Contents

Chapter One: Engineering Star 3.0 Software Summarization

§1.1 Introduction

This manual explains how to implement and use S82T/S86T system in RTK mode, by operating the Engineer Star software that installed on the handheld computer.

Note that the functions supported by Engineer Star 3.0 to control conventional systems are not discussed in this manual. Likewise, the procedure to download logged static raw data from your receiver to your desktop computer is not discussed in this manual. For more information on this procedure, please refer to the KOLIDA GNSS Processor User Manual provided on CD-ROM.

In the last chapter (Appendix), you will find how to install Engineering Star 3.0, trouble shooting and important explanations that might be useful to you in case of problems when you operate Engineering Star 3.0.

§1.2 Function

Engineering Star3.0 surveying software is the graphic software with simplicity, high efficiency and strong function. It provides the most commonly used function, such as data collection, stake-out point and stake-out line, with engineering and graphic interface. It also has the added function of stake-out curve, and stake-out road. It does not only use the characteristics of international comparable software for reference, such as convenient graphic display and precise structural module, it also combines the concrete specialty of the domestic fieldwork, making engineering star keeps up with world trend and meet the needs of fieldwork as well.
Engineering Star3.0 also has many other features, such as flexible zoom graphic interface, tabular menu, which directly display key task on the screen, abundant characteristics of fieldwork, complete edition, standard industrialized data output, coordinate collection, comprehensive RTK vector, GPS raw data and other data formations.

§1.3 Installation Requirement

Engineering Star needs to be installed in the Win CE System to work smoothly.
Win CE, as an operating system based on handheld computer, is the inlayed Win32 operating system with leading multi-task and powerful communication function. It is the strategic operating product designed specially for Non-PC products, such as information equipment, motion application, consumptive electric products and inlayed application etc.

Win CE is not simply transferred from Window NT or Windows 9x. Its applicative interface

program intimates that of Windows NT, but the inside is a totally new code foundation. Hereinafter are the two important standards.

1. No former 16 units applicative programmed interface (API)
2. The module adapting to the minimal equipment.

（1）WinCE is the minimal Windows Edition by far,

（2）WinCE is the fastest Windows Edition,

（3）WinCE is the most reliable Windows Edition,

（4）WinCE provides the most flexible operation system.

Chapter Two: Main Menus

§2.1 Main Screens

There are 6 menus giving access to the main functions of Engineer Star3.0. The figure below summarizes all the functions available from that screen.

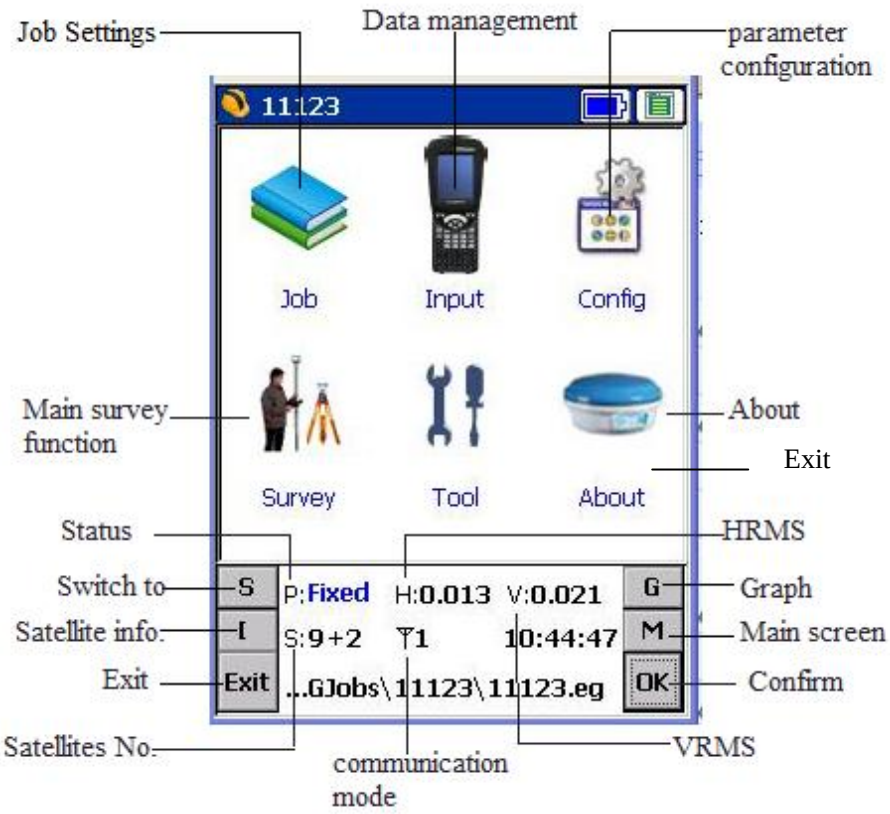


Figure2-1 Main screen

S: allows you to switch between several menus.

I: allows you to view satellite information. (see as figure 2-2)

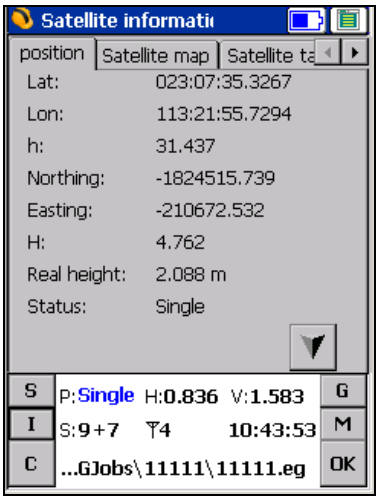


Figure2-2 view satellite info.

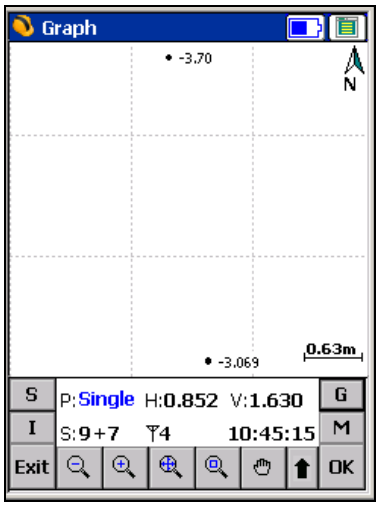


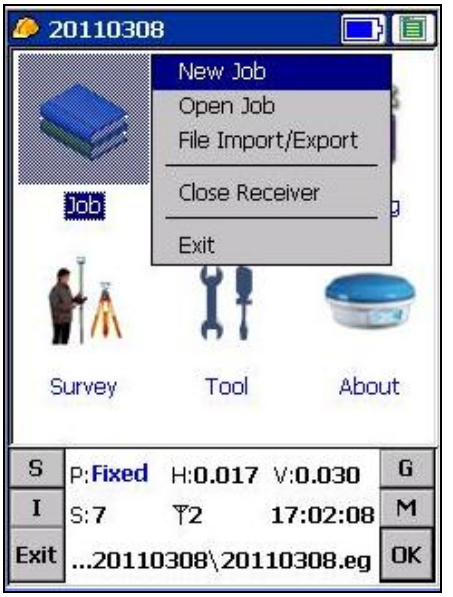
Figure2-3 Graph interface

G: switches to graph interface.(see as figure 2-3)

M: returns to main screen.

Exit Exit program.

§2.2 Job Menu



New Job: In general, you need to create a new job and input some parameters of ellipsoid and projection before you start your surveying work. A job consists of a number of file such as survey parameters, transformation parameters and result coordinates file etc.

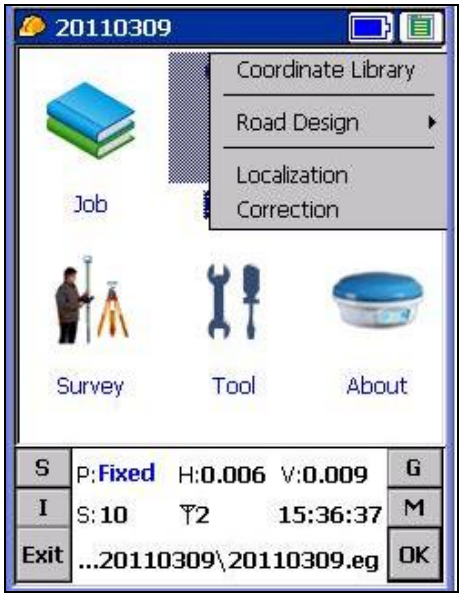
Open Job: Opens an existing job.

File Import/Export: Outputs result coordinates file with the format you want, such as: Pt ID, N, E, H, Code or Pt ID, Code, E, N, H, etc.

Close Receiver: shuts down the receiver.

Exit: exit the Engineer Star program.

§2.3 Input Menu



Coordinates Library: to manage all plane coordinates.

Road design: there are two methods for road design, element mode and intersection mode.

Localization: Calculates transformation parameters between WGS-84 and your local coordinate system.

Correction: correct point coordinate with local known coordinate.

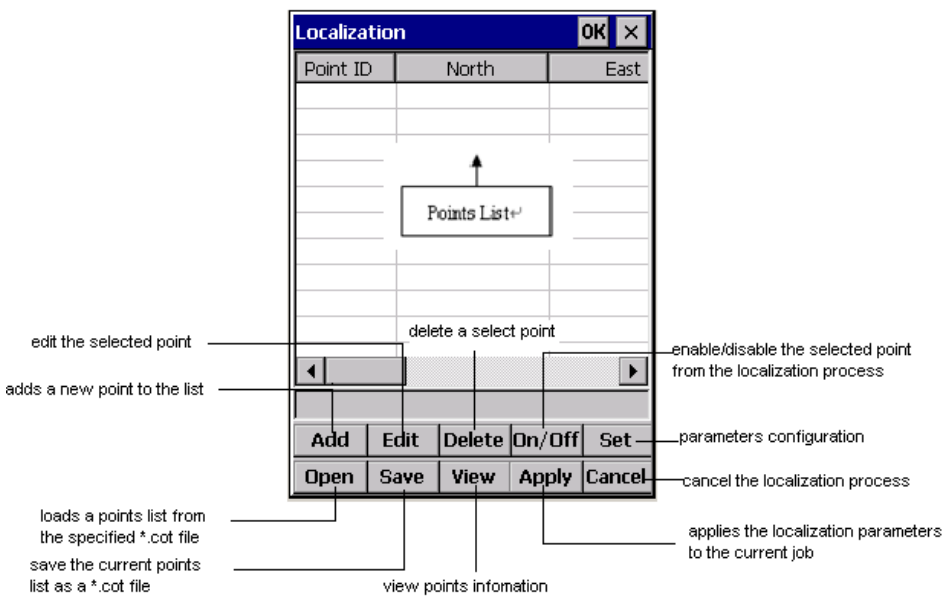
Localization

This operating mode is used in the following cases:

- The coordinate system is unknown or its characteristics are not accurate enough.
- The base station is operated on a reference point whose position was only determined in autonomous GPS mode.
- A local coordinate system is used for field operations.

In either of these three cases, you will have to localize your system before starting your job, using control points. The use of 3 control points or more is highly recommended to achieve horizontal localization. This number should be raised up to 4, or more, to ensure vertical localization, as this will guarantee the consistency of your control points.

Click the menu **Set** and select **Localization**. The screen that appears is described below.

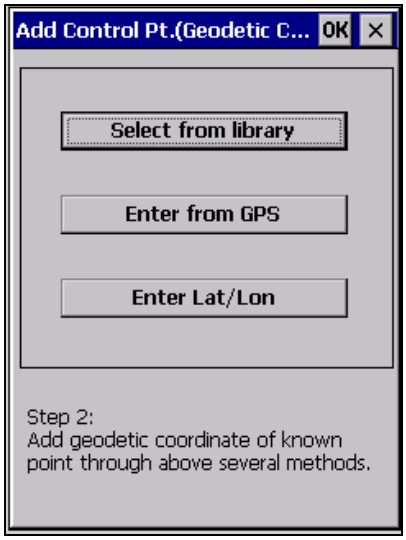


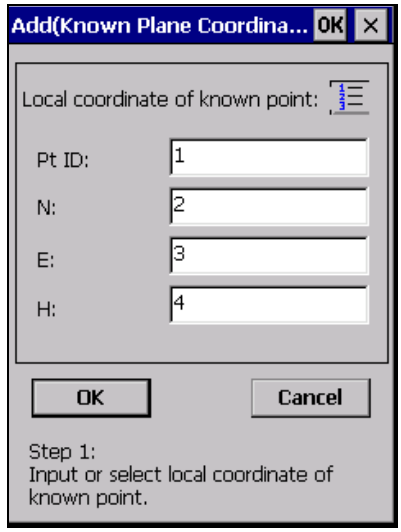
Control coordinates can be entered manually or read from a file stored in the handheld computer. When you click **Add** to add a point, a new screen is displayed.

You may either enter the points coordinates manually (see screen example opposite) or select an existing point from the pre-defined list.

Click on the  button to access the list of points available from the open job.

Click **OK** after inputting the point manually or selecting point from the list. A new screen then appears asking you to enter the true coordinates(or call raw coordinates) of the point. There are 3 different ways for entering these coordinates(see screen below)

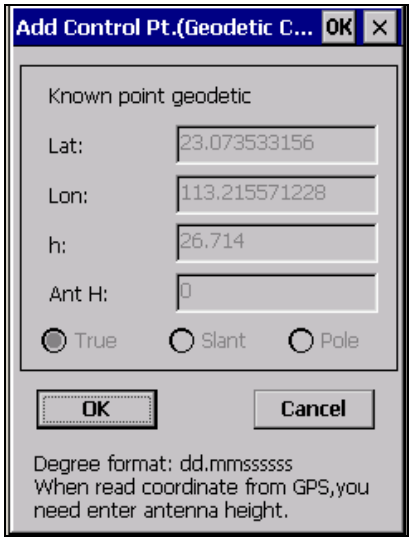




1. They can be loaded from the results of a point that was logged earlier during the same job.(*select from library*)
2. They can be read from the rover receiver. In this case, the rover should be positioned over the concerned control point. (*Enter from GPS*)
3. They can be entered manually (*Enter Lat. /Lon.*).

If you choose *Enter from GPS*, then engineer star will ask you to indicate the antenna height before the receiver output the coordinates measured for the point.(see screen example opposite)

There are three ways to indicate the antenna height,

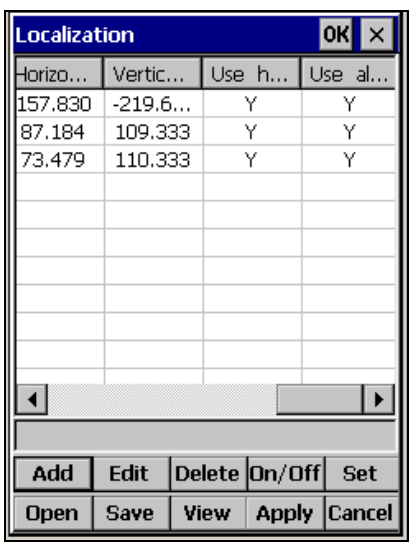


True: the vertical height is from measuring point to phase center of receiver.

Slant: the slant height is from measuring point to the line edge of antenna.

Pole: the pole height is the carbon fiber pole length, which is 2m.(this option is recommended if you use rover with carbon fiber pole)

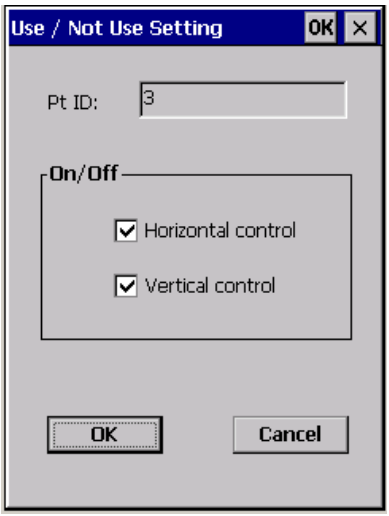
Then click **OK** to enable the result of that computation. Engineer star then takes back to the screen showing the point list. Resume the previous steps until the coordinates of all the controls point involved in the localization process have been determined.

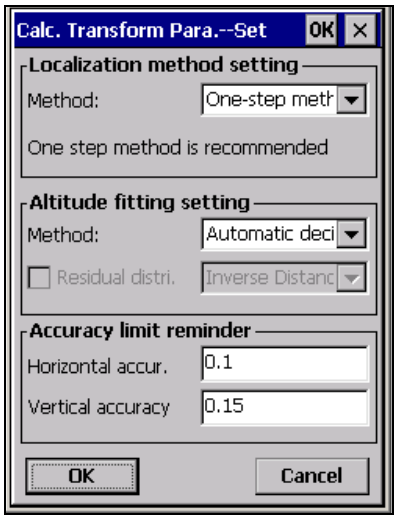


On the points list screen(see screen example above) ,check the amount of residual for each control point involved in the localization. The lower these value, the better the consistency of your control point network. If some

residuals be highly abnormal, the relevant point(s) should be deleted using the **Delete** button or removed from localization progress using the **On/off** button.

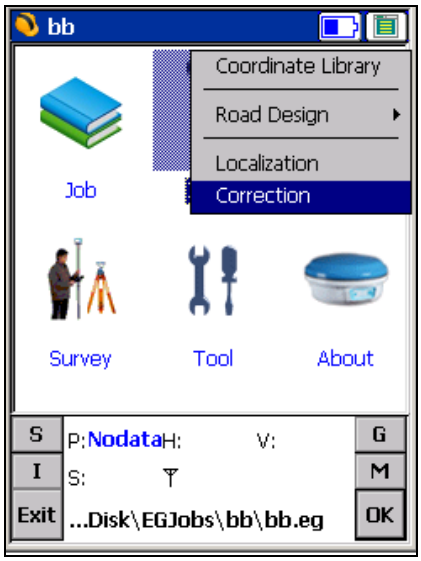
The **On/off** button gives access to a menu allowing you to enable/disable the selected control point for horizontal control progress, for vertical control progress, or for both(see screen opposite) the localization parameters can be saved as a *.cot file for the further use. Click the **Save** button to do this, but if you want the parameters effective after saved, you should use the **Apply** button, then click on the **OK** button to quit the localization dialog.

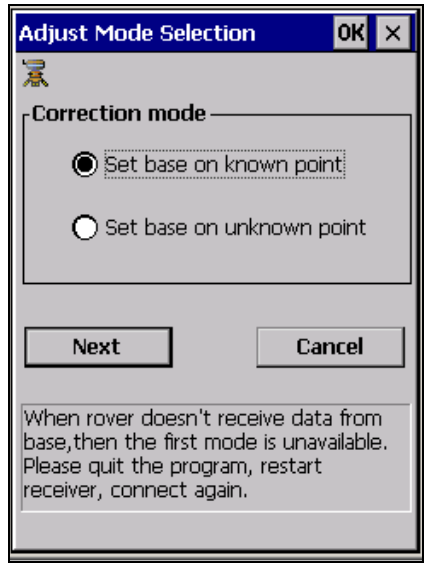




Correction

Usually we set base station on a known point, and input the known point coordinate to the base as reference coordinate, however, sometimes, we can set the base on unknown point or even we set base on known point, but we don't input the known point coordinates to base, we just use other known points to make the localization, which still can get the same effect as inputting known point to base. This method is very flexible, because sometimes, the known points are hard to reach for heavy base batch, then you can put the base on an unknown point, just take the handy rover batch to the known points, then make the localization. Because the base starts up with a random single positioning coordinate, so the base coordinate will change every time. So we need to use correction function to calculate the changing value. There are two situations as follows:

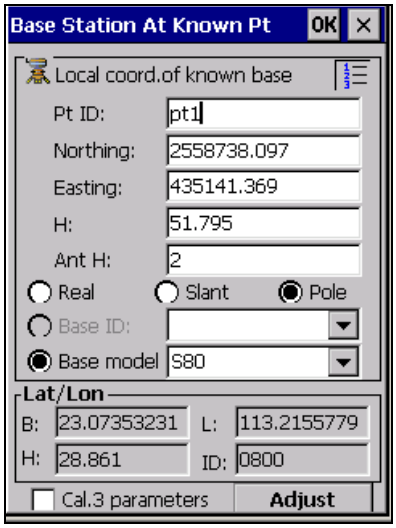




Base station on the known point (Point A)

Use one point (Base Station Point A) to adjust

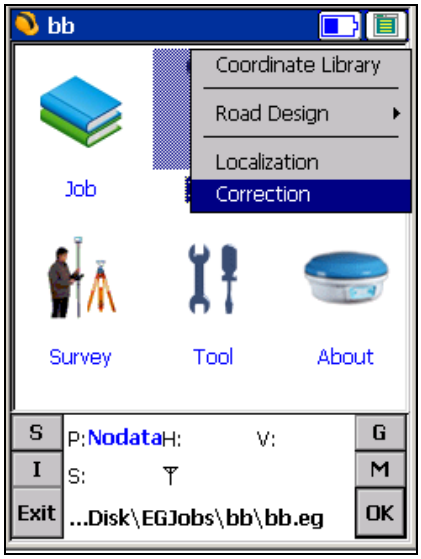
Steps: input->correction-> Set base on known point. You can just input the base known coordinate to the dialog, then you can acquire the raw data of base from rover.

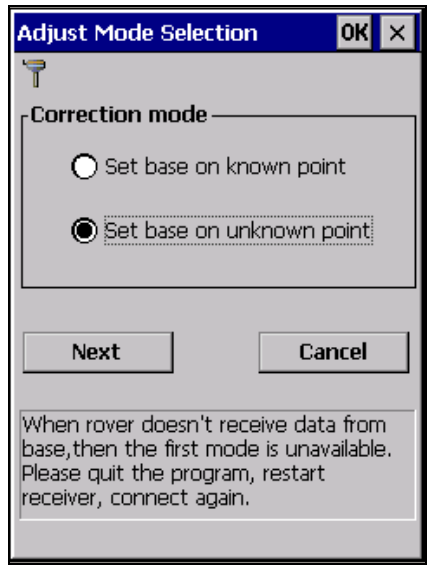


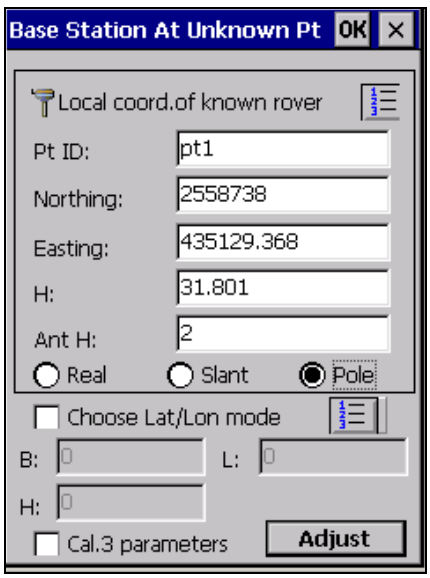
Base station on the unknown point

1) (Suppose that the point is Point B)

Step: input->correction->Set base on unknown point. Then you need put rover to a known point, and input this known point coordinate to the dialog.


bb
Coordinate Library
Road Design
Localization
Correction
Job
Survey
Tool
About
S
I
Exit
P:NodataH:
V:
S:
G
M
OK
...Disk\EGJobs\bb\bb.eg


Adjust Mode Selection
OK
Correction mode
Set base on known point
Set base on unknown point
Next
Cancel
When rover doesn't receive data from base,then the first mode is unavailable. Please quit the program, restart receiver, connect again.

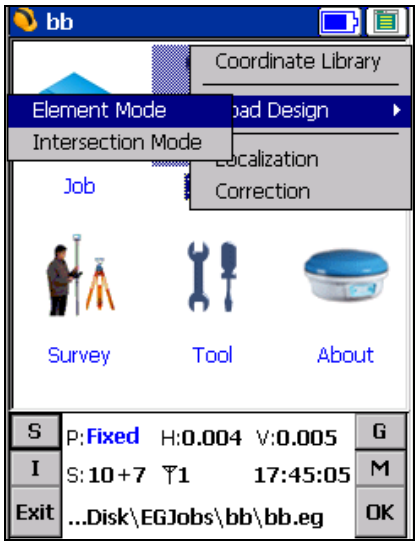

Base Station At Unknown Pt
OK
Local coord.of known rover
Pt ID:
pt1
Northing:
2558738
Easting:
435129.368
H:
31.801
Ant H:
2
Real
Slant
Pole
Choose Lat/Lon mode
B:
L:
H:
Cal.3 parameters
Adjust


Adjust Wizard Tips
OK
Are you sure to make correction?
Base modification is set on unknown
If you will make correction,
please press OK button after centering
And levelling the rover(when using the first mode,you can ignore this step)
Press cancel button to cancel correction.
OK
Cancel

Road Design

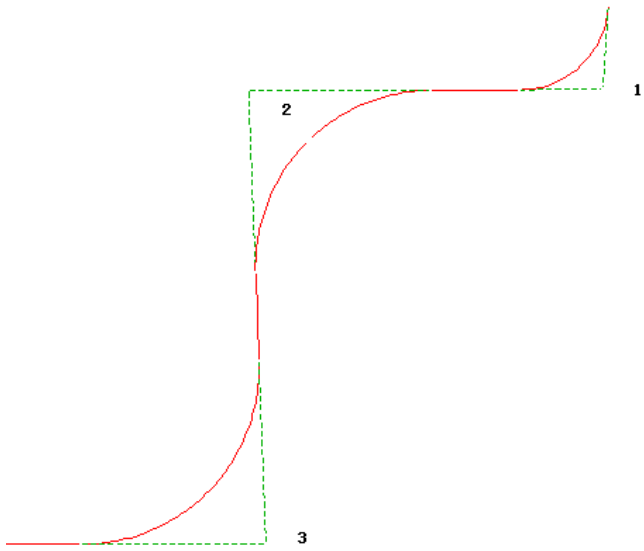
There are two manners of road design, element mode and intersection mode.

Element mode: a stretch of complicated road includes line, circle curve, transition curve. If you use element mode to design a road, you need input the parameters of every element in sequence. So it's only suitable for short distance and simple road.



Intersection mode: it's more suitable for complicate road design.

Usually the designer selects several points which is suitable for building road in map, then connect them by lines (see below figure, point 1,2,3), and designs transition curve and circle curve in every turning corner. These points are called intersection points, and this manner is called intersection mode. You only need input intersection point coordinate, radius of circle curve, length of transition curve, the program will calculate every key factor automatically (like center point of circle curve, intersection point of line and transition curve).

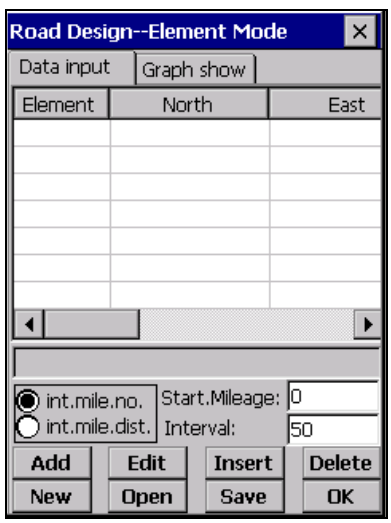


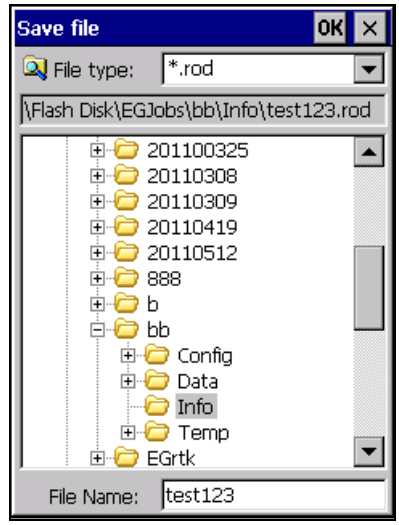
Element mode

The steps are as follows:

1. Press "**New**" button to create a road design file

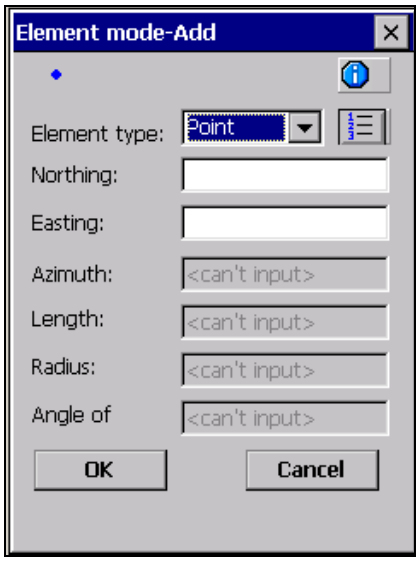
(See the screen below)





2. Input distance interval value, and give a name to the road, then press "**Add**" button to design this road.

3. You need select a start point, and must input the coordinate of it.



4. Then select a line element, you need input azimuth and length.

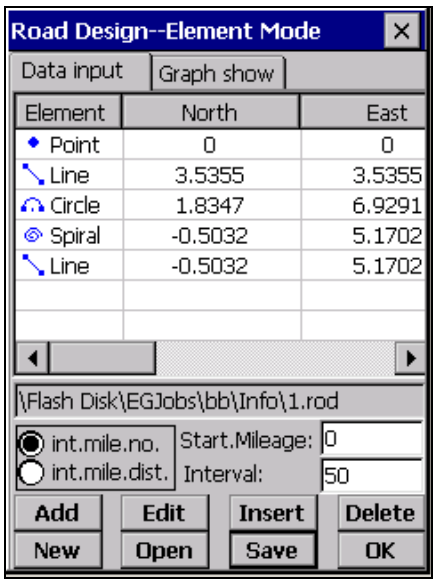
5. If there is a transition curve, you need select spiral, then input the length.

6. Select a circle element, and need input the radius.

7. The element behind the circle could be a transition curve or a line, so you can select the element as real situation, then input parameters.

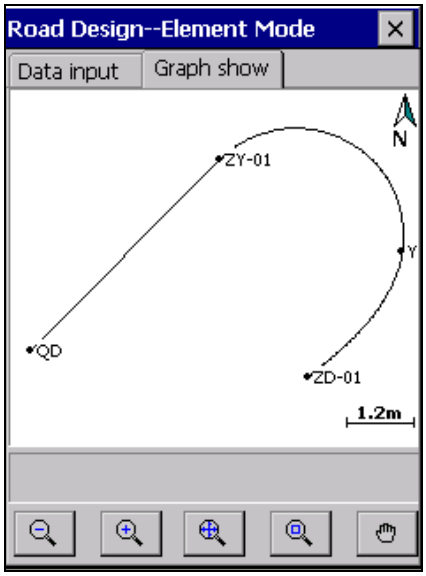
But the end element must be a line element.

After you input a section of one road, you can press "OK" button to return the main screen of road design.



Then you can press "save" button to save the design file, and it will calculate the stakeout points on the road as interval distance, all of the calculated points

are saved in the *.rod file, it also generates a *.dat file with a same file name. After this process, you can click the Graph show tab to check the design road graph. (see below screen)



About ROD file type description, please refer to following content.

File Format Instruction:

The format of road file is “ROD”, the detailed format is as follows:

CLINE FILE V1.00
START CHAINAGE, 500.0000
RN, GuoGuang-3-2-13
PT, 435118.000000, 2558744.000000,
R., 433.333000, 90.00000000,
CC, 321.751000,-500.000000,
R., 252.195000, 53.13005129,
CL, 240.000000, 346.410162,
CC, 160.875000, 500.000000,
R., 551.317000, 85.31595543,

LS: start point of line
LE: end point of line
QZ: center point of circle curve

Format Instruction：

CLINE FILE V1.00 *Default line, mark the data edition*

START CHAINAGE，X.XX *Mark the start mileage*

RN, YY *YY marks the road name*

PT marks points: *Type in the coordinates of points, the first is the east coordinates (Y), and the second is the north coordinates (X)*

R. marks lines： *defines the line and azimuth, if you do not define it, the software will auto calculate the azimuth. The first is the line length, the second is the azimuth.*

CL *marks transition curve: it is defined by the curve length and K gene, the formula of K gene is as follows:*

$$A=\sqrt{R\times L}$$

A means K gene

R means the radius of the curve

L means the length of assuasive curve

Note: transition curve must meet one arc in both ends, the first one is the length of the transition curve and the second is the K gene.

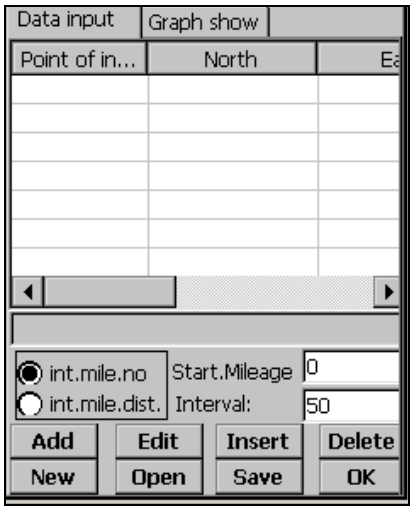
CC *marks arcs：to define the arc length and the radius, negative means left curve.*

The first is arc length, and the second is radius.

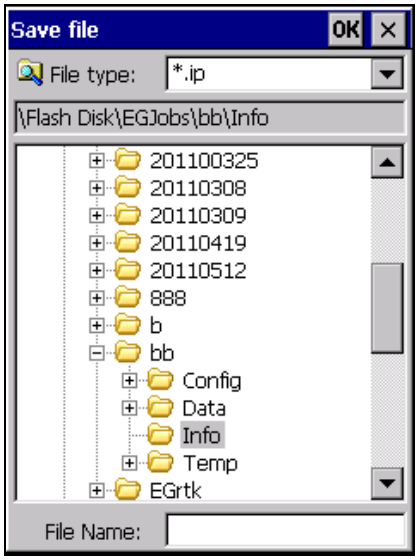
Note: the minus and plus value of radius only means the direction. Plus is the right side of the road direction, and the minus means the left side of the road direction.

Intersection mode

This screen is nearly like element mode.

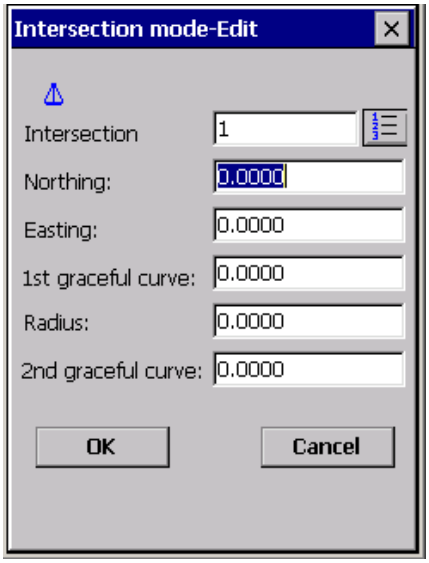


You need press "New" button to create a road design file, the file type is *.ip. And input distance interval value and road name.



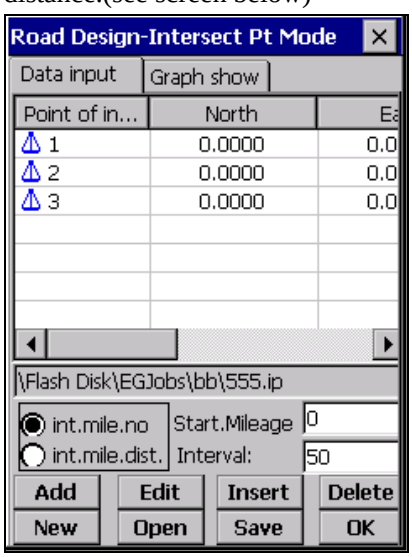
Then press "**Insert**" button to input intersection point information.

The information includes intersection point ID, coordinate, length of 1st graceful (transition) curve, length of 2nd graceful (transition) curve, Radius of circle curve.



Usually the start intersection point and last intersection point don't need input transition curve length and circle radius, just input point coordinate.

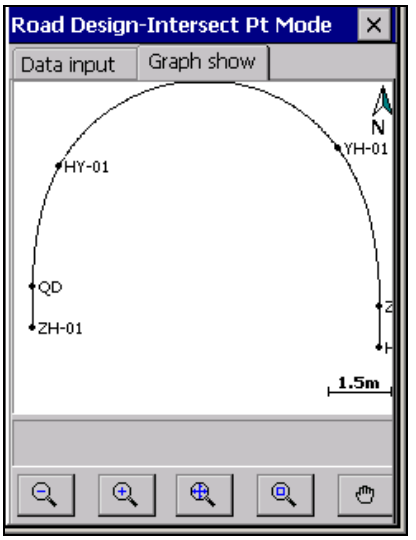
You can press "**insert**" button to add intersection point one by one. After you input all of the intersection points and related information you need to press "**save**" button to save it, it will calculate every stakeout point as interval distance.(see screen below)



If you input one intersection point by mistake, you can press "**Edit**" button to modify it, or select it and press "**Delete**" button to delete this point.

If you have a *.ip file, you can also press "Import" button to import to the screen.

When you want to check the road design graph, you can click “Graph show” tab, the designed road will show in the screen.(see screen below)



The intersection mode will generate 4 kinds of files , *.dat file, *.ip file, *.rod file.

.Dat file and .rod file are the same as the one generated in element mode. The content of .ip file is the same as rod file in stakeout road library.

About IP file format description, please refer to following content,

File format instruction

IP is road design file, the detailed format is as follows,

CLINE FILE V1.0(Intersection) */*default line, mark the file version*

START CHAINAGE,0.0000 */*mark the start mileage, in this file, the start mileage is* 0.

RN,11 */* 11 is road name*

b3,58711.7380,-4890.1240,20.0000,15.0000,20.0000,1000.0000

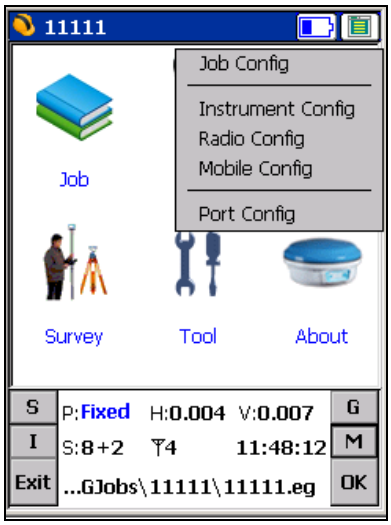
b67,58726.9090,-4872.0580,25.0000,15.0000,25.0000,0.0000

b121,58731.1310,-4888.3590,18.0000,14.0000,18.0000,0.0000

b313,58718.0170,-4875.0030,0.0000,0.0000,0.0000,0.0000

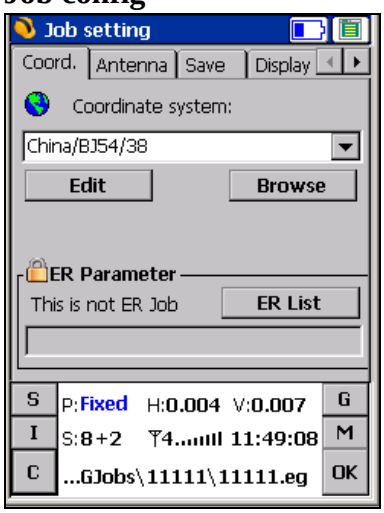
/ the 4 lines represent 4 intersection points, the field meaning is point name, N, E, length of left transition curve, circle curve radius, length of right transition curve, mileage.*

§2.4 Config Menu

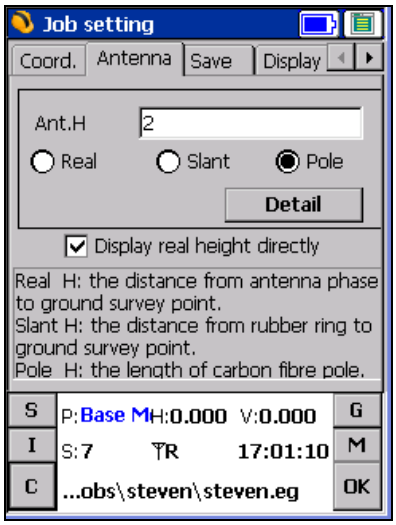


Config menu includes 5 submenus, job config, instrument config, Radio config, mobile config and port config. It covers most of parameters setting.

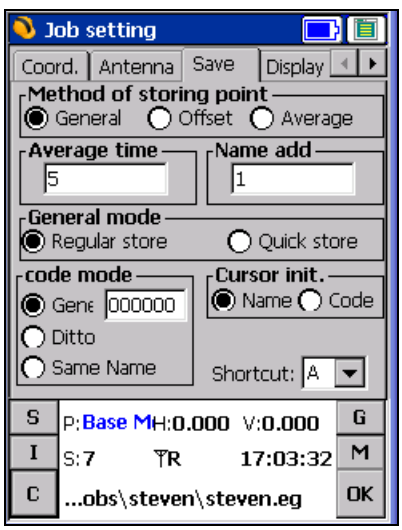
Job config



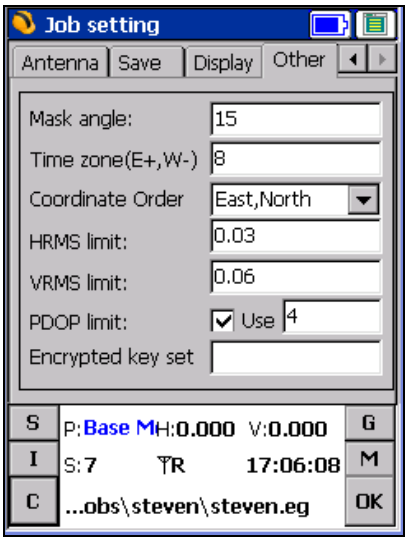
In this menu, there are 5 pages, coord., antenna, save, display, other.
In coord. Page, you can define your coordinate system, select your local system, modify projection parameters and so on..
For antenna page, you can input the pole height, the software will show the real point height which you measured on the ground.



In the save page, you can set storage method: general, offset, average, and automatic.



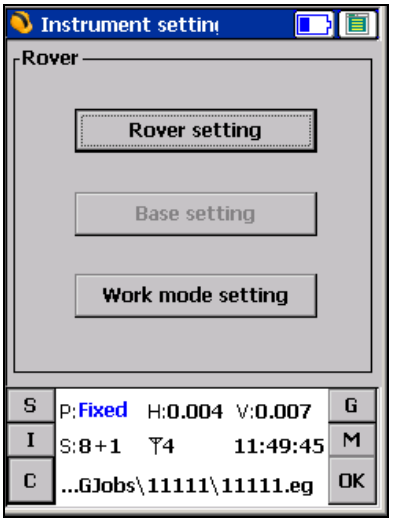
In the display page, you can specify how points will show on the screen, and their point names display method.



In the other page, you can set mask angle, time zone, pdop limit and other information.

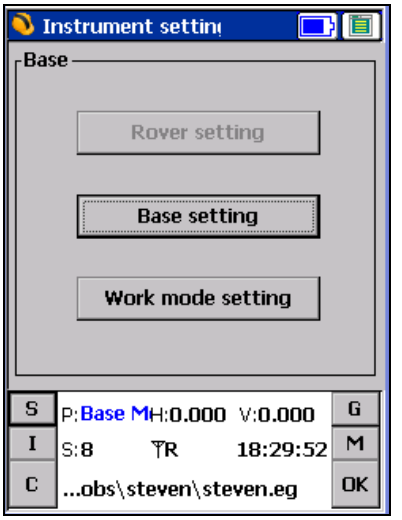
Instrument config

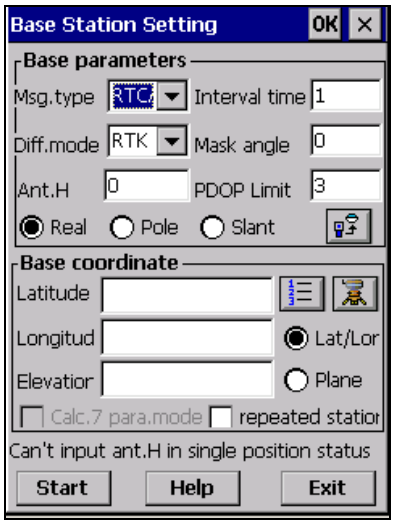
The operating mode is to set working mode and parameters, data link, it can only be operated when the engineer star connected with receiver. The operation will be effective after restarting receiver.



These operations also can be realized on receiver, about the detailed operating steps, you can refer to relevant product manual.

In base setting screen, there are two modes to set up base station. One is auto start, the other is manual start. You can set the detailed parameters after entering base setting screen (see screen below)



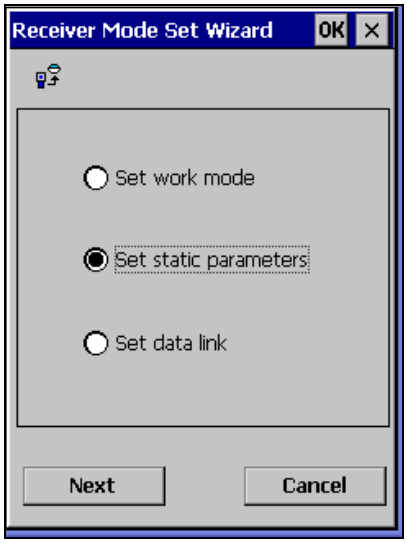


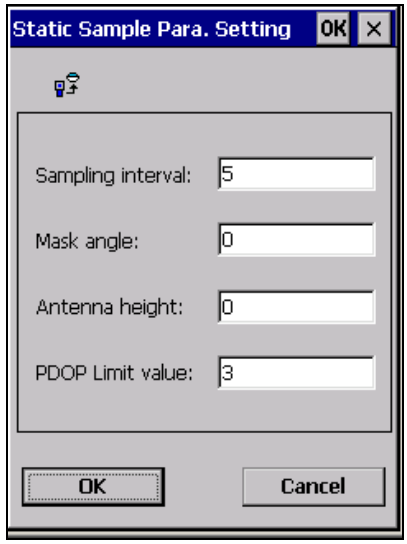
Start up base station by two methods:

If you want to make the base station transmitting signal automatically every time, you can select the first option (Base parameters), and set the transmission condition, by this way, you don't need make any operation on base station, just need power on it. But there is a shortage, even you put it on the same point, if you restart it, the base transmitting coordinate will change.

If you want to use a specified coordinate to start up base station, you need select the second option (Base Coordinate), and set the parameters, correction type, transmission interval time, PDOP, antenna height.

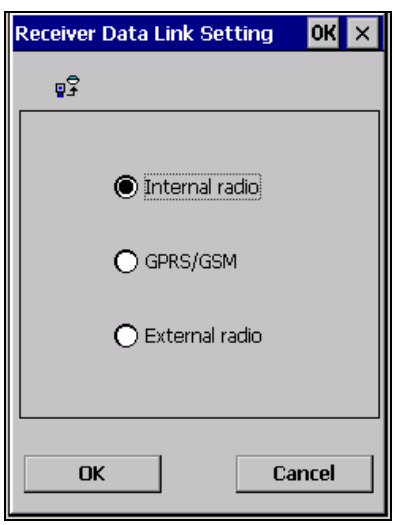
In static parameter screen, you can set observation interval time, elevation Mask angle, PDOP value, and antenna height.





Warning: if the receiver is already in static mode, you can not use engineer star to operate it, if you connect receiver by blue tooth or cable, you will see that the status is **No data.** So you also can not switch the work mode to rover mode or base mode again, you need operate on receiver.

Set data link: there are three kinds of data link: Internal radio, GPRS/GSM module, and external radio, and the operation in this screen is just suitable for RTK receiver.(see screen below)



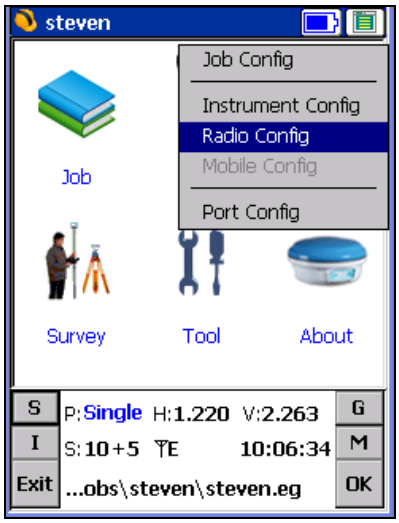
Note: you can also make this operation on receiver, please refer to relevant

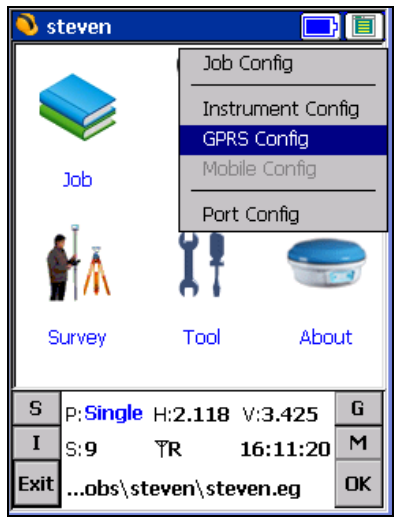
product manual.

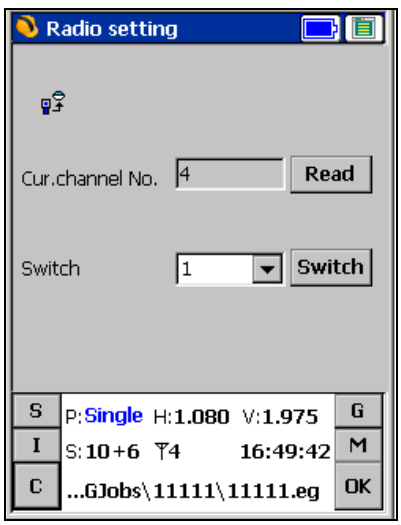
Radio Config /GPRS Config

This operating mode is to make the detailed setting to data link.

When the software connect with receiver, it will search the data link, if it find that the data link is radio, the **Radio Config** menu will appear. If the data link is GPRS, the **GPRS Config** menu will appear automatically. (see screen below)







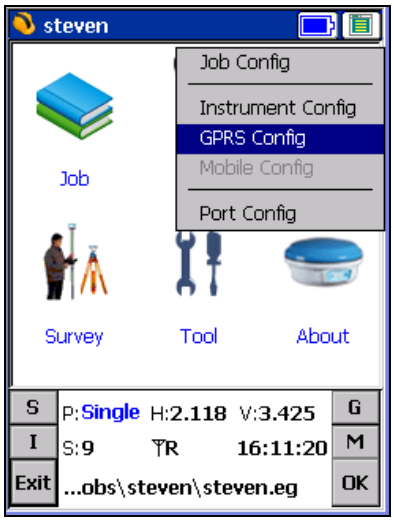
There are two buttons in this screen.

Read: reads the current radio channel, the value is between 1 and 8. When you didn't see the channel number icon 1 showing at the bottom of main screen, you can use this button to learn it. If it always shows "unknown" after you

press **Read** button, may be the built-in radio has problem.

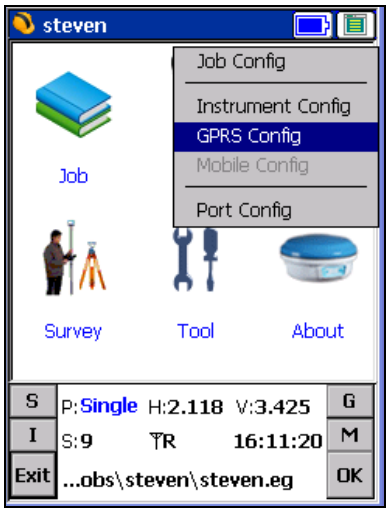
Switch: when you want to switch the built-in radio channel to specified one, you can tap the pull-down menu  and select the specified channel number, then click on **Switch** button to change it.

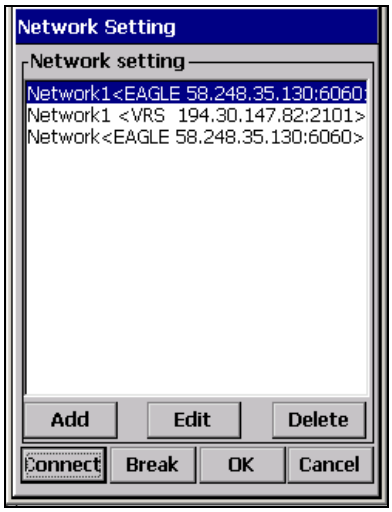
When you change the data link to gprs/gsm module, you will see the menu change to **GPRS Config**, and there is a module icon  showing at the bottom of main screen.



When you want to use gprs/gsm module to establish connection with CORS network, which transmit differential corrections via NTRIP, the steps are as follows,

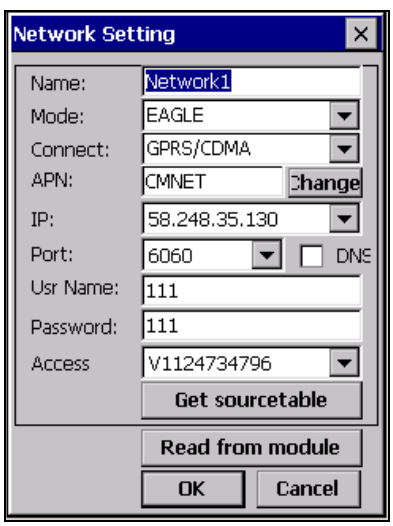
1. **Config→GPRS Config** (see screen below)





2. You can add a new cors server address to the list, or select an existed record to operate, you can edit or delete it.

Click on **Edit** button to enter parameters setting screen.



3. Input a name in the first column,

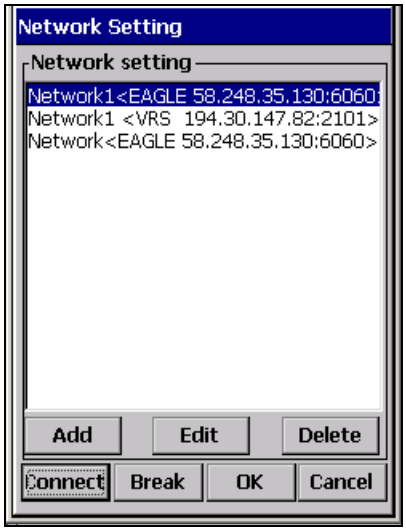
Select **GPRS/CDMA** on connect option, select **NTRIP-VRS** on mode option

- IP Address
- Port
- User Name
- Password
- APN
- Access

Note: usually this information is given by NTRIP caster (Cors network server), after you input these parameters, press **Get sourcetable** button to get the sourcetable.

After you set all parameters, you can press **OK** button to make it effective. Or press **Cancel** button to cancel the settings.

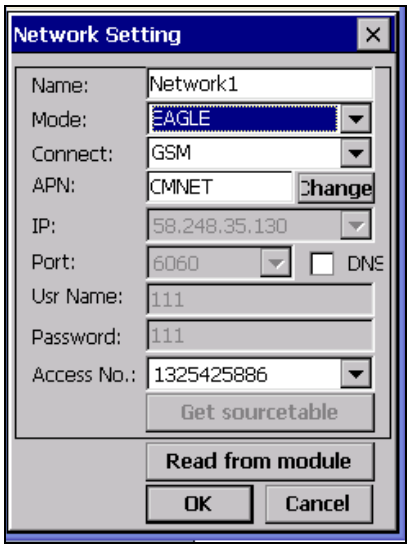
4. Press **OK** button to quit the setting screen, then you can press **Connect** button to connect with network, press **Break** to disconnect.

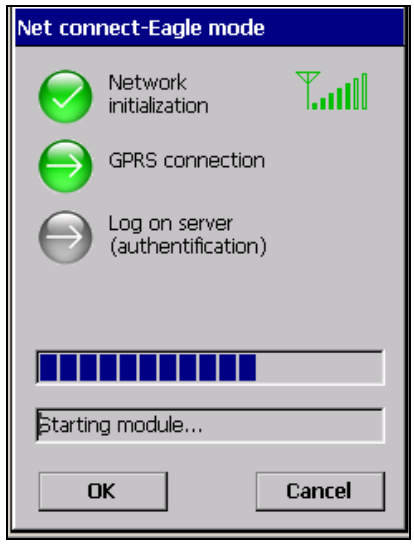


When you want to establish connection with another GPS receiver by GSM mode, the steps are as follows,

1. **Config→GPRS Config**
2. Click on **Edit** button to enter parameters setting screen
3. Selet **GSM** on connect option, select **Eagle** on mode option

（see screen below）

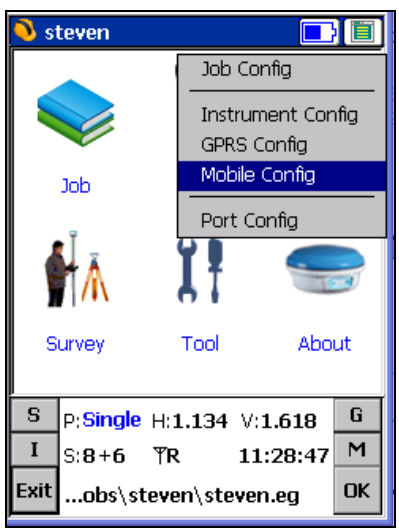


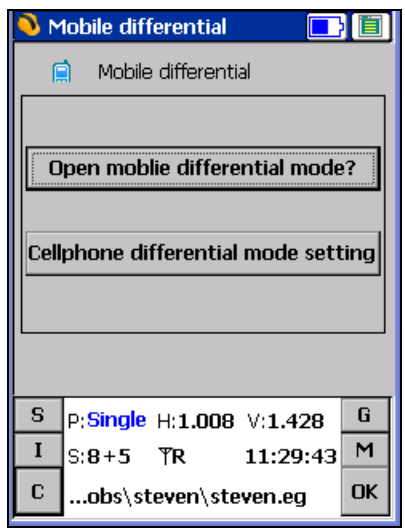


You just need to input Base receiver sim card number, then press **OK** button to make it effective. Note that the sim card must have data/fax function.
After you set the parameters, press **OK** button to quit, return to the **Net connect** screen, then restart gps receiver, the rover will connect the base automatically.

Notice: If you set the parameters once, you don't need set it again at next time, it will be saved in the module, and when you power on the receiver, the module will connect to network automatically.

Mobile config



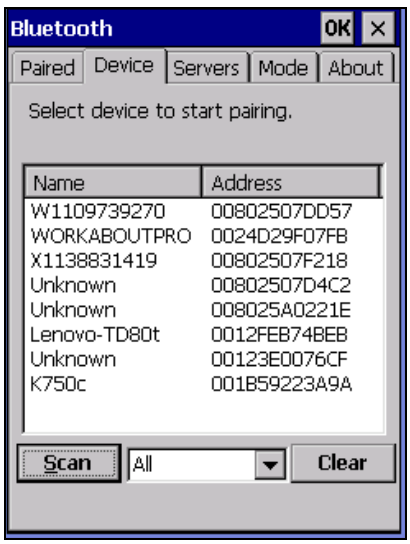


Sometimes, you can use mobile phone to replace internal gprs module, you just

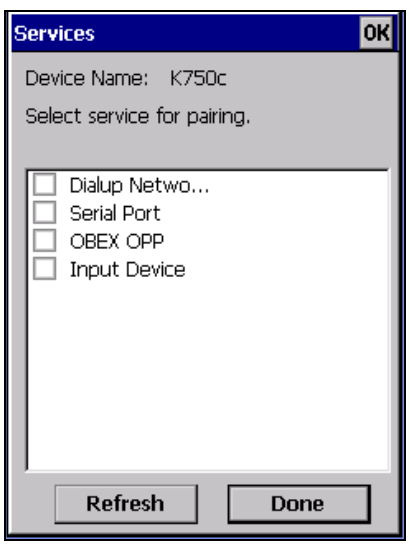
need prepare a cell phone (with bluetooth function), and make it connected with the controller,

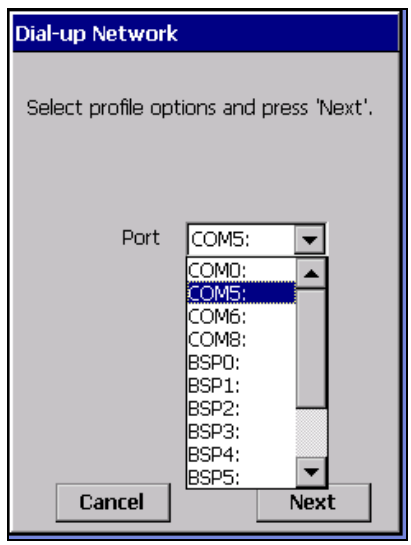
The steps are as follows,

1. Scan bluetooth device.

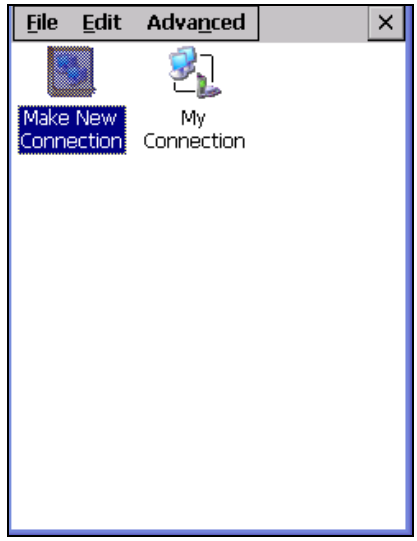


2. Select bluetooth service, for mobile phone, you need select dialup network.

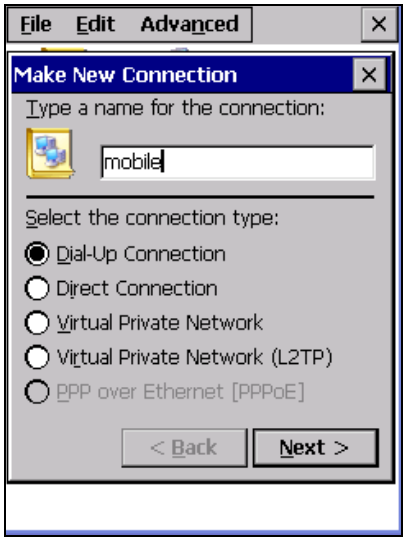


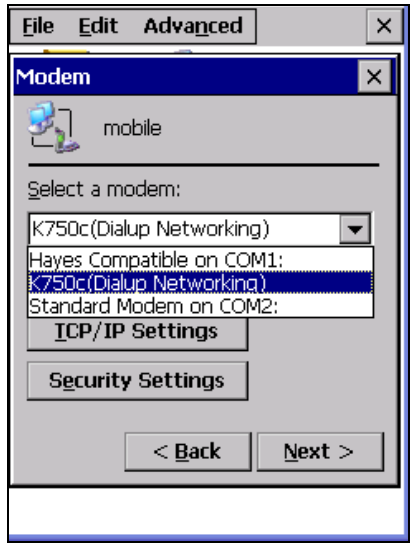


3. Select a com port for connection.
4. Enter control panel interface, select network and dial-up connections option.

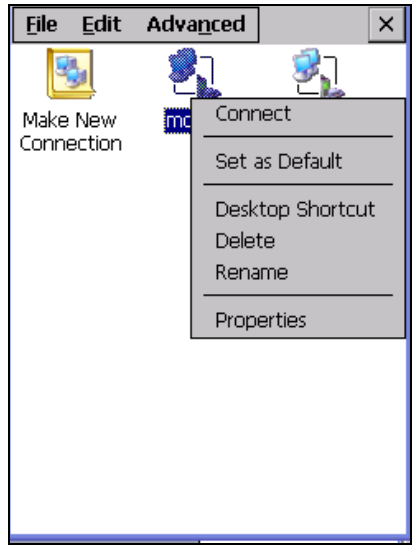


5. Tap **make new connection**, type in a name for the connection, and select **dial-up connection**, then press **Next** button.

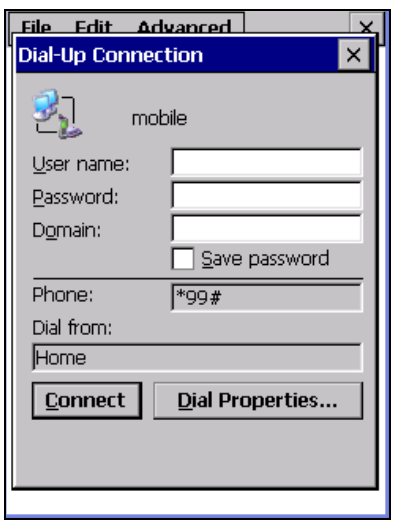


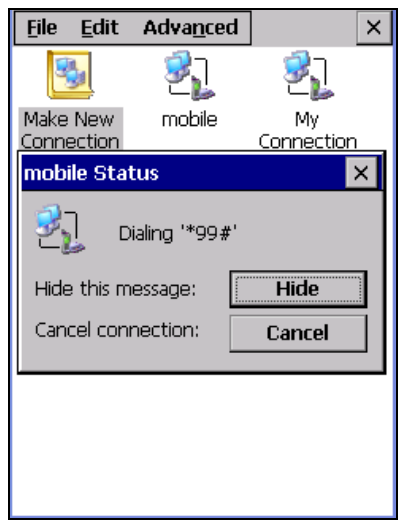


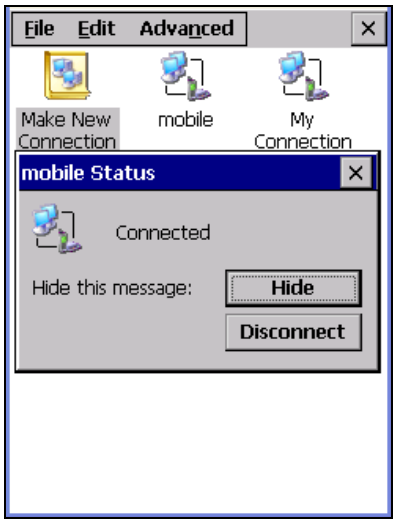
6. Select the modem. (your cell phone name), then press Next button.



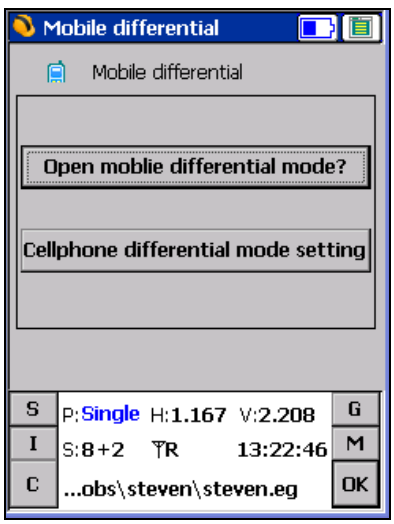
7. Input the GPRS dial number for your sim card (for example, *99#), then press **finish** button.
8. Click the new created connection, and press **connect** button. It will connect after a while.

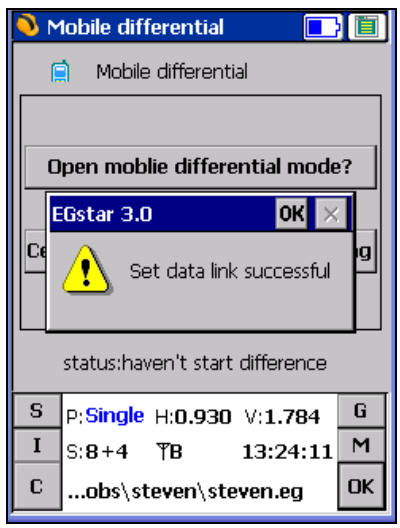




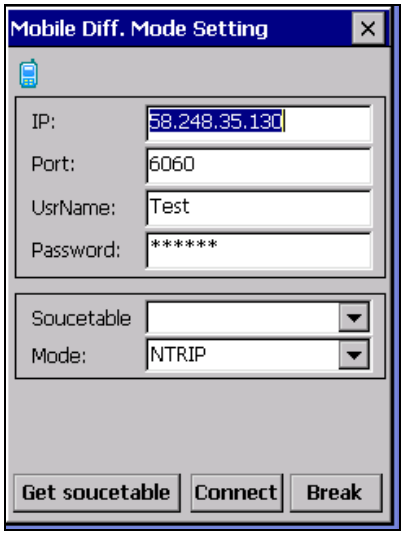


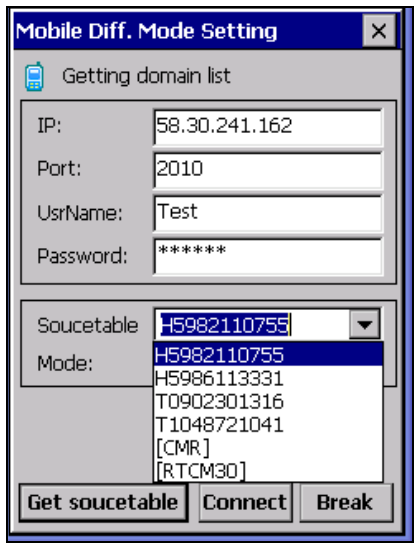
9. Then you can use the controller to connect gps bluetooth, and open engineer star, select **mobile config**.





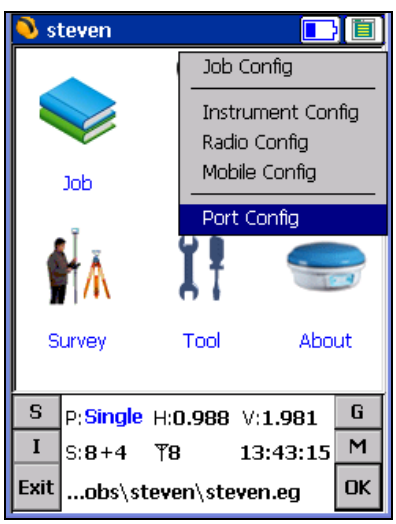
10. Then you press **open mobile differential mode** first, you will see the label B showing at the bottom of main screen, which means it's in the correct mode.
11. Select the second option to set CORS parameters.





12. After you input parameters, you can press **get sourcetable** button to get the list, and select one to connect. If the get-list process failed, you need check the gprs connection, see if it's disconnected, or if the cors server can't be accessed.
13. Press **connect** button to link to the cors server.

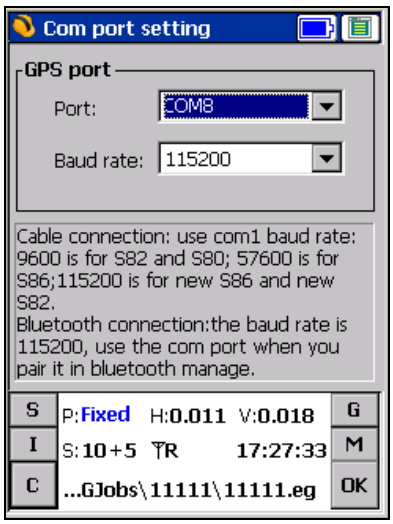
Port Config



This operating mode is to establish connection between controller and receiver via bluetooth or cable.

If you connect with receiver by bluetooth, please select **Config->port config** option, and input relevant com port no. (how to connect receiver via bluetooth,

please refer to RTK user manual).

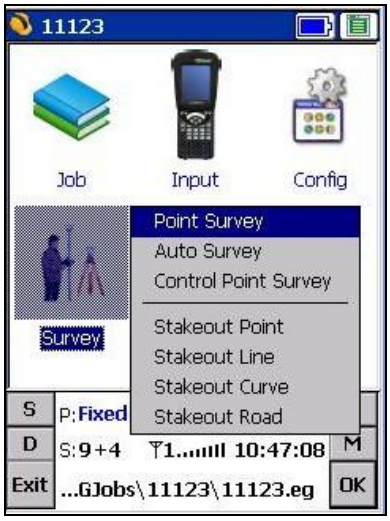


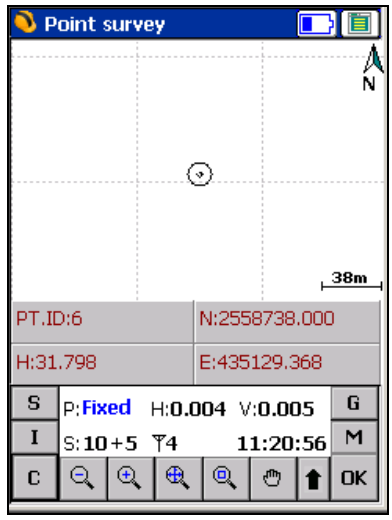
If the bluetooth link is disconnected, you can enter this menu to set it again, it will reconnect.

§2.4 Survey Menu

Point Survey: Point data collection. After you press this option, the coordinate of current rover position will be shown on pop-up screen, after you input relevant information, press **Enter** key on keyboard to confirm. To save the point, click then choose SA.

Notice: there is a hotkey to save point: button **A** on keyboard.

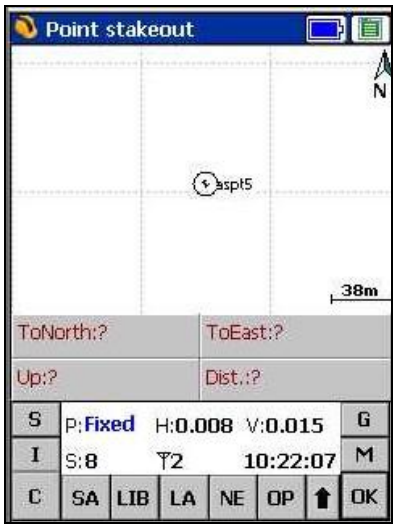


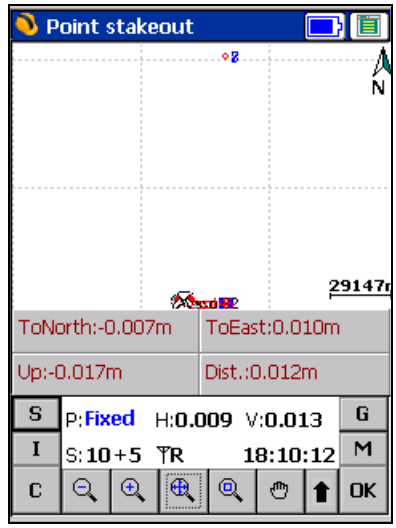


Auto Survey: store point automatically by time or distance.
Control Point Survey: when you want to make localization, you can use this function to collect raw data of control point firstly.
Stakeout Point: allows you to stakeout a selected point.
Stakeout Line: allows you to stakeout your line.
Stakeout Curve: allows you to design curve, line and spiral and stakeout them.
Stakeout Road: You should design the road file first, then use this screen to stakeout road element.

Staking out Points

Click on the **survey** menu and then select **Stakeout Point**. The following screen shows the main stakeout screen. You need press the LIB button on the tool bar to select stakeout points.





SA: save current position.
LIB: stakeout point library.
LA: previous target point.
NE: next target point.
OP: options.

switch to the tool panel on the second layer.

 zoom out

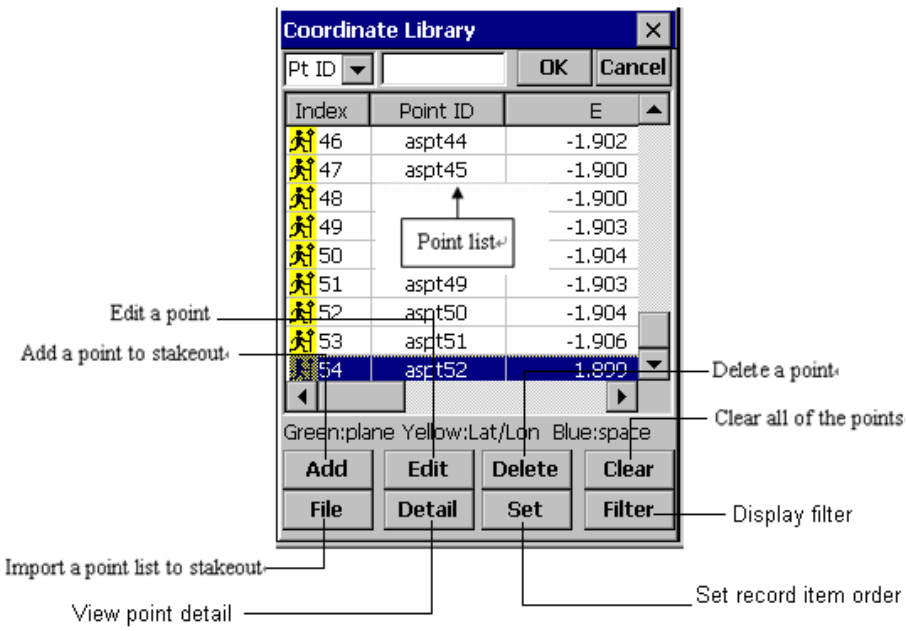
 zoom in

 zoom to all

 zoom in window

 move

You can import or edit coordinates of stakeout points on stakeout point Library.

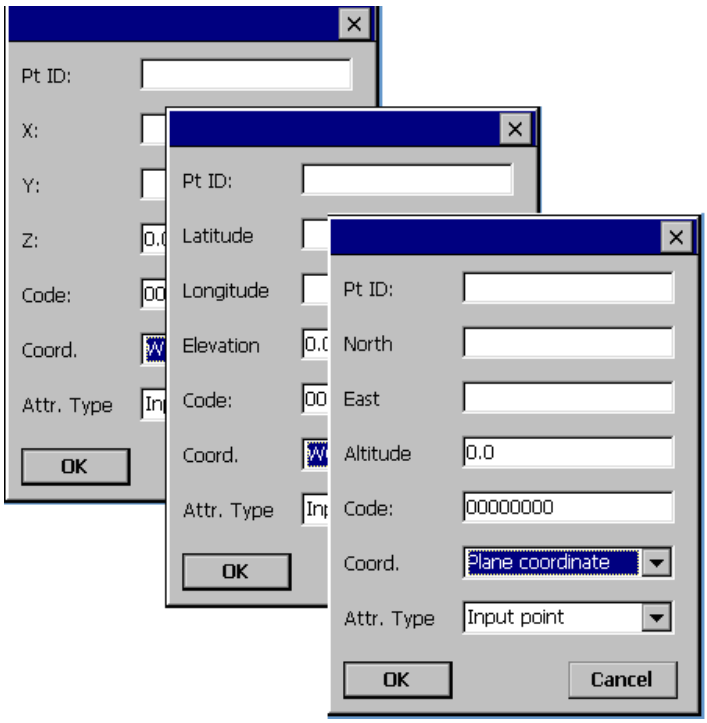


There are 3 kinds of coordinates can be added to stakeout points library.

--WGS84 space coordinate

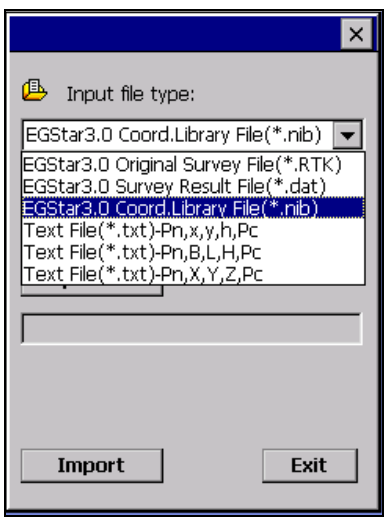
--WGS84 Lat/Lon

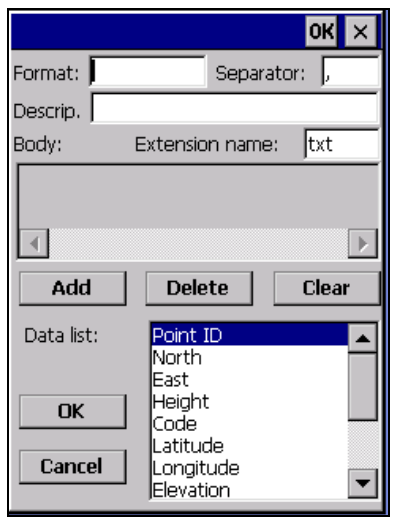
--Plane Coordinate (see as below screen)



3 kinds of coordinates

This option is just for adding few points, if you have many points needed to stake out. You can edit your point file as KOLIDA format by text editor tool. The supported file format is *.rtk ,*.dat and *.nib, also you can use user defined function to edit your own format, but it must be text format.





the file format description is as follows,

*.nib

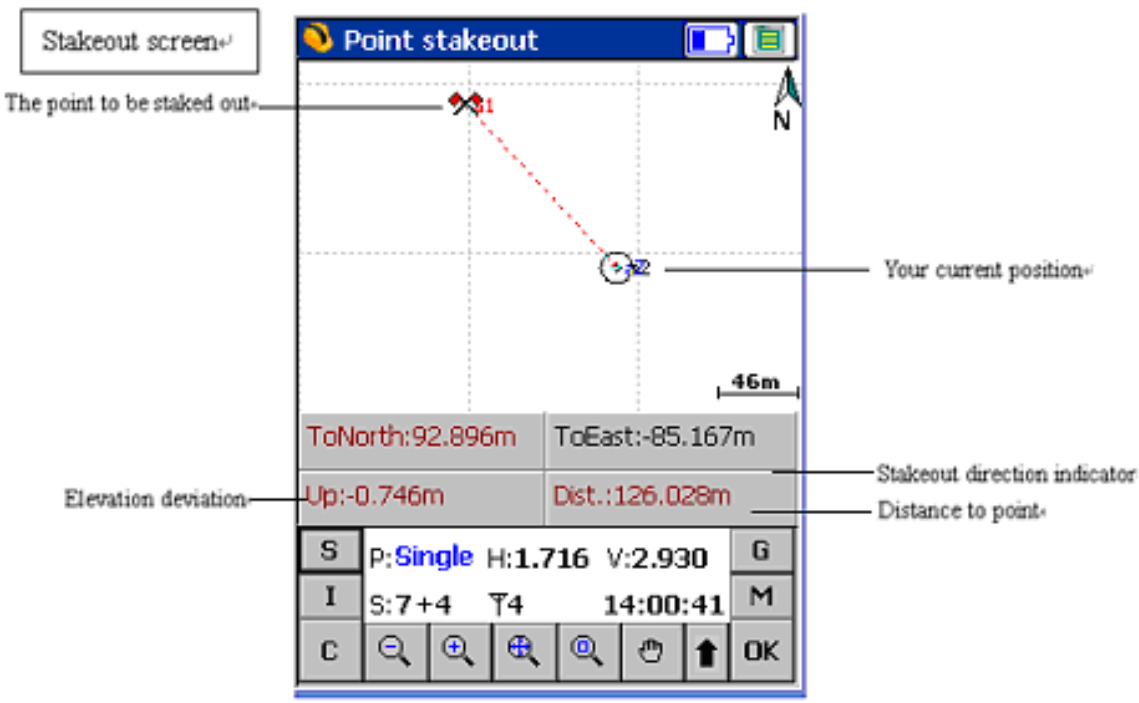
0,point name, N, E, H, code,
0,pt1,1000,1000,10,roof
…….
0,pt_n,1052,1021,20,roof

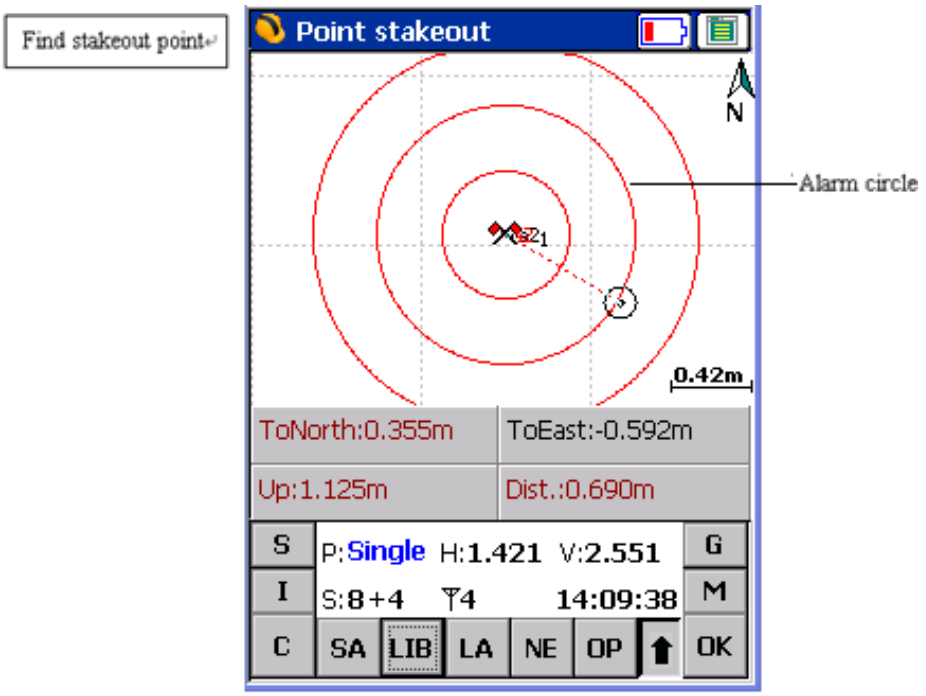
*.dat

Point name, N, E, H, code,
Pt1,1000,1000,10,roof
…….
Pt_n,2000,3000,20,roof

Remember that you need press **enter** key at the end of every line, otherwise, the point in this line will be not recognized in Estar.

After you input the stakeout point, you can select one point, then press "OK" button to stake out it.(see as following screen)



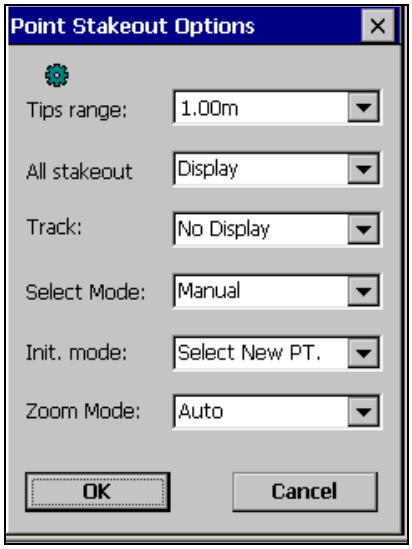


When getting closer to the point as the indicator indicated, 3 concentric circles appear in the screen informing you that you have near to the target. You can now materialize and log the Position of this point. (press hotkey "A" to log this point).

If you want to stakeout next point, you can click NE on screen or press hotkey "6" on keyboard,

If you want to stakeout previous point, you can click LA on screen or press hotkey "4" on keyboard,

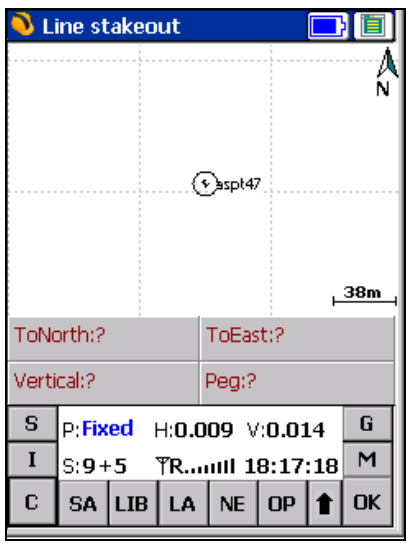
To change the setting for indication display, such as the radius of alarm circle, point display setting, click OP. (see the screen below)

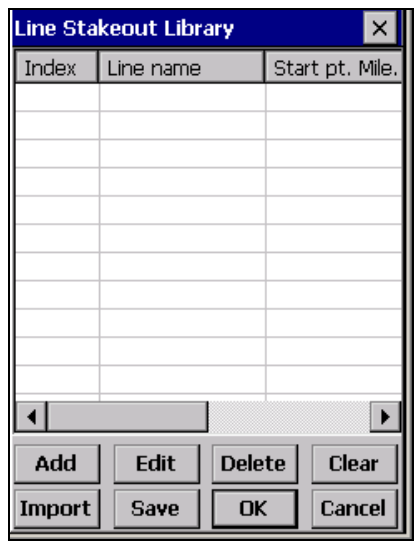


Tips range means the radius of maximum circle. If you select **Beep** option, when you enter into the area of alarm circle, the beeper will beep to remind you that you are close to the target.
Also you can define if show **all stakeout points** or not.

Staking out line

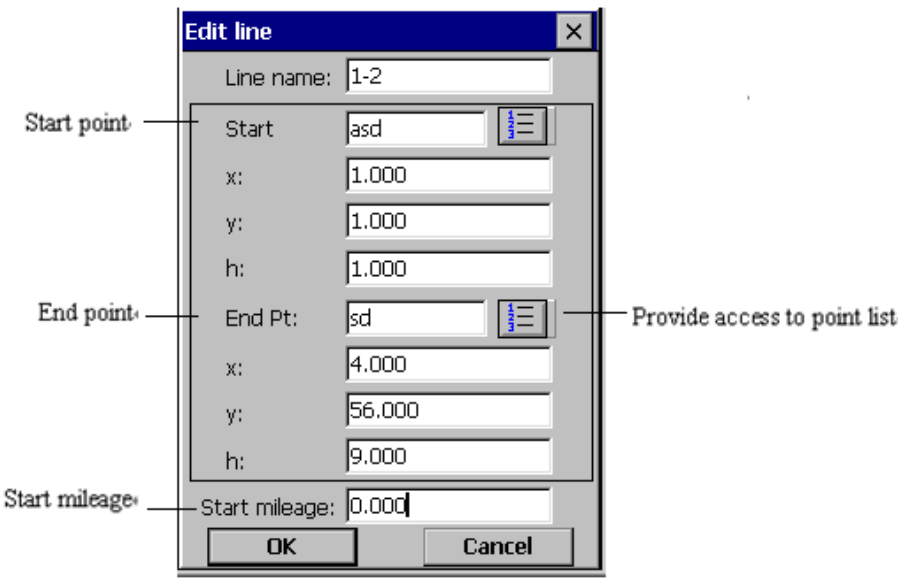
Click on **survey** menu, then select **stakeout line,** the below screen shows the main stakeout line screen. You need press **LIB** button to select stakeout line.





Then you can import or edit stakeout line in the pop-up line library. (see the above screen)

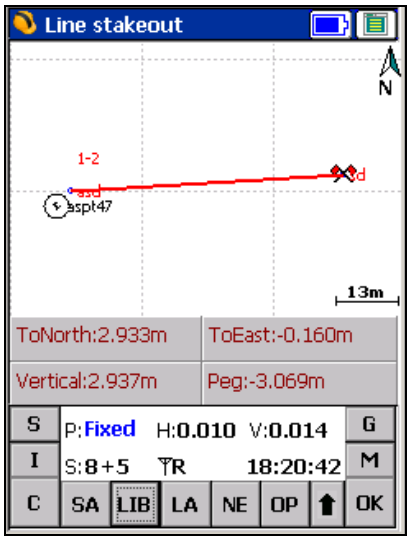
You can press "**Add**" button to edit a line to stake out, you need specify the start point and end point, also the start mileage. (see the below screen).



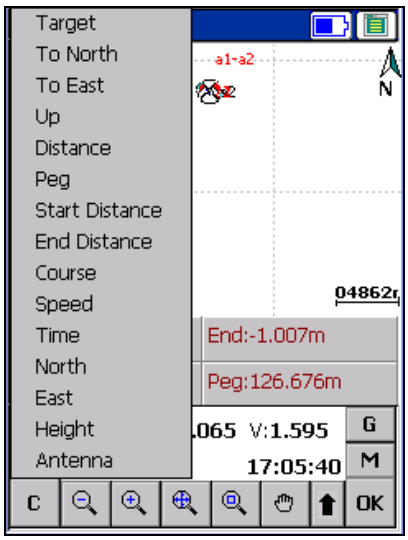
After you edit a new line, press "OK" button to return previous screen
Then you can select it to stake out.
Or you can import a stakeout file to the line library, the supported file format is *.lnb. The file format description is as follows:

*.lnb

Point name(start point), N, E, height, code,
point name(end point), N., E, height, code,
mileage of start point,line name, <line 1>
J13-1,9202.3460,7747.0240,0.0000,road,
JGL13-2,857.9000,8008.5340,0.0000,road,100.0000
<line 2>…….



After you select one line, and press "**OK**" button, you will enter stakeout line screen. (see as above screen).



Tap the middle display panel, it will pop up a list, you can choose what you want to show on the screen.

Target: stakeout line name.

To north: north offset value.

To East: east offset value.

Up: height offset distance.

Distance: vertical offset distance.

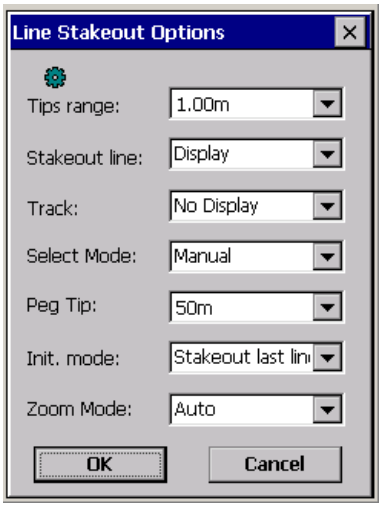
Peg: the mileage of current point.

Start.Distance: offset distance from start point of line.

End Distance: offset distance from end point of line.

And other information, like course, speed, time, north, east height and so on.

About the parameters, you can press **OP** button, refer to following figure.

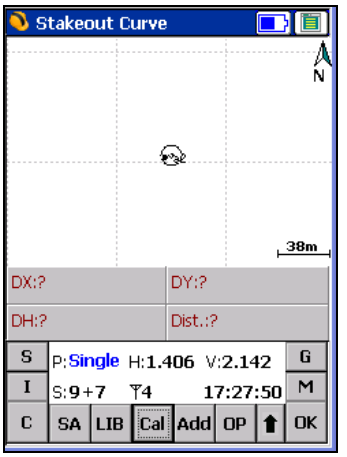


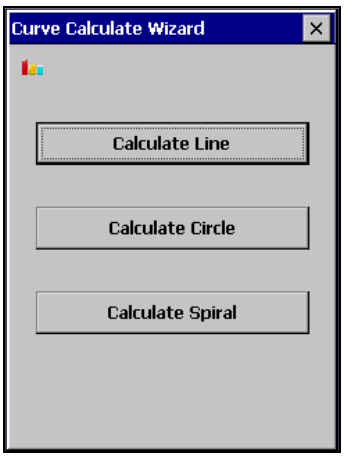
You can set alarm line by tips range option, also you can set display stakeout line or not, zoom mode and so on.

Stake out curve

It's an extension function for staking out point, which includes design, calculate and stakeout function. You can design line, circular curve and transition curve, also you need specify a distance interval, then the program will separate line (curve) into many points as the interval, then you can stake out these points to realize the function of staking out curve.

Firstly, you need press **Cal** button to select one item, there are 3 items in this menu (see the below screen)





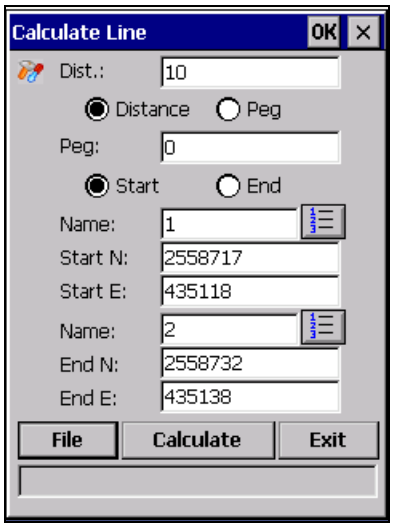
Calculate Line

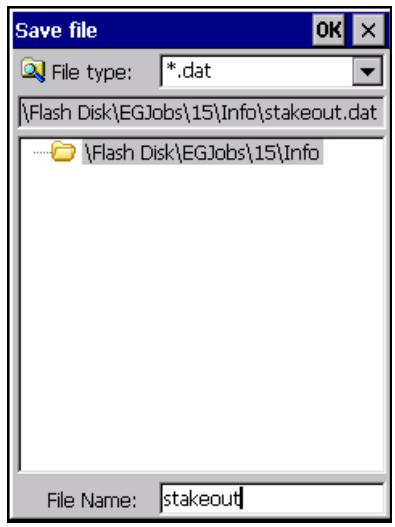
After you select **Calculate line** option, it will appear the **Calculate line** screen, In this screen, you need specify the start point, end point and distance interval and so on. (see screen below)

Interval (m): distance interval

Dist: calculate points by integral distance. For example, the mileage of start point is 4.5, and interval is 10m, the mileage of first calculated point is 14.5, second is 24.5.

No. Calculate points by integral No. for example, the start point mileage is 4.5, and interval is 10m, the first calculated point mileage is 10, second is 20.





Peg: set the mileage of the line.

Start: the specified mileage is start point's.

End: the specified mileage is end point's.

After you input all of the parameters, press "**File**" button to save the file.(See as above figure), then you can press "**Calculate**" button to calculate coordinate, the program will calculate the points automatically, the default storage path is \Flash Disk\EGJobs\job name\info\XXX.dat

Then you can press **LIB** button to select stakeout point, the following steps are the same as stakeout point.

Calculate Circle

This operating mode is suitable for circular curve.

When you enter the **Circle wizard 1-setup** screen, you need set the radius of

curve, angle (it's the turning angle of curve), peg, and the direction (azimuth).

Radius: the radius of circular curve

Dist: distance interval

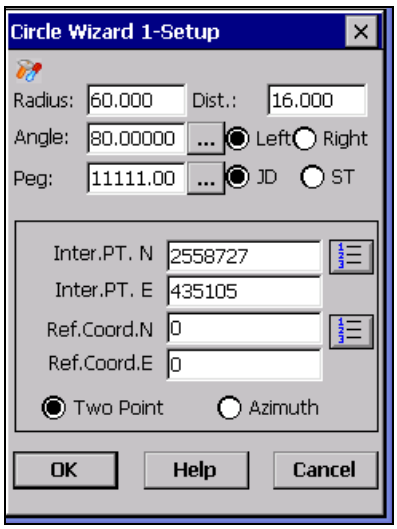
Angle: turning angle of curve

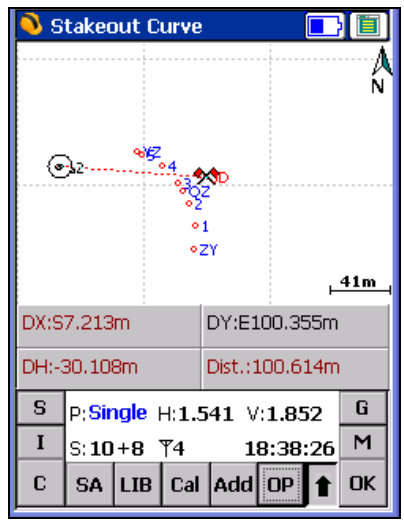
Left: the curve inclines left

Right: the curve inclines right

Peg: mileage

JD: if you select this option, it means it's intersection point mileage.



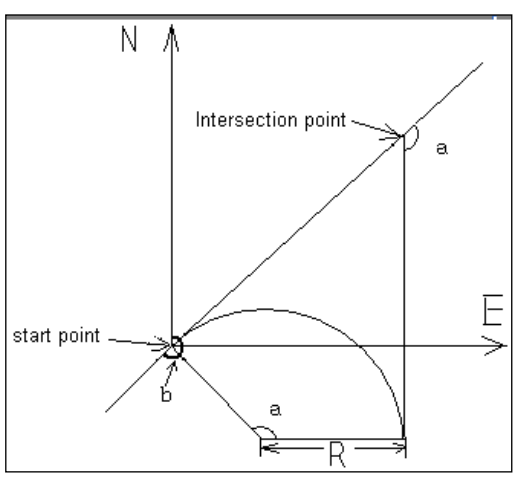


ST: if you select this option, it means it's start point mileage.

There are two manners to fix the azimuth of circular curve. One is by **two points**, you need input the coordinate of intersection point and another point in this direction. The other manner is by **azimuth,** you should know the coordinate of intersection point and the azimuth.

The radius and angle determine the length of curve, the intersection point and azimuth determine the position of curve.

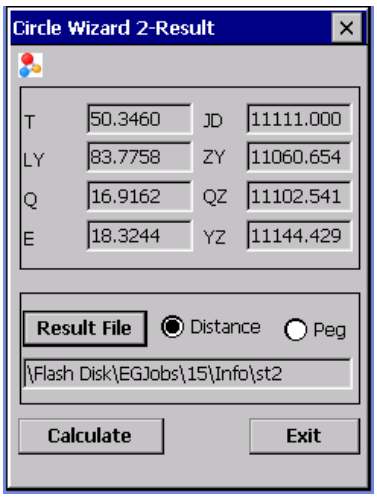
About the parameters of curve, you can refer to the following figure,



R is radius, **a** is the angle of circular curve, **b** is azimuth of circular curve, in this example, the curve inclines right.

After you input the parameter, and press "OK" button, it will

appear a new screen, it will show the calculated curve elements in the screen. You just need press "**Result**" button to save the result file, the result file type is *.dat. (see screen below),



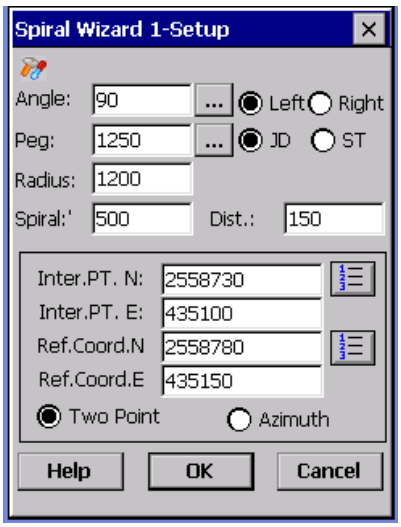
After you press **Calculate** button, it will calculate the coordinates and return to the main screen, then you can press **LIB** button to open the result file to stake out , the following steps are the same as staking out point.

Calculate spiral

This operating mode is suitable for comprehensive curve.

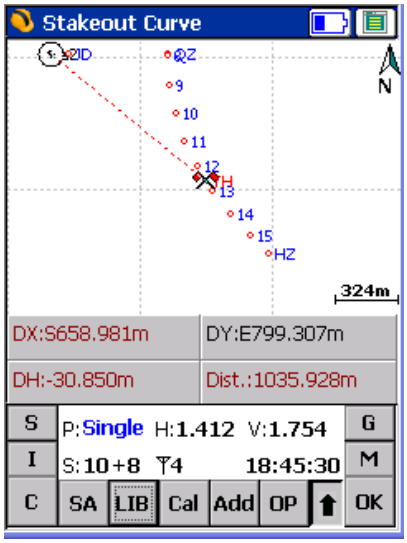
It consists of circular curve and transition curve.

So in the **spiral wizard 1-setup** screen, you need set radius of circular curve, The turning angle of whole curve, length of transition curve and so on. (see screen below)

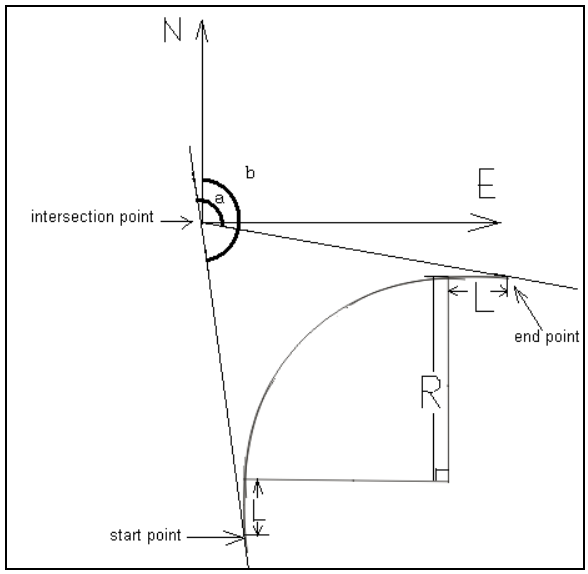


Radius: the radius of circular curve in the comprehensive curve.
Dist: distance interval for calculating point coordinate.
Angle: turning angle of whole curve.
Left: the curve inclines left
Right: the curve inclines right
Peg: mileage
ID: if you select this option, it means it's intersection point mileage.
ST: if you select this option, it means it's start point mileage
Spiral: the length of transition curve.

There are two manners to fix the azimuth of comprehensive curve. One is by **two points**, you need to input the coordinate of intersection point and another point in this direction. The other manner is by **azimuth,** you should know the coordinate of intersection point and the azimuth.
Usually it will generate two transition curves and one circular curve, it starts with transition curve, then connects a circular curve, end with the other transition curve.

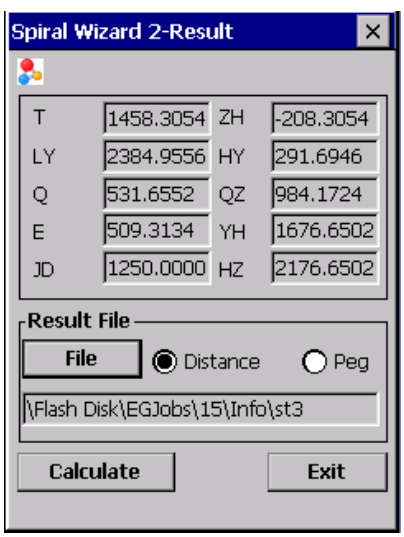


About the parameters of comprehensive curve, you can refer to following figure.



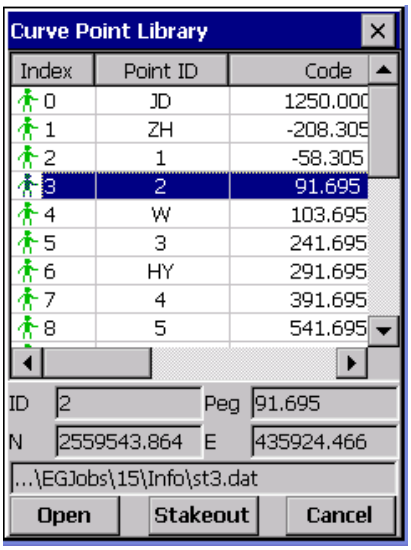
R is radius of circular curve, **a** is angle (turning angle of the curve)
b is azimuth of the curve, **L** is length of transition curve(spiral value)

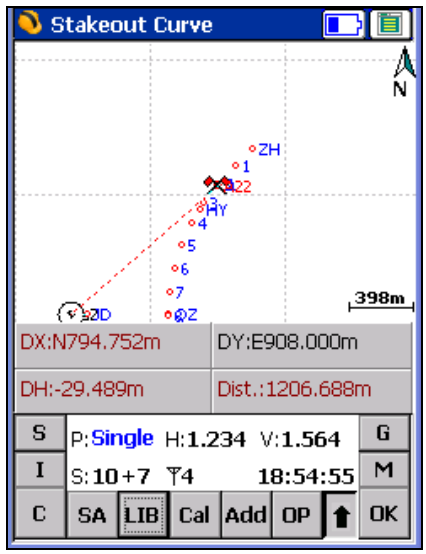
After you input the parameter, and press **OK** button, it will appear a new screen, it will show the calculated curve elements in the screen.
You just need press **File** to save the result file, the result file type is *.dat.(see screen below), after you press **Calculate** button, it will calculate the coordinates, and return to the main screen, then you can press **LIB** button to open the result file to stake out , the following steps are the same as staking out point function.



Add peg

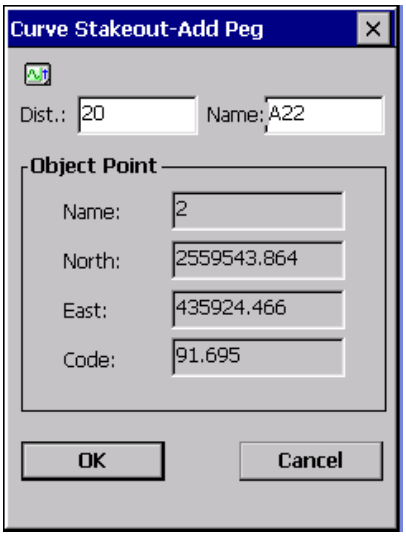
With above 3 functions, you can calculate the points on line (circle, curve) as specified interval value. But sometimes, you want to know a special point on the line (circle, curve) with random mileage value which can't be calculated by the interval value. You can use this function to realize it. For example, the interval value is 10m, after calculation, you can get the points with station 0, 10,20,30……, but now you want to get the point with station 12.5, you can use **add peg** to calculate. The steps are as follows:



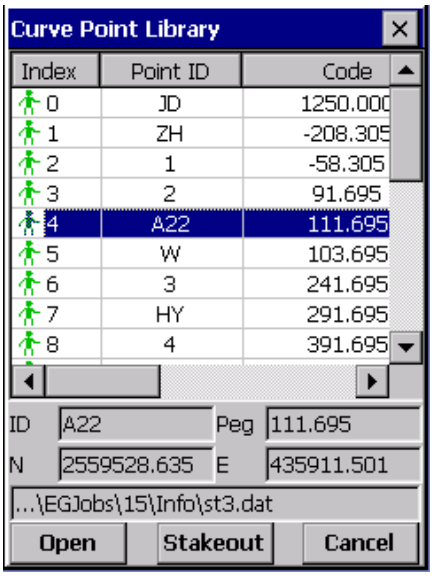


1. Select a point you want to insert behind it from library. (Point ID is 2 in the above screen).then press **Add** button.

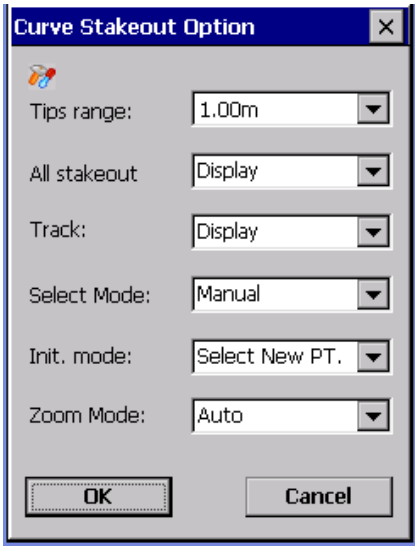
2. The mileage of the point you selected is 91.695, you want to calculate the point with mileage 111.695, just need input 20 in the **Dist**. Field. And input a point name in the **name** field**.** Then press OK button to exit.



3. You will see the added point appears on the curve, the coordinate of the point will be added in the result coordinate file (st3.dat).



Also you can press **OP** button to make some settings. (See the screen below). You can set alarm area via tips range option when you stake out. It will beep when you walk close to the target.

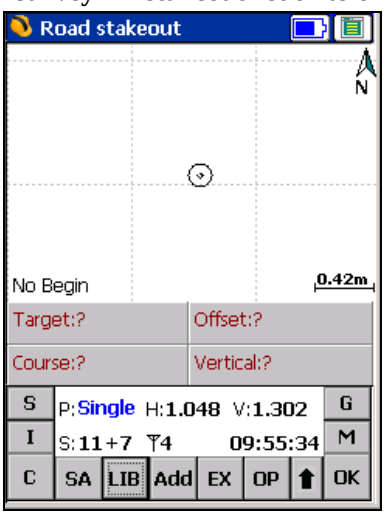


Also you can set display ways of the stakeout graph, Display all target or none.

Staking out Road

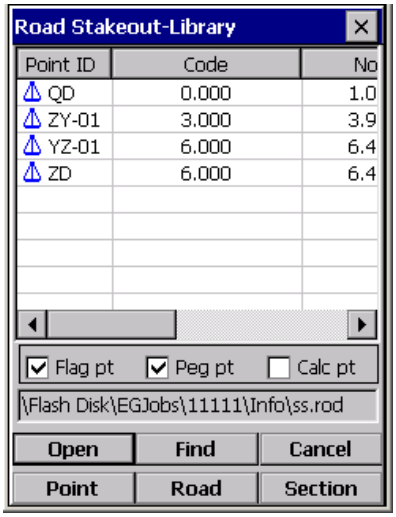
This function is very import and useful. But you need finish the road design before staking out road. The option is under the **Tools** menu.

After you make road design, you can start to stake out road, you can click "**survey**"->"**stakeout road**" to enter stakeout road screen. (See screen below)



You need press **LIB** button to select stakeout file (*.rod, *.ip)

There are 6 important buttons on this screen.(see screen below)



Open: to import stakeout-road file.
Find: to find a stakeout point by mileage, then locate on the table.

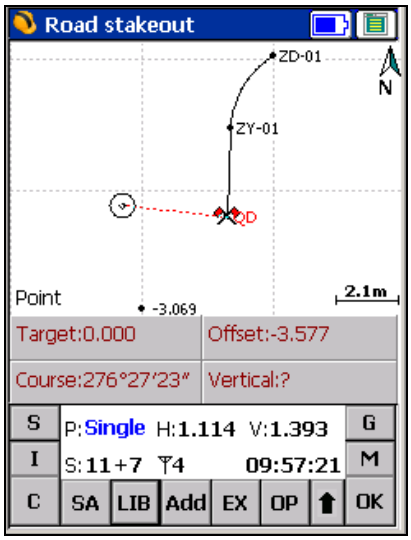
Road: it's a kind of way to stakeout, you don't need to select any point first. It will show the whole road map and your current location on the main screen, you can find the target by your current station and the offset from road. For example, you want to stake out the point with station 200, but the station of your local position is 180, the offset value is 25m, it means you need go on moving, when the station become to 200, and offset become to 0, then you find the target.

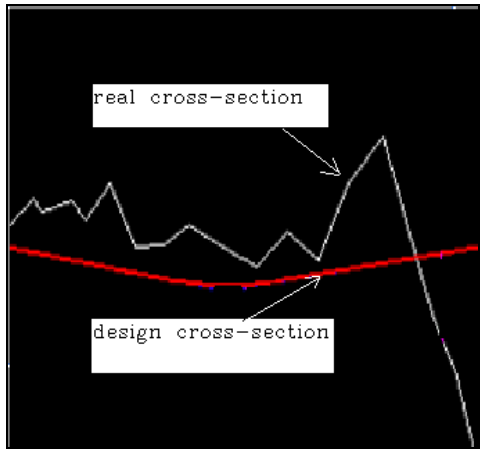
Point: you need select one point first, then press "**point mode**", the main screen is the same as stakeout point.

Section: it's designed for collecting data on cross-section. When you select one point on the table, then press "**Travel Mode**" button, it will create a cross-section line on the road (see screen below), then you can collect data on this cross-section.

Flag pt: shows the key elements on the table, like the start point of line (LS for short display), central point of circle (QZ for short display), etc.

Peg pt: shows the added points by calculation from **Add peg** function.
Cal pt: shows the calculated points by **road design** function.





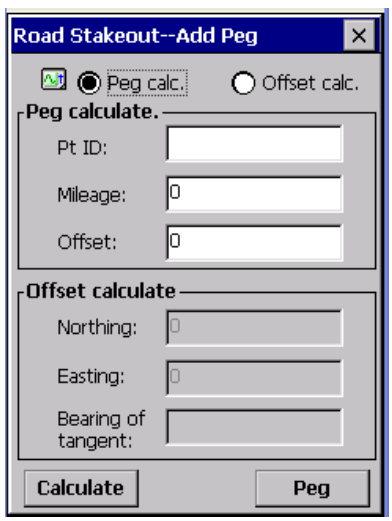
On the main screen of stakeout road, there are several additional tools.

Add peg

When you want to add a center peg on one road, you can use this command to calculate and create it.

1. You need to open a road design file first, then return to the main screen.
2. Press **Add** button, it will open a new screen.

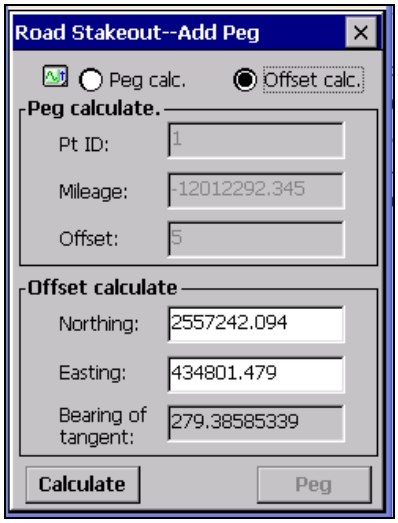
(See screen below)



There are two manners to calculate the new peg

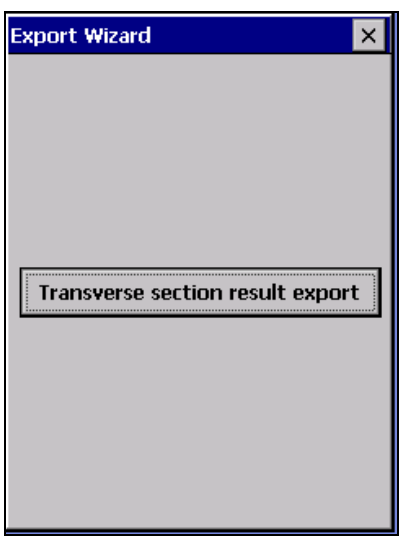
a. if you know the mileage and offset value, you can input to the above box, and press **calculate** button, it will calculate the coordinate of the point and add it to the road file.

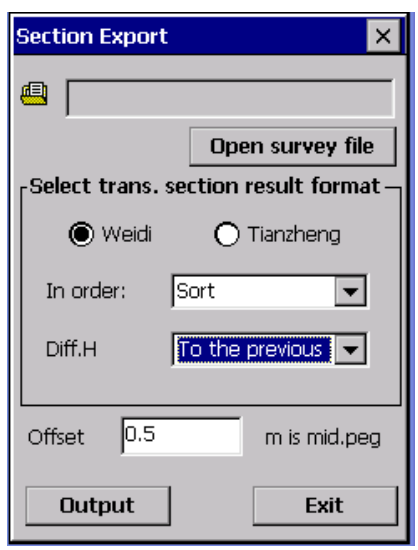
b. If you know coordinate, you can input it to the below box, then press ok button, it will calculate the station and offset value automatically.
Press Peg button to add it to the road file.



Result file export

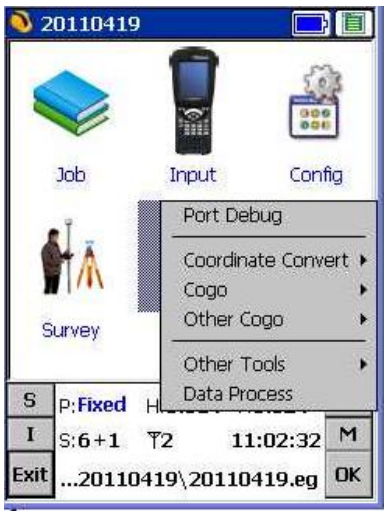
After you finish the stakeout road survey, you can press EX button to save the result. Select your survey file first, then select a format to transform. Finally you can press **output** button to save it.



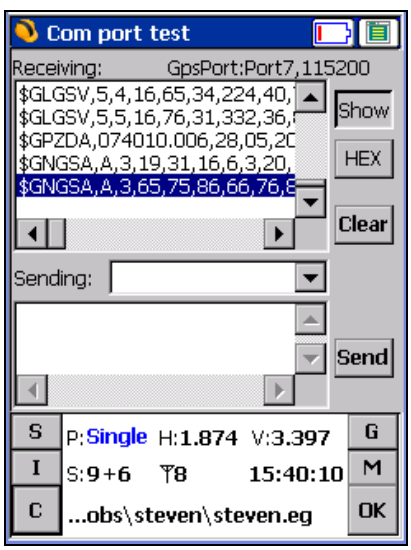


§2.5 Tool Menu

There are six submenus under the tool menu: **Port debug**, **coordinate convert, Cogo**, **other Cogo**, **other tools**, **Data process**, menus instruction is as follows:



§2.5.1 Port debug



You can view NMEA 0183 data from this dialog.

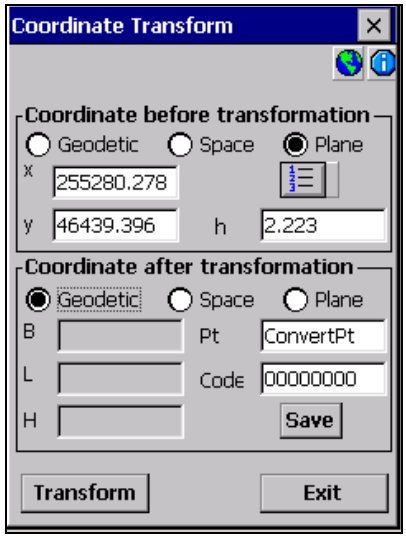
§2.5.2 Coordinate Convert (calculate parameter)

Coordinate Convert

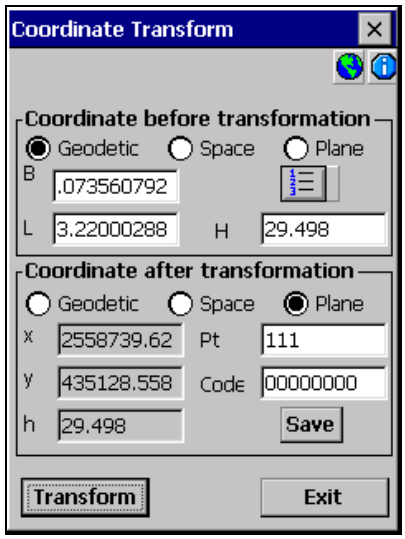
Coordinate conversion is that you can transform the coordinates between geodetic coordinates, cartesian coordinates and plane coordinates.

Operation steps:

1. To convert plane coordinate system to geodetic system, please select the plane coordinate system (N E H), and input the coordinate to the window of conversion, then select **Geodetic** in the Coordinate after transformation field. Then click **Transform** button.



2. To convert geodetic system to plane coordinate system, please select the geodetic system (Lat/Lon), input the coordinate to the window of conversion, then select **Plane** in the coordinate after transformation field. Then click **Transform** button.



Notice: Before coordinate conversion, you should set the projection scale factor. You should set it in the "**config**->**Job config**".

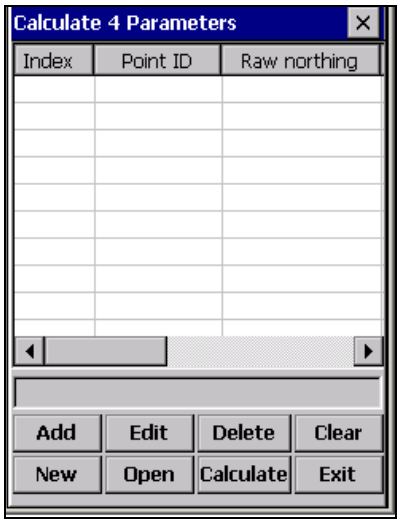
Steps: Tools→Coordinate convert→Calculate Parameter

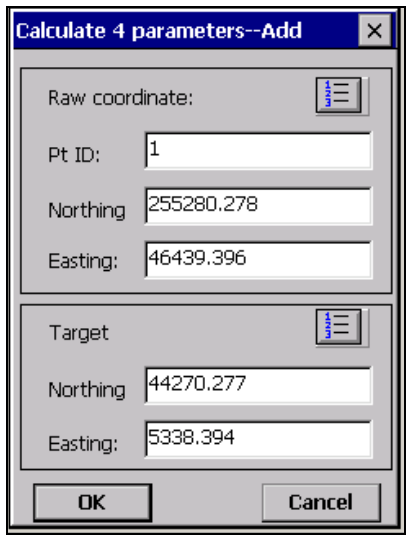
Note： This function includes Calculate Four-parameters and Calculate Seven-parameters, the operation is similar, but the meaning is different.

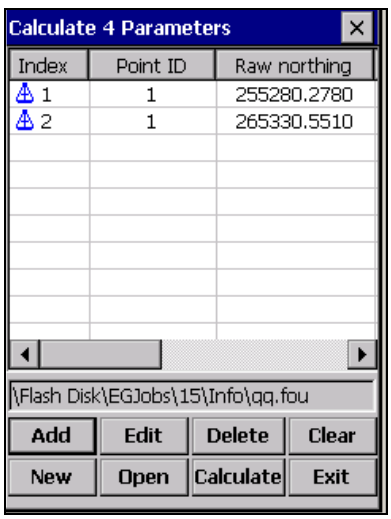
Calculate Four Parameter

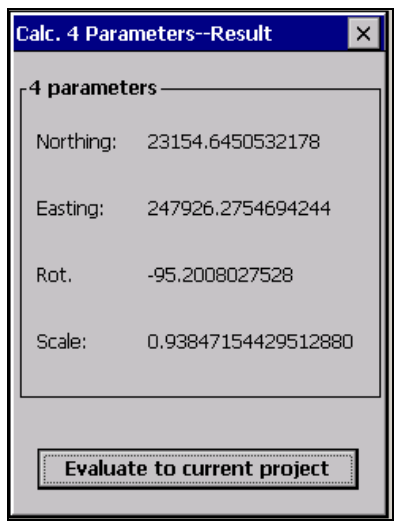
This function needs local coordinates of two or more than two points, acquire the source coordinates and input it with the local coordinates. When the points are sufficient, you can start the calculation and acquire conversion parameter (from WGS84 system to local coordinate system). Parameters include: X shift component, Y shift component, Turning angle, scale difference (Scale Ratio)

Steps: Enter **calculate four parameter**, make a new file, then click **Add** button to input coordinates in turn, click **OK** to save it, see following figure click **Calculate** to generate conversion parameter.





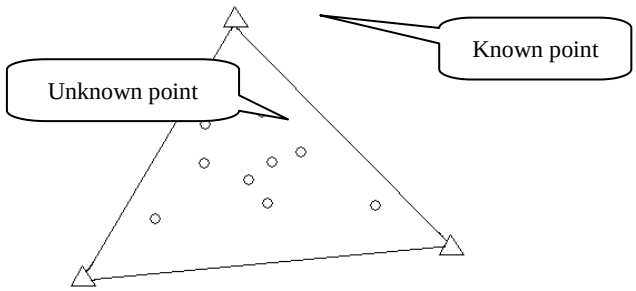




Calculate Seven Parameter (Bursa-Wolf)

If the area to be measured is too large (more than 50Km), you can use Seven Parameter to acquire more accurate coordinates, which needs three known points with local coordinates and their relative WGS-84 coordinates to calculate it. The seven transformation parameter is transformed from WGS-84 coordinates to local coordinate.

Notice: You'd better make the area of three points cover the whole survey area to acquire preferable effect.



Three known points and survey area map

The seven parameter includes: X shift component, Y shift component，Z shift component，X axis rotation, Y axis rotation, Z axis rotation, Scale difference (Scale Ratio).

Principle: As you know, the RTK survey with transformation parameter can make the plane coordinates of survey point, height accuracy and control net cooperate very well in small area (such as ten sq. km) and you only need two or more than two local coordinates. But when you do the survey work in a large area (such as hundreds of sq.km), the transformation parameter cannot improve the accuracy of plane and height within parts of area. Thus you need to use seven-parameters, the detailed operation is as follows:

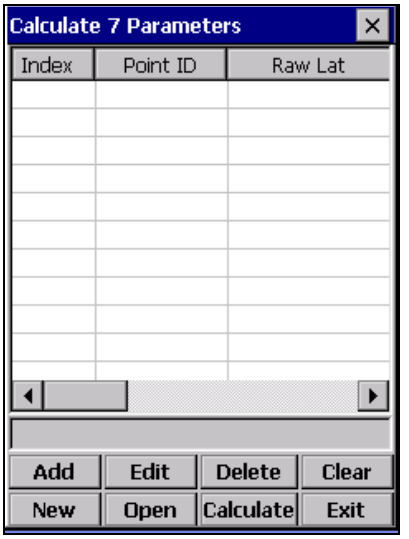
First, you need to do the control survey and level survey, and do the static control on the control point with known coordinates within the area, then select a control point A as the WGS84 reference station of static net adjustment before you start the net adjustment. Use a static instrument to do the single point survey on Point A for more than 24 hours, and then import to the software to note down the average as its WGS84 coordinates. For having done the long time survey, the absolute accuracy should be about 2m, then start the 3D adjustment, which needs to take WGS84 coordinates as known coordinates. Calculate the 3D coordinates of other points, but at least three groups, then you can acquire the seven parameters after calculation.

When you use seven parameters, open it and close 4 parameter (if it is opened). **Note**: the unit of shift component is meter, the unit of rotation parameter is second. After you finish this, you can start the detailing or layout road. The base station should be mounted on the known point according to handy principle, if the known point has been used in seven parameter calculation, the accuracy control will be better. You can also use the WGS84 longitude and

latitude of this point to set the base station.

Note: Seven-parameters has a limitation, X, Y, axis rotation values are generally second level, X, Y, Z axis shift values are usually less than 1000. If the seven parameters are not within this area, it will not work..

Steps: you can directly input the local coordinates of three known points and their WGS-84 coordinates, or open the point file to select three points.



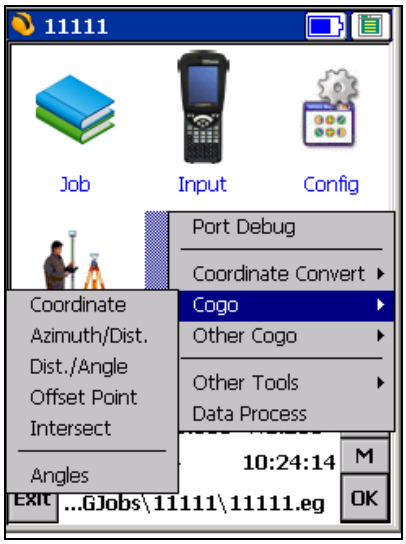
After you acquire the seven-parameters, system will automatically switch to this parameter, use this parameter and acquire the correct coordinates of the surveying point.

Note: The concept of three parameter is generated from seven parameter, if do not calculate all axis rotation and scale for seven parameter, you only need shift component which is mostly used in the small area and low-accuracy demanded area.

§2.5.3 COGO (Coordinated Geometry)

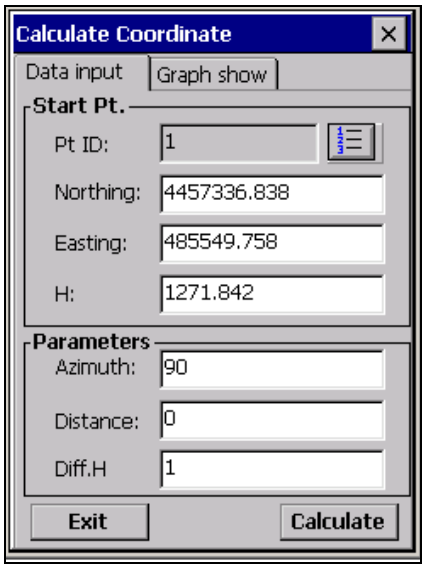
Steps: Tools→COGO

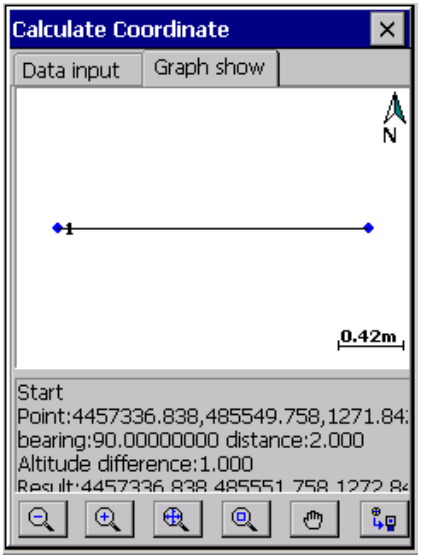
It includes coordinate, Azimuth/Dist., offset dist./angle, offset point, intersection, angles. The software provides many tools to calculating coordinate, so you can get the point coordinate very conveniently.

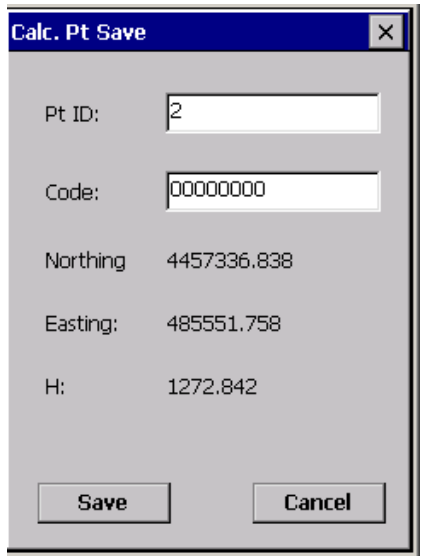


Calculate Coordinates

Calculating coordinates is to calculate unknown point coordinates by the coordinates, azimuth and distance, height difference of a known point.





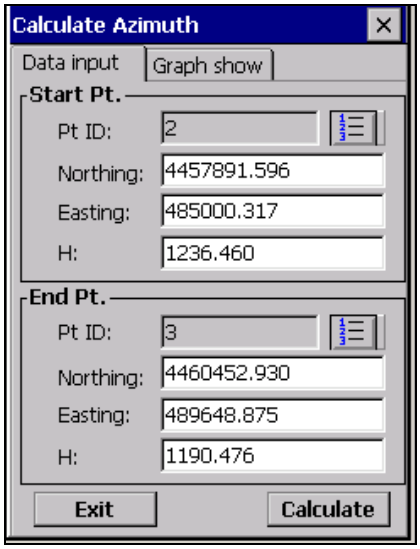


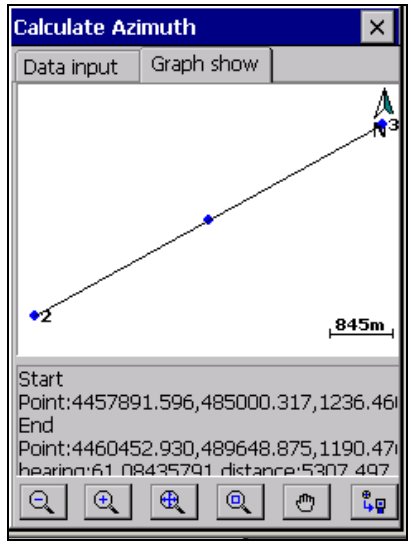
In the graph window, you can see the position of the unknown point relative to the known point. You can press  button to save the calculated coordinate. (See the screen above)

Azimuth/ Dist.

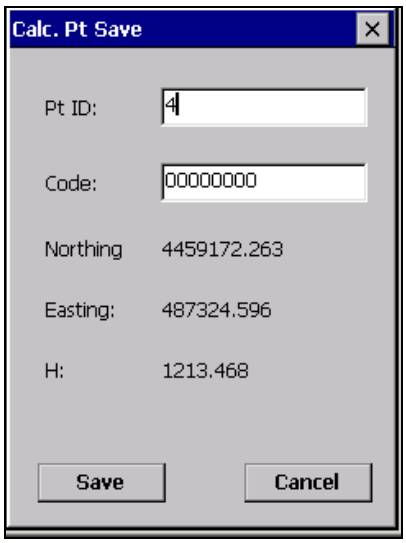
This function is to calculate the azimuth, distance and height difference and central point coordinate between two known points.

Steps: select "**Cogo->azimuth/Dist.**", input the two known points' coordinates, click **calculate** button, you will see the result of the azimuth, distance and the relative height.



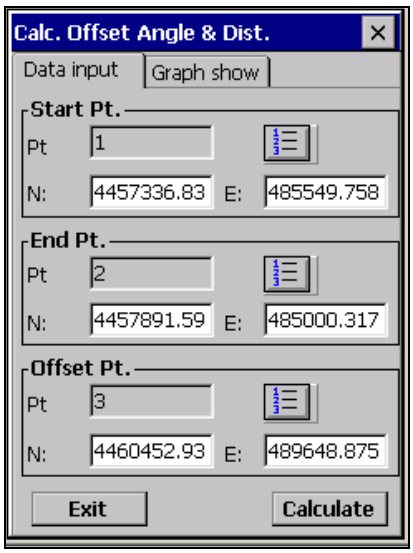


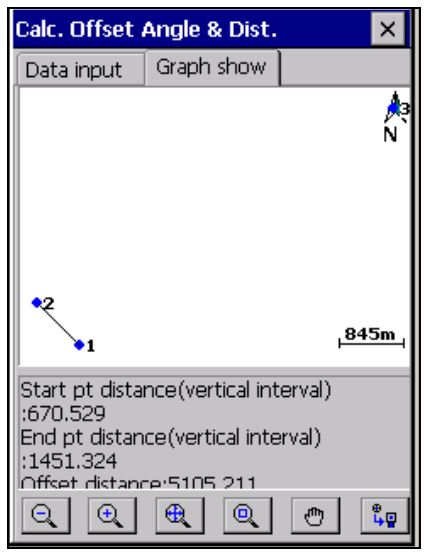
At the same time, you can see the relative graph in the window of Graph. You can press  button to save the coordinate of central point. (See the screen below)



Distance/Angle

Calculating offset distance/angle is to calculate the offset from the point to a known line (from start point to end point). Including distance to start point, distance to end point and offset distance.





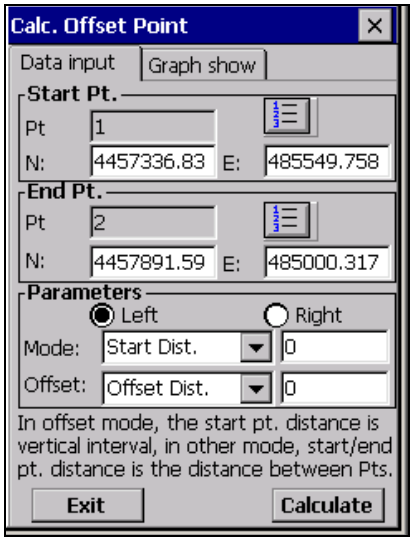
Steps: select "**Cogo->dist/angle**", input the coordinates of start point, end point and the offset point.

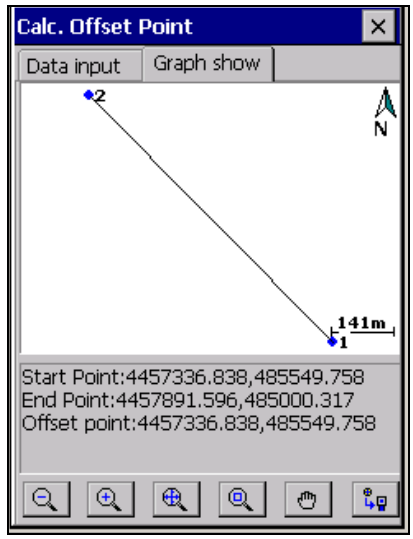
Then click **calculate** button, you will see the "start distance", "end distance" and "offset distance". The sign of offset value shows the direction of offset point. If the offset point is at left of the line, it is minus. If the offset point is at right of the line, it is positive. The line direction which we defined is start point to end. At the same time, you can see the relative graph in this page.(see the figure above)

Offset point

"**Calculate offset point**" is reversed to "**Calculate offset distance/angle".** It is to calculate the unknown point coordinates by the known offset distance and offset angle.

Steps: select "**Cogo->offset point**", input the start point coordinates, end point coordinates and the information of offset point. Then click **calculate**, you will see the result in the result page. You also can see the relative graph between offset point and the line in the display page. Furthermore, when inputting coordinates you also can press  button to select them from coordinate library.



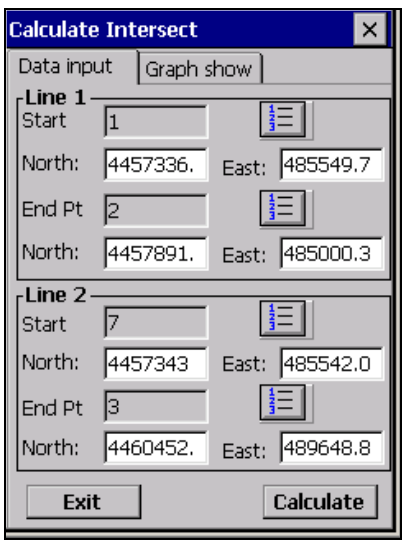


Intersection

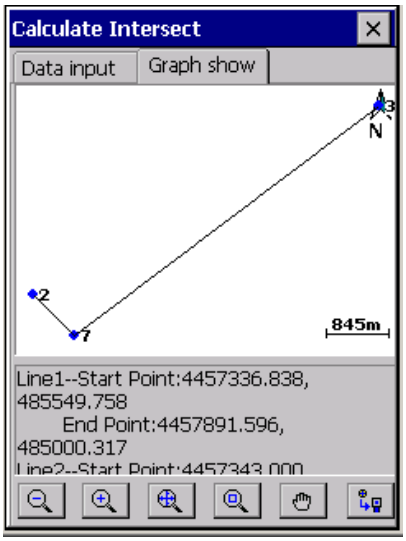
Intersection program is to calculate the position of intersection point by two known lines.

Steps: select **"Cogo->intersect"**

In the window please input start point and end point coordinates of two known lines. Or click the right button  to select the coordinates from the coordinates lib. You also can open the existed file, then select the coordinates which you need.



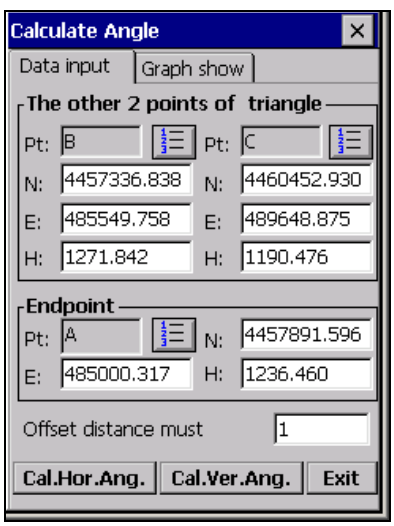
After input the coordinates, click **calculate** button, then you will see the intersection coordinates in the graph show page. You also can see the sketch map in this screen.

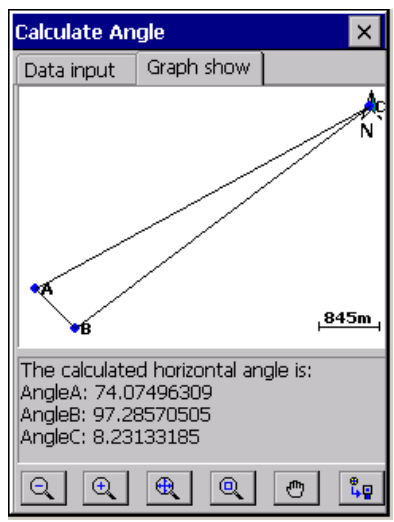


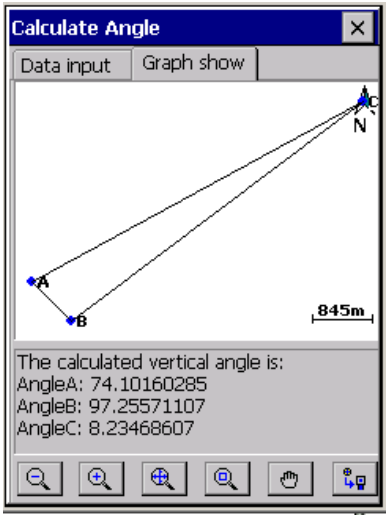
Angles

It's to calculate the horizontal and vertical angles between 3 known points which compose a triangle.

Steps: Tool->cogo>angles







Input coordinates, then press **Cal.Hor.Ang** and **Cal.Ver.Ang** buttons to get the horizontal angle and vertical angle.

OTHER COGO

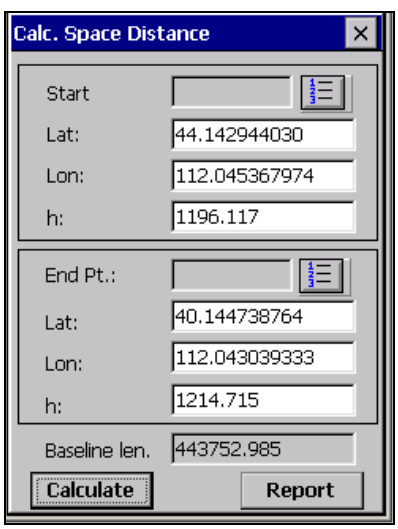
Space Distance

Space distance is to calculate the baseline length by two known points.

Steps: **Tool->Other Cogo->space distance**

Input geodetic coordinates of two points, click **calculate** button, you will get the baseline length in the last column (space dist).

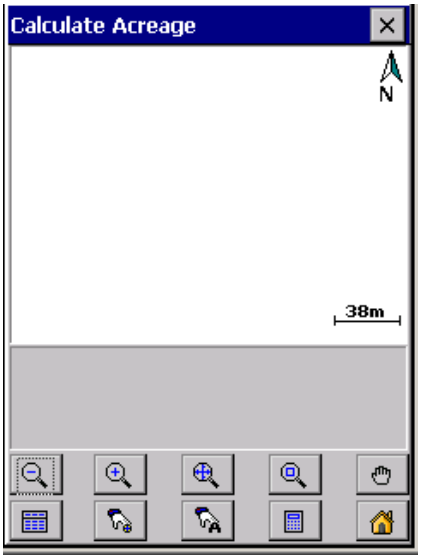
Notice: The format of latitude/ longitude is dd.mmssssss.



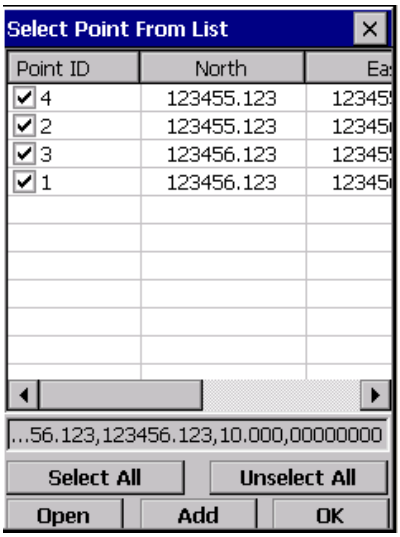
Areas

Steps: **Tool->other Cogo->Areas**

Areas is to calculate the closed area which is selected from the picture.



Steps: Firstly, other Cogo->Areas, secondly, select "open", then select surveying data, click "OK". All points will be display on the screen.

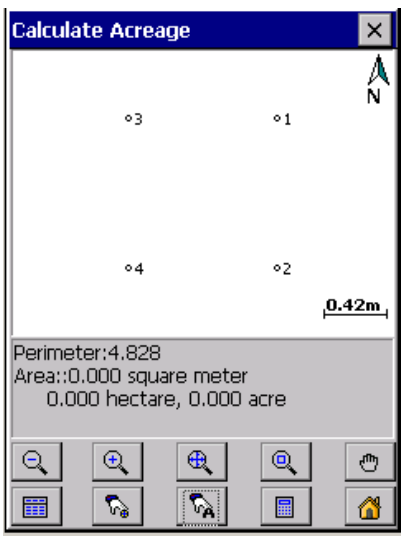


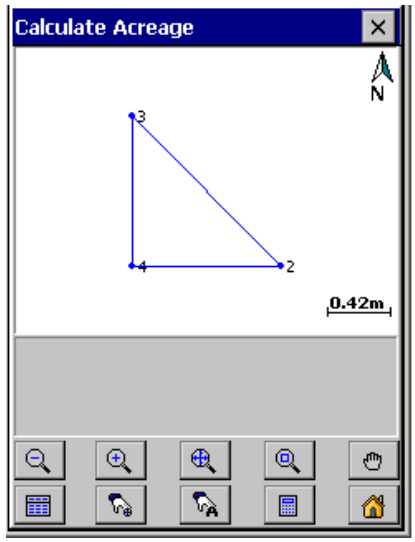
Operation of selecting points is as follows:

1. Select many points to calculate the closed area.

Click the tool button"  ", then select points in order. The last point can not connect with any point, because it will be closed automatically when you click

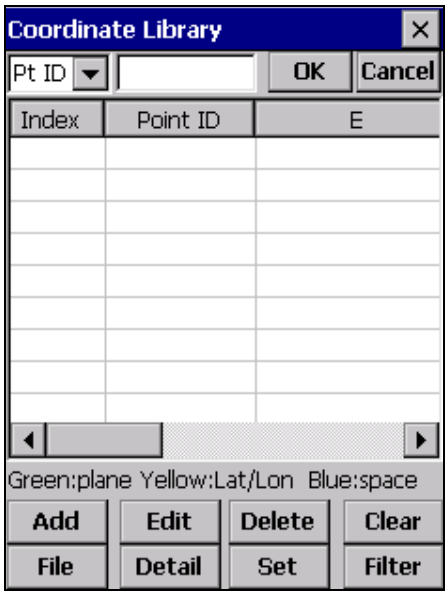
the “  ” button. For example, when you select three points, you can see their names in the list.

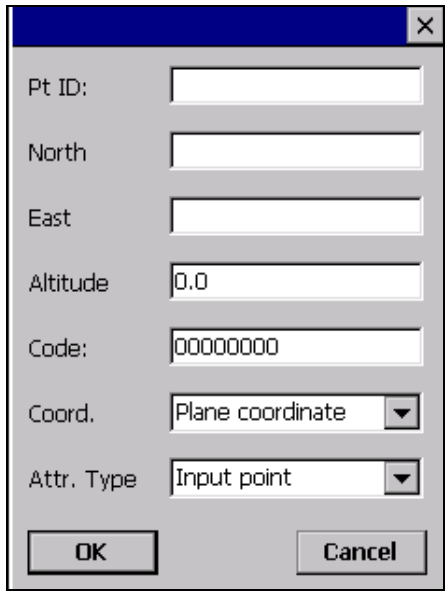


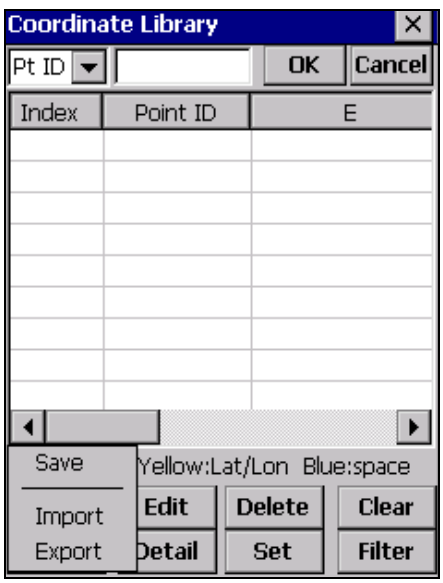


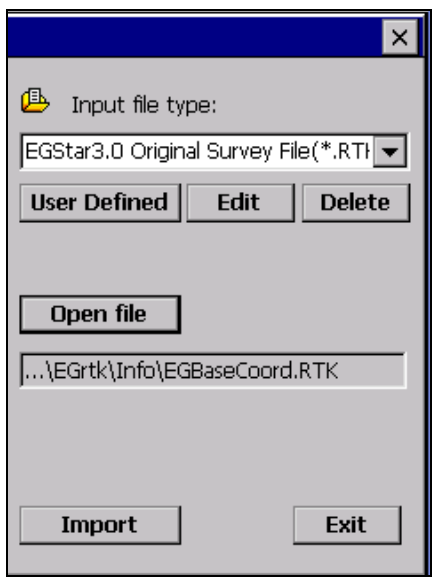
2. Insert points in the current picture.

If you find that some points are not shown in the current picture, they’re not included for area calculation, if you want to import these point to the current picture, you can click the button “  ”, now you enter the mode of “select Point From List”. Now you should notice that if you click **Open**, you can make some points shown in the current picture, but it can only show points included in the file you open. For add some extra points in the current picture, you can click button **Add**, now you enter the mode of “coordinate Library”. You have two choices: the first choice is you can click the icon **Add**, create some new points by editing the attributes of the points; the other choice is to import some points has existed in some project files. Click the icon **File** then **Import**, choose the project file to import points.









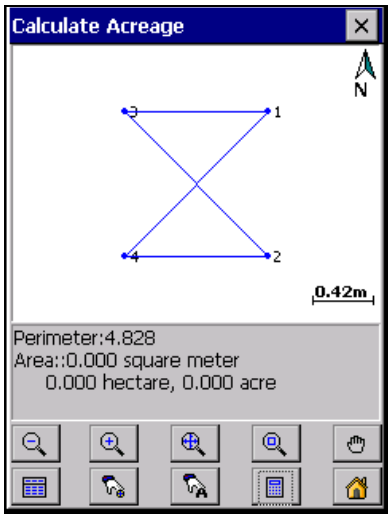
3. Unselect points in the current picture.

If you want keep some points in the current picture out of forming a closed area, you can click the left frame of "Ponint ID" to remove "  ",then the point won't connect with other points to form a closed area.

4. All points selected and cancel selected.

When you want to selected all points or cancel choice, please select the button "  ". When click the button once, all points in the picture will be selected.

When click the button again, all points will be canceled choice. Then you can select points over again.



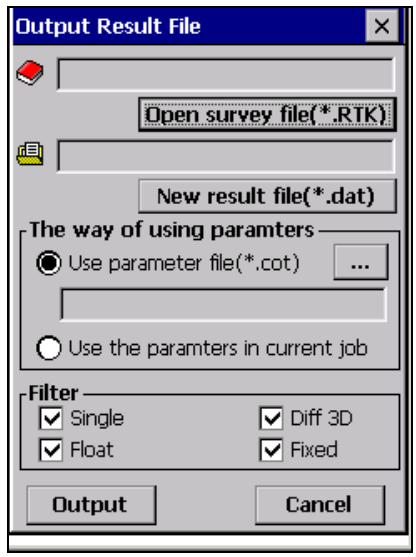
§2.5.4 Data Processing

If there is an error in calculate parameter due to the input wrong parameters, it will lead incorrect result in the following steps, you can rectify the wrong data by using this function.

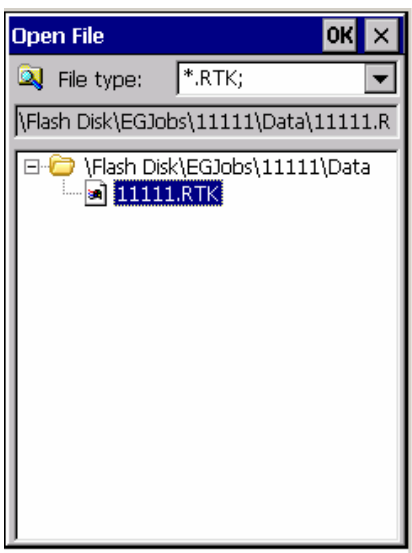
This function is the parameter correction and adjustment in batches to the survey coordinates. You can use control point library and data process to recalculate the adjustment parameter and process survey points in batches when there are some errors during coordinate input or adjustment operation. Thus effectively avoid the repeated work. There are two ways of data process:

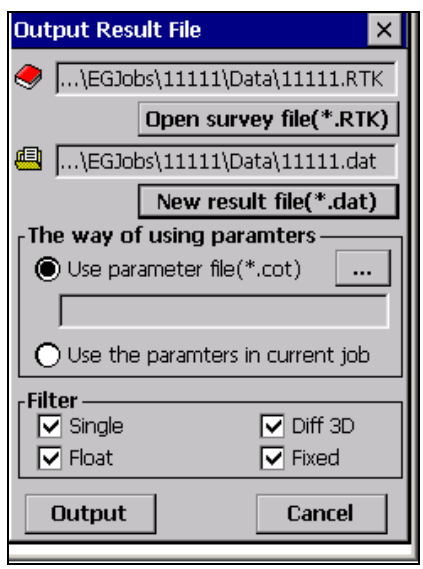
1. **Export plane coordinate result file**, this way is used more often.
2. **Export Lat/Lon result file**. It's used for calculating average Lat/Lon in average value.

Steps for the first type: Tools->Data process->export plane coordinate result file,

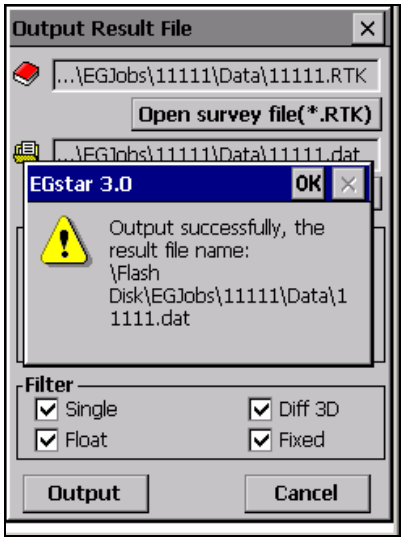


1. Open survey file (*.RTK)
2. Choose New result file (*.dat) to create a file to save new result.
3. Choose transformation parameters. You can select a *.cot file from folder, or just use the parameters in current job.
4. Filter setting. You can filter some points through this option.

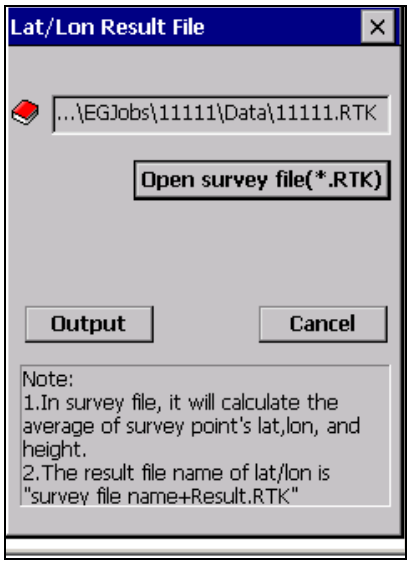


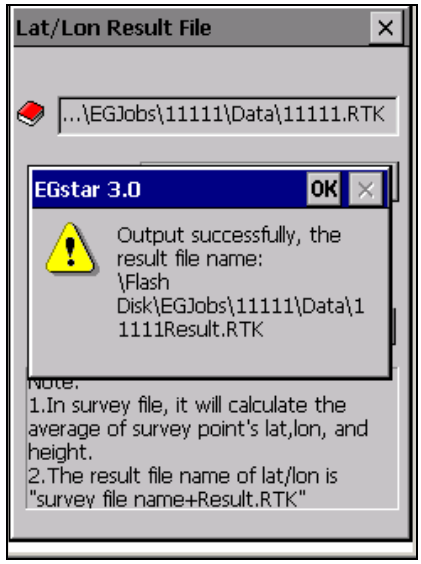


5. Press **Output** button to process and save the result file.



For the way, you just need select the raw *.RTK file, and press **Output** button, it will create the result file automatically.





§2.6 Help Menu

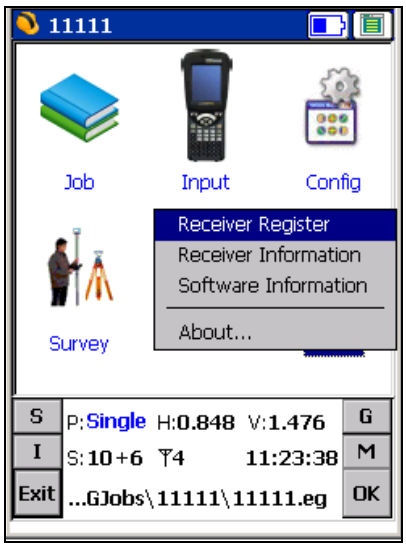
"Help" displays some information of software and system. The menu contains **Receiver Register**, **Receiver information, Software infomation** and **About**

§2.6.1 Receiver Registration

Steps: **Help→Receiver Register**

You can use this function to register the RTK receiver, prolong the service time or apply permanent code. You can register the code with cable or bluetooth, and the software must stay in connection status with receiver.

Usually the code is 20 digits, if you get a code with 31 digits, the first 11 digits is the receiver no, you can delete it, just keep last 20 digits.



Enter "**Receiver Register**" menu to type in appropriate registration code in the screen above, then click **regist** button. If the registration code is incorrect, you must register again, then you may use the instrument as soon as this operation is finished.

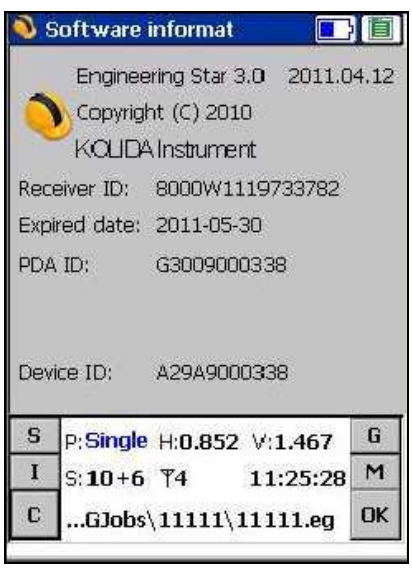
Note: Make sure the registration code matches the receiver number.

Please check the valid period of registration code to make sure it is the temporary type or permanent type.

§2.6.2 Software Information

Steps: Help→software information

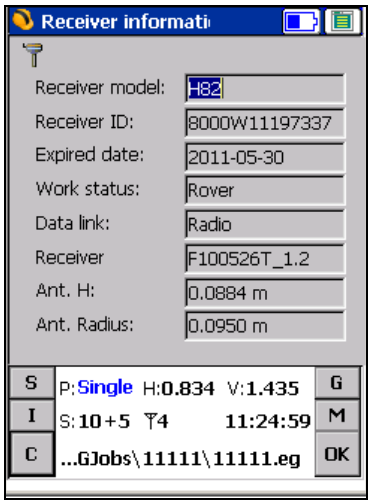
Display the copyright of the software and the contact of developer, on the below is PDA ID and device ID.



§2.6.3 Receiver Information

Steps: Help-> receiver information

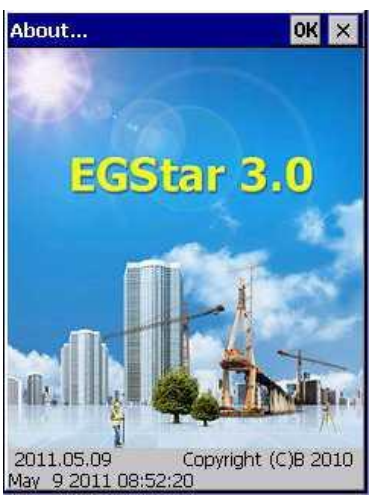
Display receiver information, including firmware information, Data link, antenna parameters and so on.



§2.6.4 About

Steps: About.

Display the software version.



Chapter Three: Instructions for Field survey

§3.1 Instrument connection

The first step of Field survey is to connect your controller with Rover via bluetooth. If you want to use a mobile phone to transmit differential data, you should connect your controller with the mobile phone via bluetooth too.

Bonding bluetooth device.

Enable Bluetooth in "Power Properties", then scan Bluetooth in Bluetooth Manager, then bond bluetooth of controller and receicer (if you need cell phone differential mode, you need bond mobile phone with the handheld PC, too).

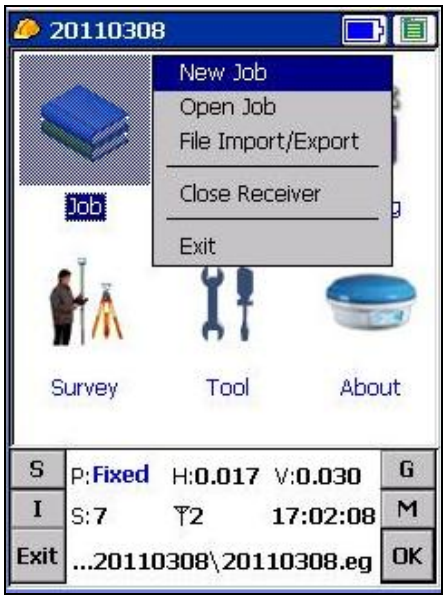
To connect receiver by bluetooth, please select **Config->port config** option, and input relevant com port no. (how to connect receiver via blue tooth, please refer to RTK user manual.

§3.2 Acquire differential data

After instrument connection, it's time to acquire differential data from Base receiver or CORS, etc. We can use internal Radio, internal SIM card with GPRS/GSM function, or cell phone differential to transmit differential data. You can refer to page 26-35 of this Estar3.0 Manual to learn how to set these 3 modes to get differential data.

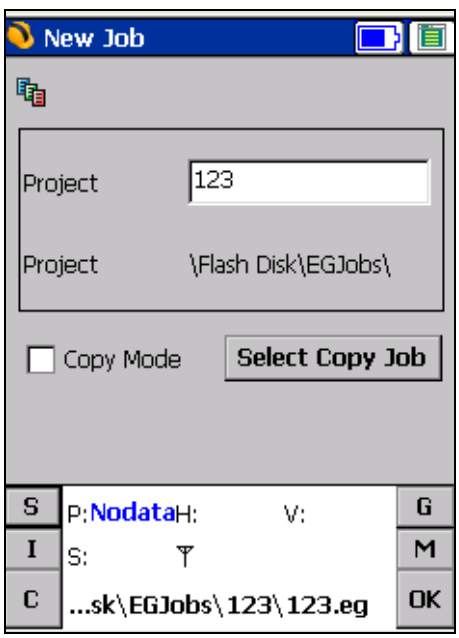
§3.3 Setup a job

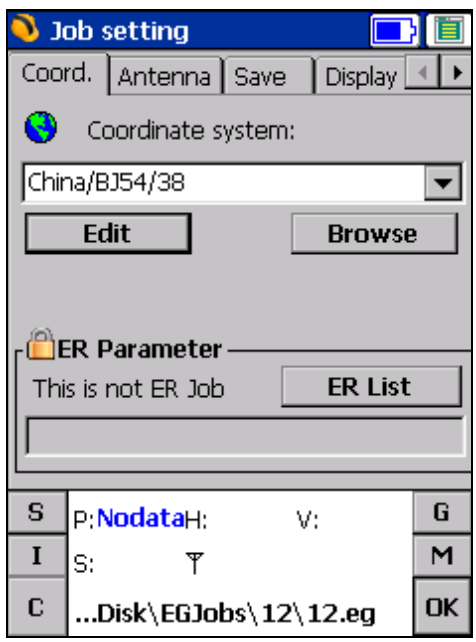
After that, you can set up a new job to start field survey. If you want to go on with your pervious work, you can choose to open job.

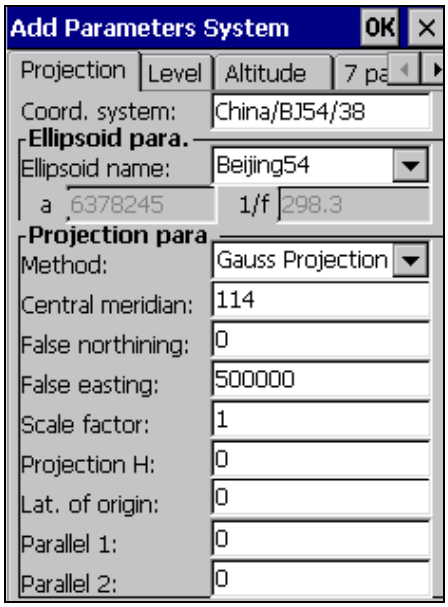


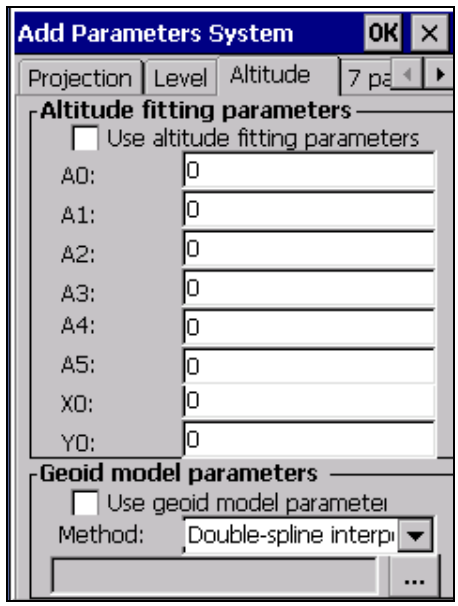
New Job: In general, you need to create a new job and input some parameters of ellipsoid and projection before you start your surveying work. A job consists of a number of file such as survey parameters, transformation parameters and result coordinates file etc.

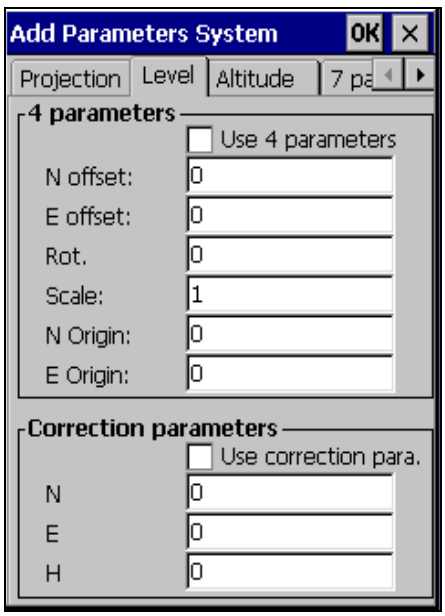
Open Job: Opens an existing job.

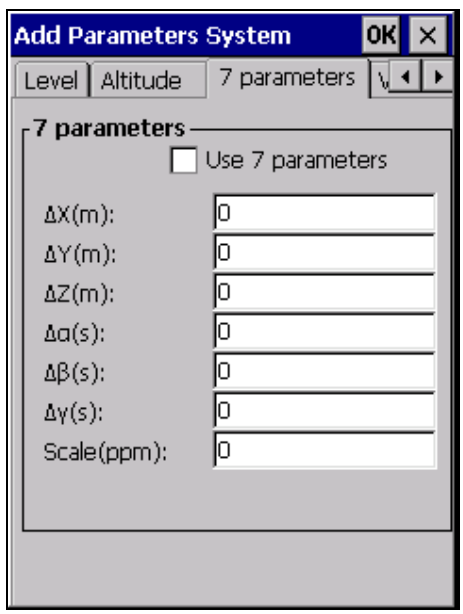


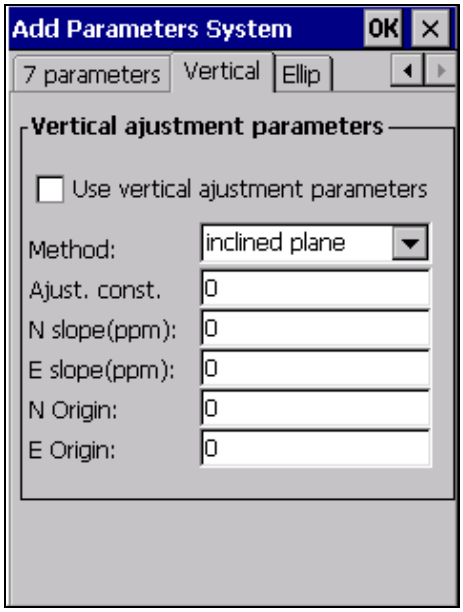


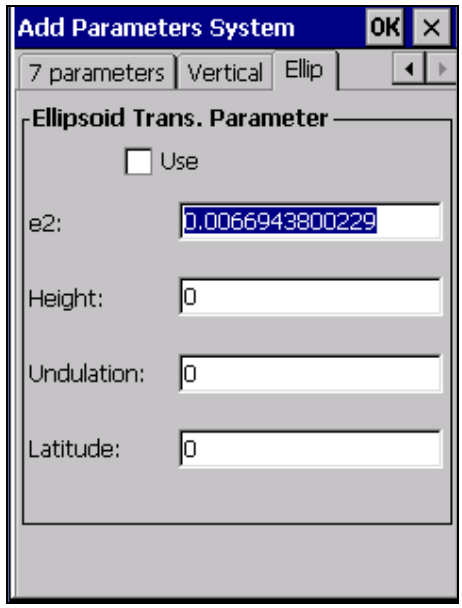

Add Parameters System
OK
Projection
Level
Altitude
7 pa
Coord. system:
China/BJ54/38
Ellipsoid para.
Ellipsoid name:
Beijing54
a
6378245
1/f
298.3
Projection para
Method:
Gauss Projection
Central meridian:
114
False northining:
0
False easting:
500000
Scale factor:
1
Projection H:
0
Lat. of origin:
0
Parallel 1:
0
Parallel 2:
0


Add Parameters System
OK
Projection
Level
Altitude
7 pa
Altitude fitting parameters
Use altitude fitting parameters
A0:
0
A1:
0
A2:
0
A3:
0
A4:
0
A5:
0
X0:
0
Y0:
0
Geoid model parameters
Use geoid model parameter
Method:
Double-spline interp
...


Add Parameters System
OK
Projection
Level
Altitude
7 pa
4 parameters
Use 4 parameters
N offset:
0
E offset:
0
Rot.
0
Scale:
1
N Origin:
0
E Origin:
0
Correction parameters
Use correction para.
N
0
E
0
H
0


Add Parameters System
OK
Level
Altitude
7 parameters
7 parameters
Use 7 parameters
ΔX(m):
0
ΔY(m):
0
ΔZ(m):
0
Δα(s):
0
Δβ(s):
0
Δγ(s):
0
Scale(ppm):
0


Add Parameters System
OK
7 parameters
Vertical
Ellip
Vertical ajustment parameters
Use vertical ajustment parameters
Method:
inclined plane
Ajust. const.
0
N slope(ppm):
0
E slope(ppm):
0
N Origin:
0
E Origin:
0


Add Parameters System
OK
7 parameters
Vertical
Ellip
Ellipsoid Trans. Parameter
Use
e2:
0.0066943800229
Height:
0
Undulation:
0
Latitude:
0

Appendix: Summarization of GNSS Survey

GPS System Brief Introduction

The Composition of GPS System

GPS, the worldwide, all-day running, high accuracy survey system, has been universally accepted in survey field. Date to the year 1973, American Department of Defense authorized Three Armies to invent a new military navigation system, we call it GPS, which is Global Position System. In February of 1978, the first testing satellite was launched, from the February of 1989 to 1993, 24 satellites were launched, which established the foundation of GPS running constellation. The running height of GPS satellite is 20200 kilometers. There are six orbits, on each dispersing four satellites. The structure contains 21 work satellites and three standby active satellites. The satellite serial is from 0 to 31, and numberless substitute satellites will be continuously launched when valid period of the old one expires to maintain the GPS constellation steady

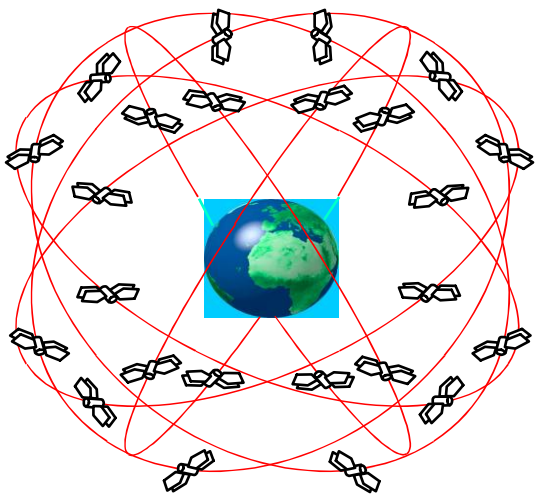


Figure 1-1 GPS star graph

There are three elements to make up GPS System. The first is Satellite element, which is constituted by the constellation in the universe. The second is the control part on the earth, which is used to control the

satellite signal, correct the satellite state, adjust the distribution of the satellite and revise the orbit information. The third is customer detector, which also named GPS instrument.

GPS signal: Satellite Guide Telephonic Code, including Broadcast Star Calendar and Almanac. Satellite State: range code, including

(1) C/A code（coarse code），Code Length: 1023bit，Cycle: 1ms，Distance: 293km；

(2) P Code（Fine Code），Code Length: $2.35*10^{14}$，Cycle: 267 days，Distance: 29.3m。

All the code will be loaded on the carrier wave to project after process. There are two carrier waves, one is L1 wave band, with the frequency 1545.42MHZ and wavelength 19.05cm，the other is L2 wave band, with the frequency 1227.60MHZ and wavelength 24.45cm。

GPS Detector can be sorted to four styles according to the function; they are Guide Style, Survey Style, Time Style and survey gesture style. It can also be sorted to four styles according to moving state, they are Handheld Style, motor-carried style, vessel-carried style and plane-carried style. The survey geoid style has two styles, one is single frequency, which can only receive L1 carrier wave, and the other is dual frequency, which can contemporarily receive L1 & L2 carrier waves.

Military navigation was designed for the GPS System Establishment, but the testing result showed that not only can it meet the military use, it can also be used in static position in centimeter or even millimeter accuracy, dynamic position in sub-meter or meter accuracy, speed measurement and time measurement. Thus GPS was generally adapted from military use to daily use, thus the first commercial GPS receiver was born. With the development of over ten years, more and more GPS have been used in various units and enterprises to create plenty production value of high efficiency.

GPS position and phase measurement.

GPS position is acquired by backside cross method after measuring the off-ground distance of each visible satellite. The distance of satellite from ground is calculated by the C/A code on the carrier wave or phase. Thus the time difference will happen from the projection of information code to the satellite receiving by the GPS antenna. The note for the time difference makes the survey realizable. Multiply the time and the velocity of light to acquire the distance from antenna to the ground.

Survey-style GPS receiver can calculate the accurate distance from antenna to the ground by carrier wave phase. Add the number of full waves of each satellite to the phase decimal, you can acquire the distance of the satellite off ground (The wave length of L1 and L2 is known),. The integer of carrier wave between satellite and antenna is called full circle blur degree ambiguity. To the centimeter accurate process, full circle number can be acquired in the course of process. To the centimeter accurate real time survey, full circle number can be

acquired in the mean time of initialization.

The minimal amount required for the satellites is four, and for the GPS receiver is two in GPS survey. This manual is based on two receivers, one is base station, and the other is rover.

Set the base station on one known point, and the rover on the point to be measured or staked out. The carrier wave phase data on these two receivers is calculated by the software embed in the mainframe board, then the 3D vector between base station and rover can be acquired. You can measure the position of rover relative to the base station, and then classify the measure technique according to the time. Real time technique uses the radio to transfer the information to the rover, and calculate the result in the mean time of surveying. Process technique needs to save the data and acquires the result with the base line calculation software back to the office.

Generally, the measure technique is subjected to such elements as receiver standard, accuracy requirement, time limit and real time result requirement, etc.

GPS Measurement Method

GPS and difference technique are used in real time and measurement after, speed static technique is only used in measurement after.

Real time kinematics (RTK)

RTK usually need five or more than five satellite to measure the phase of base station and rover.

It is necessary to initialize before measuring in order to acquire centimeter accuracy.

If you use single frequent receiver, the early sub-kinematics required the rover to be placed on the known point to create a man-made base line to initialize the measurement. Now the single frequent RTK can realize auto initialization, only the time is longer compared with the dual frequent RTK, and more easy to miss lock.

If you use dual frequent receiver to do the kinematic measurement (that is RTK), the initialization time can be greatly shorten, what's more, the initialization can be processed during movement, (that is OTF, which means On the Fly)

If the satellites received are less than four during the measurement, you need to reinitialize when the satellite number increases to four or more than four.

Difference Globe Position System（DGPS）

DGPS technique uses GPS code（C/A code）to position. It is not necessary to initialize or continuously track the satellites. The measurement accuracy is only

one to three meter.

If the carrier wave added to the distance is smooth enough, the DGPS can reach to the sub-meter accuracy.

Static and quick static

Static measurement can be used in the highest accuracy measurement, but the time needed is usually from 30 minutes to 15 hours, according to the length of the line. Static and Quick Static both need process after to acquire the accurate result.

Quick static is one method of process after, the accuracy can reach to centimeter level. It takes at

Least 8 minutes (normally 8-30 minutes) to measure by carrier wave measurement, according to

The receiver type, base line length, available satellites units and geometry shape of satellite.

You can use single frequent and dual frequent receiver to do the static measurement and the quick

Static measurement

The elements related to the RTK measurement.

RTK measurement needs to avoid some disadvantageous elements; the reason to generate these elements is for the limit of the whole GPS system.

The radio signal used by GPS is received from the satellite about twenty thousand kilometers from

The ground, they are, relatively speaking, high frequency, low power, and not easy to penetrate the barriers which interfere the sight between the satellite and the GPS receiver. In fact, all the objects between the satellite and GPS receiver are the disadvantages to the system operation. Some objects, such as buildings, can entirely screen the satellite signal. Thus GPS cannot be used in rooms, channel or under water. Some other objects, such as tree, may partly screen the reflected or refracted signal. Thus GPS signal can hardly be received in the forest area, although sometimes there will be enough signal in the forest to approximately calculate the position, the definition of signal is far from the centimeter level position. So GPS has shortage when used in forest area, but this doesn't mean GPS can only be used in the relevant open side, it can still maintain its efficiency and accuracy in some impediment area. That is because GPS needs at least five satellites which distribute appropriately to realize the accurate position, in usual occasion, there will be seven to ten GPS satellite in most area, thus the GPS measurement can be used efficiently in the area where

you can receive five satellites. In the forest or around a building, you can make the GPS measurement as long s the open side is big enough to view at least five satellites.

Another disadvantages is the RTK transferring data chain, this chain has close relationship with the electromagnetism surrounding and operation distance.

RTK position require the base station transfer the measuring data, which includes fake measured value and phase measured value, and known data to the rover station in real time. The power of RTK station is 25 watt, so the barrier is now allowed between base station and rover.

Ideal distance is that in fine satellite, atmosphere and electromagnetism condition.

Concerning the elements mention hereinbefore, it is required to select the preferable known point position when setting the base station. Please make sure the base station meet the condition below:

1. There is not any barrier within 10 degree height end angle.
2. There should not be electromagnetic radiant point in the neighborhood, such as TV launch tower, radar TV and mobile signal antenna, etc, in order to avoid disturbing the RTK signal. The distance required is more than 200m
3. You'd better set the base station at the relatively high altitude place for the better station operation distance.
4. steady ground to save the point more convenient.

Note: If the user sets the station under the objects that have strong effect to the electromagnetism transmission, such as under the tree, the satellite signal received will become aberrant.

GPS Application in the Measurement

GPS can be used to control measurement, landform measurement, staking out and aquatic operation.

Controlling measurement

The area of controlling measurement is commonly large.

Landform measurement

Landform measurement is used to measure the change of landform, the result is usually used for

Graph making.

Real-time measurement, especially the dual frequent RTK, is most suitable to the landform

measurement.

Stake out

Stake out is to position the point designed in advance on the spot. Stake out point need to acquire
the result in real time.
RTK is the only way to provide the centimeter accuracy real-time resolving project with the measuring method.

Aquatic operation.

The category of aquatic operation contains water depth measurement, aquatic navigation, warehouse volume measurement, construction position and piling inspection, etc. It needs box and needle or sound instrument to match.