

# LUKA GNSS Receiver

## User Manual



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## Revision History

| Version | Revision Date | Change Summary     |
|---------|---------------|--------------------|
| 1.0     | 20230208      | Initial Release    |
| 1.1     | 20230414      | Update Figures     |
| 1.2     | 20230614      | Update Section 3.1 |

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# Safety Information

Make sure that you have read and understood all safety requirements before you start using Tersus product.

## Conventions

The following conventions are used in this manual:

|                                                                                   |                                                                                                                               |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| !                                                                                 | Information that supplements or clarifies text.                                                                               |
|  | A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.                     |
|  | A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage. |

The following notices apply to LUKA GNSS receivers.

|                                                                                     |                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | Operating or storing the receiver outside the specified temperature range can damage it.                                                                                                                                                                                                      |
|  | Changes or modifications to this equipment not expressly approved by Tersus could void the user's authority to operate this equipment or even has risk to damage the receivers.                                                                                                               |
|  | DO NOT use the receiver in a thunderstorm as there is increasing risk of being stuck by lightning.                                                                                                                                                                                            |
|  | Install the radio antenna before switching the radio transceiver to transmit mode, or the radio transceiver may be damaged due to overheating. The energy to be transmitted cannot be emitted out without the antenna, which may cause the temperature rise and overheat of the radio module. |

**Safety: exposure to radio frequency (RF)**

Exposure to RF energy is an important safety consideration. Although our product is compliance with the safety standard released by various standard organizations, the following precautions are recommended to ensure low exposure to radio frequency radiation.

- DO NOT operate the transmitter when someone is within the following distances of the antenna:
  - Bluetooth, Wi-Fi, GSM/UTMS – less than 20cm
  - 410-470MHz UHF radio – less than 47cm
- DO NOT operate the transmitter unless all RF connectors are secured and any open connectors are properly terminated.
- DO NOT operate the equipment near electrical blasting caps or in an explosive atmosphere.
- All equipment must be properly grounded.
- All equipment should be serviced only by a qualified technician.

## Notices

### CE Marking

Tersus GNSS Inc. declares that LUKA GNSS receiver is in compliance with the essential requirements (radio performance, electromagnetic compatibility and electrical safety) and other relevant provisions of Radio Equipment Directive 2014/53/EU, Electromagnetic Compatibility (EMC) Directive 2014/30/EU, and Low voltage (LVD) Directive 2014/35/EU. Therefore the equipment is labeled with the following CE-marking.



The Declaration of Conformity may be obtained from Tersus GNSS Inc.

### Waste Electrical and Electronic Equipment (WEEE)



This product must not be disposed with household waste.

Dispose of the product appropriately in accordance with the national regulations in force in your country.

Always prevent access to the product by unauthorised personnel.

Product-specific treatment and waste management information can be received from your local Tersus distributor.

## Related Documentation

Table 0.1 Document and software used in this user manual

| Name                    | Description                                                                                                         | Link                                                                                                      |
|-------------------------|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| Tersus Tool Suite       | Tersus Tools including TersusDownload, TersusGeoPix, TersusGNSSCenter, TersusUpdate, TersusRinexConverter           | <a href="https://www.tersus-gnss.com/software">https://www.tersus-gnss.com/software</a>                   |
| Nuwa                    | Survey application running in the Android platform, David, LUKA and other NMEA devices can be configured with Nuwa. | <a href="https://www.tersus-gnss.com/software/software">https://www.tersus-gnss.com/software/software</a> |
| Tersus Geomatics Office | Post processing tool for static data.                                                                               | <a href="https://www.tersus-gnss.com/software/software">https://www.tersus-gnss.com/software/software</a> |

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# 1. Introduction

This chapter includes overview, receiver features, and devices in the package.

## 1.1 Overview

The LUKA GNSS Receiver is a new generation GNSS RTK system, which is small and light, easy to carry and operate. It supports calibration-free tilt compensation function which is immune to magnetic disturbances, leveling pole is not required. With an internal high-performance multi-constellation and multi-frequency GNSS board, the LUKA GNSS Receiver can provide high accuracy and stable signal detection. The high-performance antenna can speed up the time to first fix (TTFF) and improve anti-jamming performance. The built-in 7000mAh large capacity battery supports up to 19 hours of field work in 4G/3G/2G network and Rover radio mode. The built-in UHF radio module supports long distance communication. The rugged housing protects the equipment from harsh environments.

There are four versions of the LUKA GNSS Receiver, which can provide selectivity for the requirement from different users.

## 1.2 Receiver features

The LUKA GNSS receiver has following features:

- Supports multiple constellations & frequencies
  - GPS L1, L2, L5
  - GLONASS L1, L2
  - BeiDou B1I, B2I, B3I, B1C, B2a
  - Galileo E1, E5a, E5b
  - QZSS L1, L2, L5
- Supports 1568 channels.
- Supports 410-470MHz UHF radio<sup>(1)</sup>, 4G network, Wi-Fi, Bluetooth, NFC
- Tilt compensation without calibration, immune to magnetic disturbances<sup>(1)</sup>
- The whole design is exquisite and compact, which is more convenient to carry and operate
- 8GB internal storage
- Up to 19 hours working in 4G/3G/2G network and Rover radio mode<sup>(2)</sup>
- IP68-rated dust- & waterproof enclosure, for reliability in harsh environmental conditions
- Free subscription of Tersus Caster Service (TCS): transmit the correction data from LUKA Base to Rover

Note:

(1) IMU and built-in radio are optional.

(2) The working time of the battery is related to the working environment, working temperature and battery life.

## 1.3 Devices in the package

The devices in the package may vary according to the customer requirement. Here describes the major parts in the package.

### 1.3.1 LUKE GNSS receiver

The LUKE GNSS receiver shown as below.



Figure 1.1 LUKE GNSS receiver

#### Buttons

One button is equipped on each version of LUKE GNSS receiver.

: Power ON/OFF button. When the device is off, long press it for 2 seconds to power on the receiver. When the receiver is on, long press it for over 3 seconds to power off the receiver.

#### LED Indicators

Six LED indicators are for LUKE GNSS receiver, smart battery with power display on the bottom. The LEDs on the front panel indicate various operating conditions. The detailed LED Descriptions are shown in the tables below.

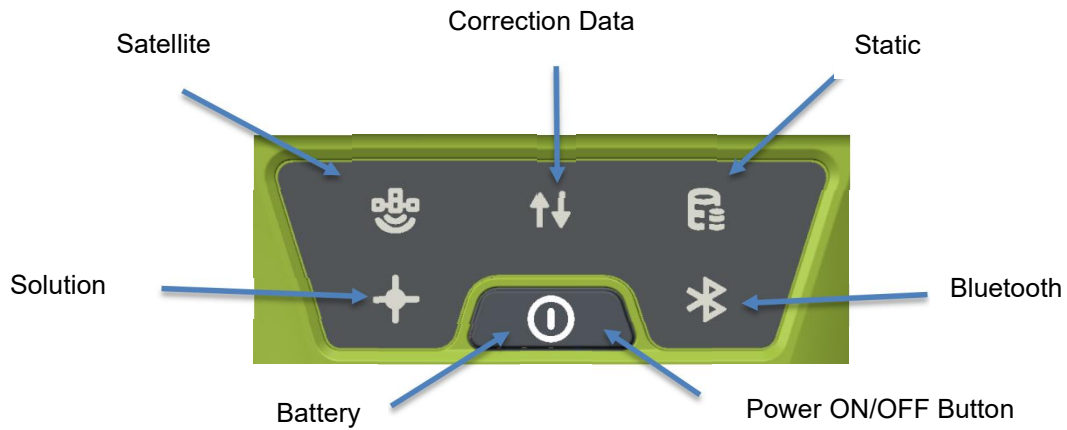


Figure 1.2 Button and LEDs on LUKA GNSS receiver

Table 1.1 LED indicators

| LED indicator                                                                                          | Description                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br>Satellite         | Green LED. Flashing every 5 seconds indicates that it is searching satellites. After satellites are searched, it flashes N times every 5 seconds, in which N indicates N satellites are found.       |
| <br>Correction data | Green LED indicates correction data.                                                                                                                                                                 |
| <br>Static Survey   | Green LED indicates static survey mode.                                                                                                                                                              |
| <br>Solution status | Green LED. Steady green indicates fixed solution, flashing 1Hz indicates floating solution, off light for other solutions.                                                                           |
| <br>Bluetooth       | Green LED indicates Bluetooth status. Steady green indicates successful Bluetooth pair, off light indicates no Bluetooth paired.                                                                     |
| <br>Battery         | Green LED. Steady green in normal operation. Slow flash indicates the battery level is between 20% and 10%. Fast flash indicates the battery level is below 10% and reminds users to change battery. |

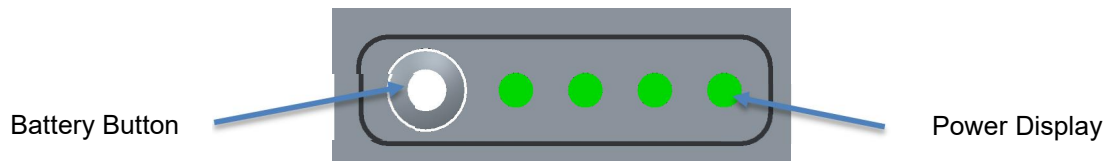


Figure 1.3 Smart battery with power display

Table 1.2 Power display and button

| LED indicator  | Description                                                                                                                                                     |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Battery Button | After clicking the battery button, the green light will be on to display the current remaining power.                                                           |
| Power Display  | Green LED. Under normal circumstances, one indicator represents 25% of the power. When charging, the green light flashes to display the current charging power. |

## LED Flash Patterns

The possible flash patterns of various states of receiver operation are listed in the table below.

Table 1.3 LED flash patterns

| Receiver mode        | Button operation                   | LED flash patterns                                                                                  |
|----------------------|------------------------------------|-----------------------------------------------------------------------------------------------------|
| Receiver OFF         | Long press the power button for 5s | All LEDs are off.                                                                                   |
| Receiver ON          | Long press the power button for 2s | All LEDs are on, then all off, and each LED starts to indicate current status after initialization. |
| Low power            | N/A                                | Battery LED flashes slow.                                                                           |
| Battery exhausting   | N/A                                | Battery LED flashes fast.                                                                           |
| Searching satellites | N/A                                | Satellite LED flashes every 5s.                                                                     |
| Satellites tracked   | N/A                                | Satellite LED flashes N times every 5s, in which N is the quantity of satellites tracked.           |

|                             |     |                                                                                                                                                                                                                                                                                    |
|-----------------------------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Receiving valid data packet | N/A | Correction data LED flashes green at 1Hz.                                                                                                                                                                                                                                          |
| Fixed solution              | N/A | Solution status LED is steady green.                                                                                                                                                                                                                                               |
| Floating solution           | N/A | Solution status LED flashes green at 1Hz.                                                                                                                                                                                                                                          |
| Firmware upgrade            | N/A | all six LEDs are on for 3s thereafter only power LED lights up, then all LEDs light up and flashes in turn when upgrading, lights off when restarting. Then all six LEDs light up for 1s thereafter only power LED lights up means it restarts successfully with updated firmware. |

**Note:** N/A means Not Applicable.

## Receiver Ports

The bottom of LUKA receiver is shown as below.

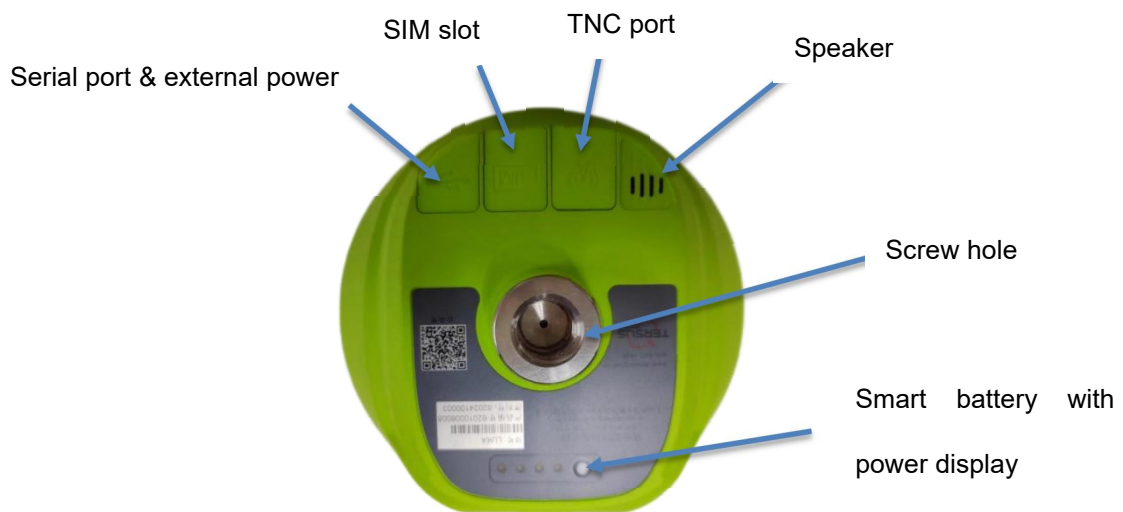
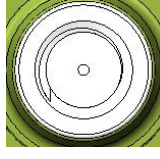


Figure 1.4 Bottom of LUKA GNSS receiver

Table 1.4 Receiver ports on the bottom side

| Icon                                                                              | Name                         | Connections                                                                |
|-----------------------------------------------------------------------------------|------------------------------|----------------------------------------------------------------------------|
|  | Serial port & external power | Device, computer, USB drive, external power, communication, external radio |
|  | SIM slot                     | Nano SIM card                                                              |
|  | TNC port                     | 410-470MHz radio antenna                                                   |
|  | Screw hole                   | 5/8" x 11 UNC-2B connector for corresponding connector and pole.           |

### 1.3.2 Type-C to USB cable

Functions:

1. Connect to the USB port of computer for data downloading;
2. Firmware upgrade, details refer to section 2.4;
3. Connect to the charger adapter to charge LUKA. Charge the battery completely before using LUKA for the first time. The charging takes approximately 3 hours at room temperature. If the battery has been stored for longer than three months, charge it before use.



Figure 1.5 Type-C to USB cable

### 1.3.3 Adapter

Connect to the Type-C cable to charge LUKA. The maximum power can reach 15W(5V 3A), realizing fast charging.



Figure 1.6 Adapter for EU



Figure 1.7 Adapter for US



Figure 1.8 Adapter for UK



Figure 1.9 Adapter for AU

EU: European, US: American, UK: British, AU: Australian

### 1.3.4 TC50 controller

The Tersus TC50 Controller is a rugged multi-functional data controller with design of 5 inch sunlight readable HD touch screen and an alphanumerical keypad. Equipped with powerful processor and android operating system, it is perfect to adapt with Tersus survey software. With professional IP68 rating, it is robust and reliable for harsh operating conditions. The large capacity lithium battery guarantees more than 10 hours of field working for a whole day of multiple surveying tasks.

#### Features:

- 5 inch sunlight readable HD touch screen
- Octa-core 2.0GHz CPU
- Android 8.1 operating system
- 4GB RAM + 64GB ROM
- 5MP front camera and 13MP rear camera
- IP68 certified grade, water/shock/dust proof
- 7000mAh battery
- Wi-Fi, Bluetooth, NFC, 4G
- USB Type-C

***Note: Although the TC50 controller uses chemical and impact resistant materials, precision instruments require careful use and maintenance and should be kept as dry as possible. In order to improve the stability and life cycle of the TC50 controller, avoid exposing the TC50 controller to extreme environments such as moisture, high temperatures, low temperatures, corrosive liquids or gases.***



TC50 must be in the specified temperature range -20 °C ~ 55 °C when

used and stored.

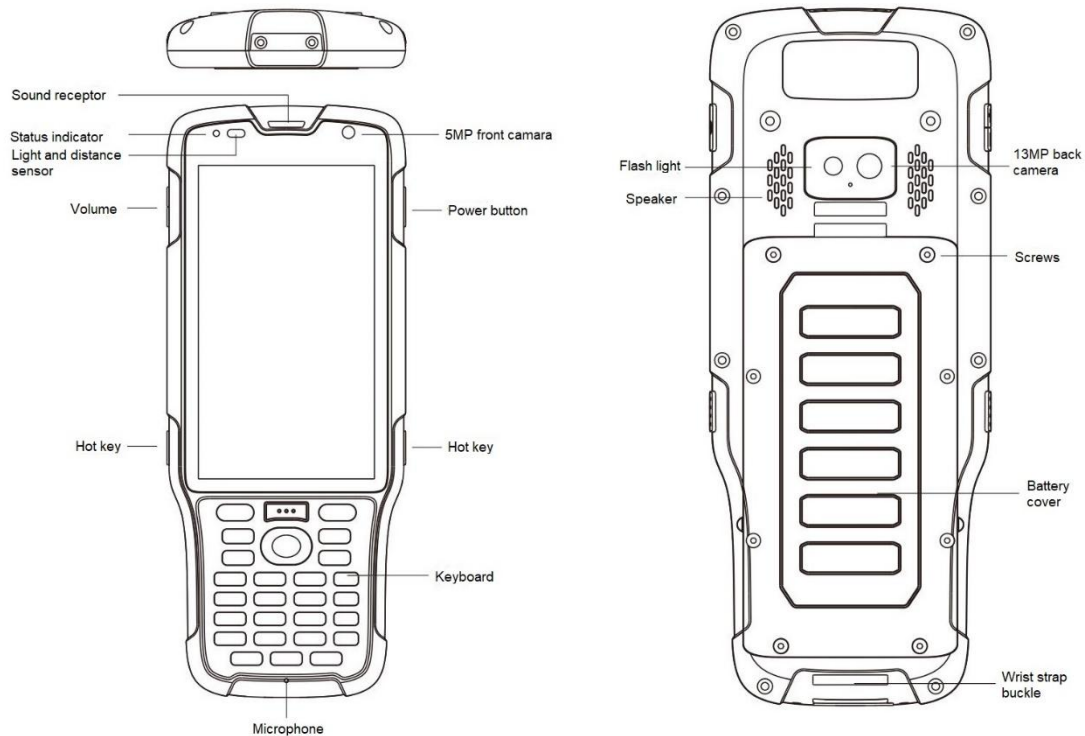


Figure 1.10 TC50 Controller

**Power on:** Press and hold the power button for 3 seconds

**Power off:** Press and hold the power button for 3 seconds, select 'Power Off' in the menu option.

**Reboot:** Press and hold the power button for 2 seconds and click "Restart" in the menu option.

**Forced restart:** Press and hold the power button for 8 seconds to force the controller to restart.

#### Introduction of functional keys:

- **Menu Key:** Select to show applications that was used recently.
- **Home Key:** Return to home screen. To view recent application, press and hold the home key.
- **Back Key:** Return to previous screen.

- **APP Key:** Quick start Nuwa application.
  - **Blue Positioning  Key:** Perform the function of starting measurement in the Survey and Stakeout interface of Nuwa application.
  - **Yellow Bulb Key:** Control the screen on and off.
- ENTER Key:** Execute the function of confirming in Nuwa application.

The accessories of TC50 Controller are listed below.

TC50 Lithium Battery (3.8V/7000mAh)

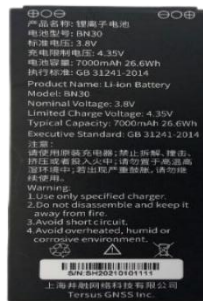


Figure 1.11 TC50 Lithium Battery

TC50 Charger (5V/1.67A, 7V/1.67A, 9V/1.67A)



Figure 1.12 TC50 Charger

Type-C Cable



Figure 1.13 Type-C cable

Functions:

1. Connect to the USB port of computer for data downloading;
2. Connect to the charger to charge TC50 controller.

### 1.3.5 External radio for LUKA

The external radio RS400H3 for LUKA below is to be installed via serial data port, and it can help LUKA transmitting signals farther than internal radio.



Figure 1.14 External radio for LUKA

When using external radio for LUKA as a base, a high gain radio antenna and a telescopic pole are needed which are shown as below.



Figure 1.15 High gain radio antenna



Figure 1.16 Telescopic pole for radio antenna

The following Serial-5pin to External-Radio-DC-5pin & Bullet-DC Cable and Bullet-DC to Alligator Clips are used to communicate with LUKA and connect to external power supply.



Figure 1.17 Serial-5pin to External-Radio-DC-5pin & Bullet-DC Cable



Figure 1.18 Stylus pen for TC20

### 1.3.6 Other accessories

Other accessories may be packed according to customer requirements.

The GNSS antenna connector is used to install LUKA to a tripod.



Figure 1.19 GNSS antenna connector

The height measure accessory is used to determine the height of LUKA with higher accuracy.



Figure 1.20 Height measure accessory

The tape measure below is to help measure height.



Figure 1.21 Tape measure

The 410-470MHz radio whip antenna is to be installed on the TNC port to transmit or receive signal for the internal radio.



Figure 1.22 410-470MHz radio whip antenna

When installing 410-470MHz radio whip antenna on LUKA, it is necessary to use a 30cm extension pole to heighten LUKA and avoid bending the 410-470MHz radio whip antenna.



Figure 1.23 Extension pole 30cm

This metal fixing plate is used to fixate the high gain radio antenna to the tripod.



Figure 1.24 Metal fixing plate

When using LUKA as a rover, you need a ranging pole.



Figure 1.25 Ranging Pole

The bracket for TC20 controller is to fix the TC50 controller on a ranging pole.



Figure 1.26 Bracket for TC50

A yellow carrying case is to store all the devices and accessories except ranging pole, high gain radio antenna and telescopic pole.



Figure 1.27 Carrying Case

The tool bag below is to store high gain radio antenna and telescopic pole for radio antenna.



Figure 1.28 Tool bag

The configuration cable for external radio RS400H3 below is used to configure parameters of the 28W radio instead of the default setting.



Figure 1.29 Configuration cable for 28W radio

## 2. General Operations

This chapter includes setting up, configuration and other related operations.

### 2.1 Setting up LUKA

#### 2.1.1 Insert the SIM card

When 4G/3G/2G network is chosen for survey operation, you need to insert a nano SIM card into LUKA GNSS receiver. Insert the nano SIM card with the contacts facing outside which is shown as below.



Figure 2.1 Insert the SIM card

To eject the nano SIM card, slightly push it in to trigger the spring-loaded release mechanism.

**Note: The SIM card is provided by your cellular network service provider.**

## 2.1.2 Fix LUKA on a tripod or ranging pole

LUKA GNSS receiver has a standard 5/8" x 11 UNC-2B connector and it can be fixed on a tripod or a ranging pole to be a base or rover according to customer requirement.



Figure 2.2 LUKA as a base without radio antenna

Table 2.1 Devices to set LUKA as a base without radio antenna

| Device Name              | Quantity | Items in the figure               |
|--------------------------|----------|-----------------------------------|
| LUKA GNSS receiver       | 1        | 1, details refer to section 1.3.1 |
| Height measure accessory | 1        | 2, details refer to section 1.3.6 |
| GNSS antenna connector   | 1        | 3, details refer to section 1.3.6 |
| Tribrach                 | 1        | 4                                 |
| Tripod                   | 1        | 5                                 |



Figure 2.3 LUKA as a rover without radio antenna

Table 2.2 Devices to set LUKA as a rover without radio antenna

| Device Name        | Quantity | Items in the figure               |
|--------------------|----------|-----------------------------------|
| LUKA GNSS receiver | 1        | 1, details refer to section 1.3.1 |
| Ranging pole       | 1        | 2, details refer to section 1.3.6 |
| Bracket for TC50   | 1        | 3, details refer to section 1.3.6 |
| TC50 Controller    | 1        | 4, details refer to section 1.3.4 |

## 2.2 LUKA configuration

You can configure LUKA GNSS receiver via button, TC50 controller or other android devices.

### 2.2.1 Configure via button

The detailed definition and configuration of button on LUKA GNSS receiver refers to section 1.3.1.

### 2.2.2 Configure via TC50 controller

The detailed introduction of TC50 controller refers to section 1.3.4 and technical specification refers section 3.2. Here in this section describes how to configure LUKA via Nuwa app which is installed in TC50 controller.

#### 2.2.2.1 Connect LUKA in Nuwa

The general operations of Nuwa app refer to *User Manual for Nuwa App* which can be downloaded on Tersus official website.

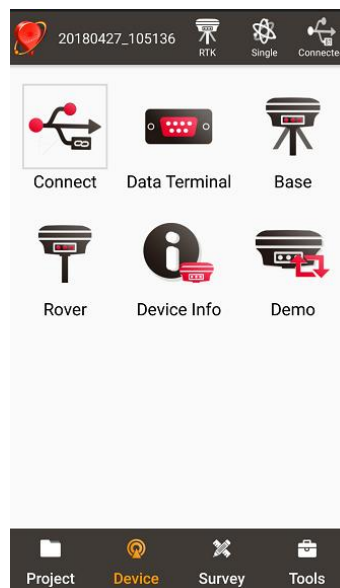


Figure 2.4 Device functional group

When LUKA GNSS receiver is powered on, to connect LUKA, put TC50 controller near the NFC logo on LUKA, the TC50 controller pair Bluetooth with LUKA automatically; or click [Device] -> [Connect] under an opened project, and select [LUKA] for the Device Type which is shown as below.



Figure 2.5 Connect LUKA via Bluetooth

Select [Bluetooth] for the Connect Type. Click [Connect Config] to search and pair the Bluetooth address of LUKA. The antenna is selected as [LUKA] by default. Then click [Connect] to enable the communication between TC50 controller and LUKA.

#### 2.2.2.2 Electronic Bubble (eBubble)

Make the body of LUKA stand on a leveled Tribrach before eBubble calibration.

Click the device information icon  on the top tool bar of Nuwa, the LUKA info is shown as below.

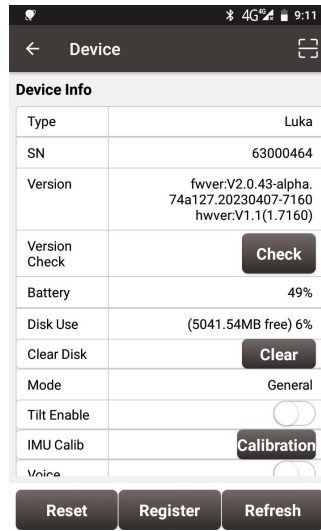


Figure 2.6 Device info of LUKA

Click **Adjust** on the right of electronic bubble to adjust bubble. On the screenshot below, the eBubble is not in the black circle and its color is red for warning purpose.

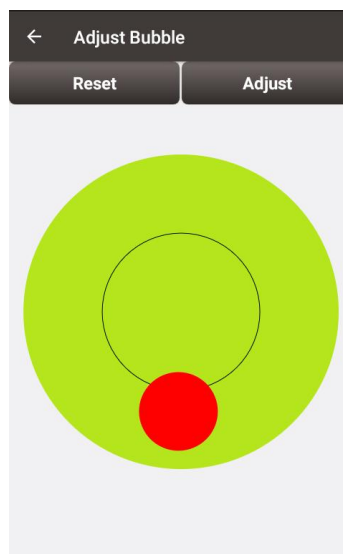


Figure 2.7 eBubble before adjusting

Click **Adjust** on the right, the eBubble is calibrated to the center inside the black circle and the bubble color turns blue.

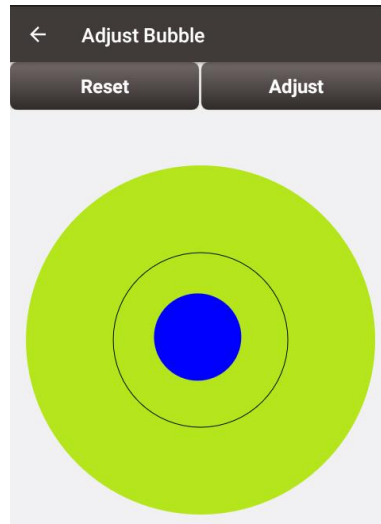


Figure 2.8 eBubble after adjusting

### 2.2.2.3 Registration

When the registration is not effective, follow below steps to complete the registration by using QR code.

Click the scan button at the top right of the device information interface and directly scan the QR code provided by Tersus to complete the registration.

### 2.2.2.4 Configure base or rover

To configure LUKA as a base or rover, back to Device interface which is shown in Figure 2.4 Device functional group, click [Base] or [Rover], then create a work mode of detailed configurations for base or rover which are shown as below.

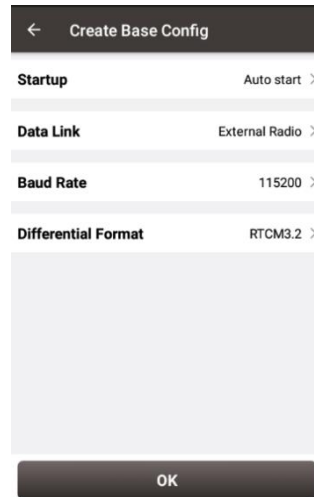


Figure 2.9 Base configuration

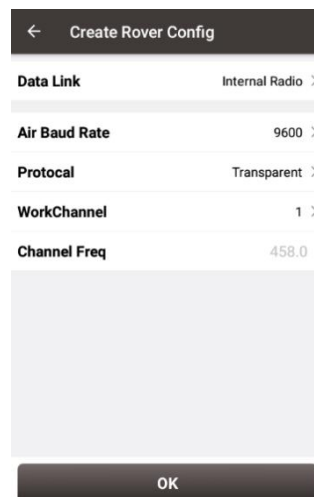


Figure 2.10 Rover configuration

Fill in the detailed information of base configuration or rover configuration, then click [OK] and back to the work mode list, select this configuration to start data transmission for base or rover which are shown as below.

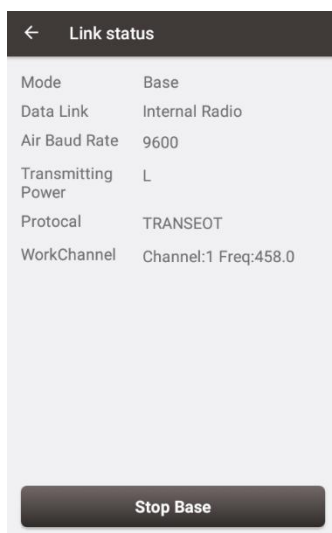


Figure 2.11 Link status of Base

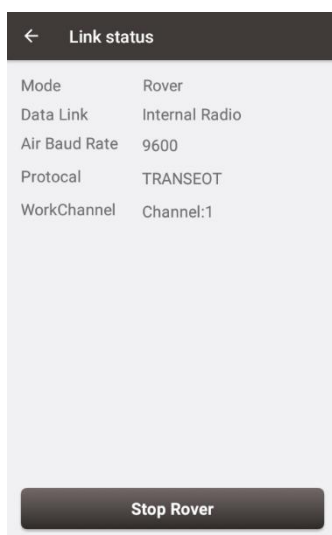


Figure 2.12 Link status of Rover

## 2.3 Data download

### 2.3.1 Connection

LUKA can be used as an USB storage device when connecting with a computer. Before connecting LUKA to a computer, ensure LUKA is powered on. Use the Type-C to USB cable in the package to connect LUKA to the USB port of a computer which is shown as below.

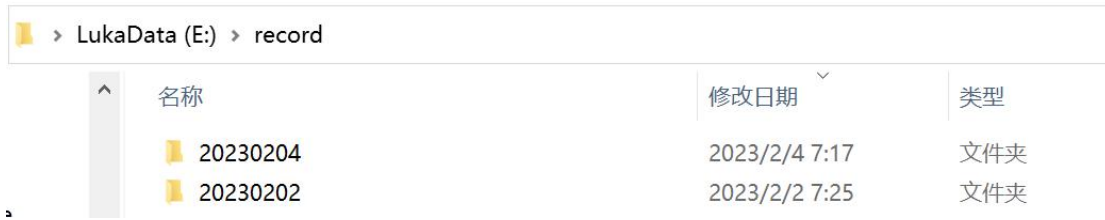


Figure 2.13 Connect LUKA to a computer

After completing the connection, a USB device is listed in the file browser of the computer. Find the data file needed to download, copy and paste it to a designated folder in your computer.

### 2.3.2 Download static data

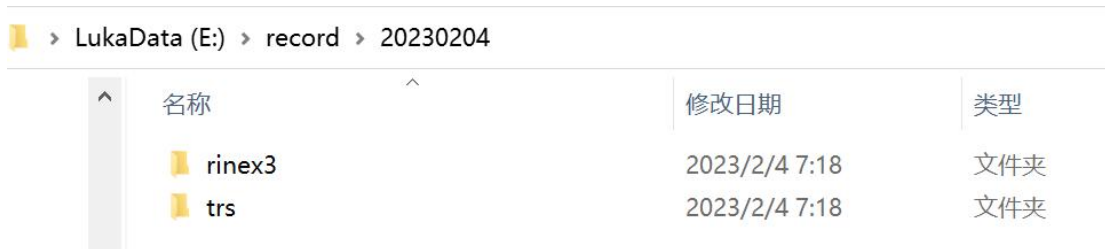
If you want to download the recorded static data for post processing, find record folder shown as below, and then copy the specific file you need to your computer.



| 名称       | 修改日期          | 类型  |
|----------|---------------|-----|
| 20230204 | 2023/2/4 7:17 | 文件夹 |
| 20230202 | 2023/2/2 7:25 | 文件夹 |

Figure 2.14 Static record folder

Each folder named after the date contains rinex format and tersus binary data, which can be downloaded and processed as you need.



| 名称     | 修改日期          | 类型  |
|--------|---------------|-----|
| rinex3 | 2023/2/4 7:18 | 文件夹 |
| trs    | 2023/2/4 7:18 | 文件夹 |

Figure 2.15 Static data for one day

### 2.3.3 Download debug data

When you don't turn on the debug mode, find debug\LOG folder and you can see rtkmain.log file which includes all the operation information of the receiver.

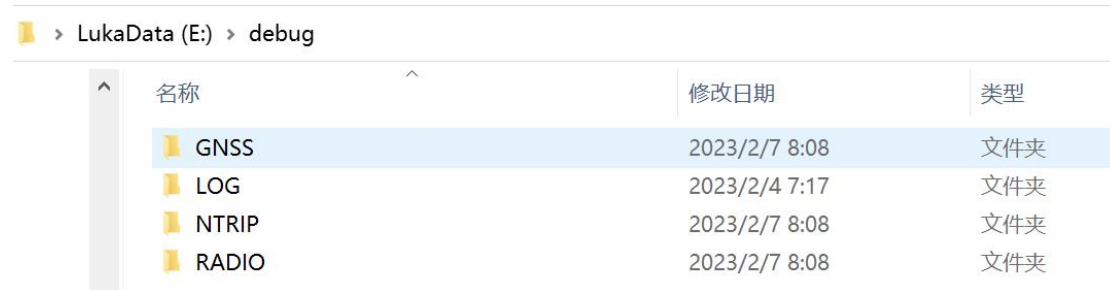


| 名称        | 修改日期           | 类型     | 大小        |
|-----------|----------------|--------|-----------|
| rtkmain_2 | 2023/2/6 9:58  | LOG 文件 | 1,800 KB  |
| update    | 2023/2/6 9:57  | LOG 文件 | 3 KB      |
| rtkmain_1 | 2023/2/2 14:32 | LOG 文件 | 66,045 KB |

Figure 2.16 rtkmain.log file location

To turn on the debug mode, you can click [Device] -> [Device Debug] -> [Set] in Nuwa app. The debug information includes GNSS, tilt, internal radio and

NTRIP information. Select the debug info you want to record and turn on the debug mode. After you select some debug info to turn on and confirm, LUKA will record them when you are doing survey work.



| 名称    | 修改日期          | 类型  |
|-------|---------------|-----|
| GNSS  | 2023/2/7 8:08 | 文件夹 |
| LOG   | 2023/2/4 7:17 | 文件夹 |
| NTRIP | 2023/2/7 8:08 | 文件夹 |
| RADIO | 2023/2/7 8:08 | 文件夹 |

Figure 2.17 Debug info folders

Send these debug info to Tersus technical support team to help solve the problems you encountered.

## 2.4 Firmware upgrade

View LUKA firmware version. When LUKA GNSS receiver is powered on, to connect LUKA, put controller near the NFC logo on LUKA, the controller pair Bluetooth with LUKA automatically; or click [Device] -> [Connect] under an opened project, and select [LUKA] for the Device Type, select [Bluetooth] for the Connect Type. Click [Connect Config] to search and pair the Bluetooth address of LUKA. The antenna is selected as [LUKA] by default. Then click [Connect] to enable the communication between controller and LUKA.

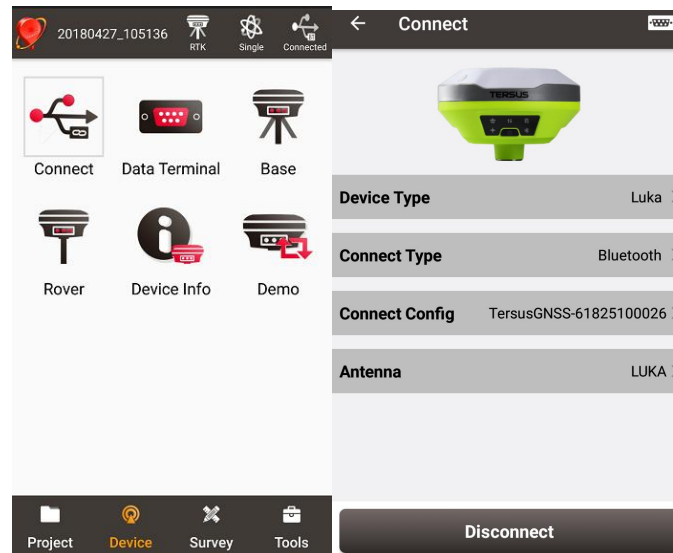


Figure 2.18 Connect to LUKA via Bluetooth

Click the device information icon  on the top tool bar of Nuwa, the LUKA info is shown as below. You can view LUKA firmware version.

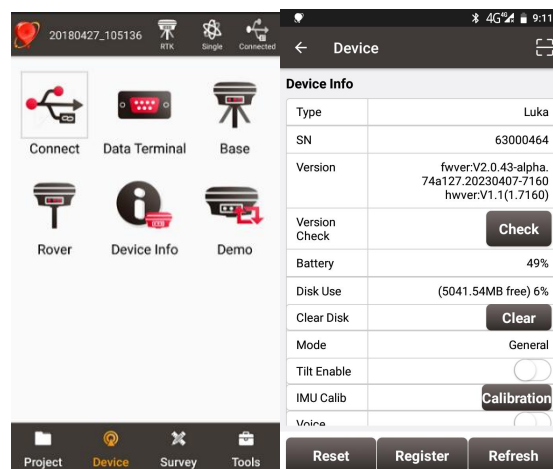


Figure 2.19 View LUKA firmware version

The detailed steps are as follows.

1) Download the latest firmware file from Tersus website <https://www.tersus-gnss.com/software/LUKA-gnss-receiver>.

Please be noted that the downloaded file is a .zip file, unzip this file to find the firmware file of .BIN format.

2) Prepare a Type-C to USB cable, when LUKA is turned on, connect the Type-C port of LUKA to the computer with a Type-C to USB cable.



Figure 2.20 connect the computer and LUKA

3) The computer interface will automatically pop up two removable disks. As shown in the figure below.



Figure 2.21 Two Removable Disks

4) Choose the LUKAUpdate removable disk and put the firmware file in the .BIN format on this removable disk. As shown in the figure below.



Figure 2.22 The FW is placed in the LUKAUpdate removable disk

5) Unplug the Type-C to USB cable, press and hold the power button for 3 seconds to shut down LUKA .

6) Make sure that LUKA is turned off, then press and hold the power button for 2 seconds to turn on LUKA.

When the six indicators on the LED panel are all on, the boot is successful,

release the power button. LUKA enters the upgrade mode when the six indicators on the LED panel are all on again, and waits for the upgrade to complete.



Figure 2.23 Upgrading

After the firmware upgrade is completed, the power LED light is on and the satellite light flashes. At this time, you can check the LUKA firmware version. If it is consistent with the latest firmware version in the removable disk, the firmware upgrade is successful.

**Note:** Please make sure the battery has enough power for the firmware upgrade. The GNSS board inside LUKA will upgrade when the firmware is upgrading, any forced power failure will cause the system crash.

## 2.5 Web UI

LUKA GNSS receiver supports being a Wi-Fi hot spot and connect with a computer or a smart terminal within five meters. You can read coordinate information, configure the receiver and upgrade the firmware through the web UI (user interface) on the browser of the computer or the smart terminal.

Follow below steps to enter the web user interface on a computer with Windows 10 operating system.

a. Upgrade the receiver to the latest firmware, and then open Wi-Fi .

Switch to [Device] -- [WIFI Setting] -- [Set] -- [Mode Config], select [AP] -- [confirm] via NUWA, as shown below.

Note: the version of NUWA app must be upgraded to V2.3.3 or above.

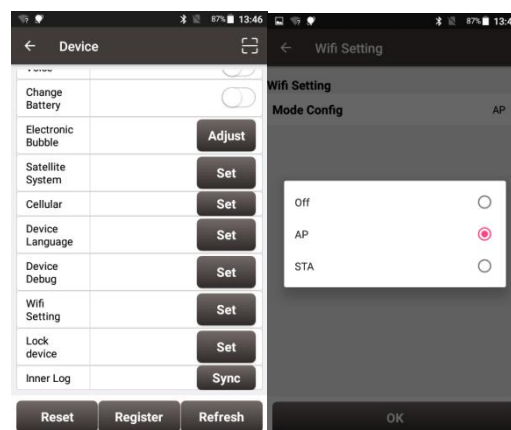


Figure 2.24 WiFi interface

b. Click the Internet connection icon on the lower right corner of the desktop. Turn on Wi-Fi connection and search the SSID of LUKA GNSS receiver which is composed of TersusGNSS and an eight digit number such as below. Click [Connect] to complete the Wi-Fi connection.

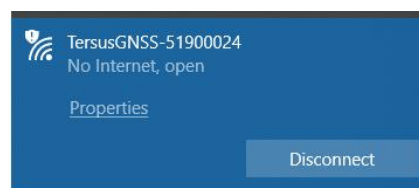


Figure 2.25 Make Wi-Fi connection

- c. Open a web browser and type 192.168.2.1 in the address bar. Type “admin” for the username and password, then click [Sign in] to enter the web UI.

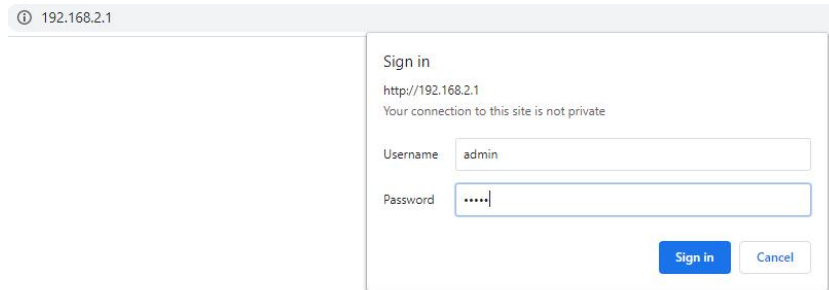


Figure 2.26 Sign in the web UI

- d. When you entered the web UI of LUKA GNSS receiver, you can see five tabs on the left and make corresponding operations such as view positioning info, view satellites info, make device settings, make connectivity settings, and upgrade firmware. [Satellites Info] - [Position Info] - view position information.



Figure 2.27 Main interface of LUKA's web UI

- e. configure the working mode and related parameters of the equipment .  
[Device Configuration] - [Mode Configuration] - select working mode - next - next - set.

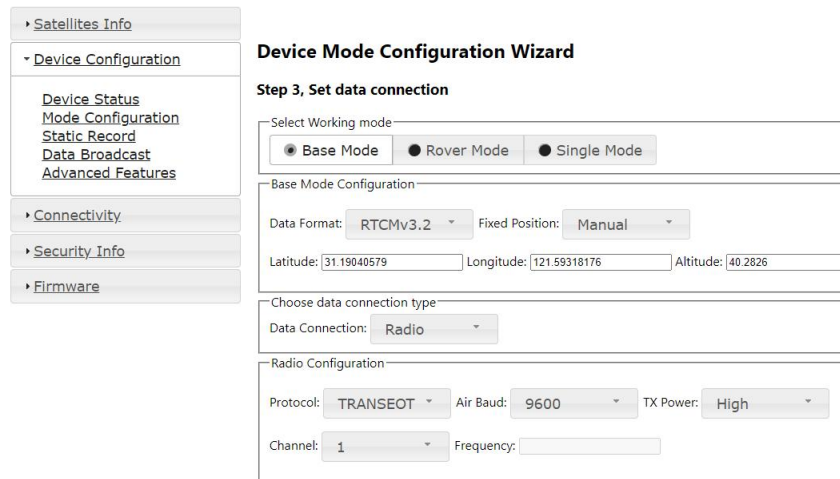


Figure 2.28 configure a working mode

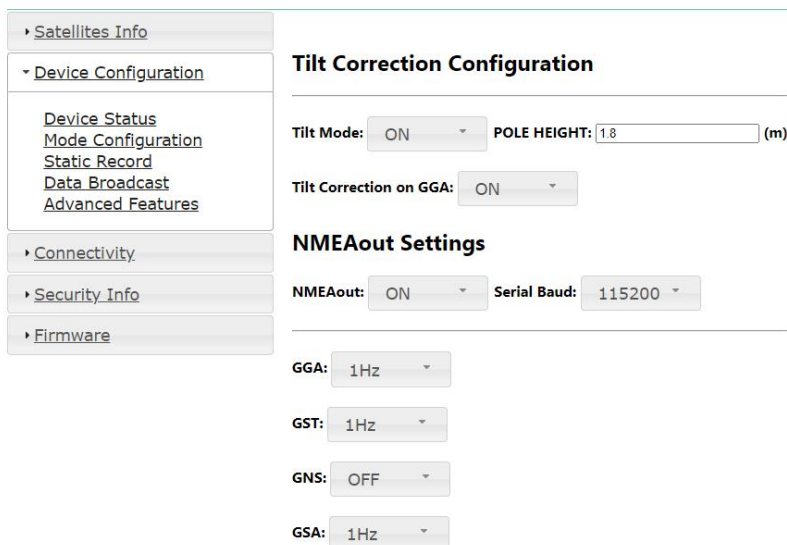
f. configure NMEA data output.

[Device Configuration] - [Advanced Features] - select tilt correction result output - select NMEA data output - select localized coordinates output - set.

In Tilt Correction Configuration, turn on tilt mode and make sure the pole height is correct, then turn on Tilt Correction On GGA, the GGA messages will no longer record the coordinates of the phase center of the antenna in the tilted state, but the coordinates of the virtual phase center assuming that the pole is vertical.

In NMEAout Settings, the configuration of the NMEA messages output frequency will take effect for both serial output and Bluetooth output.

In Localized Coordinates Configuration, select your local coordinate system, and the localized coordinates will be output in NMEA PJK messages.



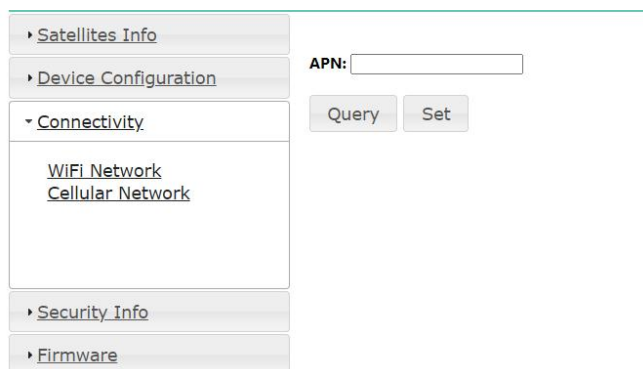
The screenshot shows the 'Device Configuration' menu on the left, with 'NMEAout Settings' selected. The main area displays the following settings:

- Tilt Correction Configuration:**
  - Tilt Mode: ON
  - POLE HEIGHT: 1.8 (m)
  - Tilt Correction on GGA: ON
- NMEAout Settings:**
  - NMEAout: ON
  - Serial Baud: 115200
  - GGA: 1Hz
  - GST: 1Hz
  - GNS: OFF
  - GSA: 1Hz

Figure 2.29 configure NMEA data output

g. configure connectivity.

[Connectivity] - [Cellular Network] - enter APN Name - set.



The screenshot shows the 'Connectivity' menu on the left, with 'Cellular Network' selected. The main area displays the following settings:

- APN: [Text Input Field]
- Buttons: Query, Set

Figure 2.30 configure connectivity

h. upgrade device firmware version via web page. [Firmware] - [Firmware Info] - [Firmware Upgrade] - click to select the file- click [upgrade].

you can use this function to upgrade after the next official version is released.

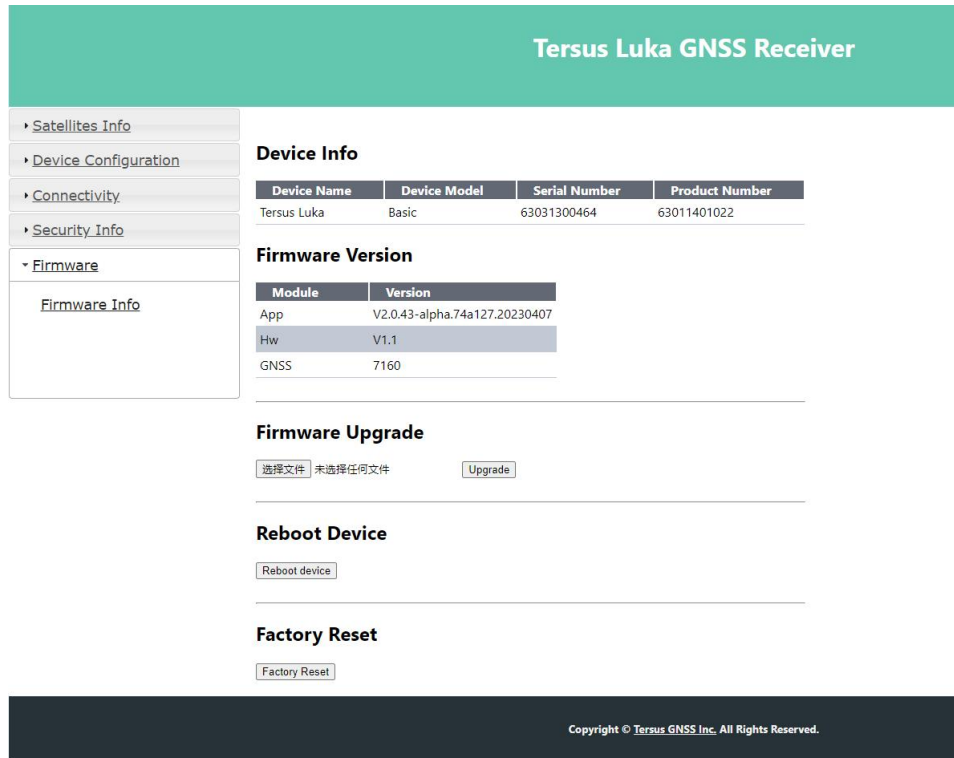


Figure 2.31 upgrade the firmware

i. manage user logins through web pages.

[Security Info] - [Account Info] - [Add User] - [Add User Dialog] - input Login Name&Alias Name&Password.

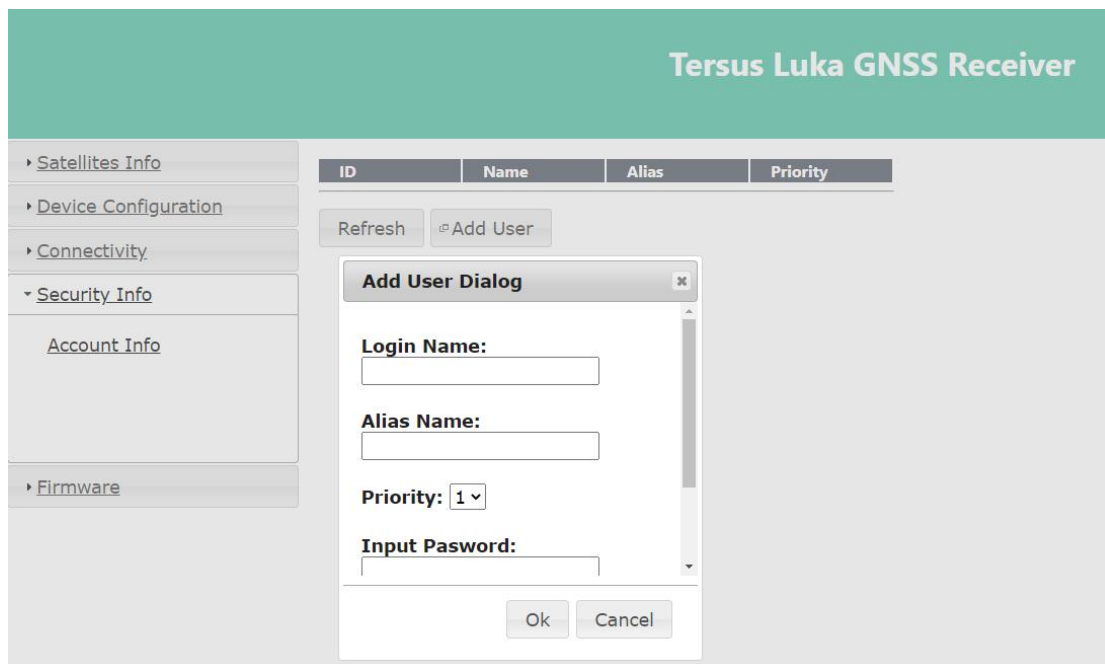


Figure 2.32 add user login

## 2.6 Operations of TC50 controller

### 2.6.1 Insert SIM card and SD card

Please note the direction of the card notch when inserting the card, inserting a non-standard card may cause damage to the SIM card slot of the controller.

The controller cannot support two CDMA cards at the same time, when two CDMA cards are installed at the same time, only one card can use the 4G network, the other card will not be able to register the network.

To install the SIM card you need to open the battery cover, remove the battery and open the SIM card cover.

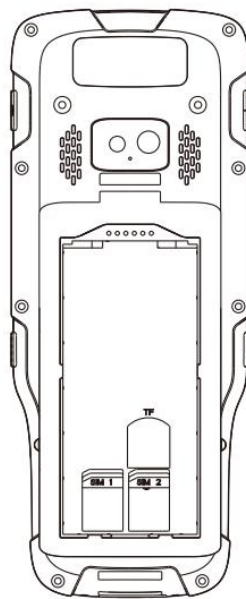


Figure 2.33 Install the SIM card

**Note:** Please power off the controller before plug in or pull out the SIM card.

## 2.6.2 Using of touch screen

**Single Click:** To select an icon. For example, click dial to open the keypad which will be displayed on the screen.

**Double Click:** To zoom-in or zoom-out. For example, to zoom-in or out of a photo, click twice when viewing a photo or browsing on the internet.

**Hold:** press and hold the screen, icon or input box to get more operation options.

a) Long-Time Click a picture in the gallery list interface, the status bar prompts to select a picture, you select to share or delete it.

b) Long-Time Click the blanks of home screen to add home screen widgets.

c) Long-Time Click the blanks of home screen wallpaper sources can be selected.

d) Long-Time Click the blanks of home screen to home settings.

**Slide Upward:** Slide up on the main screen ( or click the upward arrow icon) to view more applications.

**Slide Downward:** Slide down on any interface to open the status bar and message board.

**Slide Left and Right:** Slide left and right on the main screen to switch the desktop interface.

## 3. Technical Specifications

This chapter mainly introduces the technical specifications of LUKA GNSS receiver, TC50 Controller , external radio and internal radio whip antenna.

### 3.1 LUKA GNSS receiver

Table 3.1 LUKA GNSS receiver performance

| GNSS Performance                            |                          |                           |
|---------------------------------------------|--------------------------|---------------------------|
| Position accuracy(RMS)                      | Single Point Positioning | 1.5m (Horizontal)         |
|                                             |                          | 2.5m (Vertical)           |
|                                             | DGPS Positioning         | 0.25m (Horizontal)        |
|                                             |                          | 0.5m (Vertical)           |
|                                             | High Precision Static    | 2.5mm+0.1ppm (Horizontal) |
|                                             |                          | 3.5mm+0.4ppm (Vertical)   |
|                                             | Static & Fast Static     | 2.5mm+0.5ppm (Horizontal) |
|                                             |                          | 5mm+0.5ppm (Vertical)     |
|                                             | Post Processed Kinematic | 8mm+1ppm (Horizontal)     |
|                                             |                          | 15mm+1ppm (Vertical)      |
| Real Time Kinematic                         | 8mm+1ppm (Horizontal)    |                           |
|                                             | 15mm+1ppm (Vertical)     |                           |
| Network Real Time Kinematic                 | 8mm+0.5ppm (Horizontal)  |                           |
|                                             | 15mm+0.5ppm (Vertical)   |                           |
| Observation accuracy<br>(zenith direction)  | C/A code                 | 10cm                      |
|                                             | P code                   | 10cm                      |
|                                             | Carrier phase            | 1mm                       |
| Time To First Fix (TTFF)                    | Cold start               | <30s                      |
|                                             | Warm start               | <5s                       |
| Reacquisition                               | <1s                      |                           |
| Tilt compensation<br>accuracy (within 60° ) | ≤2cm                     |                           |
| Timing accuracy (RMS)                       | 20ns                     |                           |
| Velocity accuracy (RMS)                     | 0.03m/s                  |                           |
| Initialization (typical)                    | 4s                       |                           |
| Initialization reliability                  | >99.9%                   |                           |
| System & Data                               |                          |                           |
| Operating system                            | Linux                    |                           |
| Storage                                     | built-in 8GB             |                           |

|                               |                                                                                      |                                                    |
|-------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------|
| Data format                   | CMR, RTCM 2.3, RTCM3.x                                                               |                                                    |
| Data output                   | RINEX, NMEA-0183, Tersus Binary                                                      |                                                    |
| Data output rate              | 20Hz                                                                                 |                                                    |
| Software Support              |                                                                                      |                                                    |
| Tersus Nuwa                   |                                                                                      |                                                    |
| Communication                 |                                                                                      |                                                    |
| Cellular                      | 4G LTE/WCDMA/GSM/EDG                                                                 |                                                    |
| Cellular bands                | LTE FDD B1,B3,B7,B8,B20,B28A<br>LTE TDD B38,B40,B41<br>WCDMA B1,B8<br>GSM/EDGE B3,B8 |                                                    |
| Network protocols             | Ntrip Client, Ntrip Server, TCP, Tersus Caster Service (TCS)                         |                                                    |
| Wi-Fi                         | 802.11b/g/n                                                                          |                                                    |
| Bluetooth                     | 4.1                                                                                  |                                                    |
| Internal radio                | RF transmit power                                                                    | 0.5W/1.0W                                          |
|                               | Frequency                                                                            | 410MHz ~ 470MHz                                    |
|                               | Operating mode                                                                       | Half-duplex                                        |
|                               | Channel spacing                                                                      | 12.5KHz / 25KHz                                    |
|                               | Modulation type                                                                      | GMSK, 4FSK                                         |
|                               | Air baud rate                                                                        | 4800/9600/19200 bps                                |
|                               | Radio protocols                                                                      | TrimTalk450, TrimMark 3, South, Transparent, Satel |
| USB                           | Type-C, OTG x1                                                                       |                                                    |
| User Interface                |                                                                                      |                                                    |
| Button                        | Power button                                                                         |                                                    |
| LED indicators                | Satellite, Correction data, Static, Solution, Bluetooth                              |                                                    |
| Voice                         | Support                                                                              |                                                    |
| Power display                 | Support                                                                              |                                                    |
| Electrical                    |                                                                                      |                                                    |
| External power supply         | Support USB (5~20V)                                                                  |                                                    |
| Fast charging                 | Support, 15W max(5V 3A)                                                              |                                                    |
| Lithium battery               | 7000mAh/7.4V                                                                         |                                                    |
| Charing time                  | 3 hours (20%~90%)                                                                    |                                                    |
| Battery charging temperature: | +10°C ~ +45°C                                                                        |                                                    |
| Battery working time          | Up to 19 hours                                                                       |                                                    |
| Physical                      |                                                                                      |                                                    |
| Dimension                     | φ132x68mm                                                                            |                                                    |
| Weight                        | ≈827g                                                                                |                                                    |
| Screw hole for assembly       | 5/8"x11UNC-2B                                                                        |                                                    |
| Vibration                     | MIL-STD-810G,FIG.514.6C-1                                                            |                                                    |
| Environmental                 |                                                                                      |                                                    |

|                         |                    |
|-------------------------|--------------------|
| Operating temperature   | -40°C to +70°C     |
| Storage temperature     | -55°C to +85°C     |
| Relative humidity       | 100% not condensed |
| Water & dust proof      | IP68               |
| Pole drop onto concrete | 2m                 |

The pin definition of the TNC connector is as below:

Table 3.2 Pin definition of the TNC connector

| Connector Pin No. | Pin Definition |
|-------------------|----------------|
| Inside            | Signal         |
| Outside           | Ground         |

Table 3.3 Default factory configuration for internal radio

| Channel              | Frequency  |
|----------------------|------------|
| 00                   | 457.550MHz |
| 01                   | 458.050MHz |
| 02                   | 458.550MHz |
| 03                   | 459.050MHz |
| 04                   | 459.550MHz |
| 05                   | 460.550MHz |
| 06                   | 461.550MHz |
| 07                   | 462.550MHz |
| 08                   | 463.550MHz |
| 09                   | 464.550MHz |
| Customized frequency | 410~470MHz |

Table 3.4 Detailed configuration information for internal radio

| Protocol    | Modulation type | Channel band | Air baud rate | COM baud rate              |
|-------------|-----------------|--------------|---------------|----------------------------|
| TrimTalk450 | GMSK            | 12.5 KHz     | 4800 bps      | 9600/19200/38400/115200bps |
|             | GMSK            | 25 KHz       | 9600 bps      | 9600/19200/38400/115200bps |
| TrimMark3   | GMSK            | 50 KHz       | 19200 bps     | 9600/19200/38400/115200bps |
| Transparent | GMSK            | 12.5 KHz     | 4800 bps      | 9600/19200/38400/115200bps |
|             | GMSK            | 25 KHz       | 9600 bps      | 9600/19200/38400/115200bps |

|       |      |          |           |                            |
|-------|------|----------|-----------|----------------------------|
| Satel | 4FSK | 12.5 KHz | 9600 bps  | 9600/19200/38400/115200bps |
|       | 4FSK | 25 KHz   | 19200 bps | 9600/19200/38400/115200bps |
| South | GMSK | 12.5 KHz | 4800 bps  | 9600/19200/38400/115200bps |
|       | GMSK | 25 KHz   | 9600 bps  | 9600/19200/38400/115200bps |
|       | GMSK | 50 KHz   | 19200 bps | 9600/19200/38400/115200bps |

## 3.2 TC50 controller

Table 3.5 TC50 technical specification

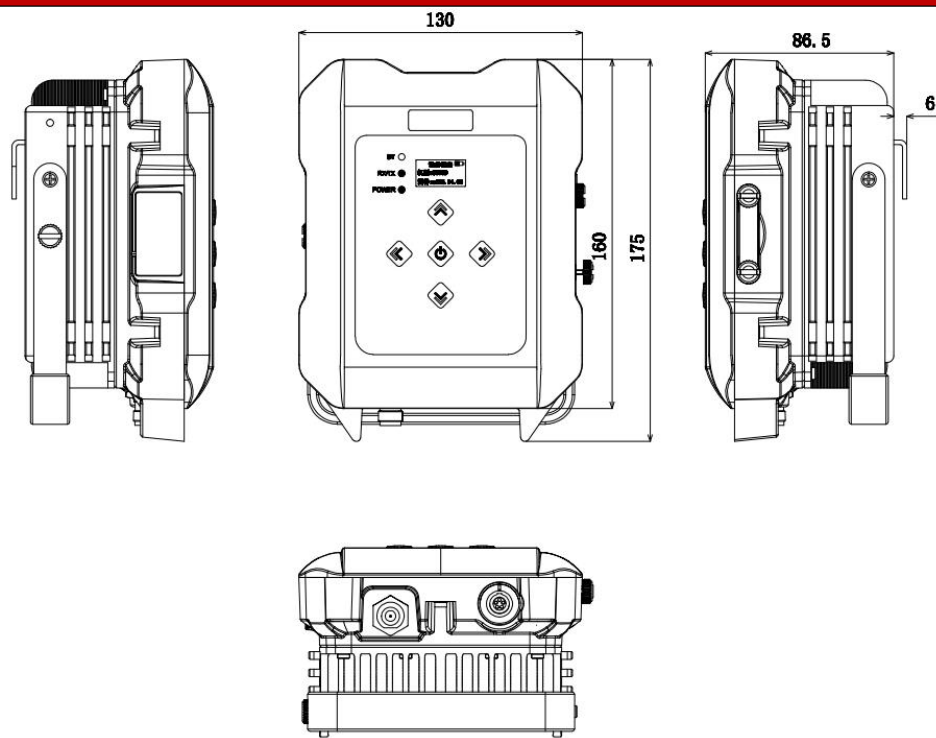
| System           |                                                                                                                                        |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Operating System | Android 8.1                                                                                                                            |
| CPU              | MT6763 Octa-Core 2.0GHz                                                                                                                |
| Memory           | 4GB RAM + 64GB ROM                                                                                                                     |
| External storage | Micro SD, up to 128GB                                                                                                                  |
| Display          | 5" sunlight-readable capacitive touch screen                                                                                           |
| Resolution       | 720x1280                                                                                                                               |
| Camera           | 5MP front, 13MP rear                                                                                                                   |
| Flash Light      | High light Flash LED                                                                                                                   |
| Electrical       |                                                                                                                                        |
| Battery          | 7000mAh 3.8V                                                                                                                           |
| Battery Life     | 14 hours                                                                                                                               |
| Charging Time    | <4 hours (fast charge)                                                                                                                 |
| Communication    |                                                                                                                                        |
| Wi-Fi            | IEEE 802.11a/b/g/n 2.4G&5G                                                                                                             |
| Cellular Mode    | Dual SIM Dual Standby                                                                                                                  |
| SIM1 & SIM2      | FDD-LTE B1/B3/B5/B7/B8<br>TD-LTE B38/B39/B40/B41<br>TDSCDMA B34/B39<br>WCDMA B1/B2/B5/B8<br>CDMA1x/CDMA2000 BC0/BC1<br>GSM B2/B3/B5/B8 |
| Bluetooth        | BT4.1 (BLE)                                                                                                                            |

|                        |                                                                  |
|------------------------|------------------------------------------------------------------|
| USB                    | USB Type-C (supports OTG)                                        |
| NFC                    | Protocol of ISO14443A/B, and ISO15693<br>Readable Distance 0~5cm |
| GNSS                   | GPS/GLONASS/BeiDou                                               |
| Sensors:               | G-Sensor, Compass, Light-Sensor, Gyro                            |
| <b>Physical</b>        |                                                                  |
| Dimension              | 207mmx84mmx20mm                                                  |
| Weight                 | 370g (include battery)                                           |
| <b>Reliability</b>     |                                                                  |
| Operating Temperature  | -20°C ~ +55°C                                                    |
| Storage Temperature    | -30°C ~ +70°C                                                    |
| Humidity               | 5% ~ 95%                                                         |
| Dustproof & Waterproof | IP68                                                             |
| Shock                  | 1.5m drop onto concrete                                          |

### 3.3 External radio for LUKA

Table 3.6 External radio RS400H3 technical specification

| General Specification  |                    |                      |
|------------------------|--------------------|----------------------|
| Frequency range        | 410~470MHz         |                      |
| Operating mode         | Simplex            |                      |
| Channel width          | 25KHz, 12.5KHz     |                      |
| Modulation Type        | GMSK/4FSK          |                      |
| Operating voltage      | 9~16V DC           |                      |
| Power consumption      | High power (28W)   | 78W @ DC 12V         |
|                        | Medium power (22W) | 60W @ DC 12V         |
|                        | Low power (5W)     | 35W @ DC 12V         |
|                        | Standby            | 2W @ DC 12V          |
| Frequency stability    | ≤ ±1.0ppm          |                      |
| Transmitter            |                    |                      |
| RF output power        | High level (28W)   | 44.5±0.5dBm @ DC 12V |
|                        | Medium level (22W) | 43.4±0.5dBm @ DC 12V |
|                        | Low level (5W)     | 37±1dBm @ DC 12V     |
| Power stability        | ±1dBm              |                      |
| Adjacent channel power | >50dB              |                      |
| Distance(Typical)      | 14-16KM            |                      |
| Antenna                |                    |                      |

|                                                                                     |                                                  |             |
|-------------------------------------------------------------------------------------|--------------------------------------------------|-------------|
| Antenna Impedance                                                                   | 50 Ohm                                           |             |
| Antenna Interface                                                                   | TNC female                                       |             |
| Modem                                                                               |                                                  |             |
| Air baud rate                                                                       | 4800bps, 9600bps, 19200bps                       |             |
| Modulation Type                                                                     | GMSK/4FSK                                        |             |
| Serial port baud rate                                                               | 9600bps, 19200bps, 38400bps, 57600bps, 115200bps |             |
| Protocol                                                                            | TRIMTALK, TRIMMK3, TRANSEOT,SOUTH, SATEL         |             |
| Environmental                                                                       |                                                  |             |
| Temperature                                                                         | Operating                                        | -40 ~ +65°C |
|                                                                                     | Storage                                          | -50 ~ +85°C |
| Dustproof and waterproof                                                            | IP67                                             |             |
| Physical Description                                                                |                                                  |             |
| Dimension                                                                           | 175 x 130 x 86.5 mm                              |             |
| Weight                                                                              | About 2.0kg                                      |             |
| Data & Power interface                                                              | LEMO 5pin                                        |             |
| Installation                                                                        | Hook                                             |             |
| Mechanical Drawing                                                                  |                                                  |             |
|  |                                                  |             |
| Signal Definition                                                                   |                                                  |             |

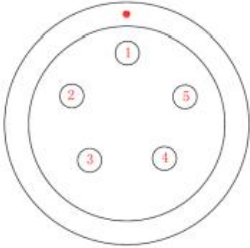
|                        |                                                                                                                     |                                                                                            |
|------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| Data & power interface |  <p>View from outside to radio</p> | Pin 1: PWR (9~16V DC)<br>Pin 2: Power GND<br>Pin 3: RXD<br>Pin 4: Signal GND<br>Pin 5: TXD |
|------------------------|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|

Table 3.7 Default factory configuration for Radio RS400H3

| Channel              | Frequency  |
|----------------------|------------|
| 00                   | 457.550MHz |
| 01                   | 458.050MHz |
| 02                   | 458.550MHz |
| 03                   | 459.050MHz |
| 04                   | 459.550MHz |
| 05                   | 460.550MHz |
| 06                   | 461.550MHz |
| 07                   | 462.550MHz |
| 08                   | 463.550MHz |
| 09                   | 464.550MHz |
| Customized frequency | 410~470MHz |

### 3.4 Radio whip antenna

The 410-470MHz radio whip antenna is to be installed on the TNC port to transmit or receive signal for the internal radio. This antenna is elastic whip structure, resistant to bending.



Figure 3.1 the 410-470MHz radio whip antenna

Table 3.8 Radio whip antenna technical specification

| Technical Specification |            |
|-------------------------|------------|
| Frequency Range         | 410~470MHz |
| Bandwidth               | 60MHz      |
| Polarization Mode       | Vertical   |
| Gain                    | 2dBi       |
| Input Impedance         | 50Ω        |
| VSWR                    | ≤2.5       |
| Maximum Power           | 20W        |
| Connector               | TNC Male   |
| Antenna Length          | 168mm      |
| Antenna Weight          | About 50g  |
| Extreme Wind Speed      | 120 Km/h   |

## 4. Typical Applications

This chapter introduces typical applications of LUKA GNSS receiver, and solutions for some possible issues.



Install the radio antenna before switching the radio transceiver to transmit mode, or the radio transceiver may be damaged due to overheating. The energy to be transmitted cannot be emitted out without the antenna, which may cause the temperature rise and overheat of the radio module.

## 4.1 Base station operation



Figure 4.1 LUKA as a base - network mode

Table 4.1 Devices of LUKA as a base network mode

| NO. | Device Name              |
|-----|--------------------------|
| 1   | LUKA GNSS receiver       |
| 2   | Height measure accessory |
| 3   | GNSS antenna connector   |
| 4   | Tribrach                 |
| 5   | Tripod                   |



Figure 4.2 LUKA as a base - internal radio

Table 4.2 Devices of LUKA as a base internal radio mode

| NO. | Device Name                   |
|-----|-------------------------------|
| 1   | LUKA GNSS receiver            |
| 2   | Height measure accessory      |
| 3   | 410-470MHz radio whip antenna |
| 4   | Extension pole 30cm           |
| 5   | Tribrach                      |
| 6   | Tripod                        |

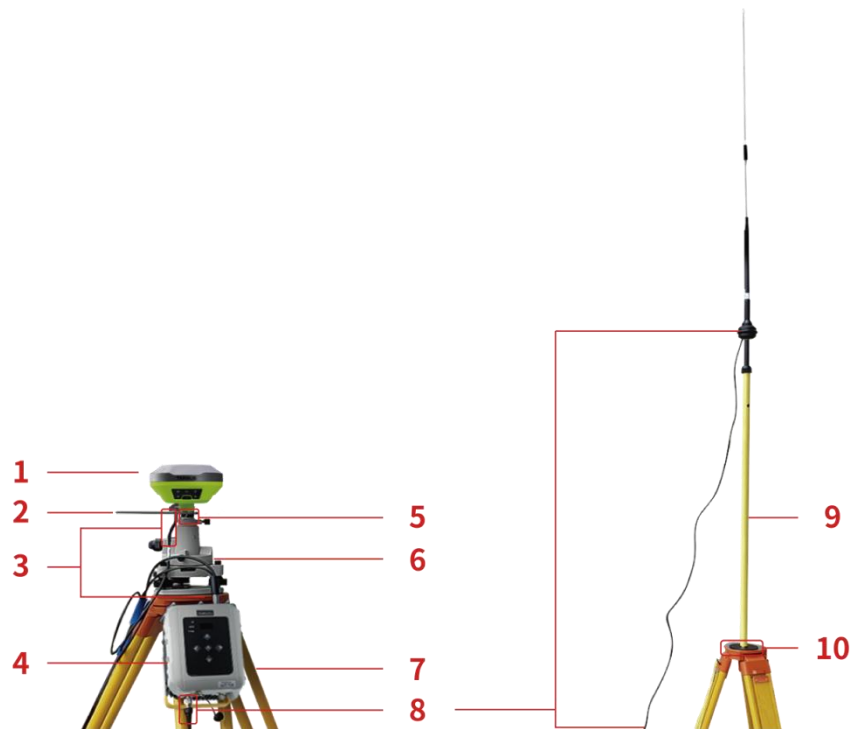


Figure 4.3 LUKE as a base – external radio

Table 4.3 Devices of LUKE as a base external radio mode

| NO. | Device Name                                  |
|-----|----------------------------------------------|
| 1   | LUKE GNSS receiver                           |
| 2   | Height measure accessory                     |
| 3   | Type-C to External-Radio-DC-5pin & Bullet-DC |
| 4   | External Radio RS400H3                       |
| 5   | GNSS antenna connector                       |
| 6   | Tribrach                                     |
| 7   | Tripod                                       |
| 8   | High Gain Radio Antenna                      |
| 9   | Telescopic pole for radio antenna            |
| 10  | Metal plate for radio antenna                |

**Note: Bullet-DC connects to ‘Bullet-DC to Alligator Clips’, and then clip to the external power supply with 12V output.**

Detailed steps of software operation:

1. Set up LUKA according section 2.1 Setting up LUKA after all the components above are ready, ensure the battery has sufficient power and insert one SIM card when 4G/3G/2G network is required for operation;
2. Long press power button to power on LUKA;
3. Use NFC function to launch Nuwa app. While the screen of TC50 Controller is unlocked, put TC50 Controller close to the LUKA NFC logo. The Bluetooth pairs automatically after a beep and Nuwa is launched requesting to open the latest project. Click [OK] and start configuring LUKA from step 7. Also you can click [Cancel] to create a new project or open an existing project, and then start configuring LUKA from step 7.
4. If using an android device without NFC function, ensure LUKA is powered on, and launch Nuwa application on the android device. Click [Project] in the main interface to create a new project or open an existing project and connect LUKA manually.
5. Back to the main interface of Nuwa app, click [Device] -> [Connect] under an opened project.
6. Select [LUKA] for the Device Type, select [Bluetooth] for the Connect Type, click [Connect Config] to search and pair the Bluetooth address of LUKA, select [LUKA] for the Antenna and click [Connect] to enable communication between the android controller and LUKA.
7. Back to [Device] - > [Base], click [New] to create a new configuration for base.

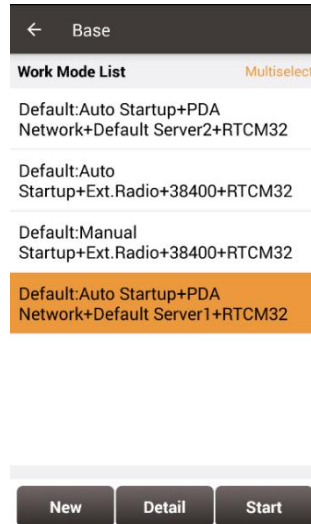


Figure 4.4 Base setting interface

8. Edit the base configuration for LUKA GNSS receiver. The startup mode can be chosen from auto start and manual start. If you choose manual start the base, you can manually type the base coordinate, or click the location icon to obtain the current base coordinate, or select a point from the control point library. The data link has four options: Receiver Network, PDA Network, Internal Radio and External Radio. Both the Receiver Network and PDA Network have three protocol options: Tersus Caster Service (TCS), Ntrip and TCP.

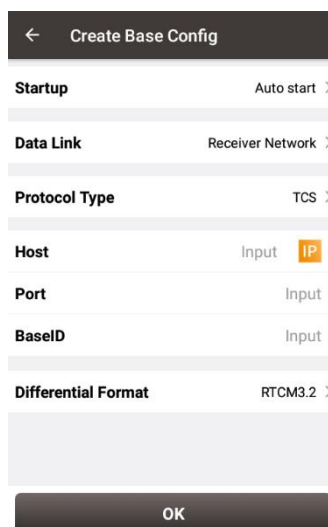
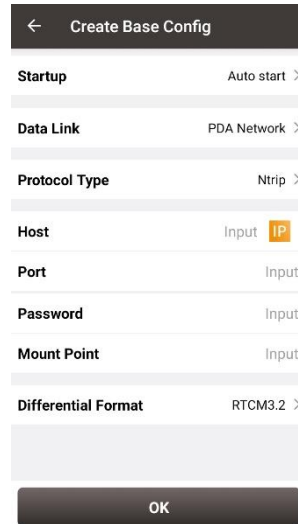


Figure 4.5 Base configuration - Receiver Network (TCS)

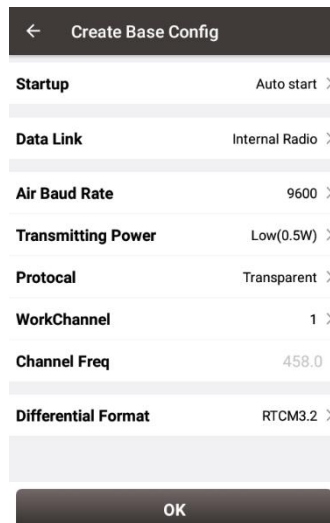


← Create Base Config

|                     |                                                                                         |
|---------------------|-----------------------------------------------------------------------------------------|
| Startup             | Auto start >                                                                            |
| Data Link           | PDA Network >                                                                           |
| Protocol Type       | Ntrip >                                                                                 |
| Host                | Input  |
| Port                | Input                                                                                   |
| Password            | Input                                                                                   |
| Mount Point         | Input                                                                                   |
| Differential Format | RTCM3.2 >                                                                               |

OK

Figure 4.6 Base configuration – PDA Network (Ntrip)

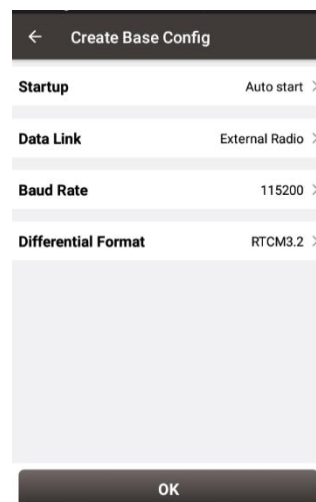


← Create Base Config

|                     |                  |
|---------------------|------------------|
| Startup             | Auto start >     |
| Data Link           | Internal Radio > |
| Air Baud Rate       | 9600 >           |
| Transmitting Power  | Low(0.5W) >      |
| Protocol            | Transparent >    |
| WorkChannel         | 1 >              |
| Channel Freq        | 458.0            |
| Differential Format | RTCM3.2 >        |

OK

Figure 4.7 Base configuration - Internal Radio



← Create Base Config

|                     |                  |
|---------------------|------------------|
| Startup             | Auto start >     |
| Data Link           | External Radio > |
| Baud Rate           | 115200 >         |
| Differential Format | RTCM3.2 >        |

OK

Figure 4.8 Base configuration - External Radio

9. After filling the information for the above configuration, click [OK]. Select this configuration in the work mode list and click [Start] to start data transmission for base which is shown as below.

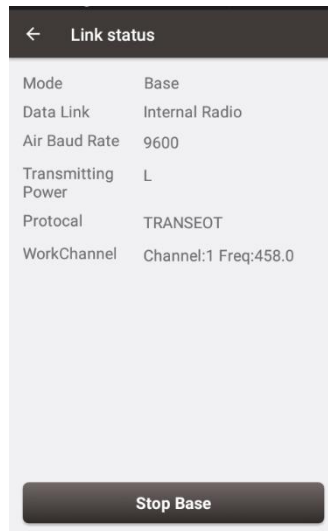


Figure 4.9 Link status of base using internal radio

## 4.2 Rover operation



Figure 4.10 LUKA as a Rover - Network Mode

Table 4.4 Devices of LUKA as a rover network mode

| NO. | Device Name        |
|-----|--------------------|
| 1   | LUKA GNSS receiver |
| 2   | Ranging pole       |
| 3   | Bracket for TC50   |
| 4   | TC50 Controller    |



Figure 4.11 LUKA as a Rover - Internal Radio

Table 4.5 Devices of LUKA as a rover internal radio mode

| NO. | Device Name                   |
|-----|-------------------------------|
| 1   | LUKA GNSS receiver            |
| 2   | 410-470MHz radio whip antenna |
| 3   | Bracket for TC50              |
| 4   | Ranging pole                  |
| 5   | TC50 Controller               |

Detailed steps of software operation:

1. Set up LUKA according section 2.1 Setting up LUKA after all the components above are ready, ensure the battery has sufficient power and insert one SIM card when 4G/3G/2G network is required for operation;
2. Long press the power button to power on LUKA;
3. Use NFC function to launch Nuwa app. While the screen of TC50 Controller is unlocked, put TC50 Controller close to the LUKA NFC logo. The Bluetooth pairs automatically after a beep and Nuwa is launched requesting to open the latest project. Click [OK] and start configuring LUKA from step 7. Also you can click [Cancel] to create a new project or open an existing project, and then start configuring LUKA from step 7.
4. If using an android device without NFC function, ensure LUKA is powered on, and launch Nuwa application on the android device. Click [Project] in the main interface to create a new project or open an existing project and connect LUKA manually.
5. Back to the main interface of Nuwa app, click [Device] -> [Connect] under an opened project;
6. Select [LUKA] for the Device Type, select [Bluetooth] for the Connect Type, click [Connect Config] to search and pair the Bluetooth address of LUKA, select [LUKA] for the Antenna and click [Connect] to enable communication between the android controller and LUKA.
7. Back to [Device] - > [Rover], click [New] to create a new configuration for base.

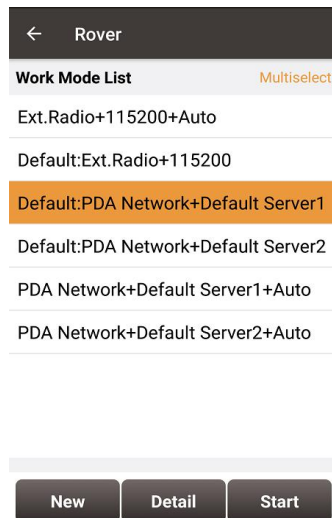


Figure 4.12 Rover setting interface

8. Edit rover configuration for LUKA GNSS receiver under different data link selections. The Receiver Network and PDA Network have three protocol options respectively: Ntrip, TCP and Tersus Caster Service (TCS).

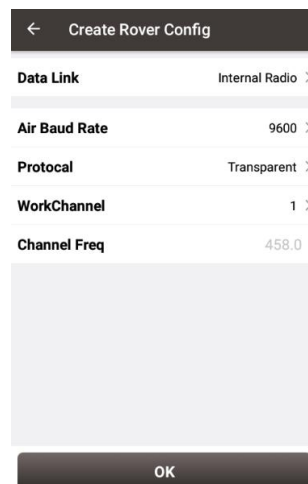


Figure 4.13 Rover configuration - Internal Radio

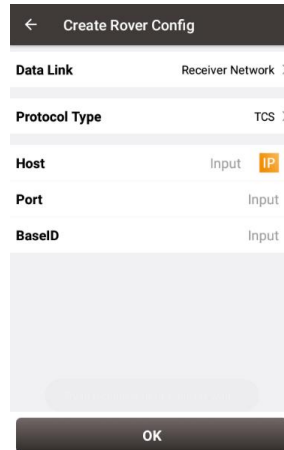


Figure 4.14 Rover configuration - Receiver Network (TCS)

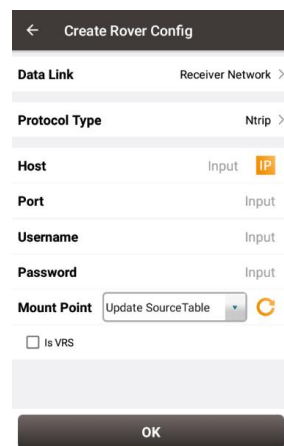


Figure 4.15 Rover configuration - Receiver Network (Ntrip)

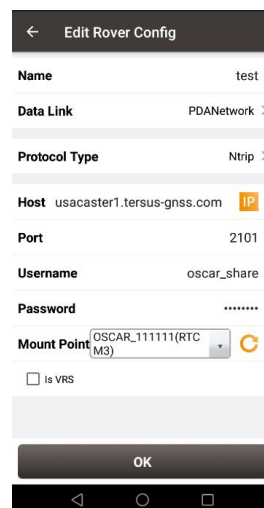


Figure 4.16 Rover configuration - PDA Network (Ntrip)

**Note: Select PDANetwork when using cellular or Wi-Fi network of a PDA such as TC50 Controller.**

9. After filling the information for the above configuration, click [OK]. Select this configuration in the work mode list and click [Start] to start data transmission for rover which is shown as below.

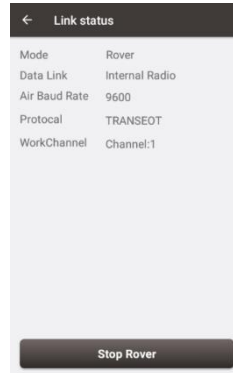


Figure 4.17 Link status of Rover using internal radio

### 4.3 Static survey

Before performing static survey, ensure the battery has sufficient power and insert one SIM card when 4G/3G/2G network is required for operation.

Detailed steps of software operation:

1. Long press the power button to power on LUKA;
2. Use NFC function to launch Nuwa app. While the screen of TC50 Controller is unlocked, put TC50 Controller close to the LUKA NFC logo. The Bluetooth pairs automatically after a beep and Nuwa is launched requesting to open the latest project. Click [OK] and start configuring LUKA from step 6. Also you can click [Cancel] to create a new project or open an existing project, and then start configuring LUKA from step 6.
3. If using an android device without NFC function, ensure LUKA is powered on, and launch Nuwa application on the android device. Click [Project] in the main interface to create a new project or open an existing project and

connect LUKA manually.

4. Back to the main interface of Nuwa app, click [Device] -> [Connect] under an opened project;
5. Select [LUKA] for the Device Type, select [Bluetooth] for the Connect Type, click [Connect Config] to search and pair the Bluetooth address of LUKA, select [LUKA] for the Antenna and click [Connect] to enable communication between the android controller and LUKA.
6. Click [Survey] -> [Static Survey], fill in the parameters of interval, cutoff angle, and etc. Then click [Start] to start static survey.

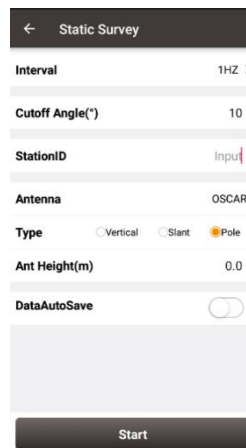


Figure 4.18 Static Survey configuration

7. If the DataAutoSave function is turned on, the static data is recorded automatically in the internal storage when power up LUKA next time. You can download data file refer to section 2.3.

## 4.4 Tilt survey and stakeout

Tilt function is only applicable for LUKA GNSS receiver Ultimate version under rover mode.

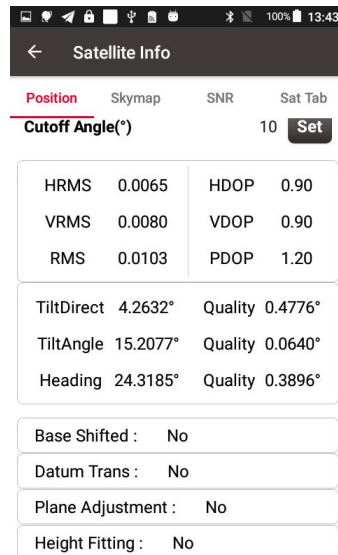
#### 4.4.1 Tilt initialization

The tilt compensation of LUKA GNSS receiver Ultimate version is free of complex calibration. The tilt compensation will be initialized when the surveyor walks forward naturally for several meters after turning on the tilt compensation function. You can start tilt survey right after you walk to the survey point.

After the LUKA GNSS receiver Ultimate version is connect in Nuwa app, and we configure it working as a Rover. Click the device icon  on the top or click [Device] under the device functional group to enter the device information interface. Turn on the [Tilt Enable] on the device interface.

When tilt function is turned on, the tilt icon on the survey interface of NUWA app starts flashing red. At this time, walk a few steps ahead, tilt the pole at any direction, then the tilt icon turns [ON] which indicates tilt compensation is valid. Now you can start tilt survey.

When the tilt compensation is valid, click the Satellite info icon to view the detailed information of tilt compensation including tilt status, tilt direction, tilt angle, heading and their quality index. Among them, the tilt direct indicates which direction is tilted, that is, the angle between the projection of the ranging pole on the ground and the north direction after tilting; the tilt angle indicates the degree of tilt, that is, the angle between the tilted pole and the vertical direction; Heading indicates the surveyor's orientation (the facing of LUKA's back, we consider LUKA's panel is always facing the surveyor).



| Satellite Info        |          |         |         |
|-----------------------|----------|---------|---------|
| Position              | Skymap   | SNR     | Sat Tab |
| Cutoff Angle(°)       |          | 10      | Set     |
| HRMS                  | 0.0065   | HDOP    | 0.90    |
| VRMS                  | 0.0080   | VDOP    | 0.90    |
| RMS                   | 0.0103   | PDOP    | 1.20    |
| TiltDirect            | 4.2632°  | Quality | 0.4776° |
| TiltAngle             | 15.2077° | Quality | 0.0640° |
| Heading               | 24.3185° | Quality | 0.3896° |
| Base Shifted : No     |          |         |         |
| Datum Trans : No      |          |         |         |
| Plane Adjustment : No |          |         |         |
| Height Fitting : No   |          |         |         |

Figure 4.19 Detailed information of tilt compensation

#### 4.4.2 Tilt survey

After turning on [Tilt Enable] and tilt initialization is finished, enter Survey interface and start tilt survey.

The tilt status is displayed at the top of the survey interface. When the tilt status is ON, it is considered that the tilt compensation accuracy is high and it is in a usable state. You can start survey using the tilted ranging pole. Please ensure that the antenna height setting is correct which will affect the tilt measurement results.

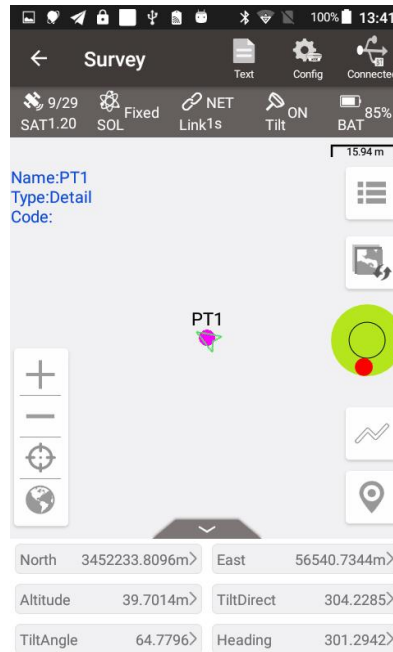


Figure 4.20 Tilt status is ON

When the status is displayed as N/A and blinking, it is considered that the accuracy of tilt compensation is reduced and it is in a state that is not recommended. This may be caused by the surveyor standing for too long, rotating the ranging pole, or hitting the ranging pole to the ground. When the status is N/A, you need to redo the initialization. Generally, you do not need to stand still, just hold the ranging pole and walk forward to the next point, the initialization is complete automatically.

**Note:** during the tilt survey, please keep the LUKA OLED display facing the surveyor as much as possible. Please do not rotate the pole or hit the pole to the ground, which will invalidate the initialization or affect the accuracy of the tilt compensation. In addition, during the tilt point survey, if it does not continue at the third epoch reached when it is set smoothing 5 epochs for surveying points, please check whether the tilt compensation is invalid. It is not allowed to continue to complete the survey in the case where the tilt initialization accuracy is low.

### 4.4.3 Tilt stakeout

After turning on [Tilt Enable] and tilt initialization is finished, enter the Point Stakeout or Line Stakeout interface and start tilt stakeout. The tilt state is also added at the top of the stakeout interface to indicate the current tilt available state.

During the tilt stakeout process, if you enter the threshold range of the stakeout setting, the software will display a virtual tilt ranging pole along with the beep sounds. It is drawn according to the tilt direction angle. When the pole is tilted in a certain direction among east, west, south and north, the virtual tilt ranging pole on the interface will also tilt in a certain direction.

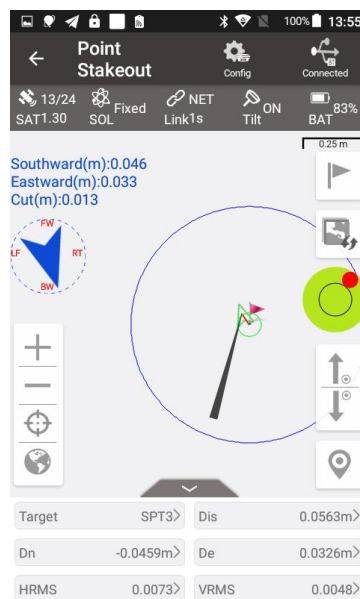


Figure 4.21 Point stakeout when tilt compensation is on

## 4.5 Issues and solutions

This section lists possible issues and effective solutions to solve them. Please read this section before contacting Tersus technical support.

1. LUKA GNSS receiver cannot receive satellite signals.

**Solution:**

- (1) Change the survey environment, and restart LUKA in an open space.

2. The internal UHF radio does not transmit data.

**Solution:**

- (1) Check whether the receiver is searching satellites normally;
- (2) Check whether the radio antenna is installed properly;
- (3) Check whether the radio module's protocol and channel are configured correctly and consistent with the configuration of rover's radio.

3. CORS network is not able to be logged in.

**Solution:**

Check whether the 4G SIM card is properly installed, and whether it can be used normally.

4. The communication between Nuwa and LUKA fails.

**Solution:**

- (1) Check whether the LUKA is powered on;
- (2) Re-search and pair the Bluetooth;
- (3) Upgrade Nuwa to the latest version.

5. There is no correction data for rover when using Ntrip work mode.

**Solutions:**

- (1) Check whether the IP address, port, user name, password is correct;
- (2) Check network. Try to use PDA/controller network to compare. Make sure there is no issue on the contact between the SIM card slot and the SIM card.
- (3) Obtain the SourceTable to check the receiver network module, ensure there is no issue on CORS service.
- (4) Try to log in with the same configuration and get a compared result if there is an extra receiver.
- (5) If still cannot log in, consult your CORS service provider.

6. How to export static observation data from LUKA?

**Solutions:**

- (1) Connect LUKA receiver with a computer through a Type-C to USB cable.
- (2) The computer detects the LUKA receiver as an external disk.
- (3) Open the Record folder, find the trs file and rinex file in its storage according to recording date.
- (4) Copy the static observation data and paste them to the designated folder in your computer.

7. How to calibrate the E-Bubble of LUKA receiver?

**Solutions:**

- (1) Firstly, install LUKA receiver on the tribrach of a tripod. Adjust the tribrach to enable the bubble to the center.
- (2) Next step, select <Adjust> in the Nuwa under Device Info -> E-Bubble to complete the calibration.

## 8. How to apply Geoid model file correctly?

### **Solutions:**

- (1) Prepare the Geoid file at first and placed in the path of Internal storage\TersusSurvey\Geoid.
- (2) Next step, launch Nuwa and go to select Project - Current Project and edit Coordinate System. Find the Height Fitting-Adjust Method and select Geoid.
- (3) Last, select the file under Geoid List and apply it.

## 9. How to configure LUKA serial port output NMEA log?

### **Solutions:**

- (1) Nuwa can configure to output NMEA by the NMEA option. It can be specified the Baud Rate, the kind of sentence.

## 10. A base receiver is working well, the rover receiver cannot get correction data, how to fix this?

### **Solutions:**

- (1) Check whether the radio antenna connects well with receiver. Carefully check whether the interface is tightened.
- (2) Check whether the air baud rate, Protocol, Bandwidth, Frequency match right with that of the base receiver.
- (3) Switchover the radio frequency to avoid the possible interference from nearby devices.

## 11. The LUKA rover works at a short distance (not normal distance) at the radio mode?

### **Solutions:**

- (1) Check whether the rover connects a radio antenna.

- (2) Adjust the radio of base at the high power gear.
- (3) Check the environment if there exists radio interference along the propagation line.

## 5. Terminology

| Abbreviation | Description                                      |
|--------------|--------------------------------------------------|
| AC           | Alternating Current                              |
| BDS          | BeiDou Navigation Satellite System               |
| CMR          | Compact Measurement Record                       |
| DC           | Direct Current                                   |
| eMMC         | Embedded Multi Media Card                        |
| GLONASS      | GLObal NAVigation Satellite System               |
| GNSS         | Global Navigation Satellite System               |
| GPS          | Global Positioning System                        |
| GSM          | Global System for Mobile Communications          |
| LED          | Light Emitting Diode                             |
| OLED         | Organic Light-Emitting Diode                     |
| PDA          | Personal Digital Assistant                       |
| PPK          | Post-Processing Kinematic                        |
| PPS          | Pulse Per Second                                 |
| QZSS         | Quasi-Zenith Satellite System                    |
| RINEX        | Receiver Independent Exchange format             |
| RMS          | Root Mean Squares                                |
| RTK          | Real-Time Kinematic                              |
| RTCM         | Radio Technical Commission for Maritime Services |
| SIM          | Subscriber Identification Module                 |
| TCP          | Transmission Control Protocol                    |
| UAV          | Unmanned Aerial Vehicle, drone                   |
| UMTS         | Universal Mobile Telecommunications System       |
| USB          | Universal Serial BUS                             |
| UTC          | Universal Time Coordinated                       |

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