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FOREWORD

Thank you for purchasing Electronic Total Station KTS-470 R Series.

KTS-470R is our second generation of Win-Total station, which realizes the automation and informationization. KTS-470R has smaller size, larger screen and control panel, it is a computer-like total station.

The WIN-CE interface of 470R is very similar with a Windows-based PC, You can connect them easily and realize real-time data exchanging and processing on both ends.

This manual is applicable to: KTS-470(R) Series Total Station.

Please read the manual completely before operating the instrument.

PRECAUTIONS

- 1. Do not collimate the objective lens direct to sunlight without a filter.
- 2. Do not store the instrument in high and low temperature to avoid the sudden or great change of temperature.
- 3. When the instrument is not in use, place it in the case and avoid shock, dust and humidity.
- 4. If the temperature varies greatly between work site and the instrument depository, do not set to work as soon as arrived; leave the instrument in the case for a while till it adapted environment temperature.
- 5. When storing the instrument long time without use, disconnect the battery from the device. The battery should be charged once a month.
- 6. Please give special attention to the packing Shock absorption is very important in long distance transportation.
- 7. For less vibration and better accuracy, the instrument should be set up on a wooden tripod rather than aluminum tripod.
- 8. Clean exposed optical parts with degreased cotton or lens tissue only!
- 9. If the instrument gets wet in the rain, do not try to power it on at once, Clean the surface with a soft cloth and then keep the instrument in a well ventilated place.
- 10. Before set up the job, check initial settings of the instrument as well as the parameters.
- 11. Unless the user is a maintenance specialist, do not attempt to disassemble the instrument by oneself.
- 12. when the laser is switched on, do not look into the objective Len with naked eye.

BATTERY NOTIFICATION

1. Battery should be recharged only with the charger SC-20 which comes with the total station.

2 .Battery Recharging Cautions:

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

Be sure to recharge the battery at a temperature of $0 \sim \pm 45$ °C, recharging may be abnormal beyond the specified temperature range .

Prohibit the use of any charger or battery that has been damaged.

3.Battery Storage Cautions:

Rechargeable battery can be repeatedly recharged 300 to 500 times. Long time totally discharge of a battery may shorten its life. The battery should be recharged at least one time a month, which will help increase its full charge capacity. Do not keep the battery at high heat and damp places. Do not short-circuit the battery.

Dispose of batteries properly. Do not throw them into fire or expose to high temperature.

SAFETY GUIDE

For laser EDM (visible laser)

Warning:

The total station is equipped with an EDM of a laser grade---3R/IIIa. It is verified by the following labels.



CAUTION LASER RADIATION-DO NOT STARE INTO BEAM 620-690nm CLASS III LASER PRODUCT

Over the vertical tangent screw sticks an indication label "CLASS III LASER PRODUCT". A similar label is pasted on the opposite side.

This product is classified as Class 3R laser product, which accords to the following standards.

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

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

Warning:

Continuously looking straight at the laser beam is harmful.

Prevention:

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

Warning:

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

Prevention:

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

Warning:

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

1. NOMENCLATURE AND FUNCTIONS

1.1 NOMENCLATURE





1.2 KEYPAD



Functions of the Keys

Key	Nomenclature	Function
Φ	Power Key	To switch power ON/OFF.
0~9	Numeric Key	To input desired numbers.
A~/	Alpha Key	To input alphabets.
·	Inputting Panel	To display inputting panel.
	Key	
B.S	Backspace	To delete one character leftward when inputting numbers or
		alphabets.
- \	Cursor Key	To move the cursor up/down/left/right.
α	Alpha Shifting	To shift to alphabet inputting mode.
	Key	
*	Star Key	To launch several common functions
ESC	ESC Key	Quit to previous screen or previous mode.
ENT	Enter Key	To finish and accept the data input.

2. SYNCHRONIZATION WITH PC

2.1 The Installation of Microsoft Activesync

There is a CD-ROM attached with the instrument. Put it into your CD-Rom driver, and install Microsoft ActiveSync, then you can establish activeSync connection between 470R and Computer.

Before Installing Microsoft ActiveSync

Before installing, read the following words carefully:

•During the installation processing, reboot your computer is required. Therefore, please save your jobs and quit all the applications before installation.

•To install Microsoft ActiveSync, you are supposed to have an USB cable (available in the product package) connect the PDA with the personal computer.

Installing Microsoft ActiveSync

• Put the CD-ROM into your disk drive.

Microsoft ActiveSync Installation Guide will be run automatically.

• Click "Next" to install Microsoft ActiveSync.



2.2 CONNECTING TOTAL STATION WITH PC

• Connect the 470R and computer with the USB cable.

• Power the total station on. The software will detect the Total station and setup the communication. When connection established successfully, the following message will display.

🕲 Licrosoft ActiveSync
<u>F</u> ile <u>Y</u> iew <u>T</u> ools <u>H</u> elp
Image: Sync Stop Image: Sync Stop Image: Sync Stop Image: Sync Stop Image: Sync Stop Image: Sync Stop
WindowsCE
Connected Synchronized
Information Type Status

Using "Browse" Function

After the synchronization, you can click "Browse" button to view the files stored in the total station. Copy, paste and deletion are synchronized on both ends. See the picture below.



3. KNOWING ABOUT YOUR KTS-470(R)

Press POWER to turn on the instrument. See the initial interface as below.



3.1 OPERATING SYSTEM

470R is based on Windows CE operating system; WINCE is quite similar to Windows system. The functions and interfaces are easy to use for the surveyor.

Note: we also provide in KTS-470R two powerful Mapping softwares: WinMG and WinEG. They can help you finish most of the office work soon after field measuring.

3.2 SETTING YOUR TOTAL STATION

You can adjust the default settings of 470R according to the following steps.

3.2.1 Backlight adjustment

The system will automatically shut the backlight when battery is running low. You can also adjust the brightness of backlight as following steps.

OPERATIONAL STEPS	KEY	DISPLAY
 Click "Control panel" On the desktop. 	Control panel	WinEG WinEG WinEG
② Use stylus to roll the scroll bar to find "Backlight" icon.	Backlight	Control PanelImage: AdjustImage: PowerImage: SystemImage: SystemImage: AdjustImage: SystemImage: SystemImage: SystemImage: AdjustImage: SystemImag
 The brightness of LCD screen backlight depends on the position of the cursor. You can turn on/off the keyboard backlight by change the lower option. 	[OK]	C LCD & KB Control Panel OK × × LCD BackLight Regulate : Dark Light LCD Close Mode : V Step By Step KeyBoard BackLight Regulate : Close Dark Light H_Light System Update Password Bluetooth

3.2.2 Touch-screen Adjustment

If your device is not responding accurately to screen taps, Adjust the touch screen by the following steps.

OPERATION STEPS	KEY	DISPLAY
 In "Control panel" find "adjust" icon. 	control panel + adjust	X Control Panel X Adjust Power Keyboard Connect Adjust Memory Mose Backlight Date/Time L Power System System
② Click "adjust""	adjust + Calibration	Eile Netword Dial-up Stylus Properties OK X X Double-Tap Calibration on Double-tap this grid to set the double-tap Set the double-tap this conto distance between taps. Sty Double-tap this icon to test your double-tap settings. If this icon doesn't change, adjust Stylus Properties <
③ Click "Calibration", and then "Recalibrate".	Calibration + Recalibrate	Eile Netword Dial-ur Dial-ur Pov Stylus Properties OK X X Dial-ur Pov Double-Tap Calibration on If your device isn't responding properly to your taps, you may need to recalibrate your screen. To start the recalibration process, tap Recalibrate. Sty Recalibrate Stylus Properties S
④ According to the prompt, use the stylus to click the cross center. Repeat as the cross moves around the screen. Totally adjust 5 points as guided.		afully press and briefly hold stylus on the center of the tarc Repeat as the target moves around the screen. Press the Esc key to cancel.

⁽⁵⁾ Press [ENT] to save new	[ENT]	New calibration settings have been measured. Press the Enter key to accept the new settings. Press the Esc key to keep the old settings.
setting.	+	
Press [Esc] to return to control	[Esc]	
panel.		

3.3 APPROACHES TO INPUT NUMBER AND CHARACTER

For Total Station KTS-470R, two kinds of inputting approaches are available. One is using the keyboard, like the keyboard of a mobile phone, with 3 characters on one key. Press it once to display the first characters. Press it twice to display the second one. And press it three times to display the third character. The other way is using soft keyboard. Press icon [\Box] to enter inputting interface. As an example, here we create a folder named "Job-1".

[Example 1: Inputting by soft keyboard]

OPERATION STEPS	KEY	DISPLAY
 Click the "Standard Survey" with stylus to open the program. 		WinEG WinEG WinEG
② Click "project" and choose "New project" on the pull-down menu.		Project New Project × Informa Project Project Meas Dat Operator Operator Coord Da Brief ✓ Fixed Dat ✓ ✓ Occ Pt:1 ✓ BS Pt:2 Others FS Pt: ✓ Create ✓

③ Press ⊡ to open the soft keyboard		ProjectXInforma ProjectProjectProjectProjectMeas Dat Occ Pt:1OperatorSS Pt:Input PanelEst 1 2 3 4 5 6 7 8 9 0 - = $(a_1 + b_2)$ Tab q w e r t y u i o p []CAP a s d f g h j k 1 ; 'Shift z x c v b n m , / \leftarrow Ct $a_1 + b_2$
④ One can switch between capital letter and lower-case though "shift" on the soft keyboard. Input "J".	[shift] + [J]	ProjectNew Project×Informa Project:dProjectJProject:dOperatorGGord Da Fixed DatBrief \checkmark Occ Pt:1 BS Pt:2 SS Pt:Input PanelFS Pt:Est] @ # \$ %^ & * () _ + DelTab Q W E R T Y U I O P { }CaP A S D F G H J K L : " Shift Z X C V B N M < > ? + + + +
(5) The system automatically returns to small letter inputting mode. Use the stylus to click characters key [o] and [b] to input "o" and "b".	[0] [b]	ProjectNew Project×Informa Project:dProjectjobProject:dOperatorGord Da Fixed DatBriefFixed DatOcc Pt:1Occ Pt:1 \checkmark BS Pt:2 SS Pt:Input PanelEst 1 2 3 4 5 6 7 8 9 0 - = \blacklozenge Tab q w e r t y u i o p [] CAP a s d f g h j k l ; 'Shift z × c v b n m ,

 ⑦ After inputting, press the "Shift" to close the soft keyboard. Press [ENT] to create the current working project. 	Project Record Edit Program X Information
Press [•] key to close soft keyboard	

[Example 2: Input by physical keyboard]

OPERATIONAL STEPS	KEY	DISPLAY
① Click "project" and choose "New project" on the pull-down menu.		Project New Project × Informa Project × Project:d Operator Operator Coord Da Brief ▲ Fixed Dat ✓ ✓ Occ Pt:1 ✓ ✓ SP Pt:2 Others ▲ FS Pt: Others ▲ Create ✓ ✓
② Switch to character input mode by press [α]. then press [4] one time to input a capital letter "J'.	[α] [4]	Project New Project X X Informa Project: di Meas Dat Occr Pt:1 BS Pt:2 SS Pt: Project is Operator BS Pt:2 SS Pt: Others SS Pt: Others FS Pt: Image: state stat
③ Press [5] twice to input letter "o", [7] twice to input "b".	[5] [5] [7] [7]	Project New Project × × Informa Project:d Meas Dat Operator Project job Informa Operator Operator Informa Informa Fixed Dat Occ Pt:1 Brief Informa Informa SS Pt: Others Informa Informa FS Pt: Others Informa Informa Informa Informa Informa Informa Create Informa Informa Informa

 Press [α] key to switch back to number inputting mode and press [-] to input-and [1] to input the number "1". 	[α] [-] [1]	ProjectNew Project×Informa ProjectProjectJob-1ProjectJob-1Meas Dat Occ Pt:1OperatorDoc Pt:2 SS Pt:BriefFS Pt:2 SS Pt:Input PanelFS Pt:Ext1 2 3 4 5 6 7 8 9 0 - = \blacklozenge Tabl q w e r t t y u i o p [1] CAP a s d f g h j k l ; 'Shift z × c v b n m , / ← Ctláü` \ \ • ↑ ←
5 After inputting, press [ENT] key.	[ENT]	Project Record Edit Program × Information Project:default.npj Meas Data: 8 6

(1) press [\square] key one time to open the soft keyboard. Press again to close it.

Or using stylus [**P**] to select "Keyboard" on pop-up menu to activate soft keyboard. When soft keyboard is activated, press [**m**] and select "Hide Input Panel" to close soft keyboard.

*2) Under the status of letter inputting mode, each key has defined 3 letters. Every time pressing will display one letter. Thus pressing once can display the first letter, the same key twice for the second, and three times to display the third letter.

4. STAR KEY (★) MODE

Press the (\bigstar) to view the common settings.

TILT: Electric Circular Vial Graphic Display.

ATMOS: Set the Temperature, Pressure, Atmospheric Correction Value (PPM) and Prism constant value (PSM).

TARGET: to set Target Type, Crosshair light, to check Signal (strength) level.

1. Electric circular bubble graphic display

Electric circular bubble can be displayed by graphic. This function will help you leveling the instrument when the circular vial is hided behind the Main body of the instrument.



Rotate the leveling screws while observing electric circular bubble. After the bubble centered at the cross point, press [Back] to return the previous interface.

2. Set the Temperature ,Pressure, Atmospheric Correction Value(PPM) and Prism constant value (PSM)

Click [Atmos] to view the Temperature, Pressure, PPM and PSM. To modify parameters, point the cursor to the textbox by stylus, and input the new value. Please Refer to "14. SYSTEM SETTINGS" for the detail.



3. Set the target type, illumination of crosshair and check the signal intensity.

Click [Target], target type, illumination of cross hair, etc. can be set.

Setting of target type:

There are two measuring modes for KTS-470 series: visible laser EDM and invisible

laser EDM. The reflector can be set as Prism, Non-prism and Reflecting Sheet.

•Refer to "technical parameters" for the parameter of different reflectors.

Setting of illumination of cross hair:

•Move the stylus to adjust the brightness of crosshair.

- L: Indicate that the crosshair is dim.
- H: Indicate that the crosshair is bright

Move the stylus from left to right to change the brightness of the crosshair from dim to bright.

Setting of signal mode:

The reflector return signal intensity was displayed in this mode. It will buzzer when return signal from the prism was received. This function is more convenient for collimation when the target is difficult to find.

The received return signal level is displayed with bar graph as follows.



Setting of Laser Pointer and Laser Plumb: change the on/off and working time of Laser pointer; set the on/off and intensity of the laser plumb (for 470RLC).

5. PREPARATION FOR MEASUREMENT

5.1 UNPACKING AND STORAGE OF INSTRUMENT

- Unpacking of instrument

Keep the case right side up with care, and open the instrument container and take out the instrument.

- Storage of instrument

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

5.2 INSTRUMENT SETUP

Put the instrument on the tripod. Level and center the instrument precisely.

Operation Reference:

1. Leveling and Centering the Instrument by plumb bob

1) Set up the tripod

1 Adjust the tripod legs to suitable length, make the tripod head parallel to the ground and tighten the screws.

② Make the center of the tripod and the occupied point approximately on the same plumb line.

(3) Set the tripod and make sure it is well stationed on the ground.

2) Put the instrument on the tripod

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

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

① Turn the leveling screw A and B to move the bubble in the circular vial, in which case the bubble is located on a line perpendicular to a line running through the centers of the two leveling screw being adjusted.



③ Turn the leveling screw C to move the bubble to the center of the circular vial.



4) Precisely leveling by using the plate vial

① Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel to the line connecting leveling screw A and B, and then bring the bubble to the center of the plate vial by turning the leveling screws A and B.



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



③Repeat the steps ①② for each 90 °(100g) rotation of the instrument and check

whether the bubble is correctly centered in all directions.

2. Centering by using the optical plummet

1) Set tripod

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

2) Install instrument and collimate the point

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

3) Use circular vial to roughly level the instrument.

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

4) Use plate vial to level the instrument accurately.

①Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel to the line connecting leveling screw A and B, and then bring the bubble to the center of the plate vial by turning the leveling screws A and B.

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

5) Precisely centering and leveling

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

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

5.3 BATTERY INFORMATION

Notice:

(1) the battery operating time will vary depending on the environmental conditions such as ambient temperature, charging time, the number of times of charging and discharging etc. It is recommended for safety to charge the battery beforehand or to prepare spare full charged batteries.

2) the battery icon shows the power level regarding the current measurement mode. The distance measurement mode consumes more power than angle

measurement mode, so the power enough for the latter is not sure applicable for the previous one. Pay particular attention to this when switching angle measurement mode to distance measurement mode, because insufficient battery power might lead to interrupted operation.

• before outdoor operation, battery power status should be well checked.

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

·Battery Recharging Cautions:

 \precsim Battery should be recharged only with the charger SC-20 going with the instrument.

Remove the on-board battery from instrument and connect it to battery charger. When the indicator lamp on the battery charger is orange, the recharging process has begun. When charging is complete (indicator lamp turns green), disconnect the charger from its power source.

Battery Removal Cautions:

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

Battery Recharging Cautions:

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

Be sure to recharge the battery at a temperature of $0 \sim \pm 45$ °C, recharging may be abnormal beyond the specified temperature range .

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

Battery Charging Cautions:

Rechargeable battery can be repeatedly recharged 300 to 500 times. Complete discharge of the battery may shorten its service life. In order to get the maximum service life, Make sure you recharge it at least once a month.

5.4 REFLECTOR PRISM

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



5.5 MOUNTING AND DISMOUNTING INSTRUMENT FROM TRIBRACH

Dismounting

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



Mounting

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

5.6 EYEPIECE ADJUSTMENT AND COLLIMATING OBJECT

Method of Collimating Object (for reference)

(1) Sight the Telescope to bright place and rotate the eyepiece tube to make the reticle clear.

② Collimate the target point with top of the triangle mark in the coarse collimator. (Keep a certain distance between eye and the coarse collimator).

Make the target image clear with the telescope focusing screw.

 $\stackrel{\wedge}{\bowtie}$ if there is parallax when your eye moves up, down or left, right, it means the diopter of eyepiece lens or focus is not well adjusted and accuracy will be influenced, so you should adjust the eyepiece tube carefully to eliminate the parallax.

5.7 VERTICAL AND HORIZONTAL ANGLE TILT CORRECTION

When the tilt sensors are activated, there will be an automatic compensation value added into the vertical and horizontal angles.

Tilt sensor must be turned on; it can help improve the precision. When a dialog of compensation displays, it indicates that the instrument is out of automatic compensation range ($\pm 3.5'$), and must be leveled manually.

KTS-470(R) Series compensates the inclination in both X and Y directions.

Example:

OPERATION STEPS	KEY	DISPLAY
If the instrument hasn't been leveling, a compensation dialog box will pop up automatically. As shown in the right graph.		Function Help × Function Help × Tilt Z-axis Y: 0°04'10" Y: 0°04'10" Y: 0°05'21" Off Back

Turn the leveling screw to make the	Function Help
black dot move into the small	Tilt mode:
circle.	
When the small black dot is in the	()
small circle, it means the instrument	Aunos
is within the auto tilt compensation	
scale $\pm 3.5'$.	$\begin{array}{c c c c c c c c c c c c c c c c c c c $
If it is outside the small circle, the	
instrument needs to be leveled	
manually.	
To set it to single axis	
compensation, click [1-axis]; To	
close compensation, click [OFF];	
To return to previous mode, click	
[Back].	

•When the instrument is set on an unstable stage especially in a windy day. You may turn off the auto tilt correction function; otherwise it may leads to a wrong value.

• If the tilt sensor turn on already (Single Axis or Dual Axis), you can level the instrument according to the electronic bubble show above.

6. BASIC SURVEY

On desktop of KTS-470R click is to open the program of basic survey, as shown in the following graph:





Description of each function key:

Function keys display at the bottom of the screen, which change with the measure mode.

The fellering	anomle links	as als from	ation lears			~
The following	graph lists	each rund	cuon key i	in every	/ measure mod	e.

Mode	Display	Softkey	Function		
	0 Set	1	0 Set horizontal angle.		
	HSet	2	Preset a horizontal angle.		
	Hold	3	Hold horizontal angle.		
∀Angle	Repeat	4	Repeat horizontal angle measurement.		
	V%	5	Switch between vertical angle and percentage.		
	HR/HL	6	Switch horizontal angle right/left		
	Mode	1	EDM mode: Fine[s]/ Fine[N]/ Fine [r]/Track		
	m/ft	2	Distance unit: meter/Feet/U.S.		
셈 Dist	layout	3	Layout measure mode		
	REM	4	Start Remote Elevation Measurement.		
	MLM	5	Start Missing Line Measurement.		
	Line Ht	6	Start Line Height Measurement.		
	Mode	1	EDM mode: Fine[s]/ Fine[N]/ Fine [r]/Track		
	Occ	2	Preset coordinates of occupied point.		
	BS	3	Preset coordinates of backsight point.		
	Setup	4	Preset instrument height and target height.		
Coord	Store	5	Start store function.		
	Offset	6	Start Offset measurement. (Angle Offset (1) /Distance		
			Offset (2)/Column Offset (3)/Plane Offset (4)).		

6.1 ANGLE MEASUREMENT

6.1.1 Horizontal Angle (Right Angle) and Vertical Angle Measurement

OPERATION STEPS	KEY	DISPLAY
①Sight the first target A.	Sight target A	Angle Measurement × VA(V): 160°59'50" PPM: 0 PA(HR): 191°57'34" PSM: -30 Dist Unit: Meter EDM Mode: Track Tilt:2-Axis VAngle Dist OSet HSet Hold Repeat V/% HR/HL Coord
 ②Set the horizontal angle of target A as 0°00′00″. Click [0 SET], press [OK] in the pop-up dialog box to confirm. 	[0 Set] [OK]	Angle Measurement × VA(V): 160°59'26" Parameters PPM: 0 PSM: -0 PSM: -0 -0 PSM: PSM: -0 -0 PSM: PSM: -0 -0 -0 PSM: -0 -0 -0
③Sight second target (B). The screen displays the horizontal and vertical angle of target B.	Sight B	Angle Measurement X VA(V): 93°18'07" PA(HR): 22°09'08" PSM: -30 Dist Unit: Meter EDM Mode: Track Tilt:2-Axis VA(V): 4Angle OSet HSet Hold Coord Repeat V/%

Make sure the mode is Angle measurement.

How to collimate the targets (For reference)

① Point the telescope toward the light, rotate the eyepiece ring, focalize the telescope so that the crosshair is clearly observed (turn the eyepiece ring to you first and then to focus).

2 Aim the target at the peak of triangle mark of the collimator. Keep a certain space between the collimator and yourself for collimation.

3 Focus the target with the focusing knob until the target is clearly seen and its center is right on the crosshair.

If parallax exists between the crosshair and the target when viewing vertically or horizontally through the telescope, focusing is incorrect or diopter adjustment is poor. This adversely affects precision in measurement or survey. So please eliminate the parallax by focusing and using diopter adjustment carefully.

6.1.2 Switch Horizontal Angle Right/Left

Make sure the mode is Angle measurement.

OPERATION STEPS	KEY	DISPLAY			
① Make sure the mode is Angle measurement.		Angle Measurement × VA(V): 93°19'42" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Track Tilt:2-Axis VAngle Dist OSet HSet Hold Repeat V/% HR/HL ∠Coord			
② Click [HR/HL] key, horizontal right angle measuring mode is shifted to left angle mode. ※1)	[HR/HL]	Angle Measurement × VA(V): 93°19'41" Parameters PPM: 0 PSM: -30 Dist Unit: Mode: Track Tilt:2-Axis VAngle Dist Dist OSet HSet Hold Repeat V/% HR/HL Coord			
※1)Every time click [HR/HL] key,	HR/HL is shifted i	in order.			

6.1.3 Horizontal Angle Reading Setting

Setting by holding the angle Make sure the mode is Angle measurement.

OPERATION STEPS	KEY	DISPLAY
①Use horizontal clamp screw and horizontal tangent screw to set the required horizontal angle.		Angle Measurement × VA(V): 145°26'17" HA(HR): 21°00'10" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis VAngle Dist
		USet HSet Hold Repeat V/% HR/HL

②Click [Hold], hold the required horizontal angle.	[Hold]	Angle Measurement × VA(V): 145°26'17" Parameters PPM: 0 PSM: -30 Meter Fine[S] HA: 21°00'10" Unlock Cancel OSet HSet Hold Coord Repeat V/%
(3)Collimate the target. ×1)		
(4)Click [Unlock]], to release the horizontal angle. The display turns back to normal angle measurement mode, setting the current horizontal angle as the value held	[Unlock]	Angle Measurement × VA(V): 145°26'17" PA(HR): 21°00'10" PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis VAngle Dist OSet HSet Hold Coord Para.
just now.		Repeat V/% HR/HL

2) Setting a Horizontal Angle from the keys

Make sure the mode is Angle measurement.

OPERATION STEPS	KEY	DISPLAY	
① Collimate the target.		Angle Measurement × VA(V): 10°04'35" PArameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis VA(V): HSet	
		Repeat V/% HR/HL	

		Angle Measurement ×		
		VA(V H Angle Set		
②Click [HSet], a dialog box pops	[HSet]	HA(H Angle Input: 120.0000 er		
up.	Input	Input Prompt e[S]		
③ Input the required horizontal	horizontal	12.2345(12°23'45"Degree) 12.7865(12.7865Gon)		
angle※1)、※2)	angle	12.45(12.45Mi)		
For Example: 120°00'00"		OSe Enter Cancel Bara		
		Repeat V/% HR/HL		
		Angle Measurement X		
 ④After inputting, press [ENT] ※ 3) When completed, normal measuring from the required Horizontal angle is possible. 	[ENT]	VA(V): 10°04'35" Parameters PPM: 0 PSM: 30 Dist Dist Dist Dist OSet HSet Hold ∠coord Parameters Repeat V/% HR/HL ∠coord Parameters		
*1) You can press [] to open inputting panel, click the numbers to input, see "3.3 APPROACHES				
TO INPUTTING NUMBERS AND LETTERS".				
\times 2) To revise wrong value, use stylus or press $[D]/[S]$ moving the cursor to right of the number need				

& 2) To revise wrong value, use stylus or press $[\mathbf{P}]/[\mathbf{\P}]$ moving the cursor to right of the number need to delete. Click $[\mathbf{\P}]$ on the panel or press [B.S.] to delete wrong value and input correct one.

3 With wrong input value (for example 70'), Setting failed, press [ENT], the system doesn't respond, input again from step (3).

6.1.4 Vertical Angle Percentage (%) Mode

Make sure the mode is Angle measurement.

Example:

OPERATION STEPS	KEY	DISPLAY
①Make sure the mode is Angle measurement.		Angle Measurement × VA(V): 87°56'20" Parameters PA(HR): 152°50'21" PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis ✓ Angle Dist OSet HSet Hold Repeat V/% HR/HL ✓ Coord

		Angle Measurement X		
②Click [V/%].	[V%]	V%: 3.60 % Parameters HA(HR): 152°50'21" PSM: -30 Dist Unit: Meter EOM Mode:Fine[S] Tilt:2-Axis		
		OSet HSet Hold		
		Repeat V/% HR/HL		
×1) Every time Click [V/%], the display mode switches accordingly.				

6.1.5 Angle Repetition Measurement

This program is used to angle repetition measurement, displaying the sum and average value of all observed angles. It records the observation times at the same time.



Example:

OPERATION STEPS	KEY	DISPLAY
① Click [Repeat] to enter into Angle Repeat function.	[Repeat]	Angle Measurement X VA(\ Angle Repeat X HA(\ HA(\ Angle Repeat X HA(\ HT: 128°18'02" HT: Count[0] Os Os Oset Hold Unlock Exit Repeat V/% HR/HL Coord SPara.
②Sight the first target A.	Sight target A	Angle Measurement X VA() Angle Repeat X HA() Angle Repeat X HH: 120°40'01" Y HH: 120°40'01" Y HH: 120°40'01" Y Image: Count[0] Dist OS OSet Hold Unlock Exit Repeat V/% HR/HL Coord
--	----------------	--
③ Click [0 Set], 0 Set the horizontal angle.	[0 Set]	Angle Measurement × VA(\ Angle Repeat HA() HA() HT: 0°00'00" HT: 0'00'00" HT: 0'00" HT: 0'0" HT: 0'00" HT: 0'0" HT: 0'0" HT: 0'0" HT: 0'0" H
		Angle Measurement X
④Use horizontal clamp screw and horizontal tangent to sight the second target B.	Sight B	VA() Angle Repeat X HA() HA() HT: 9°06'52" HT: 9°06'52" H

⁽⁶⁾ Use horizontal clamp screw and horizontal tangent to sight first target A again. ⁽⁷⁾ Click [Unlock].	Sight A again + [Unlock]	Angle Measurement × VA(\ Angle Repeat × HA(H Ht: 9°06'52" Hm: 9°06'52" Count[1] OSt OSt Hold Unlock Exit Repeat V/% HR/HL Coord Para.
 ⑧Use horizontal clamp screw and horizontal tangent to sight the second target B again. ⑨Click [Hold]. The total of angle (Ht) and the mean value of angle (Hm) are shown. 	Sight B again [Hold]	Angle Measurement X VA(\Angle Repeat X HA(\Angle Repeat X HH: 18°13'45" Hm: 9°06'52" OS OSet Hold Unlock Exit Repeat V/% HR/HL Coord Para.
 Repeat 6 ~ 9 to reach the desired number of repetition. Click [Exit] to quit angle repeat mea 	surement.	

6.2 DISTANCE MEASUREMENT

In basic surveying screen, click [Dist] to enter into distance measurement.

Distance Measurement 🛛 🛛 🗙				
VA(V):	49%	09'26"	Parameters PPM: 0	
HA(HR):	2160	946'40"	Dist Unit: Meter	
SD:	2	.228	EDM Mode:Fine[S]	
HD:	1	.685		
VD:	1	.457	VAngle 📶 Dist	
Mode	m/ft	Layout	Const Supers	
REM	MLM	Line	Z coord Para.	

NOTE:

Do not aim at strongly reflecting targets (such as traffic lights). The measured distances may be wrong or inaccurate.

When the [DIST] is triggered, the EDM measures 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.

TReflectorless EDM

•Ensure that the laser beams cannot be reflected by any object nearby with high reflectivity.

•When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. In case of temporary obstruction (e.g. a passing vehicle, heavy rain, snow, frog, etc.), the EDM may measure to the obstruction.

•When measuring longer distance, any divergence of the red laser beam from the line of sight might lead to less accurate measurements. This is because the laser beam might not be reflected from the point at which the crosshairs are pointing. Therefore, it is recommended to verify that the R-laser is well collimated with the telescope line of sight.

•Do not collimate the same target with the 2 total stations simultaneously.

FAccurate measurements to prisms should be made with the standard program (infrared mode).

Fred Laser Distance Measurement Cooperated with Reflective Foils.

The visible red laser beam can also be used to measure to reflective foils. To guarantee the accuracy the red laser beam must be perpendicular to the reflector foil and it must be well adjusted

Make sure the additive constant belongs to the selected target (reflector).

6.2.1 Setting Atmosphere Correction

•Distance measurement is influenced directly by the atmospheric conditions of the air in which distance measurement are taken.

In order to take into consideration these influences distance measurements are corrected by using atmospheric correction parameters.

Temperature: Air temperature at instrument location.

Pressure: Air pressure at instrument location.

Atmos PPM: Calculated and indicated atmospheric PPM.

6.2.1.1 Calculation of Atmospheric Correction

•The value of Atmospheric Correction can be influenced by air pressure, air temperature and the height. The calculating formula is as follows: (calculating unit:

meter)

If the pressure unit adopted is mmHg: make conversion with:

1hPa = 0.75mmHg.

•The standard atmospheric condition of KTS-470R Series (e.g. the atmospheric condition under which the atmospheric correction value of the instrument is zero) :

Pressure: 1013 hPa

Temperature: 20°C

If regardless of atmospheric correction, please set PPM value as 0.

OPERATION STEPS	OPERATION	DISPLAY
 (1) In the menu of total station, click "Meas.Setup" and then click "Atmospheric Parameters". 	[Meas.Setup] [Atmospheric parameters]	System Set OK × Measurement Set Atmospheric Parameters Con ▶ Input Temperature 20 °C Pressure 1013 hPa PPM 0 ppm PSM -30 mm
② Current Atmospheric Parameters display on the screen. use stylus and input the new data. For instance, set the temperature as 26 °C	Input Temperature	System Set OK × Measurement Set Atmospheric Parameters Con < ▶
③According to the same steps, input the value of Air pressure. click the "Save" after finishing setting.	Input Pressure + [Save]	System Set Measurement Set Atmospheric Parameters Con · · Atmospheric Parameters OK · · Atmospheric parameter settings have been saved! Save

(4) Press [OK] to save these parameters. System will get PPM value from the value of temperature and air pressure, The screen displays as the right graph.	[OK]	System Set OK × Measurement Set Atmospheric Parameters Con () Input Temperature 26 °C Pressure 1013 hPa PPM 5 ppm PSM -30 mm Save
※1The inputting range: Temperatu	re:-30~+60°C(step	length 0.1 °C) or -22 \sim +140°F (step length 1°F)
Air pressure:420 \sim 800 mm Hg(ste	ep length 1 mm Hg) o	r 560 ~ 1066 hPa (step length 0.1hpa)
16.5 \sim 31.5 inchHg	step length 0.1 inch	Hg)
Atmosphere parameters(PPM): -10	0~+100ppm (step let	ngth 1 ppm)
2)The atmosphere correction value will be calculated by the instrument according to the inputted		
temperature and pressure value.		

6.2.1.2 Input Atmospheric Correction Value directly

Test the temperature and air pressure out, and get the Atmospheric Correction Value (PPM) from the formula of Atmospheric Correction.

OPERATION STEPS	OPERATION	DISPLAY
 In the menu of total station, click "Meas.Setup" and then click "Atmospheric Parameters" 	"Meas.Setup" +"Atmospheric Parameters	System Set OK Measurement Set Atmospheric Parameters Cor Input Temperature 20 °C Pressure 1013 hPa PPM 5 ppm PSM -30 mm
②Delete the old PPM and input the new one	Input PPM Value	System Set Measurement Set Atmospheric Parameters Con 4 Input Temperature 26 °C Pressure 1013 hPa PPM 3 ppm PSM -30 mm Save

③Click [Save] to save the value.	[Save]	System Set OK × Measurement Set Atmospheric Parameters Con < ◆ Atmospheric Parameters OK × Atmospheric parameter settings Atmospheric parameter settings have been saved! Form 100 mm Save	
$\%$ 1)The inputting scope of Atmospheric parameters : -100 \sim +100 PPM(step length : 1PPM)			

Atmospheric Correction value also can be set in star key (\bigstar)mode.

6.2.2 Atmospheric Refraction and Earth Curvature Correction

When calculating the horizontal distance and the height differences, the instrument will automatically correct the effect of atmosphere refraction and the earth curvature the correction.

The atmosphere refraction and the earth curvature are calculated by the formulas as follows:

Corrected Horizontal Distance:

```
D=S * [\cos\alpha + \sin\alpha * S * \cos\alpha (K-2) / 2Re]
```

Corrected Height Differentia:

 $H=S * [sin\alpha + cos\alpha * S * cos\alpha(1-K) / 2Re]$

If the correction of atmosphere refraction and the earth curvature are neglected, the calculation formula of horizontal distance and the height differentia are: D=S \cdot cos α H=S \cdot sin α

In formula:	K=0.14 ·		····Atm	osphere R	efraction	n Modulus	
	Re=6370 k	cm ·····	^{••} The E	Earth Curv	ature Ra	adius	
	α (or β)		····The	Vertical	Angle	Calculated	From
Horizontal Pla	ane (Vertical	Angle)					
	S		····Oblic	ue Distan	ce		

NOTE: The atmosphere refraction modulus of this instrument has been set as: K=0.14. it also can be set as :K=0.2,or be set shut (0 VALUE).(refer to "14"SYSTEM SETTINGS).

6.2.3 Setting Target Type

KTS-470(R) Series Total Stations can set options of visible Laser EDM and Invisible Laser EDM, as well as reflector with prism, non-prism, and reflective sheet. User can set them according to the requirements of the job.

You can set Target Type in star key (\bigstar)model.

OPERATION STEPS	OPERATION	DISPLAY
1.Press[★] on keypad to open the system set window.	[☆]	System Set OK × Image: Constraint of the set of the
2. Click [Target] to set the type.	[Target]	Tilt Target Type
3. Use stylus to choose the type of the target.		Tilt Target Type Non-P Sheet Prism Cross Hair Illumination L L H Signal Intensity H Signal Intensity Laser plumb 30 second On 1 minute O 1 5 minute O 3
④Press [ENT] to quit.	[ENT]	
 Instruction of the target type: 		
Non-P: measure with the	visible red laser, n	o need to use prism. All of types of target are

available for measure.

G Sheet: Use the sheet as target to measure. Prism: Use the prism as target to measure.

Prism: Use the prism as the target to measure.

6.2.4 Setting the Prism Constant

Since the constants of prisms manufactured by different companies are different, the corresponding prism constant must be set. Once the prism constant is set, it would be kept even if the machine is turned off.



You also can set Prism Constant in star key (\bigstar)model.

6.2.5 Distance Measurement (Continuous Measurement)

Make sure the mode is Angle measurement.

See the Example in next page.

OPERATION STEPS	KEY	DISPLAY
① Sight at the center of prism.	Sight	Angle Measurement × VA(V): 51°51'51" PArameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis VAngle Dist OSet HSet Hold Repeat V/% HR/HL
③ Click [Dist] to enter distance measurement. The system start measuring according to EDM mode set last time.	[Dist]	Distance Measurement × VA(V): 51°51'51" Parameters PPM: 0 PSM: -30 Dist Unit: Mode:Fine[S] HD: VA VD: VD: VA VA Mode m/ft Layout REM MLM Line
③Click [Mode] to enter EDM Mode setting. Here takes Fine[r] as example.	[Mode]	Distance Measurement × VA(V EDM Mode HA(H EDM Mode O Fine[S] e[R] SD: O Fine[N] HD: Enter VD: Track Mod Enter Cancel Para.
 ④The measure result displays.※1)~ ※3) ※1) To change measuring mode, click IM 	fode], set as st	Distance Measurement × VA(V): 51°51'50" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis HD: 1.844 VD: 1.4477 Mode m/ft Layout Coord REM MLM
%2) The result is shown with buzzer source	nd.	~r

%3) Measurement may repeat automatically if the result is affected by atmospheric refraction etc.

%4) To return to Angle measurement mode, click "Angle" key.

6.2.6 Distance Measurement (Single/N-Time Measurement)

When the number of times for measurement is preset, the instrument measures the distance according to the specified number or times. The average result will be displayed.

When presetting the number of times as 1, it does not display the average distance because it is just single measurement; Single measurement is default factory setting.

OPERATION STEPS	KEY	DISPLAY
 In distance measuring Mode, click [Mode] to enter EDM Mode setting. System defaults as Fine[s]. 	[Mode]	Distance Measurement × VA(V EDM Mode × EDM Mode × EDM Mode × Image: Signal and the second secon
 ② Click Fine [N] or press [▲]/ [♥], a Times column displays on the upper right screen. Input the times of N-time measurement. 	[Fine[N]] Input times	Distance Measurement X VA(V EDM Mode EDM Mode X EDM Mode Press SD: Fine[S] AHA(H) Fine[S] SD: Fine[R] O Fine[R] O Track VD: Enter Cancel Para.
③Click [Enter]. Sight the target, system start survey based on the setting set just now.	[Enter]	Distance Measurement × VA(V): 51°50'20" Parameters PPM: 0 PSM: -30 Dist Unit: Meter SD: 2.343 HD: 1.842 VD: 1.448 Mode m/ft Layout Coord REM MLM Line Coord

1) Example: Setting the number of times

6.2.7 Fine/Tracking Measurement Mode

Fine mode: This is the common distance measurement mode.

Tracking mode: This mode measures quickly. Use this mode for stake-out measurement. It is very useful for tracing the moving object or carrying out stake-out job.

Exam	ple:
L'Aum	pro.

OPERATION STEPS	KEY	DISPLAY
①Sight the center of prism.	Sight the prism	Distance Measurement×VA(V): $60^{\circ}32'07"$ Parameters PPM: 0 PSM: -30 Dist Unit: MeterSD:2.767Dist Unit: Meter EDM Mode:Fine[3] Tilt:2-AxisHD:2.409 VD:VangleVD:1.361VangleModem/ftLayout LineREMMLMLine
② Click [Mode] to enter EDM Mode setting set it as Track.	[Mode]	Distance Measurement × VA(V EDM Mode × HA(H Fine[S] er SD: Fine[N] ack HD: Fine[R] Dist VD: Track Dist Mod Enter Cancel REM MLM Line
③Click [Enter]. Sight the target, system start survey based on the setting set just now.	[Enter]	Distance MeasurementVA(V): $60^{\circ}32'07"$ Parameters PPM: 0HA(HR): $210^{\circ}46'25"$ Dist Unit: MeterSD: 2.767 Dist Unit: MeterHD: 2.409 \bigvee AngleInit: 2-AxisVD: 1.361 \bigvee AngleInit:Modem/ftLayout \bigwedge CoordPara.

6.3 COORDINATE MEASUREMENT

6.3.1 Setting Coordinate Values of Occupied Point

Set the occupied point Coordinate according to coordinate origin, and the instrument automatically converts and displays the prism point Coordinate based on the origin and

occupied point.



OPERATION STEPS	KEY	DISPLAY
① Click [Coord] to enter into coordinate measurement.	[Coord]	Coord Measurement × VA(V): 87°08'37" Parameters PA(HR): 166°53'32" PSM: -30 North (N): >>> Dist Unit: Meter East (E):
②Click [Occ] .	[Occ]	Coord Measurement X VA(V): Occ Set HA(HR): Input North (N): 0 East (E): 2 Zenith(Z): Enter Cancel Occ Mode Occ Setup Store Offset Coord
③ Input coordinate of occupied point, after inputting one item, click [Enter] to move to the next item.	[Enter]	Coord Measurement × VA(V): Occ Set HA(HR): Input North (N): 100 East (E): 2 Zenith(Z): Enter Cancel Occ Set Mode Occ Set Occ Set Imput North (N): E E 100 Imput Zenith(Z): Enter Cancel Occ Occ Setup Store Offset

		Coord Measurement	×
		VA(V): 87°08'37" Parameter PPM: 0	rs —
		HA(HR): 166°53'32" PSM: -30 Dist Unit: M	leter
(4)After all inputting, click [Enter]	[Enter]	North (N): 99.706 EDM Mode: Tilt:2-Axis	Fine[S]
to return to coordinate measurement		East (E): 100.068	
screen.		Zenith(Z): 10.115	Dist
		Mode Occ BS	m
		Setup Store Offset	™Para.

6.3.2 Setting the Backsight Point

OPERATION STEPS	KEY	DISPLAY
①Click [BS] to enter BS Setting.	[BS]	Coord Measurement × VA(V): 122°42'25" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis North (N): >>> East (E): Zenith(Z): ✓ Angle ✓ Ist Mode Occ BS Setup Store Offset
② Input coordinate of backsight point. After inputting one item, click [Enter] to move to the next item.	[Enter]	Coord Measurement × VA(V): BS Set HA(HR): Input North (N): Input East (E): 0 Zenith(Z): Enter Cancel Input Mode Input Setup Store Offset Coord
③After inputting, click [Enter]	[Enter]	Coord Measurement × VA(V): 122°42'25" Parameters HA BS Set × HA BS Set × No Image: H(B): BS Set × Please sight BS Pt and press <yes> SI Eas Image: Hease sight BS Pt and press<yes> Ist Mode Occ BS Setup Store Offset Image: Coord</yes></yes>

④ Sight at the backsight point,		Coord Mea	surement	×
click [YES]. System sets the		VA(V):	122º42'26"	Parameters
backsight azimuth and returns		HA(HR):	225°00'01"	PSM: -30 Dist Unit: Meter
to Coordinate Measurement	[Yes]	North (N):	99.819	EDM Mode:Fine[S] Tilt:2-Axis
Screen. The screen displays		East (E):	99.819	
the backsight azimuth set just		Zenith(Z):	9.935	VAngle 📕 Dist
now.		Mode	Occ BS	
		Setup	Store Offset	Z COOru De Para.

6.3.3 Setting the Instrument Height/ Prism Height

Measure the Coordinate by entering the instrument height / prism height, Coordinate of unknown point will be measured directly.

OPERATION STEPS	KEY	DISPLAY
①Click [Setup] to enter Set Inst.Ht & R.Ht function.	[Setup]	$\begin{tabular}{ c c c c c } \hline Coord Measurement & \times \\ \hline VA(V): $106°36"55" & $Parameters$ \\ \hline PA(HR): $224°59"59" & $PM: 0$ \\ \hline PSM: 0$ \\ PSM: -30$ \\ \hline Dist Unit: Meter$ \\ \hline PSM: -30$ \\ \hline Dist Unit: Meter$ \\ \hline EDM Mode:Fine[S]$ \\ \hline Tilt:2-Axis$ \\ \hline East (E): 99.819 \\ \hline Zenith(Z): 9.935 & $$VAngle$ & $Dist$ \\ \hline Mode & Occ & BS$ \\ \hline Setup & Store & Offset \\ \hline \end{tabular}$
② Input instrument height, and target height, After inputting one item, click [Enter] to move to the next item.	Input instrument height, and target height.	Coord Measurement × VA(V): Parameters HA(HR): Parameters North (N): Input East (E): 0 Zenith(Z): Enter Cancel O Mode Setup Store Offset
③ After inputting all data, Click [Enter] to return to Coordinate Measurement Screen.	[Enter]	Coord Measurement \times VA(V):106°36'55"Parameters PPM: 0HA(HR):225°00'00"Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-AxisNorth (N):99.819Image: Constant of the second secon

6.3.4 Operation of Coordinate Measurement

Measure the Coordinate by entering coordinate of occupied point, backsight azimuth, the instrument height and prism height, coordinate of unknown point will be measured directly.

•To set coordinate value of occupied point, see Section "6.3.1 Setting Coordinate Values of Occupied Point".

•To set the instrument height and prism height, see Section "6.3.3 Setting of the Instrument Height/Prism Height".

•The Coordinate of the unknown point are calculated as shown below and displays:

Coordinate of occupied point: (N0, E0, Z0)

Coordinate of the centre of prism , originated from the centre point of the instrument: (n,e,z)

Coordinate of unknown point : (N1, E1, Z1) N1 = N0 + n E1 = E0 + eZ1 = Z0 + Inst.Ht + z - Prism .h

Coordinates of the center of the prism , originated from the center point of the instrument (N,E,Z)



Origin (0, 0, 0)

Example:

OPERATION STEPS	KEY			DISP	LAY
		Coord Me	asuremen	t	×
		VA(V):	1369	200'41"	Parameters
①Set coordinate values of occupied		HA(HR):	2579	22'54"	PSM: -30 Dist Unit: Meter
point and instrument / prism height		North (N)	: >>	>	EDM Mode:Fine[S]
×1)		East (E):			THC2-AXIS
②Set backsight azimuth \therefore ※2)		Zenith(Z)	:		🗸 🗸 🖌 🖌 🖌 🖌 🖌
(3)Collimate target. (×3)		Mode		BS	
		Setup	Store	Offset	Coord 🖄 Para.
		Coord Me	asuremen	t	×
		V0.00	1260	00/41	Parameters —
(4) Click [Coord] Measurement	[Coord]		130	100 41	PPM: 0 PSM: -30
and and the result displays $X(4)$	[Coold]	HA(HK):	257	22 34	Dist Unit: Meter EDM Mode:Fine[S]
ends and the result displays. (4)		NORTH (N)	99	.944	Tilt:2-Axis
		East (E):	99	.749	VAngle 📕 Dist
		Zenith(Z)	: 9	.834	
		Mode	Осс	BS	
		Setup	Store	Offset	
*1) In case the coordinate of occupied point is not entered, then the coordinate of occupied point set					
last time would be used. The instrum	ent height and the	prism heig	ght will b	e the valu	e you set last time.
2) Refer to Section "6.1.3 Horizontal Angle Reading Setting" or "6.3.2 Setting the Backsight Point".					
%3)Click[Mode], the mode (SINGL	.E/N-TIME/REPE	AT/TRAC	KING) ch	anges .	

%4) To return to the normal angle or distance measuring mode, click [Angle]/ [Dist].

7. APPLICATION PROGRAMS

7.1 LAYOUT

The difference between the measured distance and the preset distance is displayed. The displayed value = Measured distance – Standard (Preset) distance

• This function enables the stake-out of Horizontal Distance (HD), Vertical Difference (VD) or Slope Distance (SD) .

Example:

OPERATION STEPS	KEY	DISPLAY		
① Under the mode of Distance Measurement, click [Layout].	[Layout]	Distance Measurement × VA(V): 79°08'57" Parameters PPM: 0 PSM: -30 PSM: -30 Meter SD: SD: 0 HD: Enter VD: O Mode m/ft Layout Coord PPmaneters PPM: PSM: -30 PSM: -30 Mode m/ft Layout Coord PPara.		
		Distance Measurement X		
 2 Select the distance measurement mode (SD/HD/VD) to be laid out. After inputting the data to be laid out, click [Enter] %1) 		VA(V): 79°08'56" Parameters PPM: 0 PSM: 0 PSM: 0 PSM: 30 Meter SD: 2.233 HD: 2.233 HD: 2.233 Mode m/ft Layout Dist REM MLM Line Coord Para.		
③ Start setting out.		Distance Measurement × VA(V): 79°07'54" Parameters PPM: 0 PSM: -30 Dist Unit: Meter dSD: 2.789 Dist Unit: Meter HD: 4.932 VD: 0.947 Mode m/ft Layout Million REM MLM Line Coord		
%1)A dialog box prompts to enter slope distance you want to layout, after entering click[Enter] to				
layout SD. To layout horizontal dist	ance, input 0 in S	SD dialog box. Click [Enter], the HD box will		
prompt. After entering click [Enter]	to layout HD. To	layout height difference, input 0 in SD and HD		

box, and then the dialog box of VD to be staked out will prompt.

7.2 REMOTE ELEVATION MEASUREMENT (REM)

The Remote Elevation program calculates the vertical distance (height) of a remote object relatively to a prism and its height from a ground point (without a prism height). When using a prism height, the remote elevation measurement will start from the prism (reference point). If no prism height is used, the measurement will start from any reference point in which the vertical angle is established. In both procedures, the reference point should be perpendicular to the remote object.

7.2.1 Inputting Prism Height (h)



Example: (h=1.5m)
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OPERATION STEPS	KEY	DISPLAY
①In Distance Measurement, click [REM] to enter into REM function.	[REM]	Distance Measurement × VA(V): 231°42'52" Parameters PA(HR): 40°39'05" PSM: -30 SD: >>> Dist Unit: Meter FDM Mode:Fine[S] Tilt:2-Axis VD: ✓Angle Dist Mode m/ft Layout REM MLM Line
②As shown in the right graph, use stylus to click "With R.Ht".	[With R.Ht]	REM X Option With R.Ht With R.Ht Without R.Ht Measure PSM: -30 HD: Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Measure Continue Exit

③Input prism height.	Input prism height	REM × Option Parameters Image: Strain Str
 (5) Sight the prism center P. (5) Click [Measure] to start measure. (6) The HD between instrument and prism is displayed. 	Sight the prism [Measure]	REM X Option Parameters With R.Ht Without R.Ht Measure PSM: -30 HD: 4.932 R.Ht: 1.5 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Measure Continue Exit
⑦ Click [Continue], the prism position is entered.	[Continue]	Parameters Option With R.Ht With R.Ht With R.Ht With R.Ht PM: PPM: PSM: PSM: SM:
(8)Sight target K. The Vertical Distance (HD) is displayed. ×1)	Sight K	REM × Option Parameters With R.Ht Without R.Ht Measure PSM: -30 HD: 0.483 R.Ht: 1.5 Result Measure VD: 3.968 Exit

7.2.2 without Inputting Prism Height



OPERATION STEPS	KEY	DISPLAY
①Use stylus to click "Without R. Ht"	Without R.Ht	Coption Parameters With R.Ht Without R.Ht PBM: 0 PSM: -30 Dist Unit: Mede:Fine[R] Tilt:2-Axis Measure Continue Exit
 ②Sight prism center P. ③Click [Measure] to start survey. ④The HD between instrument and prism is displayed. 	Sight prism [Measure]	REM × Option Parameters With R.Ht Without R.Ht PSM: -30 Dist Unit: Meter HD: 2.415 Measure Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Measure Continue Exit Exit
⑤Click [Continue], The G point position is entered.	[Continue]	REM X Option Parameters With R.Ht Without R.Ht Measure PPM: 0 HD: 2.417 VA: 61°58'39" Measure Measure Continue Exit

[®] Click [Continue].	[Continue]	REM × Option	
⑦Sight target K. The Vertical Distance (VD) is displayed. ※1)	Sight target	REM × Option Parameters With R.Ht Without R.Ht Measure PSM: -30 HD: 2.417 VA: 112°04'31" Result Measure VD: 3.114 Exit	

7.3 MISSING LINE MEASUREMENT (MLM)

The Missing Line Measurement program computes the horizontal distance (dHD), slope distance (dSD) and vertical difference (dVD).

This program can accomplish this in two ways:

1. (A-B, A-C): Measurement A-B, A-C, A-D



2. (A-B, B-C): Measurement A-B, B-C, C-D



[EXAMPLE] 1. (A-B, A-C)

OPERATION STEPS	KEY	DISPLAY
①In Distance Measurement, click [MLM] to enter into missing line measurement function	[MLM]	Distance Measurement × VA(V): 231°42'52" Parameters PA(HR): 40°39'05" PSM: -30 BSD: >>> Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis HD: VD: VAngle Mode m/ft Layout REM MLM Line
②Use stylus to select A-B, A-C.		MLM Option (A-B,A-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (A-B,B-C) (B-C) (A-B,B-C) (B-C) (A-B,B-C) (B-C) (A-B,B-C) (B-C) (B-C) (A-B,B-C) (B-C) (B

③Sight prism A, click [Measure]. The HD between instrument and prism A is displayed.	[Measure]	MLM × Option (A-B,A-C) (A-B,B-C) Step 1 PSM: - 30 HD(1): 1.580 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Measure Continue Exit
(4)Click [Continue].	[Continue]	MLM × Option Parameters (A-B,A-C) (A-B,B-C) PSM: -30 PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tit:2-Axis Tit:2-Axis Measure Continue Exit Exit
⑤Sight prism B, Click [Measure]].	[Measure]	MLM X Option Parameters (A-B,A-C) (A-B,B-C) Step 1 FPM: 0 HD(1): 1.579 Step 2 Dist Unit: Meter HD(2): 2.092 Measure Continue Exit Exit
⁽⁶⁾ Click [Continue], The horizontal distance (dHD) height differentia (dVD) and slope distance (dSD) between prism A and B display.	[Continue]	MLM X Option Parameters (A-B,A-C) (A-B,B-C) Step 1 PSM: -0 HD(1): 1.579 HD(2): 2.091 Result Measure dHD:0.513 Continue dVD:-0.052 Exit

•The observation procedure of (A-B, B-C) is same as (A-B, A-C).

7.4 LINE MEASUREMENT (LINE)

The Line Measurement program allows the user to measure the height of an inaccessible object above a point. Both the inaccessible object and the point are located along an established base line. Two prisms, A and B, are set up apart from each other below the object to establish the base line. The horizontal distance is measured and set in the instrument for both prism A and B. The screen then shows the vertical distance from prism A and B, the horizontal distance from the instrument to prism B, and the distance along the base line and the screen will display the vertical distance from prism A to that point, the horizontal distance for that point. Additionally, the vertical distance between two points on the base line, Point G and L in the diagram can be measured.





OPERATION STEPS	KEY	DISPLAY
①In Distance Measurement, click [Line] to enter into line height measurement function	[Line]	Distance Measurement VA(V): 231°42'52" Parameters PA(HR): 40°39'05" PSM: -30 BSD: >>> Dist Unit: Meter EDM Mode:Fine[S] Tit:2-Axis HD: VD: Vangle Mode m/ft Layout REM MLM Line
②Use stylus select with R.H.		Line × Option Parameters With R.Ht Without PA: PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis
③ Click [Set] to set instrument height and target height. After inputting, click [Enter].	[Set]	Line X Option Parameters With P Ht Mithout Parameters HD PA: PB: Inst. Ht: R. Ht: I.5 Enter Cancel Meas Set
(4)Sight prism A, click [Meas] to start measure. After measuring, click [Continue].	[Meas]	Line X Option With R.Ht Without HD PA: 3.708 PB: Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Continue Set

⑤Sight prism B, click [Meas] to start distance measure.	[Meas]	Line X Option With R.Ht Without HD PA: 3.709 PB: 2.072 PB: 2.072 Vith Right Set
6 After measuring click [Continue].	[Continue]	Line X Option With R.Ht Without HD PA: 3.709 PB: 2.072 VD VD: 2.314 HD: 2.967 Off: 0.742 Continue Set
 (6) Sight line point L, Measured data to the line point L is displayed. VD : Vertical distance HD: Horizontal distance from the instrument to L Off : Horizontal distance from A to L 		Line × Option Parameters With R.Ht Without PA: 1.781 PB: 1.353 VD Dist Unit: Meter VD Tilt:2-Axis VD: 0.289 Off: 1.492
 Click [Continue]. This function is used when measuring the line height from the ground, OPERATIONAL STEPS: Sight the point on the line before clicking [Next]. Don't move the horizontal tangent screw when setting ground point G 	[Continue]	Line × Option Parameters With R.Ht Without PA: 1.781 PB: 1.353 VD Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis VD: -0.035 HD: 0.310 Off: 1.472 Ground Pt Continue V : 73°18'48"



7.5 TRAVERSE MEASUREMENT (RESTORE NEZ)

In this program the coordinate for the next point is stored in memory after the measurement is completed and accepted. The feature allows the user to occupy the next move-up point and use the previous occupied point for the backsight orientation. When occupying the next point and backsighting the original occupied point, the instrument will display the reverse angle for backsight orientation. If the occupied coordinate is not preset, zero (0,0,0) or the previous preset coordinate will be used for this program.



•Set the coordinate value of instrument point P0 and set the direction angle from P0 toward the known point A.

OPERATIONAL STEPS	KEY	DISPLAY
①Click [Store].	[Store]	Coord Measurement × VA(V): 36°04'04" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tit:2-Axis East (E): ✓Angle ✓ Ist Zenith(Z): ✓Angle ✓ Ist Mode Occ BS ✓Coord Setup Store Offset Coord
②Use stylus select "Store"	[Store]	Store × Option Parameters Image: Store Recall PSM: -30 PsM: -30 Dist Unit: Meter EDM Mode:Fine[R] HD: Tilt:2-Axis Meas Set Exit Exit
③Click [Set] to reset instrument height or prism height. After setting, click [Enter].	[Set]	Store X Option Parameters Stor Set Inst.Ht & R.Ht Acter HA: HD: Enter Cancel t Exit
(4)Collimate target p1 prism which the instrument moves. Click [Measure] to start survey.	[Measure]	Store × Option Recall Store Recall PSM: -30 Dist Unit: Meter HA: 265°15"39" HD: 1.727 Continue Set Exit

(5) Click [Continue]. The coordinates of P1 displays at the bottom of screen.[Continue] $[Continue]$ $PersecalPressCoord MeasurementPersecalPressPressPressCoord Measurement(6) Click [Store].Coord Measurement is set up atP1 (prism P1move to P0)[Store][Store][Store]PersecalPress<$			Store ×
(b) Click [Store]. [Store] Parameters (c) Cord Measurement YA(V): 49°39'12" Parameters YA(V): 49°39'12" Parameters PSM: 30 Dest Unit: Meter East (E): -1.721 VA(W): VA(W): Power off and move instrument to P1 (Prism P1move to P0) Mode Occ BS VCoord Parameters 7. After the instrument is set up at P1, power on and start coord. Store Parameters Parameters P1, power on and start coord. measurement. Select Store, use Store Parameters Parameters Stylus to choose "Recall". Show as the right graph. Image and direction angle toward P0 is set. The display returns to main menu. VA(V): 49°40'16" Parameters WA(V): 49°40'16" Parameters Parameters Parameters Parameters BCollimate the former instrument point P0, click [Set]. The coordinate at P1 and direction angle toward P0 is set. The display returns to main menu. VA(V): 49°40'16" Parameters PAH: 30 Parameters BCollimate the steps (1 ~ ®), as marined Store 0.000 East (E): 0.000 Dist BMode <	⑤Click [Continue] . The coordinates of P1 displays at the bottom of screen.	[Continue]	Option Parameters Store Recall PSM: -30 PSM: -30 Dist Unit: Meter HA: 265°15'51" HD: 1.727 Meas Res: N: -0.143 E: -1.721 Z: 1.567 Exit
Store×7. After the instrument is set up at P1, power on and start coord. measurement. Select Store, use stylus to choose "Recall". Show as the right graph.Parameters PFM: 0 PSM: -30 	⁽⁶⁾ Click [Store] . Coordinate of P1 will be confirmed. The display returns to main menu. Power off and move instrument to P1 (Prism P1move to P0)	[Store]	Coord Measurement × VA(V): 49°39'12" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis Tilt:2-Axis Zenith(Z): 1.567 ✓ Angle Mode Occ BS Setup Store Offset
(B) Collimate the former instrument point P0, click [Set].Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tit:2-AxisThe coordinate at P1 and direction angle toward P0 is set. The display returns to main menu.Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] 	7. After the instrument is set up at P1, power on and start coord. measurement. Select Store, use stylus to choose "Recall". Show as the right graph.		Store × Option Parameters Store PPM: 0 PSM: -30 PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Meas Set? Set Exit Exit
required.	 (B)Collimate the former instrument point P0, click [Set]. The coordinate at P1and direction angle toward P0 is set. The display returns to main menu. (D)Repeat the steps (1)~(B), as required. 		Coord MeasurementVA(V):49°40'16"ParametersPPM:0PSM:-0PSM:0Dist Unit: MeterNorth (N):-0.000East (E):D.000Zenith(Z):3.133 \checkmark AngleInit:ModeOccBS \checkmark CoordSetupStoreOffset \checkmark Coord

7.6 OFFSET MEASUREMENT (OFFSET)

There are four offset measurement modes in the Offset Measurement.

- 1. Angle offset
- 2. Distance offset
- 3. Plane offset
- 4. Column offset

7.6.1 Angle Offset

This mode is useful when it is difficult to set up the prism directly, for example at the centre of a tree. Place the prism at the same horizontal distance from the instrument as that of point A0 to measure .To measure the Coordinate of the centre position, operate the offset measurement after setting the instrument height/prism height.

•When measuring coordinates of ground point A1: Set the instrument height/prism height.

•When measuring coordinates of ground point A0: Set the instrument height only. (Set the prism height to 0)



•In the Angle Offset Measurement Mode, there are two setting methods for the vertical angle.

1.Free vertical angle : The vertical angle will be changed by rotating telescope.

2.Hold vertical angle : The vertical angle will be locked and never changed by rotating telescope.

When sighting to A0, you can select one way, [Hold] is to fix vertical angle to the prism position. When you select [Free], SD (Slope Distance) and VD (Vertical Distance) will be changed according to the movement of telescope.

OPERATIONAL STEPS	KEY	DISPLAY
① Click [Offset].	[Offset]	Coord Measurement × VA(V): 49°39'35" Parameters PA(HR): 87°30'16" PSM: -30 North (N): -0.067 Dist Unit: Meter East (E): 0.004 VAngle Zenith(Z): 3.122 Angle Offset Mode Occ Distance Offset Setup Store Plane Offset
 2 In the prompted dialogue box click [Angle Offset] to enter into angle offset measurement. 3 Use the stylus to select "Free VA" (or "Fixed VA") to start angle offset measurement. 	Angle Offset	Coord Measurement × VA(V): 49°39'35" HA(HR): 87°30'16" North (N): -0.067 East (E): 0.004 Zenith(Z): 3.122 Mode Occ Distance Offset Distance Offset Column Offset Plane Offset Pane Offset Plane Offset
④ Collimate prism P , Click [Measure] to start measurement.	Sight prism P Measure	Angle Offset × Option Fixed VA Free VA Fixed VA PSM: -30 Dist Unit: Meter HD: Tilt:2-Axis
⁽⁵⁾ Use horizontal clamp screw and horizontal tangent to sight target A0.	CollimateA0	Angle Offset × Option Fixed VA Free VA Fixed VA PMeasure Dist Unit: Meter HD: 1.726 Measure Tilt:2-Axis

	6 Click [Continue], The slope distance, horizontal distance and height differentia and coordinate from instrument to point AO will be shown ≈ 1), ≈ 2)	[Continue]	Angle Offset × Option Free VA Fixed VA PPM: PPM: PPM: PSM: -30 PSM: Measure I.727 Dist Unit: HD: 1.727 Tit:2-Axis Result V: : 49°38'13" HR: 87°29'29" SD: 2.266 N: -0.067 HD: 1.727 E: 0.004 VD: 1.468 Z: 3.134
Measure Continue Set Exit			Measure Continue Set Exit

※2) Click [Exit] to quit.

• Set Inst. Height/Prism Height before starting offset measurement.

• to set the coordinate of occupied point, refer to "6.3.1 Setting Coordinate Values of Occupied Point".

7.6.2 Distance Offset

The measurement of a place apart from a prism is possible by inputting offset horizontal distance of front and back/right and left.



•When measuring Coordinate of ground point A1: Set the instrument height / prism height

•When measuring Coordinate of ground point A1: Set the instrument height only (Set the prism height to 0)

 \bullet Setting the coordinate of occupied point $\,$, refer to "6.3.1 Setting Coordinate Values of Occupied Point".

OPERATIONAL STEPS	KEY	DISPLAY
① In Offset dialog box, click [Distance Offset] to enter into Dist. Offset.	[Distance Offset]	Coord Measurement × VA(V): 49°39'35" HA(HR): 87°30'16" North (N): -0.067 East (E): 0.004 Zenith(Z): 3.122 Mode Occ Distance Offset Column Offset Plane Offset Jane Offset Plane Offset
⁽²⁾ Move stylus to "Input", enter the offset distance. When each value is inputted, use stylus to move the next item.		Distance Offset × Input GR dRL 0 Measure Dist Unit: Meter HD Tilt:2-Axis
③After inputting "dRL", sight the prism, click [Measure] to start measure.	[Measure]	Distance Offset X Input I.6 dRL 2 Measure 1.728 Measure Continue Set Exit
(4)Click [Continue], the corrected measure result displays, as shown in the right picture. (1) , (2)	[Continue]	Distance Offset × Input dR 1.6 2 Measure HD 1.728 Result Frameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis V : 69°18'06" HR: 118°31'33" SD: 4.150 V : 69°18'06" V : 1.690 VD: 1.467 Z 3.134 Measure Continue
※1) To set instrument height or targe※2) Click [Exit] to quit.	et height, click [Set	t].

7.6.3 Column Offset

If it is possible to measure circumscription point (P1) of column directly, the distance to the center of the column (P0), coordinate and direction angle can be calculated by measured circumscription points (P2) and (P3).

The direction angle of the center of the column is 1/2 of total direction angle of circumscription points (P2) and (P3).



 \bullet Setting the coordinate of occupied point $\,$, refer to "6.3.1 Setting Coordinate Values of Occupied Point ".

OPERATIONAL STEPS	KEY	DISPLAY
① In Offset dialog box, click [Column Offset] to enter into Column Offset measurement.	[Column Offset]	Coord Measurement × VA(V): 49°39'35" Parameters HA(HR): 87°30'16" PSM: -30 North (N): -0.067 Dist Unit: Meter East (E): 0.004 VAngle Zenith(Z): 3.122 Angle Offset Mode Occ Distance Offset Setup Store Plane Offset
2 Collimate the center of the column (P1) and click [Measure] to measure. After measuring, click [Continue].	[Measure]	Column Offset × Measure Parameters HD: 1.727 Left(HR): Parameters Right(HR) Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis

③Collimate the point (P2) on the left side, as shown in the right graph. Click [Continue].	[Continue]	Column Offset X Measure Parameters HD: 1.727 Left(HR): 70°49'44" Right(HR) Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis	
		Measure Continue Set Exit	
(4)Collimate the right side of the column (P3)		Column Offset × Measure Parameters HD: 1.727 Left(HR): 70°50'45" Right(HR) 106°36'05" Measure Tit:2-Axis	
(5) Click [Continue], the distance between the instrument and center of the column (P0) will be calculated and displayed ≈ 1), ≈ 2)	[Continue]	Column Offset × Measure 1.727 HD: 1.727 Left(HR): 70°50'45" Right(HR) 106°35'59" PSM: -30 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis Result V : 59°30'17" HR: 88°43'22" SD: 2.893 N : -0.087 HD: 2.493 E : 0.771 VD: 1.468 Z : 3.135 Measure Continue	
※1) To set instrument height or target height, click [Set].※2) Click [Exit] to quit.			

7.6.4 Plane Offset

Measurement will be taken for the place where direct measuring can not be done. For example distance or coordinate measuring for an edge of a plane.

Three random target points (P1, P2, P3) on a plane will be measured at first in the Plane Offset measurement to determine the measured plane. Collimate the target point (P0) then the instrument calculates and displays coordinate and distance value of cross point between collimation axis and of the plane.



•Setting the coordinate of occupied point, refer to "6.3.1 Setting Coordinate Values of Occupied Point".

OPERATIONAL STEPS	KEY	DISPLAY
①In Offset dialog box, click [Plane Offset] to enter into Plane Offset measurement.	[Plane Offset]	Coord Measurement × VA(V): 49°39'35" PArameters PPM: 0 PSM: -30 Dist Unit: Meter Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis Tilt:2-Axis Zenith(Z): 3.122 Mode Occ Distance Offset Dist Police Column Offset Plane Offset Plane Offset
②Sight prism P1, click [Measure] to start measure After measuring, click [Continue].	[Measure] [Continue]	Plane Offset × Measure Parameters P1(HD): 1.726 P2(HD): PSM: -30 Dist Unit: Meter P3(HD): Tit::2-Axis
③ Measure the points P2 , Click[Measure] to start measure After measuring, click [Continue].	[Measure] [Continue]	Plane Offset × Measure Parameters P1(HD): 1.728 P2(HD): 1.731 P3(HD): 1.731 Dist Unit: Meter EDM Mode:Fine[R] Tilt:2-Axis
(4)Sight prism P3, Click [Measure] to start measure.	[Measure]	Plane Offset × Measure Parameters P1(HD): 1.728 P2(HD): 1.731 P3(HD): 0.988 P3(HD): 0.988 Tilt:2-Axis
---	------------	--
⑤Click [Continue] to calculate and display coordinate and distance value of cross point between collimation axis and of the plane . ※1)	[Continue]	Plane Offset X P1(HD): 1.728 P2(HD): 1.731 P3(HD): 0.988 P3(HD): 0.766 P3(HD): 0.766 P3(HD): 0.766

 \times 1) To set instrument height or target height, click [Set].

•In case the calculation of plane was not successful by the measured three points, error displays. Start measuring over again from the first point.

•Error will be displayed when collimated to the direction which does not cross with the determined plane.

7.7 PARAMETERS SETTING

In basic survey, some parameters can be set.

Communication Parameters

Factory default settings are indicated with underlines.

Menu	Selecting Item	Contents
1. Baud Rate	1200/ 2400/ 4800/	Select the baud rate
	9600/19200/38400/57600	
2.Data number	7 / 8	Select the data length seven digits or eight digits
3. Stop Bit	1 / 2	Select the stop bit.
4. Check Mode	None/Odd/Even	Select the parity bit.
		When communicating to an external device, the protocol for
		handshaking can omit the [ACK] coming from the external
5. ACK/NAK	Yes /No	device so data is not send again.
		Yes: Omit the [ACK]
		No : Standard

Other Parameters

Menu	Selecting Item	Contents
1. Coord. Ranking	NEZ/ENZ	Select the display format in the coordinate
		measurement mode for NEZ or ENZ
2.Occ Save	0 Set / Save	Select whether to save coordinate of occupied
		point or 0 Set.
3.Angle Unit	Deg/Gon/Mil	Select degree (360 °), gon (400 G) or mil (6400
		M) for the measuring angle unit to be shown on
		the display
4.Dist Unit	Meter/Int.Feet/U.S Feet	Select the distance measuring unit.

OPERATIONAL STEPS	KEY	DISPLAY
① In the main menu of basic survey, click [Para.] to enter into Parameter Setting.	[Para.]	Angle Measurement × VA(V): 30°47'24" Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt:2-Axis VArule Image: Coord OSet HSet Hold Coord Repeat V/%
②Use stylus to select items.		Parameter Set OK COM Parameters Other Parameters Data
③Click the "▼" beside "Baud", select the baud rate you need.		Parameter Set OK COM Parameters Other Parameters Data

(4) To use the default communication parameters, click [Default].	[Default]	Parameter Set OK × COM Parameters Other Parameters Data 0 7 bit 0 8 bit Baud: 1 0 2 bit Stop Bit 0 2 bit O None 0 Odd Even ACK/NAK O No Default
⁽⁵⁾ To set other parameters, click [Other Parameter]. Set as the same method.	[Other Parameter]	COM Parameter Set OK × COM Parameters Other Parameters ENZ Occ Save © ENZ OSet © Save Angle Unit © Deg Dist Unit Feet Other Parameters US-Feet
⁽⁶⁾ After setting click [OK] to quit. The display returns to basic survey main menu.	[OK]	

8. START STANDARD SURVEYING PROGRAM



In Total station main menu, click "standard" to enter standard surveying program. The screen

displays as follows:



Main feature of standard surveying program:

• Multiple Job Files

Standard Surveying program uses different files (with Job name) for raw data, coordinates and character strings. The job is given alphanumeric names. You may have many jobs in the system. You may create a new job for storing data, or you may open an existing job for data storage. You are also allowed to delete job files.

•Traverse & Topographic Recording Sequences

Backsight and Foresight observation options allow user to record traverses or sets of multiple observations in any sequence. Multiple observations of foresights and backsights are averaged dynamically.

A side shot option allows data collection for topographic surveys. Traverse and topographic collection may be combined.

Offsets

A single offset option is activated by a function key and allows manual entry of perpendicular offsets, or calculated offsets, including remote elevation from a second angle reading.

•Point Coordinate and String Generation

Coordinates are generated in real-time with optional storage. Stored coordinates are recalled at occupied stations and used for back bearing calculation.

•Horizontal Circle Setting

Backsight bearing may be set on the instrument from calculated coordinates or manual input.

•Control point Coordinate Library

Every control point library is accessible by all jobs for storage of frequently used coordinates. Control point file may be entered manually, or uploaded from computer.

• Point Code Library

Point codes may be selected from the library file.

•Edit and Delete Data

Raw data, point coordinates, control point coordinates and codes may be edited and deleted in the total station.

•Download to Serial Port

Raw data, coordinates can be sent to a computer by using a serial cable.

•Upload Point Code from Serial Port

The point code of total station may be created by uploading codes from a computer.

•Upload Roads Design data from serial port

Horizontal alignment data, vertical alignment data and cross section data for Alignment lay out can be uploaded from serial port.

• Point Setting-Out

The standard setting out program calculates bearing and distance, displays offsets from occupied point to lay-out point after each measurement. Coordinates of set-out points can be saved and differences downloaded in the fill-cut files.

Note that the scale factor defined under the SETUP will be used in the calculation of setting out distances.

•Strings Setting Out

Setting out of points by string (point code) allows the setting out of points on a line created in design software.

• Road Setting Out

Two options allow the setting out of points by chainage and offset from a road alignment. Refer to Road Alignment.

•Traverse Adjustment

The Bowditch adjustment method is used to adjust a recorded traverse. The traverse is defined by entering start and end points and the intermediate points are determined from foresight observations.

Resection

Computation of coordinates from known points. The method of calculation is dependent on the data available. Either two points with angles and distances, or three points with angles only are required. Where more than three points and up to maximum of 10 points are available the least squares method is used.

Note that the scale factor defined under the SETUP function will be used is the calculation.

•Occupied Point Elevation Computation

Computation of the occupied point elevation by single observation to a known point.

Intersections

Coordinates calculation from two known points, with either bearings or distances.

•Inverse

Computation of bearing and distance between 2 known points, Note that the scale factor defined under the MENU function will be used in the calculation of distances.

•Area Calculation

Area calculation of a serial of points defined by point code.

Radiation

Coordinates of a point can be computed by entering bearing and distance.

•Missing Line measurement

The slope distance, horizontal distance and vertical distance between two points can be computed.

•Batter boards

A program for setting out in building construction area. If two points can not be setout, a batter board can be placed in the vicinity. The intersection point of the line connecting two setout points and the batter board can be found.

• Tape Dimension

Tape dimension is a program which integrates surveying using a total station and a measuring tape. This program is especially useful when a quick survey of an object is required.

9. PROJECT

In standard survey menu, click [Project].

Irojoct	Pocord	Edit	Drogram		V
TUJELL	Record	Eult	Program		<u>^</u>
New	L L				
Open					
Delete					
Option					
Grid Fact	:or				
Data Exp	ort				
Data Imp	oort				
Latest Pi	roject 🕨 d	Measure	ement Progra	IM	
Exit					

This menu allows following functions be performed:

(1) Create, open, delete job file (2) Setting job option

(3)Set scale factor (4) Data export/import

Standard measuring program require that every time measuring you must create a job file name, if not, system will create a default file name (default) automatically. All the measuring results will be saved in this file.

9.1 CREATE NEW PROJECT

Create a new project file. A job name has a maximum of 16 characters and should be

OPERATION STEPS	KEY	DISPLAY
① In [Project] menu, click [New].	[New]	Project New Project × Informa Project × Project:a Operator Coord Da Brief ▲ Fixed Dat Occ Pt: ✓ BS Pt: Others ✓ FS Pt: Others ✓ Create ✓ ✓
⁽²⁾ In the prompt dialog box, enter name of project, operator, and brief information. After inputting one item, use stylus to click the next item. ^(X) (1)	Enter information	Project New Project X X Informa Project ash Project:a Operator Zoujk Coord Da Brief Image: Coord Da Fixed Dat Occ Pt: V SS Pt: Others V FS Pt: V V Create V V
③ Inputting all, click [Create] to save. The new created project is defaulted as current project. The system return to standard survey main menu. ※2), ※3)	[Create]	Project Record Edit Program Image: Constraint of the second s

made up from the letters A-Z, numbers 0-9 and the minus sign (# @ % + -), but the first character can not be a space.

[≫]1)Project: All the measurement data will be stored in this file.

Operator: Operator's name (Can be default).

Brief: Brief information of the project. (Can be default)

Other: The operator can enter other information, such as instrument model.(Can be default)

2) Press [ESC] key to exit the screen without saving the settings.

3 3) If the project exists, the system prompts "Project are the same!" So, select OPEN option to see a list of current jobs before creating the new job if you are not sure which jobs currently exist.

9.2 OPEN PROJECT

OPERATION STEPS	KEY	DISPLAY
①In [Project] menu,, Click [Open] or press [▲]/[▼] to select. The screen lists all jobs in internal memory.	[Open]	Open Project 全 一 一 ? OK × > \FlashDisk\ Application Data StartUp 二 桌面 > Application Data StartUp 二 桌面 System 二 小 日本 日本
②Double click to open the project, or input project name in the Name field.		Open Project 定 於 課 ∰ ? OK × \ FlashDisk\WinTS\default\ default.npi 名称(\): 类型(I): WinTS p
 ③In the prompt dialog box, double click project name to open the project. All the measurement data will be stored in this file. The display returns to standard survey main menu. ※1) 		Project Record Edit Program X Information Project:ash.npi Project:ash.npi Meas Data: 0 Coord Data: 0 Fixed Data: 0 Fixed Data: 0 Occ Pt: BS Pt: SS Pt: FS Pt: Standard Measurement Program

9.3 DELETE PROJECT

Example

OPERATIONAL STEPS	KEY	DISPLAY	
 In [Project] menu, , Click [Delete] or press [▲]/[♥] to select. The screen shows as the right graph. 	[Delete]	Delete Project × Option Project Last visit tim Del Project default.npj 2008-12-3 Del Partial project ash.npj 2008-12-9 File Option example File Coord Data File Image: Coord Data File Image: Coord Data File HZ Alignment File Browse Delete	
 ② Double click the project you want to delete. The system defaults to delete all projects. To delete some data of the project, click "Delete Files" and then choose the data files need to delete in the File Option. ※1) 		Delete Project × Option Project Last visit tim O Del Project Delete visit tim Del Partial project 2008-12-3 Delete Project ash.npj 2008-12-3 File Option Raw Data File Visit tim Coord Data File Image: State of the state	
 ③ Click [Delete]. The system prompts Delete successful!"※2)~ ※3) ※1)Delete all projects: Delete all content of the system of the system. 	[Delete] ontent of the select	Delete Project × Option Project Last visit tirr O Del Project default.npj 2008-12-3 O Del Partial project ash.npi 2008-12-9 File Option Delete Project OK × 2008-12-9 File Option Delete Project OK × 2008-12-9 V Coord Da Delete successfully! V ✓ Fill-Cut D × SouthDisk\WinTS\ash\ash.np ✓ X-Sect Data File \SouthDisk\WinTS\ash\ash.np ✓ VT Alignment File Browse Delete Ited job. ted job. Ited pob.	
×2) Current project can't be deleted.			

𝔆 3) Click [Browse] to view project in internal memory. 𝔅

9.4 PROJECT OPTION

OPERATIONAL STEPS	KEY	DISPLAY
 In [Project] menu, , Click [Option] (or press [▲]/[▼] to select), the screens as the right graph. 	[Option]	Project Project Options × Informati Fixed File × Project:del ● ○ ∩ ○ Off Meas Data ○ On ○ Off Coord Data ● ○ ∩ ○ Off Fixed Data ○ On ○ Off Occ Pt: ● ○ ∩ ○ Off SS Pt: ● ○ ∩ ○ Off FS Pt: ● ○ ∩ ○ Off Coord Save ● ○ ∩ ○ Off SS Pt: ● ○ ∩ ○ Off FS Pt: ● ○ ∩ ○ Off Set ● ● ○ ∩
②Click each item to set. Click [Set] to return.	[Set]	Project Record Edit Program X Information Project:default.npj Meas Data: 0 Meas Data: 0 Coord Data: 0 Fixed Data: 0 Ocore Pt: BS Pt: SS Pt: FS Pt: SS Pt: FS Pt: Standard Measurement Program

Options:

Fixed File: Set fixed point file [On] or [Off].

- 1) If it is set as [On], when the fixed point file will be scanned for coordinates before prompting for the coordinates. When the same point number is saved in coordinate database or fixed database. The data in [coordinate data] will be called up.
- 2) If the station file option is OFF, the fixed point file is not searched.

Coord. Display: Set whether to display coordinate of NEZ during measurement.

<u>Coord Transform</u>: Set whether to calculate and save coordinate.

1) If set as [On], when the measuring mode is H/V/SD or H/HD/VD, the coordinates will be calculated and saved automatically.

2) If set as [Off], the calculated coordinate will not be saved.

[Note]: In adjusting traverse, to save coordinate or set the calculated bearing angle into instrument, this option should be set to ON.

Layout Save: The setting of storing layout point coordinates. When the coordinates are saved, each layout point with designed coordinates and layout coordinates and cut or fill height will be listed.

%Note that System Setting apply to all jobs, when it is changed, all jobs will be affected.

9.5 GRID FACTOR

Measured horizontal distance is multiplied by the scale factor in coordinate calculation. The raw data is not altered by the scale factor. Enter the scale factor and the mean elevation into screen, the downloaded raw data will contain a scale factor record. The following grid factor is used to calculate coordinates.

Calculation Formula

1. HEIGHT FACTOR = $\frac{R}{R + ELEV}$

R : The average radius of the earth

ELEV: The height of the mean sea level

2. SCALE FACTOR

Scale factor: the scale on the measurement station GRID FACTOR Grid factor = height factor ×scale factor

Distance Calculation

- GRID DISTANCE HDg = HD × Grid factor HDg: Grid distance HD : Ground distance
- HD : Ground distance
- 2. GROUND DISTANCE

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

Enter the scale factor and elevation.

OPERATIONAL STEPS	KEY	DISPLAY
 In [Project] menu,, Click [Grid Factor] (or press [▲]/[▼] to select), the screen displays as the right graph. 	[Grid Factor]	Project Record Edit Program × Information × Proje Grid Factor Mead Coor Fixed Scale : 1 Occ BS P SS P Scale : 1 FS P Scale : 1.0000000 Enter Cancel



Note:1. Inputting range of scale: $0.990000 \sim 1.010000$. The default value: 1.00000 2. Inputting range of average altitude: $-9999 \sim 9999$ The default value: 0

10. DATA EXPORT/IMPORT

10.1 DATA EXPORT

Measuring data coordinate and data of dig/fill, cross section may be exported to specified location.

OPERATIONAL STEPS	KEY	DISPLAY
① In project menu, click [Data Export].	[Data Export]	Project Record Edit Program X New Open Delete Option Grid Factor Option Grid Factor Data Export Data Import Latest Project • # Measurement Program Exit
②In the prompt dialog, click the data you want to export. Click [Export].	[Export]	Project Record Edit Program X Informatio Project Data Export X Project:/defa Meas Data Type Data Type Ocord Data Type Ocord Data Ocord Data
③Select the place to save export data Input file name in the Name field.		Export File 🔄 🥐 📰 🕅 OK 🗙 \SouthDisk\WinTS\default\ Name: defaultRaw.txti Type: Text File (*,txt)
(4)Click [OK], then data is export to appointed position. And the display returns to standard survey main menus.	[OK]	Save As Save A

SD CARD STORAGE:

470R allow surveyors to restore data into SD card.

Export the data you need to the disk inside of the total station first. System will save the result in TXT form. Plug in the SD card, then you could find that icon of SD card in 470 system. Copy that file you need to SD card and disconnect it from total station.

SOFTWARE EXPORT

Export the project you need to the disk inside of the total station first. System will save the result in TXT form. Then connect the 470 total sation to computer with the USB cable after checking that if there Microsoft ActiveSync software has already been installed. Microsoft ActiveSync will show as follow:



At same time this icon will appear in your My computer.



Now you should find the TXT form file in Mobile Device and copy them to your PC disk. The process is completed.

10.2 DATA IMPORT

Coordinate files for setout, fixed point and code library files, alignments and cross section files for setout may be uploaded from a computer to the total station, then import to the project.

OPERATION STEPS	KEY	DISPLAY
① In Project menu, click [Data Import].	[Data Import]	Project Record Edit Program X New Open Delete Option Grid Factor Option Grid Factor Data Export Data Import Latest Project • d Measurement Program Exit
②Select the data type you need to import, and click [Import]. ※1)	[Import]	Project Record Edit Program X Information Project Data Import X Project defat Ocord Data Data Type Meas Data: Coord Data Fixed Data Coord Data: Fixed Data Fixed Data Occ Pt: BS Pt: Ocode Data SS Pt: HZ Alignment VT Alignment St Import Import
② The imported file is found.		Open File ● <th< td=""></th<>

④Click [OK], data is imported to appointed position and return to standard survey main menu.	[OK]	Import File Import File
--	------	---

 \times 1)HZ Alignment: Upload a horizontal alignment for road design layout. Data format please refer to appendix A. There is only one start point can be existed in a block of horizontal alignment data; otherwise it may cause some mistakes.

VT Alignment: Upload a vertical alignment for road alignment layout. Data format is described in Appendix A.

X-Sect Data: upload a design cross section file for road design layout: The uploaded cross sections cannot be edited nor downloaded. Data format is described in Appendix A.

11. RECORD MEASUREMENT DATA

The RECORD menu is mainly used for collecting and recording raw data. It allows setting occupied point and backsight bearing, start backsight observation, foresight observation, sideshot observation and cross section observation. In standard survey main menu, click [Record] or press $[\P]/[\blacktriangleright]$.

Project	Record	Edit	Program		×
_∫ Informat	Setup				_
Project:de	BS Obs				
Meas Data Coord Dat	FS Obs				
Fixed Dat	SS Obs				
Occ Pt:	X-Sect				
BS Pt:					
FS Pt:					
	Standard M	/leasur(ement Prograr	'n	

11.1 SETTING OCCUPIED POINT AND BACKSIGHT POINT Example:

OPERATIONAL STEPS	KEY	DISPLAY
①In [Record] menu, click [Setup] ※1)	[Set]	Occ & BS Set X Occ Occ Pt: List Inst. Ht: 1.500 Info Code: S S BS Pt: List R. Ht: 1.600 Info Azimuth: Set Set

② In "Occ PT" input the point	A:
name. Click [Info].	Occ & BS <u>Set</u>
A: The system will start searching	
function. If the point name doesn't	Inst. Code
exist in internal memory, system	CC String
will prompt to input coordinate As	BS N O
shown in the right graph.	
	Azimu Contra L
	Resection Elevation
	B:
	Occ & BS Set
	Int Code kzd
	String
$\mathbf{B} \cdot \mathbf{I} \mathbf{f}$ the point name exists in	BS - N 986.45
internal memory system will call	Z 459.65
up the point automatically and	Azi En
display on the screen	Resection Elevation
display on the sereen.	C.
	Occ & BS Set
	Inst. Ht: 15
	Code: kzd
	BS
	BSPC
	Azimuth:
	Resection Elevation
	Coord Load
C: Click [List], in the prompt box,	Pt Code
choose [Fixed Data] or [Coord.	3 kzd
Data]. The system will list	
coordinate data of project. Select	
the point name, click [Load].	
	Search Start E



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×

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fo

st

fo

set

Set

List

Code Data Fixed Data

Enter

986.457 487.441 458.654 Enter

③Input the backsight point.		Occ & BS Set × Occ Pt: 3 Inst. Ht: 1.5 Code: kzd BS Esertion R. Ht: 1.6 Azimuth: Info Resection Elevation
④ The system calculates the azimuth.		Occ & BS Set × Occ Pt: 3 List Inst. Ht: 1.5 Info Code: kzd Info BS BS Pt: 2 List R. Ht: 1.6 Info Azimuth: 88°29'11" Set
 ⑤Click [Set] to enter into BS Set function. Bks: Bearing calculated by system or entered manually. HR: Current horizontal azimuth. 	[Set]	BS Aim × BS Set Information BKS 88°29'11" HR 141°16'19" OSet Set Check N:986.457 Prompt:Please press Enter after aiming at BS Pt BS: Pt:2 Back Enter

(6)		A:	
A: If click [0 Set], then the		BS Aim	×
horizontal angle displays 0.		BS Set	Information —
Click [Enter] to guit and set BS		BKS 88°29'11"	VCC: Pt:3
azimuth as 0		HK 0°00'00"	N:980.457 E:487.441 7:459.654
		OSet Set Check	2.430.034
		Prompt:Please press Enter	BS: Pt:2
B. If click [Set] the HR displays as		atter aiming at BS Pt	N:1000.000 E:1000.000
the azimuth.		Back Enter	2:1000.000
		B:	
		BS Aim	×
		BS Set	Information
C:		BKS 88°29'11"	Pt:3 N:986 457
If click [Check], backsight point		8882911	E:487.441 Z:458.654
coordinate will be checked by		USET SET Check	BC:
measuring the slope distance of		Prompt:Please press Enter after aiming at BS Pt	Pt:2 N:1000.000
backsight point.			E:1000.000 Z:1000.000
		Back Enter	
		C:	
		BS Aim	×
		BS Set	Information ————
D:		HR 88029'11"	Pt:3 N:986.457
If click [Enter], the current		nCat Cat Chark	E:487.441 Z:458.654
horizontal angle is recorded as the			RS Checking:
initial backsight direction, and use		Prompt:Please press Enter after aiming at BS Pt	Dist Checking, Please Wait
for coordinate calculation.			
		Back Enter	
⑦Click [Enter] to finish setting BS			
point and return to standard survey	[Enter]		
main menu.			
	on key which is use	d to calculate the occupi	ed point coordinate.
Elevation: The function key for	measuring the elev	vation of a point	
Details see "11.1.1Resection" an	d "11.1.2Elevation	of Occupied Point"	

XNote: If the point exists both in the coordinate data library and fixed data library, then data from coordinate data library will be used.

11.1.1 Resection

If the coordinates of an occupied point are unknown, a resection can be performed to compute these coordinates. A resection involves the measurements from an occupied point to several other points with known coordinates. It is possible to perform a resection by measuring angles and distances or by measuring angles only. The type of measurements influences the minimum number of observations needed to perform a resection. In case of angle as well as distance measurements a minimum of 2 observations are required, by measuring angles only a minimum of 3 observations should be performed.

OPERATIONAL STEPS	KEY	DISPLAY
①In [Occ. & BS Set] menu input occupied point name, click [Resection]. If the point name doesn't exist in internal memory, system will prompt to input coordinate After saving the data, click [Resection].	[Resection]	Occ & BS Set × Occ Coord Edit × Occ Pt 4 Inst. Code kzd Cd String fo BS N 0 BS R. Z Azimu Code Enter Resection × Pt dHA dVA × e1: scale: Add Delete Para. Coord Enter
② Click [Add] to add a new resection measurement. As shown in the right graph.	[Add]	Point Measurement × Input Parameters Pt 1 Pt 1 R. Ht 1.6 Meas Result Dist Unit: Meter EM Mode:Fine[S] Tilt: Off HA 82°14'16" VA 161°48'59" SD Measure VD Mode

③Input the number of know point which used for resection and prism height.	Input PT, prism height	Point Measurement × Input Parameters Pt 11 R. Ht 1.620 Meas Result Dist Unit: Meter HA 84°41'25" VA 161°48'59" SD Measure HD Mode
(4)Click [Mode] to choose measure mode.	[Mode]	Point Measurement × Input Pt R. Ht Meas Mode × Option Fine[S] OFine[N] Fine[S] HA Fine[R] VA Fine[R] VA Angle HD Enter
		Point Measurement
⑤Sight the center of target prism, click [Measure] to start measure.	[Measure]	R. Ht 1.620 Meas Result HA 84°31'23" VA 81°11'55" SD 4.775 HD 4.719 VD 0.731

		Resection
(7)The system returns to resection		Pt dHA dVA i
main menu. The screen displays the		11. III
PT just measured If the coordinate		
is unknown, system will request		
user to input the coordinates and		٠
then return to resection main menu		e1:
then return to resection main menu.		scale: Add Delete Para Coord Enter
		Pt dHA dVA
		11 0.0000 12 0.0000 -7.2604
(8)Click [Add] again, repeat steps		
$(2) \sim (6)$ to finish measuring and	[Add]	
recording other resection points. $leph$		
1)		<
		e1: -433.717
		Add Delete Para Coord Enter
(9)In case 3 angle measurements or		
2 angle and distance measurements		11 0.0000
have been performed, the		¹² North 1897.529
coordinates of the occupied point		East 5344.035
can be displayed by pressing		Zenith 893.400
[Coord]. Click [Enter]. ※2)		▲ Enter ▶
		e1: -433.717
		Add Delete Para, Coord Enter
		Add Delete Para. Coord Enter

 ≈ 1) On the lower side of the screen discrepancies (e1) or the standard deviation in N, E, Z direction (sN, sE, sZ) of the occupied point will be displayed. Discrepancies will be shown in case two distance measurements have been performed. They are calculated using the following equations.

e1 = HD12 (Calculated using measurements) - HD12 (Calculated using known coordinates)

HD12 denotes the horizontal distance between the first and second point.

 ≈ 2) If the distance of more than three points or angles of more than four points have been measured; the standard deviation will be displayed instead of discrepancies. The number of residuals shown depends on the parameters selected. Generally, the worst observation will have the largest residual. This observation can be deleted by placing the bar on this observation using the arrow key and then press [DEL]. The observation is removed from the list. The coordinates of the occupied point, its standard deviation or discrepancies and the residuals of the remaining observations are automatically recomputed.

By clicking [Para.], the parameters which are calculated during resection can be selected. The following screen will be shown.

Resection	1					×
Pt		Res.	Paramete	r ×	4 I	
11 12 13		[Opt	t ion Elevation C	alc.	5608 1636	· ·
			Res. Meas	Save	ι.	
			Grid Factor	Calc.	ι.	
			Grid Factor	Save		
	224		BS Angle C	alc.)		
siv: -1807.2 scale:	:34		Enter		298	.008
Add	Del	lete	Para.	C	bord	Enter

•It is possible to select whether the level of the occupied point, a scale factor or the backsight bearing ('Calculate Bkb') should be calculated. Furthermore it is possible to select whether the calculated scale or the measurements which have been performed ('Store res meas') should be stored.

• After setting, click [Enter] to return to the main resection screen, saving the changed mode and (re)calculation of the occupied point, residuals and the required parameters.

 \bigcirc Press [ENT] in the resection main menu will quit this function and save the coordinates of the occupied point. In case 'Store res meas' was turned on in [PARAM], the measurements which have been performed and which are shown in the box will be saved as well.

 \bigcirc In case 'Calculate Bkb' in [PARAM] was turned on, the backsight bearing will be calculated and set by pressing [ENT] key and leaving the main resection screen. The computation will use all measurements which are shown in the box. In order to calculate a backsight bearing of high quality:

The residuals of the horizontal angle should have low values.

The user shouldn't change the horizontal angle when leaving the main resection screen.

NOTE :

1) The measurements can be performed in any order. The point numbers shown in the box in the main resection screen will be sorted by horizontal angle.

2) When 3 points are used for resection using angle measurement only, you must



consider the "danger circle."

E.g.:

1) If p1, p2, p3 and OccPt fall on the circle, the result can not be computed.

2) If the point is near the circle then the result is unstable.

3) Residuals are useful to avoid that observations of low quality will be used for the resection computation. However, in case of a small number of observations or a bad geometrical constellation of the points it is possible that one bad observation influences several residuals.

4) The unit of residuals is similar to the unit of the measurements performed. However the residuals of horizontal angle and vertical angle are always displayed in decimals. E.g.: $3^{\circ}49'50''$ shows as 3.4950

5) The message 'Occupied point coordinate is not computed ' is shown if the calculated scale is not within $0.9 \sim 1.1$.

6) More than one measurement to the same point can be performed during resection. In that case the character '*' is placed behind the point number. The average of the measurements to same point is used for the calculations.

7) The following table shows which residuals will be shown.

 Δ H: The residual of horizontal angle. Δ V: The residual of vertical angle

 Δ SD: The residual of slope distance.

NOTE:	The	residuals	which	will	be	shown	depend	on	the	measuring	mode	and
whether	r eleva	ation is ca	lculate	d.								

	Calc. Elevation : ON	Calc. Elevation : OFF
Meas Mode : H/V/SD	ΔH , ΔV , ΔSD	ΔH
Meas Mode : H/V	ΔΗ, ΔV	ΔH

11.1.2 Elevation of Occupied Point

If the elevation of a point to be occupied is not known but a point of known elevation can be observed, then the station elevation can be computed.

OPERATIONAL STEPS	KEY	DISPLA	ΑY
①In [Occ. & BS Set] main menu, click [Elevation].※1)	[Elevation]	Point Measurement Input Pt R. Ht 1.62 Meas Result HA 85°02'06" VA 81°12'02" SD HD VD	Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Record Measure Mode

		Point Measurement
② Input known PT and Prism height, and sight the center of prism. Click [Measure] to start survey.	Input PT, Target height [Measure]	Input Parameters Pt 4 R. Ht 1.62 Meas Result Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off HA 84º33'38" VA 81º12'02" SD >> HD Measure VD Mode
③After measuring click [Record].	[Record]	Point Measurement × Input Parameters PPM: 0 PSM: 30 R. Ht Point Meas Meas OK × HA Record current Obs Data? VA 4.776 HD 4.720 VD 0.731

④Click [OK].A: If the point name doesn't exist in	[OK]	A: Occ & BS Set X Occ Coord Edit St Inst. Code kzd fo String SS E 0 R. Z 0 Azim Code Enter St Resection Elevation Set
internal memory, system will prompt to input coordinate As shown in the right graph. System calculates height of occupied point automatically.		Occ & BS Set Cord Edit Cocc Pt Inst. Code kzd String BS N 100 ES E 100 E 100 F 10 Code Enter Set Code Enter Set Code Code Code Code Code Code Code Code
		Occ & BS Set Cocd Edit Cocd Edit Pt 9 Inst. Code kzd String BS N 100 E 100 Z 1.881 Azimi Code Enter Set B.
B: If the coordinate of the point exists in the file, System calculates height of occupied point automatically.		Occ & BS Set Coc Coord Edit Inst. Code kzd String BS N 3754.763 E -1208.595 R. Z -0.612 Azimu Code Enter Resection Elevation Set

11.2 BACKSIGHT OBSERVATION (BS OBS)

For record the raw data of backsight point.

Back Sight Observations only can start after setting of occupied point and backsight point.

Example:

OPERATIONAL STEPS	KEY	DISPLAY
①In [Record] menu click [BS Obs] or press [▲]/[▼] to enter into BS measurement	[BS Obs]	BS Measurement × HA 84°53'28" Pt 11 VA 81°12'02" R.Ht 1.62 SD Note Image: Comparison of the second of the seco
 ②Input PT and R.Ht (Prism height is needed only in elevation measuring). Sight prism center, click [Measure] to start survey. 	Input PT, R.Ht.	BS Measurement × HA 90°40'20" Pt 11 VA 81°12'02" R.Ht 1.864 SD >>> Note HD VD Note PPM: 0 Record PSM: -30 Dist Unit: Meter Measure EDM Mode:Fine[S] Tilt: Off Mode
③After measuring click [Record]. A dialog box shows as the right graph.	[Record]	BS Measurement × HA 87°11'12" Pt 11 VA 81°12'04" R.Ht 1.864 SD BS Obs OK × HD ? Record current Obs Data? PAram rd PSM: -30 Measure Dist Unit: Meter Mode EDM Mode:Fine[S] Mode
④Click [OK] to record data and return to standard survey main menu.	[OK]	

[NOTE]: Back Sight Observations only can starts after setting of occupied point and backsight point. Otherwise system will prompt to set occupied point and backsight point and access BS OBS screen.

11.3 FORESIGHT OBSERVATION (FS OBS)

The data of Foresight Observations mainly used for the traverse adjustment calculation. After setting Occ. point and BS point, the measuring begins.

OPERATIONAL STEPS	KEY	DISPLAY
 ①In [Record] menu click [FS Obs] or press [▲]/ [♥] to enter into FS measurement. 	[FS Obs]	FS Measurement × HA 87°11'19" Pt 1 VA 81°12'04" R.Ht 1.864 SD Note HD Code VD String PPM: 0 String PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Mode Code
②Input PT, R.Ht .※1), ※2)	Input PT, R.Ht	FS Measurement × HA 151°03'47" Pt 1 VA 81°14'40" R.Ht 1.0 SD Note
③Input code, or click [Code] to call up from code list. System lists stored codes. Click the "+" before the needed code layer. Double click the needed code.		Code Load X
(4) System prompts the dialog box. Click [OK] to select the code and return to measure screen.	[OK]	Code Load X

⑤To change measure mode, click [Mode]. Click"o" before the mode, and click [Enter].	[Mode]	FS Measurement × HA Meas Mode × VA Option SD Fine[S] HD Fine[S] VD Fine[R] VD Fine[R] O Angle Mode PSM: -3C Enter Dist Unit Enter Code Tilt: Off
⁽⁶⁾ Click [Measure] to start survey. After measuring, the results display. Click [Record], a dialog box prompts as the right graph.	[Measure] [Record]	FS Measurement × HA 146°56'37" Pt 2 VA 81°14'41" R.Ht 1.683 SD FS Obs OK × HD Parameter PK VD Parameter PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Mode Tilt: Off Mode Code
⑦ Click [OK], N、E、Z coordinates display.	[OK]	FS Measurement × HA 146°56'36" Pt 2 VA 81°14'41" R Ht 1.683 SD North 3750.818 HD East -1206.028 VD Zenith 0.542 PAramet Enter PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Mode Tilt: Off Mode Code
③ Click [Enter], the results are saved, The display returns to standard survey main menu.	[Enter]	

OPERATIONAL STEPS	KEY	DISPLAY
①In [Record] menu click [SS Obs] or press [▲]/ [▼] to enter SS Measurement.	[SS Obs]	SS Measurement × HA 146°56'40" Pt 1 VA 81°14'41" R.Ht 1.683 SD Note I HD Code VD VD String String PPArameters PPM: 0 PSM: -300 Dist Unit: Meter EDM Mode:Fine[S] Record Measure Mode Tilt: Off Code HV.R Function
②Input PT, R.Ht. Click [Measure] to start measure.	Input PT, R.Ht [Measure]	SS Measurement × HA 147°20'12" Pt 1 VA 81°14'41" R.Ht 1.683 SD >> Note HD HD Code String String PArameters PPM: 0 String String PSM: -30 Dist Unit: Meter Record Measure Mode EDM Mode:Fine[S] Code HV.R Function
③ After measuring, the results display. Click [Record], a dialog box prompts as the right graph.	[Record]	SS Measurement × HA 147°20'10" Pt 1 VA 81°14'41" R.Ht 1.683 SD SS Obs OK × HD VD Record current Obs Data? Parame PMI: OB Record Measure Mode Dist Unit: Meter Code HV.R Function

11.4 SIDESHOT OBSERVATION (SS OBS)

(4)Click [OK], N \ E \ Z coordinates display.	[OK]	SS Measurement X HA 147°20'10" Pt 2 VA 81°14'42" R H± 1.683 SD North 3750.796 HD East -1206.052 VD Zenith 0.543 PPM-metric Enter
		PSM: -30 Record Measure Mode Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Function Tilt: Off Code HV.R Function
If the point exists, system prompts whether to cover the point.		SS Measurement × HA 147°20'10" Pt 2 VA 81°14'42" R.Ht 1.683 SD Data Save OK × HD VD 2Pt has already existed, Cover? Para PPM: 2Pt has already existed, Cover? Para PSM: -30 Record Measure Mode Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Function
\bigcirc Click [Enter], the measurement results are saved. Repeat $\textcircled{2} \sim \textcircled{5}$ to finish	[Enter]	
measurement. ※1) Click [Mode], to select measure ※2) Click [Code] to call up code from	mode among Fine m code list.	[S]/Fine [N]/ Fine[R]/Track/Angle Meas.
𝔆 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅 𝔅	raw angle data.	

FUNCTION KEY

In [SS Obs], click [Function], the function menu prompts.

SS Measurement X					
HA	147º20'09"		Pt		3
VA	81º14'4	1"	R.H	łt	1.683
SD	4.768		Not	te	
HD	4.712		Coc	de	
VD	0.726		Stri	ing	
Parameters —					
IPPM:	-30	D		L.	Offset Meas
Dist Unit: Meter EDM Mode:Fine[S]		Record M		Ľ	Plane Offset
		Codo		Π	Pt to Line Mode
Tilt: (: Off				Ctrl Input

11.4.1 Offset

Apply the following procedure to a point which can not be measured directly. Measured data change to raw data directly.



A radial (forward) offset is along the line of sight, with positive away from the instrument, and a tangential (right) offset is perpendicular to the line of sight with positive to the right, as viewed from the instrument. A vertical offset is positive upwards.

•Offsets may be entered manually if measured by tape, or computed by measuring a second angle to the required point.

A tangential offset may be computed by recording a second angle to intersect with the perpendicular offset from the current observation. This method can be used to obtain an approximate position for the center of an object, for example a tree. Take a shot to the side of the object. When the offset screen has been selected, sight the center of the object, and press [Horizon] to read the horizontal angle. A perpendicular offset from the original line of sight will be computed and entered to the screen.



To compute a vertical offset (remote elevation), make an observation to an accessible point above or below the point required. When in the offset screen, sight the point required, and press [Vertical]. The vertical angle will be used to compute the difference in elevation from the ground to the point above or below. The offset will be written to the screen. Make the current target height has been entered into the point code screen before selecting [Offset].



Record an observation as close as possible to the required point.

OPERATIONAL STEPS	KEY	DISPLAY
①In [SS] function sight the prism center. Click [Measure] to start measure.	[Measure]	SS Measurement × HA 147°20'14" Pt 3 VA 81°15'20" R.Ht 1.683 SD 4.768 Note HD 4.713 Code VD 0.725 String PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Code HV.R
②Keep the instrument still, click [Function]. A dialog box prompts as the right graph.	[Function]	SS Measurement × HA 147°20'16" Pt 3 VA 81°15'20" R.Ht 1.683 SD 4.768 Note HD 4.713 Code VD 0.725 String PPM: 0 Offset Meas PIM: 0 Dist Unit: Meter EDM Mode:Fine[S] Code Offset Meas Tilt: Off Code
③In Function menu, click [Offset] to enter Offset measurement.	[Offset]	SS Measurement × HA 147°20'16" Pt VA 8 Offset Meas SD Away • HD Right • VD Vertical • PArameter Horizon Vertical Enter Horizon • Dist Unit: Meter • EDM Mode:Fine[S] Code HV.R Tilt: Off •

④Input Away offset manually. Away: off set along the line of sight	Input Away offset	SS Measurement × HA 147°18'11" Pt 3 VA 8 Offset Meas × SD Away 2 3 HD Right 0 4 VD Vertical 10 4
(5) Collimate offset target point, press [Horizon] or [Vertical], the offset value will be computed and displayed on screen Right: The offset value for right/left direction. (Corresponding [Horizon] key). Vertical: the offset value for vertical direction. (Corresponding [Vertical] key).	[Horizon] or [Vertical]	SS Measurement × HA 148° 16' 15" Pt 3 VA 8 Offset Meas × SD Away 2 HD Right 0.004 VD Vertical 0.308 PArameter Horizon Vertical PSM: -30 Offset Meas Mode Dist Unit: Meter Record Peasare EDM Mode:Fine[S] Code HV.R Tilt: Off Code HV.R
⁽⁶⁾ Click [Enter] to return to SS Measurement screen, the Offset Mode displays.	[Enter]	SS Measurement X HA 148°16'16" Pt 3 VA 81°15'20" R.Ht 1.683 SD 4.768 Note
⑦ Click [Record], system calculates coordinates of target point.	[Record]	SS Measurement × HA 148°16'15" Pt 4 VA 81°15'20" R Ht 1.683 SD North 3749.058 1 HD East -1205.058 1 VD Zenith 0.850 1 Paramett Enter Node PSM: -30 Record Measure Mode Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Function

		SS Me	easurement				×
		HA	148º16'1	l 6" F	۲t	4	
(a) Click [Enter] to return to SS	[Enter]	VA	81º15'20	0 " F	.Ht	1.683	
		SD	4.768	м	lote		
Measurement screen.		HD	4.713	c	.ode		
		VD	0.725	9	String		
		PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off		Record	і м	leasure	Mode
				Code		HV.R	Function

11.4.2 Plane Offset

This mode is similar with **[**PROGRAM **]** \rightarrow **[**Offset **]** \rightarrow **[**Plane Offset **]**. Example:

OPERATIONAL STEPS	KEY	DISPLAY			
① In SS Measurement, click [Function].	[Function]	SS Measurement × HA 145°56'38" Pt 4 VA 81°15'20" R.Ht 1.683 SD 4.768 Note HD 4.713 Code VD 0.725 String PPM: 0 0.725 String Dist Unit: Meter EDM Mode:Fine[S] Offset Meas Tilt: Off Pt to Line Mode Ctrl Input			
 ②Click [Plane Offset] to enter into Plane Offset Measure. Click [Define], to enter into Define Plane function. Click [Off] to return to SS Measurement. 	[Plane Offset]	SS Measurement × HA 145°56'38" Pt 4 VA 81°15'20" R.Ht 1.683 SD Plane Offset Set × HD Plane not defined V VD Plane Offset: Off Plane Offset: Off PSM: -30 Define On Off Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Function			
③Sight the first point of the plane, click [Measure] to start measure.	[Measure]	Point Measurement × Pt Plane 1 PPM: 0 R. Ht 1.683 Pisti Unit: Meter EDM Mode:Fine[S] Tit: Off HA 145°56'37" Record VA 81°15'20" Measure VD Mode Mode			
(4) After measuring click [Record].	[Record]	Point Measurement × Input Parameters Pt Plane2 PSM: -30 Point Meas OK × Meas HA VA Record current Obs Data? SD 4.747 HD 4.692 VD 0.722			
---	----------	---			
⁽⁵⁾ Repeat steps ⁽³⁾ ∼ ⁽⁴⁾ to finish measuring other two points for entering reference plane.		Point Measurement × Input Parameters Pt Plane3 R. Ht 1.683 Image: Parameters PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Image: Parameters Tilt: Off HA 145°56'36" VA 81°15'20" SD 4.746 HD 4.691 VD 0.722			
		SS Measurement			
 ⑥ After defining the Plane, the system prompts as the right graph. Click [On] to open Plane Offset function. ※1) 	[On]	HA 146°12'24" Pt 4 VA 81°15'20" R.Ht 1.683 SD Plane Offset Set × HD Plane Defined V VD Plane Offset: Off Paramett Define On PSM: -30 Record Measure Mode:Fine[S] Code HV.R			

⑧Click [Record] to record results of Plane Offset.	[Record]	SS Measurement × HA 151°26'43" Pt 5 VA 47°34'42" R Ht 1.683 SD North 3753.282 HD East -1207.789 VD Zenith 1.541 PAramet Enter t Mode PSM: -30 Dist Unit: Meter Record Measure Mode EDM Mode:Fine[S] Code HV.R Function
(9)Click [Enter] to save measuring results. Repeat steps $7 \sim 8$ to finish measuring other points on the plane.	[Enter]	SS Measurement × HA 153°38'52" Pt 7 VA 47°34'43" R.Ht 1.683 SD 2.276 Note HD 1.680 Code VD 1.535 String Plane Offset Mode PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Tilt: Off Code HV.R
※1) [On]: Function key used to diMode" shows[Off]: Function key used to shu	splay "Plane Offs t "Plane Offset".	et". In SS Measurement screen "Plane Offset

11.4.3 Pt. Line Mode (For Measurement from Point to Line)

A: reference point 1

This mode is used for coordinate measurement of target points P which treats A (0,0,0) as the origin and line AB as the N axis. See below:



B: reference point 2

•After measuring coordinates of point A, B, enter Point & Line Measurement Mode. Set A, B as reference point 1, 2. Set once again a coordinate system which has A as origin and line AB as N axis. Start measurement again. (Never change information of occupied point during the process.)

OPERATION STEPS	KEY	DISPLAY
(1)Measure coordinates of Point A, B, record in the memory. In SS Measurement, click [Pt. Line Mode] to enter into Point Line Mode.	[Pt. Line Mode]	SS Measurement × HA 153°39'02" Pt 7 VA 47°34'43" R.Ht 1.683 SD 2.276 Note HD 1.680 Code VD 1.535 String PArameters Plane Offset Mode PPM: 0 Offset Meas PSM: -30 Dist Unit: Meter Offset Meas EDM Mode:Fine[S] Tilt: Off Code Pt to Line Mode
②Define base line. Enter the Point number of start point and stop point If the point does not exist, it displays "Coord PT not found!" Press [Enter].		SS Measurement × HA 153°34'49" Pt 7 VA Point To Line × SD Ref. Pt1 × HD Ref. Pt1 × VD Ref. Pt2 × Paramet PTL Mode: [Off] t Mode PSM: -30 On Off Dist Unit: Meter Keter Mode EDM Mode:Fine[S] Code HV.R Function
③ After defining base line click [On] to enter into Pt. Line measure Mode.※1)	[On]	SS Measurement × HA 155°21'24" Pt 7 VA Point To Line × SD Ref. Pt1 × HD Ref. Pt2 5 Paramet PTL Mode: [Off] PPM: 0 On Off Dist Unit: Meter Mode EDM Mode:Fine[S] Code HV.R
④ Sight prism center, click [Measure] to start measure.	[Measure]	SS Measurement × HA 268°29'10" Pt 7 VA 134°09'18" R.Ht 1.683 SD Note

⑤After measuring click [Record].	[Record]	SS Measurement × HA 155°13'29" Pt 7 VA 47°34'44" R.Ht 1.683 SD SS Obs 0K × HD VD Record current Obs Data? Parame Pome Node PSM: -30 Record Measure Mode Dist Unit: Meter EDM Mode:Fine[S] Code 100 Paramic
⑥Click[OK] to display coordinate.	[OK]	Tilt: Off Code Nink Falletain SS Measurement × × × HA 155°13'28" Pt 8 VA 47°934'42" R Ht 1.683 SD North 2.953 • HD East -0.580 • VD Zenith 1.397 • Paramete Enter • Mode PSM: -30 Record Measure Mode Dist Unit: Meter EOM Mode:Fine[S] Code HV.R Function Tilt: Off Code HV.R Function
\bigcirc Click [Enter] to save the results Repeat steps $\textcircled{4} \sim \textcircled{6}$ to finish measuring other points.	[Enter]	SS Measurement × HA 155°10'52" Pt 8 VA 47°34'43" R.Ht 1.683 SD 2.342 Note 1 HD 1.729 Code 1 VD 1.580 String 1 PArameters Pt To Line Mode PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Tit: Off Code HV.R Function
※1)[On]: It is used to activate Point [Off]: It is used to disable the Point	t to Line Mode. oint to Line Mode.	

11.4.4 Control Input

Control Input function is used for editing the string and appended code of the point.

OPERATION STEPS	KEY	DISPLAY
 In SS Measurement, Click [CTRL Input] to enter into control code Input function. 	[CTRL Input]	SS Measurement × HA 153°03'56" Pt 8 VA 47°34'46" R.Ht 1.683 SD 2.342 Note 1 HD 1.729 Code VD VD 1.580 String PParameters Pt To Line Mode PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Code Pt to Line Mode Ctrl Input Code
②Input Control code, Code2 and String 2. To call up code in code lib, click [Code].	Input message	SS Measurement × HA 153°04'10" Pt 8 VA 47 Control Code × SD Control Code × 8 HD Control Code × VD Code2 × Parameter String2 • PSM: -30 Code Enter Dist Unit: Meter Code HV.R FUM Mode:Fine[S] Code HV.R
③Click [Enter], the screen returns to SS Measurement screen.		

11.5 CROSS SECTION MEASUREMENT

The cross section measurement allows points on a cross section to be measured and downloaded in "chainage, offset and elevation" format.

The operation is similar to the side shot observation. Every cross section must have a center line, to compute the chainage and offsets.



Set occupied point and backsight point.

OPERATIONAL STEPS	KEY	DISPLAY
 In [Record] menu click[X-Sect], a dialog box prompts as the right graph. Input CL Code and String and click [Enter]. 	[X-Sect] Input CL Code and String	Project Record Edit Program X Information Project:default.npj Meas Da X-Sect Coord Da X-Sect Fixed Da CL Code south Score Pt:11 String 002 SS Pt:7 Enter Standard Measurement Program
②Start cross section measurement. First measure point on center line. Input code of center line (The code should be same as the code of last screen. The program will identify that it's making center line measurement). Click [Measure] to start survey.	[Measure]	SS Measurement × HA 154°44'08" Pt 8 VA 47°34'46" R.Ht 1.683 SD >> Note HD Code south VD String 002 Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Code HV.R Function
③ After measuring, display the point result of center-line.		SS Measurement × HA 154°44'10" Pt 8 VA 47°34'46" R.Ht 1.683 SD 2.343 Note HD 1.729 Code south VD 1.580 String 002 Parameters PPM: 0 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Record Measure Mode Tilt: Off Code HV.R Function

(4)Click [Record] to record measure results.	[Record]	SS Measurement × HA 154°44'10" Pt 8 VA 47°34'47" R.Ht 1.683 SD SS Obs OK × HD V Record current Obs Data? Parame PSM: -30 Record Measure Mode Dist Unit: Meter EDM Mode:Fine[S] Code HV.R Function
⑤ Click [OK] to display the coordinates of this point. Click [Enter] to save the results.	[OK] [Enter]	SS Measurement X HA 154°44'10" Pt 9 VA 47°34'47" R.Ht 1.683 SD North 3753.199 HD East -1207.857 VD Zenith 1.397 PArameti PM: -0 Enter PSM: -30 Dist Unit: Meter Ecord Measure Mode Tilt: Off Code HV.R Function
⁽⁶⁾ The screen returns to standard measurement. Input code of each		SS Measurement × HA 154°44'12" Pt 9
point on the cross section, repeat steps $2 \sim 5$ to finish measuring other points of this chainage and save the result.		VA 47°34'46" R.Ht 1.683 SD 2.343 Note HD 1.729 Code south VD 1.580 String 002 PArameters PPM: 0 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Record Measure Mode Tilt: Off Code HV.R Function

 When the cross section is saved; the screen will display the code of mid-line and string. Click[Enter] to receive the same code or enter new code. Click " X " to quit X-Sect measurement record. 	[Enter]	Project Record Edit Program X Information Project:default.npj Meas Da X-Sect X Fixed Da CL Code South String 002 SS Pt:2 Enter Standard Measurement Program
(9) Repeat steps (2) \sim (8) to finish measuring points of cross section on other chainages.		SS Measurement × HA 155°22'47" Pt 15 VA 47°34'47" R.Ht 1.683 SD Note HD Code HD Code south YD VD String 002 PArameters PPM: 0 String 002 PSM: -30 Dist Unit: Meter Record Measure Mode Dist Unit: Meter Code HV.R Function

[NOTE]:

(1.) The maximum point number for each cross section is 60.

(2.) The chainage number automatically displayed is calculated from the horizontal distance from its occupied point to its center.

12. EDIT DATA

The edit menu provides options to edit raw data, point coordinates, the fixed point data library, and the code library.

Project Record	Edit	Program		×
Information Project:default.npj Meas Data: 16 Coord Data: 11 Fixed Data: 2 Occ Pt:4 BS Pt:11 SS Pt:8 FS Pt:2	Raw Coor Fixed Code Fill-C	Data d Data d Data e Data ut Data		
Standard I	Measuri	ement Proç	gram	

12.1 EDIT RAW DATA

To edit the raw data from the current job select **Raw Data** from the **Edit** menu.:

Raw Data Ed	lit				×
Pt	Style		Code	!	
4	Occ Pt		kzd		
11	BS Pt-Dis	t Meas			
11	BS Pt-Dis	t Meas			
15	BS Pt-Dis	t Meas			
4	Occ Pt		kzd		
11	BS Pt				
1	FS Pt-Dis	t Meas	2		
2	FS Pt-Dis	t Meas	2		
1	SS Pt-Dis	t Meas			
2	SS Pt-Dis	t Meas			
▲				•	
Search	Start	End	I	Edit	

Function keys at the bottom of the screen:

[Start]: Go to the beginning of this file.

[End]: Return to the end of the file

[Search]: To search a specific point, code or string in the file

OPERATION STEPS	KEY	DISPLAY
①In Edit menu, click [Raw Data], the system lists all measurement data of the project.	[Raw Data]	Raw Data Edit × Pt Style Code 4 Occ Pt kzd 11 BS Pt-Dist Meas 11 15 BS Pt-Dist Meas 4 16 Occ Pt kzd 17 BS Pt-Dist Meas 4 18 Pt-Dist Meas 2 11 BS Pt 1 11 BS Pt 1 11 BS Pt 1 11 SS Pt-Dist Meas 2 2 FS Pt-Dist Meas 2 1 SS Pt-Dist Meas 7 2 SS Pt-Dist Meas 7 4 Occ Pt Keas
 ②Find the needed data. A: Click the slide bar to view all data. Click the needed point name when it appears. You can press [▲]/[▼] to display the data. 		A:

B: Click [Search], in the prompt dialog box input PT, Code, String, and select between Full Name and Part Name. Click [Search] to start search. Search Start End Edit B: Raw Data Edit F5 Pr.Diet Mess 2 2 F5 Pr.Diet Mess 2 F5 Pr.Diet Mess 2 3 After finding the needed data, click [Edit] If put formation in the solution is solved in the solved in			Raw Data Ec	lit		×
B: Click [Search], in the prompt dialog box input PT, Code, String, and select between Full Name and Part Name. Click [Search] to start search. B: B: Search Start End Edit For Polet Ness 2 B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit B: Search Start End Edit Search Start End Edit Search Start End Edit Search Start End Edit Search Start End Edit Sinng: Search Start End Edit Search Start End Edit Search Start End Edit			Pt	Style	Code	
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B: Click [Search], in the prompt dialog box input PT, Code, String, and select between Full Name and Part Name. Click [Search] to start search. B: Raw Data Edit Search Start End Edit B: Raw Data Edit Search Start End Edit Sold. 762 HB: R-Ht: 1.683 Signed Start Search West Search Start End Edit Sold. 762 Sold Search Start End Edit Sold Edit Sold Edit Sold Edit Sold Search Start Search Start End Edit Sold For Start Search Start S				BS Pt-Di BS Pt-Di	st Meas st Meas	
Image: Click [Search], in the prompt dialog box input PT, Code, String, and select between Full Name and Part Name. Click [Search] to start search. Image: Search Start End Edit Image: Search Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit Image: Search Start End Edit	B·		15	BS Pt-Di	st Meas	
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(3) After finding the needed data, click [Edit], the Meas. Data Edit Image: Control to the start of th				nny j		
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(3) After finding the needed data, click [Edit], the Meas. Data Edit FS Pt Information (4) Meas Data Edit FS Pt Information (5) After finding the needed data, click [Edit], the Meas. Data Edit [Edit] Meas Data Edit (6) Input new data, and then click [Save], system returns to last screen. [Save] Raw Data Edit (7) Mate: (Save] Raw Data Edit Pt (8) Input new data, and then click [Save], system returns to last screen. [Save] Raw Data Edit Pt (8) Input new data, and then click [Save], system returns to last screen. [Save] Raw Data Edit Kad (11) BS Pt-Dist Meas 15 BP Pt-Dist Meas 2 2 FS Pt-Dist Meas (11) BS Pt-Dist Meas 2 2 FS Pt-Dist Meas 2 2 5 (4) Occ Pt kad 11 BS Pt-Dist Meas 2 2 1 4 0 0 1 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td><u> </u></td>						<u> </u>
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(3) After finding the needed data, click [Edit], the Meas. Data Edit [Edit] [Edit] [FS Pt			Search	Start	End	Edit
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(3) After finding the needed data, click [Edit], the Meas. Data Edit dialog box appears. [Edit] R.Ht: 1.683 V:81°14'41' Note: Code: 2 BD:4.762 HD:4.706 VD:0.725 Control: Code: 2 Save Save (4) Input new data, and then click [Save], system returns to last screen. [Save] Raw Data Edit Xzd (4) Input new data, and then click [Save], system returns to last screen. [Save] Raw Data Edit Xzd (4) Input new data, and measurement data can't be modified. Xzd Spt-Dist Meas Input new data (5) Pt-Dist Meas Spt-Dist Meas Spt-Dist Meas Input new data Spt-Dist Meas (5) Pt-Dist Meas Spt-Dist Meas Input new data Spt-Dist Meas Input new data (5) Pt-Dist Meas Input new data Spt-Dist Meas Input new data Spt-Dist Meas (5) Pt-Dist Meas Input new data Spt-Dist Meas Input new data Spt-Dist Meas (5) Pt-Dist Meas Input new data Spt-Dist Meas Input new data Spt-Dist Meas (5) Pt-Dist Meas Input new data Spt-Dist Meas Input new data Spt-Dist Meas Input new data (5)			Pt: 1		HR:146	56'38'
click [Edit],the Meas. Data Edit So:4.762 dialog box appears. Code: 2 String: Code: 2 Control: Code Code: 2 Save Code: 2 Save Garage Save (4) Input new data, and then click [Save] [Save],system returns to last screen. [Save] (*1), *(2) Spt-Dist Meas 2 FS Pt-Dist Meas 11 BS Pt BS Pt Spt-Dist Meas 11 BS Pt Spt.bit Meas Spt.bit Meas 2 FS Pt-Dist Meas Spt.bit Meas 11 Spt.bit Meas Spt.bit Meas 12 Spt.bit Meas Spt.bit Meas 13 Spt.bit Meas Spt.bit Meas 14 Spt.bit Meas Spt.bit Meas 15 Spt.bit Meas Spt.bit Meas	(3) After finding the needed data,	[Edit]	R.Ht: 1.	683	V:81°1	4'41
dialog box appears. Building box appears. HD:4.706 W10.0.725 Code Control: Code Control: Code Control: Code Control: Code Control: Code Control: Code String: Save Save Save	click [Edit],the Meas. Data Edit		Note:		SD:4.7	62
(4) Input new data, and then click [Save] (4) Input new data, and then click [Save] (3) System returns to last screen. (Save], system returns to last screen. (3) (1), (X2) (Save) (4) Input new data, and then click (Save) (5) Save (Save) (4) Input new data, and then click (Save) (5) Save (Save) (6) Save (Save) (7) Save (Save) (8) Save (Sav	diala a har ann ann		Code: 2		HD:4.7	'06
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(4) Input new data, and then click [Save] [Save], system returns to last screen. [Save] (*1), **2) (Save) (*1) Date, time and measurement data can't be modified. (*2) Press [ESC] to return to standard survey main menu.					_	Code
(4) Input new data, and then click [Save] [Save], system returns to last screen. [Save] (*1), *(2) (Save) (*1) Date, time and measurement data can't be modified. (*2) Press [ESC] to return to standard survey main menu.			Code2;			
(4) Input new data, and then click [Save] Raw Data Edit × [Save],system returns to last screen. [Save],system returns to last screen. [Save], * 11 BS Pt-Dist Meas **1), **2) 11 SS Pt-Dist Meas 1 1 SS Pt-Dist Meas **1) Date, time and measurement data can't be modified. * * 2 Save Pt Dist Meas **2) Press [ESC] to return to standard survey main menu. * * * * *			String2:			Save
(4) Input new data, and then click [Save] [Save], system returns to last screen. (*1), *2) [Save], system returns to last screen. [Save], system returns to last screen. **1) Date, time and measurement data can't be modified. **2) Press [ESC] to return to standard survey main menu.						
(4) Input new data, and then click [Save] Pt Style Code (4) Input new data, and then click [Save], system returns to last screen. [Save], system returns to last screen. [Save] I BS Pt-Dist Meas I (4) Occ Pt kzd 11 BS Pt-Dist Meas I I BS Pt-Dist Meas I (5) Save], system returns to last screen. (11) BS Pt I BS Pt I I BS Pt (11) BS Pt (11) BS Pt I I BS Pt I <td< td=""><td></td><td></td><td>Raw Data Eo</td><td>lit</td><td></td><td>×</td></td<>			Raw Data Eo	lit		×
(4) Input new data, and then click [Save] (4) Input new data, and then click [Save] (1) BS Pt-Dist Meas [Save],system returns to last screen. (3) Pt (4) Occ Pt (2) K2d (4) Input new data, and then click [Save] (5) Pt-Dist Meas (4) Occ Pt (4) K2d (5) Save],system returns to last screen. (4) Occ Pt (4) K2d (4) K2d (4) K2d (1) BS Pt-Dist Meas (2) Pt-Dist Meas (4) Occ Pt (4) SS Pt-Dist Meas (4) SS Pt-Dist Meas (4) SS Pt-Dist Meas (4) SS Pt-Dist Meas (4) Search (4) Start (4) Edit (4) Edit (5) Pt-Start (5) Pt-Dist Meas (4) Start (4) Edit (2) Press [ESC] to return to standard survey main menu. (4) Start (4) Edit			Pt	Style	Code	• •
(4) Input new data, and then click [Save], system returns to last screen. ※1), ※2) (3) Input new data, and then click [Save] [Save] (4) Occ Pt kzd (11) BS Pt-Dist Meas (4) Occ Pt kzd (11) BS Pt (11) BS Pt (12) SS Pt-Dist Meas (2) Pt Dist Meas (4		KZCI	
 (4) Input new data, and then click [Save] (5) Save], system returns to last screen. (8) (11) (11) (12) (12) (12) (12) (12) (12			4 11	BS Pt-D	ist Meas	
[Save], system returns to last screen. *1 BS Pt [% 1), %2) #1 BS Pt **1), %2) #1 BS Pt **1) Date, time and measurement data can't be modified. **2) **2) Press [ESC] to return to standard survey main menu.			4 11 11	BS Pt-D BS Pt-D	ist Meas ist Meas	
(bave), system returns to fast server. (**1), **2) (**1), **2) (**1) Date, time and measurement data can't be modified. (**2) Press [ESC] to return to standard survey main menu.	(4)Input new data, and then click	[Save]	4 11 11 15	BS Pt-D BS Pt-D BS Pt-D BS Pt-D	ist Meas ist Meas ist Meas	
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 *1) Date, time and measurement data can't be modified. *2) Press [ESC] to return to standard survey main menu. 	④Input new data, and then click [Save],system returns to last screen.	[Save]	4 11 15 4 11	BS Pt-D BS Pt-D BS Pt-D BS Pt-D Occ Pt BS Pt FS Pt-D	ist Meas ist Meas ist Meas kzd	
 X1) Date, time and measurement data can't be modified. X2) Press [ESC] to return to standard survey main menu. 	④Input new data, and then click [Save],system returns to last screen. ※1), ※2)	[Save]	4 11 15 4 11 2 1	BS Pt-D BS Pt-D BS Pt-D BS Pt-D Occ Pt BS Pt-D FS Pt-D FS Pt-D SS Pt-0	ist Meas ist Meas ist Meas kzd ist Meas 2 ist Meas 2 ist Meas	
Search Start End Edit ※1) Date, time and measurement data can't be modified. ※2) Press [ESC] to return to standard survey main menu.	④Input new data, and then click [Save],system returns to last screen. ※1), ※2)	[Save]	4 11 15 4 11 2 1 2	BS Pt-D BS Pt-D BS Pt-D Occ Pt BS Pt-D FS Pt-D FS Pt-D SS Pt-D SS Pt-D	ist Meas ist Meas ist Meas kzd ist Meas 2 ist Meas ist Meas	
 ※1) Date, time and measurement data can't be modified. ※2) Press [ESC] to return to standard survey main menu. 	④Input new data, and then click [Save],system returns to last screen. ※1), ※2)	[Save]	4 11 15 4 11 2 1 2 4	UCC PT BS Pt-D BS Pt-D DS Pt-D Occ Pt BS Pt FS Pt-D FS Pt-D SS Pt-D	ist Meas ist Meas ist Meas kzd ist Meas ist Meas ist Meas	•
\approx 2) Press [ESC] to return to standard survey main menu.	④Input new data, and then click [Save],system returns to last screen. ※1), ※2)	[Save]	4 11 15 4 11 2 1 2 1 2 4 Search	UCC PT BS Pt-D BS Pt-D DCc Pt BS Pt-D SS Pt-D SS Pt-D SS Pt-D SS Pt-D	ist Meas ist Meas ist Meas kzd ist Meas ist Meas ist Meas End	▼ Edit
The response of the research to preside the president mental mental mental second	 ④Input new data, and then click [Save],system returns to last screen. ※1), ※2) ※1) Date, time and measurement data 	[Save]	4 11 15 4 11 2 1 2 1 2 2 1 2 2 4 Search	Start	ist Meas ist Meas ist Meas ist Meas ist Meas ist Meas ist Meas End	▼ Edit

NOTE: 1. The range of each coordinate is from -999999999999 to 9999999999

2. Coordinates that are entered or changed are rounded to 3 decimal places.

12.2 EDIT COORDINATE DATA

The coordinates generated from the current job may be edited or point coordinates may be manually entered. In [Edit] menu click [Coord. Data].

Coord Data Edit				
Pt	Style	Code	North	
11	NEZ		566.000	
12	NEZ		1000.00	
13	NEZ		0.000	
4	NEZ		3753.28	
1	NEZ		3750.79	
2	NEZ		3750.79	
3	NEZ		3749.05	
5	NEZ		3753.5:	
6	NEZ		3753.25	
7	PTI		2.953	•
◀			•	
Search	Add	Delete	Edit	

12.2.1 Edit Coord. Data

(2) Search the needed coord data		Δ.
A: Click the slide bar to display all		Dt Style Code North A
coord. data. Click the needed point		11 NEZ 566.000
name when it appears. You can		12 NEZ 1000.00 13 NEZ 0.000
press $[\blacktriangle]/[\blacktriangledown]$ to view the data.		4 NEZ 3753.28 1 NEZ 3750.79
		2 NEZ 3750.79
		5 NEZ 3753.5:
		7 PTI 2.953.2 ▼
		Search Add Delete Edit
		B
B.		Coord Data Edit
Click [Search] in the prompt dialog		Pt Data Search X th 🔺
har inset DT. Cada String and		11 12 Input 6.000
box input P1, Code, String, and		13 Pt 00 53.29
select between Full Name and Part		1 Code 50.79
Name. Click [Search] to start		2 String 49.05
search.		6 Full Name O Part-Name 03.5.
		7 Search 53
		Search Add Delete Edit
		Coord Data Edit X
		Pt Style Code North 11 NEZ 566.000
③After finding the needed data,		12 NEZ 1000.00
click [Edit], the Coord. Data Edit		4 NEZ 3753.28
dialog box appears.		1 NEZ 3750.79 2 NEZ 3750.79
		Image: Second system NEZ 3749.05 Image: Second system Second sys
		6 NEZ 3753.25 7PTI 2.953
		Search Aug Delete Euit
		Pt Coord Edit X North
		11 Pt 3 566.000
(3)Click [Edit], the dialog box of		13 Code 0.000
this point coordinates prompts.	[Edit]	4 String 3/53.24 1 N 3750.79
		2 3749.058 3750.79 3 E 1205.058 3749.05
		5 Z 0.85 3753.5:
		7 ↓ Code Enter ↓
		Search Add Delete Edit

(4)Input new data	Input data	Coord Data Edit × Pt Coord Edit × 11 Pt 3 North 12 Code 100000 100000 13 Code 3753.26 3750.79 2 N 46 3750.79 3750.79 3 E 100 3753.25 3753.25 7 Code Enter > Search Add Delete Edit
5Click [Enter], the screen returns to the Coord. Data Edit dialog box, the data is rectified.	[Enter]	Coord Data Edit × Pt Style Code North ▲ 11 NEZ 566.000 12 12 NEZ 1000.00 13 13 NEZ 0,000 4 4 NEZ 3750.79 2 1 NEZ 3750.79 3750.79 2 NEZ 3750.79 3753.51 6 NEZ 3753.25 7 7 PTI 2.953.2 1 Search Add Delete Edit

12.2.2 Add Coord. Data

OPERATIONAL STEPS	KEY	DISPLAY		
① In Edit menu, click [Coord. Data], the system lists all coordinate data in the job.	[Coord. Data]	Coord Data Edit × Pt Style Code North ▲ 11 NEZ 566.000 1000.00 12 NEZ 1000.00 13 13 NEZ 3753.26 1 14 NEZ 3750.79 2 2 NEZ 3750.79 3 NEZ 46.000 5 NEZ 3753.25 6 NEZ 3753.25 7 PTI 2.953 1 Search Add Delete Edit		
② Click [Add], Coord Edit dialogue will display, as shown on the right.	[Add]	Coord Data Edit × Pt Coord Edit × 11 Pt 566.00(12 0 0.000 13 Code 0.000 4 String 3753.28 1 N 0 3 E 0 5 Z 0 7 Code Enter Search Add Delete		

③ Input PT ID, Code, String, and N, E, Z coordinate.	Input PT ID, Code, String, and coordinate.	Coord Data EditPtCoord Edit×11Pt9912Codesouth13Codesouth4String12N1003E1006Z107CodeEnterSearchAddDelete	North ▲ S66.000 1000.00 3753.25 3750.79 46.000 3753.51 3753.25 2.953 ► Edit
④ Click [Enter], and return to previous screen. The data will be added on the bottom of the profiles.	[Enter]	Coord Data Edit Pt Style Code 4 NEZ 1 NEZ 2 NEZ 3 NEZ 5 NEZ 6 NEZ 7 PTL 8 NEZ 99 NEZ Search Add	× North 3753.2€ 3750.7€ 3750.75 3753.25 3753.25 3753.25 3753.14 100.000 ▼ Edit

12.2.3 Delete Coord. Data

OPERATIONAL STEPS	KEY	DISPLAY
① Find the data to be deleted with the method mentioned previously.		Coord Data Edit × Pt Style Code North 4 NEZ 3753.2 1 NEZ 3750.7 2 NEZ 3750.7 3 NEZ 46.000 5 NEZ 3753.5 6 NEZ 3753.2 7 PTL 2.953 8 NEZ south 3753.1 99 NEZ south 100.00 1 • • Search Add Delete Edit
② Click [Del], a notice is displayed, as shown on the right.	[Del]	Coord Data Edit Pt Style Code North 4 NEZ 3753.2€ 1 NEZ 3750.7€ 2 WinTs OK × 750.7€ 3 OK × 750.7€ 6.000 5 6.000 5 Sure to delete data 7? 753.2€ 99 NEZ south 100.00€ Image: Search Add Delete Edit

		Coord Dat	a Edit	×
③ Click [OK] and the data are deleted. The screen returns, and the cursor moves to next row.	[OK]	Pt 13 4 1 2 3 5 6 8 99 99 • Search	Style Code NEZ NEZ NEZ NEZ NEZ NEZ NEZ NEZ south NEZ south NEZ south	North 0.000 3753.26 3750.79 3750.79 46.000 3753.5 3753.15 3753.19 100.000 ▼ E Edit

NOTE: 1. The range of each coordinate is from -9999999.999 to 9999999.999

2. Coordinates that are entered or changed are rounded to 3 decimal places.

12.3 EDIT FIXED POINT DATA

To edit the fixed point library select Fixed Data from the EDIT menu. This function is used to edit the coordinates of control point. Editing the fixed point data is similar to editing Coord.Data in the EDIT menu.

12.4 CODE DATA

To edit the code library select Code Lib from the EDIT menu.



[Delete]: Delete a layer. [Edit]: Rename a layer. [Add]: Add a layer.

12.4.1 Create New Layer

OPERATIONAL STEPS	KEY	DISPLAY
 In Edit Menu, click [Code Data], the system lists all code data in the job. 	[Code Data]	Code Edit × Image: Delete Edit Add Delete Edit Add
②Click [Add] to display a dialogue as shown on the right. Input Layer, Code and Attribute in the dialogue.	[Add]	Code Edit × Code Add × Input × Layer: Dath Code: × Attr: 0 Enter Delete Edit Add
③ A: To input new code on an existed layer, just input the code and attribute.		A: Code Edit
B: To add a layer, input the new layer, code, and attribute.		Code Add X Input Layer: EP Code: 2 Attr: 1 Enter Delete Edit Add Exit



12.4.2 Edit Code Layer/Code

OPERATIONAL STEPS	KEY	DISPLAY
①Use the stylus to click on the layer or code to be edited.		A: Layer Code Edit X 2 Attr:3 -4 -4 -path
		Delete Edit Add Exit B: Code
		Code Edit X
		Delete Edit Add Exit
② Click [Edit]. Input new data.	[Edit]	A: Edit Layer
		Delete Edit Add Exit B: Edit Code Code Edit × Edit Code Code Edit × Code Edit × Code 2 Attr 3
		Delete Edit Add Exit



12.4.3Delete Code

OPERATIONAL STEPS	KEY	DISPLAY
① Use the stylus to click the code to be deleted.		Code Edit × Image: 1 Image: 2 Image: 2 -4 Image: 2<
② Click [Delete], a notice appears as shown on the right.	[Delete]	Code Edit × Image: Second state Image: Second state Image: Second state <td< td=""></td<>

③ Click [OK], the screen returns, and the code is deleted.※1)	[OK]		Code Edit P 1 P 4 P EP P path -s Attri	9		×
			Delete	Edit	Add	Exit
×1) The layer can't be deleted when the layer contains codes.						

12.5 FILL/ CUT DATA

The fill-cut data generated by the layout option can be viewed by the [EDIT] \rightarrow [Fill-Cut Data] option.

The display shows the coordinates saved during setout, and the difference to the uploaded coordinate.

As shown in the graph below:

Fill-Cut Data			×
Pt	Code	North	
99 100	south	100.000 100.000	
•			►
Search	Next S	tart I	End

- •This function can realize search for the fill-cut data.
- •Fill-cut data can not be edited.

13. PROGRAM MENU

The menu includes below functions:

- (1) Set Out
- (2) Roads
- (3) Cogo
- (4) Traverse
- (5) **B.Boards**
- (6) Tape Dim

13.1 SET OUT

To show the SET OUT menu, from the [Program] menu, select [Set Out]. The setting out option allows setting out by point number, strings, alignments and cross sections.

•The basic routine for setting out is similar in all these methods, except for the way data is uploaded and the setup sequence.

•Setting out points allows setting out by point number in point number order. Setting out strings allows setting out by string or point code in the order in which the points were uploaded within the string. Setting out of alignment and cross sections, points are specified by chainage and offset with reference to an uploaded alignment.

13.1.1 Occupied Point& Backsight Point

In [Program] menu, click [Set Out] \rightarrow [Setup], in the prompt menu click [Set] to enter into Occ.&BS Set dialog box. The setting procedure is similar to those in [RECORD] menu.

•If alignment data exists, the occupied point screen changes to include chainage and offset:

BS Set			×
:c ———			
Occ Pt:	4	List	
Inst. Ht:	1.5	Info	
Code:		Align	
;			
BS Pt:	11	List	
R. Ht:	1.683	Info	
Azimuth:	145º26'11"	Align	
esection	Elevation	Set	
	es set occ Pt: Inst. Ht: Code: BS Pt: R. Ht: Azimuth: esection	BS Set C Occ Pt: 4 Inst. Ht: 1.5 Code: BS Pt: 11 R. Ht: 1.683 Azimuth: 145°26'11" esection Elevation	BS Set Occ Pt: 4 List Inst. Ht: 1.5 Info Code: Align BS Pt: 11 List R. Ht: 1.683 Info Azimuth: 145°26'11" Align esection Elevation Set

•Here the method of using alignment to set occupied point and backsight point will be introduced.

OPERATION STEPS	KEY	DISPLAY
① In [Program] menu, click [Setout], in the prompt box click [Setup] to enter into Occ. &BS Set screen.	[Set Out] [Setup]	Occ & BS Set × Occ Occ Isst Inst. Ht: 1.5 Info Code: Align BS BS Pt: 11 R. Ht: 1.683 Info Azimuth: 145°26'11" Align Resection Elevation Set
② If alignment data exists in internal memory, you can click [Align] to set the occupied point Here the method of using alignment to setup occupied point and azimuth angle is introduced In "Occ" field click [Align.] to start using chainage to setup station function.	[Align.]	Occ & BS Set × Occ Occ Pt: 4 List Inst Alignment Data × p Chainage 0 Offset 0 BS B Offset 0 Azimuth: 145°26'11" Align Resection Elevation Set
③Input Chainage and Offset, and click [Enter].	Input station information [Enter]	BS Set × Occ Pt: CH1001.000+ List Inst. Ht: 1.5 Info Code: Align BS BS Pt: 11 List Info Azimuth: 186°43'15" Resection Elevation Set
(4) Input instrument height and code, then click "Align." in "BS" field. In the box input Chainage and Offset and then click [Enter].		Occ & BS Set

(5)System calculates azimuth, click [Set]. In the display shown as right the Backsight azimuth is set.	[Setup]	BS Aim × BS Set Information BKS 74°05'09" HR 150°01'54" OSet Set Check Prompt:Please press Enter after aiming at BS Pt Back Enter
(6) The occupied point and backsight azimuth is saved, and then the alignment setout data screen displays.		Alignment Layout × Setup Increment 0 Chainage 0 L.offset 0 R.offset 0 L.Ht Diff 0 Chainage 0 LATOR LOFS ROFS Offset Offset 0 Ht Diff 0 R. Ht O Slope Layout

• If you already have entered the occupied point and backsight point details from either RECORD or SETOUT menus, you can skip these routines and go directly to the set out POINTS,STRINGS,ALIGN or X-SECTS.

13.1.2 Point Set Out

After setting occupied point and backsight point, you can start point setting out Example:

OPERATIONAL STEPS	KEY	DISPLAY
①In [Program] menu, click [Set Out], in the prompt box click [Points].	[Set Out] [Point]	Project Record Edit Program X Informatic Setup Set Out > Project:defa Points Roads > Meas Data: Strings Cogo > Coord Data: Alignment Traverse B.Boards Fixed Data: X-Sect B.Boards Tape Dim SS Pt:CH1002.000+0.000 SS Pt:8 FS Pt:2 Standard Measurement Program

②In the prompt dialog box input the PT and Prism Height.A:If the coordinates of the point number exists in memory, system will call up the point automatically.		A: Project Record Edit Program Froject:default.npj Meas Da Coord Da Point Layout Fixed Da Occ Pt:d BS Pt:CH SS Pt:B List Layout Standard Measurement Program
B: If the coordinate data of the point is not stored in memory, system will recommends that to input setout		B: Project Record Edit Program X Informati Project:de Meas Da Coord D Fixed Da Occ Pt:d BS Pt:cH SS Pt:8 FS Pt:2 Z O Code Enter
 point. C: The point to be set out can be presaved in the project, then click [List] to call up. 		C: Coord Load × Pt Code North ▲ 11 566.000 12 1000.000 13 0.000 4 3753.282 1 3750.796 2 3750.796 2 3750.796 3 46.000 5 3753.514 6 3753.258 8 south 3753.199 ▼ ▲ Search Start End Load
③After setting the set out point, click [Set Out] to start setting out. Sight the prism center, click [Measure] to start measure. ※1)	[Set Out] [Measure]	Layout × HA 69°30'58" Req 223°41'12" VA 47°35'31" Turn -154°10'14" SD Away 1521.554 HD Fd VD VD Right Cut PPM: 0 0 O PSM: -30 Dist Unit: Meter Mode EDM Mode:Fine[S] Coord Enter

		Layout	×
		HA 268°31'32" Req	321º16'30"
		VA 87º22'33" Turn	-52º44'58"
(4) Rotate the telescope, making		SD 1.699 Awa	3527.452
"Turn" item and " \rightarrow " item display		HD 1.697 Fd	2134.503
as 0, and ask the rodman to move		VD 0.078 Right	2809.189
the prism.		PPM: 0	998.537
		PSM: -30 Dist Unit: Meter	e Mode
		EDM Mode:Fine[S] Tilt: Off Coord	Enter
		Layout	×
5 Sight the prism center, and		HA 268°31'32" Req	321º16'30"
click [Measure] to start measure.		VA 87°22'33" Turn	0°00'00"
Ask the rod man to move prism	[Measure]	HD 1.699 Fd	-0.001
functional and hadroned Maline	[weasure]	VD 0.078 Right	0.000
Irontward and backward. Making		Parameters Cut	1.209
"Away" item and "↑" item displays		PPM: 0 PSM: -30	Mode
as 0.		EDM Mode:Fine[S]	Enter
		Layout	×
(6) When the four items are		HA 268°31'32" Req	321º16'30"
displaying 0, the point to be set out		SD 4 295 Away	
is found. "Cut" item shows the		HD 2.235 Fd	0.000
value of dig and fill		VD 0.078 Right	0.000
		Parameters Cut	1.209
When it is positive, it means to dig.		PSM: -30	Mode
When it is minus, it means to fill.		Dist Unit: Meter	Mode
		Tilt: Off Coord	Enter
		Project Record Edit Pro	gram 💷 🗙
		Information	
$\overline{7}$ After setting out click [Enter] to		Project:default.npj Meas Dat	
guit The server displays as the	[Enton]	Coord Da	
quit the screen displays as the	[Enter]	Occ Pt:2 Pt 5	
graph. Repeat steps $(2) \sim (6)$ to		BS Pt:3 R.H. 1.683	
finish setting out other point.		FS Pt:2 List La	iyout
		Standard Measuremen	t Program
⑧In PT Layout screen click "★"			
to return to Standard Survey main			
menu.			
※1) Click [Mode] to choose mode at	nong Fine[s]/Fine	[N]/Fine[r]/Track.	

Explanation:

ayou	t		
HA	123º39'31	L" Req	208º27'45'
VA [105°51'00)" Turn	-84º48'14'
5D	0.125	Away	-0.004
HD [0.120	Fd	-0.110
VD	-0.034	Right	0,116
Parai PPM:	neters	Cut 🛛	-0.001
PSM: Dist.U	-30 Init: Meter	Measure	Mode
EDM M Filt:2/	Mode:Fine[R]	Coord	Enter

The ANGLE screen displays the required horizontal angle (Req), the horizontal angle from the current to the setout point (Turn), the distance from the prism to the setout point (Away) and the difference in elevation (Cut).

The OFFSET display shows the distance from the measured point to the required setout point in the form of offsets.

Req : The required bearing angle from occupied point to setout point.

Turn: The angle that should be rotated. When it is 0, means the bearing angle is correct.

Away: The distance from prism to setout point. Positive sign indicates that prism should move far from instrument. Negative sign indicates that prism should move towards instrument. The value means the distance to be moved.

 $Fd \uparrow$: It is the distance along the line of sight to the instrument and is positive away from the instrument. Positive sign means the point is in front of sight line; Positive sign means the point is behind sightline.

Right \rightarrow : It is perpendicular to the line of sight with positive to the right when facing the instrument. Positive sign means the point is in the right side of sight line; Positive sign means the point is in the left side of sightline.

Cut: The elevation difference of the point. Positive sign indicates that this point is higher than calculated value and it should be cut. Negative sign indicates that it should be filled. The value is the fill-cut data value.

•Anytime you click " \times " on the upper right screen to return to Pt No screen, you can input a new point and set out next point. Or click [List] to call up data stored in internal memory. If the point is new, system will recommends you to input its coordinate.

13.1.3 String Setout

After setting occupied point and backsight point, you can start string setting out Example:

OPERATIONAL STEPS	KEY	DISPLAY
①In [Program] menu, click [Set Out], in the prompt menu click [Strings]	[Set Out] [Strings]	Project Record Edit Program X Information Project:default.npj Meas Datar 24 Coord Data String Layout X Fixed Data Code SPt:3 Occ Pt:2 BS Pt:3 String SS Pt:8 Layout String FS Pt:2 Standard Measurement Program
 ②Input Chainage and String of the point to be set out, and click [Set Out]. System starts to search automatically. If the string is found, the first point of this string will be displayed. As shown in the right graph, input Target height, Click [Set Out]. ※1) ③Sight the prism center and click [Measure] to start measure. The 	[Set Out] [Measure]	Project Record Edit Program Information #标题-1 @ 100% (图层 5, RGB/8) × Project:default.npj Meas Datar 24 Coord Data String Layout × Fixed Data Code 11 Occ Pt:2 String 1.685 SS Pt:8 Layout × FS Pt:2 Standard Measurement Program × HA 269°00'44" Req 225°00'00" VA 87°22'34" Turn 44°00'44" HD Fd Fd VD
 setting out method is same as point setting out. (4)After setting out click [Enter] to quit. The system displays the second point of the string. Click [Set Out] to start setting out. 	[Enter]	Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Project Record Edit Program Project:default.npj Meas Datar Project:default.npj Meas Datar Project:default.npj Meas Datar Coord Data String Layout Fixed Data Code 11 String 1.685 SS Pt:8 FS Pt:2 Standard Measurement Program

[Note]: A fixed point data file can not be used in String Setout.

13.1.4 Reference line

This program facilitates stake-out or checking lines for buildings, sections of road, simple excavations, etc.

What Reference Line is:

A reference line can be defined as a known base line. The reference line can be offset longitudinally, in parallel or vertically to the base line, or be rotated around the first base point as required.

Definition of Base Line:

The base line is fixed by 2 base points that can be defined in 3 ways:

- Measured points
- Enter coordinates using keypad
- Select point from memory



In the picture: 1 1st base point

2 2nd base point

- 3 Baseline
- 4 Reference line

In the process of using base line, the base line can be offset longitudinally, parallel and vertically or rotated. This new line is called the reference line. All measured data refers to the reference line.



Offset: Parallel offset of the reference line to the right, referred to the direction of the base line.

Line: Longitudinal offset of the start point (=reference point) of the reference line in the direction of base point.

HZ: Height offset; the reference line is higher than the selected reference height.

Rotate: Rotation of the reference line clockwise around the reference point.

The meaning of soft keys under the screen of Ref.Line Define:

[F1]([NewBL]): Return to Ref.Line Define screen to re-define base line.

[F2]([MEAS]): The offset value of point to be measured related to the reference line.

[F3]([STAKE]): Activate the Orthogonal Stake Out.

[F4]([0SET]): Set all offset values/rotate to zero.

For any of the known points and measurement points, this procedure can also compute the offset of longitude and latitude of these points relevant to reference line.

"Line & Offset" Sub-application

The 'Line & Offset' sub-application calculates from measurements or coordinate longitudinal, parallel offsets, and height differences of target point relative to reference line.



Always computes the height difference with the height of the first reference point $(\Delta - \Delta)$



OPERATIONAL STEPS	OPERATION	DISPLAY
① In Programs menu, press [Set Out] to enter "Reference line".	Click "Reference line"	Project Record Edit Program × Inforr Setup Set Out > Project Points Roads > Meas D Strings Cogo > Coord Alignment Traverse Fixed D X-Sect B.Boards Occ Pt Reference Line Tape Dim SS Pt:6 FS Pt:2 Standard Measurement Program

② Set the station and orientation, (As the method of setting job, station and orientation have been introduced previously; it will not be repeated here.)		Occ & BS Set × Occ Occ Pt: 3 List Inst. Ht: 1.5 Info Code: kzd Info BS BS Pt: 2 List R. Ht: 1.6 Info Azimuth: 88°29'11" Set
③There are three methods to define the baseline points, measure directly and call the point from List, and input the coordinates directly.	Input Pt and coordinates, click Next	Baseline Define(1) X Meas. First Pt List Pt : List R.Ht : 0 Code: Code Result N : N : 0 E : 0 Z : 0
④ Define the second point of the baseline.	Input Pt and coordinates, Click Enter	Baseline Define(2) X Meas.Second Pt List Pt : List R.Ht : 0 Code: Code Result E: N : 0 E : 0 Z : 0 Measure Mode

6 Enter the PtID and R.HT	Input the PtID and R.HT	Line Offset Meas × Meas Point PtiD: PtID: List R.HT: 0 Result dLoff: dToff: 0 dVoff: 0 Back Mode
Click Meas then get the dLOff, dToff, dVOff.		Line Offset Meas × Meas Point PtID: 5 List R.HT: 4 Result dLOff: -2.1938 dTOff: 0.7172 dVOff: -4.8994 Back Mode Meas

Orthogonal Stake-Out

User can enter longitudinal, transverse and height offsets for the target points to be set-out related to the reference line. The program calculates the difference between a measured point and the calculated point. The program displays the orthogonal (pLine, pOffset, p- $(pHz, \triangle, \triangle, \square)$) and the polar (pHz, $\triangle, \square, \triangle, \square$) differences.





③ Show layout interface, the method		Layo	ut			×
have been introduced previously; it	Click	HA	141º07'0	2"	Req [189°55'55"
will not be repeated here.	Measure	VA	79º02'03	3"	Turn	-48º48'53"
1		SD			Away	3.606
		HD			Fd [
		VD			Right 🛛	
		Parai PPM: PSM: Dist U EDM N Tilt: (ameters —		Cut [
			0 Jnit: Meter Mode:Fine[S] Off	Me	easure	Mode
				C	oord	Enter

13.2 ROAD DESIGN AND LAYOUT

13.2.1 Define Horizontal Alignment

In [Roads] menu select [Define HZ AL]. To know how to calculate an alignment, see appendix B.

•Horizontal alignment consisted of following elements: start point, straight line, circular curve and transition curve. First define the start point.

OPERATIONAL STEPS	KEY	DISPLAY			
 In [Program] menu, Click [Roads], and then click [Define HZ AL] on the menu popped up. 	[Roads]	Project Record Edit Program X Information Set Out + Set Out + Set Out + Project: Define HZ AL Roads + Meas Da Edit HZ AL Cogo + Coord Da Define VT AL Traverse Fixed Da Edit VT AL B.Boards Occ Pt:2 Tape Dim SS Pt:3 SS Pt:2 Standard Measurement Program			



The "Define HZ AL" displays current chainage and the bearing angle (the tangent line from the chainage) and the function key (For creating new line). System provides four functions: defining straight line, circular curve, transition curve, point. Select a function key, enter the detailed information of the chainage, the alignment elements will be created. Click [Save], the new chainage and bearing angle will be calculated automatically and the main alignment screen will be restored. Now other line style can be defined. Press ESC to exit current screen. To modify the element which entered in advance, you should enter the "Edit Alignment" option, the new elements can be added only in the end of the original alignment file.

Straight line

When the start point or other line style is well-defined, it allows you to define straight line. A straight line consists of bearing angle and distance; the distance value can not

be minus. Example:

OPERATIONAL STEPS	KEY	DISPLAY		
1 On the screen of input process, click [Straight], the screen will display factors of straight line to be defined.	[Straight]	Define HZ AL × State No. 2 Chainage 1000.000 Define Bearing 0°00'00" STR(1) ARC(2) TRNS(3) PT(4) Load(F1) Save(ENT) Save(ENT)		
② Input the bearing and length of the straight line.	Input bearing and distance.	Define HZ AL × State Type: Chainage 0.000 Str 2 Bearing 0°00'00" Bearing 25.0000 Straight Distance 48.42 Arc TRNS PT Load Save		
 ③ After inputting, click [Save] to save the alignment data, and display the chainage of the end of the line and its bearing. Then, you can define other arcs. When the straight line is in the midst of the alignment, the bearing of the straight line is calculated on the base of previous factors. To modify this bearing, you can input a new bearing manually. 	[Save]	Define HZ AL X State State No. 3 Chainage Define Bearing 25°00'00" Straight Arc TRNS PT Load Save		

Circular Curve



Click [ARC] in the "Define HZ AL", the circular curve can be defined. Circular curve
consists of Arc length and Radius. The rule of radius value: along the forward direction of the curve. When the curve rotates to right, the radius value is positive. When the curve rotates to left, the radius value is minus. The arc length can not be minus. Example:

OPERATIONAL STEPS	KEY	DISPLAY
① On the screen of input process, click [ARC]. The screen will display the factors of arc to be defined.	[ARC]	Define HZ AL × State Type: Chainage 10999.000 Arc- 3 Bearing 56°47'00" Radius 0 Straight Arc Length 0 Arc TRNS PT Load Save Save
② Input radius and arc length.	Input radius and arc length.	Define HZ AL × State Type: Chainage 48.420 Arc- 3 Bearing 25°00'00" Radius 200 Straight Arc Length 23.141 Arc TRNS PT Load Save Save
③ After inputting, click [Save] to save the data of this alignment.	[Save]	Define HZ AL X State No. 4 Chainage 71.561 Define Bearing 31º37'45" Straight Arc TRNS PT Load Save

Transition curve



Press [TRNS] key in the "Define HZ AL", the transition curve can be defined. Transition curve consists of the minimum radius and arc length. The rule of radius value: along the forward direction of the curve. When the curve rotates to right, the radius value is positive. When the curve rotates to left, the radius value is minus. The arc length can not be minus.

OPERATIONAL STEPS	KEY	DISPLAY
① On the screen of input process, click [TRNS], the screen will display factors of transition curve to be defined.	[TRNS]	Define HZ AL × State Type: Chainage 71.561 TRNS- 4 Bearing 31°37'45" Radius 0 Straight Arc Length 0 Fraight Arc TRNS PT Load Save
② Input radius and arc length.	Input radius and arc length.	Define HZ AL × State Type: Chainage 71.561 TRNS- 4 Bearing 31°37'45" Radius 100 Arc Arc Length 1000 Arc TRNS PT Load Save Save

		Define HZ AL			×
③ After inputting, click [Save] to	[Save]	No. 5 Define	Chainage Bearing	107 3180	1.561 206'29"
save the data of this alignment.					Straight
					Arc
					TRNS
					РТ
					Load
					Save

PT (Point)



In "Define HZ AL" menu Click [PT], the point can be defined. A point element consists of coordinates, radius and transition curve parameter A1 and A2. Radius, A1 and A2 can not be minus. If radius is entered, an arc is inserted with the specified radius. If transition curve parameter A1 or A2 is entered, a transition curve with the specified length is inserted between straight and arc.

OPERATIONAL STEPS	KEY	DISPLAY	
① On the screen of input process, click [PT], the screen will display factors of point to be defined.	[PT]	Define HZ AL State Type: Chainage 1071.561 PT-5 Bearing 318°06'29' North 0 East 0 A1 0 A2 0	yht s d e

 2 Input N, E, radius and A1, A2. You can also click [Load] to load coordinate data from the project. 	Input coordinate, radius, and arc factors.	Define HZ AL × State Type: Chainage 1071.561 PT - 5 Bearing 318°06'29" North 1800 Straight East 2000 Arc Radius 0 PT A2 0 Save
③ After inputting, click [Save] to save the data of this alignment.	[Save]	Define HZ AL × State No. 6 Chainage 4020.788 Define Bearing 54°16'02" Straight Arc TRNS PT Load Save Save Save

[NOTE]: When you want to enter A1, A2 from transition curve length L1, L2, the following equations are used:

$$A_1 = \sqrt{L_1 \operatorname{Radiu}}$$

 $A_2 = \sqrt{L_2 \operatorname{Radiu}}$

Any changes to the alignment must be done using the edit alignment option.

13.2.2 Edit Horizontal Alignment

To edit the alignment select Edit HZ AL from the Roads menu.

OPERATIONAL STEPS	KEY	DISPLAY
① In the menu of [Roads], click [Edit HZ AL] to enter into the screen of Edit HZ AL.	[Edit HZ AL]	Project Record Edit Program Information Set Out > Project: Define HZ AL Roads > Meas Da Edit HZ AL Cogo > Coord Da Define VT AL Traverse Fixed Da Edit VT AL B.Boards Occ Pt: 2 Tape Dim Standard Measurement Program

 2 The screen display the last alignment data. Search for the data to be edited. ×1) A: Click Prev. /Next to find the alignment data to be edited. 	A: Edit HZ AL X State Type: Chainage 2555.633 Str 7 Bearing 57°59'40" Bearing 57.594 Start Distance 250.084 End Prev. Next Search Exit
B: Click [Search], a dialog as shown on the right pops up. Input the chainage and click [Search].	B: Edit HZ AL × State Type: Chainage 2555.633 Str 7 Bearing 57°59'40" Bearing Distance Chainage Chainag
③ System finds the specified chainage, and displays it on the screen. Input new data.	Edit HZ AL × State Type: Chainage 2555.633 Str 7 Bearing 57°59'40" Bearing 50 Start Distance 250.084 End Prev. Next Search Exit
④ Click any key on the screen, (such as [Next]), the data is saved.	Edit HZ AL × State Type: Chainage 2555.633 Str 7 Bearing 57059'40" Bearin Edit HZ AL ØK × art Distan Edited HZ AL data has been saved! nd ev. Next Search Exit Exit Exit

(1) Start: Press this key to go to the start of the file.

End: Press this key to go to the end of the file.

Prev. : Press this key to display the previous point data.

Next : Press this key to display the previous point data.

Search: Press this key to search for data, after pressing this key, enter the required chainage and press [ENTER], the data for the chainage will be displayed.

[ESC]: Quit the screen.

It is possible to edit data and modify raw data by using above function keys. After entering the data to be modified, click any operation key on the screen key to record the modified data. To exit without saving data, press [ESC] key.

13.2.3 Define Vertical Alignment

A vertical curve consists of series of intersection points. The intersection point consists of a chainage, elevation and curve length. The start and end intersection points must be a zero curve length.



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

Intersection points can be entered in any order. After entering a point data, click [Save] to save the point data and enter next one. Press [ESC] to exit without saving.

OPERATIONAL STEPS	KEY	DISPLAY
①In [Roads] menu click [Define VT AL] to enter into defining vertical alignment function.	[Define VT AL]	Project Record Edit Program X Project Info. Set Out + Set Out + Current Define HZ AL Roads + K Meas Da Edit HZ AL Cogo + Cogo + Cood Da Define VT AL Traverse K Lib Data Edit VT AL B.Boards Set Cut + Ss PT:back1 Tape Dim Ss PT:2 Fs PT:1 Standard Measurement Program Standard Measurement Program Standard Measurement Program
 2 Input chainage, elevation and Curve Length. After inputting, click [Save]. The curve length of start and end point must be 0. 	Input chainage, elevation and Curve Length [Save]	Project Record Edit Program
③ The next defining vertical alignment screen displays. Continue to input next data.		Project Record Edit Program X Project Info. C Define VT AL Me Define Item C C Lit Oc Elevation Curve Length State Save Stanuard measurement Program

13.2.4 Edit Vertical Alignment

To modify vertical alignment data, the operational steps are same as editing horizontal alignment data.

OPERATIONAL STEPS	KEY	DISPLAY
①In [Roads] menu click [Edit VT AL] to enter into defining vertical alignment screen.	[Edit VT AL]	Project Record Edit Program X Project Info. Set Out Set Out X Current Define HZ AL Cogo X Cood Da Define VT AL Traverse B.Boards Lib Data: Edit VT AL B.Boards Tape Dim Ss PT:2 Fs PT:1 Standard Measurement Program

2 The screen displays the first	A:
alignment data, search the data	Project Record Edit Program IIII ×
needs to be edited. $(\times 1)$	Project Info.
A: Click Prev. /Next to find the alignment data needed to be edited.	Ci Edit VT AL X Ci Edit Item State Chainage 1500 Start: Chainage 1500 Start: Elevation 50 Start: Curve Length 0 Start: Start End Prev. Next Start End Prev. Next
	B:
B: Click [Search], a dialog box pops up as right graph B. Input chainage and click [Search].	Project Record Edit Program
③The specified chainage is found and displayed on the screen. Input new data.	Project Record Edit Program (X Project Info. CL Edit VT AL Chainage 1506 Elevation 44 Curve Length 0 Start End Prev. Next Search Startuard Measurement Program
 ④ Click any key on the screen. (Such as [Prev.]), the data is saved. 	Project Record Edit Program X Project Info.

13.2.5 Alignment Setout

After setting road data, you can start setting out

For an alignment setout a horizontal alignment must have been uploaded from computer by using [Set Out] \rightarrow [Alignment].

• the vertical alignment is optional, but is required to compute cut and fill. The defining method is same as defining horizontal alignment.

Rule:

Offset left: the horizontal distance from the left stake point to the center line.

Offset right: the horizontal distance from the right stake point to the center line.

Elevation difference: Left (right) is the elevation difference between left (right) stake and the center line point.



Example:

Please set the occupied point and backsight azimuth firstly.

OPERATIONAL STEPS	KEY	DISPLAY
① In Alignment Layout screen, enter the start chainage, chainage increment, and the horizontal distance from side stake point to		Alignment Layout × Setup
center line. To setout dig/fill data, the height difference is needed.		Layout Chainage LOFS ROFS Offset 0 +CHG -CHG Ht Diff 0 Slope Layout

	Alignment Layo	out		×
		1	Incremen	t 10
②After inputting the center line	L.offset 1	1	R.offset	1.5
softing out data of the start chainage	L.Ht Diff 0.2		R. Ht Dif	f 0
setting out data of the start chamage	d avout			,
displays on the lower screen.	Chainage 100	1	LOFS	ROFS
	Ht Diff		- +CHG	i -CHG
	R. Ht 0		Slope	e Layout
	Layout			×
	на 66°13	3'43"	Req	26°56'25"
(3)Here stipulate: first set out point	VA 259°3	2'58"	Turn	39º17'18"
Griefe supulate. Inst set out point	SD			112.482
on center line, and then set out				
points on left/right chainage. ×1)	ا Parameters —		Cut	
Input prism height, and click [Set	PPM: 0 PSM: -30		,	1
Out] to set out.	Dist Unit: Meter		Measure	Mode
	EDM Mode:Fine[9	5]	Coord	Enter
	Layout		_	×
	Layout HA 66°13	3'43"	Req	× 26°56'25"
(4)Sight the current prism, click	Layout HA 66°13 VA 259°3	3'43" 2'58"	Req Turn	× 26°56'25" 39°17'18"
(4) Sight the current prism, click	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3	3'43" 2'58" 09	Req Turn Away Fd	26°56'25" 39°17'18" 112.177 86 753
(4) Sight the current prism, click [Measure] to start measure and	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0	3'43" 2'58" :09 :04 :056	Req Turn Away Fd Right	26°56'25" 39°17'18" 112.177 86.753 -71.226
④Sight the current prism, click [Measure] to start measure and calculate parameter difference	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters	3'43" 2'58" :09 :04 .056	Req Turn Away Fd Right Cut	26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761
(4)Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters PPM: 0 PSM: -30 -30	3'43" 2'58" 09 04 056	Req Turn Away Fd Right Cut	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761
④Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point.	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters - PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode: Energing	3'43" 2'58" 209 204 256	Req Turn Away Fd Right Cut Measure	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode
(4)Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point.	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 PArameters	3'43" 2'58" 09 04 056 \$]	Req Turn Away Fd Right Cut Measure	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter
(4)Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point.	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters - PPM: 0 Dist Unit: Meter EDM Mode:Fine[S Tilt: Tilt: Off	3'43" 2'58" 09 04 056 \$]	Req Turn Away Fd Right Cut Measure	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter ×
(4)Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point.	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S Tilt: Off Layout HA HA 66°13	3'43" 22'58" 09 04 056 \$]	Req Turn Away Fd Right Cut Measure Coord	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter 26°56'25" x 26°56'25"
 ④ Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point. ⑤ Rotate the telescope, making 	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters - PPM: 0 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S Tilt: Off Layout HA 66°13 VA 259°3 SD 0.000	3'43" 22'58" 09 04 056 \$] \$ \$ 3'43" 22'58"	Req Turn Away Fd Right Cut Measure Coord	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter 26°56'25" 0°00'00" 0.782
 ④ Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point. ⑤ Rotate the telescope, making "Turn" item and "→" item display. 	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters - PPM: 0 PSM: -30 Dist Unit: Meter - EDM Mode:Fine[S - Tilt: Off HA 66°13 VA 259°3 SD 0.3 HD 0.3	3'43" 2'58" 09 04 056 s] 3'43" 2'58" 09 04	Req Turn Away Fd Right Cut Measure Coord Req Turn Away Ed	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter 26°56'25" 0°00'00" 0.788 0.789
 ④ Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point. ⑤ Rotate the telescope, making "Turn" item and "→" item display 	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters - PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S Tilt: Off Layout - HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0	3'43" 22'58" 09 04 056 5] 3'43" 22'58" 09 04 056	Req Turn Fd Right Cut Measure Coord	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode 999.761 Cnter 26°56'25" 0°00'00" 0.788 0.788 0.000
 ④ Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point. ⑤ Rotate the telescope, making "Turn" item and "→" item display as 0, and ask the rodman to move 	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 PArameters PM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S Tilt: Off Layout HA 66°13 VA 259°3 SD SD 0.3 HD VD -0.0 Parameters	3'43" 22'58" 009 004 056 s] 3'43" 3'43" 09 004 056 09 004 056	Req Turn Away Fd Cut Measure Coord	× 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter 26°56'25" 0°00'00" 0.788 0.788 0.788 0.000 999.761
 ④ Sight the current prism, click [Measure] to start measure and calculate parameter difference between measuring point and setting out point. ⑤ Rotate the telescope, making "Turn" item and "→" item display as 0, and ask the rodman to move prism. 	Layout HA 66°13 VA 259°3 SD 0.3 HD 0.3 VD -0.0 Parameters	3'43" 22'58" 09 04 056 s] 3'43" 22'58" 09 04 056 09 04 056	Req Turn Fd Right Cut Measure Coord Req Turn Away Fd Right Cut	 × 26°56'25" 39°17'18" 112.177 86.753 -71.226 999.761 Mode Enter 26°56'25" 0°00'00" 0.788 0.788 0.000 999.761 Mode

		HA 66°13'43" Reg	26956'25"
		VA 259°32'58" Turn	0°00'00"
⁽⁶⁾ Sight the prism center, click		SD >>> Away	0.00.00
[Measure] to start measure. Ask the		HD Fd	
rodman to move prism making		VD Right	
"Away" and "↑" display as 0		Parameters Cut	
Tindy and T alophay as o.		PSM: -30	Mode
		EDM Mode:Fine[S]	
		Tilt: Off	Enter
		Layout	×
		HA 66°13'43" Req	26º56'25"
6 When four items are 0 the		VA 259°32'58" Turn	0º00'00"
(b) when four items are 0, the		SD 0.309 Away	0.000
point to be set out is found.		HD 0.304 Fd	0.000
"Cut" item indicates the		VD -0.056 Right	0.000
dig/fill value.		PPM: 0	999.761
When it is positive, it means to dig.		PSM: -30 Dist Unit: Meter	Mode
When it is minus, it means to fill.		EDM Mode:Fine[S] Tilt: Off Coord	Enter
[®] After finish setting out one point,		Alignment Layout	×
click [Enter] to quit. The screen		Setup	
			^{nt} 10
returns to Alignment Setout main			1.5
screen.			U U
Click [LOFS]/[ROFS] , or			
+CHG/-CHG, repeat steps $2 \sim 6$			5 ROFS
to finish setting out other points. X		Ht Diff 0.2 +CH	G -CHG
1)		R. Ht O Slop	e Layout
×1) Press [LOES] (or [ROES]) corre	I sponding chainage	offset elevation difference w	ill be displayed
on the screen. The chainage and offs	et can be entered n	nanually. If the offset is minus,	the offset point

is at the left side to center line. If the offset is positive, the offset point is at the right side to center line.

Explanation for the main setout screen:

Alignment	t Layout		×
_[Setup —			
Chainage	1001	Increment	10
L.offset	1	R.offset	1.5
L.Ht Diff	0.2	R. Ht Diff	0
Lavout –			
Chainage	1001	LOFS	ROFS
Offset	0		
Ht Diff	0	+CHG	-CHG
R. Ht	0	Slope	Layout

LOFS: The key is use in setting out the left side stake. Press it to display the offset and the height difference of the left side stake.

ROFS: The key is use in setting out the right side stake. Press it to display the offset and the height difference of the right side stake.

+**CHG:** The key is use in increasing the chainage.

-CHG: The key is use in decreasing the chainage.

Slope: The key is used in slope set out.

13.2.6 Slope Setout

Slope setting-out can be performed as part of the Alignment setout option. Only after defining vertical alignment and horizontal alignment, it is possible to perform slope setting-out. In Alignment Layout menu click [Slope] to display slope layout.

Slope layout main menu:



The input cut/fill value is a ratio.



The left and right slopes may be entered for both cut and fill. Enter the required slopes using positive numbers for both cut and fill. The software selects the appropriate slope from the table depending on whether the situation is on the left or right and in excavation or fill.

Excavation or fill is determined by the estimated level at the offset of the hinge point. If the level is above the level of the hinge then the cut slope is used, otherwise the fill slope is used.



OPERATIONAL STEPS	KEY	DISPLAY
① Enter (or select) the side chainage needs to precede the slope layout.		Alignment Layout × Setup Chainage 1001 Increment 10 L.offset 1 R.offset 1.1 L.Ht Diff 0.1 R. Ht Diff 0 Layout Chainage 1001 LOFS ROFS Offset 0 +CHG -CHG Ht Diff 0 Slope Layout
 ② Click [Slope] to start slope layout. After inputting ratio of dig (or fill) of Left and Right slope After inputting, select left or right slope to layout. 	[Slope]	Slope × Input Left(1:n) Right(1:n) Cut 0 0 Fill 0 0 Left Right

③Enter into slope layout menu.	Slope X
Input the prism pole and sight a	Left(1:n) Right(1:n)
point near where it is estimated the	Cut 1.35 1.2
slope will intercept and press	I J1.05
[Measure] to take the first trial shot.	rSlope Measure
The appropriate slope is selected	Away 268.164 Measure
from the data entered in the	Right -1411.264 Mode
preceding step. The appropriate	Fine[S] Return
slope is selected from the data	
entered in the preceding step. The	
first intercept is computed assuming	
a horizontal surface at the level of	
the measured point. The error from	
measured point to calculated point	
will be displayed. The layout	
method of slope is same with point	
setting out. When the data which	
display in $[\rightarrow]$ and $[\uparrow]$ is 0, the	
setting out point is found.	
	Slope ×
	Left(1:n) Right(1:n)
(4)After laying out the point, click	Cut 1.35 1.2
[Return] to return to slope layout	
main menu. Input or select other	
slope to layout and layout as the	
same method.	

[Note]: 1) An intersection can not be computed if the ground surface passes through the hinge point.

2) The cut is not displayed because the cut at the computed point is zero.

13.2.7 Cross Section Setout

To set out design cross sections select X-Sect from the Set Out menu.

The cross section setout is similar to the alignment setout, the points are uploaded in chainage, offset and level format and a reference alignment must also exist.



X-Sects layout main menu

X-Sectior	ı			×
Chainage	Offset	El	evation	
0.000	-4.501	L 18	3.527	
0.000	-3,500) 18	3.553	
0.000	0.000	18	3.658	
0.000	3.500	18	3.553	
0.000	5.501	18	3.493	
12.669	-4.501	L 18	3.029	
12.669	-3.500) 18	3.059	
12.669	0.000	18	3.164	
Chainage 🛛	0	Offset	-4.501	Slope
Ht Diff [18.527	R.Ht	1.58	
LOFS	ROFS	+CHG	-CHG	Layout

The screen displays cross section data imported to total station. About the method please refer to "10.2 DATA IMPORT". Example:

OPERATIONAL STEPS	KEY	DISPLAY
① In the menu of Set Out, click [X-Sect].		Project Record Edit Program X Informatic Setup Set Out + Roads + Roads + Project:defa Points Roads + Cogo + Traverse Discort Pt:111 Srings Cogo + Traverse B.Boards DS Pt:105 FS Pt:114 Tape Dim Standard Measurement Program
② Data will be displayed on the screen as shown on the right.		X-Section × Chainage Offset Elevation 0.000 -4.501 18.527 0.000 -3.500 18.553 0.000 0.000 18.658 0.000 3.500 18.553 0.000 5.501 18.493 12.669 -4.501 18.029 12.669 -3.500 18.059 12.669 0.000 18.059 12.669 0.000 18.059 12.669 0.000 18.059 12.669 0.000 18.059 12.669 0.400 18.164 Chainage 0 Offset -4.501 Ht Diff 18.527 R.Ht 1.58 LOFS ROFS +CHG -CHG Layout

	X-Section X
③ Click FNC Key [+CHG]/[-CHG] to search data	Chainage Offset Elevation 4 0.000 -4.501 18.527 18.553 0.000 -3.500 18.553
forward or backward; click [LOFS]/[ROFS] to display	0.000 0.000 18.658 0.000 3.500 18.553 0.000 5.501 18.493 - 12.669 -4.501 18.029 12.669 -3.500 18.059
neighboring offset and elevation on the cross section.	112.bb9 11110 18.164 Chainage 12.669 Offset -4.501 Slope Ht Diff 18.029 R.Ht 1.58 Layout LOFS ROFS +CHG -CHG Layout
④ Select the chainage to be set out, and input the prism height of the target. Then click [Set Out] to start setting out. The method of	Layout Req 31º06'00" HA 36º55'09" Req 31º06'00" VA 117º28'24" Turn 5º49'09" SD Away 0.289 HD Fd VD VD Right Cut

%The Height Difference value is elevation value here. (Different to Horizontal Alignment Setting out)

[Note]:

1) Cross Section data can not be entered nor edited by manual input; it has to be copied into WIN total station.

OPERATIONAL STEPS:

- ① Create a new text file (.txt) on the computer and save it. See Appendix A for the format of cross section data.
- ② Copy the file to total station.

3 In the total station, import the saved data to current project by "Data Import". See "10.2 Data Import".

2) You can use [LOFS]/[ROFS] to display appointed chainage. The sequence of the displayed data is according to the sequence in text file. Enter the data in the order of its offset values (from left to right), if chainages are the same.

3) When editing the cross section data, chainages should be in the order from little to much.

13.3 COGO

The COGO menu contains a number of coordinate geometry functions. (Fixed point data can not be used in these functions.)

(1.)Intersection

- (2.)4-points intersections
- (3.) Inverse
- (4.) Area
- (5.)Radiation
- (6.) Missing line Measurement

13.3.1 Intersection

The coordinate for a point can be computed by the intersection of two known bearings.

OPERATIONAL STEPS	KEY	DISPLAY
 In [Program] menu, click [Cogo]. And click [Intersection] in Cogo menu. 	[Cogo] [Intersection]	Project Record Edit Program X Information Set Out + Roads + Roads + Project:default.npi Roads + Roads + Meas Da Intersection Cogo + Coord D 4-Intersection Traverse Fixed Da Inverse B.Boards Occ Pt: Area Tape Dim SS Pt:11 MLM FS Pt:11 Radiate Standard Measurement Program
 (2) In pop-up dialog input the point ID and azimuth/distance of point A, B that are applied in intersection. Here take azimuth intersection for example., ×1)、 × 2) If the point ID input does not exist in the project, an inputting dialog will display as shown on the right. Input the coordinate, and click [Enter] to save. 		Project Intersection × Informati Project:de Meas Data Coord Data Fixed Data Occ Pt:111 BS Pt:110 SS Pt:105 FS Pt:114 1001 No S Load Variable Coord Edit × Informati Fixed Data Occ Pt:111 To Pt Pt 1002 Azimuth 120 Distance O O S Informati Project:de Meas Data Coord Data Pt 1002 Fixed Data Code Fixed Data × Informati Coord Edit × × × Informati Coord Edit × × × Informati Coord Edit × × × Informati Coord Data Code × × Informati Coord Data Code × × Informati Coord Data Code × × Fixed Data String × × S Code Enter × S Code Enter ×

 ③ After inputting, click [Calc.], the system calculate the coordinate of the intersection. If there's no intersection, it displays "No intersection error". Input the point ID, and click [Enter]. ④ Data is saved. The display returns to standard survey main 	[Calc.]	Project Coord Edit × Informati Coord Edit × Project:de Pt 1003 Meas Data: Code Fixed Data Coord Data: Code Fixed Data Occ Pt:111 N 6.34 SS Pt:105 E 6.34 FS Pt:114 Z 0 Code Enter	
menu.			
(1) PT: The number of intersection	point.		
Azimuth: The azimuth from occ	cupied point to inte	ersection point direction.	
Distance: The distance from occupied point to intersection point.			
※2) To call up coordinate data from p	project, you can cli	ck [Load].	

[NOTE]:

If intersection is not in the specified bearing, the software creates the intersection point backward.

The intersection point can not be saved, if the coordinates are not in the allowed range

13.3.2 4-Intersection

The coordinate for a point can be computed by the intersection of four known points.



OPERATIONAL STEPS	KEY	DISPLAY
① In COGO menu click [4-Intersection].	[4-Intersection]	Project Record Edit Program X Information Set Out Project: Gefault.npi Roads Meas Da Intersection Cogo Coord D 4-Intersection Traverse Fixed D: Inverse B.Boards Occ Pt: Area Tape Dim SS Pt:1 MLM FS Pt:1 Radiate Standard Measurement Program
 ②In the popped up dialog box enter the points used for 4-Intersection. If the entered PT doesn't exist in project, program will request you to enter coordinates. ※1) 		Project Record Edit Program X Information Y Proje 4-Intersection Y Y Meas Pt (Line)A-1 Coor A-2 Occ A-2 BS P Pt (Line)B-1 SS P B-2 Load Calc.
 ③After inputting, click [Calc.], to calculate the coordinates of intersection point. If no intersection exists, "No Intersection!" will display. Input the point name and click [Enter] ④The data is saved and the display returns to standard survey main menu. 	[Calc.]	Project Record Edit Program Informati Coord Edit X Proje 4-In Pt 6 Meas Code String 2 Occt String 2 0 Occt N 66 6 SS P E 80 7 FS P Z 10 0

[NOTE]:

1) If there is no intersection point, the message "No Intersection" will be displayed.

2) If intersection is not in the specified bearing, the software creates the intersection point backward.

3) The intersection point can not be saved, if the coordinates are not in the allowed range.

13.3.3 Inverse

OPERATIONAL STEPS	KEY	DISPLAY
①In COGO menu click [Inverse].	[Inverse]	Project Record Edit Program X Information Set Out X Project:default.npi Roads X Meas Da Intersection Cogo X Fixed Da Intersection Cogo X Fixed Da Inverse B.Boards X Occ Pt: Area Tape Dim X X SS Pt:1 MLM X X X Standard Measurement Program X X X
 ②Enter From PT and To PT. If the entered PT doesn't exist in project, program will request you to enter coordinates. ※1)、※2) 		Project Record Edit Program X Informati Inverse X X Project:def From Pt X X Meas Data: To Pt X X Fixed Data: Calc. Result X X SS Pt:105 FS Pt:114 X X X Load Calc. Calc. X X
③After inputting, click [Calc.], to calculate the coordinates ※3)	[Calc.]	Project Percord Edit Program X Informati Inverse X X Project:def From Pt 10 X Meas Data: To Pt 12 X Coord Data: Calc. Result X X BS Pt:110 SS Pt:105 HD: 1.864 YD: -28.687 Load Calc. Calc.
④Press[ESC] to returns to standard survey main menu.	[ESC]	
※1) To call coordinate data from proj	ject, Click [Load].	
%2)From PT: Pt shows start from w	hich point.	
To PT: Pt shows finish at which From Pt	ı point.	
※3)Azimuth: Azimuth from start poHD: Distance between two poir	bint to end point.	To Pt

VD: Height difference between two points. Positive sign means start point is higher than end point while minus means lower.

13.3.4 Area

The points used to calculate area can be gained in two ways: use specified points or points with a common coding.

13.3.4.1 Area Using Specified Points

An area can be calculated by marking at least 3 points.

OPERATIONAL STEPS	KEY	DISPLAY		
①In COGO menu click [Area].	[Area]	Project Record Edit Program ▲ Information Set Out → Project: Gefault.npi Roads → Meas Da Intersection Cogo → Goord D 4-Intersection Traverse Fixed Da Inverse B.Boards Occ Pt: Area Tape Dim SS Pt:1 MLM SS Pt:1 FS Pt:1 Radiate Standard Measurement Program		
② A dialog box pops up. Click "Marked Pt to Calculate" and click [Enter]. ※1)	[Enter]	Project Record Edit Program Image: Constraint of the second data of the se		

③ A: Click [Mark] to mark pts used for area calc. ※2)		A: Area Calculation X Pt Mark Code A 2 4 5 10 11 12 13 Search Mark Mark All Del All Calc.				
B: You can click [Search] to search PT in project.		B: Area Calculation X Pt Data Search X 1 2 4 5 10 11 5 10 11 5 10 12 13 14 Full Name Part-Name Search Mark All Del All Calc.				
 ④ Click [Calc.] to calculate the area. The number used to calculate and area will be shown. ※3)、※4) 	[Calc.]	Project Record Edit Program X Information Project: Area Calc. Result X Meas Da Code: Code: X Fixed Da String: Code: X Occ Pt: Total: 3 X Area: 25.132 m.sq Fs Pt:11 Enter Standard Measurement Program Standard Measurement Program Standard Measurement Program				
⑤Click [Enter] to quit and return to	[Enter]					
Standard Survey Main Menu.						
※1) Marked Pt to Calc.: specify wh	l ich points should b	be used for the area calculation				
One kind of Pt to Calc: Compute the	e area of a figure er	closed by points with a common coding.				
%2)[Search]: Search the required point number data in data file.						
[Mark]: Mark the points to be	used in area calcula	ation				
[Mark All]: Mark all points in	[Mark All]: Mark all points in project, and use them to calc.					
[Del All]: Delete all marks	[Del All]: Delete all marks					
X3)Total: The number of the points	% 3)Total: The number of the points which is used in area calculation					
Area: The enclosed area of the points which is used in area calculation						
%4) An area can be calculated by marking at least 3 points If less than 3 pts the program will prompts						
"At least 3 Pts are required!")						

13.3.4.2 Area Calculation by Using Code

The area of a figure enclosed by points with a common coding can be computed. When recording points observe them in the correct sequence and give each point the same point code.

Example:

OPERATIONAL STEPS	KEY	DISPLAY
 ①In Area Option, click "One kind of Pt to calc", and click [Enter]. ※1) 	[Enter]	Project Record Edit Program X Information Project:default.nni Project:default.nni Meas Data: Coord Data Area Calculation Fixed Data: Option Option Marked Pt to calc. DS Pt:110 One series of Pt to calc. FS Pt:114 Enter Standard Measurement Program
^② Input Code and String used for area. Click [Enter].		Project Record Edit Program X Information Project:default.npj Meas Data Meas Data Area Calculation X Meas Data Code Code Code Code String String String String String String String Enter Standard Measurement Program
③ The program will search data meets the requirement and calculate the area.		Project Record Edit Program X Information Project: Area Calc. Result Code: 5 Meas Da Code: 5 String: Code: 5 Occ Pt: Total: 6 Area: 85.946 m.sq FS Pt:11 Enter Standard Measurement Program
(4) Click [Enter] to quit and return to Standard Survey Main Menu.	[Enter]	

Usually (m^2) or (ft^2) is used as a unit for an area. If the area is larger than 10000m.sq then the unit is changed to Ha (hectare). The unit is changed to AC (acre) if

the closed area is 43560ft.sq or more.

[NOTE]:

- (1.) Area is not calculated correctly if enclosed lines cross each other.
- (2.) If less than 3 points are found which have been marked the software will show the message "3 PTS required".
- (3.) The data in fixed points file can not be used in this program.

13.3.5 Missing Line Measurement

This function can be used to calculate the length of a line by measuring the start and end point of this line.

You should set the occupied points and backsight azimuth before the measurement.

OPERATIONAL STEPS	KEY	DISPLAY
①In Area Option, click [MLM]	[MLM]	Project Record Edit Program X Information Set Out Set Out Project: Roads Project: default.npi Roads Taverse Roads Meas Da Intersection Cogo Cogo Cogo Coord D 4-Intersection Traverse B.Boards Occ Pt: Area Tape Dim SS Pt:11 MM FS Pt:11 Radiate Standard Measurement Program

② Input the Pt used for MLM measurement. ※1)		Project Record Edit Program Informat MLM X Project:de MLM Pti Meas Data MLM Pt2 Fixed Data Calc. Result Occ Pt:11 BS Pt:105 FS Pt:114 Load Calc. Set Occ. & BS point: Set Occ.
		Occ & BS Set
		Occ List Inst. Ht: 1.65 Code: Info
(If occupied point and Backsight		BS Pt: 110 List
azimuth has not been defined, the		R. Ht: 1.58 Info
dialog box as right will pops up)		Azimuth: 45°00'00"
ulalog box as right will pops up.)		Resection Elevation Set
		Pt does not exist in project:
		SS Measurement X
		VA 117°26'15" R.Ht 1.58
		SD Note
		HD Code abc
		VD String 002
		PPM: 0
If the entered point doesn't exist in		Dist Unit: Meter
project, program will request you to		Tilt: Off Code HV.R Function
measure this point.		
③The result is calculated out and		Project Record Edit Program
displayed.		
dHd: Horizontal distance between		Meas Data Coord Dat MLM Pt2 5
the two points.		Fixed Data Calc. Result
dVd: Height difference between		BS Pt:110 GS Pt:110 GS Pt:110
two Points;		SS PC 105 FS Pt:114 dVd: 3.048
dSd: Slope distance between two		
points.		
④Press [ESC] to guit and return to	[ESC]	
Standard Survey Main Menu	[]	
×1) To call according to date for	inat Clini- II 1	
×1) To call coordinate data from proj	Ject, Click [Load].	

[Note]: dVd is defined as the height of the second point minus the height of the first point. Due to this reason dVd can be negative.

dSd is defined as the length of the missing line.

dHd is defined as the length of the projected missing line in the horizontal plane. dSd and dHd are always positive.

13.3.6 Radiate

The coordinate for a point can be computed by entering the Azimuth and Distance.



OPERATIONAL STEPS	KEY	DISPLAY
①In COGO menu click [Radiate].	[Radiate]	Project Record Edit Program Information Set Out Image: Set Out Project:default.npi Roads Roads Meas Da Intersection Cogo Coord D 4-Intersection Traverse Fixed Da Inverse B.Boards Occ Pt: Area Tape Dim SS Pt:1 MLM FS Pt:1 Radiate Standard Measurement Program



13.4 TRAVERSE ADJUSTMENT

The Bowditch (compass rule) adjustment method is used to adjust a recorded traverse. The traverse is defined by entering start and end points and the intermediate points are determined from foresight observations. The coordinates for the start and end points must be known.

•If the coordinates of the initial BKS PT are known, the software calculates the bearing from the point data.

•The foresight option must be used to record observations to the traverse points and the observed end point must have a different point number to the known point.

•To adjust angles the end point must be occupied and a known point observed to measure the closing angle. The point number used for this observation must be

different from the known point too.



Start Pt: 111	Bl	KS Pt: 1	10	End Pt: 116	Close	Pt: 117	
Known Pt: 110	111	916	917				

Example:

1. Measurement

OPERATIONAL STEPS	KEY	DISPLAY
①Select a known point and set up the instrument on the point. (For example Pt 111) Set pt 110 as back sight point. After setting, click [Set].		Occ & BS Set × Occ Pt: 111 List Inst. Ht: 1.65 Info Code:
⁽²⁾ Program calculates out the Backsight azimuth, click [Setup] to set current horizontal as the Backsight azimuth, and click [Enter].		BS Aim × BS Set Information BKS 45°00'00" HR 45°00'00" OSet Set Check Check Prompt:Please press Enter after aiming at BS Pt BS: Pt:110 N:150.000 E:150.000 Z:15.000 Back Enter

③In [Record] menu click [FS Obs].	[Record] [FS Obs]	Project Record Edit Program X Information Setup Projectide BS Obs Setup Setup
④Sight the traverse point 112, use [Record] to record the measured coordinates.		FS Measurement × HA 44°59'59" Pt 112 VA 81°23'33" R.Ht 1.5 SD 10.870 Note HD 10.748 Code 5 VD 1.627 String PArameters PPM: 0 0 0 PSM: -30 0 0 0 Dist Unit: Meter EDM Mode:Track Mode Code Tit: Off 0 7 0 0 VA 81°22'32" R.Ht 1.5 5 VD 2.876 P 112 VA 81°22'32" R.Ht 1.5 SD North 8.662 0 VD Zenith 2.876 0 PAramet Enter P P PM: 0 0 Record Measure Dist Unit: Meter Enter P S EDM Mode:Track Mode Code Code
 Move the instrument to PT112. Turn on the machine and select [Record], re-measure occupied point (PT112), backsight point (PT111), sight traverse point (PT113).Click record. 		FS Measurement × HA 44°59'59" Pt 113 VA 81°23'33" R.Ht 1.5 SD Note HD Code 5 VD String String PSM: -30 PSM: -30 Dist Unit: Meter EOM Mode:Track Mode Code Tilt: Off Code Code Code

⁽⁶⁾ Repeat 1)~4 to measure and record coordinates of each traverse point. (The number of traverse point is entered according to length and requested accuracy).	
⑦When the instrument is moved to PT115, measure a known point (916), record as PT116.	FS Measurement × HA 44°59'59" Pt 114 VA 81°22'32" R Ht 1.5 SD North 8.632 HD East 8.632 VD Zenith 2.869 Paramet Enter PSM: -30 Record Dist Unit: Meter Record EDM Mode: Track Mode Tilt: Off Code
⑧To calculate traverse, you should set station on PT116, and sight another known point (such as 917), measure and record as PT117. Here the PT117 is the closing point.	FS Measurement × HA 45°00'00" Pt 117 VA 81°23'33" R.Ht 1.58 SD 10.860 Note HD 10.738 Code 5 VD 1.625 String 2 Perameters PPM: 0 Dist Unit: Meter EDM Mode: <track< td=""> Made Code</track<>

2. Adjustment:

OPERATIONAL STEPS	KEY	DISPLAY
① In [Program] menu, Click [Traverse].	[Traverse]	Project Record Edit Program X Information Set Out Project:default.npj Roads Meas Data: 118 Cogo Coord Data: 134 Traverse Fixed Data: 5 B.Boards Occ Pt:111 Tape Dim SS Pt:104 SS Pt:104 FS Pt:114 Standard Measurement Program

② Enter Start Point, and click [Enter].	Enter start Point [Enter]	Project Record Edit Program X Information
⁽³⁾ When the entered start Point is same as the start Point in internal memory, the screen will display a dialog box to enter end point. Enter the End Point, (Measured Point) and known Point, these two Point must be different.		Project Record Edit Program
(4) After entering End PT and		Project Record Edit Program
known point, click [Enter], program calculates close difference. and displays the result. Click [Enter] to confirm.		Project:d Traverse × Meas Dat Coord Dat Fixed Dat Occ Pt:11 BS Pt:110 SS Pt:104 FS Pt:114 Enter

⁽⁶⁾ The screen pops up" Elevation Adjust?" Here, click [OK] to adjust. Not to change and data, please click X.	Project Record Edit Program X Information Project:d Traverse X Meas Dat Coord Dat Fixed Dat Occ Pt:11 BS Pt:104 Cose Close X Image: Close BS Pt:104 FS Pt:114 Elevation adjust? Image: Close Image: Close Image: Close FS Pt:104 FS Pt:104 Elevation adjust? Image: Close Image: Close Image: Close FS Pt:104 FS Pt:104 Enter Image: Close Image: Close Image: Close FS Pt:104 FS Pt:104 FS FS FS FS FS
⑦The display returns to standard survey main menu.	

If the closure point is measured: (The step 1, 2 are same as above).

OPERATIONAL STEPS	KEY	DISPLAY
⁽³⁾ After entering Start Pt, system prompts to enter End Pt (Measured Point number) and the known Pt, these two points should be different.		Project Record Edit Program X Information Project:d Meas Dat Coord Da Fixed Dat Occ Pt:11 BS Pt:104 FS Pt:114 Enter
④Enter Close Pt (Measured Point number) and the known Pt, these two points should be different too.		Project Record Edit Program X Information

 (5) The close difference is calculated and displayed. Click [Enter]. 	Project Record Edit Program X Information
⁽⁶⁾ The azimuth results display. If the angle is in the allowed range of close difference, click [Enter].	Project Record Edit Program × Information Project:d Information × Project:d Information × × Meas Dat Coord Da × × Fixed Dat Calc. Azi 221°55'26" Calc. Azi 221°55'23" SS Pt:110 FS Pt:111 Enter ×
⑦ Click [Enter], the system calculates angle adjustment and displays the result. Click [Enter].	Project Record Edit Program X Information
[®] Here the screen pops up "Coord Adjust" Press [OK] to adjust Not to change any data, click"★".	Project Record Edit Program Information



13.5 BATTER BOARDS

When setting out points, particularly for building plots, it is usually necessary to mark a point with an offset so that the point can be re-established after work has been carried out in the work area. In this case batter board can be used: the intersection point (of a batter board and the line that connects two points that have to be set out) can be marked. Later, the intersection points are used by pulling a string line between these points. In this way, the required points can be reconstructed.

•There are two ways to proceed:

First way is using two sides of the batterboard. The user is advised to use this method in case high accuracy is required, control of the measurements is required or one batterboard is used to mark more than one intersection point. Refer to Chapter 13.5.1.

Second way is using one side of the batterboard. The user is advised to use this method in case a quick method is required. Refer to Chapter 13.5.2.

13.5.1 Method 1: Batter board using two sides

The two sides of batterboard should be measured now. Put the reflector above one side of the batterboard, enter a number for this point (BB point 2) and press Enter. Operating Procedure:

- (A) Two setout point (S1 and S2) are selected and one side of the batterboard is measured (BB1).
- (B) The other side of the batterboard is measured (BB2). The intersection point of the batterboard and the line connecting S1 and S2 is calculated. Next, the distance (D1) from BB1 to intersection point and the distance (D2) from BB2 to intersection point are calculated.



OPERATIONAL STEPS	KEY	DISPLAY
① In [Program] menu, click [B.Boards].		Project Record Edit Program X Information Set Out Name Name Name Name Project:default.npj Roads Name Nam Nam Name
② A: Input Setout P1 and click [Enter].		A: Project Record Edit Program (X Information Project Boards Define Meas Da Coord C Fixed D Setout P1 Fixed D Setout P2 Occ Pt: Board P1 SS Pt:1 Board P2 FS Pt:1 List S.O. Enter
B: If the Point is unknown, a dialog box will pops up to request you to enter the coordinates. After inputting, click [Enter].		B: Project Record Edit Program X Project BC Meas Di Coord E Fixed Di S String Occ Pt: BS Pt:1 SS Pt:2 E Code Enter

③Enter Setout P2 and click [Enter].	Project Record Edit Program X Information Project; Boards Define X Meas Define X Setout P1 100 Fixed D Setout P1 100 Fixed D Occ Pt: Board P1 Board P1 Board P2 FS Pt:1 Board P2 FS Pt:1 List S.O.
④ A Now define the batter board, enter Board 1 and click [Enter].	A: Project Record Edit Program Information Project: Boards Define Meas Di Setout P1 100 Fixed D. Setout P2 101 Occ Pt: Board P1 1 SS Pt:1 Board P2 FS Pt:1 List S.O. Enter
B If the point is unknown, SS Measurement dialog box will pop up. After measuring, the data is record to the project.	B: SS Measurement × HA 222°52'50" Pt 103 VA 109°26'02" R.Ht 0 SD Note HD Code south VD String 002 Parameters - PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Code HV.R Function
⑤Enter Board 2.	Project Record Edit Program X Information Boards Define X Project: Boards Define X Meas Da Setout P1 99 Coord D Setout P2 102 Occ Pt: Board P1 103 BS Pt:1 SS Pt:1 Board P2 104 FS Pt:1 List S.O. Enter Standard Measurement Program Standard Measurement Program
(6) A dialog box shows the distances from intersection to PT1 and PT 2. ※1)	Coord D Fixed Da Occ Pt: Be S B.Boards OK × OK × Occ Pt: Be S Dist to Pt1:0.021 Dist to Pt2:4.567 SS Pt:11 Be Standard Measurement Program
---	---
⑦Click "OK", the intersection is set out.	Layout × HA 221°03'41" Req 225°00'00" VA 81°23'31" Turn -3°56'19" SD Away 0.274 HD Fd VD VD Right Cut PPM: 0 PSM: -30 Dist Unit: Meter Mode Tilt: Off Coord

 \times 1) Click \sim to quit batter board program.

*The setout of this intersection point is identical to Point Setout, which is discussed in paragraph 13.1.3, except for two differences.

- 1) Automatically the intersection point is chosen for setting out.
- 2) CUT is not shown at the screen.

NOTE:

- 1) If the intersection point is not on the batterboard, the message "Point Not on Batterboard!" is shown on the screen.
- 2) In case a batterboard is used twice and its position hasn't changed, it is not necessary to re-measure the sides of the batterboard. Use the same number for the sides of the batterboard.
- 3) The error message "Invalid value ! "is shown if the batterboard and the line connecting the two setout points are parallel.
- The coordinates of the calculated intersection point are recorded in the coordinate 4) file. The number of this intersection point is, compared to the highest existing number, incremented by one.

13.5.2 Method 2: Batterboards using one side

Click [S.O.] in case you want to measure only one side of the batterboards.



Procedure

Example:

Operating procedure :

- (A) Two setout points (S1 and S2) are selected and one side of the batterboard is measured (BB 1). An approximate distance D1 is shown.
- (B) The position of the pole is changed according to the value of D1 and a measurement is performed. The distance D1 is now precise. The process has to be repeated until D equals zero to find the intersection point.

OPERATIONAL STEPS	KEY	DISPLAY
①After entering Setout Points and Board1 click [S.O].		Project Record Edit Program X Information
 The screen displays as right. Dist. indicates the distance from the pole to the intersection point. Move the pole along the batter board and click [Measure]. Dist. now indicates a precise distance. The intersection point is found when Dist. equals zero. 		Project Record Edit Program X Information Project Boards Define X Meas Di Single Pt Mode X Fixed D Setout Dist 0.313 SS Pt:1 SS Pt:1 Measure Mode Enter List S.O. Enter Enter

NOTE :

1) After the first side of the Batter board has been measured and [S.O.] has been selected, it is assumed that the orientation of the batter board is perpendicular to

the line connecting the two setout points. The distance D1 is calculated using this assumption. Next a second point on the batter board is measured. From now on the distance D1 will be calculated using the correct orientation of the batterboard.D1 will now be more precise.

- 2) The error message 'Invalid value 'is shown if the batter board and the line connecting the two setout points are parallel.
- 3) The coordinates of the calculated intersection point are recorded in the coordinate file. The number of this intersection point is, compared to the highest existing number, incremented buy one.

13.6 TAPE DIMENSIONS

Tape dimensions is a program which integrates surveying using a total station and a measuring tape. This program is especially useful when a quick survey of an object is required. It is assumed that all angles of this object are rectangular.



Example: measure an object by TAPE DIM. Two corners of the object are measured using the total station and a reference line is defined. Next the other sides of the object are measured using a measuring tape. When the last side is measured, the closing error will be shown.

Example:

OPERATIONAL STEPS	KEY	DISPLAY
①In [Program] menu, Click [Tape Dim].		Project Record Edit Program X Information Set Out + Roads + Roads + Project: Gogo + Roads + Roads + Meas Data: 109 Cogo + Traverse Fixed Data: 5 B.Boards B.Boards Occ Pt:10 Tape Dim SS Pt:224 FS Pt:117 Standard Measurement Program

②Enter PT A (Start PT) and PT B	A:
(End PT) on Re. line and click[Enter].AIf the point exists in project, then the Re. Line is defined.	Tape Dim Measure X Ref. Line F Pt A F Pt B F End Pt F Dist O Pt F Code End Enter
B If the point doesn't exist in project, the SS Measurement dialog box pops up. Measure and record this point.	B: <u>SS Measurement</u> × HA 226°54'44" Pt 999 VA 109°25'38" R.Ht 0 SD Note HD Code abc VD String 002 Parameters PPM: 0 PSM: -30 Dist Unit: Meter EDM Mode:Fine[S] Tilt: Off Code HV.R Function
③ After defining Re. Line, click [Enter], the screen displays as right.	Tape Dim Measure Ref. Line Pt A 223 Pt B 224 End Pt 224 Dist 0 Pt 10088 Code End

④ The reference line is defined,	A: Left
now use a tape to measure the line	Tape Dim Measure
which perpendicular to the	Ref. Line Sketch map
reference line, and start from End	Pt A 223
PT of reference line. First select	Pt B J224
direction in which the straight line	Measure
proceeds and enter Dist PT and	End Pt 1000
Code and click [Enter] The line is	Pt 1001
defined and displayed. If the line is	
defined and displayed. If the line is	
at the left hand side, press [Left]	B: Right
key. If the line is at the right hand	Ref. Line Sketch man
side of reference line, press [Right]	Pt A 223
key. %1), %2)	Pt B 224
	End Pt 10088
	R Dist 100
	Pt 10089 Left Right
	Code Ford Forter
	Tape Dim Measure
	Tape Dim Measure × Ref. Line Sketch map
⑤ Repeat step ④ and Tape	Tape Dim Measure × Ref. Line Sketch map Pt A 223 pt a 223
(5) Repeat step (4) and Tape measure the object in light of its	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224
(5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224
(5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the reference line are graphically	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure End Pt End Pt 10091 B Dist 800
(5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure X Ref. Line X Pt A 223 Pt B 224 Measure X End Pt 10091 R Dist 800 Pt 10092
(5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure × Ref. Line × Pt A 223 Pt B 224 Measure × End Pt 10091 R Dist 800 Pt 10092 Code End
(5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure × Ref. Line × Pt A 223 Pt B 224 Measure × End Pt 10091 R Dist 800 Pt 10092 Code End End Enter
(5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure Sketch map End Pt 10091 R Dist 800 Pt 10092 Code Left Tape Dim Measure × [Ref. Line Sketch map
(5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure Sketch map End Pt 10091 R Dist 800 Pt 10092 Code End Tape Dim Measure × Ref. Line Sketch map Pt A 223
(5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed.	Tape Dim Measure X Ref. Line X Pt A 223 Pt B 224 Measure Sketch map End Pt 10091 R Dist 800 Pt 10092 Code Left Ref. Line Sketch map Pt A 223 Pt B 224 Tape Dim Measure X Ref. Line Sketch map Pt A 223 Pt B 224 Tape Dim OK
 (5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, slick [Endly the second structure] 	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure Sketch map End Pt 10091 R Dist 800 Pt 10092 Code End Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Misclose: Misclose: rMeasure 771 128
 (5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, click [End], the screen displays the indication. 	Tape Dim Measure X Ref. Line X Pt A 223 Pt B 224 Measure Sketch map End Pt 10091 R Dist 800 Pt 10092 Code Left Ref. Line Sketch map Pt A 223 Pt B 224 Measure X Ref. Line Sketch map Pt A 223 Pt B 224 Misclose: 771.128
 (5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, click [End], the screen displays the misclose. 	Tape Dim Measure Pt A Pt B 224 Measure End Pt 10091 R Dist 800 Pt 10092 Code Left Right Code End End End End End End End End End Pt A 223 Pt B 224 Measure Ft B 224 Misclose: 771.128 End Pt 10092 R Dist 800
 (5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, click [End], the screen displays the misclose. 	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure End Pt 10091 R Dist 800 Pt 10092 Code End Enter Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure Sketch map Pt A 223 Pt B 224 Misclose: 771.128 Pt B 10092 R Dist 800 Pt 10092 Left Right Code Enter
 (5) Repeat step (4) and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, click [End], the screen displays the misclose. 	Tape Dim Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Measure Left End Pt 10091 R Dist 800 Pt 10092 Code End End Pt 10092 Code Sketch map Pt B 224 Measure × Ref. Line Sketch map Pt A 223 Pt B 224 Tape Dim Ok × Misclose: 771.128 End Pt 10092 R Dist 800 Pt 10092 Left Right Code End
 (5) Repeat step ④ and Tape measure the object in light of its shape. The new line plus the reference line are graphically displayed. (6) After measuring the last point, click [End], the screen displays the misclose. (7) Click [OK], The display returns 	Tape Dim Measure X Ref. Line Sketch map Pt A 223 Pt B 224 Measure End Pt 10091 R Dist 800 Pt 10092 Code End End Enter X Ref. Line Pt A 223 Pt A 223 Pt B 224 Measure Sketch map Pt A 223 Pt B 224 Misclose: 771. 128 Pt B 224 Misclose: 771. 128 Pt 10092 Left Left Right Code End Pt 10092 Left Rot End

```
%1) stipulation of Left, Right: Along with extending direction of straight line, turn left is Left.%2)Inputting range of Dist: 0.001~1000
```

There are two ways to return to the main menu :

1) Press [ESC] key in case you have measured an open polygon. All points defined are automatically stored.

2) Click [End] to quit in case you have measured a closed polygon. The closing error (the distance between the last point and the first reference point) will be displayed. Click [OK] key to store all points defined and to return to main menu. NOTE :

The reference line and the lines defined by offsets are graphically shown only in case at least one offset has been entered.

14. SYSTEM SETTINGS

1, UNIT SETTING OPTIONS

Menu	Selecting Item	Contents
1. Ang. Unit	deg/gon/mil	Select degree (360 °), gon (400 G) or mil (6400 M)
		for the measuring angle unit to be shown on the
		display
2. Dist.Unit	Meter/Int.Feet/U.S	Select the distance measuring unit Meter, Int. Feet
	Feet	or U.S Feet.
3. Temp.Unit	°C/ °F	Select the temperature unit for the atmospheric
		correction
4. Pres.Unit	mmHg/ hpa/ inHg	Select the air pressure unit for the atmospheric
		correction.

2, MEASURING SETTINGS

,				
Menu	Selecting Item	Contents		
1. Min. Ang.	1"/5"/0.1"	Select the minimum angle reading $1''/5''/0.1''$.		
Min.Dist	1mm/0.1mm	Select the minimum distance reading 1mm/0.1mm.		
2. V-0	Zenith/Level	Select the vertical angle reading for Zenith 0 or		
		Horizontal 0.		
3.Tilt	OFF/1axis/2axis	Select the tilt sensor option for OFF, (1axis) vertical		
		only or (2axis) vertical and horizontal		
4. W-Corr.	0/0.14/0.20	Select the coefficient correction for refraction and		
		earth curvature. Selections for the refraction		
		coefficient are :		
		OFF(No Correction), K =0.14 or K =0.20		

Correction for atmosphere refraction and the earth curvature

The instrument will automatically correct the effect of atmosphere refraction and the earth curvature when calculating the horizontal distance and the height differences.

The correction for atmosphere refraction and the earth curvature are done by the formulas as follows:

Corrected Horizontal Distance: D=S * [cosa+ sina* S * cosa (K-2) / 2Re]

Corrected Height Differentia: H=S * [sina + cosa*S * cosa (1-K) / 2Re]

 \bigcirc If the correction of atmosphere refraction and the earth curvature is neglected, the calculation formula of horizontal distance and the height differentia are: D=S·cosa H=S·sina In formula: K=0.14Atmosphere Refraction Modulus Re=6370 kmThe Earth Curvature Radius α (or β)The Vertical Angle Calculated From Horizontal Plane (Vertical Angle)

S.....Oblique Distance

NOTE: The atmosphere refraction modulus of this instrument has been set as: K=0.14. The value of K can be 0.14, 0.2, or shut: (0 VALUE) Example:

OPERATIONAL STEPS DISPLAY KEY (1) In the main menu click "Meas. [Meas. Setup] Basic Survey Std Survey WinMG Setup". VinEG Meas. Setup **Control Panel** System Set OK × Unit Set Measurement Set Atmospheric Parame Angle Unit-(2) Click options of setting 🖲 Degree 🔿 Gon O Mil Distance Unit parameter. Meter O Feet O US-Feet Temperature Unit -O °F ● ℃ Pressure Unit -O mmHg 🔘 hPa 🔿 inHg Save OK × System Set Unit Set Measurement Set Atmospheric Parame Angle Unit \frown Mat ок 🗙 Unit Set ③After setting, click [Save]. Unit settings have been saved! [Save] Pressure Unit 🔿 mmHg 🛛 🔿 inHg 🔘 hPa Save

④ Click [OK], the settings are saved.	[OK]	System Set OK × Unit Set Measurement Set Atmospheric Paramed • Angle Unit O begree Gon Mil Distance Unit O Meter • Feet US-Feet Temperature Unit O °C • F Pressure Unit ● mmHg hPa inHg Save
(5)To set Measurement setting, click "Measurement Setting", repeat steps (2) \sim (4) to make the measurement setting. After setting, click " \times ".		System Set OK × Unit Set Measurement Set Atmospheric Paramed Angle min reading 0 5" Vertical angle mode 0 5" Vertical angle mode 0 Level 0 Tilt mode 0 1-axis 2-axis Atmospheric reflection coefficient 0 0.14 0.20 Save

15. CHECK AND ADJUSTMENT

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

15.1 PLATE VIAL



Check

Please refer to Chapter 3.2 "Leveling by Using Plate Vial"

Adjust

1. Adjust leveling screws, make plate bubble centered;

2. Rotate the instrument 180 °, watch the offset of plate level;

3. Tweak adjustment screws (on the right of the plate vial) with the correction pin to make plate bubble to move half of the offset back;

4. Rotate the instrument 180 °, check adjustment result;

5. Repeat the above steps until the plate level is centered in all directions.

15.2 CIRCULAR VIAL

Check:

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

Adjust

1. Adjust circular bubble after plate bubble is centered.

2. Loosen the screw (one or two) opposite with bubble deflective direction;

3. Tighten the screw on the direction accordant deflective until circular bubble is centered;

4. Adjust three adjustment screws for several times until circular bubble is centered;

5. The force power fixing three adjustment screws must be consistent when circular level is centered at last.

15.3 INCLINATION OF RETICLE

Check:

1. Sight object A through the telescope and lock the horizontal and vertical clamp screws.

2. Move object A to the edge of the field of view with the vertical tangent screw (point A')

3. Adjustment is not necessary if object A moves along the vertical line of the reticle and point A' still in the vertical line.

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



Adjust

1. If the object A does not move along with the vertical line, firstly remove the eyepiece cover to expose the three or four reticle adjusting screws.

2. Loosen all the reticle adjusting screws uniformly with an adjusting pin. Rotate the reticle around the sight line and align the vertical line of the reticle with pointA'.

3. Tighten the reticle adjusting screws uniformly. Repeat the inspection and adjustment to see if the adjustment is correct.

4. Replace the eyepiece cover.



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

Check

1. Set object A at about 100 meters away the same height as the instrument, and make the vertical angle with $\pm 3^{\circ}$. Then level and center the instrument and turn on the power 2. Sight object A in FaceI and read the horizontal angle value. (e.g.: Horizontal angle L=10°13'10").

3. Loosen the vertical and horizontal clamp screws and rotate the telescope. Sight object A in Reverse faceand read the horizontal angle value. (e.g.: Horizontal angle $R = 190^{\circ}13'40''$).

4. 2 C =L-R $\pm 180 \cong -30'' \ge \pm 2 \ 0$ ", adjustment is necessary.

Adjust

A. Electronic Adjustment Operation Steps:

OPERATIONAL STEPS	KEY	DISPLAY
①After leveling the instrument, in the main menu click [System Setup].		System Set OK Unit Set Measurement Set Atmospheric Parame Angle Unit Degree Gon Mil Distance Unit Meter Feet US-Feet Temperature Unit o °F Pressure Unit mmHg hPa inHg Save Meter Save Meter Save Save Save Save Save Save Meter Save Save Save Save Save Save Save Save
 In the menu bar click to show Collimation as right. 		System Set OK × Constants List V0 Adjustment Collimation Horit • < Step-1> Front V Angle: 91º06'09" H Angle: 350º50'52" Target should be within horizontal ±3° Set





B. Optics Adjustment (professional maintenance man only)

1. Use the tangent screw to adjust the horizontal angle to the right reading which has been eliminated C, $R+C=190^{\circ}13'40''-15''=190^{\circ}13'25''$

2. Take off the cover of the reticle between the eyepiece and focusing screw. Adjust the left and right adjusting screws by loosening one and tightening the other. Move the reticle to sight object A exactly.

3. Repeat inspection and adjustment until $\mid 2 C \mid < 2 0$ ".

4. Replace the cover of the reticle.

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

15.5 VERTICAL INDEX DIFFERENCE COMPENSATION Check

1. Mount and level the instrument and make the telescope parallel with the line connecting the center of the instrument to any one of the screws. Lock the horizontal clamp screw.

2. After turning on the power, zero the vertical index. Lock the vertical clamp screw and the instrument should display the vertical angle value.

3. Rotate the vertical clamp screw slowly in either direction about 10mm in circumference, and the error message "b" will appear. The vertical axis inclination has exceeded 3' at this time and exceeds the designated compensation range.

4. Rotate the above screw to its original position, and the instrument display screen will show the vertical angle again, meaning that the vertical index difference compensation function is working.

Adjust

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

15.6 ADJUSTMENT OF VERTICAL INDEX DIFFERENCE (I ANGLE) AND SETTING VERTICAL INDEX 0

Inspect the item after finishing the inspection and adjustment of items in 15.3 and 15.5.

Check

1. Power on after leveling the instrument. Collimate object A in Face I and read the

Vertical angle value L.

2. Rotate the telescope. Sight object A in Face II and read the Vertical angle value R. 3. If the vertical angle is 0 in zenith, i=(L+R-360)/2

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

4. If $|i| \ge 10''$ should set the Vertical Angle 0 Datum again.

Adjust:

OPERATIONAL STEPS	KEY	DISPLAY
① After leveling the instrument, click System Setup in the main menu.	[System Setup]	System Set OK × Unit Set Measurement Set Atmospheric Parame ▲ Angle Unit Degree Gon Mil Distance Unit ●
② In the menu bar, click VO Adjustment. The screen diaplays as right. Sight the target precisely in Front face, click [Set].	Sight the target in Front face [Set]	System Set OK Constants List VD Adjustment Collimation VA 89°45'18" VADJ -0°00'51" HADJ 0°00'11" 2-axis compensator is on. Level before measuring!
③ Rotate the telescope and precisely sight the same target in Reverse face. Click [Set].	Sight prism in Reverse face [Set]	System Set OK × Constants List V0 Adjustment Collimation Hori < Step-2 > Reverse VA 271°14'47" VADJ 0°00'44" HADJ -0°00'54" Tips 2-axis compensator is on. Level before measuring! Set



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

• The vertical angle displayed in zero point setting has not been compensated or modified, only for reference during setting.

15.7 HORIZONTAL AXIS ERROR COMPENSATION ADJUSTMENT

As the horizontal axis error only affects the angle of sight, it can be only confirmed through observing the target the height of which is obviously lower or higher than the instrument.

To avoid the influence of sight axis, user must have an associated adjustment before adjusting sight axis.

It is unnecessary to collimate the prism or the target plane to ascertain the transverse axis error. Therefore user is enabled to launch this adjustment at any time. Select a recognizable point which is rather far away from the instrument, and much higher or lower than the instrument. Make sure it can be precisely collimated twice.

OPERATIONAL STEPS	KEY	DISPLAY
① After leveling the instrument, click System Setup in the main menu.	[System Setup]	System Set OK × Unit Set Measurement Set Atmospheric Parame ▶ Angle Unit © Degree Gon Mil Distance Unit © Meter Feet US-Feet Temperature Unit © °C °F Pressure Unit © mmHg hPa inHg Save
⁽²⁾ In the menu bar click Horizontal Axis. The screen displays as right. Sight the target precisely in front face, Click [Set] 10 times.	Sight the prism in front face, Click [Set] 10 times	System Set OK × V0 Adjustment Collimation Horizontal Axis Inst • • < Step-1 > Front 7/10 V Angle: 129°14'19" H Angle: 48°38'58" Tips Target must be out of horizontal direction±15° Input Set
③ Rotate the telescope and precisely sight the same target in reverse face . Click [Set] 10 times.	sight the same target in reverse face Click [Set] 10 times	System Set OK × V0 Adjustment Collimation Horizontal Axis Inst • • < Step-2 > Reverse 8/10 V Angle: 231°45'28" H Angle: 228°39'16" Tips Target must be out of horizontal direction±15° Input Set
(4) After setting, the screen displays as right. Click [Set].	[Set]	System Set OK × V0 Adjustment Collimation Horizontal Axis Inst > < Step-2 > Reverse 10/10 V Angle: 231°45'25" H H Angle: 228°39'14"



15.8 OPTICAL PLUMMET

Check

1. Set the instrument on the tripod and place a piece of white paper with two crisscross lines on it right below the instrument.

2. Adjust the focus of the optical plummet and move the paper so that the intersection point of the lines on the paper comes to the center of the field of view.

3. Adjust the leveling screws so that the center mark of the optical plummet coincides with the intersection point of the cross on the paper.

4. Rotate the instrument around the vertical axis, and observe whether the center mark position coincides with the intersection point of the cross at every 90 $^{\circ}$.

5. If the center mark always coincides with intersection point, no adjustment is necessary.

Otherwise, the following adjustment is required.



Adjust

1. Take off the protective cover between the optical plummet eyepiece and focusing knob.

2. Fix the paper. Rotate the instrument and mark the point of the center of optical plummet which falls on the paper at every 90°. As illustrated: Point A, B, C, and D.

3. Draw lines that attach AC and BD and mark the intersection point of the two lines as O.

4. Adjust the four adjusting screws of the optical plummet with an adjusting pin until the center mark coincides with Point O.

5. Repeat the inspection and adjusting steps to make the instrument meets the requirements.

6. Replace the protective cover.

15.9 INSTRUMENT CONSTANT (K)

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

Check

1. Mount and level the instrument on Point A at a plain field. Use the vertical hair to mark Point B and Point C with the distance of 50m on the same line, and set the reflector accurately.

2. After setting temperature and air pressure, measure the horizontal distance of AB and AC accurately.

3. Set the instrument on Point B and center it accurately, measure the Horizontal Distance of BC accurately.

4. Then the Instrument Constant can be obtained:

K = AC - (AB + BC)

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



Adjust

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

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

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

Input Instrument Constant:

OPERATIONAL STEPS	KEY	DISPLAY
① In [System Setup] menu, click Instrument Constant. The current Instrument Constant and Multiple Constant are displayed.	[Instru ment Consta nt]	System Set OK × Horizontal Axis Instrument Constants System Ir • Current values
② In Input New Values field enter new constant. You can enter Mul. Cons. if needed. Click [Set].	Input instru ment consta nt [Set]	System Set OK × Horizontal Axis Instrument Constants System Ir Current values Inst. Cons. 0 Mul. Cons. 0 ppm Inst. Cons. 2 mm Mul. Cons. 0 ppm Set Set
③Click [OK].	[OK]	System Set OK X Horizontal Axis Instrument Constants System Ir Image: System Ir Current values Instrument Constants Set OK X Instrument Constants Set OK X Instrument constants have been saved! Instrument constants have been saved! Instrument constants Set
※1) Horizontal compensation adjust, vertical	l compensa	ation and EDM adjusting: are set by the factory,
please do not make any setting.		

15.10 PARALLELISM BETWEEN LINE OF SIGHT AND EMITTING AXIS

Check:

1. Set the reflector 50m away from the instrument.

2. Collimate the center of the reflector prism with telescope reticle.

3. Switch on the instrument, and enter into Distance Measurement Mode. Press [DIST] (or [All]) to measure. Rotate the Horizontal Tangent Screw and Vertical Tangent Screw to launch electric collimation and make the light path of EDM unblocked. In the bright zone find the center of emitting photoelectric axis.

4. Check the center of reticle to coincide with the center of emitting photoelectric axis. If so, the instrument is proved eligible.

Adjustment:

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



15.11 TRIBRACH LEVELING SCREW

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

15.12 RELATED PARTS FOR REFLECTOR

1 The Tribrach and Adapter for Reflector

The plate vial and optical plummet in the adapter and tribrach should be checked. Refer to Chapter 15.1 and 15.8 for more information.

2 Perpendicularity of the prism pole

As illustrated in Chapter 15.8, mark '+' on Point C, place the tine of the prism pole on the Point C and do not move during the inspection. Place the two feet tine of Bipod on the cross lines of Point E and F. Adjust the two legs "e' and "f" to make the bubble on the prism pole centered.

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

Set the instrument on Point B to another cross lines. With the same way to flex the

Leg "f" to make Point C and D on the central line of reticle.

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

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

16. Technical Specification

		KTS-472R	KTS-475R			
Distance Measurement						
Max distance	Single	5.0Km	5.0Km			
(Good	prism					
weather)	None	300m	300m			
	prism					
Displa	y	Max: 999999999999999999999999999999999999				
Precis	ion	With prism: $\pm (2+2\times 10^{-6})$ mm (II)				
		Without prism: $\pm (5+3 \times 10^6)$ mm (III)				
Measur	e time	Quick measure 1.0s, Track 0.5s				
Atmospheric	correction	Auto correction				
Reflection	prism	Auto	correction			
correc	tion					
Angle Measu	rement					
Measuring method		Absolute code				
Raster diamet	er	79mm				
	Horizontal	(0-360) °				
Measuring	Measuring angle					
range	vertical	±72 °				
	angle					
Min displa	ay unit	1"/5"	Selectable			
Accur	acy	2" (II)	5" (III)			
Detection r	nethod	Horizontal: Dua	l Vertical : Dual			
Telesco	ре					
Image		Erect				
Tube len	gth	154mm				
Effective ap	perture	45mm, (EDM: 50mm)				
Magnifica	tion	30X				
Field of vi	iew	1 '30'				
Resolving power		3"				
Minimum fo	cusing	1m				
distance	e					
Auto Compe	nsator					
System		Dual axis Liquid-e	electric			

Work range	±3'	
Compensation error	6"	
Vial		
Plate vial	30"/2mm	
Circular vial	8'/2mm	
Optical Plummet		
Image	Erect	
Magnification	3X	
Focusing range	0.5m~∞	
Field of view	5 °	
Display		
Туре	LCD 3.2inch WindowsCE.NET English operation system	
On-board Battery		
Power supply	Rechargeable Ni-H battery	
Voltage	DC 7.2V	
Continuous operation	8 hours	
time		
Size & weight		
Dimension	200mmX190mmX350mm	
Weight	6.0Kg	

17. ACCESSORIES

Carrying Case	1 pc
Main Body	1 pc
Battery	2 pcs
Charger	1 pc
Plummet	1 pc
Correction Pin	2 pcs
Fur Brush	1 pc
Screwdriver	1 pc
Allen key	2 pcs
Cloth	1 pc
Dryer	1 pc
Operation Manual	1 pc
Certificate	1 pc
Stylus pen	2 pc
USB data cable	1 pc

(APPENDIX-A)

1. EXPORT DATA FROM TOTAL STATION

After saving the data collected by total station by "Data Export" to appointed route, use U disk or synchronizing software (use Microsoft ActiveSync to synchronize total station and PC.) to copy to your computer, then you can view the data.

1.1 Raw Data Format

WinCE	
(Identifier)	(Included information)
PROJECT	Project name, description of file saving path.
DATE	Date & time
NAME	name of the surveyor
INST	Serial number of instrument
UNITS	(unit)meter/feet/US-feet, degree, gon, mil
SCALE	Grid factor, scale, and height
ATMOS	Temp (℃), press (hPa)
STN	point ID, instrument height, identifier of station PT
XYZ	X(E), $Y(N)$, $Z(H)$
BKB	Point number, Backsight azimuth, Backsight angle
BS	Point number[, Target height]
FS	Point number, Target height, Point number coding[, String]
SS	Point number, Target height, Point numbercoding[, String]
CTL	control code[, point code 2[, String]](optional)
HV	HA(Horizontal angle), VA(Vertical angle)
SD	HA(Horizontal angle), VA(Vertical angle), SD(Slanting distance)
HD	HA(Horizontal angle), HD(horizontal distance), VD(Height
differentia)	
NOTE	note
RES_OBS	Point number, Target height, observation times

1.2 Coordinate Data Format

Point number, E, N, H, code 111,1.059,1.059,1.298,, 112,1.000,1.000,2.596,, 113,1.059,1.059,1.297,, 114,1.059,1.059,1.297,,

115,1.059,1.059,1.297,,

Additionally, the coordinate format of point to line program is: PT, E, N, Height, code, string, start reference PT, end reference PT 3,29.145,31.367,100.632,PT,1,2 4,128.365,56.367,115.732,PT,1,2 110,29.364,31.526,100.904,PT,101,103 111,49.892,3.958,112.834,PT,101,103

2. IMPORT DATA TO TOTAL STATION

Data can be imported includes coordinate data, fixed point data, code data, horizontal alignment data, vertical alignment data and cross section data. Create a new text file(.txt) on the computer, after editing and saving the data, use U disk or synchronizing software (use Microsoft ActiveSync to synchronize total station and PC.) to copy to the total station, and use "Data Import to import to current project.

Data editing formats are displayed as follows.

2.1 Coordinate Data/Fixed Point Data Format

You should edit the coordinate data format on the computer as follows:

Point number, E, N, Z, code 1,1000.000,1000.000,1000.000,STN 2,990.000,1010.000,100.000,STN 101,994.890,1000.964,100.113,STN 102,993.936,1007.799,100.800,STN 103,998.515,1009.639,100.426,STN 104,1002.068,1002.568,100.342,STN 1001,1004.729,997.649,100.1153,PT 1002,1003.702,990.838,100.799,PT 1003,7911.990,990.358,100.403,PT 1004,997.311,998.236,100.354,PT

2.2 Cross Section Data Format

Cross section data format editing on the computer is as follows: Chainage, Offset, Height[, code] 0.000,-4.501,18.527 0.000,-3.500,18.553 0.000,0.000,18.658,CL01 0.000,3.500,18.553 0.000,5.501,18.493 12.669,-4.501,18.029 12.669,-3.500,18.059 12.669,-0.000,18.164,CL01 12.669,3.500,18.059 12.669,5.501,17.999

2.3 Point P Coding Format

The code files enclosed in code library, should assure that every line has a code, which includes entity number and layer name, etc. Every entity is ended by carriage return.

The edited coding format is as follows:

Code[, Entity[, Layer]] TREE,1,VEG FENCE,2,BDY CL,2,CL EP,2,ROAD GUTTER,2,ROAD PATH,2,PATH DRAIN,2,DRAIN BM,1,CONTROL MH,1,DRAIN GUS,1,UTILITY WATER,2,UTILITY LP,1,UTILITY LIGHTS,1,UTILITY ROCK,2,NS

•When there is no definition in code library, the default value for entity is "1", and for layer is "0".

2.4 Horizontal Line

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

Each recorded format is:

KEYWORD nnn,nnn[,nnn]

Here:

START POINTstake number, E, NSTRAIGHTazimuth, distanceARCradius, arc lengthSPIRALradius, lengthPTE, N[, A1, A2](A1, A2: LENGTH)

Example 1: START 1000.000,01050.000,1100.000 STRAIGHT 25.0000,48.420 SPIRAL 20.000,20.000 ARC 20.000,23.141 SPIRAL 20.000,20.000 STRAIGHT 148.300,54.679

Example 2: START 1000.000,1050.000,1100.000 PT 1750.000,1300.000,100.000,80.800 PT 1400.000,1750.000,200 PT 1800.000,2000.000

2.5 Vertical Curve

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

Data format is: Stake number, height, length 1000.000,50.000,0.000 1300.000,70.000,300.000 1800.000,70.000,300.000 2300.000,90.000,0.000

(APPENDIX-B) CALCULATE ROAD ALIGNMENT

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

NOTE:

•Road alignment data can be uploaded from computer or can be entered manually. Transect data can only be uploaded from computer.

•Road alignment and transect data is managed by chainage.

•One job corresponds to one road alignment, you can use several jobs to create several alignments.

1. ROAD ALIGNMENT ELEMENTS

There are two ways to enter the alignment elements:

- 1) Download from PC.
- 2) Manually entered on the WinCE (R) series.

	1
Alignment Element	Parameter
Straight	Bearing, Distance
Transition Curve	Radius, Length of Transition
	Curve
Arc	Radius, Length of Arc
РТ	N, E, radius, A1, A2

How to enter the alignment data is explained below:

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



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

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

CH	0
Ν	1100.000
Е	1050.000

Press [ENT] and then click (PT) on the screen, Enter the following data:

Ν	1300.000
E	1750.000
R	100.000
A1	80.000
A2	80.000

Enter the following data in the above way:

-	
Ν	1750.000
E	1400.000
R	200.000
A1	0.000
A2	0.000

N	2000.000
E	1800.000
R	0.000
A1	0.000
A2	0.000

The format of the data above transmitted to computer is as follows: START 0.000,1050.000,1100.000 CRLF PT 1750.000,1300.000,100.000,80.000,80.000 CRLF PT 1400.000,1750.000,200.000,0.000,0.000 CRLF PT 1800.000,1800.000,2000.000 CRLF

2. CALCULATION ROAD ALIGNMENT ELEMENTS

(1) Calculation of the length of transition curve

$$L_{1,2} = \frac{A_{1,2}^2}{R}$$
 $L_{1,2}$: Length of clothoid

 $A_{1,2}$: Parameter of clothoid R: Radius $L_1 = \frac{A_1^2}{R} = \frac{80^2}{100} = 64 \text{ m}$ $L_2 = \frac{A_2^2}{R} = \frac{80^2}{100} = 64 \text{ m}$

(2) Calculation of Deflection Angle

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

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

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

(3) Calculation of transition coordinates

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

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

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

$$= 64(1 - \frac{0.01024}{10} + \frac{0.0 \ 1 \ 0 \ 4 \ 8 \ 5}{2 \ 1 \ 6} - \frac{6}{9360} (0 \ 1 \ 0 \ 7 \ 3 \ 4)$$

$$= 64(1 - 0.0 \ 1 \ 0 \ 2 \ 0.0 \ 0 \ 0 \ 0 \ 4 \ 8 \ 05050 \ 0 \ 0 \ 0)^{1}$$

$$= 64(1 - 0.0 \ 1 \ 0 \ 2 \ 0.0 \ 0 \ 0 \ 4 \ 8 \ 05050 \ 0 \ 0 \ 0)^{1}$$

$$= 64(1 - 0.0 \ 1 \ 0 \ 2 \ 0.0 \ 0 \ 0 \ 0 \ 4 \ 8 \ 05050 \ 0 \ 0 \ 0)^{1}$$

$$= 64 * \ 0.98981$$

$$= 63.348$$
Similarly, the value of E is:

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

$$= 64(0.10666667 - 0.00078019 \cdot 0.0000025 - 0)$$

$$= 6.777$$
This example is symmetry spiral transition N1=N2, E1=E2
(4)Calculation of shift value \Delta AR

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

$$\Delta R = 6.777 - 100(1 - \cos18^{\circ}20'06'')$$

= 1.700 Symmetry spiral transition $\Delta R_1 = \Delta R_2$

(5) Calculation of Spiral Transition coordinate $N_m = N - Rs$ i $\pi = 63.348 - 100sin18^{\circ}20'06'' = 31.891$ Symmetry spiral transition $N_{m1} = N_{m2}$

(6) Calculation of Tangent Distance

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

 $LA = +111^{\circ}55'47'', \quad c \circ c = \frac{1}{s i r}, \quad \cot = \frac{1}{tan}$
 $D_1 = 100 * \tan(111^{\circ}55'47''/2) + 1.7(1 / \sin 111^{\circ}55'47'')$
 $-1.7(1 / \tan 111^{\circ}55'47'') + 31.891$
 $=148.06015 + 1.8326 + 0.6844 + 31.891$
 $=182.468$
 $D_1 = D_2$

(7) Calculation of the coordinate KA1 $N_{KA1} = N_{IP1} - D_1 \cdot c \circ \alpha_1$ $E_{KA1} = E_{IP1} - D_1 \cdot s i \alpha_1$

Bearing from BP to IP1 $\Rightarrow \alpha_1 = 74\ 03'16.6''$ $N_{KAI} = 1300 - 182.468 * \cos 74\ 03'16.6'' = 1249.872 \text{ m}$ $E_{KAI} = 1750 - 182.468 * \sin 74^{\circ}03'16.6'' = 1574.553 \text{ m}$ (8) Calculation of Arc Length $L = R(LA - \tau_1 + \tau_2)$ $= R\ (111\ 55'47'' - 2 * 18\ 20'06'')$ $= 100(75^{\circ}15'35'' \frac{\pi}{180^{\circ}})$ = 131.353 m(9) Calculation of the coordinate KA2

$$N_{KA2} = N_{IP1} - D_2 \cdot \mathbf{c} \circ \boldsymbol{\alpha}_2$$
$$E_{KA2} = E_{IP1} - D_2 \cdot \sin \boldsymbol{\alpha}_2$$

Bearing from IP1 to IP2 $\Rightarrow \alpha_2 = 322 \ 07'30.1''$ $N_{KA2} = 1300 - (-182.468) * \cos 322^{\circ}07'30.1'' = 1444.032 \text{ m}$ $E_{KA2} = 1750 - (-182.468) * \sin 322^{\circ}07'30.1'' = 1637.976 \text{ m}$

(10) Calculation of coordinates BC, EC which is ARC (IP1,IP2,EP) Arc length $CL = R \cdot IA$ $IA = 95 \ 52'11''$

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

$$TL = R \cdot \tan(\frac{IA}{2}) = 200 * \tan(95^{\circ}52'11''/2) = 221.615 \text{ m}$$

Each coordinates are computed :

 $N_{BC} = N_{IP2} - TL \cdot \cos\alpha_{2}$ $E_{BC} = E_{IP2} - TL \cdot \sin\alpha_{2}$ $N_{EC} = N_{IP2} - TL \cdot \cos\alpha_{3}$ $E_{EC} = E_{IP2} - TL \cdot \sin\alpha_{3}$ here: $\alpha_{2} \quad \text{(Bearing from IP1 to IP2)} = 322 \text{ } 07'30.1''$ $\alpha_{3} \quad \text{(Bearing from IP2 to EP)} = 57 \text{ } 59'40.6''$ $N_{BC} = 1750 - 221.615 \text{ } \cos322 \text{ } 07'30.1'' = 1575.068 \text{ m}$ $E_{BC} = 1400 - 221.615 \text{ } \sin322^{\circ}07'30.1'' = 1536.058 \text{ m}$ $N_{BC} = 1750 - (-221.615) \text{ } \cos57^{\circ}59'40.6'' = 1867.456 \text{ m}$ $E_{EC} = 1400 - (-221.615) \text{ } \sin57^{\circ}59'40.6'' = 1587.929 \text{ m}$

The calculated results display as below :



The coordinates and the distance are calculated as below :

Compute the length of straight line Straight line BP KA1= $\sqrt{(1249.872-1100.000)^2 + (1574.553-1050)^2} = 545.543$ m straight line KA2 BC = $\sqrt{(1575.068 - 1444.032)^2 + (1536.058 - 1637.976)^2} = 166.005$ m straight line EC EP = $\sqrt{(2000 - 1867.456)^2 + (1800 - 1587.929)^2} = 250.084$ m Start point coordinate (BP) Ν 1100.000 m E 1050.000 m straight line (between BP and KA1) 74 03'16.6" Bearing Distance 545.543 m Transition clothoid (between KA1 and KE1) -100 m ("-"sign is turn left curve toward the end point) Radius Length 64 m ARC (between KE1 and KE2) -100 m ("-" sign is turn left curve toward the end point) Radius Length 131.354 m Transition (Between KE2 and KA2)

-100 m ("-" sign is turn left curve toward the end point) Radius Length 64 m Straight line (between KA2 and BC) 322°07′30.1″ Bearing 166.004 m Distance Arc (between BC and EC) 200 (without sign is turn right curve toward the end point) Radius Length 334.648 m Straight line (between EC and EP) 57°59'40.6" Bearing Distance 250.084 m