# SL7 GNSS RTK System

# User Manual

## Manual Revision

SatLab GEOSOLUTIONS AB

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# SL7

## GNSS RTK System

## User Manual

# Preface

## Introduction

Welcome to the SatLab SL7 receiver. This introduction describes how to use this product.

## Experience requirement

To help you use the SatLab products better, SatLab suggests that you read the instructions carefully. If you are unfamiliar with the products, please refer to https://www.satlab.com.se/

## Tips for safe use

**Notice**: These are special operations and need your special attention. Please read them carefully.

**Warning**: The contents here are very important as the wrong operation may damage the machine. This can lead to the loss of data, or break the system and endanger your safety.

## Exclusions

Before using the product, please read these operating instructions carefully, as they will help you to use it better. GeoSolution i Göteborg AB assumes no responsibility if you fail to operate the product according to the instructions or operate it wrongly because you have misunderstood them.

SatLab is committed to constantly perfecting the product's functions and performance, improving its service quality and reserves the right to change these operating instructions without notice.

We have checked the contents of the instructions and software and hardware but please note the possibility of deviation. The pictures in the operating instructions are for reference only and the actual products may vary from them.

## Technology and service

If you have any technical issues, please call the SatLab technology department for help, and we will answer your question.

## Relevant information

You can obtain this introduction by:

Purchasing SatLab products: this manual is found in the instrument container and will help you to operate the instrument.

Logging on to the SatLab official website and downloading the electronic version of this introduction from Partner Center: http://members.SatLab.com.cn/

## Advice

If you have any suggestions for this product, please email us: sales@SatLab.com.cn. Your feedback information will help us to improve our product and service.

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# Chapter 1

## Overview

**This chapter contains:**

- Foreword

- Features

- Use and precautions

## 1.1 Foreword

SL7 GNSS receiver brings superior performance and high efficiency that will support your fieldwork with reliable solutions. Equipped with an upgraded high-definition starlight camera, SL7 brings out an excellent visual stakeout experience in low-light conditions. The compact and lightweight design makes SL7 a feasible and portable choice for engineering personnel in collecting data and improving positional accuracy.

## 1.2 Features

1. With an ultra-light EPP material instrument case it is more durable and portable.
2. A lower camera is used for AR stakeout with an accuracy of better than 1 cm.
3. The inclusion of a high-performance patch antenna both enhances the low elevation angle tracking capabilities and maintains a high gain for higher elevation satellites.
4. It can bring accurate and reliable results and boost efficient fieldwork with a self-developed built-in IMU and core algorithm.
5. Hi-Fix technology enables both continuous connectivity and quality results as a certain level of accuracy continues to be guaranteed even in the absence of differentials.

## 1.3 Use and precautions

The SL7 receiver is designed to be resistant to both chemicals and impact, but precision instruments require careful use and maintenance and care should be taken.

**Notice:**
**This equipment complies with radiation exposure limits set forth for a controlled environment. This equipment should be installed and operated with a minimum distance of 1m between the radiator and your body. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.**

We recommend that a distance of 0.31m or more be maintained between this device and people during operation. Operations closer than this distance is not recommended.

The product shall not be permanently installed outdoors because protection against water and dust is not guaranteed Please bring back to indoors in rainy weather.

This device needs a license from the national regulatory authority before use.

The receiver must be within the specified temperature range when it is used and stored. For detailed requirements, please refer to Chapter 3: Technical specification.

**Notice:** This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference.

(2) this device must accept any interference received, including interference that may cause undesired operation.

To ensure the continuous tracking observation of the satellite and quality of the satellite signal, the space above the station should be as wide as possible, with no obstacles above the 15° elevation angle. To reduce the interference of various electromagnetic waves on the GNSS satellite signal, there should be no strong electromagnetic interference within a range of about 200 meters around the station, such as TV towers, microwave stations, and high-voltage transmission lines. To avoid or reduce the occurrence of multipath effects, the station should be away from terrain and features with strong reflectors, such as high-rise buildings, water, etc.

# Chapter 2

## Product introduction

**This chapter contains:**

- Overall appearance
- Button & LED
- WEB management system
- Static survey
- Tilt survey
- Firmware upgrade
- AR Stake

## 2.1 Overall appearance

The product's appearance is divided into three parts: the upper cover, bottom cover and control panel.

*Figure 2-1-1*

### 2.1.1 Upper cover

*Figure 2-1-2*

### 2.1.2 Bottom cover

The bottom cover includes the SMA antenna interface and Type-C USB interface.

*Figure 2-1-3*

1. Power button 2. Speaker 3. Connection screw

4. Camera 5. Type-C USB interface 6. SMA antenna interface

◇ Type-C USB interface: to upgrade the firmware and download static data.

◇ SMA antenna interface: connect the radio antenna while using the Internal UHF mode.

◇ Protective plug: used for dustproof and waterproof sockets.

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**Notice**:

1. If you don't use the SMA antenna interface and USB interface, please cover the rubber plug to protect them from dust and water.

2. When the speaker is flooded, the sound may be silent or hoarse, but it will return to normal after it has dried.

---

### 2.1.3 Control cover

The control panel includes a satellite light, power button and data light.

*Figure 2-1-4*

1. Satellite LED 2. Data LED 3. Power button

## 2.2 Button & LED

### 2.2.1 Button function

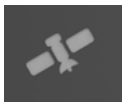
*Table 2-2-1 Button function description*

| Function | Description |
|---|---|
| Power-on | Press and hold the power button for 1 second. |
| Power-off | Press and hold the power button for more than 3 seconds but less than 6 seconds. |
| Forced shutdown (use when the device crashes) | Press and hold the power button for at least 12 seconds. |
| Query current status | Press the power button once to receive the product's current working status. |
| Reset motherboard | When the device is powered on, press and hold the power button for 6 seconds and release it after hearing a second "dingdong" sound. |
| Switch working mode | Double-click the power button to change the mode. Each double-click switches to a different working mode, and click the power button to confirm the one you want. |

### 2.2.2 LED

*Table 2-2-2 LED function description*

| Function | Status | Description |
|---|---|---|
| Power LED(red) | Long-term light out | In the non-charging state or after the power is full, the power red light is always off. |
| | Long-term lighting | In the charging state, and the power is not fully charged, the power red light is always on. |
| Power LED(green) | Flash | The power is ≤10%. |
| | Long-term lighting | 1. RTK mode: no correction data.<br>2. Static mode: sampling has not started. |
| | Flash | 1. RTK mode:<br>flashes at the frequency of the correction transmit and reception.<br>2. Static mode:<br>Sampling interval >1s: flashes at the sampling interval.<br>Sampling interval ≤1s: flashes once per second. |

| Function | Status | Description |
|---|---|---|
| Data LED | Off | 1. RTK mode: no correction data.<br>2. Static mode: sampling has not started. |
|  Satellite LED | Long-term lighting | The satellite is tracked. |
| | Flash | The satellite is not tracked. |

## 2.3 WEB management system

SL7 has a built-in web management system that can be used to set the receiver's working mode, and data output, as well as view receiver information and satellite information. The receiver's Wi-Fi name is its S/N. You can connect it to a controller or phone (the default password is 12345678) inputting the IP address 192.168.20.1 into the browser to log in.

Note: The web management system can only be visited when the receiver's Bluetooth isn't connected.

### 2.3.1 Main menu

After logging into the web management system, you can click Start to enter the main menu. Each option of the main menu contains drop-down menus.

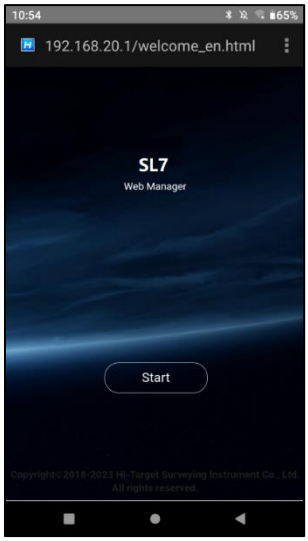



*Figure 2-3-1 Home*

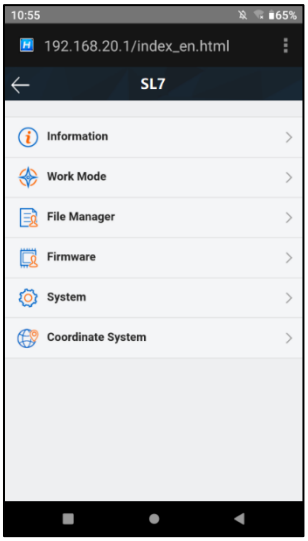



*Figure 2-3-2 Main menu*

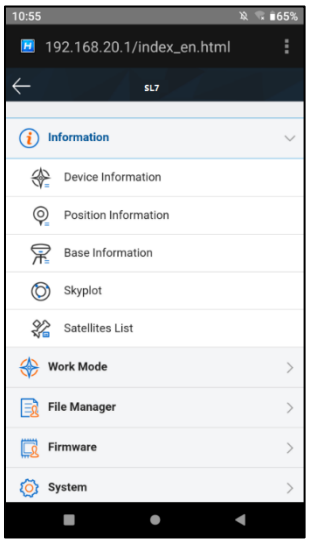



*Figure 2-3-3 Information*

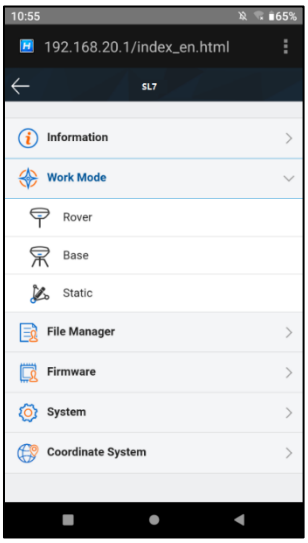



*Figure 2-3-4 Work mode*

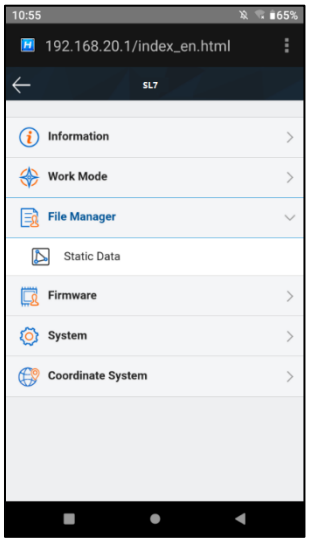



*Figure 2-3-5 File manager*

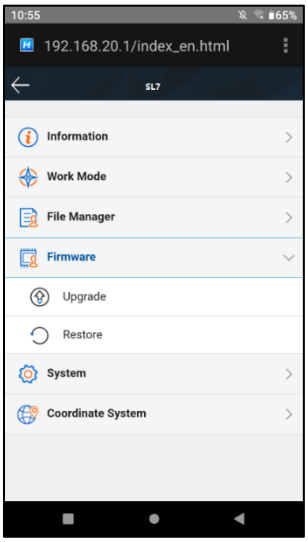



*Figure 2-3-6 Firmware*

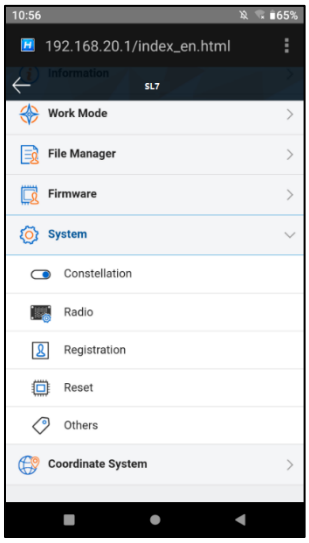



*Figure 2-3-7 System*

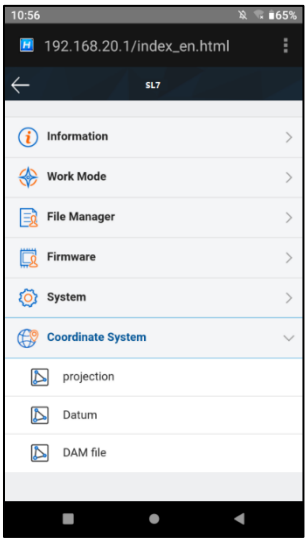



*Figure 2-3-8 Coordinate System*

*Table 2-3-1 Menu description*

| Main menu | Sub-menu | Description |
|---|---|---|
| Information | Device info | Device model, version, registration info, etc. |
| | Position info | Coordinates, satellite tracking, solution state, etc. |
| | Sky plot | Check the sky plot |
| | Satellites list | Satellite tracking information |
| Work Mode | Rover | Data link and parameter settings of the rover |
| | Base | Data link and parameter settings of the base |
| | Static | Static measurement parameter settings |
| File Manager | Static data | Download, delete and format static data |
| Firmware | Upgrade | Select and upgrade the firmware |
| | Restore | Restore the system |
| System | Constellation | The switches of satellite tracking |
| | Radio | Radio frequency list |
| | Registration | Device registration and information |
| | Reset | Reset the motherboard |
| | Others | Switch of the static RINEX and volume control, etc |
| Coordinate System | Projection | Modify projection model, central meridian, scale factor, etc. |
| | Datum | Modify source ellipsoid, target ellipsoid and transformation model |
| | DAM File | Export/import of coordinate system parameters in dam format |

### 2.3.2 Information

1. Device information

This includes the main information about the device: device model, S/N, firmware version, OEM info, battery power, work mode, configuration parameters and others.

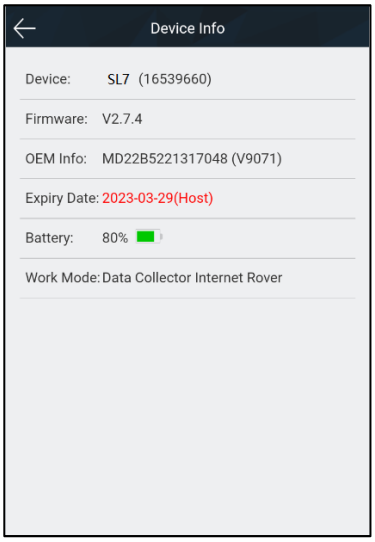



*Figure 2-3-9 Device information*

2. Position information

This shows the device's position, satellites, the solution state, latency, PDOP and time.

*Figure 2-3-10 Position information*

3. Sky plot

This displays satellites that are visible from the device and switches for each constellation.

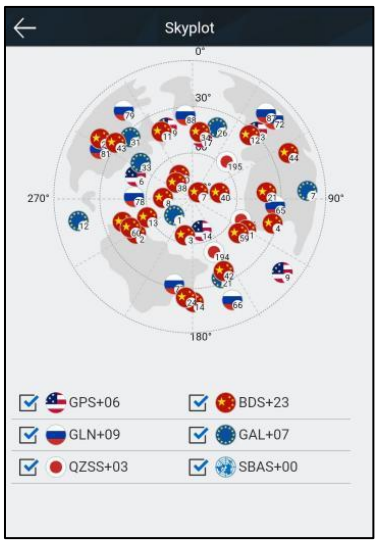
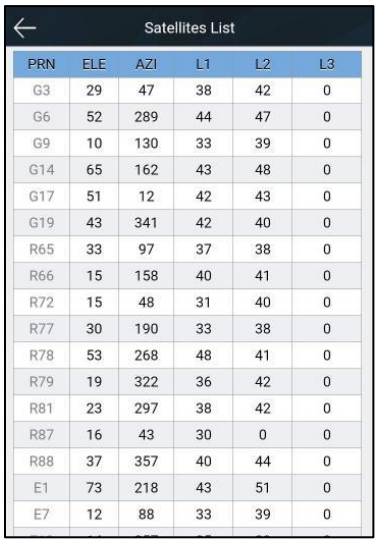



*Figure 2-3-11 Sky plot*

4. Satellites list

This shows the satellite tracking information.




| PRN | ELE | AZI | L1 | L2 | L3 |
|---|---|---|---|---|---|
| G3 | 29 | 47 | 38 | 42 | 0 |
| G6 | 52 | 289 | 44 | 47 | 0 |
| G9 | 10 | 130 | 33 | 39 | 0 |
| G14 | 65 | 162 | 43 | 48 | 0 |
| G17 | 51 | 12 | 42 | 43 | 0 |
| G19 | 43 | 341 | 42 | 40 | 0 |
| R65 | 33 | 97 | 37 | 38 | 0 |
| R66 | 15 | 158 | 40 | 41 | 0 |
| R72 | 15 | 48 | 31 | 40 | 0 |
| R77 | 30 | 190 | 33 | 38 | 0 |
| R78 | 53 | 268 | 48 | 41 | 0 |
| R79 | 19 | 322 | 36 | 42 | 0 |
| R81 | 23 | 297 | 38 | 42 | 0 |
| R87 | 16 | 43 | 30 | 0 | 0 |
| R88 | 37 | 357 | 40 | 44 | 0 |
| E1 | 73 | 218 | 43 | 51 | 0 |
| E7 | 12 | 88 | 33 | 39 | 0 |

*Figure 2-3-12 Satellites list*

### 2.3.3 Work mode

1. Rover

Set up the rover's data link and parameters. The rover station data link includes Internal UHF, Internal GSM, and External Radio.

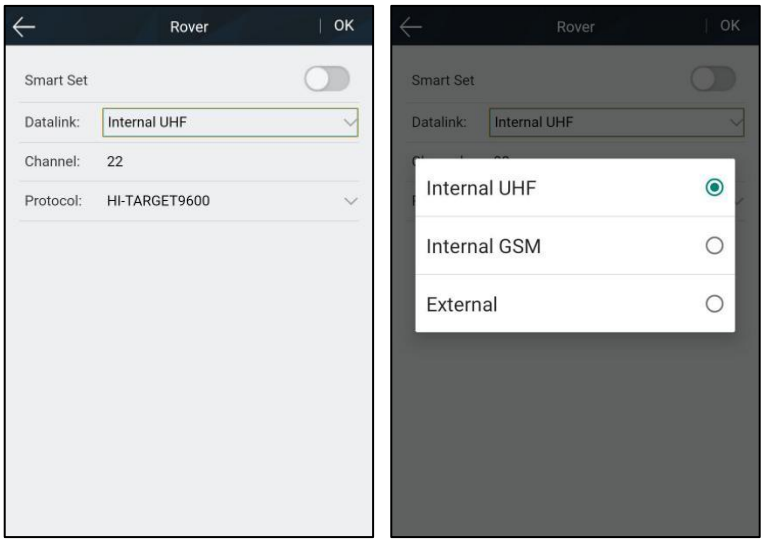



*Figure 2-3-13 Rover*

2. Base

Set up the data link and parameters of the base and get the point coordinates by averaging. The base station data link mode includes Internal UHF, Internal GSM, and External Radio.

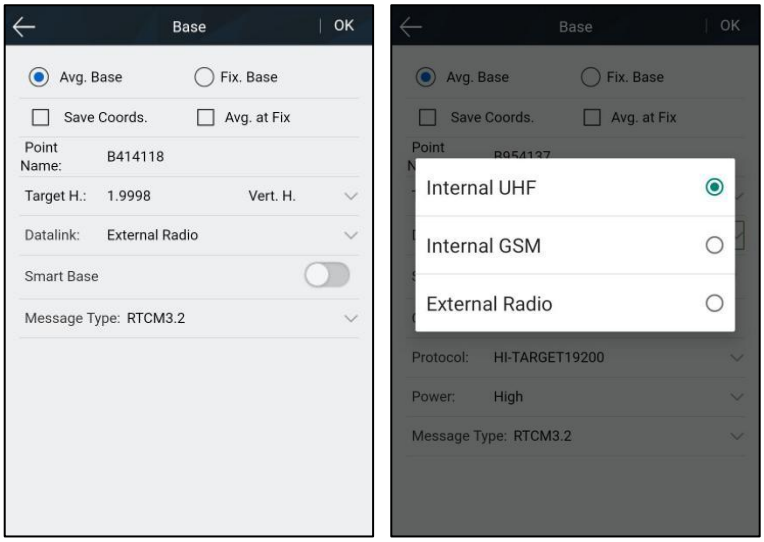



*Figure 2-3-14 Base*

3. Static

Set up the file name and parameters of the static collection.

Note: After ticking Static Mode, you can only cancel it in the base rover setting interface.

*Figure 2-3-15 Static*

### 2.3.4 File manager

1. Static data

Display the static data files, which support the options of Download, Delete and Format.

Note: After checking the "Static Mode", you can only uncheck the "Static Mode" in the base station mode or rover mode.

*Figure 2-3-16 Static data*

### 2.3.5 Firmware

1. Upgrade

Display specific device version information. Click Select, choose the upgrade package and then click Start. The receiver will automatically detect and upgrade the firmware.

*Figure 2-3-17 Upgrade*

2. Restore

You can restore the system to its state after the last firmware upgrade.

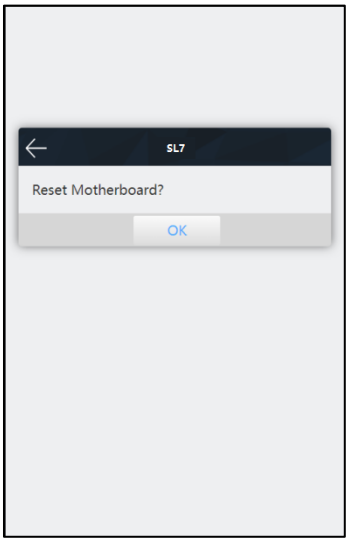



*Figure 2-3-18 Restore*

### 2.3.6 System

1. Constellation

Switches of the satellite tracking.

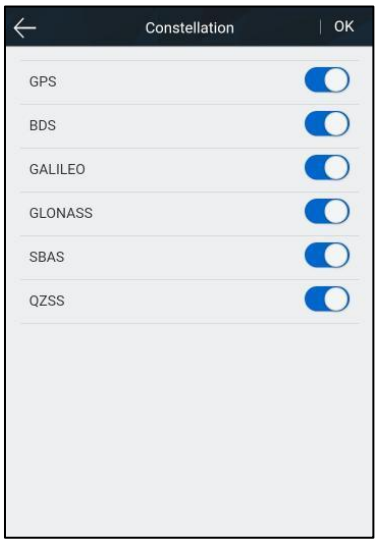



*Figure 2-3-19 Constellation*

2. Radio

You can select the radio modulation protocol from HI-TARGET19200, HI-TARGET9600, TRIMTALK450S, TRIMTALK III, SATEL-3AS, SOUTH19200, SOUTH9600, CHC19200, CHC9600, TRANSEOT.

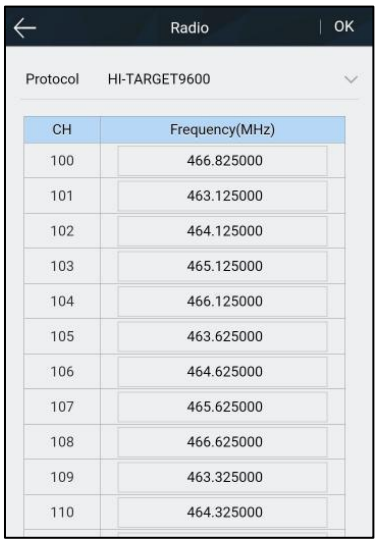



*Figure 2-3-20 Radio*

3. Registration

Display the registration information of the receiver. You can select the registration type, and then enter the corresponding code to register online.

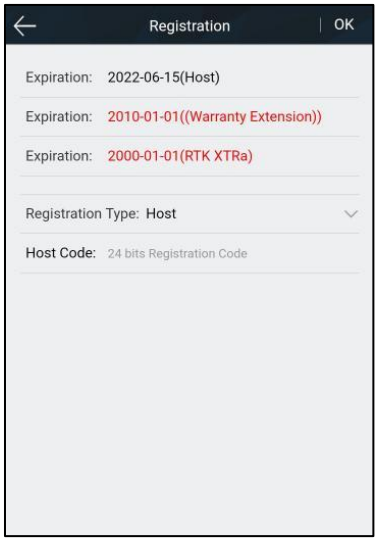



*Figure 2-3-21 Registration*

4. Reset

Reset the motherboard.

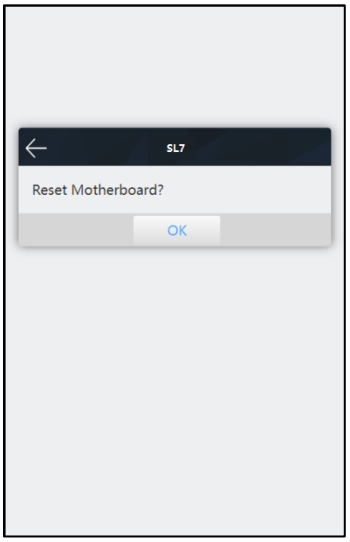



*Figure 2-3-22 Reset*

5. Others

You can set the switches of the Store RINEX Data and Check Base Position, select the RINEX version, and adjust the voice volume of the receiver.

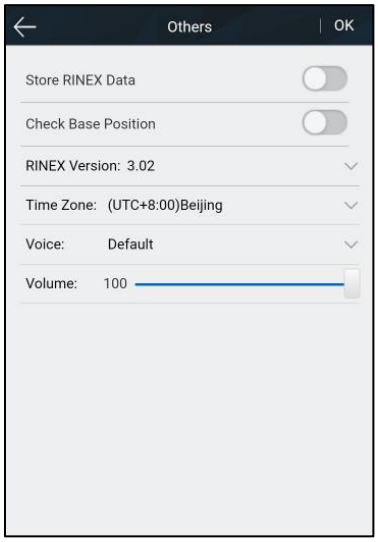



*Figure 2-3-23 Others*

### 2.3.7 Coordinate System

1. Projection

Configure planar projection parameters, such as projection model, central meridian, and scale factor.

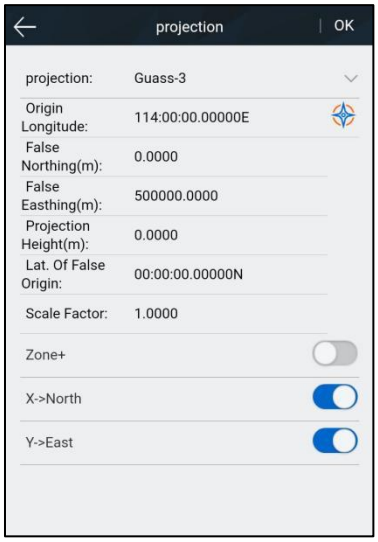



*Figure 2-3-24 Projection*

2. Datum

Configure the geodetic coordinate system of the source and target ellipsoids, and optionally the transformation model of both.

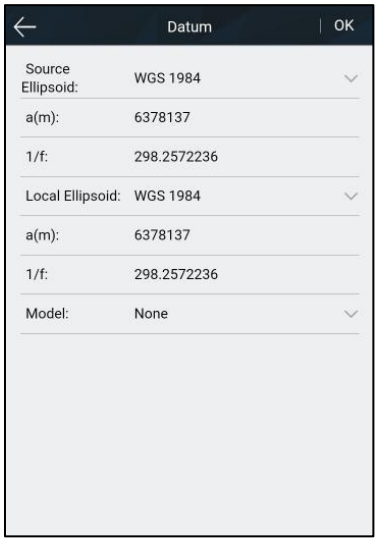



*Figure 2-3-25 Datum*

3. DAM File

Import and export coordinate system configuration parameters in the format of the dam that can be linked to the controller Satsurv's coordinate system.

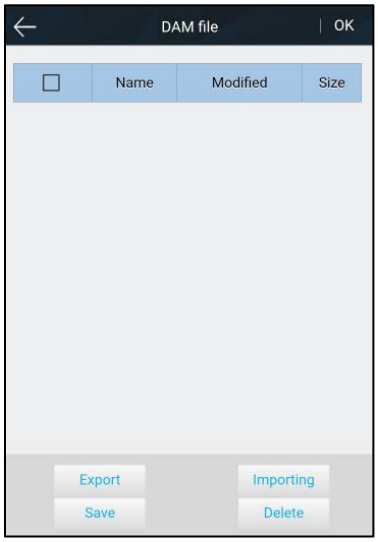



*Figure 2-3-26 DAM File*

## 2.4 Static survey

The static survey is a kind of positioning survey, which is mainly used to establish various control networks.

### 2.4.1 Static settings

There are two ways to set up the device to work in the static mode:

1. Satsurv software – static interface – to set up the static or temporary static mode.

2. Web interface – work mode – to set up the static or temporary static mode.

Users can download the static data file to the computer, if necessary, and then use the static post-processing software (HBC data processing software package) to process the data.

### 2.4.2 Static data collection steps

1. Set up the receiver on a control point with a tripod, making sure the tripod is strictly centered and leveled. The benchmark must be installed.

2. Measure the slant height of the receiver three times in three directions, ensuring that the difference of each measurement is less than 3mm, and then take the average value as the final height. The slant height of the receiver is measured from the center of the measuring point to the upper part of the top of the benchmark.

3. Record the point name, S/N, receiver height and beginning time.

4. Press the power button to power on and set up the static collecting mode.

5. Turn off the receiver after the static data is collected and record the turn-off time.

6. Download and process the static collection data.

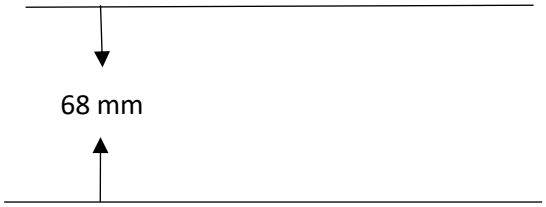



*Figure 2-4-1 Height*

**Notice**: Don't move the tripod or change the collecting set while the receiver is collecting data.

### 2.4.3 Static Data Download

1. Download by USB cable

Connect the receiver to a computer with the Type-C USB cable and copy the static data to the computer. The static data is in the GNSS folder of the static drive.

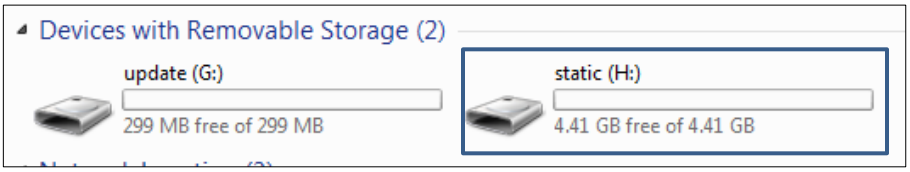



*Figure 2-4-2 Static Drive*

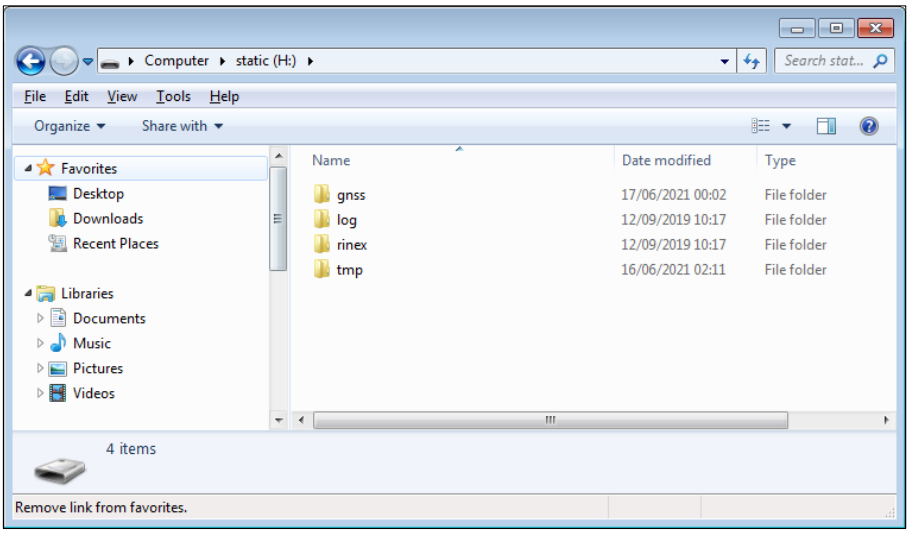



*Figure 2-4-3 Static Drive*

2. Download in the web management system

The Wi-Fi name of the receiver is its S/N. You can connect it to a controller or phone (the default password is: 12345678) and then input the IP address 192.168.20.1 into the browser to log into the WEB management system. Then, open the file manager interface and select the static file that needs to be exported. Click Download and the file can be downloaded to the controller or phone.

The default save path of the static data to be downloaded from the website is device internal storage > MyFavorite. You can customize the save path according to your needs.

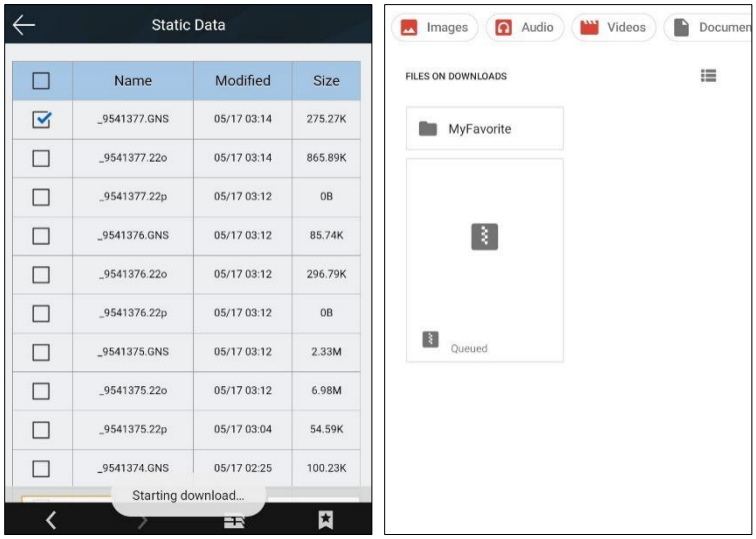



*Figure 2-4-4*

## 2.5 Tilt Survey

### 2.5.1 Calibration-free Tilt Survey

Connect the receiver in the Satsurv software and open the Tilt Survey in the option at Survey → Surveying Configure → Data interface. Click the Tilt Survey icon and follow the prompt on the Satsurv interface to finish the initialization.

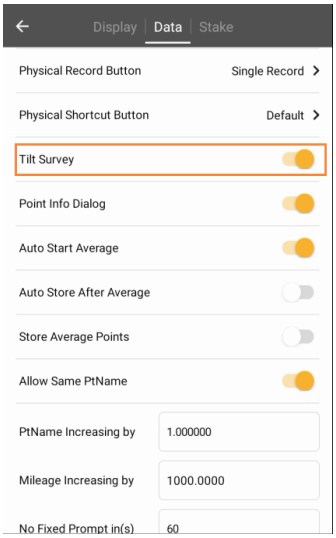



*Figure 2-5-1 Tilt Survey*

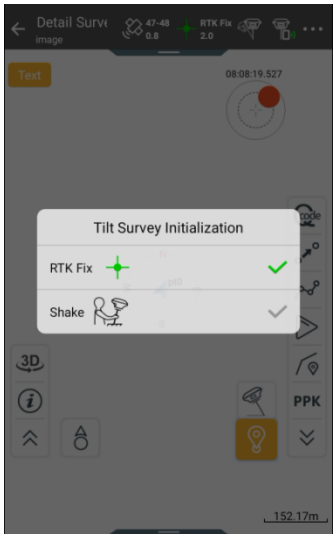



*Figure 2-5-2 Shake*

Shake the receiver back and forth (once every second) for initialization until Shake is marked with

When all of the initialization items are ticked, the receiver prompts “Tilt compensation started” and the tilt survey icon becomes illuminated. This means that the tilt survey initialization is now complete and you can perform the tilt survey on the receiver.

**Notice**: Don't move the tripod or change the collecting set while the receiver is collecting data.

1. Make sure the pole height is consistent with the set pole height before the tilt survey.

2. When turning on the Tilt Survey switch, you will need to complete the initialization operation before normal use.

3. To meet most users' operational needs, the maximum measurement angle of the tilt survey is 70°.

4. To ensure measurement accuracy, do not turn the device quickly during the measurement process.

5. Data quality is not as good in an occluded environment. If accuracy requirements are high, please try to use this function in an open environment.

6. When you enter the tilt survey for the first time every 7 days, you need to complete the static calibration according to the prompts you receive. Let the device stand for about 10 seconds to complete this.

## 2.6 Firmware Upgrade

You can upgrade the firmware of the receiver, motherboard and module by using a USB cable, the web management system or online remotely.

### 2.6.1 Upgrade by USB Cable

Steps to using a USB cable in order to upgrade the firmware:

1. Turn on the receiver and connect it to a computer with the cable attached. This will show the updated drive in the receiver.

2. Copy the firmware (which can be downloaded from our official website or the technical team) to the receivers update drive. Disconnect the computer and restart the receiver, which automatically recognizes the firmware and starts the firmware upgrade process.

3. There will be different prompt voices for the success or failure of the upgrade. If it fails, please contact our technical team.

*Figure 2-6-1 Update Drive.*

### 2.6.2 Upgrade by Using the Web Management System

Copy the firmware to the controller or phone and use Wi-Fi to connect it to the receiver. The name of the Wi-Fi is the device's S/N. Then, input 192.168.20.1 to log in, click Firmware upgrade - Select - File to choose the firmware, and then click start to transfer the new firmware version.

---

**Notice**:

1. When the download fails, it will resume downloading if the network recovers within two minutes; otherwise, it will exit the firmware upgrade detection.

2. It will not forcibly power off during the upgrade. If the power is forcibly cut off, the instrument may be damaged and become abnormal.

---

## 2.7 AR Stake

SL7 supports AR stakeout function. The iHand55 controller and the software Satsurv V3.0.2 or later versions are required.

The AR stakeout scene is defined as when the stakeout point is approximately 3m from the receiver, the camera of the receiver is called, and the precise position of the stakeout point is displayed in real time through the controller.

### 2.7.1 AR Stake Instructions

1. Device Preparation

Preparation before AR stakeout:

(1) Use the iHand55 controller to connect the SL7 via WIFI;

(2) The receiver has entered the tilt survey mode;

(3) The solution state is fixed solution.

2. Stakeout Process

After entering the point stakeout interface:

(1) Input the stakeout point;

(2) Click the AR stakeout button

;

(3) Complete the prompts for the stakeout;

(4) The stakeout is successful.

Click the AR stakeout button, when the distance from the stakeout point is > 3m, use the control AR stakeout (control navigation); if the distance from the stakeout point is less than or equal to 3m, switch to the AR stakeout (receiver navigation).

*Figure 2-8-1 Control Navigation*

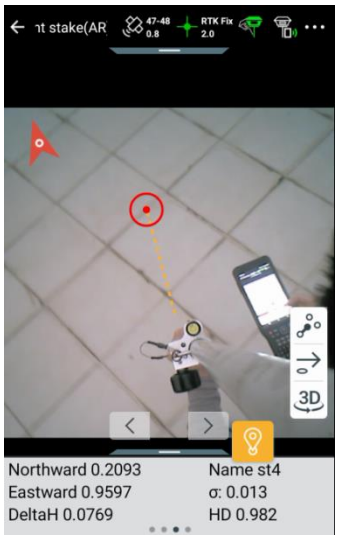



*Figure 2-8-2 Receiver Navigation*

For detailed steps, please refer to ‘Satsurv Software User Manual’ - Point Stakeout (AR Stakeout).

# Chapter 3

## Technical Specification

**This chapter contains:**

-Technical Specification

## 3.1 Technical Parameters

*Table 3-1-1 Technical Parameters*

| Configuration | | Detailed Indicators |
|---|---|---|
| GNSS configuration | Channels | 1408 |
| | Satellite signals are tracked simultaneously[1] | BDS: B1I, B2I, B3I, B1C, B2a, B2b* |
| | | GPS: L1C/A, L1C, L2P(Y), L2C, L5 |
| | | GLONASS: L1, L2 |
| | | GALILEO: E1, E5a, E5b, E6* |
| | | QZSS: L1, L2, L5, L6* |
| | | IRNSS: L5* |
| | | SBAS: L1C/A, L5 |
| | Output format | ASCII: NMEA-0183, Binary data |
| | Positioning output | 1~20Hz |
| | Static data format | GNS and RINEX |
| | Message type | RTCM2.X, RTCM3.X |
| | Network mode | VRS, FKP, MAC;<br>Supports NTRIP protocol |
| System configuration | Operating system | Linux system |
| | Data storage | 8G internal storage;<br>Supports automatic cyclic storage of static data |
| Accuracy and reliability[2] | RTK position precision | Horizontal: ± (8+1×$10^{-6}$D) mm<br>(D is the distance between measurement points) |
| | | Vertical: ± (15+1×$10^{-6}$D) mm<br>(D is the distance between measurement points) |
| | Static measurement precision | Horizontal: ± (2.5+0.5×$10^{-6}$D) mm<br>(D is the distance between measurement points) |
| | | Vertical: ± (5+0.5×$10^{-6}$D) mm<br>(D is the distance between measurement points) |
| | | Horizontal: ± 0.25m+1ppm |

| | | |
|---|---|---|
| | DGPS position precision | Vertical: ± 0.50m+1ppm |
| | SBAS position precision | 0.5m |
| | Tilt survey precision[3] | Less than 8mm+0.7mm/°tilt (2.5cm accuracy in the inclination of 60°) |
| | AR stake precision | Typical accuracy: 2cm |
| | AR measurement precision | 2cm ~ 4cm |
| | Initialization time | 2-10s |
| | Initialization reliability | ＞99.99% |
| | Breakpoint continuity test | Provides RTK measurements even with differential signal interruptions |
| Camera | Pixel | Professional dual HD cameras: 2MP & 5MP |
| | Function | Support live view stakeout, image measurement, working distance 2~15m |
| Data communication | I/O ports | USB type C interface, SMA interface. |
| | Cellular Mobile | Full band support for cellular mobile network<br><br>LTE FDD:B1/B3/B5/B7/B8/B20 LTETDD:B38/B40/B41<br>WCDMA:B1/B5/B8<br><br>GSM:850/900/1800/1900MHz |
| | Wi-Fi | 802.11 b/g access point and client mode for WiFi hotspot service |
| | Bluetooth | Bluetooth® 4.0/2.1+EDR, 2.4GHz |
| | Internal UHF | Power: 0.5W/1W/2W (adjustable) |
| | | Frequency: 410MHz~470MHz |
| | | Protocol: HI-TARGET, TRIMTALK450S, TRIMMARK III, TRANSEOT, SATEL, CHC, SOUTH |
| | | Channels: in total: 116, 16 configurable |
| Sensors | Tilt survey | Built-in high-precision inertial guidance, automatic attitude compensation |

| | | |
|---|---|---|
| User interface | Button | Power button*1 |
| | LED prompt light | 3 LED lights: satellite light, data light, power button |
| Functional applications | Advanced features | NFC flash connection, WebUI interaction, firmware upgrade by U disk |
| | Intelligent application | Intelligent voice |
| | Remote service | Message push, online upgrade |
| Physical | Host battery | High-capacity lithium battery 6900mAh.<br>Working time longer than 15 hours[4] |
| | External power supply | USB 15W charging |
| | Size | Φ130mm×79mm |
| | Weight | ≤0.97kg |
| | Power consumption | 2.6 W |
| | Material | The housing is made of magnesium alloy |
| Environment | Water/dustproof | IP68 |
| | Drop test | Resist natural fall from a 2-meters-high measuring rod |
| | Relative humidity | 100% non-condensing |
| | Operation temperature | -45°C ~ +75°C |
| | Storage temperature | -55°C ~ +85°C |

**Notice**:

1. BDS B2b, GALILEO E6, QZSS L6, and IRNSS L5 are available through firmware upgrades.
2. The measurement accuracy, precision, reliability and initialization time depend on various factors, including tilt angle, number of satellites, geometric distribution, observation time, atmospheric conditions and multi-path validation. The data is derived under normal conditions.
3. Irregular operations such as rapid rotation and high-intensity vibration may affect the inertial guidance accuracy.
4. The battery operating time is related to the operating environment, operating temperature and battery life.

# Chapter 4

## Accessories and Interface

**This chapter contains:**

- Data cable
- Antenna
- Battery & charger

## 4.1 Data cable

Type-C cable: Used to connect the receiver to a PC for upgrading firmware and downloading static data.

*Figure 4-1-1 Type-C cable*

## 4.2 Antenna

The UHF radio antenna is used in the Internal UHF mode.

*Figure 4-2-1 Radio Antenna*

## 4.3 Battery & charger

1. Battery: The receiver has a built-in 6900mAh/7.2V battery.

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**Notice** : If the battery needs to be stored for a long time, it should be charged to about 70% and then placed in a dry, low-temperature environment. It is recommended that you charge and discharge the battery every 3 months. If you do not have the conditions that are needed for charging and discharging, take out the battery after 3 months and charge it to about 70% before storing it once more.

---

2. Charger: To charge the receiver, use the standard charger. When it is in charge, the power button light will turn red.

*Figure 4-3-1 Cable and Charge*

**Notice**: Please use this product's standard charger to charge the receiver. We will not be responsible for any accidents that occur during the charging process or any damage to the instrument if you use other chargers instead.