General specifications

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

Physical specifications

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

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

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

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

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

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

Electrical specifications

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

Communication specifications

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

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

GPS satellite signal tracking

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

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

Integrated radio options

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

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

Variable configuration options

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

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

[1]Float solution only.

[2]Moving base CMRs only.

[3]Moving base CMR output only.

Upgrading the receiver

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

The SPS550 and SPS750 Max receivers cannot be upgraded further.

APPENDIX

A

NMEA-0183 Output

In this appendix:

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

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

NMEA-0183 message overview

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

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

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

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

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

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

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

Common message elements

Each message contains:

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

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

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

Message values

NMEA messages that the receiver generates contains the following values.

Latitude and longitude

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

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

Direction

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

Time

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

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

NMEA messages

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

ADV Position and Satellite information for RTK network operations

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

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

Table A.1 ADV subtype 110 message fields

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

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

Table A.2 ADV subtype 120 message fields

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

GGA Time, Position, and Fix Related Data

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

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

Table A.3 GGA message fields

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

GSA GPS DOP and active satellites

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

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

Table A.4 GSA message fields

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

GST Position Error Statistics

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

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

Table A.5 GST message fields

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

GSV Satellite Information

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

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

Table A.6 GSV message fields

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

HDT Heading from True North

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

$GPHDT,123.456,T*00

Table A.7 Heading from true north fields

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

PTNL,AVR

Time, Yaw, Tilt, Range for Moving Baseline RTK

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

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

Table A.8 AVR message fields

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

PTNL,GGK

Time, Position, Position Type, DOP

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

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

Table A.9 PTNL,GGK message fields

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

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

PTNL,PJK

Local Coordinate Position Output

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

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

Table A.10 PTNL,PJK message fields

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

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

PTNL,VGK

Vector Information

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

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

Table A.11 PTNL,VGK message fields

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

PTNL,VHD

Heading Information

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

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

Table A.12 PTNL,VHD message fields

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

RMC Position, Velocity, and Time

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

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

Table A.13 GPRMC message fields

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

ROT Rate and Direction of Turn

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

$GPROT,35.6,A*4E

Table A.14 ROT message fields

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

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

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

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

Table A.15 VTG message fields

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

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

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

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

Table A.16 ZDA message fields

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

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

APPENDIX

B

GSOF Messages

In this appendix:

- Supported message types
- GSOF message definitions

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

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

Supported message types

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

GSOF message definitions

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

TIME

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

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

Table B.1 Time (Type 1 record)

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

Table B.1 Time (Type 1 record)

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

LLH

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

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

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

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

ECEF

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

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

Table B.3 ECEF position (Type 3 record)

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

ECEF DELTA

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

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

Table B.4 ECEF Delta (Type 6 record)

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

NEU DELTA

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

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

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

Table B.5 NEU Delta (Type 7 record)

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

Velocity

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

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

Table B.6 Velocity (Type 8 record)

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

PDOP

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

- PDOP
- HDOP
- VDOP
- TDOP

Table B.7 PDOP (Type 9 record)

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

SIGMA

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

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

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

Table B.8 Sigma (Type 12 record)

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

SV Brief

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

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

Table B.9 SV brief (Type 13 record)

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

Table B.9 SV brief (Type 13 record)

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

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

SV Detail

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

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

Table B.10 SV detail (Type 14 record)

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

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

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

UTC

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

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

Table B.11 UTC (Type 16 record)

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

Batt/Mem

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

- Remaining battery power
- Remaining memory

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

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

Attitude

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

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

Table B.13 Attitude (Type 27 record)

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

Flags

Table B.14 Position flags 1: bit values

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

Table B.15 Position flags 2: bit values

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

Table B.16 Flags: Bit values

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

Table B.17 Velocity flags: Bit values

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

Table B.18 SV flags: 1 bit values

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

Table B.19 SV flags: 2 bit value

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

Table B.20 Attitude flags

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

Data collector report structure

Table B.21 Attitude calculation flags

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

Table B.22 Report packet 40h structure

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

Table B.23 Receiver Status code

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

APPENDIX

C

Adding Internal Radio Frequencies

In this appendix:

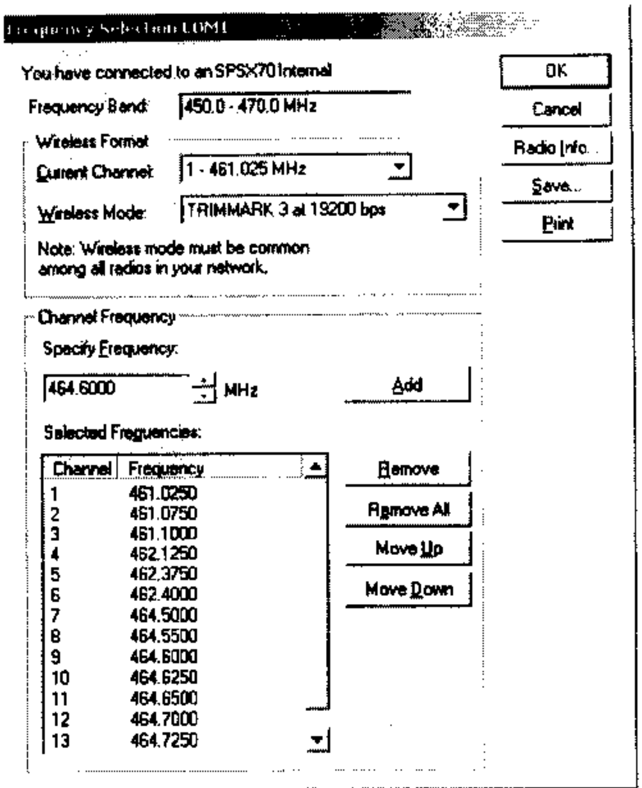
- Adding receive frequencies for the 450 MHz internal radio

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

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

Adding receive frequencies for the 450 MHz internal radio

1. Start the WinFlash utility. The *Device Configuration* screen appears.
2. From the *Device type* list, select the appropriate receiver.
3. From the *PC serial port* field, select the serial (COM) port on the computer that the receiver is connected to.
4. Click **Next**. The *Operation Selection* dialog appears. The *Operations* list shows all of the supported operations for the selected device. A description of the selected operation is shown in the *Description* field.
5. Select Configure Radio and then click **Next**. The *Frequency Selection* dialog appears:



6. In the *Wireless Format* group, select the appropriate channel and wireless mode. The Wireless mode must be the same for all radios in your network.
7. In the *Specify Frequency* field, enter the frequency you want to add.
8. Click **Add**. The new frequency appears in the *Selected Frequencies* list.

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

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

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

APPENDIX

D

Real-Time Data and Services

In this appendix:

- RT17 Streamed Data service

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

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

RT17 Streamed Data service

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

Using the keypad and display to configure RT17 outputs

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

Using the web interface to configure RT17 outputs

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

APPENDIX

E

Upgrading the Receiver Firmware

In this appendix:

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

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

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

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

The WinFlash utility

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

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

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

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

Installing the WinFlash utility

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

To install the WinFlash utility from the CD:

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

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

Upgrading the receiver firmware

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

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

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

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

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

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

8. Click **OK**.

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

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

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

10. Click **OK**.

Forcing the receiver into Monitor mode

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

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

APPENDIX

F

Troubleshooting

In this appendix:

- Receiver issues

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

Please read this section before you contact Technical Support.

Receiver issues

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

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

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

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

Glossary

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

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

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

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

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

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

GNSS Global Navigation Satellite System.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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