

# USER GUIDE

## **Trimble® SPSx50 Modular GPS Receiver**

Version 1.0  
Revision B  
March 2006



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## 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.

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## 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.

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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.

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**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](http://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](http://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,

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PO Box 3642  
Sunnyvale, CA 94088-3642  
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+1-408-481-8000

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



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

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- 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



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**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.

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## 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

<b>Safety Information</b> . . . . .	<b>v</b>
Regulations and safety . . . . .	v
Type approval . . . . .	v
Exposure to radio frequency radiation . . . . .	v
For 450 MHz radio . . . . .	v
For license-free 900 MHz radio . . . . .	vi
For Bluetooth radio . . . . .	vi
Installing antennas . . . . .	vi
Battery safety. . . . .	vii
<b>1 Introduction</b> . . . . .	<b>13</b>
About the SPSx50 receivers . . . . .	13
SPS550 GPS receiver . . . . .	13
SPS550H GPS receiver . . . . .	13
SPS750 GPS receiver . . . . .	13
SPS850 Extreme GPS receiver . . . . .	14
Related Information . . . . .	14
Technical Support. . . . .	14
Your Comments . . . . .	14
<b>2 Features and Functions</b> . . . . .	<b>15</b>
SPS550 features . . . . .	16
SPS550H features . . . . .	17
SPS750 features . . . . .	17
SPS750 <i>standard</i> features . . . . .	17
SPS750 Basic. . . . .	19
SPS750 Max . . . . .	19
SPS850 Extreme features . . . . .	19
Base station . . . . .	20
Rover . . . . .	21
Use and care . . . . .	21
COCOM limits . . . . .	21
Keypad and display. . . . .	22
Rear connectors . . . . .	23
<b>3 Batteries and Power</b> . . . . .	<b>25</b>
External power . . . . .	26
Battery safety. . . . .	26
Battery performance . . . . .	26
Charging the Lithium-ion battery. . . . .	27
Storing the Lithium-ion battery . . . . .	27
Removing the rechargeable Lithium-ion battery . . . . .	28

Operating the receiver with a Trimble controller . . . . .	28
<b>4 Setup Guidelines . . . . .</b>	<b>29</b>
Base station operation guidelines . . . . .	30
Base station components . . . . .	30
Base station setup guidelines . . . . .	31
Permanent installation antenna cabling for the SPSx50 Modular GPS receiver and SPS770 GPS receiver . . . . .	33
Rover operation guidelines . . . . .	33
Rover receiver components . . . . .	34
Rover receiver setup guidelines . . . . .	35
<b>5 Setting up the Receiver . . . . .</b>	<b>39</b>
Connecting the receiver to external devices . . . . .	40
Trimble controller with SCS900 Site Controller software . . . . .	40
External radio-modems . . . . .	41
Common ways to set up a base station . . . . .	42
Setting up a base station for permanent or semi-permanent installation. . . . .	42
Setting up a base station for daily site use: T-Bar . . . . .	43
Setting up a mobile base station: Tripod and fixed height tripod . . . . .	44
Common ways to set up a rover receiver . . . . .	47
Setting up the rover receiver on a jobsite vehicle . . . . .	47
Setting up the rover receiver on a rod . . . . .	49
Setting up a rover receiver on a belt or in a backpack . . . . .	50
Setting up a pair of SPSx50 GPS receivers to provide heading . . . . .	51
The Moving Baseline RTK positioning technique. . . . .	51
Mounting a pair of SPSx50 GPS receivers . . . . .	52
Assembling the receivers . . . . .	53
Installing the receiver . . . . .	57
Mounting the antennas . . . . .	57
Configuring the receiver pair . . . . .	57
Interfacing using the NMEA protocol . . . . .	58
<b>6 Configuring the SPSx50 Using the Keypad and Display . . . . .</b>	<b>59</b>
Button functions . . . . .	60
Power button operations . . . . .	60
Home screen . . . . .	61
Status screens . . . . .	61
Configuring the SPSx50 as a base receiver . . . . .	61
Configuring the receiver . . . . .	62
Configuring the SPSx50 as a rover receiver . . . . .	64
Configuring the receiver . . . . .	64
Configuring system settings . . . . .	65

<b>7</b>	<b>Configuring the Receiver Settings . . . . .</b>	<b>67</b>
	Using the SCS900 Site Controller software to configure the base station, the rover, and the radios . . . . .	68
	Configuring the receiver to log data for postprocessing . . . . .	69
	Configuring Ethernet settings . . . . .	69
	Configuring the SPSx50 receiver using a web browser . . . . .	72
	Supported browsers . . . . .	72
	Changing the settings . . . . .	74
<b>8</b>	<b>Automatically Setting up a Mobile Base Station Using AutoBase Technology . . . . .</b>	<b>87</b>
	AutoBase Warning . . . . .	88
	Working with AutoBase technology . . . . .	88
	Scenario One: First visit to a site with AutoBase Warning turned off . . . . .	88
	Scenario Two: First visit to a site with AutoBase Warning turned on . . . . .	89
	Scenario Three: Repeat visit to a site with AutoBase Warning turned off . . . . .	89
	Scenario Four: Repeat visit to a site with AutoBase Warning turned on . . . . .	90
	Flowchart showing the AutoBase process . . . . .	91
<b>9</b>	<b>Default Settings . . . . .</b>	<b>93</b>
	Default receiver settings . . . . .	94
	Resetting the receiver to factory defaults . . . . .	94
	Data Logging option . . . . .	94
	Logging data after a power loss . . . . .	95
<b>10</b>	<b>Specifications. . . . .</b>	<b>97</b>
	General specifications . . . . .	98
	Physical specifications . . . . .	98
	Electrical specifications . . . . .	100
	Communication specifications . . . . .	101
	GPS satellite signal tracking . . . . .	102
	Integrated radio options. . . . .	102
	Variable configuration options. . . . .	103
	Upgrading the receiver . . . . .	103
<b>A</b>	<b>NMEA-0183 Output. . . . .</b>	<b>105</b>
	NMEA-0183 message overview . . . . .	106
	Common message elements . . . . .	107
	Message values . . . . .	107
	NMEA messages . . . . .	107
<b>B</b>	<b>GSOFF Messages. . . . .</b>	<b>123</b>
	Supported message types . . . . .	124
	GSOFF message definitions . . . . .	124
	TIME . . . . .	124

LLH . . . . .	.125
ECEF . . . . .	.125
ECEF DELTA . . . . .	.126
NEU DELTA . . . . .	.126
Velocity . . . . .	.127
PDOP . . . . .	.127
SIGMA . . . . .	.127
SV Brief . . . . .	.128
SV Detail . . . . .	.129
UTC . . . . .	.130
Batt/Mem . . . . .	.130
Attitude . . . . .	.131
Flags . . . . .	.132
Data collector report structure . . . . .	.134
<b>C Adding Internal Radio Frequencies . . . . .</b>	<b>135</b>
Adding receive frequencies for the 450 MHz internal radio. . . . .	.136
<b>D Real-Time Data and Services . . . . .</b>	<b>137</b>
RT17 Streamed Data service . . . . .	.138
Using the keypad and display to configure RT17 outputs. . . . .	.138
Using the web interface to configure RT17 outputs . . . . .	.138
<b>E Upgrading the Receiver Firmware . . . . .</b>	<b>139</b>
The WinFlash utility . . . . .	.140
Installing the WinFlash utility. . . . .	.140
Upgrading the receiver firmware . . . . .	.140
Forcing the receiver into Monitor mode. . . . .	.141
<b>F Troubleshooting . . . . .</b>	<b>143</b>
Receiver issues. . . . .	.144
<b>Glossary . . . . .</b>	<b>147</b>

# 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](http://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](http://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](http://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](http://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](mailto:ReaderFeedback@trimble.com).

# Features and Functions

## In this chapter:

- SPS550 features
- SPS550H features
- SPS750 features
- SPS850 Extreme features
- Use and care
- COCOM limits
- Keypad and display
- Rear connectors

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
- $-40^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $+149^{\circ}\text{F}$ ) 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 an 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 an 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
- $-40^{\circ}\text{C}$  to  $+65^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $+149^{\circ}\text{F}$ ) 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.



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

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## 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

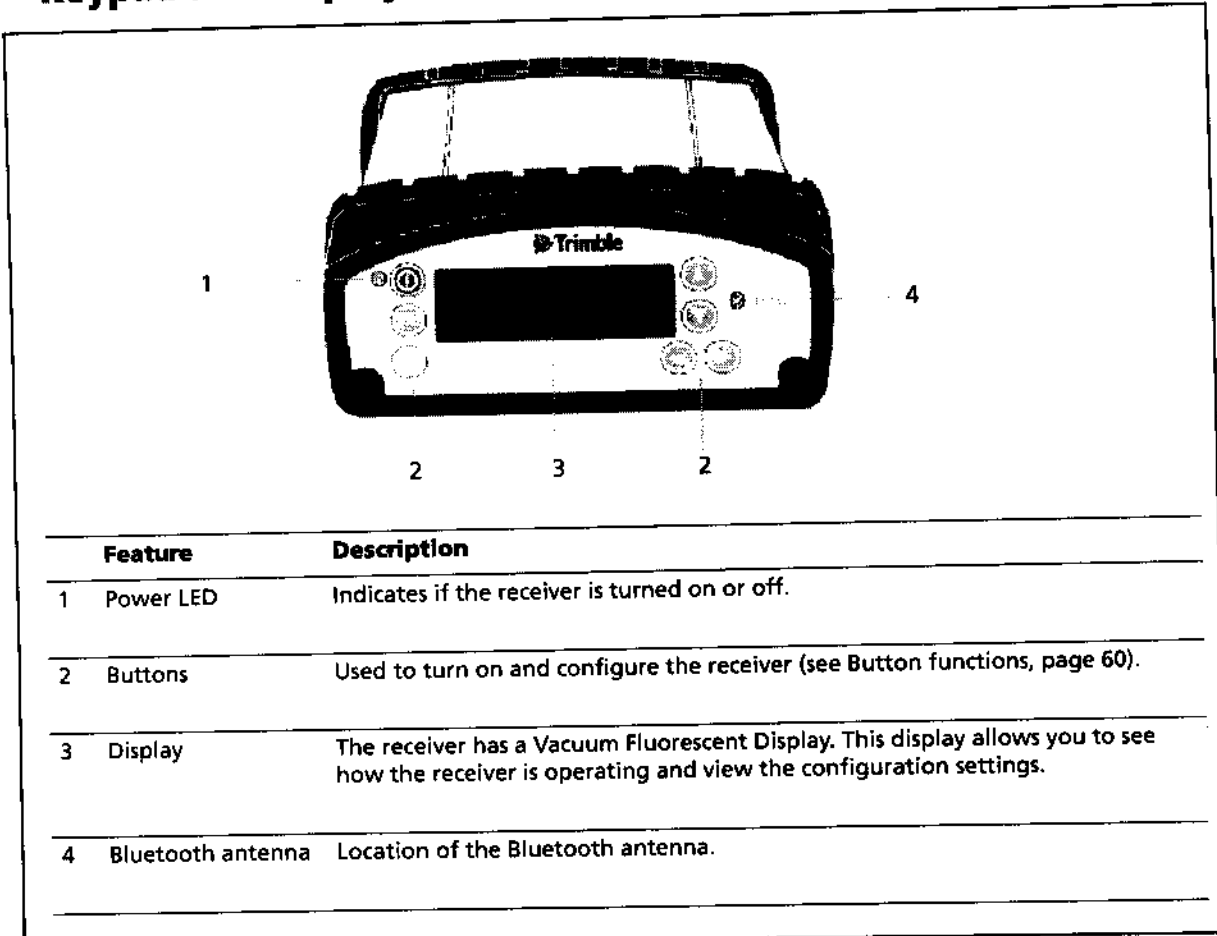
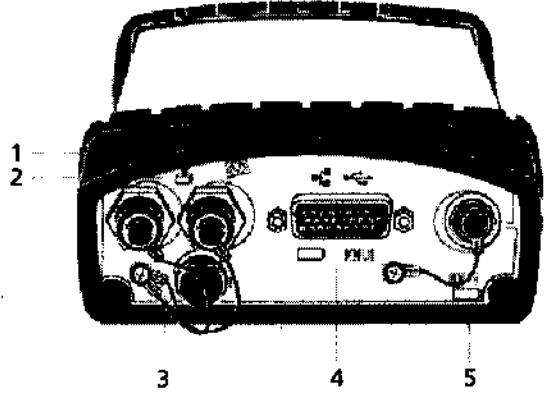


Figure 2.1 Front view of the SPSx50 GPS receiver

## Rear connectors



Connector type	Description
1 TNC	Connect to the GPS antenna
2 <ul style="list-style-type: none"> <li>• TNC (450 MHz Internal radio)</li> <li>• Reverse polarity TNC (900 MHz internal radio)</li> <li>• Not installed, system without internal radio</li> </ul>	Connect to the radio antenna
3 Vent plug	External venting plug for pressure equalization
4 High Density DB26	<ul style="list-style-type: none"> <li>• Ethernet connectivity to a 10/100 Base-T network through an RJ45 jack on a multiport adaptor (P/N 57167)</li> <li>• 'Slave' USB communications through the USB type B connector on the Multiport adaptor (P/N 57167)</li> <li>• '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)</li> <li>• Primary power from a Trimble AC/DC power supply (P/N 48800-00) using the multiport adaptor (P/N 57167)</li> <li>• Power input from an SPS700 total station battery cradle system using the adaptor (P/N 56653)</li> <li>• Full 8 wire RS-232 serial communications using the 26-9-pin multiport adaptor (P/N 57168) or a 26-pin serial communications cable</li> <li>• 3 wire RS-232 serial adaptor</li> </ul>
5 Lemo (7-pin/ 0-shell)	<ul style="list-style-type: none"> <li>• 3 wire RS-232 serial communications using a 7-pin/ 0 shell Lemo cable</li> <li>• 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)</li> <li>• CAN</li> </ul>

Figure 2.2 Rear view of the SPSx50 GPS receiver





## 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 rechargeable internal Lithium-ion battery. Charge and use the battery only in strict accordance with the instructions below.



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**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.
- 



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**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  $-40\text{ }^{\circ}\text{C}$  to  $+65\text{ }^{\circ}\text{C}$  ( $-40\text{ }^{\circ}\text{F}$  to  $+149\text{ }^{\circ}\text{F}$ ). However, operation at temperatures of less than  $0\text{ }^{\circ}\text{C}$  ( $32\text{ }^{\circ}\text{F}$ ) 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  $-40^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $+158^{\circ}\text{F}$ ).

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:

<b>Controller</b>	<b>Cable</b>	<b>Controller connector</b>	<b>Receiver connector</b>
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)	705

## 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](http://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)
Heliac LDF4/50	165 m (540 ft)
Heliac 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<sup>1</sup>, 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.

<sup>1</sup> 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.



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**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.

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- 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 frequencies 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.

## 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

	<b>Use this cable connector ...</b>	<b>and connect the cable to ...</b>	<b>Cable part number</b>
<b>To connect a SPSx50 Modular GPS receiver to a ...</b>			
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	
<b>To connect a SPS770 GPS receiver to a ...</b>			
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	
<b>To connect a SPSx80 Smart GPS antenna to a ...</b>			
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.

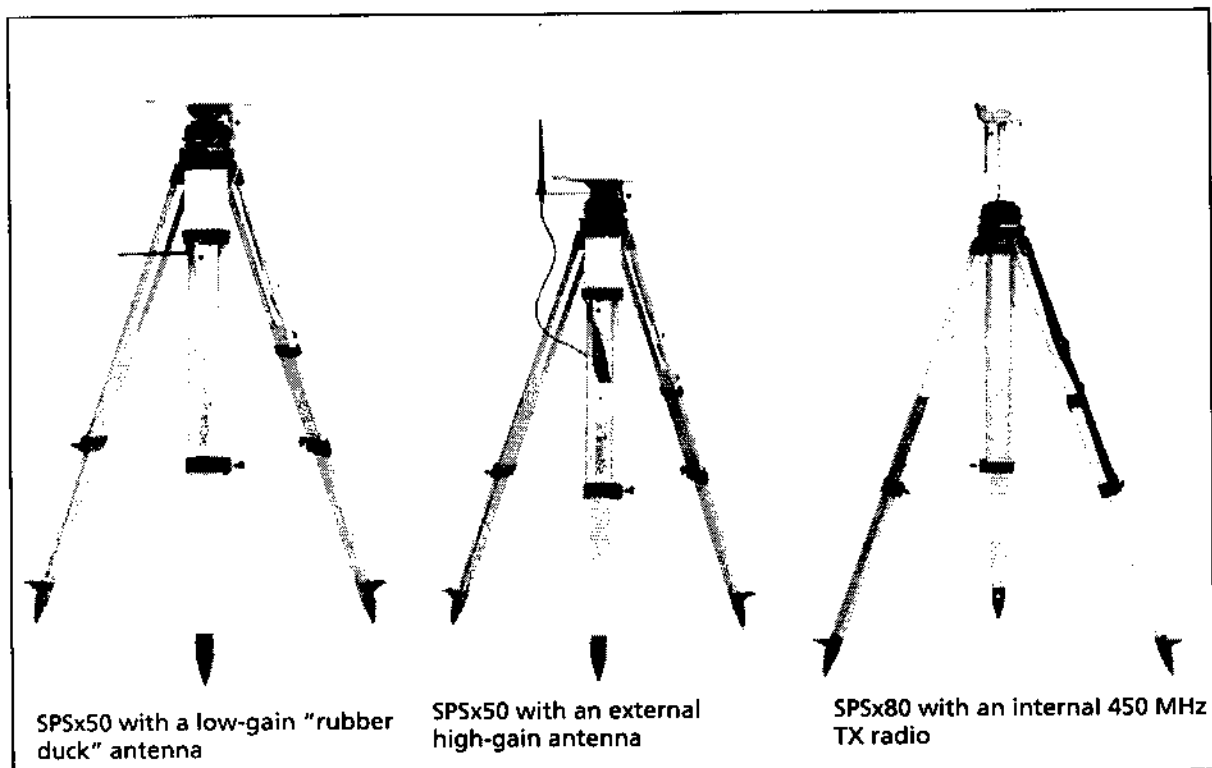


Figure 5.3 Tripod and tribrach setup for the SPSx50 and the SPSx80

### 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.

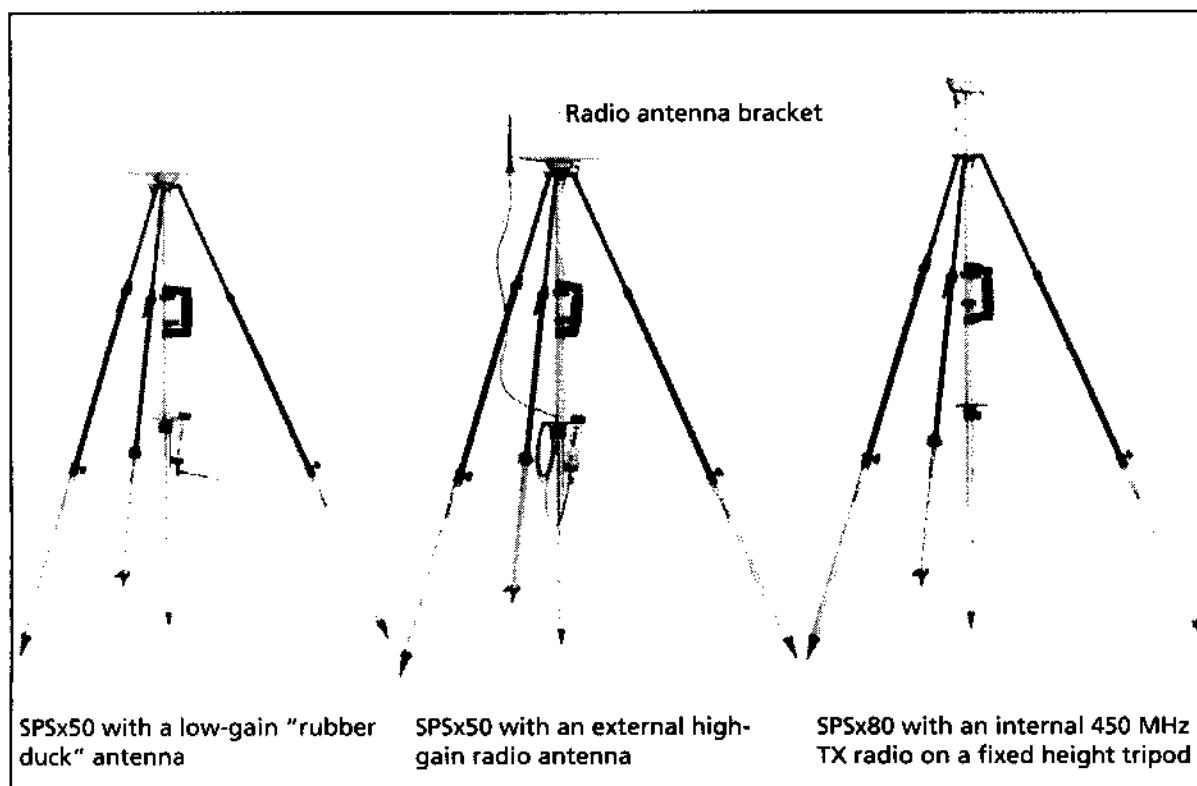


Figure 5.4 Fixed height tripod setup for the SPSx50 and SPSx80