USER MANUAL

RCS

RUIDE

Version: EN.1808

FORWORDS

Thank you for purchasing Total Station RCS.
This manual will give a detailed and complete instruction. Please read it carefully before using the instrument.

PRECAUTIONS

1. Do not collimate the objective lens directly to the sunlight without a filter.
2. Do not store the instrument in extremely high or low temperature, in order to avoid the sudden or great change of temperature.
3. When the instrument is not in use, store it in the case and avoid shock, dust and humidity.
4. If there is great difference between the temperature in work site and that in store place, you should leave the instrument in the case till it adapts to the temperature of environment.
5. If the instrument has not been used for a long time, you should remove the battery for separate storage. The battery should be charged once a month.
6. When transporting the instrument should be placed in its carrying case, it is recommended that cushioned material should be used around the case for support.
7. For less vibration and better accuracy, the instrument should be set up on a wooden tripod rather than an aluminum tripod.
8. Clean exposed optical parts with degreased cotton or less tissue only!
9. Clean the instrument surface with a woolen cloth after use. If it gets wet, dry it immediately.
10. Before opening, inspect the power, functions and indications of the instrument as well as its initial setting and correction parameters.
11. Unless the user is a maintenance specialist, do not attempt to disassemble the instrument by yourself even if you find the instrument abnormal.

SAFETY GUIDE

INTEGRATED DISTANCE METER (VISIBLE LASER)

Warning

The total station is equipped with an EDM of a laser grade of 3R/IIIa. It is verified by the following labels.
On the vertical tangent screw sticks an indication label "CLASS III LASER PRODUCT".
This product is classified as Class 3R laser product, which accords to the following standards.

IEC60825-1:2001 "SAFETY OF LASER PRODUCTS".

Class 3R/III a laser product: It is harmful to observe laser beam continuously. User should avoid sighting the laser at the eyes. It can reach 5 times the emitting limit of Class2/II with a wavelength of 400mm-700mm.

Warning

Continuously looking straight at the laser beam is harmful.

Prevention

Do not stare at the laser beam, or point the laser beam to others' eyes. Reflected laser beam is a valid measurement to the instrument.

Warning

When the laser beam emits on prism, mirror, metal surface, window, etc., it is dangerous to look straight at the reflex.

Prevention

Do not stare at the object which reflects the laser beam. When the laser is switched on (under EDM mode), do not look at it on the optical path or near the prism. It is only allowed to observe the prism with the telescope of total station.

Warning

Improper operation on laser instrument of Class 3R will bring dangers.

Prevention

To avoid to be harmed, each user is required to take safety precautions, and take everything under control within the distance that would incur dangers (according to IEC60825-1:2001).

The following shows the explanation related to the key sections of the Standard.

Laser instrument of Class 3R is applicable outdoors and in construction field (measurement, defining lines, leveling).

a) Only those persons who are trained with related course and authenticated are allowed to install, adjust, and operate this kind of laser instrument.

b) Stand related warning symbols in the scale of use.

c) Prevent any person to look straight at or use optical instrument to observe the laser beam.

d) To prevent the harm caused by laser, block the laser beam at the end of the working route. When the laser beam exceeds the limit area (harmful distance*) and when there are motivating persons, stopping the laser beam is a must.

e) The optical path of the laser should be set higher or lower than the line of sight.

f) When the laser instrument is not in use, take care of it properly. The person who is not authenticated is not allowed to use.

g) Prevent the laser beam from irradiating plane mirror, metal surface, window, etc., especially beware of the surface of plane mirror and concave mirror.

* Harmful distance means the maximum distance between the start point and the point which the laser is weakened to a degree that doesn't harm people.

The internal EDM instrument equipped with a Class 3R/III a Laser has a harmful distance of 1000m (3300ft). Beyond this distance, the laser intensity is weakened to Class I (Looking straight at the laser beam causes no harm to the eyes.)

LASER PLUMMET

The laser plummet built into the product produces a visible red laser beam which emerges from the bottom of the product. The product is a Class 2/Ⅱ Laser Product.

Class 2 Laser Product is in accordance with:

IEC 60825-1:1993 "Safety of Laser Products"

EN 60825-1:1994 + AⅡ:1996: "Safety of Laser Products".

Class Ⅱ Laser Product is in accordance with:

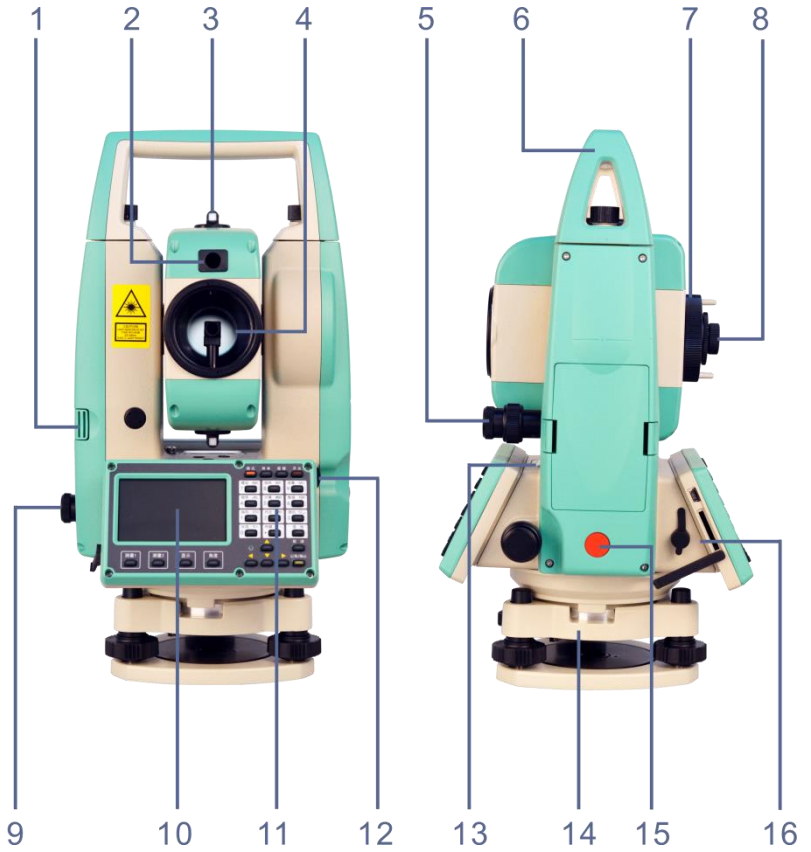
FD121CFR ch.1$ 1040:1998 (U.S. Health and Human Services Secretary, Federal rules code)

Class 2 Laser Products:

Do not stare into the beam or direct it unnecessarily at other persons. Eye protection is normally afforded by aversion responses including the blink reflex.

1. OVERVIEW

1.1 PART NAMES

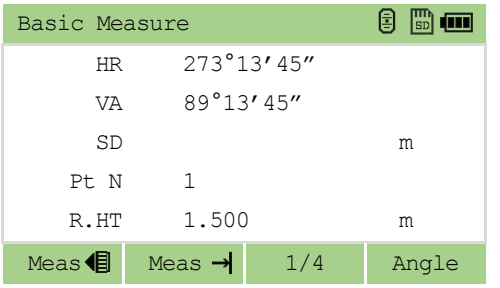


1. Battery	9. Horizontal Clamp Screw
2. Guide Light	10. RS232, SD Card, Mini USB Port
3. Collimator	11. Screen
4. Objective Lens	12. ATMOSense Detector
5. Carrying Handle	13. Keyboard
6. Telescope Focusing Ring	14. Tribrach
7. Telescope Eyepiece	15. Circular Vial
8. Vertical Clamp Screw	16. Plate Vial

ACCESSORIES

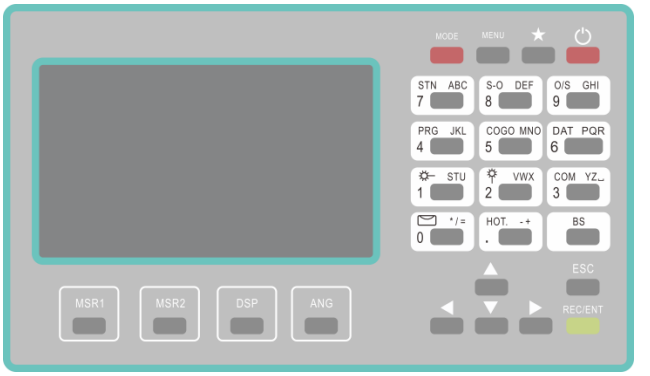
Carrying Case	Fur Brush	User Manual
Battery	Screw Driver	Warranty Card
Charger	Hexagon Wrench	Software CD
Plumb Bob	Cloth	
Adjusting Pin	Rain Cover	

1.2 DISPLAY



Basic Measurement Menu

1.3 KEYPAD



1.4 SOFT KEYS

Key	Function
PWR	Power ON/OFF
☆	Star key, includes quick settings for laser plummet, laser pointer, COMM parameter, PPM, light and sound, etc.
MENU	Displays the Function Menu Menu 1. Job 6. Data 2. Setting 7. Set Stn 3. Adjustment 8. Stake Out 4. Program 9. Collect 5. COGO 10.Road Back Time Info
MODE	Changes the input mode: alphabetic or numeric; Launches quick code mode in basic measurement display.
REC/ENT	Accepts the input or records the data. In basic measurement display, press it for 1 second to select the data saving mode (CP or SS).
ESC	Returns to last screen. Cancels the data input.

MSR1	Measures the distance with the mode this key has been predefined. Press it for 1 second to view and change the measuring mode.
MSR2	Measures the distance with the mode this key has been predefined. Press it for 1 second to view and change the measureing mode.
DSP	Shift the display. Press it for 1 second to launch customizing items.
ANG	Displays the angle measuring menu. Or sets the horizontal angle to zero. Or continuous angle measuring. Or F1/F2 angle measuring. Or maintains the horizontal angle.
STN ABC 7	Displays the Station Setup menu. Or inputs the number 7, letter A, B, and C.
S-O DEF 8	Displays the stake-out menu. Press it for 1 second to display the setting about stake-out. Or inputs number 8, and letter D, E, F.
O/S GHI 9	Displays the Offset Point Measurement menu. Or inputs number 9, letter G,H,I.
PRG JKL 4	Displays the Programs menu. Or inputs number 4, letter J, K, L.
COGO MNO 5	Displays the COGO menu. Or inputs number 5, and letter M, N, O.
DAT PQR 6	Displays RAW, XYZ, or STN data, depending on your setting. Or inputs number 6, and letter P, Q, R.
☼ STU 1	Switch for the laser pointer. Press it for 1 second to set the function to be assigned to this key. Or inputs number 1, and letter S, T, U.
VWX 2	Switch for the laser plummet. Press it for 1 second to set the function to be assigned to this key. Or inputs number 2, and letter V, W, X.
COM YZ_ 3	Enter the comm parameter setting interface. Or Inputs number 3, letter Y, Z, and Space.
HOT. - + .	Displays the *HOT* menu. Or inputs – , + and ..
✉ * / = 0	Displays the electric bubble. Or inputs *, /, =, 0.

1.5 SYMBOLS & ABBREVIATION

Symbols

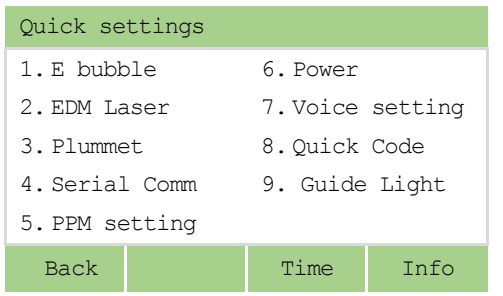
	Symbol	Meaning
The status of the SD card		Without SD card inserted
		With SD card inserted
The working status of the dual-axis compensator		The axis of X and Y direction are on
		The compensator is off
		The axis of X direction is on

The target type		Non-prism
		Prism
		Reflector sheet

Abbreviation List

HA	horizontal angle
VA	vertical angle
SD	slide distance
AZ	azimuth angle
HD	horizontal distance
VD	vertical distance
HL	Horizontal angle (left): 360°-HA
V%	ratio of slope
N	North coordinate
E	East coordinate
Z	Elevation
PT	point
HT	height
CD	code
PPM	atmospheric correction value
P1	Point 1
P2	Point 2
HI	instrument height
BS	backsight point
ST	surveying station
Tips	*When “d” is in front of any abbreviations above, it means it is a difference value.

1.6 QUICK SETTING(☆KEY)



Quck settings includes all the commonly-used settings. In the window opened as above, press [1], [2], [3], [4], [5]… corresponding to the items to choose the settings.

1. E bubble	Setting the compensator
2. EMD laser	Turn on/off the laser pointer
3. Plummet	Turn on/off the laser plummet
4. Serial Comm	Setting the comm. Parameters for RS232 port
5. PPM setting	Setting the atmosphere correction
6. Power	Setting backlight and power management
7. Voice setting	Setting the voice
8. Quick Code	Activate or deactivate the quick code function
9. Guide light	Turn on/off the guide light

2. PREPARATION

2.1 UNPACKING AND STORING

· Unpacking

Place the case lightly with the cover upward, and unlock the case, take out the instrument.

· Store of instrument

Cover the telescope cap, place the instrument into the case with the vertical clamp screw and circular vial upwards (Objective lens towards tribrach), and slightly tighten the vertical clamp screw and lock the case.

2.2 INSTRUMENT SETUP

Mount the instrument on a tripod. Level and center the instrument precisely.

Operation Reference:

1. Leveling and Centering the Instrument by plumb bob.

1) Setting up the tripod

a. Extend the legs to suitable length, make the tripod head approximately leveld to the ground and tighten the leg screws.

b. Make the center of the tripod and the occupied point approximately on the same plumb line.

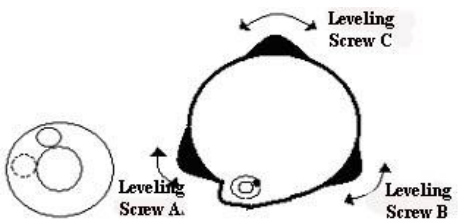
c. Step on the tripod to make sure if it is well stationed on the ground.

2) Fix the instrument on the tripod.

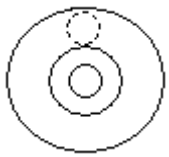
Place the instrument carefully on the tripod head and slide the instrument by loosening the tripod screw. If the plumb bob is positioned right over the center of the point, slightly tighten the tripod.

3) Roughly leveling the instrument by using the circular vial.

a. Turn the leveling screw A and B to move the bubble in the circular vial, in which case the bubble is located on a line perpendicular to a line running through the centers of the two leveling screw being adjusted.

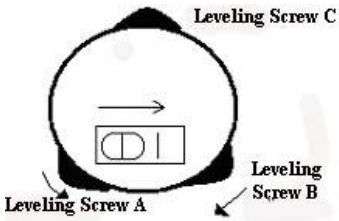


b. Turn the leveling screw C to move the bubble to the center of the circular vial.

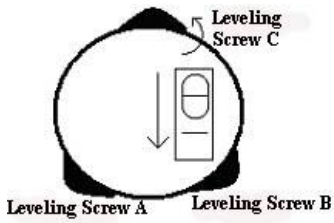


4) Precisely leveling by using the plate vial.

a. Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel to the line connecting leveling screw A and B, and then bring the bubble to the center of the plate vial by turning the leveling screws A and B.



b. Rotate the instrument 90º (100gon) around its vertical axis and turn the remaining leveling screw or leveling C to center the bubble once more.



c. Repeat the steps a and b for each 90º (100gon) rotation of the instrument and check whether the bubble is correctly centered in all directions.

2. Centering by using the optical plummet.

1) Set tripod

Lift tripod to suitable height, ensure equal length of three legs, spread and make tripod head parallel to the ground, and place it right above the measurement station point. Prop up tripod on the ground and fix one leg.

2) Install instrument and collimate the point

Set instrument carefully on tripod, tighten the central connecting screw and adjust optical plummet to make the reticle distinctly. Hold the other two unfixed legs with both hands and adjust position of these two legs through observation of optical plummet. As it approximately aims at the station point, make all three legs fixed on the ground. Adjust three leg screws of the instrument to make optical plummet collimate precisely to the station point.

3) Use circular vial to roughly level the instrument.

Adjust length of three legs of tripod; make the circular vial bubble of the instrument in the middle.

4) Use plate vial to level the instrument accurately.

a. Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel to the line connecting leveling screw A and B, and then bring the bubble to the center of the plate vial by turning the leveling screws A and B.

b. Rotate the instrument 90°, make it perpendicular to the connecting line of level screws A and B. Turn level screw C to make the bubble of the plate vial in the middle.

5) Precisely centering and leveling

Through observation of optical plummet, slightly loosen the central connecting screw and move the instrument evenly (Don't rotate the instrument), making the instrument precisely collimating to the station point. Then tighten the central connecting screw and level the instrument precisely again.

Repeat this operation till the instrument collimate precisely to the measurement station point.

2.3 BATTERY

TIPS

1) The battery operating time depends on the environmental conditions such as ambient temperature, charging time, times of charging and discharging etc. It is recommended to fully charge the battery before operation or prepare spare batteries.

2) Distance measurement consumes more power than angle measurement.

3) When the measurement mode is changed, the battery power will not immediately show the decrease or increase. The battery power indicating system shows the general status but not the instantaneous change of battery power.

CAUTIONS

1) Use the original charger HC-III.

Remove the on-board battery and connect it to battery charger. When the indicator light on the battery charger is red, the recharging process is on. When recharging is complete, the indicator lamp turns green.

2) Before removing the battery from the instrument, make sure that the power is turned off. Otherwise, the instrument may be damaged.

3) The charger has built-in circuitry for protection from overcharging. However, do not leave the charger plugged into the power after recharging is completed.

Be sure to recharge the battery at a temperature from 0° to 45°C. Recharging may be abnormal beyond specified temperature range.

When the indicator light does not light after connecting the battery and charger, either the battery or the charger may be damaged. Please contact technician for repairing.

4) Rechargeable battery can be recharged 300 to 500 times. Complete discharge of the battery may shorten its life.

In order to get the maximum life, be sure to recharge it at least once a month.

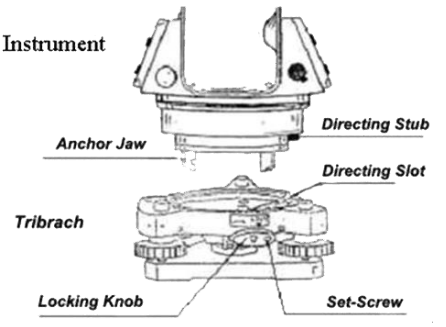
2.4 REFLECTORS

When measuring distance, a reflector needs to be placed at the target place. Reflector system comes with single prism or triple prisms, which can be mounted with tribrach onto a tripod or mounted onto a prism pole. Reflector system can be self-configured by users according to the job.

2.5 MOUNTING AND DISMOUNTING

Dismounting

If necessary, the instrument (including reflector prisms with the same tribrach) can be dismounted from tribrach. Loosen the tribrach locking screw in the locking knob with a screwdriver. Turn the locking knob about 180° counter-clockwise to disengage anchor jaws, and take off the instrument from tribrach.



Mounting

Insert three anchor jaws into holes in tribrach and line up the directing stub with the directing slot. Turn the locking knob about 180°clockwise and tighten the locking screw with a screwdriver.

2.6 EYEPIECE ADJUSTMENT AND COLLIMATING OBJECT

Method of Collimating An Object (for reference)

1) Sight the Telescope to bright place and rotate the eyepiece tube to make the reticle clear.
2) Collimate the target point with top of the triangle mark in the coarse collimator. (Keep a certain distance between eye and the coarse collimator).
3) Make the target image clear with the telescope focusing screw.

If there is parallax when your eye moves up, down or left, right, it means the diopter of eyepiece lens or focus is not well adjusted and accuracy will be influenced. You should adjust the eyepiece tube carefully to eliminate the parallax.

2.7 INPUTTING MODE

All characters can be input in the screen.

Press [BS] to delete one character in the left of the cursor.

When the inputting scale is wider than the screen, it can be moved to left automatically. When the inputting scale is full, it cannot be input anymore.

When an ABC is displayed on the upper right corner of the screen, capital letters can be input via the keypad. While 123 is displayed, numbers can be input. When abc is displayed, lowercase letters can be input. In any measurement screens or screens that need to be input manually, press [MODE] to shift between alphabet mode and numeric mode.

In letter inputting mode, 3 letters are set in one key. Every pressing can display one of the letters in the cursor. For example, in ABC mode, press [9] 3 times to input the letter of I.

Characters that have been input can be edited. Press [▶] to move the cursor to the item that needs to be edited, the cursor will stay on the character and twinkle, input the new character.

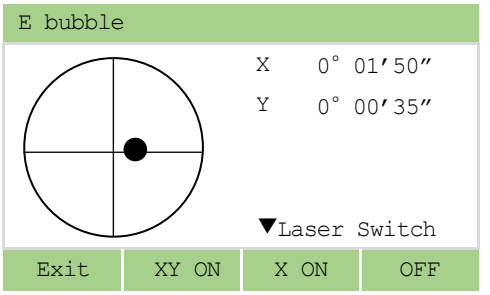
2.8 LEVELING

As the tilt sensor is activated, automatic correction of vertical angle for mislevelment is displayed.

To ensure a precise angle measurement, tilt sensor must be activated. The display can be used to fine level the instrument.

If the instrument hasn't been leveled roughly, the screen displays that the instrument is out of the automatic correction range, and that it needs to be leveled manually. Please refer to "2.2 Instrument Setup" for detailed leveling instruction.

RCS compensates the vertical angle reading as well as both vertical and horizontal angle reading due to inclination of the vertical axis in the X direction and XY directions.



- ❖ Press 0 to enter to automatic compensation function.
- ❖ Rotate the foot screws to make both values within 1'.
- ❖ Press [▼] to turn on/off the laser plummet

- ➢ When the instrument is placed on an unstable stage or in a windy weather condition, the display of vertical angle is unstable. You can switch off the auto tilt correction function of vertical angle.
- ➢ If the mode of auto correction is ON, in the condition that the instrument has not been leveled, the program will demand that the instrument must be leveled at first, so as to enter other functions.

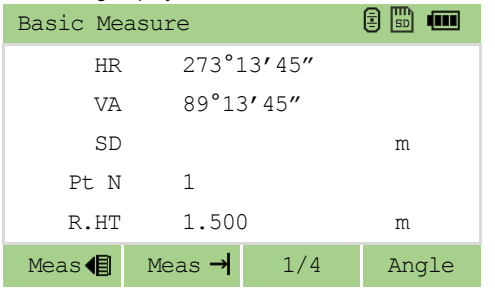
3. ROUTINE MEASUREMENTS

3.1 CAUTIONS FOR DISTANCE MEASUREMENT

After setting up and switching on correctly, the Total Station is immediately ready for measuring.

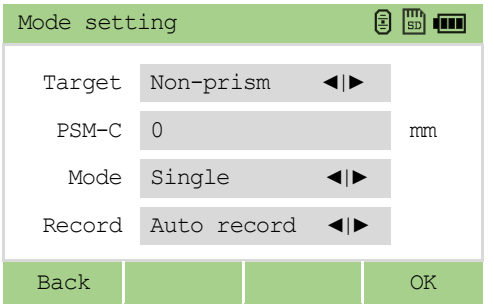
All shown displays are examples. It is possible that local software versions are different from the basic one.

Example of a possible measuring display:



3.2 EDM SETTING

Press [MSR1] or [MSR2] for 1 second to enter each measurement function it is specified.



- ❖ Hod [MSR1] for 1 secod
- ❖ Press navigation key [▲] [▼] [◄] [►] to select the setting
- ❖ Press [OK] to save the setting

➢ 1) All options in each item in measurement setting:

Target: Prism, sheet and non-prism.

PSM-C: Input prism constant directly (under prism mode). Scale: -999～999mm

Mode: Single, 2 times, 3 times, 4 times, 5 times, Repeat, Tracking.

Record: Enter to record, Auto record, Only measure. This mode controls the mode operation of [MSR1]/MSR2] in basic measurement function.

If "Enter to record" is adopted, a screen of "Rec Pt" is displayed to inform the user to check and confirm before data is recorded.

"Auto record" is a quick shooting and recording mode. The instrument automatically records the point using the default PtID, and then returns to the basic measurement screen.

"Only measure" is the default measuring mode. After a measurement, the instrument stops in the BMS and waits for you to press [REC/ENT] before recording the point.

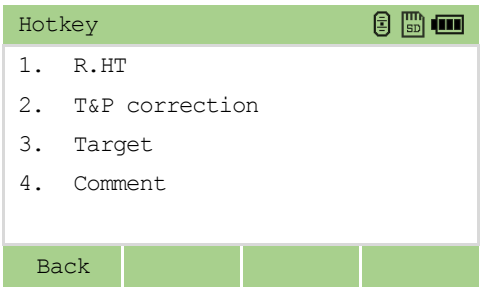
➢ 2) The measurement mode setting of [MSR2] is the same as it. When pressing [MSR1] or [MSR2], the system activates the corresponding measurement mode to measure.

3.3 HOT KEY

[HOT] Key includes the inputting function of target height, temperature & pressure, target selection and note. It is available on any observation screen.

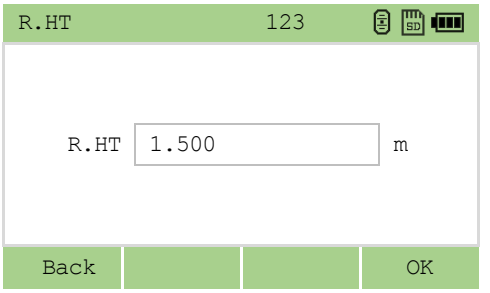
3.3.1 Set the Height of the Target

To change the height of the target (HT) or temperature, pressure, press [HOT].



❖ Press [HOT] to display the [HOT] key menu.

❖ Press [1] to enter into HT setting function.



❖ Enter the height of the target manually.

❖ Press [REC/ENT] to return to basic measurement screen.

3.3.2 Set the Temperature & Pressure

Atmosphere Correction:

The speed of light in air is extremely fast. And it is not a constant, but changes with the temperature and pressure of atmosphere. Once atmosphere correction is set, this instrument can implement atmosphere correction automatically.

Even the instrument is powered off, the atmosphere correction value is still kept.

The formula of atmosphere correction: (unit: meter))

$$PPM = 273.8 - \frac{0.2900 \times \text{pressure value (hPa)}}{1 + 0.00366 \times \text{temperature value (°C)}}$$

If the pressure unit is mmHg：

1hPa = 0.75mmHg

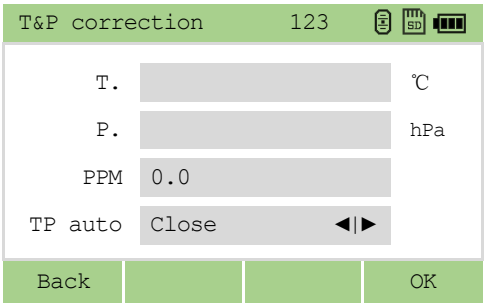
➢ When disregarding atmosphere correction, set PPM value to 0.

Standard atmospheric condition of Total Station RCS (i.e. the atmospheric condition that the atmosphere correction value of the instrument is 0):

Pressure: 1013 hPa

Temperature: 20°C

Using [HOT] Key and [2] can set temperature and pressure values. Enter the ambient temperature and pressure, the PPM value is updated automatically.



❖ Press [2] in HOT key menu to enter into Temp&Pres Setting.

❖ Input temperature value and press [REC/ENT] to move to next item. Input pressure value and press [REC/ENT]

➢ 1) The inputting scope: Temperature:-40 - +60°C (step length 0.1°C) or -40 - 140°F (step length 0.1°F)
Air pressure: 420 - 799.5mmHg (step length 0.1mmHg) or 560 - 1066 hPa (step length 0.1hpa)
16.5 - 31.5 inchHg (step length 0.1 inchHg)

➢ 2) The atmosphere correction value will be calculated by the instrument according to the inputted temperature and pressure value.

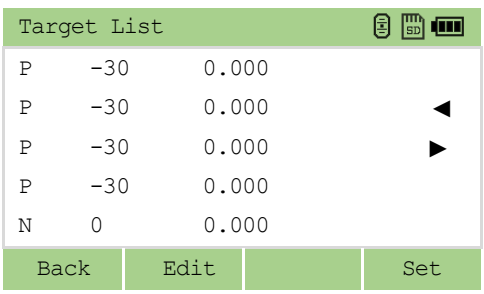
3.3.3 Select Target Set

A target set specifies settings for the target type, the prism constant, and height of target.

When you change the selected target set, all the three settings are changed. You can use this function to quickly switch between two types of targets, such as a reflecting sheet and a prism.

To select a target set, use [▲]/[▼] to highlight the target set in the list and press [ENT]. To change the settings defined in a target set, highlight the target set in the list. Then press "Edit" softkey.

When a target set is selected, the Type and Const values are copied to both [MSR1] and [MSR2] settings. If you have specified a value for HT, this value is also copied to the current HT.



❖ In Hot Key menu, press numeric key [3] to enter target function.

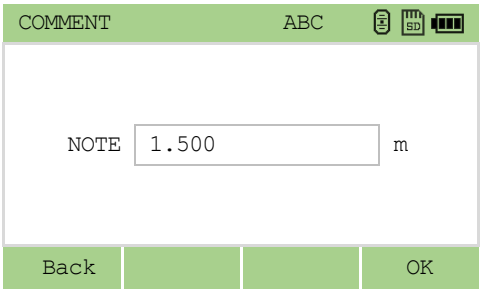
❖ Press [▲]/[▼] to select target set, and then press [ENT].

❖ To edit the target set, highlight the target set and press Edit. After editing, press [ENT]

- 1)Type=prism/non prism/reflector sheet
  Constant=-999 - 999mm
  HT=-9999.999 - 9999.999mm

3.3.4 Enter a Field Note

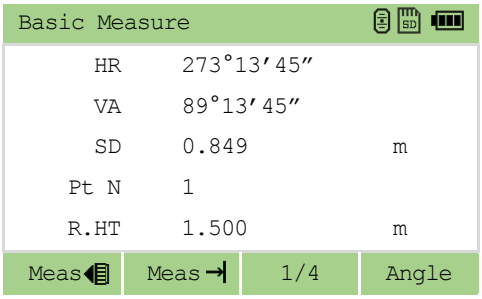
To enter a field note, press [HOT] and then press [4]. This function can be used at any time on any observation screen. Each note can be up to 50 characters. The note is stored as a CD record in the raw data.



- ❖ In HOT Key menu press numeric key [4] to enter Note function.
- ❖ Input note and then press [OK].

3.4 START SURVEY

After finishing all settings, you can start surveying. The survey result is displayed in 4 pages including all data of routine survey. Press DSP to view.
Please set a job, station and backsight azimuth before measurement.

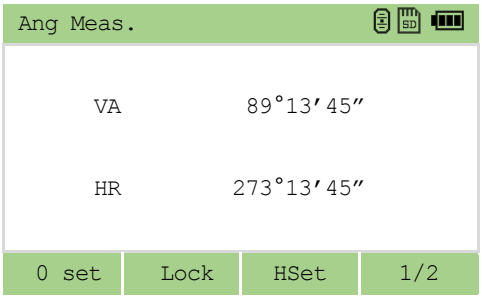


- ❖ Collimate to the center of target prism, press [MSR1] or [MSR2].
- ❖ Display the result of measurement in four pages, including all normal measure functions such as measure of angle, distance and coordinate, etc.
- ❖ Press [DSP] or [▲]/[▼] to view each page.

- To change the height of the target (HT), temperature, or pressure, press [HOT].
- Settings that relate to corrections (T-P, Sea level, C&R) are included in the job settings. These settings are job-specific. Changing of any item will create a new job or shut off all jobs

3.5 ANGLE MEASUREMENT

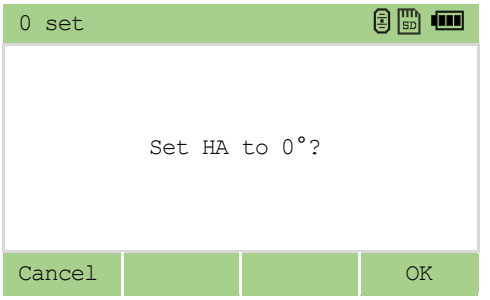
To open the Angle menu, press [ANG] in the basic measurement screen.



- ❖ In BMS press [ANG] to enter angle observation function.
- ❖ Select the function from the function bar.

3.5.1 0SET

Press [0 set] to set HA as 0, press [ENT] and then return to basic measurement screen.

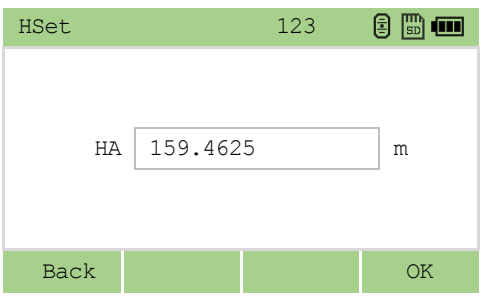


❖ In Angle menu press [0 set] to enter to 0SET function.

❖ Press [ENT], Program sets the current horizontal angle as 0, and returns to basic measurement screen.

3.5.2 Enter the Horizontal Angle

Set the horizontal angle to be a certain value.



❖ In Angle menu press [HSet] to enter into the function of horizontal angle inputting.

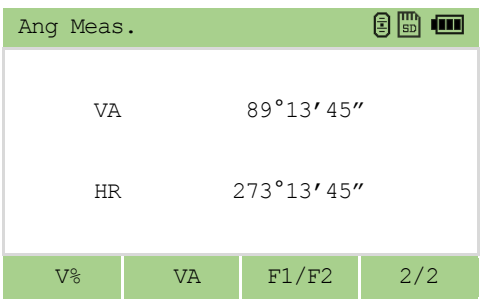
❖ Input horizontal angle, and then press [ENT]

➢ To enter 159°46'25", type 159.4625.

3.5.3 Face-1/Face 2 Measurement

Using F1/F2 measurements effectively cancels out mechanical constant error to obtain maximum accuracy for measuring angles.

If the HA has been adjusted from a F1/F2 measurement, the Backsight also must be measured in F1/F2 during the station setup.

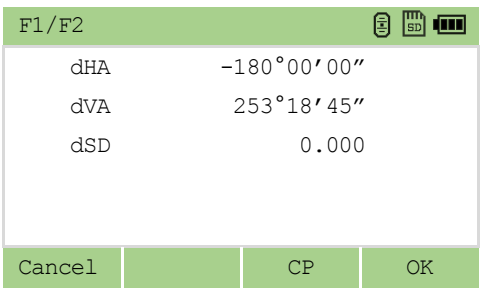


❖ Sight the target in F1.

❖ In Angle menu page 2, press [F1/F2] to enter into the function of F1/F2 measurement.

❖ The system asks to turn to F2, turn to F2, sight the target and press [ENT].

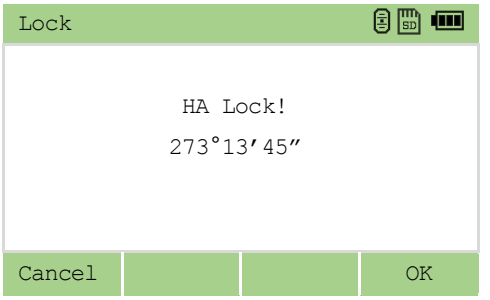
❖ The calculated F1/F2 measurements are displayed



❖ Press [OK] if accept the measured result.

3.5.4 Hold

Hold the horizontal angle reading, and rotate the instrument to the designated direction.



❖ In Angle menu press [Lock] to enter into the function of horizontal angle inputting.

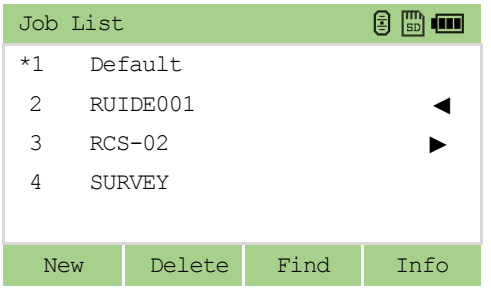
❖ Use the horizontal clamp screw or horizontal tangent to sight the target.

❖ Press [ENT] to set the horizontal angle of the target.

4. JOB MANAGEMENT

Press [MENU] to display the MENU screen. Choose [1] to enter the job management.

4.1 OPEN A JOB

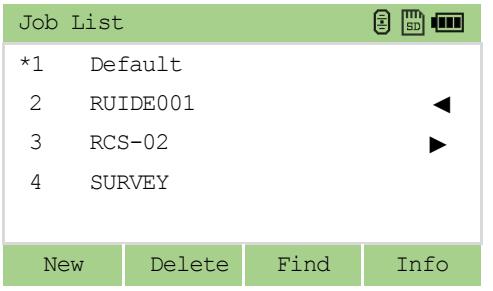


❖ Select the item by [▲]/[▼], and then press [ENT] to open the job.

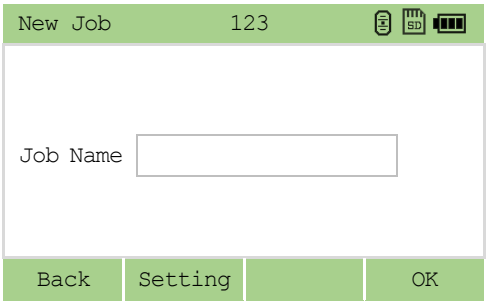
* in front of the job means it is the current job

❖ Program sets the job as current job, and returns to MENU screen

4.2 CREATE A NEW JOB



❖ Press [New] to create a new job.



❖ Enter the new job name (within eight characters)

❖ Press [Setting] entering the job settings.

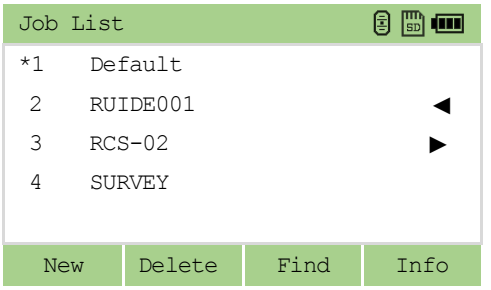
Job Settings

The following 12 settings are set when a job is created, and they can't be changed.

Item	Option
Scale	0.99000 - 1.01000
T-Pcrn.	ON/OFF
SeaLevel	ON/OFF
C&R crn	OFF/0.14/0.200
Angle	DEG/GON/MIL
Dist	Meter/USA Feet/USA Inch/IntlFeet/IntlInch
Temp	°C / °F
Press	hPa/mmHg/inHg
VA 0	Zenith/ Vertical/Vert±90
AZ 0	North/ South
Order	NEZ/ENZ
HA	Azimuth/0 to BS

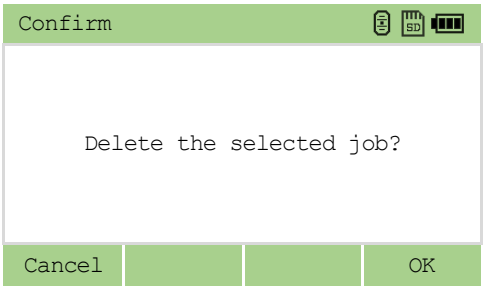
To change the setting in the selected field, press [◀]/[▶]; To move between fields, press [▲]/[▼].

4. 3 DELETE JOBS



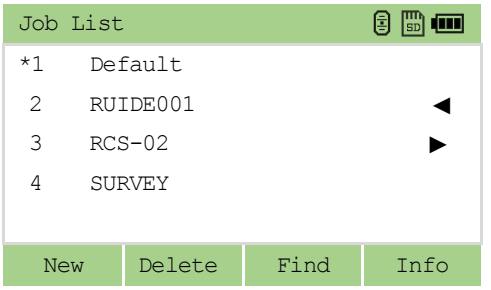
❖ In the job list， move the cursor to the job that you want to delete by [▲]/[▼].

❖ Press [Delete] to delete the job.



❖ Press [OK] to confirm or [Cancel] to cancel.

4.4 DISPLAY JOB INFORMATION



❖ Highlight the job that you want to display the information by pressing [▲]/[▼].

Job Info			
Jobname		RUIDE	
Number		11	
Time		2018-04-02	
		15:06:25	
Back	Setting		Rename

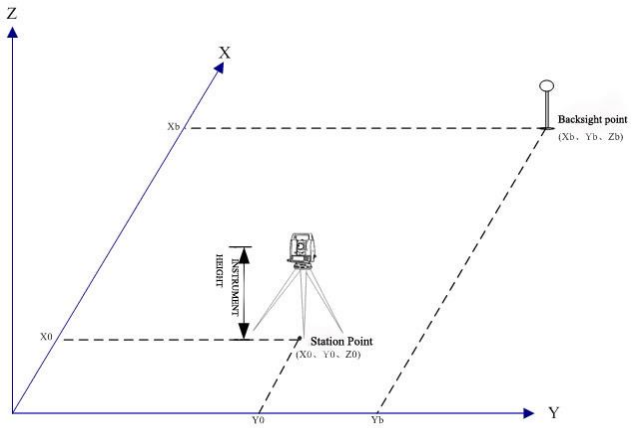
❖ Press [Info] to display the job info, including the job name, number of records and time.

5. STN ABC 7 KEY

To open the Station Setup menu, press STN ABC 7 in the BMS.

5.1 SET UP A STATION WITH KNOWN POINTS

5.1.1 Set up a Station with Known Coordinates



Stn Pt	123		
Pt N	S		
Inst.Ht	1.500	m	
Input	New	Call	OK

❖ In [Stn Setup] menu press [1] to enter into the function of using known point to set station.

❖ Input the point name and instrument height, press [ENT]

BS select			
1. Coordinate			
2. Angle			
Cancel			

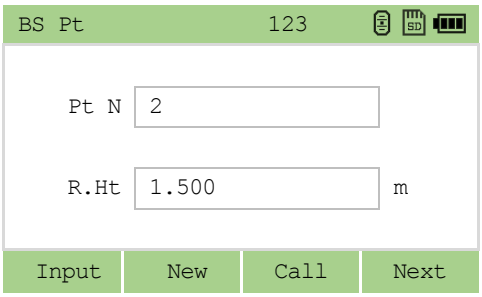
❖ Select an input method for defining the backsight point:

1. To sight the backsight by entering coordinates.
2. To sight the backsight by entering the azimuth angle.

❖ Press 1, sight tbe backsight by entering coordinate.

About determine backsight by inputting coordinates, there are two conditions: measuring to and not measuring to the backsight point.

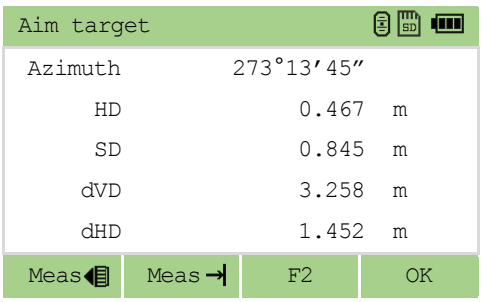
Measure the backsight point



❖ Input the point name and target height, press [Next]

❖ Sight the BS on Face-1 (F1), press [MSR1] or [MSR 2] to record a full shot (with HA/VA/SD value).

After Measuring, the result is displayed as showed below:

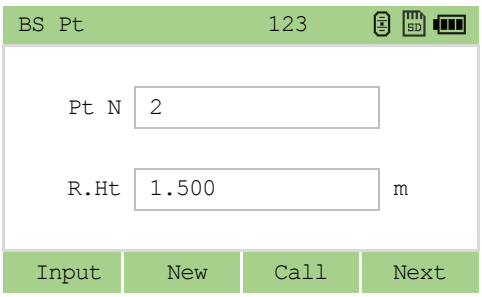


❖ To determine the backsight point only by F1，press [OK] to end measuring.

❖ To determian the backsight point by F1/F2 measurement, press [F2], turn to Face-2, press [MSR] to record another full shot.

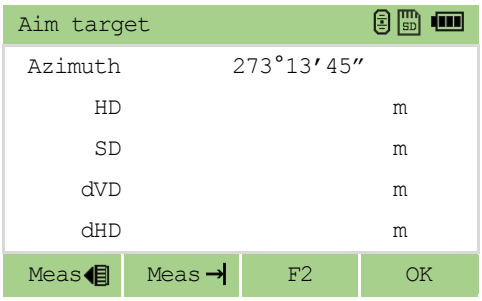
❖ Press [OK] to finish setting backsight.

Not measure the backsight point



❖ Input the point name and target height, press [Next]

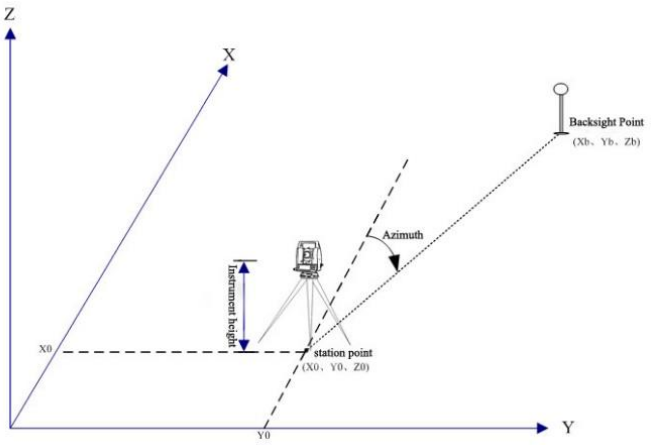
The program calculates the azimuth and displays as below.



❖ Sight the BS on Face-1 (F1), directly press [OK] to finish setting the backsight.

❖ Procedure records the station and raw data to current job and finish setting up station. Screen returns to basic measurement screen.

5.1.2 Sight the Backsight by Entering the Azimuth Angle



ANG Orientation 123			
Pt.N	2		
Azimuth	30		
R.HT		m	
Cancel			OK

❖ In BS select interface, Press 2, sight the backsight by entering the azimuth angle.

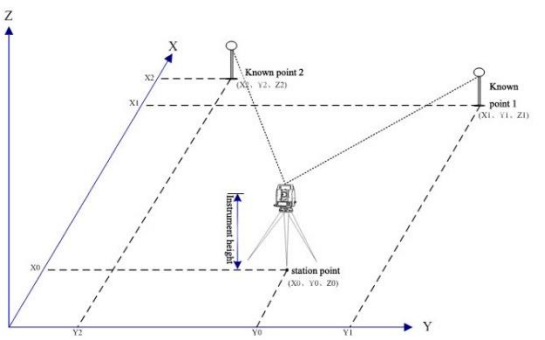
❖ Input a point name

❖ Input the azimuth, press [OK]

Aim target			
Azimuth	30°00′00″		
HD		m	
SD		m	
dVD		m	
dHD		m	
Meas	Meas	F2	OK

❖ Sight the backsight point on F1 and press [OK] to finish setting the backsight.

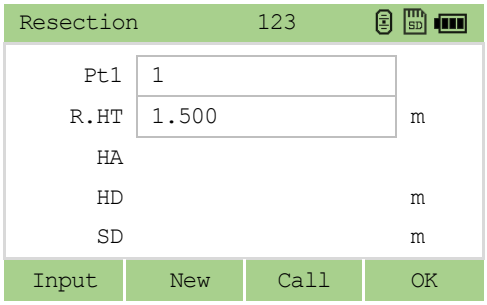
5.2 MULTIPLE POINT RESECTION



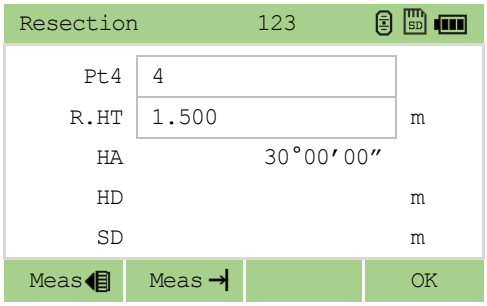
A resection sets up the station using angle/distance measurements to known points.

— You can use a maximum of 10 points in a resection.
— Measurements can be distance and angle, or angle only.
— Calculation starts automatically when enough measurements are taken.
— You can delete poor observations and recalculate if necessary.

If the angle between known point 1 and known point is extremely acute or extremely oblique, the resulting solution will be less reliable geometrically.

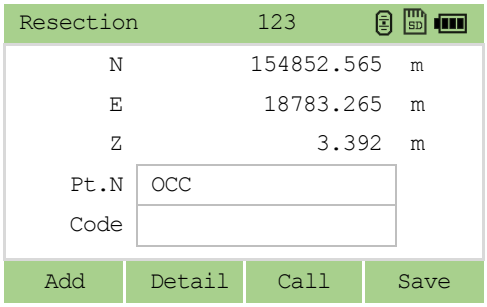


❖ In [Stn Setup] menu press [2] to start the resection.
❖ Enter the point name for the first observation point (Pt1), and the target heght, then press [OK].



❖ Sight the target prism on F1and press [MSR] to start survey. If only need to measure angle, press [ENT].
❖ Repeat above to measure other target points.

When the instrument has enough data; it calculates the station (STN)



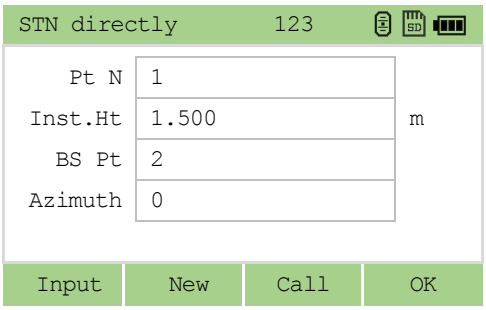
❖ Press the [Add] key to take more measurements.
❖ Press [Detail] to view the measurements, you can delete poor observations or add observation point.
❖ Press [Save] or [ENT] to record when the results are OK.

➢ The minimum data required for a resection is either three angle shots, or two distance shot.
➢ Basically, Stn-Z is calculated from distance-measured data. If no distances are measured, then Stn-Z is calculated using angle-only measurements to known points with 3D coordinates.

5.3 SET STATION DIRECTLY

Setting up the station directly without coordinates.
The station point (ST) in this function defaults to a new point number. For the new point, MP (0, 0, 0) is stored as the coordinates. When the ST is manually changed to a known point name, the station is set up on the coordinates of the known point.
Even if both ST and BS are known points, this function does not calculate the backsight angle (AZ)

automatically. To calculate the AZ between two known points (ST and BS), use [Stn Setup]→[1.Known].



❖ In [Stn Setup] press [3] to enter into STN Directly function.

❖ Leave the Pt N field blank.

❖ Input instrument hieight, press [ENT]. The station point will default to be (0,0,0)

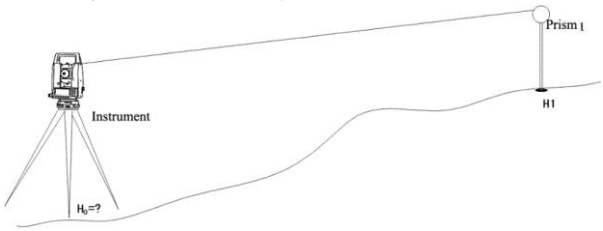
❖ Leave this BS field blank. The backsight azimuth (AZ) defaults to zero.

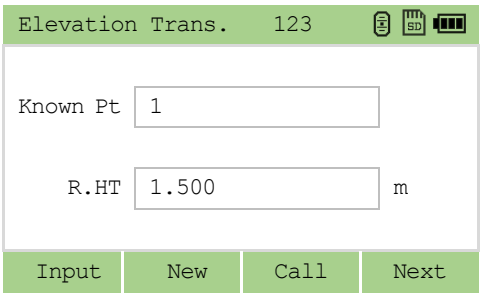
❖ Sight the BS and press [OK].

5.4 HEIGHT TRANSFER (DETERMINING STATION ELEVATION)

This function determines the height of the instrument from measurements to target points with known heights, in two faces.

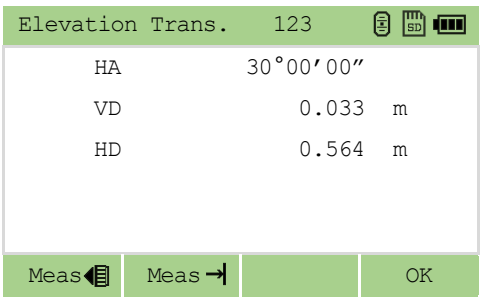
After measuring, the new height of station is displayed.





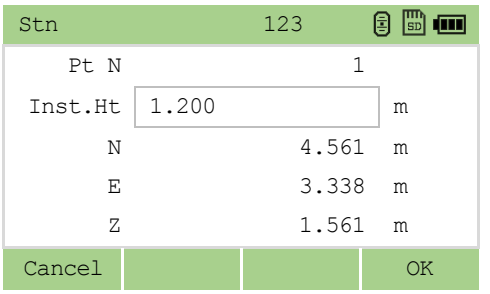
❖ In [Stn Setup] press [4] to enter into height transfer function.

❖ Input level point name, target height, and press [ENT]



❖ Sight the center of prism on Face-1, press [MSR] to start survey.

❖ After finishing measurement, the result is displayed



❖ Press [OK], The result dialog box is displayed, press [OK] to confirm.

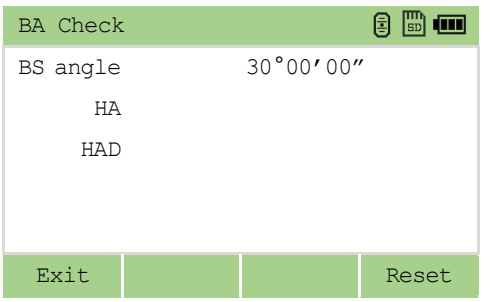
❖ To remeasure, press [Cancel].

➢ When the HI is changed, the Z coordinate is updated before the station is recorded.

➢ You must complete a station setup before you use the Height Transfer function.

5.5 CHECKING AND RESETTING THE BACKSIGHT DIRECTION

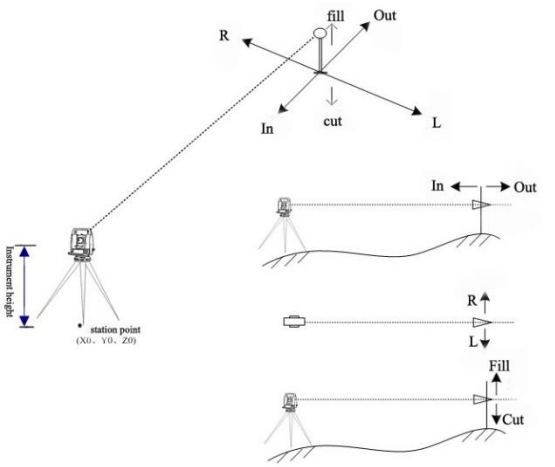
You must complete a station setup before you use the BS check function.



❖ In [Stn Setup] press [5] to enter into Backsight Check function.

❖ Sight the BS point, and press [Reset] to reset the horizontal angle to the HA set in last station setup. Or press [Abrt] or [ESC] to cancel the process and return to the basic measurement screen.

6. KEY

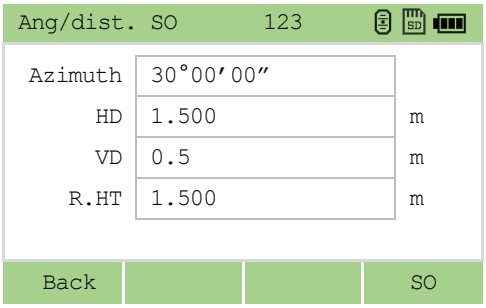


To display the Stakeout menu, press .

You should setup station and backsight azimuth before stake-out.

6.1 STAKE OUT ANGLE AND DISTANCE

Specifying the stakeout point by angle and distance.

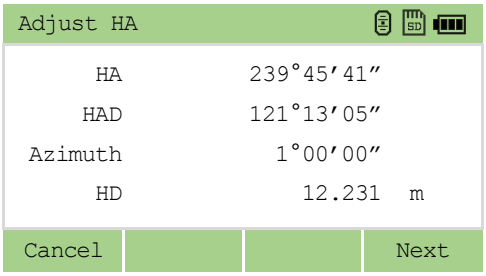


❖ Press [1] to display the input screen for the distance and angle to the target.

❖ Input the values and press [SO]

Azimuth: Horizontal angle to stakeout point

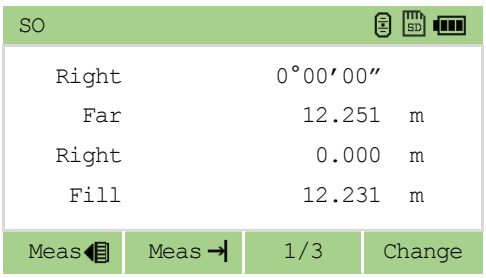
VD: Vertical distance from station point to stakeout point



❖ Start staking out. First Rotate the instrument until the HAD displays as 0°00'00". Press [Next]

❖ Sight the target and press [MSR] to start measuring.

❖ The differences between the target position and the stakeout point are displayed.



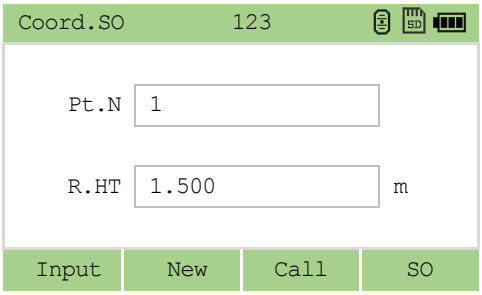
❖ Move the prism forward or backward according to the arrowhead until all the values turn to be 0.

❖ Press [ENT] to record the stakeout point.

❖ Press [Change] to stake out another point.

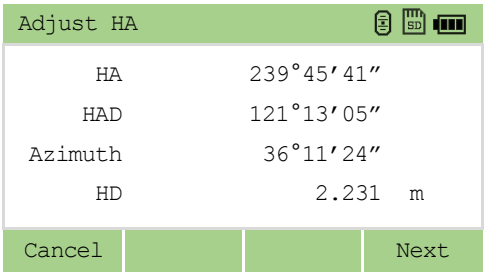
6.2 COORDINATES STAKEOUT

Input the XYZ of stakeout point, and carry on stake-out.



❖ In SO menu, press [2] to enter to coordinate stakeout function.

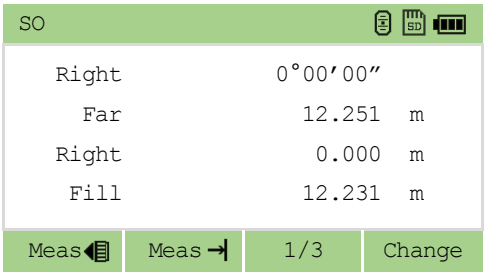
❖ Input the point name and target height and press [SO].



❖ Start staking out. First Rotate the instrument until the HAD displays as 0°00'00", press [Next]

❖ Sight the target and press [MSR] to start measuring.

❖ The differences between the target position and the stakeout point are displayed.



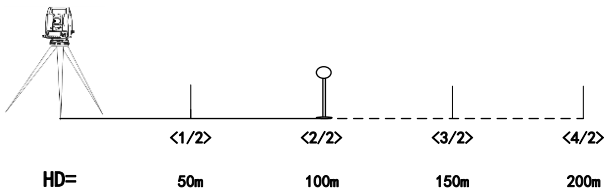
❖ Move the prism forward or backward according to the arrowhead until all the values turn to be 0.

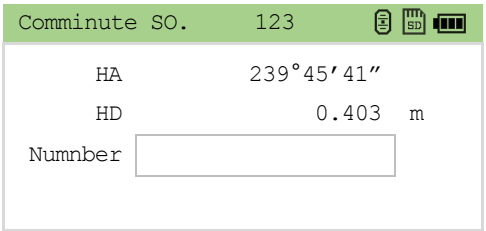
❖ Press [ENT] to record the stakeout point.

❖ Press [Change] to stake out another point.

6.3 PARTLINE SO

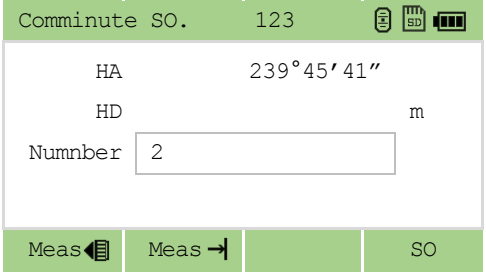
This function divides the line between the instrument and the target by an input span number. It then guides you to stake out the points, one by one. For example, if you measure to the end point at 100 m from the instrument and set the span total to 2, the following four points are calculated and can be staked.





❖ In SO menu press [3] to enter into PartLine SO function.

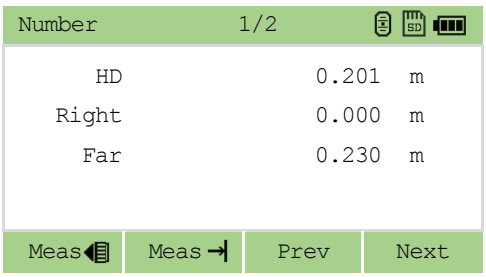
❖ Set up the baseline. Sight the target, and press [MSR] to start survey. System set up a base line between the instrument and the measured point.



❖ Enter the total partition number, and press [SO].

❖ The observation screen for the first stake (from the instrument) appears.

❖ Sight the prism and press [MSR].

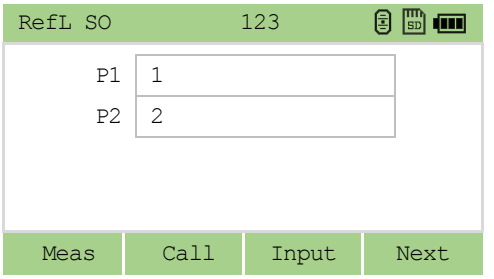


❖ Move the prism forward or backward according to the arrowhead until all the values turn to be 0.

❖ Press [ANG] to stake out other points

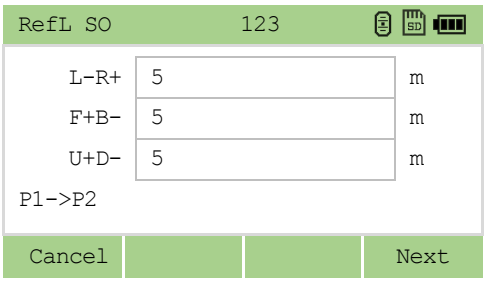
6.4 REFLINE STAKEOUT

This function allows you to stake out a point based on the relationship to a specified line.



❖ In [SO] menu press [4] to enter to Ref.Line stakeout function.

❖ Enter the start point (P1) and the end point (P2) of the line.



❖ Enter offsets to the line. And press [Next]

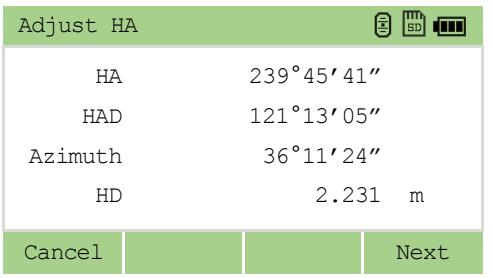
F+B-: Distance from P1 along the line.

L-R+: Offset to baseline

(+): Right side of the P1-P2 line

(-): Left side of the P1-P2 line

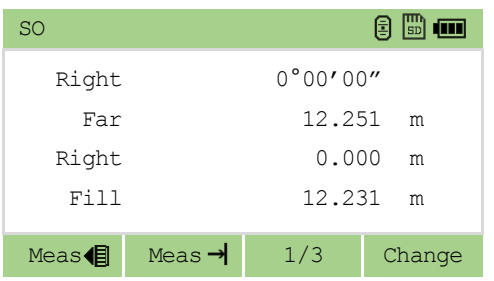
U+D-: dVD to line



❖ Start staking out. First Rotate the instrument until the HAD displays as 0°00'00".

❖ Sight the target and press [MSR] to start measuring.

❖ The differences between the target position and the stakeout point are displayed.



❖ Move the prism forward or backward according to the arrowhead until all the values turn to be 0.

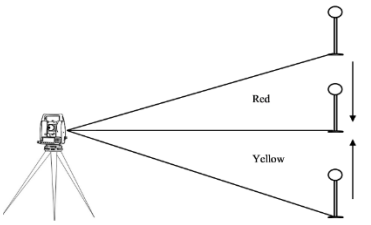
❖ Press [ENT] to record the stakeout point.

❖ Press [Change] to stake out another point.

6.5 GUIDE LIGHT

By emitting two visible beams of coherent light, one red and one yellow, enabling the rodman to locate the correct line quickly and easily by finding the position where both light blink alternately.

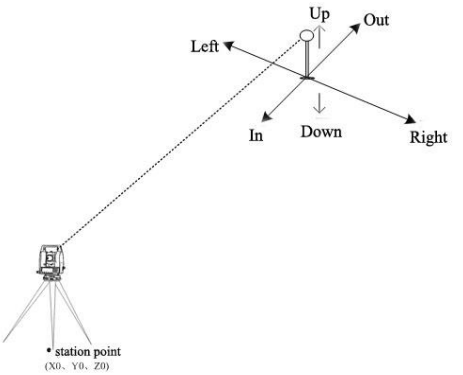
Press numeric key [8] to enter to stake-out function. The screen will show “Open the guiding light?”. Press [MSR1] to cancel or press [ANG] to activate the guide light function.



- When only seeing the yellow light, move the prism to the right
- When only seeing the red light, move the prism to the left.
- When seeing both lights blinking alternately, it means the prism is in the correct line.

7. KEY

7.1 DISTANCE OFFSETS



You should setup station and backsight azimuth before offset measurement.

Dist.offset	123	
HR	92°23′45″	
VA	24°44′58″	
SD		m
R.HT	1.500	m
Meas	Meas	1/4	OK

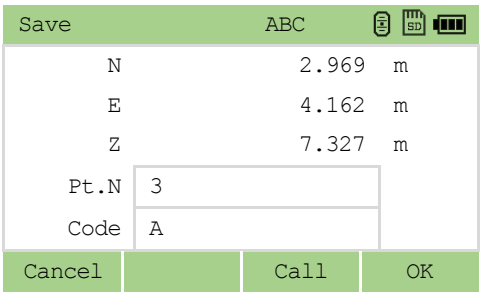
❖ In [Offset] menu press [1] to enter to distance offset function.

❖ If you have not taken a distance measurement before entering this function, a temporary measurement screen appears. Sight the target and press [MSR].

Dist.offset	123	
L-R+	5	m
F+B-	5	m
U+D-	5	m
Cancel			Next

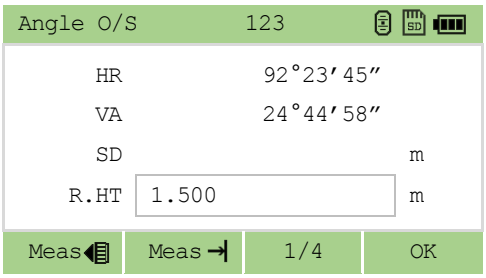
❖ Enter combination of distance offset to specify the point.

❖ Press [Next]



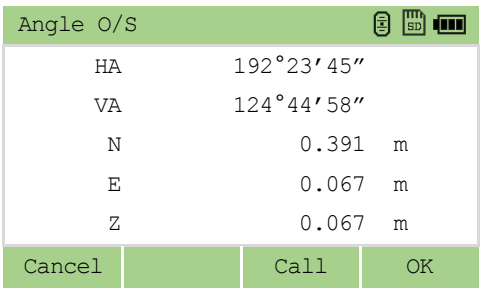
❖ The calculated coordinates are shown. Enter a PT and CD value, press [ENT] to record. The display returns to BMS.

7.2 MEASURING ANGLE OFFSETS

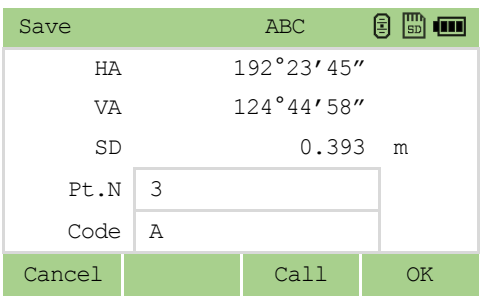


❖ In [Offset] menu, press [2] to enter angle offset function.

❖ If you have not taken a distance measurement before entering this function, a temporary measurement screen appears. Sight the target and press [MSR].



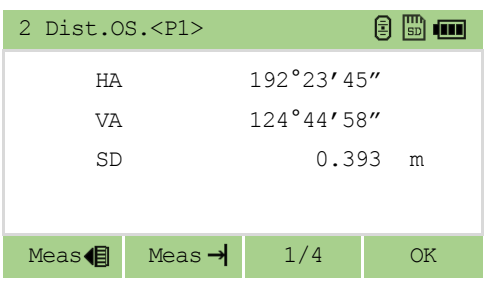
❖ To take the angle offset, rotate the alidade and telescope. The measured distance (HD) remains unchanged.



❖ To record the offset point, press [OK]

❖ The XYZ data is also recalculated based on the new angle. In the dialogue box of results calculated by the program, press [ENT] to record.

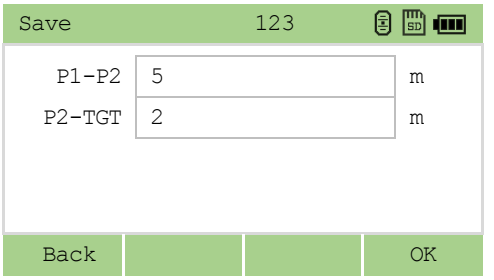
7.3 TWO-PRISM POLE



❖ In [Offset] menu, press [3] to enter the 2Prism Pole function.

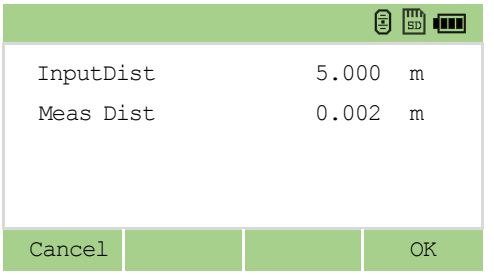
❖ Sight the first prism and press [MSR].

❖ Sight the second prism and press [MSR].



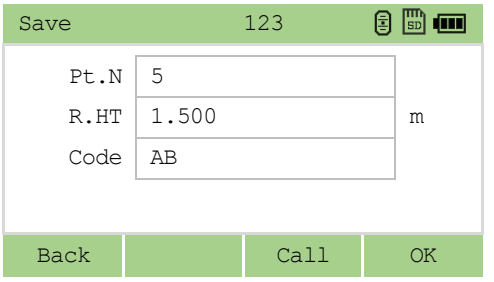
❖ Enter the distance between the second prism and the target point.

❖ Alternatively, if you don't need QA information, you can leave the distance between the first and the second prism blank.



❖ If you entered a P1-P2 distance, the QA screen appears. Compare the entered value and the measured distance to check the accuracy of the observation.

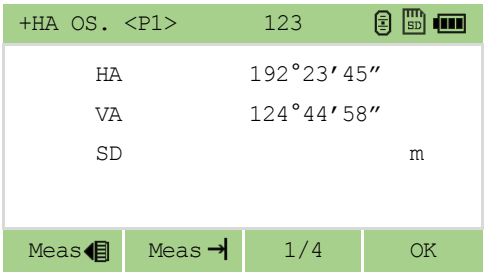
❖ To reinput the distances, press [Cancel].To confirm, please press [OK].



❖ Press [OK] to record the point.

7.4 +HA LINE

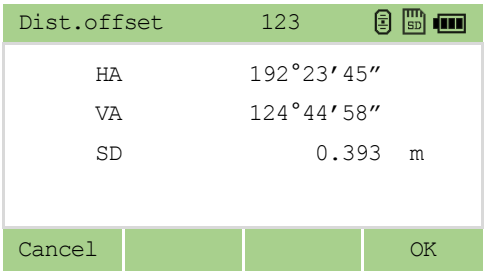
This function is to extend a line by horizontal angle offset.



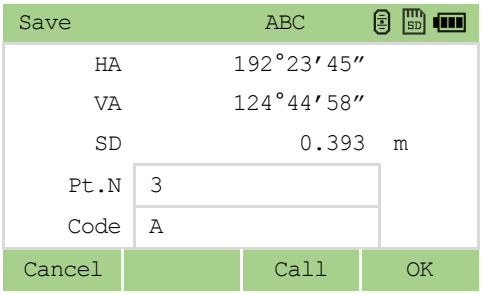
❖ In [Offset] menu, press [4] to enter the line extension (+HA) function.

❖ Sight the first prism and press [MSR].

❖ Sight the second prism and press [MSR].



❖ Sight the alternative place on the same vertical line as the desired target point.

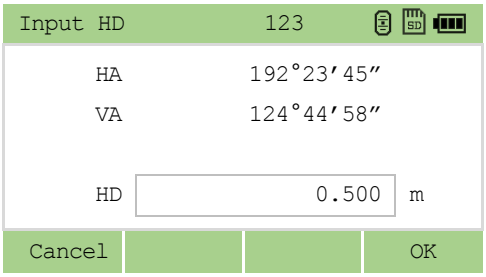


❖ Press [ENT] to calculate the coordinates and the raw data of the target point.

❖ Enter a PT (and CD) value, and press [ENT] to Record the point. The height of target is fixed to 0.0000 for the offset point.

7.5 INPUT HD

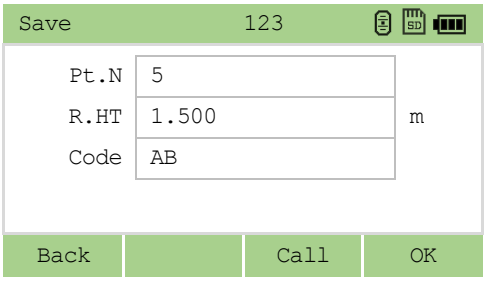
This function is useful when the instrument is very close to the point and it is difficult to take a measurement using the EDM.



❖ In [Offset] menu press [5] to enter to Input HD function.

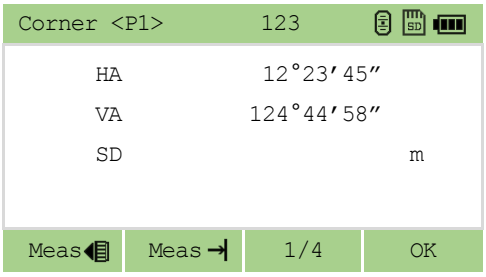
❖ Turn the telescope in the direction of the point that you want to store.

❖ Enter the HD and press [OK].



❖ Enter a PT (and CD) value and press [ENT], The target point is calculated and recorded as an SS record.

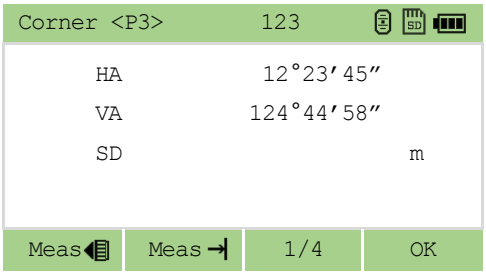
7.6 CALCULATE A CORNER POINT



❖ In [Offset] menu, press [►] to display the second page of Offset. Press [6] to enter the corner point function.

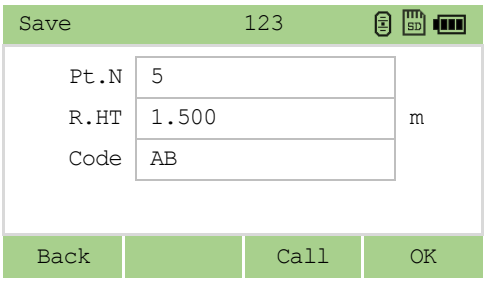
❖ Take a distance measurement to the first point on the wall.

❖ Take a distance measurement to the second point on the same wall.



❖ Take a distance measurement to the third point on the second wall.

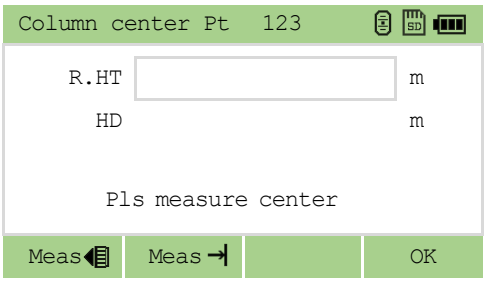
❖ If the two walls are at right angles, press the Calc softkey to calculate the corner point by three points.



❖ If you take a measurement to a fourth point, the corner point can be calculated as the intersection of two walls (P1-P2 and P3-P4).

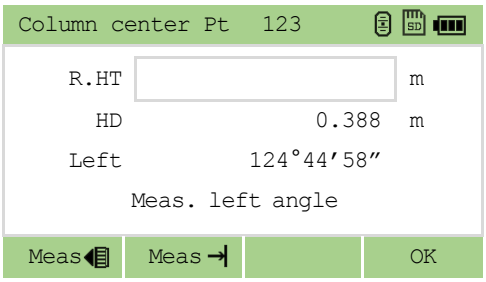
❖ Enter a PT (and CD) value and press [ENT], The target point is calculated and recorded as an SS record.

7.7 COLUMN

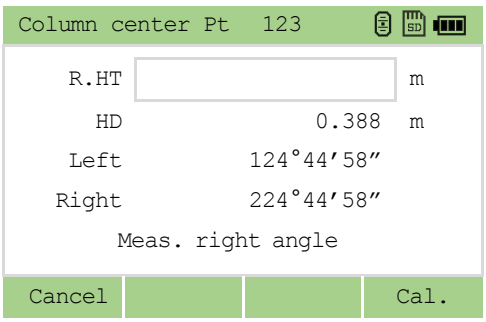


❖ In Page 2 of [Offset] menu, press [7] to enter Column function.

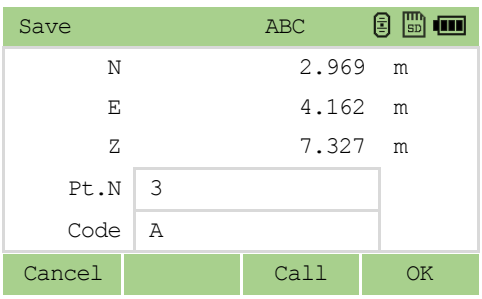
❖ Sight any point on the surface of the column and press [MSR]. Press [OK]



❖ Sight the left edge of the column. Press [OK]



❖ Sight the right edge of the column. Press [Cal.]



❖ Enter a PT (and CD) value and press [ENT], The target point is calculated and recorded as an SS record.

7.8 EXTEND THE SLOPE DISTANCE

Meas.	123	
HR	192°23′45″	
VA	124°44′58″	
SD		m
R.HT	0.500	m
Meas	Meas	1/4	OK

❖ In Page 2 of [Offset] menu, press [8] enter the function for extending the slope distance

❖ Sight the target and press [MSR].

Dist.offset	123	
HA	192°23′45″	
VA	124°44′58″	
SD	0.439	m
dSD	1.200	m
Cancel		OK

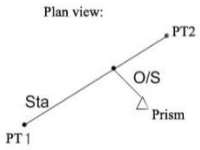
❖ Enter the slope distance You can enter any value from -99.99 through +99.99m.Press [ENT] to record the point.

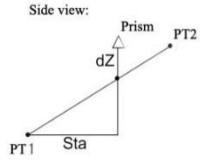
Save	123	
Pt.N	5	
R.HT	1.500	m
Code	AB	
Back		Call	OK

❖ Enter a PT (and CD) value and press [ENT], the target point is calculated and recorded as an SS record.

8. KEY

8.1 2 POINT REFLINE

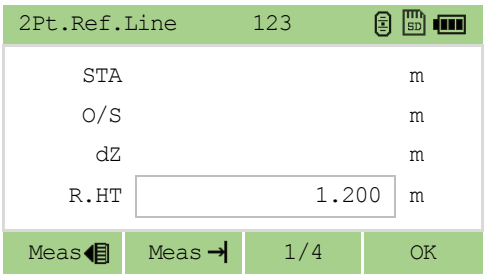




2Pt.Ref.Line	123	
P1	1	
P2		
Input	Call	Meas.	OK

❖ In [Program] menu, press [1] to enter 2Pt.Ref.Line function.

❖ Input the first and second point of the reference line.

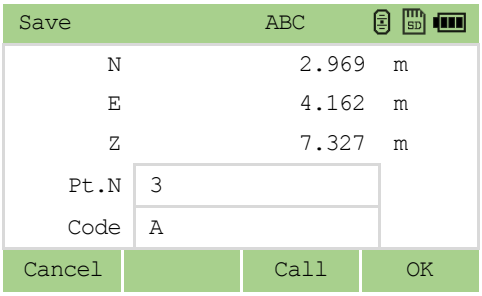


❖ Sight the target and press [MSR] to start measurement.

STA: Horizontal distance from P1 to the measure point along the P1-P2 line

O/S: Horizontal offset from the P1-P2 line to the measured point

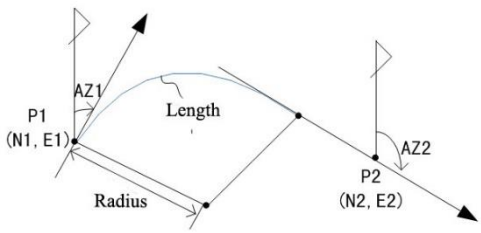
dZ: Vertical offset from the P1-P2 line to the measured point

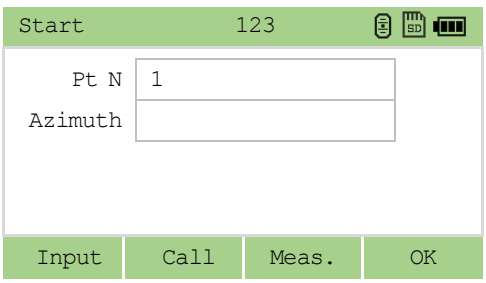


❖ Press [OK] to record.

8.2 REFERENCE ARC

Measuring distance and offset values on the arc-curve.

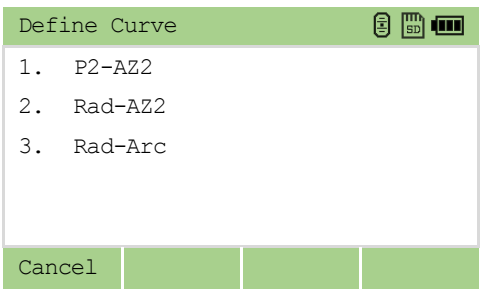




❖ In [Program] menu, press [2] to enter Ref. Arc function.

❖ Enter the start of the curve point P1 and the azimuth of its tangent line.

❖ Press [OK]



❖ Choose a method to define the arc

1. P2-AZ2.

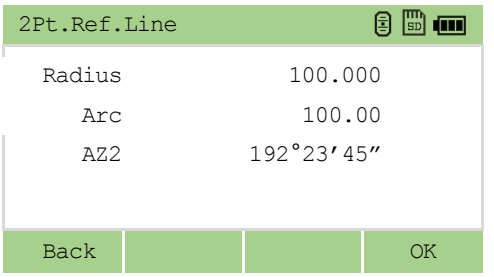
Input point name of P2 and azimuth of its tangent line (AZ2).

2. Rad-AZ2

Input the radial and azimuth of its tangent line (AZ2).

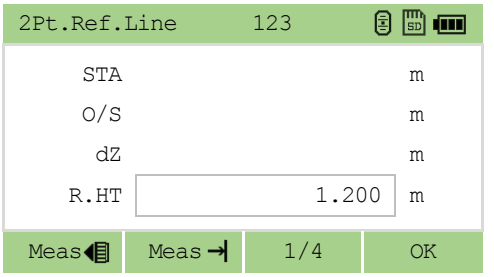
3. Rad-Arc

Input radial and arc length.



❖ The instrument calculates the curve. If the curve length (Len) is too large for a circle of the given radius, it is shortened. If the curve is reasonable, press [OK] to confirm.

❖ Sight the center of prism, and press [MSR].



STA: Horizontal distance from P1 to the measure point along the P1-P2 line

O/S: Horizontal offset from the P1-P2 line to the measured point

dZ: Vertical offset from the P1-P2 line to the measured point

❖ Press [OK] to record.

➢ In the radius (Rad) field, enter a positive value for a clockwise curve. Enter a negative value for a counterclockwise curve.

➢ P2 can be any point on the tangent line that is to exit the curve.

8.3 REMOTE DISTANCE MEASUREMENT

This function measures the horizontal distance, vertical distance, and slope distance between two points.

User can select between two different methods:

MimRadial(A-B，A-C)

Mim Cont. (A-B，B-C)

rSD: Slope distance between two points

rHD：Horizontal distance between two points

rVD: Vertical distance between two points

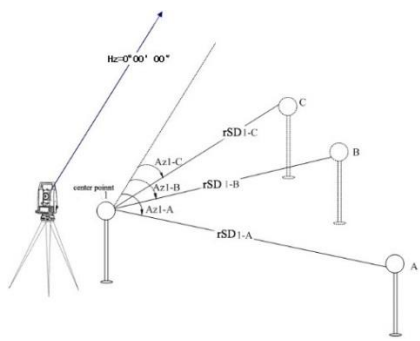
RV%：rV% Percentage of grade (rVD/rHD) × 100%

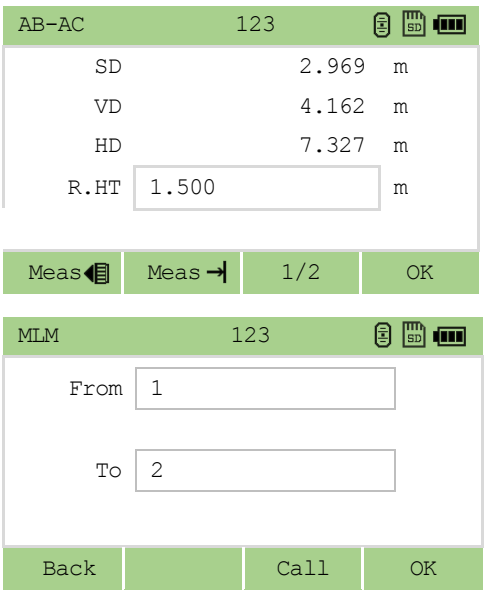
rGD：Vertical grade (rHD/rVD)

rAZ：Azimuth from first point to second point

8.3.1 MimRadial

Measuring between the current and the first point measured.





❖ Sight the first point and press [MSR]. The distance from the station point to the first point is displayed.

❖ Sight the second point press [MSR], the distances between 1st and 2nd point are displayed.

❖ Sight the third point and press [MSR 1]/[MSR 2], the distances between the first and third point are displayed.

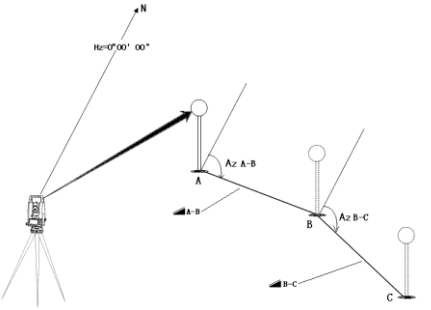
❖ Repeat to measure to other points

❖ To record the distance and angle information as a comment record, press [ENT] in the 1/2 or 2/2 observation screen. Default point numbers are displayed. (STN=0, PT=1, PT=2, PT=3…), it can be changed.

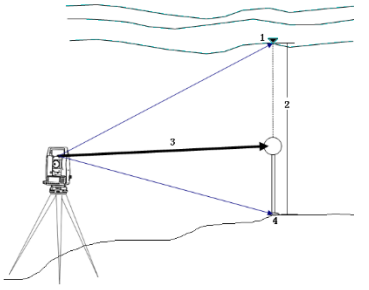
8.3.2 Mim Cont.

Measuring between the current point and the immediately preceding point, ie, the first point to the second point, the second point to the third point, and so on.

Other operations are same as MimRadial.



8.4 REMOTE ELEVATION MEASUREMENT (REM)



1. Target Point
2. Z
3. Slope Distance
4. Base Point

REM	123	
R.HT	1.200	m
VA	42°23′45″	
HD		m
VD		m
Z		m
Meas	Meas	

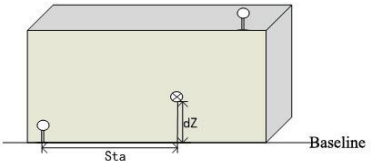
❖ In [Program] press [5] to enter REM function.
❖ Enter the target height, Sight the target point and press [MSR].

REM	123	
R.HT	1.200	m
VA	42°23′45″	
HD		m
VD		m
Z		m
Meas	Meas	

❖ Loosen the vertical clamp, and turn the telescope to aim at the target point. The difference in elevation (Z) is displayed.

8.5 2-PT REFERENCE PLANE (V-PLANE)

Measuring distance and offset values on the vertical plane.



V-Plane	123
P1	
P2	
Input	Call	Meas.	OK

❖ In the second page of [Program] press[6] to enter 2-Pt Reference Plane (V-Plane) function.
❖ Input the first point to define the plane.
❖ Input the second point on the vertical plane, and press [OK].

V-Plane		
HA	42°23′45″	
VA	42°23′45″	
Sta	0.102	m
dZ	1.229	m
Cancel		1/2	Save

❖ Once the plane is defined, the calculated Sta and dZ values are updated as you move the telescope. No distance measurement is required.

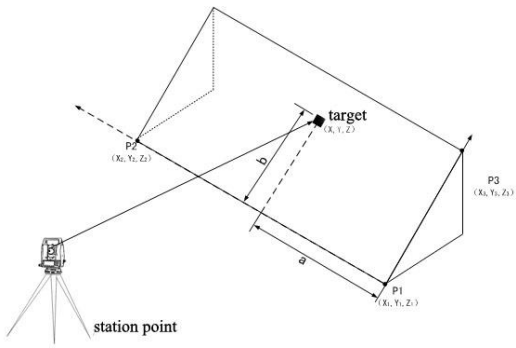
Sta：Horizontal distance from P1 to the target point along the baseline

dZ: Vertical distance from P1 to the target point

❖ Press [Save] to save the point.

8.6 3-PT REFERENCE PLANE (S-PLANE)

Measuring distance and offset values on the slope.



S-Plane	123		
Pt1			
Pt2			
Pt3			
Input	Call	Meas.	OK

❖ In the second page of [Program] press [7] to enter 3-Pt Reference Plane (S-PLANE) function.

❖ Input the first point to define the slope plane.

❖ Input the second point.

❖ Input the third point on the plane.

S-Plane			
HA	42°23′45″		
VA	42°23′45″		
a	0.102	m	
b	1.229	m	
Cancel		1/2	Save

❖ Once the plane is defined, the calculated a and b values are updated as you move the telescope. No distance measurement is required.

a: Distance between P1 and the point that is perpendicular to the target point along the P1-P2 line

b: Length of the perpendicular line from the target point to the P1-P2 line

9. COGO MNO 5 KEY

Coordinate geometry (COGO) calculations.

9.1 INVERSE CALCULATING

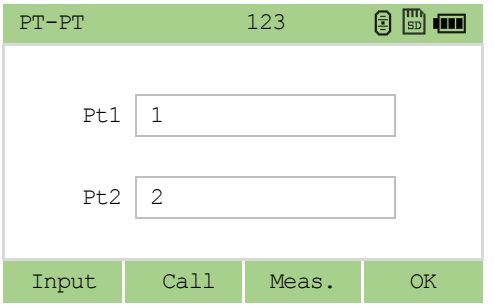
9.1.1 Inverse PT-PT

Calculating angle and distance between two coordinates: PT-PT calculates the distance and the angle between two input points.

Inverse			
1. PT-PT			
2. 3 PT Ang.			
Cancel			

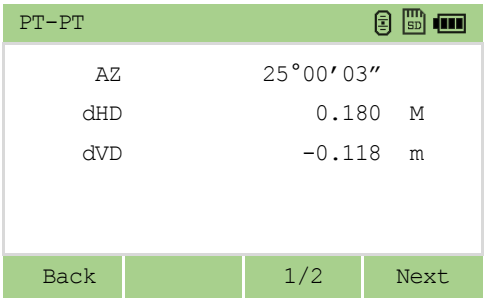
❖ Press [5] entering the COGO menu.

❖ Press [1] choose Inverse and then press [1] entering the PT-PT function



❖ Input the two points. These points can be input manually, or call from the internal memory or measured on site.

❖ Press [OK]



❖ The azimuth, horizontal distance, and vertical distance from the first point to the second point are displayed. Press [Dsp] to switch between two pages.

Second page:

Gd: Grade (HD/VD)

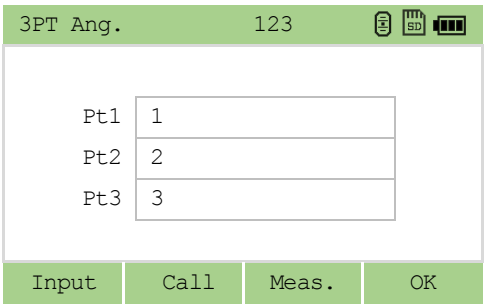
V%: 100/Gd

rSD: Slope distance PT1 to PT2

❖ Press [Next] to go on PT-PT inverse.

9.1.2 3PT Angle

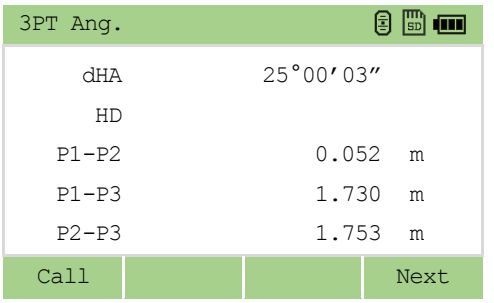
The 3pt angle calculates the angle between two lines defined by three points.
PT1 is the base point. Two lines are to be defined by P2 and P3, both from P1.



❖ In Inverse menu, press [1] entering the PT-PT function.

❖ Input the three points

❖ Press [OK] to display the result.

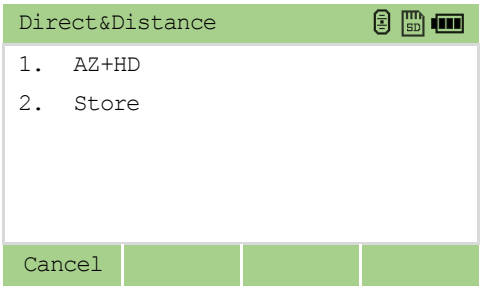


❖ To continue 3 Pt. Angle function, press [Next]

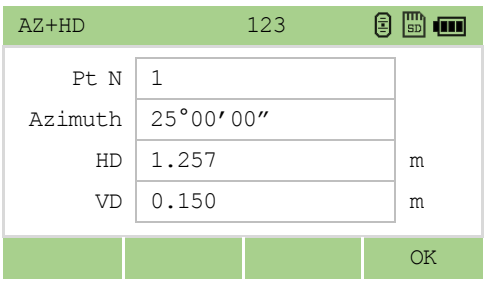
9.2 DIRECT AND DISTANCE (AZ&DIST)

Use angle and distance to calculate coordinate. There are two ways to calculate new points in AZ&Dist function.

9.2.1 AZ+HD

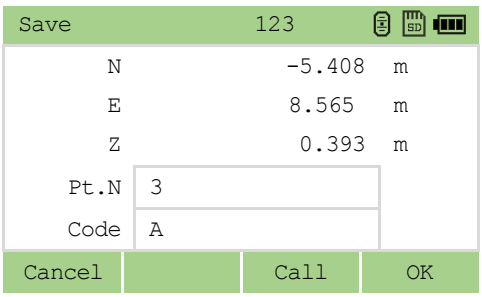


❖ Press [2] choose Direct&Distance and then press [1] entering the AZ+HD function.



❖ Input the base point, azimuth, HD and VD.

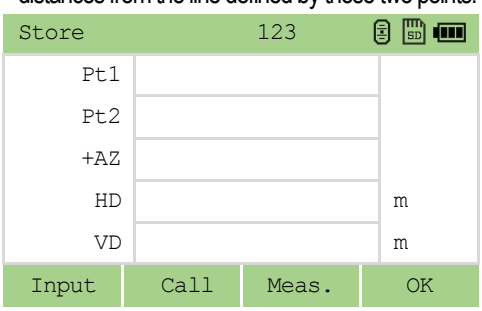
❖ Press [OK] to calculate the coordinate.



❖ Press [OK] to record.

9.2.2 Store

Store function calculates a new point based on the two defined points and angle, horizontal and vertical distances from the line defined by those two points.

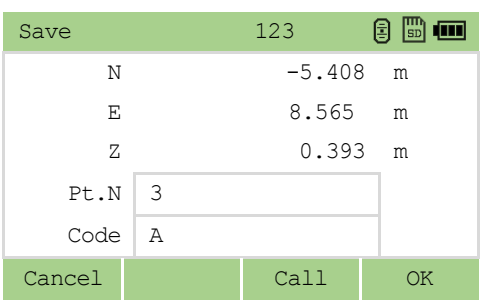


❖ In Direct&Distance menu, press [2] entering Store function.

❖ Input the two points defining the baseline

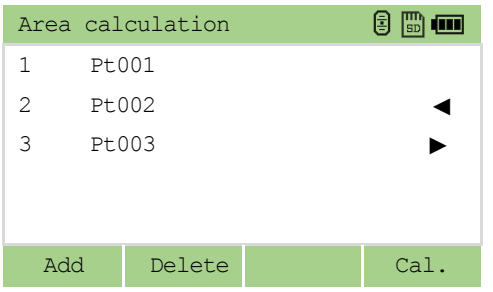
❖ Enter the plus-minus angle, horizontal distance, and vertical distance from the baseline defined by P1-P2

❖ Press [OK] to calculate the coordinate



❖ Press [OK] to record.

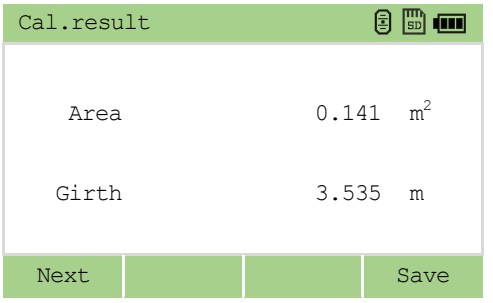
9.3 CALCULATE AREA



❖ In Cogo menu press numeric key [3] to enter to Area calculating function.

❖ Press [Add] to add the points until you have defined all the points in the lot

❖ Press [Cal.] to calculate the area and girth.



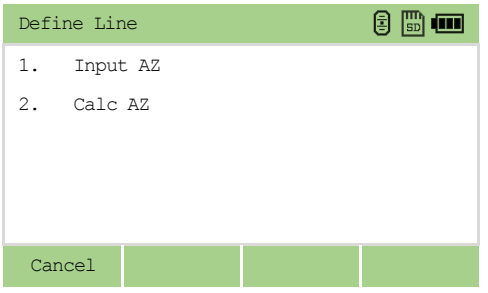
❖ Press [Next] to add points to the graph.

❖ Press [Save] to record the area

9.4 LINE AND OFFSET

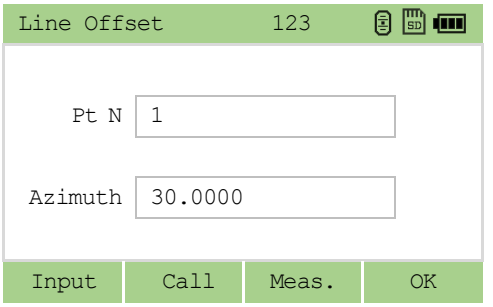
Calculate coordinates from line and offset. The line can be defined by two ways, a base point and azimuth, or two points

9.4.1 Input AZ



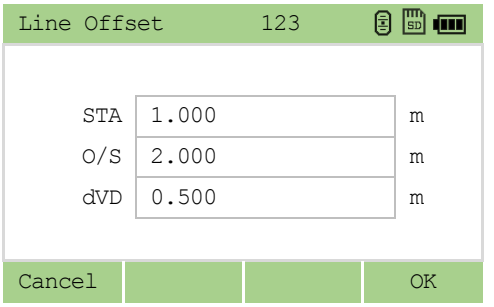
❖ In COGO menu, press [4] entering line & offset function.

❖ Press [1] choose Input AZ function



❖ Input the base point and the azimuth.

❖ Press [OK].



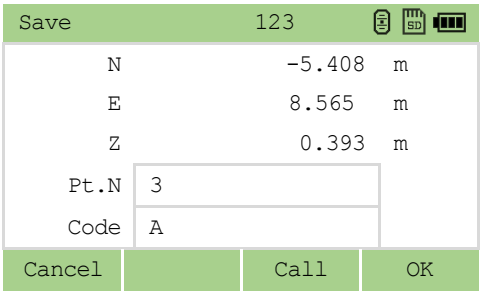
❖ Enter the STA, O/S and dVD

STA: the horizontal distance along the baseline.

O/S: the horizontal distance perpendicular to the line.

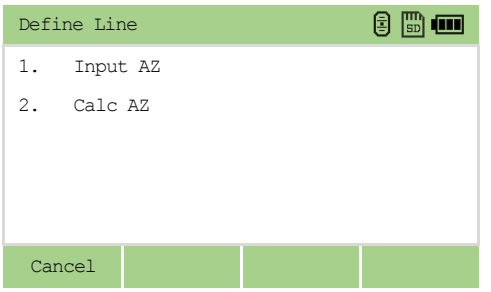
dVD:vertical distance to the baseline

❖ Press [OK] to calculate the coordinate

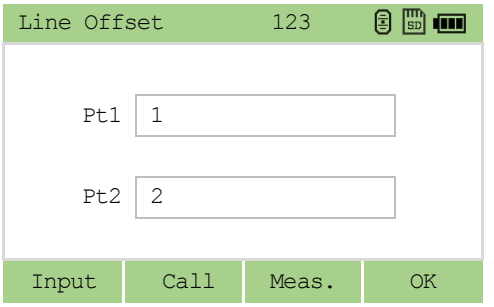


❖ Press [OK] to save the point

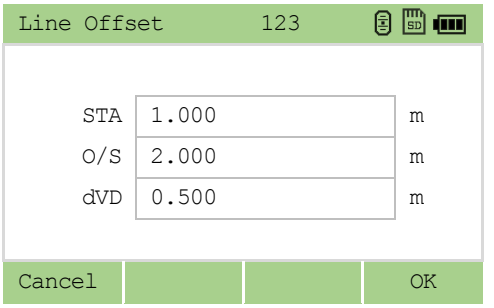
9.4.2 Calculate AZ



❖ Press [2] to choose calculate AZ by two points



❖ Enter the two points to define the base line.



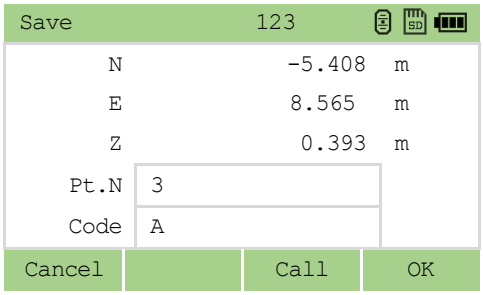
❖ Enter the STA, O/S and dVD

STA: the horizontal distance along the baseline.

O/S: the horizontal distance perpendicular to the line.

dVD:vertical distance to the baseline

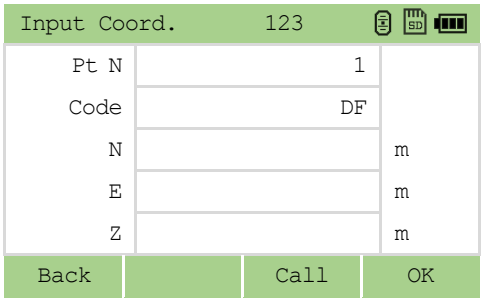
❖ Press [OK] to calculate the coordinate



❖ Press [OK] to save the point

- A negative value in the Sta field means the opposite direction along the defined bearing line.
- A negative value in the O/S field is for the left-hand side of the bearing line

9.5 INPUT COORDINATES MANUALLY



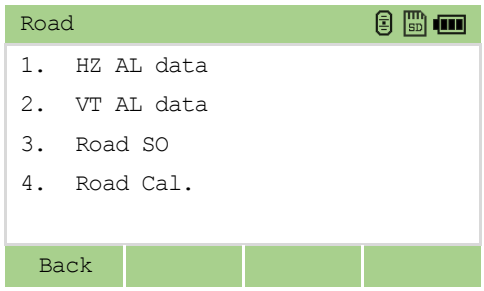
❖ In Cogo menu press key [5] to manually enter the XYZ coordinates.

❖ Enter the coordinate and point name, code. Press[OK] to save the point

10. ROADS

This program enables you to easily define a line or curve or spiral as a reference for measurements and stake outs. It supports chainages, as well as incremental stake-outs and offsets.

Before starting road design and stake-out, user should set job, station, and orientation first.



10.1 DEFINE HZ ALIGNMENT

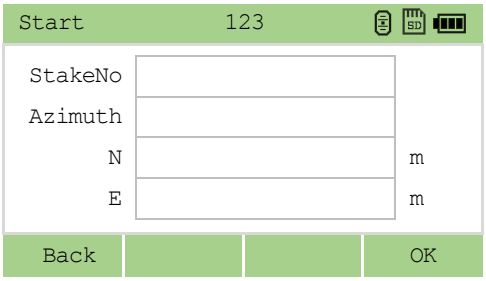
Horizontal alignment consists of the following elements: start point, line, curve and spiral.

To define a horizontal alignment, user should first input the detailed information (Chain, N, E coordinate) of start point.

The element of start point consists of the start chainage and E, N coordinate of start point. Enter these details, and press [ENT] to display the main line inputting screen.

The screen displays: current chainage, the azimuth angle of the tangent on the chainage, and the function key of the establishing new line. The system provides three functions: defining line,

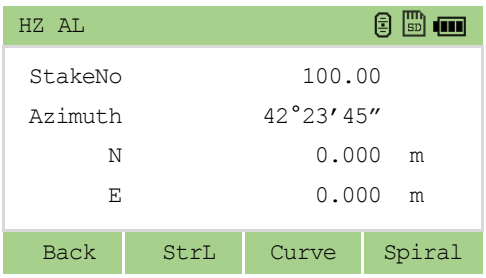
curve(C-cureve), spiral(T-curve).



❖ In MENU, press [0] to enter the Road function.

❖ Select "1.HZ AL data" to enter into define HZ Alignment function. Then select "Define HZ AL".

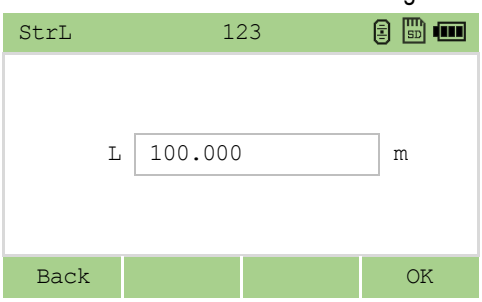
❖ Input the chainage of start point, and N, E coordinates. Press [OK]



❖ The display enters to the Define HZ alignment main menu.

Straight Line

When the start point or other line type is defined, user can define line. A line consists of azimuth angle and distance. The distance value can not be negative.



❖ Press [StrL] to enter into the straight line defining menu.

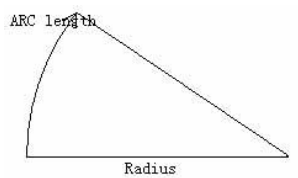
❖ Input the length of the line, press [OK]

❖ The display shows the end chainage of the straight line and its azimuth.

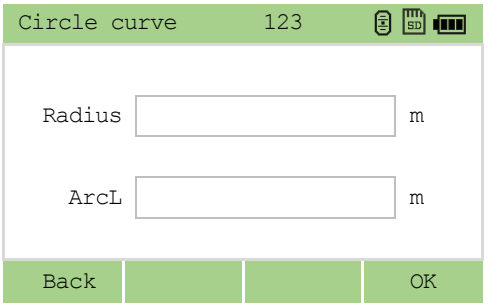
❖ Now, user can define other curves.

➢ When the line is in the middle of road, the azimuth angle of the line is calculated according to the previous elements.

Curve

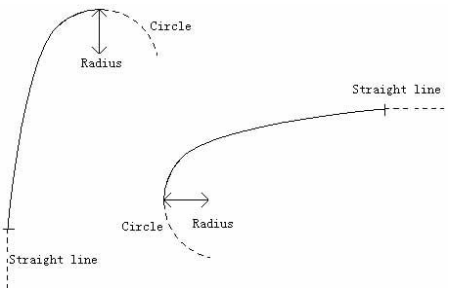


Press [C-curve] in "Define HZ AL" menu to define the arc. A curve consists of arc length and radius. The rule of radius value: along the forward direction of the curve. When the arc turns right, the radius value is positive; while the arc turns to left, the radius value is minus. The arc length can neither be negative nor longer than the circumference.

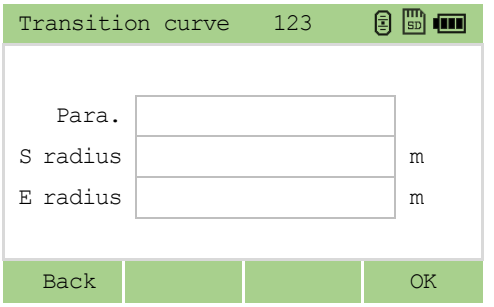


- Press [C-curve] to enter into the curve defining menu.
- Input radius and arc length, and press [OK] to record this data.
- The display shows the end chainage of the curve and its azimut

Spiral



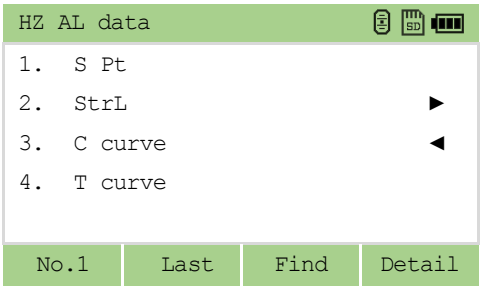
In Define HZ AL screen press [T-curve] to define transition. A transition consists of the parameter, start radius and end radius. The rule of radius value is same as the rule of radius value. Similarly, the arc length can't be negative.



- Press [T-curve] to enter into the spiral defining menu.
- Input radius and parameter, and press [OK] to record this data.
- The display shows the end chainage of the spira and its azimut

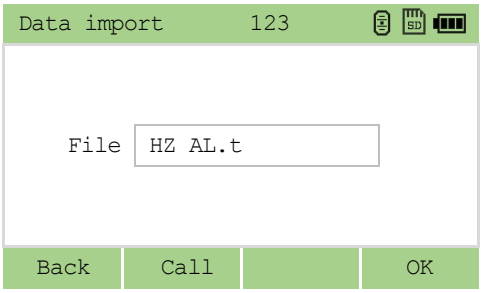
10.2 EDIT HORIZONTAL ALIGNMENT DATA

In the process of defining horizontal alignment, editing is available.



- In HZ Alignment select "Edit HZ AL".
- Select the data to be edited, press [ENT]
- Press [Edit], input the new data, , press [OK], then [ESC] to choose other elements to edit.

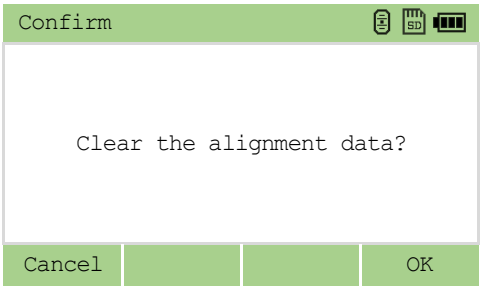
10.3 RECEIVE HZ AL



- In HZ Alignment select “Import HZ AL”.
- Select the file to be imported
- Press [OK] to start

10.4 DELETE HORIZONTAL ALIGNMENT DATA

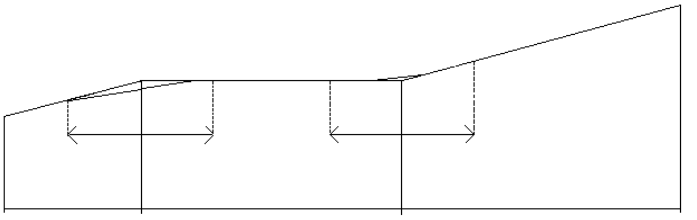
The horizontal alignment data in internal memory can be deleted. Operation is shown below.



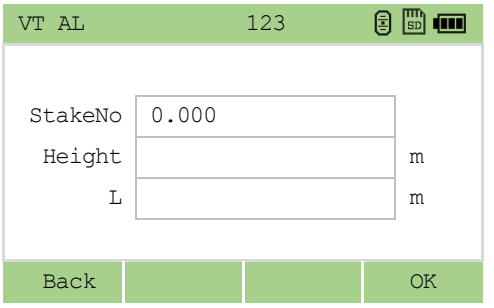
- In HZ Alignment select “Delete HZ AL”.
- Press [OK] to delete all the horizontal alignment.

10.5 DEFINE VERTICAL ALIGNMENT

A vertical alignment consists of a series of intersections, including a chainage, height and curve length. The length of start point and end point must be zero.



Chainage	1000	1300	1800	2300
Height	50	70	60	90
Curve length	0	300	300	0



- In Roads menu select “2.VT AL data” to enter to define VT Alignment function.
- Select “Define VT AL”.
- Input chainage, elevation and length, then press [OK].

➢ For the menu of Edit VT AL, Import VT AL and Clear VT AL, please refer to steps of HZ AL data.

10.6 STAKE OUT ROADS

To stake out alignment, the alignment type should be defined first. 2 methods of defining horizontal alignment are available: installing in the computer via the data communication software or inputting manually in program "Road".

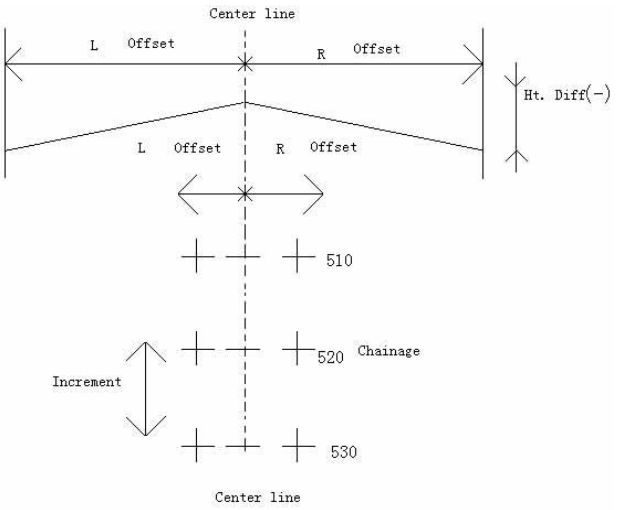
The vertical alignment data is unnecessarily to be defined, unless it is required to compute dig and fill. The method to define is similar to that of horizontal alignment.

Rules of alignment stake-out data:

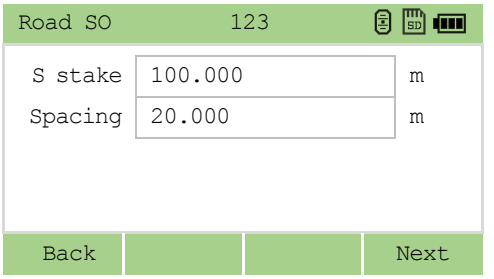
Offset left: Horizontal distance between the left chainage and central line.

right: Horizontal distance between the right chainage and central line.

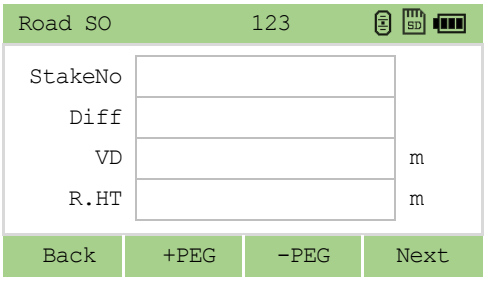
Vertical Difference Left (right): vertical difference between left (right) chainage and the central line point.



In the process of stake-out, user should first stake out points on the central line, then the featured points on both sides.



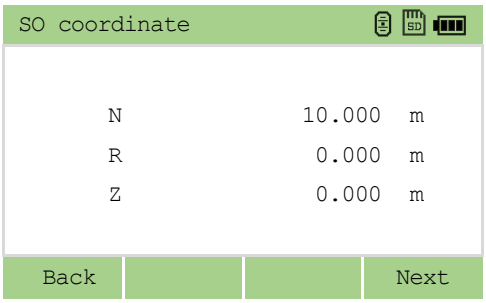
- In Roads menu select "3. Road SO".
- Input the start chainage and chainage increment.
- Press [Next]



- Input the chainage number, the left and right offset (Diff), and height difference (VD) and target height.

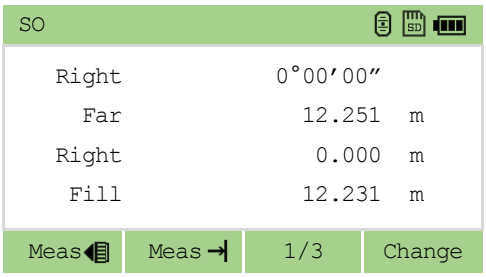
+PEG: The key is used to increase the chainage.

-PEG: The key is used to increase the chainage.



❖ Press [Next], it shows the calculated coordinate.

❖ Press [Next]



❖ Enters the Stake out interface.

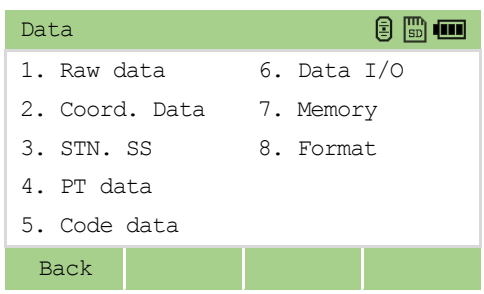
❖ Move the prism forward or backward according to the arrowhead until all the values turn to be 0.

❖ Press [ENT] to record the stakeout point.

❖ Press [Change] to stake out other point of the road.

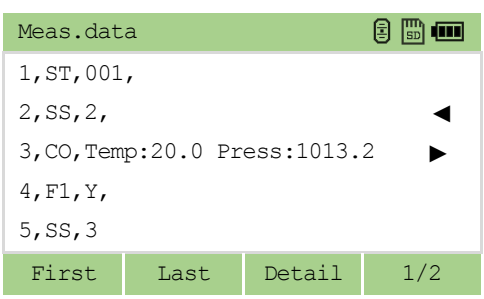
11. DATA MANAGEMENT

Press [MENU]-6.[Data] to enter the data management screen. Users can view, edit, add, delete the data, format the memeory and check the memory status.



11.1 RAW DATA

You can view, delete the raw data.

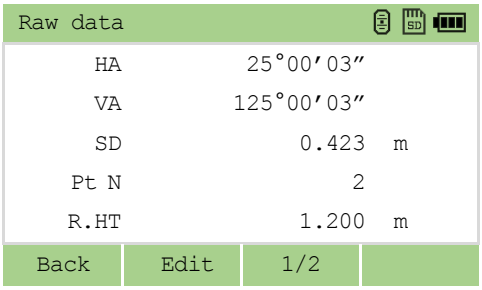


❖ Press [1] in data management to enter the raw data screen.

❖ Press [▲]/[▼] to choose the records.

❖ Press [◀]/[▶] to view the other pages of the raw data.

❖ Press [Delete] in page 2 to delete the raw data.

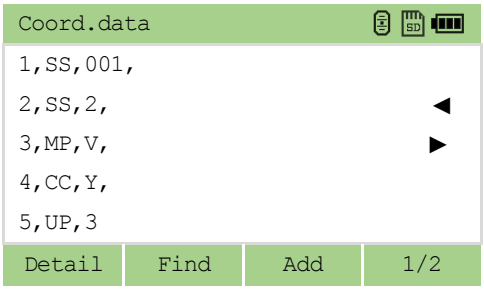


- ❖ Press [Detail] to view the detail of the record.
- ❖ Press [DSP] to view the next page.
- ❖ Press [Edit] to edit the raw data

- ➢ SS：Sideshots (topo shots). All shots from the basic measurement screen are stored as SS records.
  CP：Shots taken in the Angle or Repeat menus, or in the basic measurement screen.
  F1/F2：Face-1 /Face-2 measurements.
- ➢ Raw records contain “PT”, “HT”, “CD” and “HA/VA/SD”.

11.2 COORDINATE DATA

In Data menu press [2: Coord. Data], then coordinate data is displayed in a list, with the newest record at the bottom of the screen. Use [▲]/[▼] to scroll through the records. (Use [◀]/[▶] to move up or down one page), press [ENT] to see more detailed information.
The header (XYZ, YXZ, NEZ or ENZ) depends on the Coord.

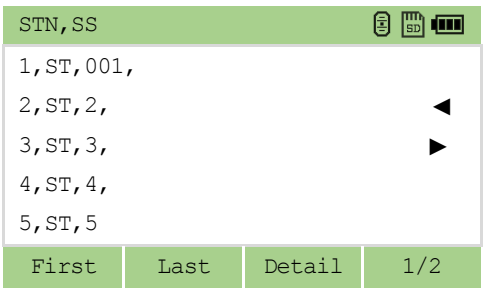


- ❖ Press [Detail] to view the coordinate data
- ❖ Press [Find] to search the data.
- ❖ Press [Add] to add a new coordinate data.
- ❖ Press [Delete] in page 2 to delete the data.

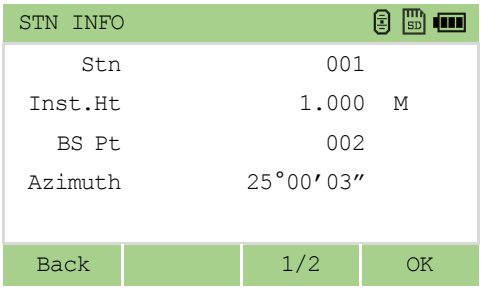
- ➢ UP：uploaded point coordinates
  MP：manually input point coordinates
  CC：points calculated in Cogo
  RE：Points calculated in Resection.
  SS：Sideshots, All shots from the basic measurement screen are stored as SS records.

11.3 VIEW RECORDS BY STATION

View sideshot recorded under a certain station point.

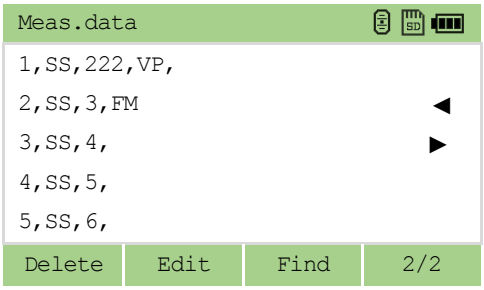


- ❖ Press [3] to select STN,SS.
- ❖ Station data lists are showed.
- ❖ Press [▲]/[▼] to move up and down
- ❖ Press [◀]/[▶] to view the other pages.
- ❖ Press [Delete] in page 2 to delete the station record.



❖ Press [Detail] to view the station record.

❖ Press [OK] to display all the sideshots under this station.



❖ Press [Delete] to delete the SS record.

❖ Press [Edit] to edit the SS record.

❖ Press [Find] to search for the SS record.

11.4 POINT NAME LIST AND CODE LIST

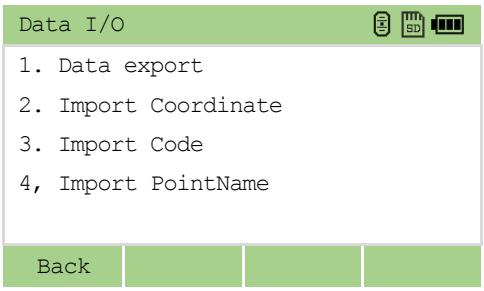
The instrument stores two list files: a list of PT names and a list of CD names. The structure and functionality of these files is the same， i.e. Delete, Edit, Add points/codes and layer.

The PT name list is useful if you have to handle more than one pattern of point names. For example, you may need to use points named PT=1, 2, 3 as well as PT=C1, C2, C3

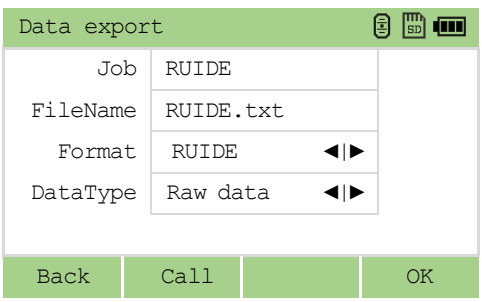
The code list is a list of feature codes. You can use it to store your own codes.

11.5 DATA EXPORT AND IMPORT

Insert the SD card, users can export the data to SD card or import the data in the SD card to total station



❖ Press [6] to enter the data import/export screen.



❖ Choose the job to be exported, and the data format, then press [OK] to export.

Job: The job to be exported

FileName: The file name in SD card

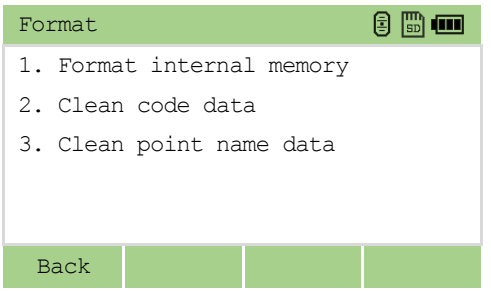
Format: includes RUIDE, SDR33 and TOPCON format

DataType: includes Raw data and Coordinates data.

11.6 MEMORY AND FORMAT

Users can view the memory status of the total station.

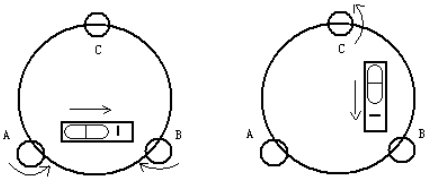
Format function includes formatting the total station memory, formatting the point name and code data.



12. CHECK AND ADJUSTMENT

This instrument has undergone a strict process of checking and adjustment, which ensures that it meets quality requirement. However, after long periods of transport or under a changing environment, there may be some influences on the internal structure. Therefore, before the instrument is used for the first time, or before precise surveys, user should launch check and adjustment introduced in this chapter to ensure the precision of the job.

12.1 PLATE VIAL



Check

Please refer to Chapter 3.2 “Leveling by Using Plate Vial”

Adjust

1. Adjust leveling screws, make plate bubble centered;
2. Rotate the instrument 180°; watch the offset of plate level;
3. Tweak adjustment screws (on the right of the plate vial) with the correction pin to make plate bubble to move half of the offset back;
4. Rotate the instrument 180°, check adjustment result;
5. Repeat the steps above until the plate level is centered in all directions.

12.2 CIRCULAR VIAL

Check

No adjustment is required if the bubble of circular vial is in the center after checking and adjustment of the plate vial.

Adjust

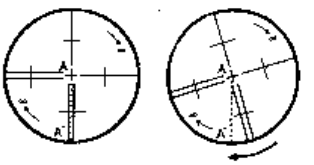
1. Adjust circular bubble after plate bubble is centered.
2.Loosen the screw (one or two) opposite with bubble deflective direction;
3.Tighten the screw on the direction accordant deflective until circular bubble is centered;
4.Adjust three adjustment screws for several times until circular bubble is centered;
5.The force power fixing three adjustment screws must be consistent when circular level is centered at last.

12.3 INCLINATION OF RETICLE

Check

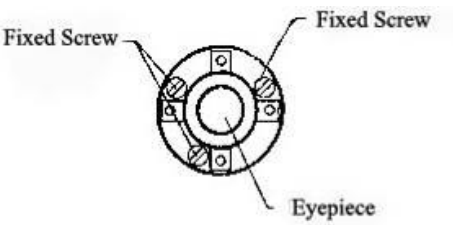
1. Sight object A through the telescope and lock the horizontal and vertical clamp screws.
2. Move object A to the edge of the field of view with the vertical tangent screw (point A').
3. Adjustment is not necessary if object A moves along the vertical line of the reticle and point A' still in the vertical line.

As illustrated， A'offsets from the center to the cross hair tilts, then need to adjust the reticle.



Adjust

1. If the object A does not move along with the vertical line, firstly remove the eyepiece cover to expose the three or four reticle adjusting screws.
2. Loosen all the reticle adjusting screws uniformly with an adjusting pin. Rotate the reticle around the sight line and align the vertical line of the reticle with pointA'.
3. Tighten the reticle adjusting screws uniformly. Repeat the inspection and adjustment to see if the adjustment is correct.
4. Replace the eyepiece cover.



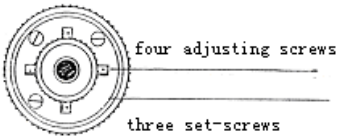
12.4 PERPENDICULARITY BETWEEN LINE OF SIGHT AND HORIZONTAL AXIS (2C)

Check

1. Set object A at about 100 meters away the same height as the instrument, and make the vertical angle with ±3°. Then level and center the instrument and turn on the power

2. Sight object A in FaceI and read the horizontal angle value. (e.g.: Horizontal angle L=10°13'10").
3. Loosen the vertical and horizontal clamp screws and rotate the telescope. Sight object A in Face Ⅱ and read the horizontal angle value. (e.g.: Horizontal angle R= 190°13'40").
4. 2C=L-R±180°=-30"≥±20", adjustment is necessary.

Adjust



1. Use the tangent screw to adjust the horizontal angle to the right reading which has been eliminated C, R+C=190°13'40"-15"=190°13'25"
2. Take off the cover of the reticle between the eyepiece and focusing screw. Adjust the left and right adjusting screws by loosening one and tightening the other. Move the reticle to sight object A exactly.
3. Repeat inspection and adjustment until | 2C | ＜20".
4. Replace the cover of the reticle.

Note: After adjustment, need to check the photoelectricity coaxiality.

12.5 VERTICAL INDEX DIFFERENCE COMPENSATION

Check

1. Mount and level the instrument and make the telescope parallel with the line connecting the center of the instrument to any one of the screws. Lock the horizontal clamp screw.
2. After turning on the power, zero the vertical index. Lock the vertical clamp screw and the instrument should display the vertical angle value.
3. Rotate the vertical clamp screw slowly in either direction about 10mm in circumference, and the error message "b" will appear. The vertical axis inclination has exceeded 3 ´ at this time and exceeds the designated compensation range.
4. Rotate the above screw to its original position, and the instrument display screen will show the vertical angle again, meaning that the vertical index difference compensation function is working.

Adjust

If the compensation function is not working, send the instrument back to the factory for repair.

12.6 ADJUSTMENT OF VERTICAL INDEX DIFFERENCE (I ANGLE) & SETTING VERTICAL INDEX O

Inspect the item after finishing the inspection and adjustment of items in 12.3 and 12.5.

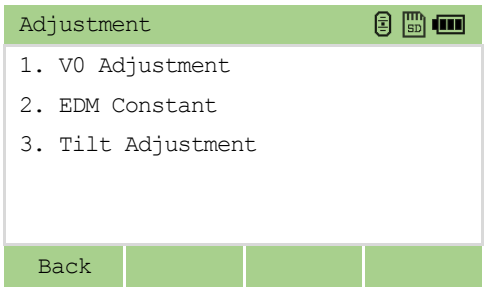
Check

1. Power on after leveling the instrument. Collimate object A in Face I and read the Vertical angle value L.
2. Rotate the telescope. Sight object B in Face Ⅱ and read the Vertical angle value R.
3. If the vertical angle is 0° in zenith，i=(L+R-360°)/2

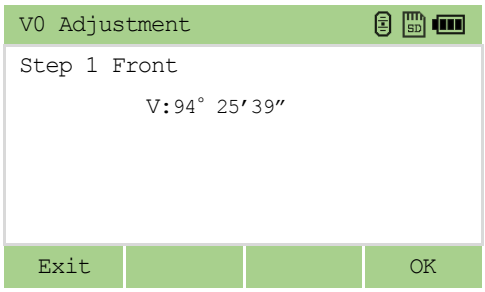
If the vertical angle is 0° in horizon. i= (L+R-180°)/2 or (L+R-540°)/2.

4. If ｜i｜ ≥10" should set the Vertical Angle 0 Datum again.

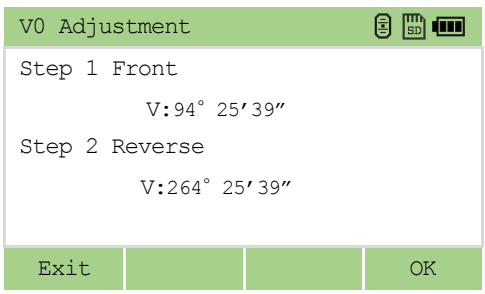
Adjust



- Press [Menu]
- Press [3] to enter the adjustment screen
- Press [1] to enter the V0 adjustment screen



- In Face I, precisely collimate target and press [OK].



- Rotate the telescope, and collimate the same target precisely in Face II. Press [OK].
- The screen displays the adjusting value, press [OK] to finish the setting.

Note:

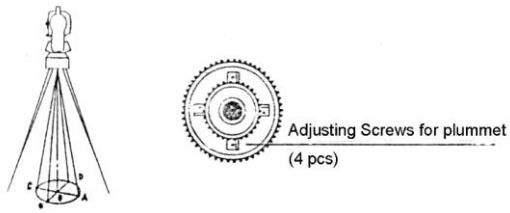
1. Repeat the checking steps to measure the Index Difference (i angle). If the Index Difference cannot meet the requirement, user should check whether the three steps of the adjustment and the collimation are right. Then set again according to the requirement.
2. If Index Difference still not meets the requirement after the repeated operation, the instrument should be returned to factory for inspection and repair.

12.7 OPTICAL PLUMMET

Check

1. Set the instrument on the tripod and place a piece of white paper with two crisscross lines on it right below the instrument.
2. Adjust the focus of the optical plummet and move the paper so that the intersection point of the lines on the paper comes to the center of the field of view.
3. Adjust the leveling screws so that the center mark of the optical plummet coincides with the intersection point of the cross on the paper.
4. Rotate the instrument around the vertical axis, and observe whether the center mark position coincides with the intersection point of the cross at every 90°.
5. If the center mark always coincides with intersection point, no adjustment is necessary.

Otherwise, the following adjustment is required.



Adjust

1. Take off the protective cover between the optical plummet eyepiece and focusing knob.
2. Fix the paper. Rotate the instrument and mark the point of the center of optical plummet which falls on the paper at every 90°. As illustrated: Point A, B, C, and D.
3. Draw lines that attach AC and BD and mark the intersection point of the two lines as O.
4. Adjust the four adjusting screws of the optical plummet with an adjusting pin until the center mark coincides with Point O.
5. Repeat the inspection and adjusting steps to make the instrument meets the requirements.
6. Replace the protective cover.

12.8 INSTRUMENT CONSTANT (K)

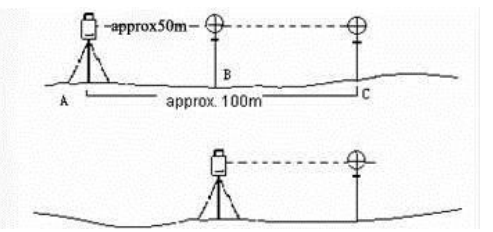
Instrument constant has been checked up and adjusted in the factory, K=0. It seldom changes and it is suggested to check one or two times every year. The inspection should be made on the base line, also can be made according to the following method.

Check

1. Mount and level the instrument on Point A at a plain field. Use the vertical hair to mark Point B and Point C with the distance of 50m on the same line, and set the reflector accurately.
2. After setting temperature and air pressure, measure the horizontal distance of AB and AC accurately.
3. Set the instrument on Point B and center it accurately, measure the Horizontal Distance of BC accurately.
4. Then the Instrument Constant can be obtained:

$$K = AC - (AB + BC)$$

K should be near to 0, If $|K| > 5mm$, the instrument should be strictly inspected in the standard baseline site, and adjusted according to the inspection value.



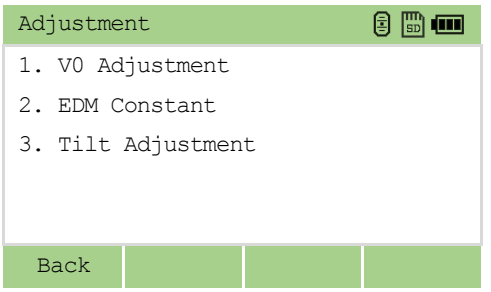
Adjust

If a strict inspection proves that the Instrument Constant K has changed and is not close to 0. If the operator wants to adjust, should set Stadia Constant according to the Constant K

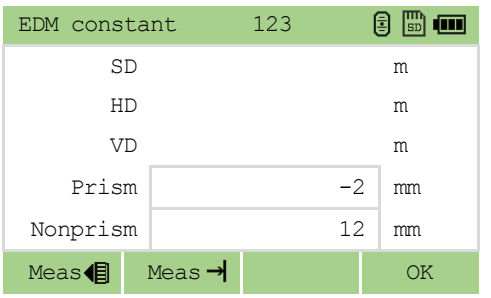
●Set the orientation via the Vertical Hair to maintain Point A, B, C on the same line precisely. There must be a fixed and clear centering mark on the ground of Point B

●Whether the prism center of Point B coincides with the Instrument Center is a significant step to inspect the accuracy. So on Point B the tripod or compatible tribrach should be used. It will decrease the difference.

Input Instrument Constant:



❖ Press [2] to enter the constant setting screen.

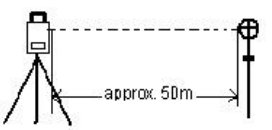


❖ Input the constant, and press [OK]

Prism: Constant for measuring at prism mode

Nonprism: Constant for measuring at non-prism mode

12.9 PARALLEL BETWEEN LINE OF SIGHT AND EMITTING PHOTOELECTRIC AXIS



Check

1. Set the reflector 50m away from the instrument.
2. Collimate the center of the reflector prism with reticle.
3. Switch on the instrument, and enter to Distance Measurement Mode. Press [DIST] (or [All]) to measure. Rotate the Horizontal Tangent Screw and Vertical Tangent Screw to launch electric collimation and make the light path of EDM unblocked. In the bright zone find the center of emitting photoelectric axis.
4. Check the center of reticle to coincide with the center of emitting photoelectric axis. If so, the instrument is proved eligible.

Adjust

If the center of reticle deviates from the center of emitting photoelectric axis, user should send the instrument to professional repair department.

12.10 TRIBRACH LEVELING SCREW

If the leveling screw appears flexible, adjust the two adjusting screw in the leveling screw to tighten the screw appropriately.

12.11 RELATED PARTS FOR REFLECTOR

1. The Tribrach and Adapter for Reflector

The plate vial and optical plummet in the adapter and tribrach should be checked. Refer to Chapter 10.1 and 10.8. for more information.

2. Perpendicularity of the prism pole

As illustrated in Chapter 10.8, mark '+' on Point C, place the tine of the prism pole on the Point C and do not move during the inspection. Place the two feet tine of Bipod on the cross lines of Point E and F. Adjust the two legs "e' and "f" to make the bubble on the prism pole centered.

Set and level the instrument on Point A near the cross. Sight the tine of Point C with the center of reticle, and fix the Horizontal Clamp Screw. Rotate the telescope upward to make D near the horizontal hair. Flex the prism pole Leg "e" to make the D in the center of reticle. Then both Point C and D are on the central line of reticle.

Set the instrument on Point B to another cross lines. With the same way to flex the Leg "f" to make Point C and D on the central line of reticle.

Through the adjustment of the instrument on Point A and B, prism pole has been perpendicular. If the bubble offsets from the center, adjust the three screws under circular vial to make the bubble centered.

Check and adjust again until the bubble is in the center of the vial from both directions of the prism pole.

13. SPECIFICATION

	RCS
TELESCOPE	
Length	152mm
Objective Lens Diameter	Telescope: 45mm Distance Meter: 47mm
Magnification	30x
Image	Erect
Field of View	1°30'
Resolving Power	3"
Mini. Focus	1.5m
DISTANCE MEASUREMENT	
Single Prism	5000m
Non-Prism	400m
Accuracy - Prims Mode	±(2mm+2ppm x D)m.s.e.
Non-Prism	±(3mm+2ppm x D)m.s.e.
Measuring Time	Fine: 0.5s, Normal: 0.3s
Meteorologic Correction	Auto Sensing
Prism Constant	Manual Input
ANGLE MEASUREMENT	
Method	Absolute Encoding
Detecting System	H: 2 sides V: 2sides
Min. Reading	1"
Accuracy	2"
Diameter of Circle	79mm
Vertical Angle 0°	Zenith: 0°/Horizontal: 0°
Unit	360°/400gon/6400mil
DISPLAY	
Display Unit	Graphic LCD 400*240 dots with Backlight
No. of Unit	2 sides
Keyboard	Alphanumeric Keys
TILT CORRECTION	
Tilt Sensor	Dual Axis
Method	Liquid Electric
Range	±4'
Accuracy	1"
LEVEL SENSITIVITY	
Plate Level	30"/2mm
Circular Level	8'/2mm
OPTICAL PLUMMET (OPTIONAL– INTERNAL LASER PLUMMET)	
Image	Erect
Magnification	3X

Focusing Range	0.3m ~ ∞
Field of View	5°
DATA STORAGE & INTERFACE	
Internal Memory	2Mb
Data Interface	R232/SD Card/Mini-USB
GENERAL	
Laser Class - EDM	Class IIIA
-Laser Plummet	Class II
Working Temperature	-20°C ~ +50°C
Battery Type	Rechargeable Li-on Battery
Battery Voltage	DC 7.4V
Working Time	16h

14. ERROR CODE LIST

ERROR CODE	DESCRIPTION	SOLUTION
System Error 001	Error in opening the system parameter file	Format. If format is invalidation, the instrument should be sent for repair.
System Error 002	Error in opening files	
System Error 003	Error in initializing files	
System Error 004	Error in writing files	
System Error 005	Error in reading files	
System Error 006	Error in deleting files	
System Error 007	Error in hardware parameter	
System Error 034	Upper vertical CCD error	1. Change a good angle board to check whether it works. 2. If no, change this CCD.
System Error 035	Shorter horizontal CCD error	
System Error 036	Longer horizontal CCD error	
System Error 037	Lower vertical CCD error	
ERROR36	Problem with internal light path signal	If the signal is 0, change the laser emitter or fiber.
ERROR32	Problem with dimmer motor system	Change or reinstall the dimmer motor

【APPENDIX-A】DESIGN ROAD LINE DATA

1. RAW DATA

The format of data transmitted from total station to the PC is as follows:

RUIDE FORMAT: Take RTS item as example

Data Transferred to PC	Explanation
CO,Ruide Raw data	The type of transmitted data
CO,RTS	File name
CO,Description:	JOB description
CO,Client:	
CO,Comments:	
CO,Downloaded 2007-03-02 22:40:59	Download date and time
CO,Software: Pre-install version:07.03.02	Software version number
CO,Instrument: Ruide RCS 115101	Serial number of instrument
CO,Dist Units: Metres	Distance unit
CO,Angle Units: DDDMMSS	Angle unit
CO,Zero azimuth: North	AZ Zero azimuth
CO,VA: Zenith	VA Zero azimuth
CO,Coord Order: NEZ	Coordinate order
CO,HA Raw data: HA zero to BS	HA
CO,Projection correction: OFF	Projection correction
CO,C&R correction: ON	C&R correction
CO,Tilt Correction: OFF	Tilt correction
CO,RTS <JOB> Created 2007-03-02 22:37:25	JOB creating time
MP,1,,10.000,10.000,1.000,VM MP,5,,50.000,50.000,5.000,MP	Input coordinate manually，the sequence is: pointID，N/E，E/N，Z，code
CO,Temp:20.0 C Press:1013.2 hPa Prism:-30mm 2007.03.02 22:38:26	Temp, Press, Prism constant, Date, Time
ST,1,,5,,1.600,45.0000,0.0000	Station data, the sequence is: Station pointID, Backsight pointID, height of instrument, azimuth(AZ), horizontal angle (HA)
F1,5,1.800,1.999,176.5958,99.2715, 23:26:28	Result of backsight point F1 orientation, the sequence is: pointID, target height, slope distance, horizontal angle, vertical angle, time
SS,2,1.800,1.088,359.5959,62.4302, 22:38:45,MA	Target point measurement data, the sequence is: PointID, target height, slope distance, HA, VA, code

MP,99,,20.000,3.000,6.000,	
CO,Pt:100 SO deltas N: E: Z:-3.131	
SO,,,1.800,1.089,5.0432,84.5528, 22:40:28,	Data of stake-out, the sequence is: , , , target height, slope distance, HA, VA, time

2. COORDINATES DATA

The format of uploaded/downloaded coordinate data is determined by user's setting. For example: the coordinate format is set as:

PointID, E，N，Z，Code
101,994.890,1000.964,100.113,RUIDE
102,993.936,1007.799,100.800,STN
103,998.515,1009.639,100.426,STN
104,1002.068,1002.568,100.342,STN
1001,1004.729,997.649,100.1153,PT
1002,1003.702,990.838,100.799,PT
1003,7911.990,990.358,100.403,PT
1004,997.311,998.236,100.354,PT

3. CODE LIST

The code list which is put in the code store, should be guaranteed that every line has one code which includes serial number and code, and every line is ended by carriage returns. The format of code list is:

Serial number (quick code number), code

When there is no definition of code, the code is default as the content of serial number. In quick code function, one can transfer code by entering serial number.

For example：

1，VEG
2，BDY
3，CL
4，ROAD
5，ROAD
6，PATH
7，DRAIN
8，CONTROL
9，DRAIN
10，UTILITY

4. HORIZONTAL LINE

The horizontal line is transmitted from computer to instrument through line element, including initial definition. It should be included in initial definition the number of the start stake and coordinate of this point. The line elements include point, straight, arc, and transition curve.

Each recorded format is:

(KEYWORD) nnn, nnn [, nnn]

Here：

START POINT stake number, E, N
STRAIGHT azimuth, distance
ARC radius, arc length
SPIRAL radius, length
PT E，N[，A1，A2]
(A1, A2: LENGTH)

For example1：
START 1000.000, 1050.000, 1100.000
STRAIGHT 25.0000, 48.420
SPIRAL 20.000, 20.000
ARC 20.000, 23.141
SPIRAL 20.000, 20.000
STRAIGHT 148.300, 54.679

Example 2：
START 1000.000, 1050.000, 1100.000
PT 1750.000, 1300.000, 100.000, 80.800
PT 1400.000, 1750.000, 200.000
PT 1800.000, 2000.000

5. VERTICAL CURVE

Input vertical curve data from computer through typical point and stake number, the vertical curve data should include the height, curve length, and the curve length of start point and terminal point is zero.
Data format is:
Stake number, height, length

For example：
1000.000, 50.000, 0.000
1300.000, 70.000, 300.000
1800.000, 70.000, 300.000
2300.000, 90.000, 0.000

【APPENDIX-B】CALCULATE ROAD ALIGNMENT

The road alignment stake-out program can stake out the alignment elements including straight, arc and transition curve.

NOTE:

1) Road alignment data can be uploaded from computer or can be entered manually.
2) Road alignment data is managed by chainage.

1. ROAD ALIGNMENT ELEMENTS

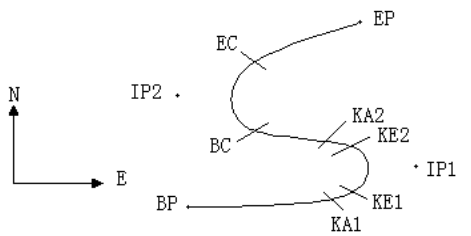
There are two ways to enter the alignment elements:

1) Download from PC.
2) Manually entered on the RCS.

How to enter the alignment data is explained below:

Alignment Element	Parameter
Straight	Bearing, Distance
Transition Curve	Radius, Length of Transition Curve
Arc	Radius, Length of Arc
PT	N, E, radius, A1, A2

Note: When downloading from computer or selecting PT option, you do not have to calculate the Parameter.



Pt	North (N)	East (E)	Radius (R)	Transition curve A1	Transition curve A2
BP	1100.000	1050.000			
IP1	1300.000	1750.000	100.000	80.000	80.000
IP2	1750.000	1400.000	200.000	0.000	0.000
EP	2000.000	1800.000			

Example:

To enter the following data select DEF AL of ROADS in PROG menu:

Stake number 0
N 1100.000
E 1050.000

Press [ENT] and then press [F4] (PT), Enter the following data:

N 1300.000
E 1750.000

R	100.000
A1	80.000
A2	80.000

Enter the following data in the above way:

N	1750.000
E	1400.000
R	200.000
A1	0.000
A2	0.000

N	2000.000
E	1800.000
R	0.000
A1	0.000
A2	0.000

The format of the data above transmitted to computer is as follows:

START 0.000，1050.000，1100.000 CRLF

PT 1750.000，1300.000，100.000，80.000，80.000 CRLF

PT 1400.000，1750.000，200.000，0.000，0.000 CRLF

PT 1800.000，1800.000，2000.000 CRLF

2. CALCULATION ROAD ALIGNMENT ELEMENTS

(1) Calculation of the length of transition curve

$$L_{1.2} = \frac{A_{1.2}^2}{R}$$

$L_{1.2}$: Length of clothoid

$A_{1.2}$: Parameter of clothoid

R : Radius

$$L_1 = \frac{A_1^2}{R} = \frac{80^2}{100} = 64\ \text{m} \qquad L_2 = \frac{A_2^2}{R} = \frac{80^2}{100} = 64\ \text{m}$$

(2) Calculation of Deflection Angle

$$\tau = \frac{L^2}{2A^2}$$

$$\tau_1 = \frac{64^2}{2 \cdot 80^2} = 0.32\ \text{rad} \quad \Rightarrow \quad \text{deg} \quad \Rightarrow \quad 0.32 \frac{180}{\pi} = 18°20'06''$$

$$\therefore \quad \tau_1 = -\tau_2$$

(3) Calculation of transition coordinates

$$N = A \cdot \sqrt{2\tau}\ (1 - \frac{\tau^2}{10} + \frac{\tau^4}{216} - \frac{\tau^6}{9360} \ldots.)$$

$$E = A \cdot \sqrt{2\tau}\ (\frac{\tau}{3} - \frac{\tau^3}{42} + \frac{\tau^5}{1320} - \frac{\tau^7}{7560} \ldots.)$$

$$N = 80 \cdot \sqrt{2 \cdot 0.32}\ (1 - \frac{(0.32)^2}{10} + \frac{(0.32)^4}{216} - \frac{(0.32)^6}{9360} \ldots.)$$

$$= 64(1 - \frac{0.01024}{10} + \frac{0.01048576}{216} - \frac{0.00107341824}{9360})$$

$$= 64(1 - 0.01024 + 0.00004855 - 0.00000011)$$

$$= 64 * 0.98981$$

$$= 63.348$$

Similarly, the value of E is:

$$E = 80 \cdot \sqrt{2 \cdot 0.32}\ (\frac{0.32}{3} - \frac{(0.32)^3}{42} + \frac{(0.32)^5}{1320} - \frac{(0.32)^7}{7560} \ldots.)$$

$$= 64(0.10666667 - 0.00078019 + 0.0000025 - 0)$$

$$= 6.777$$

This example is symmetry spiral transition. N1=N2，E1=E2

(4) Calculation of shift value ΔR

$$\Delta R = E - R(1 - \cos\tau)$$

$$\Delta R = 6.777 - 100(1 - \cos 18°20'06'')$$

$$= 1.700$$

Symmetry spiral transition $\Delta R_1 = \Delta R_2$

(5) Calculation of Spiral Transition coordinates

$N_m = N - R\sin\tau$ =63.348-100sin18°20'06"=31.891

Symmetry spiral transition $N_{m1} = N_{m2}$

(6) Calculation of Tangent Distance

$$D_1 = R\tan(\frac{LA}{2}) + \Delta R_2 \cos ec(LA) - \Delta R_1 \cot(LA) + N_{m1}$$

$LA = +111°55'47''$， $\cos ec = \frac{1}{\sin}$ ， $\cot = \frac{1}{\tan}$

$$D_1 = 100 * \tan(111°55'47"/2) + 1.7(1/\sin 111°55'47") - 1.7(1/\tan 111°55'47") + 31.891$$
$$= 148.06015 + 1.8326 + 0.6844 + 31.891$$
$$= 182.468$$

$$D_1 = D_2$$

(7) Calculation of the coordinate KA1

$$N_{KA1} = N_{IP1} - D_1 \cdot \cos\alpha_1$$

$$E_{KA1} = E_{IP1} - D_1 \cdot \sin\alpha_1$$

Bearing from BP to IP1 $\Rightarrow$ $\alpha_1 = 74°03'16.6"$

N_{KA1} = 1300 –182.468 * cos 74°03'16.6"=1249.872 m

E_{KA1} = 1750 –182.468 * sin 74°03'16.6"=1574.553 m

(8) Calculation of Arc Length

$$L = R(LA - \tau_1 + \tau_2)$$

=*R*(111°55'47"-2 * 18°20'06")

$$=100(75°15'35" \frac{\pi}{180^\circ})$$

=131.353 m

(9) Calculation of the coordinate KA2

$$N_{KA2} = N_{IP1} - D_2 \cdot \cos\alpha_2$$

$$E_{KA2} = E_{IP1} - D_2 \cdot \sin\alpha_2$$

Bearing from IP1 to IP2 $\Rightarrow$ $\alpha_2 = 322°07'30.1"$

N_{KA2} = 1300 –(-182.468) * cos 322°07'30.1"= 1444.032 m

E_{KA2} = 1750 –(-182.468) * sin 322°07'30.1"= 1637.976 m

(10) Calculation of coordinates BC， EC which is ARC (IP1,IP2,EP)

Arc length $CL = R \cdot IA$

IA= 95°52'11"

Then *CL*=200 * 95°52'11"* $\frac{\pi}{180^{\circ}}$ =334.648 m

Tangent length $TL = R \cdot \tan(\frac{IA}{2}) = 200 * \tan(95°52'11"/2) = 221.615$ m

Each coordinates are computed:

$$N_{BC} = N_{IP2} - TL \cdot \cos\alpha_2$$

$$E_{BC} = E_{IP2} - TL \cdot \sin\alpha_2$$

$$N_{EC} = N_{IP2} - TL \cdot \cos\alpha_3$$

$$E_{EC} = E_{IP2} - TL \cdot \sin\alpha_3$$

Here:

α_2 (Bearing from IP1 to IP2) = 322°07'30.1"

α_3 (Bearing from IP2 to EP) = 57°59'40.6"

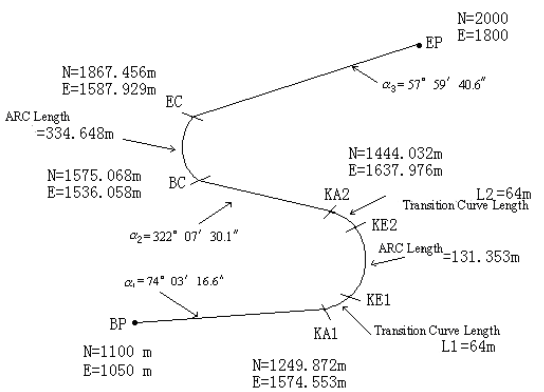
N_{BC} = 1750 - 221.615 * cos322°07'30.1" =1575.068 m

E_{BC} = 1400 - 221.615 * sin322°07'30.1" =1536.058 m

N_{EC} = 1750 –(-221.615) * cos57°59'40.6"=1867.456 m

E_{EC} = 1400 –(-221.615) * sin57°59'40.6"=1587.929 m

The calculated results display as below:



The coordinates and the distance are calculated as below ：

Compute the length of straight line

Straight line

BP·KA1= $\sqrt{(1249.872-1100.000)^2+(1574.553-1050)^2}=545.543$ m

straight line KA2·BC

$=\sqrt{(1575.068-1444.032)^2+(1536.058-1637.976)^2}=166.005$ m

straight line

EC·EP = $\sqrt{(2000-1867.456)^2+(1800-1587.929)^2}=250.084$ m

Start point coordinate (BP)

N 1100.000 m

E 1050.000 m

Straight line (between BP and KA1)

Bearing 74°03'16.6"

Distance 545.543 m

Transition clothoid (between KA1 and KE1)

Radius -100 m ("-"sign is turn left curve toward the end point)

Length 64 m

ARC (between KE1 and KE2)

Radius -100 m ("-" sign is turn left curve toward the end point)

Length 131.354 m

Transition (Between KE2 and KA2)

Radius -100 m ("-" sign is turn left curve toward the end point)

Length 64 m

Straight line (between KA2 and BC)

Bearing 322°07'30.1"

Distance 166.004 m

Arc (between BC and EC)

Radius 200 (without sign is turn right curve toward the end point)

Length 334.648 m

Straight line (between EC and EP)

Bearing 57°59'40.6"

Distance 250.084 m