Hi-Target

Surveying the World,Mapping the Future

V500 GNSS RTK System

User Manual

Manual Revision

Revision Date	Revision Level	Description
June. 2023	1	V500 GNSS RTK System User Manual

V500

GNSS RTK System

User Manual

Preface

Introduction

Welcome to the Hi-Target V500 GNSS receiver. This introduction describes how to use this product.

Experience requirement

To help you use the Hi-Target series products better, Hi-Target suggests that you read the instructions carefully. If you are unfamiliar with the products, please refer to *www.hi-target.com.cn*

Tips for safe use

Notice: The contents here are special operations and need your special attention. Please read them carefully.

Warning: The contents here are generally very important as the wrong operation may damage the machine. This can lead to the loss of data, or even 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. Hi-Target Surveying Instrument Co. Ltd assumes no responsibility if you fail to operate the product according to the instructions, or operate it wrongly because you have misunderstood them.

Hi-Target 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 the software & hardware without eliminating the possibility of deviation. The pictures in the operating instructions are for reference only. In the case of non-conformity with products, the products shall prevail.

Technology and service

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

Relevant information

You can obtain this introduction by:

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

Logging on to the Hi-Target official website and downloading the electronic version of this introduction from *Partner Center*: *http://members.hi-target.com.cn/*

Advice

If you have any suggestions for this product, please email them to: *sales@hi-target.com.cn*. Your feedback information will help us to improve the product and service.

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Chapter 1

Overview

This chapter contains:

- Foreword
- Features
- Use and precautions

1.1 Foreword

V500 GNSS receiver brings superior performance and high efficiency that will support your fieldwork with reliable solutions. Equipped with an upgraded high-definition starlight camera, V500 brings out an excellent visual stakeout experience in low-light conditions. The compact and lightweight design makes V500 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 V500 GNSS receiver is designed to have chemical and impact resistance, but precision instruments require careful use and maintenance.

Notice: 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.

In order 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 200m 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 Stakeout

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, 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

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

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

◇ Protective plug: Used for dustproof and waterproof sockets.

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 LED

2.2 Button & LED

2.2.1 Button function

Table 2-2-1 Button function description

Function	Description
Power-on	Long press the power button for 1 second.
Power-off	In the power-on state, long press the power button for more than 3 seconds but less than 6 seconds.
Forced shutdown（use when the device crashes）	Press the power button for at least 12 seconds.
Query current status	Press the power button once to voice the product's current working status.
Reset motherboard	When the device is powered on, long press the power button for 6 seconds and release it after hearing the second "dingdong" sound.
Switch working mode	Double-click the power button to enter the mode switch. After each double-click, switch to a working mode, and click the power button to confirm it.
One-key setting station	When the device is powered off, long press the power button for 6s to turn it on.

2.2.2 LED

Table 2-2-2 LED function description

Function	Status	Description
Power LED(red)	Long-term lighting	When the device is powered off, it is for charging the device.
	OFF	It is not charging or fully charged.
Power LED(green)	Flash	The power ≤10%.
	Long-term lighting	1. RTK mode: No correction data. 2. Static mode: Sampling has not started.

Data LED	Flash	1. RTK mode: Flashes at the frequency of the correction transmit and receives. 2. Static mode: Sampling interval >1s: Flashes at the sampling interval. Sampling interval ≤1s: Flashes once per second.
	Off	1. RTK mode: No correction data. 2. Static mode: Sampling has not started.
Satellite LED	Long-term lighting	Satellite is tracked.
	Flash	Satellite is not tracked.

2.3 WEB management system

V500 has a built-in web management system that can be used to set the receiver's working mode, 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) and then input the IP address *192.168.20.1* into the browser to log onto the web management system.

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 interface. Each option of the main menu contains drop-down menus.

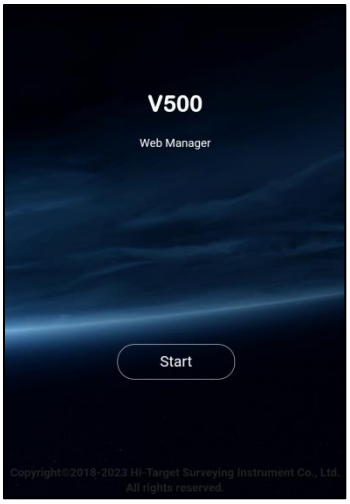


Figure 2-3-1 Home

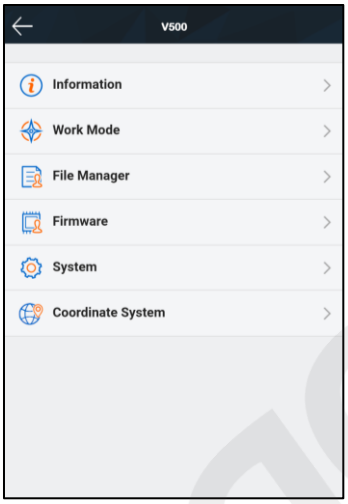


Figure 2-3-2 Main menu

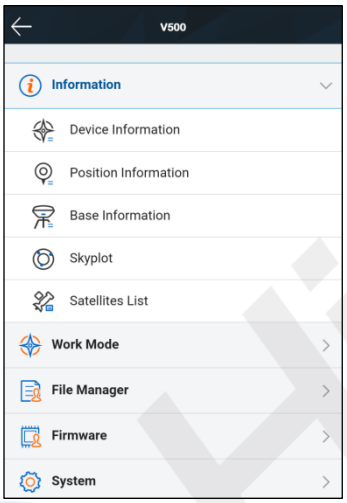


Figure 2-3-3 Information

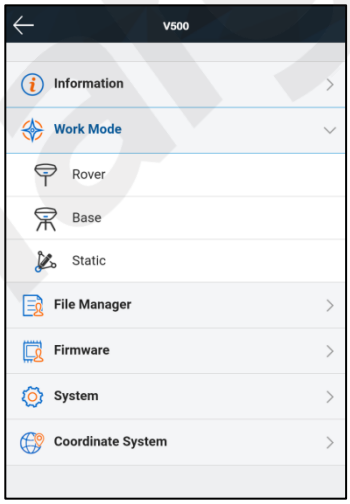


Figure 2-3-4 Work mode

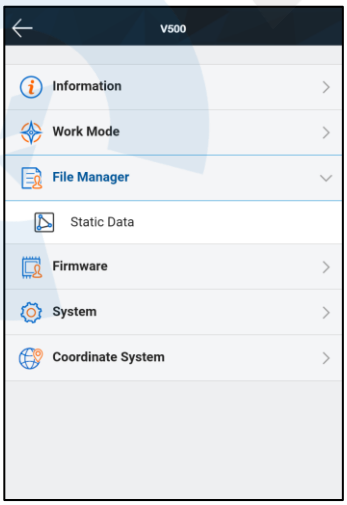


Figure 2-3-5 File manager

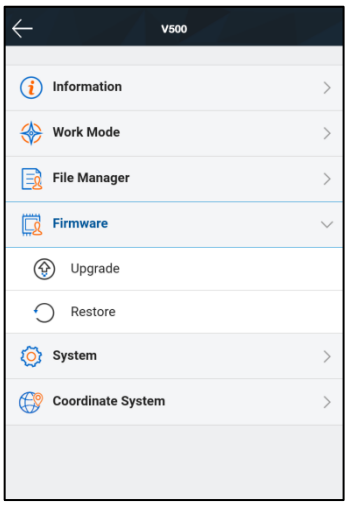


Figure 2-3-6 Firmware

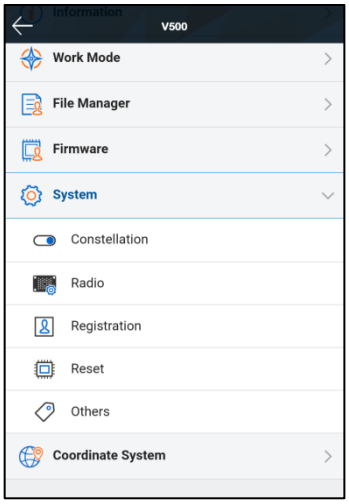


Figure 2-3-7 System

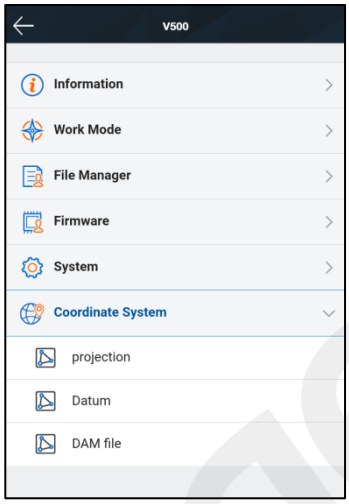


Figure 2-3-8 Coordinate System

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.
	Base info	Coordinates and distance to the base
	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 satellite tracking switches
	Five-pin port	Output settings of the five-pin
	Radio	Radio frequency list
	Reset	Reset the motherboard
	Registration	Device registration and information
	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

Includes the main information about the device: device model, S/N, firmware version, OEM info, battery power, work mode, configuration parameters, etc.

Figure 2-3-9 Device information

2. Position information

Includes the device's position, satellites, solution state, latency, PDOP and time, etc.

Figure 2-3-10 Position information

3. Base information

Includes the coordinates and distance of the base in the rover mode.

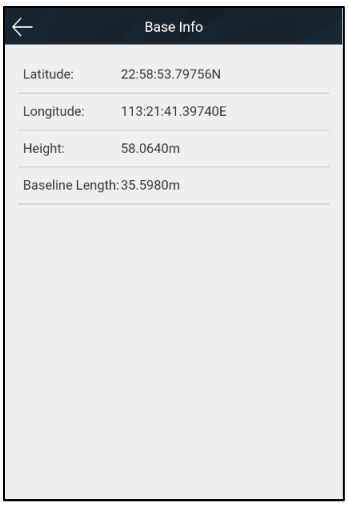


Figure 2-3-11 Base information

4. Sky plot

Displays the visual satellites of the device and the switches of each constellation.

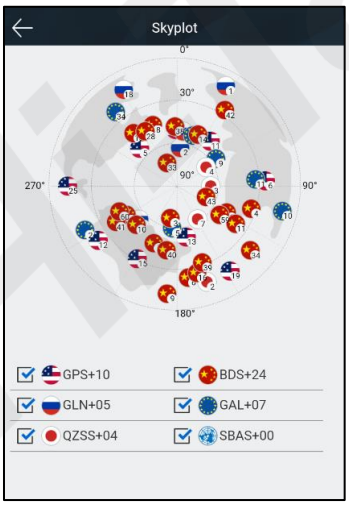
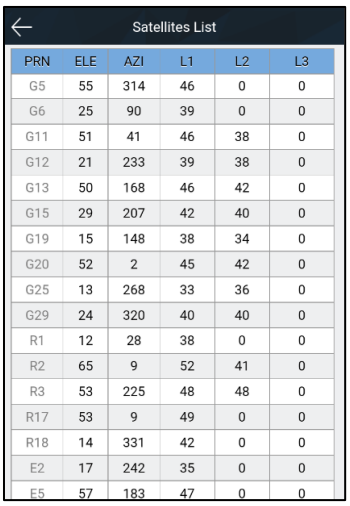


Figure 2-3-12 Sky plot

5. Satellites list

Shows the satellite's tracked information.



PRN	ELE	AZI	L1	L2	L3
G5	55	314	46	0	0
G6	25	90	39	0	0
G11	51	41	46	38	0
G12	21	233	39	38	0
G13	50	168	46	42	0
G15	29	207	42	40	0
G19	15	148	38	34	0
G20	52	2	45	42	0
G25	13	268	33	36	0
G29	24	320	40	40	0
R1	12	28	38	0	0
R2	65	9	52	41	0
R3	53	225	48	48	0
R17	53	9	49	0	0
R18	14	331	42	0	0
E2	17	242	35	0	0
E5	57	183	47	0	0

Figure 2-3-13 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.*

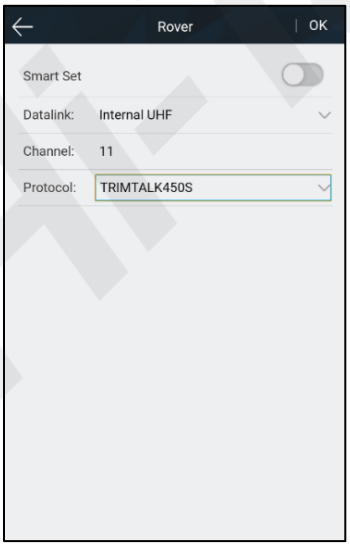


Figure 2-3-14 Rover

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.*

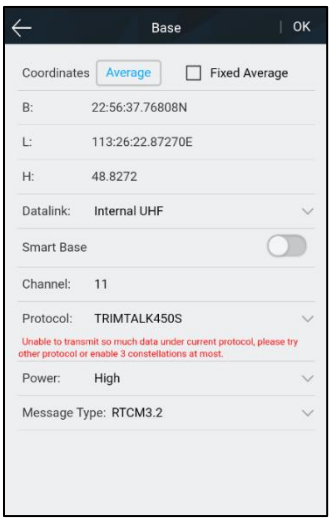


Figure 2-3-15 Base

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.

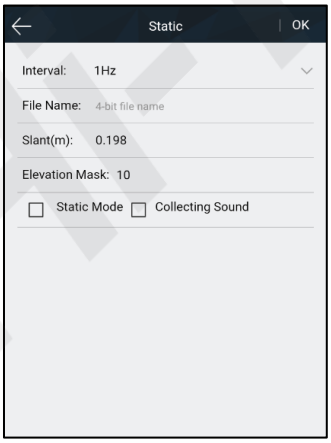


Figure 2-3-16 Static

2.3.4 File manager

1. Static data

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

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

Figure 2-3-17 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 it and upgrade the firmware.

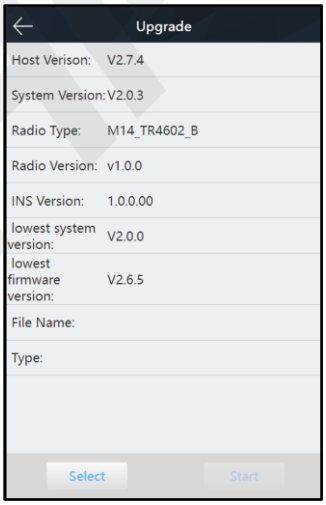


Figure 2-3-18 Upgrade

2. Restore

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

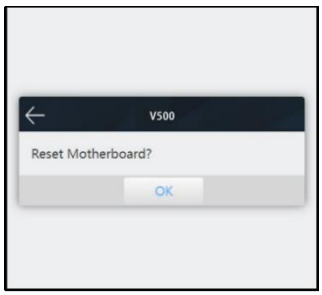


Figure 2-3-19 Restore

2.3.6 System

1. Constellation

Switches of the satellite tracking.

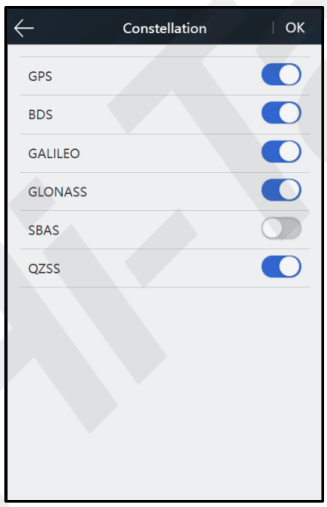


Figure 2-3-20 Constellation

2. Radio

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

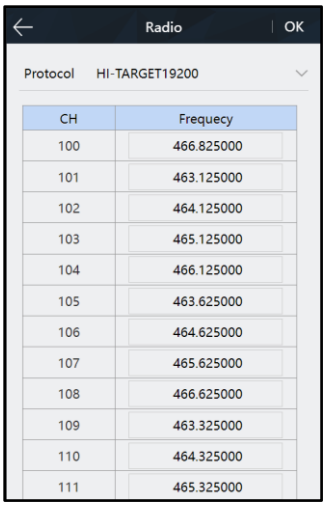


Figure 2-3-21 Radio

3. Registration

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

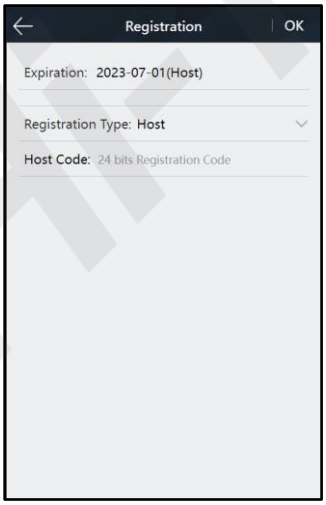


Figure 2-3-22 Registration

4. Reset

Reset the motherboard.

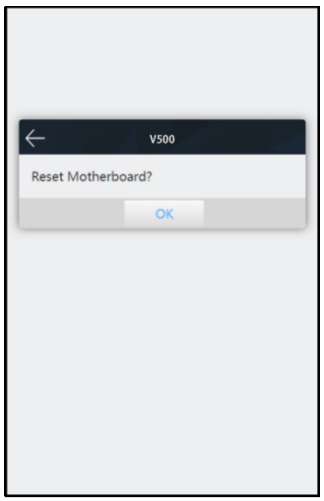


Figure 2-3-23 Reset

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.

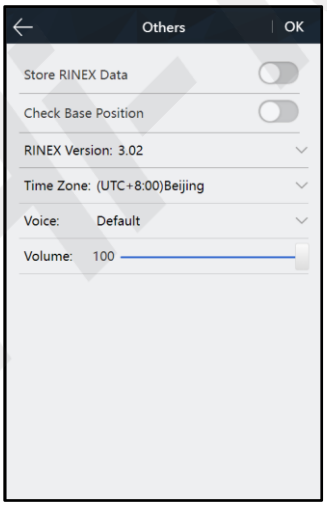


Figure 2-3-24 Others

2.3.7 Coordinate system

1. Projection

Frequently-used projections are built-in such as Gauss, Mercator and Lambert.

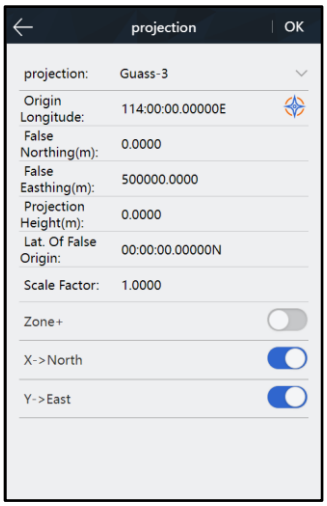


Figure 2-3-25 Projection

2. Datum plane

Users can define source ellipsoid, local ellipsoid and datum transfer model settings.

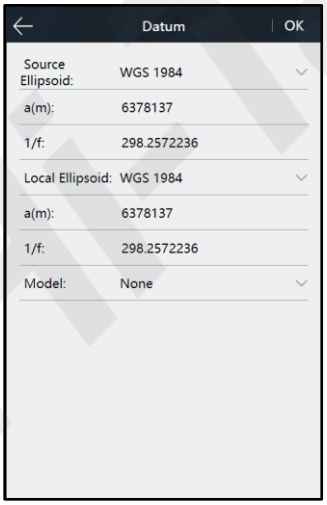


Figure 2-3-26 Datum

3. DAM file

Each software project corresponds to a separate '.dam' file and a new file will be created when a new project is created. This will have the same name as the project.

Figure 2-3-27 DAM File

2.4 Static survey

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. Hi-Survey 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.

(Note: The radius of the benchmark is 0.130m, and the benchmark's distance from the phase center of the receiver is 0.0848m.)

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 post-process the static collection data.

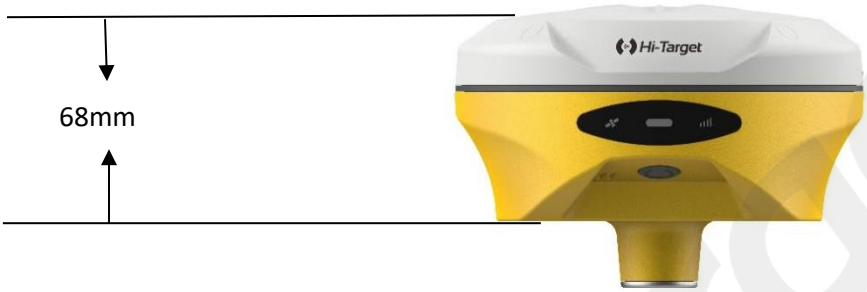


Figure 2-4-1 Height

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.

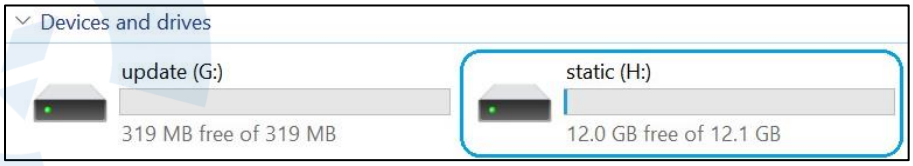


Figure 2-4-2 Static Drive

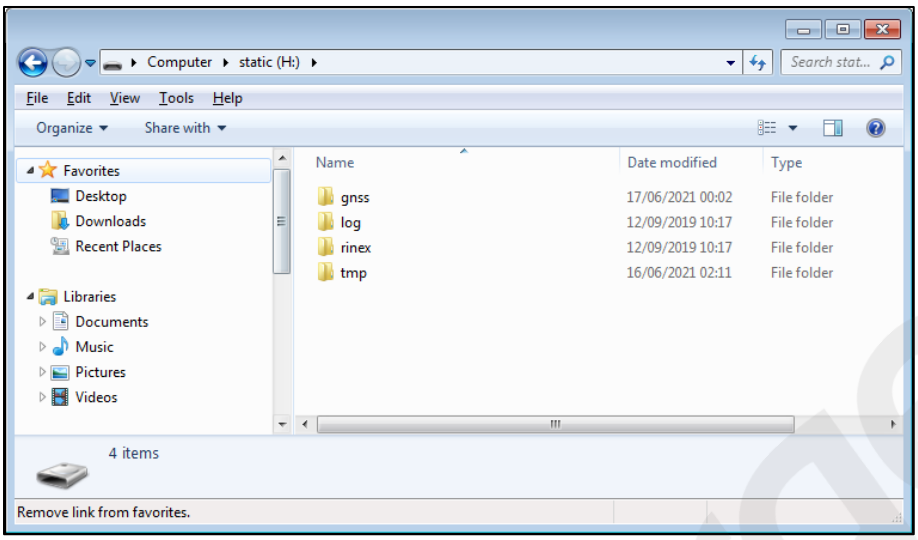


Figure 2-4-3 Static Drive

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. Now, 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.

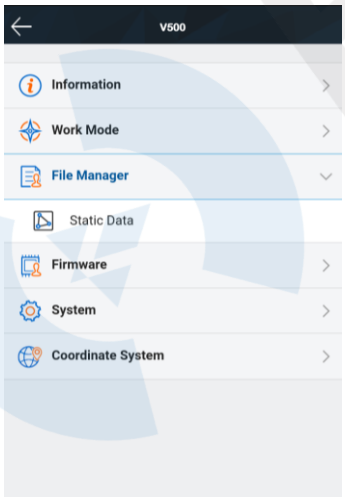


Figure 2-4-4

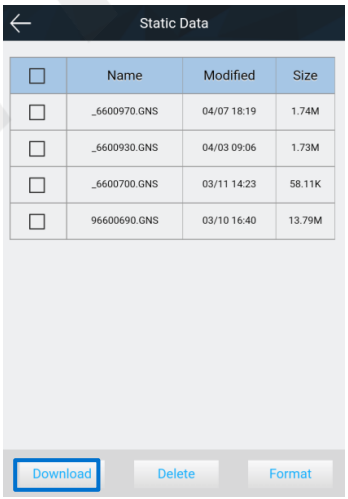


Figure 2-4-5

Figure 2-4-6

2.5 Tilt survey

2.5.1 Calibration-free tilt survey

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

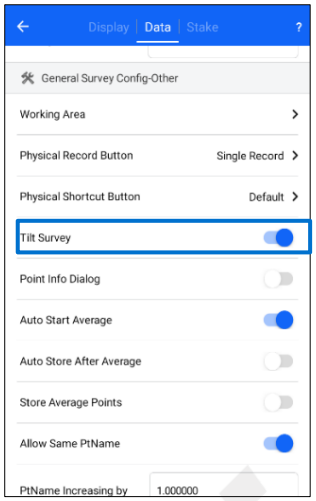


Figure 2-5-1 Tilt Survey

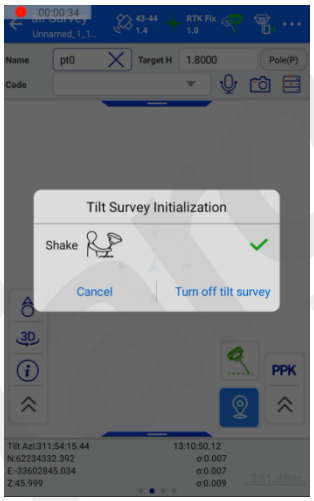


Figure 2-5-2 Shake

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:

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

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

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

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

5. The data quality is not good in the occluded environment. If the 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. Just let the device stand for about 10s 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 and remote online.

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 the receiver and the computer with the cable attached. This will show the update drive.

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

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. Now, input 192.168.20.1 to log in, click Firmware upgrade - Select - File to choose the firmware, and then click start to upgrade it.

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 Stakeout

V500 supports AR stakeout function. The iHand55 controller and the software Hi-Survey 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 Stakeout Instructions

1. Device Preparation

Preparation before AR stakeout:

(1) Use the iHand55 controller to connect the V500 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).

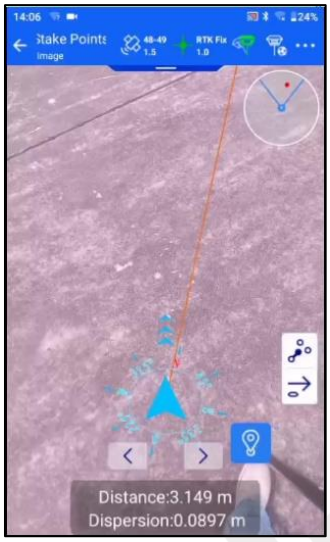


Figure 2-7-1 Control Navigation

Figure 2-7-2 Receiver Navigation

For detailed steps, please refer to ‘Hi-Survey 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 Signal[1]	Channel	1408
	GPS	L1C/A, L1C, L2P(Y), L2C, L5
	BDS	B1I, B2I, B3I, B1C, B2a, B2b
	GLONASS	L1, L2, L3
	Galileo	E1, E5a, E5b, E6*
	QZSS	L1, L2, L5, L6*
	IRNSS	L5*
	SBAS	L1, L2, L5
	L-BAND*	B2b-PPP*
Positioning Performance[2]	High-Precision Static	**Horizontal**: 2.5 mm + 0.1 ppm RMS **Vertical**: 3.5 mm + 0.4 ppm RMS
	Static and Fast Static	**Horizontal**: 2.5 mm + 0.5ppm RMS **Vertical**: 5 mm + 0.5ppm RMS
	Post Processing Kinematic (PPK / Stop & Go)	**Horizontal**: 8mm + 1ppm RMS **Vertical**: 15mm + 1ppm RMS Initialization time: Typically 10 min for base and 5 min for rover Initialization reliability: Typically>99.9%
	PPP	**Horizontal**: 10cm **Vertical**: 20cm
	Code Differential GNSS Positioning	**Horizontal**: ±0.25m+1ppm RMS **Vertical**: ±0.5m+1ppm RMS **SBAS**: 0.5m (H), 0.85m (V)
	Real Time Kinematic (RTK)	**Horizontal**: 8mm+1ppm RMS **Vertical**: 15mm+1ppm RMS **Initialization time**: Typically <10s **Initialization reliability**: Typically > 99.9%
	Time to first Fix	**Cold start**:< 45s **Hot start**:< 30s **Signal re-acquisition**:< 2s
	Hi-Fix[5]	**Horizontal**: RTK+10mm / minute RMS | **Vertical**: RTK+20mm / minute RMS
	Tilt Survey Performance[3]	Additional horizontal pole-tilt uncertainty typically less than 8mm+0.7mm/°tilt(2.5cm accuracy in the inclination of 60°)
	Image stakeout accuracy	1cm
	Dimensions (W x H)	130mm × 68mm

Physical	Weight	≤ 0.75kg (1.65lb)
	Operation temperature	-40℃~+75℃ (-40℉~+167℉)
	Storage temperature	-55℃~+85℃ (-67℉~+185℉)
	Humidity	100% non-condensing
	Water/dustproof	IP68 dustproof, protected from temporary immersion to depth of 1.0m (3.28ft)
	Shock and vibration	MIL-STD-810G, 514.6
	Free fall	Designed to survive a 2m(6.56ft) natural fall onto concrete
Electrical	Internal Battery[4]	Internal 7.4V / 6800mAh lithium-ion rechargeable battery
		RTK rover(UHF/Cellular): up to 24 hours
	External power	using standard smartphone chargers or external power banks (Support 5V 2.8A Type-C USB external charging)
Communication	I/O Interface	1 × USB type C port; 1 × SMA antenna port
	WiFi	Frequency 2.4GHz, Supports 802.11 a/b/g/n
	Bluetooth	BT 5.2, 2.4GHz
	Internal UHF Radio	Power: 0.5W/1W/2W Adjustable
		Frequence: 410MHz~470MHz
		Protocol: HI-TARGET, TRIMTALK450S, TRIMMARK III, SATEL-3AS, TRANSEOT, etc.
		Working Range: Typically 3~5km, optimal 8~15km
		Channel: 116 (16 scalable)
Camera	Function	Professional starlight night vision HD camera, large viewing angle, support live view stakeout
Control Panel	Physical button	1
	LED Lights	Satellite, Signal, Power
System Configuration	Storage	16GB ROM internal storage
	Output format	ASCII: NMEA-0183
	Output rate	1Hz~20Hz
	Static data format	GNS, Rinex
	Real Time Kinematic (RTK)	RTCM2.X, RTCM3.X
	Network Mode	VRS, FKP, MAC, Support NTRIP protocol

Notice:

[1]BDS B2b, GALILEO E6, QZSS L6, IRNSS L5 can be provided by firmware upgrade.

[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, etc. The data are derived under normal conditions.

[3]Irregular operations such as rapid rotation and high-intensity vibration may affect the inertial navigation accuracy.

[4]The battery operating time is related to the operating environment, operating temperature and battery life

[5]Accuracies are dependent on GNSS satellite availability. Hi-Fix Positioning ends after 5 minutes without differential data.Hi-Fix is not available in all regions, check with your local sales representative for more information.

Descriptions and Specifications are subject to change without notice

Chapter 4

Accessories and interfaces

This chapter contains:

- Data cable
- Antenna
- Battery & charger

4.1 Data cable

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

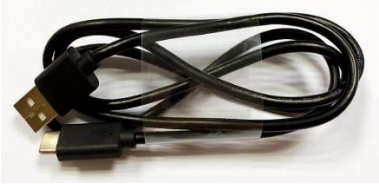


Figure 4-1-1 Type-C cable

4.2 Antenna

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

Figure 4-2-1 UHF radio antenna

4.3 Battery

1. Battery: The receiver has a built-in 6800mAh/7.4V battery.

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 charger

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.

Surveying the World,Mapping the Future

Frequency Band(s)

This device operates with the following frequency bands and maximum frequency power.

NOTE:

The product is compliant with these power limits required by the European Union. Frequency bands supported by the product vary by model.

WIFI: ＜ 20 dBm

BT: ＜ 10dBm

UHF: 2W Rated

GNSS, NFC,

EU DECLARATION OF CONFORMITY

Hereby, Hi-Target Surveying Instrument Co., Ltd. declares that GNSS RTK Receiver with model V500 is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following Internet address: https://en.hi-target.com.cn/.

FCC Caution

§15.19 Labeling requirements.

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

§15.21 Information to user.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

§15.105 Information to the user.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.

-Increase the separation between the equipment and receiver.

-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-Consult the dealer or an experienced radio/TV technician for help.

RF warning for mobile device:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 50cm between the radiator & your body.