

Power-Off Screen

Hold down the **Power** button for a few seconds. The Spectra Precision logo will appear on the screen.



After a few seconds, the message “Powering off...” will follow, indicating that the receiver is being turned off.

If the anti-theft protection is still enabled when you ask for receiver power-off, a message will ask you to confirm your request.



If you wish to keep using the anti-theft protection, press **OK** and then the receiver will complete the power-off sequence as described above.

If you want to remove the anti-theft protection before turning off the receiver, press **Escape**, go back to **Advanced Settings** to remove the anti-theft protection (see *page 37*). Then you can turn off the receiver as explained above.

Using a USB Key



To Copy Files

Whenever you connect a USB key to the receiver via cable P/N107535, the following screen is displayed:



This screen is displayed for a few seconds. If you press **OK** while this screen is still displayed, all the G-files and log files stored in the receiver will be copied to the root folder on the USB key (or will overwrite the files with same name). Otherwise the copy operation will be skipped and the receiver will come back to the General Status screen. The screen looks like this while the files are being copied.



The same will happen if you power on the receiver with a USB key already connected to the receiver.

To Upgrade the Firmware

When a new firmware upgrade is available, it is easy to install the new firmware using a USB key.

- Use your computer to copy the installation file (a *.tar file) to the root directory of the USB key.
- The receiver being turned off, connect the USB key to the receiver through cable P/N 107535 (provided).
- Press the **OK** button and the **Power** button simultaneously for a few seconds. This starts the upgrade.

The screen will read successively:

{Spectra Precision logo}
USB Upload
Upgrading Firmware Step 1/5
Upgrading Firmware Step 2/5
Upgrading Firmware Step 3/5
Upgrading Firmware Step 4/5
Upgrading Firmware Step 5/5
Upgrading Firmware Complete
{Booting: Spectra Precision logo}
{Regular receiver startup to General Status screen}

Let the receiver proceed with the upgrade. **Do not turn off the receiver while the upgrade is in progress.**

NOTE: If there is no USB key connected or the key does not contain any firmware upgrade file, then the process will abort after a few seconds.

Because data has to be decompressed on the USB key during an upgrade, the USB key must be unlocked, with at least 100 MBytes of free memory, before starting the upgrade. The upgrade will fail if there is not enough free space on the key.

Getting Started With the Web Server

Introduction to the Web Server

Description and Function

The Web Server is a receiver-embedded, HTML-based firmware application, designed to enable the receiver owner (the “administrator”) to monitor and control the SP90m GNSS receiver through a TCP/IP connection.

Running the Web Server for the First Time

As the receiver owner, after establishing a TCP/IP connection between your computer and the receiver (via its Ethernet port or via WiFi; see *page 52* and *page 47*), do the following:

- Run a web browser on your computer.
- Type the IP address (or host name) of the receiver in the web browser, then press the Enter key (see *page 51*).

This will launch the Web Server in the receiver, which in turn will open a web page in the web browser.

Depending on how the Web Server has been configured, you may be asked to log in. The first time you launch the Web Server, use the default connection profile (the “administrator profile”) to log in. This profile is the following:

- Username: **admin**
- Password: **password**

You can customize the administrator profile by changing the username and password. The Web Server will let you do this from its **Security** page (see on-line Help file attached to this page).

Security

The receiver owner may restrict the access to the Web Server by implementing one of the three possible security levels described below, sorted from the highest to the lowest security level:

1. **Enabled:** On launching the Web Server, the user is requested to log in by entering a username and password. After having logged in, the user has full control over the receiver (operation monitoring, access to configuration). As the administrator, you may decide to share the administrator profile (username and password) with other trustworthy users. You may also create new connection profiles for some other authorized users using \$PASH commands.

Remember that registered users have exactly the same rights as the administrator, including managing users through \$PASH commands.

2. **Enabled with Anonymous Access:** Anyone who has been given the IP address or host name of the receiver has direct access to the Web Server (no log-in required). Only receiver monitoring is allowed in this case. An anonymous user CANNOT change the receiver configuration.

After the Web Server has been launched with this level of security, the administrator, or any other authorized user, can log in on the **Security** page (see on-line Help attached to this web page).

3. **Disabled:** No security is implemented with this option. Anyone who has been given the IP address or host name of the receiver has direct access to the Web Server, both for monitoring the receiver or changing its configuration. With this low protection level, the receiver owner will be well-advised to keep the receiver IP address or host name as confidential as possible.

WiFi-Based TCP/IP Connection

Setting Up the WiFi Device


- If the WiFi device has been turned off, it first needs to be turned back on:
 - On the receiver front panel, press one of the horizontal keys until you see the WiFi screen.
 - Press **OK**.
 - Select **ON**:



- Press **OK** again. After a few seconds the screen displays “WiFi ... ON”.

- Then you should indicate how the WiFi device will be power-controlled and whether it will operate as a WiFi client, as WiFi access point or both. Follow the steps below:
 - The previous screen being still displayed, press **OK**.
 - Select **Settings**:



- Press **OK** again.
- Choose a power mode for the WiFi device: press **OK**, select either **Manual** or **Automatic** (see explanations on *page 35* before making a choice) and then press **OK**.
- Press any of the vertical keys and then press **OK**.
- Choose an operating mode for the WiFi device: select either **Client**, **Access Point** or **AP and Client**, depending on the use case (see the next three sections below) and then press **OK**.
- On your laptop or smart phone, start searching for WiFi devices. When your SP90m receiver has been found, select it and then enter the WiFi key (by default the receiver serial number) to allow a WiFi connection with the receiver.
- Back on receiver side, press  to go back to the WiFi “root” screen. If you have selected **Access Point** or **AP and Client**, you will be able to read the IP address of the WiFi access point in the lower line. Type in this IP address (fixed, static address: 192.168.130.1) in your computer or smart phone’s web browser to launch the receiver’s Web Server.



When a WiFi connection is active, one or two of the following icons appear on the General Status screen:



The first one indicates that the WiFi device is used as an access point and the second one as a client.

Using the WiFi Device as Access Point

Use the receiver's WiFi device as access point in the following cases:

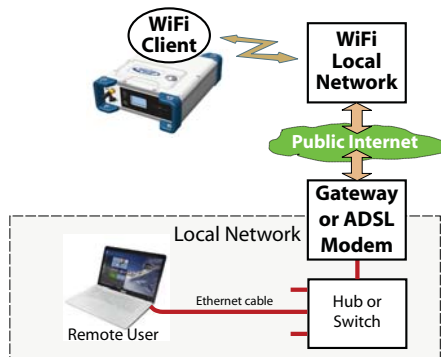
- You want to access the Web Server from any WiFi-capable device such as a computer or a mobile device (e.g. smart phone).
- You are located within WiFi range of the SP90m.



Using the WiFi Device as Client

Use the receiver's WiFi device as client in the following cases:

- You want a remote access to the Web Server and Internet is easily accessible from the location where you are.
- The SP90m is operated in a location where only a local WiFi network is available.



To select a WiFi network, you have to run the Web Server:

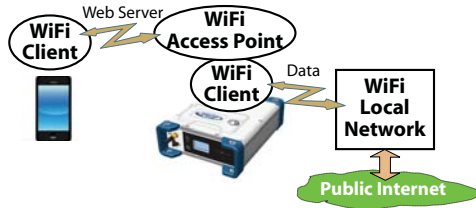
- Go to **Receiver > Network > WiFi**
- Unless already done, turn on the WiFi device, select the client mode and click **Configure**.
- Scan for WiFi networks, select one and then connect to it. The WiFi screen on the receiver should look as shown.

```
WiFi Client ON
WiFi Network Name
60% Connected
172.16.12.204
```

Using the WiFi Device as both Access Point and Client

Use the receiver's WiFi device as both access point and client in the following cases:

- You want to access the Web Server from your computer or smart phone.
- The SP90m is configured to receive or transmit corrections over the Internet via WiFi.
- You are located within WiFi range of the SP90m.



In this use case, the Web Server will be run from the smart phone via the receiver's WiFi device used as access point, whereas corrections will be routed over the Internet using the receiver's WiFi device as client.

Ethernet-Based TCP/IP Connection

In this use case, you will have to use a standard Ethernet cable (fitted with an RJ45 connector at either end) to connect the receiver to the local network.

To make this connection successful, you may have to take advice from your IT expert, depending on the local IP network environment. You should inform this person of the following before proceeding:

- The SP90m is not fitted –and cannot be fitted– with a firewall. If a firewall is needed in your local network, it should be installed on a device other than the SP90m.
- HTTP port #80 is used by default in the receiver to access the Web Server.

The choice of using the DHCP mode or not within the local network is also the decision and responsibility of the IT expert.

Typically, there are two possible cases of TCP/IP connection:

- TCP/IP connection within a local network.
- TCP/IP connection through the public Internet.

These are detailed in the sections below.

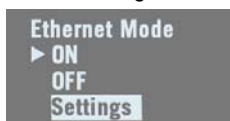
NOTE: It is assumed that the reader knows how to send \$PASH commands to the receiver.

Setting Up the Ethernet Device

- If the Ethernet device has been turned off, you first need to turn it back on:
 - On the receiver front panel, press one of the horizontal keys until you see the Ethernet screen.
 - Press **OK**.
 - Select **ON**:



- Press **OK** again. After a few seconds the screen displays “Ethernet ON”.
- Then you should indicate whether the receiver will be assigned a static IP address (DHCP off) or a dynamic IP address (DHCP on). If you don't know which option to use, ask your local IT expert. Follow the steps below:
 - The previous screen being still displayed, press **OK**.
 - Select **Settings**:



- Press **OK** again.
 - Choose the desired option and then press **OK**.
 - If you chose **DHCP Mode: ON**, there is nothing else to be done.

If you chose **DHCP Mode: OFF**, press one of the vertical arrows to access the **Static Address** screen. Press **OK** and then enter successively each of the figures making up the static IP address. Press **OK** when you are done.

When the IP connection is active, the icon below appears on the General Status screen:

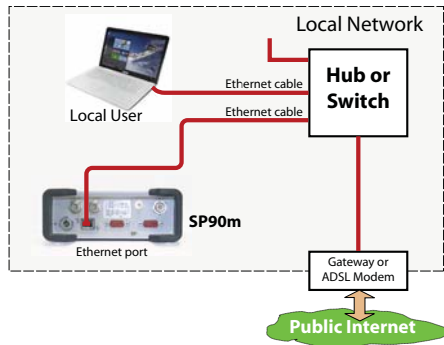


NOTE: If you activate DHCP and there is no DHCP server in your network responding to the request, a static IP address (of the type 169.254.1.x) will be automatically assigned to the receiver (and displayed on the Ethernet screen). This is the IP address you should choose to connect to.

TCP/IP Connection Within a Local Network

In this use case, the receiver and the computer are connected to the same local area network (LAN) and may even be in the same room. Here the communication will not take place through the public Internet, but simply within the local network.

The connection diagram typically is the following.



The valid receiver IP address is **the one shown in the lower line on the Ethernet screen.**

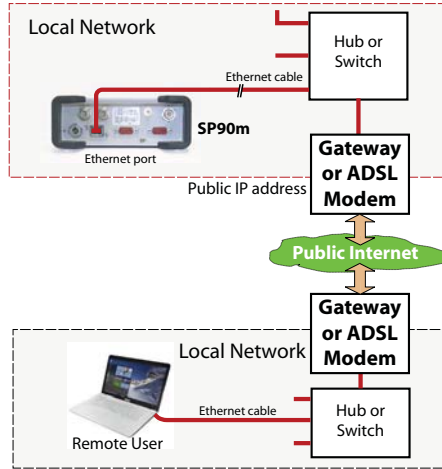
Example indicating the IP address to use with DHCP On:

```
Ethernet ON
DHCP ON
IP:10.20.4.30
```

TCP/IP Connection Through the Public Internet

In this use case, the receiver and computer are connected to different local networks. Here the communication will necessarily take place through the public Internet.

The connection diagram typically is as follows.



In this configuration, the IT expert should take all the necessary steps for the receiver owner to be able to access the SP90m through the public IP address of the local network. **In this case, the IP address shown on the receiver display screen is NOT the one to be entered in the web browser.**

It is therefore the responsibility of the IT expert to provide the appropriate connection information:

<IP address:port number> or host name

Introduction to Multi-Operating Mode

The SP90m is a multi-application GNSS receiver, making it possible to use different operating modes simultaneously.

The limitation to that feature is very simple to understand: **The maximum number of baselines the SP90m can calculate simultaneously is 3.** The capability for the SP90m to support several operating modes simultaneously is simply derived from that statement.

NOTE: Working in a Trimble RTX mode does not “consume” a baseline, which means that the above statement would be more accurate if we said, “The maximum number of baselines the SP90m can calculate simultaneously is 3 + RTX”.

The consequences of this rule are as follows:

- In single-antenna configuration:
 - In Hot Standby RTK, you can configure the receiver to use up to three independent correction sources (= three baselines), thus making it possible to have up to two different backup position solutions available in case the first source of position solution fails.
 - In Hot Standby RTK + Relative RTK, you can only set two independent correction sources (= two baselines), to have a backup position solution available in case the first source of position solution fails. The third baseline is dedicated to the Relative RTK mode.
- In a two-antenna configuration, the heading mode may be combined with all of the existing rover modes:
 - Autonomous
 - RTK
 - Hot Standby RTK
 - RTK + Relative RTK
 - Only Relative RTK
 - Dual RTK
 - Dual Relative RTK

However, in Hot Standby RTK, there can only be two independent sets of corrections used (not three because one baseline is dedicated to computing heading).

Besides, the rover and moving base modes can be run simultaneously. To make this work, you should first configure the receiver as a rover, then as a moving base (and not the other way round). That way, while base corrections will be generated and delivered via your programmed output messages, the receiver will continue to compute RTK positions for its own location provided the required external corrections continue to enter the receiver.

Using SP90m With a Single Antenna

The reader is supposed to know how to run the Web Server (see *Getting Started With the Web Server on page 46*) and how to use the receiver user interface (see *Receiver User Interface on page 26*) before reading this section.

Remember, when using the Web Server, at any time you can access context-sensitive help by pressing this key:



Specifying the Model of Antenna Used

When using one single GNSS antenna connected to SP90m, only GNSS input #1 can be used. GNSS input #2 must not be used in a single GNSS antenna setup.

The setting described below is required prior to configuring the receiver in any of the operating modes described in the following sections.

Use the Web Server to specify the model of antenna connected to GNSS input #1:

- Go to **Receiver > Position > Sensors/Antennas Setup**.
- Set **Multi-Sensor Mode** to **Single Antenna**.
- Choose the point on the antenna for which you want the SP90m to compute the position (L1 phase center, ARP or ground mark).
- Describe the model and height of antenna used as the primary antenna:
 - Manufacturer
 - Antenna name and its RINEX name.
 - Method used to measure the antenna height (i.e. choice of the point on the antenna from which the height measurement is performed).
 - Value of measured distance according to the chosen antenna height measurement method.

NOTE: Entering the height makes sense if you want to get the position of the ground mark or if you enter the ground mark coordinates as a base's reference position.

- Keep the secondary antenna defined as UNKNOWN.
- Press **Configure**. The antenna model is now set.

NOTE: When configuring a static base from the receiver front panel, you will be able to select the model of antenna used (for the primary antenna). By default, if you leave the base mode to operate the receiver as a rover, the receiver will assume this antenna model is still used in the rover configuration.

Raw Data Recording



On the receiver's General Status screen, the following icons will appear in succession at a rate of 1 second when the receiver is actually collecting raw data:



Using the Web Server

Using the Web Server to launch data recording is particularly suitable for remote-controlled, static raw data collection.

- Go to **Receiver > Memory**.
- Enable **Data Recording**.
- Enter a site name for the location occupied by the receiver.
- Choose the memory where to save the raw data file.
- Choose a recording interval in Hz. Additionally, you may ask the receiver to record the "TTT" message resulting from the advent of any incoming external event and/or the "PTT" message providing the time-tagging of the PPS signal.
- Click **Configure**. The receiver starts recording the default messages programmed on port M (as listed after **Data type**). To change the content of this message, refer to *Raw Data Recording on page 77*.

In the right part of the **Memory** tab screen, at the bottom of the list of files stored in the selected memory, you can now see – shown in red – the name of the file being created.

Working from the Receiver Front Panel

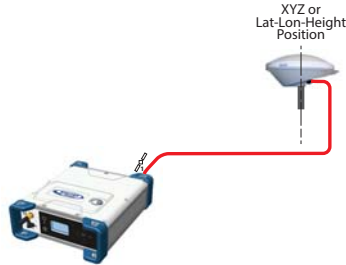
Working from the receiver front panel to launch data recording allows a rover operator to choose between "Static" or "Stop & Go" data collection. A USB key connected to the receiver front panel may be used to save the raw data file once created.


- Press one of the horizontal keys until you see the "Record OFF" screen.

- Press **OK**.
- Choose the option that suits your requirements in terms of data collection type (Static or Stop & Go), the storage location (Mem or USB) used to save the file, then press **OK**.

This starts the data recording. Refer to *Raw Data Recording on page 42* to learn more about the workflow used.

Autonomous or SDGPS (SBAS) Rover

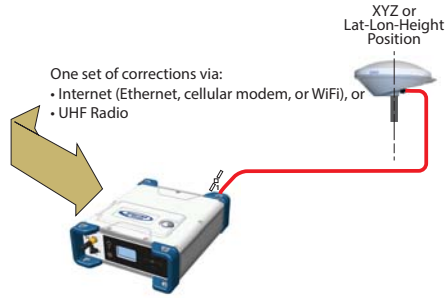



On the receiver's General Status screen, the receiver will display "AUTO" or "SDGPS" when computing a position respectively in autonomous or SDGPS mode. The computed position is displayed after pressing .


Use the Web Server to configure the receiver:

- Go to **Receiver > Position > Rover Setup**
- Set **Processing Mode** to **Autonomous**
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to **SBAS Differential Position** or **Standalone Position**.
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**. The receiver starts operating in autonomous mode. If SBAS satellites are received, the receiver will be able to deliver positions with SBAS Differential accuracy (provided SBAS is enabled; see **Receiver > Satellites**).

RTK or DGPS Rover



On the receiver's General Status screen, the receiver will display "FIXED" (with short "FLOAT" transition time) or "DGPS" when computing a position respectively in RTK or DGPS mode. The computed position is displayed after pressing .

When corrections are received and used,  is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*).

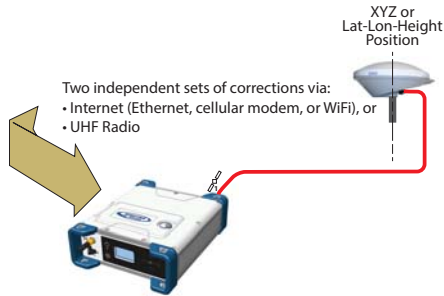
To configure the receiver as a DGPS or RTK rover, use the Web Server as follows:


- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to RTK.
- Select how the corrections are being transmitted to the receiver by setting **Input Mode** accordingly. If you choose **Automatic**, the receiver will find by itself which of its ports is used to acquire corrections. If you choose **Manual**, you need to specify this port.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (GPS is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **RTK Position** or **(RTCM) Differential Position** to match with the selected operating mode (respectively RTK or DGPS).
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.


- If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.

Hot Standby RTK Rover

Hot Standby RTK is similar to RTK except that two or three independent sets of corrections are received instead of one. The receiver will choose the best of the two or three sets of corrections in order to improve position availability and accuracy.



On the receiver's General Status screen, the receiver will display "FIXED" (with short "FLOAT" transition time) when computing a position in Hot Standby RTK mode. The computed position is displayed after pressing .

When at least one set of corrections is received and used,  is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*). The displayed age of corrections is always that of the corrections actually used in the position computation.

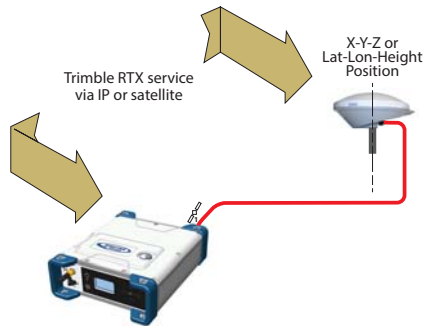
To configure the receiver as a Hot Standby RTK rover, use the Web Server as follows:

- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to **Hot Standby RTK**.
- Select how the two (or three) sets of corrections are being transmitted to the receiver by setting **Input Mode** accordingly. If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire the sets of corrections. If you choose **Manual**, you need to specify each of the ports used.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (GPS is the default


selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **RTK Position** to match with the selected operating mode.

- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire the two sets of corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.

Trimble RTX Rover



Using a Trimble RTX service in the SP90m requires that you first buy a subscription to this service. On the other hand, the receiver is ready to operate in Trimble RTX mode (dedicated firmware option has been pre-installed at the factory) provided an L-band capable GNSS antenna is used.

On the receiver's General Status screen, the receiver will display "RTX" when computing a position using a Trimble RTX service. The computed position is displayed after pressing .

To configure the receiver in RTX, use the Web Server as follows:

- Go to **Receiver > Position > Rover Setup**.
- Choose the channel through which RTX corrections enter the receiver by setting **Corrections Source** accordingly:
 - If you choose **Automatic**, the receiver will find by itself which channel to use (**L-Band** or **NTRIP**).
 - If you choose **L-Band**, the receiver will expect RTX corrections to come from a satellite.
 - If you choose **NTRIP**, the receiver will expect RTX corrections to come from the Internet.

NOTE: RTX corrections will come from the Internet only after you have taken all the steps to implement an active IP connection, either via GSM, WiFi or Ethernet. The connection to the remote RTX service will then be automatic.

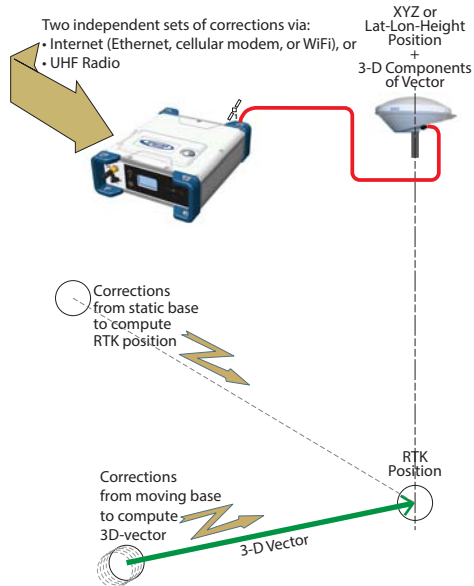
- Set **Engine Mode** to **ON**.
- Select the datum and plate in which to deliver the coordinates of the computed position:
 - If you select **OFF**, the position will be expressed in the ITRF2014 current epoch datum.
 - If you select **ON**, choose a datum and a tectonic plate.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **PPP Position** to match with RTX.
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.

WARNING: The way you set **Processing Mode** is very important here. If for example it is set to **RTK** and every step has been taken to have RTX corrections available (see *page 58*), then the receiver will automatically choose between RTX and RTK depending on which of these two modes is providing the best position solution. You will be able to know which mode is currently used by taking a look at the receiver's General Status screen.

RTK + Relative RTK Rover

Reminder: Relative RTK refers to the ability of the SP90m to compute and deliver the three components of the vector connecting a mobile base to this receiver. The components of the vector are provided with centimeter accuracy, just as is the position of the SP90m, as computed in RTK using corrections received from a static base.

One of the typical applications of Relative RTK is the constant monitoring of the position of a vessel relative to that of another vessel or to the jib of a crane used on a quay.



On the receiver's General Status screen, the receiver will display "FIXED" (with short "FLOAT" transition time) when computing a position in RTK mode. The computed RTK position is displayed after pressing . A new press on this button will display the components of the vector.

When at least one set of corrections is received and used, is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*).

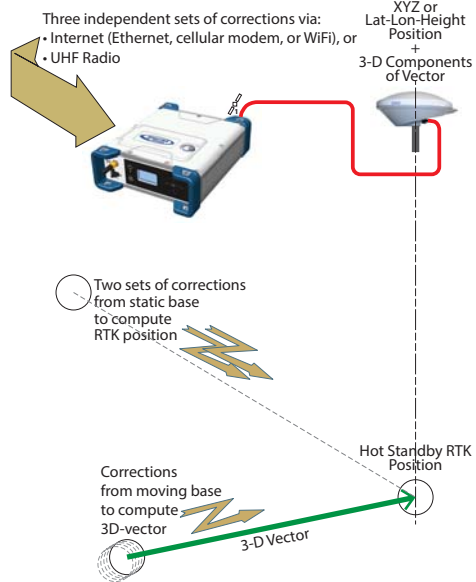
To configure the receiver in RTK+Relative RTK, use the Web Server as follows:


- Go to Receiver > Position > Rover Setup.
- Set Processing Mode to RTK + Relative RTK.

- Select how the two sets of corrections are being transmitted to the receiver by setting **Input Mode** accordingly.
If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire the two sets of corrections.
If you choose **Manual**, you need to specify these two ports. The “**BRV**” line defines the port routing the corrections from a moving base allowing vector computation whereas the “**RTK**” line defines the port routing the corrections from a static base allowing position computation.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **RTK Position** to match with the selected operating mode.
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire the two sets of corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.


Hot Standby RTK+ Relative RTK

This mode is similar to RTK+Relative RTK (see *page 62*) except that the RTK position is a “Hot Standby RTK” one (see also *page 59*). The combination of these two modes may be summarized as shown in the diagram below.



On the receiver’s General Status screen, the receiver will display “FIXED” (with short “FLOAT” transition time) when computing a position in Hot Standby RTK mode. The displayed age of corrections is always that of the corrections actually used in the position computation. The computed position is displayed after pressing .

The components of the vector are visible in the Web Server (in **Receiver > Position > Vectors** tab on the right) or by programming an NMEA VCR or VCT message on one of the receiver ports (see Web Server’s I/Os tab).

When at least one set of corrections is received and used,  is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*).

To configure the receiver in Hot Standby RTK + Relative RTK, use the Web Server as follows:

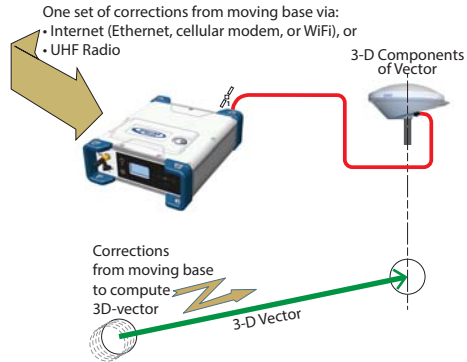
- Make sure the Heading mode is off.
- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to **Hot Standby RTK + Relative RTK**.


- Select how the three sets of corrections are being transmitted to the receiver by setting **Input Mode** accordingly.
If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire the three sets of corrections.
If you choose **Manual**, you need to specify these three ports. The “**BRV**” line defines the port routing the corrections from a moving base allowing vector computation, whereas the “**Standby RTK**” lines define the ports routing the corrections (from one or two static bases), allowing position computation.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **RTK Position** to match to the selected operating mode.
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire the three sets of corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.

Relative RTK Rover


Reminder: Relative RTK refers to the ability for the SP90m to compute and deliver the three components of the vector connecting it to a mobile base. The components of the vector are provided with centimeter accuracy.

One of the typical applications of Relative RTK is the constant monitoring of the position of a vessel relative to that of another vessel or to the jib of a crane on a quay.



On the receiver's General Status screen, the receiver will display "AUTO" or "SDGPS" when computing a position in standalone or SBAS mode. The computed position is displayed after pressing .

The components of the vector are visible in the Web Server (in **Receiver > Position > Vectors** tab on the right) or by programming an NMEA VCR or VCT message on one of the receiver ports (see Web Server's I/Os tab).

When corrections are received and used,  is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*).

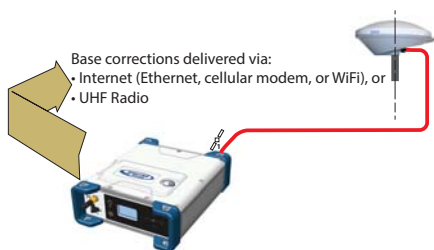
To configure the receiver in Relative RTK, use the Web Server as follows:

- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to **Only Relative RTK**.
- Select how the corrections are being transmitted to the receiver by setting **Input Mode** accordingly. If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire the corrections. If you choose **Manual**, you need to specify the port.
- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (GPS is the default selection) or change the **Output Position Type** field. Be

aware the position computed in Relative RTK, in terms of accuracy, is an SBAS Differential position at best.

- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire the two sets of corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all the radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.

Static or Moving Base



Using the Web Server

To configure the receiver as a base, use the Web Server as follows:

- Go to **Receiver > Position > Base Setup**.
- Use the **Station ID**. field to enter the identification number. Remember, the station ID should comply with the type of correction data format it generates. As a reminder, this is the list of authorized numbers in relation to the format used:
 - RTCM 2.3: 0-1023
 - CMR/CMR+: 0-31
 - ATOM & RTCM3.x: 0-4095
- Select whether the base is stationary (**Static**) or in motion (**Moving**).

If you choose **Static**, you need to specify the exact location of the base. You can do this in two different ways:

- Type in the three geographical coordinates (**Latitude, Longitude, Height**) of the base, as well as the position on the antenna (**Reference Position**) for which these coordinates are given.
- Or click on the **Get Current Position** button to make the currently computed position the new base position. In this case, it is assumed that the receiver actually calculates a position at the time you click the button. As a result, the above three coordinates fields above are overwritten with the current computed position, and the **Reference Position** field is automatically set to “**L1 Phase Center**”.

NOTE: The antenna height was entered when specifying the number of antennas used (see *page 55*).

- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (GPS is the default selection).
- Click **Configure**.
- Set the device used by the receiver to send out its corrections:
 - If corrections are broadcast via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are broadcast over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help).
- You still have to set which corrections the base will generate. This is detailed in *Base Data Messages on page 76*.

NOTE: You may also set a base to use a virtual antenna. This is required when a rover using the corrections from this base has no information on the model of GNSS antenna used at the base. In this case a virtual antenna can be used (ADVNULLANTENNA or GPPNULLANTENNA). If you don't need a virtual antenna, just keep the **Manufacturer** field set to OFF.

Working from the Receiver Front Panel

The receiver user interface offers an alternative to the Web Server to set up a static base. Please follow the detailed procedure described in *Base Mode on page 39*.

Using SP90m With Two Antennas

The reader is supposed to know how to run the Web Server (see *Getting Started With the Web Server on page 46*), and how to use the receiver user interface (see *Receiver User Interface on page 26*) before reading this section.

Remember, when using the Web Server, at any time you can access context-sensitive help by pressing this key:



Specifying the Models of Antennas Used

When using SP90m with two GNSS antennas, both GNSS input #1 and GNSS input #2 are used.

The setting described below is required prior to configuring the receiver in any of the operating modes described in the sections that follow.

Use the Web Server to specify the models of antennas connected to input #1 and input #2:

- Go to **Receiver > Position > Sensors/Antennas Setup**.
- Set **Multi-Sensor Mode** to **Two Antennas** or **Two Antennas (L1 only on input#2)** depending on the reception capability of the model of antenna you connect to input #2.
- Choose the point on the antenna for which you want the SP90m to compute the position (L1 phase center, ARP or ground mark).
- For each of the two antennas (primary and secondary antennas), describe the model and height of antenna used:
 - Manufacturer
 - Antenna name and its RINEX name
 - Method used to measure the antenna height (i.e. choice of the point on the antenna from which the height measurement is performed)
 - Value of measured height according to the chosen antenna measurement method.

NOTE 1: Entering the height only makes sense if you want to get the position of the ground mark.

NOTE 2: Antenna heights are not required when computing heading.

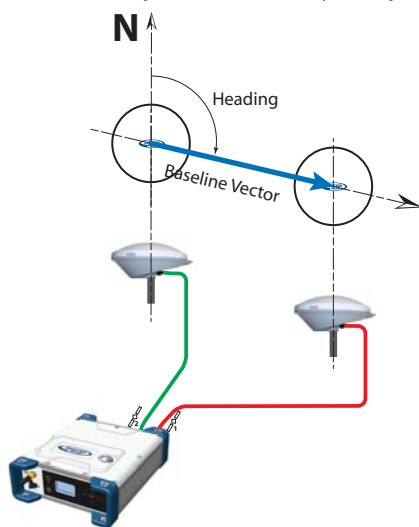
- Press **Configure**. The two antenna models are now set.

NOTE: When configuring a static base from the front panel, you will be able to select the antenna model used for the

primary antenna. By default, if you leave the base mode to operate the receiver as a rover, the receiver will assume this antenna model is still used as the primary antenna. You cannot choose an antenna model for the secondary antenna using the front panel. This operation needs to be done within the Web Server.

SP90m Delivering Heading Measurements

The receiver will measure the heading angle of the vector connecting the secondary antenna to the primary antenna.



On the receiver's General Status screen, the receiver will display "AUTO" or "SDGPS" indicating that the position for the primary antenna is either computed in autonomous or SDGPS mode respectively.

Press one of the vertical keys to see the computed position for the primary antenna (marked ①) and the heading screen. No position is computed for the secondary antenna (marked ②).

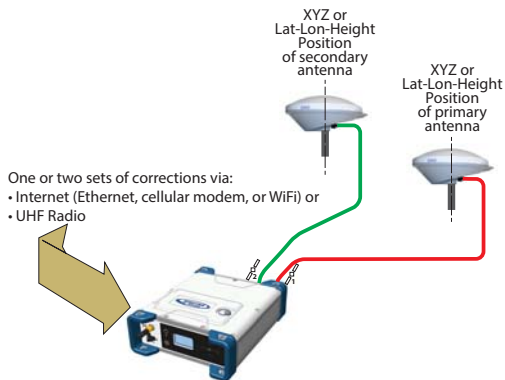
Use the Web Server to configure the receiver:

- Go to **Receiver > Position > Heading Setup**
- Set **Mode** to **Heading**. This automatically sets **Input** to **Internal**.
- Use the **Length Type** field to choose the way you want the receiver to specify the baseline, i.e. the distance between the primary and secondary antennas:

- If it is assumed to be strictly fixed (the two antennas are mounted on a unique, rigid support), select **Fixed**. With this option, you may set the receiver to auto-calibrate the heading computation. In this case keep the **Auto-Calibration** option enabled. Or you may prefer to disable this option, in which case you will have to type in the exact length of the baseline, in meters (in the **Vector Length** field).
- If you think it may slightly vary over time (due to support deformation, presence of wind, etc.), select **Changing (Flex)**. If you choose this option, no auto-calibration is required.
- Enter the possible two offsets in relation to your antenna installation (see *GNSS Antennas Setup for Heading Measurements on page 19*) as well as the maximum expected vertical angle (**Max. Baseline Elevation**) the baseline may present compared to the horizontal, and the permitted tolerance on the baseline length (**Baseline Tolerance**).
- Click **Configure**. The receiver starts operating in heading mode.


Dual-RTK Rover

The SP90m may be configured to provide two RTK positions, one per antenna. These results can subsequently be used to compute the heading angle resulting from the orientation of the two antennas, while providing an accurate position for each of these two antennas.



On the receiver's General Status screen, the receiver will display "FIXED" (with short "FLOAT" transition time) when computing a position in RTK DGPS mode for the primary antenna.

Press one of the vertical keys to see the computed position for the primary antenna (marked ①) and the secondary antenna (marked ②).

When corrections are received and used,  is displayed on the General Status screen together with the age of corrections (see *General Status on page 28*).

To configure the receiver as a Dual RTK rover, use the Web Server as follows:

- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to **Dual RTK**.
- Select how the corrections are being transmitted to the receiver by setting **Input Mode** accordingly.

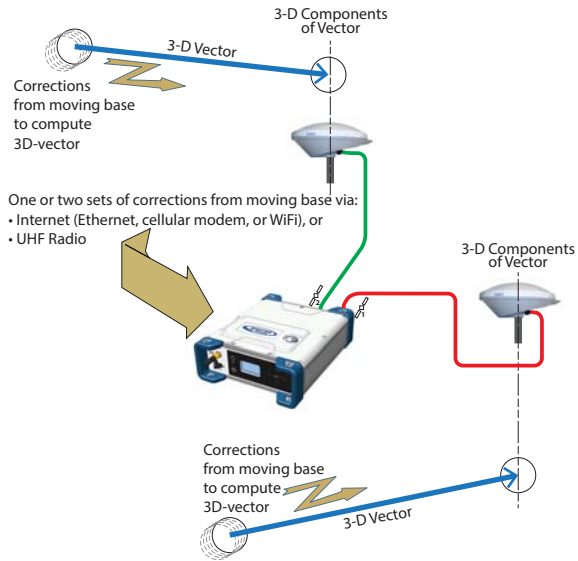
If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire corrections.

If you choose **Manual**, you need to specify each of the two ports. The “RTK-1” line will define the port routing the corrections allowing the receiver to compute the position of the primary antenna, whereas the “RTK-2” line will define the port routing the corrections allowing the receiver to compute the position of the secondary antenna.

NOTE: The same set of corrections, hence the same port, can be used for both antennas.

- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case. Typically you will choose **RTK Position** to match to the selected operating mode.
- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help). Then go to **Receiver > I/Os** to start data reception in NTRIP or Direct IP mode.

Dual-Relative RTK



To configure the receiver as a Dual Relative RTK rover, use the Web Server as follows:

- Go to **Receiver > Position > Rover Setup**.
- Set **Processing Mode** to **Dual Relative RTK**.
- Select how the corrections are being transmitted to the receiver by setting **Input Mode** accordingly.

If you choose **Automatic**, the receiver will find by itself which of its ports are used to acquire corrections.

If you choose **Manual**, you need to specify each of the two ports and possibly the base antenna for which these corrections are computed and delivered (select **N/A** for a single-antenna base). The “**BRV-1**” line will define the port routing the corrections from a moving base allowing the receiver to compute the vector to the primary antenna, whereas the “**BRV-2**” line will define the port routing the corrections from a moving base allowing the receiver to compute the vector to the secondary antenna.

NOTE: The same set of corrections from the same moving base, hence the same port, can be used for both antennas.

- Additionally, in the **Other Settings** section, you may change the primary GNSS system used (**GPS** is the default selection), limit the level of position accuracy to less than what the receiver can actually achieve in this case.

Typically you will choose **RTK Position** to match to the selected operating mode.

- Select the model of dynamics that suits the movement pattern of your rover best.
- Click **Configure**.
- Set the device used by the receiver to acquire corrections:
 - If corrections are received via radio, go to **Receiver > Radio** to enter all radio parameters. You may use the internal radio or an external radio.
 - If corrections are received over the Internet, go to **Receiver > Network** to set the device used (this may be Ethernet, Modem or WiFi; more information about how to set up these devices can be found in the relevant context-sensitive Help).

Programming Data Outputs

The reader is supposed to know how to run the Web Server (see *Getting Started With the Web Server on page 46*) before reading this section.

Remember, when using the Web Server, at any time you can access context-sensitive help by pressing this key:



- Go to **Receiver > I/Os > Input Setup and Output Messages**. In the right-hand part of the Web Server window, all receiver ports are listed, and for each of them, you can read the message or messages currently programmed to be output on this port at the specified data rate(s).
- To add or modify a message on a port, click on the line corresponding to that port. This updates the left-hand part of the window from which you can add or modify as many messages as you wish.

You may need to re-select the matching category in the upper field to access the desired message. For example if NMEA and ATOM messages are programmed on a given port, re-select ATOM in the upper field to access the definition of the ATOM messages. Same applies to NMEA messages.

For any further question about how to handle messages, please refer to the on-line Help.

Rover Output Messages

You will typically use a rover to generate NMEA messages to deliver its results (see complete list on *page 78*). Note that part of these results are also visible on the receiver front panel and in the right-hand section of the Web Server window.

You will typically use the receiver to output the following NMEA messages:

- One GNSS antenna used:

Output	NMEA Message
Position (Autonomous, SDGPS, RTK, Hot Standby RTK or RTX)	GGA
Relative RTK	VCR

- Two GNSS antennas used:

Output	NMEA Message
Heading	HDT VCT HPR
Dual RTK*	GGA
Dual Relative RTK*	VCR

* When the same types of NMEA messages are output on the same port for the two GNSS antennas, special markers are inserted into the flow of messages so that the recipient device can recognize which messages are coming from which antenna.

For example the output of GGA messages will look like this:

```
$PASHD,#1,123456.00,ABCD,BEG*cc<cr><lf>
$GPGGA,...
$PASHD,#1,123456.00,ABCD,END*cc<cr><lf>
$PASHD,#2,123456.00,ABCD,BEG*cc<cr><lf>
$GPGGA,...
$PASHD,#2,123456.00,ABCD,END*cc<cr><lf>
```

Each NMEA message is inserted between a beginning (BEG) and end (END) marker (shown in bold characters in the example above). The marker header indicates for which antenna the NMEA message that immediately follows refers to. For example, a GGA message inserted between two “\$PASHD,#1,..” lines means the message is about the primary antenna. Same for VCR.

Base Data Messages

You will typically use a base to generate ATOM RNX messages. RTCM and CMR/CMR+ are also possible options. Program this output on port D if you are using the internal radio to broadcast these messages. Use port A, B or F if you are using an external radio connected to either of these serial ports.

Program this output on an IP port if your base is broadcasting its messages over the Internet:

- To an external NTRIP caster
- To the embedded NTRIP caster (see Web Server Online Help file)
- To an external IP server (receiver in client mode)
- To port I (8888) or J (8889) (receiver in server mode) with different modes (single or multiple connections).

Raw Data Recording

A default raw data output exists, which you should not modify unless you have specific needs. This output is made available on port M, which, at user's choice, stands for either the receiver's internal memory or a USB device (USB key or hard disk). Port M is the port used to save the collected raw data as a G-file.

Memory	Internal Memory	M	-	ATOM-PVT(1 Hz) ATOM-ATR ATOM-NAV/ ATOM-DAT ATOM-RNX-0(1 Hz) ATOM-OCC
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This output consists of the following ATOM messages:

- PVT: Positioning results
- ATR: Attributes (antenna parameters, receiver description)
- NAV: Satellite navigation information
- DAT: Raw navigation data
- RNX-0: Receiver observations
- OCC: Site occupation information

G-files can be processed in *SPSO* (Spectra Precision Office Software) or by the *RINEX converter* utility.

When two antennas are used, note that by default, only PVT, ATR and RNX-0 are recorded for the secondary antenna.

Memory	Internal Memory	M	-	ATOM-PVT(1 Hz) ATOM-ATR ATOM-NAV/ ATOM-DAT ATOM-RNX-0(1 Hz) ATOM-OCC	ATOM-PVT(1 Hz) ATOM-ATR ATOM-RNX-0(1 Hz)
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Available NMEA Messages

See details in Appendix.

Name	Description
ALR	Alarms
ARA	True heading
ARR	Vector & Accuracy
ATT	True heading
AVR	Time, yaw, tilt
BTS	Bluetooth status
CAP	Received base antenna
CPA	Received antenna height
CPO	Received base position
DDM	Differential decoder message
DDS	Differential decoder status
DTM	Datum Reference
GBS	GNSS Satellite Fault Detection
GGA	GNSS position message
GGK	GNSS position message
GGKX	GNSS position message
GLL	Geographic position - Latitude/Longitude
GMP	GNSS Map Projection Fix Data
GNS	GNSS Fix Data
GRS	GNSS Range Residuals
GSA	GNSS DOP and Active Satellites
GST	GNSS Pseudo-range Error Statistics
GSV	GNSS Satellites in View
HDT	True heading
HPR	True heading
LTN	Latency
MDM	Modem state and parameter
POS	Position
PTT	PPS time tag
PWR	Power status
RCS	Recording status
RMC	Recommended Minimum Specific GNSS Data
SBD	BEIDOU Satellites Status
SGA	GALILEO Satellites Status (E1,E5a,E5b)
SGO	GALILEO Satellites Status (E1,E5a,E5b,E6)
SGL	GLONASS Satellites Status
SGP	GPS Satellites Status
SIR	IRNSS Satellites Status
SLB	L-Band Satellites Status
SQZ	OZSS Satellites Status
SSB	SBAS Satellites Status
TEM	Receiver temperature
THS	True heading and status
TTT	Event marker
VCR	Vector and accuracy
VCT	Vector and accuracy
VEL	3D velocity and velocity accuracy
VTG	Course Over Ground and Ground Speed
ZDA	Date and time

Specifications **GNSS Engine**

- 480 GNSS tracking channels:
 - GPS L1 C/A, L1P (Y), L2P (Y), L2C, L5, L1C
 - GLONASS L1 C/A, L1P, L2 C/A, L2P, L3, L1/L2 CDMA
 - GALILEO E1, E5a, E5b
 - BeiDou B1, B2, B3 ⁽¹⁾
 - QZSS L1 C/A, L1 SAIF, L1C, L2C, L5
 - IRNSS L5
 - SBAS L1 C/A, L5
- Two MSS L-band tracking channels
- Two GNSS antenna inputs

Features

- Patented Z-tracking to track encrypted GPS P(Y) signal
- Patented Strobe™ Correlator for reduced GNSS multi-path
- Patented Z-Blade technology for optimal GNSS performance:
 - Highest quality of raw data (availability/reliability) to meet reference station applications
 - Full utilization of signals from all seven GNSS systems (GPS, GLONASS, BeiDou, Galileo, QZSS, IRNSS, and SBAS)
 - Enhanced GNSS-centric algorithm: fully-independent GNSS signal tracking and optimal data processing, including GPS-only, GLONASS-only or BeiDou-only solution (autonomous to full RTK) ⁽²⁾
 - Fast and stable RTK solution
 - Fast Search engine for quick acquisition and re-acquisition of GNSS signals
- Patented SBAS ranging for using SBAS code & carrier observations and orbits in RTK processing
- Position in local datums and projections with RTCM-3 transformation data
- Support for Trimble RTX™ real-time correction services
- Trimble RTX™ PPP engine
- Hot Standby RTK Algorithms
- Flying RTK Algorithms

- RTK base and rovers modes, post-processing mode
- Moving base
 - RTK with Static & Moving Base corrections supported
 - Multi-dynamic mode (static/moving Base and Rover functions simultaneously)
 - RTK against a moving base for relative positioning
 - Adaptive velocity filter to meet specific dynamic applications
- Heading and Roll/Pitch
 - Accurate and fast heading using dual-frequency, multi-GNSS algorithms
 - RTK or Trimble RTX and heading processing simultaneously
 - Heading engine with optional baseline length self-calibration
 - Adaptive velocity filter to meet specific dynamic applications
- Up to 50 Hz real-time raw data (code & carrier and position, velocity, and heading output) ⁽³⁾
- Reference Inputs/Outputs: RTCM 3.2 ⁽⁴⁾, RTCM 3.1/3.0/2.3/2.1, CMR/CMR+, CMRx ⁽⁵⁾, ATOM ⁽⁶⁾
- Supported RTK networks: VRS, FKP, MAC
- NTRIP protocol
- Navigation outputs: NMEA-0183, ATOM
- PPS output
- Event marker input
- UHF networking
- One-push Ashtech Trouble Log (ATL)

GNSS Sensor Performance

- Time to First Fix (TTFF):
 - Cold start: < 60 seconds
 - Warm Start: < 45 seconds
 - Hot Start: < 11 seconds
 - Signal re-acquisition: < 2 seconds
- Position accuracy (HRMS), SBAS: < 50 cm (1.64 ft) ⁽⁷⁾
- Update rate: Up to 50 Hz ⁽³⁾
- Latency: < 10 ms ⁽⁸⁾
- Velocity Accuracy: 0.02 m.sec HRMS

- Maximum Operating Limits ⁽⁹⁾
 - Velocity: 515 m/sec
 - Altitude: 18,000 m

Precise Positioning Performance

Real-Time Accuracy (RMS) ⁽¹⁰⁾ ⁽¹¹⁾

- Real-Time DGPS Position:
 - Horizontal: 25 cm (0.82 ft) + 1 ppm
 - Vertical: 50 cm (1.64 ft) + 1 ppm
- Real-Time Kinematic Position (RTK):
 - Horizontal: 8 mm (0.026 ft) + 1 ppm
 - Vertical: 15 mm (0.049 ft) + 1 ppm
- Network RTK ⁽¹²⁾:
 - Horizontal: 8 mm (0.026 ft) + 0.5 ppm
 - Vertical: 15 mm (0.049 ft) + 0.5 ppm

Trimble RTX™ (Satellite and Cellular/Internet (IP)) ⁽¹³⁾ ⁽¹⁴⁾

- CenterPoint® RTX
 - Horizontal (HRMS): < 4 cm
 - Initialization: < 30 min. (typical)
 - Operating range (inland): Nearly worldwide
- CenterPoint RTX Fast
 - Horizontal (HRMS): < 4 cm
 - Initialization: < 5 min. (typical)
 - Operating range (inland): In select regions

Heading ⁽¹⁵⁾ ⁽¹⁶⁾ ⁽¹⁷⁾

- Accuracy (RMS): 0.2° per 1 m of baseline length
- Initialization time: < 10 sec typical
- Baseline length: < 100 m

Flying RTK

- 5 cm (0.165 ft) + 1 ppm (steady state) horizontal for baselines up to 1000 km

Real-Time Performance

(10) (11)

- Instant-RTK® Initialization:
 - Typically 2-second initialization for baselines < 20 km
 - Up to 99.9% reliability
- RTK initialization range:
 - > 40 km

Post-Processing Accuracy (RMS)

(10) (11)

Static, Rapid Static:

- Horizontal: 3 mm (0.009 ft) + 0.5 ppm
- Vertical: 5 mm (0.016 ft) + 0.5 ppm

High-Precision Static ⁽¹⁸⁾:

- Horizontal: 3 mm (0.009 ft) + 0.1 ppm
- Vertical: 3.5 mm (0.011 ft) + 0.4 ppm

Post-Processed Kinematic:

- Horizontal: 8 mm (0.026 ft) + 0.5 ppm
- Vertical: 20 mm (0.065 ft) + 1.0 ppm

Data Logging Characteristics

- Recording Interval: 0.02 ⁽¹⁹⁾-999 seconds

Memory

- 8 GB internal memory
- Memory is expandable through external USB sticks or hard drives
- Over four years of 15 sec. raw GNSS Data from 14 satellites (logged to internal 8GB Nand Flash)

Embedded Web Server

- Password-protected Web Server
- Full receiver monitoring and configuration
- FTP push function
- Embedded FTP server and NTRIP caster ⁽²⁰⁾
- NTRIP Server and instant real-time multi-data streaming over Ethernet
- DHCP or manual configuration (static IP address)
- DynDNS® technology support

User and I/O Interface

- User Interface:
 - Graphical OLED display with 6 keys and 1 LED
 - WEB UI (accessible via WiFi or Ethernet) for easy configuration, operation, status and data transfer
- I/O interface:
 - 1 x USB OTG
 - Bluetooth v4.0 + EDR/LE, Bluetooth v2.1 + EDR
 - WiFi (802.11 b/g/n)
 - 3.5G quad-band GSM (850/900/1800/1900 MHz) / penta-band UMTS module (800/850/900/1900/2100 MHz)
 - 1 x Ethernet, RJ45 (Full-Duplex, auto-negotiate 10 Base-TX / 100 Base-TX)
 - 1 x Lemo, RS232 (radio connection and external power)
 - 1 x DB9, RS232 (PPS output and CAN bus)
 - 1 x DB9, RS422/232 (Event marker input)
 - 2 x TNC, GNSS antenna input
 - 1 x TNC, UHF radio antenna connector
 - 1 x SMA, GSM antenna connector
 - 1 x SMA, Bluetooth/WiFi antenna
 - PPS output
 - Event marker input
 - Galvanic Insulation (Except USB)
 - Ready for CAN bus (NMEA 2000 compatible)

Physical and Electrical Characteristics

- Size: 16.5 x 20.6 x 6.5 cm (6.5 x 8.1 x 2.6 in)
- Weight: GNSS receiver: 1.66 kg (3.66 lb) without UHF / 1.70 kg (3.75 lb) with UHF
- Battery life:
 - 4 hrs (RTK Base, GNSS On, UHF Tx On), 12.8 W average power consumption
 - 6 hrs (RTK Rover, GNSS On, UHF Rx On), 5.9 W average power consumption
- Li-ion battery, 27.8 Wh (7.4 V x 3.7 Ah). Acts as a UPS in case of a power source outage
- 9-36 V DC input (EN2282, ISO7637-2)
- External DC power limits feature

Environmental Characteristics

- Operating temperature ⁽²¹⁾: -40° to +65°C ⁽²²⁾ (-40° to +149°F)
- Storage temperature ⁽²³⁾: -40° to +95°C (-40° to +203°F)
- Humidity: Damp Heat 100% humidity, + 40°C (+104°F); IEC 60945:2002
- IP67 (waterproof and dustproof): IEC 60529
- Drop: 1m drop on concrete
- Shock: MIL STD 810F (fig. 516.5-10) (01/2000). Sawtooth (40g / 11ms)
- Vibrations: MIL-STD 810F (fig. 514.5C-17) (01/2000)

(1) Product is designed to fully support BeiDou B3 signals as soon as the officially published signal Interface Control Documentation (ICD) becomes available.

(2) All available GNSS signals are processed equally and combined without preference to any particular constellation for optimal performance in harsh environment.

(3) 50 Hz output is available as firmware option (20 Hz output is a standard feature). At 50 Hz, a limited set of messages can be generated simultaneously through a single port.

(4) RTCM-3.2 Multiple Signal Messaging (MSM) guarantees compatibility with 3rd party for each GNSS data.

(5) A Trimble proprietary format.

(6) ATOM: Open Ashtech format.

(7) VRMS for Autonomous/SBAS positions are usually twice as high as HRMS.

(8) Heading latency is usually twice as high.

(9) As required by the U.S. Department of Commerce to comply with export licensing restrictions.

(10) Accuracy and TTFF specifications may be affected by atmospheric conditions, signal multipath and satellite geometry.

(11) Performance values assume minimum of five satellites, following the procedures recommended in the user guide. High multipath areas, high PDOP values and periods of severe atmospheric conditions may degrade performance.

(12) Network RTK PPM values are referenced to the closest physical base station.

(13) Requires L1/L2 GPS+GLONASS at a minimum.

(14) Accuracy and TTFF specifications may be affected by atmospheric conditions, signal multipath, satellite geometry and L-band service availability. Trimble RTX correction services are only available on land.

(15) Accuracy and TTFF specifications may be affected by atmospheric conditions, signal multipath, satellite geometry and corrections availability and quality

(16) L1/L2 data required.

(17) Figures of pitch accuracy are twice as high.

(18) Depending on baselines, precise ephemeris and long occupations up to 24 hrs may be required to achieve the high precision static specifications.

(19) A Recording Interval of 0.05 is based on a 20 Hz output. The default changes to 0.02 if the optional 50 Hz output firmware option is installed.

(20) Embedded NTRIP Caster is available as firmware option.

(21) Depends on whether the internal battery is used or not:

- With internal battery being charged: +45°C (+113°F) max.
- With internal battery being discharged: +60°C (+140°F)
- Without internal battery (external power supply): +65°C (+149°F)
under conditions of installation.

At very high temperature, the UHF module should not be used in transmitter mode. With the UHF transmitter on radiating 2W of RF power, the operating temperature is limited to +55°C (+131°F).

(22) At this temperature, hand protection may be needed to safely handle the system's lower aluminum housing (as per EN60945).

(23) Without battery. Battery can be stored up to +70°C (+158°F).

NOTE: All performance values are given assuming a minimum of five satellites are used, and following the procedures recommended in the user guide. High multipath areas, high PDOP values and periods of severe atmospheric conditions may degrade performance.

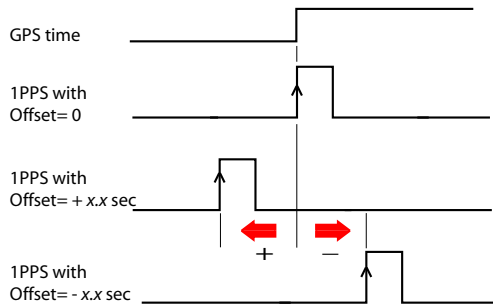
1PPS Output

This output delivers a periodic signal that is a multiple or submultiple of 1 second of GPS time, with or without offset. Using the 1PPS output is a standard feature of the receiver (no firmware option needed).

The 1PPS output is available on port F, pin 9.

You can set the properties of the 1PPS signal using the \$PASHS,PPS command. These properties are:

- Period: a multiple (1 to 60) or submultiple (0.1 to 1 in 0.1-second increments) of 1 second of GPS time.
- Offset: Amount of time in seconds before (+) or after (-) a full second of GPS time.



- Active edge, i.e. the edge (falling or rising) synchronized with GPS time. (On the diagram above, the rising edge is set to be the active edge)

You can read the current properties of the 1PPS output using the \$PASHR,PPS command.

The signal specifications for the 1PPS output are as follows:

- Signal level: 0-5 V
- Pulse duration: 1 ms
- Jitter: < 100 ns
- Slope transient time: < 20 ns

You can also output the exact GPS time of the active edge of the 1PPS output signal using the \$PASHR,PTT command.

The receiver will respond to this command right after the next 1PPS signal is issued, taking into account the chosen offset.

Event Marker Input

This input is used to time-tag external events. When an external event is detected on this input, the corresponding GPS time for this event is output as a \$PASHR,TTT message on any port. The time tag provided in the message represents the exact GPS time of the event to within 1 μ second. A single message is output for each new event.

Using the event marker input is a standard feature of the receiver (no firmware option needed).

The event marker input is located on port B, pin 7.

You can choose whether it will be the rising or falling edge of the event marker signal that will trigger the time tagging of the event. This choice can be done using the \$PASHS,PHE command.

The signal specifications of the event marker input are as follows:

- Signal level: ± 10 V
- Permitted transient time on active edge: < 20 ns

Resetting the Receiver

With the SP90m turned off, press the two horizontal arrow keys (right and left) AND the Power button simultaneously for a few seconds until the power LED turns green.



This starts the receiver. The screen first displays the logo, then **Reset mode** is displayed for a while. At the end of this sequence, all receiver factory settings are restored.

The following parameters, functions and devices are not impacted by the reset sequence:

- Last ephemeris data saved in the receiver (except for SBAS data)
- Last almanac data saved in the receiver
- Last position and time computed by the receiver
- Anti-theft status and parameters
- Startup protection status and parameters
- Ethernet device power status (will remain ON if it was ON before, or OFF if it was OFF) as opposed to all other devices (WiFi, Modem, Bluetooth)
- All settings (PIN code, APN, login, password, etc.) relevant to modem, Bluetooth, WiFi, Ethernet, Web Server
- SMS phone list, email address list and settings
- Automatic power-on and power-off settings
- Receiver validity period.

Upgrading the Receiver Firmware

This can be done in different ways:

- Using the Web Server. Go to **Receiver > Configuration > Firmware Upgrade**.
- USB key + OLED display (see *page 37*).
- USB key + key combination at receiver startup (see *page 44*).
- Using the *SP Loader* software utility (see below).

SP Loader Software Utility

Use Spectra Precision *SP Loader* software to:

1. Upgrade the receiver firmware
2. Install new firmware options based on the use of a POPN delivered to you following the purchase of one of these options.
3. Validate CenterPoint RTX subscription.
4. Read the warranty expiration date of a GNSS receiver.

Installing SP Loader

SP Loader can be downloaded from:

http://www.spectraprecision.com/eng/sp90m.html#_WUJSUdxLdhE

(Click on the Support tab to access the download link.)

The install file is an executable file. Simply double-click on this file to start installation. Follow the instructions on the screen to complete the installation.

Getting Started With SP Loader

SP Loader will use either a serial (RS232), Bluetooth or USB connection to communicate with the receiver. USB is recommended.

1. Connect your computer to the SP90m using a USB connection.
2. Run SP Loader on your computer.
3. Select the computer's port ID used to communicate with the receiver. This port ID should correspond to the computer's USB port.

NOTE: An easy way to identify which port ID on your computer is the USB port is to run SP Loader first without the USB connection and read the list of available ports in SP Loader. After restoring the USB connection with the receiver, check that list again. An extra port ID will then be listed, being the one assigned to the USB port. Select that port. (You don't need to define a baud rate for a USB port.)



4. To upgrade receiver firmware, install a new firmware option or validate a CenterPoint RTX subscription, see sub-sections below.

Upgrading Receiver Firmware

You are not allowed to upgrade a receiver if anti-theft or/and start up protection is active or if the receiver is operated with an in-progress or expired validity period.

Firmware upgrades will be downloadable from the Spectra Precision website in the form of compressed “.tar” files. The name of the “.tar” file, as well as the step-by step upgrade procedure will be given in the accompanying *Release Note*. Completing a firmware upgrade procedure will take up to 10 minutes. For this reason, it must be run with the receiver powered from either a properly charged internal battery or using an external power source.

Unless otherwise specified in the *Release Note* attached to the upgrade package, follow the instructions below to complete the upgrade of your receiver:

1. Follow the first three steps described in *Getting Started With SP Loader on page 88*.
2. Click **Upgrade**. Wait until SP Loader has detected the receiver.
3. Browse your computer in search of the upgrade file.
4. Select the file and click **Open**. SP Loader then provides information on the currently installed firmware, the new firmware as well as the current state of the battery (if the internal battery is used).

This should tell you if you can run the upgrade with the battery, or rather use a fresh one or an external power supply.



5. When you are ready, click on the **Update** button.
6. Let the receiver proceed with the upgrade (a status window is displayed showing a progress bar). **Ensure the receiver is not turned off while installation is in progress.**
7. After successful completion of the upgrade, click **Close** to close the status window. Check that the new firmware is

now installed (version and date displayed in the SP Loader main window).

8. Click **Close** again, then **Exit** to quit SP Loader.

Installing a Firmware Option

Before you start this procedure, make sure you have received an email from Spectra Precision containing the *POP*N (Proof Of Purchase Number) corresponding to the firmware option you have purchased.

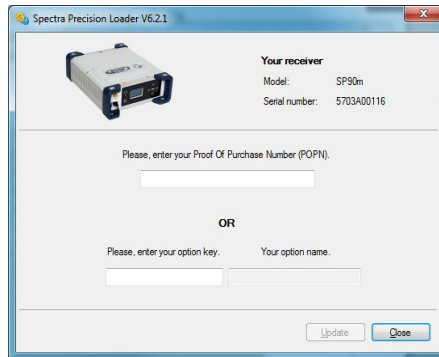
NOTE : Your computer needs an Internet connection to install a firmware option using a POPN.

With the POPN now in your possession, do the following to install a new firmware option:

- Follow the first three steps described in *Getting Started With SP Loader on page 88*.
- Click **Option**. Wait until SP Loader has detected the receiver.

SP Loader then displays the serial number of your receiver and prompts you to enter the POPN.

(There is an alternate method to activate a firmware option, which is to enter the option key (provided by Spectra Precision) corresponding to the desired firmware option, and to specify that option in the nearby field.)



- Enter the POPN and then click on **Update**. Let the receiver proceed with the installation of the firmware option (a status window is displayed showing a progress bar). **Ensure the receiver is not turned off while installation is in progress.**
- After successful completion of the installation, click **Close** to close the status window.
- Click **Close** again, then **Exit** to quit SP Loader.

Activating a CenterPoint RTX Subscription

After you have purchased a CenterPoint RTX subscription, *Trimble Positioning Services* will email you an activation code.

Use the same procedure as the one used to install a firmware option (see *page 90*; the available RTX subscriptions are listed as firmware options). The only difference is that no POPN is provided for this procedure. Just enter the code provided by *Trimble Positioning Services* and specify the type of subscription you purchased before you click **Update**.

Reading Receiver Warranty Expiration Date

SP Loader can be used to query the Spectra Precision database for the warranty expiration date of your GNSS receiver. (After a receiver warranty has expired, remember receiver firmware upgrades are no longer free of charge.)

You don't need to have your receiver connected to *SP Loader* to read its warranty expiration date. Just enter its type and serial number and *SP Loader* will return this information to you, provided there is an active Internet connection on your computer, and your receiver is known to the database.

- Run *SP Loader* on your computer.
- Click on **Warranty**
- Select the type of your receiver and enter its serial number
- Click on **Compute**. *SP Loader* returns the warranty expiration date in a field underneath the **Compute** button.

Additionally, *SP Loader* generates a proprietary command that you can run in your receiver if you want to be sure your receiver has the correct warranty expiration date in memory. Carefully write down this command

Use **Terminal Window** in Survey Pro, or **GPS Utility > Send Command** in FAST Survey to apply this command to the receiver.

NOTE: When upgrading the receiver firmware using a computer with an Internet connection, be aware *SP Loader* will at the same time automatically check the warranty expiration date of your receiver. *SP Loader* will ask you if it can update this date if it is found wrong.

SP File Manager Software Utility

SP File Manager allows you to copy “log” files and G-files directly from the receiver’s internal memory to the desired folder on your office computer.

Additionally you can delete any G-file or “log” file from the receiver’s internal memory.

G-files are GNSS raw data files in proprietary format (ATOM). “Log” files are editable text files listing all the operations performed by the receiver in one day.

SP File Manager is available from the Spectra Precision website as an executable file (*SPFileManagerSetup.exe*) through the link below:

<http://www.spectraprecision.com/eng/sp90m.html#WUJSUdxLdhE>

(Click on the Support tab to access the download link.)

Installing SP File Manager


SP File Manager is very easy to install:

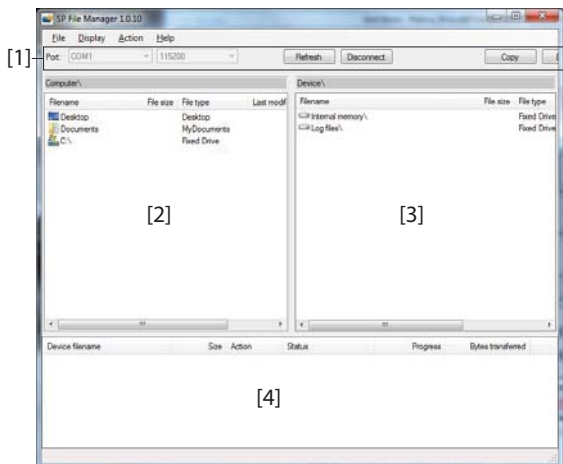
- Download the executable file from the Spectra Precision website (use above link).
- Double-click on the file to complete the installation.

Connecting SP90m to your Computer

SP File Manager will use either a serial (RS232), Bluetooth or USB connection to communicate with the receiver. USB is recommended.

Getting Started With SP File Manager

Double-click on . The *SP File Manager* window which then appears is detailed below.



[1]: SP File Manager toolbar. This toolbar consists of the following items:

- **Port** and baud rate scroll-down lists: Let you choose which serial port is used on computer side for the connection with the receiver (baud rate only makes sense when an RS232 serial line is used). Use 115200 Bd to communicate with SP90m.
- **Connect / Refresh** button: **Connect** allows you to activate the connection between the computer and the receiver via the chosen serial line.


When the connection is established, the button is changed into **Refresh**, which allows you to update the content of the two *SP File Manager* panes ([2] and [3] described below)

- **Disconnect** button: Allows you to deactivate the connection currently established between the computer and the receiver.
- **Copy** button: Copies the file(s) selected in pane [3] to pane [2]. In pane [2], you have to open the folder where to copy to before clicking on the **Copy** button.
NOTE: Copied files have different creation dates and times compared to those of their respective original files. The new dates and times are those corresponding to when the files were copied.
- **Delete** button: Deletes the files currently selected in pane [2] or [3].

[2]: Pane showing the content of the currently open folder on computer side.

[3]: Pane showing the content of the currently open folder on receiver side. The receiver's root folder contains two to three sub-folders:

- **Internal memory**: Lists all G-files recorded by the receiver in its internal memory
- **Log files**: Contains log files (one per day). Each log file lists all the actions performed by the receiver in one day.
- **USB key**, if one is currently connected to the receiver.

To open a folder, double-click on it. To go back to the parent folder, click on .

[4]: Pane showing copy/delete operations in progress, and all those completed since the connection with the receiver was established. This pane is cleared at the beginning of each new working session of *SP File Manager*.


Establishing a Connection with the Receiver

- Set up the USB connection between the computer and receiver.
- Turn on the receiver.
- Launch *SP File Manager* on your computer. This opens the *SP File Manager* window.
- Select the right COM port (see also the Note in *Getting Started With SP Loader on page 88*) and then click on the **Connect** button.

As a result, the pane on the right-hand side of the window lists the two or three folders that can be seen on the receiver.

Copying Files to the Office Computer


- In the right-hand side of the window, double-click on the sub-folder containing the files you want to copy to the computer.

(If needed, click on  to go back to the parent folder and open another sub-folder.)

- In the left-hand side of the window, browse your computer to the folder where to copy the files (recipient folder).
- In the right-hand side of the window, highlight the file(s) you want to copy.
- Click on the **Copy** button. Files are then copied, as requested. The lower part of the screen provides reports information on the copy operations in progress.

Deleting Files from the Receiver

- In the right-hand side of the window, double-click on the sub-folder containing the files you want to delete from the receiver.

(If needed, click on  to go back to the parent folder and open another sub-folder.)

- Still in the right-hand side of the window, highlight the file(s) you want to delete.
- Click on the **Delete** button. Files are then deleted. The lower part of the screen provides reports information on the delete operations in progress.

UHF Networking

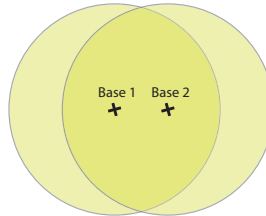
This feature allows a rover to receive corrections from up to three different bases broadcasting separately their corrections via radio, on the same frequency channel, but at different times so the rover can receive these corrections properly.

UHF networking can be implemented in SP90m provided you use Survey Pro as the field software.

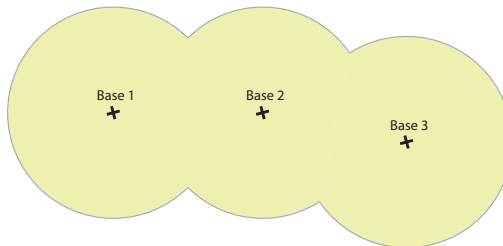
UHF networking may be used in two different modes:

- **Manual:** The rover operator chooses which of the bases to work with. The bases will all be within range so the operator can change the base used at all times (see diagram below).

Typically, the manual mode is used when redundancy is required in terms of corrections availability within a working area. On the diagram below, the darker area represents the area where the rover can operate from any of the two bases.



- **Automatic:** The rover will automatically switch to the base within range that provides the best quality of corrections. Typically the automatic mode is used when you need to extend the UHF radio coverage.



Implementing UHF networking on rover side consists of:

1. Activating this mode.
2. Choosing between automatic or manual selection of the base used. In Survey Pro, this setting is accessible from the **GNSS Status** function after you have started a survey. Selecting the manual mode means specifying the ID of the base you would like to work with.

NMEA Messages **ALR: Alarms**

\$PASHR,ALR,d1,d2,c3,s4,d5,s6*cc

Parameter	Description	Range
d1	Alarm code	0-255
d2	Alarm sub-code	0-255
c3	Stream ID reporting the alarm (if relevant, otherwise blank field): <ul style="list-style-type: none"> • A, B, F: Serial port • U: USB serial port • C, H, T: Bluetooth port • D: Internal radio • E: CSD modem • P, Q: TCP/IP client stream • I, J: TCP/IP client server • M: G-file 	A-F, H-J, M, P, Q, U
s4	Alarm category	BLUETOOTH, INPUT, MEMORY, MODEM, NETWORK, OTHER, POWER, PVT, RADIO, WIFI
d5	Alarm level: <ul style="list-style-type: none"> • 0: Low • 1: Medium • 2: High 	0-2
s6	Description	
*cc	Checksum	*00-*FF

ARA: True Heading

This message delivers either pitch- OR roll-related data (speed, accuracy), not both at the same time, depending on how the antennas are installed.

\$PASHR,ARA,f1,m2,f3,f4,f5,f6,f7,f8,f9*cc

Parameter	Description	Range
f1	*0* when message content is valid	
m2	Current UTC time of attitude fix (hhmmss.ss)	000000.00-235959.99
f3	Heading speed, in degrees/sec	"-": Turn bow left "+": Turn bow right
f4	Pitch speed, in degrees/sec	"-": Downwards "+": Upwards
f5	Roll speed, in degrees/sec	"-": To port (left) "+": To starboard (right)
f6	Heading RMS accuracy, in degrees	
f7	Pitch RMS accuracy, in degrees	
f8	Roll RMS accuracy, in degrees	
f9	(Empty)	
*cc	Checksum	*00-*FF

ARR: Vector & Accuracy

\$PASHR,ARR,d0,d1,d2,m3,f4,f5,f6,f7,f8,f9,f10,f11,f12,d13,d14,d15,d16*cc

Parameter	Description	Range
d0	Vector number	1, 2, 3
d1	Vector mode: <ul style="list-style-type: none"> • 0: Invalid baseline • 1: Differential • 2: RTK float • 3: RTK fixed • 5: Other (dead reckoning, bad accuracy, difference between standalone positions). Messages with d1=5 may further be masked if users only want proven vector estimates. 	0-3, 5
d2	Number of SVs used in baseline computation (L1 portion)	0-99
m3	UTC time (h:mm:ss.ss)	000000.00-235959.99
f4	Delta antenna position, ECEF 1st coordinate (in meters)	±99999.999
f5	Delta antenna position, ECEF 2nd coordinate (in meters)	±99999.999
f6	Delta antenna position, ECEF 3rd coordinate (in meters)	±9999.999
f7	1st coordinate of standard deviation	99.999
f8	2nd coordinate of standard deviation	99.999
f9	3rd coordinate of standard deviation	99.999
f10	1st/2nd coordinate correlation	±99.999999
f11	1st/3rd coordinate correlation	±99.999999
f12	2nd/3rd coordinate correlation	±99.999999
c13	Reference data ID	1, 2, port letter
d14	Vector coordinate frame ID: <ul style="list-style-type: none"> • 0: XYZ 	0
d15	Vector operation: <ul style="list-style-type: none"> • 0: Fixed mode (vector length is constrained) • 1: Calibration (vector length is being calibrated) • 2: Flex mode 	0-2
d16	Clock assumption: <ul style="list-style-type: none"> • 0: Clock is assumed to be different for the "head" and "tail" of the vector (see Comments below) • 1: Clock is assumed to be the same for the "head" and "tail" of the vector (see Comments below) 	
*cc	Checksum	*00-*FF

ATT: True Heading

This message delivers either pitch OR roll angles, not both at the same time, depending on how the antennas are installed.

\$PASHR,ATT,f1,f2,f3,f4,f5,f6,d7*cc

Parameter	Description	Range
f1	Week time in seconds.	000000.00-604799.99
f2	True heading angle in degrees.	000.00-359.999999
f3	Pitch angle in degrees.	±90.000000
f4	Roll angle in degrees.	±90.000000
f5	Carrier measurement RMS error, in meters.	Full range of real variables
f6	Baseline RMS error, in meters.	Full range of real variables
d7	Integer ambiguity is "Fixed" or "Float": <ul style="list-style-type: none">• 0: Fixed• >0: Float	0, >0
*cc	Checksum	*00-*FF

AVR: Time, Yaw, Tilt

\$PTNL,AVR,m1,f2,Yaw,f3,Tilt,,,f4,s5,f6,d7*cc

Parameter	Description	Range
m1	Current UTC time of vector fix (hhmmss.ss)	000000.00-235959.99
f2,Yaw	Yaw angle, in degrees.	
f3,Tilt	Tilt angle, in degrees.	
f4	Range, in meters	
d5	GNSS quality indicator: <ul style="list-style-type: none">• 0: Fix not available or invalid• 1: Autonomous GPS fix.• 2: Differential carrier phase solution RTK (float)• 3: Differential carrier phase solution RTK (fixed)• 4: Differential code-based solution	0-4
f6	PDOP	0-9.9
d7	Number of satellites used in solution	
*cc	Checksum	*00-*FF

BTS: Bluetooth Status

\$PASHR,BTS,C,d1,s2,s3,d4,H,d5,s6,s7,d8,T,d9,s10,s11,d12*cc

Parameter	Description	Range
C,d1	Port C: <ul style="list-style-type: none">• 0: Not connected• 1: A device is connected	0, 1
s2	Device name connected to port C	64 char. max.
s3	Device address connected to port C(xx:xx:xx:xx:xx:xx)	17 char.
d4	Bluetooth link quality for the port C connection	0-100
H,d5	Port H: <ul style="list-style-type: none">• 0: Not connected• 1: A device is connected	0, 1
s6	Device name connected to port H	64 char. max.
s7	Device address connected to port H (xx:xx:xx:xx:xx:xx)	17 char.
d8	Bluetooth link quality for the port H connection	0-100
T,d9	Port T: <ul style="list-style-type: none">• 0: Not connected• 1: A device is connected	0, 1
s10	Device name connected to port T	64 char. max.
s11	Device address connected to port T (xx:xx:xx:xx:xx:xx)	17 char.
d12	Bluetooth link quality for the port T connection	0-100
*cc	Checksum	*00-*FF

CAP: Received Base Antenna

\$PASHR,CAP,s1,f2,f3,f4,f5,f6,f7*cc

Parameter	Description
s1	Antenna name, "NONE" if no name received for the base antenna.
f2	L1 North offset, in mm
f3	L1 East offset, in mm
f4	L1 Up offset, in mm
f5	L2 North offset, in mm
f6	L2 East offset, in mm
f7	L2 Up offset, in mm
*cc	Checksum

CPA: Received Antenna Height

\$PASHR,CPA,f1,f2,f3,m4,f5*cc

Parameter	Description	Range
f1	Antenna height, in meters. This field remains empty as long as no antenna height has been received.	0-99.999
f2	Antenna radius, in meters	0-9.9999
f3	Vertical offset, in meters	0-99.999
m4	Horizontal azimuth, in degrees, minutes (dddmm.mm)	0-35959.99
f5	Horizontal distance, in meters	0-99.999
f2, f3, m4, f5	Not applicable, all empty fields	-
*cc	Checksum	*00-*FF

CPO: Received Base Position

\$PASHR,CPO,m1,c2,m3,c4,f5*cc

Parameter	Description	Range
m1	Latitude in degrees and minutes with 7 decimal places (ddmm.mmmmmmm)	0-90
c2	North (N) or South (S)	N, S
m3	Longitude in degrees, minutes with 7 decimal places (dddmm.mmmmmmm)	0-180
c4	West (W) or East (E)	W, E
f5	Height in meters	±99999.999
*cc	Checksum	*00-*FF

DDM: Differential Decoder Message

\$PASHR,DDM,c1,s2,s3,d4,s5,f6,f7,s8*cc

Parameter	Description	Range
c1	Port receiving corrections	A-E, I, P, Q, Z
s2	Message transport	RT2, RT3, CMR, CMX or ATM
s3	Message number/Identifier	e.g. 1004 for RT3, RNX for ATM, etc.
d4	Counter of decoded messages	0-9999
s5	Base ID	
f6	Time tag, in seconds, as read from the decoded message	
f7	Age of corrections, in seconds	
s8	Attribute	60 characters max.
*cc	Checksum	*00-*FF

DDS: Differential Decoder Status

\$PASHR,DDS,d1,m2,d3,c4,s5,c6,d7,d8,d9,d10,d11,f12,f13,d14,n(d15,
f16,f17)*cc

Parameter	Description	Range
d1	Differential decoder number. "1" corresponds to first decoder, etc. An empty field means the decoder used is not known.	1-4
m2	GNSS (output) time tag	000000.00-235959.99
d3	Number of decoded messages since last stream change	0-127
c4	ID of port from which corrections are received	A-E, I, P, Q, Z
s5	Protocol detected (empty means "no data")	RT2, RT3, CMR, ATM, CMX
d6	Time window, in seconds: • "0" if not defined or just initialized • "200" means equal to or greater than 200	0-200
d7	Percentage of estimated overall data link quality/availability. Empty if not defined.	0-100
d8	Percentage of deselected information. Empty if not defined.	0-100
d9	CRC percentage. Empty if not defined.	0-100
d10	Standard of latency, in milliseconds	0-16383
d11	Mean latency, in milliseconds	0-16383
f12	Mean epoch interval, in seconds	0.00-3600
f13	Min. epoch interval, in seconds	0.00-3600
d14	Number (n) of different messages detected since last stream change	0-63
d15	Message type	RT2: 1-63 RT3: 1001-4094 CMR: 0(obs), 1(loc), 2(desc), 3(glo), 12(cmr+), 20 (glo encrypted) ATM: 0-15 CMX: no message reported
f16	Interval of last message, in seconds	0.000-1023.000
f17	Age of last message, in seconds	0.000-1023.000
*cc	Checksum	

DTM: Datum Reference

\$GPDTM,s1,,f2,c3,f4,c5,f6,s7*cc

Parameter	Description	Range
s1	Local datum code: <ul style="list-style-type: none"> W84: WGS84 used as local datum 999: Local datum computed using the parameters provided by the RTCM3.1 data stream. 	W84, 999
f2	Latitude offset, in meters	0-59.999999
c3	Direction of latitude	N, S
f4	Longitude offset, in meters	0-59.999999
c5	Direction of longitude	E, W
f6	Altitude offset, in meters	±0-99.999
s7	Reference datum code	W84
*cc	Checksum	*00-*FF

GBS: GNSS Satellite Fault Detection

\$--GBS,m1,f2,f3,f4,d5,f6,f7,f8,h9,h10*cc

Parameter	Description	Range
m1	UTC time of the GGA or GNS fix associated with this message (hhmmss.ss)	000000.00-235959.99
f2	Expected error in latitude, in meters, due to bias, with noise= 0	0.0-99.9
f3	Expected error in longitude, in meters, due to bias, with noise= 0	0.0-99.9
f4	Expected error in altitude, in meters, due to bias, with noise= 0	0.0-99.9
d5	ID number of most likely failed satellite	1-32 for GPS 33-64 for SBAS 65-96 for GLONASS 97-128 for Galileo 129-160 for BeiDou 193-202 for QZSS
f6	Probability of missed detection for most likely failed satellite	0.00-1.00
f7	Estimate of bias, in meters, on most likely failed satellite	0.0-99.9
f8	Standard deviation of bias estimate	0.0-99.9
h9	GNSS system ID	0-F
h10	GNSS signal ID	0-F
*cc	Checksum	*00-*FF

GGA: GNSS Position Message

\$GPGGA,m1,m2,c3,m4,c5,d6,d7,f8,f9,M,f10,M,f11,d12*cc

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
m2	Latitude of position (ddmm.mmmmm)	0-90 0-59.999999
c3	Direction of latitude	N, S
m4	Longitude of position (dddmm.mmmmm)	0-180 0-59.999999
c5	Direction of longitude	E,W
d6	Position type: <ul style="list-style-type: none">• 0: Position not available or invalid• 1: Autonomous position• 2: RTCM Differential (or SBAS Differential)• 3: Not used• 4: RTK fixed• 5: RTK float• 6: Estimated (dead reckoning) mode	0-6
d7	Number of GNSS Satellites being used in the position computation	3-26
f8	HDOP	0-99.9
f9,M	Altitude, in meters, above mean seal level. "M" for meters	± 99999.999,M
f10,M	Geoidal separation in meters. "M" for meters.	± 999.999,M
f11	Age of differential corrections, in seconds	0-600999
d12	Base station ID	0-4095
*cc	Checksum	*00-*FF

GGK: GNSS Position Message

See Trimble documentation.

GGKX: GNSS Position Message

\$PTNL,GGKx,m1,m2,m3,c4,m5,c6,d7,d8,f9,f10,M,d11,f12,f13,f14,f15*cc

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
m2	UTC date of position (mmddyy)	010101-123199
m3	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c4	Direction of latitude	N, S
m5	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c6	Direction of longitude	E,W
d7	Position type: <ul style="list-style-type: none"> • 0: Position not available or invalid • 1: Autonomous GPS fix • 2: RTK float solution or RTK location status • 3: RTK fix solution • 4: Differential, code phase only solution • 5: SBAS solution • 6: 3D network solution for RTK float or RTK location • 7: RTK fixed 3D network solution • 8: 2D network solution for RTK float or RTK location • 9: RTK fixed 2D network solution • 10: OmniSTAR HP/XP solution • 11: OmniSTAR VBS solution • 12: RTK location • 13: Beacon DGPS • 14: RTK Global 	0-14
d8	Number of GNSS Satellites being used in the position computation	3-26
f9	PDOP	0-99.9
f10,M	Ellipsoid height of fix (antenna height above ellipsoid. "M" for meters.	± 99999.999,M
d11	Number of extension fields to follow.	
f12	Sigma East	0.000-999.999
f13	Sigma North	0.000-999.999
f14	Sigma Up	0.000-999.999
f15	Propagation age	
*cc	Checksum	*00-*FF

GLL: Geographic Position - Latitude/Longitude

\$GPGLL,m1,c2,m3,c4,m5,c6,c7*cc

Parameter	Description	Range
m1	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c2	Direction of latitude	N, S
m3	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c4	Direction of longitude	E,W
m5	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
c6	Status <ul style="list-style-type: none">• A: Data valid• V: Data not valid	A, V
c7	Mode indicator: <ul style="list-style-type: none">• A: Autonomous mode• D: Differential mode• N: Data not valid• E: Estimated (dead reckoning) mode	A, D, N, E
*cc	Checksum	*00-*FF

GMP: GNSS Map Projection Fix Data

\$--GMP,m1,s2,s3,f4,f5,s6,d7,f8,f9,f10,f11,d12*cc

Parameter	Description	Range
"\$--GMP" Header	\$GPGMP: Only GPS satellites are used. \$GLGMP: Only GLONASS satellites are used. \$GNGMP: Several constellations (GPS, SBAS, GLONASS) are used.	\$GPGMP, \$GLGMP, \$GNGMP
m1	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
s2	Map projection identification: • LOC: Local coordinate system • Empty if no local coordinate system	LOC
s3	Map zone (empty)	
f4	X (Northern) component of grid (or local) coordinate, in meters	±999999999.999
f5	Y (Eastern) component of grid (or local) coordinate, in meters	±999999999.999
s6	Mode indicator: • N: No fix • A: Autonomous • D: Differential • R: Fixed RTK • F: Float RTK	N, A, D, R, F
d7	Number of GNSS Satellites being used in the position computation	3-26
f8	HDOP	0-99.9
f9	Altitude above mean seal level, or local altitude, in meters.	± 99999.999,M
f10	Geoidal separation in meters.	± 999.999,M
f11	Age of differential corrections, in seconds	0-999.9
d12	Base station ID	0-4095
*cc	Checksum	*00-*FF

GNS: GNSS Fix Data

\$--GNS,m1,m2,c3,m4,c5,s6,d7,f8,f9,f10,f11,d12*cc

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
m2	Latitude of position (ddmm.mmmmmm)	0-90 0-59.999999
c3	Direction of latitude	N, S
m4	Longitude of position (dddmm.mmmmmm)	0-180 0-59.999999
c5	Direction of longitude	E, W
s6	Mode indicator (1 character by constellation): <ul style="list-style-type: none">• N: No fix• A: Autonomous position• D: Differential• R: RTK Fixed• F: RTK Float	N, A, D, R, F
d7	Number of GNSS satellites being used in the position computation.	3-26
f8	HDOP	0-99.9
f9	Altitude above mean sea level.	±99999.999
f10	Geoidal separation, in meters	±999.999
f11	Age of differential corrections, in s	0-999
d12	Base station ID (RTCM only)	0-4095
*cc	Checksum	

GRS: GNSS Range Residuals

\$--GRS,m1,d2,n(f3)*cc

Parameter	Description	Range
"\$--GRS" Header	\$GPGRS: Only GPS satellites are used. \$GLGRS: Only GLONASS satellites are used. \$NGRS: Several constellations (GPS, SBAS, GLONASS) are used. \$GBGRS: Only BeiDou satellites are used. \$NGRS: Several constellations are used (GPS, SBAS, GLONASS, QZSS, BeiDou)	\$GPGRS \$GLGRS \$GBGRS \$NGRS
m1	Current UTC time of GGA position (hhmmss.ss)	000000.00-235959.99
d2	Mode used to compute range residuals	Always "1"
f3	Range residual for satellite used in position computation (repeated "n" times, where n is the number of satellites used in position computation). Residuals are listed in the same order as the satellites in the GSA message so that each residual provided can easily be associated with the right satellite.	±999.999
*cc	Checksum	*00-*FF

GSA: GNSS DOP and Active Satellites

\$--GSA,c1,d2,d3,d4,d5,d6,d7,d8,d9,d10,d11,d12,d13,d14,f15,f16,f17*cc

Parameter	Description	Range
"\$--GSA" Header	\$GPGSA: Only GPS satellites are used. \$GLGSA: Only GLONASS sats are used. \$GBGSA: Only BEIDOU sats are used \$NGGSA: Several constellations (GPS, SBAS, GLONASS, BEIDOU) are used.	\$GPGSA, \$GLGSA, \$GBGSA, \$NGGSA
c1	Output mode: • M: Manual • A: Automatic	M, A
d2	Position indicator: • 1: No position available • 2: 2D position • 3: 3D position	1-3
d3-d14	Satellites used in the position solution (blank fields for unused channels)	GPS: 1-32 GLONASS: 65-96 SBAS: 1-44 GALILEO: 1-30 QZSS: 1-5 BEIDOU: 1-35 IRNSS: 1-7
f15	PDOP	0-9.9
f16	HDOP	0-9.9
f17	VDOP	0-9.9
*cc	Checksum	*00-*FF

GST: GNSS Pseudo-range Error Statistics

\$--GST,m1,f2,f3,f4,f5,f6,f7,f8*cc

Parameter	Description	Range
"\$--GST" Header	\$GPGST: Only GPS satellites are used. \$GLGST: Only GLONASS satellites are used. \$NGGST: Several constellations (GPS, SBAS, GLONASS, BEIDOU) are used.	\$GPGST, \$GLGST, \$NGGST
m1	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
f2	RMS value of standard deviation of range inputs (DGNSS corrections included), in meters	0.000-999.999
f3	Standard deviation of semi-major axis of error ellipse, in meters	0.000-999.999
f4	Standard deviation of semi-minor axis of error ellipse, in meters	0.000-999.999
f5	Orientation of semi-major axis of error ellipse, in degrees from true North	0 to 180
f6	Standard deviation of latitude error, in meters	0.000-999.999
f7	Standard deviation of longitude error, in meters	0.000-999.999
f8	Standard deviation of altitude error, in meters	0.000-999.999
*cc	Checksum	*00-*FF

GSV: GNSS Satellites in View

\$--GSV,d1,d2,d3,n(d4,d5,d6,f7),h8*cc

Parameter	Description	Range
"\$--GSV" Header	\$GPGSV: GPS satellites. \$GLGSV: GLONASS satellites \$GAGSV: GALILEO satellites \$SGSV: SBAS satellites (including QZSS L1 SAIF) \$QGSV: QZSS satellites \$BGSV: BeiDou satellites \$IGSV: IRNSS satellites	\$GPGSV, \$GLGSV \$GAGSV \$SGSV \$QGSV \$BGSV \$IGSV
d1	Total number of messages	1-4
d2	Message number	1-4
d3	Total number of satellites in view	0-16
d4	Satellite PRN	GPS: 1-32 GLONASS: 65-96 SBAS: 1-44 GALILEO: 1-30 QZSS: 1-5 BEIDOU: 1-35 IRNSS: 1-7
d5	Elevation in degrees	0-90
d6	Azimuth in degrees	0-359
f7	SNR in dB.Hz	30.0-60.0
h8	Signal ID	0-F
*cc	Checksum	*00-*FF

HDT: True Heading

\$GPHDT,f1,T*cc

Parameter	Description	Range
f1,T	Last computed heading value, in degrees "T" for "True".	0-359.99
*cc	Checksum	*00-*FF

HPR: True Heading

This message delivers either pitch OR roll angles, not both at the same time, depending on how the antennas are installed.

\$PASHR,HPR,m1,f2,f3,f4,f5,f6,d7,d8,d9,f10*cc

Parameter	Description	Range
m1	UTC time of attitude data (hhmmss.ss).	000000.00-235959.99
f2	True heading angle in degrees.	000.00-359.99999
f3	Pitch angle in degrees.	±90.00000
f4	Roll angle in degrees.	±90.00000
f5	Carrier measurement RMS error, in meters.	Full range of real variables
f6	Baseline RMS error, in meters. (=0 if baseline is not constrained)	Full range of real variables
d7	Integer ambiguity: • 0: Fixed • >0: Float	0, >0
d8	Attitude/heading mode status: • 0: Operation with fixed baseline length • 1: Calibration in progress • 2: Flex (flexible) baseline mode ON	0, 1, 2
d9	Character string of the type "y.xxx" defined as follows: • "y" refers to the antenna setup: y=0: no length constraint is applied y=1: heading mode (one vector) y=2: attitude mode (2 vectors) y=3: attitude mode with 3 or more vectors • Each "x" (0 to 9) represents the number of Double Differences (DD) used in the corresponding baseline. If this number is greater than 9, then "9" is reported. If there are only 2 vectors, the last x is "0" Double differences refer to the very last integer second time-tagged epoch.	y.xxx
f10	PDOP corresponding to vector V12, as computed for the very last integer second (time-tagged epoch). Empty if PDOP unknown.	
*cc	Checksum	*00-*FF

LTN: Latency

\$PASHR,LTN,d1*cc

Parameter	Description	Range
d1	Latency in milliseconds.	
*cc	Optional checksum	*00-*FF

MDM: Modem State and Parameter

\$PASHR,MDM,c1,d2,s3,PWR=s4,PIN=s5,PTC=d6,CBS=d7,APN=s8,LGN=s9,PWD=s10,PHN=s11,ADL=c12,RNO=d13,MOD=s14,NET=d15,ANT=s16*cc

Parameter	Description	Range
c1	Modem port	E
d2	Modem baud rate	9
s3	Modem state. *NONE* means that MODEM option [Z] is not valid.	OFF, ON, INIT, DIALING, ONLINE, NONE
PWR=s4	Power mode: • AUT: Automatic • MAN: Manual	AUT, MAN
PIN=s5	PIN code	4-8 digits
PTC=d6	Protocol: • 0: CSD • 1: GPRS	0-1
CBS=d7	Not used CSD mode: • 0: V.32 9600 bauds • 1: V.110 9600 bauds ISDN	0-1
APN=s8	Access Point Name (GPRS)	32 char. max.
LGN=s9	Login (GPRS)	32 char. max.
PWD=s10	Password (GPRS)	32 char. max.
PHN=s11	Phone number (CSD)	20 digits max.
ADL=c12	Auto-dial mode	Y, N
RNO=d13	Maximum number of re-dials (CSD)	0-15
MOD=s14	Modem model (empty if unknown)	Centurion PHS8
NET=d15	2G/3G selection mode: • 0: Automatic (2G or 3G) • Forced to operate in 2G	0-1
ANT=S16	GSM antenna used: • INT: Internal • EXT: External	INT, EXT
*cc	Checksum	*00-*FF

POS: Position

\$PASHR,POS,d1,d2,m3,m4,c5,m6,c7,f8,f9,f10,f11,f12,f13,f14,f15,f16,d17*cc

Parameter	Description	Range
d1	Flag describing position solution type: <ul style="list-style-type: none"> • 0: Autonomous position • 1: RTCM code differential (or SBAS/BDS differential) • 2: RTK float (or RTX) • 3: RTK fixed (or RTX) • 5: Estimated (dead-reckoning) mode • 9: SBAS differential • 10: BeiDou Differential • 12: RTK float • 13: RTK fixed • 22: RTK Float Dithered • 23: RTK Fixed, Dithered 	0-3, 5, 9-10, 12-13, 22-23
d2	Count of satellites used in position computation	0-26
m3	Current UTC time of position (hhmmss.ss)	000000.00- 235959.99
m4	Latitude of position (ddmm.mmmmm)	0-90° 00-59.999999 minutes
c5	North (N) or South (S)	N, S
m6	Longitude of position (dddmm.mmmmm)	0-180° 00--59.999999 minutes
c7	East (E) or West (W)	E, W
f8	Altitude above the WGS84 ellipsoid	±9999.000
f9	Age of differential corrections (seconds)	0-999.9
f10	True Track/Course Over Ground, in degrees	0.0-359.9
f11	Speed Over Ground, in knots	0.0-999.999
f12	Vertical velocity in m/s	±999.999
f13	PDOP	0-99.9
f14	HDOP	0-99.9
f15	VDOP	0-99.9
f16	TDOP	0-99.9
d17	Base station ID	0-4095
*cc	Checksum	*00-FF

PTT: PPS Time Tag

\$PASHR,PTT,d1,m2*cc

Parameter	Description	Range
d1	Day of week: <ul style="list-style-type: none">• 1: Sunday• 7: Saturday	1-7
m2	GPS time tag in hours, minutes, seconds	0-23:59:59.9999999
*cc	Checksum	*00-*FF

PWR: Power Status

\$PASHR,PWR,d1,[f2],[f3],[d4],[d5],[f6],[d7],[d8],d9[,d10]*cc

Parameter	Description	Range
d1	Power source: <ul style="list-style-type: none">• 0: Internal battery• 1: External battery• 2: External DC source	0-2
f2	Output voltage of battery (internal), in volts	0.0-12.0
f3	Empty	
d4	Percentage of remaining battery energy	0-100
d5	Empty	
f6	DC input voltage from external power, in volts	0.0-30.0
d7	Battery charging status: <ul style="list-style-type: none">• 0: Charging• 1: Discharging• 2: Fully charged• 3: Fully discharged	0-3
d8	Empty	
d9	Internal temperature, in degrees C	
d10	Battery temperature, in degrees C	
*cc	Checksum	*00-*FF

RCS: Recording Status

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\$PASHR,RCS,c1,d2,s3,d4,f5,f6,f7,d8,d9)*cc

Parameter	Description	Range
c1	Recording status: <ul style="list-style-type: none"> • Y: Data recording in progress; receiver will keep on recording data after a power cycle. • N: No data recording in progress; after a power cycle, no recording will start either. • S: No data recording in progress, but receiver will start recording data after a power cycle. • R: Data recording in progress, but receiver will stop recording data after a power cycle. 	Y, N, S, R
d2	Memory where data file is recorded: <ul style="list-style-type: none"> • 0: Internal memory 	
s3	Data filename	255 char. max.
d4	Recording rate, in seconds:	0.05-960
f5	Occupation type: <ul style="list-style-type: none"> • 0: Static • 1: Quasi-static • 2: Dynamic 	0-2
d6	Occupation state: <ul style="list-style-type: none"> • 0: In progress • 1: No occupation 	0-1
s7	Occupation name	255 char. max.
*cc	Checksum	*00-*FF

RMC: Recommended Minimum Specific GNSS Data

\$GPRMC,m1,c2,m3,c4,m5,c6,f7,f8,d9,f10,c11,c12*cc

Parameter	Description	Range
m1	Current UTC time of position (hhmmss.ss)	000000.00-235959.99
c2	Status <ul style="list-style-type: none">• A: Data valid• V:	A, V
m3	Latitude of position (ddmm.mmmmm)	0-90 0-59.999999
c4	Direction of latitude	N, S
m5	Longitude of position (dddmm.mmmmm)	0-180 0-59.999999
c6	Direction of longitude	E,W
f7	Speed Over Ground, in knots	000.0-999.9
f8	Course Over Ground, in degrees (true)	000.0-359.9
d9	Date (ddmmyy)	010100-311299
f10	Magnetic variation, in degrees	0.00-99.9
c11	Direction of variation	E, W
c12	Mode indicator: <ul style="list-style-type: none">• A: Autonomous mode• D: Differential mode• N: Data not valid	A, D, N
*cc	Checksum	*00-*FF

SBD: BEIDOU Satellites Status

\$PASHR,SBD,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-37
d2	Satellite PRN number	1-37
d3	Satellite azimuth, in degrees	0-359
d4	Satellite elevation, in degrees	0-90
f5	Satellite B1 signal/noise in dB.Hz	0.0-60.0
f6	Satellite B2 signal/noise in dB.Hz	0.0-60.0
f7	Satellite B3 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status	
*cc	Checksum	*00-*FF

SGA: GALILEO Satellites Status (E1,E5a,E5b)

\$PASHR,SGA,d1,n(d2,d3,d4,f5,,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-36
d2	SV PRN number	1-36
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV E1 signal/noise in dB.Hz	0.0-60.0
f6	SV E5b signal/noise in dB.Hz	0.0-60.0
f7	SV E5a signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status	
*cc	Checksum	*00-*FF

SGL: GLONASS Satellites Status

\$PASHR,SGL,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-24
d2	SV PRN number	1-24
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV L1 signal/noise in dB.Hz	0.0-60.0
f6	SV L2 signal/noise in dB.Hz	0.0-60.0
f7	SV L3 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status	
*cc	Checksum	*00-*FF

SGO: GALILEO Satellites Status (E1,E5a,E5b,E6)

\$PASHR,SGO,d1,n(d2,d3,d4,f5,f6,f7,f8,f9,c10,c11)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-36
d2	SV PRN number	1-36
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV E1 signal/noise in dB.Hz	0.0-60.0
f6	SV E5b signal/noise in dB.Hz	0.0-60.0
f7	SV E5a signal/noise in dB.Hz	0.0-60.0
f8	SV E6 signal/noise in dB.Hz	0.0-60.0
f9	Empty	
c10	Satellite usage status	
c11	Satellite correcting status	
*cc	Checksum	*00-*FF

SGP: GPS Satellites Status

\$PASHR,SGP,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-63
d2	SV PRN number	1-63
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV L1 signal/noise in dB.Hz	0.0-60.0
f6	SV L2 signal/noise in dB.Hz	0.0-60.0
f7	SV L5 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status below)	
*cc	Checksum	*00-*FF

SIR: IRNSS Satellites Status

\$PASHR,SIR,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-7
d2	SV PRN number	1-7
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	Empty	
f6	Empty	
f7	SV L5 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status below)	
*cc	Checksum	*00-*FF

SLB: L-Band Satellites Status

\$PASHR,SLB,d1,n(d2,d3,d4,d5,f6)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-11
d2	L-Band satellite number	01-07, 08-11
d3	Continuous tracking interval, in seconds	
d4	SV azimuth angle, in degrees	0-359
d5	SV elevation angle, in degrees	0-90
f6	SV signal/noise in dB.Hz	0.0-60.0
*cc	Checksum	*00-*FF

SQZ: QZSS Satellites Status

\$PASHR,SQZ,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	0-5
d2	SV PRN number	1-5
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV L1 signal/noise in dB.Hz	0.0-60.0
f6	SV L2 signal/noise in dB.Hz	0.0-60.0
f7	SV L5 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status	
*cc	Checksum	*00-*FF

SSB: SBAS Satellites Status

\$PASHR,SSB,d1,n(d2,d3,d4,f5,f6,f7,c8,c9)*cc

Parameter	Description	Range
d1	Number of visible satellites	1-44
d2	SV PRN number	1-39, 40-44
d3	SV azimuth in degrees	0-359
d4	SV elevation angle in degrees	0-90
f5	SV L1 signal/noise in dB.Hz	0.0-60.0
f6	Empty field	
f7	SV L5 signal/noise in dB.Hz	0.0-60.0
c8	Satellite usage status	
c9	Satellite correcting status	
*cc	Checksum	*00-*FF

TEM: Receiver Temperature

\$PASHR,TEM,s1*cc

Parameter	Description	Range
d1	Receiver internal temperature, in thousandths of degrees	
*cc	Checksum	*00-*FF

THS: True Heading and Status

\$PASHR,TEM,f1,c2*cc

Parameter	Description	Range
f1	Last computed heading value, in degrees (true).	000.00-359.99
c2	Solution status: <ul style="list-style-type: none">• A: Autonomous• E: Estimated (dead reckoning)• M: Manual input• S: Simulator• V: Data not valid (including standby)	A, E, M, S, V
*cc	Checksum	*00-*FF

TTT: Event Marker

\$PASHR,TTT,d1,m2*cc

Parameter	Description	Range
d1	Day of week: <ul style="list-style-type: none">• 1: Sunday• 7: Saturday	1-7
m2	GPS time tag in hours, minutes, seconds	0-23:59:59.9999999
*cc	Optional checksum	*00-*FF

VCR: Vector and Accuracy

\$PASHR,VCR,d0,c1,d2,m3,f4,f5,f6,f7,f8,f9,f10,f11,f12,d13,c14*cc

Parameter	Description	Range
d0	Baseline number (see \$PASHS,BRV)	1, 2, 3
c1	Baseline mode: <ul style="list-style-type: none"> • 0: Invalid baseline • 1: Differential • 2: RTK float • 3: RTK fixed • 5: Other 	0-3, 5
d2	Number of SVs used in baseline computation (L1 portion)	0-99
m3	UTC time (hhmmss.ss)	000000.00-235959.99
f4	First coordinate of delta antenna position, ECEF, in meters	±999999.999
f5	Second coordinate of delta antenna position, ECEF, in meters	±999999.999
f6	Third coordinate of delta antenna position, ECEF, in meters	±99999.999
f7	Standard deviation, first coordinate	99.999
f8	Standard deviation, second coordinate	99.999
f9	Standard deviation, third coordinate	99.999
f10	Correlation (half)	±9.999999
f11	Correlation (one third)	±9.999999
f12	Correlation (two third)	±9.999999
d13	Base station ID (same as GGA)	0-4095
c14	Baseline coordinate frame ID: <ul style="list-style-type: none"> • 0: XYZ 	0
*cc	Checksum	*00-*FF

VCT: Vector and Accuracy

\$PASHR,VCT,c1,d2,m3,f4,f5,f6,f7,f8,f9,f10,f11,f12,d13,d14,d15,d16,d17*cc

Parameter	Description	Range
c1	Baseline mode: <ul style="list-style-type: none"> • 0: Invalid baseline • 1: Differential • 2: RTK float • 3: RTK fixed • 5: Other 	0-3, 5
d2	Number of SVs used in position computation	3-26
m3	UTC time (hmmss.ss)	000000.00-235959.99
f4	Delta antenna position, ECEF X coordinate (in meters)	±99999.999
f5	Delta antenna position, ECEF Y coordinate (in meters)	±99999.999
f6	Delta antenna position, ECEF Z coordinate (in meters)	±9999.999
f7	Standard deviation X coordinate (latitude)	99.999
f8	Standard deviation Y coordinate (longitude)	99.999
f9	Standard deviation Z coordinate (height)	99.999
f10	Correlation XY	±9.999999
f11	Correlation XZ	±9.999999
f12	Correlation YZ	±9.999999
d13	Base station ID (same as in GGA)	0-4095
d14	Baseline coordinate frame ID: <ul style="list-style-type: none"> • 0: XYZ 	0
d15	Baseline number	1-3
d16	VRS: <ul style="list-style-type: none"> • 0: Physical • 1: Virtual • Empty: Not known 	Empty, 0, 1
d17	Static mode assumption: <ul style="list-style-type: none"> • 0: Static • 1: Moving • Empty: Not known 	Empty, 0, 1
*cc	Checksum	*00-*FF

VEL: Velocity

\$PASHR,VEL,f1,m2,f3,f4,f5,f6,f7,f8,d9*cc

Parameter	Description	Range
f1	Reserved	1
m2	Current UTC time of velocity fix (hhmmss.ss)	
f3	Easting velocity, in m/s	
f4	Northing velocity, in m/s	
f5	Vertical velocity, in m/s	
f6	Easting velocity RMS error, in mm/s	
f7	Northing velocity RMS error, in mm/s	
f8	Vertical velocity RMS error, in mm/s	
d9	Applied effective velocity smoothing interval, in ms (empty if unknown)	
*cc	Checksum	*00-FF

VTG: Course Over Ground and Ground Speed

\$GPVTG,f1,T,f2,M,f3,N,f4,K,c5*cc

Parameter	Description	Range
f1,T	COG (with respect to True North) T for "True" North: COG orientation	000.00-359.99
f2,M	COG (with respect to Magnetic North) M for "Magnetic" North: COG orientation	000.00-359.99
f3,N	SOG (Speed Over Ground) N for "knots": SOG unit	000.00-999.999
f4,K	SOG (Speed Over Ground) K for "km/hr": SOG unit	000.00-999.999
c5	Mode indicator: • A: Autonomous mode • D: Differential mode • N: Data not valid	A, D, N
*cc	Checksum	*00-FF

ZDA: Date & Time

\$GPZDA,ZDA,m1,d2,d3,d4,d5,d6*cc

Parameter	Description	Range
m1	UTC time (hhmmss.ss)	000000.00-235959.99
d2	Current day	01-31
d3	Current month	01-12
d4	Current year	0000-9999
d5	Local zone offset from UTC time (hour)	-13 to +13
d6	Local zone offset from UTC time (minutes)	00-59
*cc	Checksum	*00-FF

Index

Symbols

"LOC" *31*

"W84" *31*

Numerics

1PPS *86*

A

Access point (WiFi) *49*

Accessories *4*

ADSL modem *53*

Anonymous mode *47*

Antenna (Bluetooth/WiFi) *9*

Antenna (GNSS) *7*

Antenna (GSM, external) *11*

Antenna (UHF radio) *11*

ATL *3*

AUTO *28*

Auto-calibration *71*

Automatic power-on/off *23*

Automatic receiver power-on/off *3*

Azimuth offset *21*

B

Backup battery *13*

BASE *28*

Base data *76*

Battery *24*

Battery (external) *25*

Battery Information *29*

Battery model *13*

Bottom mount *18, 19*

BRV *63*

BRV-1, BRV-2 *73*

Buzzer *14*

C

Cellular antenna *11*

Charger *25*

Client (WiFi) *49*

Coaxial cables *7*

Combining operating Modes *54*

D

Data Link Information *28*

Default configuration *2*

DGPS *28*

Direct IP *34*

Direction keys *26*

Display screen *9*

E

Earth connection *12*

Electric isolation (optical) *12*

Elevation offset *20*

Escape button *27*

Ethernet *36, 50*

Ethernet port *12*

Event marker *87*

Event marker input *87*

Expiration date *91*

External event *87*

F

Factory settings *2*

FEC *33*

Firmware upgrade *89*

Firmware upgrades *8*

FIXED *28*

Flex *71*

FLOAT *28*

Fuse *25*

G

Gateway *52, 53*

General Status screen *28*

Geoid model *103, 106*

GNSS input #1 *11*

GSM antenna *11*

H

Heading *70*

Host name *34*

Hub *52, 53*

I

Icons on General Status screen *28*

Install firmware option *90*

Instant RTK *82*

Insulation (electric) *12*

IP address on receiver identification screen

52

L

LAN *52, 53*

LED (power) *10*

LOC *31*

Local settings *50*

Lug *18*

M

Memory Information *29*

Modem Information *29*

Modem screen *34*

Mount point *34*

Moving base *67*

N

NMEA messages *78, 96*

NTRIP *34*

O

OK button *27*

OLED 9
One-antenna configuration 55
Options (firmware, pre-installed) 7

P

Pinouts 14, 15, 17
POPIN 8
Position Solution screen 31
Power button 9
Power cord 6
Power mode 23
Power Off screen 43
PPS 86
Public IP address 53

R

Radio screen 32
Raw data recording 56, 77
Raw Data Recording Information 29
Receiver Information screen 31
Repeater 33
Resetting the receiver 87
RTK-1, RTK-2 72
RTX 60

S

S DGPS 28
SCR 33
Scroll button 9
SD Card, Bluetooth, USB information 30
Security 46
Semi-major axis 109
Semi-minor axis 109
Serial ports 12
SIM card 13
SMA 11
SP File Manager 92
SP File Manager (copy files) 94
SP File Manager (delete files) 94
SP Loader 88
Survey Pro 3
Switch 52, 53

T

Trimble RTX subscription 91
Tripod mount 18
Two-antenna configuration 69

U

UHF input 11
UHF networking 95
Upgrade procedure (firmware) 89
Upgrade receiver firmware 89
Upgrading firmware 44
USB (OTG) 10
USB driver 10

USB key 44
USB port 10

V

VESA 19
Virtual antenna 68

W

W84 31
Warranty (end of) 91
Web browser 46
Welcome screen 26
WiFi 35, 47
WiFi Information 29
WiFi key 36
Workflow (User Interface) 26

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