (Mean Sea Level).
Note on precision: For positions computed autonomously, northing, easting, and height are given to one decimal place (±0.1 m). For positions computed with differential GPS or RTK, they are given to three decimal places (±0.001 m).	
	Data Fields: Local Projection Position Record (if position is out of zone)
4	The fixed text 'Check Zone'. *Note:* No further fields appear when the position is out of zone.

B.2.12RT Survey Data

Contains survey data in the same format as a downloaded .DAT file. Survey data consists chiefly of raw measurement data (.DAT file record 17); it may also contain position fix data (record 11) and ephemeris data (record 21), depending on parameter settings. In concise format, a compressed version of record 17 is used.

This cycle printout contains much of the same information as *Position Calculations* and *Raw Measurements*, but is a more efficient way of getting the data out of the receiver.

The formats of the records in this cycle printout are described in the *4000SE/SSE RS-232 Interface Data Collector Format Specifications Manual*. See the Bibliography for a full citation.

B.3 Other Per-Cycle Output

Three other groups of screens control types of output that are produced once per receiver cycle, the same as cycle printouts:

- Outgoing RTCM-104 messages, from the *Control* menu's RTCM-104 OUTPUT screen. (See the section RTCM-104 Output in Chapter 5.)
- Incoming RTCM-104 messages, from the *Control* menu's RTCM-104 INPUT screen. (See the section RTCM-104 Input in Chapter 5.)
- Outgoing NMEA-0183 messages containing real time information about position, course, and speed, from the *Control* menu's NMEA-183 OUTPUT item. (See the section NMEA Output in Chapter 5.)

B.3.1 RTCM-104 Input/Output

The RTCM-104 Input printout is available only with the RTCM-104 Input Option. The RTCM-104 Output printout is available only with the RTCM-104 Output Option.

The *RTCM-104 Input* printout contains selected fields from message types 1, 2, 3, and 16 in the incoming RTCM-104 message stream. Similarly, the *RTCM-104 Output* printout contains selected fields from the same message types in the outgoing RTCM-104 message stream. These two types of cycle printouts use the same format.

The procedure for controlling these printouts is unusual because the printout name does not appear as a parameter on any screen. To control these printouts, select the *Control* menu's RTCM-104 OUTPUT or RTCM-104 INPUT item, as appropriate. Then press the MORE softkey to display the *second* screen for the printout you chose. To enable or disable the printout, press the PRINTOUT. . . . CHANGE softkey.

In the ASCII format printout, each record is a decoded and scaled representation of an RTCM message. Records appear in four different formats, as shown in Figure B-8 and described in Table B-11, below.

Messages are formatted like NMEA-0183 messages, although they are not within the NMEA-0183 standard.

Type 1

Type	*Stn*	*Hlt*	*Zcnt*	*SV*	*Prc*	*Rrc*	*IOD*	*UDRE*	*Csum*
$DGPRC,	0,	0,	1185.0,	2,	-145.90,	-0.140,	125,	0,*	75
$DGPRC	0,	0,	1185.0,	13,	-43.66,	-0.062,	222,	0,*	7e
$DGPRC,	0,	0,	1185.0,	26,	-39.00,	0.030,	132,	0,*	7d

Type 2

Type	*Stn*	*Hlt*	*Zcnt*	*SV*	*dPrc*	*dRrc*	*IOD*	*UDRE*	*Csum*
$DGDDC,	0,	0,	1188.0,	2,	0.16,	0.000,	124,	2,*	72
$DGDDC,	0,	0,	1188.0,	13,	0.02,	0.000,	221,	1,*	62
$DGDDC,	0,	0,	1188.0,	26,	-1.32,	0.000,	113,	2,*	6a

Type 3

Type	*Stn*	*Hlt*	*Zcnt*	*X-Pos*	*Y-Pos*	*Z-Pos*	*Csum*
$DGREF,	0,	0,	1698.6,	-2691506.828,	-4301010.425,	3851969.412,	*49

Type 16

Type	*Stn*	*Hlt*	*Zcnt*	*Special message*	*Csum*
$DGASC,	0,	0,	1701.0,	TRIMBLE NAVIGATION,	*04

Figure B-8. RTCM-104 Input and Output

Table B-11. RTCM-104 Input and Output Record Formats

Field Name	Description
Type	'$DG': Marks beginning of new message. Rest of field: identifies message type: PRC: Pseudorange Correction (type 1 or 9). REF: Reference Station Position (type 3). DDC: Delta-Differential Correction (type 2). ASC: Special message (Type 16).
Stn	Reference station (base station) ID.
Hlt	Reference station (base station) health.
Zcnt	Z-count time tag.
SV	Satellite number.
DPRC	Pseudorange correction.
DRRC	Pseudorange rate correction.
IOD	Ephemeris issue number.
UDRE	User differential range error estimate.
X-Pos Y-Pos Z-Pos	X, Y, and Z coordinates.
Csum	Checksum; the exclusive *or* of the characters (bytes) between '$' and '*'. It is represented as two hexadecimal digits (in ASCII).

B.3.2 NMEA-0183

Note – Available only with the NMEA-0183 Output Option.

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

All messages conform to the NMEA-0183 Version 2.0 format. All begin with '$' and end with a carriage return and a line feed. Data fields follow ',' delimiters and are variable in length. Null fields still follow a ',' delimiter but contain no information.

The optional checksum field is the last field in a message and follows the '*' 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.

The supported messages are:

- ALM: GPS week number, SV health, and complete almanac data for one SV. One message per SV, up to a maximum of 32.
- BWC: Bearing and distance to waypoint (only with Navigation Package Option).
- GBS: SV fault detection with estimated bias statistics (only with QA/QC Option).
- GGA: Time, position, and fix related data.
- GLL: Position fix, time of position fix, and status.
- GRS: Range residuals for each SV (only with QA/QC Option).
- GSA: GPS receiver operating mode, SVs used for navigation and DOP values.
- GST: Pseudorange measurement noise statistics in the position domain (only with QA/QC Option).

- GSV: Number of SVs visible, PRN numbers, elevation, azimuth and SNR values.
- PTNL, DOP: DOP values and PDOP mask. A proprietary Trimble message.
- PTNL, TSN: SNR and differential status data. A proprietary Trimble message.
- PTNL, TSS: GPS positioning mode, PDOP and SVs used for positioning. A proprietary Trimble message.
- RMB: Navigation data from present position to a destination waypoint (only with Navigation Option).
- RMC: Time, date, position, course and speed data (only with Navigation Option).
- VTG: Actual track made good and speed over ground.
- WPL: Latitude and longitude of specified waypoints (only with Navigation Option).
- XTE: Cross-track error; magnitude of the position error perpendicular to the leg and the direction to steer to intersect the leg (only with Navigation Option).
- ZDA: UTC day, month, and year, and local time zone offset.

Common Message Elements

Fields and delimiters. Each message consists of:

- A message ID consisting of '$GP' followed by the message type. For example, the message ID of the ALM message is '$GPALM'.
- A comma.
- A number of fields that depends on the message type, separated by commas.

- An asterisk.
- A checksum.

Here is an example of a simple message with six fields plus the message ID and checksum:

```
$GPZDA,152145,21,05,1993,-7,00*50
```

Latitude. Latitude is represented as *ddmm.mmmm*. Longitude is always represented as *dddmm.mmmm*, where. Direction (north, south, east, or west) is presented in a separate field.

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

Direction. Direction is a single character: 'N', 'S', 'E', or 'W' for *North*, *South*, *East*, or *West.*

Time. Time values are in UTC, and are represented as *hhmmss*, where:

- *hh* is hours, from 00 to 23.
- *mm* is minutes.
- *ss* is seconds.

ALM: GPS week, SV health, & almanac for one satellite.

```
$GPALM,1,1,03,698,00,6ae6,1d,779f,fdef,a10d68,
  6469a6,7c1f62,5f5839,,*43
```

The fields are:

1. Total number of ALM messages for this cycle.
2. Message sequence number.
3. SV PRN number, 01 to 32.
4. GPS week number.
5. SV health status.
6. Eccentricity.

7. Almanac reference time.
8. Inclination angle.
9. Rate of right ascension.
10. Root of semi-major axis.
11. Argument of perigee.
12. Longitude of ascension node.
13. Mean anomaly.
14. A f0, clock parameter.
15. A f1, clock parameter.

BWC: Bearing and distance to waypoint (only with Navigation Package Option, and only when valid “from” and “to” waypoints are defined).

```
$GPBWC,151756,3723.3333,N,12202.2222,W,162,T,,,
  0.1262,N,0001*58
```

1. UTC of bearing fix.
2. Latitude of waypoint.
3. Direction of latitude (N or S).
4. Longitude of waypoint.
5. Direction of longitude (E or W).
6. Bearing to waypoint.
7. Fixed text ‘T’ shows that bearing is relative to true north.

8,9. Not used.

10. Distance to waypoint.
11. Fixed text ‘N’ shows that distance to waypoint is in nautical miles.
12. Waypoint ID number.

GBS: SV fault detection with estimated bias statistics (only with QA/QC Option).

```
$GPGBS,192537,,,,,,,*4A
```

This message is generated only with QA/QC Option.

1. UTC of the GGA fix associated with this sentence.
2. Expected error in latitude, noise = 0 meters.
3. Expected error in longitude, noise = 0 meters.
4. Expected error in altitude, noise = 0 meters.
5. Most likely failed SV PRN number.
6. Probability of missed detection for most likely failed SV.
7. Estimate of bias on most likely failed SV.
8. Standard deviation of bias estimate.

GGA: Time, position, and fix related data.

```
$GPGGA,151924,3723.454487,N,12202.269799,W,2,09,
  0.9,-17.49,M,-25.67,M,1,0000*57
```

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, 00–12.
8. HDOP.
9. Antenna height, MSL reference.

10. Fixed text ‘M’ shows that the unit of measure for altitude is meters.
11. Geoidal separation.
12. Fixed text ‘M’ shows that the unit of measure for geoidal separation is meters.
13. Age of differential GPS data record, Type 1. Null when DGPS not used.
14. Base station ID, 0000-1023.

GLL: Position fix, time of position fix, and status.

```
$GPGLL,3723.454333,N,12202.269667,W,151933,A*3E
```

1. Latitude.
2. Direction of latitude (‘N’ or ‘S’).
3. Longitude.
4. Direction of longitude, (‘E’ or ‘W’).
5. UTC of position.
6. Fixed text ‘A’ shows that data is valid.

GRS: Range residuals for each SV (only with QA/QC Option).

```
$GPGRS,192537,0,19.38,-1.95,0.65,1.48,-30.46,
  -24.15,19.96,,,,,*5D
```

This message type is available only with QA/QC Option.

1. UTC of the GGA fix associated with this sentence.
2. Mode:

   0: Residuals were used to calculate the position given in the matching GGA sentence (*a priori*).

   1: Residuals were recomputed after the GGA position was computed (preferred mode).

3-14. Range residuals for SVs used in the position solution. Order must match order of PRN numbers in GSA. When GRS is used GSA and GSV are generally required (null for unused fields).

GSA: GPS receiver operating mode, SVs used for navigation, and DOP values.

```
$GPGSA,A,3,19,28,14,18,27,22,31,29,,,,,1.7,1.0,
  1.3*35
```

1. Mode:
   M = Manual, forced to operate in 2D or 3D.
   A = Automatic, 3D/2D.
2. Mode:
   1 = Fix not available.
   2 = 2D.
   3 = 3D.

3-14. ID's of SVs used in position fix (null for unused fields).

15. PDOP.

16. HDOP.

17. VDOP.

GST: Pseudorange measurement noise statistics in the position domain (only with QA/QC Option).

```
$GPGST,192537,47.87,13.12,8.76,98.75,8.89,13.04,
  19.19*7A
```

This message type is available only with QA/QC Option.

1. UTC of GGA fix associated with this sentence.
2. RMS value of standard deviation of the range inputs to the navigation process. Range inputs include pseudoranges and DGPS corrections.
3. Standard deviation of semi-major axis of error ellipse (meters).
4. Standard deviation of semi-minor axis of error ellipse (meters).

5. Orientation of semi-major axis of error ellipse (degrees from true north).
6. Standard deviation of latitude error (meters).
7. Standard deviation of longitude error (meters).
8. Standard deviation of altitude error (meters).

GSV: Number of SVs in view, PRN numbers, elevation, azimuth & SNR values.

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

1. Total number of messages of this type in this cycle.
2. Message number.
3. Total number of SVs visible.
4. SV PRN number.
5. Elevation in degrees, 90½ maximum.
6. Azimuth, degrees from true north, 000½ to 359½.
7. SNR, 00-99 dB (null when not tracking).

8-11. Information about second SV, same format as fields 4-7.

12-15.Information about third SV, same format as fields 4-7.

16-19.Information about fourth SV, same format as fields 4-7.

PTNL, DOP: DOP values and PDOP mask.

```
$PTNL,DOP,1.4,0.9,1.1.0.7,7.0*7D
```

1. PDOP.
2. HDOP.
3. VDOP.
4. TDOP.
5. PDOP mask.

PTNL, TSN: SNR and differential status data.

```
$PTNL,TSN,09,19,22,28,12,14,7,18,32,27,14,22,11,16,
  5,31,10,29,24,1,0000*70
```

1. Total number of SVs visible.
2. SV PRN number.
3. SNR.

4-5; 6-7;...*n*-1,*n*. Same information as 2 & 3 for each SV visible.

n+1. Age of differential GPS data in seconds.

n+2. Base station ID, 0000-1023.

PTNL, TSS: GPS positioning mode, PDOP and SVs used for positioning.

```
$PTNL,TSS,A,3,08,19,28,14,18,27,22,31,29,1.7*2E
```

1. Mode:
   M = Manual, forced to operated in 2D or 3D.
   A = Automatic, 3D/2D.
2. Mode:
   2 = 2D.
   3 = 3D.
3. Number of SVs being used for positioning.
4. SV PRN number.

5-*n*. Remaining SV PRN numbers.

n+1. PDOP.

RMB: Navigation data from present position to a destination waypoint (only with Navigation Package Option).

```
$GPRMB,A,0.0028,L,0000,0001,3723.3333,N,12202.2222,
  W,0.1267,162,,*78
```

1. Data status:
   A = Data valid.
   V = Warning, data not reliable.
2. Cross track error, maximum 9.99 nautical miles.
3. Direction to steer, ‘L’ (left) or ‘R’ (right).
4. FROM waypoint ID.
5. TO waypoint ID.
6. TO waypoint latitude.
7. Direction of latitude (N or S).
8. TO waypoint longitude.
9. Direction of longitude (E or W).
10. Range to destination, nautical miles, maximum 999.9.
11. Bearing to destination in degrees relative to true north.
12. Destination closing velocity, knots.
13. Arrival status:
    A = Arrival circle entered or perpendicular passed.
    Null = Have not arrived.

RMC: Time, date, position, course and speed data (only with Navigation Package Option).

```
$GPRMC,152101,A,3723.454208,N,12202.269759,W,0.00,0,
  210593,,*24
```

1. UTC of position fix.
2. Status:
   A = Valid data.
   V = Warning, data not reliable.
3. Latitude of position fix.
4. Direction of latitude (N or S).
5. Longitude of position fix.

6. Direction of longitude (E or W).
7. Speed over ground, knots.
8. Track made good, degrees for true north.
9. Date, format *ddmmyy*.

10,11. Not used.

VTG: Actual track made good and speed over ground.

```
$GPVTG,0,T,,,0.00,N,0.00,K*33
```

1. Track made good.
2. Fixed text ‘T’ shows that track made good is relative to true north.

3-4. Not used.

5. Speed over ground in knots.
6. Fixed text ‘N’ shows that speed over ground is in knots.
7. Speed over ground in kilometers/hour.
8. Fixed text ‘K’ shows that speed over ground is in kilometers/hour.

WPL: Latitude and longitude of specified waypoints (only with Navigation Package Option).

```
$GPWPL,3723.3333,N,12202.2222,W,0001*5E
```

1. Waypoint latitude.
2. Direction of latitude (N or S).
3. Waypoint longitude.
4. Direction of longitude (E or W).
5. Waypoint ID number.

XTE: Cross-track error, distance to leg, and steering direction (only with Navigation Package Option, and only when valid “from” and “to” waypoints are defined).

```
$GPXTE,A,A,0.0023,L,N*6F
```

1. Status:
   A = Valid data.
   V = Warning, data not reliable.
2. Fixed text ‘A’.
3. Magnitude of cross-track error.
4. Direction to steer to intersect leg: ‘L’ for left or ‘R’ for right.
5. Fixed text ‘N’ shows that magnitude of cross-track error is in nautical miles.

ZDA: UTC day, month, and year, and local time zone offset.

```
$GPZDA,152145,21,05,1993,-7,00*50
```

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.

Glossary

This section defines technical terms and abbreviations used in Series 4000 documentation.

These definitions are oriented to the needs of Series 4000 users. Many have been simplified to exclude details that are not relevant to the Series 4000, or to reduce the amount of technical background required to understand them. For more formal definitions for many of these terms, see the glossary in the GPSurvey General Reference, listed in the Bibliography.

absolute positioning — See *Autonomous positioning.*

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 that is 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, etc.

alphanumeric mode — The receiver mode in which you can enter letters, numerals, and some punctuation marks into data fields. You can toggle the keypad between alphanumeric mode and numeric mode by pressing the ALPHA key, or the ALPHA/NUMERIC softkey (if it is available). See also *numeric mode.*

altitude reference — The datum used as a reference for height measurements. A Series 4000 receiver can be set to use either of two altitude references: the WGS-84 reference ellipsoid, or mean sea level (OSU 84).

Anti-Spoofing — 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. *Anti-Spoofing* is abbreviated *AS;* do not confuse it with Selective Availability (SA).

application — A class of tasks that a GPS receiver can be used to accomplish. Control surveying, topographic surveying, and navigation are examples of applications.

AS — See *Anti-Spoofing.*

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.*

auto-survey timer
A Series 4000 feature which allows a receiver to “sleep” until a session is scheduled to start, then wakes it up and runs the session. The auto-survey timer allows an unattended receiver to run for long periods without exhausting its battery or filling up its memory with logged data.

azimuth
The angle between a point of reference and another point, as seen by an observer in a specified location. The Series 4000 uses *azimuth* to denote the angle true north and the bearing of a satellite or other celestial object relative to the observer. Abbreviated *AZM* or *AZMTH*.

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* in some procedures.

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 results of which GPS is capable.

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 “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, precise ephemeris.*

C/A code
See *Coarse/Acquisition code.*

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
A pseudorandom noise code (PRN) modulated onto a GPS satellite's L1 signal. This code helps the receiver compute its distance from the satellite. Usually abbreviated “C/A code.” See also *P-code.*

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* in some procedures.

Control Segment
That part of a GPS system which 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 survey.*

corrected antenna height The vertical distance from the antenna's phase center to the ground. Since the corrected antenna height is usually difficult to measure directly, Series 4000 receivers and postprocessing software can compute it from an uncorrected antenna height.

correction See *Pseudorange correction.*

cycle (1) One complete wave of a radio signal; 360½ 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.

cycle printout Any of a class of outputs that a Series 4000 receiver writes to a serial port periodically, in most cases once per cycle (per epoch). You can enable and disable each type of cycle printout from the *Control* menu. See also *One-Shot Printout.*

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.

data logging The process of recording satellite data in a file stored in the receiver's memory or on a computer's disk. See also *External data logging* and *Internal data logging.*

data logging parameters Any of several groups of parameters that affect the way a receiver logs data in different procedures. Quick-start parameters are used for quick-start static surveys; session parameters are stored in session definitions for use in preplanned static surveys; FastStatic parameters are used in FastStatic surveys; and so on. Each set of data logging parameters typically includes an elevation mask, a sync time, and the minimum number of SVs required for data to be logged. See also *Positioning parameters.*

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 generally 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* and *WGS-84.*
delta pseudorange correction	The difference between the PRC term from the current issue of the data ephemeris (IODE) and the previous issue. The dPRC allows DGPS rovers that have not acquired the new ephemeris to continue using the corrections. Abbreviated *dPRC.*
delta range rate correction	The difference between the range rate correction (RRC) from the current issue of the data ephemeris (IODE) and the previous issue. The dRRC allows DGPS rovers that have not acquired the new ephemeris to continue using the corrections. Abbreviated *dRRC.*
differential GPS	A positioning procedure that uses two receivers, a rover at an unknown location and a base station at a known, fixed location. The base station computes corrections based on the differences between its actual and observed ranges to the satellites being tracked. The coordinates of the unknown location can be computed with meter-level precision by applying these corrections to the satellite data received by the rover. Differential GPS is used for precision positioning, stakeout, navigation, and GIS data-acquisition applications. Abbreviated *DGPS.*
differential station	See *Rover.*

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.”
dPRC	See *Delta pseudorange correction.*
dRRC	See *Delta range rate correction.*
dual-frequency	Using both the L1 and L2 signals from GPS satellites. Used to describe Series 4000 receivers, antennas, procedures, etc. 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	A Cartesian coordinate system used for satellite positioning. Abbreviated *ECEF.* 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 0½ N, 0½E, 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 0½ N, 90½W. The WGS-84 datum is defined with reference to the ECEF coordinate system.
easting	See *NEH.*
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.

event mark A record of the occurrence of an event, such as the closing of a photogrammetric camera's shutter. A receiver can log an event mark containing the time of the event and an alphanumeric comment entered through the keypad to describe the event. An event can be triggered through the keypad or by an electrical signal input on one of the receiver's ports.

external data logging The process of recording observation data directly to a computer's disk. The data is transferred from the receiver to the computer as it is generated, through their respective serial ports.

FastStatic surveying A surveying procedure that produces precise results suitable for control surveys. FastStatic surveying can be somewhat less precise than static surveying, but requires substantially less time.

field notes	In Series 4000 terminology, alphanumeric notes entered in a data log file during the data logging process, which apply to the data logging session as a whole.
file	A collection of related data stored in a computer system or similar device. Computers customarily store files on magnetic disks. A receiver equipped with the Memory Option can log data in files stored in battery-powered random access memory (RAM) even when the receiver is turned off.
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 4000 receiver supports XON/XOFF flow control on all serial ports, and 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 4000.
GPS time	A measure of time used internally by the NAVSTAR 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. As of 15 July 1993, GPS time was 9 seconds ahead of UTC.
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." See also *Corrected antenna height* and *Uncorrected antenna height.*
HVEL	Horizontal velocity.
internal data logging	The process of recording data in a receiver's internal memory. Logged data must be downloaded to a computer's hard disk for postprocessing.
Issue of data ephemeris	A value identifying a version of an ephemeris. Abbreviated *IODE*.
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).

kinematic alarm An alarm that a receiver sounds during a kinematic or RTK surveying procedure if the procedure is interrupted by high PDOP or loss of satellite lock.

kinematic surveying A surveying procedure in which used primarily for topographic surveying. Kinematic surveying is an efficient means of conducting a topographic survey, but it is sensitive to high PDOP and loss of satellite lock. See also *Continuous kinematic surveying* and *Stop-and-go kinematic surveying.*

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 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. Often abbreviated LAT.

latitude/longitude/height A method of describing a position by its latitude and longitude on a datum. Abbreviated LLH. See also *Northing/easting/height.*

LCD Liquid crystal display.

leapfrog kinematic surveying A type of kinematic surveying in which the base station and rover trade roles during the survey. It can be used to conduct surveys over a larger region than can radial-arm surveying, in which a single stationary receiver retains the role of base station throughout. Leapfrog kinematic surveying is not described in this book.

LED Light-emitting diode.

LLH See *Latitude/longitude/height.*

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 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 0½ meridian and the plan that passes through the axis of rotation and the point of interest. Often abbreviated LON.

LON Longitude; an abbreviation used in receiver screens.

mark A place occupied by a receiver's GPS antenna during an observation. A mark is customarily "marked" before the survey is performed by a stake, a spot of paint, or other means. There are two types of marks: reference marks, whose coordinates are known, and survey marks, whose coordinates are to be determined. Some receiver screens refer to mark as *points* or as *stations.*

mark ID An eight-character code used to identify a mark in a FastStatic survey. Equivalent to a point ID in a kinematic survey.

mask See *Elevation Mask*, *PDOP Mask*.

mean sea level 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. GPS receivers use the OSU-84 reference to define mean sea level. Abbreviated *MSL*.

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.

NAV BEACON XL A fully automatic marine radio beacon sold by Trimble. It is designed to interface directly with a Series 4000 receiver. It receives differential GPS broadcasts conforming to the International Association of Lighthouse Authorities (IALA) and outputs data in RTCM SC-104 format.

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. Series 4000 receivers can provide navigation services with the differential GPS and RTK procedures, and with autonomous positioning.

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.

NEH See also *Northing/easting/height.*

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. Many Series 4000 receivers can output standard NMEA-0183 messages.

northing See *NEH.*

northing/easting/height 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. Abbreviated NEH. See also *LLH.*

numeric mode A receiver mode in which you can enter only numerals into data fields. You can toggle the keypad between alphanumeric mode and numeric mode by pressing the ALPHA key, or the ALPHA/NUMERIC softkey (if it is available). See also *alphanumeric mode.*

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.

occupation The period during which a receiver stays at a mark while making an observation.

one-shot printout Any of a class of outputs that a Series 4000 receiver produces on a serial port once, on demand. A one-shot printout is equivalent to what computer users call a *report.* See also *Cycle Printout.*

OSM2 Office Support Module 2, a power supply, battery charger, and interface device used with Trimble's portable receivers.

overdetermined solution A solution (a position fix) computed with tracking information from more than the minimum number of satellites required for that type of fix. A receiver can use the additional information to compute a position that is more accurate than would otherwise be possible.

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	See *Mark.*
point ID	An eight-character code used to identify a mark in a kinematic survey; equivalent to a mark ID in a FastStatic survey.
positioning mode	A mode which specifies the type of position fixes a receiver computes. The positioning modes are: auto 3D/2D, 3D, 2D, and 1D. The positioning mode and the number of available satellites determine the type of fix the receiver computes. A receiver's positioning mode does not determine whether it is logging position fixes.
positioning parameters	A group of data logging parameters used to compute DGPS corrections or position fixes in real time. Elevation mask, sync time, and reference position are maintained as positioning parameters. Series 4000 receivers maintain a set of positioning parameters through various screens in the *Control* menu. See also *Data logging parameters.*
postprocess	To process satellite data on a computer after it has been collected. Postprocessing programs compute baselines, positions, and other results. Trimble offers several postprocessing programs for use in various applications with data collected by various procedures.
power-up parameters	A group of parameters that a receiver can be configured to reset to their factory default values each time the receiver is powered up.
PRC	See *Pseudorange correction.*

precise ephemeris	A set of data that describes the exact position of a GPS satellite over a period of time in the past. See also *broadcast ephemeris, ephemeris.*
precise positioning service	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. Abbreviated *PPS.* 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). Series 4000 receivers use differential GPS to perform precision positioning with a precision of 1-5 meters.
preplanned survey	A static survey or other data logging session which is programmed into the receiver through the *Sessions* screens to start and stop data logging automatically. See also *Quickstart*.
primary function keys	Six keys in the lower right part of a Series 4000 receiver's keypad, which represent the receiver's six major functions. The primary function keys are STATUS, SAT INFO, CONTROL, SESSIONS, LOG DATA, and MODIFY.
printout	A set of data that a receiver writes to one of its serial ports. Printouts may be fed to a printer, or to some other device such a computer or navigational display. See also *One-Shot Printout, Cycle Printout.*

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.

procedure A well-defined series of steps for performing the operations required by an application. Static surveying, kinematic surveying, and differential GPS are examples of procedures.

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 4000 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.

pseudorange correction In the RTCM-104 message format, a unit of information that describes the error in a satellite's signal as calculated by a base station at a known point. Informally called a "correction." Corrections may be applied to satellite data collected by a DGPS rover to compute much more accurate position fixes. Corrections may be broadcast by radio for real time use, or logged for later use. Abbreviated *PRC*.

pseudostatic surveying	A surveying procedure that produces a moderately precise position fix from two occupations of the same mark, each lasting about ten minutes, separated by one to four hours. Pseudostatic surveying is an obsolete procedure, now largely replaced by kinematic surveying.
quickstart survey	A static survey or other data logging session which is run without first being scheduled through the *Sessions* screens. See also *Preplanned.*
quickstart parameters	A group of data logging parameters used to conduct a quickstart static survey. See also *Positioning parameters, Session parameters.*
radial-arm surveying	A type of surveying procedure in which a single base station remains at the same location throughout a survey, and all baselines are measured "radially" from that location.
range	The distance from a satellite to an observer.
range rate	The rate of change in a satellite's range.
range rate correction	A correction term that describes the change in a satellite's signal errors over time. Abbreviated *RRC.*
Real-Time Kinematic	See *RTK.*
receiver	As used in this manual, "receiver" usually refers to a Series 4000 GPS receiver. References to other types of receivers are qualified when confusion is possible—*e.g.,* "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 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 point See *Reference mark.*

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 receiver, 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.

RPDOP Relative PDOP; the normalized accumulated PDOP over a measurement interval. RPDOP is used as a guide to the adequacy of receiver observations during RTK measurements in *Static* mode.

RRC	See *Range rate correction.*
RTCM SC-104	A standard format for differential GPS corrections; used to transmit corrections from a base station to rovers. Known informally as “RTCM-104.” The name is a contraction of “Radio Technical Commission for Maritime Services, Special Committee 104,” the name of the group that defined the standard.
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. *RTK* is derived from the phrase “Real-Time Kinematic.”
SA	See *Selective Availability.*
Satellite datasatellite 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 — 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. Selective Availability is abbreviated *SA;* do not confuse it with Anti-Spoofing (AS). See also *Anti-Spoofing.*

session — (1) A data logging period with a start time, an observation time, an elevation mask, and a type of data to be logged (positions and/or satellite data). (2) Any of 30 descriptions of such data logging periods which you can define in the *Sessions* process, and can use to run preplanned surveys. (3) A period during which data is logged.

session parameters — A group of data logging parameters that are stored in a session definition for use in preplanned surveys. They include start and stop times, elevation mask, PDOP, sync time, minimum number of satellites required for data logging, and reference position. A Series 4000 receiver maintains one set of surveying parameters for each defined session, and one set each for each surveying procedure. See also *Positioning parameters, Quickstart parameters.*

***Sessions* procedure** — A procedure that defines a session (meaning 2). It is initiated by the [SESSIONS] key.

single-frequency — Using only the L1 carrier phase signal from GPS satellites. Used to describe receivers, antennas, procedures, etc. See also *Dual-frequency.*

SNR — A measure of a satellite's signal strength, expressed in arbitrary units. SNR is a contraction of “signal-to-noise ratio.”

softkey Any of four keys to the right of a receiver's LCD screen, whose functions depend on the screen being displayed. Each screen displays names for the softkey(s) that are meaningful in that context. Trimble documentation presents softkey names in small caps, like this: “the ACCEPT softkey.”

Space Segment The part of the NAVSTAR GPS system that operates in space, *i.e.*, the satellites. See also *Control Segment, User Segment.*

special controls A group of parameters defined by the *Sessions* procedure, which affect the way data is logged in a static survey or a non-survey data logging session.

stakeout A type of application in a GPS receiver is used to locate the points with specified sets of coordinates. The points are then marked (staked out) for later use. Stakeout is typically used to prepare a site for an engineering project.

standard positioning service 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. This term is abbreviated *SPS.* See also *precise positioning service.*

static surveying A surveying procedure that produces very precise results but requires long occupations, usually about an hour per survey mark. Because of its high precision, static surveying is especially suitable for conducting control surveys.

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.

station ID (1) An eight-character code used to identify a mark in a static survey; equivalent to a mark ID in a FastStatic survey. (2) In DGPS or RTK, an identifying number between 0000 and 1023 that is entered at the base station and transmitted in the RTCM corrections. DGPS and RTK rovers use the ID to distinguish one base station's transmissions from another's.

stop-and-go kinematic surveying A variety of kinematic surveying in which the rover stops at each survey mark for an observation that lasts about two minutes. See also *Continuous kinematic surveying.*

survey mark A mark whose coordinates are to be determined in the course of a survey. Also known in some procedures as a *survey point* or *survey station.*

survey point, survey station See *Survey mark.*

SV Space vehicle; specifically, a GPS satellite.

sync time A receiver parameter that determines the length of a cycle.

TDC1 See *Trimble Data Collector.*

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 4000 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 survey.*

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.

Trimble Data Collector Any of several handheld devices designed to control a roving receiver; also used for data management. It is required equipment for RTK surveying, and recommended for kinematic surveying. The types of Trimble Data Collectors suitable for use with Series 4000 receivers are the Survey Controller, the Seismic Controller, and the Asset Surveyor. Abbreviated *TDC1*.

UDRE See *User differential range error.*

uncorrected antenna height An antenna's height above the ground as measured according to a specified procedure, which varies with the type of antenna. In most cases the measurement is made diagonally from the mark to a designated point on the antenna's groundplane. Series 4000 receivers can compute an antenna's true (corrected) height from measurements of its uncorrected height.

URA An acronym for “User Range Accuracy”; 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 differential range error	A number that describes possible errors in RTCM-104 corrections according to definitions in the RTCM specifications. A DGPS base station assigns a UDRE value to the corrections it generates. Abbreviated *UDRE*.
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	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). Abbreviated *UTC.* 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.

Bibliography

Asset Surveyor Operation Manual, Trimble P/N 20891 (version 1.26, July 1993).
Asset Surveyor Quick Reference Card, Trimble P/N 20912 (July 1993).

Documentation for the Asset Surveyor, a handheld data collector used in GIS data acquisition.

DeltaNav QC System Operation Manual, Trimble P/N 21204-00 (revision B, 1993).

Gives instructions for using the DeltaNav QC System, a PC-based software product for doing real-time quality assurance and quality control (QA/QC) in a navigation system that contains a Series 4000 GPS receiver.

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

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

A Field Guidebook for Static Surveying, Trimble P/N 20390 (1991).
A Field Guidebook for Dynamic Surveying, Trimble P/N 20391 (1992).

These booklets review the principles of static and dynamic surveying, and describe the process of planning, preparing, and performing each type of survey. They concentrate on the surveying procedures themselves rather than the mechanics of configuring and operating equipment.

Guidebooks for additional surveying procedures are in development; consult your Trimble sales representative for current information.

4000MSK DGPS Reference Station Addendum to the Series 4000SSE User Guide (December 1993, no part number).

Model-specific information for the 4000MSK; a supplement to the *4000SSE User Guide*, below.

4000SSE User Guide, Trimble P/N 23863-00 (March 1994).

Model-specific information for the 4000SSE.

4000 SSi User Guide, Trimble P/N 26509-00 (February 1995).

Model specific information for the 4000SSi.

4000SE/SSE RS-232 Interface Data Collector Format Specifications Manual, Trimble P/N 22794-00 (revision B, January 1994).

Describes the Series 4000's Data Collector Compatible Protocol, used to communicate with Trimble handheld data loggers and to make receiver firmware updates. This manual is useful primarily to programmers.

General Reference for the GPS Pathfinder System, Trimble P/N 18470-00 (September 1992).

A reference manual for the PFINDER program as well as the Pathfinder receiver.

GIS Surveyor System Overview, Trimble P/N 22252-00 (1993).

A complete description of GIS data acquisition. Nominally written for the GIS System Surveyor, but applies to all Series 4000 receivers that can serve this application. Covers concepts, project planning, use of the Asset Surveyor, and associated computer software, as well as operation of the receiver itself.

GPLoad User Guide, Trimble P/N 24478-00 (February 1994).

A guide to the use of GPLoad, a computer program for transferring data between a computer and a Series 4000 receiver or data collector. Note that GPLoad is a component of GPSurvey, although it may also be run independently; this manual is for GPLoad run independently of GPSurvey. The *GPSurvey Software User's Guide* documents the use of GPLoad in the context of GPSurvey.

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.

GPSurvey General Reference, Trimble P/N 20827-00 (July 1992).
GPSurvey Software User's Guide, Volume I, Trimble P/N 20829-00 (July 1992).
GPSurvey Software User's Guide, Volume II, Trimble P/N 21067-00 (July 1992).

These manuals constitute the documentation for GPSurvey, a suite of Microsoft Windows applications and utilities for postprocessing static and FastStatic survey data. They include documentation for the GPSurvey utilities, one of which (QuickPlan) is also available as a separate product. They are sold as a set, together with *GPSurvey Release Notes,* as P/N 20484-01.

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.

Local Datum and Zones Option: Software Release Notes, Trimble P/N 23775-00 (1993).

Describes the concepts that underlie the Local Datum/Zones feature, and the DATM4000 program, which is used to download a specific local datum and local zone definition to a receiver.

Model 4000 Remote Control Interface Operation Manual, Trimble P/N 12693 (revision D, April 1990).

Describes the Series 4000's Remote Control Interface, which allows other devices to control the receiver and request data from it through a serial port. This manual is useful to programmers who want to write software that controls a Series 4000 receiver from a computer or other device.

Note that the Remote Control Interface is an obsolete protocol. Trimble recommends using the Data Collector Compatible Protocol for new applications. See the *4000SE/SSE RS-232 Interface Data Collector Format Specifications Manual* for information.

NAV BEACON XL Operators Manual, Trimble P/N 21458-00 (July 1991).

Describes the operation of the NAV BEACON XL receiver.

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

PFINDER Software Reference, Trimble P/N 20618-00 (September 1992).
PFINDER Software User's Guide, Trimble P/N 18473-00 (September 1992).

Describe PFINDER, a program used to define data dictionaries and postprocess data for GIS data acquisition. It can also be used to postprocess other DGPS data. For additional information about PFINDER, see the *General Reference for the GPS Pathfinder System.*

POST-NAV II Differential GPS Post-Mission Navigation Software User Manual, Trimble P/N 21316 (revision A, July 1992).

Describes POST-NAV II, Trimble's postprocessing program for precision positioning applications.

Series 4000 Quick Reference Series.

These are short documents designed to present often-needed information in a convenient, readily used format. They are small enough to fit in a shirt pocket. The ones that describe field procedures are printed on durable, water-resistant paper.

FastStatic Survey Quick Reference, Trimble P/N 24168-00 (January 1994).

Kinematic Survey Quick Reference, Trimble P/N 24169-00 (January 1994).

Static Survey Quick Reference, Trimble P/N 24167-00 (January 1994).

Recommendations of Special Committee 104, Differential NAVSTAR/GPS Service, Draft of November 20, 1985.

Defines Version 1.0 of the RTCM message protocol. It can be obtained from the publisher:

Radio Technical Commission for Maritime Services
Post Office Box 19087
Washington, DC 20036
Telephone: 202-639-4006

RTCM Recommended Standards for Differential *NAVSTAR GPS Service,* RTCM Paper 134-89 / SC 104-68, Trimble P/N 19454 (January 1, 1990).

Defines Version 2.0 of the RTCM message protocol. It can be obtained from the publisher (at the address given for Version 1.0, above) as well as from Trimble.

Series 4000 Application Guide, Trimble P/N 27249-00 (February 1995).

Instructions for using a Series 4000 to perform the various procedures it is capable of performing. Assumes basic familiarity with the receiver's operation, obtainable from the appropriate *User's Guide.*

Site Surveyor System Release Notes, Trimble P/N 23015-00 (June 1993).

Describes procedures for performing a Real-Time Kinematic (RTK) survey with a Series 4000 receiver and a Survey Controller.

Survey Controller Operation Manual, Trimble P/N 21822 (version 2.00, July 1993).

Describes the use of the Survey Controller and the Seismic Controller, two varieties of handheld data collector for Series 4000 receivers. These devices enable you to operate a receiver while carrying it in a backpack, and provide an alphanumeric keyboard for easier data entry. They are convenience for many kinds of field work, and a necessity for some.

Version 2.00 of this manual contains useful information about Real-Time Kinematic (RTK) surveying, for which a Survey Controller or Seismic Controller is required equipment.

Trimble Navigation DeltaNav QC System Operation Manual, Trimble P/N 21204 (revision B, 1993).

Gives instructions for using the DeltaNav QC System, a PC-based software product for doing real time quality assurance and quality control (QA/QC) in a navigation system that contains a Series 4000 GPS receiver.

TRIMMAP Survey Software General Reference Guide, Trimble P/N 22060 (version 5.00, February 1993).

User manual for TRIMMAP, a DOS application that prepares maps from logged position fixes.

TRIMNET Survey Network Software User's Manual, Trimble P/N 16536 (revision B, January 1991).

User manual for TRIMNET, a DOS application that does least-squares adjustment on a network of position fixes in a survey. TRIMNET is included in the TRIMVEC Plus package.

TRIMNET Plus Survey Network Software User's Manual, Trimble P/N 19043 (revision A, November 1991).

User manual for TRIMNET Plus, an enhanced version of TRIMNET (above) that is included in the GPSurvey package.

TRIMTALK 900 Operation Manual, Trimble P/N 21220-00 (revision B, August 1993).

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

TRIMVEC Plus GPS Survey Software User's Manual and Technical Reference Guide, Trimble P/N 12351 (revision D1, February 1991).

User manual for TRIMVEC Plus, a DOS application which does postprocessing for kinematic and static surveys, and processes static surveys with multiple base stations.

URS for DOS Software Manual, Trimble P/N 22252-00 (version 1.00, March 1993).

URS for DOS Software Manual Release Notes, no part number (version 1.02, August 1993).

Operation manual for URS for DOS, a program used for external data logging in differential GPS and GIS data acquisition.

Using Radio Communication Systems with GPS Surveying Receivers, Trimble literature ID #1-611-0082 (revision A, February 1993).

This brief document suggests some measures you can take to deal with interference when using GPS receivers with radio links.

Index

E

F

G

H

I

K

L

M

N

O

P

Q

R

S