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 provides an overview of how to set up the receiver using a web browser. For more information, select the Help link from the web page.

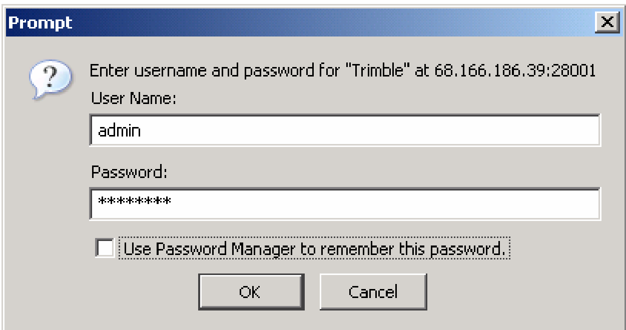
Supported browsers

The following browsers are supported:

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

To connect to the receiver using a web browser, enter the IP address of the receiver into the address bar of the web browser as shown:

1. 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 the password for the root account has been changed or a different account is being used, contact the receiver administrator for the appropriate login information.

Once you are logged in, the following web page is displayed that lets you configure the settings of the receiver:

The web interface to the SPSx50 receiver is available in the following languages:

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

To display the web interface in the desired language, click the corresponding country flag.

The web interface to the SPSx50 receiver uses a frame type structure to view and configure the settings of the receiver. The receiver has several configuration menus on the left of the browser window. The image below shows the configuration menus.

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

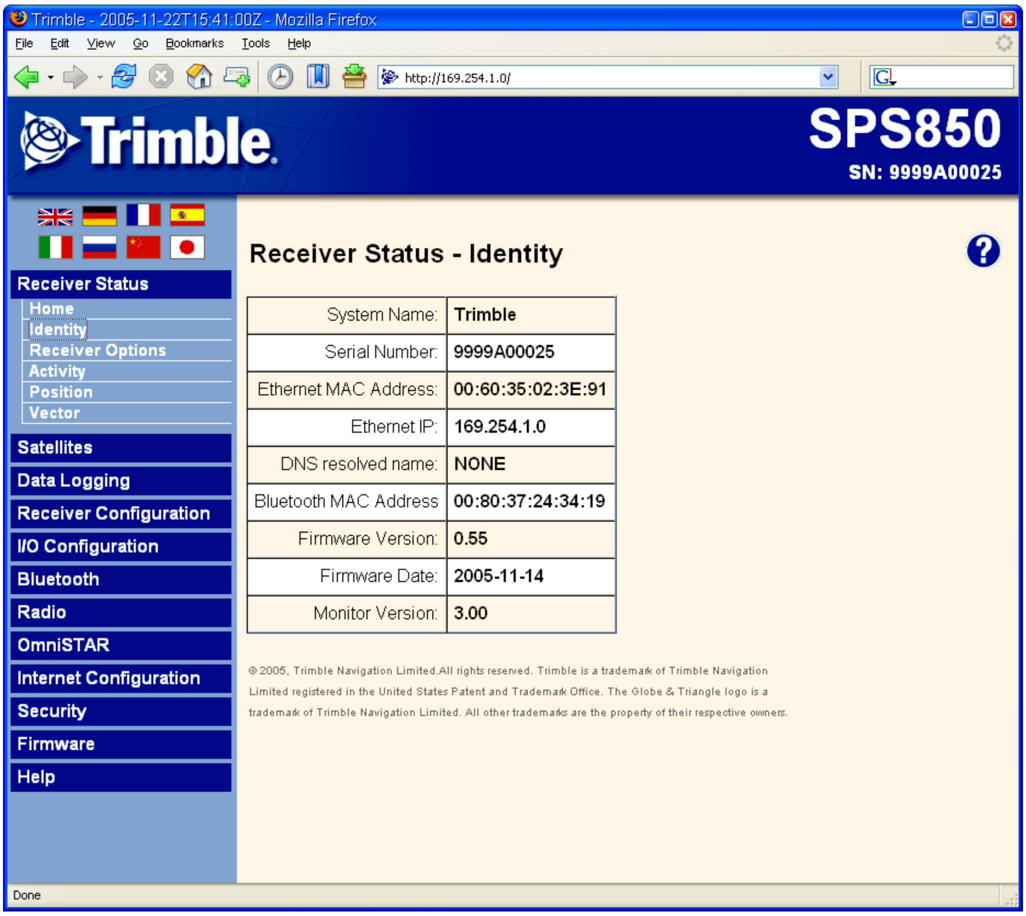
Each configuration menu contains related submenus for configuring the receiver and monitoring receiver performance.

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

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.

The image below shows the *Receiver Status* / *Identity* screen.

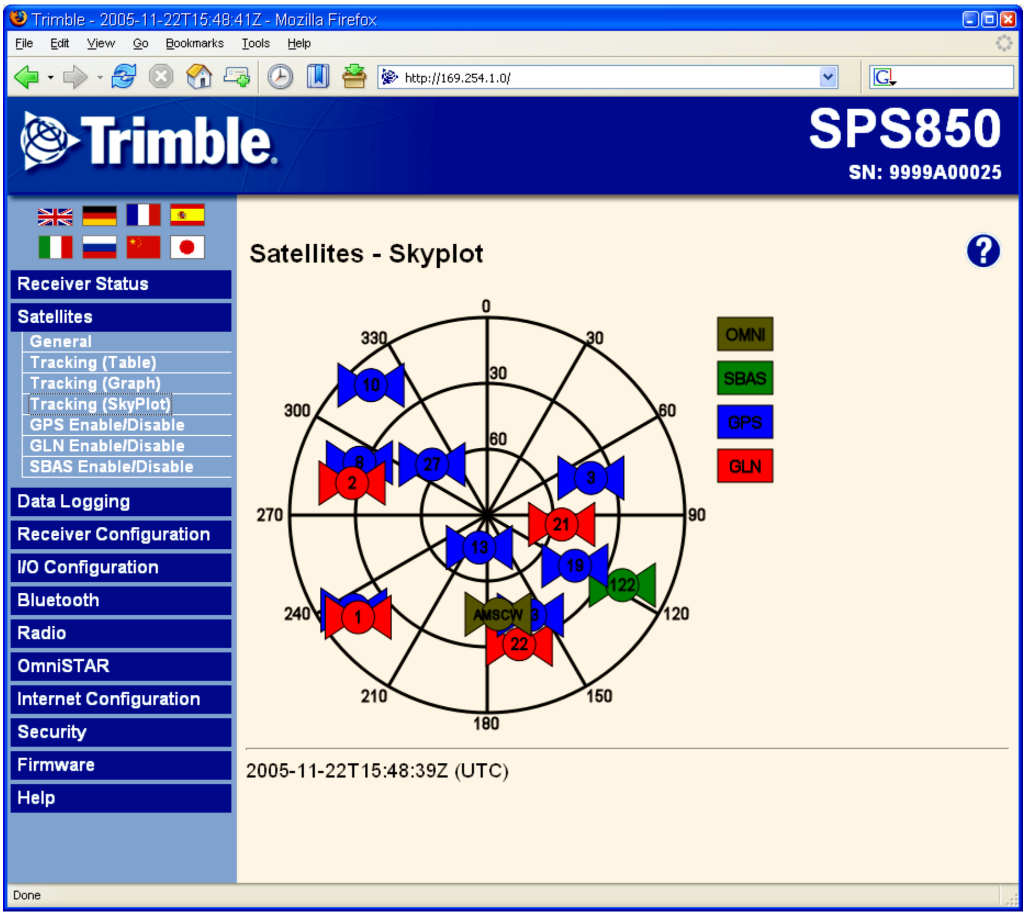


Satellites menu

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 90.*

The image below shows the *Satellite / Tracking (Sky Plot)* screen.



Data Logging menu

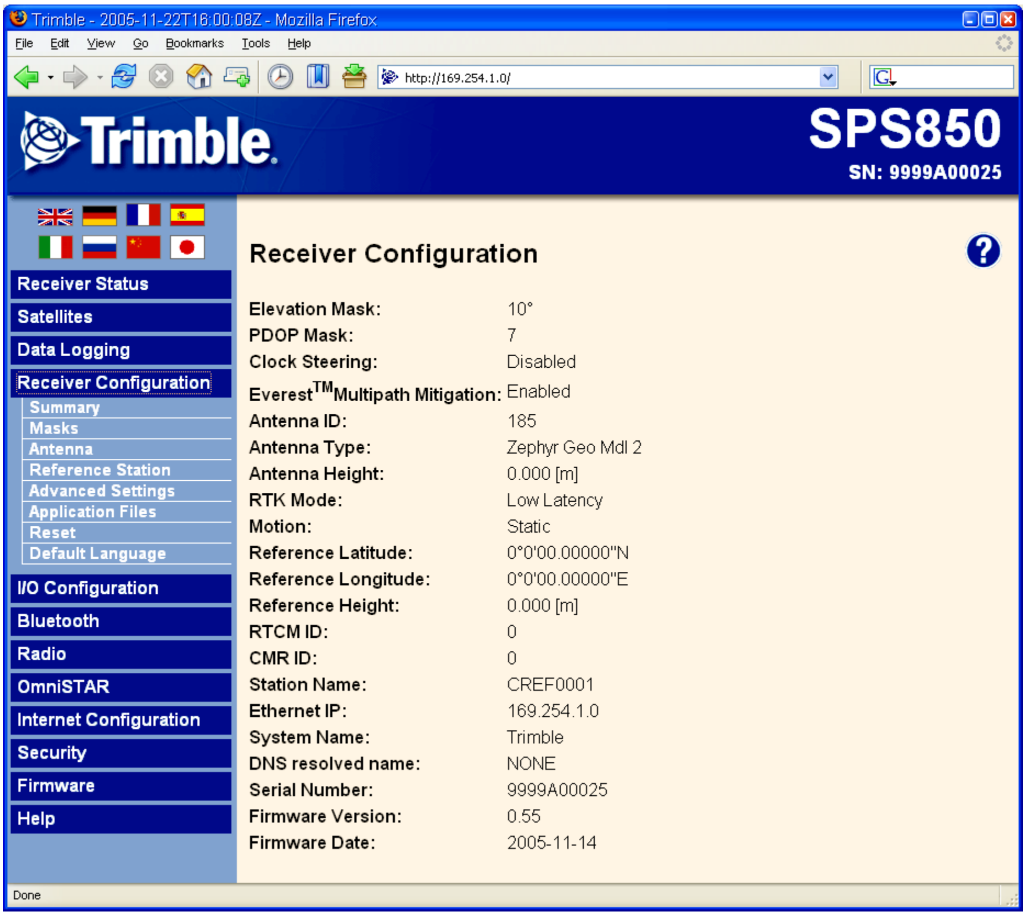
Use the *Data Logging* menu to set up the SPSx50 receiver to log static GPS data. This menu is only available if the receiver has the data logging option enabled. You can also configure settings such as observable rate, position rate, continuous logging, continuous logging rate, and whether to auto delete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

The image below shows the *Data Logging / Configuration* screen.

Receiver Configuration menu

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

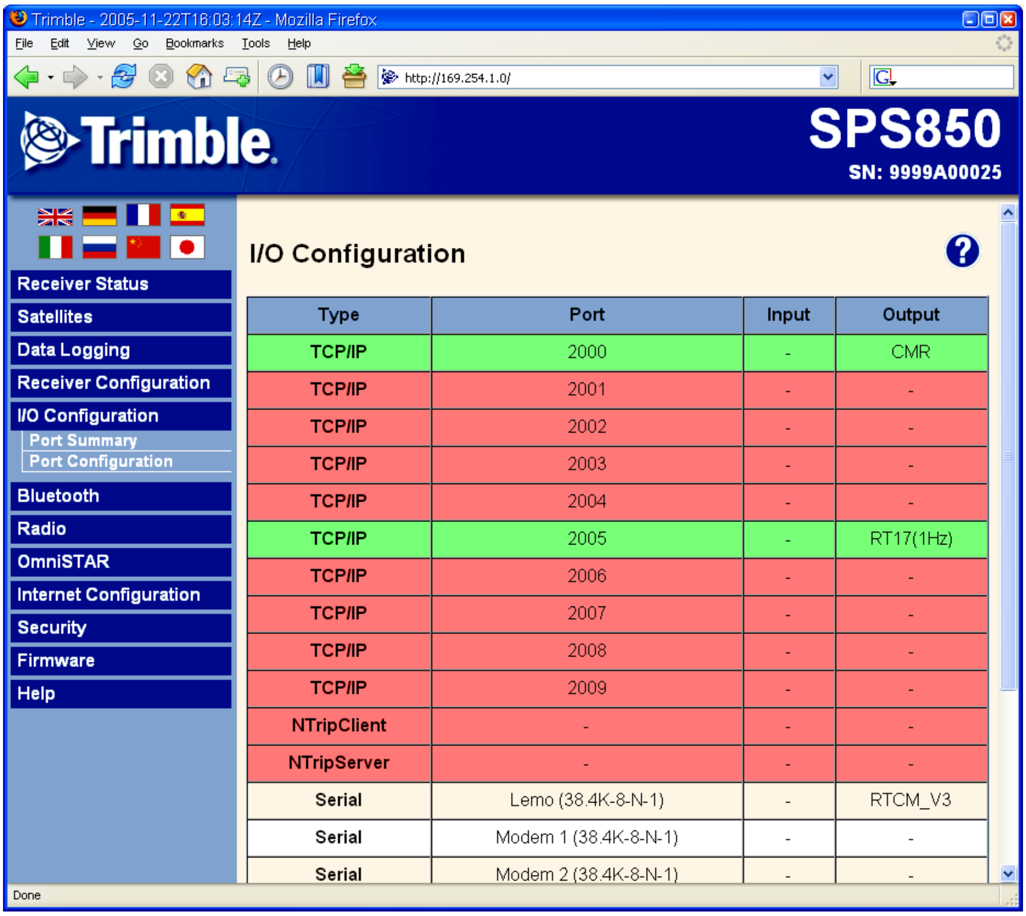
The image below shows the *Receiver Configuration / Summary* screen.



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.

The image below shows the *I/O Configuration / Port Summary* screen:

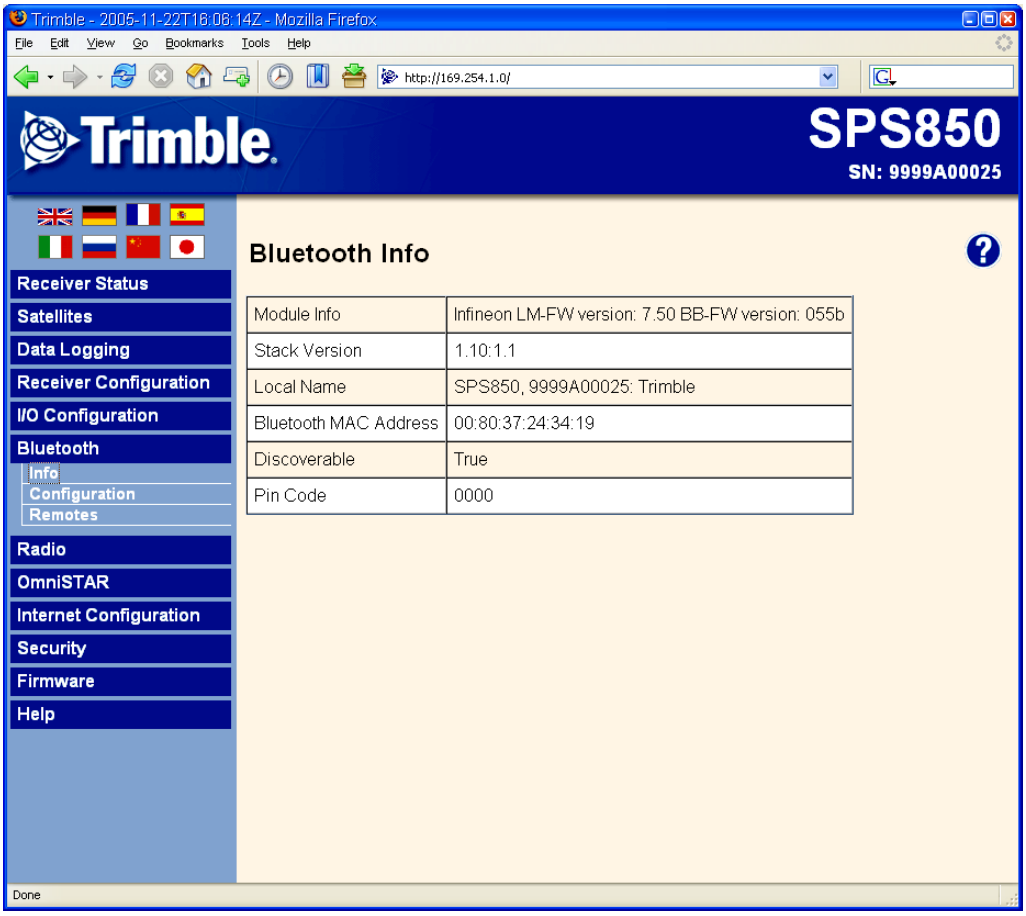


Bluetooth menu

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

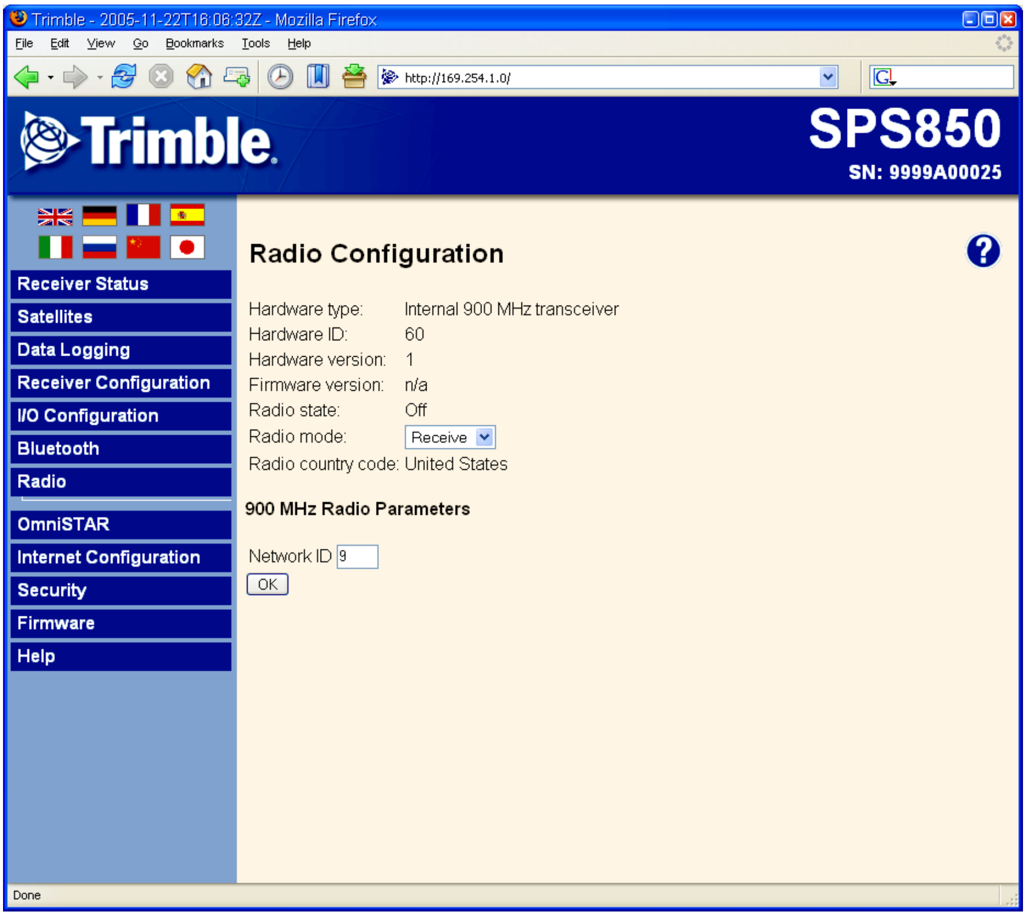
The image below shows the *Bluetooth* / *Info* screen.



Radio menu

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

The image below shows the *Radio Configuration* screen.



OmniSTAR menu

All SPSx50 receivers, except the SPS550H, are capable of receiving OmniSTAR corrections. By default, OmniSTAR tracking is turned on in the receiver. For the receiver to receive the OmniSTAR corrections, you must set it to track OmniSTAR satellites and it must have a valid OmniSTAR subscription. The receiver is capable of positioning 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

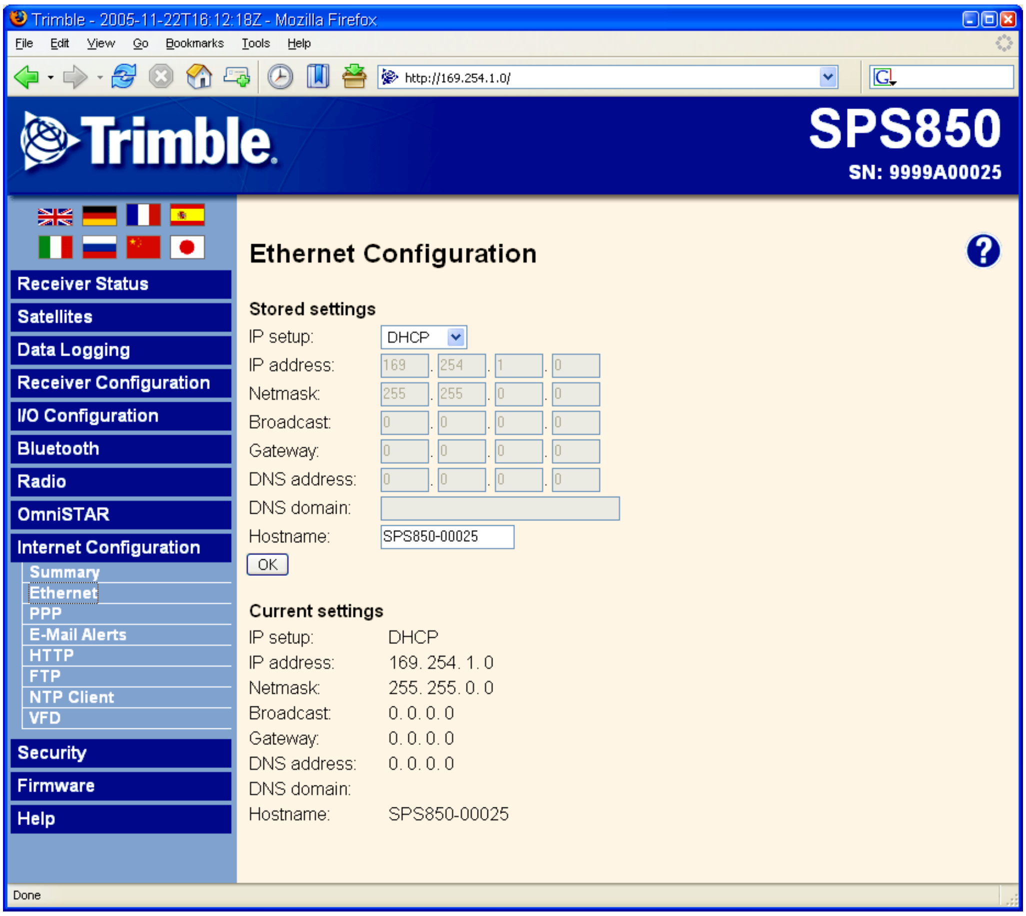
The image below shows the *OmniSTAR / Configuration* screen:

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 77.

The VFD (Vacuum Florescent Display) port allows you to use the SPSx50 Remote Front application to view and navigate the SPSx50 receiver display across a network.

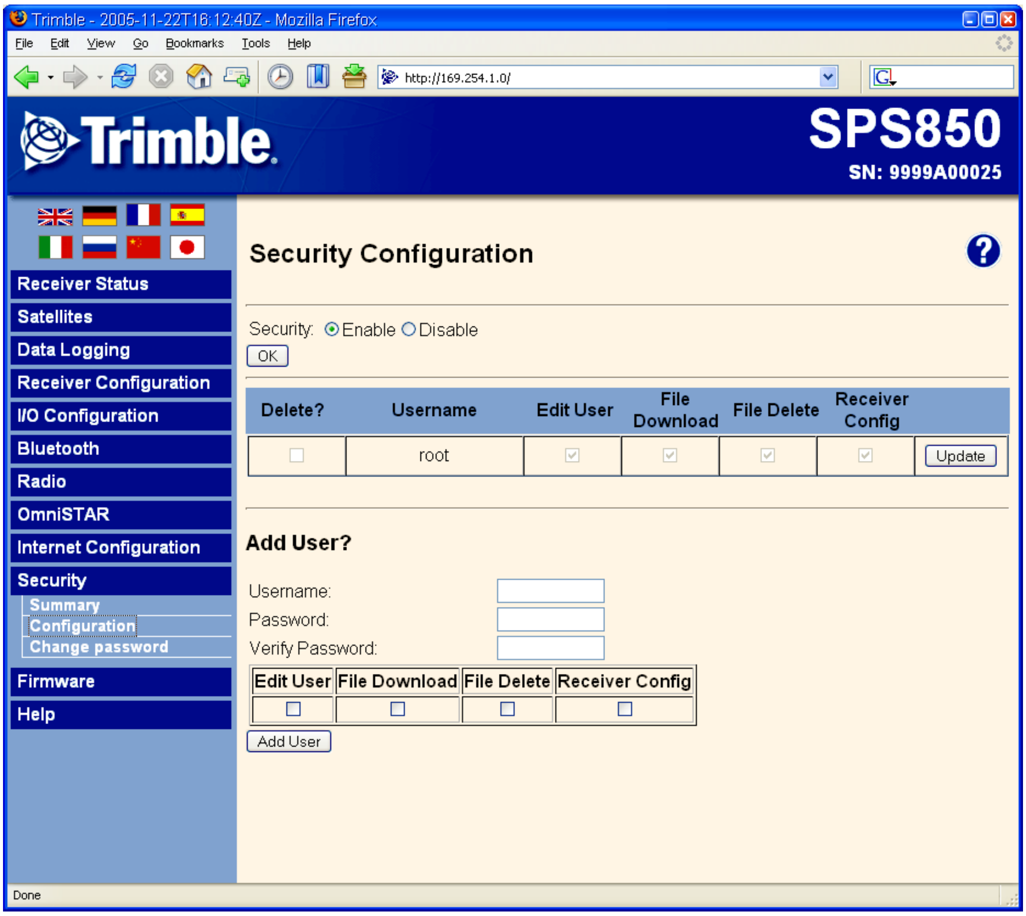
The image below shows the *Internet Configuration* / *Ethernet* screen.



Security menu

Use the *Security* menu to configure the login accounts for accessing the SPSx50 receiver using a web browser. Each account consists of a username, password, and permissions. This feature allows administrators the ability to give limited access to other users. The security can be disabled for the receiver. However, Trimble discourages this as it makes the receiver susceptible to unauthorized configuration changes.

The image below shows the *Security / Configuration* screen.



Firmware menu

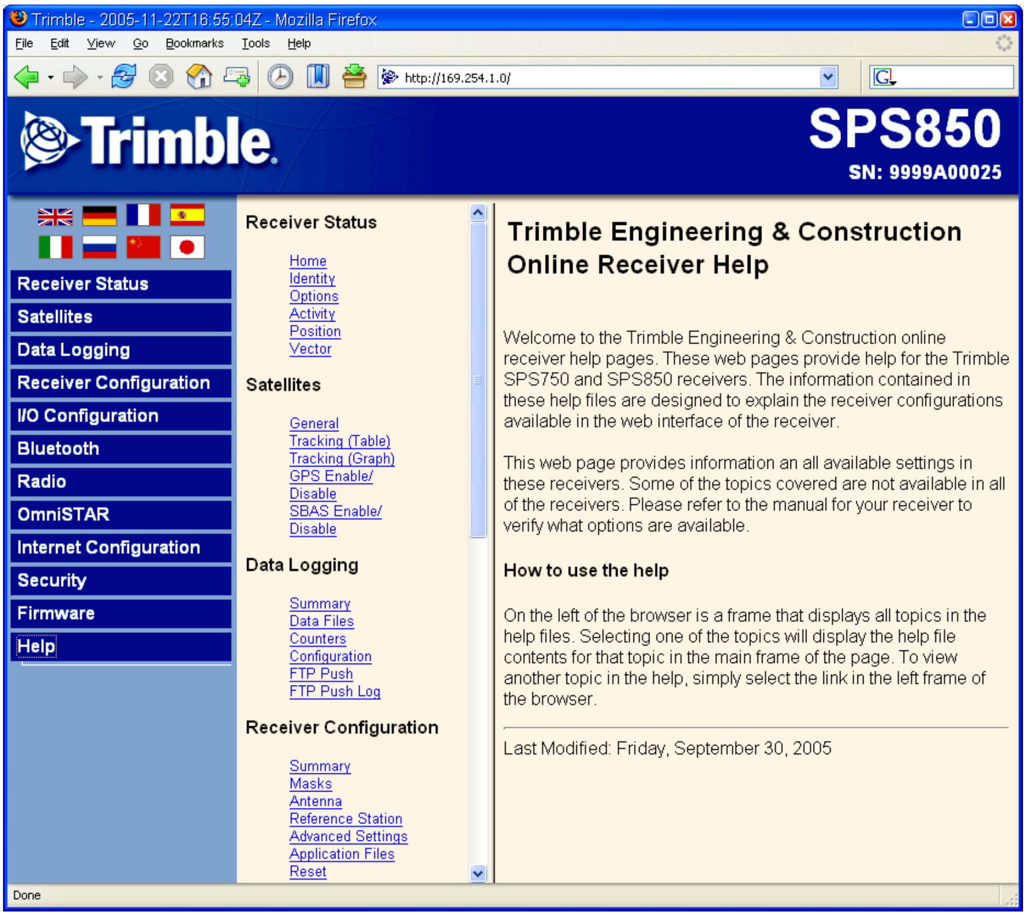
Use the *Firmware* menu to verify the current firmware and load new firmware to the SPSx50 receiver. This functionality provides you with the ability to upgrade firmware across a network or from a remote location without having to connect to the receiver with a serial cable.

The image below shows the *Firmware* screen.

Help Menu

The *Help* menu provides information on each of the receiver settings available in a web browser. Selecting the *Help* menu opens new windws. You can then select the section that you want to view the help for. The Help files are stored on the Trimble Internet site (www.trimble.com/sitepositioning.shtml<<check address please so users can click and go straight to correct location>>) so that Trimble can update the Help files between firmware releases. If you do not have access to the Internet, a copy of the receiver Help files are also supplied on the *Trimble SPS GPS Receiver CD*.

The image below shows the *Help* screen.



CHAPTER

8

Autobase Feature

In this chapter:

Autobase is a feature of the Trimble SPS GPS 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 the SPS GPS receivers 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.

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.

<Rob. Comment from Alan: ìIt will also be available in SPS880 but it operates a little differently because the receiver has no display. Rob Miller to advise on this please. <Please provide me with text. thanks.> <Comment from Rob: Geoffrey to comment/provide text>>

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 power on the receiver the first time on a point, and you do not need to manually configure the base station settings.

By default, the SPS GPS 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 chapter 5 on how to access the System Setup screens. <<cross-ref to do later>>

Working with Autobase

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

Scenerio 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. The receiver is powered on.
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.

Scenerio 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. The receiver is powered on.
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 will be streamed until the base station is set up using the keypad and display or an SCS900 controller.

Scenerio 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. The receiver is powered on.
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 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.

Scenerio 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. The receiver is powered on.
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 is not displayed.
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 to the previous setup, then you must enter the corrected height for the antennae (using the keypad and display) before starting measurements. Failure to achieve the correct 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 have been 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 inadvertently been deleted. In this case, you should use the display and keypad or the SCS900 system to manually set up the base station. Make sure that you use the same base latitude, longitude, and height as in the previous setup. If the same base station latitude, longitude, and height or a known control point is not used, 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, that 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 potentially eliminate gross errors typically associated with repeated daily setups of the base station.

Autobase Process

Figure 8.1 shows the Autobase process.

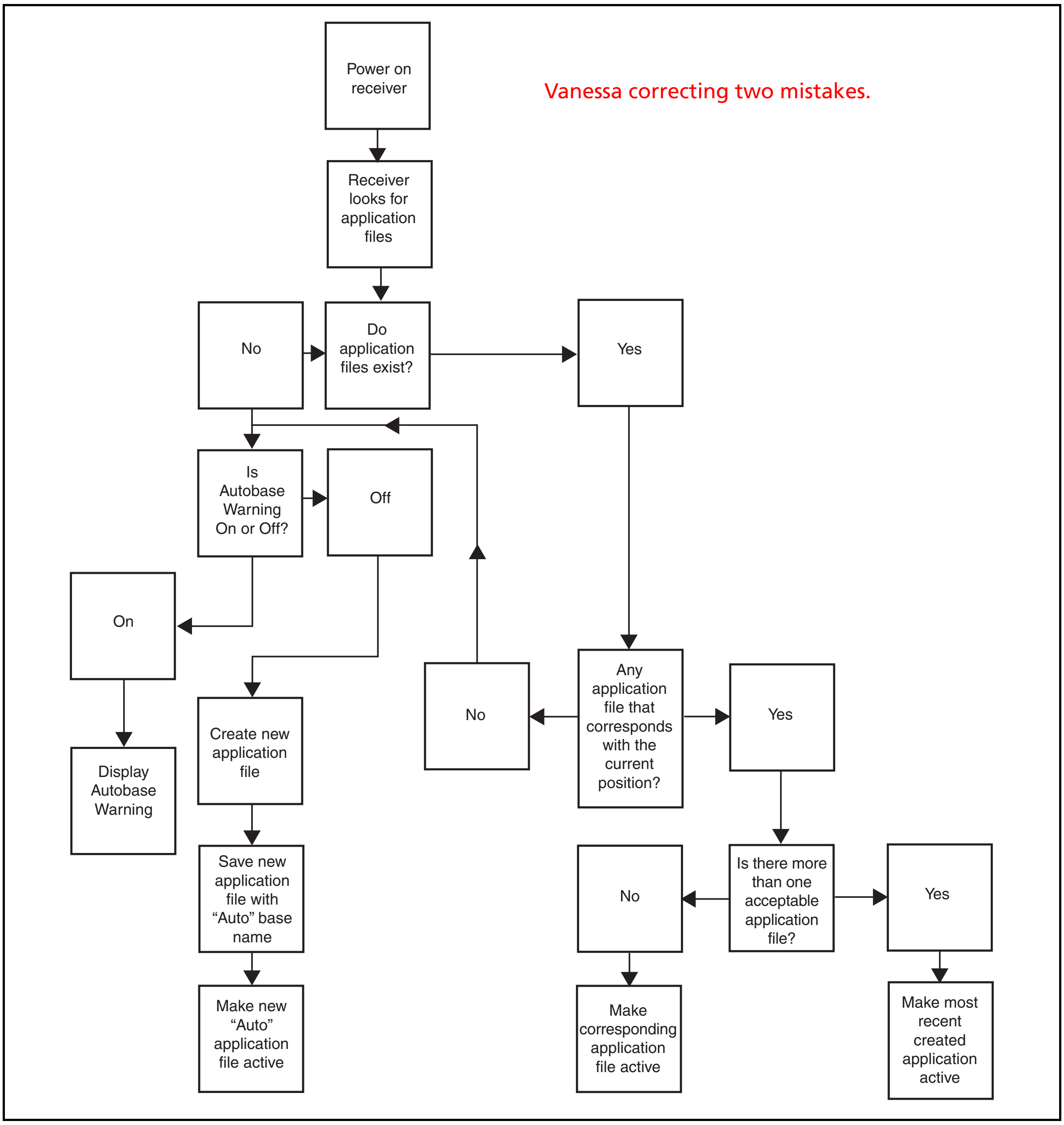


Figure 8.1 Autobase process chart

CHAPTER

9

Default Settings

In this chapter:

All SPSx50 Modular GPS receiver settings are stored in application files. The default application file is stored permanently in the receiver, and contains the factory default settings for the receiver. You cannot modify the default application file. 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.

For more information, see Configuring the Receiver Using Applicaton Files (SPS770, SPSx80), page 47.

Default receiver settings

These settings are defined in the default application file.

Table 9.1 Default settings

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, on the receiver, press and hold down 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 need to 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, the receiver tries—when power is restored—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, you need to complete the following steps:

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

CHAPTER

10

Specifications

In this chapter:

This chapter details the specifications and default option bit settings of the SPSx50 GPS receivers. The SPSx50 modular GPS receiver is available in the following standard configurations:

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

Specifications are subject to change without notice.

General specifications

Feature	Specification
Keyboard and display	Backlit VFD display 16 characters by 2 rows On/Off key for one button start up with Autobase 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 for GPS L1/L2 operation only.
Antenna type	Zephyr Geodetic - Model 2 included in the kit

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

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

Performance – SPS550

Feature	Specification
Measurements	• Advanced Trimble Maxwell 5 Custom GPS chip • Trimble R-Track™ technology for tracking the new L2C Civil signal and L5 signal for GPS modernization (SPS850 Extreme only) • High-precision multiple correlator for L1, L2, and L5 pseudo-range measurements • Unfiltered, unsmoothed pseudo-range measurements data for low noise, low multipath error, low time domain correlation and high dynamic response • Very low noise L1, L2, and L5 carrier phase measurements with <1 mm precision in a 1 Hz bandwidth • L1, L2, and L5 signal-to-noise ratios reported in dB-Hz • 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) • WAAS / EGNOS / MSAS
Code differential GPS positioning[1]	
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 / MSAS	
Horizontal accuracy[2]	Typically <1 m (3.28 ft)
Vertical accuracy[2]	Typically <5 m (16.40 ft)
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)
Heading accuracy with additional SPS550, SPS550H, SPS750 Max, or SPS850	0.3° RMS (10 m antenna separation). Does not require shore-based corrections for heading solution.

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

[2] Depends on WAAS/EGNOS/MSAS system performance.

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 Li-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	18 hours. Varies with temperature
450 MHz 2.0W systems	18 hours; varies with temperature
900 MHz 2.0W systems	18 hours; varies with temperature
Base station operation times on internal battery	
External radio	20 hours; varies with temperature
450 MHz 0.5 W systems	12 hours; varies with temperature
450 MHz 2.0 W systems	9 hours; varies with temperature
900 MHz 1.0 W systems	12 hours; varies with temperature
Certification	Class B Part 15, 22, 24 FCC certification Canadian FCC CE mark approval C-tick approval UN ST/SG/AC.10.11/Rev. 3, Amend. 1 (Li-Ion Battery) UN ST/SG/AC. 10/27/Add. 2 (Li-Ion Battery) UN T1 - T8 (Li-Ion Battery) 49 CFR Sections 100-185 (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) (via multi-port adaptor)
Bluetooth	Ethernet (via multi-port adaptor) (SPS750 Max only) Fully integrated, fully sealed 2.4 GHz Bluetooth[1]
Integrated radios	Fully integrated, fully sealed internal 450 MHz, TX, RX, or TXRX Fully integrated, fully sealed internal 900 MHz, TX, RX, or TXRX
Channel spacing (450 MHz)	12.5 K Hz or 25 KHz spacing available Dealer Changeable with TX, TX/RX End user settable with RX only
Frequency approvals (900 MHz)	USA (-10), Australia (-20), New Zealand (-30)
450 MHz transmitter radio power output 900 MHz transmitter radio power output	0.5 W / 2.0 W (2 watt upgrade only available in certain countries) 1.0 W
External GSM/GPRS, cellphone support	Supported for direct dial and Internet-based VRS correction streams Cellphone orGSM/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
Carrier	Supports BINEX and smoothed carrier

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

Receiver options – SPS550

Receiver	Specifications
SPS550	DGPS Base or Rover, Heading Base, Heading Rover
SPS550H	Heading Add-on only (Heading Rover)

Receiver options

Receiver	Specifications
Internal Data Logging option	Provides approx 27Mb of internal memory for static data measurements

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 ***** Geoffrey to confirm whether this is actually called L1/Ls*****	✗	✗	✗	✗	✗	✓
GPS SBAS corrections	WAAS	✓	✗	✓	✓	✓	✓
	EGNOS	✓	✗	✓	✓	✓	✓
	MSAS	✓	✗	✓	✓	✓	✓
OmniSTAR corrections	XP	✓	✗	✓	✓	✓	✓
OmniSTAR corrections	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 0.5 W	✓	✗	✓	✗	✓	✓

Radio option	SPS550	SPS550H	SPS750 Basic base	SPS750 Basic rover	SPS750 Max	SPS850 Extreme
450 MHz Receive	✓	×	×	✓	✓	✓
900 MHz Transmit 1.0 W	×	×	✓	×	✓	✓
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)	✓	×	×	✓	✓	✓
CMR outputs (Base)	×	×	✓	×	✓	✓
RTCM inputs (Rover)	✓	×	×	✓	✓	✓
RTCM outputs (DGPS Base)	✓	×	✓	×	✓	✓
Moving Base (Position/Heading)	✓	✓	✓	✓	✓	✓
10 Hz measurements	✓	✓	×	×	×	✓
20 Hz measurements	×	×	×	×	×	✓
Data logging (postprocessed) See <<add CR TO PREV CH, TO SECTION DATA LOGGING ***** >>	×	Optional	Optional	Optional	Optional	Optional
VRS capable	✓ Location GPS	×	✓	×	✓	✓
Internet/IP enabled	✓	✓	✓	✓	✓	✓
RTK range limit	× Location RTK	2.4 km (1.5 miles)	None	2.4 km (1.5 miles)	None	None

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 <<cross-ref Upgrading the rcvr using Winflash>>.

The SPS550 and SPS750 Max receivers cannot be upgraded further.

APPENDIX

A

NMEA-0183 Output

In this appendix:

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 where detailed information about each message can be found.

Message	Function	Page
ADV	Position and Satellite information for RTK network operations	116
GGA	Time, position, and fix related data	117
GSA	GNSS DOP and active satellites	118
GST	Position error statistics	119
GSV	Number of SVs in view, PRN, elevation, azimuth, and SNR	120
HDT	Heading from True North	121
PTNL,AVR	Time, yaw, tilt, range, mode, PDOP, and number of SVs for Moving Baseline RTK	122
PTNL,GGK	Time, position, position type and DOP values	123
PTNL,GGK_SYNC	Time, synchronized position, position type and DOP values	124
PTNL,PJK	Local coordinate position output	125
PTNL,VGK	Time, locator vector, type and DOP values	126
PTNL,VHD	Heading Information	127
RMC	Position, Velocity, and Time	128
ROT	Rate of turn	129
VTG	Actual track made good and speed over ground	130
ZDA	UTC day, month, and year, and local time zone offset	131

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 applications 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

The following values can be found in NMEA messages that the receiver generates.

Latitude and Longitude

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

- dd or ddd is degrees
- mm.mm*mm* 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 to 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.3 and Table A.2 describes 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° to 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° to 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° to 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 to 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 to 1023. A null field when any reference station ID is selected and no corrections are received.
15	The checksum data, always begins with *

GSA GNSS 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 to 32, of satellite used in solution, up to 12 transmitted
4	PDOP-Position dilution of precision, 0.5 to 99.9
5	HDOP-Horizontal dilution of precision, 0.5 to 99.9
6	VDOP-Vertical dilution of precision, 0.5 to 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° to 359°
7	SNR, 00–99 dB (null when not tracking)
8–11	Information about second SV, same format as fields 4–7
12–15	Information about third SV, same format as fields 4–7
16–19	Information about fourth SV, same format as fields 4–7
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,GGK_SYNC

Time, Synchronized Position, Position Type, DOP

The PTNL,GGK_SYNC message has the same format as the PTNL,GGK message, but outputs Synchronized 1 Hz positions even in Low Latency mode. An example of the PTNL,GGK_SYNC message string is shown below. Table A.10 describes the message fields.

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

Table A.10 PTNL,GGK_SYNC message fields

Field	Meaning
0	message ID $PTNL,GGK_SYNC
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_SYNC 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.11 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.11 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.12 describes the message fields.

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

Table A.12 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.13 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.13 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.14 describes the message fields.

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

Table A.14 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.15 describes the message fields.

$GPROT,35.6,A*4E

Table A.15 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.16 describes the message fields.

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

Table A.16 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.17 describes the message fields.

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

Table A.17 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 to ±13 hours
6	Local time zone offset from GMT, ranging from 00 to 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 message 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 set up the SPSx50 Modular GPS receiver to output GSOF, see Chapter 6, Configuring the SPSx50 Modular GPS Receiver Using the Keypad and Display and Chapter , Configuring the SPSx50 Receiver Using a Web Browser<<what about the other receivers?>>.

Supported message types

The following table summarizes the GSOF messages supported by the receiver, and shows the page where detailed information about each message can be found.

Message	Description	Page
TIME	Position Time	134
LLH	Latitude, Longitude, Height	135
ECEF	Earth-Centered, Earth-Fixed Position	135
ECEF DELTA	Earth-Centered, Earth-Fixed Delta Position	136
NEU DELTA	Tangent Plane Delta	136
Velocity	Velocity Data	136
PDOP	PDOP Info	137
SIGMA	Position Sigma Info	137
SV Brief	SV Brief Info	138
SV Detail	SV Detailed Info	139
UTC	Current UTC Time	140
BATT/MEM	Receiver Battery and Memory Status	140
ATTITUDE	Attitude Info	141

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	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	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.

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

† These records are only output if a valid DGPS/RTK solution is computed.

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.o 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†
	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

Table B.9 SV brief (Type 13 record)

Field	Item	Type	Value	Meaning
	SV Flags2	Char	See Table B.19	Second set of satellite status bits
†	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†
	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)††
	SNR L2	Char	dB * 4	Signal-to-noise ratio of L2 signal (multiplied by 4)††

†	Includes all tracked satellites, all satellites used in the position solution, and all satellites in view.
††	Set to zero for satellites that are not tracked on the current frequency (L1 or L2

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 ??? 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 presentage
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 moving base antenna and the heading antenna. It contains the following data:

- Tilt or vertical angle, in radians, from the moving base antenna to the heading antenna relative to a horizontal plane through the moving base antenna
- Heading or yaw, in radians, relative to True North

- Range or slope distance between the moving base antenna and the heading 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

Table B.15 Position flags 2: bit values

Bit	Meaning
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 ot 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

Table B.18 SV flags: 1 bit values

Bit	Meaning
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

Table B.20 Attitude flags

Bit	Meaning
4	Range valid 0: No 1: Yes
5-7	Reserved

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

Data collector report structure

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 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 Data collector format report packet structure

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 receiving frequencies for the 450 MHz internal radio

If the receiver has the optional internal 450 MHz radio installed, you ***must*** use the WinFlash software to add receiving frequencies to the default list. If you purchased the transmit option, the broadcast frequencies must be programmed at the factory.

To install the WinFlash software, see <<appendix D>>

Adding receiving frequencies for the 450 MHz internal radio

1. Start the WinFlash software.

   The *Device Configuration* screen appears.

2. From the *Device type* list, select the appropriate receiver.

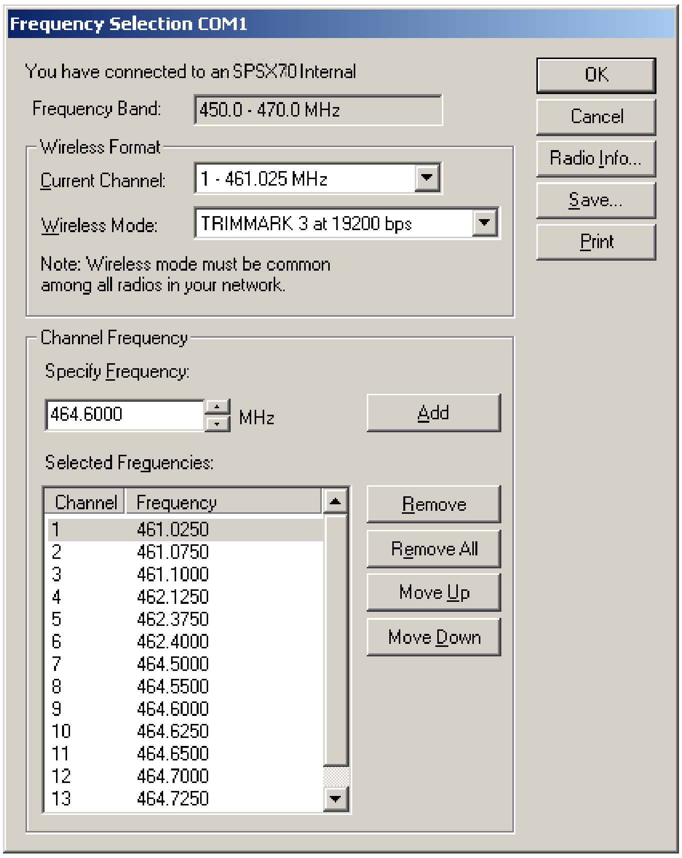
3. From the *PC serial port* field, select the serial (COM) port on the computer that the receiver is connected to.

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 *Edit Frequency* field, enter the frequency you require.

8. Click **Add**. The new frequency appears in the *Selected Frequencies* list.

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

9. Once you configure all the frequencies you require, click **OK**.

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

***Note** – You can only configure receive frequencies. The FCC approved transmit frequencies must be specified and configured by Trimble.*

APPENDIX

D

Real-time Data and Services

In this appendix:

This chapter describes the RT17 Streamed Data service available with the SPS750 Max and SPS850 Extreme GPS receivers.

By default, the receivers do not have the Binary Output option enabled. This option is required to stream RT17 messages from the receiver. To enable this option on your receiver, please contact you local Trimble dealer.

The RT17 streamed data service is required on any GPS receiver that will be incorporated into a Trimble Virtual Reference Station (VRS™) network.

RT17 Streamed Data service

An RT17 service provides GPS observations, ephemeredes, 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. This data stream is required for reference stations in a Trimble Virtual Reference Station (VRS) network.

RT17 outputs can be set up using the keypad and display or the web interface for the receiver.

Using the keypad and display to output RT17

The RT17 output configuration is done during the base and rover setup using the keypad and display. For more information, see Outputting corrections, page 72.

Using the web interface to output RT17

The RT17 output is set up using the I/O Configuration menu of the web interface of the receiver. The stream can be configured to allow multiple client connections on a single port or be restricted to a single client connection. The output stream can be protected by requiring a password to only allow authorized connections on the port. For more information, see I/O Configuration menu, page 87.

APPENDIX

E

Upgrading the Receiver Firmware

In this appendix:

Your receiver is supplied with the latest version of receiver firmware installed. If a later version becomes available, upgrade the firmware installed on your receiver using the WinFlash software.

You can also upgrade the SPSx50 receiver through the web interface. See Appendix E <<UPDATE XREF>>.

The WinFlash Software

The WinFlash software 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 software.

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

Installing the WinFlash software

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

To install the WinFlash software 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 vX.XX with SPS770/SPS780 drivers and firmware*. <is this correct?>
4. Follow the on-screen instructions.

The WinFlash software 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 software. 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**.

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 check the fuse if applicable.
	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 the wrong port, it is likely that it will cut off earlier than normal.
		Check pinouts with multimeter to ensure internal wiring is intact.

Issue	Possible cause	Solution
Receiver does not log data.	Insufficient memory.	Delete old files by holding down ⓘ for 30 seconds. Delete the old files by using the delete and purge functions available in the Data Logging menu (see page 85) of the web interface.
	Data Logging option is disabled.	Order the data logging option from your local Trimble dealer. Data logging is disabled as standard on all SPS GPS receivers. Check your original purchase order or the receiver configuration using the web interface to see if data logging is enabled on your receiver.
	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 30 seconds.
The receiver is not responding.	Receiver needs soft reset.	Turn off the receiver and then turn it back on again.
	Receiver needs full reset.	Press ⓘ for 30 seconds.

Issue	Possible cause	Solution
The base station receiver is not broadcasting.	Port settings between reference receiver and radio are incorrect.	Using the SCS900 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.
	The user is utilizing AutoBase and the Autobase warning function is enabled.	If the user sets 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.

Issue	Possible cause	Solution
Roving receiver is not receiving radio.	The base station receiver is not broadcasting.	See page 160.
	Incorrect over air baud rates between reference and rover.	Connect to the roving receiver's 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.
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 to 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 to 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 placed in a location with clear line of sight to the sky Restart the receiver as a last resort by powering down and restarting.

Glossary

This section explains some of the terms used in this manual.

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 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 is a GPS antenna and receiver positioned on a known location specifically to collect data for **differential correction** Base data needs to be collected at the same time as you collect data on a rover unit. A base station can be a permanent station that collects base data for provision to multiple users, or a rover unit that you locate on known coordinates for the duration of the datalogging session.
Binary exchange format	See **BINEX**.
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 difference between the carrier signal generated by the internal oscillator of a receiver and the carrier signal coming in from the satellite.
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 adapter that connects a laptop computer to a cellular telephone 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	(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 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 it 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**.
Dilution of Precision	See **DOP.**
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 survey type: for real-time survey measurement it is set at one second; for postprocessed survey measurement it can be set to a rate of between one second and one minute. For example, if data measurement is measured every 15 seconds, loading data using 30-second epochs means loading every other 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, 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 contains 21 satellites in 3 orbital planes, with 3 on-orbit spares.
GNNS	Global Navigation Satellite System
GSOF	General Serial Output Format
HDOP	(Horizontal Dilution of Precision) Dilution of Precision (**DOP**) is 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. 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).
Horizontal Dilution of Precision	See **HDOP**.
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.
MTSAT Satellite-Based Augmentation System	See **MSAS**.
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 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 utilises 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) **Dilution of Precision** (DOP) is 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 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.
Position Dilution of Precision	See **PDOP**.
postprocessing	Postprocessing is the processing of satellite data after it has been collected in order to eliminate error. This involves using PC software to compare data from the rover to data collected at the base station.

real-time differential GPS	Also known as real-time differential correction, DGPS. Real-time differential GPS is the process of correcting GPS data as you collect it. This is achieved by having corrections calculated at a base station sent to the receiver via 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 the use of single-frequency code phase data that is sent from a GPS base station to a rover GPS receiver and the resultant position accuracy is sub-meter. The rover receiver can be at a long range (greater than 100 kms) from the base station.
rover	A rover is any mobile GPS receiver collecting or updating 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 the newer Version 3 RTCM protocol, available on certain Trimble dual-frequency receivers. The Version 3 RTCM protocol is more compact but is not as widely supported as Version 2 today.
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 applied to wide area (**WAAS**, **EGNOS**, **MSAS**). Networks of reference stations are used and 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 10.0 and 15.0 dBHz. The quality of a GPS position is degraded if the SNR of one or more satellites in the constellation falls below 4.0.
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	Abbreviation for 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 station**s 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 WGS-84 is an abbreviation for World Geodetic System 1984. WGS-84 has superseded WGS-72 as the **datum** used by GPS since January 1987.

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