GNSS POSITIONING SYSTEM

R90-X

USER MANUAL

RUIDE

1. A BRIEF INTRODCTION

RUIDE dedicates to offer the most advanced GNSS equipment to surveyors.

RTK surveying technology, as a cutting-edged and efficient surveying technology, has been playing a more and more important role in surveying work. RUIDE guarantees that R90-X, its latest RTK receiver, is suited for nowadays demands of precision, reliability and user-friendliness.

About RTK R90-X

R90-X is able to receive both GPS signal frequencies and satellite signals from GLONASS and GALILIEO systems, and that's why we also call it "GNSS" receiver.

R90-X series mainframe is integrated with a GNSS antenna, GNSS module, UHF transmitting and receiving radio, radio antenna, GSM/GPRS modem, Bluetooth module and battery. The rover is highly integrated so that the surveyor only needs the handheld data controller to do the surveying work.

R90-X is designed according to the standard of advanced GNSS receiver technology, which is featured with higher stability, less power losing, smaller volume, and lighter weight. Furthermore, it has special design in waterproof, dustproof and vibration-proof. The batteries and built-in radio is installed in the bottom of the mainframe, which make the waterproof and dustproof functions more effective.

UHF antenna is studied in order to make its electromagnetic center connected with the electromagnetic center of dual-frequency antenna: so that it reduces at the same time the interference and makes the volume much smaller. The tight electronic shielding can avoid the interference more effective.

4 Features

Integrated design and Anti-jamming property are combined perfectly. The Integrated design is the fashion of surveying equipment. Avoiding "antenna", module design can resolve the jamming problem effectively.

Mastering the core of data transfer radio technology. The performance of data transfer technology is at the same level of international state-of-art technology. The bit error rate (BER) is 10^{-7} and the radio collision problem is decreased.

Industrial module with three proof design (dustproof, waterproof, quakeproof). Professional module, high-intensity enclosure material and excellent waterproof function enables R90-X a better performance in field surveying.

Double interfaces (USB, serial com port) transfer with high speed,64M memory. Besides the ordinary serial port, R90-X adopts USB connection technology to make the static data transferred more convenient. The built-in 64M memory can meet the need of 80 hours of static collecting with 1 second interval.

Technology Specifications

Technology pass on, Comprehensive. Core technology of RTK data link make the performance of R90-X reaches the international state-of-art level. It contains double-key operation, wireless, Bluetooth communication, waterproof/ dustproof/vibration-proof design. All the technologies are integrated in R90-X, which secures the stability of the mainframe.

Neat design, strive for excellence. The neat design of internal configuration, UHF antenna make the electromagnetic central of UHF antenna connect with the electromagnetic central of Dual-frequency antenna, at the time of reduce the interference, it can improve the configuration of mainframe as well as making the volume much smaller. The tight electronic shielding, can avoid the interference more effectively.

Serving today, looking forward to tomorrow. R90-X system, with the steady radio data communication module, proves it an economical and dependable solution in the RTK surveying work. Furthermore, R90-X provides an optional configuration of GPRS/GSM radio module which is based on VRS net RTK technology.

Focus on quality, strive for excellence. Light and wireless receiver unit weighs only 1.2 kg, making the rover much lighter and convenient to handle. The low power losing of receiver makes the single battery a long lasting life.

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2. R90-X Mainframe

2.1 The Outlook of Mainframe

Fig. 2-1

The mainframe has an almost cylindrical shape, with a base larger than the height. There are three parts: an upper cap, a rubber loop and the main structure. The upper cap protects the GNSS antenna placed inside. The rubber loop has the function to soften possible shocks or falls. In the front of the main structure there are 2 keys and 3 lights, on the bottom side there is one slot for the built-in radio and GSM module, and one for the battery and SIM card. All the others components of the receiver (Bluetooth device, main board, OEM board, etc.) are contained inside the main structure.

2.2 Interface

The mainframe interfaces are shown in Fig. 2-2: the left port (five pins LEMO) is used for external power supply and external radio, the right port (nine pins serial port) is used for data transferring between receiver and computer or between receiver and the handheld. Near the radio & GSM/GPRS module there is the radio antenna interface.

Fig. 2-2

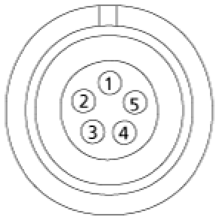


Fig. 2-3

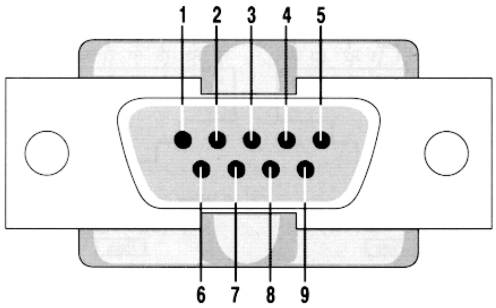


Fig. 2-4

2.3 The Installation of Battery

Under the place of battery, there is a SIM card slot, necessary when a connection with GSM is used.

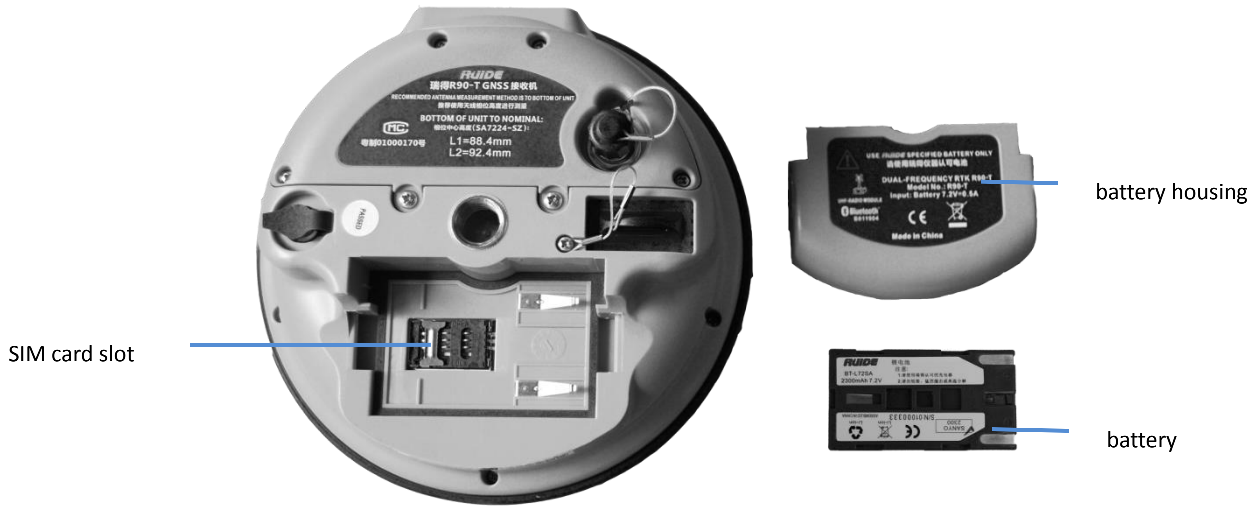
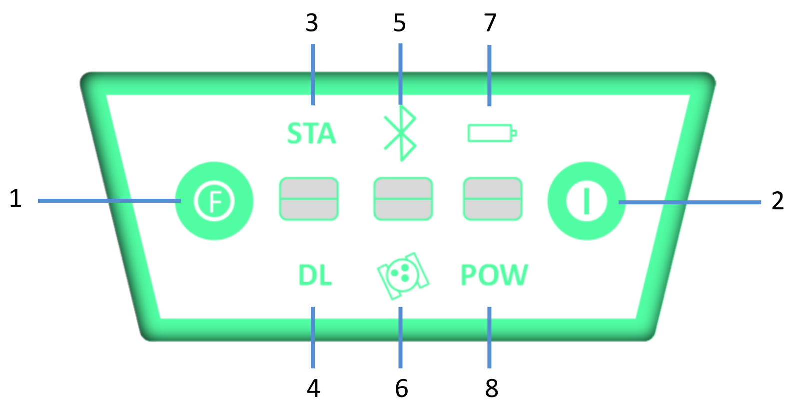


Fig. 2-5

2.4 Indicator light and instrument setup



1. Function Key
2. Power Key
3. Status Light
4. Data Link Light
5. Bluetooth Light
6. Satellite Light
7. Built-in Power Supply Light
8. External Power Supply Light

There are 3 indicator lights, each of which is with 2 different colors referred to 2 different functions.
From left to right:
1st light: status indicator light (red); data link indicator light (green).
2nd light: Bluetooth indicator light (red); satellite indicator light (green).
3rd light: battery power light (red); external power supply indicator light (green).

The usages of them are as below:
BAT (red): Built-in power supply light (Fig. 2-7).
It contains 2 kinds of status:
1. Fixed: power supply in good condition.
2. Flashing: loss of power supply.

Usually when the light begins to flash, you have still one hour of remaining power.

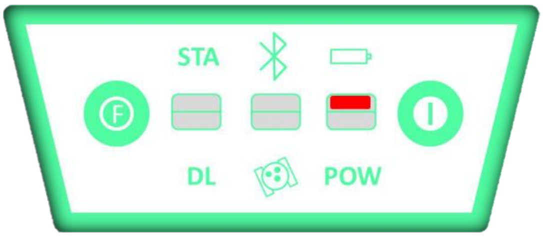


Fig. 2-7 Built-in Battery Light

PWR (green): External power supply light (Fig. 2-8).
It contains 2 kinds of status:
1. Fixed: power supply in good condition.
2. Flashing: loss of power supply.

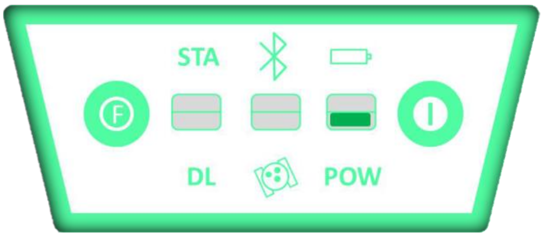


Fig. 2-8 External Power Light

BT (red): Bluetooth indicator light (Fig. 2-9).
Once you have connected the controller with the receiver, this light will keep on.

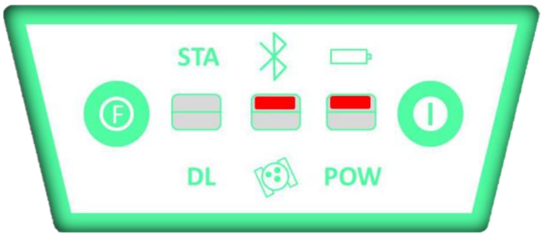


Fig. 2-9 Bluetooth Light

SAT (green): Satellite light (Fig. 2-10).
It shows the amount of locked satellites. When the receiver links one or more satellite signals, it will start to blink for a

number of times equal to the number of locked satellites.

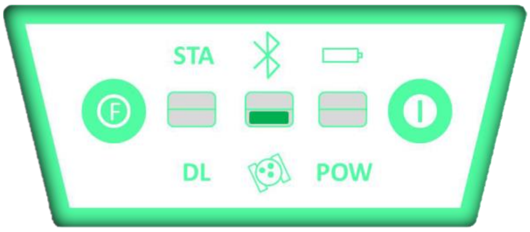


Fig. 2-10 Satellite Light

STA (red): Status light (Fig. 2-11)

In static mode, it blinks when the receiver is recording data, with the same frequency of the sample rate. In base mode, it blinks when the base is transmitting data. In rover mode and internal radio datalink, it blinks when rover is receiving the signal, with a variable frequency determined by the data rate. In rover mode and GPRS/GSM data link, it is lighted up when receiver is not connected and it blinks every 10 seconds after the connection.

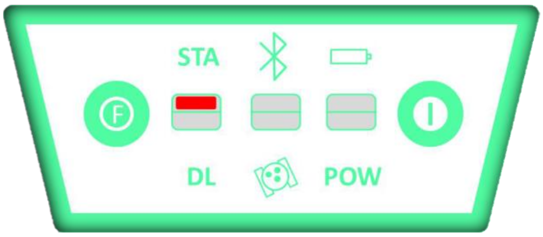


Fig. 2-11 Status Light

DL (green):Data Link light (Fig. 2-12).

In static mode, it keeps lighted up. In rover mode and internal radio data link, it blinks together with STA light and with a variable frequency, determined by the data rate, if it is receiving corrections. In rover mode and GPRS/GSM data link, it blinks both if it is trying to connect and when it is receiving corrections (with a variable frequency determined by the data rate), so only by STA light you can understand if you are connected. If DL light blinks very fast, it means that it doesn't detect the SIM card inside the slot.

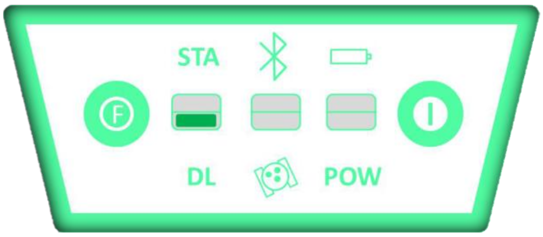


Fig. 2-12

Receiver Mode	PWR (red)	STA (red)	DL (green)	Satellite (green)
Receiver ON Sufficient Power	ON	Not Relevant	Not Relevant	Not Relevant
Receiver ON Low Power	Flashing	Not Relevant	Not Relevant	Not Relevant
Logging of Static Data	ON	Flashing with Frequency of Data Sampling	ON	Flashing for a number of times equal to the amount of locked satellites
Transmitting Data by External Radio	ON	Flashing Every Second	OFF	Flashing for a number of times equal to the amount of locked satellites

Transmitting Data by Built-in Radio	ON	Flashing (Following the Data rate)	Flashing (Following the Data rate)	Flashing for a number of times equal to the amount of locked satellites
Receiving Data by Built-in Radio	ON	Flashing (flowing the data rate)	Flashing (Following the Data rate)	Flashing for a number of times equal to the amount of locked satellites
Receiving Data by GPRS/GSM device	ON	Flash every 10 seconds	Flashing (Following the Data rate)	Flashing for a number of times equal to the amount of locked satellites

F Key: Function key.
It can switch the working mode (static, base and rover) and types of RTK communication of (built-in radio , external radio or GPRS/GSM).

I Key: Power key.
It powers on/off the receiver function and has a confirm function.

Power on receiver: Press and hold I key for at least 1 second, the receiver will be powered on.

Power off receiver: Press and hold I key for a few seconds, after 3 beeps, all light turns off, at the same time, release the key, and the receiver is turned off.

Self-Check: When the receiver works abnormally, you can launch a self-check to fix it. The step is:

- Press and hold I key for more than 10 seconds, as for turning it off, but keep holding the key after all lights are turned off.
- Release the key when you hear another beep: receiver will start to launch a self-check.

Self-check lasts typically 1 minute: during this process, the meanings of the lights are:

- Left Light: if data link (green) turns on, radio module has no problem. If, on the contrary, status light (red) turns on, then radio module may have problems.
- Middle Light: if satellite light (green) turns on, GPRS module has no problem. If, on the contrary, Bluetooth light (red) turns on, then the GPRS module may have problems.
- Right light: if external power supply light (green) turns on, GNSS board has no problem. If, on the contrary, battery light (red) turns on, then GNSS board may have problems.

After the self-check procedure, the receiver will turn on and begin to work normally. It’s better for a new machine to perform at least one initial self-check.

How to select the working mode?

- Insert the battery in the battery housing, press and hold I key and F key at the same time, the receiver will start.
- Keep holding I key and F key until the 6 lights blink at the same time (Fig. 2-13), then release the keys.

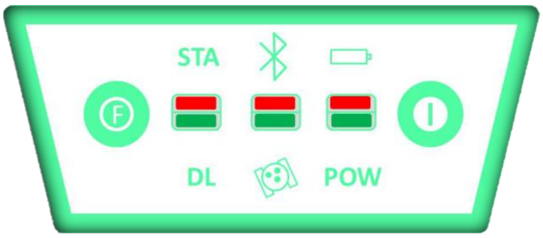


Fig. 2-13 Six Lights Blinking at the same time

- Now every time you press F key, the 6 lights will begin to blink by turns from right to left. You can select 3 different red lights, each of them refers to one working mode.
- Press I key when the chosen light is blinking and the receiver will start the working mode selected.

Rover Mode

When the light stops on the STA light, press I key to confirm, you will enter to rover mode. Such as following figure:

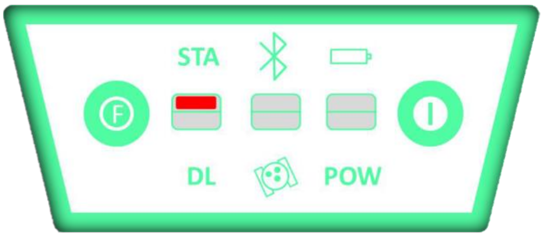


Fig. 2-14 Status Light

Base Mode

When the light stops on the Bluetooth light, press I key to confirm, you will enter to base mode, such as following figure:

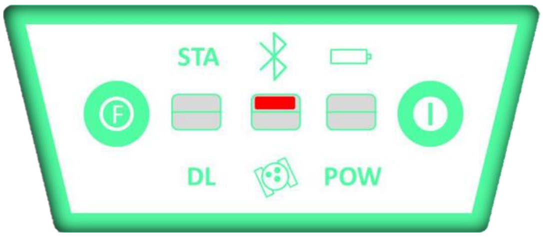


Fig. 2-15 Bluetooth Light

Static mode

When the light stops on the BAT light, press I key to confirm, you will enter to static mode, such as following figure:

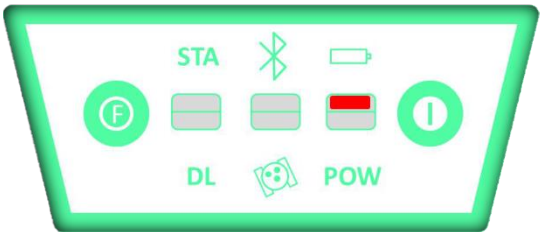


Fig. 2-16 Built-in Power Light

How to select data link?

After you entered work mode, hold F key until you hear 2 beeps, then you can see a green light blinking. Release the key and wait some seconds, then press F key, the 3 green lights will blink by turns. Then you can select different green light, each of which refers to different data link mode. This situation refers only to the rove and base mode, since in static mode there is no green light blinking.

Built-in radio

When the green light stops on the DL light, press I key to confirm, you will shift to use built-in radio, as following figure:

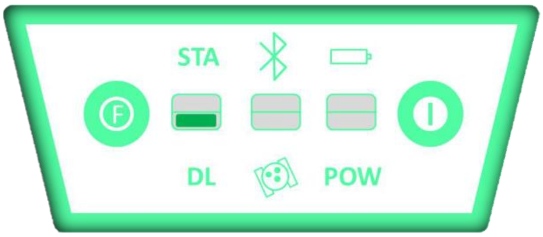


Fig. 2-17 Data Link Light

GPRS/GSM Module

When the green light stops on the SAT light, press I key to confirm, you will shift to use GPRS/GSM module as data link, as following figure:

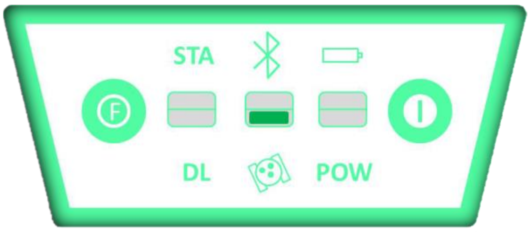


Fig. 2-18 Satellite Light

External radio

When the green light stops on the BAT light, press I key to confirm, you will shift to use external radio as data link, as following figure:

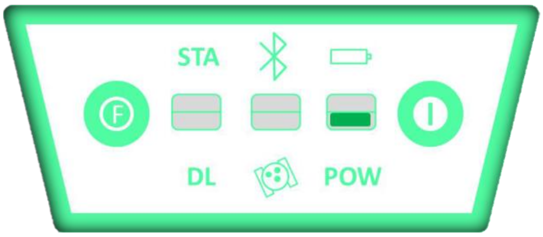


Fig. 2-19 External Power Light

How to check the working mode and data link during work ?

You can press F key one time to check the working mode and data link mode. There are 6 kinds of status.

Static Mode

When you press F key one time, if you see the following figure, it means it's in static mode.

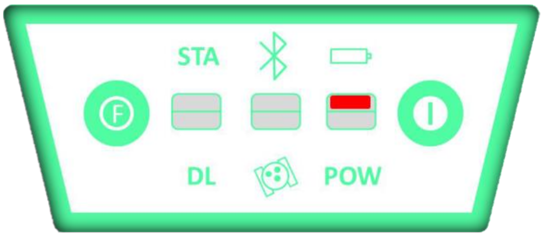


Fig. 2-20 Built-in Power Light

Rover & Built-in Radio

When you press F key one time, if you see the following figure, it means it's in rover & built-in radio mode.

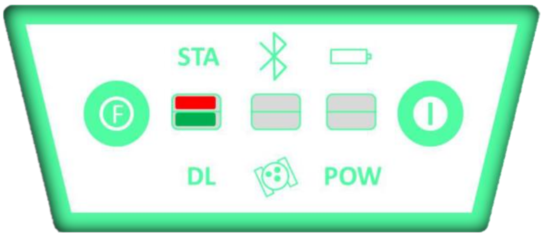


Fig. 2-21 Status & Data Link Lights

Rover & GPRS/GSM Module

When you press F key one time, if you see the following figure, it means it's in rover & GPRS/GSM module mode.

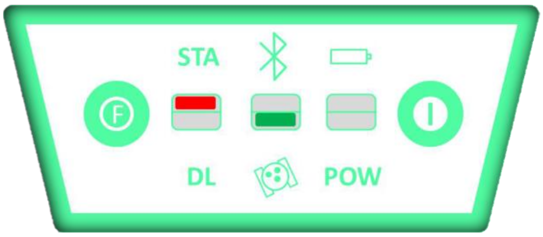


Fig. 2-22 Status & Satellite Lights

Rover & External Radio

When you press F key one time, if you see the following figure, it means it’s in rover & external radio mode.

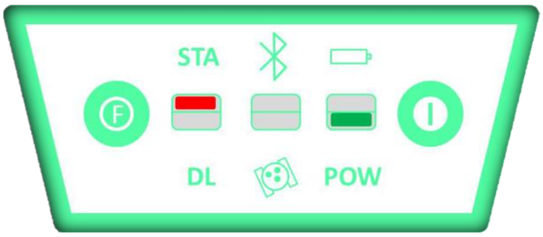


Fig. 2-23 Status & External Power Lights

Base & External Radio

When you press F key one time, if you see the following figure, it means it’s in base & external radio mode.

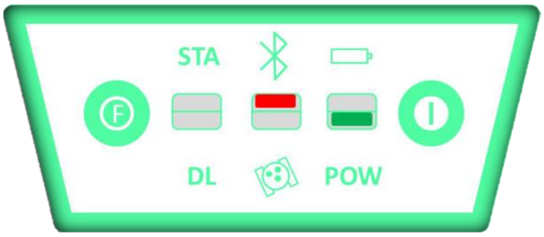


Fig. 2-24 Bluetooth & External Power Lights

Base & GPRS/GSM Module

When you press F key one time, if you see the following figure, it means it’s in base & GPRS/GSM module mode.

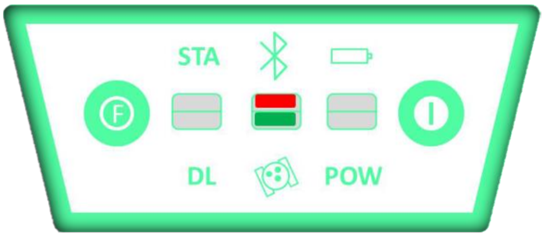


Fig. 2-25 Bluetooth & Satellite Lights

Base & Internal Radio

When you press F key one time, if you see the following figure, it means it’s in base mode and using internal radio for communication.

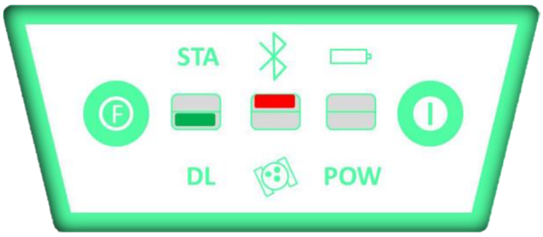


Fig. 2-26 Bluetooth & DL LEDs (Base & Internal Radio)

3. R90-X EXTERNAL RADIO

3.1 About the Radio ADL

Pacific Crest is the leading provider of high-performance data links for the geomatic industry based on the acceptance of its communications protocols as the standard for RTK surveying.

The external radios are high speed wireless semi-manual data transfer radios whose baud rate can reach 19200bps, which is used in GNSS system R90-X.

These radios adopt GMSK adjust mode, and they have a very low bit error rate (BER).

They adopt a transparent mode to transfer data to the RTK GNSS system.

The data transfer interface of radios is the standard RS-232 interface (serial port); it can do data transferring with any terminal equipment which has RS-232.

They adopt advanced wireless booting technology, data processing technology and base band processing technology which ensures a long operational life. There are three frequency ranges for ADL radios, 410-430MHZ, 430-450MHZ and 450-470MHZ.

3.2 Introduction of ADL Radio

ADL Sentry is an advanced, high speed, wireless data link built to survive the rigors of precise positioning and environmental monitoring applications. This sophisticated 0.1-4.0 Watt radio modem utilizes Pacific Crest's next generation Advanced Data Link (ADL) technology. ADL Sentry's supports two serial ports that allow configuration without interrupting the data flow.

Fig. 3-1 ADL External Radio

The ADL product line is compatible with GPS/GNSS RTK equipment worldwide allowing for easy integration with other equipment or systems.

1). The TX LED indicates that the ADL Sentry is broadcasting. In most applications, the TX LED will flash approximately once per data packet.

2). The PWR LED indicates the power status and also provides a low external voltage supply indicator. When lit, power is turned on. The PWR LED will blink to indicate if the external voltage supply is approaching the minimum value. If the PWR LED does not respond to the On/Off button, then the level of the external voltage supply should be inspected.

3). The RX LED flashes to indicate that the ADL Sentry is receiving signals from another radio or from a source of interference. The default is Signal received, but you can use ADLCONF configuration software to reset the radio so that when its RX LED flashes it means Data packets received. During normal operation, the RX LED will flash at a once-per-second rate indicating the reception of transmissions from the transmitting radio. If the RX LED is on continuously, then a source of interference may be impacting the ability of the ADL Sentry to receive data. Try repositioning the antenna, or changing to another channel at both the transmitter and receiver to reduce or eliminate the interference.

4). The PGM LED can be programmed to behave in user-definable ways.

3.3 How to Set up ADL Radio

To operate your ADL Sentry radio in the field you will need an antenna, a portable power supply and a cable to connect to a data source such as a GNSS receiver.

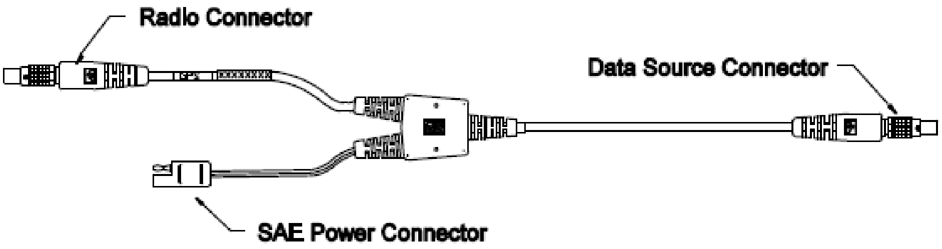


Fig. 3-2 ADL Sentry Data/Power Cable

We recommend you inspect the antenna center push-pin contact to make sure that it makes good contact with the antenna mount. A good antenna connection is critical to system performance.

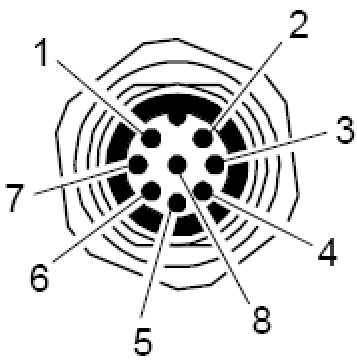


Fig. 2.3 – ADL data and Power connector

Pin No.	Description
1	Signal Ground
2	Power Ground
3	TX
4	RX
5	RTS
6	N/C
7	CTS
8	9-30 VOLTS, 2 AMP MAX

Warning: Although transmitting without an antenna will not cause damage to the ADL Sentry, it is not recommended. Using a gained antenna will raise the Effective Isotropic Radiated Power of the ADL Sentry radio. Make sure the resultant Effective Isotropic Radiated Power does not exceed your licensed limit.

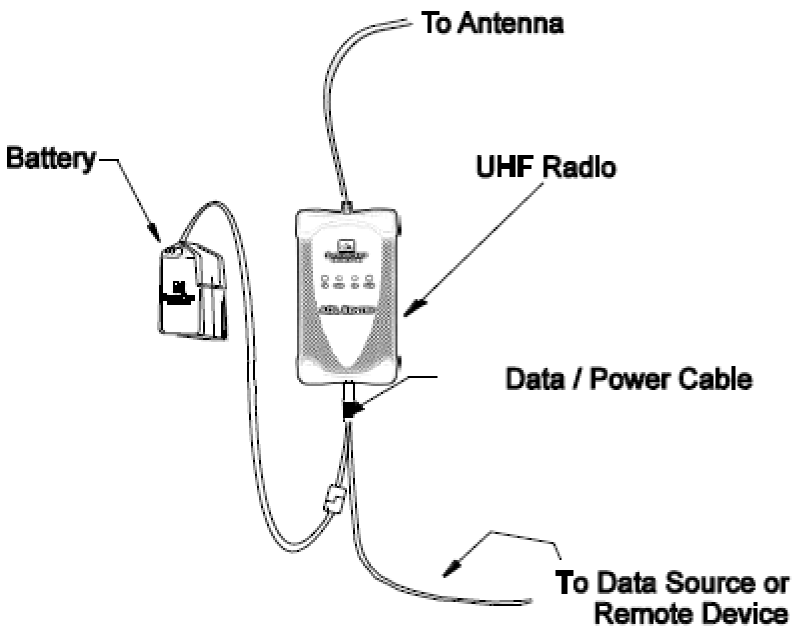


Fig. 3-3 ADL Sentry Setup

2.4 Radio channel and Communication Protocol Configuration

Usually we use ADLCONF software to configure ADL radio. The radio will turn on when it is connected to power. ADLCONF is a suite of software utilities for configuring and troubleshooting Pacific Crest's Advanced Data Link (ADL) line of digital communication radios and modems.

Step 1:

Connect to an ADL radio. Open this software and click on ***Connect*** on the upper right of ADLCONF main screen. ***Soft Break*** and ***Power On Capture*** are two methods to put the radio into a mode that accepts command from ADLCONF as the Fig 3-4 shows. Then you can see the basic information in DEMO mode. See the Fig 3-5 below.

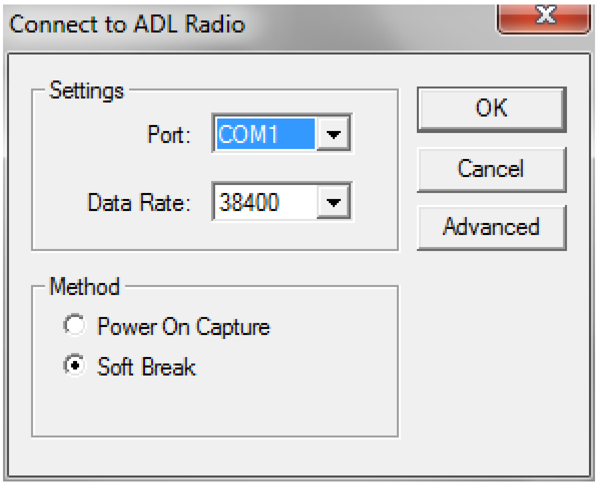


Fig. 3-4 Connecting radio to PC

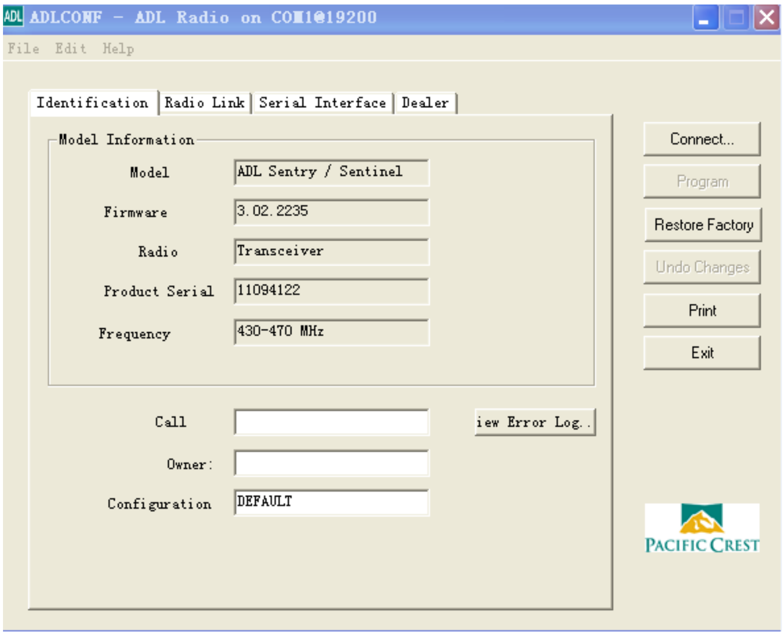


Fig. 3-5 Basic Information

Step 2:

In ***Radio Link,*** you can change the current radio channel and link rate. You can also modify ***Modulation***, ***Sensitive***, ***TX power level*** and more ***Advanced*** settings. For more introduction, you could find in ADL user guide which under the installation directory.

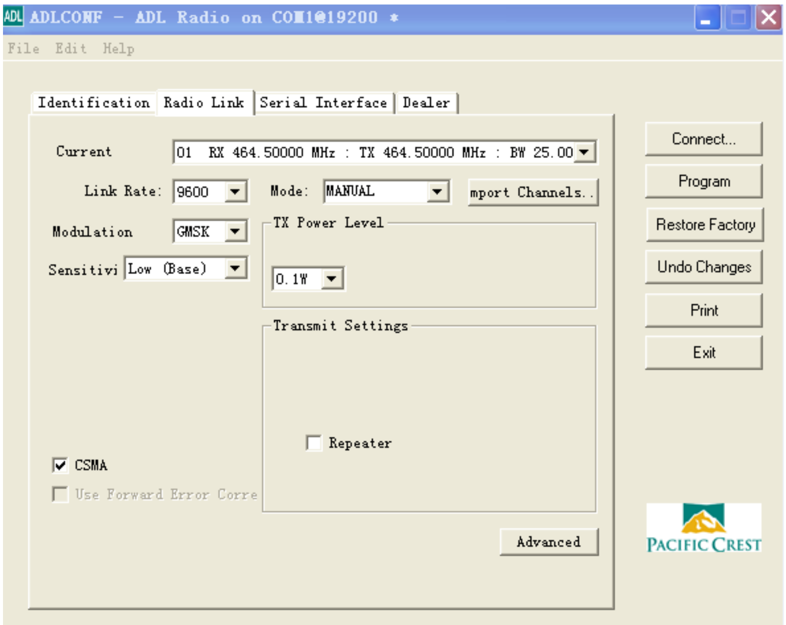


Fig. 3-6 Radio Link

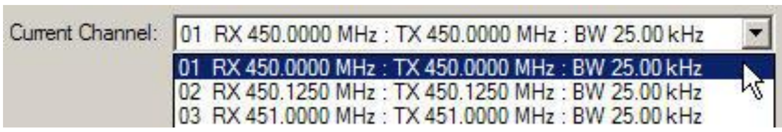


Fig. 3-7 Radio Channel

Your radio's channel table can comprise more than one channel, but the radio can be set only to one channel at a time. The ***Current Channel*** field indicates the current setting. Click the down arrow to the right of the ***Current Channel*** field to display all the channels in your channel table. To select another channel, simply click on it.

Note: your radio will not be set to this new channel until you click the Program button.

While all ADL radios can be reconfigured using ADLCONF, some models have user interfaces that allow you to select other channels on the front of the radio while others can be reconfigured only using ADLCONF.

Step 3:

In ***Serial Interface***, you can change the radio communication protocol as ***SOUTH***. Please select ***SOUTH*** if you want to work with our GDL series. Also do not forget to Program after you make the decision. See the Fig 3-8. One more thing is that if you want to change the bandwidth from 25 to 12.5 or back, a dongle is requested.

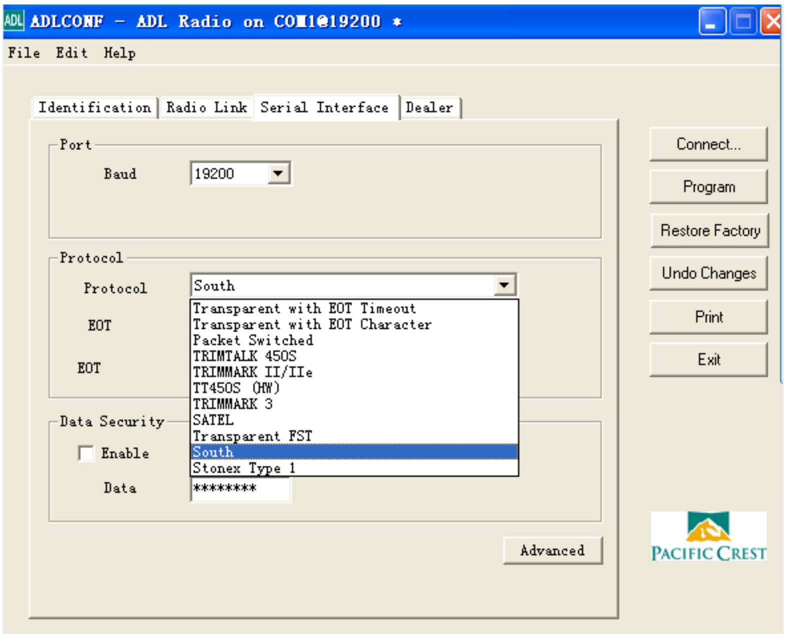


Fig. 3-8 Protocol Modification

You can find the latest ADLCONF Software and its manual on Pacific Ocean's official website.

4. THE INTRODUCTION OF R90-X ACCESSORIES

4.1 The Case of R90-X

There are 2 cases for R90-X, one is for rover and the other for base. The internal components of these 2 cases are different.

Fig. 4-1 Carrying Case

4.2 Battery and Charger

<u>Receiver</u>

The standard configuration contains two types of battery and a slot for rechargeable batteries and an adapter. The battery is Lithium-ion battery.

Fig. 4-2 Li-on battery

Fig. 4-3 Battery Charger

<u>Psion Battery and Charger.</u>

Fig. 4-4 Controller Battery

Fig. 4-5 Adapter & Charger

4.3 The Receiving Antenna and Transferring Antenna of Data Link

R90-X adopts a UHF transferring antenna which is suitable for field surveying, and an all-direction receiving antenna.

Fig. 4-6 Transferring Antenna & Receiving Antenna

4.4 Cables

4.4.1 Radio Cable

External power supply cable (PCRR) shape a “Y” connection cable.

It is used to connect the base mainframe (red), transmitting radio (blue) and connect the accumulator (red and blue clip). It has the function of power supply and data transfer.

Fig. 4-7 Cable for External Power Supply

4.4.2 Controller Cable

USB communication cable is used for connecting handheld controller and computer, using the software Microsoft ActiveSync if you use Windows XP or an earlier version, or Windows Mobile Device Center if you use Windows Vista or Windows 7 (these programs are available in Microsoft website for free). Below are different cables for different controllers.

Fig. 4-8 USB Communication Cable for Psion

Fig. 4-9 USB Communication Cable

4.4.3 Receivers Cable

Multi-function communication cable: this cable is used for connecting receiver and computer used for transferring the static data, updating firmware and the license. It can also be used for connecting GEOS controller and receiver, in case of malfunctioning of the Bluetooth device. See Fig. 4-10.

Fig. 4-10 Multi-function Communication Cable

Inside the Psion bundle there is also a cable used for connecting Psion and receiver, in case of malfunctioning of Bluetooth device. See Fig. 4-11.

Fig. 4-11 Communication Cable between Psion and Receiver

4.5 Other Accessories

Other accessories includes 2.45m retractable pole, 30cm supporting pole, bracket for controller, tribrach with plummet, tripod (wood or aluminum, with quick or twist clamps), connector between receiver and tribrach, and measuring tape.

Fig. 4-12 2.45m retractable pole

Fig. 4-13 30cm supporting pole

Fig. 4-14 Bracket for controllers

Fig. 4-15 Tribrach and adapter with optical plummet

Fig. 4-16 Connector between tribrach and receiver

Fig. 4-17 Measuring tape

Notice: On the basis of the configuration chosen (base or rover), some of these accessories are included or not in the receiver bundle.

5. OPERATION

5.1 The Installation of Base and Rover

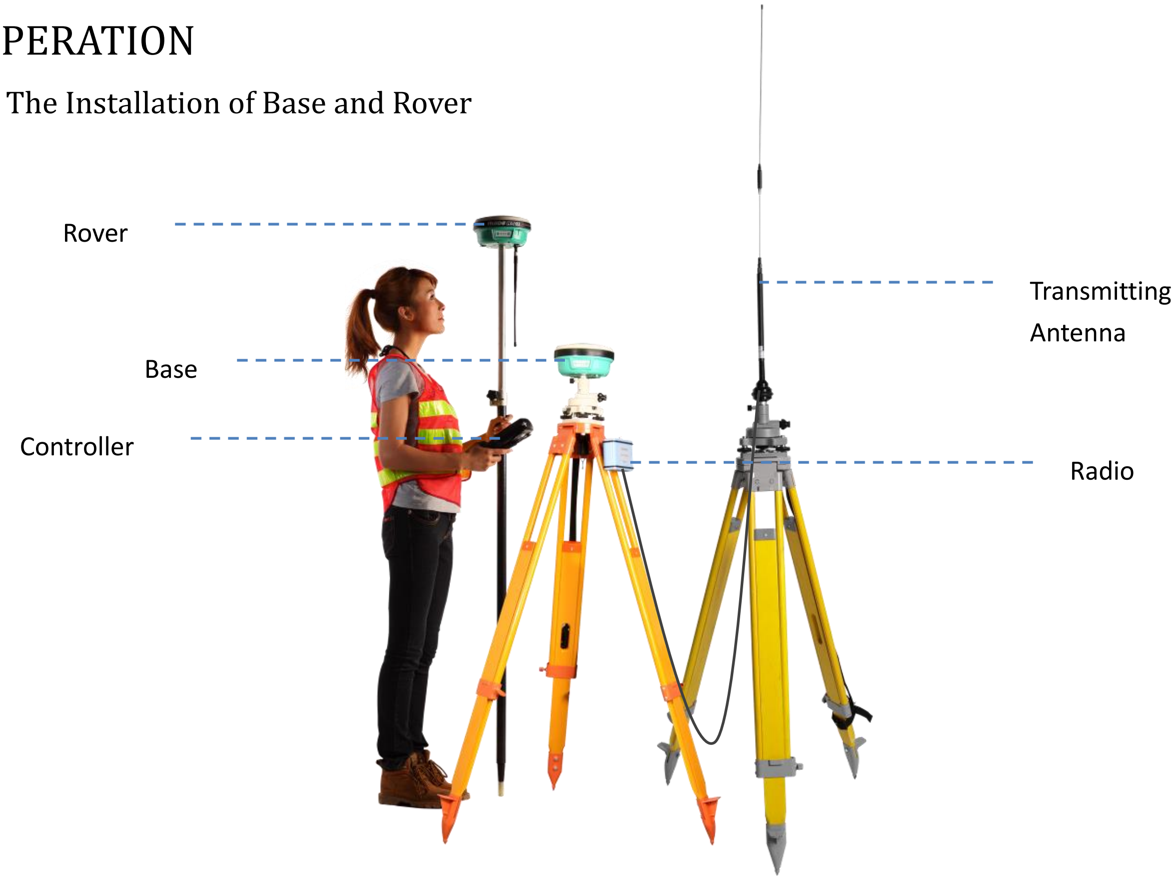


Fig. 5-1 Base and Rover Configuration

Installation of Base

1). Set the tripod on a location with known coordinates or unknown coordinates. Mount the base receiver onto the tribrach.

2). Set the transmitting antenna and radio: it would be better to use a pole support. Rise the antenna as high as possible, then put the radio at suitable position, and connect the multi-function communication cable.

3). Make sure that the connection is right, then switch on the radio and base unit.

Installation of Rover

1). Install the pole, rover and receiving antenna, then power on the rover.

2). Install the bracket, fix the handheld controller to the bracket, and open the controller to connect the Bluetooth. Then you can do the setting of the instrument.

5.2 Instruments Settings

Fig. 5-2 Display Keys

The setting of base and rover can be set manually as below:

Rover Mode

Hold Ⓘ and Ⓕ key until these six lights are flashing at the same time, then press Ⓕ key to choose the working mode:

Press Ⓘ key when the light of STA is on, to choose the working mode of rover.

After a few seconds, hold Ⓕ key for about 5 seconds, until you hear the second beep, release Ⓕ key, and press Ⓕ key

to confirm the choosing of the communication mode.
When the light of DL is on, press Ⓘ key to confirm the choosing of built-in radio communication mode.
When the light of SAT is on, press Ⓘ key to confirm the choosing of GSM communication mode.
When the light of PWR is on, press Ⓘ key to confirm the choosing of external radio communication mode.

Base Mode

Hold Ⓘ and Ⓕ key until these six lights are flashing at the same time, then press Ⓕ key to choose the working mode:
Press Ⓘ key when the light of BT is on, to choose the working mode of base. After a few seconds, hold Ⓕ key for about 5 seconds, until you hear the second beep, release Ⓕ key , press Ⓕ key to choose the communication mode.
When the light of DL is on, press Ⓘ key to confirm the choosing of internal transmit mode.
When the light of PWR is on, press Ⓘ key to confirm the choosing of GSM transmit mode.
Press Ⓘ key to confirm the choosing of external radio transmit mode.

Static mode

Hold Ⓘ and Ⓕ key until these six lights are flashing at the same time, then press Ⓕ key to choose the working mode:
When the light of BAT is on, Press Ⓘ key to choose the static mode.
When you next turn on the receiver, the working mode is the mode you lastly selected.

According to your preference, you can set the parameters of the receiver via handheld controller both for the working mode and lighting. But you cannot switch from one mode to another.
For instance, the rover parameters include: sampling interval, mask angle, antenna height, maximum accepted PDOP value.
Without using the controllers the receiver works with default parameters.
The static mode parameters cannot be selected by the controller, but only modifying the file “config.ini” on receiver hard disk.

5.3 Operation of LEDs

Static Mode

The data link and power LEDs will remain on during operation. When there are sufficient satellites found, the receiver will start recording epochs, and the status indicator LED will flash according to sampling interval (5 seconds by default) and the satellite LED will flash a number of times equal to the fixed satellites.

Base Mode

After setting the mode and power on the instrument, the base will enter the transmit mode
1.PDOP<2.5; 2. When the satellite amount>8 and PDOP<4.5, the base will enter to the transmit status, the data link flash twice every five seconds, the status indicator light flash every one second, it means the base transmits normal, the interval is 1 second.
If you need to change the interval, or reset the transmit condition, you should connect the controller with receiver by cable or Bluetooth first.

Rover Mode

Bluetooth and power LED will remain on during operation. The satellite LED will blink according to the number of satellites as described for static mode. Data link LED will blink with the frequency of 1 second, while Status light will blink with a frequency of about 5 seconds.

5.4 How to Design the Net

The net design is mainly decided according to the user’s requirement. However, outlay, time interval of observation, type

of receiver and the receiver amount, etc also decide the net design.
In order to meet user's requirement, we should keep the principle as follows:

1). GPS net normally forms closed graph by independent observation borders, such as triangle, polygon or connecting traverse, etc, to add checking conditions and to improve the net consistency.
2). When designing the net, the net point should be superposition with the original ground net points. The superposition points are generally no less than three and distribute evenly on the net in order to ensure the changing parameters between GPS net and local net.
3). GPS net point should be overlaid with level points, and the other points are normally united-surveyed with level surveying way or the equivalent way. You can also set some level united-surveyed points in order to offer geoid's information.
4). In order to observe and level united-survey, we often set GPS net points at a clear and easy arriving field.
5). We often distribute some well eyeshot azimuth points around GPS net to ensure united-survey direction. The distance from azimuth to observation station should be more than 300 meters.

According to different purpose of GNSS surveying, independent observation borders of GPS net should compose definite geometry graph. The basic graphs are as follows:

1). Triangle net

The triangle in GPS net is composed of independent observation borders. It has a strong geometry structure and well self-checking ability. It can also find out the coarse difference of result and to share the difference to each baseline with adjustment.
But this net need a lot of observation, especially when receivers are lacking, it will require much more observation time. So only when the requirements on accuracy and security are very high, as well as receivers are more than three, we can use this graph, see Fig. 6-3.

2). Circle net

Circle net is composed of many loops which are formed of many independent observation borders. This net is similar with one of the classical surveying-lead net. Its structure is a little worse than triangle net. The amount of baselines in closed loop decides the self-checking ability and consistency.
General speaking, the amount of baselines has such limit as follows:
The advantage of circle net is with small workload, good self-checking and consistency. But the main disadvantage is that the accuracy of indirect-observed border is lower than that of direct-observed border, and the baseline accuracy of neighbor points distributes unevenly. In field surveying, we usually use annexed traverse as special example according to practical situation and the net usage. This requirement for this traverse is the high accuracy for the known vectors between two point ends. Furthermore, the amount of annexed traverses cannot exceed the limits.

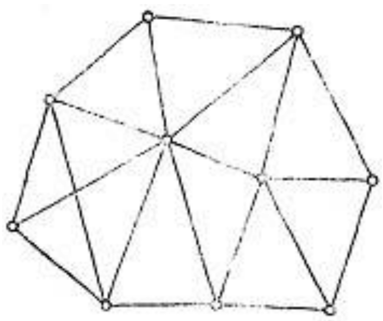


Fig. 5-3 Triangle Net

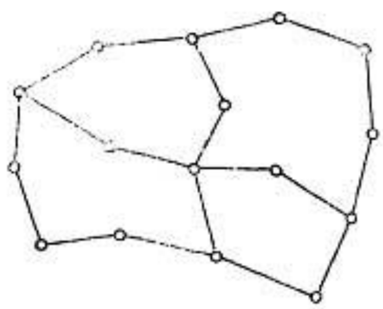


Fig. 5-4 Circle Net

3). Star shape net

Star net has simple geometry graph, but the baselines of it mostly don't compose a closed graph, so it has a bad checking ability and consistency.

The advantage of this net is that it only needs two receivers, the work is very simple, so it is mostly used in the quick surveying as quick static orientation and kinematical orientation. This working mode is widely used in project layout, border surveying and GIS surveying, etc.

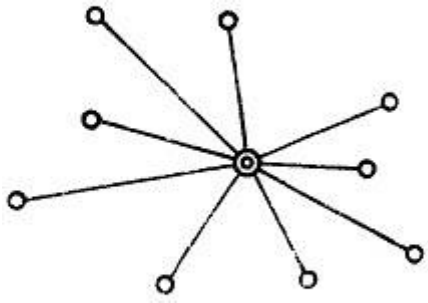


Fig. 5-5 Star Net

5.5 How to Measure Antenna Height

After fixed the instrument, you should measure antenna height at the beginning and the end of every period of time to ensure the accuracy “mm” level. We usually measure from the center point on the ground to the center waterproof loop of antenna. That is an inclined height.
Please refer to Fig. 5-6.

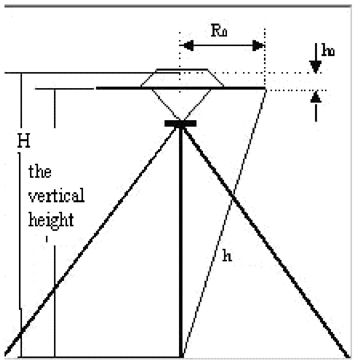


Fig. 5-6 Measuring antenna height

We use a formula to calculate antenna height.

$$H = \sqrt{h^2 - R_0^2} + h_0 \qquad (5\text{-}3)$$

“h” is the inclined height that measured from the point on the ground to the waterproof loop of the antenna.

R_0 is the radius of the antenna.

h_0 is the distance from antenna phase center to the middle of the antenna.

H is the calculation result. We usually measure antenna height twice and adopt the average.
Attention: *We input the inclined height as the antenna height, which is the inclined distance from the point on the ground to the waterproof loop of the antenna.*

5.6 How to Download Static Data

For a correct connection between receiver and the computer, follow the procedure below. By using a different procedure it may be very difficult to make a connection.
Turn on the receiver, connect the cable to the communication interface of the receiver (9-pins port) , then insert the USB port in the PC. The taskbar will show as follows:

Fig. 5-7 Taskbar of Windows when Connecting to Receiver

The PC recognizes the receiver as a "removable disk". Open the "removable disk", and then you can get the data files in the memory.

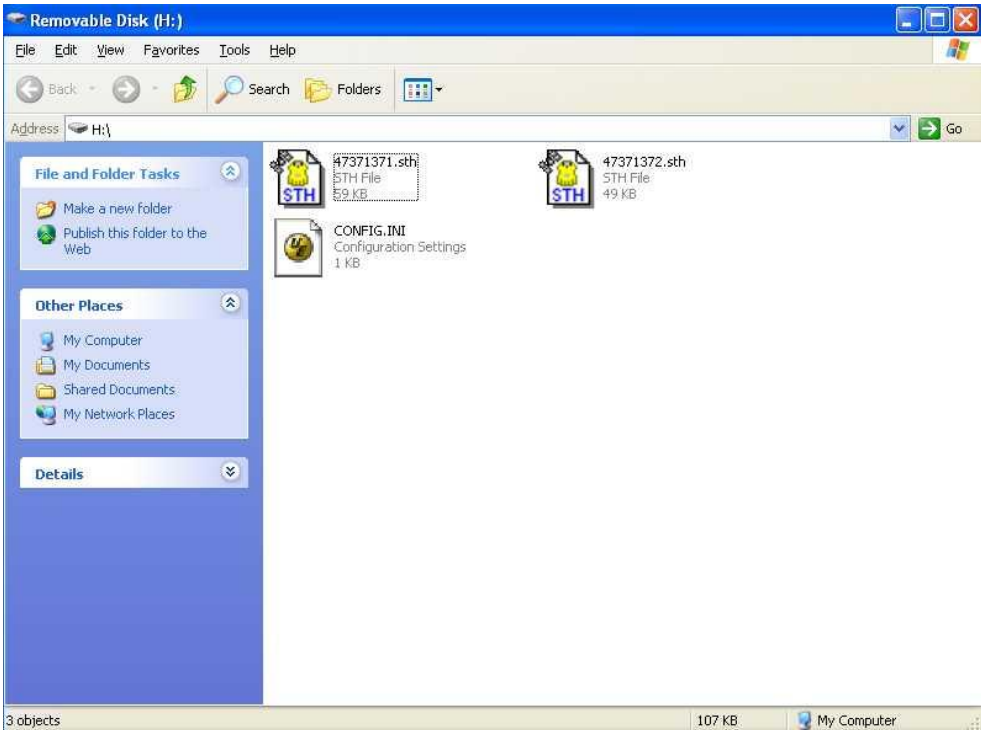


Fig. 5-8 Example of Files in Receiver

As Fig. 5-8 shows, *.STH* file is the data file collected by receiver. The modification time is the time of the last epoch collected. You can copy the original file to PC and the file names if necessary. You can see also the *CONFIG.INI* file. You can open it as a text file and set some parameters of static mode: sampling frequency, minimum elevation angle, etc.

5.7 Registration of Receiver

You should connect the receiver to PC using the same procedure as to download static data (see Session 6.6) , then open "*CONFIG.INI*" file.

In this file, many parameters are saved. Search for the parameter "serial number". It is composed of a 31 character code: the first 11 characters identify the receiver while the last 20 character are the code, you have to substitute the correct code and save the file.

APPENDIX 1: FAQ

1. The receiver is set in static mode but it does not save data even if more than three satellites are fixed. The three red lights are blinking.
Solution: The internal memory of receiver is full, please delete some files.

2. The external and built-in power lights are blinking and I fail to receive differential corrections.
Solution: The serial code expires, please contact RUIDE or your local dealer of RUIDE for a new code.

3. I fail to connect the handheld controller and receiver by Bluetooth.
Solution: You are in static mode and Bluetooth is disabled, please switch the mode.
If you are in rover or base mode and Bluetooth still does not work, please perform a receiver self-check.
If the problem persists, please check *CONFIG.INI*. It may be in a wrong format. Please contact RUIDE or your local dealer of RUIDE for a new *CONFIG.INI* file.

4. The receiver is set in rover mode and GSM data link, the SIM card is placed in its slot under the battery. However I fail to read the SIM card.
Solution: Every SIM has its PIN number, it must be disabled. Moreover, check the SIM card on a cell-phone whether there is enough money in the SIM for connecting to the Internet.

APPENDIX 2: TECHNICAL SPECIFICATION

Model		**R90**	**R90-T**	**R90-X**
No. of Channel		120	220	
Configuration		Dual frequency for GPS, GLONASS, BEIDOU and SBAS.		
Single Tracked	GPS	L1, L2, L2C	L1 C/A, L2E, L2C, L5 (reserved)	
	GLONASS	L1, L2	L1C/A,L1P,L2C/A(GLONASS M only),L2P	
	BEIDOU	E1	B1, B2	
Position Accuracy				
Code Differential	Horizontal	25cm+1ppm RMS		
	Vertical	50cm+1ppm RMS		
	SBAS	Typically <5m 3DRMS		
Realtime Kinematic	Horizontal	10.0mm+1.0ppmRMS	8.0mm+1.0ppm RMS	
	Vertical	20.0mm+1ppm RMS	15.0mm+1.0ppm RMS	
	Time to Work	<10s	<8s	
Static Performance	Horizontal Accuracy	5.0mm+0.5ppm RMS	3.0mm+0.5ppm RMS	
	Vertical Accuracy	10.0m+0.5ppm RMS	5.0m+0.5ppm RMS	
Communication		UHF RX/TX antenna port		
		GPRS/GSM signal antenna port		
		9-pin serial port (baud rate up to 115,200kbps)		
		5-pin LEMO interface		
		Multicable with USB interface for connecting with PC		
		Bluetooth 2.4GHz class II, maximum range 50m		
Internal Radio Modem	Frequency	450-470MHz		410-430MHz or 430-450MHz or 450-470MHz
		RX		RX & TX
	Output Power	0.5W		
GSM/GPRS Modem	Protocol	NTRIP		
Bluetooth		2.4GHz Bluetooth, Stollmann's BlueMod+B20 functioned		
Power	Internal Battery	7.4V, 2500mAh Li-on battery, 12-15V DC power input		
	Battery Running Tim	6-10 hours on average		
Weight		1.2kg with internal battery and internal radio		
Dimension		184mm x 18mm x 96mm		
Environmental	Operation Temp.	-40°C to 75°C (-49°F to 167°F)		
	Storage Temp.	-55°C to 85°C (-67°F to 185°F)		
	Shock/Drop	2m		
Waterproofing		IP67		
Data Output	Internal	64MB		4GB
		Update rate: 1Hz, 2Hz, 5Hz, 10Hz, 20Hz and 50Hz outputs		
		Reference outputs: CMR, CMR+, RTCM 2.1, RTCM 2.2, RTCM 2.3, RTCM 3.0, RTCM 3.1		

APPENDIX 2: TECHNICAL SPECIFICATION OF ADL RADIO

General Specifications	
Communication	1 RS-232 port, 115.2 kbps maximum
Power	
External	9.0 – 30.0 VDC, 2 Amp maximum
During RX	0.6 Watts nominal @ 12.0 VDC
During TX	7 Watts nominal @ 12.0 VDC, 1 W RF output 13.4 Watts nominal @ 12.0 VDC, 4 W RF output
Modem Specifications	
Link Rate/Modulation	19,200 bps/4FSK 9600 bps/4FSK 19,200 bps/GMSK 16,000 bps/GMSK 9600 bps/GMSK 8000 bps/GMSK 4800 bps/GMSK
Link Protocols	Transparent EOT/EOC, Packet-switched, TRIMTALK™, TRIMMARK™ TT450S (HW), SATEL®
Forward Error Correction	Yes
Radio Specifications	
Frequency Bands	390-430, 430-470 MHz
Frequency Control	Synthesized 12.5 kHz tuning resolution Frequency stability +/- 1 PPM
RF Transmitter Output	Programmable to 0.1 – 4 Watts (where permitted)
Sensitivity	-110 dBm BER 10-5
Type Certification	All models are type accepted and certified for operation in the U.S., Europe, Australia, New Zealand, and Canada
Environmental Specifications	
Enclosure	IP67 (Dustproof and watertight to depth of 1 meter for 30 minutes)
Operating Temperature (Receiver)	-40˚ to +85˚ C (-40˚ to +185˚ F)
Operating Temperature (Transmitter)	-40˚ to +65˚ C (-40˚ to +149˚ F)
Storage Temperature (Receiver/Transmitter)	-55˚ to +85˚ C (-67˚ to +185˚ F)
Vibration Spec:	MIL-STD-810F
Mechanical Specifications	
Dimensions	8.89 cm L x 4.6 cm W x 16.0 cm H 3.5” L x 1.809” W x 6.3” H
Weight	690 grams (1.52 lbs.)
Data/Power Connector	8-pin Turck-type
RF Connector	50 Ohm, TNC-female