USER GUIDE

Trimble® SPSx50 Modular GPS Receiver

Version 1.0
Revision B
March 2006

Trimble

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Legal Notices

Release Notice

This is the March 2006 release (Revision B) of the *SPSx50 Modular GPS Receiver User Guide*. It applies to version 1.0 of the SPSx50 Modular GPS receiver.

Limited Warranty Terms and Conditions

Product Limited Warranty

Subject to the terms and conditions set forth herein, Trimble Navigation Limited ("Trimble") warrants that for a period of (1) year from date of purchase this Trimble product (the "Product") will substantially conform to Trimble's publicly available specifications for the Product and that the hardware and any storage media components of the Product will be substantially free from defects in materials and workmanship.

Product Software

Product software, whether built into hardware circuitry as firmware, provided as a standalone computer software product, embedded in flash memory, or stored on magnetic or other media, is licensed and not sold. If accompanied by a separate end user license agreement, use of any such software will be subject to the terms of such end user license agreement (including any differing limited warranty terms, exclusions and limitations), which shall control over the terms and conditions set forth in this limited warranty).

Software Updates

During the limited warranty period you will be entitled to receive such Fix Updates and Minor Updates to the Product software that Trimble releases and makes commercially available and for which it does not charge separately, subject to the procedures for delivery to purchasers of Trimble products generally. If you have purchased the Product from an authorized Trimble distributor rather than from Trimble directly, Trimble may, at its option, forward the software Fix Update or Minor Update to the Trimble distributor for final distribution to you. Major Upgrades, new products, or substantially new software releases, as identified by Trimble are expressly excluded from this update process and limited warranty. Receipt of software updates shall not serve to extend the limited warranty period.

For purposes of this warranty the following definitions shall apply: (1) "Fix Update" means an error correction or other update created to fix a previous software version that does not substantially conform to its published specifications; (2) "Minor Update" occurs when enhancements are made to current features in a software program; and (3) "Major Upgrade" occurs when significant new features are added to software, or when a new product containing new features replaces the further development of a current product line. Trimble reserves the right to determine, in its sole discretion, what constitutes a significant new feature and Major Upgrade.

Warranty Remedies

If the Trimble Product fails during the warranty period for reasons covered by this Limited Warranty and you notify Trimble of such failure during the warranty period, Trimble at its option will repair OR replace the nonconforming Product, OR refund the purchase price paid by you for the Product, upon your return of the Product to Trimble in accordance with Trimble's standard return material authorization procedures.

How to Obtain Warranty Service

To obtain warranty service for the Product, please contact your Trimble dealer. Alternatively, you may contact Trimble to request warranty service at +1-408-481-6940 (24 hours a day) or e-mail your request to trimble_support@trimble.com. Please be prepared to provide:

- your name, address, and telephone numbers
- proof of purchase
- this Trimble warranty card
- a description of the nonconforming Product including the model number
- an explanation of the problem.

The customer service representative may need additional information from you depending on the nature of the problem.

Warranty Exclusions and Disclaimer

This Product limited warranty shall only apply in the event and to the extent that (i) the Product is properly and correctly installed, configured, interfaced, maintained, stored, and operated in accordance with Trimble's applicable operator's manual and specifications, and; (ii) the Product is not modified or misused. This Product limited warranty shall not apply to, and Trimble shall not be responsible for defects or performance problems resulting from (i) the combination or utilization of the Product with hardware or software products, information, data, systems, interfaces or devices not made, supplied or specified by Trimble; (ii) the operation of the Product under any specification other than, or in addition to, Trimble's standard specifications for its products; (iii) the unauthorized, installation, modification, or use of the Product; (iv) damage caused by: accident, lightning or other electrical discharge, fresh or salt water immersion or spray; or exposure to environmental conditions for which the Product is not intended; or (v) normal wear and tear on consumable parts (e.g., batteries). Trimble does not warrant or guarantee the results obtained through the use of the Product. NOTICE REGARDING PRODUCTS EQUIPPED WITH TECHNOLOGY CAPABLE OF TRACKING SATELLITE SIGNALS FROM SATELLITE BASED AUGMENTATION SYSTEMS (SBAS) (WAAS/EGNOS, AND MSAS), OMNISTAR, GPS, MODERNIZED GPS, OR GLONASS SATELLITES, OR FROM IALA BEACON SOURCES: TRIMBLE IS NOT RESPONSIBLE FOR THE OPERATION OR FAILURE OF OPERATION OF ANY SATELLITE BASED POSITIONING SYSTEM OR THE AVAILABILITY OF ANY SATELLITE BASED POSITIONING SIGNALS.

THE FOREGOING LIMITED WARRANTY TERMS STATE TRIMBLE'S ENTIRE LIABILITY, AND YOUR EXCLUSIVE REMEDIES, RELATING TO PERFORMANCE OF THE TRIMBLE PRODUCT. EXCEPT AS OTHERWISE EXPRESSLY PROVIDED HEREIN, THE PRODUCT AND ACCOMPANYING DOCUMENTATION AND MATERIALS ARE PROVIDED "AS-IS" AND WITHOUT EXPRESS OR IMPLIED WARRANTY OF ANY KIND, BY EITHER TRIMBLE OR ANYONE WHO HAS BEEN INVOLVED IN ITS CREATION, PRODUCTION, INSTALLATION, OR DISTRIBUTION, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TITLE, AND NONINFRINGEMENT. THE STATED EXPRESS WARRANTIES ARE IN LIEU OF ALL OBLIGATIONS OR LIABILITIES ON THE PART OF TRIMBLE ARISING OUT OF, OR IN CONNECTION WITH, ANY PRODUCT.

SOME STATES AND JURISDICTIONS DO NOT ALLOW LIMITATIONS ON DURATION OR THE EXCLUSION OF AN IMPLIED WARRANTY, SO THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

Limitation of Liability

TRIMBLE'S ENTIRE LIABILITY UNDER ANY PROVISION HEREIN SHALL BE LIMITED TO THE AMOUNT PAID BY YOU FOR THE PRODUCT. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL TRIMBLE OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGE WHATSOEVER UNDER ANY CIRCUMSTANCE OR LEGAL THEORY RELATING IN ANYWAY TO THE PRODUCTS, SOFTWARE AND ACCOMPANYING DOCUMENTATION AND MATERIALS, (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF DATA, OR ANY OTHER PECUNIARY LOSS), REGARDLESS OF WHETHER TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF ANY SUCH LOSS AND REGARDLESS OF THE COURSE OF DEALING WHICH DEVELOPS OR HAS DEVELOPED BETWEEN YOU AND TRIMBLE. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, THE ABOVE LIMITATION MAY NOT APPLY TO YOU.

PLEASE NOTE: THE ABOVE TRIMBLE LIMITED WARRANTY PROVISIONS WILL NOT APPLY TO PRODUCTS PURCHASED IN THOSE JURISDICTIONS, SUCH AS COUNTRIES OF THE EUROPEAN ECONOMIC COMMUNITY, IN WHICH PRODUCT WARRANTIES ARE OBTAINED FROM THE LOCAL DISTRIBUTOR. IN SUCH CASE, PLEASE CONTACT YOUR TRIMBLE DEALER FOR APPLICABLE WARRANTY INFORMATION.

Registration

To receive information regarding updates and new products, please contact your local dealer or visit the Trimble website at www.trimble.com/register. Upon registration you may select the newsletter, upgrade or new product information you desire.

Notices

Class B Statement – Notice to Users. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules and Part 90. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

Canada

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

This apparatus complies with Canadian RSS-310, RSS-210, and RSS-119.

Cet appareil est conforme à la norme CNR-310, CNR-210, et CNR-119 du Canada.

Europe

This product (the SPSx50 Modular GPS receiver) is intended to be used in all EU member countries.

This product has been tested and found to comply with the requirements for a Class B device pursuant to European Council Directive 89/336/EEC on EMC, thereby satisfying the requirements for CE Marking and sale within the European Economic Area (EEA). Contains Infineon radio module PBA 31307. These requirements are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential or commercial environment.

Australia and New Zealand

This product conforms with the regulatory requirements of the Australian Communications Authority (ACA) EMC framework, thus satisfying the requirements for C-Tick Marking and sale within Australia and New Zealand.

Taiwan – Battery Recycling Requirements

The product contains a removable Lithium-ion battery. Taiwanese regulations require that waste batteries are recycled.

廢電池請回收

Directive 1999/5/EC

Hereby, Trimble Navigation, declares that the SPSx50 GPS Receiver is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Notice to Our European Union Customers

For product recycling instructions and more information, please go to www.trimble.com/ev.shtml.

Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power.), Call +31 497 53 24 30, and ask for the "WEEE Associate". Or, mail a request for recycling instructions to:

Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

Declaration of Conformity

We, Trimble Navigation Limited,

935 Stewart Drive
PO Box 3642
Sunnyvale, CA 94088-3642
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declare under sole responsibility that the products:
SPSx50 Modular GPS receiver, NetR5
comply with Part 15 of FCC Rules.

Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation.

Safety Information

Before you use your Trimble® SPS GPS receiver, make sure that you have read and understood all safety requirements.

Regulations and safety

The receivers contain an internal radio-modem and can send signals through Bluetooth® wireless technology (SPSx50 Modular GPS receiver and the SPSx80 Smart GPS antenna only) or through an external data communications radio. Regulations regarding the use of the radio-modems vary greatly from country to country. In some countries, the unit can be used without obtaining an end-user license. Other countries require end-user licensing. For licensing information, consult your local Trimble dealer.

Before operating an SPSx50 Modular GPS receiver or SPSx80 Smart GPS antenna, determine if authorization or a license to operate the unit is required in your country. It is the responsibility of the end user to obtain an operator's permit or license for the receiver for the location or country of use.

For FCC regulations, see Notices, page iii.

Type approval

Type approval, or acceptance, covers technical parameters of the equipment related to emissions that can cause interference. Type approval is granted to the manufacturer of the transmission equipment, independent from the operation or licensing of the units. Some countries have unique technical requirements for operation in particular radio-modem frequency bands. To comply with those requirements, Trimble may have modified your equipment to be granted Type approval. Unauthorized modification of the units voids the Type approval, the warranty, and the operational license of the equipment.

Exposure to radio frequency radiation

For 450 MHz radio

Safety. Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in General Docket 79-144 on March 13, 1986.

Proper use of this radio modem results in exposure below government limits. The following precautions are recommended:

- ***DO NOT*** operate the transmitter when someone is 20 cm (7.8 inches) of the antenna.
- ***DO NOT*** operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.

- ***DO NOT*** operate the equipment near electrical blasting caps or in an explosive atmosphere.
- All equipment must be properly grounded according to Trimble installation instructions for safe operation.
- All equipment should be serviced only by a qualified technician.

For license-free 900 MHz radio

CAUTION – For your own safety, and in terms of the RF Exposure requirements of the FCC, always observe the precautions listed here.

- Always maintain a minimum separation distance of 20 cm (7.8 inches) between yourself and the radiating antenna on the SPSx50 radio-modem.
- Do not co-locate the antenna with any other transmitting device.

For Bluetooth radio

The radiated output power of the internal Bluetooth wireless radio is far below the FCC radio frequency exposure limits. Nevertheless, the wireless radio shall be used in such a manner that the Trimble receiver is 20 cm or further from the human body. The internal wireless radio operates within guidelines found in radio frequency safety standards and recommendations, which reflect the consensus of the scientific community. Trimble therefore believes the internal wireless radio is safe for use by consumers. The level of energy emitted is far less than the electromagnetic energy emitted by wireless devices such as mobile phones. However, the use of wireless radios may be restricted in some situations or environments, such as on aircraft. If you are unsure of restrictions, you are encouraged to ask for authorization before turning on the wireless radio.

Installing antennas

CAUTION – For your own safety, and in terms of the RF Exposure requirements of the FCC, always observe these precautions:
– Always maintain a minimum separation distance of 20 cm (7.8 inches) between yourself and the radiating antenna.
– Do not co-locate the antenna with any other transmitting device.

This device has been designed to operate with the antennas listed below, and having a maximum gain of 5 dBi. Antennas not included in this list, or having a gain greater than 5 dBi, are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

The antennas to be used with the 450 MHz radio are 0 dBi and 5 dBi whip antennas. The antennas to be used with the 900 MHz radio are 0 dBi, 3 dBi, and 5 dBi whip antennas.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

Battery safety

WARNING – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage.
To prevent injury or damage:
– Do not use or charge the battery if it appears to be damaged. Signs of damage include, but are not limited to, discoloration, warping, and leaking battery fluid.
– Do not expose the battery to fire, high temperature, or direct sunlight.
– Do not immerse the battery in water.
– Do not use or store the battery inside a vehicle during hot weather.
– Do not drop or puncture the battery.
– Do not open the battery or short-circuit its contacts.

WARNING – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.
To prevent injury or damage:
– If the battery leaks, avoid contact with the battery fluid.
– If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
– If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.

WARNING – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.
To prevent injury or damage:
– Do not charge or use the battery if it appears to be damaged or leaking.
– Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
– Discontinue charging a battery that gives off extreme heat or a burning odor.
– Use the battery only in Trimble equipment that is specified to use it.
– Use the battery only for its intended use and according to the instructions in the product documentation.

Contents

CHAPTER

1

Introduction

Welcome to the *SPSx50 Modular GPS Receiver User Guide*. This manual describes how to set up and use the Trimble® SPSx50 Modular GPS receivers.

The SPS GPS receivers is a family of receivers that comprise the SPSx50 Modular GPS receivers, SPS770 GPS receivers, and the SPSx80 Smart GPS antennas. Where necessary, this manual contains references to specific receivers in the product family. When information is specific to a particular model, then the specific model name is used.

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

About the SPSx50 receivers

The SPSx50 Modular GPS receiver family comprises the following receivers:

- SPS550
- SPS550H
- SPS750 Basic base
- SPS750 Basic rover
- SPS750 Max
- SPS850 Extreme

SPS550 GPS receiver

The Trimble SPS550 is a dual-frequency location GPS receiver. The SPS550 can operate as a DGPS reference station or as a DGPS rover receiver, and can use Satellite Based Augmentation Systems (SBAS). The receiver can also function as a rover receiver that uses OmniSTAR XP or HP correction services. The SPS550 is ideal for mobile applications on marine vessels and site vehicles where Real-Time Kinematic (RTK) accuracy is not needed. The SPS550 can be used with the SPS550H GPS receiver to provide both position and precise heading solutions for marine applications.

SPS550H GPS receiver

The Trimble SPS550H is an add-on receiver that can be combined with the SPS550, SPS750 Max, or SPS850 Extreme to provide a precise heading capability using Trimble moving base technology.

SPS750 GPS receiver

The Trimble SPS750 is a dual-frequency GPS receiver with the ability to receive OmniSTAR corrections. The receiver is available in the following configurations:

- SPS750 Basic base
- SPS750 Basic rover
- SPS750 Max

The SPS750 can be configured using the keypad and display, a web browser, or the Trimble SCS900 Site Controller software. The SPS750 makes it easy to set up a mobile base station or a

permanent base station for continuous operation. The SPS750 is also an ideal mobile receiver for semi-permanent mounting on vehicles and marine vessels.

SPS850 Extreme GPS receiver

The Trimble SPS850 Extreme is a triple-frequency GPS plus GLONASS receiver with the ability to receive OmniSTAR corrections. The SPS850 Extreme can operate as a base station or rover. The receiver can be configured using the keypad and display, web browser, or Trimble SCS900 Site Controller software. The SPS850 Extreme makes it easy to set up a mobile base station or a permanent base station for continuous operation. The SPS850 Extreme is also an ideal mobile receiver for semi-permanent mounting on vehicles and marine vessels.

Related Information

Sources of related information include the following:

- Help – The SCS900 Site Controller software has built-in, context-sensitive help that lets you quickly find the information you need. Access it from the *Help* menu. Alternatively, click the **?** button in a dialog, or press F1. On a Microsoft® Windows® CE device, select *Start* / *Help*.
- Release notes – The release notes describe new features of the product, information not included in the manuals, and any changes to the manuals. They are provided as a .pdf file on the *Trimble SPS GPS Receiver CD*.
- Trimble training courses – Consider a training course to help you use your GPS system to its fullest potential. For more information, go to the Trimble website at www.trimble.com/training.html.

Technical Support

If you have a problem and cannot find the information you need in the product documentation, contact your local dealer. Alternatively, go to the Support area of the Trimble website (www.trimble.com/support.shtml). Select the product you need information on. Product updates, documentation, and any support issues are available for download.

If you need to contact Trimble technical support, complete the online inquiry form at www.trimble.com/support_form.asp.

Your Comments

Your feedback about the supporting documentation helps us to improve it with each revision. E-mail your comments to ReaderFeedback@trimble.com.

CHAPTER

2

Features and Functions

In this chapter:

Trimble SPSx50 Modular GPS receivers are ideal for the following infrastructure development, site development, and marine construction applications:

- Mobile base station for RTK or DGPS applications
- Permanent base station for Virtual Reference Station (VRS™), RTK, or DGPS applications (SPS550, SPS750, and SPS850 only).

Note – The permanent base station for VRS requires an option to be enabled. For more information, please contact your Trimble dealer.

- RTK rover on rod, backpack, site vehicle, or marine vessel
- Site and marine location applications using OmniSTAR HP or XP corrections
- Site and marine location applications using DGPS RTCM corrections

You can use the SPSx50 Modular GPS receivers with the Trimble SCS900 Site Controller software.

These receivers all feature a keypad and display so you can configure the receiver without using a controller or computer.

All the receivers can record GPS data to the internal memory, and optionally transfer the data over a USB or serial connection, or download data through an Ethernet connection.

SPS550 features

The receiver provides the following features:

- Location GPS – Sub-meter DGPS rover and base station capability
- Decimeter accuracy when using RTK corrections by radio link or VRS
- OmniSTAR XP/HP for a base station free service
- Optional internal 450 MHz (3 frequency bands) radio with transmit and receive capability (SPS550 only)
- Optional internal 900 MHz radio with transmit and receive capability (SPS550 only)
- WAAS/EGNOS and MSAS Satellite Based Augmentation (SBAS) compatibility
- 24-channel L1/L2 GPS receiver – Single-frequency GPS for DGPS position solution and dual-frequency GPS for OmniSTAR XP/HP and heading solution
- Long-life integrated battery, typically 10 hours operation as a base station or 12 hours as a rover
- Integrated display and keypad for rapid system configuration and status checking, without the need for a controller
- Integrated Bluetooth wireless technology for cable-free configuration and operation with a controller
- Ethernet support, so that the receiver can be configured remotely across an Ethernet network or the Internet
- Attached or external radio antenna option for rover or "High Gain" base station operation
- Small, lightweight design – 1.65 kg (3.64 lbs) receiver only, with battery
- Permanent/semi-permanent and mobile quick setup DGPS base station capability
- The ability to broadcast corrections through multiple radio links from one base station receiver (for example, through an internal 450 MHz radio and an external 900 MHz radio)
- Tough aluminum housing
- IP67 environmental rating
- –40° C to +65° C (–40° F to +149° F) operating temperature range
- 9 V to 30 V DC input power range, with over-voltage protection
- Two-line, 16-character VFD (Vacuum Fluorescent Display) display

SPS550H features

The SPS550H receiver provides the following features:

- Precise Heading Add-on GPS receiver
- 24-channel L1/L2 GPS receiver for heading solution
- Long-life integrated battery, typically 12 hours as a rover
- Integrated display and keypad for rapid system configuration and status checking, without the need for a controller
- Integrated Bluetooth wireless technology for cable-free configuration and operation with a controller
- Ethernet support, so that the receiver can be configured remotely across and Ethernet network or the Internet
- Dual-frequency antenna, dual SPS receiver mounting frame, and interconnecting cable
- Small, lightweight design – 1.65 kg (3.64 lbs) receiver only, with battery
- Tough aluminum housing
- IP67 environmental rating
- –40° C to +65° C (–40° F to +149° F) operating temperature range
- 9 V to 30 V DC input power range, with over-voltage protection
- Two-line, 16-character VFD (Vacuum Fluorescent Display) display

SPS750 features

The SPS750 receiver provides the following standard features. For features specific to each model, see below.

SPS750 standard features

- Integrated GPS receiver and radio
- 450 or 900 MHz radio:
  - SPS750 Max has transmit and receive capabilities
  - Basic base has transmit capabilities only
  - Basic rover has receive capabilities only
- 24-channel L1/L2 GPS receiver
- OmniSTAR XP and HP service capability

- WAAS/EGNOS (Wide Area Augmentation System/European Geo-Stationary Navigation System), and MSAS Satellite Based Augmentation (SBAS) compatibility
- Long- life integrated battery, typically 10 hours operation as a base station or 12 hours as a rover
- Operation parameters configured using the WinFlash utility, Trimble SCS900 Site Controller software, the integrated display and keyboard for system configuration with a controller, or the Web receiver interface
- Integrated Bluetooth wireless technology for cable-free configuration and operation with a controller
- External GPS antenna choice for base station or rover operation
- Attached or external radio antenna option for rover or high-gain base station radio operation
- Small, lightweight design – 1.65 kg (3.64 lbs) receiver only, with battery; 4 kg (8.82 lbs) complete system weight (rover including controller and rod)
- Permanent/semi-permanent and mobile quick setup base station capability
- Backpack, belt, rod, truck, and marine vessel mounting options for rover applications
- Capable of all site measurement and stakeout operations within 1.5 km (SPS750 Basic) and typically >5 km (SPS750 Max)
- Easy-to-use menu system for rapid configuration and status checking
- AutoBase™ technology for rapid and automated repeated daily base station setups
- Ethernet support, so that the receiver can be configured remotely across and Ethernet network or the Internet
- The ability to broadcast corrections via multiple radio links from one base station receiver (for example, via an internal 450 MHz radio and an external 900 MHz radio)
- Two-line, 16-character VFD (Vacuum Fluorescent Display) display
- CAN (Controller Area Network) support
- Rugged, weatherproof construction with an IP67 environmental rating
- –40° C to +65° C (–40° F to +149° F) operating temperature range
- 9 V DC to 30 V DC input power range, with over-voltage protection

SPS750 Basic

- Base station only, or Rover only, operation

SPS750 Basic base

- Entry-level, low cost RTK base station
- Unrestricted operational range for rovers and grade control systems
- Integrated transmit-only radio
- Easily upgraded to the SPS750 Max

SPS750 Basic rover

- Entry-level, low cost RTK rover receiver
- 2 Hz measurement update rate
- 2.4 km (1.5 mile) operational range from the base station
- Integrated receive-only radio
- Ideal for contractors new to GPS as a starter system or for operating multiple small projects
- Easily upgraded to the SPS750 Max

SPS750 Max

- RTK base station and rover operation in a single receiver
- Integrated receive/transmit radio
- 5 or 10 Hz measurement update rate
- Unrestricted rover operation range from a base station
- Operates within a VRS network, for base station-free rover capability
- For marine applications: Moving baseline and heading capability when a Max or Extreme receiver is combined with an SPS550H GPS receiver or an RTK rover-capable SPSx50 GPS receiver

SPS850 Extreme features

The SPS850 Extreme receiver provides the following features:

- Integrated GPS receiver and radio
- 450 or 900 MHz radio with transmit/receive capability
- 72-channel L1/L2/L2C/L5 GPS plus L1/L2 GLONASS receiver
- OmniSTAR XP and HP service capability

- WAAS/EGNOS, and MSAS Satellite Based Augmentation (SBAS) compatibility
- Long- life integrated battery, typically 10 hours operation as a base station or 12 hours as a rover
- Integrated display and keypad for system configuration without a controller
- Integrated Bluetooth wireless technology for cable-free configuration and operation with a controller
- External GPS antenna choice for base station or rover operation
- Attached or external radio antenna option for rover or "High Gain" base station operation
- Small, lightweight design – 1.65 kg (3.64 lbs) receiver only, with battery; 4 kg (8.82 lbs) complete system weight (rover including controller and rod)
- Permanent/semi-permanent and mobile quick setup base station capability
- Backpack, belt, rod, truck, and marine vessel mounting options for rover applications
- Within radio or cellular phone coverage, full site measurement and stakeout capability
- Rover operation capability within a VRS (Virtual Reference Station) network
- Easy-to-use menu system for rapid configuration and status checking
- AutoBase technology for rapid and automated repeated daily base station setups
- The ability to broadcast corrections via multiple radio links from one base station receiver (for example, via an internal 450 MHz radio and an external 900 MHz radio)
- Two-line, 16-character VFD (Vacuum Fluorescent Display) display
- Rugged, weatherproof construction with an IP67 environmental rating
- –40° C to +65° C (–40° F to +149° F) operating temperature range
- 9 V to 30 V DC input power range, with over-voltage protection

Base station

- Unrestricted operational range for rovers and grade control systems
- Base station and rover operation in a single receiver
- Integrated receive/transmit radio
- Integrated Ethernet and IP capability facilitates base station and receiver configuration over the Internet or via Ethernet connection on a computer network

- For marine applications: Moving baseline and heading capability when a Max or Extreme receiver is combined with an SPS550H GPS receiver or an RTK rover-capable SPSx50 GPS receiver

Rover

- 5, 10, or 20 Hz measurement update rate
- Unrestricted rover operation range from a base station
- Base station-free rover capability within a VRS network
- Base station-free rover capability using OmniSTAR HP or XP services, with <30 cm (1 ft) accuracy
- Ideal for contractors who operate mid to large size projects with machine control

Use and care

This product is designed to withstand the rough treatment and tough environment that typically occurs in construction applications. However, the receiver is a high-precision electronic instrument and should be treated with reasonable care.

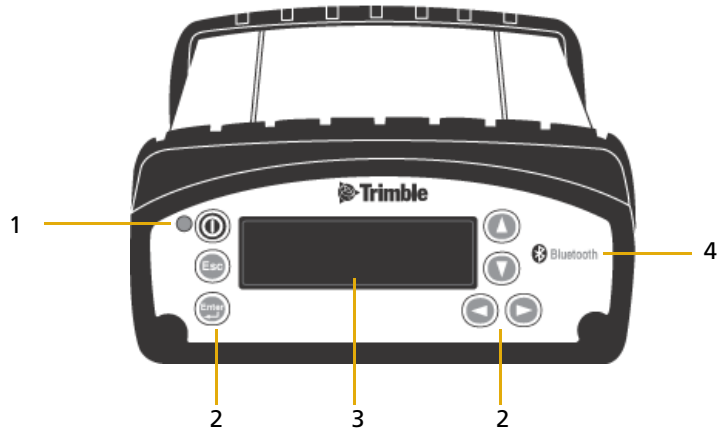
CAUTION – Operating or storing the receiver outside the specified temperature range can damage it. For more information, see Chapter 10, Specifications.

COCOM limits

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

- Immediate access to satellite measurements and navigation results is disabled when the receiver velocity is computed to be greater than 1000 knots, or its altitude is computed to be above 18 000 meters. The receiver GPS subsystem resets until the COCOM situation clears. As a result, all logging and stream configurations stop until the GPS subsystem is cleared.

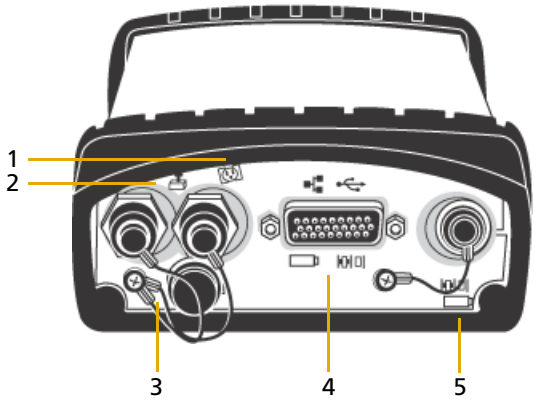
Keypad and display



	Feature	Description
1	Power LED	Indicates if the receiver is turned on or off.
2	Buttons	Used to turn on and configure the receiver (see Button functions, page 60).
3	Display	The receiver has a Vacuum Fluorescent Display. This display allows you to see how the receiver is operating and view the configuration settings.
4	Bluetooth antenna	Location of the Bluetooth antenna.

Figure 2.1 Front view of the SPSx50 GPS receiver

Rear connectors



	Connector type	Description
1	TNC	Connect to the GPS antenna
2	• TNC (450 MHz Internal radio) • Reverse polarity TNC (900 MHz internal radio) • Not installed, system without internal radio	Connect to the radio antenna
3	Vent plug VENT: TO NOT REMOVE	External venting plug for pressure equalization
4	High Density DB26	• Ethernet connectivity to a 10/100 Base-T network through an RJ45 jack on a multiport adaptor (P/N 57167) • 'Slave' USB communications through the USB type B connector on the Multiport adaptor (P/N 57167) • 'Host' USB communications through the USB type A connector on the 26-pin to Hirose adaptor (P/N 56653) and Hirose to USB type A cable (P/N 73841001) • Primary power from a Trimble AC/DC power supply (P/N 48800-00) using the multiport adaptor (P/N 57167) • Power input from an SPS700 total station battery cradle system using the adaptor (P/N 56653) • Full 8 wire RS-232 serial communications using the 26-9-pin multiport adaptor (P/N 57168) or a 26-pin serial communications cable • 3 wire RS-232 serial adaptor
5	Lemo (7-pin/ 0-shell)	• 3 wire RS-232 serial communications using a 7-pin/ 0 shell Lemo cable • Secondary power from a Trimble battery (P/N 32364-00 or 32365-00) or a 12 V battery using the Fused Lemo Power Cable (P/N 46125-00) • CAN

Figure 2.2 Rear view of the SPSx50 GPS receiver

CHAPTER

3

Batteries and Power

In this chapter:

- External power
- Battery safety
- Battery performance
- Charging the Lithium-ion battery
- Storing the Lithium-ion battery
- Removing the rechargeable Lithium-ion battery
- Operating the receiver with a Trimble controller

The SPSx50 GPS receiver uses an internal rechargeable Lithium-ion battery, which can be replaced only at an Authorized Trimble Service Center.

The receiver can also be powered by an external power source that is connected to the Lemo or modem port.

The operational time provided by the internal battery depends on the type of measurement and operating conditions. Typically, the internal battery provides 10 hours operation as a base station and 12 hours as a rover during measurement operations using the internal radio.

Note – *All battery operation tests are carried out with new, fully charged batteries at room temperature and full receiver configuration operational. Older batteries, at temperatures significantly higher or lower than room temperature, will have a reduced performance. Receivers operating with reduced configuration will have a higher performance.*

External power

The GPS receiver uses an external power source in preference to its internal batteries. If the receiver is not connected to an external power source, or if the external power supply fails, the internal batteries are used.

While carrying out static measurements for postprocessed computations using the internal memory, if no external power is supplied and the internal battery is drained, the receiver shuts down. No data is lost and when power is restored, the receiver restarts in the same status as it was when power was lost.

Battery safety

The receiver is powered by a rechargable internal Lithium-ion battery. Charge and use the battery only in strict accordance with the instructions below.

WARNING – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage.
To prevent injury or damage:
– Do not use or charge the battery if it appears to be damaged. Signs of damage include, but are not limited to, discoloration, warping, and leaking battery fluid.
– Do not expose the battery to fire, high temperature, or direct sunlight.
– Do not immerse the battery in water.
– Do not use or store the battery inside a vehicle during hot weather.
– Do not drop or puncture the battery.
– Do not open the battery or short-circuit its contacts.

WARNING – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.
To prevent injury or damage:
– If the battery leaks, avoid contact with the battery fluid.
– If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
– If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.

Battery performance

To optimize battery performance and extend battery life:

- Fully charge all new batteries before use.
- Batteries perform best when they are not used at extreme temperatures. The receiver is designed to operate at –40 °C to +65 °C (–40 °F to +149 °F). However, operation at temperatures of less than 0 °C (32 °F) can cause a rapid drop in battery life.
- Do not allow a battery that is in storage to discharge to below 5 V.

Charging the Lithium-ion battery

The rechargeable Lithium-ion battery is supplied partially charged. Charge the battery completely before using it for the first time. If the battery has been stored for longer than three months, charge it before use.

The internal battery charges fully in 8 hours when connected to a suitable power source.

WARNING – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.
To prevent injury or damage:
– Do not charge or use the battery if it appears to be damaged or leaking.
– Charge the Lithium-ion battery only with a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
– Discontinue charging a battery that gives off extreme heat or a burning odor.
– Use the battery only in Trimble equipment that is specified to use it.
– Use the battery only for its intended use and according to the instructions in the product documentation.

Storing the Lithium-ion battery

If you must store a Lithium-ion battery for long periods, make sure that it is fully charged before it is stored, and that you charge it at least once every three months while it is stored.

Do not allow a battery that is in storage to discharge to below 5 V. A battery that reaches deep discharge level (5 V or less) cannot be recharged and must be replaced. (To protect a battery that is in use from deep discharge, the receiver switches power sources or stops drawing power when the battery pack discharges to 5.9 V.)

All batteries discharge over time when not in use, and they discharge faster in colder temperatures. Do not store the receiver at temperatures outside the range –40 °C to +70 °C (–40 °F to +158 °F).

The SPSx50 receiver has an internal Lithium-ion battery. The internal battery will only charge from an external power source that delivers more than 15 volts, for example, an AC power adaptor. The receiver is supplied with a mains power supply unit that recharges the battery inside the receiver when it is connected through the adaptor to the modem port or the Lemo port. When you use the receiver on large projects, from a permanent or semi-permanent base station location in a site trailer, Trimble recommends that you use this power supply at all times to keep the internal battery charged. This provides an uninterrupted power supply and will keep the site operational for more than 10 hours after a power failure.

Keep all batteries on continuous charge when not in use. You can keep batteries on charge indefinitely without damage to the receiver or to the batteries.

Removing the rechargeable Lithium-ion battery

The internal Lithium-ion battery should be removed only at an authorized Trimble Service Center. If the battery is removed at an unauthorized service center, the remaining warranty on the product will be void.

Operating the receiver with a Trimble controller

You can operate an SPS GPS receiver with any Trimble controller, for example, a TSC2 or TCU controller, that is running the SCS900 software. Typically, the receiver and the controller operate from their own individual power sources. The receiver and controller can communicate through Bluetooth wireless technology and can be connected without a cable. However, if a cable is required, the following information indicates which cable to use with which controller:

Controller	Cable	Controller connector	Receiver connector
TSC2	P/N 18532	DSub9	DSub9
TCU	P/N 5302007	6H (Marked "Com" on the controller GPS holder)	DSub9
TCU (alternative connection)	P/N 53004007	6H (Marked "Com" on the controller GPS holder)	7OS

CHAPTER

4

Setup Guidelines

In this chapter:

- Base station operation guidelines
- Rover operation guidelines

GPS Real-Time Kinematic (RTK) operation provides centimeter-level accuracy by eliminating errors that are present in the GPS system. For all RTK operations, you require both a base station and a rover receiver.

This chapter introduces the concepts of base station and rover operation, provides information to help you identify good setup locations, describes best practices for setting up the equipment, and outlines the precautions that you need to take to protect the equipment.

Note *– This chapter provides setup information for all the receivers in the SPS GPS receiver family.*

Base station operation guidelines

A base station consists of a receiver that is placed at a known (and fixed) position. The receiver tracks the same satellites that are being tracked by the rover receiver, at the same time that the rover is tracking them. Errors in the GPS system are monitored at the fixed (and known) base station, and a series of position corrections are computed. The corrections are sent through a radio link to the rover receiver, where they are used to correct the real time positions of the rover.

Base station components

The base station has the following components:

- GPS receiver
- GPS antenna
- Base station radio
- Power supply

GPS receiver and GPS antenna

The base station GPS receiver can be one of following types:

- A Smart GPS antenna, such as the SPSx80, which incorporates a GPS receiver, GPS antenna, power supply, and base station radio into a single compact unit. A Smart GPS antenna can be rapidly set up on a tripod, fixed height tripod, or T-Bar anywhere that is convenient on the jobsite.
- A Modular GPS receiver, such as the SPSx50, which incorporates a GPS receiver, power supply, and base station radio in a single unit. The GPS antenna (and, optionally, the base station radio antenna) is separate from the receiver. Because the GPS antenna is separate, you can use the following optimized components:
  - a geodetic antenna with large ground plane, to eliminate multipath (the major source of GPS errors) at the base station
  - a high gain or directional radio antenna, to increase broadcast range and to provide maximum coverage

  You can also place a modular GPS receiver in an easily accessible and secure location, safe from theft and the weather, while the antennas are placed high on a tower or building, clear of obstructions and able to deliver maximum performance.

You can use either type of receiver in a permanent, semi-permanent, or daily quick setup configuration. If semi-permanent or permanent operation is required, however, the modular receiver delivers significant advantages.

Base station setup guidelines

For good performance, observe the following base station setup guidelines:

- Place the GPS receiver in a location on the jobsite where equal range in all directions provides full coverage of the site. This is more important on larger jobsites, where the broadcast range of the base station radio may limit the operations of the GPS system.
- Place the GPS antenna in a location that has a clear line of sight to the sky in all directions. Do not place the GPS antenna near vertical obstructions such as buildings, deep cuttings, site vehicles, towers, or tree canopy.
- Place the GPS and radio antennas as high as practical. This minimizes multipath from the surrounding area, and enables the radio to broadcast to the maximum distance.

Note – *The GPS antenna must have a clear line of sight to the sky at all times during operation.*

- Choose the most appropriate radio antenna for the size and footprint of the site. The higher the gain on the antenna, the longer the range. If there is more focus on the transmission signal, there is a reduced coverage area. A 3 db or 5 db gain antenna provides a mix of good range and reasonable directional coverage.
- Make sure that the GPS receiver does not lose power. The GPS receiver has an integrated battery, which has to be charged. To operate for the full day without loss of power at the base station, provide external power. Sources of external power include:
  - AC power
  - 12 V car or truck battery
  - Trimble custom external battery pack
  - Generator power
  - Solar panel

  When you use an external power supply, the integrated battery provides a backup power supply, enabling you to maintain continuous operation through a mains power failure.

  When the GPS receiver is connected to a power source greater than 15 V, the integrated battery is continuously charged from the connected power source. This helps to ensure that the battery stays charged (SPS770 and SPSx50 only).
- Do not locate a GPS receiver, GPS antenna, or radio antenna within 400 meters (about 1312 feet) of:
  - a powerful radar, television, or cellular communications tower
  - another transmitter
  - another GPS antenna

Cellular phone towers can interfere with the base station radio broadcast and can stop corrections from reaching the rover receiver. High-power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits. This does not harm the receiver, but can prevent the receiver electronics from functioning correctly.

Low-power transmitters, such as those in cellular phones and two-way radios, do not interfere with receiver operations.

- Do not set up the base station directly beneath or close to overhead power lines or electrical generation facilities. The electromagnetic fields associated with these utilities can interfere with GPS receiver operation. Other sources of electromagnetic interference include:
  - Gasoline engines (spark plugs)
  - Televisions and computer monitors
  - Alternators and generators
  - Electric motors
  - Equipment with DC-to-AC converters
  - Fluorescent lights
  - Switching power supplies
- Place the GPS receivers in a protected and secure location. If the base station is in the center of a jobsite where heavy machinery is operating, place flags around the base station to warn operators of its existence.
- If you place the SPSx50 Modular GPS receiver or SPS770 GPS receiver in a lock box on the jobsite to protect the receiver from theft or from the weather, shield the lock box from direct sunlight and provide ventilation for the receiver through an inlet and extractor fan. A receiver that has a broadcast radio generates significant heat. Do not allow the temperature in the box to exceed 65 °C (149 °F).

  If working in a cold climate, you may need to provide heat to the receiver. Do not operate the receiver below –40 °C (–40 °F).
- Trimble recommends that, wherever possible, you keep GPS receiver equipment dry. The receivers are designed to withstand wet weather, but keeping them dry prolongs their life and reduces the effects of corrosion on ports and connectors. If the equipment gets wet, use a clean dry cloth to dry the equipment, and then leave the equipment open to the air to dry. Do not lock wet equipment in a transport case for prolonged periods. Avoid exposing the GPS receiver to corrosive liquids and salt water wherever possible.

- Trimble recommends that you install lightning protection equipment at permanent base station locations. Equipment should include a gas capsule lightning protector in the GPS and radio antenna feed line and appropriate safety grounding. A static dissipater near the antennas can reduce the likelihood of a direct lightning strike. Also protect any communications and power lines at building entry points. For more information, contact your local Trimble dealer, or go to the Huber and Suhner website (www.hubersuhnerinc.com).
- Trimble recommends that you use surge protection equipment on all permanently installed equipment.

Permanent installation antenna cabling for the SPSx50 Modular GPS receiver and SPS770 GPS receiver

Many permanent base station installations have unique cabling requirements. Depending on the available infrastructure, you may need to mount the antenna a considerable distance from the receiver.

The SPSx50 and SPS770 can withstand a loss of 12 dB between the GPS antenna and the receiver. The degree of loss in a coaxial cable depends on the frequency of the signal passing through it. Table 4.1 lists some common cable types and the maximum length you can use before an inline amplifier for GPS frequencies is required.

Table 4.1 Maximum cable lengths

Cable type	Maximum length (for use without an inline amplifier)
RG-214	30 m (100 ft)
LMR-400	70 m (230 ft)
LMR-500	85 m (280 ft)
LMR-600	106 m (350 ft)
Heliax LDF4/50	165 m (540 ft)
Heliax LDF4.5/40	225 m (740 ft)

Rover operation guidelines

The second part of the RTK GPS system is the rover receiver.

The rover receiver is mounted on a pole, vehicle, marine vessel, or in a backpack, and is moved between the points that require measurement or stakeout. The rover receiver is connected to a base station or to a source of RTK corrections such as a Virtual Reference Station (VRS) system. The connection is provided by an integrated radio, a

cellular modem in the controller, or through an external cellular phone that is connected to the receiver either by Bluetooth wireless technology or by means of a cable.

The correction stream for some other positioning solutions, such as SBAS (WAAS/EGNOS, and MSAS) and the OmniSTAR XP or HP service[1], is broadcast through geostationary satellites, and detected by the GPS antenna itself. No integrated radio or base station is required.

Rover receiver components

The rover receiver has the following components:

- GPS receiver
- GPS antenna
- Optional integrated radio receiver and antenna for RTK operations
- Optional items for the different mounting options (see below)

In most rover applications, the receiver operates entirely from its own integrated battery unit. On a vehicle or on a marine vessel, however, an external power supply can be used. Use an external power supply if one is provided. The internal battery then acts as a uninterruptible power supply, covering any external power failures.

Choose a rover receiver according to the needs of the job:

- A Smart GPS antenna, such as the SPSx80, incorporates the GPS receiver, GPS antenna, power supply, and receive radio into a single compact unit. A Smart GPS antenna can be rapidly set up on a pole, vehicle, or backpack. This makes it easy to carry when you are measuring around the jobsite.
- A Modular GPS receiver, such as the SPSx50, incorporates the GPS receiver, receive radio, and power supply into a single unit. The GPS antenna and, optionally, the receive radio antenna, is separate from the receiver. When you use a modular GPS receiver as a rover, you can use optimized components placed in the best locations for your application. For example:
  - A small, lightweight rover antenna can be mounted on a pole or backpack; placed in a high, inaccessible location on a marine vessel mast or cabin; or placed on a site vehicle roof or truck bed.
  - A rubber duck radio antenna, or an external radio antenna, can be mounted on a vehicle or vessel roof to provide maximum coverage.

  A Modular GPS receiver can be placed in a location that is both easily accessible and safe from theft and the weather. The antennas can be placed high on a vehicle or vessel roof, clear of obstructions and able to deliver maximum performance.

1. OmniSTAR is only available with the SPSx50 Modular GPS receiver.

Rover receiver setup guidelines

For good rover operation, observe the following setup guidelines:

- Place the GPS antenna in a location that has a clear line of sight to the sky in all directions. Do not place the antenna near vertical obstructions such as buildings, deep cuttings, site vehicles, towers, or tree canopy. GPS rovers and the base station receive the same satellite signals from the same satellites: if you obscure the signals at times, the system will be unable to provide RTK Fixed positions.
- Place the GPS and radio antennas as high as possible to minimize multipath from the surrounding area. The receiver must have a clear line of sight to the sky at all times during operation.
- GPS satellites are constantly moving. Because you cannot measure at a specific location now does not mean that you will not be able to measure there later, when satellite coverage or location improves. Use GPS planning software to identify the daily best and worst satellite coverage times for your location, and then choose measurement times that coincide with optimal GPS performance. This is especially important when operating in the worst GPS locations.
- The SPS770 Extreme, the SPS850 Extreme, and SPS880 Extreme can track the GPS L2C modernization signal. Additionally, the SPS850 Extreme and SPS880 Extreme can track the GPS L5 modernization signal and the GLONASS satellite constellation. These signals help you to get positions at the worst times of the day and in the worst GPS locations, but do not guarantee that you will.
- To get a fixed position solution with centimeter accuracy, initialize the rover receiver. For initialization to take place, the receiver must track at least five satellites that the base station is also tracking. In a dual-satellite constellation operation, for example, GPS and GLONASS, the receiver must track at least six satellites.
- To maintain a fixed position solution, the rover must continuously track at least four satellites that the base station is also tracking. In a dual-satellite constellation operation, for example, GPS and GLONASS, the receiver must track at least five satellites.The radio link between the base and rover receivers must also be maintained.
- Loss of the satellite signals or loss of the radio link results in a loss of centimeter position accuracy. From Fixed, the receiver changes to Float or Autonomous mode:
  - In Float mode, the rover has connection to the base station through a radio, but has not yet initialized.
  - In Autonomous mode, the rover has lost radio contact with the base station receiver, and is working by itself with the available GPS signals.

- On a vehicle or marine vessel, place the GPS antenna in a location as free from shock and vibration as possible. For the modular receivers, a single magnetic mount is normally sufficient to hold the antenna in a suitable location, whereas for the larger smart antenna, a triple magnetic mount is normally recommended. Good alternatives include a 5/8" thread bolt in a suitable location on the roof bars, or a door-mounted pole bracket.

CAUTION – The SPS880 Extreme is not suited to on-vehicle operation where it will be subject to heavy vibration, that is, operation in rough ungraded terrain. Use in these conditions can damage the SPS880 Extreme.

- To mount the modular receiver on a pole, use two pole mounting brackets and a second tripod clip (P/N 571 204 300). See Figure 4.1.

Figure 4.1 Rod mount for modular receiver

To mount the modular receiver on a marine vessel, use the receiver bracket (P/N 56830-00). For marine moving base and heading applications, use the receiver bracket to mount two receivers together.

- Make sure that the rover receiver does not lose power. An SPSx50 is typically powered by its internal battery for the entire day. You cannot change the battery, but the charge lasts for longer than a day. The batteries in the SPSx80 can be changed when flat. (See Chapter 3, Batteries and Power). If you do not use the rover receiver very often, ensure that it is charged at least every three months. For vehicle operation or marine vessel operation, Trimble recommends that you use an external power source so that the internal battery can be saved for times when the receiver is being used off the vehicle or vessel.
- Do not locate the receiver or antenna within 400 meters (1312 ft) of powerful radar, television, cellular communications tower, or other transmitters or GPS antennas. Low-power transmitters, such as those in cellular phones and two-way radios, normally do not interfere with receiver operations. Cellular towers can interfere with the radio and can interfere with GPS signals entering the receiver. High-power signals from a nearby radio or radar transmitter can overwhelm the receiver circuits. This does not harm the receiver, but it can prevent the receiver electronics from functioning correctly.
- Do not use the rover receiver directly beneath or close to overhead power lines or electrical generation facilities. The electromagnetic fields associated with these utilities can interfere with GPS receiver operation. Other sources of electromagnetic interference include:
  - gasoline engines (spark plugs)
  - televisions and computer monitors
  - alternators and generators
  - electric motors
  - equipment with DC-to-AC converters
  - fluorescent lights
  - switching power supplies
- Trimble recommends that, wherever possible, all GPS receiver equipment is protected from rain or water. Although, the receivers are designed to withstand all wet weather conditions, keeping the receivers dry prolongs the life of the equipment and reduces the effects of corrosion on ports and connectors. If the equipment gets wet, use a clean dry cloth to dry the equipment, and then leave the equipment open to the air to dry. Do not lock wet equipment in a transport case for prolonged periods. Wherever possible, avoid exposing the GPS receiver to corrosive liquids and salt water.
- If you are using the rover receiver in open spaces, Trimble recommends that you stop work during electrical storms where the risk of lightning strike is high.
- Where cables are involved, Trimble recommends that you use cable ties to secure the cables to the rod or other equipment to avoid inadvertent snagging while moving about the jobsite. Be careful not to kink, twist, or unnecessarily extend cables, and avoid trapping them in vehicle doors or windows. Damage to cables can reduce the performance of GPS equipment.

Internal radio setup for rover operations

The internal radio of the SPS GPS receiver is delivered with the transmit (Tx) radio frequencies preprogrammed into the receiver. To add receive (Rx) radio frequencies to 450 MHz radios, use the WinFlash utility (see Appendix C, Adding Internal Radio Frequencies). Radio frequences cannot be added to the 900 MHz radios.

Once the radio frequencies are configured, use the controller or receiver to select channel frequencies during base station or rover setup operations.

CHAPTER

5

Setting up the Receiver

- Connecting the receiver to external devices
- Common ways to set up a base station
- Common ways to set up a rover receiver
- Setting up a pair of SPSx50 GPS receivers to provide heading

This chapter provides guidelines for setting up the SPSx50 receiver as a base station, or as a rover receiver in a range of common use scenarios.

This chapter also describes the procedure for setting up a pair of receivers for heading and moving base marine construction applications.

Note – *This chapter provides setup information for all the receivers in the SPS GPS receiver family.*

Connecting the receiver to external devices

You can connect an SPSx50 to the following devices:

- a Trimble controller running Trimble SCS900 Site Controller software
- an external radio-modem
- HYDROpro™ software

Trimble controller with SCS900 Site Controller software

To connect a Trimble controller that is running the SCS900 Site Controller software to an SPS GPS receiver, use Bluetooth wireless technology (for all except the SPS770 GPS receiver) or a serial cable. Table 5.1 shows how to connect the cables for each combination of SPS GPS receiver and Trimble controller.

Table 5.1 Connecting to a Trimble controller running the SCS900 Site Controller software

	Use this cable connector ...	and connect the cable to ...	Cable part number
To connect a SPSx50 Modular GPS receiver to a ...			
TSC2	DB9	TSC2	32960
	Lemo	SPSx50	
TCU	6-pin Hirose	TCU	53004007
	Lemo	SPSx50	
TSCe™	Lemo	TSCe	31288-*xx*
	Lemo	SPSx50	This cable is available in different lengths. The -*xx* indicates the length of the cable, in meters.
ACU	4-pin Hirose	ACU	44147
	Lemo	SPSx50	
To connect a SPS770 GPS receiver to a ...			
TSC2	DB9	TSC2	32960
	Lemo (Port 1)	SPS770	
TCU	6-pin Hirose	TCU	53004007
	Lemo (Port 1)	SPS770	
TSCe	Lemo	TSCe	31288-*xx*
	Lemo (Port 1)	SPS770	This cable is available in different lengths. The -*xx* indicates the length of the cable, in meters.
ACU	4-pin Hirose	ACU	44147
	Lemo	SPSx50	
To connect a SPSx80 Smart GPS antenna to a ...			
TSC2	DB9	TSC2	32960
	Lemo (Port 1)	SPSx80	
TCU	6-pin Hirose	TCU	53004007
	Lemo (Port 1)	SPSx80	

Table 5.1 Connecting to a Trimble controller running the SCS900 Site Controller software

	Use this cable connector ...	and connect the cable to ...	Cable part number
TSCe	Lemo	TSCe	31288-*xx*
	Lemo (Port 1)	SPSx80	This cable is available in different lengths. The -*xx* indicates the length of the cable, in meters.
ACU	4-pin Hirose	ACU	44147
	Lemo	SPSx80	

External radio-modems

The most common data link for Real-Time Kinematic (RTK) operation is a radio. The SPSx50 is available with the following internal radios:

- 410–430 MHz (Tx/Rx, Rx only, or Tx only)
- 430–450 MHz (Tx/Rx, Rx only, or Tx only)
- 450–470 MHz (Tx/Rx, Rx only, or Tx only)
- 900 MHz (Tx/Rx, Rx only, or Tx only)

Note – *"Tx" indicates that the radio transmits corrections. "Rx" indicates that the receiver receives corrections. "Tx/Rx" indicates that the radio both transmits and receives corrections.*

If the SPSx50 does not have an internal transmit radio, or you want to connect to higher power or to a secondary external transmit radio or cellular modem, use the 26-pin port, the Lemo port, or Bluetooth wireless technology.

The SPSx50 supports the following Trimble base radios:

- TRIMMARK™ 3
- Trimble SNB900
- Trimble PDL450
- Trimble HPB450

The SPSx50 receiver also supports third-party transparent radios and third-party cellular modems.

When used with an SPSx50 GPS receiver, most external radios require an external power source. Only the Trimble SNB900 radio-modem has an internal battery and does not require external power.

Configure the external radio separately, using either the configuration program for the external radio or the radio display and keypad.

To configure the SPSx50 for RTK operation, follow the base setup procedure to set the following parameters:

- Set the base station coordinates
- Enable the RTCM or CMR+™ corrections stream on the selected serial port.

Common ways to set up a base station

You can set up a base station in different ways depending on the application, coverage area, degree of permanence versus mobility, and available infrastructure. Before you set up a base station, please read Chapter 4, Setup Guidelines.

Setting up a base station for permanent or semi-permanent installation

For construction applications, where machine and site positioning operations using GPS will be carried out over a long time (weeks, months, or years), ensure that you choose the base station location carefully.

A semi-permanent or permanent base station helps to eliminate the types of error that can result from repeated daily setups, and ensures that you always use the GPS antenna at the exact original location. The requirement for a permanent base station setup increases as more receivers that use the base station as a source of corrections, increases the cost of any base station downtime.

On the largest jobsites, and on those that remain operational for the longest time, a permanent or semi-permanent installation is a popular solution. An SPSx50 or SPS770 GPS receiver is typically used as the base station, located in a site office or trailer where it is easy to access (to check or configure), and where it is secure from theft and the weather. The GPS and radio antennas are normally mounted on a permanent structure on the roof of the building, where they are high and clear from obstructions and where the radio antenna can provide the maximum range of operation.

The GPS antenna most commonly used is the Trimble Zephyr Geodetic™ Model 2. This antenna has a large ground plane that eliminates multipath, providing the best GPS performance at the base location. The antennas are connected to the receiver by high quality RF cables.

The receiver is connected to a permanent power supply (mains or generator power). The internal battery of the receiver is always being charged, and acts as an uninterruptible power supply if there is a power failure. In some cases, the receiver may also be connected by an Ethernet cable to the Internet, so that it can be monitored and configured from a remote location, and can warn an administrator by e-mail or text message if there is a change to the configuration. In these situations, the receiver can transmit GPS RTK corrections to a remote radio or receiver over the Internet, for rebroadcast requirements, without using repeaters.

Figure 5.1 SPSx50 receiver permanent installation

Setting up a base station for daily site use: T-Bar

For construction applications where a daily setup and takedown of equipment is required for security reasons, Trimble recommends that you use a T-Bar setup.

The T-Bar consists of a post mounted in concrete (so it cannot move), which has a solid metal T-Bar mounted to it to provide lateral separation between the GPS antenna and radio antenna. The T piece of the T-Bar has a vertical rod at each end. Each end terminates in a 5/8"×11 thread to which the antennas can be mounted. Trimble recommends that one end is clearly marked ***GPS*** and the other end is clearly marked ***Radio*** so that at each daily setup, the GPS and radio antennas are mounted at the same location. Switching antennas by mistake introduces a position error in all resulting measurements. You can buy the parts you need to make a T-Bar from any reputable hardware store. Make certain that the T-Bar cannot rotate after construction. Rotation of the T-Bar can introduce a position error into all subsequent measurements.

On the upright post, mount either a bracket (to which the GPS receiver can be mounted), or a well-ventilated lockbox (in which the GPS receiver itself can be secured).

Each day, mount the GPS antenna on the ***GPS*** end of the T-Bar and the radio antenna on the ***Radio*** end of the T-Bar. Connect the antennas to the receiver using the appropriate cables.The receiver uses its own integrated battery, or an external 12 V battery through the 12 V crocodile clips cable that are provided with the receiver. If you choose to use AC power, remember that the heat generated by the charging process and the radio transmitter increases the need for good ventilation around the receiver.

In such scenarios, an SPSx80 Smart GPS antenna is also often used. Simply mount the SPSx80 on the T-Bar, and optionally connect to an external battery or radio unit.

Advantages

Use of a T-Bar setup ensures that the base station is set up with exactly the same position and height every day. This helps eliminate the errors typically associated with daily tripod setup. For example, wrong antenna height, base not set up over the point, base set up in the wrong location.

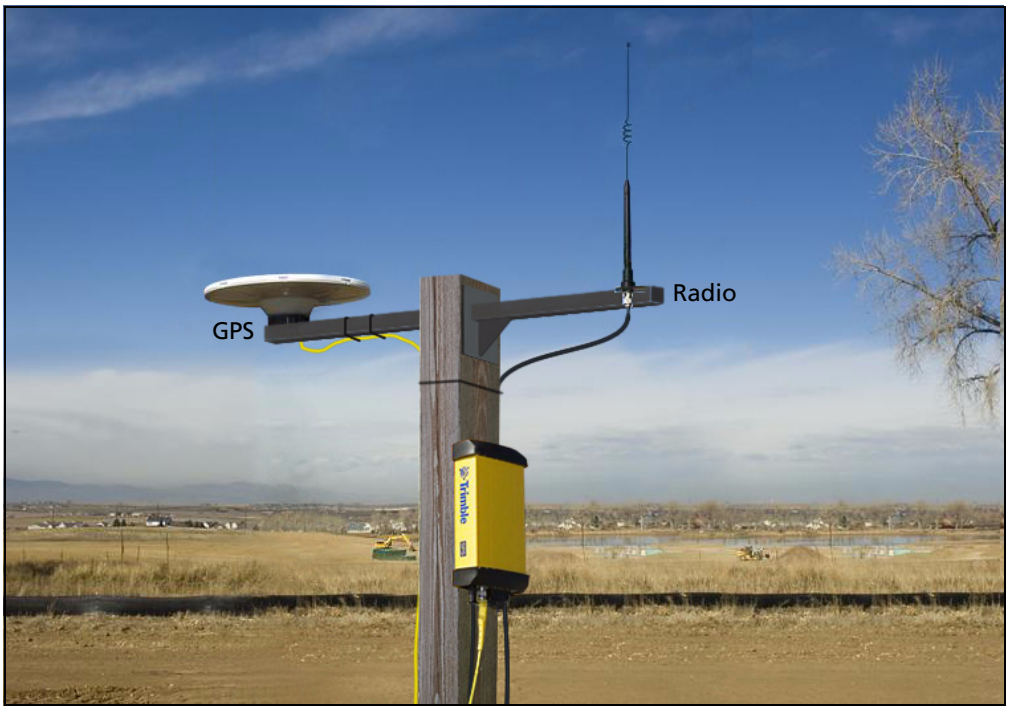


Figure 5.2 System set up on a T-bar showing an external radio antenna to gain longer range

Setting up a mobile base station: Tripod and fixed height tripod

If you are repeatedly moving between jobsites, or if you are visiting a jobsite for the first time before a T-Bar or similar setup can be established, Trimble recommends that you use either a tripod and tribrach setup, or a fixed height tripod.

The fixed height tripod is quicker and easier to set up over a control point. Take great care to ensure that the GPS antenna is set up accurately over the control point, and that the GPS antenna height is measured accurately, in the right way (vertical or slope

height) to the right location on the antenna (base of antenna or to a specified location on the antenna). When you start the rover receiver, it is extremely important to check in, at one or more known locations, to check for possible position or height errors. Checking in at a known location is good practice and can avoid costly errors caused by a bad setup.

Typically, the tripod and fixed height tripod methods do not give significant height clearance above the ground, and can reduce the range of operation caused by radio limitations.

Tripod and tribrach setup

In the tripod setup, the tripod is located over the control point, and the tribrach and tribrach adaptor is mounted on the tripod and centered over the point.

1. Mount the GPS antenna on the tribrach adaptor.
   - If you are using a SPSx80 Smart GPS antenna, use the 25 cm spacer rod provided with the SPSx80 base station accessory kit. This allows the radio antenna in the receiver to clear the head of the tripod.
2. Clip the GPS receiver to the tripod (SPSx50 and SPS770 only).
3. Connect the GPS antenna to the receiver using the appropriate cable (SPSx50 and SPS770 only).
4. If necessary, connect the GPS receiver to an external 12 V power supply. Use the crocodile clip cable or the Trimble custom power pack.

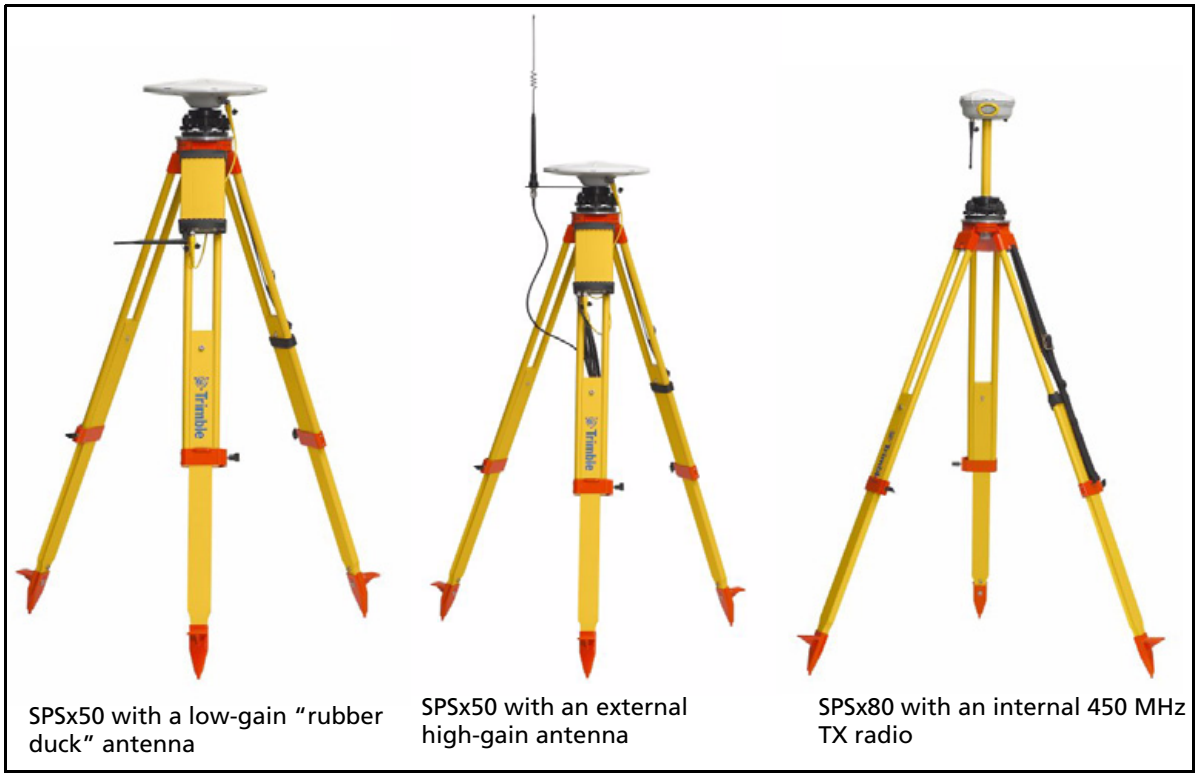


Figure 5.3 Tripod and tribrach setup for the SPSx50 and the SPSx80

Fixed height tripod setup

A fixed height tripod setup is similar to a tripod setup, but is simplified by the central leg of the tripod, that is placed directly on the control point. If the central leg is leveled accurately, the fixed height tripod is quick and easy to set up, and provides an accurate way to measure the true antenna height.

1. Set up the tripod over the control point.
2. Attach the GPS antenna to the head of the tripod.
3. If using an external high-gain radio antenna, mount the radio antenna to the radio antenna bracket that is attached to the head of the tripod (beneath the GPS antenna). See Figure 5.4.
4. If using the SPSx50 Modular GPS receiver, hook the receiver to the center leg of the tripod, using the tripod clip.
5. If using the SPSx80 Smart GPS antenna, you can mount the antenna using the 25 cm spacer rod (supplied with the SPSx80 Base Station Accessory kit) so that the radio antenna clears the head of the tripod.

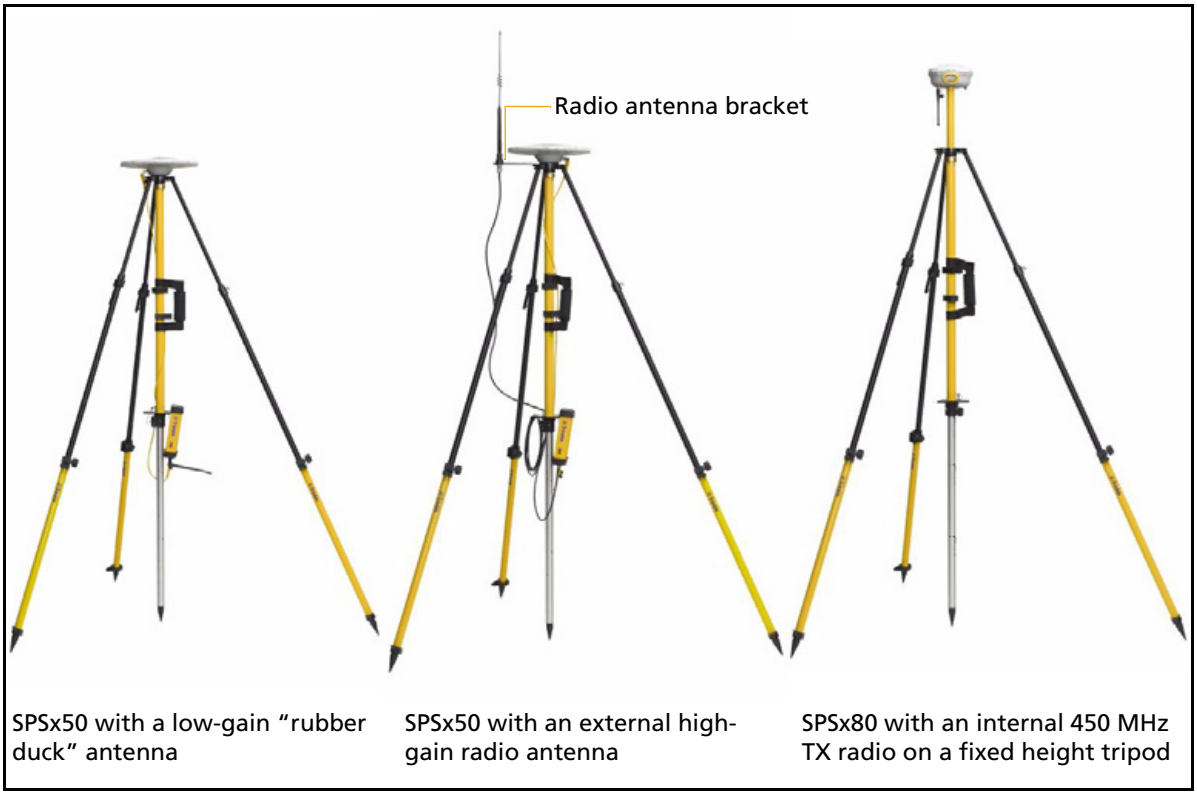


Figure 5.4 Fixed height tripod setup for the SPSx50 and SPSx80

Common ways to set up a rover receiver

You can set up a rover receiver in different ways depending on the application. The components that make up a rover receiver are:

- GPS receiver
- GPS antenna
- controller/computer
- rod mounting equipment, including a rod, receiver bracket, and controller bracket
- vehicle mounting equipment, including a suction cup and ball joint, extension arm, controller bracket, magnetic antenna mount, and necessary cables.
- backpack equipment, including backpack and antenna-mounting rod
- marine vessel mounting equipment, including receiver bracket, cables, antenna, and radio antenna brackets.

Setting up the rover receiver on a jobsite vehicle

CAUTION – This following rover setup is suited only to offroad (jobsite) vehicle use. Do not use this method on a vehicle that is driven at speed or in traffic.

1. Do one of the following, depending on your receiver:
   - SPSx50 or SPS770: Mount the GPS antenna for the receiver on the roof of the vehicle. Use a single magnetic mount or a 5/8"×11 thread bolt attached to the roof bars. Run the GPS antenna cable for the receiver into the vehicle either through a rubber grommet in the roof, or through the passenger door window, which needs to be left slightly open during operation.
   - SPSx80: Mount the receiver on the roof of the vehicle. Use a triple magnetic mount or a 5/8"×11 thread bolt attached to the roof bars.
2. Place and secure the GPS receiver in a convenient location in the vehicle.

   The GPS receiver can be controlled through the controller connected using Bluetooth wireless technology (SPSx50 or SPSx80) or a cable connected to a port on the receiver (SPS770).

   The receiver needs to be accessed only to turn it on at the start of each measurement session. It may be more convenient if the SPSx50 is placed in a location where the vehicle operator can see the keypad and display, to monitor receiver status and to configure settings as required. Most receiver capability can be controlled using the SCS900 Site Controller software.
3. Attach the suction cup to the front windscreen, dashboard, or other convenient location in the vehicle, making sure that it does not obstruct the driver's view.

4. Attach the RAM extension arm to the suction cup, and the controller bracket to the RAM extension arm.
5. Lock the controller into the controller bracket and then adjust the bracket until the controller is in the most convenient location. Make sure that the controller does not restrict visibility through the front windscreen during vehicle use.
6. Lock the brackets so that the controller is held securely. If required, connect either the GPS receiver or the controller to an in-vehicle power supply as needed.

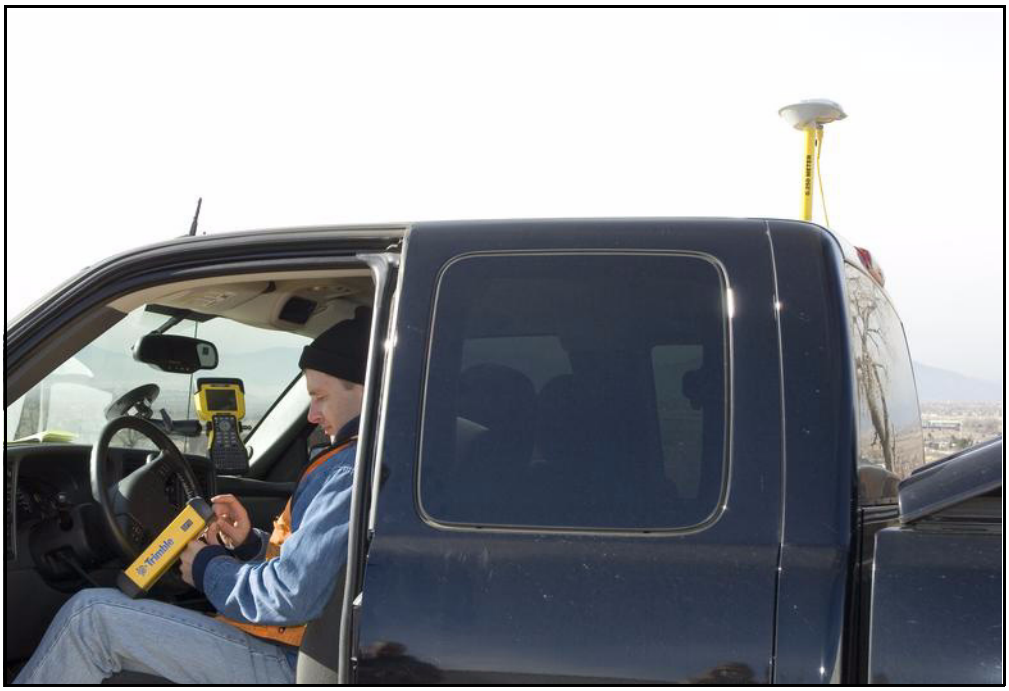


Figure 5.5 Configuring SPSx50 from the cab. A Zephyr Model 2 antenna is mounted on the roof

Setting up the rover receiver on a rod

For rod-based operation, mount the SPSx50 Modular GPS receiver as follows:

1. Mount the two rod brackets on the rod.
2. Tighten the top bracket, making sure that it is at a convenient height for the receiver.
3. Place the receiver in the slot in the rod bracket, and secure with the tripod clip.
4. Move the lower rod bracket down until it is over the second tripod clip on the receiver, and then tighten the rod bracket onto the rod. The receiver is held in place between the two brackets.
5. Insert the controller into the controller bracket as shown opposite.
6. Use the 5/8" thread to attach the GPS antenna to the top of the rod.
7. Use the GPS antenna cable to connect GPS antenna to the receiver.

For rod-based operation, mount the SPSx80 Smart GPS antenna as follows:

1. Mount the receiver on the top of the rod using the 5/8"×11 thread in the base of the SPSx80.
2. Insert the controller into the controller bracket.
3. The SPSx80 and controller communicates through Bluetooth wireless technology. However, if a cable is required, connect the cable between the controller and receiver (see Figure 5.6 through Figure 5.7).

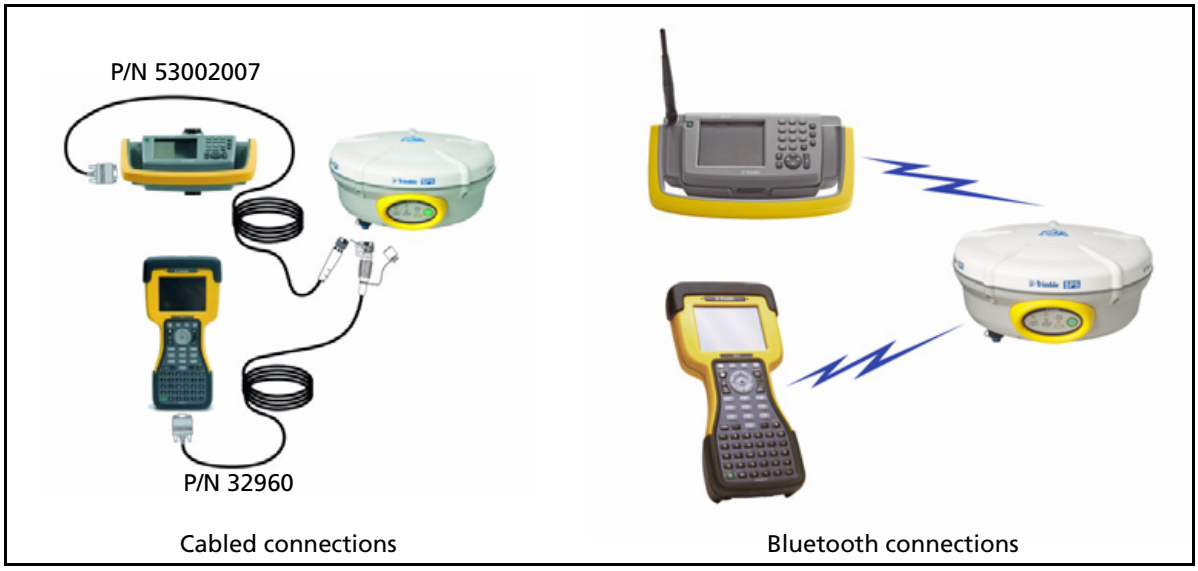


Figure 5.6 Connections for a rover SPSx80 setup, a TSC2 or TCU controller, and a 450 Mhz base station

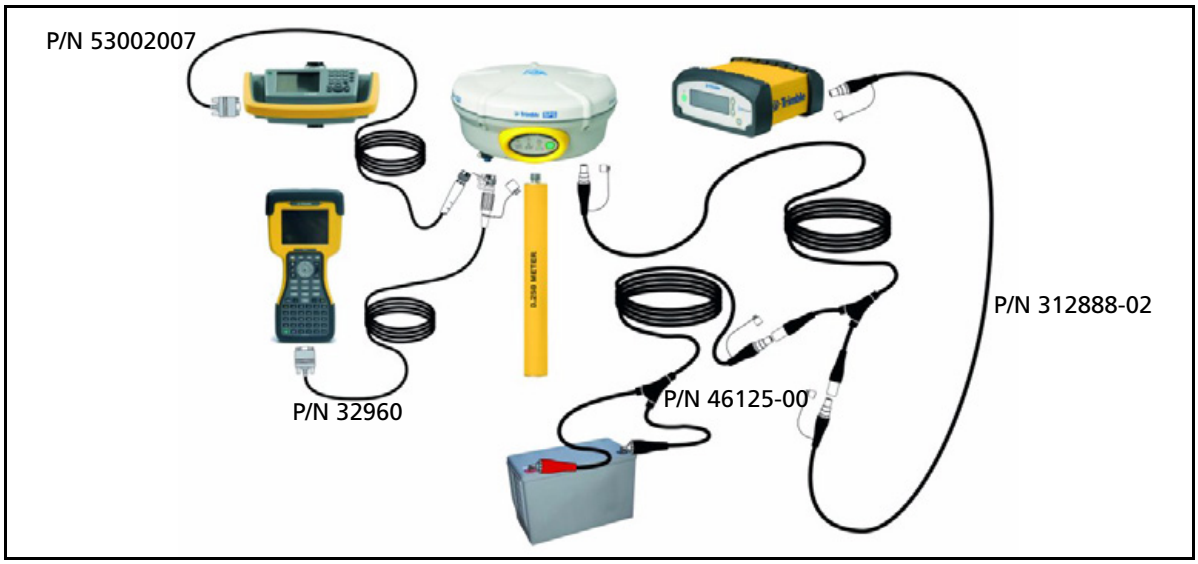


Figure 5.7 Cabled connections for an SPSx80 setup, a TSC2 or TCU controller, and a 900 Mhz base station (with external power)

Setting up a rover receiver on a belt or in a backpack

If you prefer to work free of the weight of a pole, you can mount the rover receiver on a belt (SPS770 or SPSx50 only) or carry it in/on a backpack (all receivers). When you wear the receiver on a belt, ensure that the display is always visible so that you can easily check the status of the receiver. If you carry the receiver in a backpack, use an external radio antenna mount to allow for optimal radio signal reception. If you use a low gain antenna mounted directly on the receiver in a backpack, it may affect the radio signal reception and reduce the likelihood of obtaining an RTK Fixed solution.

Setting up a pair of SPSx50 GPS receivers to provide heading

The SPS550H receiver is permanently in Heading mode and, when combined with a suitable Trimble receiver, provides GPS heading. Other SPSx50 GPS receivers can be used for heading only if they can operate in Heading mode (see Configuring the receiver pair, page 57).

The SPS550H is a dual-frequency GPS receiver with a dual-frequency antenna, but it does not operate as a stand-alone DGPS receiver. To compute a true north heading and to be capable of positioning, the receiver requires an output message from another SPSx50 receiver. To determine the precise vector between two moving objects, pair the SPS550H Heading add-on with any one of the following SPSx50 receivers:

- SPS550
- SPS750 Max
- SPS850

Connect the antenna on the SPS550H to the other SPSx50 receiver to determine the precise GPS heading between the two antennas. The SPS550H GPS receiver shows the heading on the two-line display, and outputs the heading data in NMEA or binary format.

Tip – To create a single, compact GPS position and heading unit, use the mounting frame provided to stack the SPS550H GPS receiver on top of another SPSx50 GPS receiver. See below. Use the Marine Heading Cable (P/N 57169) provided.

The Moving Baseline RTK positioning technique

In most RTK applications, the reference receiver remains stationary at a known location and the rover receiver can move. However, Moving Baseline RTK is an RTK positioning technique in which both reference and rover receivers can move about. Moving Baseline RTK is useful for GPS applications that require vessel orientation.

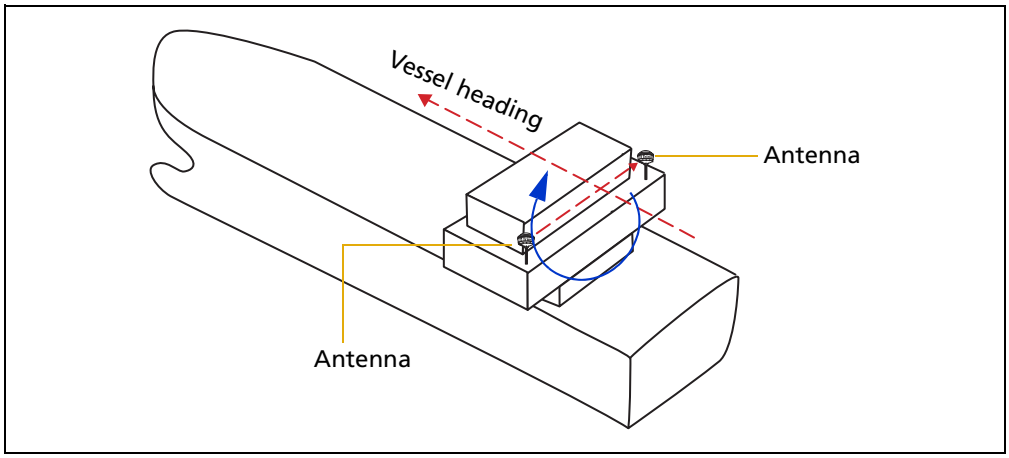


Figure 5.8 Vessel heading from Moving Baseline RTK

With Moving Baseline RTK, the reference receiver broadcasts Compact Measurement Record (CMR™) data every epoch, while the rover receiver performs a synchronized baseline solution at 10 Hz. The resultant baseline solution has centimeter-level accuracy. To increase the accuracy of the absolute location of the two antennas, the Moving Reference receiver can use differential corrections from a static source, such as a shore-based reference station.

Mounting a pair of SPSx50 GPS receivers

To obtain a position and heading solution, you need to connect two SPSx50 receivers to make one compact unit. A mounting bracket and interconnecting cable is supplied with the SPS550H receiver. Set up the receivers, antennas, and cables as shown in Figure 5.9.

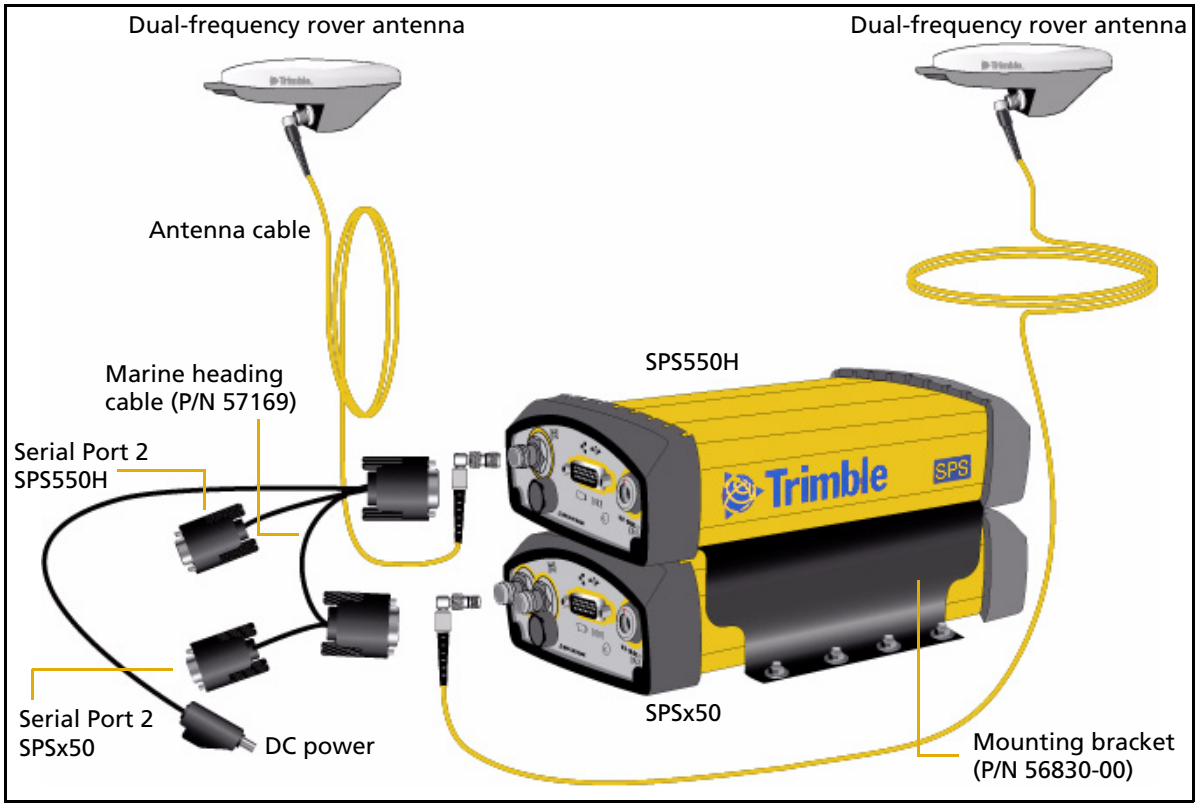


Figure 5.9 Installation setup for the SPS550H with another SPSx50 receiver for position and heading

Assembling the receivers

Figure 5.10 shows an SPS550 and an SPS550H set up to provide a Heading solution. To assemble the receivers, you need a Phillips head #1 screwdriver and a 1/4" socket set or wrench (spanner).

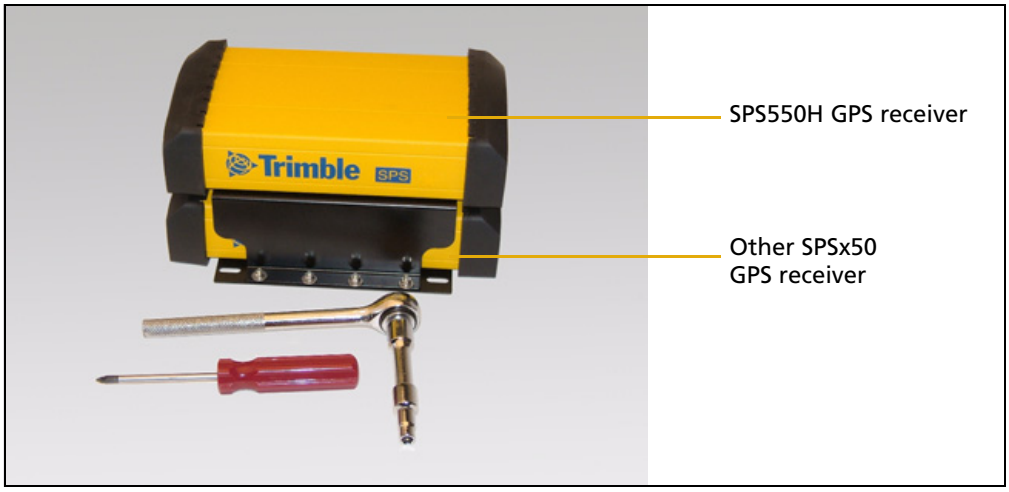
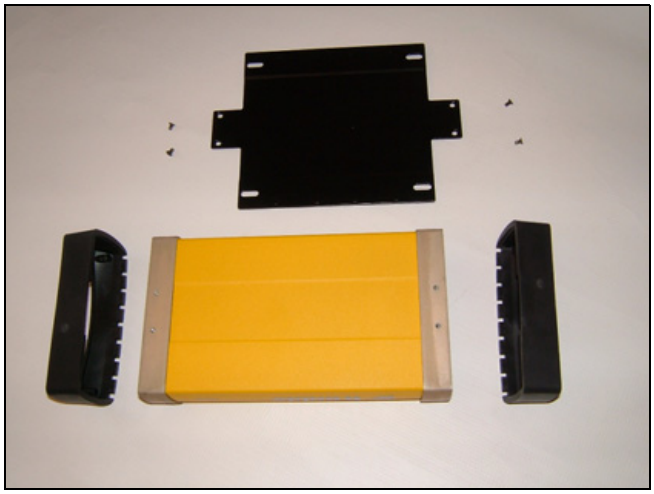


Figure 5.10 Completed assembly with the SPS550H GPS receiver on top

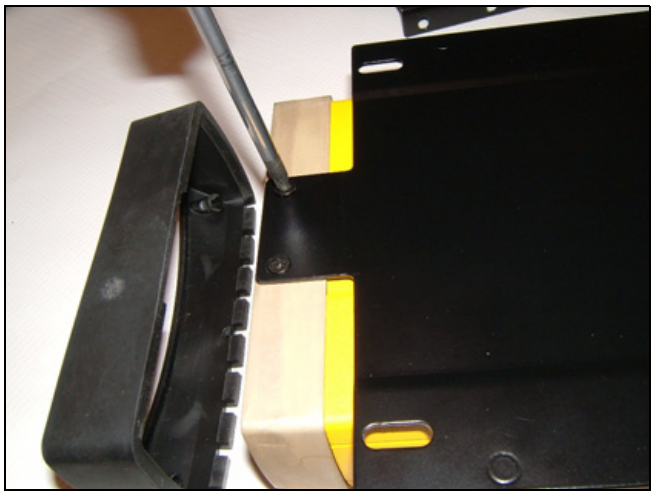
To assemble the receivers using the mounting frame that is provided:

1. Invert the SPSx50 GPS receiver and then remove the rubber endcaps.

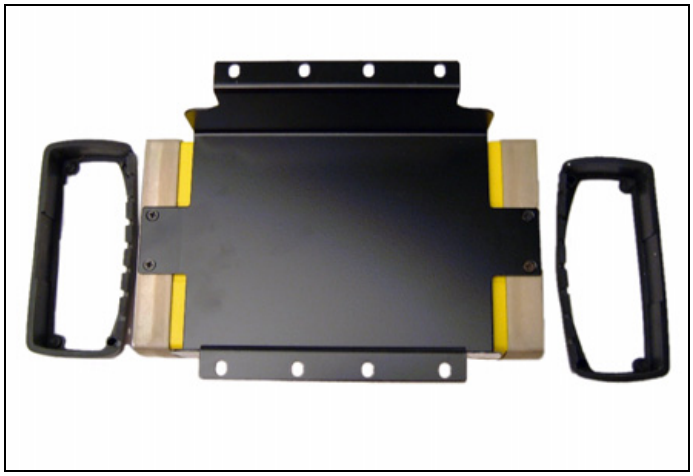


2. Prepare the flat black plate and the four Posi screws. (These are part of the mounting frame.)
3. Position the black plate on the SPSx50 GPS receiver.

4. Use the four Posi screws to secure the plate to the receiver. (Secure two screws at each end.) The black plate is now attached to the bottom of the SPSx50 GPS receiver.

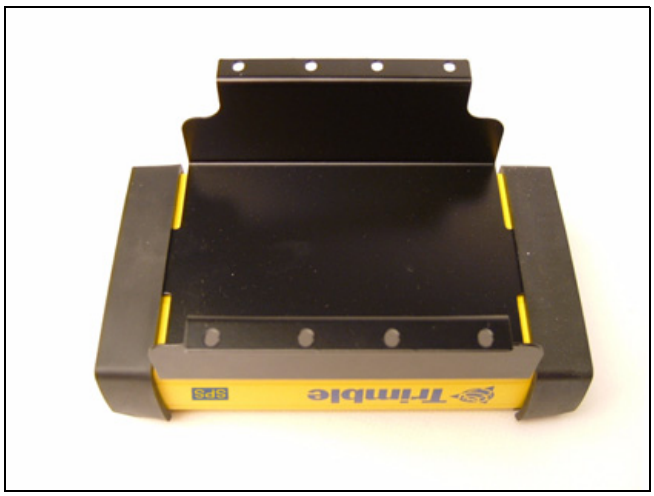


5. Replace the rubber endcaps.
6. Invert the SPSx50 receiver again. This returns the receiver to its normal orientation.
7. Set aside the SPSx50 receiver.
8. Invert the SPS550H receiver and then remove the rubber endcaps.



9. Position the black cradle on the SPS550H GPS receiver. (The black cradle is part of the mounting frame.)
10. Use the four Posi screws to attach the black cradle to the receiver. The black cradle is now attached to the bottom of the SPS550H.

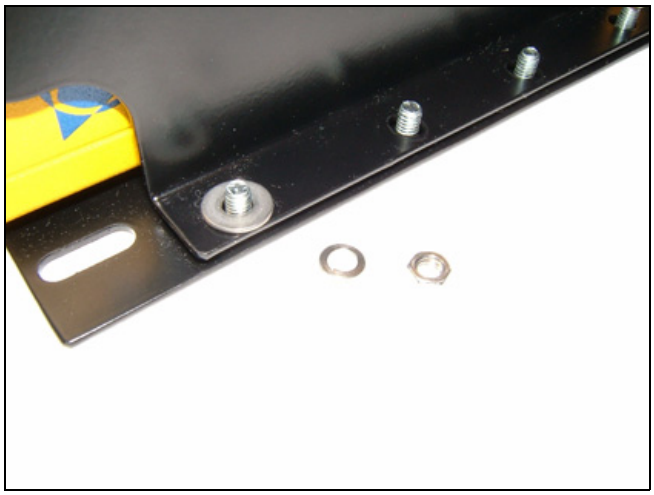
11. Replace the rubber endcaps.



12. Place the black cradle on the black base plate. This places the SPS550H GPS receiver on top of the SPSx50 GPS receiver.

13. Make sure that the display is facing in the same direction on both receivers.
14. Prepare the eight nuts, spring washers, and flat washers.

15. Insert the first bolt. Attach the flat washer, the spring washer, and finally the nut and then tighten firmly. Secure all eight bolts in this way.



16. Attach one connector from the Marine Heading Cable (P/N 57169) to the 26-pin connector on the rear of the SPS550H GPS receiver. Attach the other connector from the cable to the 26-pin connector on the rear of the SPSx50 receiver. The cable can be connected either way around.

The cable connects the two GPS receivers so that the Heading solution is available. The DC power lead on the cable supplies power to both receivers in the stack. The two DB9 female connectors on the cable access serial port 2 on each receiver.

Installing the receiver

Select a location at which all of the following conditions are met:

- the receiver is not exposed to temperature extremes
- the receiver is not exposed to moisture extremes (such as rain, snow, water blasters, or wash systems)
- the receiver is protected from mechanical damage
- you can connect and disconnect cables without placing undue stress on them

Mounting the antennas

You ***must*** install each antenna at the correct location. Poor or incorrect placement can influence accuracy and reliability.

Ideally, mount the two antennas as far apart as possible and at about the same height on the structure. Mount the antennas fore and aft along the vessel centerline or on a line that is at a known orientation to the centerline. Always mount an antenna at a location that ensures a good view of the sky.

Follow these guidelines to select the antenna location:

- Choose an area with a clear view of the sky. The antenna must be above any metallic objects.
- Do not mount the antenna close to stays, electrical cables, metal masts, or other antennas.
- Do not mount the antenna near a transmitting antenna, a radar array, or near satellite communication equipment.
- Avoid areas with high vibration, excessive heat, electrical interference, and strong magnetic fields.

Use a 5/8"×11 stainless steel bolt to mount each of the antennas. There is a threaded bolt hole in the base of the antenna.

Configuring the receiver pair

One of the receivers must be nominated as a Heading unit. The other receiver is nominated as a Moving Base unit. For this configuration to work, you must use the Marine heading cable (P/N 57169).

To set up the Heading unit:

1. From the Home screen, press Enter twice. The *Mode* screen appears.

2. Select *Heading* mode. The SPSx50 display shows two extra settings for heading:
   - *Heading Adjustment*. Enter a positive value in decimal degrees. The value is applied to the raw heading value before it is output in the NMEA HDT message or displayed on the front panel of the receiver. This value is used when the two antennas are not mounted parallel to the vessel axis.
   - *Minimum Heading Solution*. Enter the minimum requirement for the GPS solution that will provide the heading value. The default of RTK Fixed provides the highest precision, but in conditions of extreme multipath or obstruction, an RTK Fixed solution may not be continuously available. In such conditions, select RTK Float if a lower precision is acceptable.

To set up the Moving Base unit:

1. From the Home screen, press 

twice. The *Mode* screen appears.
2. Select Moving Base mode.

Interfacing using the NMEA protocol

The SPS550H GPS receiver can output messages such as NMEA HDT for heading, and NMEA GGA for position. The SPS550H always reports the solution status of the moving baseline solution that is being used to compute the heading. For example, the Modem (serial port 2) on the SPS750, which is typically RTK Fixed Integer. However, if the external computer must know the exact quality of the position, you can use the NMEA output from the base receiver. The base receiver reports the solution status of the position, for example, Fixed Integer, Floating, or DGPS.

CHAPTER

6

Configuring the SPSx50 Using the Keypad and Display

In this chapter:

- Button functions
- Power button operations
- Home screen
- Status screens
- Configuring the SPSx50 as a base receiver
- Configuring the SPSx50 as a rover receiver
- Configuring system settings

The receiver features a keypad and display (see Keypad and display, page 22) so that you can configure the receiver without using a controller or computer.

Button functions

The SPSx50 has seven buttons on the front panel to control the receiver. Use the buttons to turn the receiver on and off and to check or change the receiver settings.

Button	Name	Function
	Power	Turns the receiver on and off. To turn the receiver off, hold the **Power** button for two seconds.
	Escape	Returns to the previous screen or cancels changes being made on a screen.
	Enter	Advances to the next screen or accepts changes made on a screen.
	Up	Moves the cursor between multiple fields on a screen or makes changes to an editable field.
	Down	Moves the cursor between multiple fields on a screen or makes changes to an editable field.
	Left	Moves the cursor between characters in a field that can be changed.
	Right	Moves the cursor between characters in a field that can be changed. Press this button to enter Edit mode.

Power button operations

Press the Power button  to turn the receiver on and off. In addition, you can tap the Power button to return to the Home screen, or hold down the Power button to perform the following operations:

To ...	Hold the  button for ...	Notes
turn off the receiver	two seconds	The display shows a countdown timer. When the display goes blank, release the **Power** button.
clear the almanac, ephemeris, and SV information	15 seconds	The display show a countdown timer. When the display goes blank, continue to hold the **Power** button. The display shows a countdown time to clear the almanac and ephemeris. When the counter reaches 0, release the **Power** button.
reset the receiver to its factory defaults and the default application file	35 seconds	The display show a countdown timer. When the display goes blank, continue to hold the **Power** button. The display show a countdown to clear the almanac and ephemeris. When the counter reaches 0, continue to hold the **Power** button. The display indicates a countdown to resetting the receiver. When the counter reaches 0, release the **Power** button.
force the receiver to power down	at least 60 seconds	If the method above does not work, use this method to force the receiver to turn off. When the Power LED goes off, release the **Power** button.

Home screen

The Home screen is the main screen displayed on the SPSx50 receiver. If the receiver is displaying another screen and is left idle for 60 seconds, you are returned to the Home screen. It shows the following information:

- Number of satellites being tracked
- Internal battery power remaining
- Current mode configuration
- Internal radio activity
- Internal radio channel or network

Status screens

The SPSx50 GPS receivers have several view-only status screens that allow you to review the current settings of the receiver. The status screens provide the following information:

- Position solution
- CMR and RTCM IDs
- Base name and code
- Latitude, longitude, and height
- Antenna height
- Horizontal and vertical precision
- Receiver firmware version
- Receiver serial number
- Receiver IP address

To access these screens from the Home screen, press  or  .

Configuring the SPSx50 as a base receiver

To set up the SPSx50 as a base receiver, use AutoBase technology, the Trimble SCS900 Site Controller software, or the receiver keypad.

The AutoBase feature automatically configures the receiver settings for you; there is no need to use the keypad. The receiver obtains a position and outputs RTK corrections on the internal radio (if available) or on the LEMO port. See Chapter 8, Automatically Setting up a Mobile Base Station Using AutoBase Technology.

The receiver is configured step-by-step to ensure that all appropriate settings are configured. To move between steps in the configuration process, press  .

Configuring the receiver

1. In the Home screen, press Enter. Use the *Operation Mode* screen to configure system settings, mode settings, or to view the SV (satellite) status. Mode Settings is the default setting.
2. Press Enter. Use the *Mode* screen to select whether the receiver will operate as a base or rover. Base is the default setting.
3. Press Enter. Use the *Base Station* screen to select whether the receiver is going to use a "Here" position or if the current coordinates in the receiver will be changed.
4. Press ▷. When Edit Current begins to flash, the receiver is in Edit mode and you can change the current setting.
5. Press ▽. The setting changes to New Base (Here).
6. Press Enter to accept the change.
7. Press Enter again. The *Base Name* screen appears. See next.

Changing the name and description of the base station

In the *Base Name* screen:

1. Press ▷. When the first character of the base name begins to flash, the receiver is in Edit mode and you can change the current setting.
2. Press △ or ▽ to change the value of the character.
3. Press ▷ to move the cursor to the next character.
4. Repeat Step 2 through Step 3 to enter the name of the base station. The name can be up to 16 characters. Press Enter to accept the change.
5. Press Enter again. Use the *Base Code* screen to change the code (description) for the base station.
6. Press ▷. When the first character of the base code begins to flash, the receiver is in Edit mode and you can change the current setting.
7. Press △ or ▽ to change the value of the character.
8. Press ▷ to move the cursor to the next character.
9. Repeat Step 7 through Step 8 to enter the code of the base station. The code can be up to 16 characters.
10. Press Enter to accept the change.
11. Press Enter again. The *Base Latitude* screen appears. See next.

Setting the reference latitude, longitude, and height of the base station

In the *Base Latitude* screen:

1. The base was set up with a "Here" position, so press Enter.
2. The *Base Longitude* screen is used to change the reference longitude of the base station. The base was set up with a "Here" position, so press Enter.
3. The *Point Height* screen is used to change the reference height of the base station. The base was set up with a "Here" position, so press Enter.
4. Use the *Antenna Type* screen to select the type of antenna used with the receiver. Press ▷. When the antenna name begins to flash, the receiver is in Edit mode and you can select an antenna.
5. Press ▽ to scroll through the antenna models.
6. Once the correct antenna name appears, press Enter to accept the change.
7. Press Enter again. The *Measured To* screen appears. See next.

Measuring and changing the antenna height

In the *Measured To* screen:

1. Press ▷. When the antenna measurement method begins to flash, the receiver is in Edit mode and you can select an antenna measurement method.
2. Press ▽ to scroll through the measurement methods. Once the correct measurement method appears, press Enter to accept the change.
3. Press Enter.
4. Use the *Antenna Height* screen to change the height of the antenna. Press Enter. When the first character of the antenna height begins to flash, the receiver is in Edit mode and you can change the antenna height.
5. Press △ or ▽ to change the value of the character.
6. Press ▷ to move the cursor to the next character.
7. Repeat Step 5 through Step 6 to enter the height of the antenna.
8. Press Enter to accept the change.
9. Press Enter again. The *Output* screen appears. See next.

Outputting corrections

In the *Output* screen:

1. Press ▷ to enter Edit mode for the port.
2. Press △ or ▽ to change which port will be used to output corrections.
3. Press Enter to accept the change.
4. Press ▽ to move the cursor to the *Format* field.

5. Press ▷ to enter Edit mode for the format.
6. Press △ or ▽ to change which correction message will be output on the port.
7. Press Enter to accept the change.
8. Press Enter again.
9. Use the *NMEA* screen to set up NMEA outputs from the receiver. Press Enter to accept the default of no NMEA messages.
10. Use the *GSOF* screen to set up GSOF outputs from the receiver. Press Enter to accept the default of no GSOF messages.
11. Use the *RT17* screen to set up RT17 outputs from the receiver. Press Enter to accept the default of no RT17 messages. The Home screen appears and the base setup is complete.

Configuring the SPSx50 as a rover receiver

You can use the Trimble SCS900 Site Controller software or the receiver keypad to set up the SPSx50 base receiver.

The receiver is configured step by step to ensure that all appropriate settings are configured. To move between steps in the configuration process, press Enter.

Configuring the receiver

1. In the Home screen, press Enter. Use the *Operation Mode* screen to configure system settings, mode settings, or to view the SV (satellite) status. Mode Settings is the default setting.
2. Press Enter. Use the *Mode* screen to select whether the receiver will operate as a base or rover.
3. Press ▷. When the mode begins to flash, the receiver is in Edit mode and you can change this setting.
4. Press ▽ to change to Rover.
5. Press Enter to accept the change.
6. Press Enter again to move to the *Elevation mask and RTK mode* screen. See next.

Changing the elevation mask and RTK mode

1. Press ▷. When the value for the current elevation mask begins to flash, the receiver is in Edit mode and you can change the setting.
2. Press ▽ to change the elevation mask to the required value.

Note – *Trimble recommends that you do not set the elevation mask to a value lower than 10 degrees.*

3. Press Enter to accept the change.

4. Press ▽.
5. In the *Mode* field, press ▷. When the current mode begins to flash, the receiver is in Edit mode and you can change this setting.
6. Press ▽ to change the desired RTK mode of the receiver.
7. Press Enter to accept the change.
8. Press Enter again. The *Antenna Type* screen appears. See next.

Selecting the antenna

In the *Antenna Type* screen:

1. Press ▷. When the antenna name begins to flash, the receiver is in Edit mode and you can select the type of antenna that is to be used with the receiver.
2. Press ▽ to scroll through the antenna models.
3. Once the correct antenna name appears, press Enter to accept the change.
4. Press Enter again. The *NMEA* screen appears. See next.

Outputting corrections

In the *NMEA* screen, set up outputs from the receiver:

1. Press Enter to accept the default of no NMEA messages.
2. Use the *GSOF* screen to set up GSOF outputs from the receiver. Press Enter to accept the default of no GSOF messages.
3. Use the *RT17* screen to set up RT17 outputs from the receiver. Press Enter to accept the default of no RT17 messages. The Home screen appears, and the base setup is complete.

Configuring system settings

You can use the keypad and display of the SPSx50 receiver to configure the following receiver settings:

- Display language
- Display and input units
- Baud rate, parity, data bits, and stop bits for serial ports
- Display power saver
- AutoBase warning

To access the system settings:

1. In the Home screen, press Enter. Use the *Operation Mode* screen to configure system settings or mode settings, and to view the SV (satellite) status. Mode Settings is the default setting.
2. Press ▷. When the operation mode begins to flash, the receiver is in Edit mode and you can change this setting.
3. Press ▽ to change to System Setup.
4. Press Enter to accept the change.
5. Press Enter again.
6. Use the *Display Language* screen, if necessary, to change the language. Choose English, French, German, Italian, or Spanish. Press Enter to accept the change.
7. Press Enter again. Use the *Display and Input Units* screen, if necessary, to change the units to Meters or Feet.
8. Press Enter to accept the change.
9. Press Enter again. Use the *Port Settings* screen, if necessary, to change the port.
10. Press Enter to accept the change.
11. Press Enter again. Use the *Screen Pwr Savr* screen to choose On, Off, or Auto. If you use the Auto setting, the screen turns off after 60 seconds of inactivity. The Power LED remains lit so that you can tell if the receiver is on or off. If an error message appears, the screen comes back on. Press Enter to accept the change and then press Enter again to move to the next screen.
12. If you are using an SPS750 or SPS850, the *Autobase warning* screen appears. See Chapter 8, Automatically Setting up a Mobile Base Station Using AutoBase Technology.
13. Press Enter to accept the change.
14. Press Enter again. When the Home screen appears, the system setup is complete.

CHAPTER

7

Configuring the Receiver Settings

In this chapter:

- Using the SCS900 Site Controller software to configure the base station, the rover, and the radios
- Configuring the receiver to log data for postprocessing
- Configuring Ethernet settings
- Configuring the SPSx50 receiver using a web browser

You can configure the SPS GPS receiver family in a variety of ways. This chapter describes the different configuration methods, and explains when and why each method is used.

The SCS900 Site Controller software is likely to be your main tool to set up and operate the receiver on a daily basis. All necessary field configurations are handled through the SCS900 software running on a TSC2 or TCU controller. For more information, refer to the *Trimble SCS900 Site Controller Software Getting Started Guide* or the *Trimble SCS900 Site Controller Software Office Guide*.

The external software detailed in this chapter is primarily used to update the receiver firmware and to configure upgrades or radio channels.

Using the SCS900 Site Controller software to configure the base station, the rover, and the radios

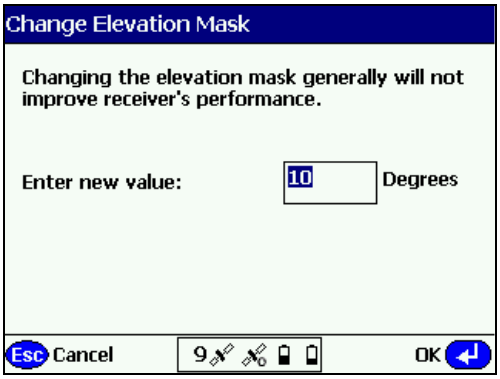
As part of a total system solution for construction applications, the SPS GPS receivers are operated by a TSCe, ACU, TCU, or TSC2 controller running the SCS900 Site Controller software. The SCS900 Site Controller software provides the tools to configure and start the GPS receiver in the modes used by the SCS900 system: Base Station, RTK Rover, DGPS Rover, OmniSTAR rover, SBAS Rover (using WAAS/EGNOS and MSAS). Wizards help you through the process and, where possible, assign suitable default operational parameters to the system. This eliminates the need for an operator to know how to configure the receiver with the right settings.

The SCS900 Site Controller software manages:

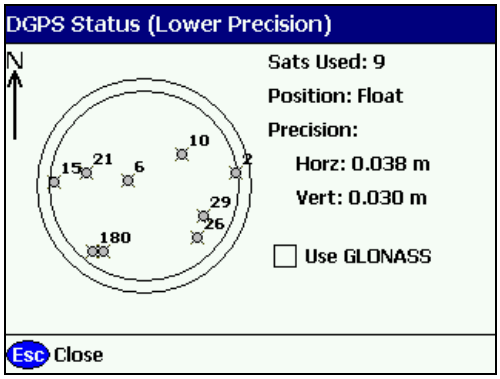
- the radio, whether internal or external
- all cellular communications components, such as modems and cellphones
- the use of the Bluetooth wireless technology

The software also scans communication ports on the receiver to identify connected devices. If the software cannot automatically identify the connected component, for example, a GPS antenna, it offers options (often with graphics) to help you manually select the correct component.

The SCS900 Site Controller software allows you to set operational tolerances and settings (such as those shown below), which must be achieved before measurements can be accepted. When outside of these tolerances, the SCS900 Site Controller software warns you through on-screen messages or indications, and the non-automatic acceptance of recorded positions. To set operational tolerances, go to the the *Settings* menu in the SCS900 Site Controller software.



Example 1: From the Sky Plot screen, press Ctrl+M to open this screen and change the angle below which the receiver will not track satellites



Example 2: Use the Sky Plot screen to set if the receiver will track GLONASS satellites

Configuring the receiver to log data for postprocessing

The SPS GPS receivers do not come equipped with the Data Logging option. The receivers can have this added either at the time of purchase, or at a later date as an option. With the Data Logging option enabled, the receiver has available memory that facilitates the collection of GPS observations over a period of time, and that can be used with GPS postprocessing software such as the Trimble Geomatics Office™ for the computation of control networks and baselines.

Note – *The SCS900 system does not support postprocessed applications. Trimble recommends that you use either the front panel keypad and display, the Web User Interface, or (SPS770, SPSx80 only) the GPS Configurator software to configure the receiver for postprocessed measurement sessions.*

Configuring Ethernet settings

The SPSx50 receiver has an Ethernet port so that the receiver can connect to an Ethernet network. You can use the Ethernet network to access, configure, and monitor the receiver. No serial cable connection to the receiver is necessary.

The SPSx50 receiver requires the following Ethernet settings:

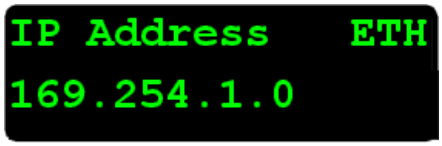
- IP setup: Static or DHCP
- IP address
- Netmask
- Broadcast
- Gateway
- DNS address
- HTTP port

The default setting for the HTTP port is 80. The HTTP port is not assigned by the network. HTTP port 80 is the standard port for web servers. This allows you to connect to the receiver by entering only the IP address of the receiver in a web browser. If the SPSx50 receiver is set up to use a port other than 80, you will need to enter the IP address followed by the port number in a web browser.

Example of connecting to the receiver using port 80: http://169.254.1.0

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

The default setting of the SPSx50 receiver is to use DHCP. Using DHCP enables the receiver to obtain the IP address, Netmask, Broadcast, Gateway, and DNS address from the network.



When an SPSx50 receiver is connected to a network using DHCP, an IP address is assigned to the receiver by the network. To verify the IP address of the receiver, select the up button from the keypad when the *Home* screen is displayed. The Ethernet IP address appears as shown.

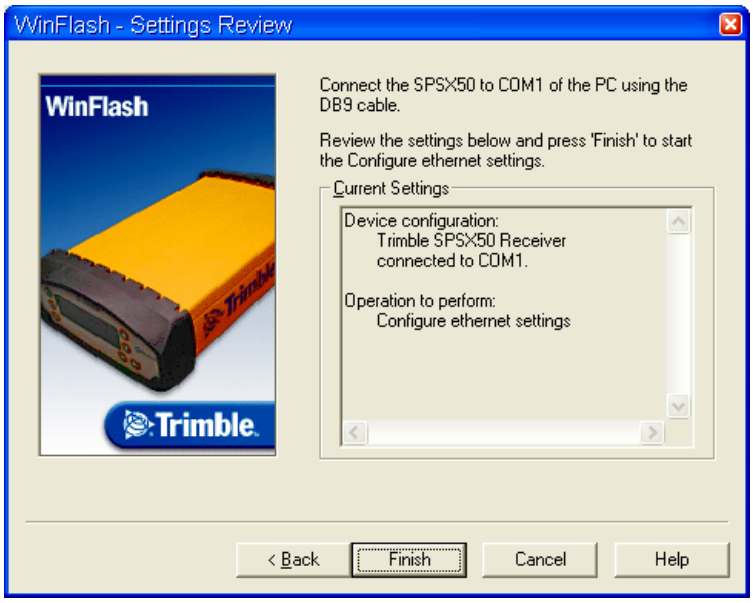
If your network installation requires the receiver to be configured with a static IP address, you can configure the Ethernet settings using the web server or the WinFlash utility. The web server can be only used when the receiver is connected to a network and has a valid Ethernet configuration.

Use the WinFlash utility to configure the Ethernet settings of a receiver that is to be connected to a network that requires static IP addresses:

1. Contact the network administrator for the correct settings for the SPSx50 receiver.
2. Connect the SPSx50 receiver to a computer running the WinFlash utility using the serial cable provided with the receiver.
3. Turn on the SPSx50 receiver.
4. On the computer, start the WinFlash utility.
5. From the *Device Configuration* screen, select Trimble SPSx50 Receiver. From the *PC serial port* list, select the appropriate PC serial port. Click **Next**:

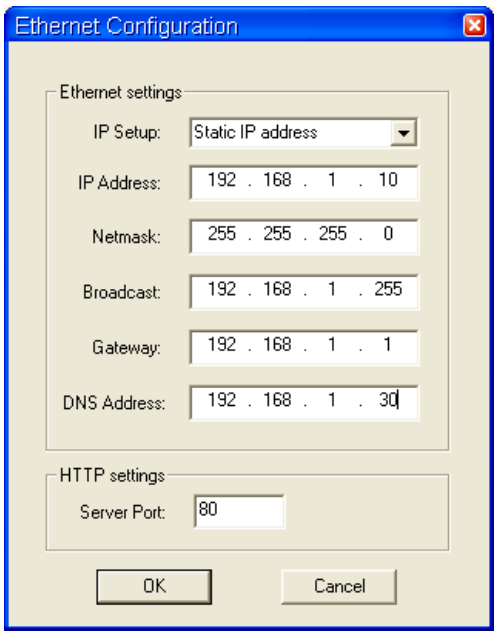
6. From the *Operation Selection* screen, select Configure ethernet settings, and then click **Next**:

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



Once the WinFlash utility connects to the receiver, the *Ethernet Configuration* dialog appears.

8. Enter the network settings in the *Ethernet Configuration* dialog. Click **OK**:



The Broadcast setting is the IP address that is used to broadcast to all devices on the subnet. This is usually the highest address (usually 255) in the subnet.

Configuring the SPSx50 receiver using a web browser

The SPSx50 receiver can be configured using the keypad and display, Trimble SCS900 Site Controller software, or a web browser. This section describes how to set up the receiver using a web browser.

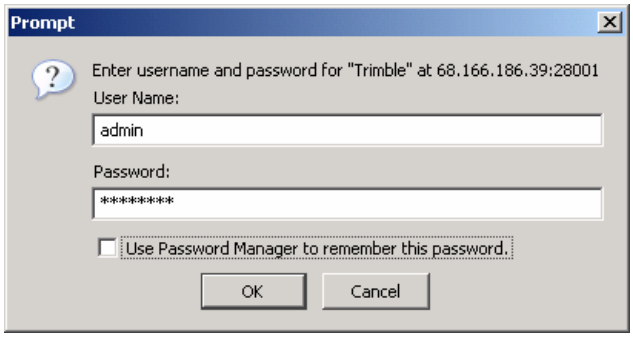
Supported browsers

- Mozilla Firefox version 1.07 or later (version 1.50 is recommended for Windows, Macintosh, and Linux operating systems)
- Microsoft Internet Explorer version 6.00 or later for Windows operating systems

To connect to the receiver using a web browser:

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

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



The default login values for the SPSx50 receiver are:

– User Name: admin

– Password: password

If you cannot connect to the receiver, the password for the root account may have been changed, or a different account may be being used. Contact your receiver administrator for the appropriate login information.

Once you are logged in, the welcome web page (see Figure 7.1) appears.

Figure 7.1 SPS GPS receiver Home webpage

Changing the settings

Use the webpage to configure the receiver settings. The web interface shows the configuration menus on the left of the browser window, and the settings on the right. Each configuration menu contains related submenus to configure the receiver and monitor receiver performance.

Note – *The configuration menus available vary based on the version of the SPSx50 receiver.*

A summary of each configuration menu is provided here. For more detailed information about each of the receiver settings, select the *Help* menu.

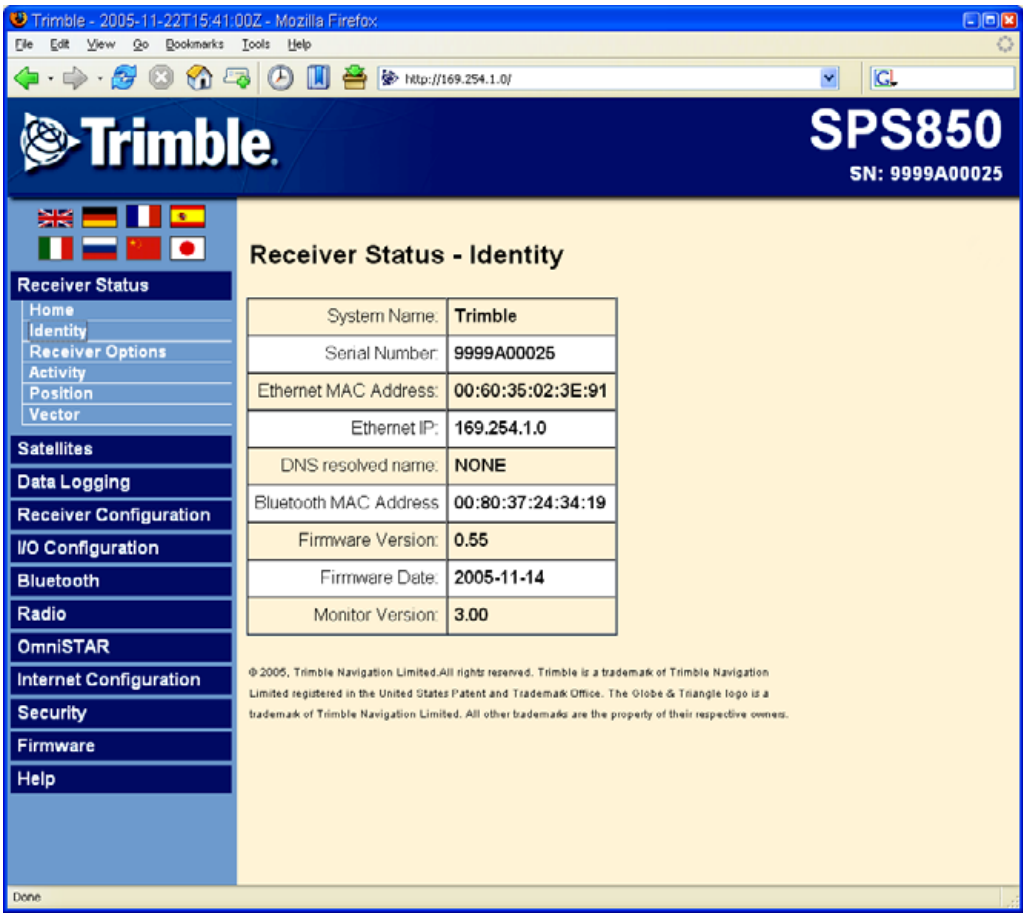
To display the web interface in another language, click the corresponding country flag. The web interface is available in the following languages:

- English
- German
- French
- Spanish
- Italian
- Russian
- Chinese
- Japanese

Receiver Status menu

The *Receiver Status* menu provides a quick link to review the receiver's available options, current firmware version, IP address, temperature, runtime, satellites tracked, current outputs, available memory, position information, and more.

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

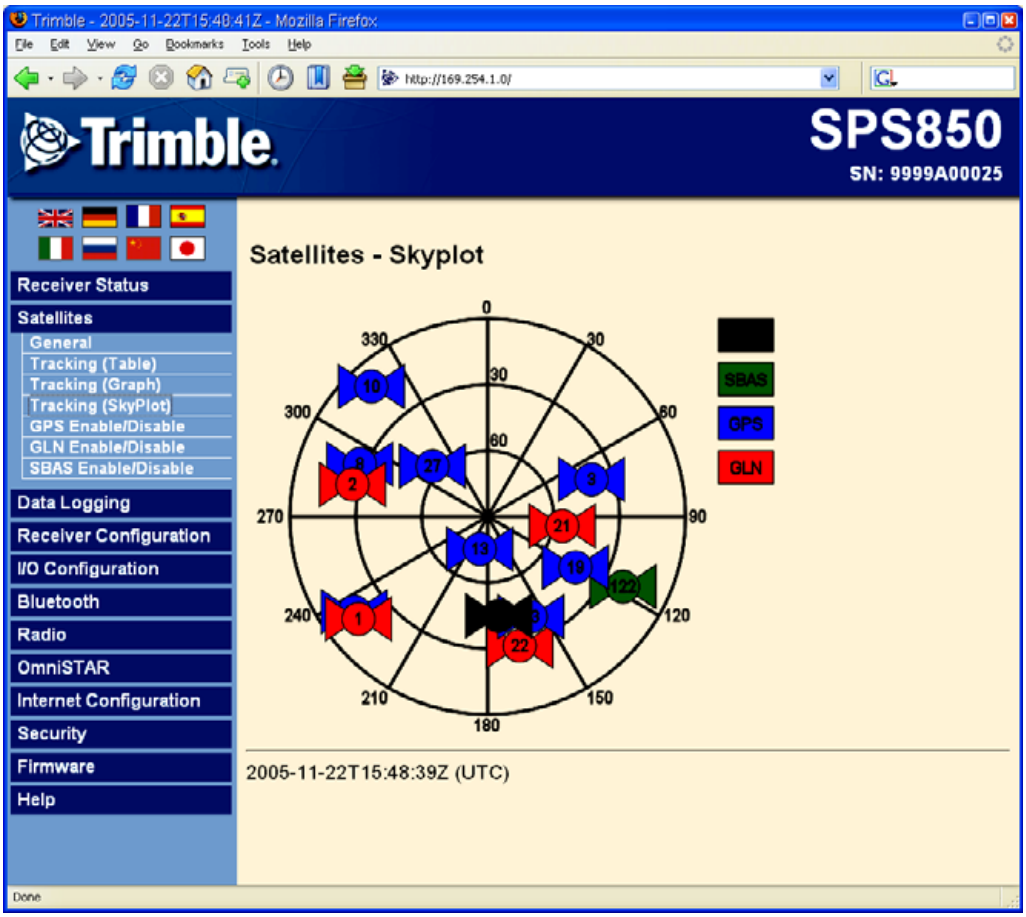


Satellites menu

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

Note – *To configure the receiver for OmniSTAR, use the OmniSTAR menu. See page 82.*

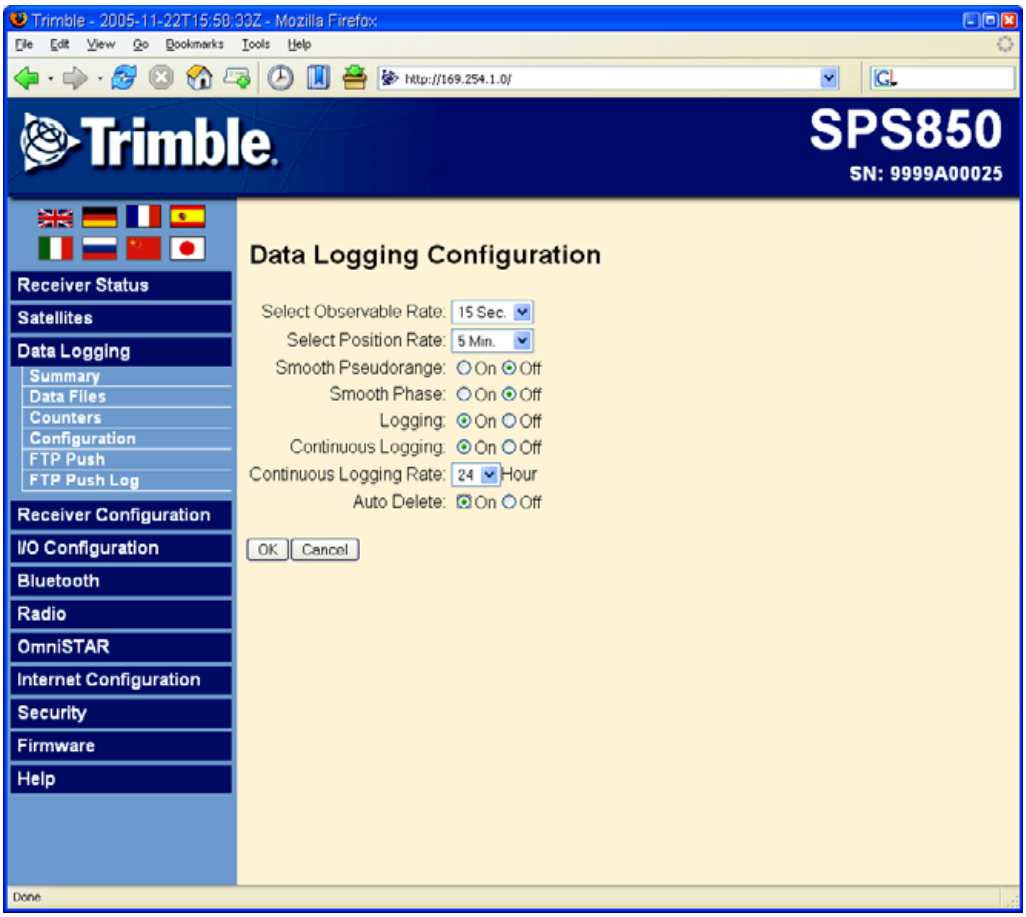
This figure shows an example of the screen that appears when you select *Satellite / Tracking (Sky Plot)*.



Data Logging menu

Use the *Data Logging* menu to set up the SPSx50 receiver to log static GPS data. This menu is available only if the receiver has the Data Logging option enabled. You can also configure settings such as observable rate, position rate, continuous logging, continuous logging rate, and whether to auto delete old files if memory is low.

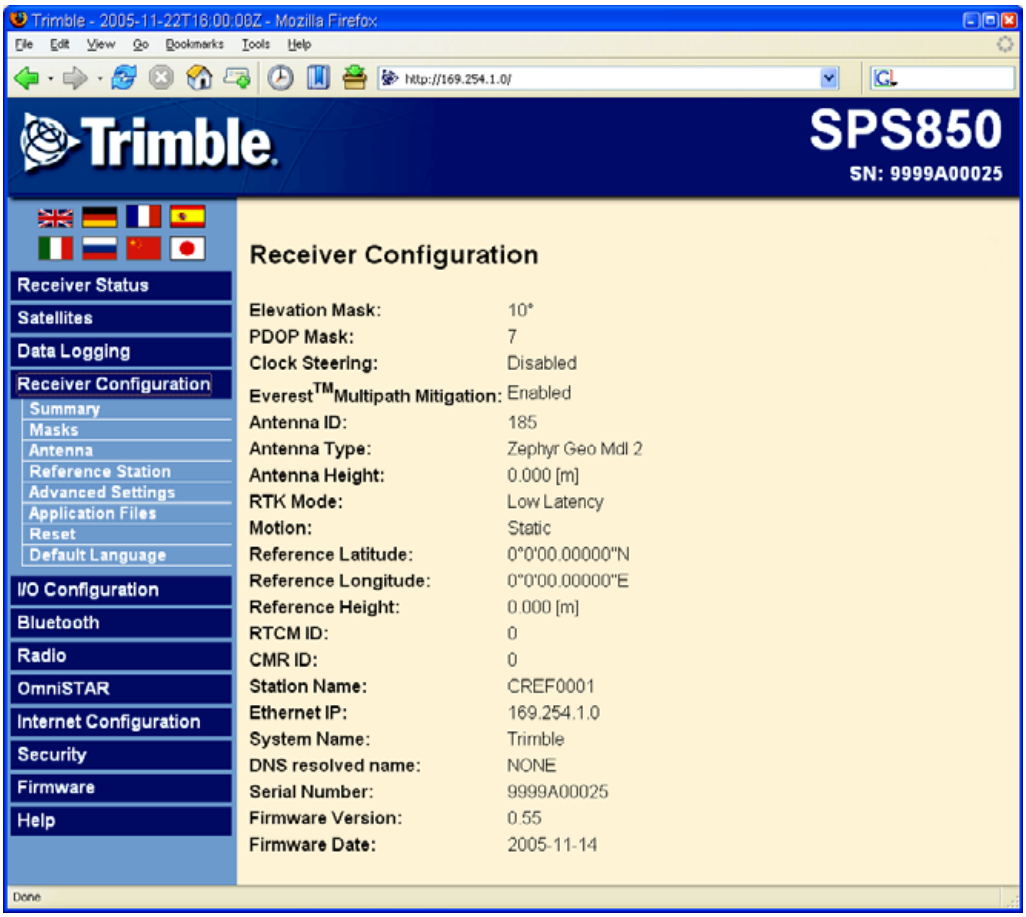
This figure shows an example of the screen that appears when you select *Data Logging / Configuration*.



Receiver Configuration menu

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

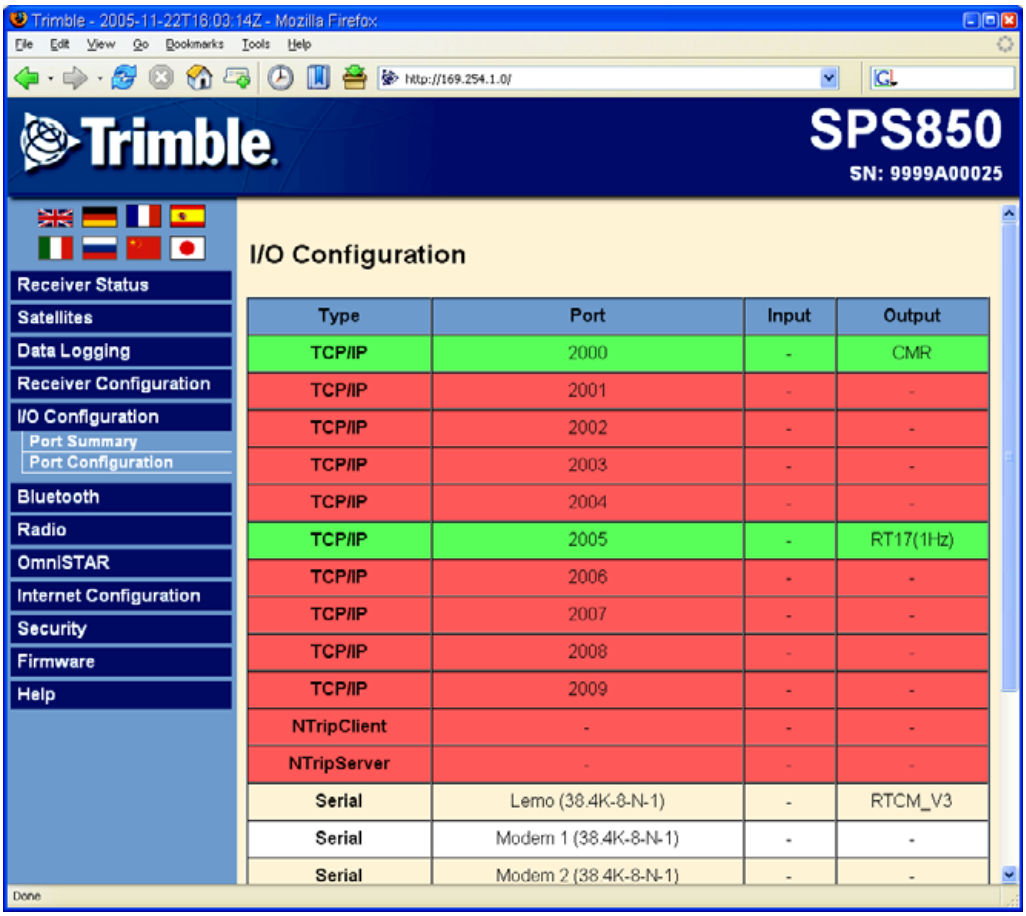
This figure shows an example of the screen that appears when you select *Receiver Configuration* / *Summary*.



I/O Configuration menu

Use the *I/O Configuration* menu to set up all outputs of the SPSx50 receiver. The receiver can output CMR, RTCM, NMEA, GSOF, RT17, or BINEX messages. These messages can be output on TCP/IP, UDP, serial, Bluetooth, or radio ports.

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

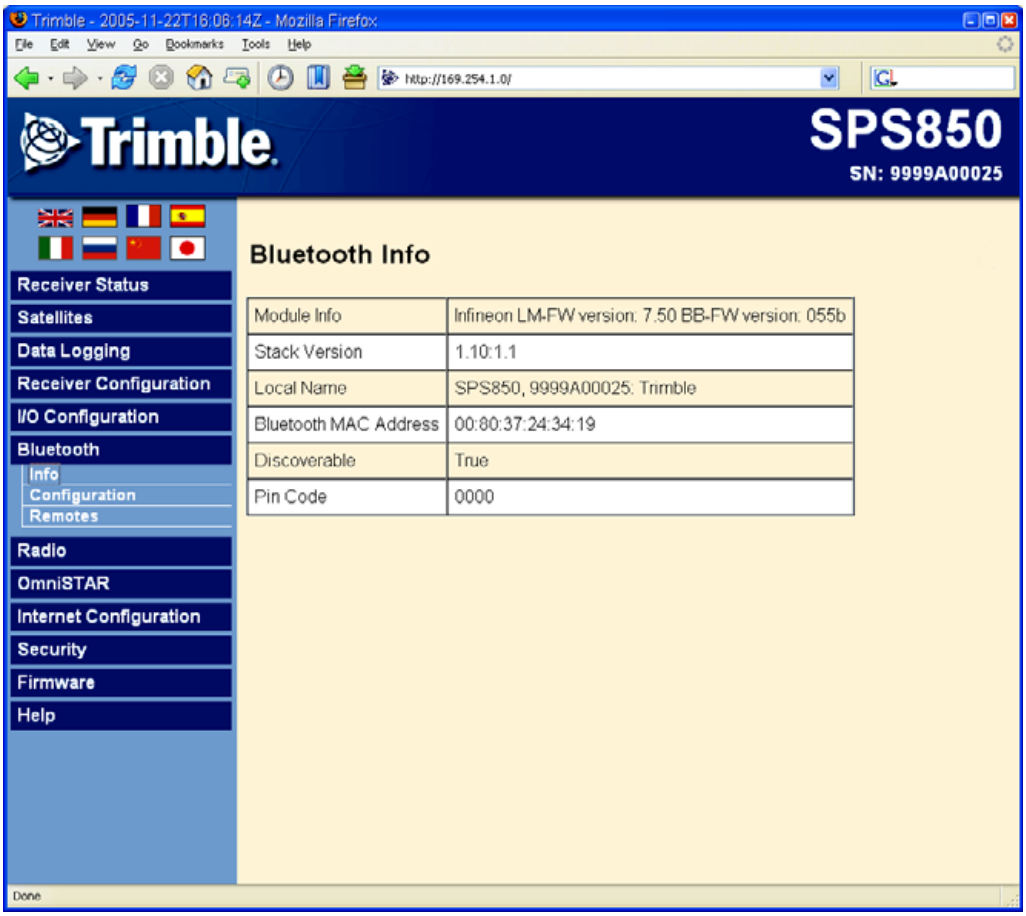


Bluetooth menu

Use the *Bluetooth* menu to configure the receiver to connect to other Trimble devices that use Bluetooth wireless technology. These devices can be used to configure the receiver, and generate or receive corrections. The following Trimble devices can be connected to the SPSx50 receiver using Bluetooth wireless technology:

- TSC2 controller
- TCU controller
- TSCe controller
- ACU controller
- SNB900 radio-modem
- Other Bluetooth-enabled SPS GPS receivers

This figure shows an example of the screen that appears when you select *Bluetooth* / *Info*.



Radio menu

Use the *Radio* menu to configure the internal radio of the receiver, if applicable. The SPSx50 receivers are available with 410–430 MHz, 430–450 MHz, 450–470 MHz, or 900 MHz radios. The SPS550H receiver does ***not*** have an internal radio.

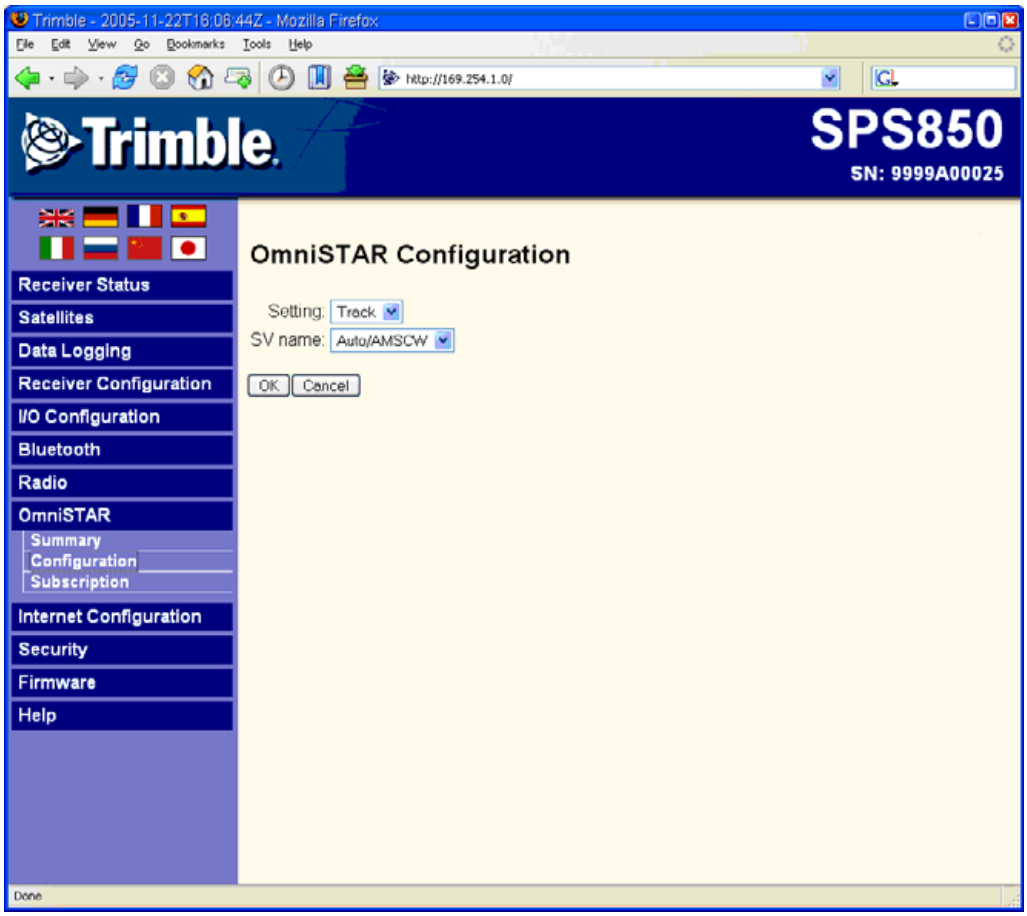
This figure shows an example of the screen that appears when you select *Radio*.

OmniSTAR menu

All SPSx50 receivers, except the SPS550H, can receive OmniSTAR corrections. By default, OmniSTAR tracking is turned on in the receiver. To receive OmniSTAR corrections, you must set the receiver to track OmniSTAR satellites and it must have a valid OmniSTAR subscription. The receiver can position with OmniSTAR XP or HP. To purchase a subscription for your receiver, contact OmniSTAR at:

www.OmniSTAR.com
North & South America, 1-888-883-8476 or 1-713-785-5850
Europe & Northern Africa, 31-70-317-0900
Australia & Asia, 61-8-9322 5295
Southern Africa, 27 21 552 0535

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

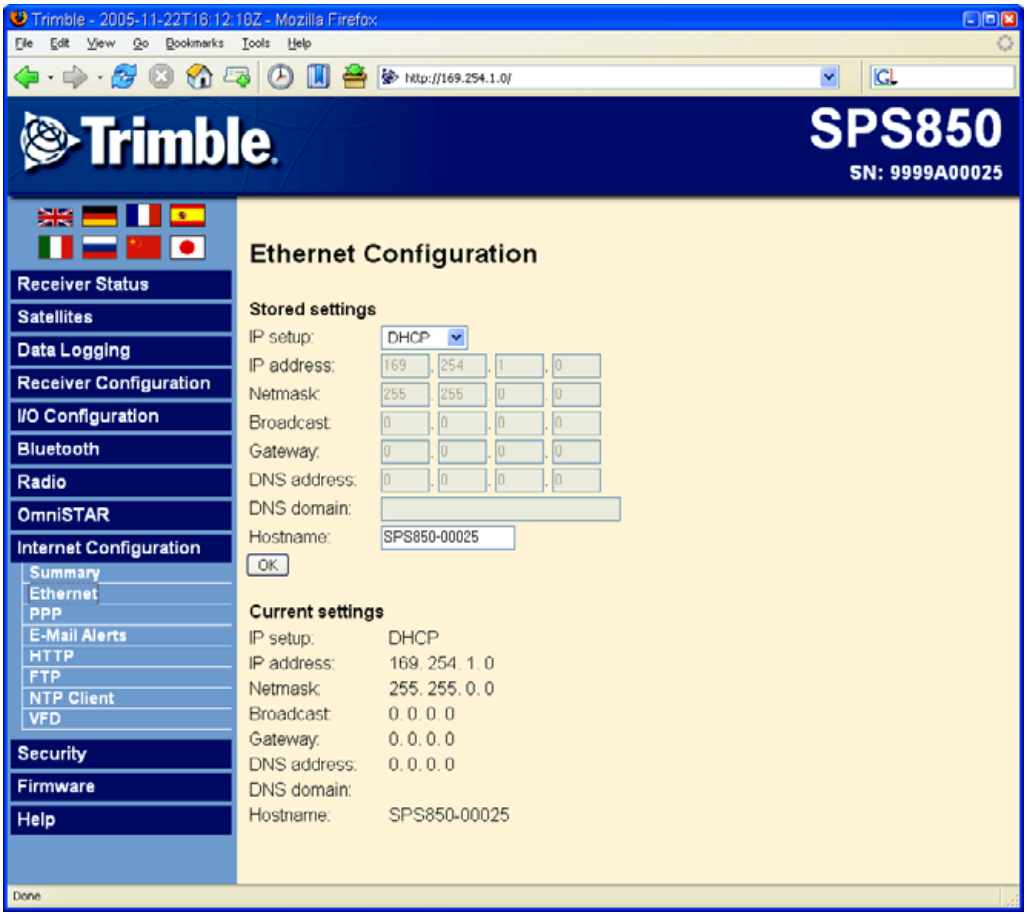


Internet Configuration menu

Use the *Internet Configuration* menu to configure Ethernet settings, e-mail alerts, PPP connection, HTTP port, FTP port, and VFD port settings of the receiver. For information on the Ethernet settings, see Configuring Ethernet settings, page 69.

The VFD port allows you to use the SPSx50 Remote Control application to view and navigate the SPSx50 receiver through a mock display and keypad interface. To allow the SPSx50 Remote Control to connect to the receiver, you need to enable the VFD port. To do this, select *Internet Configuration* / *VFD*.

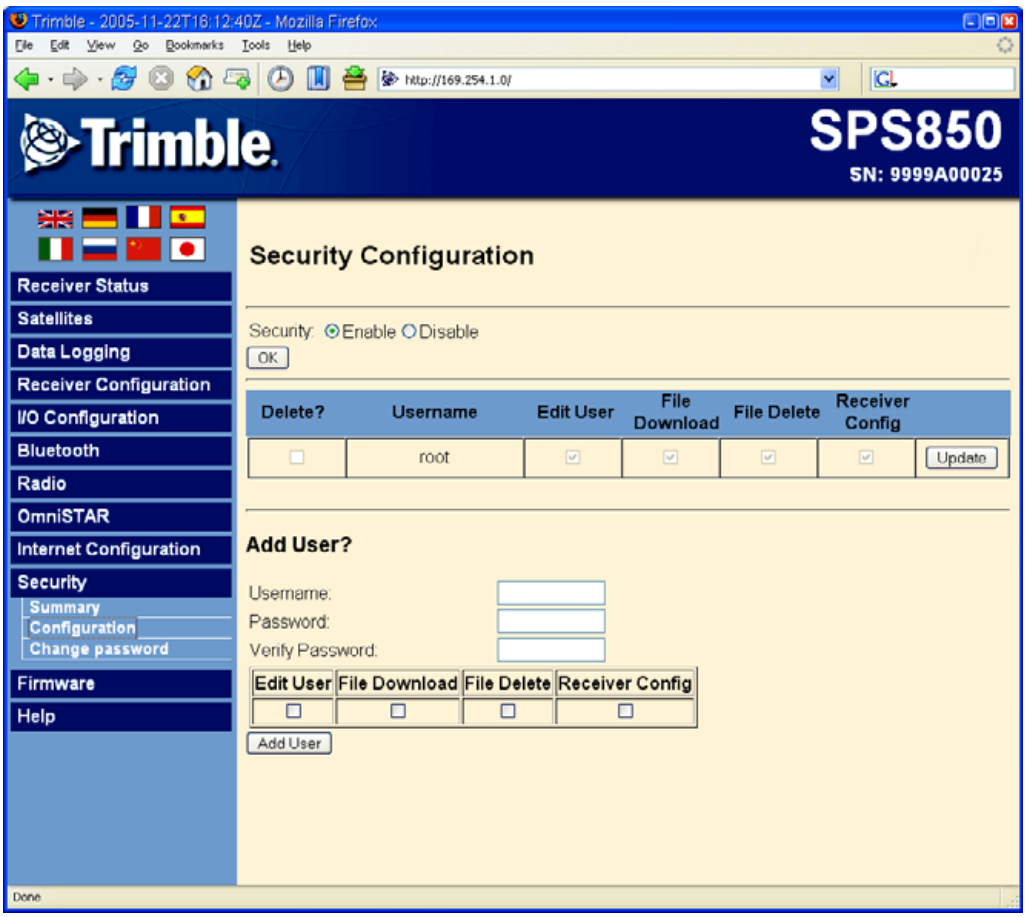
This figure shows an example of the screen that appears when you select *Internet Configuration* / *Ethernet*.



Security menu

Use the *Security* menu to configure the login accounts for all users who will be permitted to configure the SPSx50 receiver using a web browser. Each account consists of a username, password, and permissions. Administrators can use this feature to limit access to other users. Security can be disabled for a receiver. However, Trimble discourages this as it makes the receiver susceptible to unauthorized configuration changes.

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



Firmware menu

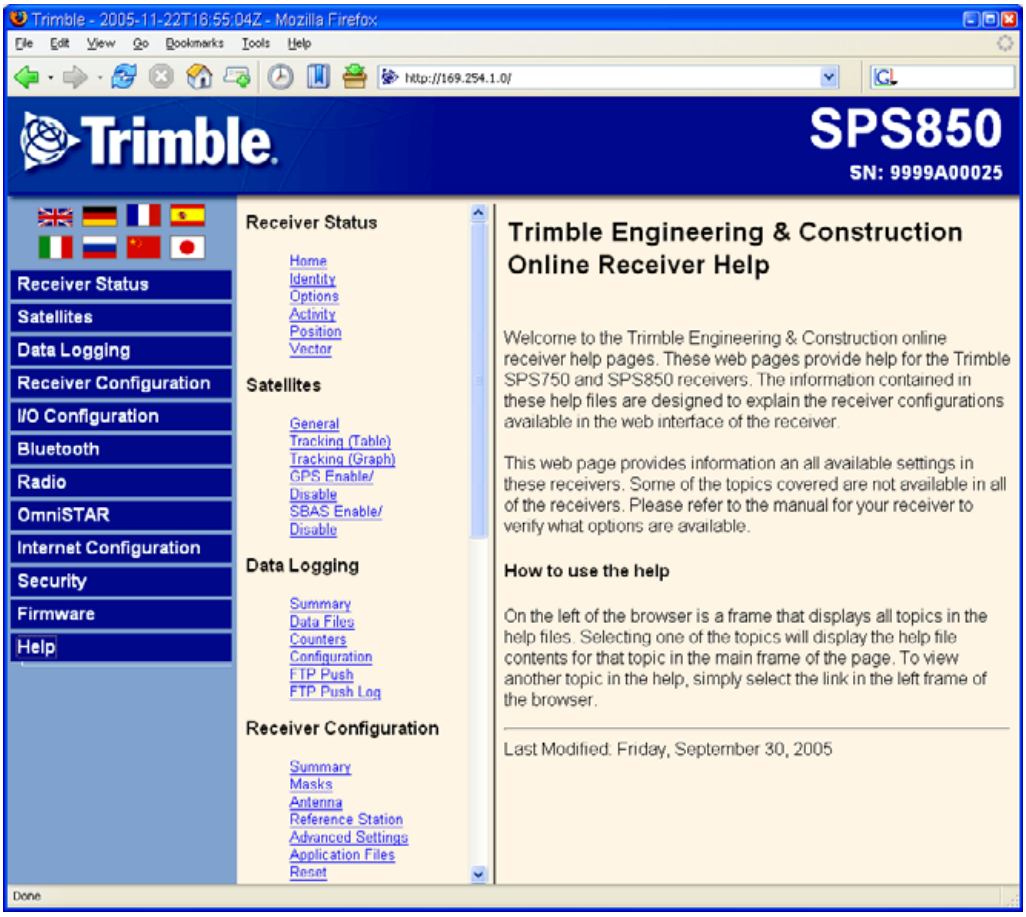
Use the *Firmware* menu to verify the current firmware and load new firmware to the SPSx50 receiver. You can upgrade firmware across a network or from a remote location without having to connect to the receiver with a serial cable.

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

Help Menu

The *Help* menu provides information on each of the receiver settings available in a web browser. Selecting the *Help* menu opens new windows. Select the section of the Help that you want to view. The Help files are stored on the Trimble Internet site and are updated between firmware releases. If you do not have access to the Internet, there is also a copy of the receiver Help files on the *Trimble SPS GPS Receiver CD*. (This copy shows the Help files as they were when the CD was published).

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



CHAPTER

8

Automatically Setting up a Mobile Base Station Using AutoBase Technology

In this chapter:

The AutoBase technology is a feature of the Trimble SPSx50 receivers that enables you to reduce daily setup time for mobile base stations and to reduce the likelihood of using incorrect base station coordinates during setup.

The AutoBase feature allows you to set up a SPSx50 receiver as a base station receiver and save you time so you do not need to reconfigure the receiver at the start of each day. It also allows you to set up the base station on a new site without needing to configure the settings in the receiver.

Even if you have used the AutoBase feature in other Trimble receivers, Trimble recommends that you read this chapter carefully because new functions in this feature provide greater benefit to you.

AutoBase Warning

The AutoBase Warning, when enabled, prevents the receiver from creating a new base station position and begin operating as an RTK base station when no previous base station position exists that corresponds to the current position of the receiver.

When the AutoBase Warning is on, the receiver will not begin transmitting RTK corrections from a base position (latitude, longitude, and height) that is not a part of the GPS site calibration. When the AutoBase Warning is off, the receiver begins transmitting RTK corrections from a new base position. You need only turn on the receiver the first time on a point, and you do not need to manually configure the base station settings.

By default, the SPSx50 receivers have the AutoBase Warning turned on. The receiver uses the AutoBase Warning setting to control how the receiver performs when different criteria are met. You can turn the AutoBase Warning on or off using the keypad and display. For more information, see Configuring system settings, page 65.

Working with AutoBase technology

This section contains some example scenarios. In each section, there is a step-by-step process that explains what you will experience in each scenerio.

Scenario One: First visit to a site with AutoBase Warning turned off

The following actions occur when you set up the base station for the first time on a new point and the AutoBase Warning is turned off:

1. Turn on the receiver.
2. The receiver begins tracking satellites.
3. The receiver determines the current position.
4. The receiver reviews the previous base station positions stored in the receiver.
5. The receiver does not find any base station that corresponds to the current position.
6. The receiver creates a new base station location for the current location.
7. The receiver sets the antenna height to 0. The antenna height is measured to the antenna phase center.

CAUTION – On each reoccupation of the point, you must ensure that the receiver antenna is set up in exactly the same location and at exactly the same height. Trimble also recommends that you use a T-bar or Fixed height tripod so that the position is easy to re-establish. Failure to achieve the same height position for the antenna results in errors in heights in subsequent measurements.

Where you set up each time with potentially different antenna heights, Trimble recommends that on the first setup after AutoBase has completed its process, that you edit the antenna height (using the receiver keypad and display). The updated antenna height changes the AutoBase setup, so that on subsequent setups, when you again change the antenna height, you will get correct height information during measurement. At the first setup, Trimble recommends that you change the AutoBase setup and antenna height ***before*** you carry out a site calibration.

8. The receiver begins generating RTK CMR+ corrections.
9. The RTK corrections begin streaming over the internal radio. If there is no internal radio, the receiver defaults to streaming the corrections on the Lemo port.

Scenario Two: First visit to a site with AutoBase Warning turned on

The following actions occur when you set up the base station for the first time on a point, and the AutoBase Warning is turned on:

1. Turn on the receiver.
2. The receiver begins tracking satellites.
3. The receiver determines the current position.
4. The receiver reviews the base positions stored in the receiver.
5. The receiver does not find any base station that corresponds to the current position.
6. The receiver displays a warning that AutoBase has failed.
7. No RTK corrections are streamed until the base station is set up using the keypad and display or an SCS900 controller.

Scenario Three: Repeat visit to a site with AutoBase Warning turned off

The following actions occur when you repeat a base station setup on a point, and the AutoBase Warning is turned off:

1. Turn on the receiver.
2. The receiver begins tracking satellites.
3. The receiver determines the current position.
4. The receiver reviews the base station positions stored in the receiver.
5. The receiver finds a base station position that corresponds to the current position.
6. The receiver loads the previous base information.

7. The antenna type, antenna height and measurement method used in the previous setup of this base station are applied.

CAUTION – If the antenna height is different to the previous setup, then you must enter the corrected height for the antenna (using the keypad and display) before starting measurements. Failure to achieve the correct antenna height position for the antenna results in errors in heights in subsequent measurements.

8. The receiver begins generating RTK CMR+ corrections.
9. The RTK corrections begin streaming on the radio or port defined in the application file.

Scenario Four: Repeat visit to a site with AutoBase Warning turned on

The following actions occur when you repeat a base station setup on a point, and the AutoBase Warning is turned on:

1. Turn on the receiver.
2. The receiver begins tracking satellites.
3. The receiver determines the current position.
4. The receiver reviews the base station positions stored in the receiver.
5. The receiver finds a base station position that corresponds to the current position.
6. Since a base station position is found, the AutoBase warning does not appear.
7. The receiver loads the previous base information.
8. The antenna type, antenna height, and measurement method used in the previous setup of this base station are applied.

CAUTION – If the antenna height is different from the previous setup, then you must enter the corrected height for the antenna (using the keypad and display) before starting measurements. Failure to achieve the correct antenna height position for the antenna results in errors in heights in subsequent measurements.

9. The receiver begins generating RTK CMR+ corrections.
10. The RTK corrections begin streaming on the radio or port defined in the previous setup of this base station.

Note – *Autobase recalls base station positions that are stored in the receiver. If the receiver has been previously set up on a control point but the stored base station position is not found in the receiver, it is possible that the information may have accidently been deleted. In this case, use the display and keypad or the SCS900 system to manually set up the base station. Make sure that you use the same base station latitude, longitude, and height as in the previous setup otherwise you will experience position or height errors in all subsequent measurements.*

Trimble recommends that after any new base station setup, or at the start of each measurement session, you measure a known point to verify that position and height errors are within tolerance. This is good practice and it takes just a few seconds to eliminate potentially gross errors typically associated with repeated daily base station setups.

Flowchart showing the AutoBase process

Figure 8.1 shows the AutoBase process.

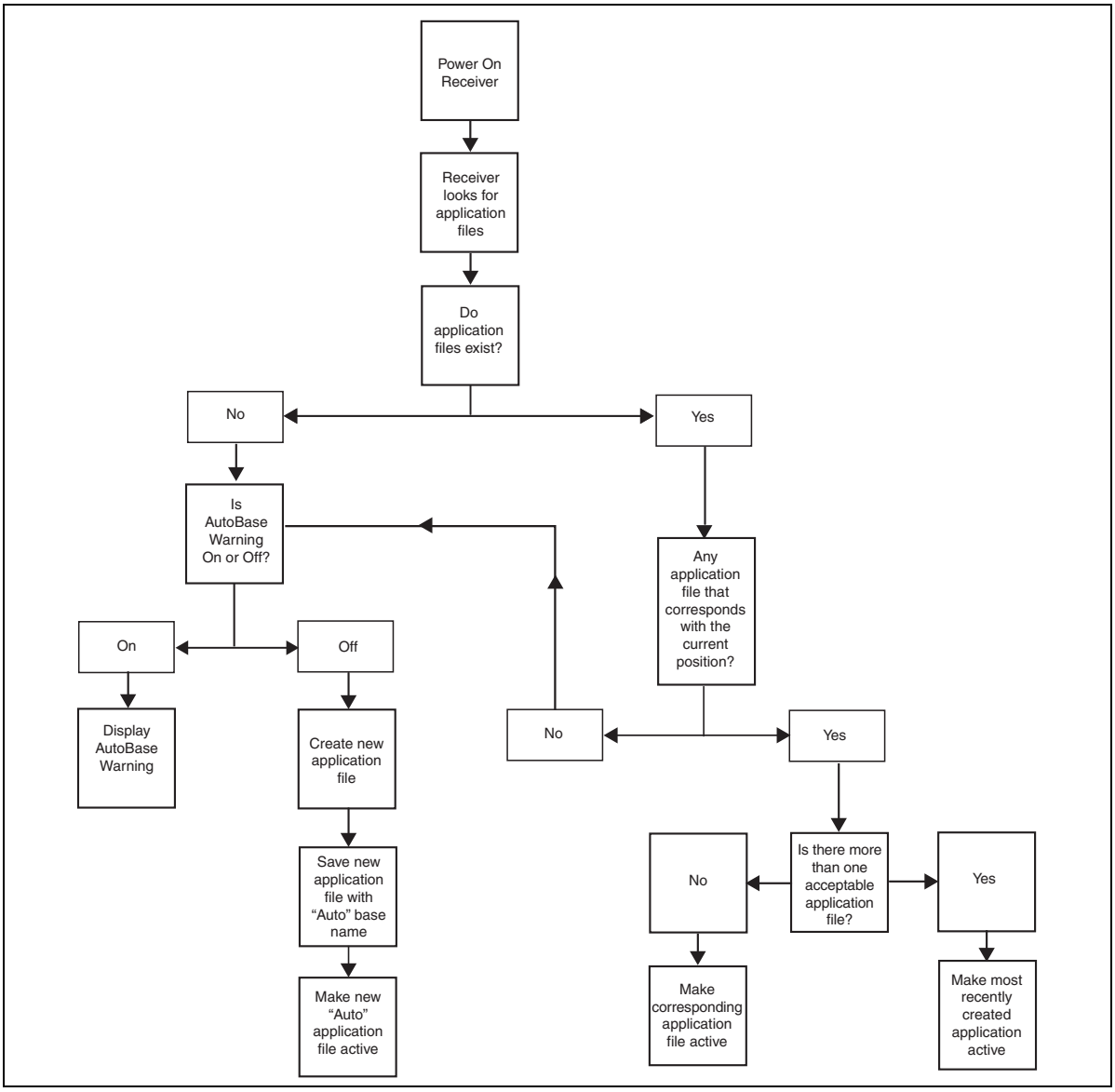


Figure 8.1 Autobase feature

CHAPTER

9

Default Settings

In this chapter:

- Default receiver settings
- Resetting the receiver to factory defaults
- Data Logging option

All settings are stored in application files. The default application file, Default.cfg, is stored permanently in the receiver, and contains the factory default settings for the SPSx50. Whenever the receiver is reset to its factory defaults, the current settings (stored in the current application file, Current.cfg) are reset to the values in the default application file.

Default receiver settings

These settings are defined in the default application file.

Function		Factory default
SV Enable		All SVs enabled
General Controls:	Elevation mask	10°
	PDOP mask	7
	RTK positioning mode	Low Latency
	Motion	Kinematic
Lemo Port:	Baud rate	38,400
	Format	8-None-1
	Flow control	None
Modem Port:	Baud rate	38,400
	Format	8-None-1
	Flow control	None
Input Setup:	Station	Any
NMEA/ASCII (all supported messages)		All ports Off
Streamed output		All types Off Offset = 00
RT17/Binary		All ports Off
Reference position:	Latitude	0°
	Longitude	0°
	Altitude	0.00 m HAE (Height above ellipsoid)
Antenna:	Type	Zephyr Geodetic Model 2
	Height (true vertical)	0.00 m
	Measurement method	True vertical

Resetting the receiver to factory defaults

To reset the receiver to its factory defaults, press ⏻ for 35 seconds.

Data Logging option

By default, the Data Logging option is turned off in SPS GPS receivers. If you choose to log data using a GPS receiver, you must enable the option and acquire suitable GPS postprocessing software, such as the Trimble Geomatics Office software. For more information, please contact your Trimble dealer.

Postprocessed GPS data is typically used for control network measurement applications and precise monitoring. GPS measurement data is collected over a period of time at a static point or points and then postprocessed to accurately compute baseline information.

Logging data after a power loss

If power is unexpectedly lost while the receiver is logging data, once power is restored, the receiver tries to return to the state it was in immediately before the power loss. The receiver does not reset itself to default settings.

If the receiver was logging data when power was lost, data logging is not resumed. To resume data logging after a power loss:

1. Restart the receiver. When power is cycled on the receiver, the receiver will turn on but with data logging off.
2. Use the web browser or the keypad and display to turn data logging back on.

CHAPTER

10

Specifications

In this chapter:

This chapter details the specifications for the SPSx50 GPS receiver.

Specifications are subject to change without notice.

General specifications

Feature	Specification
Keyboard and display	VFD display 16 characters by 2 rows On/Off key for one button startup using AutoBase technology Escape and Enter key for menu navigation 4 arrow keys (up, down, left, right) for option scrolls and data entry
Receiver type	Modular GPS receiver
Antenna type	
Base station	Zephyr Geodetic Model 2
Rover	Zephyr Model 2 Also supports legacy antennas Zephyr, Zephyr Geodetic, Micro-Centered™, Choke ring, Rugged Micro-Centered.

Physical specifications

Feature	Specification
Dimensions (LxWxH)	24 cm (9.4 in) x 12 cm (4.7 in) x 5 cm (1.9 in) including connectors
Weight	1.65 kg (3.64 lbs) receiver with internal battery and radio 1.55 kg (3.42 lbs) receiver with internal battery and no radio
Temperature[1]	
Operating	–40 °C to +65 °C (–40 °F to +149 °F)
Storage	–40 °C to +80 °C (–40 °F to +176 °F)
Humidity	100%, condensing
Waterproof	IP67 for submersion to depth of 1 m (3.28 ft)
Shock and vibration	Tested and meets the following environmental standards:
Shock, non operating	Designed to survive a 2 m (6.6 ft) pole drop onto concrete MIL-STD-810F, Fig.514.5C-17
Shock, operating	To 40 G, 10 msec, saw-tooth
Vibration	MIL-STD-810F, FIG.514.5C-17
Measurements	• Advanced Trimble Maxwell™ Custom GPS chip • L2C Civil signal and L5 signal for GPS modernization (SPS850 Extreme only) • Very low noise L1, L2, and L5 carrier phase measurements with <1 mm precision in a 1 Hz bandwidth • Proven Trimble low elevation tracking technology • 72 Channels L1 C/A Code, L2C, L5C, L1/L2/L5 Full Cycle Carrier, GLONASS L1/L2 (L2C, L5 and GLONASS L1/L2 tracking capability available only in the SPS850 Extreme only) • WAAS/EGNOS, and MSAS
Code differential GPS positioning[2]	
Horizontal accuracy	±(0.25 m + 1 ppm) RMS, ± (9.84 in + 1 ppm) RMS
Vertical accuracy	±(0.50 m + 1 ppm) RMS, ± (19.68 in + 1 ppm) RMS
WAAS/EGNOS, and MSAS	
Horizontal accuracy[3]	Typically <1 m (3.28 ft)
Vertical accuracy[2]	Typically <5 m (16.40 ft)

Feature	Specification
OmniSTAR Positioning	
XP Service Accuracy	Horizontal 20 cm (7.87 in), Vertical 30 cm (11.80 in)
HP Service Accuracy	Horizontal 10 cm (3.93 in), Vertical 15 cm (5.90 in)
Real Time Kinematic (RTK) positioning	
Horizontal	±(10 mm + 1 ppm) RMS, ± (0.38 in +1 ppm) RMS
Vertical	±(20 mm + 1 ppm) RMS, ± (0.78 in +1 ppm) RMS
Initialization time	
Regular RTK operation with base station	Single/Multi-base minimum 10 sec + 0.5 times baseline length in km, <30 km
RTK operation with Scalable GPS infrastructure	<30 seconds typical anywhere within coverage area
Initialization reliability[4]	Typically >99.9%

[1] Receiver will operate normally to –40 °C. Bluetooth module and internal batteries are rated to –20 °C.

[2] Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended practices.

[3] Depends on WAAS/EGNOS, and MSAS system performance.

[4] May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality

Electrical specifications

Feature	Specification
Power	
Internal	Integrated internal battery 7.4 V, 7800 mA-hr, Lithium-ion Internal battery operates as a UPS in the event of external power source outage Internal battery will charge from external power source when input voltage is >15 V Integrated charging circuitry
External	Power input on Lemo 7P0S is optimized for lead acid batteries with a cut off threshold of 10.5 V Power input on the 26-pin DSub connector is optimized for Trimble Lithium-ion battery input (P/N 49400) with a cut-off threshold of 9 V Power source supply (Internal / External) is hot swap capable in the event of power source removal or cut-off 9 V to 30 V DC external power input with over-voltage protection Receiver will auto power on when connected to external power of 15 V or greater
Power consumption	<6 W, in RTK rover mode with internal receive radio <8 W in RTK Base mode with internal transmit radio
Base station operation times on internal battery	Typically 8–10 hours based on transmitter power, types of messages transmitted, and temperature
Rover operation time on internal battery	
450 MHz	12 hours; varies with temperature
900 MHz	12 hours; varies with temperature
Base station operation times on internal battery	
450 MHz	10 hours; varies with temperature
900 MHz	10 hours; varies with temperature
Certification	Part 15.247 and Part 90 FCC certifications Class B Device FCC Part 15 and ICES-003 certifications RSS-310, RSS-210 and RSS-119 Industry Canada certifications ACMA AS/NZS 4295 approval CE mark compliance C-tick mark compliance UN ST/SG/AC.10.11/Rev. 3, Amend. 1 (Li-Ion Battery) UN ST/SG/AC. 10/27/Add. 2 (Li-Ion Battery) WEEE

Communication specifications

Feature	Specification
Communications	
Port 1 (7-pin 0S Lemo)	3-wire RS-232 CAN
Port 2 (DSub 26-pin)	Full RS-232 (via multi-port adaptor)
	3-wire RS-232
	USB (On the Go)
	Ethernet
Bluetooth	Fully integrated, fully sealed 2.4 GHz Bluetooth[1]
Integrated radios	Fully integrated, fully sealed internal 450 MHz, Tx, Rx, or Tx/Rx
	Fully integrated, fully sealed internal 900 MHz, Tx, Rx, or Tx/Rx
Channel spacing (450 MHz)	12.5 KHz or 25 KHz spacing available
Frequency approvals (900 MHz)	USA (-10), Australia (-30), New Zealand (-20)
450 MHz transmitter radio power output	0.5 W / 2.0 W (2 watt upgrade only available in certain countries)
900 MHz transmitter radio power output	1.0 W
External GSM/GPRS, cellular phone support	Supported for direct dial and Internet-based VRS correction streams
	Cellular phone or GSM/GPRS modem inside TSC2 controller
Receiver position update rate	1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning (varies by receiver model)
Data Input and Output	CMR, CMR+, RTCM 2.0, RTCM 2.1, RTCM 2.3, RTCM 3.0
Outputs	NMEA, GSOF, and RT17

[1] Bluetooth type approvals are country specific. Contact your local Trimble office or representative for more information.

GPS satellite signal tracking

This table shows the GPS satellite signal tracking capability for each receiver in the SPSx50 Modular GPS receiver family.

GPS signal type	Class	SPS550	SPS550H	SPS750 Basic base	SPS750 Basic rover	SPS750 Max	SPS850 Extreme
GPS signals	L1/L2	✓	✓	✓	✓	✓	✓
	L2C	×	×	×	×	×	✓
	L5	×	×	×	×	×	✓
GLONASS signals	L1/L2	×	×	×	×	×	✓
GPS SBAS corrections	WAAS	✓	✓	✓	✓	✓	✓
	EGNOS	✓	✓	✓	✓	✓	✓
	MSAS	✓	✓	✓	✓	✓	✓
OmniSTAR corrections	XP	✓	×	✓	✓	✓	✓
	HP	✓	×	✓	✓	✓	✓

Integrated radio options

Except for the SPS550H, all the receiver configurations are available with or without internal radios with 450 MHz or 900 MHz frequency ranges. The SPS550H is not available with a radio. This table shows the radio options available for each receiver type in the SPSx50 Modular GPS receiver family.

Radio option	SPS550	SPS550H	SPS750 Basic base	SPS750 Basic rover	SPS750 Max	SPS850 Extreme
No radio	✓	✓	✓	✓	✓	✓
450 MHz Transmit	✓	×	✓	×	✓	✓
450 MHz Receive	✓	×	×	✓	✓	✓
900 MHz Transmit	✓	×	✓	×	✓	✓
900 MHz Receive	✓	×	×	✓	✓	✓
External 450 MHz Transmit	Optional	×	Optional	Optional	Optional	Optional
External 900 MHz Transmit	Optional	×	Optional	Optional	Optional	Optional

Variable configuration options

This table lists the default options for each receiver type in the SPSx50 Modular GPS receiver family.

Radio option	SPS550	SPS550H	SPS750 Basic base	SPS750 Basic rover	SPS750 Max	SPS850 Extreme
CMR inputs (Rover)	✓[1]	✓[2]	×	✓	✓	✓
CMR outputs (Base)	✓[3]	×	✓	×	✓	✓
RTCM inputs (Rover)	✓	×	×	✓	✓	✓
RTCM outputs (DGPS Base)	×	×	✓	×	✓	✓
Moving Base (Position/Heading)	✓	✓	×	×	✓	✓
10 Hz measurements	✓	✓	×	×	✓	✓
20 Hz measurements	×	×	×	×	×	✓
Data logging (postprocessed)	×	×	Optional	Optional	Optional	Optional
VRS capable	✓ Location GPS	×	✓	×	✓	✓
Internet/IP enabled	✓	✓	✓	✓	✓	✓
RTK range limit	None	2.4 km (1.5 miles)	None	2.4 km (1.5 miles)	None	None

[1]Float solution only.

[2]Moving base CMRs only.

[3]Moving base CMR output only.

Upgrading the receiver

You can upgrade the SPS750 Basic base and SPS750 Basic rover to the SPS750 Max at any time. The upgrade changes all standard options to SPS750 Max capability, and includes the radio option upgrade. When you purchase the receiver upgrade, your Trimble dealer will provide you with a set of codes to change the receiver configuration. See also Appendix E, Upgrading the Receiver Firmware.

The SPS550 and SPS750 Max receivers cannot be upgraded further.

APPENDIX

A

NMEA-0183 Output

In this appendix:

- NMEA-0183 message overview
- Common message elements
- NMEA messages

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

NMEA-0183 message overview

When NMEA-0183 output is enabled, a subset of NMEA-0183 messages can be output to external instruments and equipment connected to the receiver serial ports. These NMEA-0183 messages let external devices use selected data collected or computed by the GPS receiver.

All messages conform to the NMEA-0183 version 3.01 format. All begin with $ and end with a carriage return and a line feed. Data fields follow comma (,) delimiters and are variable in length. Null fields still follow comma (,) delimiters but contain no information.

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

The following table summarizes the set of NMEA messages supported by the receiver, and shows the page that contains detailed information about each message.

Message	Function	Page
ADV	Position and Satellite information for RTK network operations	108
GGA	Time, position, and fix related data	109
GSA	GPS DOP and active satellites	110
GST	Position error statistics	111
GSV	Number of SVs in view, PRN, elevation, azimuth, and SNR	112
HDT	Heading from True North	113
PTNL,AVR	Time, yaw, tilt, range, mode, PDOP, and number of SVs for Moving Baseline RTK	114
PTNL,GGK	Time, position, position type and DOP values	115
PTNL,PJK	Local coordinate position output	116
PTNL,VGK	Time, locator vector, type and DOP values	117
PTNL,VHD	Heading Information	118
RMC	Position, Velocity, and Time	119
ROT	Rate of turn	120
VTG	Actual track made good and speed over ground	121
ZDA	UTC day, month, and year, and local time zone offset	122

To enable or disable the output of individual NMEA messages, do one of the following:

- Create an application file in the GPS Configurator software that contains NMEA output settings and then send the file to the receiver.
- Add NMEA outputs in the *Serial outputs* tab of the GPS Configurator software and then apply the settings. (You cannot use the GPS Configuration software to load application files to the SPSx50 Modular GPS receivers.)
- For SPSx50 Modular GPS receivers, set up the NMEA output using the keypad and display or a web browser.

Common message elements

Each message contains:

- a message ID consisting of *$GP* followed by the message type. For example, the message ID of the GGA message is *$GPGGA*.
- a comma
- a number of fields, depending on the message type, separated by commas
- an asterisk
- a checksum value

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

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

Message values

NMEA messages that the receiver generates contains the following values.

Latitude and longitude

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

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

Direction

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

Time

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

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

NMEA messages

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

ADV Position and Satellite information for RTK network operations

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

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

Table A.1 ADV subtype 110 message fields

Field	Meaning
0	message ID $PPGPADV
1	Message sub-type 110
2	Latitude
3	Longitude
4	Ellipsoid height
6	Elevation of second satellite, in degrees, 90° maximum
7	Azimuth of second satellite, degrees from True North, 000° through 359°
8	The checksum data, always begins with *

$PGPPADV,120,21,76.82,68.51,29,20.66,317.47,28,52.38,276.81,22,42.26,198.96*5D

Table A.2 ADV subtype 120 message fields

Field	Meaning
0	message ID $PPGPADV
1	Message sub-type 120
2	First SV PRN number
3	Elevation of first satellite, in degrees, 90° maximum
4	Azimuth of first satellite, degrees from True North, 000° through 359°
5	Second SV PRN number
6	Elevation of second satellite, in degrees, 90° maximum
7	Azimuth of second satellite, degrees from True North, 000° through 359°
8	The checksum data, always begins with *

GGA Time, Position, and Fix Related Data

An example of the GGA message string is shown below. Table A.3 describes the message fields.

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

Table A.3 GGA message fields

Field	Meaning
0	message ID $GPGGA
1	UTC of position fix
2	Latitude
3	Direction of latitude: N: North S: South
4	Longitude
5	Direction of longitude: E: East W: West
6	GPS Quality indicator: 0: Fix not valid 1: GPS fix 2: Differential GPS fix 4: Real Time Kinematic, fixed integers 5: Real Time Kinematic, float integers
7	Number of SVs in use, range from 00 through 12
8	HDOP
9	Orthometric height (MSL reference)
10	M: unit of measure for orthometric height is meters
11	Geoid separation
12	M: geoid separation is measured in meters
13	Age of differential GPS data record, Type 1 or Type 9. Null field when DGPS is not used.
14	Reference station ID, ranging from 0000 through 1023. A null field when any reference station ID is selected and no corrections are received.
15	The checksum data, always begins with *

GSA GPS DOP and active satellites

An example of the GSA message string is shown below. Table A.4 describes the message fields.

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

Table A.4 GSA message fields

Field	Meaning
0	message ID $GPGSA
1	Mode 1, M = manual, A = automatic
2	Mode 2, Fix type, 1 = not available, 2 = 2D, 3 = 3D
3	PRN number, 01 through 32, of satellite used in solution, up to 12 transmitted
4	PDOP-Position dilution of precision, 0.5 through 99.9
5	HDOP-Horizontal dilution of precision, 0.5 through 99.9
6	VDOP-Vertical dilution of precision, 0.5 through 99.9
7	The checksum data, always begins with *

GST Position Error Statistics

An example of the GST message string is shown below. Table A.5 describes the message fields.

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

Table A.5 GST message fields

Field	Meaning
0	message ID $GPGST
1	UTC of position fix
2	RMS value of the pseudorange residuals; includes carrier phase residuals during periods of RTK(float) and RTK(fixed) processing
3	Error ellipse semi-major axis 1 sigma error, in meters
4	Error ellipse semi-minor axis 1 sigma error, in meters
5	Error ellipse orientation, degrees from true north
6	Latitude 1 sigma error, in meters
7	Longitude 1 sigma error, in meters
8	Height 1 sigma error, in meters
9	The checksum data, always begins with *

GSV Satellite Information

The GSV message string identifies the number of SVs in view, the PRN numbers, elevations, azimuths, and SNR values. An example of the GSV message string is shown below. Table A.6 describes the message fields.

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

Table A.6 GSV message fields

Field	Meaning
0	message ID $GPGSV
1	Total number of messages of this type in this cycle
2	Message number
3	Total number of SVs visible
4	SV PRN number
5	Elevation, in degrees, 90° maximum
6	Azimuth, degrees from True North, 000° through 359°
7	SNR, 00–99 dB (null when not tracking)
8–11	Information about second SV, same format as fields 4 through 7
12–15	Information about third SV, same format as fields 4 through 7
16–19	Information about fourth SV, same format as fields 4 through 7
20	The checksum data, always begins with *

HDT Heading from True North

The HDT string is shown below, and Table A.7 describes the message fields.

$GPHDT,123.456,T*00

Table A.7 Heading from true north fields

Field	Meaning
0	message ID $GPHDT
1	Heading in degrees
2	T: Indicates heading relative to True North
3	The checksum data, always begins with *

PTNL,AVR

Time, Yaw, Tilt, Range for Moving Baseline RTK

The PTNL,AVR message string is shown below, and Table A.8 describes the message fields.

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

Table A.8 AVR message fields

Field	Meaning
0	message ID $PTNL,AVR
1	UTC of vector fix
2	Yaw angle in degrees
3	Yaw
4	Tilt angle in degrees
5	Tilt
6	Reserved
7	Reserved
8	Range in meters
9	GPS quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential carrier phase solution RTK (Float) 3: Differential carrier phase solution RTK (Fix) 4: Differential code-based solution, DGPS
10	PDOP
11	Number of satellites used in solution
12	The checksum data, always begins with *

PTNL,GGK

Time, Position, Position Type, DOP

An example of the PTNL,GGK message string is shown below. Table A.9 describes the message fields.

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

Table A.9 PTNL,GGK message fields

Field	Meaning
0	message ID $PTNL,GGA
1	UTC of position fix
2	Date
3	Latitude
4	Direction of latitude: N: North S: South
5	Longitude
6	Direction of Longitude: E: East W: West
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution, RTK(float) 3: Differential, fixed carrier phase integer-based solution, RTK(fixed) 4: Differential, code phase only solution (DGPS). Also, OmniSTAR XP/HP converging 5: SBAS solution – WAAS, EGNOS 6: RTK Float 3D in a VRS/Network. Also OmniSTAR XP/HP converged 7: RTK Fixed 3D in a VRS/Network 8: RTK Float 2D in a VRS/Network
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M: ellipsoidal height is measured in meters
12	The checksum data, always begins with *

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

PTNL,PJK

Local Coordinate Position Output

An example of the PTNL,PJK message string is shown below. Table A.10 describes the message fields.

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

Table A.10 PTNL,PJK message fields

Field	Meaning
0	message ID $PTNL,PJK
1	UTC of position fix
2	Date
3	Northing, in meters
4	Direction of Northing will always be N (North)
5	Easting, in meters
6	Direction of Easting will always be E (East)
7	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution, RTK(float) 3: Differential, fixed carrier phase integer-based solution, RTK(fixed) 4: Differential, code phase only solution (DGPS). Also, OmniSTAR XP/HP converging 5: SBAS solution – WAAS, EGNOS 6: RTK Float 3D in a VRS/Network. Also OmniSTAR XP/HP converged 7: RTK Fixed 3D in a VRS/Network 8: RTK Float 2D in a VRS/Network
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M: ellipsoidal height is measured in meters
12	The checksum data, always begins with *

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

PTNL,VGK

Vector Information

An example of the PTNL,VGK message string is shown below. Table A.11 describes the message fields.

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

Table A.11 PTNL,VGK message fields

Field	Meaning
0	message ID $PTNL,VGK
1	UTC of vector in hhmmss.ss format
2	Date in mmddyy format
3	East component of vector, in meters
4	North component of vector, in meters
5	Up component of vector, in meters
6	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution, RTK(float) 3: Differential, fixed carrier phase integer-based solution, RTK(fixed) 4: Differential, code phase only solution (DGPS). Also, OmniSTAR XP/HP converging 5: SBAS solution – WAAS, EGNOS 6: RTK Float 3D in a VRS/Network. Also OmniSTAR XP/HP converged 7: RTK Fixed 3D in a VRS/Network 8: RTK Float 2D in a VRS/Network
7	Number of satellites if fix solution
8	DOP of fix
9	M: Vector components are in meters
10	The checksum data, always begins with *

PTNL,VHD

Heading Information

An example of the PTNL,VHD message string is shown below. Table A.12 describes the message fields.

$PTNL,VHD,030556.00,093098,187.718,-22.138,-76.929,-5.015,0.033,0.006,3,07,2.4,M*22

Table A.12 PTNL,VHD message fields

Field	Meaning
0	message ID $PTNL,VHD
1	UTC of position in hhmmss.ss format
2	Date in mmddyy format
3	Azimuth
4	ΔAzimuth/ΔTime
5	Vertical Angle
6	ΔVertical/ΔTime
7	Range
8	ΔRange/ΔTime
9	GPS Quality indicator: 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution, RTK(float) 3: Differential, fixed carrier phase integer-based solution, RTK(fixed) 4: Differential, code phase only solution (DGPS). Also, OmniSTAR XP/HP converging 5: SBAS solution – WAAS, EGNOS 6: RTK Float 3D in a VRS/Network. Also OmniSTAR XP/HP converged 7: RTK Fixed 3D in a VRS/Network 8: RTK Float 2D in a VRS/Network
10	Number of satellites used in solution
11	PDOP
12	The checksum data, always begins with *

RMC Position, Velocity, and Time

The RMC string is shown below, and Table A.13 describes the message fields.

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

Table A.13 GPRMC message fields

Field	Meaning
0	message ID $GPRMC
1	UTC of position fix
2	Status A=active or V=void
3	Latitude
4	Longitude
5	Speed over the ground in knots
6	Track angle in degrees (True)
7	Date
8	Magnetic variation in degrees
9	The checksum data, always begins with *

ROT Rate and Direction of Turn

The ROT string is shown below, and Table A.14 describes the message fields.

$GPROT,35.6,A*4E

Table A.14 ROT message fields

Field	Meaning
0	message ID $GPROT
1	Rate of turn, degrees/minutes, "–" indicates bow turns to port
2	A: Valid data V: Invalid data
3	The checksum data, always begins with *

VTG Over Ground and Speed Over Ground or Track Made Good and Speed Over Ground

An example of the VTG message string is shown below. Table A.15 describes the message fields.

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

Table A.15 VTG message fields

Field	Meaning
0	message ID $GPVTG
1	Track made good (degrees true)
2	T: track made good is relative to true north
3	Track made good (degrees magnetic)
4	M: track made good is relative to magnetic north
5	Speed, in knots
6	N: speed is measured in knots
7	Speed over ground in kilometers/hour (kph)
8	K: speed over ground is measured in kph
9	The checksum data, always begins with *

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

An example of the ZDA message string is shown below. Table A.16 describes the message fields.

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

Table A.16 ZDA message fields

Field	Meaning
0	message ID $GPZDA
1	UTC
2	Day, ranging between 01 and 31
3	Month, ranging between 01 and 12
4	Year
5	Local time zone offset from GMT, ranging from 00 through ±13 hours
6	Local time zone offset from GMT, ranging from 00 through 59 minutes
7	The checksum data, always begins with *

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

APPENDIX

B

GSOF Messages

In this appendix:

- Supported message types
- GSOF message definitions

This appendix provides information on the General Serial Output Format (GSOF) messages that the SPS GPS receivers support. GSOF messages are a Trimble proprietary format and can be used to send information such as position and status to a third-party device.

For information on how to output GSOF messages from the SPSx50 Modular GPS receiver, refer to Chapter 6, Configuring the SPSx50 Using the Keypad and Display and Chapter 7, Configuring the Receiver Settings in the *SPSx50 Modular GPS Receiver User Guide*.

Supported message types

This table summarizes the GSOF messages that are supported by the receiver, and shows the page that contains detailed information about each message.

Message	Description	Page
TIME	Position time	124
LLH	Latitude, longitude, height	125
ECEF	Earth-Centered, Earth-Fixed position	125
ECEF DELTA	Earth-Centered, Earth-Fixed Delta position	126
NEU DELTA	Tangent Plane Delta	126
Velocity	Velocity data	127
PDOP	PDOP info	127
SIGMA	Position Sigma info	127
SV Brief	SV Brief info	128
SV Detail	SV Detailed info	129
UTC	Current UTC time	130
BATT/MEM	Receiver battery and memory status	130
ATTITUDE	Attitude info	131

GSOF message definitions

When GSOF output is enabled, the following messages can be generated.

TIME

This message describes position time information. It contains the following data:

- GPS time, in milliseconds of GPS week
- GPS week number
- Number of satellites used
- Initialization counter

Table B.1 Time (Type 1 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	01h	Position time output record
1	Record length	Char	0Ah	Bytes in record
2–5	GPS time (ms)	Long	msecs	GPS time, in milliseconds of GPS week
6–7	GPS week number	Short	number	GPS week count since January 1980
8	Number of SVs used	Char	00h-0Ch	Number of satellites used to determine the position (0-12)
9	Position flags 1	Char	See Table B.14	Reports first set of position attribute flag values

Table B.1 Time (Type 1 record)

Field	Item	Type	Value	Meaning
10	Position flags 2	Char	See Table B.15	Reports second set of position attribute flag values
11	Initialized number	Char	00h-FFh	Increments with each initialization (modulo 256)

LLH

This message describes latitude, longitude, and height. It contains the following data:

- WGS-84 latitude and longitude, in radians
- WGS-84 height, in meters

Table B.2 Latitude, longitude, height (Type 2 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	02h	Latitude, longitude, and height output record
1	Record length	Char	18h	Bytes in record
2–9	Latitude	Double	Radians	Latitude from WGS-84 datum
10–17	Longitude	Double	Radians	Longitude from WGS-84 datum
18–25	Height	Double	Meters	Height from WGS-84 datum

ECEF

This message describes the ECEF position. It contains the following data:

- Earth-Centered, Earth-Fixed X, Y, Z coordinates, in meters

Table B.3 ECEF position (Type 3 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	03h	Earth-Centered, Earth-Fixed (ECEF) position output record
1	Record length	Char	18h	Bytes in record
2–9	X	Double	Meters	WGS-84 ECEF X-axis coordinate
10–17	Y	Double	Meters	WGS-84 ECEF Y-axis coordinate
18–25	Z	Double	Meters	WGS-84 ECEF Z-axis coordinate

ECEF DELTA

This message describes the ECEF Delta position. It contains the following data:

- Earth-Centered, Earth-Fixed X, Y, Z deltas between the rover and base position, in meters.

Table B.4 ECEF Delta (Type 6 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	06h	Earth-Centered, Earth-Fixed (ECEF) Delta output record
1	Record length	Char	18h	Bytes in record
2–9	Delta X	Double	Meters	ECEF X-axis delta between rover and base station positions
10–17	Delta Y	Double	Meters	ECEF Y-axis delta between rover and base station positions
18–25	Delta Z	Double	Meters	ECEF Z-axis delta between rover and base station positions

NEU DELTA

This message contains Tangent Plane Delta information. It contains the following data:

- North, East, and Up deltas of the vector from the base to the rover (in meters) projected onto a plane tangent to the WGS-84 ellipsoid at the base receiver.

Note – *These records are only output if a valid DGPS/RTK solution is computed.*

Table B.5 NEU Delta (Type 7 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	06h	Tangent Plane Delta output record
1	Record length	Char	18h	Bytes in record
2–9	Delta east	Double	meters	East component of vector from base station to rover, projected onto a plane tangent to the WGS-84 ellipsoid at the base station
10–17	Delta north	Double	meters	North component of tangent plane vector
18–25	Delta up	Double	meters	Difference between ellipsoidal height of tangent plane at base station and a parallel plane passing through rover point

Velocity

This message provides velocity information. It contains the following data:

- Horizontal velocity, in meters per second
- Vertical velocity, in meters per second
- Heading, in radians, referenced to WGS-84 True North

Table B.6 Velocity (Type 8 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	08h	Velocity data output record
1	Record length	Char	0Dh	Bytes in record
2	Velocity flags	Char	See Table B.17	Velocity status flags
3–6	Speed	Float	Meters per second	Horizontal speed
7–10	Heading	Float	Radians	True north heading in the WGS-84 datum
11–14	Vertical velocity	Float	Meters per second	Vertical velocity

PDOP

This message describes the PDOP information. It contains the following data:

- PDOP
- HDOP
- VDOP
- TDOP

Table B.7 PDOP (Type 9 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	09h	PDOP information output record
1	Record length	Char	10h	Bytes in record
2–5	PDOP	Float		Positional Dilution of Precision
6–9	HDOP	Float		Horizontal Dilution of Precision
10–13	VDOP	Float		Vertical Dilution of Precision
14–17	TDOP	Float		Time Dilution of Precision

SIGMA

This message describes the Position Sigma information. It contains the following data:

- Position RMS
- Sigma east, in meters
- Sigma north, in meters
- Sigma up, in meters

- Covariance east-north
- Error Ellipse Semi-major axis, in meters
- Error Ellipse Semi-minor axis, in meters
- Orientation of Semi-major axis in degrees from True North
- Unit variance
- Number of epochs

Table B.8 Sigma (Type 12 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Ch	Position sigma information output record
1	Record length	Char	26h	Bytes in record
2–5	Position RMS	Float		Root means square of position error calculated for overdetermined positions
6–9	Sigma east	Float	Meters	
10–13	Sigma north	Float	Meters	
14–17	Covar. east-north	Float	number	Covariance east-north (dimensionless)
18–21	Sigma up	Float	Meters	
22–25	Semi-major axis	Float	Meters	Semi-major axis of error ellipse
26–29	Semi-minor axis	Float	Meters	Semi-minor axis of error ellipse
30–33	Orientation	Float	degrees	Orientation of semi-minor axis, clockwise from True North
34–37	Unit variance	Float		Valid only for over-determined solutions. Unit variance should approach 1.0 value. A value of less than 1.0 indicates that apriori variances are too pessimistic.
30–39	Number of epochs	short	count	Number of measurement epochs used to compute the position. Could be greater than 1 for positions subjected to static constraint. Always 1 for kinematic.

SV Brief

This message provides brief satellite information. It contains the following data:

- Number of satellites tracked
- The PRN number of each satellite
- Flags indicating satellite status

Table B.9 SV brief (Type 13 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Dh	Brief satellite information output record
1	Record length	Char		Bytes in record
2	Number of SVs	Char	00h-18h	Number of satellites included in record[1]

Table B.9 SV brief (Type 13 record)

Field	Item	Type	Value	Meaning
	The following bytes are repeated for Number of SVs			
	PRN	Char	01h-20h	Pseudorandom number of satellites (1-32)
	SV Flags1	Char	See Table B.18	First set of satellite status bits
	SV Flags2	Char	See Table B.19	Second set of satellite status bits

[1]Includes all tracked satellites, all satellites used in the position solution, and all satellites in view.

SV Detail

This message provides detailed satellite information. It contains the following data:

- Number of satellites tracked
- The PRN number of each satellite
- Flags indicating satellite status
- Elevation above horizon, in degrees
- Azimuth from True North, in degrees
- Signal-to-noise ratio (SNR) of L1 signal
- Signal-to-noise ratio (SNR) of L2 signal

Table B.10 SV detail (Type 14 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	0Eh	Detailed satellite information output record
1	Record length	Char	1 + 8×(number of SVs)	Bytes in record
2–9	Number of SVs	Char	00h-18h	Number of satellites included in record[1]
	The following bytes are repeated for Number of SVs			
	PRN	Char	01h-20h	Pseudorandom number of satellites (1–32)
	Flags1	Char	See Table B.18	First set of satellite status bits
	Flags2	Char	See Table B.19	Second set of satellite status bits
	Elevation	Char	Degrees	Angle of satellite above the horizon
	Azimuth	Short	Degrees	Azimuth of satellite from True North
	SNR L1	Char	dB * 4	Signal-to-noise ratio of L1 signal (multiplied by 4)[2]
	SNR L2	Char	dB * 4	Signal-to-noise ratio of L2 signal (multiplied by 4)[2]

[1]Includes all tracked satellites, all satellites used in the position solution, and all satellites in view.

[2]THe SNR L1 and SNR L2 items are set to zero for satellites that are not tracked on the current frequency.

UTC

This message describes current time information. It contains the following data:

- GPS time, in milliseconds of GPS week
- GPS week number
- GPS to UTC time offset, in seconds

Table B.11 UTC (Type 16 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	10h	
1	Record length	Char	09h	Bytes in record
2–5	GPS millisecond of week	Long	msecs	Time when packet is sent from the receiver, in GPS milliseconds of week
6–7	GPS week number	Short	number	Week number since start of GPS time
8–9	UTC offset	Short	seconds	GPS to UTC time offset
10	Flags	Char	See Table B.16	Flag bits indicating validity of Time and UTC offsets

Batt/Mem

This message provides information relating to the receiver battery and memory. It contains the following data:

- Remaining battery power
- Remaining memory

Table B.12 Batt/Mem (Type 37 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	25h	
1	Record length	Char	0Ah	Bytes in record
2–3	Battery capacity	Unsigned short	percentage	Remaining battery capacity in percentage
4–11	Remaining memory	Double	hours	Estimated remaining data logging time in hours

Attitude

This message provides attitude information relating to the vector between the Heading antenna and the Moving Base antenna. It contains the following data:

- Tilt or vertical angle, in radians, from the Heading antenna to the Moving Base antenna relative to a horizontal plane through the Heading antenna
- Heading or yaw, in radians, relative to True North
- Range or slope distance between the Heading antenna and the Moving Base antenna

Table B.13 Attitude (Type 27 record)

Field	Item	Type	Value	Meaning
0	Output record type	Char	1Bh	Attitude information
1	Record length	Char	2Ah	Bytes in record
2–5	GPS time	Long	msecs	GPS time in milliseconds of GPS week
6	Flags	Char	See Table B.20	Flag bits indicating validity of attitude components
7	Number of SVs used	Char	00h-0Ch	Number of satellites used to calculate attitude
8	Calculation mode	Char	See Table B.21	Positioning mode
9	Reserved			Reserved
10–17	Tilt	Double	radians	Tilt relative to horizontal plane
18–25	Yaw	Double	radians	Rotation about the vertical axis relative to True North
26–33	Reserved			Reserved
34–41	Range	Double	meters	Distance between antennas
42–43	PDOP	Short	0.1	Position Dilution of Precision

Flags

Table B.14 Position flags 1: bit values

Bit	Meaning
0	New position 0: No. 1: Yes.
1	Clock fix calculated for current position 0: No. 1: Yes.
2	Horizontal coordinates calculated this position 0: No. 1: Yes.
3	Height calculated this position 0: No. 1: Yes.
4	Weighted position 0: No. 1: Yes.
5	Overdetermined position 0: No. 1: Yes.
6	Ionosphere-free position 0: No. 1: Yes.
7	Position uses filtered L1 pseudoranges 0: No. 1: Yes.

Table B.15 Position flags 2: bit values

Bit	Meaning
0	Differential position 0: No. 1: Yes.
1	Differential position method 0: RTCM (Code) 1: RTK, OmniSTAR HP (Phase)
2	Differential position method 0: Differential position is code (RTCM) or a float position (RTK) 1: Differential position is a fixed integer phase position (RTK if Bit-0 = 1, WAAS if Bit-0=0)
3	OmniSTAR HP 0: Not active 1: OmniSTAR HP differential solution
4	Position determined with static as a constant 0: No. 1: Yes.
5	Position is network RTK solution 0: No. 1: Yes.
6–7	Reserved (set to zero)

Table B.16 Flags: Bit values

Bit	Meaning
0	Time information (week and millisecond of week) validity 0: Not valid 1: Valid
1	UTC offset validity 0: Not valid 1: Valid

Table B.17 Velocity flags: Bit values

Bit	Meaning
0	Velocity data validity 0: Not valid 1: Valid
1	Velocity computation 0: Computed from doppler 1: Computed from consecutive measurements
2–7	Reserved (set to zero)

Table B.18 SV flags: 1 bit values

Bit	Meaning
0	Satellite Above Horizon 0: No. 1: Yes.
1	Satellite Currently Assigned to a Channel (trying to track) 0: No. 1: Yes.
2	Satellite Currently Tracked on L1 Frequency 0: No. 1: Yes.
3	Satellite Currently Tracked on L2 Frequency 0: No. 1: Yes.
4	Satellite Reported at Base on L1 Frequency 0: No. 1: Yes.
5	Satellite Reported at Base on L2 Frequency 0: No. 1: Yes.
6	Satellite Used in Position 0: No. 1: Yes.
7	Satellite Used in Current RTK Process (Search, Propagate, Fix Solution) 0: No. 1: Yes.

Table B.19 SV flags: 2 bit value

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

Table B.20 Attitude flags

Bit	Meaning
0	Calibrated 0: No. 1: Yes.
1	Tilt valid 0: No. 1: Yes.
2	Yaw valid 0: No. 1: Yes.
3	Reserved
4	Range valid 0: No. 1: Yes.
5–7	Reserved

Data collector report structure

Table B.21 Attitude calculation flags

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

Table B.22 Report packet 40h structure

Byte	Item	Type	Value	Meaning
0	STX	CHAR	02h	Start transmission.
1	STATUS	CHAR	See Table B.23	Receiver status code.
2	PACKET TYPE	CHAR	40h	Report Packet 40h.
3	LENGTH	CHAR	00h–FAh	Data byte count.
4	TRANSMISSION NUMBER	CHAR		Unique number assigned to a group of record packet pages. Prevents page mismatches when multiple sets of record packets exist in output stream.
5	PAGE INDEX	CHAR	00h–FFh	Index of current packet page.
6	MAX PAGE INDEX	CHAR	00h–FFh	Maximum index of last packet in one group of records.

Table B.23 Receiver Status code

Byte number	Message	Description
Bit 0	1	Reserved
Bit 1	1	Low battery
Bit 2–7	0–63	Reserved

APPENDIX

C

Adding Internal Radio Frequencies

In this appendix:

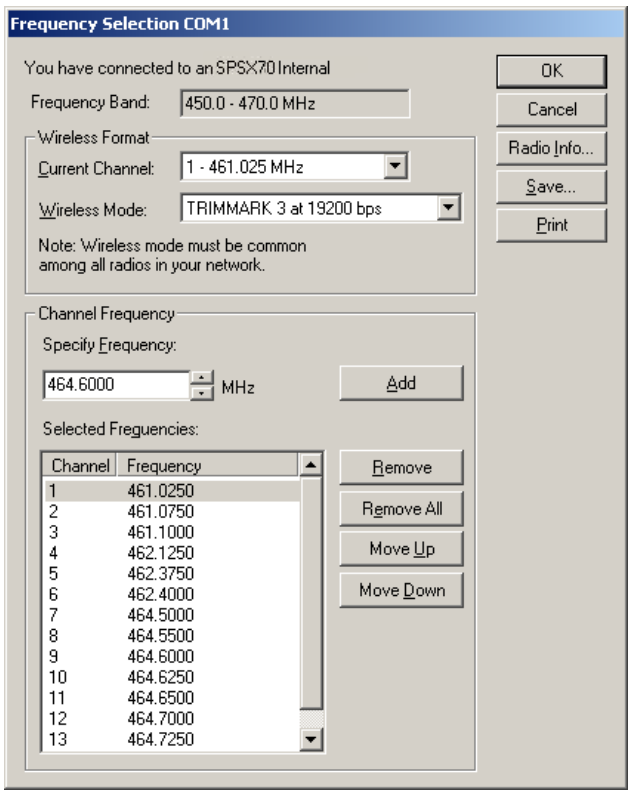
- Adding receive frequencies for the 450 MHz internal radio

If you have installed the optional internal 450 MHz radio in your GPS receiver, use the WinFlash utility to add the relevant ***receive*** frequencies to the default list of frequencies. To install the WinFlash utility, see Installing the WinFlash utility, page 140.

If you have also purchased the ***transmit*** option (SPSx50 and SPSx80 only), Trimble must specify and configure the (FCC-approved) transmit broadcast frequencies at the factory. You cannot configure these yourself.

Adding receive frequencies for the 450 MHz internal radio

1. Start the WinFlash utility. The *Device Configuration* screen appears.
2. From the *Device type* list, select the appropriate receiver.
3. From the *PC serial port* field, select the serial (COM) port on the computer that the receiver is connected to.
4. Click **Next**. The *Operation Selection* dialog appears. The *Operations* list shows all of the supported operations for the selected device. A description of the selected operation is shown in the *Description* field.
5. Select Configure Radio and then click **Next**. The *Frequency Selection* dialog appears:
6. In the *Wireless Format* group, select the appropriate channel and wireless mode. The Wireless mode must be the same for all radios in your network.
7. In the *Specify Frequency* field, enter the frequency you want to add.
8. Click **Add**. The new frequency appears in the *Selected Frequencies* list.



Note – *The programmed frequencies must conform to the channel spacing and minimum tuning requirements for the radio. To view this information, click* ***Radio Info****. You can select 12.5 kHz or 25 kHz channel spacing. All radios in your network must use the same channel spacing.*

9. Once you have configured all the frequencies that you require, click **OK**.

   The WinFlash utility updates the receiver radio frequencies and then restarts the receiver.

APPENDIX

D

Real-Time Data and Services

In this appendix:

- RT17 Streamed Data service

The RT17 Streamed Data service is available only with the SPS850 Extreme GPS receivers. It is required on any GPS receiver that will be incorporated into a Trimble Virtual Reference Station (VRS) network.

By default, the Binary Output option is not enabled in the GPS receivers. The option must be enabled before RT17 messages can be streamed from the receiver. To enable the option, please contact you local Trimble dealer.

RT17 Streamed Data service

An RT17 service provides GPS observations, ephemerides, and other information, as defined for that service. When a "client" connects to the service, all data flow is from the receiver to the client.

Using the keypad and display to configure RT17 outputs

You can configure RT17 output during the base and rover setup using the keypad and display. See Outputting corrections, page 65.

Using the web interface to configure RT17 outputs

You can configure RT17 output using the *I/O Configuration* menu of the web interface of the receiver. Configure the stream to allow multiple client connections on a single port, or restrict the stream to a single client connection. To allow only authorized connections on the port, protect the output stream by requiring a password. See I/O Configuration menu, page 79.

APPENDIX

E

Upgrading the Receiver Firmware

In this appendix:

- The WinFlash utility
- Upgrading the receiver firmware
- Forcing the receiver into Monitor mode

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

You can also upgrade the SPSx50 receiver through the web interface. See Configuring the SPSx50 receiver using a web browser, page 72.

Firmware updates are available to download from the Trimble website. Go to www.trimble.com / Support / select the link to the receiver that you need updates for and then click Downloads.

The WinFlash utility

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

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

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

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

Installing the WinFlash utility

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

To install the WinFlash utility from the CD:

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

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

Upgrading the receiver firmware

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

   The *Operation Selection* screen appears. The *Operations* list shows all of the supported operations for the selected device. A description of the selected operation is shown in the *Description* field.
5. Select *Load GPS software* and then click **Next**.

   The *GPS Software Selection* window appears. This screen prompts you to select the software that you want to install on the receiver.
6. From the *Available Software* list, select the latest version and then click **Next**.

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

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

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

8. Click **OK**.

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

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

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

10. Click **OK**.

Forcing the receiver into Monitor mode

If the receiver will not go into Monitor mode to load new firmware, complete the following steps:

1. Turn off the receiver.
2. Press and hold Esc while turning on the receiver.
3. Continue to hold the Esc button as the display shows the countdown timer.
4. Once the display shows Remote Monitor Active:1, release the Esc button.
5. The receiver is forced into Monitor mode and you can load the new firmware.

APPENDIX

F

Troubleshooting

In this appendix:

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

Please read this section before you contact Technical Support.

Receiver issues

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

Issue	Possible cause	Solution
The receiver does not turn on.	External power is too low.	Check the charge on the external battery and, if applicable, check the fuse.
	Internal power is too low.	Check the charge on the internal battery.
	External power is not properly connected.	Check that the Lemo connector or 26-pin adaptor is seated correctly, and that the cable is secured to the receiver.
		Check for broken or bent pins in the connector.
	Faulty power cable.	Check that you are using the correct cable for the port/battery.
		Check that the correct battery is connected to a particular port. The ports on the SPSx50 receiver are optimized for use with different types of battery. The 26-pin connector is optimized for Trimble custom external batteries, and the Lemo port is optimized for external 12 V batteries such as car, motorcycle, or truck batteries. If the wrong type of battery is connected to a wrong port, it is likely that it will cut off earlier than normal.
		Check pinouts with a multimeter to ensure internal wiring is intact.
Receiver does not log data.	Insufficient memory.	Delete old files. Do one of the following: • Press ⏻ for 35 seconds. • Use the delete and purge functions in the *Data Logging* menu (see above) of the web interface.
	Data Logging option is disabled.	Order the Data Logging option from your local Trimble dealer. By default, Data logging is disabled on all SPS GPS receivers. To see if data logging is enabled on your receiver, check your original purchase order or the receiver configuration using the web interface.
	The receiver is tracking fewer than four satellites.	Wait until the receiver display shows that more than four satellites are being tracked.
	The internal memory needs to be reformatted	Press ⏻ for 35 seconds.
The receiver is not responding.	Receiver needs a soft reset.	Turn off the receiver and then turn it back on again.
	Receiver needs a full reset.	Press ⏻ for 35 seconds.

Issue	Possible cause	Solution
The base station receiver is not broadcasting.	Port settings between reference receiver and radio are incorrect.	Using the SCS900 Site Controller software, connect to the reference radio through the receiver. If no connection is made, connect directly to the radio and change the port settings. Try to connect through the receiver again to ensure that they are communicating.
	Corrections are routed to a port rather than to the internal radio modem.	Check that corrections are routed correctly using the receiver keypad and display.
	A rubber duck antenna is connected directly to the radio antenna port on the receiver, or an external high-gain antenna is connected via cable to the radio antenna port on the receiver.	Check that the connections are made correctly and to the right connectors. Ensure that the connectors are seated tightly and that there are no signs of damage to the cable.
	You are using AutoBase and the AutoBase Warning function is enabled.	If you set up on a new point on a site that has not been occupied previously, the AutoBase Warning will prohibit the base station from broadcasting.
	Faulty cable between receiver and radio.	Try a different cable. Examine the ports for missing pins. Use a multimeter to check pinouts.
	No power to radio.	If the radio has its own power supply, check the charge and connections. If power is routed through the receiver, ensure that the receiver's external power source is charged and that power output on Port 3 is enabled.
Rover receiver is not receiving radio.	The base station receiver is not broadcasting.	See the issue,The base station receiver is not broadcasting. above.
	Incorrect over air baud rates between reference and rover.	Connect to the rover receiver radio, and make sure that it has the same setting as the reference receiver. The SCS900 software automatically configures the over-the-air baud rate to 9600.
	Incorrect port settings between roving external radio and receiver.	If the radio is receiving data and the receiver is not getting radio communications, use the SCS900 software to check that the port settings are correct.
	The radio antenna cable and GPS antenna cable are mixed up.	Make sure that the external radio antenna cable is connected between the TNC connector marked RADIO and the radio antenna.

Issue	Possible cause	Solution
The receiver is not receiving satellite signals	The GPS antenna is connected to the wrong antenna connector.	Make sure that the GPS antenna cable is tightly seated in the GPS antenna connection on the receiver and not connected to the wrong / radio antenna connector.
	The GPS antenna cable is loose.	Make sure that the GPS antenna cable is tightly seated in the GPS antenna connection on the GPS antenna.
	The cable is damaged.	Check the cable for any signs of damage. A damaged cable can inhibit signal detection from the antenna at the receiver.
	The GPS antenna is not in clear line of sight to the sky.	• Make sure that the GPS antenna is located with a clear view of the sky. • Restart the receiver as a last resort (turn off and then turn it on again).

Glossary

almanac	A file that contains orbit information on all the satellites, clock corrections, and atmospheric delay parameters. The almanac is transmitted by a GPS satellite to a GPS receiver, where it facilitates rapid acquisition of GPS signals when you start collecting data, or when you have lost track of satellites and are trying to regain GPS signals. The orbit information is a subset of the emphemeris / ephemerides data.
AutoBase	AutoBase technology uses the position of the receiver to automatically select the correct base station; allowing for one button press operation of a base station. It shortens setup time associated with repeated daily base station setups at the same location on jobsites.
base station	Also called *reference station*. A base station in construction, is a receiver placed at a known point on a jobsite that tracks the same satellites as an RTK rover, and provides a real-time differential correction message stream through radio to the rover, to obtain centimeter level positions on a continuous real-time basis. A base station can also be a part of a virtual reference station network, or a location at which GPS observations are collected over a period of time, for subsequent postprocessing to obtain the most accurate position for the location.
BINEX	BInary EXchange format. BINEX is an operational binary format standard for GPS/GLONASS/SBAS research purposes. It has been designed to grow and allow encapsulation of all (or most) of the information currently allowed for in a range of other formats.
broadcast server	An Internet server that manages authentication and password control for a network of VRS servers, and relays VRS corrections from the VRS server that you select.
carrier	A radio wave having at least one characteristic (such as frequency, amplitude, or phase) that can be varied from a known reference value by modulation.
carrier frequency	The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz.
carrier phase	The time taken for the L1 or L2 carrier signal generated by the satellite to reach the GPS receiver. Measuring the number of carrier waves between the satellite and receiver is a very accurate method of calculating the distance between them.
cellular modems	A wireless adaptor that connects a laptop computer to a cellular phone system for data transfer. Cellular modems, which contain their own antennas, plug into a PC Card slot or into the USB port of the computer and are available for a variety of wireless data services such as GPRS.
CMR **CMR+**	Compact Measurement Record. A real-time message format developed by Trimble for broadcasting corrections to other Trimble receivers. CMR is a more efficient alternative to RTCM.
covanance	The mean value.

datum	Also called *geodetic datum*. A mathematical model designed to best fit the geoid, defined by the relationship between an ellipsoid and, a point on the topographic surface, established as the origin of the datum. World geodetic datums are typically defined by the size and shape of an ellipsoid and the relationship between the center of the ellipsoid and the center of the earth. Because the earth is not a perfect ellipsoid, any single datum will provide a better model in some locations than in others. Therefore, various datums have been established to suit particular regions. For example, maps in Europe are often based on the European datum of 1950 (ED-50). Maps in the United States are often based on the North American datum of 1927 (NAD-27) or 1983 (NAD-83). All GPS coordinates are based on the WGS-84 datum surface.
deep discharge	Withdrawal of all electrical energy to the end-point voltage before the cell or battery is recharged.
DGPS	See real-time differential GPS.
differential correction	Differential correction is the process of correcting GPS data collected on a rover with data collected simultaneously at a base station. Because the base station is on a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the rover data. Differential correction can be done in real-time, or after the data has been collected by postprocessing.
differential GPS	See real-time differential GPS.
DOP	Dilution of Precision. A measure of the quality of GPS positions, based on the geometry of the satellites used to compute the positions. When satellites are widely spaced relative to each other, the DOP value is lower, and position accuracy is greater. When satellites are close together in the sky, the DOP is higher and GPS positions may contain a greater level of error. PDOP (Position DOP) indicates the three-dimensional geometry of the satellites. Other DOP values include HDOP (Horizontal DOP) and VDOP (Vertical DOP), which indicate the accuracy of horizontal measurements (latitude and longitude) and vertical measurements respectively. PDOP is related to HDOP and VDOP as follows: $PDOP^2 = HDOP^2 + VDOP^2$
dual-frequency GPS	A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.
EGNOS	European Geostationary Navigation Overlay Service. A satellite-based augmentation system (SBAS) that provides a free-to-air differential correction service for GPS. EGNOS is the European equivalent of WAAS, which is available in the United States.
elevation mask	The angle below which the receiver will not track satellites. Normally set to 10 degrees to avoid interference problems caused by buildings and trees, and multipath errors.
ellipsoid	An ellipsoid is the three-dimensional shape that is used as the basis for mathematically modeling the earth's surface. The ellipsoid is defined by the lengths of the minor and major axes. The earth's minor axis is the polar axis and the major axis is the equatorial axis.
emphemeris / ephemerides	A list of predicted (accurate) positions or locations of satellites as a function of time. A set of numerical parameters that can be used to determine a satellite's position. Available as broadcast ephemeris or as postprocessed precise ephemeris.

epoch The measurement interval of a GPS receiver. The epoch varies according to the measurement type: for real-time measurement it is set at one second; for postprocessed measurement it can be set to a rate of between one second and one minute. For example, if data is measured every 15 seconds, loading data using 30-second epochs means loading every alternate measurement.

feature A feature is a physical object or event that has a location in the real world, which you want to collect position and/or descriptive information (attributes) about. Features can be classified as surface or non-surface features, and again as points, lines/breaklines, or boundaries/areas.

firmware The program inside the receiver that controls receiver operations and hardware.

GLONASS Global Orbiting Navigation Satellite System. GLONASS is a Soviet space-based navigation system comparable to the American GPS system. The operational system consists of 21 operational and 3 non-operational satellites in 3 orbit planes.

GNSS Global Navigation Satellite System.

GSOF General Serial Output Format. A Trimble proprietary message format.

HDOP Horizontal Dilution of Precision. HDOP is a DOP value that indicates the accuracy of horizontal measurements. Other DOP values include VDOP (vertical DOP) and PDOP (Position DOP).

Using a maximum HDOP is ideal for situations where vertical precision is not particularly important, and your position yield would be decreased by the vertical component of the PDOP (for example, if you are collecting data under canopy).

L1 The primary L-band carrier used by GPS satellites to transmit satellite data.

L2 The secondary L-band carrier used by GPS satellites to transmit satellite data.

L5 The third L-band carrier used by GPS satellites to transmit satellite data. L5 will provide a higher power level than the other carriers. As a result, acquiring and tracking weak signals will be easier.

Moving Base Moving Base is an RTK positioning technique in which both reference and rover receivers are mobile. Corrections are sent from a “base” receiver to a “rover” receiver and the resultant baseline (vector) has centimeter-level accuracy.

MSAS MTSAT Satellite-Based Augmentation System. A satellite-based augmentation system (SBAS) that provides a free-to-air differential correction service for GPS. MSAS is the Japanese equivalent of WAAS, which is available in the United States.

multipath Interference, similar to ghosts on a television screen, that occurs when GPS signals arrive at an antenna having traversed different paths. The signal traversing the longer path yields a larger pseudorange estimate and increases the error. Multiple paths can arise from reflections off the ground or off structures near the antenna.

NMEA National Marine Electronics Association. NMEA 0183 defines the standard for interfacing marine electronic navigational devices. This standard defines a number of 'strings' referred to as NMEA strings that contain navigational details such as positions. Most Trimble GPS receivers can output positions as NMEA strings.

OmniSTAR The OmniSTAR HP/XP service allows the use of new generation dual-frequency receivers with the OmniSTAR service. The HP/XP service does not rely on local reference stations for its signal, but utilizes a global satellite monitoring network. Additionally, while most current dual-frequency GPS systems are accurate to within a meter or so, OmniSTAR with XP is accurate in 3D to better than 30 cm.

PDOP	Position Dilution of Precision. PDOP is a DOP value that indicates the accuracy of three-dimensional measurements. Other DOP values include VDOP (vertical DOP) and HDOP (Horizontal Dilution of Precision). Using a maximum PDOP value is ideal for situations where both vertical and horizontal precision are important.
postprocessing	Postprocessing is the processing of satellite data after it has been collected, in order to eliminate error. This involves using computer software to compare data from the rover with data collected at the base station.
real-time differential GPS	Also known as *real-time differential correction* or *DGPS*. Real-time differential GPS is the process of correcting GPS data as you collect it. Corrections are calculated at a base station and then sent to the receiver through a radio link. As the rover receives the position it applies the corrections to give you a very accurate position in the field. Most real-time differential correction methods apply corrections to code phase positions. RTK uses carrier phase measurements. While DGPS is a generic term, its common interpretation is that it entails the use of single-frequency code phase data sent from a GPS base station to a rover GPS receiver to provide sub-meter position accuracy. The rover receiver can be at a long range (greater than 100 kms (62 miles)) from the base station.
rover	A rover is any mobile GPS receiver that is used to collect or update data in the field, typically at an unknown location.
Roving mode	Roving mode applies to the use of a rover receiver to collect data, stakeout, or control earthmoving machinery in real time using RTK techniques.
RTCM	Radio Technical Commission for Maritime Services. A commission established to define a differential data link for the real-time differential correction of roving GPS receivers. There are three versions of RTCM correction messages. All Trimble GPS receivers use Version 2 protocol for single-frequency DGPS type corrections. Carrier phase corrections are available on Version 2, or on the newer Version 3 RTCM protocol, which is available on certain Trimble dual-frequency receivers. The Version 3 RTCM protocol is more compact but is not as widely supported as Version 2.
RTK	real-time kinematic. A real-time differential GPS method that uses carrier phase measurements for greater accuracy.
SBAS	Satellite-Based Augmentation System. SBAS is based on differential GPS, but applies to wide area (WAAS/EGNOS and MSAS) networks of reference stations. Corrections and additional information are broadcast via geostationary satellites.
signal-to-noise ratio	SNR. The signal strength of a satellite is a measure of the information content of the signal, relative to the signal's noise. The typical SNR of a satellite at 30° elevation is between 47 and 50 dBHz. The quality of a GPS position is degraded if the SNR of one or more satellites in the constellation falls below 39.
skyplot	The satellite skyplot confirms reception of a differentially corrected GPS signal and displays the number of satellites tracked by the GPS receiver, as well as their relative positions.
SNR	See signal-to-noise ratio.
triple frequency GPS	A type of receiver that uses three carrier phase measurements (L1, L2, and L5).
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian.

VRS

Virtual Reference Station. A VRS system consists of GPS hardware, software, and communication links. It uses data from a network of base stations to provide corrections to each rover that are more accurate than corrections from a single base station.

To start using VRS corrections, the rover sends its position to the VRS server. The VRS server uses the base station data to model systematic errors (such as ionospheric noise) at the rover position. It then sends RTCM correction messages back to the rover.

WAAS

Wide Area Augmentation System. WAAS was established by the Federal Aviation Administration (FAA) for flight and approach navigation for civil aviation. WAAS improves the accuracy and availability of the basic GPS signals over its coverage area, which includes the continental United States and outlying parts of Canada and Mexico.

The WAAS system provides correction data for visible satellites. Corrections are computed from ground station observations and then uploaded to two geostationary satellites. This data is then broadcast on the L1 frequency, and is tracked using a channel on the GPS receiver, exactly like a GPS satellite.

Use WAAS when other correction sources are unavailable, to obtain greater accuracy than autonomous positions. For more information on WAAS, refer to the FAA website at http://gps.faa.gov.

The EGNOS service is the European equivalent and MSAS is the Japanese equivalent of WAAS.

WGS-84

World Geodetic System 1984. Since January 1987, WGS-84 has superseded WGS-72 as the datum used by GPS.

The WGS-84 datum is based on the ellipsoid of the same name.