Hi-Target

HTS-220 Series Total Station Manual

Preface

Thanks a lot for purchasing our HTS-220 series total station !

This manual is your good helper , please read it carefully before using the instrument and keep it safely.

Product affirm :

In order to get the best service from our company, please feedback your instruments' version including number, purchasing date and your suggestions to us after the purchasing of the product.

We will attach great importance to any piece of advice from you,

We will be very concerned about any detail of our products,

We will make great efforts to provide better quality.

Notice:Our company has the right to upgrade and improve the technical parameters of instruments, which may not be announced in advance .The pictures in the manual are only for reference and kind prevail.

◆ **Features：**

Rich Feature: the company's HTS-220 Series Total Station is equipped with a wealth of measurement applications including data storage, parameter settings and other functions for a

1、Absolute coded dial

With absolute digital dial, instruments can be measured directly when it powers on. The measured azimuth angle result will not be lost even when the instrument shut off.

2、powerful memory management

Large-capacity EMS memory , easy to manage the file system, serving to add, delete and transfer data

3、No prism ranging

The series Total Station HTS-220R with laser ranging No-Prism is capable of surveying for long distance, fast and precise measurements with various materials and different colors of objects (such as building walls, poles, wires, cliff wall, mountain, mud , stakes, etc.). For those which are hard or impossible to be reached, the application of Prism features can be a good measurement tasks.

4、special measurement procedure

The series total station is equipped with the basic surveying function as well as special measurement procedures, undertaking REM, offset measuring, stakeout, Resection, area measurement and calculation, road design etc. to meet the needs of professional measurement.

5、eyepiece changeable

The instruments' eyepiece can be changed, and equipped with a diagonal eyepiece, serving to observe zenith and high buildings

6、An optional laster plumb

The site features is easy to instruct and set up stations

NOTE：

Avoid look directly into the sun with the eyepiece when measuring. Recommended to use solar filter to reduce the impact

1、 Avoid extreme temperature when storing equipment and sudden changes in temperature when using the instrument.

2、 The instrument should be loaded in box placed in dry and ventilated place and prevented from shock, dust and moisture when it is not in use.

3、 In order to get good accuracy, you should leave the instrument in the box if the instrument temperature has large difference between working and storing you may unpack the box and employ the instrument until the instrument reaches the temperature at the working field.

4、 If the instrument is not used for a long time, the battery should be unloaded and stored separately and charged once a month to prolong battery life.

5、 The instrument should be installed in box when it is transported. Extrusion, collision and violent vibration need to be carefully avoided during the transport process . The soft mat May be placed around the box on the long-distance transportation.

6、 It is better to use high quality wooden foot stool to make sure the stability of measurement and improve its accuracy ,when setting up the instrument.

7、 Only use absorbent cotton or lens paper to wipe the instrument gently If exposed optical device need to be cleaned.

8、 Use flannelette or hairbrush to clean the instrument after using. Do not electrify and start up after the device got wet in a rain. using clean soft cloth to wipe it dry and put it at ventilated place for a period of time to make the instrument fully dry before using or packing.

9、 Inspect instrument carefully and comprehensively to ensure its indicators, function, power supply, initial setting and correction parameters meet the requirements before operating.

10、 If the function is abnormal, non-professional maintenance persons are not allowed to dismantle the device without authorization in case of any unnecessary damage.

11、 the emitted light of the no-prism total station HTS-220R is laser, do not direct to eyes.

● Security Guide

Pay attention to the following safety matters when you use the laser ranging free of prism.

Warning:

Total station fit out laser level 3R/ⅢIa which is recognized by the loge, which is above:

the vertical locking screw saying: "3A laser product ".This product belongs to Class 3R level laser .According to the following standards IEC 60825-1: 2001Class 3R/ⅢIa laser product can reach five times of emission limits of the Class 2/Ⅱ in the wavelength between 400nm-700nm.

Warning :

Continuous stare into the laser beam is harmful.

Prevention:

Do not stare at laser beam Or point to others The reflected beams is the effective signal of the instrument. It's safety to observe by eyepice.

Warning:

When the laser beam is irradiated reflected by prisms, plane mirrors, surface of metal and windows, it's dangerous to look straight into the reflected beams.

Prevention :

Don't stare at the reflected beams. When the laser is switched on (distance mode), do not obstruct optical path or stand near the prism. Target at a prism with total station telescope only.

Warning :

It's dangerous to use the Class 3R laser device inproperly.

Prevention:

To avoid injury, each user must carry safety prevention measures and operate the instrument within the safety scope according to standard IEC60825-1: 2001).

The following is the explanation of the main part of the standard: Class 3R level raser products are used outdoors and in construction (surveying with No-Prism).

A: Only trained and certified personnels are allowed to install, adjust and operate the laser equipment.

B: set up appropriate laser warning sign within the operating field

C: To prevent anyone from looking into the laser beam use an optical instrument to observe.
D: in order to prevent laser damage to persons, the laser beams should be blocked at the end of the working route, and also should be cut off when people work in the restricted area (harmful distance) Where laser beams crossing are harmful.
E: the route of the laser beam must set to be higher or lower than the human eye.
F: properly store and safekeep the laser products when they it is not used, unauthenticated personals are not allowed to use it.
G: Do not point laser beams at surfaces such as plane mirror, metal surface, window, especially the surface of plane mirror and concave mirror.
Harmful Distance is the maximum distance from the starting point of the laser beams to where people are right safe.The built-in harmful idstance of the Class 3R/ⅠⅠⅠa laser is 1000m(3300ft) and the laser intensity will reduce to that of Class 1 products (which does not harm eyes) if people is out of this range.

Contents

1、The functions of the instrument

Total station is a survey instrument for measuring geodetic azimuth and target distance and for calculating the coordinates of target points automatically. Total station plays an important role in the economic construction and national defense construction. It's widely applied to mineral reconnaissance and excavation, construction of railways, highways, Bridges, water conservancy and urban planning. Military engineering construction such as harbor, fortress, airport and base must base on accurate geodetic surveying in the national defense construction. In recent years, electronic total station has become a useful tool in the accurate positioning in large precision industry, shipbuilding and aviation industry.

HTS-220 angel measurement use absolute encoding digital angle measurement system, distance measuring system use integrated circuit control board range. Complete measurement, calculation, display, storage by microcomputer technology. It can simultaneously display horizontal angle ,vertical angle, slope distance, horizontal distance and geodetic difference. It can be performed to a variety of patterns measurement such as angel and slope.

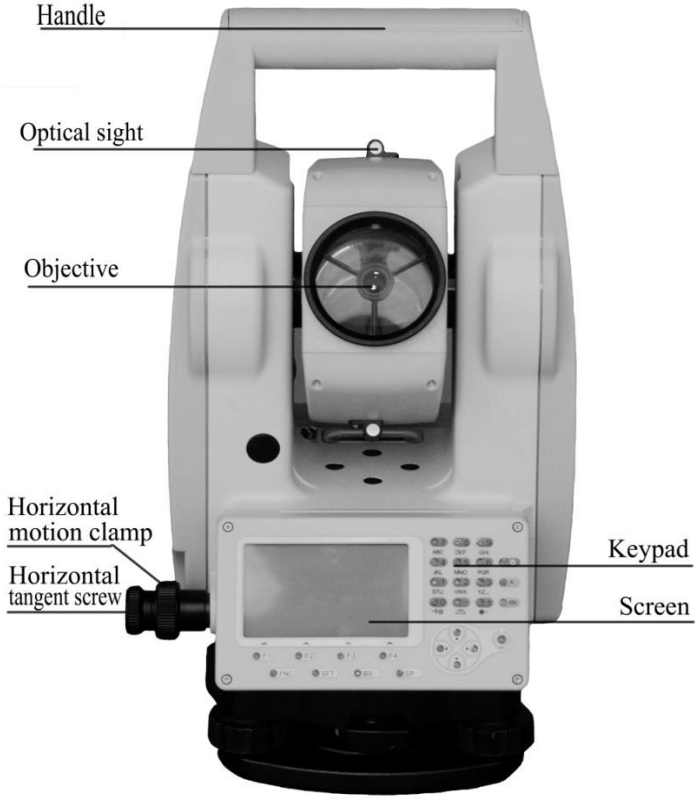
Ranging in reflector less is designed secificly to building engineers, especially or all kinds of construction field. It can be widely used in measuring three-dimensional coordinates of a building and elevation, in surveying section, triangle control, topographic, cadastral and property and in determining verticality and positioning line.

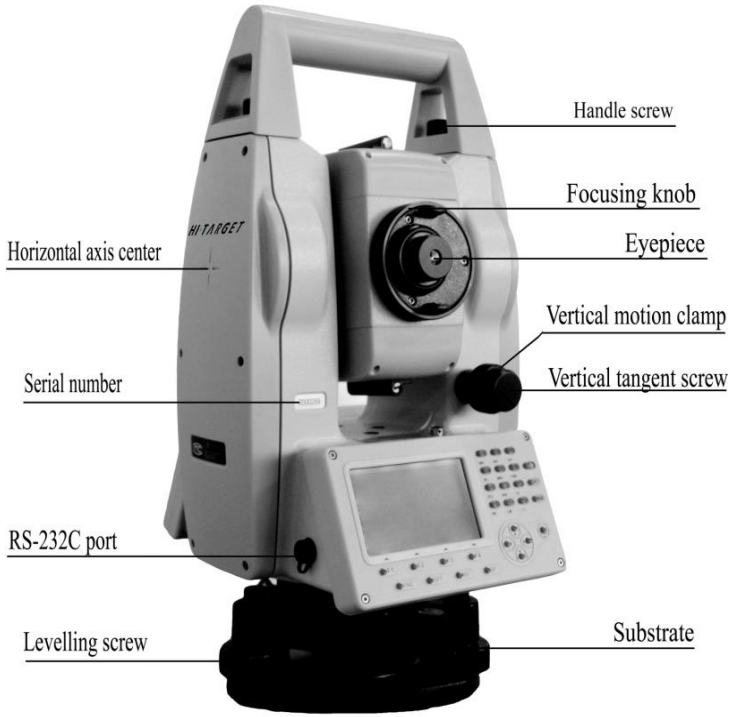
In this series, **HTS-220R** is reflector less and **HTS-220** is not.

This series of instruments can link to handbook, communication format support the Topcon GTS-6. Choose Bluetooth or COM based on specific configuration of the instruments..

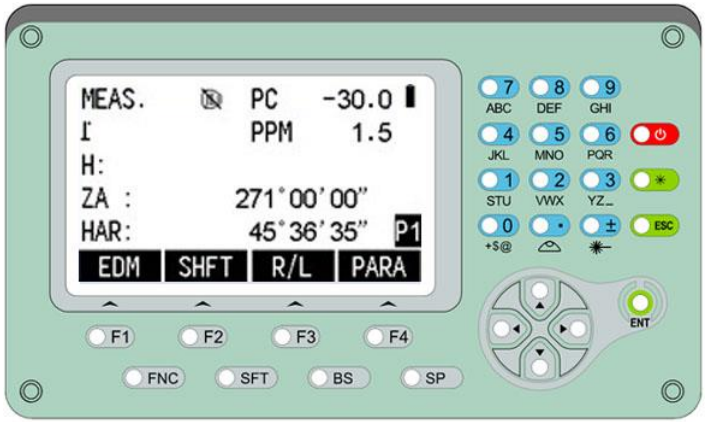
2、Name and function of each part

2.1 Name




Handle screw
Focusing knob
Eyepiece
Horizontal axis center
Vertical motion clamp
Vertical tangent screw
Serial number
RS-232C port
Levelling screw
Substrate
HI TARGET

2.2 Keys Functions and information display



Keys	Function
⏻	Power on / Power off
☀	Turn on or turn off the screen and key backlight
ESC	Cancel previous operation or return to the "Status Screen"
ENT	Confirm entry, store data or move the cursor to the next line
FNC	1、Change displayed-page to change softkeys references .the function of entered target height in lofting, opposite side and remote height.
SFT	Switch between alphabetic and numeric input
BS	Delete a character on the left
SP	1、Input a space 2、trigger the function of modifying ranging parameters .
▲	Move cursor up
▼	Move cursor down
◀	Move cursor to the left
▶	Move cursor to the right
1~9 (with	Input number or choose menu

shift mode off)	
. (with shift mode off)	1、 Input decimal point in the digital input function. 2、 input special characters：\ # Enter the automatic compensation screen without input function
+/－(with shift mode off)	1、 Change symbol 2、 Input * / + in the character input 3、 Enter laser align and laser centering screen without input function.
1~9(with shift mode on)	Alphabet input
.(with shift mode on)	Start up the circular level display function (Tilt angle display)
+/－(with shift mode on)	Start up the laser
F1~F4	Select the corresponding softkey on the display

3、Preparation before measurement

3.1 Unpack and store instrument

- unpack

Put down the box gently and turn up the cover then turn on the lock, open the cover and take out the instrument.

- deposit

Cover up the telescope mirror and make the vertical motion of alidade upwards then put the instrument horizontally (keep the objective upwards) into box. Then screw vertical motion gently. Cover up the box cover and lock the box. Loose horizontal and vertical axis as much as possible to reduce he shock damage to instrument.

3.2 Setting up the instrument

- Operating reference：

If the battery is mounted after the instrument is set up, the instrument will tilt slightly. So, First mount the battery, then set the instrument up.

3.2.1 Centering and levelling

1）setting up the tripod

• Extend the tripod legs to provide a comfortable posture.

•Setting up the tripod over the marked point on the ground, and center it.

2）install the instrument on a tripod.

•Place the instrument on the tripod head.

• Fix the instrument on the tripod.

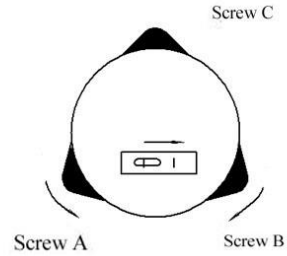
3）Leveling instrument roughly by circular level.

•Turn on the instrument and switch the laser plummet and the electronic .level function on.

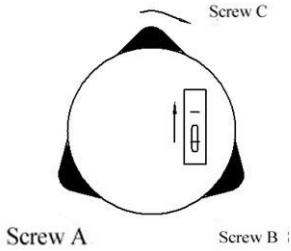
•move the tripod legs and use the tirbrach screws to center the instrument over the ground point. Adjust the tripod legs to level the circular level.

4）Leveling instrument accurately by tube level

①Loosen the horizontal clamp, and turn the instrument until the plate level is parallel to the line between leveling foot screws A and B. Use leveling foot screws A and B to center the bubble.



②Rotate instrument 90°by vertical axis, then use foot screw C to center the bubble.



③Repeat steps above until the bubble is at the same place in all directions.

3.2.2 Centering by centering tool (optional or laser)

1）Set up a tripod

Extend a tripod to the appropriate height make sure the legs are spaced at equal intervals and the head is approximately level .Set the tripod so that the head is positioned over the surveying point. Brace tripod on the ground and keep one leg fixed.

2）Set up instrument and spotting

Put instruments on a tripod carefully, and tighten the center connection screw. Adjust the optical centering tool to make reticule clear (open instrument and laser centering if it's a laser centering tool).Handle another two unfixed legs, and adjust their position through the observation of the optical plummet. Make the three legs of the tripod fixed on the ground when the optical plummet is aligned to the station

approximately .Adjust three feet screws of total station and keep the optical centering tool (or laser centering) aiming at the station accurately.

3）Leveling instrument roughly by circular level.

（same as The section above that discusses centering and leveling with plumb bob）

4）Leveling instrument accurately by tube level

（same as The section above that discusses centering and leveling with plumb bob）

5）Centering and leveling accurately

Loosen center connection screw slightly and move instrument Horizontally (Don't rotate instrument) through observation to optical plummet, making the instrument aim at station accurately. Tighten the center connection screw and leveling instrument accurately again.

This operation should be repeated till the plumb aims at station accurately.

3.3 About the battery

● Mounting the battery

☆ Fully charge the battery before measurement.

☆ Cut off the power before removing the battery

➢ Step mounting the battery

1、Insert the battery to the instrument.

2、 Press the top of the battery until you hear a click sound.

➢ Step Remove battery

1、Press the button downward.

2、Remove the battery by pulling it toward you

● Battery information

▮ ——power is adequate, operating available.

▮ ——The battery can be used for 4 hours when this symbol first appears. If you cannot master the consumed time, you should prepare a spare battery or charge the battery before using.

▮ ——End of the operation as soon as possible and replace the battery and charge if running out of power.

▯ ——It takes several minutes for the instrument to shut down when this symbol first appears. The battery has few power now

and should be replaced an recharged.

Notice：

① The operating time of battery depends on environmental conditions such as ambient temperature, time and times of charging and so on the battery is suggested to be prepared or charged ahead before operation to keep it safety.

②The battery symbol only indicates power capability under current measurement mode. The remained capacity of the battery shown under current mode does not guarantee its capacity under other modes .Because consumption of power in distance measurement mode is more than that in angle measurement mode ,the instrument may end ranging sometimes due to insufficient capacity of battery (when switching between modes).

Notice in charging：

• Though overcharging protection is installed in the instrument, please plug off the battery immediately after finishing charging.• Charging range from 0°~±45℃. Abnormal responds of instrument occurs over this range.

•Rechargeable for 300—500 times , It may shorten Service time of the battery completely.

• Charge the battery once a month no matter if it is used to prolong its longevity..

3.4 Reflecting prism

When using a prism mode for measuring distance ,reflection prism should be placed where the target is. A reflecting prism group includes one or three prisms that can connect prism group placed at the base of the tripod with the dock connector or by placing them in the stem directly. Prism group may need to be configured by users based on target.

3.5 Load or unload the base

● install

Put the three fixed feet in the corresponding bases, make the instrument in a triangular base, clockwise lock the button by 180 ° to lock the base, and then fix screw with a screwdriver to screw it out at a

fixed lock knob.

●dismantle

If necessary, the triangle base can be removed from the instrument (including the same base of reflection prism base connector) by loosening the lock knob base fixed screw with a screwdriver, and anticlockwise locking button about 180 ° , then separate the instrument from base.

3.6 Adjust telescope objective and aiming target.

Aiming method (reference)

① Rotate the telescope and point it to the bright sky and focus reticule clearly (by rotating eyepiece in own direction and focusing reticule slowly)

②Aim at the target with the crosswire in optical sight , and keep an appropriate distance when aiming (about 200mm)

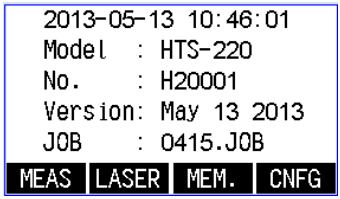
③Use telescope focus screw to make target clear.

It means that focus or eyepiece diopter is not adjusted adjusted when there is a parallax with eye moving up and down ,thus focus carefully and adjust eyepiece to reduce parallax.

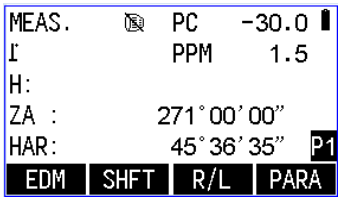
4、Basic Functions

4.1 Turn on / off

Press and hold the power key for about one second, then release the key to boot into the initial screen, as followed :

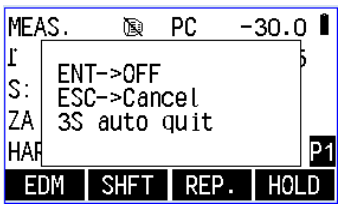


After a stay for about one second to enter the Basic Measurement Screen.



In the basic measurement screen, press [ESC] key to return to the initial screen and enter the memory operation functions and configuration screens.

Press the power button to go to the pop-up confirmation box, as follows.



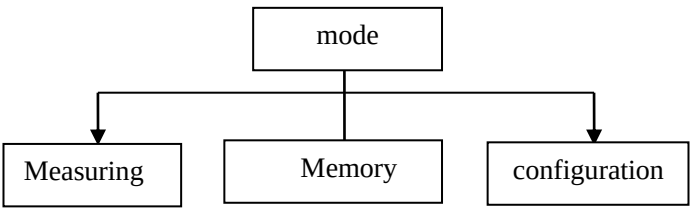
Press【ENT】to power off the instrument or press【ESC】to exit the prompt box The prompt box will disappear if no operation is exert to the instrument for three seconds.

4.2 Display symbols

- Display symbols

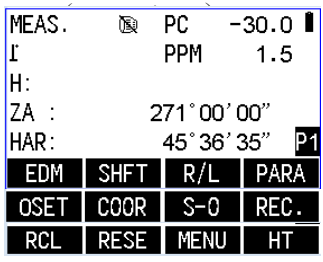
symbols	Meaning
PC	Prism Constant
PPM	Parts Per Million
ZA	Zenith Angle (zenith 0°)
VA	Vertical Angle（horizontal 0° / ±90°）
%	Slope
S	Slope Distance
H	Horizontal Distance
V	Vertical Distance
HAR	Horizontal Angle Right
HAL	Horizontal Angle Right
⊥+	Lean effective compensation

- Mode Structure Overview

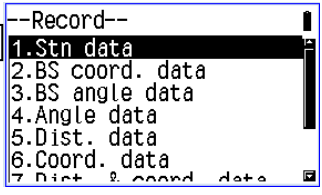


- Mode structure detailing

(Measuring)



(Recording)



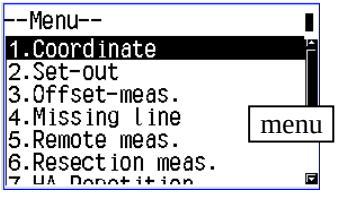
REC.

ESC

MEAS

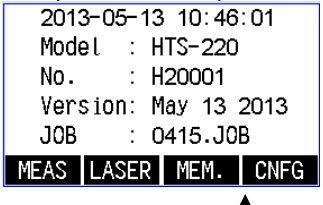
ESC

(Menu)



menu

(Status Screen)

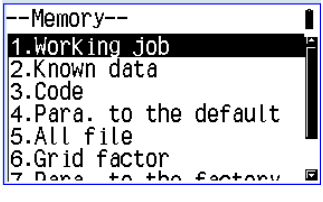


ESC

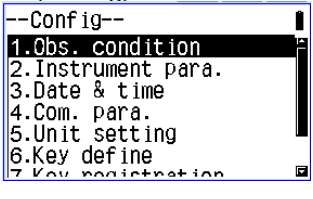
MEM.

CNFG

(Storage)



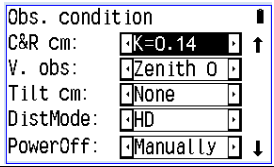
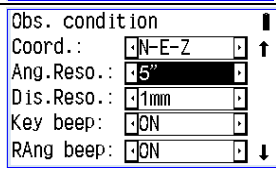
(Setting)



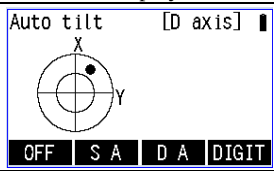
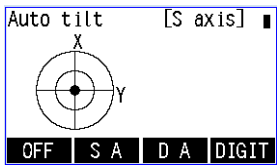
4.3 Set the tilt correction option

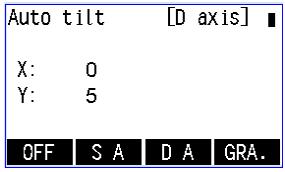
Tilt sensor make sure the accuracy of angel measuring. It can also level instrument better. If the screen display “beyond compensation”, you will need to level the instrument manually.

▶Step **set up initial correction switch**

Operating Steps	Key	Display
(1) Power on → 【ESC】 → 【CNFG】 →1.obs. condition.	POWER 【ESC】 【CNFG】 【1】	
(2)move the cursor to “Tilt cm”, choose “S A” or “D A” or “None”.	▲▼ ◀ ▶	

▶Step leveling instrument

Operation process	Key	Display
(1) In all measurement screen, press [•] to enter electronic blister display.	【 • 】	
(2) Manually level the instrument with the tribrach screws. According to the method described in 3.2 to make black circles centered at right. Single-axis: Only compensate vertical angle. Double-axis: Onlycompensate horizontal angle press【OFF】to turn off compensation.		

(3) press 【DIGIT】to display compensation values in digital form. Being horizontally leveled is shown when compensation value approaches to 0.	【DIGIT】	

- The vertical angle display will be unstable when the instrument is in an unstable condition or windy weather ,then shutting down the compensator is appropriate . An interruption of the measurement caused by constant display of 'Tilt over!' will be avoided.You can shut down compensator function with key【 • 】.

4.4 Background lighting

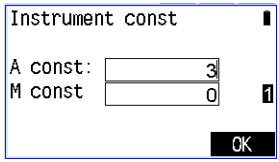
• Background lighting can be used in dim environments.
press【☼】to turn on the screen backlight, following process "Turn off→ A brightness →Two brightness →Three brightness → Turn off".

4.5 Setting the instrument parameters

• In set up mode, make sure set up is conform to reference parameters
Detail operating refer to "19.1 change observation condition of instrument".

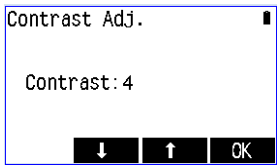
4.6 Setting the instrument constants

Instrument constants including "additive constant" and "multiplying constant", it has been calibrated in the factory. You can obtain a constant value according to "inspection and calibration of instrument constant" method.

Operation process	Key	Display
(1)power on→【ESC】→【CNFG】→2.instrument para.→3.inst. constant Press【OK】to confirm the input.	POWER 【ESC】 【CNFG】 【2】 【3】	

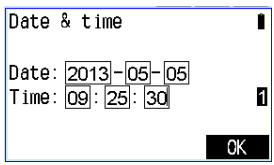
4.7 Setting the display contrast

•It is possible to set the display contrast so that you can see the display clearly.

Operating Steps	Key	Display
(1) power on→【ESC】→【CNFG】→2.instrument para.→4.contrast Adj. 【↑】【↓】adjust contrast value, press【OK】 to back to menu.	POWER 【ESC】 【CNFG】 【2】 【4】	

4.8 Setting date and time

• The date/time of the instrument can be set under the "instrument parameter Settings" . The method is shown below：

Operating Steps	Key	Display
(1)power on→【ESC】→【CNFG】→3.date &time , After entering one item press【ENT】to next item. press【OK】to save date and time and return.	POWER 【ESC】 【CNFG】 【3】	

4.9 Choose working file

Instrument operation not only requires a large amount of data but also generates large volumes of data . All these data is stored in the instrument's file system in the form of documents .It is a good habit that choosing the required files ahead for the measuring work.

Instrument used by the file type to distinguish extensions ,Including:

- .JOB file is working file, save date and invoke coordinate.
- PCODE.LIB file is coding file, save and invoke code.

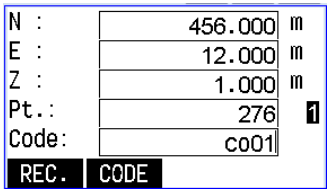
- COORD.PTS file is known coordinate, save known coordinate date and invoke coordinate.
- .LSH file is horizontal alignment file, use in the road lofting.
- .LSV file is vertical alignment file, use in the road lofting.

These files are not necessary in all applications, you can select different application functions as appropriate.

Choose working file refer to chapter17.1

4.10 Input number and alphabet

User can input numbers and alphabets and also the mix of numbers and alphabets.



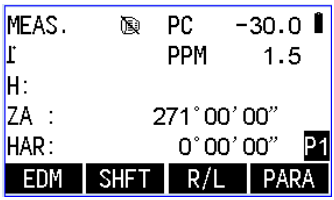
for example：

- The numerical only frame can't change to alphabetic entry.
- You can input number and letter in the edit frame of point inputting, press 【SHFT】 to switch from number and alphabet. (Press quickly according to the order of signs below, because alphabet is constituted by three keys , cycle between alphabets).

4.11 Introduction

- Tilt compensation automatic

  It means that you have set up single axis or dual-axis compensation when there is a "⊥" sign in the display window. As show in the figure：



- Eliminate parallax

When the observer eyes moving slightly in front of the eyepiece, relative displacement between target and the reticule is called the parallax. Parallax causes error, therefore, it should be based on the reticle focusing will eliminate parallax before the observation.

- Cut off the power automatic
  To save power, the instrument can cut off power after shut-down 30 minutes. The cut off function can open or close when set the observation condition, refer to "20、instrument parameters setting."
- Dirty spot recognition of the code disk .
  On the interface of angle in real time to refresh, turn the instrument, and when angle displaying "###°##′##″ or "###.####" , it means the code disk is dirty and needed to be cleaned.

You can complete your survey by using this instrument after you have a good command of setting, figuration and basic operate.

5、Angel measurement

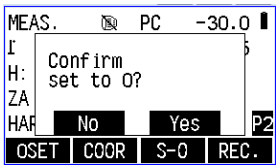
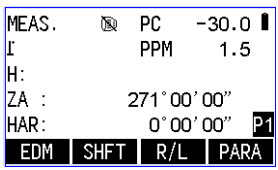
Check the following one more time before measurement：

1）Leveling accurately.
2）Charging adequately
3）The horizontal circle and vertical circle indexing have been completed.
4）The parameters are set in conformity with measurement condition.

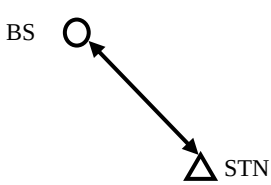
5.1 Measuring the Horizontal Angel Between Two Points.

• To measure the included angel between two points, the horizontal angle can be set to 0 at any direction.

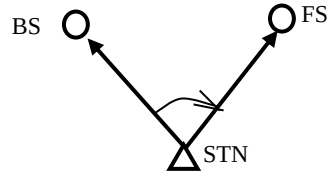
▶Step

Operating Steps	Key	Display
（1）on the first page of the MEAS mode screen, press【FNC】to enter the second page（display P2）And press【0SET】，pop-up ask message box.	【FNC】 + 【0SET】	
（2）press【ENT】，the horizontal angle of the collimation direction is 0.	Zero setting	

EXAMPLE：**Measuring the horizontal angel between two points**



（1）



（2）

Operating Steps	Key	Display
(1)Using the horizontal clamp and the horizontal fine motion screw , sight the first target.On the second page of the “MEAS mode screen” Press[0SET].	【0SET】 + 【ENT】	MEAS. PC -30.0 PPM 1.5 H: ZA : 271°00’00” HAR: 0°00’00” P1 EDM SHFT R/L PARA
(2)Sight the second target, the displayed horizontal angel(HAR) is the included angle between the two points.	Sight the 2nd target	MEAS. PC -30.0 PPM 1.5 H: ZA : 271°00’00” HAR: 45°36’35” P1 EDM SHFT R/L PARA

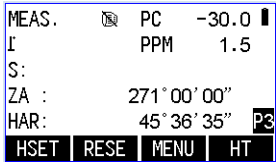
5.2 Setting the Horizontal Angle to a Required Value(Horizontal Angle Hold)

5.2.1 Setting the horizontal angel to a required value using 【HSET】

• You can set the horizontal angle in the sighted direction to any required value.

►Step

Operating process	Key	Display
（1）On the first page of the “MEAS Mode Screen” ,press【HSET】,the “Required Angle Setting Screen” appears .When	【HSET】	Set HA HAR: 45.3635 1 OK

turning the horizontal angle to right,[HRA] is displayed. When turning it to left,[HAL] is displayed.		
（2）Enter the value you want to set, press “OK”. The “MEAS Mode Screen” appears and the value which is set as the horizontal angel is displayed.	Enter angle value + 【ENT】	

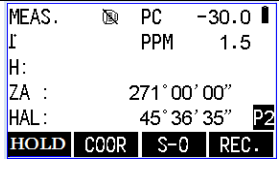
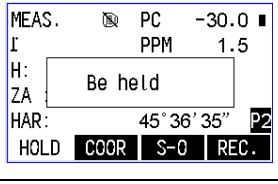
☆Entry rules

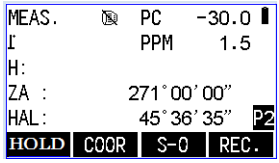
- Press【. 】to set the input of angle symbol in degree, minute, second.
- When you want to enter 45° 36′ 35″ ,input 45.3635.
- Correct entered value.
- 【BS】: Delete a number/ character on the left cursor.
- 【SP】: Delete the input date.
- Stop input progress :【ESC】

5.2.2 Setting a required value using 【HOLD】

- It is possible to use the horizontal angle hold function to set the horizontal angle of the sight direction to the required angle.

▶ **Step**

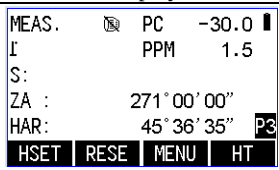
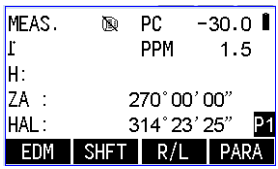
Operating process	Key	Display
（1）Use “Key define”, display 【HOLD】function in the survey mode.		
（2）Use the horizontal clamp and the fine motion screw to display the desired angle of the horizontal angle . Press 【HOLD】 once, the horizontal angel	【HOLD】	

is in the hold status.		
（3）Sight the target and press 【HOLD】once. Horizontal angle [HOLD] is canceled and the desired angle is set for the target.	Lock angle	

5.3 Horizontal Angle Display Option(left /right)

- It is possible to switch between horizontal angel clockwise display (Left) and horizontal angel counterclockwise display (Right).
- For this operation, allocate the function keys to display 【R/L】,according to the method of “Key define”

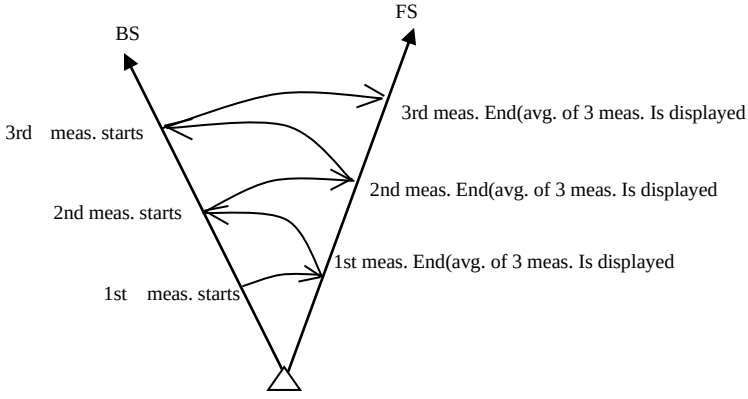
▶Step

Operating process	Key	Display
（1）Allocate the function keys to display 【R/L】 function, horizontal angle display becomes clockwise(HAR).		
Press【R/L】, horizontal angle display switch from clockwise (HAR) to counterclockwise (HAL). HAL=360°- HAR Press【R/L】once more to return clockwise.	【R/L】	

5.4 Horizontal Angle Repetition

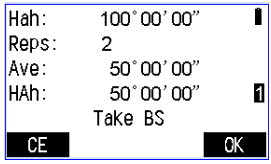
To get the greater precision of the horizontal angle, perform repetition measurement.

- For this operation, allocate the function keys to display 【REP.】 according to the method of “Key define” and invoke.



▶Step

Operating process	Key	Display
On the “MEAS Mode Screen”, press【REP.】.The “Repetition BS Sighting Screen” is displayed. Horizontal angle set to 0°.	【REP.】 + aim at backsigh t	Hah: 0°00’00” Reps: 0 Ave: 0°00’00” HAh: 0°00’00” 1 Take BS CE OK
（2）Sight the BS point and press【OK】, the “Repetition FS Sighting Screen” is displayed.	【OK】	Hah: 0°00’00” Reps: 0 Ave: 0°00’00” HAh: 0°00’00” 1 Take FS CE OK
（3）Sight the FS and press【OK】once more, “Repetition BS Sighting Screen” is displayed a second time.	Aim at foresight + 【OK】	Hah: 50°00’00” Reps: 1 Ave: 50°00’00” HAh: 50°00’00” 1 Take BS CE OK
（4）Sight the BS again and press【OK】, the “Repetition FS Sighting Screen” is displayed s second time.	Sight the BS+ 【OK】	Hah: 50°00’00” Reps: 1 Ave: 50°00’00” HAh: 0°00’00” 1 Take FS CE OK

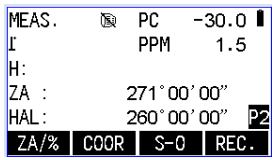
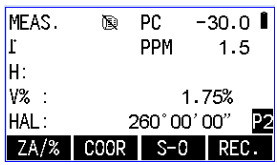
(5)Sight the FS again and press【OK】. The average value of the horizontal angle is displayed on the third line. Repeat 4,5 Steps if continue. When completed, press 【ESC】	Aim at foresight + 【OK】	

• Maximum repeat times：10
• Maximum angle accumulated value：359°59′59″

5.5 Slope in %

- ◆ It is possible to display the gradient as a %.
- ◆ For this operation, allocate the function keys to display 【ZA/%】 according to the method of “Key define”

▸Step

Operating process	Key	Display
（1）In the MEAS mode, allocate the function keys to display【ZA/%】		
（2）Press【ZA/%】, The vertical angel is displayed as a gradient(V%).Press 【ZA/%】again to return the original vertical angle display.	ZA/%	

☆Display Range:±100%
☆When the vertical angle format set “HA 0” or “HA 0±90”, “VA” is displayed instead of “ZA”.

6、Distance Measurement

Measurements to strongly reflecting targets such as to traffic lights in Reflector EDM mode without prism should be avoided. The measured distances may be wrong or inaccurate.

When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment.

If e.g. people, cars, animals, swaying branches, etc. cross the laser beam while a measurement is being taken, a fraction of the laser beam is reflected and may lead to incorrect distance values. Avoid interrupting the measuring beam while taking reflectorless measurements or measurements using reflective foils.

6.1 Setting for Distance Measurement.

◆ Set parameters before distance measuring:
- Atmospheric correction factor
- Prism constant correction value
- Target type
- Distance measurement mode

EXAMPLE atmospheric correction

•The atmospheric correction is necessary for accurate distance measurement because the velocity of the light in air is affected by the temperature and air pressure. Once you set the temperature and air pressure, the correction value is calculated and set into memory.

Correction formula：

$$PPM = 277.8 - \frac{0.2900 \times \text{atmospheric pressure}\ (hPa)}{1 + 0.00366 \times \text{temperature}\ (℃)}$$

1hPa=0.75mm Hg

If the atmospheric correction is not required, please set PPM to zero.

• Standard meteorological conditions (atmospheric correction value =0)：

press：1013hPa
temperature：20℃

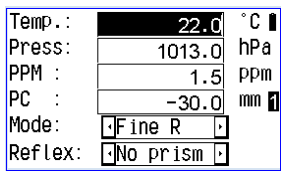
EXAMPLE distance measurement mode

◆ The following are the measurement time and the smallest distance display for each measurement in different measurement method when a prim is used.

• Fine Measurement
accuracy：±（2+2PPM×D）mm (D for distance)
Measure time：<3seconds
Minimum display：1mm

• Tracking measurement
Measure time：<1second
Minimum display：10mm

◆ Setting for distance measurement

operation	display
In MEAS mode, press【SP】,the "parameters set screen" is displayed. Set follow items: 1、temperature 2、air pressure 3、atmospheric correction value PPM 4、prism constant correction value 5、distance measurement mode 6、target type After setting , press【ENT】.	

◆ Set method and contents：

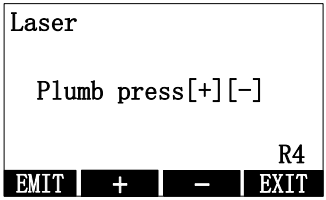
item	Set method
Temp	①Entering temperature, atmosphere value, instrument will calculate the atmosphere correction automatic and display the PPM column ②Entering atmosphere correction PPM directly
Press	
PPM	
PC	Enter the prism's constant correction value
Mode	Select it with symbol： Fine "r", Fine AVG "n=", Fine "s" , Tracking
Reflex	Set the target type: prism, reflector less,Sheet.

NOTICE：
Temperature range：-30~+60℃ or -40~+140℉

Air pressure range：500~1400hPa
Atmospheric correction PPM input range：-499~+499
Prism constant range：-99~+99mm

6.2 Laser Pointer and Laser Plummet

In the initial screen, press the【laser】the “Laser option” screen is displayed . Press the [+] /[-] key to switch the laser pointer on/off.

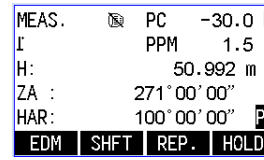
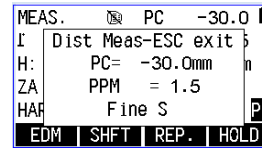
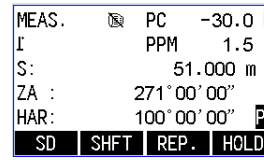
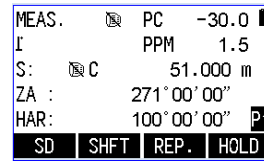


- The laser plummet will be switched on as soon as the “Laser Option” screen is displayed. Press the [+] or [-] keys to adjust the brightness of the laser plummet. Exit the screen, laser plummet shut down automatically.
- Press [EMIT], switch the laser pointer in the telescope.
- **Range mark:** In the bottom right corner of the page as shown above, this mark is the distance Range identifier, where R4 represents 400m, L6 stands for 600m, L8 stands for 800m, and so on.

6.3 Distance and Angle Measurement

• An angle can be measured at the same time as the distance measured.
• When recording measurement data, see “Recording Distance Data” chapter.
• Check the following once more before measuring a distance：
1）The instrument is set up correctly over the surveying point.
2）Battery is fully charged
3）The horizontal circle and vertical circle indexing have been completed.
4）The parameters are set up correctly with measurement conditions.
5）Atmospheric correction, prism constant correction and distance measurement mode has been set up.
6）The center of the prism is correctly sighted and the intensity of the return signal is sufficiently high.

▶Step S/H/V selection and distance measurement

Operating process	Key	Display
In the MEAS mode, press 【SHFT】to select the desired distance mode. Each time 【SHFT】pressed ,the distance measurement changes. S：slope distance H：horizontal distance V：height difference	【SHFT】	
（2）Press【SD】to start distance measurement, information about distance measurement(distance measuring mode, prism constant correction value, atmospheric correction value) will display on the screen by a flashing display.	【SD】	
（3）When distance measurement completed, a short been sounds. and the measured distance data “S”, vertical angle “ZA” and horizontal angle “HAR” are displayed.		
（4）When repeat measurement is performed , press 【ESC】to stop the distance measuring and display the measured result.	【ESC】	

• If the Fine “s” or Fine AVG “n=” measurement mode is selected, measurement stops automatically after desired times measurement completed.

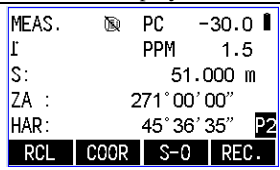
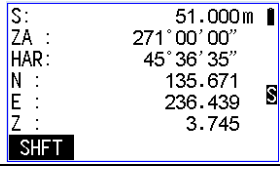
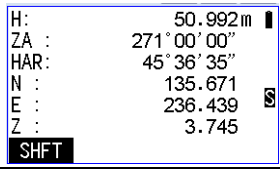
6.4 Review of the Measured Data

• The distance and angle measurement data will be stored in the

memory until the power is off. These distance measured value, vertical angle, horizontal angle, the coordinate values can be displayed on the screen, it is possible to convert the distance measurement values into the horizontal distance, elevation difference, and slope distance by press 【SHFIT】.

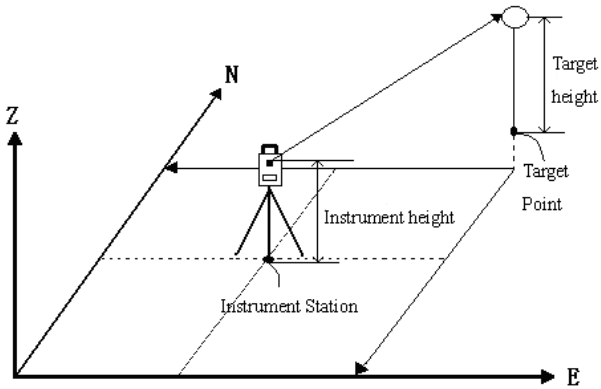
• For this operation, you should first define key by【RCL】 according to the method of "Key define"

▸Step

Operating process	Key	Display
（1）In MEAS mode, allocate the function keys to display【RCL】, and press 【RCL】	【RCL】	
（2）The recent measured data is stored and display on the screen.		
press【SHFT】, switch between slope distance, horizontal distance, height difference , press【ESC】to back to the survey mode.	【SHFT】	

7、Coordinate Measurement

•It is possible to get the 3-demensional coordinate of the target based on the station point coordinate, instrument height, and target height which are entered in advance.



•It is possible to set the azimuth angle of the BS station by entering the coordinates of the station point and the BS and then sighting the BS to be measured.

• The following preparation are needed before measuring：

Station point coordinates setting

Azimuth angle setting

• The coordinate format settings, please refer to “4.5 Set the instrument parameter option”

7.1 Entering Instrument Station Data

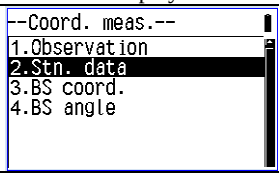
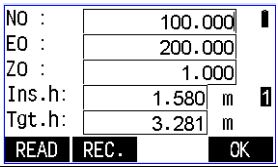
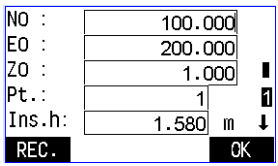
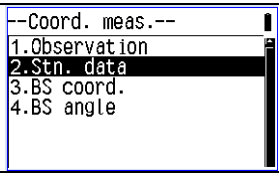
• Before the coordinate measurement, enter the instrument station coordinates, the instrument height and target height.

• Measure the instrument height and target height with a tape measure.

• Coordinate data can be registered in advance.

• Station data can be recorded in the JOB which has been selected. For the JOB selection method, refer to "17.1.1 Select the current working file"

▸Step

Operating process	Key	Display
（1）in the second page of the MEAS mode screen, press【COOR】 and display coordinate measurement menu .	【COOR】	
（2）choose “2.Stn.data” and press【ENT】（or press number 2），enter the instrument station data.	“2.Stn. data” + 【ENT】	
Set the following items：N0、E0、Z0（instrument station coordinate）、instrument height、target height. once you set an item, press【ENT】. Press【REC.】 record instrument station data.	Input station data + 【ENT】	
（4）press【OK】to end the instrument station data setting.	【OK】	

Notice：

Coordinate input range： -99999999.999 ~ +99999999.999

The instrument heigh input range：0~+999.999

The target height input range：-999.999~+999.999

☆ Read coordinate data: press【READ】（refer to the follow“read coordinate date in advance”

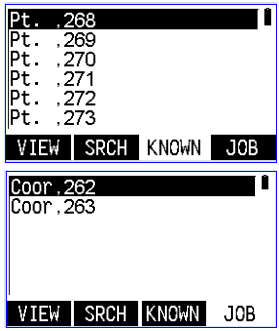
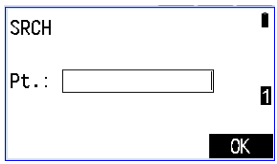
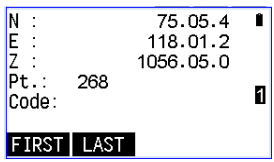
☆ Saving station data: press【REC.】（refer to “record station data”）

◆ **Reading in Registered Coordinate Data**

• If you want to read in and set coordinate data form memory ,press the【READ】and read the required coordinate data.

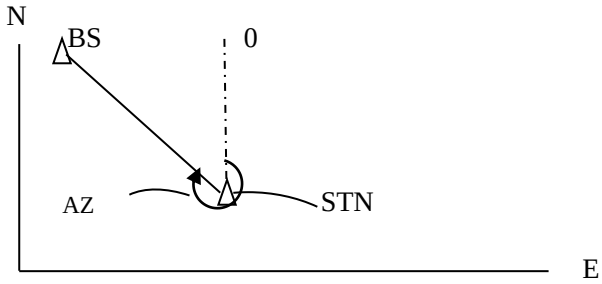
• Both known coordinate data saved in memory and the coordinate data in the selected JOB can be read in.

▸Step

Operating process	Key	Display
(1)Press【READ】, The "Coordinate data points list screen " is displayed. 【KNOWN】:Coordinate data saved in the known data memory. 【JOB】:Coordinate data saved in selected JOB	【READ】 【JOB】	
(2)Press【▲】or【▼】 to select the required item. Use the point number to search for coordinate data ,press 【SRCH】.	【SRCH】	
(3)press【VIEW】to read point, and display the coordinate date on the screen. Press【ESC】to back to the"Coordinate data points list screen "	【LAST】	
(4)press【ENT】to back to station set screen.	【ENT】	

7.2 Azimuth Angle Settings

• After the instrument station coordinate and the BS coordinate have been set, sight the BS and perform a key operation to automatically set the azimuth angle of the BS station.



7.2.1 Backsight by angle

It is possible to set the backsight by entering the azimuth directly.

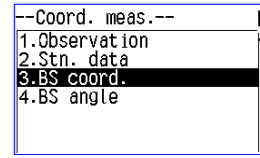
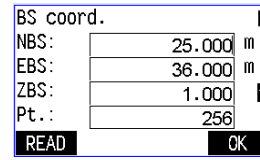
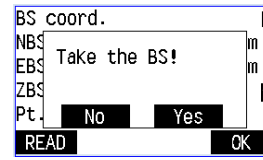
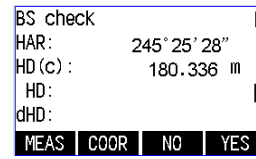
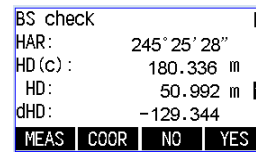
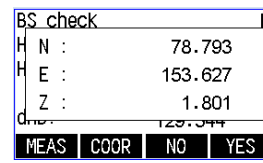
▸Step

Operating process	Key	Display
（1）press 【▲】【▼】 to move the cursor on“4.BS angle” then press【ENT】（or press number 4 directly）	“4.BS angle” + 【ENT】	--Coord. meas.-- 1.Observation 2.Stn. data 3.BS coord. 4.BS angle
enter desired angle and sight the backsight , then press 【OK】	Input azimuth angle + 【OK】	Set AZ HAR: 45 OK
Back to coordinate survey menu screen after completing AZ Set.		

7.2.2 Backsight by coordinate

As soon as enter the backsight coordinate data, the system will calculate the azimuth according to the instrument station coordinates and backsight coordinates.

▸Step

Operating process	key	Display
（1）in the menu display , choose “3, BS coord”.	“3.BS coord” + 【ENT】	
（2）enter backsight coordinate data, when set each item ,press 【ENT】. press【READ】to read in memory.	input backsight coordinate + 【ENT】	
（3）The system calculate the azimuth by station point and backsight point , press【OK】and sight the backsight target.	【OK】	
（4）sighting the backsight target, press【ENT】. Press【MEAS】to check the backsight. If you want to ignore check, press【NO】.	【ENT】	
（5）press【MEAS】 to measure to backsight, the result is displayed on the screen.	【MEAS】	
（6）press【COOR】, you can view the backsight coordinate, 【ENT】or【ESC】to return	【COOR】	

7.3 Coordinate measurement

• After station data and backsight azimuth set, the coordinate values of the target can be got by the distance and angle measurement.

The coordinate values of the target are calculated and displayed as following：

Station coordinate：（N0，E0，Z0）

instrumental height：

Prism height：

Height difference：Z

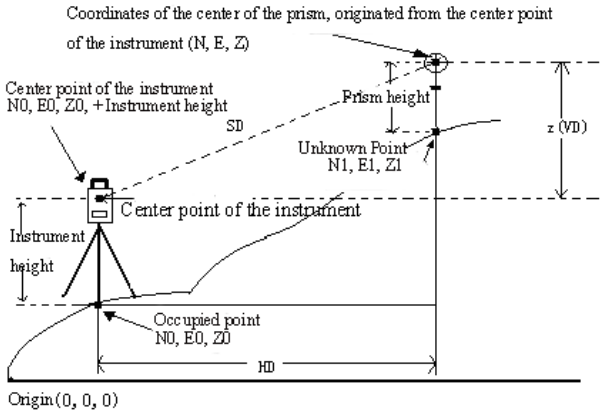
The difference from center of the instrument to the center of the prism：（n,e,z）

Unknown point coordinate：（N1、E1、Z1）

N1=N0 + n

E1=E0 + e

Z1=Z0 + instrument height + z - reflector height



• Please check the following once more before measuring：

1、Instrument is correctly set up over the surveying point .

2、Battery is fully charged

3、The horizontal circle and the vertical circle indexing have been completed.

4、The parameters are set in conformity with measurement conditions.

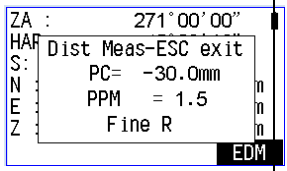
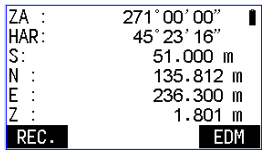
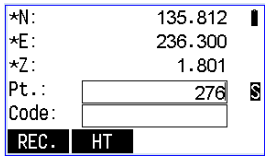
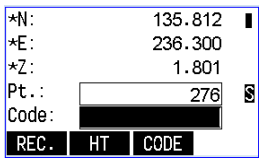
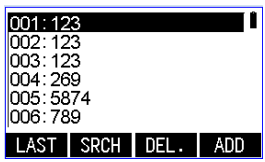
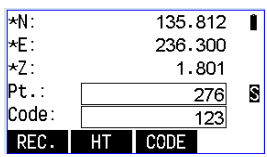
5、Atmospheric correction, prism constant correction and ranging

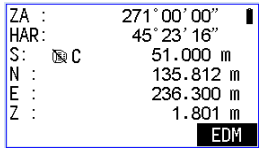
mode is set up correctly

6、the center of the target is sighted correctly and intensity of the returned signal is sufficiently high.

7、station data and backsight azimuth set have been done.

▸Step

Operating process	Key	Display
（1）Sight the center of target, choose“1. Observation” in the survey coordinate menu screen and press【ENT】(or press number 1 directly）.	“1.Observation” + 【ENT】	
（2）Complete the measurement ,the coordinate data of the target, vertical angle and horizontal angle between targets is displayed.		
(3)To record the coordinate data in the JOB, press 【REC.】. The coordinate data recording screen is displayed. Set the following items. PT.: target point name Code: code or note information. Press▼or 【ENT】after setting each item. •When the curser is in the code line, press【CODE】 and display code list, press▲or ▼to select the desired one, press【ENT】 and return data.	【REC.】 【CODE】 【REC.】	   

(4)Sight the next target and press【EDM】to start the measurement. press【ESC】to end up the coordinate measurement and return to coordinate measurement menu screen.	【EDM】	

☆ Remember the following when record:

①the maximum length of the point number is 14 characters

②the maximum length of the code is 14 characters

☆Code enter in advance, refer to introduction “ 17.3.1 input coding”

8、Staking out measurement

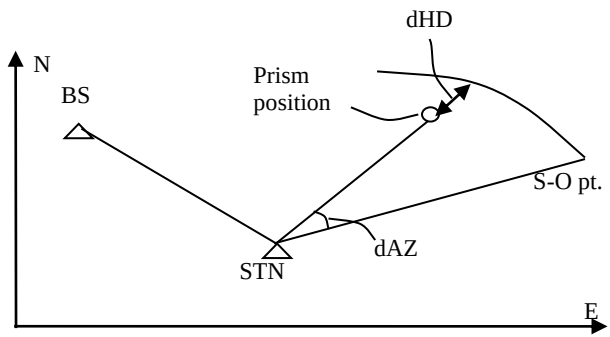
• The staking out measurement is used to set out the required point. The difference between the previously input data to the instrument (the setting-out data) and the measured value can be displayed by measuring the horizontal angle, distance or coordinates of the sighted point

Displayed value = Difference between measured value and setting-out data.

8.1Coordinate Stake out measurement

• This measurement is used to set out the point of a certain coordinate away from the reference point.

•After setting the coordinates to be set out,the instrument calculates the setting out horizontal angle and horizontal distance and stores the value in memory.According to the horizontal angle and horzontal distance,the required point location can be set out.



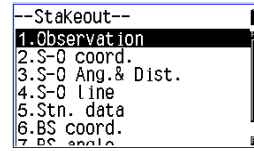
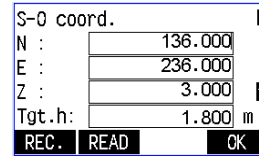
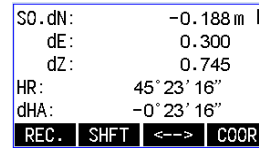
• It is possible to perform coordinates setting out measurement when on the Menu Mode and "2. S-O" is selected.

• It is possible to output the coordinate data previously registered and set it as the setting-out coordinates.

• To find the Z coordinate, attach the target to a pole, etc., with the same target height.

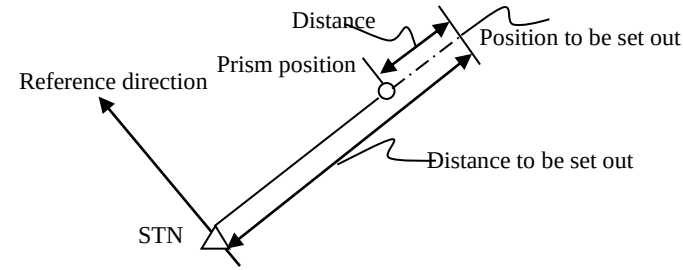
▸Step

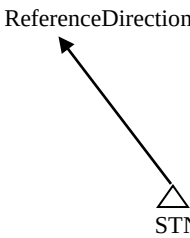
Operating process	Key	Display

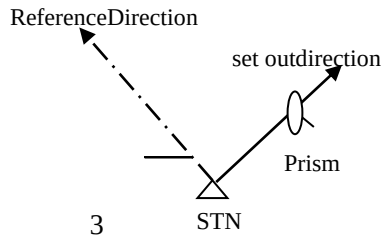
（1）Press【S-O】 in the MEAS mode page 2, “Stake out Menu Screen ”is displayed	【S-O】	
（2）choose “2,S-O coord.” and press【ENT】， or press the . Enter the coordinate. 【REC.】：record coordinate currently 【READ】：read coordinate value from memory	“2. S-O coord.” + 【ENT】	
（3）press【OK】,the distance and horizontal angle setting-out data is calculated and [dN],[dE],[dZ] and [dHA] are displayed.	【OK】	

8.2 Distance Stake out

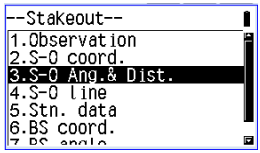
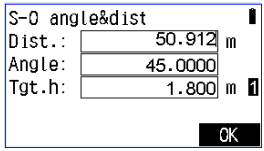
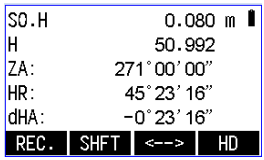
• The point can be found based on the horizontal angle from the reference direction and the distance from the instrument station.







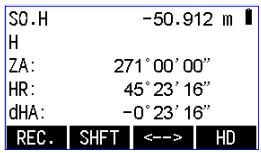
▸Step

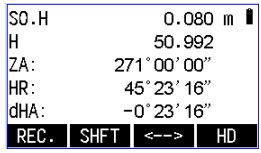
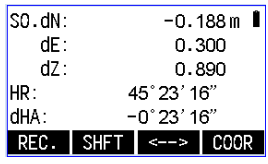
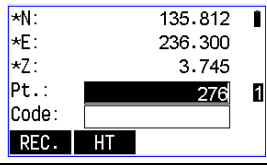
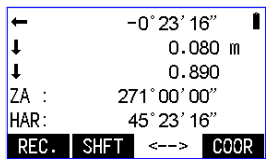
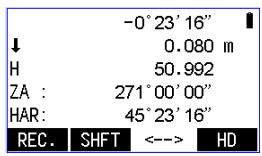
Operating process	Key	Display
（1）press【S-O】 in the MEAS mode page 2, “Stake out Menu Screen ”is displayed	【S-O】	
（2）Select”3, S-O Ang.& Dist.” and press【ENT】, Enter the following items： 1. Distance from the instrument station to the position to be set out. 2. Included angle between the Reference direction and the position to be set out.	“3. S-O Ang.& Dist.” + 【ENT】	
（3）Press【OK】,The “Stake out Screen ” is displayed	【OK】	

8.3 Set out

The principle of set out measurement is rotate the instrument until the angle is about 0° 0′ 0″ , set the target on the sight-line and sight it from the telescope.

▸Step

Operating process	Key	Display
（1）After performing the set out measurement,the “set out observation screen ” is display.	【OK】	

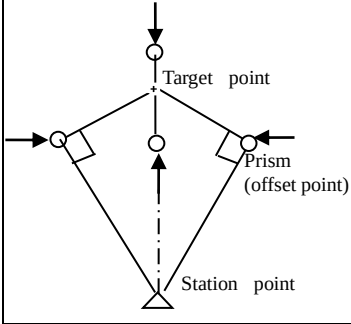
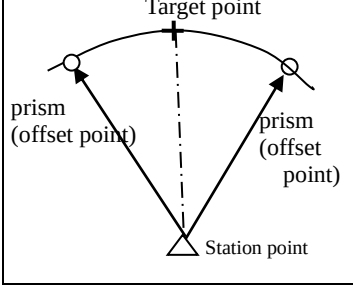
（2）Press【HD】, perform measurement of the target. SO.H：horizontal distance difference H：horizontal distance from instrument to the target dHA：angle difference	【HD】	
（3）press 【SHFT】, switch to coordinate display screen, press【COOR】 to measure the target again.	【SHFT】	
（4）press【REC.】, Record the current coordinate data.	【REC.】	
（5）press【←→】to switch the guide screen **First line：** the angle should be rotate. **Second line：** the movement direction of the target is in-dicated by the arrows pointing upwards and downwards. (↓：Move the target towards youself ↑：Move the target away from yourself） **Third line：** prism move distance of moving up or down.	【←→】	
（6）press【SHFT】to switch the measurement mode.	【SHFT】	

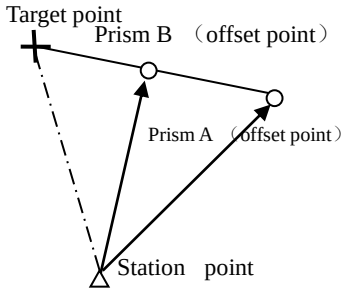
(7) Press【ENT】 to stake out the next point, and the screen displays" Enter next point ? 【No】【Yes】".Press 【ENT】and it will display the coordinate and name of the next point ,then will enter to the measurement screen for staking out.（Only for coordinate stake out measurement.）	【ENT】	

9、Offset measurement

• Offset measurements are performed in order to find a point where a target cannot be installed directly or to find the distance and angle to a point which cannot be sighted. It is possible to find the distance and angle to a point you wish to measure (target point) by installing the target at a location (offset point) a little distance from the target point and measuring the distance and angle from the surveying point to the offset point.

• The target point can be found in the following three ways ：

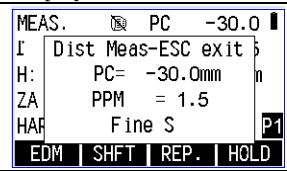
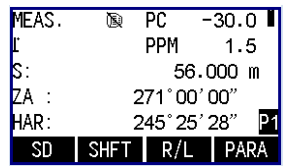
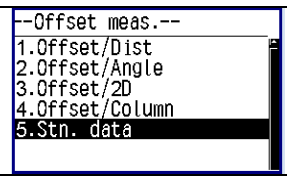
graphical representation	method
1. Single-distance Offset measurement 	•When the offset point is positioned to the left or right of the target point, make sure the angle formed by lines connecting the offset point to the target point and to the instrument station is approximately 90 ° . •When the offset point is ositioned in front of or behind the target point, install the offset point on a line linking the instrument station with the target point.
2. angle offset measurement 	• Install the offset point as close as possible to the target point to its left or right.make the distance between the target to the station point is approximate the same as the distance between and the station point.

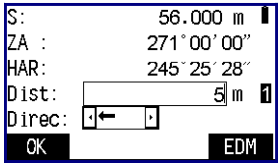
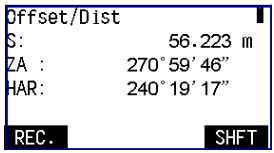
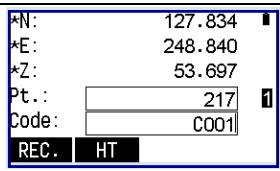
3. two distance offset measurement  	• Install offset points A and B on a line extend-ing from the target point, measure A and B,then enter the distance between B and the target point to find the target point.

• For this operation, press the “key function configuration” to define key of the methods described in [eccentric] function
• Eccentric measuring in menu mode by “3, eccentric measuring”
• The eccentric measurement mode prior to the measurement of the eccentric mode

9.1 Single distance offset measurement

▸Step

Operating process	Key	Display
（1）Sight the offset point in the measurement mode, press 【SD】 to start measuring。	【SD】	
（2）Measurement stopped (repeat measurement mode, press 【ESC】), The slope distances, vertical angles, and hori-zontal angles of the instrument station and the offset point are displayed.	【ESC】	
（3）In MEAS mode , press the 【OFFS】,the “Offset Menu Screen ” is diaplayed	【OFFS】	

(4) Select“1. Offset/Dist” press【ENT】, Set the follow date items： Eccentric distance： 1. Horizontal distance from the target point to the offset point. 2. Direction of the offset press【◄】or【►】to set the direction of the offset point from the target.	“1. Offset/Dist” + 【ENT】	
（5）Press【OK】, The "Offset Observation Results Screen" is dis-played, and the slope distances, vertical angles, and horizontal angles of the instrument station and the target point are displayed. The display is diffrence from diffrent measurement mode.	【OK】	
（6）press【REC.】to record the result.	【REC.】	

Notice：• The direction of the offset point：

→ The target point on the right of the prism

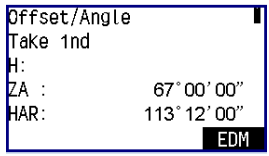
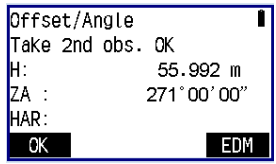
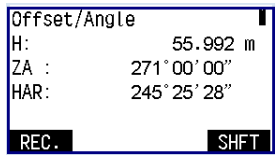
← The target point on the left of the prism

↑ The target point on the ahead of the prism

↓ The target point on the back of the prism

9.2 Angle offset measurement

▶Step

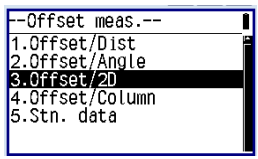
Operating process	Key	Display
（1）in the angle offset function, press 【EDM】 measure the offset point and display the result on the screen.	【EDM】	
（2）The slope distance, vertical angle, and hori-zontal angle of the instrument station and the target point are displayed.	【EDM】	
（3）Accurately sight the direction of the target point and press [OK]	【OK】	
（4）other operation refer to single distance offset measurement.		

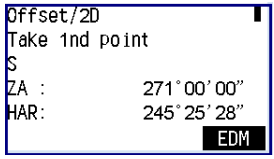
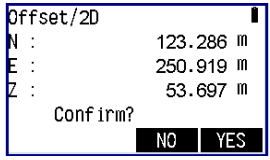
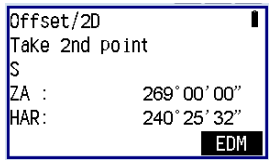
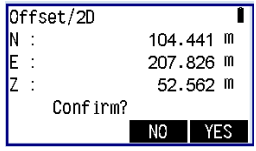
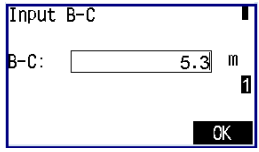
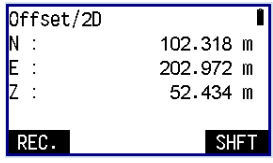
9.3 Double distance offset measurement

☆ **Notice：**

Install two offset points (1st target and 2nd target) on a straight line from the target point,observe the 1st target and 2nd target, then enter the distance between the 2nd target and the target point to find the target point

▶ Step

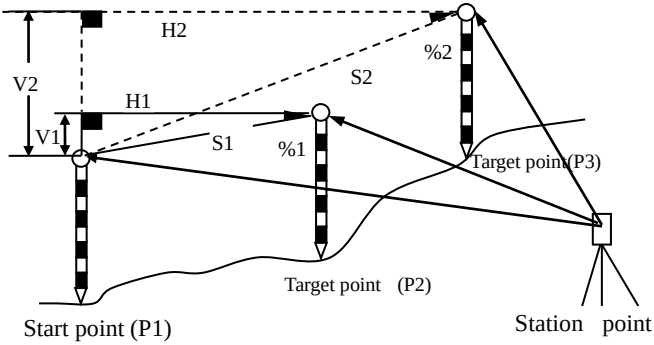
Operating process	Key	Display
（1）In MEAS mode ,press [OFFS],the “offset measurement screen ” is displayed.		

（2）Select “3. Offset/2D” and press【ENT】. The “1st Target observation Screen” is displayed.	“3. Offset/2D” + 【ENT】	
（3）Sight the target A and press 【EDM】to start measurement. The measurement result is displayed after measurement completed.	【EDM】	
（4）press【OK】，（repeat observation the target press【NO】）	【OK】	
（5）Sight the target B and press 【EDM】to start the measuremet.the result is displayed.	【EDM】	
（6）Enter the offset distance ,and press【OK】	【OK】	
（7）The instrument calculate and display the coordinate of target point.	【OK】	
（8）other operation refer to single distance offset measurement.		

• Input range of offset distance：-999.999~+999.999m

10、Missing Line Measurement

• Missing line measurement is used to measure the slope distance, horizontal distance , and horizontal angle to a target from the start target without moving the instrument.

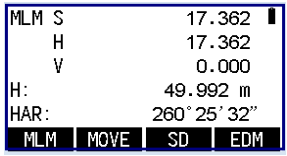
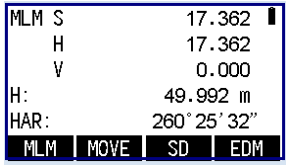
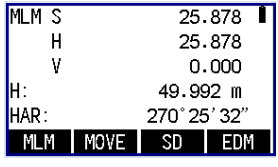


• To find the height difference (V) between 2 points, use a pole etc. to make the target height of all the targets identical.

10.1 Measuring the distance between multiple targets

▸Step measure multi-point distance

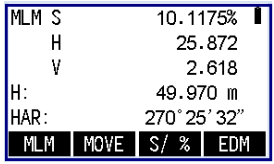
Operating process	Key	Display
（1）Press the “MLM” in the MEAS mode on the third page.	【MLM】	MLM S: ZA : 269°00’00” HAR: 240°25’32” MLM MOVE SD EDM
（2）Sight the first target, press【 EDM】,the measured values are displayed on the screen.	【EDM】	MLM H: 49.992 m ZA : 269°00’00” HAR: 240°25’32” MLM MOVE SD EDM

（3）Sight the second target , press【MLM】, start missing line measurement	【MLM】	
When the measurement is completed ,the result is displayed： MLM S： Slope distance of the two target H： horizontal distance between of the two target V： height difference between the two target H：horizontal distance between station andP2 HAR：horizontal angle between station and P2 Repeat observation：【EDM】		
(4)Sight the third target and press【MLM】 to start measurement.When the observation is completed, the "Missing Line Measurement Results Screen" is dis-played. The values displayed are the slope distance,horizontal distance, and the height difference between starting position and 3rd target.	【MLM】	
（6）press【ESC】to end and return	【ESC】	

10.2 Slope between two points

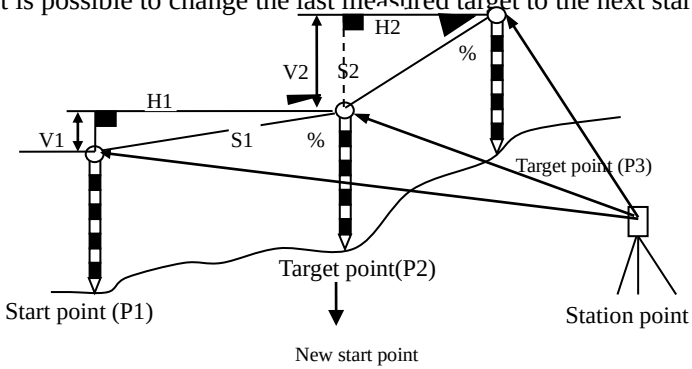
• Slope between start point P1 and second point P2 can be displayed by%

▸Step

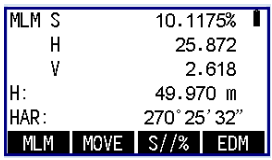
Operating process	Key	Display
Press 【SD】 with the measured value is displayed, the. At the moment, 【SD 】change to【S/%】. press【S/%】 and restore the original screen.	【SD】	

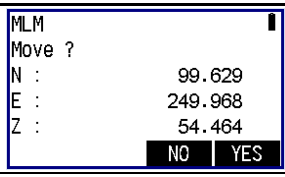
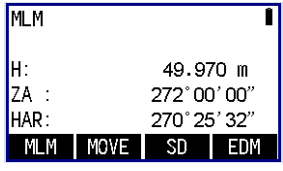
10.3 Change the start target

• It is possible to change the last measured target to the next start target.



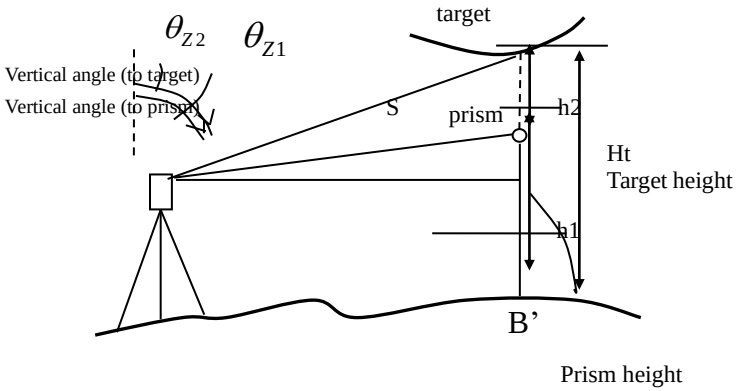
▶ Step

Operating process	Key	Display
（1）Observe the starting position and target following the steps in Measuring the distance between multiple targets.		

Press【MOVE】	【MOVE】	
（3）Press【YES】, the “Missing line measurement screen” is displayed, the last target measured becomes the next start target.	【YES】	

11 REM measurement

●Remote high measurement suit for measuring the height to the target (such as a power cable, bridge, etc) can not be set prism .



• The calculation formula：

$$Ht = h1 + h2$$

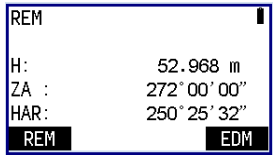
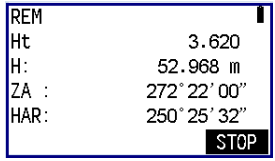
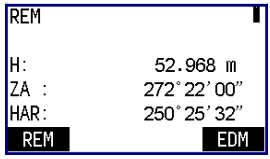
$$h2 = Sin\theta_{Z1} \times Ctg\theta_{Z2} - S\cos\theta_{Z1}$$

• To operate, define key by function 【Remote meas】according to the "key function distribute"

• You can choose "5,remote meas" to measure remote measurement in menu mode

▶ Step

Operating process	Key	Display
(1)Set the target under or over the object and measure the target height with a tape measure.	【MENU】	--Menu-- 1.Coordinate 2.Set-out 3.Offset-meas. 4.Missing line 5.Remote meas. 6.Resection meas.
（2）press"5.Remote meas"	5.remore meas.	REM H: ZA : 272°00'00" HAR: 250°25'32" REM EDM

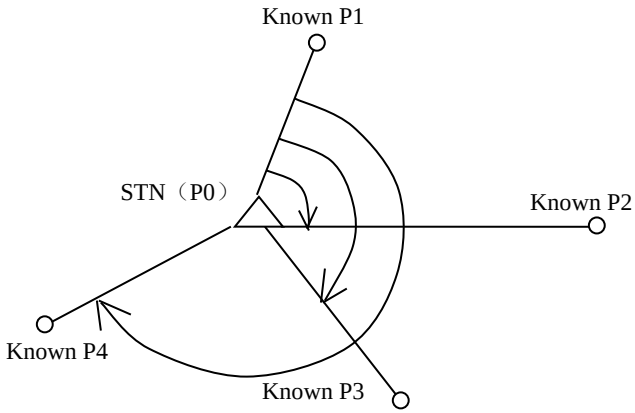
（3）Press【EDM】to start measurement.	【EDM】	
（4）Sight the target, Press【REM】, the item "ht" display the height from the surveying point to the object .	【REM】	
(5)press【STOP】to stop this operating •【EDM】: observe the target again •【REM】: start REM measurement	【STOP】	
(6)press【ESC】back to the former screen	【ESC】	

Maximum observation angle：±89°
Maximum observation height：±9999.999m

12、Resection Measurement

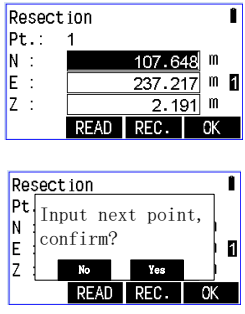
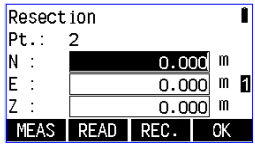
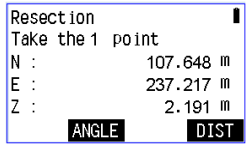
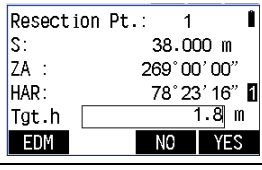
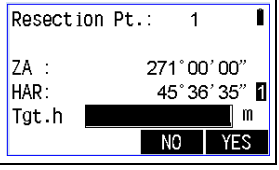
●It is possible to use resection to determine the coordinate of the instrument station by measuring multiple known points.

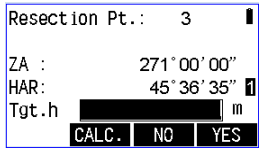
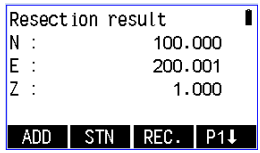
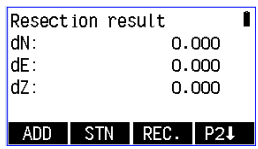
Enter valus or observation values	Output
Ni、Ei、Zi：coordinate value of the given point	N0、E0、Z0：coordinate of station
Hi：horizontal angle value	
Vi：vertical angle value	
Di：distance value	



- The instrument can calculate the station point's coordinate by observe 2-4 known points.
  - 3、 When the distance can be measured .2 known points is required.
  - 4、 When there is even one point can not be measured ,3 known points is required.
- Resection survey is available by choosing "6,resection"in the menu mode.
- The known coordinates of the point can be read from the memory in advance.
- It is possible to record set known point coordinate data or calculated instrument station data in the JOB which has been selected.
- Target height will recover to its initial value by completing resection measurement.

▸Step

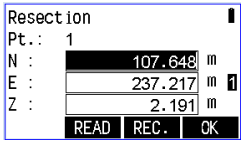
Operating process	Key	Display
（1）In the MENU mode press”6.Resection meas”. Enter the first known point date and press【OK】，pop up as shown in the interface and press 【ENT】。 •interrupt input ： 【ESC】 • read coordinate data:【READ】 • record coordinate data: 【REC.】	”6.Resection meas” + 【OK】 + 【ENT】	
（2）Press【OK】and 【ENT】after setting the first point . • repeat the first Step and enter all the given points	Input coordinate date	
（3）all the given point is entered completed. Sight the first target, press 【ANGLE】for angle measurement only, if distance measurement is needed,press【DIST】	【MEAS】	
（4）when pressed 【DIST】，the result value is displayed. Press【YES】to continue , press【NO】to re-survey this point.	【DIST】	
（5）【ANGLE】only offer the angle measurement . Press 【YES】to continue surveying, press【NO】to re-survey this point.	【ANGLE】	

（6）Repeat Step 4 and Step 5 to measure the known points. When the number of observation values is enough, 【CALC.】will display on the screen. Press [YES] to automatically start calculations after observations of all known points are completed.surveying • re-observe the same point: 【NO】 • Observe next point:【YES】 • Calculate station coordinate：【CALC.】	【CALC.】	
（7）When calculate is completed, result will be displayed on the screen NEZ：calculate station coordinate dN/dE/dZ:the standard differential which indicate the precision of the observation Press【P1↓】to switch results	【CALC.】 【P1】	 
（8）press【STN】to set the result as the instrument station coordinate and the result will be stored.	【STN】	
（9）Press【REC.】to store the station coordinate and then exit.		

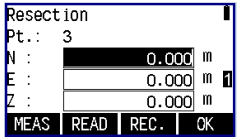
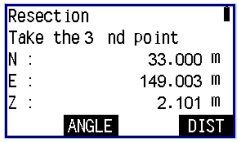
• Abandon calculate result and observe again：【ESC】
• Abandon calculate result and add known points：【Add point】

12.1 Re-obervation

●It is possible to re-observe a known point from the first point or to re-observe only the final known point.

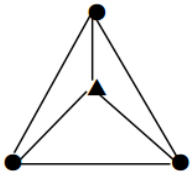
Operating process	Key	Display
（1）Press【ESC】 to back to the former display, former data is still on the screen.	【ESC】	

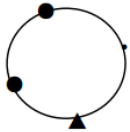
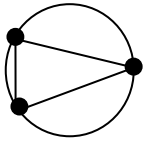
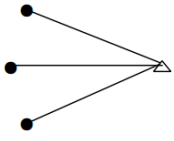
12.2 Add known points

Operating process	Key	Display
(1)Press【ADD】 in the result display screen.	【ADD】	
(2)After adding the points, when there is a known point which has not be measured, perform from the known point.	【MEAS】	

▶Introduction **Notice of resection**

•It is impossible to calculate the coordinate of the unknown point(station point),if the unknown point and the known points are on the edge of a single circle.

	• The arrangement such as shown on the left are liable : ▲: Unknown Point ●: Known Point

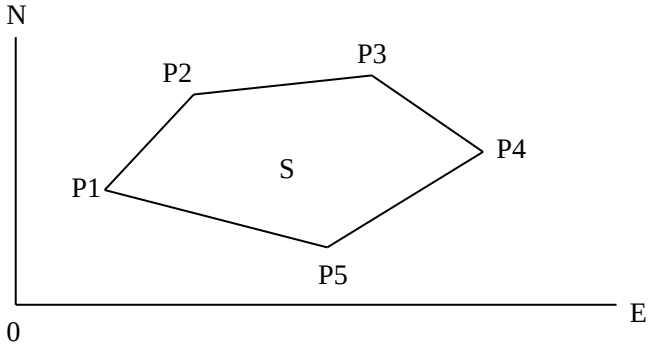
	• It is impossible to calculate the correct result.
	• when the known points is on the edge of a same circle, take one of the following measures: set the observation station at the center of the triangle if possible
	• in some cases it is impossible to calculate the coordinate of the instrument station if the include angle between the known points is too small. It is difficult to imagine that the longer the distance between the instrument station and the known points, the narrower the include angle between known points. Be careful because the points can easily be aligned on the edge of a single circle.

13、Area calculation

It is possible to calculate the polygon area which are the connection of by some points data, the coordinate data can be measured or read from memory. And the following two methods can be alternately performed.

Coordinate（given value）： P1 (N1, E1)，P2 (N2, E2) ，P3 (N3, E3) …

Area（calculated value）： S

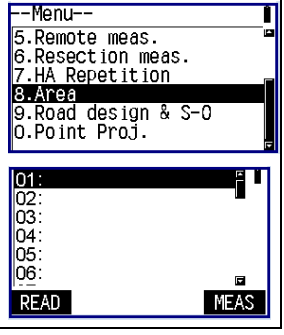


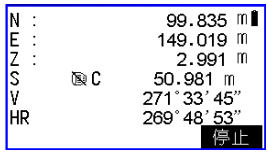
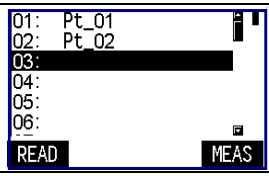
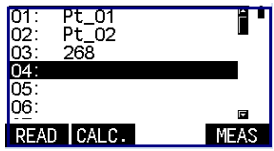
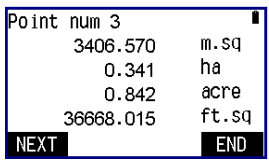
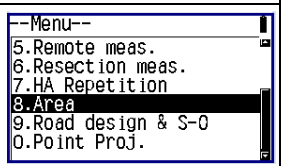
• The number range of coordinate points that constitute polygon：3~20

Notice： • the area calculate result will be incorrect when the points is less than three.

• The consequence of the given points must be gclockwise or counterclockwise, otherwise the result of the calculation will be incorrect.

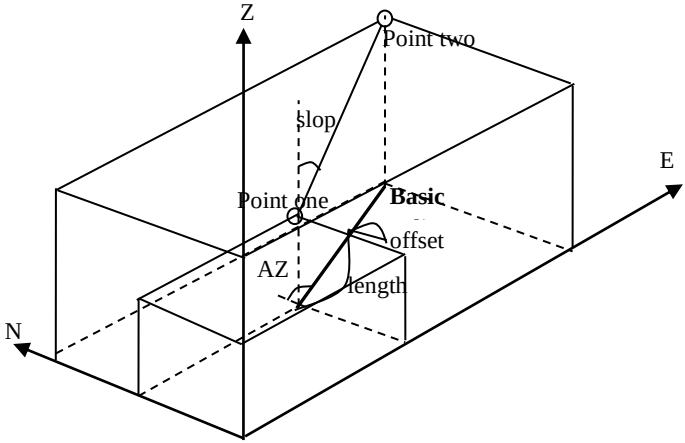
▸Step

Operating process	Key	Display
(1) On the 【MENU】 display, select the "8.area ". the points which take part in the calculate of the area calculation can be read from the memory or measurement.	【MENU】 + “8.Area”	

(2)Sight the first point of the polygon ,then press 【MEAS】 , the measurement results will be displayed on the screen.	【MEAS】	
(3)When complete the measurement, the result will showed as "pt_01".	【STOP】	
Repeat Steps 2 to 3, finish the point measurement in clockwise or counterclockwise		
(5) You can also use coordinate data in memory. Press the 【READ】, select the desired points in the memory, the information will be display on the screen.	【READ】	
(6) Complete measurement, press【CALC】,then you can get the result.	【CALC】	
(7) Press 【END】, stop area calculation and return to the menu screen. Press[【NEXT】 to perform the area calculation program again.	【END】	

14、Straight-line set out

It is used to setting-out the baseline to the point that distance to the baseline is designed. It is also used to measure the distance from the baseline to a measuring point.



14.1Define baseline

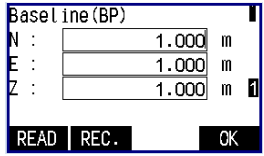
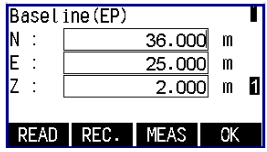
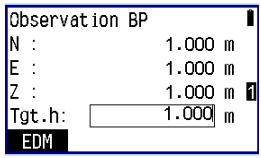
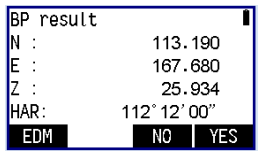
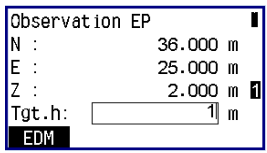
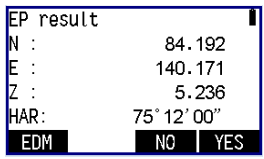
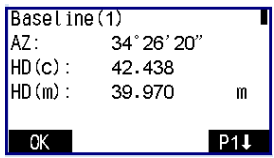
It is required to define the baseline before perform the measurement. The baseline can be defined by entering the two-point coordinates. The ratio values indicate the differences between the coordinates entered and the coordinates of the observation.

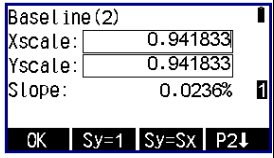
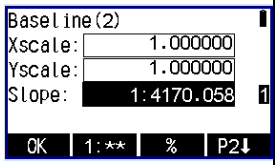
$$\text{ratio } valucs = \frac{Hdist'(\text{the distance calculated by the coordinates of obvervation})}{Hdist(\text{the distance calculated by the coordinates inputted})}$$

• The ratio is 1, if the first or the second points is not be observed.
• The definition of the baseline can be used for straight-line set out measurement and point projection.

▸Step

Operating process	Key	Display

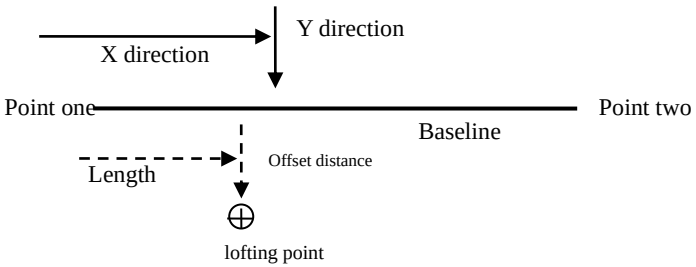
(1) In the MEAS mode, arrange【S-O】 to the soft keys firstly. Select the "4.S-O line", then select the "1. Def. baseline ".	1. Def. baseline	
(2) Press 【READ】,get coordinate data form memory You can also manually enter the known points.	【OK】	
(3)Complete set the points , press 【MEAS】 to measure baseline point.. If do not to measure baseline start and end point, press 【OK】 directly to Step (7).	【MEAS】	
(4) Sight the first point of the baseline, and press 【EDM】,the results are displayed on the screen.	【EDM】	
(5) Press【YES】,to confirm the results . Press 【NO】to measure the start point again	【YES】	
(6)Sight the end(second) point of the baseline, press 【EDM】, then the measurement results will be displayed on the screen.	【EDM】	
(7)Press【YES】,confirm the results. The instrument can calculate the distance between the start point to the end point, and we can get the scale factor on the display.	【OK】	

		
(8)Press 【OK】 , complete the definition of the baseline, and return to the menu. Press 【F4】to page ,press 【Sy=1】,set scale factor Y to 1,When you focus on" slope" ,press 【1:**】 to convert ratio display mode 1:**= elevation: horizontal distance	【1：**】	

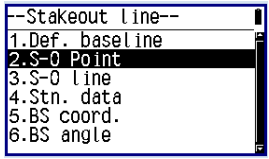
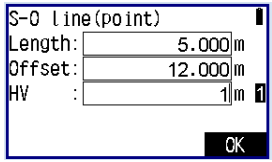
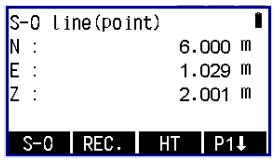
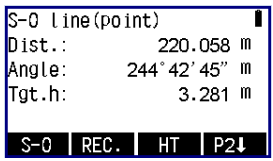
14.2 Straight-lint point set out

The instrument can calculate the coordinate of setting out point by the entering length value and the offset value based on certain baseline, and set the target on the position of the calculated coordinate.

• Define baseline before setting out.

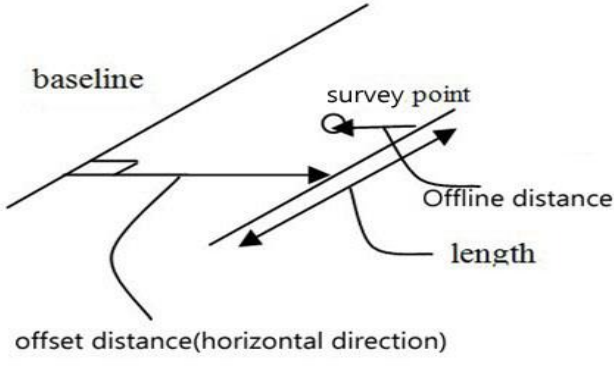


▶Step

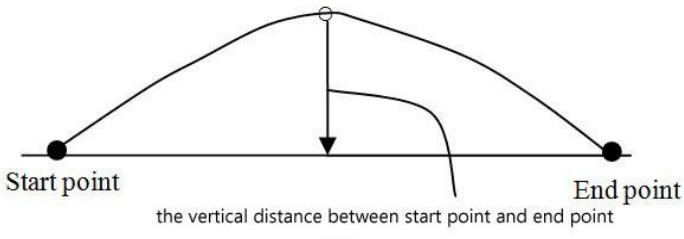
Operating process	Key	Display
（1）In the line stakeout menu, choose "2 point stakeout", then press【ENT】。	“2.point stakeout” +【ENT】	
（2）Enter the following items: length: the distance of baseline start point to the point which stake point projected to baseline. Offset: the vertical distance from stake point to the baseline	Input length、offset、Height differenc e	
(3) Press 【OK】,to calculate and display the coordinate of stake point.(press 【F4】to page 2) Record: save the calculated coordinate. Press 【HT】to register the target height. Press【S-O】to setting out the point.	【OK】 【F4】	 

14.3 Line setting-out

Line setting-out is used to measure the horizontal and vertical distance from the point to baseline.

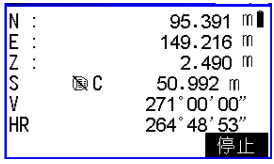
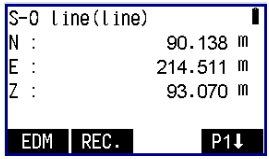
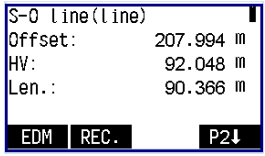
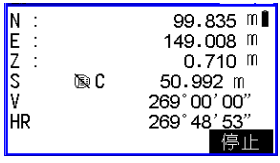


section view



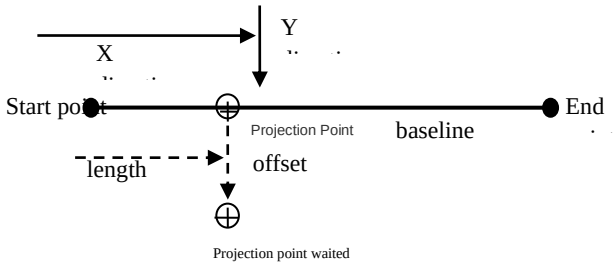
▶ Step

Operating process	Key	Display
（1）In the line stakeout menu, choose "3.S-O line ",then press【ENT】.	“3.S-O line”+【ENT】	--Stakeout line-- 1.Def. baseline 2.S-O Point 3.S-O line 4.Stn. data 5.BS coord. 6.BS angle
Enter offset value: Offset: the moved distance in horizontal direction of baseline. Moved to right the value is plus, moved to left the value is minus.	Input length、offset	S-O line(line) Offse 5 m 1 EDM

（3）Sight the first target, then press【EDM】,the screen will show the results.	Focus on target+ 【EDM】	
(4)The results is displayed on the screen(press【F4】 go to page 2）. Offset: the offset from measure point to required position ,right offset is plus, the left offset is minus HV: the height difference from measure point to baseline. If the value is plus ,it means that the point is above the baseline. If it is minus, it means that the point is below the baseline Len.: the distance from the point to its projection on baseline	【F4】	 
(5)Sight the next target, press 【EDM】 ,Press 【REC.】 to save the result 。	Focus on the next target+ 【EDM】	

15、Point projection

Point projection is used to project a point to a known baseline. It is possible to enter the coordinate or get the coordinate from measurement.



15.1 definition of the baseline

● the definition of the baseline can be used in line setting-out measurement and point projection.

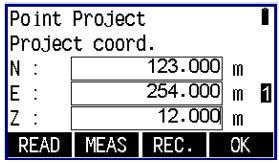
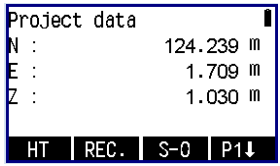
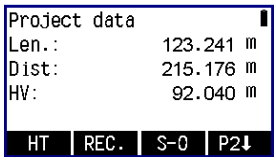
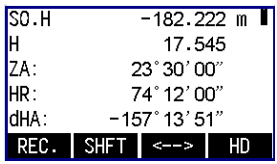
See Chapter 14.1 Steps.

15.2 point projection

Define the baseline before point projection .

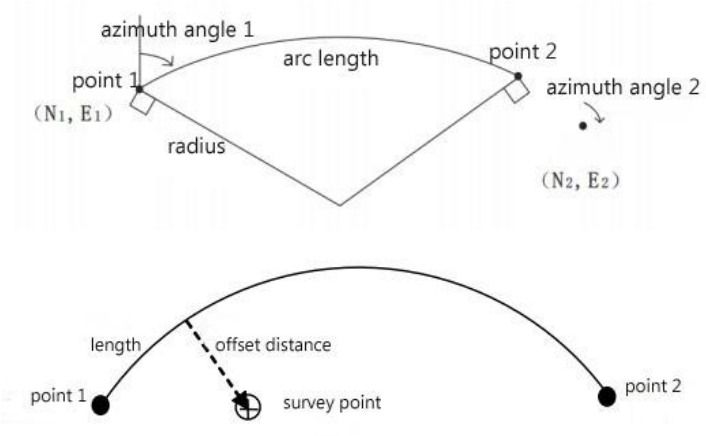
▸Step

Operation process	Key	Display
3、 Define baseline，refer to14.1。		
4、 Choose "2 point projection "in projection menu, then press【ENT】.	“2.point projection” + 【ENT】	--Point projection-- 1.Def. baseline 2.Point projection 3.Arc 4.Stn. data 5.BS coord. 6.BS angle

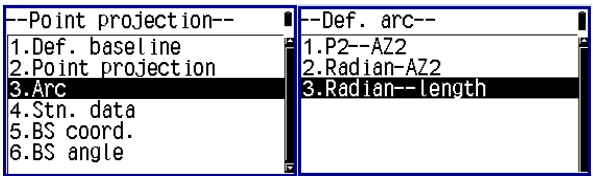
5、 Enter the point of the projection or press 【MEAS】 to get the projection point coordinate .If you want to save the coordinate ,press 【REC.】To get the coordinate form memory press【READ】	input the projection point coordinates	
6、 Press 【OK】, Then the instrument will calculate and display the results:(press 【 F4】 to page 2) Len: the start point to project point Dist: the vertical distance from the project point to the baseline. HV: the height from the point (ready to project)to foot point on the baseline. Press 【HT】 to enter the target height Press 【REC.】to save	【OK】 【F4】	 
（5）Press【S-O】 to perform point projection set out.	【S-O】	
（6）Press【ESC】		

15.3 Reference Arc

We can define an arc through three ways, and then measure a target point, so you can get the data relationship between target and the arc.

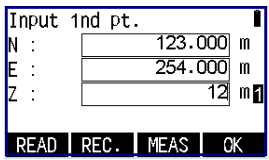


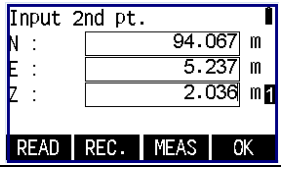
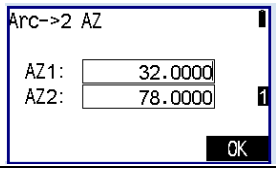
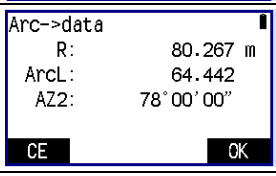
- You can enter this menu through point projection menu
- You can define “arc” to keys, and reach function menu through basic measurement interface
- You can define arcs by three ways



15.3.1two endpoint+two azimuth to define the arc

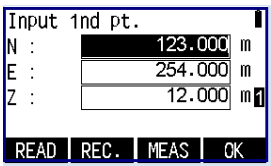
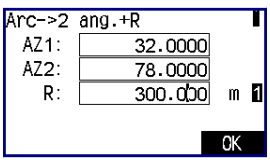
▸Step

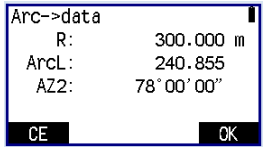
Operation process	key	display
◆ Choose “1.P2—AZ2” In the menu ,enter the P1 coordinate 【READ】:get the coordinate from memory. 【REC.】:record the current coordinate 【MEAS】:measure point P1	“1.P2—AZ2”	

【OK】: confirm your entry		
◆ Enter the P2 coordinate ,the operation is the same with P1	【YES】	
◆ After inputting the tangent line azimuth of the two points, press【OK】。	【YES】	
◆ Calculate to get the arc data 【CE】: back to menu 【OK】: go to target point measurement	【YES】	

15.3.2 Endpoint+R+two azimuth to define arc

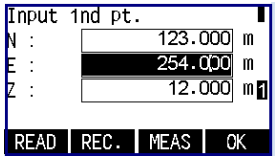
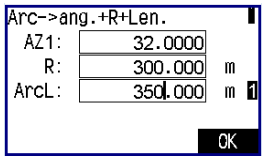
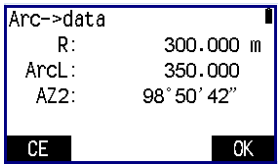
▸Step

Operation process	key	Display
（1）Choose “2.radian--AZ2”,you can enter the P1 coordinate 【READ】: get the coordinate from memory 【REC.】: record the current coordinate 【MEAS】: measure P1 【OK】:confirm your entry	“2.radian--AZ2”	
（2）After setting the radius and tangent azimuth of two endpoints, press【OK】.	【yes】	

（3）Get the arc data 【CE】：back to menu 【OK】：go into target point measurement, refer to chapter 15.3.4	【yes】	

15.3.3 One endpoint+radian +one azimuth+arc length+radius to define arc

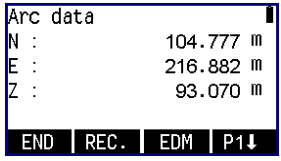
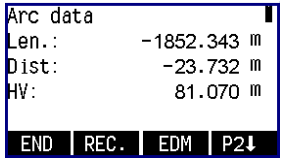
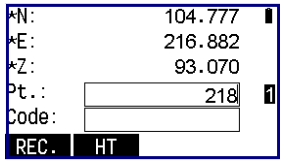
▸Step

Operation process	Key	Display
（1）Choose"3.radian--length" in the menu ,you can input the P1 coordinate 【READ】: get the coordinate 【REC.】：record the current coordinate 【MEAS】：measure P1 【OK】：confirm ,go to next Step	3.radian--length"	
（2）Input the tangent line azimuth of an endpoint ,and the arc radius ,press 【OK】。	【OK】	
（3）Calculate and get the arc data 【CE】：back to menu 【OK】：go to target point measurement ,refer to chapter 15.3.4	【OK】	

15.3.4 Arc reference line target point measurement

▸Step

Operation process	key	display

（1）In the arc data interface,press【OK】,go to target point measure	【OK】	
（2）Sight the target point，press【EDM】,get the target point coordinate	【EDM】	
（3）Press【F4】,to page up and down, show you the relationship data between target point and arc	【F4】	
（4）Press【REC.】,to record the current point coordinate	【REC.】	
（5）Press【END】，back to menu.		

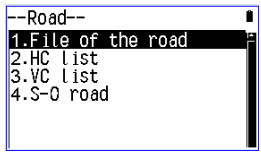
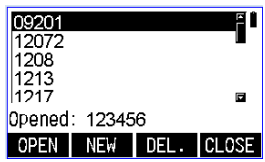
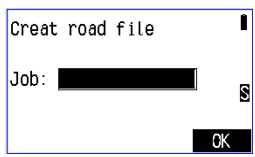
16、Road design and set out

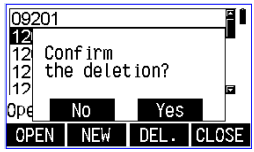
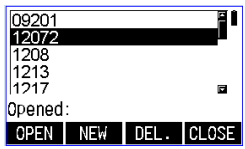
You can set out the designed point by horizontal and vertical curve, stake number and the deviation .

16.1 Road file management

Manage the road file

▸Step

Operation process	Key	Display
（1）Choose “9.Road design & S-O” in the【MENU】, then press【ENT】.	“9.Road design & S-O” + 【ENT】	
（2）Select “1. File of the road “in “9.Road design and S-O” menu	“1. File of the road “	
（3）Press【NEW】，to create a new road file. Enter a name of the new road file, press【OK】,then you can create Horizontal and vertical alignment file with the same name.	【NEW】	

（4）Press【DEL.】to delete a road file. When completed, the list will be refreshed.	【DEL.】 【ENT】	
（5）Press【OPEN】,to set the current file as the road working file. Press 【CLOSE】to set the current road file empty.	【CLOSE】	

16.2 Define horizontal alignment of roadway （at most 30 datum）

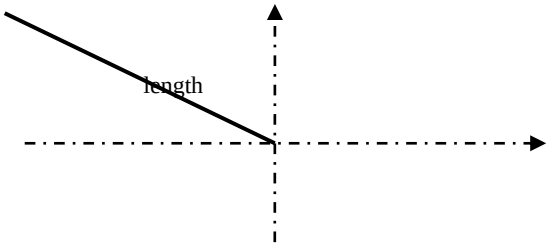
The horizontal curve data can be manually edited , and also be imported from the computer. There are two ways to define the horizontal alignment :one is "element ", another is "intersection".

16.2.1 Define a horizontal alignment by “element method”

The element method consists of the following elements: the starting point, straight line, circle and easement curve.

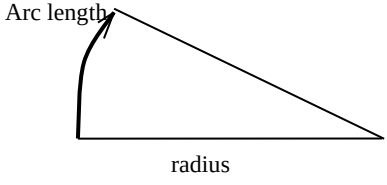
- **Straight line**

The straight line can be defined when start point and other type of line have been defined.



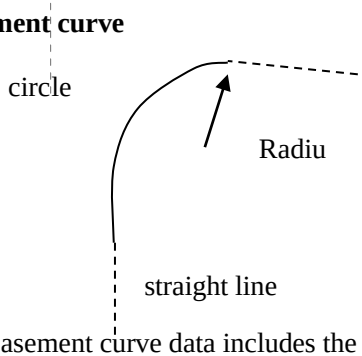
Straight line includes azimuth and distance, and the distance can not be minus.

- **Circle**



Circular curve includes radius and arc length. The rules of radius: Along the curve direction, when turning to the right , the radius is positive, negative radius when turning to the left. Arc length cannot be negative.

- **Easement curve**

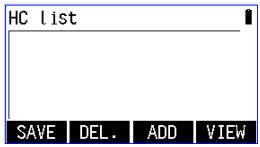
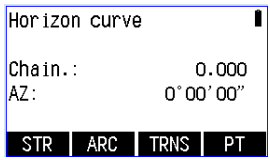
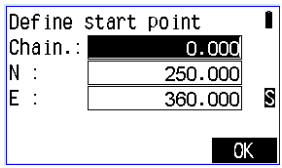
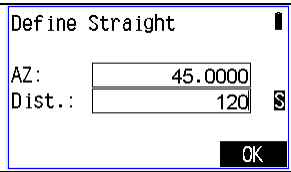
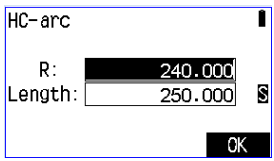
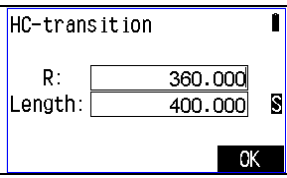


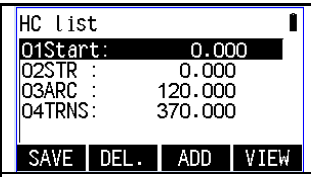
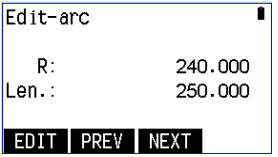
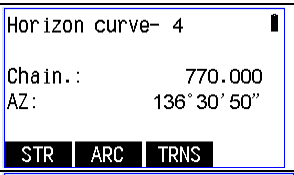
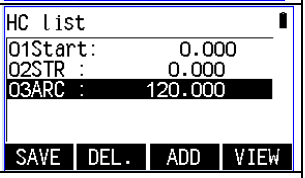
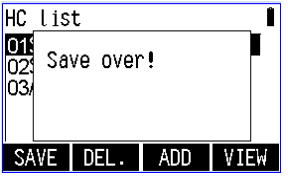
Easement curve data includes the minimum radius and arc length.The radius positive-negative regularity of easement curve is the

same as the radius of circle. Also, the arc length cannot be negative

Follow is the input Steps of the horizontal alignment element method.

▸Steps

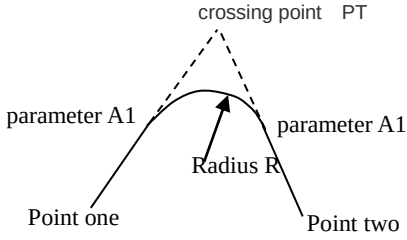
Operating procedure	Key	Display
（1）Choose “2.HC list” from the road menu.	“2.HC list”	
（2）Press 【ADD】 . If you haven’t input starting point, you will come in starting point interface whatever straight line, circular curve or easement curve you choose. Input the start point and press 【OK】.	【ADD】 【OK】	 
（3）Press 【STR】 come in the straight line data input screen. When completed setting, press 【OK】.	【STR】	
（4）Press 【ARC】 come in the circular curve data input interface. When completed setting ,press 【OK】 .	【ARC】	
（5）Press 【TRNS】 come in the easement curve data input interface.	【TRNS】	

（6）Complete setting all line data, press【ESC】return to horizontal alignment list interface.	【ESC】	
（7）Press【VIEW】to show the road data of the line you chosen. Here we choose the circular curve as an example. ·You can view the road date in the list according to【▼】【▲】. Press【EDIT】to edit the road data.	【VIEW】	
（8）Press 【ADD】 to add new road data.	【ADD】	
（9）Press【DEL.】to delete the chosen line date (start point is forbidden).	【DEL.】	
（10）Press 【SAVE】in the prompt box to save the data in the current opened road file.	【SAVE】	

Note: If you don't save the data, there will be no data or the data existent earlier in the road file when you restart the total station.

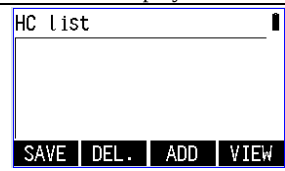
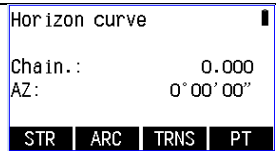
16.2.2 Define the horizontal alignment by “intersection method”

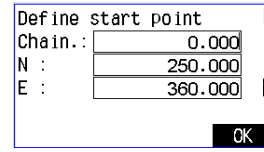
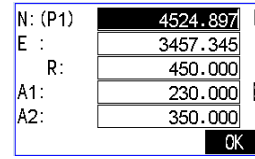
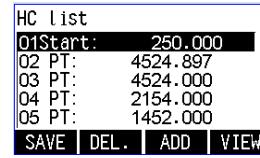
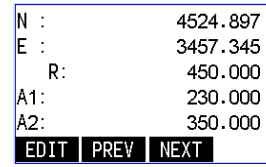
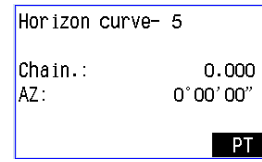
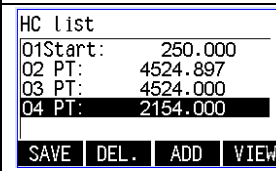
The intersection of point includes coordinate，radius and parameters A1,A2 of the easement curve.The radius and parameters A1,A2 can’t be minus.If inputting radius there will be inserted an arc with a specified radius between the current point and the next point. If inputting easement curve and parameters A1,A2 there will be inserted an easement curve with a specified length between the straight line and the arc. Don’t mix the point of intersection with the straight line,arc and easement curve,or the calculation will be wrong.

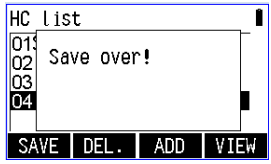


Follow is the Intersection method definition of horizontal alignment input Steps.

▸Steps

Operating procedure	Key	Display
（1）Choose “2. HC list” from the road menu.	“2. HC list”	
（2）Press 【ADD】 come in line choose interface . If you haven’t input starting point, you will come in starting point interface.	【ADD】 【OK】	

		
（3）Input start point,then press 【OK】 come in the point of intersection input interface. Press 【OK】 to input the next point of intersection.	【OK】	
（4）After input all points of intersection press【ESC】 return to horizontal alignment list interface. It is line+N coordinate of the intersection in the list .	【ESC】	
（5）Press【VIEW】to show the detail data of the current road you chosen. ·You can view the road date in the list according to【◄】or【►】. ·Press【EDIT】 to edit the road data,the operation is the same as the input.		
（6）Press 【ADD】 to continue to add new road data.	【ADD】	
（7）Press【DEL.】to delete the line date chosen(start point is forbidden).	【DEL.】	

（8）Press 【SAVE】in the prompt box to save the data in the current opened road file.	【SAVE】	

Note：Use the following formula to compute when you input A1,A2 according to L1，L2。

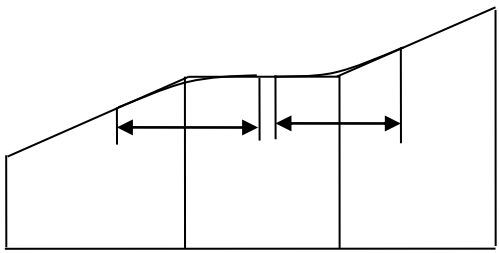
$$A_1 = \sqrt{L_1 \cdot radius}$$

$$A_2 = \sqrt{L_2 \cdot radius}$$

You can edit the alignment just according to the alignment menu.

16.3 Define the vertical alignment(Up to 30 datum)

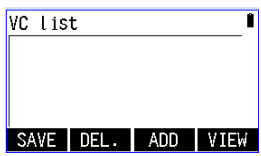
Vertical alignment consists of a set of intersection points. Intersection point including pile number, height and the curve length. The curve length of starting point and end point of vertical alignment must be zero.

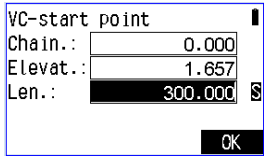
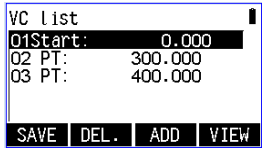
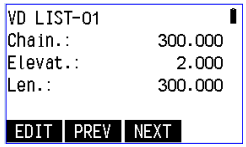
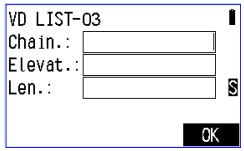
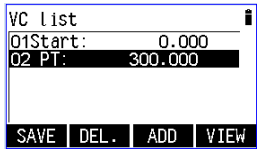
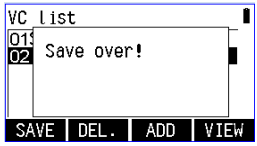


Piles number	1000	1300	1800	2300
Elevation	50	70	60	90
Distance	0	300	300	0

Following is the vertical alignment input Steps.

▸Steps

Operating procedure	Key	Display
（1）Choose “3. VC list” from the road menu.	“3. VC list”	

（2）Press 【ADD】 come in line choose interface. After input data, press 【OK】 to input the next point.	【ADD】	
（3）After input line data, press【ESC】return to vertical alignment list interface.	【OK】	
（4）Press 【VIEW】 to show the detail data of the current road you chosen. ·You can view the road date in the list according to【▼】【▲】 ·Press 【EDIT】 to edit the road data,the operation is the same as the input.。	【VIEW】	
（5）Press 【ADD】 to continue to add new road data.	【ADD】	
（6）Press【DEL.】to delete the line date chosen(start point is forbidden).	【DEL.】	
（7）Press 【SAVE】, and then press 【ENT】 in the prompt box to save the data in the current open road file.	【SAVE】	

16.4 Stake out road

You can do alignment lofting of the design points according to

design road pile number and deviation.

You must define the line first for alignment lofting.The way to define the alignment: Load the data from computer according to the function【receive horizontal alignment data】in【road design & S-O】, or input by hand in 【HC list】.

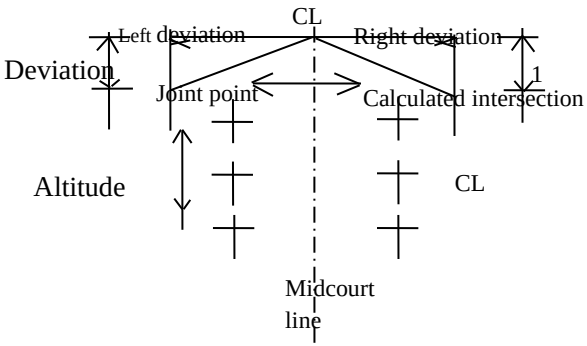
The vertical alignment don't have to define,but you have to define it if calculating altitude

e difference. The definition method is the same as the horizontal alignment.

The definition of the alignment loftinon as shown below.

Deviation left: Mean the horizontal distance between left pile and center line, right: Mean the horizontal distance between right pile and center line.

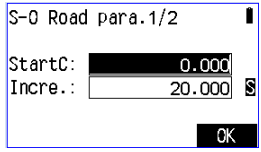
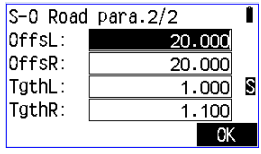
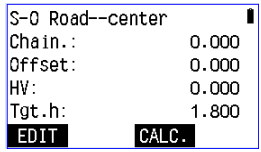
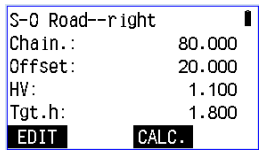
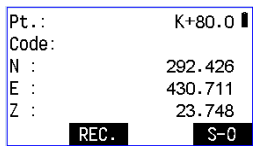
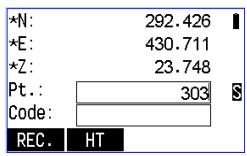
Altitude difference left(right): Mean the horizontal distance between left(right) pile and center line, respectively.



When having setted up station point and backsight point ,we can begin Staking out road.

▸Steps

Operating procedure	Operating	Display

（1）Select “4. S-O road”in the “Road lofting” menu.	“4. S-O road”	
（2）After input data, press 【OK】 come in calculating parameter interface.	【OK】	
(3)After input parameter , press 【OK】 come in the interface that you can select pile number,left,right,and center pile. ·Press【◄ 】【►】 to left and right pile.·Press【▼】【▲】 increase or decrease of pile number. ·Press 【EDIT】 to edit the calculation parameters of the pile.	【OK】	 
（4）Press【CALC.】and the current pile point coordinate data are calculated. If need to compute other pile point data, then press 【ESC】 to return to Step 3.	【CALC.】	
（5）Press【REC.】to record the current pile point coordinate data.。	【REC.】	
（6）Press 【HT】 come in the setting-out survey of current pile point. Specific operation see setting-out	【HT】	

survey		

Note: If the road data is saved, you can go directly into the road lofting without having to input data when you star up the next time. 。

Following is the statement of the lofting parameter:

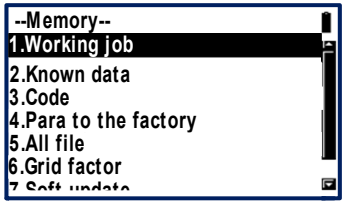
Left deviation (right deviation): Current left pile(right pile).

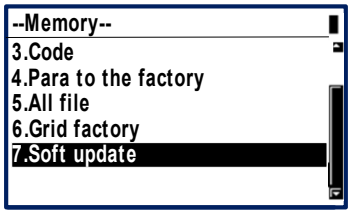
Left altitude difference (right altitude difference): Current left pile(right pile).

Increase or decrease of pile number: increase or decrease according to the distance between the piles.

17、Data recording

Memory mode screen





- Enter the memory mode, press 【MEM.】 on the status screen.
- In the memory mode, the operation of the data about work file and memory can be done.
- Select work file;
- Delete work file;
- Register the known data in advance;
- Clear the coordinate data in memory;
- Read the coordinate data from memory;
- Input code;
- Read code;
- Output the data of work file to computer;
- Software upgrade

The machine supports up to 8G U disk read and write, when running the program, don't insert or pull out the U disk. If you pull out the U disk when the instrument checking it, the subsequent operations may cause error!

17.1 JOB file

17.1.1 Select current JOB file

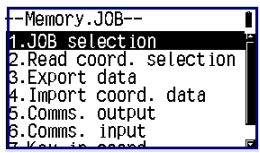
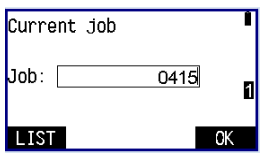
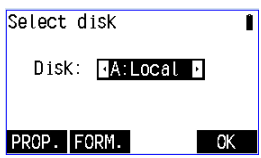
• Before recording the data, select the work file of recording and the file to be read. It is possible to read coordinate data from the file which is selected for read. Following is the data that can be recorded into the work file.

• Observation data

  • Instrument station data and backsight data

  • Annotation data

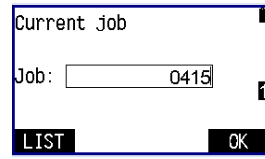
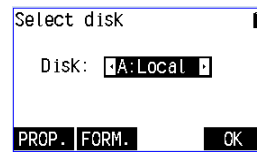
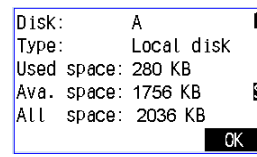
▸Steps

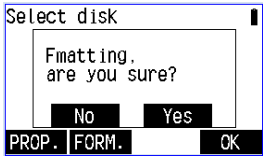
Operating procedure	Operating	Display
（1）In the memory mode, select “1.work file” and then press【ENT】,the “File Management Screen” is displayed.	“1.Work file” + 【ENT】	
（2）Select “1.JOB selection” and then press【ENT】,the “JOB name edit screen” is displayed. Input the file name and then press 【OK】 to set the current working file.	“1.JOB selection” +【ENT】	
（3）Press 【LIST】 , enter the disk selection screen. A：local---Mean the instrument internal storage B：SD card----Mean the inserted SD card. In some cases it will damage the data	【LIST】	

if pull out the SD card without cut off the power.		
（4）Press 【OK】 to enter the file list screen to display all the work file name. Press 【▲】 or 【 ▼ 】 to move the cursor to the work file name you want, and press 【 SELT 】to select the work file desired.	【OK】/ 【 SELT 】	
（5）Press【ESC】to return to work file management list screen.	【ESC】	

17.1.2 **Check the memory status and format disk**

According to this operation you can check the instrument memory capacity, the remaining space and format disk.

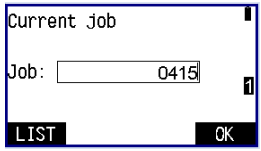
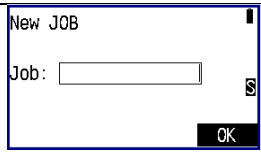
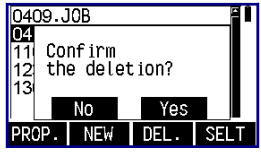
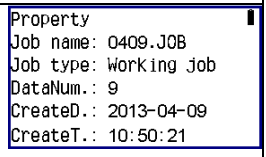
Operating procedure	Key	Display
（1）According to the first and second Steps described in the select current work file, the “Current job selecting” screen is displayed.		
（2）Press 【LIST】 into the disk selection screen.	【LIST】	
（3）Press 【PROP.】 to display the attribute information in the current disk.	【PROP.】	

（4）Press the 【FORM.】, you will be asked whether format the selected disk. Press 【ENT】 and the disk will be formatted. (this operation need to be careful)	【Format 】	

17.1.3 Work file management

Set up a new work file. The file name can be letters A to Z, also it can be Numbers 0-9 or a combination of both, can't contain characters do not conform to the rules and use the existing file name.

▸Steps

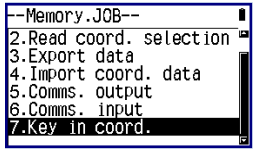
Operation procedure	Operation	Display
（1）In “current job selecting” screen. Press 【LIST】 into the file list.	【LIST】 【OK】	 
（2）Press 【NEW】,In the new file creation screen, input the file name and press 【OK】.	【New】	
Press【DEL.】to delete the selected file form memory. Press 【ENT】 to confirm delete when dialog prompted.	【DEL.】	
（4）Press 【PROP.】 to display the current file attributes	【PROP.】	

17.1.4 Select the file for reading

The file which has be selected to read data from can be used to

read coordinates data.

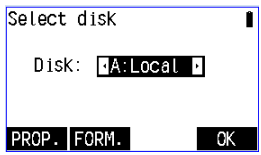
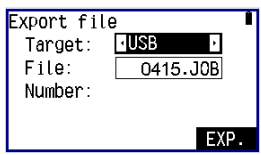
▸Steps

Operating procedure	Operating	Display
（1） Press "2. Read coord. selection " , then press 【ENT】in “memory.work file” list. Select the file for reading.	"2. Read coord. selection "+ 【ENT】	

17.1.5 Export file data

It is need to insert the SD card or USB flash disk to firstly if export the data from the local disk or SD card into the SD card or USB flash disk, all the exported file will automatically convert to TXT format file.

▸Steps

Operating procedure	Key	Display
（1） Select “ export file data” in “memory.work file” menu.	“3.Export file data” + 【ENT】	
（2）Select the disk of the work file to be exported, then press 【OK】 into the work file list.	【OK】	
（3）Select the file to be exported, then press 【NEXT】. Select the target disk, you can change the file name again, then press 【EXP.】 to start exporting data.	【Next】 + 【EXP.】	

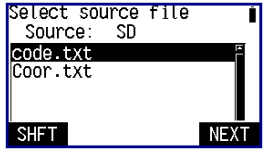
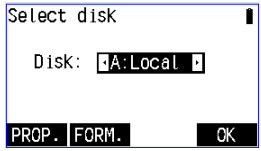
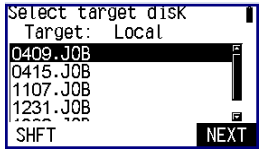
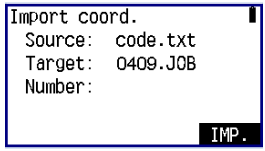
17.1.6 Import the coordinate data

• Need to insert the SD card or USB flash disk to import the data from the USB flash disk or SD card to a local disk or SD card. You can't do

this operation between the local disk files.

•The format of the file imported: PTNO (point number),E, N, Z, CODE (code) , each line ends with "enter+ newline", and at the file end must have a empty line of "enter + newline", in other word, press the enter key again behind the last data.

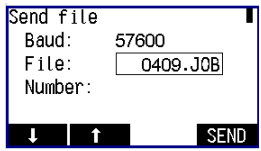
▸Steps

Operating procedure	Key	Display
（1）Press 【ENT】 after select "4.import coord.data" in the "memory.work file" menu, It will display the file for the coordinate imported.	"4.import coord.data "	
（2）Press【SHFT】you can switch between SD card and USB flash disk. Selected file, press 【NEXT】, and it will display the selection of the target disk.	【NEXT】	
（3）After selecting the disk, press【OK】, it will display a list of work files in the disk.	【OK】	
（4）After selecting the target file, press 【NEXT】, the information about the import operation is displayed , then press 【IMP.】, preform importing the coordinate data.	【NEXT】 + 【IMP.】	

17.1.7 Send the file data to a computer

It is need to connect the instrument and PC computer with the serial port line, and match up with the transfer software.

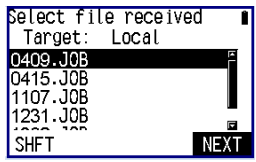
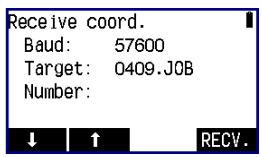
▸Steps

Operating procedure	Key	Display
(1)Select “5. Comms.output” in“memory.work file”, then Press 【NEXT】.	“5.Send file data” + 【NEXT】	
（1）Select the file to be sent, then press 【NEXT】,the “send file information screen” is displayed. ·Press【↑】 to increase baud rate. ·Press【↓】to decrease baud rate. ·Press 【SEND】 to start sending data , it will refresh the "send number" in the process of sending until send over.	【NEXT】	

17.1.8 Receive coordinate data

It is need to connect the instrument and PC computer with the serial port line, and match up with the transfer software.

▸Steps

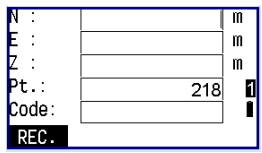
Operating procedure	Key	Display
（1）Select “6.Comms input” in“memory.work file”, then Press 【NEXT】.	“6.Comms input” + 【NEXT】	
（2）Select the file to receive the coordinate data , then press 【NEXT】,the “receive coordinates information screen” is displayed. ·Press【↑】 to increase baud rate.	【NEXT】	

·Press【↓】to decrease baud rate. ·Press 【RECV.】 to start receiving data , it will refresh the "receive number" in the process of receiving until receive over.		

17.1.9 Input coordinate data

· Can input the coordinate data to the work file by hand.

▸Steps

Operating procedure	Key	Display
（1）Select “7.Key in coord” of the“memory.work file”, then press 【ENT】. After inputting the coordinate data , press 【REC.】, the coordinates are recorded into the current working file. If you want to view the data, see the data view method in the record mode.	“7.Key in coord” + 【ENT】	

17.2 Known points management

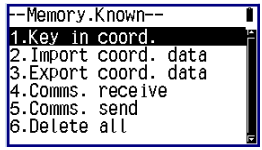
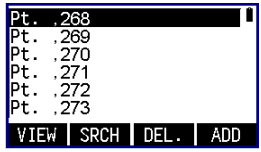
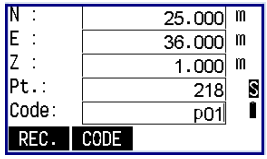
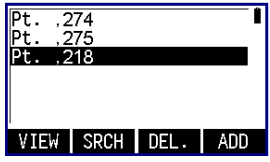
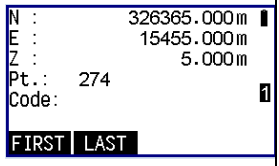
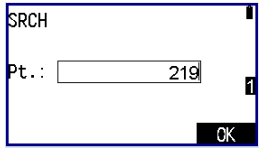
• Known coordinates can be input and stored in the instrument in advance. These data can be used as station point, backsight point, and setout point.

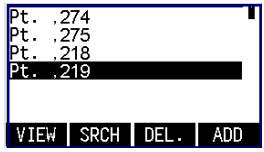
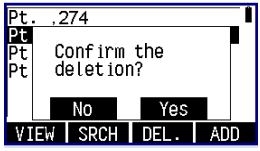
• The known coordinate data input in advance can use the keyboard, also can from external devices.

17.2.1Known coordinate management

▸Steps

Operating procedure	Key	Display

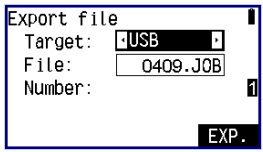
（1）Select “2.known data” in the memory mode, then press 【ENT】 into known data menu screen.	“2.known data” + 【ENT】	
（2）Select “1.Key in coord” , then press 【ENT】 into the name list of coordinate data. Press 【ADD】,coordinate edit screen is displayed. Press 【 ENT 】 or 【 ▼ 】 every time you input a data item.	“1.Key in coord” + 【ADD】	 
（3）Press【REC.】to store the coordinate in the file of the known coordinate. Press 【ESC】 return to the known coordinate list screen when the coordinate data input is finished.	【ESC】	
（4）Press 【VIEW】 to view the points data. · 【FRIST】 view the first data. ·【LAST】 view the last data. ·【▼】View the next data. ·【▲】View the previous data.	【VIEW】	
（5）Press 【SRCH】and Input the point name desired and press 【OK】 to return the list of point, and the cursor is focused on the point name find.	【SRCH】 【OK】	

		
（6）Press【DEL.】and the confirmation prompt dialog box is given, then press【ENT】to delete.	【DEL.】	

17.2.2Export coordinate data

·Need to insert the SD card or USB flash disk to continue, export the data from the local disk or SD card into the SD card or USB flash disk, all the exported file suffix will automatically convert to TXT format file.

▸Steps

Operating procedure	Key	Display
（1） Select “3. Export coord. data”in “memory.work file” list , then press【ENT】.	“3. Export coord. data”	
（2）Selected the target disk, you can change the file name , then press【EXP.】to start exporting data, you will be prompted when finish exporting.	【EXP.】	

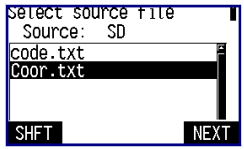
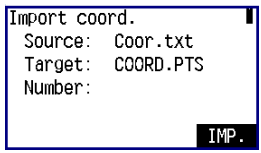
17.2.3 Import file data

·Need to insert the SD card or USB flash disk to import the data in the SD card or USB flash disk into the file in of known point in the local disk.

·The format of the file imported: PTNO (point number),E, N, Z, CODE (code) , each line ends with "enter+ newline”, and the file tail must have a empty line of carriage return + newline, in other word,

press the enter key again behind the last data.

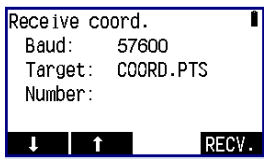
▸Steps

Operating procedure	Key	Display
（1）Press 【ENT】 after select “2.import coord.data” in the “memory.work file” menu, It will display the source selection of the file with the coordinate imported. Press 【SHFT】 you can switch between SD card and USB flash disk.	“2.import coord.data ” + 【ENT】	
（2）After selecting the target file, press 【NEXT】, then press 【IMP.】 begin to import the coordinate data. Notify when done.	【NEXT】	

17.2.4 Receive coordinate data

·This function need to use the serial port line, connect the instrument and PC computer, and match up with the “transfer software”.

▸Steps

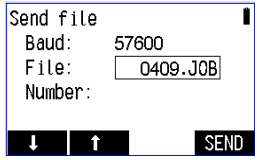
Operating procedure	Key	Display
Select “4.Comms.receive” in“memory.work file”, then Press 【ENT】. (4)Select the file to receive the coordinate data , then press【NEXT】to the receive screen. ·Press【↑】 to increase baud rate. ·Press【↓】to decrease baud rate. ·Press 【RECV.】 to start receiving data until finished , it will refresh the "receive	“4.Comms.receive” + 【ENT】	

number" in the process of receiving.		

17.2.5 Import coordinate data

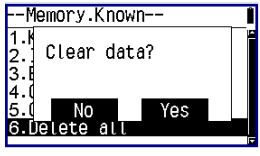
·This function need the serial port line, connect the instrumentation and PC computer, and match up with the “transfer software”.

▸Steps

Operating procedure	Key	Display
Select “5.Comms. send” in“memory.work file”, then Press 【ENT】. Select the file to receive the coordinate data , then press 【NEXT】 into the receive screen. ·Press【↑】 to increase baud rate. ·Press【↓】to decrease baud rate. ·Press 【SEND】 to start sending data until finished , it will refresh the "send number" in the process of sending.	“5.Comms. send” + 【ENT】	

17.2.6 Delete all the coordinate data

•This operation will delete all the known coordinate data in the memory immediately.

Operating procedure	Key	Display
（1）Select “6. Delete all” in the “memory. known data” screen, then press 【ENT】, and the deletion confirmation prompt	“6. Delete all” + 【ENT】	

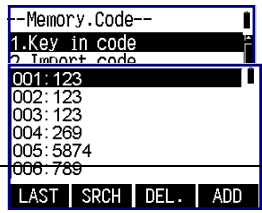
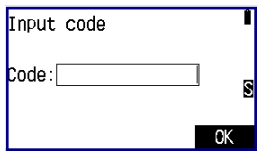
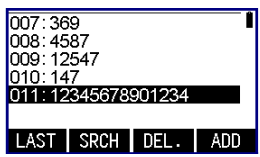
dialog box is given. Press 【ENT】 again to delete all data, press【ESC】to cancel.		

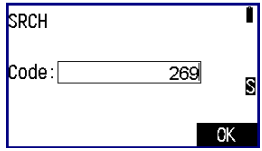
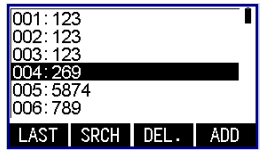
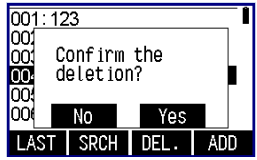
17.3Code management

·Code can be deposited in the instrument memory in advance.
·When recording station data or observation data, you can invoke the code in memory.

17.3.1 Input code

▸Steps

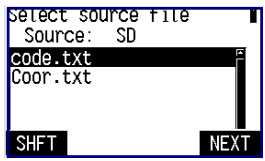
Operating	Key	Display
（1）Select “3.Code” in the memory mode, and then press 【ENT】 into the code menu screen.	“3.Code” + 【ENT】	
Select “1.Key input code” and then press 【ENT】into the code menu, press 【ADD】 into the input code screen.	“1.Key input code” 【ADD】	
（2）Press【LAST】, and the button change to 【FRIST】,and the focus position to the last. ·Press 【FRIST】, and the button change to 【LAST】,and the focus position to the first.	【LAST】	

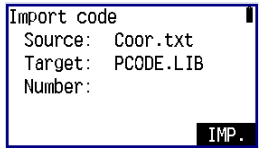
（3）Press 【SRCH】 and Input code and then press 【SRCH】 to return to points list, the focus position to the code searched.	【SRCH】 【OK】	 
（4） Press【DEL.】, and the confirmation prompt dialog box is given, then press 【ENT】 to delete.	【DEL.】	

17.3.2 Import the code

·Need to insert the SD card or USB flash disk to continue, import the code from the SD card or USB flash disk into the code file in the local disk. ·The format of the file imported: CODE (code), each line ends with "enter+ newline", and the file tail must have an empty line of carriage return + newline, in other word, press the enter key again behind the last data.

▸Steps

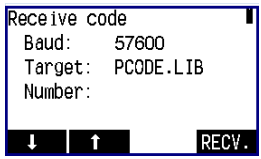
Operating procedure	Key	Display
（1）Select “2.Import code” in the “memory.code”, then Press 【ENT】 you can enter the source of disk file selection screen. Press 【SHFT】 you can switch between SD card and USB flash disk select of the target disk.	“2.Import code”	

（2）After selecting the file, press 【NEXT】into import screen, then press 【IMP.】 to start importing the code. Notify when done.	【Next】	

17.3.3 Receive code

·This function need to use the serial port line, connect the instrumentation and PC computer, and match up with the “transfer software”.

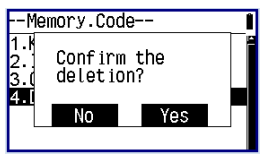
▸Step

Operating procedure	Key	Display
Select “3.Comms. code ” in“memory.code”, then Press 【ENT】. ·Press【↑】 to increase baud rate. ·Press【↓】to decrease baud rate. ·Press 【RECV.】 to start receiving code data until finished , it will refresh the "receive number" in the process of receiving.	“3.Comms. code ” + 【ENT】	

17.3.4 Delete all code data

• This operation will delete all the code data in the memory immediately.

▸Steps

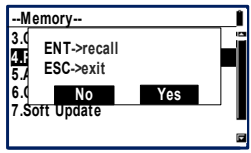
Operating procedure	Key	Display
（1）Select “4.delete all” in the “memory,code”, then press【ENT】, and the screen shows a confirmation dialog box . Press 【ENT】again will delete all the code data.	“4.Delete all” + 【ENT 】	

Press 【ESC】 to cancel.		

17.4 Restore the factory parameter

• This operation will make the instrument parameters restore to factory Settings.

▸Steps

Operating procedure	Operating	Display
（1）Select “4.Para. to the factory” in the memory management mode, and then press 【ENT】, the confirmation dialog box is given, then press 【ENT】 to confirm or press【ESC】 to cancel.	“7.Para. to the factory”+ 【ENT 】	

17.5 All files

▸Steps

Operating procedure	Key	Display
Select “5.All files” in the memory management mode, then press 【ENT】 and choose disk ,then press 【OK】to show the file list. PCODE.LIB code fixed file and COORD.PTS known coordinate file The two files system is set automatically and can’t be deleted. *.JOB work file *.LSH horizontal alignment file *.LSV vertical alignment file PCODE.LIB code fixed file COORD.PTS	“5.All files” + 【ENT】 + 【OK】	

*.JOB working file *.LSH Horizontal alignment *.LSV Vertical alignment file		

Note: Other operating see the working file

17.6 The grid factor setting

When calculating the coordinates, the horizontal distance measured must multiply by the scale factor. The original data will not change because of the scale factor.

Computation formula

1. $$\text{Altitude factor} = \frac{R}{R + ELEV}$$

R: The average radius of earth
ELEV :mean sea level altitude

2. Scale factor
Scale factor: Scale factor of the station

3.Grid factor
Grid factor=altitude factor×scale factor

Distance calculation

1. Grid distance
HDg=HD×grid factor
HDg：Grid distance
HD：Ground distance
2. ground distance

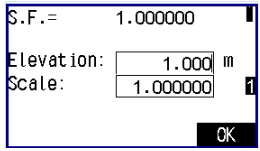
$$HD = \frac{HDg}{\text{Grid factor}}$$

Note: 1.The input range of the scale factor: 0.99~1.01
2.The input range of the average height above sea level :

-9999.9999~9999.999 9

The average altitude retained after the decimal point one, the default value is 0.

▸Steps

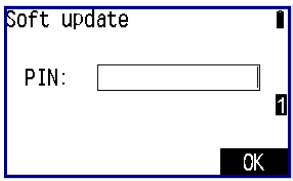
Operating procedure	Key	Display
Select"6.grid factor" in the memory management menu, and then press【ENT】, the screen will display the current setting. Input altitude factor and scale factor, then press【OK】, it will Compute the grid factor again.	"6.Grid factor" + 【ENT 】	

17.7Software upgrading

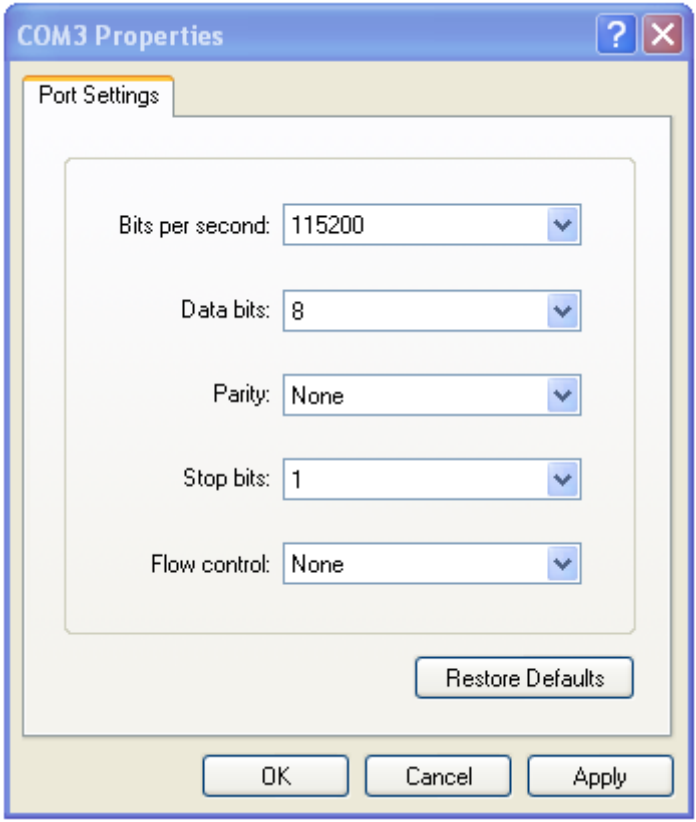
Warning:

The following functions must be carried out under the guidance of professionals, if the operation is wrong, it may lead to the instrument can't work properly!

This function is prepared for the users to upgrade the instrument software.

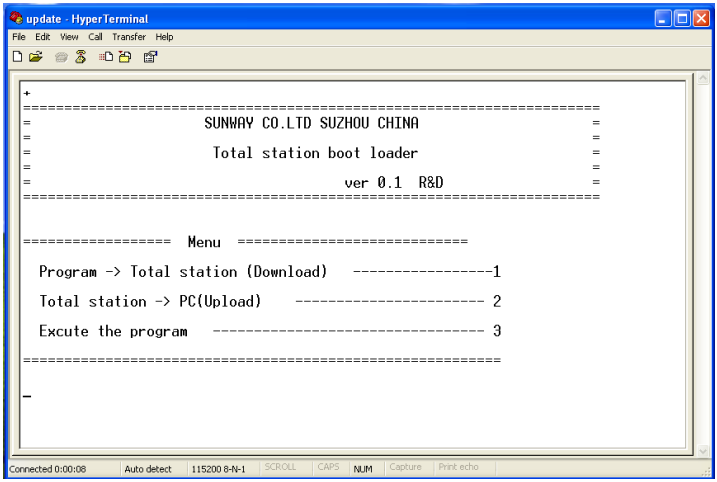


1. Input PIN code(82543), and then press【ENT】,the instrument will be turned off.
2. Connected to the computer through a serial cable, after installing the correct driver premise, open a HyperTerminal software, configure the correct serial port, it will "bits / sec" is set to 115200, "Data Flow Control" is set to "None" and press [OK];

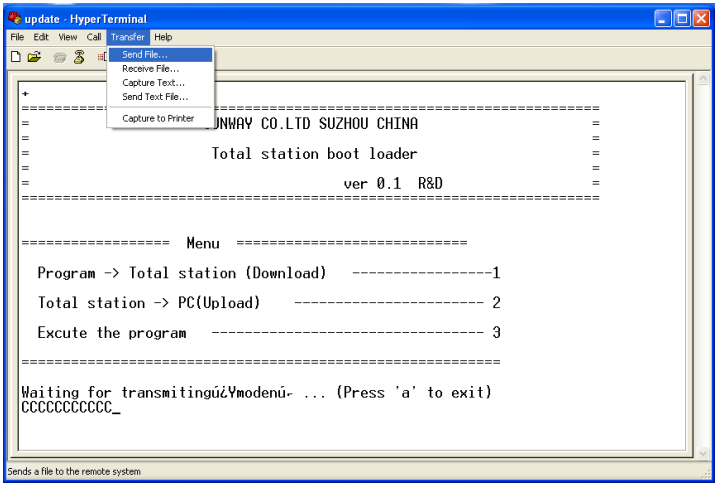


3. Press the power key of the instrument in Hyper Terminal , shown as follows:

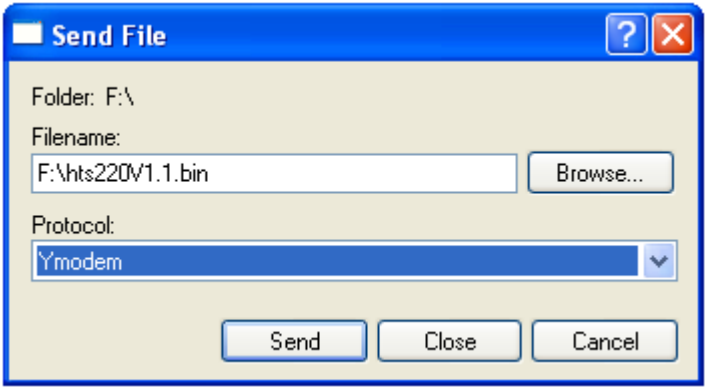
Note: Software upgrade operation must be careful once you select the instrument into the upgrade status; If press "3" in the picture below, you can also resume running the previous program.



4. Press【 1 】button on the keyboard into waiting to send program state, and then select "send file".



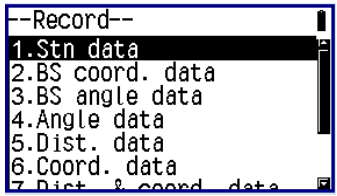
5. Select the new edition total station software, click on "send" button;

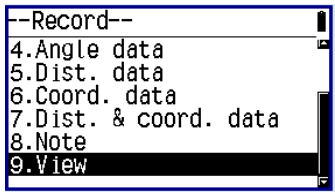


6. It will display the sending application process, then close the super terminal, starting up after removing the instrument battery and then putting in again. The current software is the new version updated previously.

18、The date recording in the record mode

Record mode screen



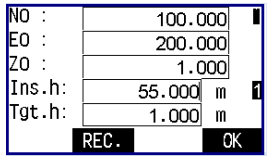
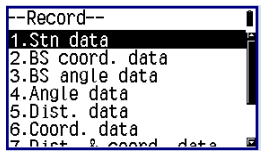
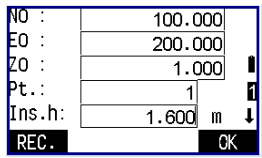
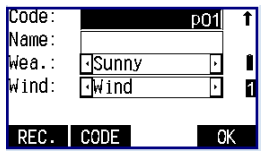
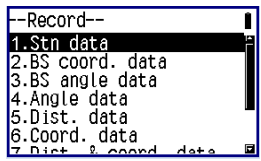


- Enter the record mode, and press 【REC.】in the measurement menu.
- the recording can be performed with the data-related operations in the record mode .
- The data of Angle, distance, and coordinate observed can be recorded in the work file.
- Record the data of station point
- Record the data of backsight coordinate
- Record the data of backsight angle
- Record the data of angle measurement
- Record the data of distance measurement
- Record the data of coordinate
- Record the data of distance and coordinate
- Record the data of note
- View the data of work file

18.1 Record the station data

- The station data can record in the work file in the record mode.
- the record data include coordinate of station point, point number, coding, instrument height, the observer, date and time of observation, weather conditions, wind, temperature, pressure, meteorology, correction, prism constant correction and distance measurement mode.

▸Steps

Operating procedure	Key	Display
（1）Enter the record menu, then select“1.Stn data” and press 【ENT】. Can press to invoke the coordinate or input directly.	“1.Stn data” + 【ENT 】	
（2）Press 【OK】 to record station coordinate, instrument height, target height into the current system parameter , then return the menu.	【OK】	
（3）Press【REC.】enter the input screen of station storage. Can input the following data items: Station coordinate, station name, instrument height, coding, name, weather, wind.	【REC.】	 
（4） After Input the station data, press 【REC.】to stored the station data in the current working file, then return record menu.	【REC.】	

Note: It will record the current ranging parameters at the time recording the station data.

18.2 Record the backsight coordinate data

There are two kinds of methods to record backsight data:

•Backsight by angle

•Backsight by coordinate

Recording backsight coordinate data see “7.2.2Backsight by

coordinate".

18.3 Record backsight angle data

Recording backsight angle data see "7.2.1Backsight by angle".

Explanation: When recording angle,distance,coordinate data:

① In order to avoid reduplicative recording the same measurement data, after every record completed, the instrument will not display the 【record】 function before observing the new measurement data .

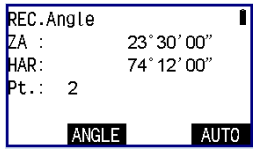
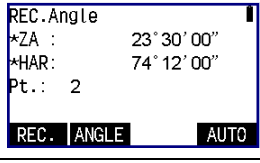
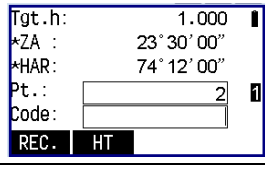
②For the use of automatic functions can be easily and automatically complete from the angle measurement to record the entire process.

③ When Using the 【auto】 key, the angle measurement is not necessary in the measurement mode. Press 【auto】 in the record mode you can complete measuring and recording the results automatically, at the moment , the point name is the origin point number add 1,and the code remains unchanged.

18.4 Record the angle measurement data

• the record data is: Vertical angle, horizontal angle code and the target height.

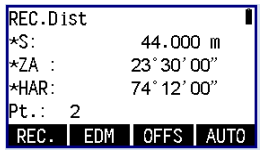
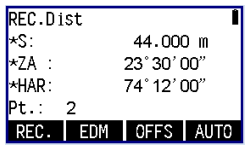
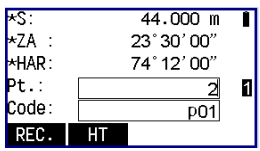
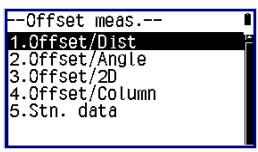
▸Steps

Operating procedure	Key	Display
（1）Enter the record menu ,select"4.angle data" and then press 【ENT】.	"4.Angle data" + 【ENT 】	
（2）Press【ANGLE】 to record the current angle, and the 【REC.】 key is effective.	【ANGLE】	
（3）Press 【REC.】 into record data careen. Press 【SAVE.】 return to angle measurement after recording the data.。	【ENT.】	

18.5 Record the distance measurement data

- In the record mode, the observation data of distance measurement, eccentricity measurement can be recorded in the work file.
- The recorded data include slop distance, vertical angle, horizontal angle, point number, code and the target height.
- The eccentricity measurement in the record mode: press 【OFFSET】 to complete the eccentricity measurement in the record mode.

▸Steps

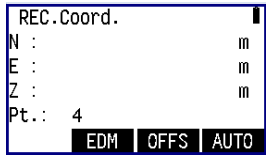
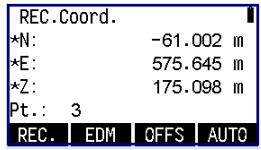
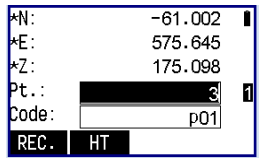
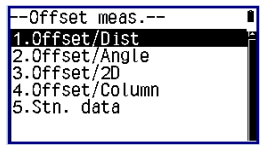
Operating procedure	Key	Display
（1）Enter the record menu ,select“5.Dist. data” and then press 【ENT】.	“5.Dist. data” + 【ENT 】	
（2）Press【EDM】to observe the current angle and distance, and the 【REC.】 key is effective when observing successfully.。	【EDM】	
（3）Press 【REC.】 into record data screen. Press 【REC.】 return to distance measurement after recording the data.	【ENT.】	
（4）Press 【OFFSET】 to eccentricity menu, specific operation see the eccentricity function.	【OFFSET】	

18.6 Record the coordinate measurement data

- In the record mode, the observation data of coordinate measurement, eccentricity measurement can be recorded in the work file.
- The recorded data include the coordinate of N,E,Z, point number, target height and the code.• The eccentricity measurement in the

record mode: In the record mode press 【OFFSET】to complete the eccentricity measurement in the record mode.

▸Steps

Operating procedure	Key	Display
（1）Entering the record menu ,select“6.coord. data” and then press 【ENT】.	“6.coord. data” + 【ENT 】	
（2）Press【EDM】to observe the current coordinate, the 【REC.】 key is effective when observing successfully.	【EDM】	
（3）Press 【REC.】 into record data screen. Press 【REC.】 return to distance measurement after recording the data.。	【REC.】	
（4）Press 【OFFSET】 to eccentricity menu, specific operation see the eccentricity function.	【OFFSET】	

18.7 Record the distance data and coordinate data

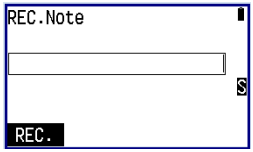
This function can complete the distance and coordinate measurement of the observation point at the same time , and store the coordinate data and distance data created in the work file respectively. Operation procedure is the same as the coordinate data record.

18.8 Record the annotation data

• In the record mode, you can input the annotation and record the it in

the work file.

▸Steps

Operating procedure	Key	Display
（1）Enter the record menu, select“8.annotation data” and then press 【ENT】. After inputting the annotation data, press 【save】 to save.	“8.Annotation data” + 【ENT 】	

18.9Access to the data of work file

- In the record mode, you can access to the data in the selected work file.
- Performing this operation, you can also press the "key function configuration" which describes a method to define the access function to the keys, and then invoke.
- When invoking the data of the work file, you can search through the point number, but it does not applied to the annotation data.
- Operation Steps ere similar to "17.2.1 known coordinate management”.

19、The instrument parameter setting and calibration

• This chapter introduces the parameter settings in the set mode. Once these parameters are set, they will be saved until changing again.

19.1 Change the instrument observation conditions

• The following table gives the instrument parameters to be set and the options.

Table 1：

Setup screen	Parameter	Option(*:factory settings)
Observation conditions setting	Atmospheric correction	No correction*
		K=0.14（Correction，take K=0.14）
		K=0.20（Correction，take K=0.20）
	vertical Angle format	Zenith zero*
		Horizontal zero
		horizontal±90°
	Tilt compensation	No compensation
		Single axis
		Dual axis（with double axis compensator machine)
	Distance type	Slope distance
		Horizontal distance
		level difference
	Auto power-off	30 minutes off
		Manual shutdown
	Coordinate formate	N—E—Z*
		E—N—Z
	Angle minimum	1″*
		5″
		10″
	Distance minimum	0.1mm
		1mm*

	Buzzer button	On*
		Off
	Right angle buzzer	On*
		Off

Table 2：

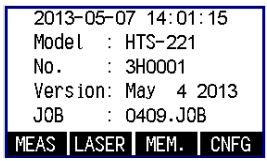
Setup screen	Parameter	Option(*:factory settings)
Communication parameter setting	Baud rate	1200b/s,2400b/s
		4800b/s ,9600b/s*
		19200b/s,38400b/s
		57600b/s,115200b/s

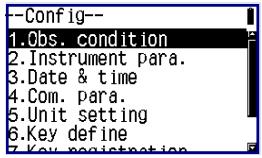
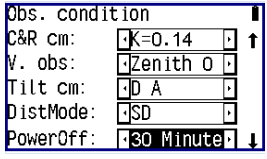
Table 3:

Setup screen	Parameter	Option(*:factory settings)
Units Setup	Temperature	℃（Centigrade）*
		℉(Fahrenheit)
	Atmospheric pressure	hPa（Millipascal)
		mmHg（millimeter of mercury）
		inHg（inch of mercury）
	Angle	Degree(360 degrees system)*
		GON(400 degrees system)（400）
		MIL）
	Distance	m
		Ft(U.S foot)
		Fi(International foot)
		Foot and inch

Hereinafter "observation conditions setting" for example, the same way as the rest.

▸Steps

Operating	Key	Display
（1）Press 【ESC】 enter the status screen in the survey screen.	【ESC】	

（2）Press 【CNFG】 enter the configuration screen in the status screen.	【CNFG】	
（3）Select“1.Obs. conditions”and then press 【ENT】 into observation conditions setting. Can view and change the observation condition parameter settings in this operation. Use 【▲】 or 【▼】 (【ENT】) can make the parameter item focus moving up or down. Use 【◄ 】or【 ►】 can change the parameter settings in the line with focus. Each time change a parameter item, the cursor must be removed in order to save the changes	“1.Obs. conditions ” + 【ENT】	

19.2Key functional configuration

- Allow users to configurate the key functions for the instrument in different measurements in the measurement mode. The keys defined will be saved forever until changing again.
- The characteristics that users can free to define the key function location will surely greatly convenient the users and increase the working efficiency of the measurement.
- Press 【CNFG】 enter the configuration screen in the status screen. Select “6.key function configuration” and press 【ENT】or directly press【6】into the key function configuration definition menu screen.
- Can do the following operations in the key function configuration:
  - Key define
  - Key registration
  - Key recall

19.2.1 Key function define and registration

• in the Key define screen, the users can allocate the function again. the new definition of key functions will be displayed in the measurement mode and is kept until being defined again. The instrument internal storage provides users with two check location, they are user defined key 1 and user defined key 2.

Notes：Once defining or checking the new function of the keys, the original keys function or the function checked will be cleared.

The following functions can be assigned to the measurement mode in any page.

1）Slope distance, horizontal distance and level difference: Start distance measurement

2）Switch: Distance type selection (Slope distance, horizontal distance and level difference)

3）Zero setting: the zero setting of horizontal angle

4）Angle setting：Known horizontal Angle setting

5）Left/right Angle: left and right angle selection

6）Repeat observe : the repetitive observation of the horizontal Angle

7） Lock Angle: Horizontal Angle locked or unlocked

8） ZA/%：Gradient type selection

9）Height：Instrument high setting, target height setting

10）Record: Measurement data record

11）Hanging high: Start hanging high measurement

12）Opposite edge：Start opposite edge measurement

13）New: Shows the latest measurement data

14）View: View the data of the current working file

15）Parameters: Distance measurement parameter settings

16）Coordinate: Start the coordinate measurement

17）Stake out: Start to stake out

18）Offset : Start eccentric measurement

19） Menu: Turn to menu mode

20）Resection: Start resection measurement

21）Arc: Arc surveying

22）F/M：Meter and foot

23）Area: Start area surveying

24）Road: Start road surveying

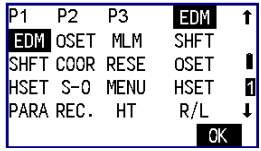
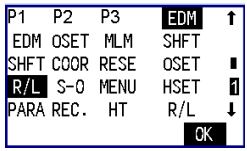
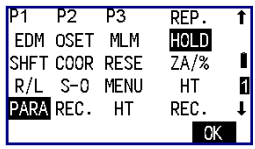
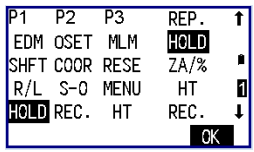
25）Point Projection: Point projection calculate

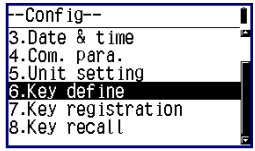
26）Line Setting Out: Straight line setting out.
• Default key function:
Page 1: Slope distance, switch, set angle, parameters
Page 2: Zero setting, coordinate, setting out, record
Page 3: Opposite side, resection, menu, height

19.2.2 Key function assignment

•Customer can define the keys with this 12 function freely and they can be kept until redefined.
Definitions for key functions can be arbitrary.

▸Step

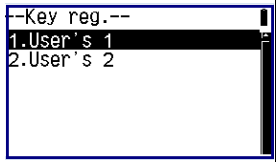
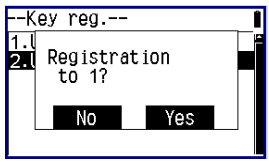
Operation Procedure	Key	Display
（1）In setting mode, choose “6.Key define”, then press 【ENT】	“6.Key define”+ 【ENT】	
（2）Use【◄】or【►】to highlight the key. “Pn”means page N.	【◄】or 【►】	
（3）use【▲】or【▼】, highlight the function.	【▲】or 【▼】	
（4）Press [ENT] to step 3 to specify the functions defined in step 2 on the specified keys.	【ENT】	

（5）repeat from Step2 to Step 4 to complete the function definition. Then press 【OK】to end key function assignment and return to the menu key function definitions.	【OK】	

19.2.3 Key function recall

•The key function user had customized can be stored in a library as user defined 1 and user defined 2.

▸Step

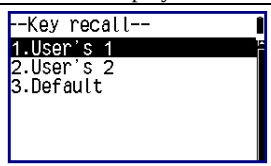
Procedure	Key	Display
（1） In setting mode, choose“7.Key registration ”,then press【ENT】.	“7.Key registration ”+【ENT】	
（2）Select “1.User’s 1”, then press 【ENT】. Then choose【YES】	“1.User’s 1”+【ENT】	
（3）Save in user defined 2 with the same way.		

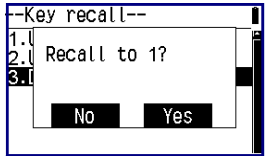
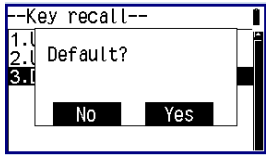
19.2.4 Key function restore

•You can apply user defined settings or default settings when you want.

Note: The current functions will be covered by the restored ones!

▸Step

Procedure	Key	Display
（1）In setting mode, choose “8.Key recall”, then press【ENT】	“8.Key recall”+【ENT】	

（2）Choose “1.User’s 1”, then press【ENT】,then press OK to apply the user defined 1	“1.User’s 1”+【ENT】	
（3）you can applly user defined 2 in the same way		
（4）choose “3. Dfault”, then press【ENT】, then confirm. The key will have the factory default function	【ENT】	

19.3 Instrument parameters settings

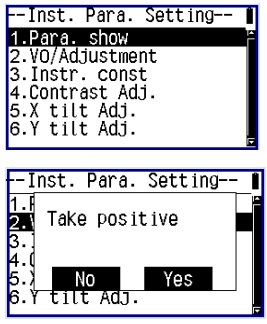
Warning：

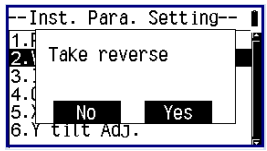
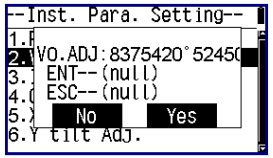
The following functions must be carried out under the guidance of professionals, if the operation is wrong, it may lead to the instrument can’t work properly!

After inspection, the instrument should be calibrated again if the parameters are changed.

19.3.1 Index Error Calibration

▶Step

Operation process	Key	display
（1）In setting mode, choose “2.Instrument para.”, then press【ENT】 to enter the instrument setting menu. Choose “2. VO/Adjustment” to do calibration.	“2.Instrument para.”+ “2. VO/Adjustment”	

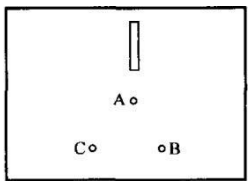
（2）Aim at target with face left, then click【ENT】.	【ENT】	
（3）Aim at target with face right, then click【ENT】,then the calibration result will be displayed. Click 【ENT】 to save the parameters.	【ENT】	

Note: If there is no special requirement, the compensator should be turned on before Index error correction.

19.3.2 Compensator Calibration

Before compensating for the compensator, make sure that the indicator difference is recalibrated in accordance with 19.3.1 procedure in the closed compensator state.

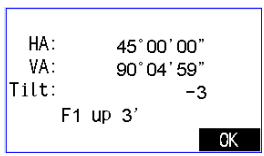
First, place the instrument as picture shown below with collimator facing up. This will help screw A to adjust the inclination of the instrument.

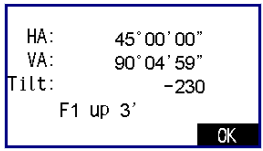
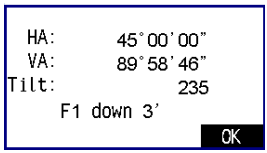
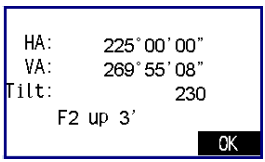
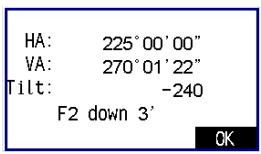


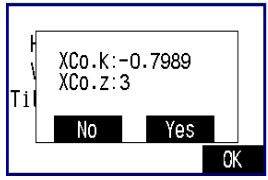
Enter the interface of tilt calibration:

These are the calibration of x-direction of vertical axis

▶Step

Operation process	Key	display
（1）In setting mode，“2.Instrument para.” then press【ENT】，go to machine parameter setting menu. Then choose“5.X title Adj”。	“5.X title Adj” + 【ENT】	

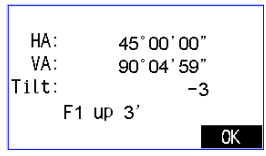
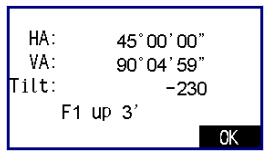
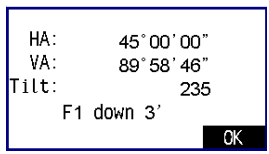
（2）Level the instrument, focus on the reticle of collimator, record the vertical angle V0.Use fine tuning to set the vertical angle as V0+3′,focus on the reticle center accurately, wait for stable value, press【OK】。	Adjust vertical angle + Adjust angle foot screw	
（3）Use fine tuning to set the vertical angle as V0-3′,focus on the reticle center accurately, wait for stable value, press【OK】。	【OK】 + Adjust vertical angle + Adjust angle foot screw	
（4）Use fine tuning to set the vertical angle as V0,focus on the reticle center accurately		
（5）Reverse the telescope, focus on the reticle of collimator, record the vertical angle V1.Use fine tuning to set the vertical angle as V1-3′,focus on the reticle center accurately, wait for stable value, press【OK】。	【OK】	
（6）Use fine tuning to set the vertical angle as V1+3′,focus on the reticle center accurately, wait for stable value, press【OK】。	【OK】	

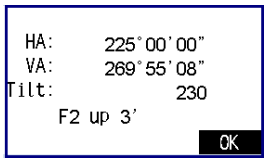
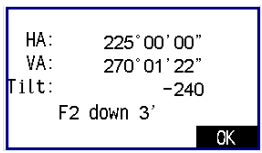
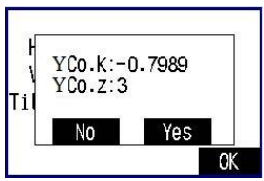
（7）After Finishing, it will display the calibration results, press【ENT】,save and back to menu。	【ENT】	

Note: CoK (linear coefficient): If absolute value > 1.5, you need to re-calibrate; In the correction process by pressing the ESC key, will exit, holding compensator parameters unchanged.

These are the calibration of y-direction of vertical axis

▶Step

Operation process	Key	display
（1）In setting mode，“2.Instrument para.” then press【ENT】，go to machine parameter setting menu. Then choose“6. Y title Adj”.	“6. Y title Adj” + 【ENT】	
（2）Level the instrument, focus on the reticle of collimator, record the vertical angle V0.Use fine tuning to set the vertical angle as V0+3′,focus on the reticle center accurately, then turn the instrument counterclockwise 90 °,wait for stable value, press 【OK】,and then turn 90 ° clockwise back to the original direction;	Adjust vertical angle + Adjust the foot screw	
（3）Use fine tuning to set the vertical angle as V0-3′,focus on the reticle center accurately, then turn the instrument counterclockwise 90 °,wait for stable value,press【OK】, and then	【OK】 + Adjust vertical angle + Adjust	

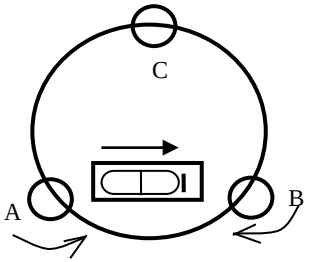
turn 90 ° clockwise back to the original direction;	angle foot screw	
（4）Use fine tuning to set the vertical angle as V0,focus on the reticle center accurately		
（5）Reverse the telescope, focus on the reticle of collimator, record the vertical angle V1.Use fine tuning to set the vertical angle as V1-3′,focus on the reticle center accurately, then turn the instrument counterclockwise 90 °,wait for stable value, press 【OK】,and then turn 90 ° clockwise back to the original direction;	【OK】	
（6）Use fine tuning to set the vertical angle as V1+3′,focus on the reticle center accurately, then turn the instrument counterclockwise 90 °,wait for stable value, press 【OK】.	【OK】	
（7）After Finishing, it will display the calibration results, press【ENT】,save and back to menu.	【ENT】	

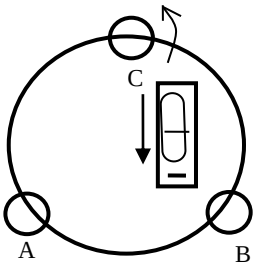
Note: CoK (linear coefficient): If absolute value > 1.5, you need to re-calibrate; In the correction process by pressing the ESC key, will exit, holding compensator parameters unchanged.

20、Checkout and calibration

The instrument at the factory has to undergo a rigorous inspection and correction, meeting the quality requirements. However, after long transport or environmental change, its internal structure will be some impact. Therefore, the new purchased instruments should be checked and calibrated before surveying to ensure the precision.

20.1 Tube level





- **Checkout**

Refer to the chapter "Leveling instrument accurately by tube level "of" Setting up the instrument ".

- **Calibration**

1. In the calibration, if the leveling bulb diverge from the center, use the foot spiral which parallels the leveling tube to adjust to make the bubble move half of the distance to the center. For the remaining, use the calibration needle to turn the level calibration screw (in the right of the water-level) to adjust the bubble to the center.
2. Turn the instrument for 180 °, check that whether the bubble is in the center. If the bubble is not centered, repeat Step (1) until the bubble to the center.
3. Turn the instrument for 90°, use the third foot screw to adjust the bubble to the center.

·Repeat the Steps of checkout and calibration until the bubble in the center in every directions

20.2 Circular level

- **Checkout**

After the level tube is calibrated correct, if the circular level bubble

also in the center ,so there is no need to calibrate.

• **Calibration**

If the bubbles is not in the center, use the correction needle or six angle wrench to adjust the correction screw which under the bubble to make the buble to the center. For calibration ,you shall first loosen the calibration screw (1 or 2) which opposite to the direction of the bubble offset, then tighten the other correction screw in the offset direction to make the bubble in the center. When the bubble is in center, make sure the pressure of the three calibration screws are consistent.

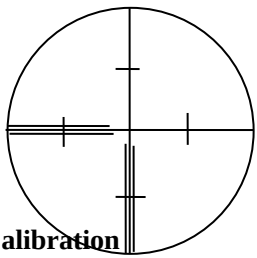
20.3 Telescope reticle

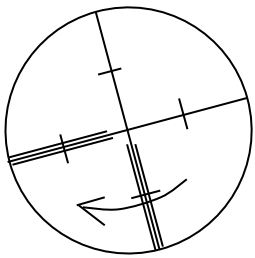
• **Checkout**

After leveling the instrument find a target A with the telescope, make the center of the crosshair focused on target A and fixed horizontal and vertical brake handwheel.

1. Rotate telescope vertical micrometer handwheel, move A point to the edge of the field of view (A 'points).

2. If A moves along the vertical line of the crosshair , but A point is still in the vertical line, as the left picture, the crosshair doesn't need to calibrate. If A point deviate from vertical line center, as the right pictured, the crosshair is slant, so need to calibrate the reticle.





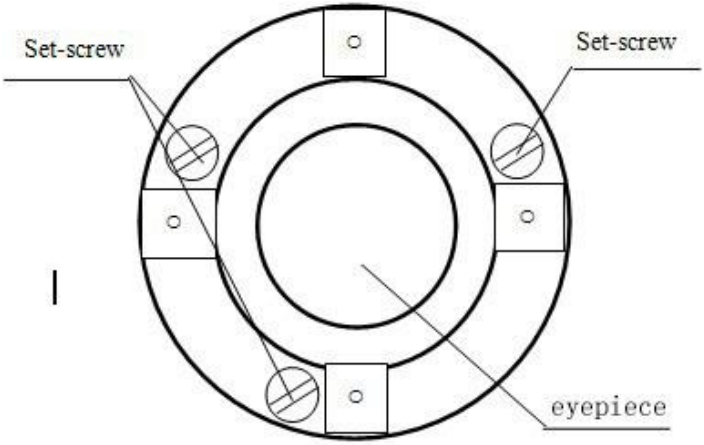
·**Calibration**

1. first, take down the reticle cover between telescope eyepiece and focusing handwheel, and you can see four fixed screw of the reticle bed (sees attached figure).

2. Unscrew the three fixed screw evenly with screwdriver , rotate the reticle around collimation axis, to make A point on the vertical line of the reticle.

3. Tighten the screw evenly, test the calibration results with the above

methods.
4. Put the protective cover back.



20.4 The verticality of collimation axis and horizontal axis （2C）

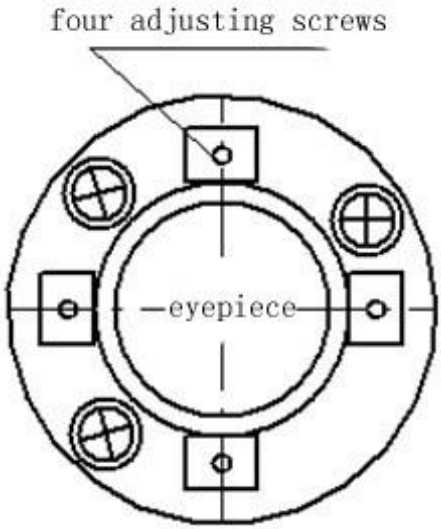
• **Checkout**

1. Set a target A in about 100m away, and make sure the vertical angle of the target is within ± 3 °. Precisely level the instrument and switch on it.
2. Make the telescope focused on target A in face left, and read the horizontal angle.
For example: horizontal Angle L = 10°13 '10"
3. loosen the vertical and horizontal brake handwheel, turn the telescope, rotate the alidade to face right and focus on the same target A. Before aiming please tighten the horizontal and vertical brake handwheel and read the horizontal angle.
For example: level Angle R = 190°13 '40"
4. 2 C = L-(R ±180 °) = -30 "≥±20, need to calibrate.

• **Calibration**

1. Use the horizontal micrometer handwheel to adjust the horizontal angle to the right reading which has eliminated the C.
R + C = 190°13 '40 "-15 "= 190°13' 25".
2. Take down the reticle bed cover between the telescope eyepiece and focusing handwheel, adjust the calibration screw of the crosshair

on the left and right. First, loosen the screw on one side, and screw up the screw on the other side, move the reticle and focus on target A.
3. Repeat the test Steps, calibrate it to | 2 C | < 10.
4. Tighten the calibration screws, put the protective cover back.



Notice: Check the photoelectric coaxiality after calibrating.

20.5 Vertical plate index zero automatic compensation

- **Checkout**

1 Set up and level the instrument, make the direction of the telescope consistent with the line between the center of the instrument and any of the foot screw.
2. The vertical plate index change to zero after switching on, tighten the vertical brake handwheel, the instrument display the current telescope vertical Angle.
3. Slowly rotate feet X to 10 mm around in one direction, the display of the vertical Angle will change from changing until disappear to appear "compensation beyond!" correspondingly , it indicate that the dip Angle of the verticalaxis is bigger than 3 ', beyond the range of

vertical plate compensator design . When rotating the feet spiral recovery in the opposite direction , instruments shows vertical Angle again, if you can see the change when testing it again and again in critical positions, it says that vertical plate compensator works normally.

· **Calibration**

When you find that instrument compensation is useless or abnormal, it should be sent to the factory for checking.

20.6 Vertical collimation error (I Angle) and vertical collimation zero value setting

• **Checkout**

1. Boot after settling and leveling the instrument, focus the telescope on a clear goals A, get the face left reading of vertical Angle L.
2. Turn the telescope to aim A and get the reading R for face right.
3. If the vertical zenith angle is 0 °, then i = (L + R-360 °) / 2, if the vertical Angle level is 0 . Then i = (L + R-180 °) / 2 or (L + R-540 °) / 2.
4. If | i |≥10", may be you need reset the zero value of vertical index.
5. operation refers to chapter 9.6.1 "index error calibration"

Note: 1 repeat the checkout Steps to retest the index error again (i Angle). If the index error still can not accordance with requirements , it should check the three Steps of calibration index zero setting (in the course of zero setting ,the vertical angle showed is not compensated and corrected, it is just for reference) to see whether it is incorrect, whether the focusing of target is correct, reset according to the requirements.

6. If it still can not accordant with the requirements after repeated operation, it should be sent to the factory for checking.

20.7Plummet

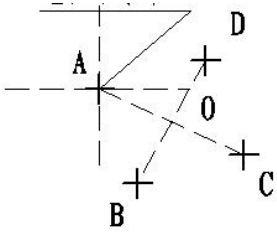
• **Checkout**

1. Set up the instrument to the tripod, draw a cross on a white paper and put it on the ground below the instrument.
2. Adjust the focal length of the optical plummet (for the optical plummet) or press key★ to switch on laser plummet , move the white

paper to make the cross in the center in the field of view (or laser flare).
3. Turn the feet screw ,make the center mark of the plummet coincide with the cross center.
4. Rotate alidade, every turn of 90 °, observe the contact ratio of the optical plummet and cross center .
5. When rotate the alidade, the center of the optical plummet always coincide with the cross center, there is no need to calibrate. Otherwise you should calibrate as the following methods.

- **Calibration**

1. Take down the screw cover between the optical plummet eyepiece and the focusing handwheel.
2. Fix the white paper with a cross, and mark the points when the instrument rotates 90 °,as the figure shows A, B, C, D points.
3. Connect the diagonal points A、C and B、D with a straight line, the intersection name of the two line is O.
4. Use the calibration needle to adjust the four calibration screw, to make the center mark of the plummet coincide with point O .
5. Repeat Step 4, check and calibrate until it meet the requirements.
6. With the laser plummet, unbolt the laser cover, using 1 # hex



wrench to adjust the three screws, fasten one side and loosen the other side, and adjust the laser flare to point O.
7. Put the cover back in place.

20.8 Instrument additive constant (K)

The instrument constant is inspected when it out, and correct it inside the machine, make K = 0. Instrument constant change rarely, but we suggest that check it this way for one or two times each year. The

checkout should be done in the standard baseline , or you can take the following simple method.

• **Checkout**

1. Choose a flat field A to set up and level the instrument , mark three points A、B、C in the same line ,their interval is 50m, and set up the reflection prism accurately.
2. After setting the temperature and pressure data, accurately measure the horizontal distance of AB、AC .
3. Setting up and centering the instruments accurately, measure the horizontal distance of BC accurately.
4. You can get the instrument ranging constant:

K = AC-(AB + BC)

K should be close to 0, if | K | > 5 mm ,it should be send to standard baseline field for strict checking, then calibrate it based on the checking value.

• **Calibration**

If it turns out the instrument constant does not close to 0 but changing after strict inspection , you need to calibrate it, set the instrument additive constant according to the comprehensive constant K value . Such as: the K has been measured as -5 according to the method above, and the original instrument constant is -20,so the new value should be set as -20-(5) =-15; Input-15 through "menu-> 6-> 3" and then confirm .

● Use the vertical line of the reticle to orientate, make A, B and C at the same line accurately. There must be a clear mark for point B the ground to focus on.

● Whether the prism center of B coincide with the instrument centers is the guarantee of checking the accuracy, so, you had better use tripod and all-purpose tribrach, for example, if you change the three hand type prism connector with tribrach, keep the tripod and tribrach stable, just change the prism and the part above tribrach of instrument, and it can reduce the error of misalignment.

20.9 The parallelism of collimation axis and photoelectricity axis

• **Checkout**

1. Set up the reflecting prism 50 meters long from the instrument.
2. Focus on the reflecting prism center with telescope crosshair accurately .
3. Through the key ★-> parameters-> signal, observe maximum value of the signal, find the center of the launch axis.
4. Check whether the telescope crosshair center coincide with the emission photoelectricity axis center, if they coincide on the whole we can say it qualified.

- **Calibration**

If the telescope crosshair center deviate from emission photoelectricity axis center largely, send it to professional repair and calibration department.

20.10 No prism ranging

The red laser beam is coaxial with the telescope, used for no prism ranging , and it is sent by telescope. If the instrument has been calibrated, red laser beams will coincide with the line of sight. External influence such as the vibration, the larger temperature change and other factors may make laser beam and viewing not overlap.

● Before precise ranging, you should check whether the direction of the laser beam is coaxial . Otherwise, it could lead to inaccuracy .

Warning:

Looking straightly at the laser is dangerous.

Prevention:

Don't look laser beams directly, or focus on others.

- **Checkout:**

Put the gray side of the reflector towards the instrument, and put it 5 meters and 20 meters away. Start laser direction function. Focus on the reflector center by the telescope crosshair center, then check the position of the red laser point. Generally speaking, the telescope is equipped with special filter, human eyes cann't see laser point through the telescope,you can see the offset between the red laser point and the reflector crosshair center, you can observe this above the telescope or at the side face of reflector . If laser center coincide with the crosshair center, it indicate that the adjustment meet required accuracy. If the offset between the point position and the mark of crosshair is out of limit, will need to send it to professional department for adjustment.

21、Technical parameters

Function			Unit	Configuration
				HTS-220R
Telescope	Imaging		—	Erect
	Magnification		×	30
	Field of view		—	1 ˚20′
	Min.target distance		m	1.5
	Effective aperture		mm	40/50(EDM)
Angle measurement (Hz, V)	2C index error		(″)	1.4
	Angle i index error		(″)	2.0
	Angle measurement method		—	Absolute encoder
	Minimum reading		(″)	1
Distance measurement (IR)	Range	Single prism	km	3
		Triple prism	km	5
		No- prism1	m	400/600
	Time	Repeated	s	2(first 3)
		Tracking	s	0.8
	Minimum display		mm	0.1
	Accuracy	Prism	mm	±(2＋2×10^{-6}D)
		No- prism		±(3＋2×10^{-6}D)
Tilt compensator	Compensation method		—	Biaxial type
	Compensation range		（′）	±3
Communication Port			—	RS232C
U disk interface			—	Yes
Bluetooth			—	Yes
Temperature and pressure sensor			—	NO
SD card			—	Yes
Display	Screen		—	Both sides（280*160，Black and white screen）

	Illumination		—	Support
Laser Plumb	Laser (optional) Laser Plumb		—	Wavelength 635nm Maximum output power (adjustable): not less than 0.4 m W, not more than 1.0 mW
Level	Tubular level		（″）/2 mm	30
	Round level		（′）/2 mm	8
Built-in application			—	Support
Battery supply	Type		—	Rechargeable High-energy lithium battery
	Voltage		V	7.4
	Power		W	＜ 2.2
	Battery capacity		mAh	3000
	Working duration	Angle	h	18
		Dist+Angle	h	8 （At + 20 ° C, constant measuring mode）

1: Refers to good weather conditions (visibility is not less than 30km), the goal of KODAK CAT NO.E1527795 (90% of reflecting surface)

Attachment A Road calculation example

- **Horizontal Curve**

1.Element

⑴Input element

number	element	Start point X	Start point Y	azimuth	length	radius
1	Straight line	1099877.123	4578452.654	120.30250	88.12	
2	Easement Curve				100	200
3	Circle Curve				80	200
4	Easement Curve				50	200
5	Easement Curve				45	-150
6	Circle Curve				125	-150
7	Easement Curve				62	-150
8	Straight line				30	

⑵Calculate King-pile coordinate interval：25

Calculated value

number	Stake number	X	Y
1	0.000	1099877.123	4578452.654
2	25.000	1099864.432	4578474.193
3	50.000	1099851.741	4578495.732
4	75.000	1099839.050	4578517.272
5	88.120	1099832.390	4578528.575
6	100.000	1099826.347	4578538.804
7	125.000	1099813.310	4578560.134
8	150.000	1099799.305	4578580.839

9	175.000	1099783.746	4578600.395
10	188.120	1099774.794	4578609.984
11	200.000	1099766.173	4578618.155
12	225.000	1099746.535	4578633.600
13	250.000	1099725.125	4578646.476
14	268.120	1099708.688	4578654.087
15	275.000	1099702.279	4578656.588
16	300.000	1099678.498	4578664.280
17	318.120	1099661.029	4578669.092
18	325.000	1099654.388	4578670.891
19	350.000	1099630.474	4578678.158
20	363.120	1099618.263	4578682.949
21	375.000	1099607.584	4578688.147
22	400.000	1099586.640	4578701.745
23	425.000	1099568.243	4578718.630
24	450.000	1099552.901	4578738.333
25	475.000	1099541.041	4578760.307
26	488.120	1099536.325	4578772.546
27	500.000	1099532.962	4578783.937
28	525.000	1099528.087	4578808.446
29	550.000	1099524.876	4578833.238
30	550.120	1099524.862	4578833.357
31	575.000	1099521.947	4578858.066
32	580.120	1099521.347	4578863.151

2.Intersection

⑴Input element

NO.	X	Y	Easement curve A1	Radius	Easement Curve A2	Station
1	126595.622	326532.868				
2	127029.195	328544.441	711.09	2528.248	711.09	2057.769
3	126270.297	330165.767	550.05	2017.0340	0	0

4	12679 7.134	331957. 950	0	1699.11 93	504.8 44	0
5	12930 6.674	332294. 008	636.1 69	2023.55 27	550.9 38	0
6	13001 4.424	334370. 388	0	0	0	0

⑵Calculate King-pile coordinate Interval：500

Value

NO.	Stake NO.	X	Y
1	0.000	126595.622	326532.868
2	500.000	126700.972	327021.643
3	1000.000	126806.322	327510.418
4	1105.563	126828.565	327613.611
5	1305.563	126868.121	327809.646
6	1500.000	126894.146	328002.286
7	2000.000	126892.623	328501.469
8	2500.000	126793.052	328990.623
9	2749.107	126707.910	329224.621
10	2949.107	126625.526	329406.849
11	3000.000	126604.016	329452.973
12	3099.107	126563.629	329543.472
13	3500.000	126444.885	329925.686
14	4000.000	126406.074	330422.894
15	4483.815	126485.817	330898.918
16	4500.000	126490.455	330914.423
17	5000.000	126703.815	331364.622
18	5500.000	127038.580	331733.585
19	6000.000	127465.969	331989.592
20	6365.804	127816.349	332092.209
21	6500.000	127949.036	332112.201
22	6515.804	127964.700	332114.301
23	6516.206	127965.099	332114.355
24	6716.206	128162.844	332144.159
25	7000.000	128437.402	332205.044
26	7500.000	128887.275	332430.323

27	8000.000	129270.830	332749.096
28	8500.000	129564.769	333151.998
29	8785.668	129685.352	333410.708
30	8935.668	129735.494	333552.069
31	9000.000	129756.249	333612.961
32	9500.000	129917.564	334086.224
33	9800.219	130014.424	334370.388

theoretical value

NO.	Stake NO.	X	Y
1	0.000	126595.622	326532.868
2	500.000	126700.972	327021.643
3	1000.000	126806.323	327510.419
4	1105.563	126828.565	327613.611
5	1305.563	126868.121	327809.646
6	1500.000	126894.146	328002.286
7	2000.000	126892.623	328501.469
8	2500.000	126793.051	328990.623
9	2749.107	126707.910	329224.621
10	2949.107	126625.526	329406.849
11	3000.000	126604.016	329452.974
12	3099.107	126563.629	329543.472
13	3500.000	126444.885	329925.686
14	4000.000	126406.074	330422.895
15	4483.815	126485.817	330898.918
16	4500.000	126490.455	330914.424
17	5000.000	126703.815	331364.622
18	5500.000	127038.580	331733.585
19	6000.000	127465.969	331989.592
20	6365.804	127816.349	332092.209
21	6500.000	127949.037	332112.201
22	6515.804	127964.700	332114.301
23	6516.206	127965.099	332114.355

24	6716.206	128162.844	332144.159
25	7000.000	128437.402	332205.044
26	7500.000	128887.275	332430.323
27	8000.000	129270.830	332749.096
28	8500.000	129564.769	333151.999
29	8785.668	129685.352	333410.708
30	8935.668	129735.494	333552.069
31	9000.000	129756.249	333612.961
32	9500.000	129917.564	334086.224
33	9800.219	130014.424	334370.388

- **Vertical Curve**

Input Intersection

Intersection	Station of changing slope point	Elevation of changing slope point	Length
Start point	0	324.325	0
1	508.36	329.247	84.560
2	1000.48	325.689	52.806
3	1320.236	320.563	120.000
4	1524.265	323.215	28.585
5	1699.888	324.585	31.445
Endpoint	1800.244	325.999	0

Single point elevation

NO.	Station	Calculated Value	theoretical value
1	0.000	324.325	324.325
2	100.000	325.293	325.293
3	200.000	326.261	326.261
4	300.000	327.230	327.230
5	400.000	328.198	328.198
6	500.000	329.051	329.051
7	600.000	328.584	328.584
8	700.000	327.861	327.861
9	800.000	327.138	327.138

10	900.000	326.415	326.415
11	1000.000	325.636	325.636
12	1100.000	324.094	324.094
13	1200.000	322.490	322.491
14	1300.000	321.079	321.079
15	1400.000	321.600	321.600
16	1500.000	322.900	322.900
17	1600.000	323.806	323.806
18	1700.000	324.611	324.611
19	1800.000	325.996	325.996
20	1900.000	0.000	0.000
21	2000.000	0.000	0.000
22	2100.000	0.000	0.000

Attachment B File format introduction

These following example to instruct exported file format

```
STA      ST001,1.2050,AD
XYZ       100.000,100.000,10.000
BKB      BS001,45.2526,50
BS        BS001,1.800
HVD       98.2354,90.2314,10.235
SC        A1,1.800,CODE1
NEZ       104.662,99.567,10.214
SD        A2,1.800,CODE1
HVD       78.3628,92.4612,4.751
SA        A3,1.800,CODE1
HV        63.2349,89.2547
NOTE     this note
```

The first record consists of two lines:
The information of first line: record type, name, elevation, code
Such as:

STA refers to test site
BKB refers to back sight Angle data
BS refers to back sight
SC refers to coordinate data
SD refers to distance measurement data
SA refers to Angle measurement data

The second line information: data types, data records
Such as:

NEZ refers that the following data are coordinates
ENZ refers that the following data are coordinates
HVD refers that the following data are horizontal Angle and vertical Angle and slope distance
HV refers that the following data are horizontal Angle and vertical Angle

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