4000SSi User Guide

4000SSi Geodetic Surveyor

4000SSi Geodetic System Surveyor

4000SSi Site Surveyor

Part Number: 26509-00

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Revision Notice

This is the first release of this guide, Series 4000SSi User Guide, Part Number (26509-00) Revision A, February 1995. This guide describes receiver firmware version 7.0.

Reader Comment Form

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3. Unauthorized modification or misuse
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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)

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Preface

Welcome to Trimble's high-performance 4000SSi receivers. The 4000SSi Geodetic Surveyor, the 4000SSi Geodetic System Surveyor, and the 4000SSi Site Surveyor provide high-precision positioning, surveying and navigation functions.

Scope and Audience

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

Organization

This manual contains the following chapters and appendices:

- Chapter 1, Introduction - briefly describes the features of the 4000SSi receiver.
- Chapter 2, Getting to Know the 4000SSi - shows you how to unpack the receiver, turn it on and off, and confirm that it is in working order. This chapter also introduces the receiver's connectors and controls, and shows how to use the keypad and display.

- Chapter 3, How to Use the 4000SSi- gives an overview of the applications for which the 4000SSi receiver can be used. It also discusses some topics that apply to all applications, such as how to connect the receiver to a power source. All of these topics are discussed in detail in the *Series 4000 Application Guide*.
- Appendix A, Options, Spares, and Accessories - describes options, spare parts, accessories, and software that are available with or for the 4000SSi receiver. It also lists the receiver's technical specifications.
- Appendix B, TheNAVSTAR Global Positioning System - gives a brief introduction to the satellite system that the 4000SSi receiver uses to acquire positioning data.

Related Information

This manual assumes that you are familiar with the application for which you intend to use the 4000SSi receiver, for example, control surveying or precision positioning. It also assumes that you are familiar with the principles of the Global Positioning System (GPS), and with the terminology used to discuss it. For example, you should understand such terms as space vehicle (SV), Elevation Mask, and Dilution of Precision (DOP).

If you are not familiar with GPS, we suggest that you read Appendix B before you go beyond the end of this chapter. For more information, see Trimble's booklet *GPS, A Guide to the Next Utilit* . For a complete citation to this booklet, see the Bibliography in the *Series 4000 Receiver Reference*.

To download and postprocess logged data, you should know how to use a personal computer 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 such asCOPY, REN, and DEL.

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

Update Notes

You will find a Warranty Activation Sheet with your 4000SSi receiver. By sending in yourWarranty Activation Sheet, you are automatically sent update notes as they become available. When you receive these packages, read them. They contain important information about the changing software and hardware. Contact your local Trimble Dealer for more information about the support agreement contracts for software and firmware, and an extended warranty 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:

+408-732-6717
+408-732-8514
+408-732-8936 (for a high speed modem)

Technical Assistance

If you have problems and cannot find the information you need in the 4000SSi receiver documentation, 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)

The Technical Assistance Center phones are answered from 6 AM to 6 PM Pacific Standard Time. A competent support technician will take your call, isolate your difficulty, and provide technical assistance.

FaxBack

FaxBack is a completely automated fax response system that allows you to select documents and catalogs of available documents to be faxed back to a fax machine. FaxBack guides you through the call with a pre-recorded voice message describing the available documents such as data sheets, application notes, technical documentation, configuration guides, assembly drawings, and general information.

The FaxBack system is available 24 hours a day, seven days a week. Simply dial FaxBack from a touch-tone telephone at (408) 481-7704 and follow the voice prompts.

FaxBack: +408-481-7704

Other Manuals

The 4000SSi receiver is accompanied by several pieces of documentation:

- The *Series 4000SSi User Guide* (this document) describes the 4000SSi receiver, and especially those features that are not shared by other Series 4000 receivers. It also shows you how to unpack, check out, and operate the receiver.
- The *Series 4000 Receiver Reference* describes all features found in Series 4000 receivers, in complete detail. It is useful when you must 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 precision positioning. 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 operating the 4000SSi receiver as explained in this manual, the *Series 4000 Application Guide* and the *Quick References* (below) are the only pieces of documentation you ordinarily will need to take into the field.
- The *Series 4000 Quick References* summarize the procedures most often performed with Series 4000 receivers. They are much less detailed than the *Series 4000 Application Guide*, but their compact format makes them easy to carry in your shirt pocket or backpack.

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` represents what is printed on the screen by the DOS system or program.

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

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

Helvetica Bold represents a software command button.

Notes, Cautions, and Warnings

Notes, 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.

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

Warning – Warnings alert you to situations that could cause unrecoverable data loss. A warning precedes the text it is referencing.

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1 Introduction

The 4000SSi Geodetic Surveyor, the 4000SSi Geodetic System Surveyor, and the 4000SSi Site Surveyor provide high-precision positioning, surveying, and navigation functions. They automatically acquire and track GPS satellites on the L1 and L2 channels. They also combine exceptionally low-noise C/A code measurements with carrier aided filtering and smoothing techniques to provide precise position, velocity, and time solutions. Super-trak™ signal processing technology provides enhanced RF interference immunity, improved satellite signal acquisition, and more robust satellite signal tracking.

These receivers present position, time, and satellite tracking data on a 4-line, 40-character front-panel display. All raw and computed data are available through bi-directional RS-232 ports for transmission by radio modem, logging on a computer, or input to navigation instruments.

1.1 Applications of the 4000SSi

The 4000SSi receiver is designed to excel in surveying applications. It can perform static, FastStatic, and kinematic surveys. Survey data can be logged externally on a computer or internally for later downloading to a computer

With the addition of the RTK (Real-Time Kinematic) Functions Option, the 4000SSi receiver can be used to do real-time surveying for stakeout applications.

Trimble provides several computer programs that postprocess logged data for various types of applications.

The 4000SSi receiver can also be used for precision positioning and GIS data-acquisition applications using differential GPS (DGPS). DGPS computes position fixes that are accurate to about 1 meter RMS horizontal and 1.6 meter RMS vertical.

DGPS corrections generated by the base station are broadcast by radio to the rovers, which use them to compute high-precision position fixes in real-time from the satellite data they collect. Real-time DGPS position fixes can be displayed and recorded, or can be used by other devices to maintain a vehicle's course or position.

DGPS position fixes can also be computed by a postprocessing program using data logged by the stations.

The 4000SSi receiver also provides navigation functions such as displaying bearing, range to a destination, and cross-track error. The Geodetic System Surveyor provides extended navigation functions, including the ability to store and use as many as 99 waypoints.

1.2 The 4000SSi Geodetic Surveyor Features

The 4000SSi Geodetic Surveyor has these features:

- Maxwell technology, the GPS industry's most advanced signal processing hardware.
- Super-trak technology, advanced satellite signal tracking hardware and firmware.
- Satellite tracking on 9 channels (12 channels optional), with carrier phase processing and P-code processing on both L1 and L2 frequencies. Can be configured to automatically process when P-code is encrypted (when Anti-Spoofing is active).
- Makes low-noise C/A code measurements with carrier aided filtering and smoothing.

- Continues last operation after power-down / power-up cycles.
- Performs static, FastStatic, kinematic surveys, DGPS operations in postprocessing or real-time mode, and real-time surveys with the addition of the RTK Functions Option.
- Processes RTCM differential corrections in firmware. Delivers position fixes accurate to 1 meter RMS horizontal and 1.6 meter RMS vertical, or better, when used as a rover for differential GPS. Updates position and velocity up to once per second.
- Using RTCM 2.1 type messages, you can perform real-time surveying with RTK to a precision of 1 cm + 2ppm.
- Automatically calculates overdetermined solutions when enough satellites are available.
- Can automatically compute 3D or 2D position fixes depending on the number of satellites being tracked.
- Can log survey or position data for later downloading in 1 MB of solid-state, battery-backed memory. Can output survey or position data to a serial port for external logging or real-time processing.

1.3 The 4000SSi Geodetic System Surveyor Features

The 4000SSi Geodetic System Surveyor has all of the features of the Geodetic Surveyor plus others, many of which enhance its usefulness in navigation and research applications:

- Has 2.5 MB of internal memory instead of 1 MB for substantially greater data logging capacity.
- Has extensive navigation functions, including range, bearing, and directional components to a destination, cross-track error display, and storage and use of up to 99 waypoints.
- Communicates with other instruments using the NMEA-0183 protocol.
- Accepts RTCM SC-104 corrections, enabling it to operate as a rover for differential GPS. With the RTCM-104 Output Option, generates RTCM SC-104 corrections, enabling it to operate as a base station.
- Can output a highly accurate one pulse/second (1 PPS) signal for external timing functions.
- Can record time-stamped event marks and associated user-entered notes along with logged data.

1.4 The 4000SSi Site Surveyor Features

The 4000SSi Site Surveyor is configured for real-time, cm-accurate, surveying and has these features:

- Maxwell technology, the GPS industry's most advanced signal processing hardware.
- Super-trak technology, advanced satellite signal tracking hardware and firmware.

- Satellite tracking on 9 channels (12 channels optional), with carrier phase processing and P-code processing on both L1 and L2 frequencies. Can be configured to automatically process when P-code is encrypted (when Anti-Spoofing is active).
- Makes low-noise C/A code measurements with carrier aided filtering and smoothing.
- Continues last operation after power-down / power-up cycles.
- Performs RTK surveys for stakeout applications.
- Can optionally perform static, FastStatic, and kinematic surveys, and DGPS operations in postprocessing mode.
- Automatically calculates overdetermined solutions when enough satellites are available.
- Can automatically compute 3D or 2D position fixes depending on the number of satellites being tracked.
- Can optionally log survey or position data for later downloading in solid-state, battery-backed memory.

All models of the 4000SSi receiver accommodate several optional features, such as additional internal memory, quality assurance / quality control (QA/QC) indicators, and RTK support. See Appendix A for detailed information about options.

1.5 Notes on Use and Care

The 4000SSi receiver is designed to tolerate the sort of rough treatment that equipment may suffer in the field. But it is a high-precision electronic instrument, treat it with reasonable care.

The receiver operates in temperatures from –20° to +55° Celsius. The antenna operates from –40° to +65° Celsius.

The enclosure is sealed and buoyant. A waterproof vent allows internal air pressure to adjust to altitude changes.

High-power signals from a near-by radio or radar transmitter may overwhelm the instrument's receiver circuits. This will not harm the instrument, but may prevent it from functioning. To avoid problems, try not to use the 4000SSi receiver within 400 meters of powerful radar, television, or other transmitters. Low-power transmitters such as the ones in portable phones and walkie-talkies normally do not interfere with 4000SSi receiver operations. For more information, see the Trimble technical note *Using Radio Communication Systems with GPS Surveying Receivers*.

1.6 Note on COCOM Limits

The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on the 4000SSi receiver

Immediate access to satellite measurements and navigation results is disabled when the receiver's velocity is computed to be greater than 1000 knots, or its altitude is computed to be above 18,000 meters. Access is restored immediately when both limits are no longer exceeded.

During the violation period, all displays of position and velocity-related quantities are blanked, and all access to those quantities through the serial ports is disabled. All applicable data fields in serial output have zero values. These fields include raw GPS measurements, position and velocity results, and navigation results (cross-track error, etc.). External data logging is not allowed during the violation period. Internal data logging is not affected.

2 Getting to Know the 4000SSi

A surveying system based on a 4000SSi receiver must contain, at a minimum, the following:

- A Geodetic Surveyor SSi, or Geodetic System Surveyor SSi or a Site Surveyor SSi.
- An antenna with cables, carrying case, and other accessories.
- A software package for postprocessing survey results or other data.
- For kinematic surveying only: An optional Survey Controller or Seismic Controller.
- For RTK operations only: A Survey Controller or Seismic Controller and a digital radio such as the TRIMTALK 900.
- For GIS data acquisition only: An Asset Surveyor and optional digital radio.
- For differential GPS operations only: An appropriate digital radio, and an optional Survey Controller or Seismic Controlle .

2.1 Unpacking the Receiver

Inspect the shipping boxes and equipment for damage as you unpack, and check the contents of each box against the enclosed packing list. If anything is missing, immediately notify the Trimble Service Department (1-800-TRIMBLE). If anything is damaged, notify the Trimble Service Department and the carrier. Keep the shipping boxes and packing material for the carrier's inspection. Trimble will arrange for repair or replacement of the equipment without waiting for the claim against the carrier to be settled.

Use the form at the end of this manual to record the serial numbers of the receiver, antenna, and any other Trimble equipment. A serial number sticker is located on the bottom or back of each component. Copy or remove the form and store it in a safe place in case the equipment is lost, stolen, or damaged.

2.2 Controls and Connectors

The 4000SSi receiver is enclosed in water resistant yellow plastic housings with carrying straps. Each receiver has a four-line liquid crystal display (LCD), a soft-touch keyboard, a timer indicator on the front panel, and data, power, and antenna connectors on the rear panel. See Figure 2-1 and Figure 2-2.

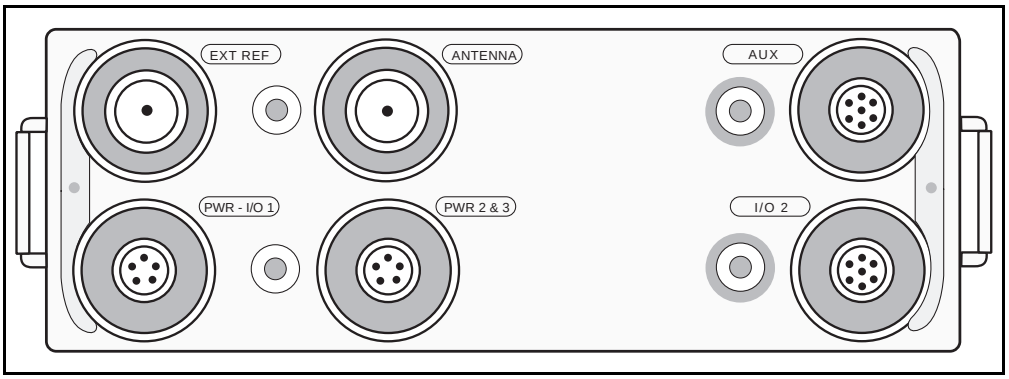


Figure 2-1. 4000SSi Rear Panel

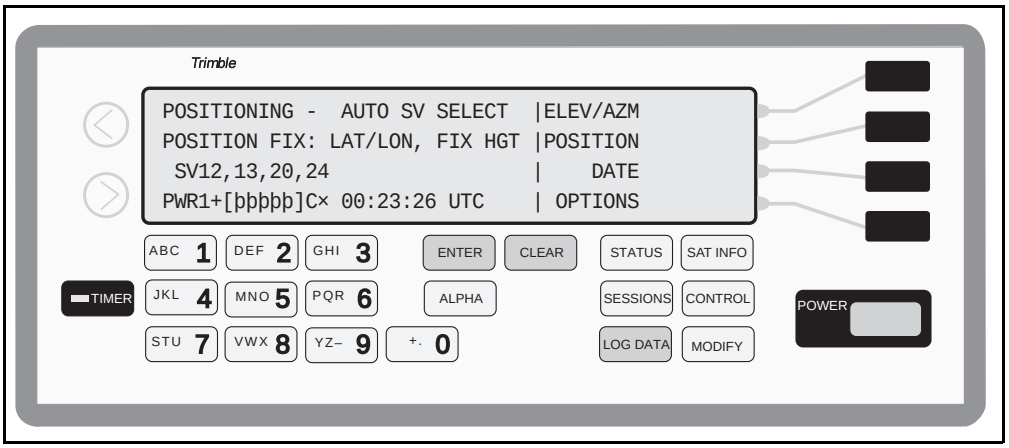


Figure 2-2. 4000SSi Front Panel

2.2.1 Rear Panel Connectors

The receiver's connectors are illustrated in Figure 2-1 and their functions are described in Table 2-1. For descriptions of the connector pinouts, see Appendix A.

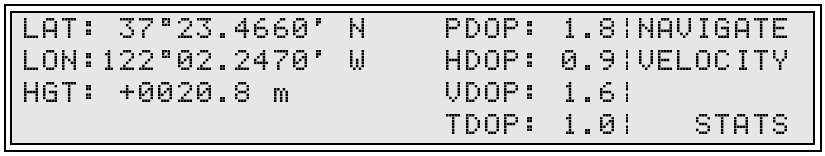
Table 2-1 Connectors on the Rear Panel

Connector	Function
PWR – I/O 1	Serial port 1; 10.75--35 VDC power input and output.
I/O 2	Serial port 2; power output with direct connection to power lines on PWR – I/O 1.
PWR 2&3	Serial port 3 (if Four Serial Port Option is installed). Dual battery power port; each port can be used as input for operating receiver or output for recharging batteries.
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).
ANTENNA	Antenna input.
EXT REF	External timebase input (if External Frequency Input Option is installed).

2.2.2 Screen Control Keys

The keys to the left and right of the LCD (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, this screen shows labels for the first, second, and fourth softkeys. (In this example the third softkey has no function.)



2.2.3 The Main Keypad

The main keypad (Figure 2-2, lower half) 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 groups of receiver functions:

- [STATUS] displays current information about the status and configuration of the receiver and the satellites being tracked. 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 processing, 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 if the Memory option is installed.
- LOG DATA displays screens that let you select defined stations and sessions, and start and stop data logging. It also provides the quickstart function to start data logging without pre-defining a station and session.
- 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 enters 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 section 2.4.4 on page 2-17, for more details.)

The numeric keypad is used to enter data. ALPHA toggles the receiver between numeric mode and alphanumeric mode. (See page 2-22 for more information on alphanumeric fields.)

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 during inactive periods of data logging). When the Auto Survey Timer is enabled, the TIMER light flashes. (This is possible only if the Memory option is installed.)

2.3 Checking the Receiver's Operation

You should confirm that the receiver is operational as soon as possible after you unpack it. This will also get the receiver ready for some data entry exercises you will be invited to work through in section 2.4 on page 2-11.

If the instructions given here do not fit your power source or antenna, see section 3.9 on page 3-8 for more information.

If your receiver does not behave as described here, be sure you have performed all of the steps correctly. If you cannot find the cause of the problem, call the Trimble Assistance Center

1. **Position receiver.** Put the receiver in a place where the appropriate type of power is available, and mount the antenna where it has a clear view of the sky.
2. **Attach antenna.** Use only an antenna that is packaged with the 4000SSi receiver, or another Trimble antenna sold for use with the 4000SSi receiver. Attach one end of the antenna cable to the antenna, and the other end to the ANTENNA connector on the receiver.

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

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3. **Attach a power source.** You can attach an AC-powered Trimble Office Support Module 2 (OSM2) to either the PWR – I/O 1 connector or the PWR 2&3 connector, or you may use any other suitable power supply with the supplied dual DC power cable. You may attach the receiver's standard battery module to the receiver as shown in Figure 2-3. The battery module is designed to make electrical connections automatically when it is attached. Remember to charge the battery before using it. (See the *Series 4000 Application Guide*.)

Caution – Trimble equipment warranties are valid only if you power the receiver from a fused, regulated DC power source.

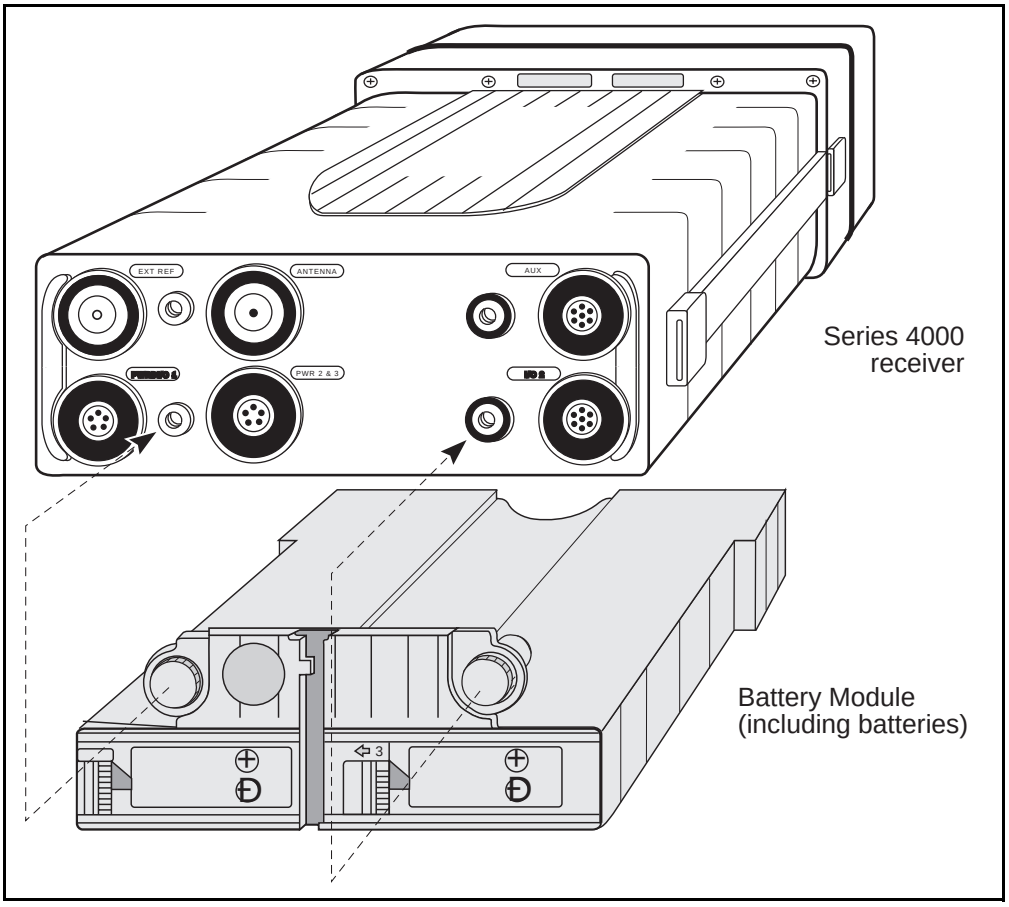


Figure 2-3. Attaching the Battery Module to the 4000SSi

4. Turn on power. Press the POWER key. The receiver should beep and display a power-on screen on the LCD:

```
TRIMBLE 4000 GEODETIC SURVEYOR SSi
       Copyright (c) 1988-95 TNL
            POWER-UP TESTS
```

5. **LOG DATA menu.** Your receiver should display this screen after a few seconds self-testing:

```
QUICK-START NOW! (SINGLE SURVEY)      --
    START PRE-PLANNED (SINGLE SURVEY) --
START FAST STATIC OR KINEMATIC SURVEY --
                                  MORE --
```

When you see this screen, press the STATUS key.

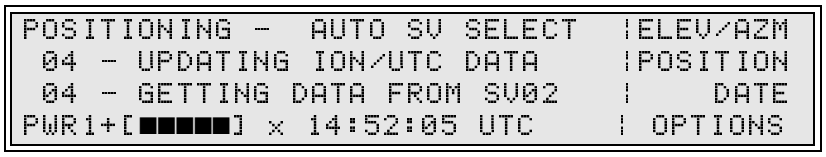
6. **Collect almanac.** The first time the receiver is powered on after it has been unpacked or after a hardware reset, it must collect an almanac to tell it what satellites should be available at what times. First, it searches for a satellite:

```
POSITIONING -   AUTO SV SELECT  ¦ELEV/
AZMSETTING TIME AUTO SKY SEARCH ¦POSITION
  SEARCHING FOR SVS             ¦    DATE
PWR1+[■■■■■] ×  2:17     UTC    ¦ OPTIONS
```

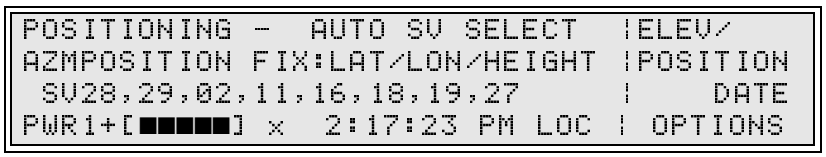
When a satellite is located, it briefly displays a screen similar to this:

```
POSITIONING -  AUTO SV SELECT  ¦ELEV/AZM
SETTING TIME - AUTO SKY SEARCH ¦POSITION
LOCKED TO SV 02                ¦    DATE
PWR1+[■■■■■] × 14:50    UTC    ¦ OPTIONS
```

Then it displays this screen while it collects the almanac and other required information from the satellite signals. It takes about 15 minutes for the receiver to collect this information.

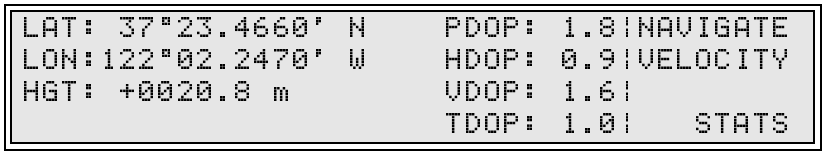


7. **Status screen.** When the receiver has collected the almanac (or if it already has one from earlier use), it displays the Status screen:



The second line says POSITION FIX, followed by the positioning mode the receiver is using. This screen shows that the receiver has started computing 3D position fixes.

8. **Position screen.** Press the **POSITION** softkey. The receiver should display a screen similar to this one:



LAT, LON, and HGT should show your current position. Since the receiver is not applying a base station's corrections to its measurements, the coordinates it displays are uncorrected. Therefore, do not be concerned if the coordinates vary within about 100 meters of your actual position.

9. **Power off.** If you are not going to read the following section at this time, you may turn the receiver's power off. Press POWER and hold it down until the screen goes blank.

2.4 Using the Keypad and Display

This section explains how to use the receiver's keypad and interpret its display. Once you acquire these skills you will be ready to learn how to use the receiver in your work.

Caution – This section suggests some exercises that will change certain information stored in your receiver's memory. If you are sharing your receiver with other users, ask them if it is all right for you to change the waypoint definitions. If it is not, you may have to skip the exercises.

2.4.1 How the Receiver Uses Screens

The receiver uses its LCD to show many different displays of data about its location, its internal status, the satellites it is tracking, and so on. Each 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 processing.

Most of these groups of screens are hierarchic. Imagine the screens as a group of boxes on an organization chart. From a particular top-level screen you typically can display several second-level screens, from which you can display several third-level screens, and so on. Figure 2-4 illustrates the hierarchic relationships among the first few screens in two groups, *Status* and *Control*.

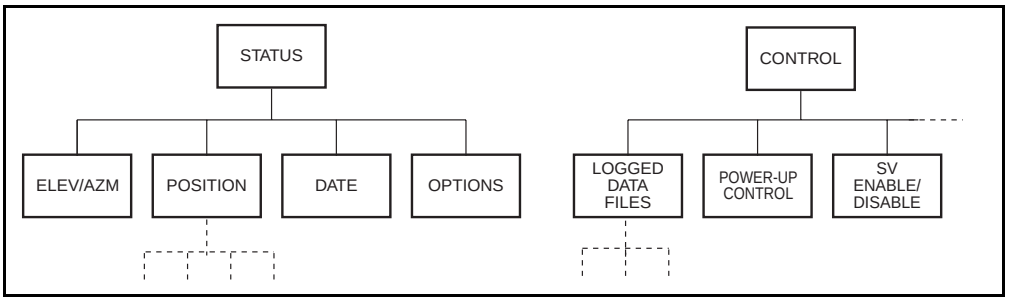


Figure 2-4. Status and Control Screen Hierarchy

The screen hierarchy controls your movement from screen to screen both going down the hierarchy and coming back up. For example, from the *Control* screen you can display either the POWER-UP CONTROL screen or the SV ENABLE/DISABLE screen, so from the POWER-UP CONTROL or SV ENABLE/DISABLE screen you can return to the *Control* screen, and to no other. Also, if you want to go from the POWER-UP CONTROL screen to the SV ENABLE/ DISABLE screen, you must first return to the *Control* 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 *Control* screen is the next higher screen relative to both the POWER-UP CONTROL screen and the SV ENABLE/DISABLE 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.

2.4.2 An Example

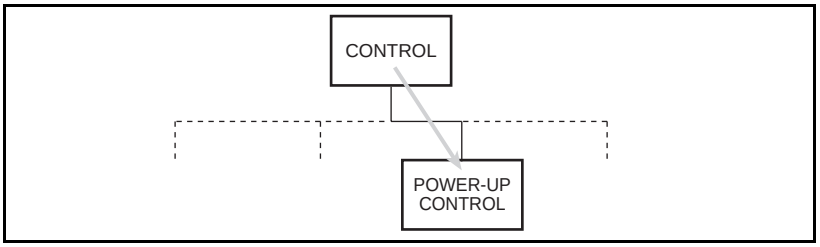
If you have turned the receiver off, turn it back on and wait for it to display the “Quick-Start Now, Start Preplanned...” menu. Then press the CONTROL key. The receiver should display a screen similar to this one:

```
RECEIVER CONTROL:      ¦ LOGGED DATA FILES
(1 of 9)               ¦   POWER-UP CONTROL
                       ¦ SV ENABLE/DISABLE
                       ¦                MORE
```

Press the **POWER-UP CONTROL** softkey. The receiver displays a screen like this one:

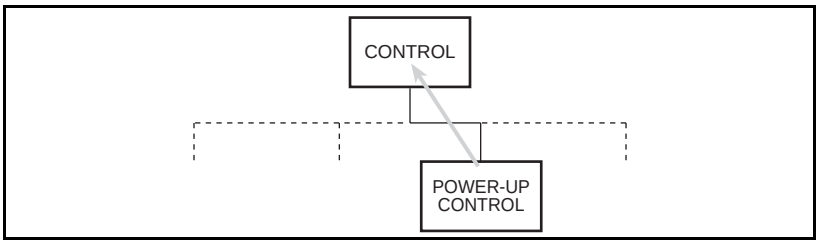
```
POWER-UP INITIALIZATION CONTROL

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

You have moved down one level in the hierarchy from the main Control screen to the POWER-UP CONTROL screen.



This screen controls whether or not the receiver will reset certain operating parameters to their default values at power-up.

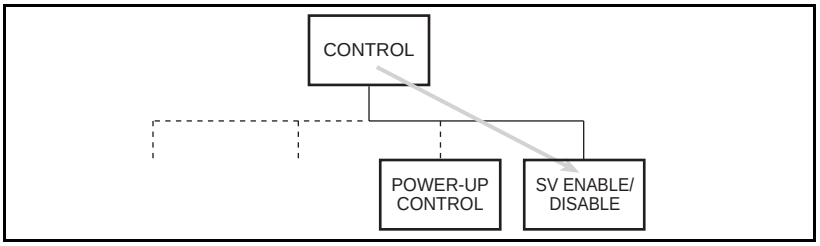
At this point, though, let us travel back up the hierarchy to the *Control* screen. To do so, press the CLEAR key.



Now press the **SV ENABLE/DISABLE** softkey. The receiver displays a screen like this one:

```
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
```

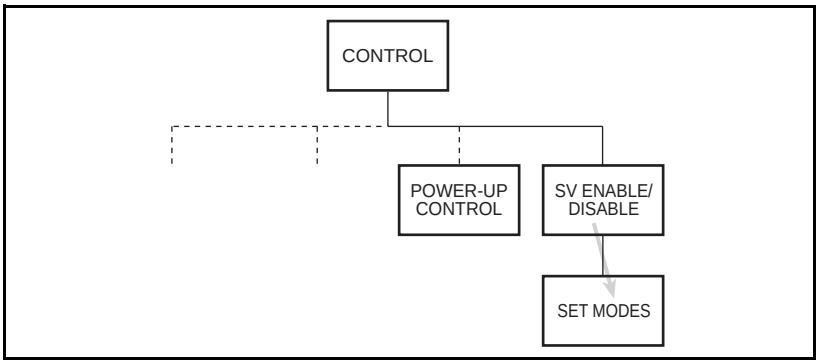
This screen shows which satellites are enabled (so that the receiver will track them if they are available and healthy) and which are disabled (so that it will not).



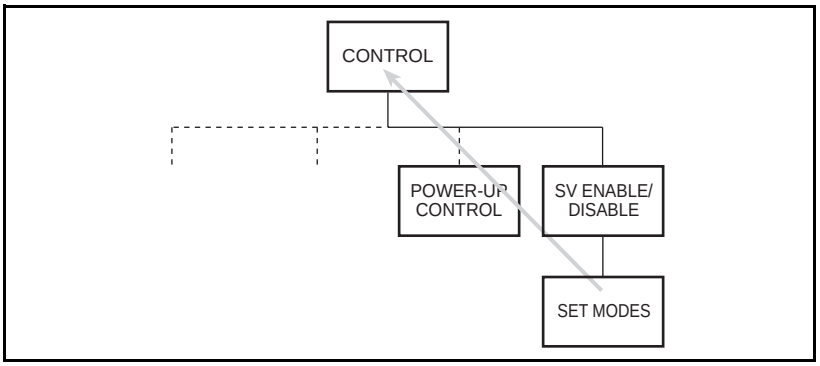
Press the **SET MODES** softkey. The receiver displays a screen like this one:

```
ENABLE/DISABLE MODE:   SV03 ¦    NEXT SV
                            ¦    PREV SV
 CURRENT MODE:              ¦
               ENABLED      ¦CHANGE MODE
```

You have moved another level down the *Control* screen hierarchy.



Press the CONTROL key to display the main *Control* screen again. This returns the receiver directly to the main *Control* screen, even though it must go up through more than one level of the hierarchy.

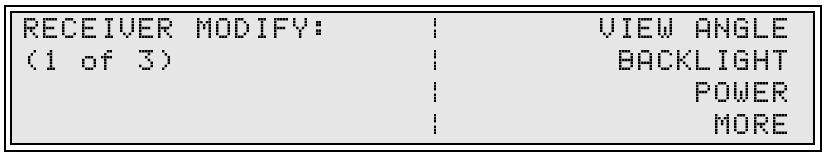


Now press CLEAR. The receiver displays the *Status* screen. This is the receiver's *main* main screen, at the top of the hierarchy. Press CLEAR enough times and you will return to this screen from any other screen the receiver may display.

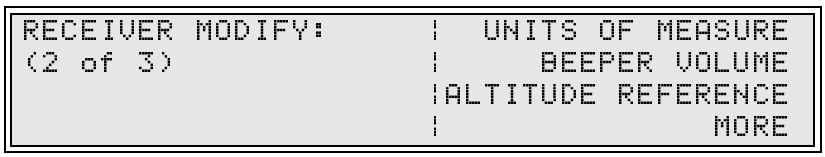
2.4.3 About Menus

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

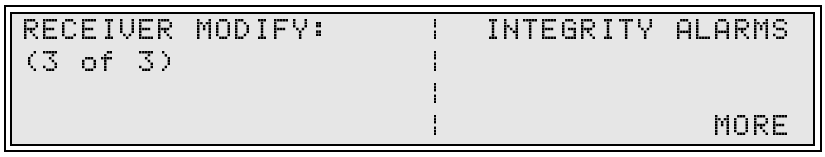
Menus that have more than four choices are displayed in segments. For example, the *Modify* screen displays this menu:



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:



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



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 appear only if corresponding options are installed. Be aware that your receiver's menus may not show all of the items that appear in the manuals.

2.4.4 Entering Data and Moving from Field to Field

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

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 CONTROL key, then press the **MORE** softkey until you see a softkey labeled **REFERENCE POSITION**. Then press that softkey. The receiver displays a screen like this one:

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

This screen sets the reference position (the accepted position of the GPS antenna), which is used for a variety of purposes.

The cursor (a blinking rectangle, 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. The softkeys change as the cursor moves from field to field.

```
ENTER REFERENCE POSITION:      ¦    EAST
 LAT   37°23.4727805' N        ¦    WEST
 LON  122°02.2437615' W        ¦    HERE
 HGT  -0007.430 m              ¦  ACCEPT
```

```
ENTER REFERENCE POSITION:      ¦    PLUS
 LAT   37°23.4727805' N        ¦   MINUS
 LON  122°02.2437615' W        ¦    HERE
 HGT  -0007.430 m              ¦  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 this function.)

The [CLEAR] key moves the cursor the other way:

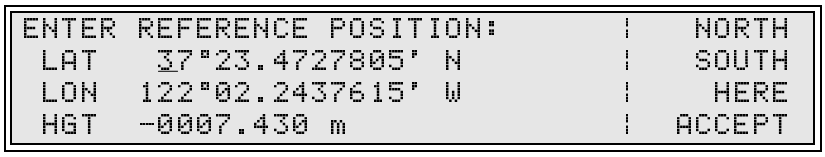
- From the interior of a field to the beginning of the field.
- From the beginning of a field to the beginning of the preceding field.
- From the beginning of the screen's first field to a higher screen—usually, but not always, one level up the hierarchy

The [<] and [>] keys move the cursor left and right within a field. In some screens (but not all), they will 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.

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 REFERENCE POSITION screen's first field, if it is not already there.



The **NORTH** and **SOUTH** softkeys change the latitude's hemisphere. Press these keys a few times and watch the hemisphere change.

Numeric Fields

Some fields require you to enter numeric values. The three coordinate fields in the REFERENCE POSITION screen are examples.

To enter a numeric value, simply enter the numerals through the keypad. To enter a LAT value of 35º 05.2487000', for example, you would press 3 5 0 5 2 4 8 7 0 0 0. (The cursor skips over the degree and minute signs and the decimal point, which the keyboard does not change.)

When you enter a character in the last digit of a 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 35º 05.2487000' to 35º 06.0000000'. Move the cursor to the beginning of the LAT field, if necessary, and press [>] three times to advance the cursor to the '5' in the minutes part of the field. 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 [<], then [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 REFERENCE POSITION screen, the receiver discards changes to LON or HGT when you use [CLEAR] to return from that field to the preceding one.

Some character fields allow you to enter letters as well as numbers. See page 2-22 for more information on alphanumeric fields.

Combination Fields

Some fields allow either multiple-choice or numeric entry. A field with a limited number of numeric values often works this way; you can enter a value with the numeral keys or increase and decrease the value by pressing softkeys labeled **NEXT** and **PREV**.

Other fields allow only numeric entry or only multiple-choice entry. For example, the LAT, LON, and HGT fields in the REFERENCE POSITION screen allow only numeric entry. The direction fields that follow LAT, LON, and HGT allow only multiple-choice entry.

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 to the first field of the same screen.

Press **ACCEPT** now to make the receiver leave the REFERENCE POSITION screen and accept the coordinates you have entered.

To discard information you have entered, press CLEAR. To return to a higher screen, press CLEAR until the cursor returns to the start of the first field on the screen; then press it once more.

Try this now. Select REFERENCE POSITION again and change the value of the LAT field. Then press CLEAR; then select REFERENCE POSITION again. The value of LAT has not changed; when you pressed CLEAR, the receiver discarded it.

CLEAR *only* affects information entered through the numeric keypad. When you change a multiple-choice value with a softkey, the change takes effect immediately. Pressing CLEAR may make the receiver leave the field or the screen, but will not discard the changed value.

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’ ‘--’ (a hyphen); the 0 key represents ‘0’ (zero), space, ‘+’ (plus), and ‘.’ (period or decimal point).

Entry method 1. When you press a numeral key in an alphanumeric field, the receiver not only puts that numeral in the field 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.)

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

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= 30C            ¦ "I"
```

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= G0C            ¦ "I"
```

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, for erasing 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. If you press [5], for example, you will see this:

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

Then you can 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"
```

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= GMI          ¦ "U"
```

Entry method 2. Some users consider this method of entering alphanumeric data more efficient.

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"
```

Note – If you tried changing the time zone identifier on a receiver that is already configured for use, do not accept your changes; they could confuse other users. Leave the ADJUST LOCAL TIME screen by pressing [CLEAR]. If you have already accepted your changes, return to the screen and set the time zone identifier back to its original value.

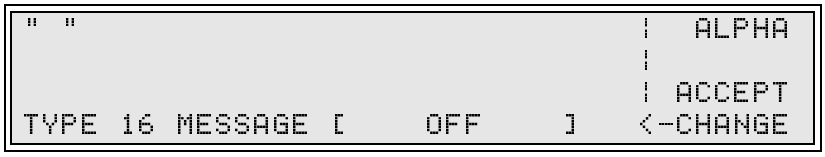
Numeric/Alphanumeric Fields

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. (Your receiver can display this field only if it 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. The receiver will display this screen:

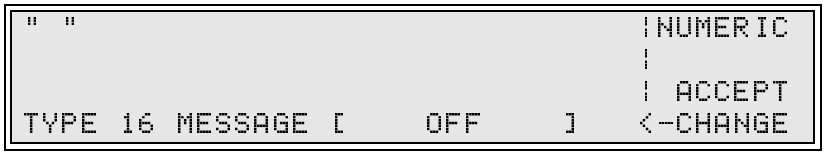
```
RTCM-104 REFERENCE STATION      <-   MORE
       PRINTOUT [    OFF     ]  <- CHANGE
 CTS->XMT DELAY [  0.0 SEC   ]  <- CHANGE
TYPE 16 MESSAGE [    OFF     ]  <- CHANGE
```

Press the **TYPE 16 MESSAGE... CHANGE** softkey. The receiver will display this screen:

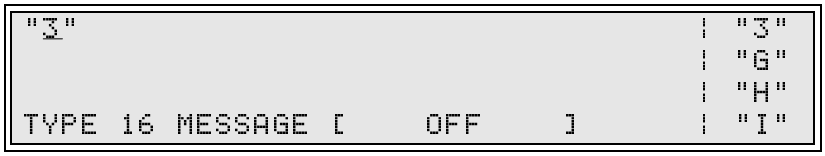


The cursor is in the first position of an empty field that accepts either numeric or alphanumeric data.

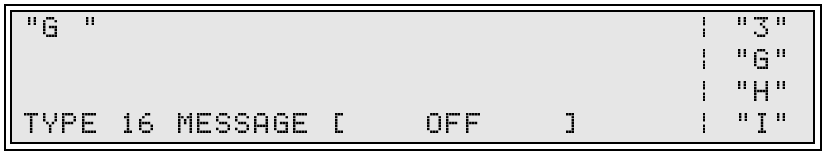
The first softkey, labeled **ALPHA**. This label implies that the field is now accepting *numeric data*; you can press the **ALPHA** softkey to *make it start accepting* alphanumeric data. Conversely, when the softkey is labeled **NUMERIC**, the field is accepting *alphanumeric data*; you can press the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



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



Now press the second softkey and you will see this:



You can accept or discard the information you have entered by pressing ENTER or CLEAR, just as you can when entering numeric data. Since the field uses all four softkeys for the character menu, though, it makes the softkeys' usual functions inaccessible. If you need to select one of those functions, you can 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 How to Use the 4000SSi

This chapter discusses applications for which the 4000SSi receiver is commonly used. The applications are described in detail in the *Series 4000 Application Guide.*

3.1 Control Surveying

A control survey determines the relationships among a small number of points, with high precision. These points may then be used as reference marks (control points) for other surveys.

The 4000SSi receiver supports two surveying procedures that are suitable for control surveying: static surveying and FastStatic surveying. Each of these procedures requires one receiver located at a reference mark, and one or more other receivers located at survey marks, whose coordinates are to be determined. The receivers must make simultaneous observations of a specified minimum number of satellites for a specified minimum time. The position of each survey mark may then be determined by postprocessing the observed data, using Trimble's GPSurvey software on a PC.

Static surveying is the most precise procedure, and the slowest. It requires observations of at least four satellites for a period of 30 to 60 minutes on baselines of up to 15 km. (Longer baselines require longer observations.)

FastStatic surveying is a substantially faster procedure, and is only slightly less precise. It is limited to operations within a radius of about 20 km, and it is more sensitive to high PDOPs than static surveying is. It requires simultaneous observations of at least four satellites for a period of 5 to 20 minutes. Because of the relatively short observation time, a single rover customarily is used to make observations at several survey marks in the course of a survey.

3.2 Topographic Surveying

A topographic survey determines the relationships among a large number of points, usually with lower precision than a control survey It is called topographic because the results typically are used to make a map of an entire region, or of an entire set of features (for example, roads) within a region.

The 4000SSi receiver supports kinematic surveying, the procedure that is customarily used in topographic surveying applications.

Kinematic surveying requires one receiver located at a reference mark, and one or more rovers that move about, stopping briefly to take a position fix at each survey mark. The recommended observation time for a position fix is about two minutes with typical receiver parameter settings.

Each rover can be equipped with a Survey Controller or a Seismic Controller. This is a handheld control unit with a full alphanumeric keypad; it controls all of the receiver's operations during the survey allowing the receiver to remain in the operator's backpack.

While kinematic surveying combines high productivity with reasonably high accuracy, it imposes some additional requirements on surveying personnel. Each roving receiver must be initialized at a known location (a *station*) at the beginning of the survey, and must track a minimum of four receivers throughout the survey, even while roving. If a receiver's tracking of at least four satellites is interrupted for even a few seconds, the receiver must return to a station to be reinitialized before it can proceed.

After a kinematic survey has been performed, the position of each survey mark may be determined by postprocessing the observed data with Trimble's TRIMVEC Plus software running on a PC.

3.3 Stakeout

Stakeout refers to locating points with specified coordinates and marking them, typically by setting a stake in the ground. The 4000SSi receiver supports stakeout applications with differential GPS, described in section 3.4 on page 3-4.

For higher precision, the RTK Firmware Option enables the receiver to support RTK (Real-Time Kinematic) surveying. RTK is similar to kinematic surveying except that the base station transmits data to the rovers by radio, enabling each rover to compute and display its position in real time. Logging satellite data and/or position fixes for postprocessing with Trimble's TRIMVEC and TRIMMAP software is optional.

RTK requires that each rover be equipped with a Survey Controller or a Seismic Controller for controlling the receiver, displaying information, and importing reference coordinates from earlier control surveys.

RTK also requires a radio transmitter attached to the base station, and a communications receiver attached to each rover. Trimble's TRIMTALK 900 is a short-range portable transceiver that may be used for this purpose in the United States and certain other countries. Trimble can supply or recommend appropriate receivers for use in countries where the TRIMTALK 900 is not authorized.

3.4 Precision Positioning

Precision positioning is a type of application in which a receiver computes position fixes in real time. It may involve tracking the position of a vehicle (such as a crop dusting aircraft) or controlling servomechanisms that maintain the position of a mobile object (such as a marine oil exploration platform).

The 4000SSi receiver can serve precision positioning applications with differential GPS (DGPS). This procedure uses two receivers, one operating at a reference mark (the base station, or reference station), the other operating on the vessel or vehicle to be tracked or controlled (the rover, or differential station). The base station must be linked to the rover by radio. This enables the base station to transmit corrections which describe the errors in the satellite signals that both receivers are tracking. By processing satellite signals and corrections the rover can compute accurate position fixes in real time.

DGPS operations often can use a publicly available base station rather than one specially set up by the user. Such base stations are operated by an increasing number of public and private agencies, notably the United States Coast Guard.

The bandwidth required for DGPS is substantially lower than that required for RTK. While the TRIMTALK 900 radio can be used for DGPS, other alternatives are more economical and operate over greater distances. Trimble can supply or recommend appropriate equipment for various specific applications.

DGPS can also be done by logging satellite data on both receivers and postprocessing it on a PC with Trimble's POSTNAV Ⅱ or PFINDER software. This mode of operation sacrifices the ability to compute position fixes in real time, but eliminates the need for a radio link and for a reliable communication channel between the receivers.

3.5 GIS Data Acquisition

Collecting data for a geographic information system (GIS) requires the ability to compute position fixes for points and to record data about the attributes of those points. The 4000SSi receiver can be used for GIS data acquisition when equipped with a TDC1 running the Asset Surveyor software. The TDC1 is a handheld data collection device with a full alphanumeric keypad for data entry.

Any of the surveying or positioning procedures described here may be used, depending on the application's need for accuracy and its other requirements. Use Trimble's PFINDER software for postprocessing.

3.6 Navigation

Navigation is not one of the 4000SSi receiver's primary functions, but it can be useful in the course of your surveying work. For example, you could use navigation to find the marker for reference marks in a large area that has no useful landmarks.

Navigation uses position fixes derived from differential GPS or RTK if either of those positioning techniques is in use. If not, it uses autonomous mode positioning.

The basic 4000SSi Geodetic Surveyor has simple navigation functions; it can show you the range and bearing to a specified set of coordinates, display cross-track error, etc. The Geodetic System Surveyor and the Geodetic Surveyor with Navigation Package Option have an expanded set of navigation features, most notably the ability to store up to 99 predefined waypoints and follow a course that passes through any sequence of waypoints on the way to the destination.

You can navigate with the 4000SSi receiver by using either of two positioning procedures: differential GPS or autonomous operation. Differential GPS is described in section 3.4 on page 3-4; its characteristics are the same for navigation as for other applications. Autonomous operation simply means that the receiver is computing its position in real time without the aid of a base station. It is accurate to ±10--20 meters horizontal RMS when Selective Availability (S/A) is inactive, and ±100 meters when Selective Availability is active.

3.7 Different Parameters for Different Procedures

Different parameters apply to different procedures, but the same types of parameters often appear in more than one procedure. One example is the Elevation Mask, which determines the lowest elevation at which the receiver will use measurement data from a satellite. The receiver maintains one Elevation Mask parameter for each of the basic types of surveying procedures: quickstart static, FastStatic, kinematic, and RTK. In addition, there is a separate Elevation Mask for each of the 50 session definitions you can enter, and an Elevation Mask for positioning (non-survey) operations.

This distinction applies to other parameters too. For example, there is a separate sync time parameter for each type of procedure.

In general, the positioning parameters are set from the *Control* menu; the preplanned static survey parameters are set from the *Sessions* process; and the other types of survey parameters are set from the appropriate parts of the main *Log Data* menu.

3.8 The Trimble Data Collectors

Trimble data collectors are a family of handheld units designed to control a roving receiver. All of the data collectors use the same hardware, but they provide different firmware for use in different procedures: Survey Controller and Seismic Controller software for surveying applications, and Asset Surveyor software for GIS data acquisition.

Using a data collector has several advantages:

- Its alphanumeric keyboard and larger display make the receiver easier to control.
- It can do things that a Series 4000 receiver alone cannot, such as downloading reference mark coordinates from a computer, displaying operational data in graphical form; displaying a skyplot during survey operations to help you avoid obstructions; and the ability to enter feature codes from user-customized library.
- It lets the operator carry the receiver in a backpack throughout the survey. If the data collector is attached to the rangepole's data collector bracket, the operator can easily enter data with one hand while holding the rangepole with the other. This makes it feasible for a single person to operate a rover.

A data collector is required equipment for the RTK surveying procedure and the GIS data-acquisition procedure. It is optional for the kinematic surveying procedure and the DGPS procedure.

3.9 Data and Power Connectors

This section discusses the most important aspects of the connectors. All of the receiver's connectors are on the rear panel. The connections are shown in Figure 2-1 on page 2-3. The *Series 4000 Receiver Reference* describes them in detail, including their pin-outs and cables, and in appropriate cases their electrical characteristics. The *Series 4000 Application Guide* provides a condensed version of the same information for field use.

3.9.1 Power

The 4000SSi receiver can input power through the PWR – I/O 1 and PWR 2&3 connectors. The receiver requires a 1-ampere, 11 to 35 VDC power supply. The receiver will switch to an different power source voltage if the alternative source is connected to the receiver's power port when the battery voltage drops below 10.75 VD . If an alternative power source is not connected to the receiver's power port, the receiver will turn itself off.

The 4000SSi receiver can supply 0.5 ampere at 12 VDC through ports PWR – I/O 1 and I/O 2. This power output can be used to operate a low-power remote device such as a remote display or a radio modem. For more information, consult the *Series 4000 Receiver Reference* or the *Series 4000 Application Guide*.

The power sources most often used with the 4000SSi receiver are the Office Support Module 2, the battery module, and the 10 ampere-hour external battery (a separately ordered accessory). Other batteries and power adapters are mentioned in Table A-8 on page A-9.

Caution – The receiver's DC power inputs have no user-serviceable fuses. Any DC power supply used to power it must be protected by a 3 to 5-ampere load fuse. Failure to observe this precaution may damage the receiver and void its warranty. All Trimble battery cables have in-line fuses to protect the receiver.

Office Support Module 2 (OSM2)

This device allows the receiver to operate from line power and change four camcorder batteries and one 6 or 10 Ah battery. It can accept power at all widely used voltages and frequencies, including 100, 120, 220, and 240 VAC at 50 and 60 Hertz. It also provides a standard DE9S connector for serial port communications while charging through the PWR – I/O 1 port.

Battery Module

The Battery Module uses two standard camcorder batteries, which can hold enough power for about three hours of operation. The module attaches to the bottom of the receiver; simply slide the plastic tabs into their receptacles on the receiver and rotate the knurled knobs until snug. (See Figure 2-3 on page 2-8.) The module automatically connects to the receiver's PWR 2&3 port when attached.

Loose Camcorder Batteries

You can carry camcorder batteries in the receiver's backpack and attach them to the receiver with a cable. The dual battery input cable (P/N 18294) connects one battery to each of the receiver's power ports 2 and 3; the quadruple battery input cable (P/N 21184) connects two batteries to each port. Both of these cables plug into the PWR 2&3 connector at one end and clip to the batteries at the other end.

External Battery Pack

The 6 and 10 ampere-hour external battery packs are designed to be carried on a shoulder strap. The 6 AH pack has a hard case and strap; the 10 AH pack has a carrying bag. Either pack may be connected to the PWR – I/O 1 or PWR 2&3 port using a supplied cable. The 6 AH pack can hold enough power for approximately 10 hours of operation; the 10 AH pack can hold enough power for 16 hours.

3.9.2 Antennas

The 4000SSi receiver can use any of several antenna types, each one appropriate for a particular set of applications. The *Series 4000 Application Guide* contains a table of antennas for Series 4000 receivers, showing the procedures for which each is suited.

3.9.3 Serial Ports

The receiver has two standard serial ports. It supports XON/XOFF flow control on port 1, and XON/XOFF or CTS/RTS flow control on port 2. When the Four Serial Port Option is installed the receiver has four serial ports, supporting XON/XOFF flow control on ports 1 and 3, and XON/XOFF or CTS/RTS flow control on ports 2 and 4.

The receiver presents port 1 on the PWR – I/O 1 connector, and port 2 on I/O 2. If the Four Serial Port Option is installed, it presents port 3 on PWR 2&3 and port 4 on AUX.

Cables

You can connect any port to a computer or other device with an appropriate cable:

- Use P/N 18826 (LEMO 5-pin to DE9S) to connect to PWR – I/O 1 (port 1) or PWR 2&3 (port 3).
- Use P/N 18827 (LEMO 7-pin to DE9S) to connect to I/O 2 (port 2) or AUX (port 4).
- Use the P/N 14284 to connect the OSM2 to PWR – I/O 1 and bring out serial port 1 on the OSM2's DE9S connector.

All of these configurations are compatible with any standard serial port in a DTE configuration, a standard PC configuration, and for most peripheral devices such as printers. To connect to a device in a DCE configuration (standard for modems and many other types of computers), use a null modem cable between the data cable and the device.

Each port's baud rate and data format are configurable from the receiver's front panel. See the *Series 4000 Receiver Reference* for details.

Split Cables

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 *Series 4000 Receiver Reference* describes the wiring required for a split cable.

3.9.4 1 PPS and Time Tag

The 4000SSi receiver can output a 1 pulse/second (1 PPS) time strobe on the AUX connector, and an associated ASCII time tag on a user-selected serial port. The *Series 4000 Receiver Reference* describes the AUX pin-outs, the time strobe's electrical characteristics, and the properties of the time tag.

3.9.5 Event Mark Input (Only with Event Marker Input Option and Memory Option)

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. The pulse is input on the AUX port; the *Series 4000 Receiver Reference* describes the port's pin-outs and the input's electrical characteristics.

An event mark can also be generated manually from the front panel with the *Log Data* screens. The *Series 4000 Receiver Reference* chapter on *Log Data* describes the relevant screen and procedure for using it. This does not put a pulse into the rear panel, but logs the same type of message.

3.9.6 INT/EXT Timebase (Only with External Frequency Input Option)

The INT/EXT TIMEBASE parameter lets you drive the receiver's timebase from a 5 or 10 MHz external frequency source attached to the EXT REF connector instead of the receiver's internal quartz-crystal oscillator. The *Series 4000 Receiver Reference* describes the electrical characteristics of an acceptable external frequency source.

The internal oscillator is accurate enough for most applications, but for very high-precision surveys you may prefer to use an external frequency source such as a high-stability atomic standard clock.

A Options, Spares, and Accessories

This appendix describes lists the 4000SSi receiver specifications. It also describes options, spare parts, accessories, and software available with or for the 4000SSi receiver.

A.1 Technical Specifications

Table A-1 lists the physical characteristics of the 4000SSi receiver.

Table A-1. 4000SSi Physical Characteristics

Size	9.8" × 11" × 4" (24.8 cm × 28 cm × 10.2 cm) (W × D × H).
Weight	6.8 lbs (3.1 kg) for receiver alone. 12 lbs (5.5 kg) for receiver, battery, cable, and backpack.
Power	Nominal 11–35 VDC, 10.5 watts. AC power operation with office support module. 0.0 MB in Site Surveyor SSi.
Internal memory	1.0 MB in Geodetic Surveyor SSI. 2.5 MB in Geodetic System Surveyor SSi.
Temperature range	Operating: –20º to +55°C Storage: –30º to +75°C.
Humidity range	To 100%. Enclosure is fully sealed and buoyant.

Table A-2 lists the general specifications of the 4000SSi receiver.

Table A-2. General Specifications

Start-up time	Less than 2 minutes from power-on to survey start.
Tracking	9 channels of dual frequency P-code and full cycle carrier-phase or 9 channels L1 C/A code, dual frequency full cycle carrier-phase and L2 range derived from Super-trak.
Data logging interval	0.5 second to 15 minutes.
Data logging format	Compact format; compatible with all current members of the Series 4000.
Internal data logging capacity	Geodetic Surveyor SSi: 1.0 MB holds 26 hours of 5-satellite dual frequency data at 15 second logging intervals; 1.8 hours at 1.0 second intervals. Geodetic System Surveyor SSi: 2.5 MB holds 65 hours of 5-satellite dual frequency data at 15 second logging intervals; 4.5 hours at 1.0 second intervals. Additional memory is available for both models.
External data logging	Corrections and all data available for archiving through RS-232 ports.
Data link rates	110 to 57,600 baud (port 1) or 50 to 57,600 baud (ports 2 through 4).
Battery operating time	Maximum: 3 hours per fully charged camcorder battery. Recommended for planning: 2 hours per battery.
Display	Backlit LCD, 4 lines × 40 characters, with adjustable viewing angle.
Keyboard	Alphanumeric, functions, and softkeyentry.
Antenna	External antenna with maximum 30-meter RG-213 cable.

A.1.1 Static Surveys

The 4000SSi receiver uses P-code on both L1 and L2 frequencies. When P-code is encrypted, the receiver uses C/A code on L1 and the L2 range is derived from Super-trak. Table A-3 lists the static survey specifications for the 4000SSi receiver.

Table A-3. Static Survey Specifications

Survey modes	Quickstart, preplanned, or auto-timed preplanned survey.
Accurac	Horizontal, 5mm + $10^{-6} \times$ baseline. Vertical, 10mm + $10^{-6} \times$ baseline. Azimuth, 1.0 + 5/*d* arc seconds, where *d* is baseline length in kilometers. Assumes at least five satellites tracked continuously using recommended static surveying procedures, utilizing the L1 and L2 signals at all sites. Precise ephemerides and meteorological data may be required.

A.1.2 Kinematic Surveys

The 4000SSi receiver uses P-code on both L1 and L2 frequencies. When P-code is encrypted, the receiver uses C/A code on L1 and the L2 range is derived from Super-trak. Table A-4 lists the kinematic survey specifications for the 4000SSi receiver.

Table A-4. Kinematic Survey Specifications

Survey modes	Continuous or stop-and-go.
Accurac	2 cm + $10^{-6} \times$ baseline (typical with Compact L1/L2 Antenna without groundplane).
Minimum occupation time	Continuous: 1 second. Stop & Go: 2 seconds (with five satellites)

A.1.3 Differential GPS Positioning

Table A-5 lists the differential GPS positioning specifications for the 4000SSi receiver

Table A-5. Differential GPS Positioning Specifications

Accurac	Typically < 1 meter RMS horizontal and < 1.6 meter RMS vertical, assuming at least five satellites and PDOP < 4.

A.1.4 Navigation (Geodetic System Surveyor SSi Only)

Firmware supports waypoint-based route planning with deviation-from-track and distance-to-next-waypoint available for 99 waypoints.

A.2 Options

Table A-6 lists options that are available for Series 4000 receiver models, and shows which ones are accepted by the 4000SSi receiver. These options are described in more detail in the *Series 4000 Receiver Reference*.

- A check (✓) means that this option is standard on this model.
- *Opt* means that this option is available on this model, and may be installed by the user after purchase.
- *F/I* means that this option is available on this model, but must be factory-installed, either at the time of purchase or later.
- A dash (--) means that this option is not available on this model.

Table A-6. Options for the 4 0 0 0 S S

Option	Part #	4000SSi Geodetic Surveyor	4000SSi Geodetic System Surveyor	4000SSi Site Surveyor	Notes
Signal Preprocessing Options					
Maxwell technology	--	✓	✓	✓	Improves precision of all measurements.
Dual-Frequency	--	✓	✓	✓	Tracks both L1 and L2 carriers.
12 Channel	19425-00	*F/I*	*F/I*	*F/I*	Tracks 12 satellites instead of 9.
L2 P-Code	--	--	--	--	Tracks P-code on L2 carrier only.
L1/L2 P-Code	--	✓	✓	✓	Tracks P-code on both L1 and L2 carriers.
Carrier-Phase	--	✓	✓	✓	Computes SV range from carrier phase shift.
Super-trak	--	✓	✓	✓	Improves the acquisition of low power satellite signals, maintains better lock on signals once acquired, improves tracking under conditions of high RF interferenc , and provides L2 range.

Table A-6. Options for the 4000SSi (Continued)

Option	Part #	4000SSi Geodetic Surveyor	4000SSi Geodetic System Surveyor	4000SSi Site Surveyor	Notes
Memory Options					
1 MB memory	--	✓	--	--	Only one memory upgrade may be installed per receiver.
Upgrade to 2.5 MB	19363-00	*Opt*	--	*Opt*	
Upgrade to 5 MB	22767-07	*Opt*	--	*Opt*	
Upgrade to 10 MB	22767-12	*Opt*	--	*Opt*	
Upgrade to 20 MB	22767-22	*Opt*	--	*Opt*	
2.5 MB memory	--	--	✓	--	
Upgrade to 5 MB	22767-08	--	*Opt*	*Opt*	
Upgrade to 10 MB	22767-13	--	*Opt*	*Opt*	
Upgrade to 20 MB	22767-23	--	*Opt*	*Opt*	

Table A-6. Options for the 4000SSi (Continued)

Option	Part #	4000SSi Geodetic Surveyor	4000SSi Geodetic System Surveyor	4000SSi Site Surveyor	Notes
Input/Output Options					
Two Serial Port	--	✓	✓	✓	Provides two or four serial (RS-232) ports for inputting and outputting many kinds of data.
Four Serial Port	22046-00	--	*F/I*	--	
RTCM-104 Input	19378-03	*Opt*	✓	*Opt*	Enables use as a DGPS or Real-Time Kinematic (RTK) rover (RTK option required for Geodetic and Geodetic System Surveyors).
RTCM-104 Output	19379-03	*Opt*	*Opt*	*Opt*	Enables use as a DGPS or RTK base station.
NMEA-0183 Output	19382-01	*Opt*	✓	*Opt*	Provides serial output for communication with other navigation instruments.
1 PPS Output1	9377-01	*Opt*	✓	*Opt*	Provides precise 1 pulse/second electrical output.
Event Marker Input1	9376-01	*Opt*	✓	--	Logs time stamped events marked by keypad input or an external electrical pulse.
External Frequency Input	19388-01	--	*F/I*	--	Uses a high-precision external clock as timebase.

Table A-6. Options for the 4000SSi (Continued)

Option	Part #	4000SSi Geodetic Surveyor	4000SSi Geodetic System Surveyor	4000SSi Site Surveyor	Notes
Other Options					
Kinematic Functions	--	✓	✓	*Opt*	Conducts kinematic surveys.
Navigation Package	19375-01	*Opt*	✓	--	Provides multiple waypoints and other extended navigation features.
QA/QC	19384-01	*Opt*	*Opt*	*Opt*	Provides real-time accuracy statistics for position fixes.
RTK Functions	19390-01	*Opt*	*Opt*	✓	Conducts RTK surveys. Requires firmware for BOOT v3.30 and NAV v5.64 or above.
Remote Download	19371-01	*Opt*	*Opt*	--	Lets a computer download data files by remote command.
On-the-fly Initialization	24338-10	--	--	*Opt*	Enables initialization while moving for real-time survey operation.
Static/Data Logging	24818-00	--	--	*Opt*	Enables static surveying with data logging. Adds 1 MB memory.

A.3 Accessories and Spare Parts

The following tables list the accessories and spare parts that are available for the 4000SSi receiver.

Table A-7. Series 4000SSi Receivers

P/N	Description
24840-01	4000SSi Geodetic Surveyor.
24840-51	4000SSi Geodetic System Surveyor.
24840-21	4000SSi Site Surveyor

Table A-8. Batteries, Power Sources, and Cable

P/N	Description
13543-00	Rechargeable 6 ampere-hour external battery, with hard case and cable.
13542-00	Rechargeable 10 ampere-hour external battery, with soft case and cable.
17466	Rechargeable 2.3 ampere-hour external battery (camcorder battery).
17210-00	Battery module; holds two camcorder batteries. Attaches to bottom of receiver and requires no power cable.
20669-00	Office Support Module 2 (OSM2); a 100–240 VAC power adapter, data cable, and battery charger. Automatically adapts to local line voltage. Includes power cable and *Operation Manual.*
11017O	SM2 power cord for U.S. style outlets.
16668-00	General purpose power adapter; attaches the PWR – I/O 1 port to a 12 VDC terminal strip. Also provides a DE9S connector for access to one of the receiver's serial ports.
14109	Replacement fuse for general purpose power adapter or any rechargeable battery; a 5-ampere ATO automobile fuse.
14555-00	General purpose battery cable; LEMO 5-pin to terminal clips. Suitable for use on PWR – I/O 1 or PWR 2&3.

Table A-8. Batteries, Power Sources, and Cables (Continued)

P/N	Description
16474	Fused DC power cable.
18939	Dual input fused DC power cable; LEMO 5-pin to pigtails. Suitable for use on PWR 2&3 only.
18294	Dual camcorder battery input cable; LEMO 5-pin to battery clips. Connects one battery to each power port (POWER 2 and POWER 3).
21184	Quadruple battery input cable; LEMO 5-pin to battery clips. Connects two batteries to each power port (POWER 2 and POWER 3).
16041-00	Data and Power Connector Adapter; splits the PWR – I/O 1 connector into a LEMO 5-pin connector for power and a DE9S connector for serial port 1

Table A-9. Antennas and Acces s o r i e

P/N	Description
22020-00	Compact L1/L2 antenna without groundplane.
23033-00	Compact L1/L2 antenna with groundplane.
23903-00	Permanent Reference Station L1/L2 Geodetic antenna. Similar to the Compact L1/L2 antenna with groundplane, but intended for permanent installation. The groundplane is more heavily built and is not removable.
16046-10	Antenna kit with Compact L1/L2 antenna without groundplane, 10 meter antenna cable, antenna height measuring rod, and carrying pouch.
16046-00	Antenna kit; same as above, but with groundplane. The carrying pouch is a larger one that holds the antenna with groundplane attached.
17200-00	Modular antenna (a single-frequency antenna; mounts on receiver).
17198	Replacement measuring tape for Modular antenna.
19487	Quick-release bayonets (set of two).
19493	Quick-release adapter.

Table A-9. Antennas and Accessories (Continued)

P/N	Description
18604	Soft case for Modular antenna and Battery Module.
16217-00	Soft case for Compact L1/L2 antenna with groundplane.
23520	Carrying pouch for Compact L1/L2 antenna without groundplane.
16192	Carrying pouch for Compact L1/L2 antenna with groundplane.
18375	RTK initializer (holds two antennas at a fixed distance for RTK initialization).
12178	Tripod.
12179	Tribrach with optical plummet and tribrach adapter for threaded equipment.
12180	Tribrach adapter; a replacement or extra unit for use with the tribrach above.
16162	Antenna height measuring rod.
12920-00	Magnetic mount for temporarily attaching an antenna to ferrous surfaces.
18555	Rangepole with tripod support, softcase, quick release bayonet and adapter, and data collector bracket.
19488	Replacement rangepole.
16162	Antenna height measuring rod.
14553-00	10 meter antenna cable.
14553-01	5 meter antenna cable (RG-58 coax.).
16054-00	30-meter antenna cable extension with in-line amplifier (RG-213 coax).
14551-00	30-meter antenna cable (RG-213 coax).

Table A-10. Serial Data Cables

P/N	Description
18826	LEMO 5-pin to DE9S data cable.
18827	Serial data cable for port 1 or 3; 5 feet long, LEMO 7-pin to DE9S.
18826	Serial data cable for port 2 or 4; 5 feet long, LEMO 5-pin to DE9S.
16454	LEMO 7-pin to BNC adapter; for 1 PPS output an event marker input through the AUX port. Terminates in two BNC connectors, one for each type of data.
14284	RS-232 data download cable; a 6-foot DE9P to DE9S cable. Connects an OSM2 to a PC.
17202	Null modem cable (DE9P to DE9S).
16041-00	Data and power connector adapter; splits the PWR – I/O 1 connector into a LEMO 5-pin connector for power and a DE9S connector for serial port 1.

Table A-11. Software

P/N	Description
—	LOGST; software for external data logging on a PC. Accompanies the Memory Option, and thus is part of the standard 4000SSi receiver package.
19453-01	4000; software for downloading logged data to a PC. Accompanies the Memory Option, and thus is part of the standard 4000SSi receiver package.
21317-00	Post-Nav II; postprocessing software for precision positioning applications. Combines data logged by a base station and a rover to compute corrected position fixes. Has processing filters for low, medium, and high dynamic environments, and for steady state and static environments.

Table A-11. Software (Continued)

P/N	Description
13887-00	DeltaNav R; DGPS reference station software. Generates RTCM SC-104 corrections from satellite measurements. Allows more user interaction and control than the RCTM-104 Output Option available in receiver firmware.
13888-00	DeltaNav N; DGPS rover software. Computes corrected position fixes from RTCM SC-104 corrections and satellite measurements. Allows more user interaction and control than the RCTM-104 Input Option available in receiver firmware.
21586-00	DeltaNav QC; quality assurance / quality control software for precision positioning applications. Processes RTCM SC-104 corrections and satellite data from a GPS receiver in real time to provide accurate real-time position fixes, position accuracy statistics, and real-time fault detection and isolation. It also provides navigation functions, and can be interfaced with navigation equipment.
17939-01	TRIMVEC Plus: Postprocessing software for kinematic and static surveys and for multi-baseline static surveys.
19041-03	TRIMNET Plus: Least-squares network adjustment software for all types of baseline surveys. Note that this program is distributed only on 3 1/2 inch diskettes.
20484-11	GPSurvey, dual-frequency version: postprocessing software for static and FastStatic surveys. Includes TRIMNET Plus and several related utilities. Runs under Microsoft Windows. May be packaged with a receiver or purchased separately.
18788-00	PFINDER: Postprocessing software for precision positioning, mapping, and GIS data-acquisition applications using DGPS data. Can display GIS data and export data to other applications. Packaged with documentation and differential correction security key.

Table A-11. Software (Continued)

P/N	Description	
22055-01	TRIMMAP: Mapping software for all survey procedures. Supports use of a Survey Controller for surveying applications. Several optional TRIMMAP modules are available:	
	22064-01	TRIMCONTOUR (U.S. version): 3D ground modeling for contour plans.
	21971-01	TRIMCONTOUR (European version).
	22071-01	TRIMPROFILE: Profile and cross-section plotting system.
	22080-01	TRIMVOLUME: Volume calculation system.
	22088-01	TRIMCALC: 3D coordinate geometry system.
	22096-01	TRIMMOSS: Input and output of MOSS GENIO files.
	22104-01	TRIMDIGITIZE: Digitizes existing drawings.
	22112-01	TRIMSEISMIC: Seismic survey processing functions.
21688-10	Universal Reference Station (URS) for DOS; external data logging software for base stations.	
21688-00	Universal Reference Station (URS) for OS/2; external data logging software for base stations.	
22833-01	Quick Plan session planning software; computes satellite visibility schedules, elevations and azimuths, etc. Both Quick Plan and an enhanced version named Plan are included in the GPSurvey postprocessing package.	
24122-00	DATM4000 software; downloads configurations for the Local Datum/ Zones feature.	

Table A-12. Radio Links and Acce s s o r i e

P/N	Description
19605-01	TRIMTALK 900 Radio Package: radio/modem, Operation Manual, and software diskette. Suitable for use as a base station radio, rover radio, or repeater.
22884-00	7 dB radio antenna with mounting clamps and 2-foot cable. For use with a base station radio or repeater.
23031-00	Rover radio antenna with adapter.
21396-00	Antenna/adapter mounting kit; mounts antenna on a tripod. Primarily for use with a rover radio.
21322	50-foot power/communications cable; connects a base station radio's POWER I/O port to receiver's PWR – I/O 1 port.
21323	Same as 21322, but connects to receiver's I/O 2 port.
2029	73-foot power/communications cable; connects a rover radio's POWER I/O port to receiver's PWR – I/O 1 port.
21109	Same as 20297, but connects to receiver's I/O 2 port.
21109	Power cable; connects radio's POWER I/O port to a Series 4000 receiver's power connector. The radio may also be powered directly from a battery with any of the receiver power cables listed in Table A-8.

Table A-13. Other Accessor i e

P/N	Description
18607	Transport case; a ruggedized airline transport case with space for a receiver, camcorder batteries, OSM2, cables, and documentation.
18777-00	Receiver dust caps; a set of dustproof, watertight plastic caps for a receiver's LEMO connectors.
20966	Rigid frame receiver backpack, for FastStatic field operations.
18603	Lightweight backpack, for use with rover.
16454	LEMO 7-pin to dual BNC adapter for event mark input.

Table A-13. Other Accessories (Continued)

P/N	Description
18344-10	TRK48 keyboard; a remote handheld interface for data entry and display in kinematic surveys. Has no data storage capability.
20778-00	Survey Controller (640 KB memory). External data collector and interface cables for baseline surveying applications; supports kinematic, RTK, and DGPS procedures.
20778-04	Survey Controller (4 MB memory).
20778-10	Seismic Controller (640 KB memory). External data collector and interface cables for baseline surveying operations. Similar to the Survey Controller, but also supports an external graphics display for seismic surveying.
20778-14	Seismic Controller (4 MB memory).
20888-00	Asset Surveyor (640 KB memory). External data collector and interface cables for GIS data acquisition.
22165	Y-cable for connecting a receiver and an external sensing device to a data collector for GIS data acquisition.

Table A-14. Services

P/N	Description
26921-21	One-year warranty extension for 4000SSi Geodetic Surveyor, Geodetic System Surveyor, or Site Surveyor.
26921-24	Four-year warranty extension for 4000SSi receiver.
26922-11	One-year firmware update subscription for 4000SSi Geodetic Surveyor, Geodetic System Surveyor or Site Surveyor.
	Firmware update subscriptions provide updates made necessary by U.S. government-initiated changes in GPS. They also provide incremental improvements in the receiver firmware whichTrimble may implement over the four-year period, furnished upon request only. They do not cover new capabilities or major improvements to the product.
26922-14	Four-year firmware update subscription for Series 4000SSi receiver.

B The NAVSTAR Global Positioning System

This appendix briefly describes the NAVSTAR Global Positioning System (GPS), its capabilities, and its current status. For more information, see *GPS, A Guide to the Next Utilit* . The Bibliography of the *Series 4000 Receiver Reference* gives a complete citation.

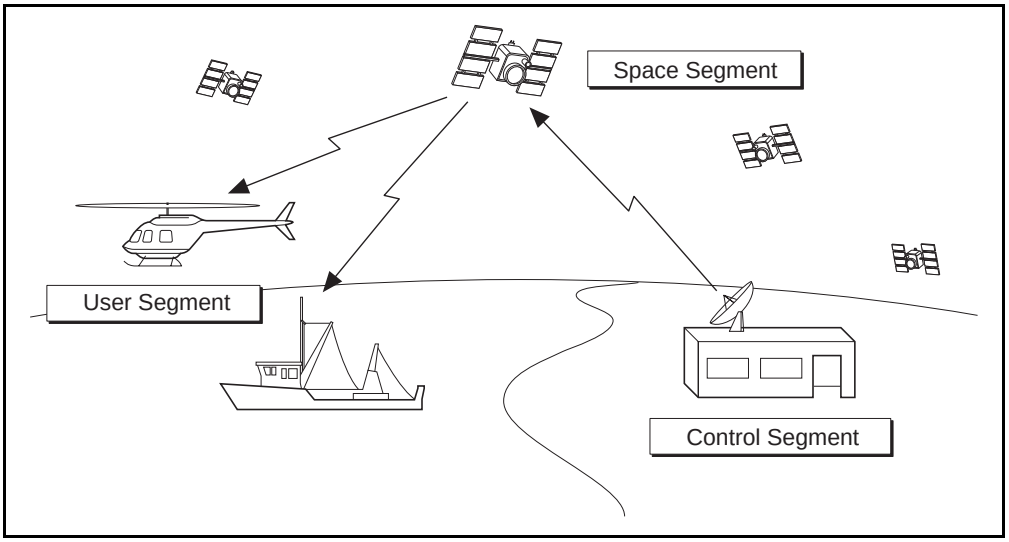


Figure B-1. Components of the NAVSTAR Global Positioning Syste

B.1 Components of the NAVSTAR GPS

Figure B-1 illustrates the major components of the NAVSTAR GPS.

The space segment consists of up to 24 satellites, each equipped with several high-precision frequency standards and radio equipment for receiving commands from and transmitting ranging and positioning data to the ground. Each satellite orbits the earth at an altitude of approximately 20,000 km and is usually visible for a period of several hours per transit. When the space segment is complete, from 6 to 11 satellites will be visible at any time and place.

The control segment consists of several ground stations of various types. Monitor stations continuously monitor the satellite signals for errors and changes. The Master Control station collects data from each monitor station, processes it, and prepares health and ephemeris data describing the satellites' behavior and orbit. The new data is then sent to the upload station, where it is uploaded (transmitted) to the satellites. Each satellite puts the new data into its Navigation Message and transmits it to users. Uploads are generally performed once a day for each satellite.

The user segment consists of the various GPS receivers that make use of data transmitted by the satellites. They are used for a variety of navigation and surveying applications on land and sea, in the air, and in space.

B.2 Signals Transmitted by GPS Satellites

GPS satellites transmit ranging and positioning data on two carrier-phase signals. The L1 signal is at a frequency of 1575.42 MHz. The L2 signal is at 1227.60 MHz.

Each satellite continuously broadcasts ranging and positioning information on both carriers. This information includes the satellite's ephemeris, the GPS time (which is similar to UTC), the satellite's clock behavior for the next day of operation, and status information on all satellites. The information, collectively called NAVDATA, is updated each hour, and is normally valid for the next four hours.

The L1 signal is modulated by two pseudorandom noise (PRN) ranging codes, Coarse/Acquisition code (C/A code) and the Precise code (P-code). The L2 signal is modulated with the P-code only. GPS receivers use these codes to determine their positions. Each satellite broadcasts a distinct PRN code so that a receiver can positively identify each satellite that it receives signals from.

B.3 How a GPS Receiver Determines Its Position

When a GPS receiver is operating, it continuously tracks available satellites, acquires new ones as they rise above the horizon, records the position information the satellites broadcast, and analyzes each satellite's PRN codes.

A GPS receiver makes distance (ranging) measurements by reproducing the PRN code transmitted by each satellite it is tracking, and measuring the delay between the code it generates and the code it receives. This delay is the propagation time of the signal. As a first approximation, the propagation time multiplied by the speed of light equals the distance to the satellite. Each of the ranges defines the radius of a sphere with the satellite at its center; ideally, all of the spheres intersect at one point, which is the position of the receiver.

In fact, atmospheric delays and numerous other factors introduce errors to this simple model of GPS. Most of the subtleties in the NAVSTAR system concern ways to compensate for such errors.

B.4 GPS Status

The GPS space segment is composed of a complete system of 24 production satellites (Block II) backed by replacement satellites (Block IIR). At this time, the system is deemed fully operational. The United States Government has stated that current NAVSTAR users do so at their own risk, and that the Government may change or end the operation of the NAVSTAR system at any time and without warning.

B.5 Selective Availability and Anti-Spoofing

The discussion of GPS satellite signals, above, mentioned that the signals include two PRN ranging codes. One code is the C/A code, transmitted on the L1 carrier only. This is an unencrypted code, and thus is available to all GPS users.

During periods when Selective Availability (S/A) is in effect, the C/A code includes a randomly varying offset which introduces errors of up to 100 meters RMS in a GPS receiver's apparent position.

The second PRN code is the P-code, transmitted on both the L1 and L2 carriers. During periods when Anti-Spoofing (AS) is in effect the P-code is encrypted, making it available only to authorized (primarily military) users. Encrypted P-code is often called Y-code.

Selective Availability and Anti-Spoofing are implemented only for Block II satellites. Both features apply to specific satellites on a variable, unannounced basis.

Certain Trimble receivers can make a specialized type of measurement of this Y-code information to retain their fully accuracy during AS.

C Serial Number Form

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

Table C-1. Receiver Information

Description	Serial Number	Part Number

Table C-2. Antenna Information

Description	Serial Number	Part Number

Table C-3. Power Source Information

Description	Serial Number	Part Number

Table C-4. Battery Information

Description	Serial Number	Part Number

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Reader Comment Form

Series 4000SSi User Guide **February 1995**
P/N: 26509-00 **Revision A**

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I use the following Trimble product _____

for _____

Please circle a response for each of the statements below:

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The manual is well organized.	1	2	3	4	5
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The information in the manual is accurate.	1	2	3	4	5
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The manual contains enough examples.	1	2	3	4	5
The examples are appropriate and helpful.	1	2	3	4	5
The layout and format are attractive and useful.	1	2	3	4	5
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Please answer the following questions:

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