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## FOREWORD

Thank you for purchasing our Electronic Total Station NTS-660 series!  
Please read these instructions carefully before operating the instrument.

### FEATURES:

1. Icons Menu Display  
NTS-660 series Total Station features largely in its icons menu display and availability of surveying programs customization. This intelligent and versatile model is particularly applicable for professional and construction survey.
2. Absolute Encoding Disk  
The instrument has equipped with an absolute encoding disk. You can start measurement directly after turning on the instrument. The angle data will be well kept even if you replace the battery during operation.
3. Powerful Memory Management  
The instrument adopts the program module with 16 M internal memory and can record the surveying data and coordinate data up to 40000 points. You can manage the memory conveniently and add, delete, modify and transfer the data.
4. Small & Light EDM Head  
The appearance and internal structure of the Total Station has adopted a totally new design, with the EDM head smaller, lighter and more convenient for survey.
5. Instrument Tilt Graphic Display  
The new model has instrument tilt graphic display. You can level the instrument by observing the electric vial on the screen .
6. Preset Standard Surveying Programs  
Besides the basic surveying modes (angle, distance, coordinate measurement), several standard surveying programs are built in. You can carry out REM, angle offset, MLM, staking-out by distance or Coordinate, setting new point and etc. to meet the diversing requirements of professional survey.

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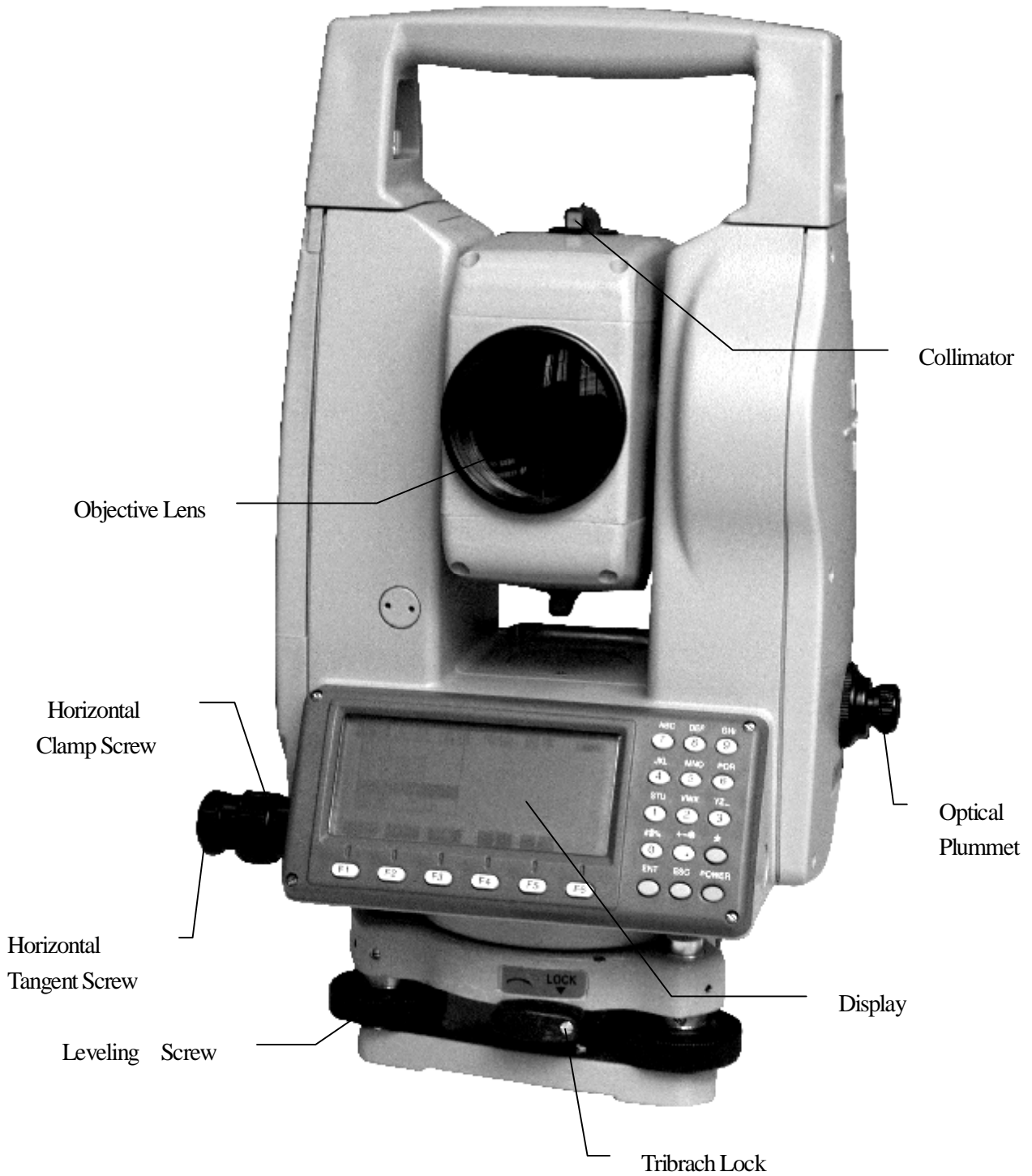
## **PRECAUTION**

1. Never collimate the objective lens direct to sunlight without a filter.
2. Never store the instrument in high and low temperature, avoid the sudden and great change of temperature.
3. When not using the instrument, place it in the case and avoid shock, dust and humidity.
4. If there is great difference between the temperature in work site and that in store place, you should leave the instrument in the case till it fits the temperature of environment.
5. If the instrument has not been used for a long time, you should remove the battery for separate storage. The battery should be charged once a month.
6. When transporting the instrument should be placed in its carrying case, it is recommended that cushioned material should be used around the case for support.
7. For less vibration and better accuracy, the instrument should be set up on a wooden tripod than an aluminum tripod .
8. Clean exposed optical parts with degreased cotton or lens tissue only!
9. Clean the instrument surface with a woolen cloth after use. If it gets wet, dry it immediately.
10. Before operating, inspect the power, functions and indications of the instrument as well as its initial setting and correction parameters.
11. Unless you are a maintenance specialist, do not attempt to disassemble the instrument by yourself even if you find the instrument abnormal.

---

# 1 NOMENCLATURE AND FUNCTIONS

## 1.1 NOMENCLATURE







## 1.2 DISPLAY

- DISPLAY

In general the upper lines display the measuring data, and the bottom line displays the soft key functions which are changed in different measurement modes.

- Contrast

The contrast and illumination of display window are adjusted by star (★) key .

- Example

Angle Measurement Mode

【Angle Measurement】	
V :	87° 56' 09"
HR:	120° 44' 38"
<span style="border: 1px solid black; padding: 2px;">SD</span> <span style="border: 1px solid black; padding: 2px;">HD</span> <span style="border: 1px solid black; padding: 2px;">NEZ</span> <span style="border: 1px solid black; padding: 2px;">OSET</span> <span style="border: 1px solid black; padding: 2px;">HOLD</span> <span style="border: 1px solid black; padding: 2px;">P2</span>	

V-angle (V): 87° 56' 09"  
H-angle (HR): 120° 44' 38"

Distance Measurement Mode

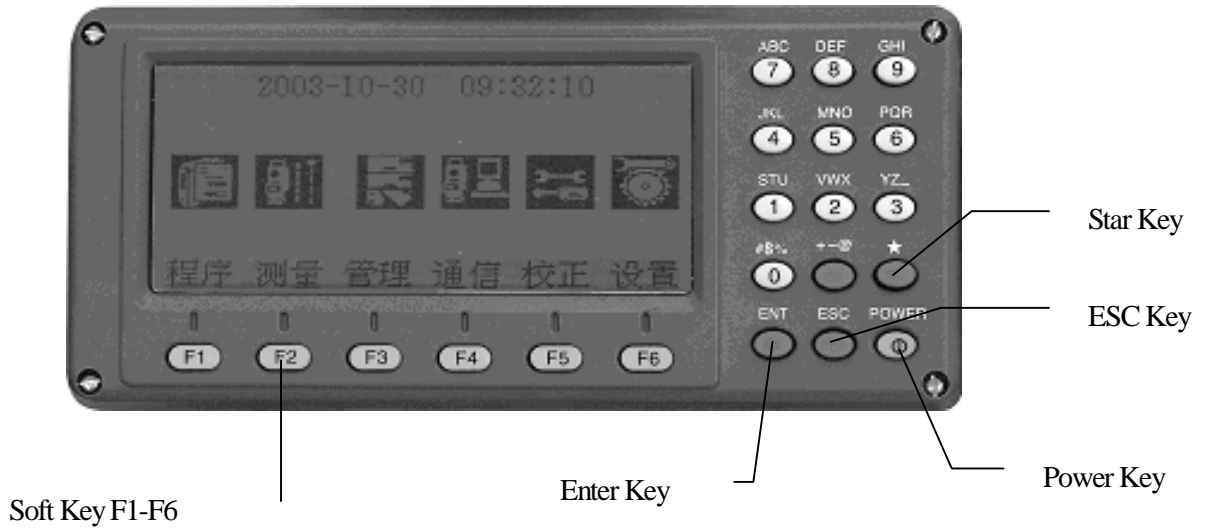
【SD Mesurement】	
V :	87° 56' 09"
HR:	180° 44' 38"
SD:	12.345
	PSM 30
	PPM 0
	(m) FR
<span style="border: 1px solid black; padding: 2px;">SD</span> <span style="border: 1px solid black; padding: 2px;">HD</span> <span style="border: 1px solid black; padding: 2px;">NEZ</span> <span style="border: 1px solid black; padding: 2px;">OSET</span> <span style="border: 1px solid black; padding: 2px;">HOLD</span> <span style="border: 1px solid black; padding: 2px;">P2</span>	

V-angle (V): 87° 56' 09"  
H-angle (HR): 180° 44' 38"  
Slope Distance (SD): 12.345 m

### ·Display Marks

Display	Content	Display	Content
V	V-angle	*	EDM working
V%	percent grade	M	Meter unit
HR	H-angle Right	ft	Feet unit
HL	H-angle Left	F	Fine mode
HD	Horizontal Distance	T	Tracking mode (10mm)
VD	Elevation Difference	R	Repeat measurement
SD	Slope Distance	S	Single measurement
N	N coordinate	N	N-times measurement
E	E coordinate	ppm	atmospheric correction value
Z	Z coordinate	psm	prism constant value

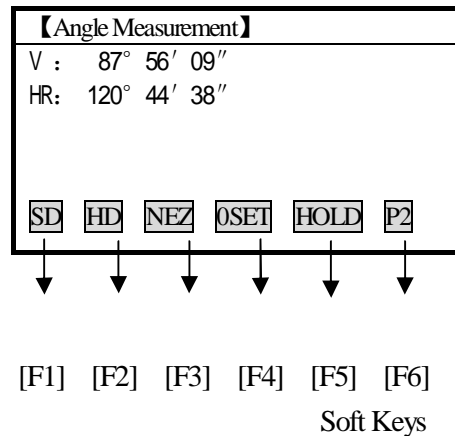
### 1.3 OPERATING KEY



Key	Nomenclature	Function
F1~F6	Soft key	Functions refer to the message displayed.
0~9	Numeric key	To enter numerals.
A~/	Alpha key	To enter alphabets.
ESC	Esc key	To return to the previous mode or display.
★	Star key	For some presetting or displaying.
ENT	Enter key	To press after confirmation of inputting values .
POWER	Power key	ON/OFF of power source.

### 1.4 FUNCTION KEY (SOFT KEY)

The Soft Key message is displayed at the bottom line of display , it changes in different measuring mode .



<b>【Angle Measurement】</b>					
V :	87°	56'	09"		
HR:	120°	44'	38"		
SD	HD	NEZ	OSET	HOLD	P2
REC	HSET	R/L	v/%	TILT	P1

Angle Measurement

<b>【SD Measurement】</b>					
V :	87°	56'	09"		
HR:	120°	44'	38"		
SD:				PSM	30
				PPM	0
				(m)	FR
MEAS	MODE	ANGLE	HD	NEZ	P2
REC	SO	MEAN	m/ft		P1

Slope Distance Measurement

<b>【HD Measurement】</b>					
V :	87°	56'	09"		
HR:	120°	44'	38"		
HD:				PSM	30
VD:				PPM	0
				(m)	FR
MEAS	MODE	ANGLE	HD	NEZ	P2
REC	SO	MEAN	m/ft		P1

Horizontal Distance Measurement

<b>【Coordinate Measurement】</b>					
N :	12345.578				
E :	-12345.678				
Z :	10.123			PSM	30
				PPM	0
				(m)	FR
MEAS	MODE	ANGLE	HD	NEZ	P2
REC	SO	MEAN	m/ft		P1

Coordinate Measurement

Mode	Display	Soft Key	Function
Angle Measurement	SD	F1	To run slope distance measurement mode
	HD	F2	To run horizontal distance measurement mode
	NEZ	F3	To run coordinate measurement mode
	Oset	F4	To set horizontal angle is set to 0° 0' 0"
	Hold	F5	To hold the horizontal angle
	REC	F1	To collect the measured data to PDA
	Hset	F2	To set the horizontal angle by inputting value
	R/L	F3	To switch R/L alteration of horizontal angle
	V/%	F4	To switch the vertical angle and percent grade
Tilt	F5	To set the tilt function ON/Off. If ON, the display shows the correction value	
Slope Distance Measurement	Meas	F1	To run slope distance measurement mode. And switch continuous / N-time (single) measurement mode
	Mode	F2	To switch the mode for single / N-time / repeat / tracking
	Angle	F3	To run angle measurement mode
	HD	F4	To run horizontal distance measurement mode, and view the horizontal distance after N-time or single measurement.
	NEZ	F5	To run coordinate measurement mode, and view the coordinate value after N-time or single measurement.

	Record	F1	To record measured data to PDA
	SO	F2	To run stake-out mode
	Mean	F3	To set the number of N-times measurement
	m/ft	F4	To switch meter or feet unit
Horizontal Distance Measurement	Meas	F1	To run horizontal distance measurement mode. And switch continuous / N-time (single) measurement mode
	Mode	F2	To switch the mode for single / N-time / repeat / tracking
	Angle	F3	To run angle measurement mode
	SD	F4	To run slope distance measurement mode, and view the slope distance after N-time or single measurement.
	NEZ	F5	To run coordinate measurement mode, and view the coordinate value after N-time or single measurement.
	REC	F1	To record measured data to PDA
	SO	F2	To run stake-out mode
	Mean	F3	To set the number of N-time measurement
	m/ft	F4	To switch meter or feet unit
Coordinate Measurement	Meas	F1	To run coordinate measurement mode
	Mode	F2	To switch the modes for single / N-time / repeat / tracking
	Angle	F3	To run angle measurement mode
	SD	F4	To run slope distance measurement mode, and view the slope distance after N-time or single measurement.
	HD	F5	To run horizontal distance measurement mode, and view the horizontal distance after N-time or single measurement.
	REC	F1	To record measured data to PDA
	HT	F2	To input the instrument height / prism height
	Mean	F3	To set the number of N-time measurement
	m/ft	F4	To switch meter or feet unit
	SET	F5	To preset the coordinate of occupied point

## 1.5 STAR KEY MODE

Press the (★) to view the instrument settings . These settings will be displayed in 2 screens.. Press [F5] (P2↓) key to view the next screen, then to press [F5] (P1↓) to return to the frist screen .

You may modify the settings by pressing the (★) :

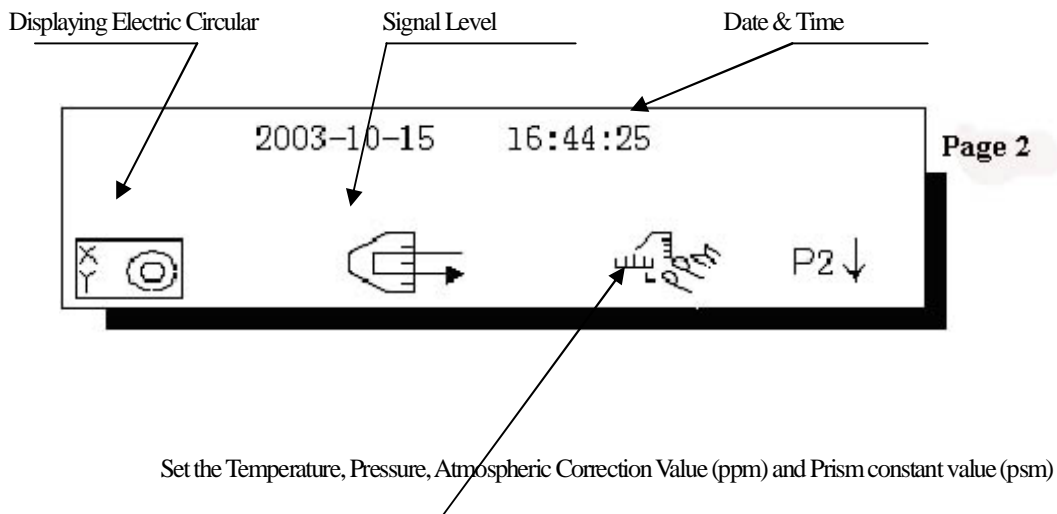
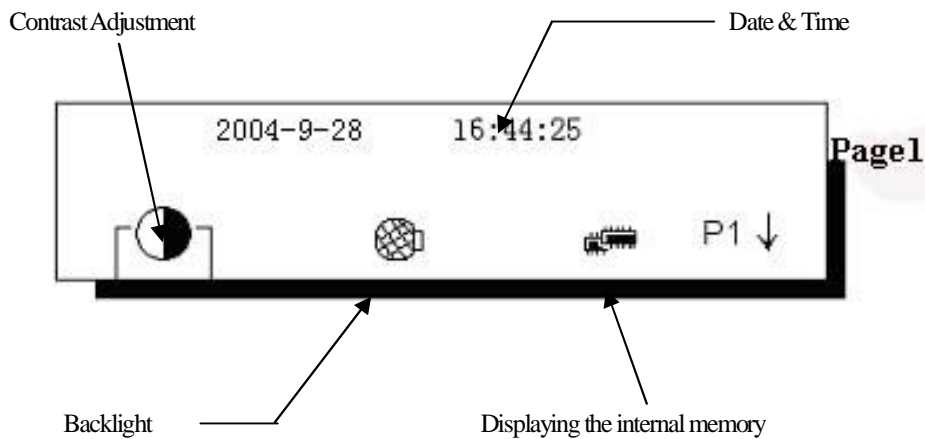
### Screen One

1. Date & Time
2. Contrast Adjustment [F1] & [F2]

- 3. Illumination ON/OFF [F3]
- 4. Free Memory [F4]

**Screen Two**

- 5. Electric Circular Vial Graphic Display [F2]
- 6. The light acceptance quantity level (Signal level) is displayed [F3]
- 7. Set the Temperature , Pressure, Atmospheric Correction Value (ppm) and Prism constant value (psm) [F4]



**1 View Date & Time**

The date and time can be viewed on both screens . To change the displayed order of the date, (Date/Month/Year), (Month/Date/Year) or (Year/Month/Date), see chapter 8 “Parameters Setting Mode”.

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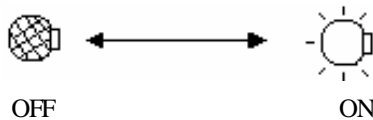
## 2 Adjust the contrast of display

This enable you to adjust the contrast of the display

## 3 Turn the display back light ON/OFF

When the back light is OFF, the light icon is dark.

To turn on the back light, press the [F3] key. Press [F3] again to turn the back light off .

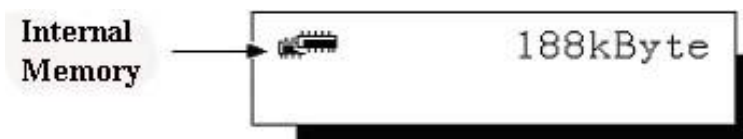


## 4 View the free memory

The amount of free memory for the internal memory can be displayed.

Press the [F4] key to view the free memory.

The icon shows the size of the amount of free internal memory.



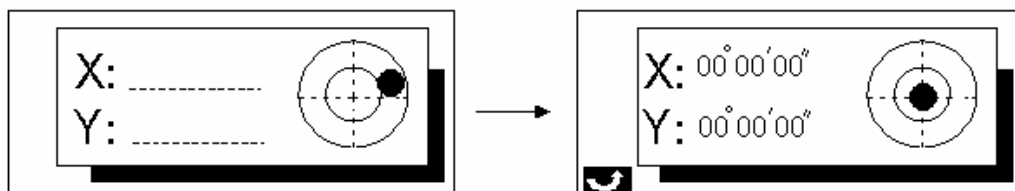
Refer to Chapter 6 “Memory Management Mode” for further more options and instructions .

## 5 Electric circular vial graphic display

Electric circular vial can be displayed by graphic. This function is good for leveling the instrument when the circular vial is difficult to check directly.

Press the [F5] key to get to Screen 2 on the display.

On the display of the reverse side, the graphic bubble moves in reverse .



Rotate the leveling screws while observing the display. After leveling, press [F1] key to return the previous mode.

---

## 6 Set audio mode

The light acceptance quantity level (Signal Level) is displayed in this mode. When reflected light from the prism is received, a buzzer sounds. This function is more convenient for collimation when the target is difficult to find.

Press [F5] key (P1 ↓) to get to screen 2, then press [F3] key. The received return signal level is displayed with bar graph as follows.



No light acceptance



Minimum quantity level



Maximum quantity level

- (1) To stop the buzzer, refer to Chapter 8 “Parameters Setting Mode”
- (2) It is also possible to display the signal level in Distance Measurement Mode .

## 7 Set the Temperature ,Pressure, Atmospheric Correction Value (ppm) and Prism constant value (psm)

Press [F5] key to get to Screen 2 then press [F4] key to view the Temperature, Pressure Atmospheric Correction Value (ppm) and Prism constant value (psm). Refer to Chapter 2.4 “Prism Constant Value” and Chapter 2.5 “Atmospheric Correction” for further instructions .

### 1.6 AUTO POWER OFF

If no key operation is done for the setting time (30 minutes) , the power turns off automatically. Refer to Chapter 8 “Parameters Setting Mode” for more instructions.

















## 2 INITIAL SETTING

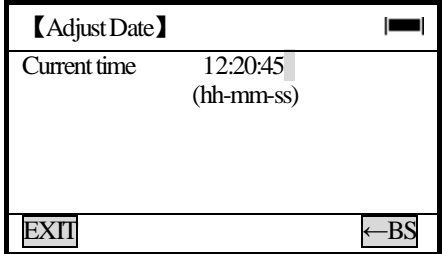
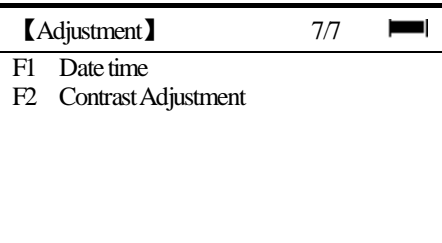
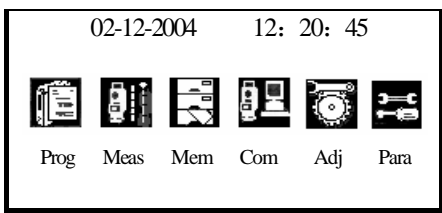
### 2.1 SETTING INSTRUMENT CONSTANT

To set the instrument constant which is obtained in section 17.8 “Checking and Adjusting of Instrument Constant, refer to the following:

Operating Procedures	Operation	Display
① Press the [F5] key from the main menu	[F5]	<p>【Adjustment】 5/7</p> <p>F1 V0 Adjustment F2 Collimation F3 Horizontal Axis F4 V0/Axis (Constant list) F5 Instrument Constant</p>
② Press [F5] (Instrument Constant) key	[F4]	<p>【Instrument Constant】</p> <p>EDM Offset 30 mm Modify?</p> <p>YES NO</p>
③ Press [F5] (YES) key ④ Input value and press [ENT] key	[F5] Input value [ENT]	<p>【Instrument Constant】</p> <p>EDM Offset 30 mm</p> <p>EXIT ←BS</p>
⑤ Press [F5] (OK) key. The display returns to [Adjustment] menu .	[F5]	<p>【Adjustment】 5/7</p> <p>F1 V0 Adjustment F2 Collimation F3 Horizontal Axis F4 V0/Axis (Constant list) F5 Instrument Constant</p>

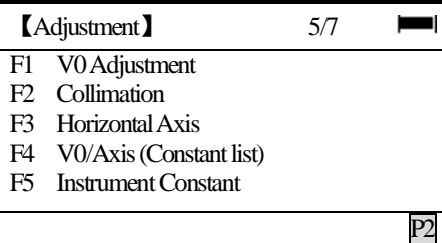
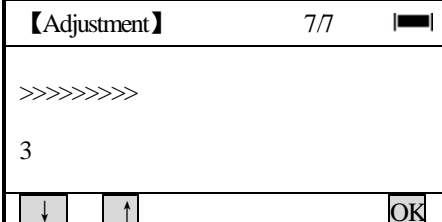
## 2.2 SETTING DATE AND TIME

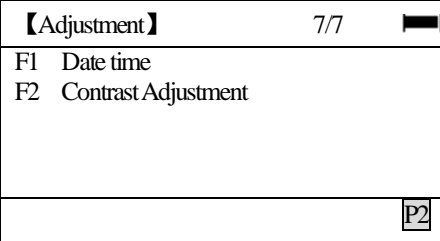
Operating Procedures	Operation	Display
① Press [F5] key from the main menu and get to page 2	[F5]	<b>【Adjustment】</b> 7/7  F1 Date time F2 Contrast Adjustment
	[F6]	
② Press [F1] key to view current values	[F1]	<b>【Adjust Date】</b>  Current date is 2004-04-11 (yy-mm-dd) Modify?
		 
③ Press [F5] (YES) key to set date	[F5]	<b>【Adjust Date】</b>  Current date is 2004-04-11 (yy-mm-dd)
		 
④ Input new date and press [ENT] key [Example: 04-02-12]	[0] [4]	<b>【Adjust Date】</b>  Current date is 2004-06-12 (yy-mm-dd)
	[0] [6] [1] [2] [ENT]	
		 
⑤ Press [F5] (YES) key to set time	[F5]	<b>【Adjust Date】</b>  Current time is 15:11:03 (hh-mm-ss) Modify?
		 

<p>⑥ Enter new time [Example: 12: 20: 45]</p>	<p>[1] [2] [2] [0] [4] [5]</p>	
<p>⑦ Press [ENT] key, the display returns to [Adjustment] menu</p>	<p>[ENT]</p>	
<p>⑧ Press [ESC] key to return to main menu</p>	<p>[ESC]</p>	
<ul style="list-style-type: none"> <li>● [F6] (Back Space) key is used in modifying time. (Press [F1] (Exit) key or [ESC] key to exit from the time displays</li> <li>● The order of date can be modified, see Chapter 8 “Parameters Setting Mode”</li> </ul>		

## 2.3 ADJUSTING THE CONTRAST OF LCD

The contrast of LCD can be adjusted.

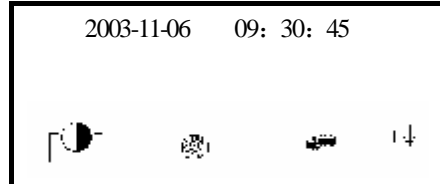
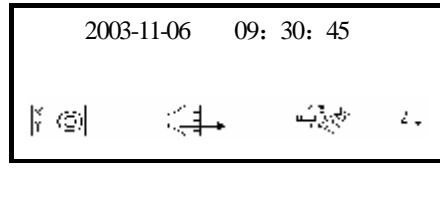
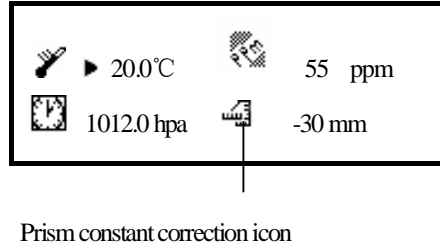
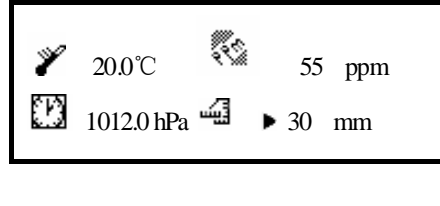
Operating Procedures	Operation	Display
<p>① From the main menu, press [F5] key to enter [Adjustment] menu</p>	<p>[F5]</p>	
<p>② Press [F6] to page 2, then press [F2] access Contrast adjusting screen</p>	<p>[F4]</p>	

<p>③ By pressing [F1] (↓), [F2] (↑) to adjust. Press [F6] (OK) to return to the adjustment screen .</p>	<p>[F1] or [F2] [F6]</p>	
---	----------------------------------	--

## 2.4 SETTING THE PRISM CONSTANT

The default prism constant value is set as -30. When using different brands of prism, it is necessary to set the prism constant correction value of that specific prism. Once the correction value for prism constant is set, it is retained after power is OFF .

- Setting the prism constant value is in the STAR Key (★) mode .
- Example : The prism constant value : 30 mm

Operating Procedures	Operation	Display
<p>① Press STAR (★) key</p>	<p>[★]</p>	
<p>② Press [ F5] key to go to the page 2, then press [F4] key to view current setting value</p>	<p>[F5]</p>	
<p>③ Press [F4] (→, ←) or [F5] (↓, ↑) to move the cursor (▶) to the prism constant correction icon</p>	<p>Move cursor</p>	 <p>Prism constant correction icon</p>
<p>⑤ Input the prism constant correction value. ※1) The display returns to Star (★) key menu</p>	<p>Enter values</p>	
<p>※1) Input range: -100 mm ~ +100 mm</p>		<p>1 mm step</p>

## 2.5 SETTING ATMOSPHERIC CORRECTION

The velocity of light through air is not constant and depends on the atmospheric temperature and pressure. The correction system of this instrument corrects automatically when the correction value is set. 20°C/68°F and 1013.25pha/760mmHg/29.9inHg as a standard value for 0ppm in this instrument .The values are kept in the memory even after POWER is OFF .

Setting the atmospheric value is in the STAR key (★) mode .

### 2.5.1 CALCULATION OF ATMOSPHERIC CORRECTION

The followings are the correction formulas: (Unit: meter)

$$PPM = 273.8 - \frac{0.2900 \times \text{Pressure Value (hPa)}}{1 + 0.00366 \times \text{Temperature (}^\circ\text{C)}}$$

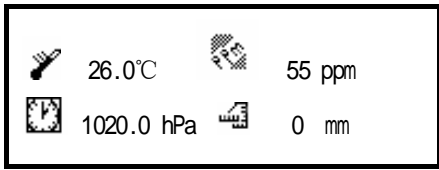
If the pressure unit is mmHg , use :

$$1\text{hPa} = 0.75\text{mmHg} \text{ to compute}$$

- If you don't use Atmospheric Correction , set the PPM value as zero .
- Standard weather condition for NTS Series (Atmospheric Correction value is zero ):

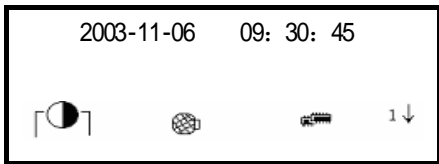
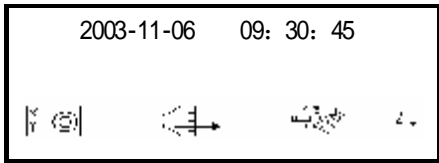
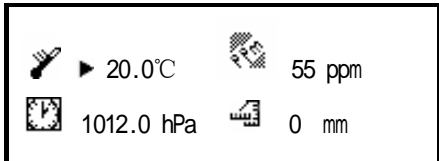
Pressure : 1013 hPa Temperature : 20°C

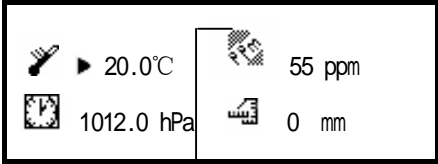

Operating Procedures	Operation	Display
① Press STAR (★) key	[★]	
② Press [F5] key to get to the function as in page 2	[F5]	
③ Press [F4] key, current setting value is displayed	[F4]	<p>Temperature setting</p>
④ Enter Temp. Value and press [ENT] key. [Example] : Temp.: +26°C The cursor moves to Pressure setting	Enter Temp. [ENT]	

automatically		
⑤ Input Pressure value, and press [ENT]. [Example] : Pres. 1020 hPa  The display returns to previous mode ※1), ※2 )	Enter Pres. [ENT]	
※1) Range: Temp.-30 ~ +60°C (0.1°C Step) or -22 ~ +140°F(1°F step) Pres: 420 ~ 800 mm Hg (1 mm Hg step) or 560 ~ 1066 hPa (0.1hpa step) 16.5 ~ 31.5 inchHg (0.1 inchHg step) The Atmospheric Correction constant PPM : -100 ~ +100 PPM (1PPM step) Prism Constant Value PC: -100 ~ +100 mm (1mm step)  ※2) The atmospheric correction value is calculated from the input temperature and pressure		

## 2.5.2 SETTING ATMOSPHERIC CORRECTION VALUE

Measure the temperature and air pressure to find atmospheric correction value (ppm) from the correction formula.

Operating Procedures	Operation	Display
① Press STAR (★) key	[★]	
② Press [F5] key to get to the function as in page 2	[F5]	
③ Press [F4] key. Current setting value is displayed	[F4]	

④ Press [F5] (▶) key to move the cursor to PPM setting	Move Cursor	 <p style="text-align: center;">PPM setting</p>
⑤ Enter atmospheric correction value and press [ENT] key ※1) The display returns to previous mode .	Enter ppm [ENT]	
※1)Input range: -100 ppm ~ +100 ppm		1ppm step

## 2.6 ATMOSPHERIC REFRACTION AND EARTH CURVATURE CORRECTION

The instrument will correct the influence of atmosphere refraction and earth curvature when measuring Horizontal Distance and Elevation Difference.

The correction refraction and earth curvature can be calculated as the following formula:

### Corrected Horizontal Distance :

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

### Corrected Elevation Distance :

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

● If the correction of atmospheric refraction and earth curvature is neglected, the formula calculating the Horizontal Distance and Elevation Difference is as follows :

$$D=S \cdot \cos \alpha$$

$$H=S \cdot \sin \alpha$$

K=0.14 ..... Atmospheric refraction coefficient

Re=6370 km ..... Radius

$\alpha$  (或  $\beta$ ) ..... The vertical angle calculated from horizon

S ..... Slope Distance

**Note:** In the factory the atmospheric refraction coefficient of the instrument is set as K=0.14 .For the value of K, there are two kinds, that is K=0.14 and K=0.2, also you can select OFF. When you want to modify the K value, refer to Chapter 8 “Parameters Setting Mode” .

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## 3 PREPARATION FOR MEASUREMENT

### 3.1 UNPACKING AND STORE OF INSTRUMENT

- **Unpacking of instrument**

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

- **Store of Instrument**

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

### 3.2 SETTING THE INSTRUMENT UP

Mount the instrument to the tripod. Level and center the instrument precisely to ensure the best performance. Use the tripod with a relevant tripod screw.

#### Operation Reference: Leveling and Centering the Instrument

##### 1, Setting up the tripod

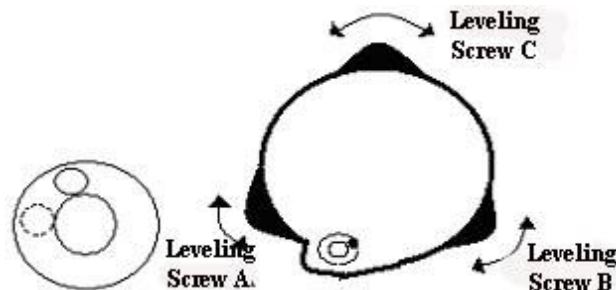
- ① First, extend the extension legs to suitable length, make the tripod head be parelle to the ground and tighten the screws.
- ② Make the center of the tripod be perpendicular to the occupied point.
- ③ Step on the tripod to make sure if it is well stationed on the ground.

##### 2, Attaching the instrument on the tripod

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

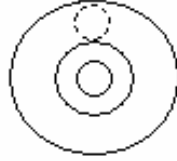
##### 3, Roughly leveling the instrument by using the circular vial

- 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 .



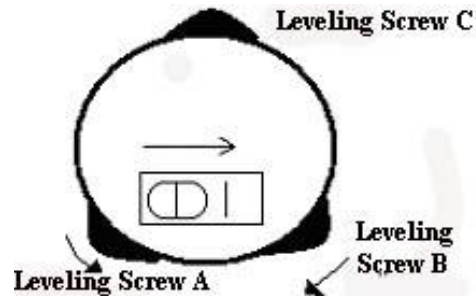
- ② Turn the leveling screw C to move the bubble to the center of the circular vial.



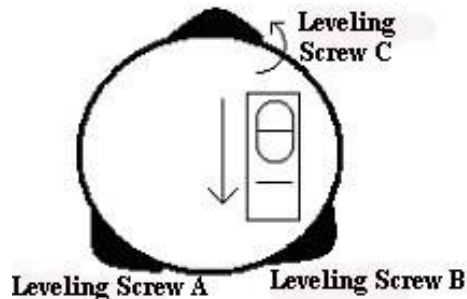


#### 4, Leveling by using the plate vial

① Rotate the instrument horizontally by loosening the Horizontal Clamp Screw and place the plate vial parallel with 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.



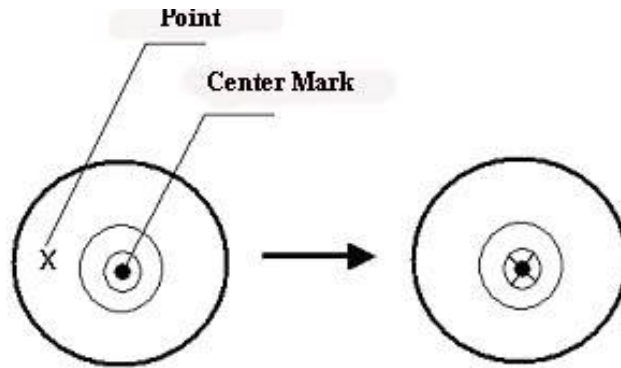
② Rotate the instrument  $90^\circ$  (100g) around its vertical axis and turn the remaining leveling screw or leveling C to center the bubble once more.



③ Repeat the procedures ①② for each  $90^\circ$  (100g) rotation of the instrument and check whether the bubble is correctly centered in all directions.

#### 5, Centering by using the optical plummet

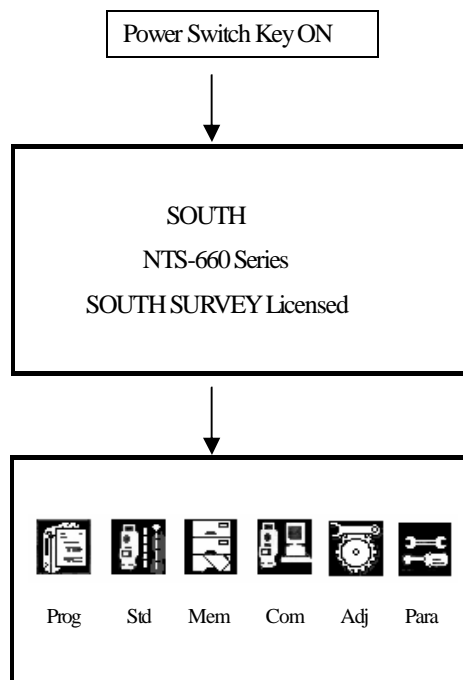
Adjust the eyepiece of the optical plummet telescope to your eyesight. Slide the instrument by loosening the tripod center screw; place the station point onto the center mark of the optical plummet . Sliding the instrument carefully in order not to rotate that allows you to get the least dislocation of the bubble.



### 6, Completely leveling the instrument

Level the instrument precisely in a similar way to Step 4. Rotate the instrument and check whether the bubble is in the center of the plate vial regardless of the telescope direction, then tighten the tripod center screw hard.

### 3.3 POWER SWITCH KEY ON

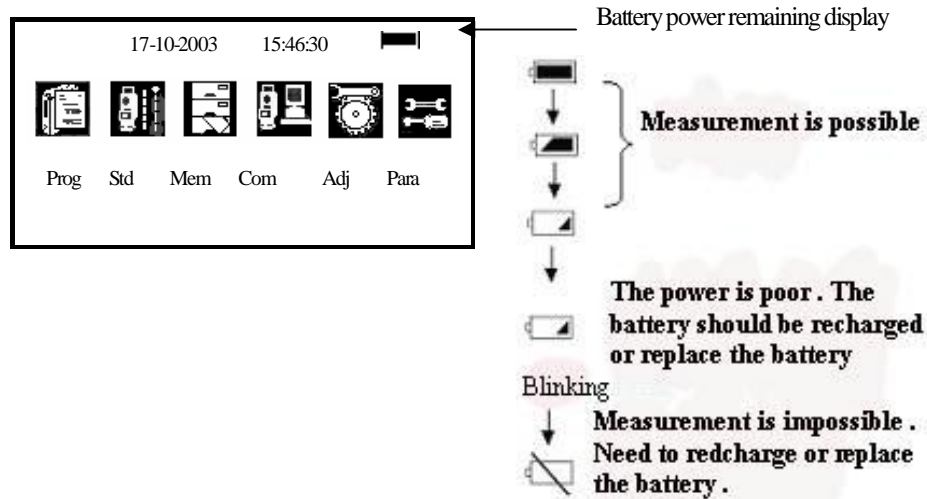


Main Menu

- Confirm the battery power shown on the display. Replace it with another charged battery or charge when battery level is low. Refer to section 3.4 “Battery Power Remaining Display”.

### 3.4 BATTERY POWER REMAINING DISPLAY

Battery power remaining display indicates the power condition .



#### NOTE :

- 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 power remaining display 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.
- ③ When 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 of power status, but it would not indicate the instantaneous change of battery power.

#### • Battery Recharging Cautions:

- ☆ Battery should be recharged only with the charger NC-30 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 and will be completed in about 1.5 hours. When charging is complete (indicator lamp turns green) , remove the battery from the charger and 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.

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• **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  $0^{\circ} \sim \pm 45^{\circ} \text{ C}$ , recharging may be abnormal beyond the specified temperature range .
- ☆ When the indicator lamp does not light, even after connecting the battery and charger, either the battery or the charger may be damaged.

• **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, be sure to recharge it at least once a month.

### 3.5 REFLECTOR PRISMS

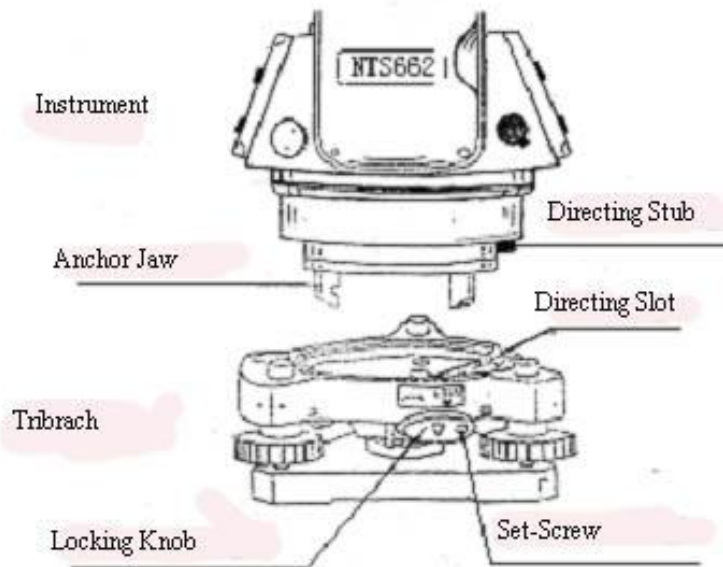
When measuring distance, a reflector prism needs to be placed at the target place. Reflector systems come with single prism and triple prisms, which can be mounted with tribrach onto a tripod or mounted onto a prism pole. Unique Mini prism systems allow setups at corners that are hard to reach. Illustrated are some prism systems that match:



### 3.6 MOUNTING AND DISMOUNTING INSTRUMENT FROM TRIBRACH

• **Dismounting**

If necessary, the instrument can be dismounted from tribrach. Loosen the tribrach locking screw in the locking knob with a screwdriver. Turn the locking knob about 180 degree 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 degree clockwise and tighten the locking screw with a screwdriver.

### 3.7 EYEPIECE ADJUSTMENT AND COLLIMATING OBJECT

- **Method of Collimating Object (for reference)**

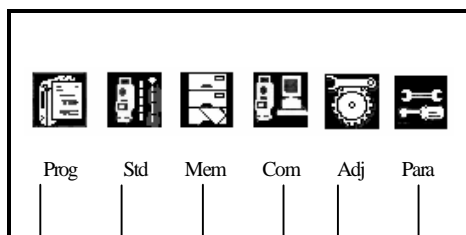
- ① Sight the Telescope to the sky and rotate the eyepiece tube to make the reticle clear .
- ② Collimate the target point with top of the triangle mark in the coarse collimator. (keep a certain distance between eye and the coarse collimator).
- ③ Make the target image clear with the telescope focusing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

☆ If there is parallax when your eye moves up , down or left , right , that 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.

### 3.8 MAIN MENU

The main menu contains following items:

Select the menu by pressing soft keys [F1]~[F6] .



**Parameters Setting Mode**

The Parameters Settings are momerized even power is off (See Chapter 8 “Parameters Setting mode”)

**Adjustment Mode** for Inspection and Adjustment

- Adjustment of compensation systematic errors of instrument
  - Setting Instrument Constant Value
  - Setting Date & Time
  - Setting LCD Contrast
- (Chapter 2 “Initial Setting”)

**Communication Mode**

- Setting of **PROTOCOL**
- Data file in/out. (See Chapter 7 “Communication Mode”)

**Memory Management Mode**

- Displaying file memory status
- Protecting/Deleting/Rename
- Initialization (See Chapter 6 “Memory Management Mode”)

**Measurement Mode**

- Angle measurement
- Distance measurement
- Coordinate Measurement (See Chapter 4 “Measurement Mode”)

**Program Mode (Application Measurement)**

- Standard Surveying Programs
  - Setting a direction angle for horizontal orientation
  - Lead measurement
  - Remote elevation measurement (REM)
  - Missing line measurement (MLM)
  - Repetition angle measuement (REP)
  - Layout (LAYOUT)
  - Line measurement
  - Offset measurement (OFFSET)
- (See Chapter5 “PROGRAM MODE”)

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### 3.9 VERTICAL AND HORIZONTAL ANGLE TILT CORRECTION

When the tilt sensors are activated, automatic correction of vertical and horizontal angle for mislevelment is displayed.

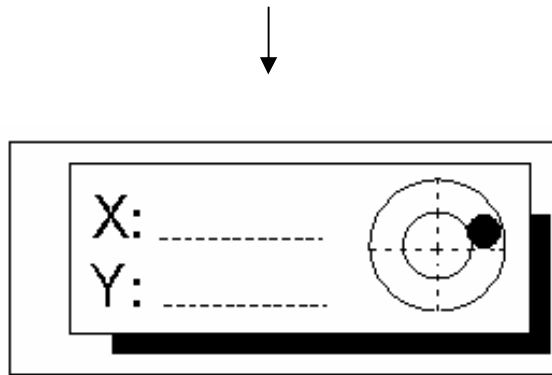
To ensure a precise angle measurement, tilt sensors must be turned on.

(See Chapter 8 “Parameters Setting Mode”).

The display can also be used to fine level the instrument. If the (TILT OVER) display appears, the instrument is out of automatic compensation range and must be leveled manually.

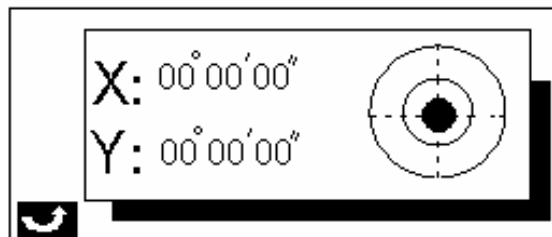
- NTS-660 compensates both the vertical angle and the horizontal angle readings due to inclination of the standing axis in the X and Y directions.

- The instrument tilts over correction range:



↓

Rotate the leveling screws and level the instrument:



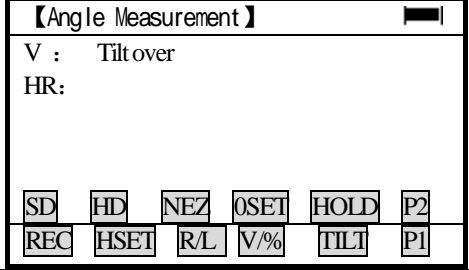
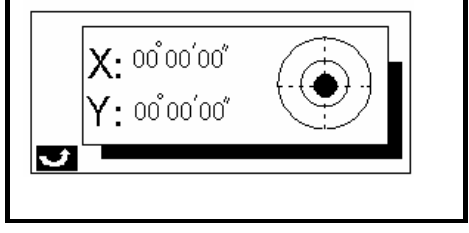
After leveling, the display returns to the previous mode.

- The display of Vertical or Horizontal angle is unstable when instrument is on an unstable stage or is used during a windy day. You can turn off the auto tilt correction function of V/H angle in this case. Refer to Chapter 8 “Parameters Setting Mode”

- If the Tilt Correction is ON. (Single Axis or Dual Axis, refer to Chapter 8 “Parameters Setting

Mode”), If instrument is not well leveled, the [Tilt] key can be selected in page 2, observe the electric vial and level the instrument.

► **Procedure**

Operating Procedures	Operation	Display
① Press [F2] key in menu display , then press [F6] key to get the function in page 2	[F2] [F6]	
② The display shows tilt correction value. (Access the measurement menu only after leveling the instrument).	[F2]	
<p>● The settings performed here will be interlocked with setting in Chapter 8 “Parameters Setting Mode”.</p>		

### 3.10 COMPENSATION OF SYSTEMATIC ERROR OF INSTRUMENT

- 1) Error of vertical axis (X , Y tilt sensor offset)
- 2) Collimation error
- 3) Error of vertical angle 0 Index
- 4) Error of horizontal axis

The errors above mentioned can be compensated by software, which are calculated internally according to each compensation value. Also these errors can be compensated by software collimating one side of the telescope that is carried out to delete the error by turning in normal and reverse both sides of telescope so far .

- To adjust or reset the above compensation value, see Chapter 17 “Check and Adjustment“ .
- Disable the compensation, see Chapter 8 “Parameters Setting Mode“ or Chapter 17 “Check and Adjustment” .



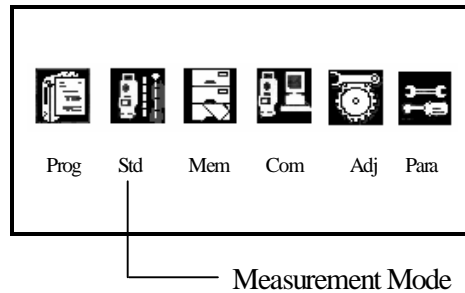
### 3.11 HOW TO ENTER NUMERALS AND ALPHABET LETTERS

This enables you to enter numerals or alphabet letters.

**[Example] To rename the file in Memory Management mode .**

Operating Procedures	Option	Display
Press [F3] (Mem) key from the main menu icons, then press [F6] (File) key and press [F2] (Rename) key ① Press [F1] (Num) key , to enter alphabet letter mode .	[F3] [F6] [F2] [F1]	
② Enter Alphabets, ※1) input "S" input "O" input "U" Move cursor input "T" input "H" input " _ "	[1] [5] [1] [F4] [1] [9] [3]	
③ Press [F1] (Alpha) key, to enter numeric mode Input "112"	[F1] [1] [1] [2]	
④ Press [ENT] key	[ENT]	
※1) When entering an alphabet in the same key consecutively, press [F4] (→) key to move the cursor to the right, then press the same alphabet key again.		

## 4 MEASUREMENT MODE



Angle Measurement, Distance Measurement, Coordinate Measurement

### 4.1 ANGLE MEASUREMENT

#### 4.1.1 HORIZONTAL ANGLE (RIGHT) AND VERTICAL ANGLE MEASUREMENT

Make sure the mode is in Angle measurement

Operating Procedures	Operation	Display
① Collimate the 1st target (A)	Collimate A	<div style="border: 1px solid black; padding: 5px;"> <p>【Angle Measurement】 <span style="float: right;">▬</span></p> <p>V : 87° 56' 09"</p> <p>HR: 130° 44' 38"</p> <p style="text-align: center;">SD HD NEZ OSET HOLD P2</p> </div>
② Set horizontal angle of target A at 0°00' 00" Press [F4] (OSE) key and [F6] (set) key	[F4]  [F6]	<div style="border: 1px solid black; padding: 5px;"> <p>【H-0set】 <span style="float: right;">▬</span></p> <p>HR: 0° 00' 00"</p> <p style="text-align: center;">ESC SET</p> <hr/> <p>【Angle Measurement】 <span style="float: right;">▬</span></p> <p>V : 87° 56' 09"</p> <p>HR: 0° 00' 00"</p> <p style="text-align: center;">SD HD NEZ OSET HOLD P2</p> </div>
③ Collimate the 2 <sup>nd</sup> target (B). The H/V angle of target B will be displayed.	Collimate B	<div style="border: 1px solid black; padding: 5px;"> <p>【Angle Measurement】 <span style="float: right;">▬</span></p> <p>V : 57° 16' 09"</p> <p>HR: 120° 44' 38"</p> <p style="text-align: center;">SD HD NEZ OSET HOLD P2</p> </div>

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.

#### 4.1.2 SWITCH HORIZONTAL ANGLE RIGHT/LEFT

Make sure the mode is in Angle measurement

Operating Procedures	Operation	Display
① Press [F6] (P1↓) key, turn to page 2	[F6]	<div style="border: 1px solid black; padding: 5px;"> <p>【Angle Measurement】 <span style="float: right;">▬</span></p> <p>V : 87° 56' 09"</p> <p>HR: 120° 44' 38"</p> <p>[SD] [HD] [NEZ] [OSET] [HOLD] [P2]</p> <p>[REC] [HSET] [R/L] [V%] [TILT] [P1]</p> </div>
② Press [F3] key, the mode Horizontal Angle Right (HR) switches to Angle Left (HL)	[F3]	<div style="border: 1px solid black; padding: 5px;"> <p>【Angle Measurement】 <span style="float: right;">▬</span></p> <p>V : 87° 56' 09"</p> <p>HL: 239° 15' 22"</p> <p>[REC] [HSET] [R/L] [V%] [TILT] [P1]</p> </div>
③ Measure the target in the same way as in HR mode .		
<ul style="list-style-type: none"> <li>● Every time [F3] (R/L) key is pressed, HR/HL mode switches .</li> <li>● The R/L switch can be disabled (R/L Lock), refer to Chapter 8 “Parameters Setting Mode”</li> </ul>		

#### 4.1.3 HORIZONTAL ANGLE READING SETTING

1) Setting by holding the angle

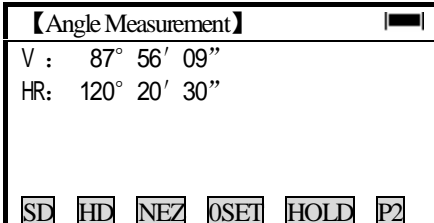
Make sure the mode is in angle measurement.

Operating Procedures	Operation	Display
① Use Horizontal tangent screw to set the required horizontal angle .	Display Angle	
② Press [F5] (HOLD) key, hold the required horizontal angle.	[F5]	
③ Collimate the target ※1 )	Collimate	
④ Press [F6] (REL) key to release the horizontal angle The display turns back to normal angle measurement mode	[F6]	
※1) To return to the previous mode , press [F1] (ESC) key		

## 2) Setting a Horizontal Angle from the keys

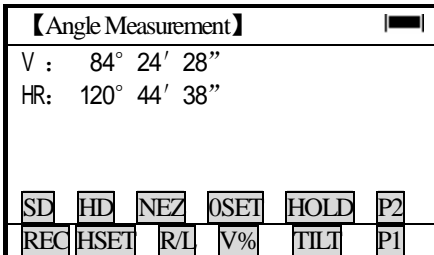
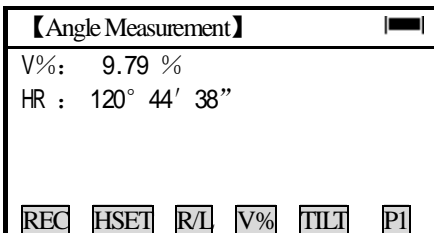
Make sure the mode is Angle measurement

Operating Procedures	Operation	Display
① Collimate the target	Collimate	
② Press [F6] (P1↓) key to enter page 2, then press [F2] (H-Set) key ③ Input the required horizontal angle ※1 For Example : 120°20' 30"	[F6] [F2] Input angle value	

<p>④ Press [ENT] key ※2)</p> <p>When completed, normal measuring from the required Horizontal angle is possible.</p>	<p>[ENT]</p>	
<p>※1) To revise wrong value, press [F6] (BS) key to move cursor, or press [F1] (ESC) key to input correct value.</p> <p>※2) With wrong input value (for example 70'), Setting failed, input again from step③.</p>		

#### 4.1.4 VERTICAL ANGLE PERCENTAGE (%) MODE

Make sure the mode is in Angle measurement.

Operating Procedures	Operation	Display
<p>① Press [F6] (P1↓) key to get the function in page 2</p>	<p>[F6]</p>	
<p>② Press [F4] (V%) key ※1)</p>	<p>[F4]</p>	
<p>※1) Every time pressing [F4] (V%) key, the display mode switches accordingly.</p>		

## 4.2 DISTANCE MEASUREMENT

### 4.2.1 SETTINGS THE ATMOSPHERIC CORRECTION

Before setting the atmospheric correction, obtain the correction value by measuring the temperature and pressure.

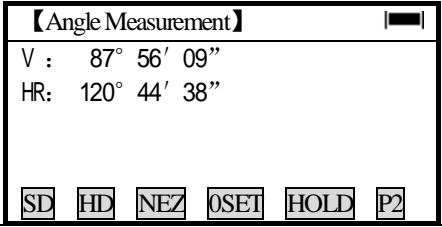
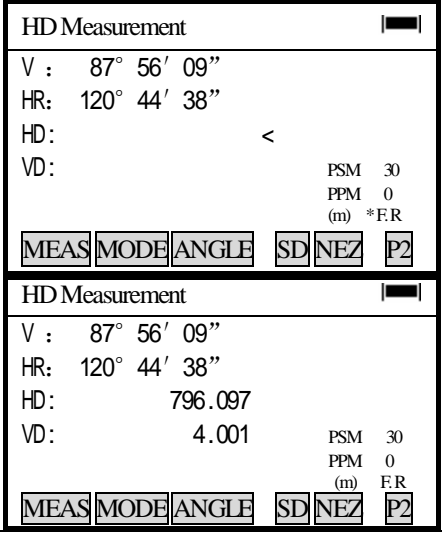
Setting the atmospheric correction is in the Star (★) key mode, see Chapter “2.5 Setting of Atmospheric Correction”.

### 4.2.2 SETTING THE PRISM CONSTANT

Prism Constant value is -30. Set correction for prism at -30. If the prism is from other manufacturers the appropriate constant shall be set beforehand. Refer to Chapter 2.4 “Set Prism Constant”. The setting value will be kept in the memory even after power is off.

#### 4.2.3 DISTANCE MEASUREMENT (CONTINUOUS MEASUREMENT)

Make sure the mode is in Angle measurement

Operating Procedures	Operation	Display
① Collimate the center of prism.	Collimate	
② Press [F1] (SD) key or [F2] (HD) key, press [F2] (MODE) key, to enter Continuous fine measurement mode. ※1, 2)  [Example] Horizontal distance mode The result shown ※3) ~ ※6)	[F2]	
<p>※1) The following letters shown in the 4<sup>th</sup> line on the right in the display window represent such measurement modes.</p> <p>F: Fine    T: Tracking R: Continuous(Repeat)                    S: Single    N: N-time</p> <p>※2) To change measuring mode, press [F2] (MODE) key .</p> <p>※3) When EDM is working , the “*” mark appears in the display .</p> <p>※4) The result is shown with buzzer sound.</p> <p>※5) Measurement may repeat automatically if the result is affected by atmospheric refraction etc .</p> <p>※6) To return to the angle measurement mode, press [F3] (VH) key .</p>		

#### 4.2.4 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 from leaving factory .

### 1) Setting the number of times

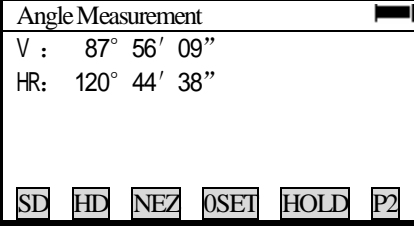
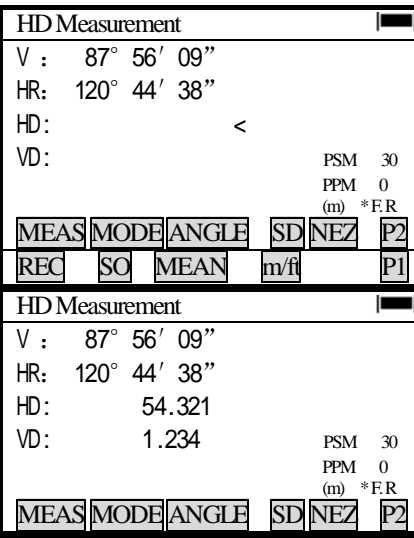
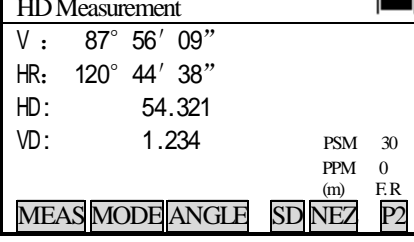
Make sure the mode is in Angle measurement.

Operating Procedures	Operation	Display
① Press [F1] (SD) or [F2] (HD) key	[F1] or [F2]	
② Press [F6] (P1 ↓) key to get the function in page 2. ③ Press [F3] (MEAN) key, input the number of times . [Example] 3 times	[F6] [F3] [3]	
④ Press [ENT] key, N-times measurement starts .	[ENT]	

### 2) Measurement Method

Make sure the mode is in Angle Measurement .

Operating Procedures	Operation	Display
----------------------	-----------	---------

① Collimate the center of prism	Collimate	
② Press [F1] (SD) key or [F2] (HD) key, select the measurement mode. [Example] Horizontal distance, N-time measurement starts	[F1] or [F2]	
③ The average value is displayed with buzzer sound and mark “ * ” disappears.		
<ul style="list-style-type: none"> <li>● Press [F1] (MEAS) key to repeat measurement after the measurement finishes.</li> <li>● Press [F3] (VH) key to return to the angle measurement mode.</li> </ul>		

#### 4.2.5 FINE / TRACKING MEASUREMENT MODE

☆Fine mode: This is the normal distance measurement mode  
Measurement time: approx 3 seconds  
The minimum unit is 1mm (0.001 ft)

☆Tracking mode: This mode measures in a shorter time than in fine mode. Use this mode for stake-out measurement. It is very useful for tracing the mobile object or carrying out engineering stake-out job.  
Measurement time: approx 1 second  
The minimum unit is 10mm (0.02 ft)



▶ **Refer to the following:**

Operating Procedures	Operation	Display
① Collimate the center of prism	Collimate	
② Press [F1] (SD) key or [F2] (HD) key Select measuring mode ※1) [Example] HD measurement mode starts.	[F1] or [F2]	
③ Press [F2] (MODE) key, return to tracking mode.		
※1) Every time pressing [F2] (MODE) key, the mode will be changed in procedure 3		

#### 4.2.6 STAKE-OUT

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: Stake-out of Vertical Difference]**

Operating Procedures	Operation	Display
① Press [F6] (P1 ↓) key in the distance measurement mode to get the function in page 2	[F6]	

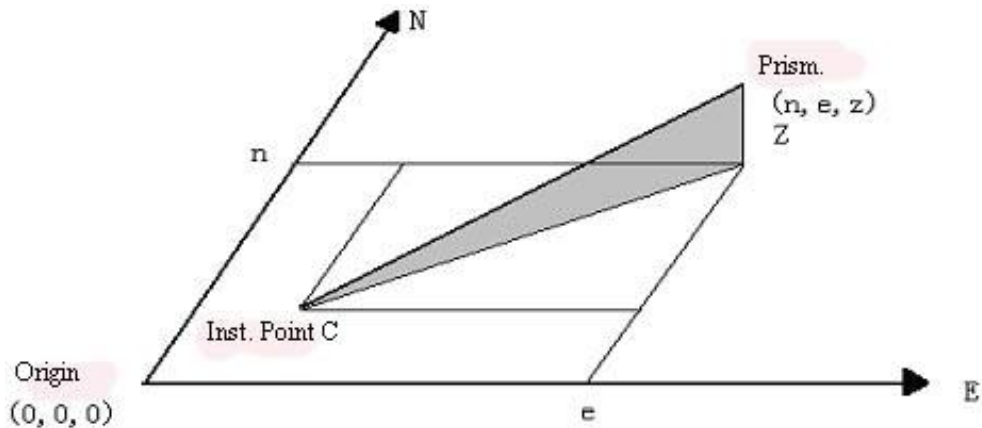
② Press [F2] (SO) key	[F2]	<div style="border: 1px solid black; padding: 5px;">           Stake Out <span style="float: right;">▬</span>            HD: <input style="width: 100px;" type="text"/>            VD: <input style="width: 100px;" type="text"/>  <hr/> <span style="float: left;">[ESC]</span> <span style="float: right;">[←BS]</span> </div>
③ Enter the vertical difference for stake-out, and press [ENT] key. The measurement starts .	Enter value [ENT]	<div style="border: 1px solid black; padding: 5px;">           HD Measurement <span style="float: right;">▬</span>            V : 90° 10' 20"            HR: 120° 30' 40"            HD: &lt;            dVD: <input style="width: 100px;" type="text"/> <div style="float: right; text-align: right;">             PSM 30              PPM 0              (m) *ER           </div> <hr/> <span style="float: left;">[REC] [SO] [MEAN] [m/ft] [PI]</span> </div> <div style="border: 1px solid black; padding: 5px;">           HD Measurement <span style="float: right;">▬</span>            V : 90° 10' 20"            HR: 120° 30' 40"            HD: 12.345            dVD: 0.009           <div style="float: right; text-align: right;">             PSM 30              PPM 0              (m) ER           </div> <hr/> <span style="float: left;">[REC] [SO] [MEAN] [m/ft] [PI]</span> </div>
<p>● To return to normal distance measurement mode, reset the standard distance to "0" or turn the power switch off.</p>		

## 4.3 COORDINATE MEASUREMENT

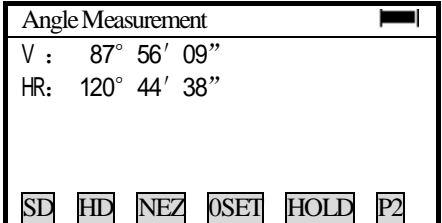
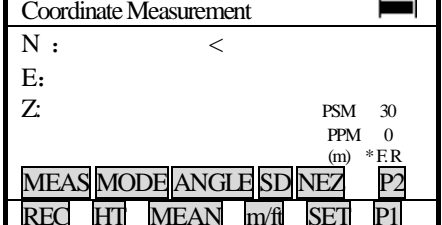
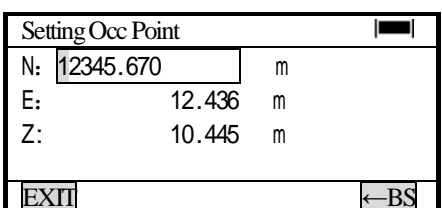
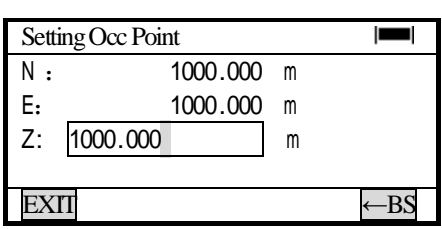
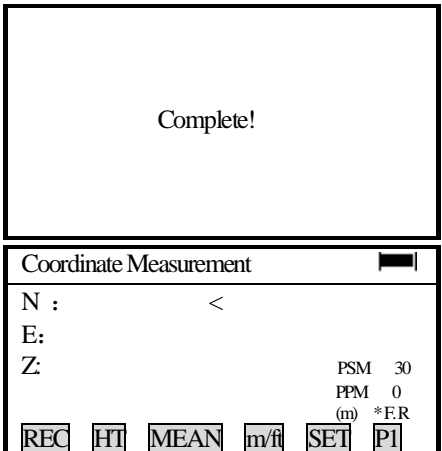
### 4.3.1 SETTING COORDINATE VALUES OF OCCUPIED POINT

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.

It is possible to retain the Coordinate of the occupied point after turning the power off (Resume mode : on), refer to Chapter 8 "Parameters Setting Mode" .



Make sure the mode is in Angle Measurement mode .

Operating Procedures	Operation	Displays
① Press [F3] (NEZ) key	[F3]	
② Press [F6] (P ↓) to get the function in page 2 .	[F6]	
③ Press [F5] (set) key, the previous data will be shown .	[F5]	
④ Input new data and press [ENT] key ※1)	N coord [ENT] E coord [ENT] Z coord [ENT]	
⑤ Measurement starts		
※1) To cancel the setting, press [F1] (EXIT) key .		

### 4.3.2 SETTING THE INSTRUMENT HEIGHT / PRISM HEIGHT

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

Ensure the mode is in Angle Measurement mode .

Operating Procedures	Operation	Display
① Press [F3] (NEZ) key	[F3]	
② Press [F6] (P1 ↓) key from the coordinate measurement mode to get the function in page 2	[F6]	
③ Press [F2] (HT) key to show previous data .	[F5]	
④ Input instrument height, and press [ENT] key ※1 ⑤ Input prism height, press [ENT] key The display returns to coordinate measurement mode.	Inst. HT [ENT] Prism [ENT]	 
※1) To cancel the setting , press [F1] (EXIT) key .		

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### 4.3.3 OPERATION OF COORDINATE MEASUREMENT

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

- To set coordinate value of occupied point, see Section 4.3.1 “Setting Coordinate Values of Occupied Point”.
- To set the instrument height and prism height, see Section 4.3.2 “Setting of the Instrument Height/Prism Height”.
- The Coordinate of the unknown point are calculated as shown below and displays:

Coordinate of occupied point :  $(N_0, E_0, Z_0)$

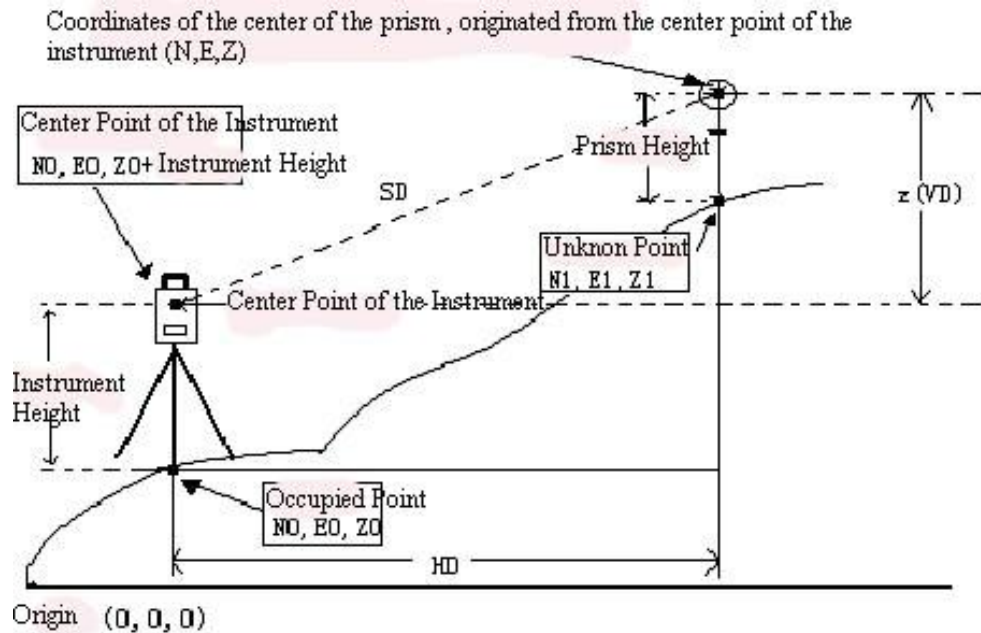
Coordinate of the center of prism ,originated from the center point of the instrument :  $(n,e,z)$

Coordinate of unknown point :  $(N_1, E_1, Z_1)$

$$N_1 = N_0 + n$$

$$E_1 = E_0 + e$$

$$Z_1 = Z_0 + \text{Inst.H} + z - \text{Prism.h}$$



Ensure the angle measurement mode .

Operating Procedures	Operation	Display
① Set coordinate values of occupied point and instrument / prism height ※1 ※2 ② Set the direction angle of known point A ※2 ③ Collimate target B	Set the direction angle  Collimate	
④ Press [F3] (NEZ) Key ※3	[F3]	
⑤ The result will be shown .		

※1) In case the coordinate of instrument point is not entered , (0, 0, 0) will be used as the instrument point. The instrument height and the prism height will be calculated as 0 when they have not been set .  
 ※2) Refer to Section 4.1.3 “Measuring from the Required Horizontal Angle” or Section 5.1 “Setting a Direction Angle for Backsight Orientation ”.  
 ※3) Pressing [F2] (MODE) key , the mode (SINGLE/N-TIME/REPEAT/TRACKING) changes .

●To return to the normal angle or distance measuring mode , press [F6] (P2↓) key to get the function as on page 1 , then press [F3] (angle) , [F4] ( SD) or [F5] (HD) key .

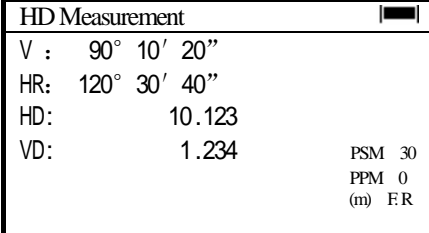
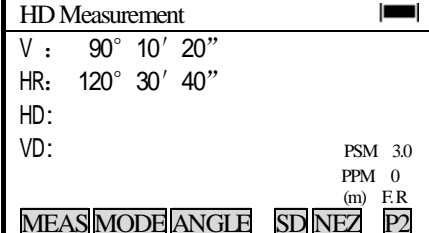
#### 4.4 DATA OUTPUT

The measured result can be transferred from the instrument to data collector.

**[ Example : Distance measurement mode ]**

Make sure the mode is in Distance measurement mode.

Operating Procedures	Display
① Operate the data collector to measure the distance, measurement will get started.	

<p>② The result will be shown and transferred to the data collector.</p>	
<p>③ The display will automatically return to the distance measurement mode.</p>	

The following data will automatically return to the distance measurement mode .

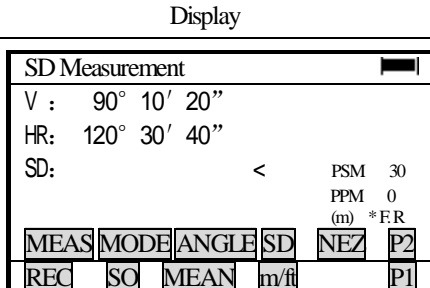
MODE	OUTPUT
Angle Measurement mode (V, HR or HL)	V, HR (or HL)
Horizontal Disrance Meausrement mode (V, HR, HD,VD)	V, HR, HD, VD
Slope Distance Measurement mode (V, HR, SD)	V, HR, SD, HD,
Cooedimates Meaurement mode	N, E, Z, HR

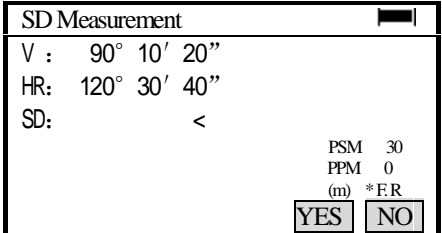
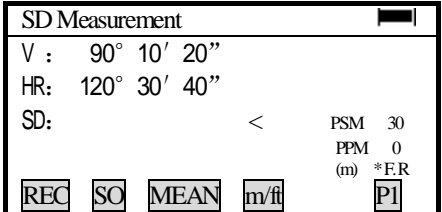
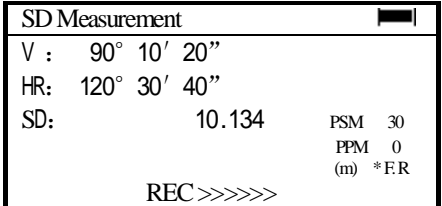
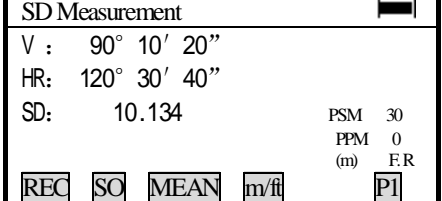
#### 4.5 DATA OUTPUT BY SOFT KEY (REC)

By pressing the soft key (REC), the measured result can be exported to an external device.

**[Example : Slope distance measurement mode ]**

Make sure it is in the Slope Distance measurement mode.

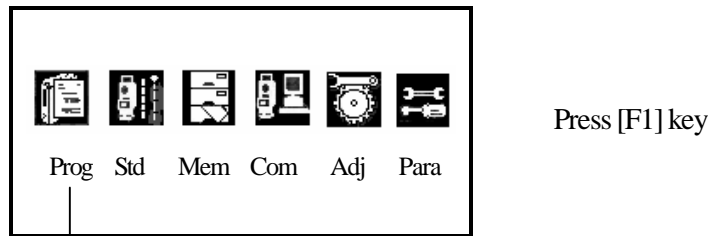
Operating Procedures	Operation	Display
<p>① Press [F6] (P1↓) key to get the function in page 2 .</p>	<p>[F6]</p>	

<p>② Press [F1] (REC) key . Measurement continues.</p>	<p>[F1]</p>	
<p>③ Press [F5] (YES) key The measurement will start</p>	<p>[F5]</p>	
<p>④ After the measurement, the result will be held then recorded .</p>		
<p>⑤ The screen will return to previous display.</p>		



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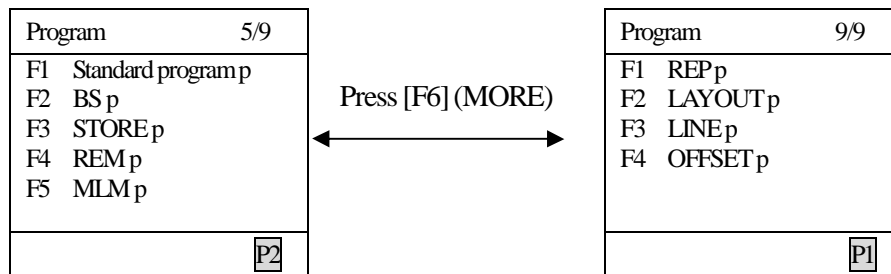
## 5 PROGRAM MODE



PROGRAMS (Application Surveying Programs)

- 1、 Setting a direction angle for backsight orientation (BS) .
- 2、 Lead measurement
- 3、 Remote Elevation Measurement (REM)
- 4、 Missing Line Measurement (MLM)
- 5、 Repetition Angle Measurement . (REP)
- 6、 Layout (LAYOUT)
- 7、 Line Measurement (LINE)
- 8、 Offset Measurement (OFFSET) .

- The loaded surveying programs are displayed on the menu.

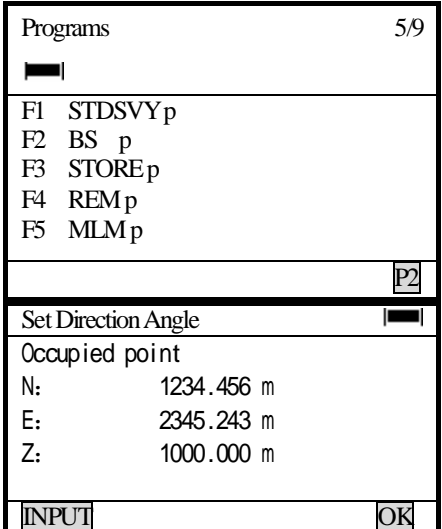
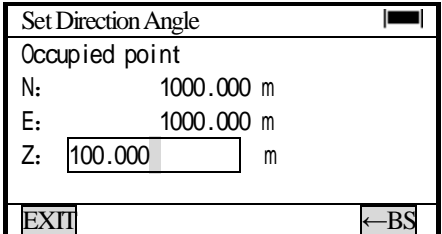
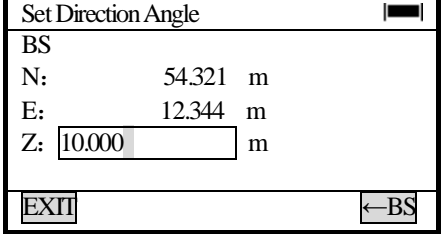
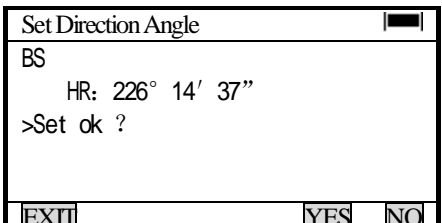
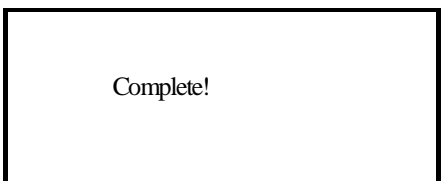


### 5.1 SETTING A DIRECTION ANGLE FOR BACKSIGHT ORIENTATION

(Entering the instrument and backsight coordinate value)

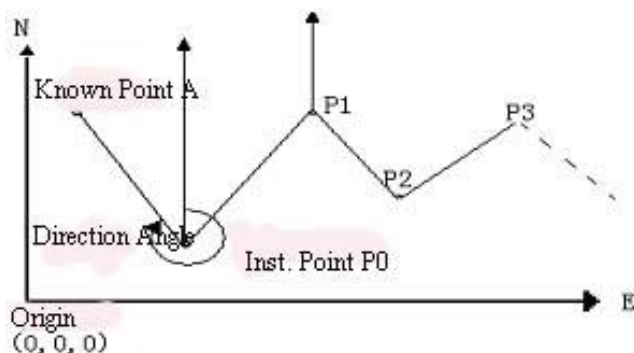
The occupied coordinate input and the backsight input can be displayed. After the coordinate values for both points are entered, the instrument computes the backsight direction angle. Only the occupied coordinate values are stored in memory if the option is selected to [ON] in the Parameters Modes option, refer to Chapter 8 “Parameters Setting Mode”.

**Example :**

Operating Procedures	Operation	Display
<p>① Press [F2] key, current data of occupied point will be shown.</p> <p>※ To input a new coordinate value, press [F1] (input) key</p>	<p>[F2]</p>	 <p>Programs 5/9</p> <p>█</p> <p>F1 STDSVY p F2 BS p F3 STORE p F4 REM p F5 MLM p</p> <p>[F2]</p> <p>Set Direction Angle █</p> <p>Occupied point</p> <p>N: 1234.456 m E: 2345.243 m Z: 1000.000 m</p> <p>[INPUT] [OK]</p>
<p>② Input a new coordinate value, press [ENT] key.</p>	<p>[ENT]</p>	 <p>Set Direction Angle █</p> <p>Occupied point</p> <p>N: 1000.000 m E: 1000.000 m Z: 100.000 m</p> <p>[EXIT] ←BS</p>
<p>③ Input N and E , Z coordinate of backsight point.</p> <p>Example : N : 54.432 m E : 12.234 m Z : 10.000 m</p>	<p>Ncoordinate [ENT] ECoordinate [ENT] ZCoordinate [ENT]</p>	 <p>Set Direction Angle █</p> <p>BS</p> <p>N: 54.321 m E: 12.344 m Z: 10.000 m</p> <p>[EXIT] ←BS</p>
<p>④ Sight backsight point.</p>	<p>Sight backsight point A</p>	 <p>Set Direction Angle █</p> <p>BS</p> <p>HR: 226° 14' 37"</p> <p>&gt;Set ok ?</p> <p>[EXIT] [YES] [NO]</p>
<p>⑤ Press [F5] (YES) key The display returns to main menu.</p>	<p>[F5]</p>	 <p>Complete!</p>

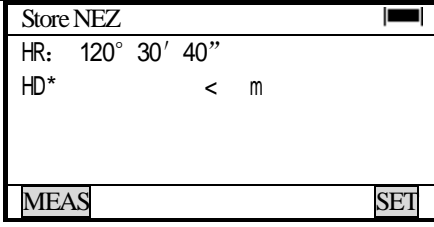
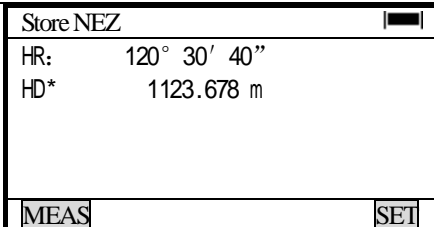
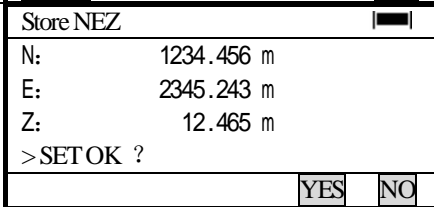

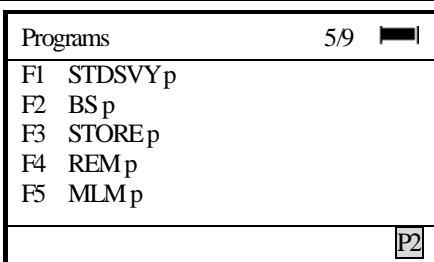
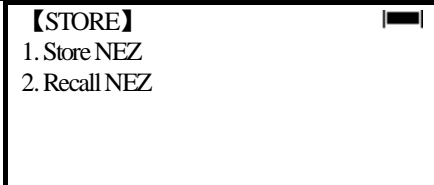
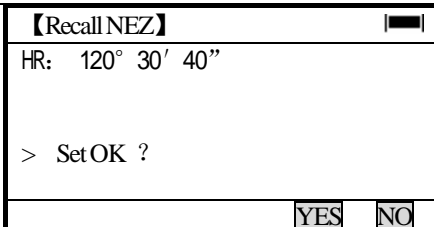
## 5.2 LEAD MEASUREMENT (STORE NEZ)

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.

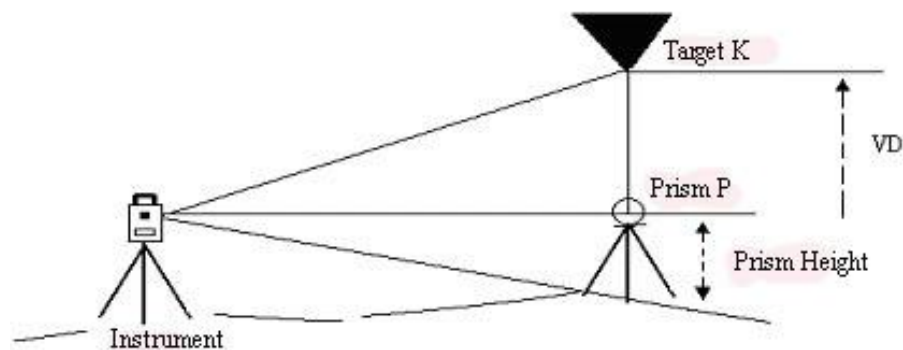
Operating Procedures	Operation	Display
① Press [F3] (STORE) key .	[F3]	<div style="border: 1px solid black; padding: 5px;"> <p>Programs 5/9 <span style="float: right;">█</span></p> <p>F1 STDSVYtp</p> <p>F2 BS p</p> <p>F3 STORE p</p> <p>F4 REM p</p> <p>F5 MLM p</p> <hr/> <p style="text-align: right;">P2</p> <hr/> <p>STORE <span style="float: right;">█</span></p> <p>1. Store NEZ</p> <p>2. Recall NEZ</p> </div>
② Press [F1] (Store NEZ) key ※To reset the height of instrument or prism, press [F5] (HT) key	[F1]	<div style="border: 1px solid black; padding: 5px;"> <p>Store NEZ <span style="float: right;">█</span></p> <p>HR: 120° 30' 40"</p> <p>HD: m</p> <hr/> <p>MEAS <span style="float: right;">HT</span></p> </div>

<p>③ Collimate target p1 prism which the instrument moves .</p> <p>④ Press [F1] (MEAS) key</p> <p>Measuring will start .</p>	<p>Collimate P1</p> <p>[F1]</p>	
<p>⑤ Horizontal distance and horizontal angle are shown</p>		
<p>⑥ Press [F6] (SET) key</p> <p>Coordinate of P1 will be shown</p>	<p>[F6]</p>	
<p>⑦ Press [F5] (YES) Key</p> <p>Coordinate of P1 will be decided.</p>	<p>[F5]</p>	
<p>⑧ The display returns to main menu.</p> <p>Power off and move instrument to P1 (Prism P1 move to P0)</p> <p>⑨ After the instrument is set up at P1, power on and start measurement.</p>	<p>Power off Move to P1</p> <p>Power on Select [program]</p>	
<p>⑩ Press [F3] (STORE) key</p>	<p>[F3]</p>	
<p>(11) Press [F2] (Recall NEZ) key</p>	<p>[F2]</p>	

<p>(12) Collimate the former instrument point P0, press [F5] (YES) key The coordinate at P1 and direction angle toward P0 is set. The display returns to main menu.</p>	<p>Colimate P0 [F5]</p>	<div style="border: 1px solid black; padding: 10px; text-align: center;">Complete!</div>
<p>(13) Repeat the procedure ①~(12) as required.</p>		<div style="border: 1px solid black; padding: 5px;"> <p>Programs <span style="float: right;">5/9 <span style="font-size: small;">█</span></span></p> <hr/> <p>F1 STDSVY p F2 BS p F3 STORE p F4 REM p F5 MLM p</p> <hr/> <p style="text-align: right;"><span style="border: 1px solid black; padding: 2px;">P2</span></p> </div>

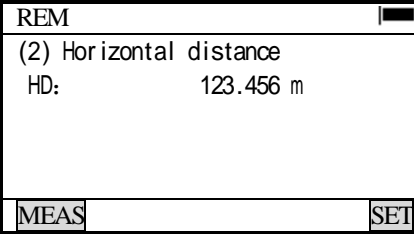
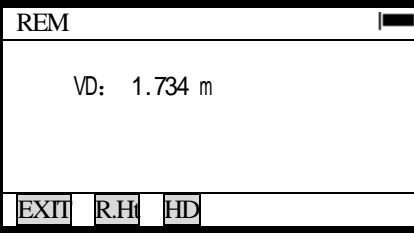
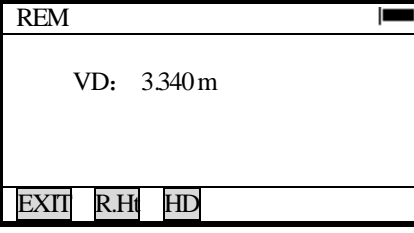
### 5.3 REMOTE ELEVATION MEASUREMENT (REM)

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.

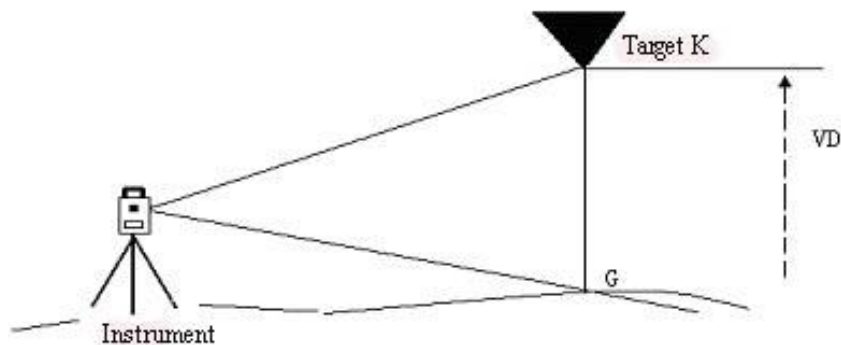


**1) With prism height input (h) (Example : h =1.5m)**

Operating Procedures	Operation	Display
① Press [F4] (REM) key	[F4]	<div style="border: 1px solid black; padding: 2px;">           Programs <span style="float: right;">5/9 <span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            F1 STDSVY p            F2 BS p            F3 STORE p            F4 REM p            F5 MLM p  <div style="text-align: right; border: 1px solid black; padding: 2px;">P2</div> </div> <div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            Prism Height            F1: YES            F2: NO         </div>
② Press [F1] (YES) key	[F1]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            (1) Prism height            R Ht : <input style="width: 50px;" type="text"/> m  <div style="text-align: right; border: 1px solid black; padding: 2px;">EXIT <span style="float: right;">←BS</span></div> </div>
③ Input prism height, press [ENT] key	Input prism height [ENT]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            (1) Prism height            P.H : <input style="width: 50px; border: 1px solid black;" type="text" value="1.500"/> m  <div style="text-align: right; border: 1px solid black; padding: 2px;">EXIT <span style="float: right;">←BS</span></div> </div> <div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            (2) Horizontal distance            HD: <input style="width: 50px;" type="text"/> m  <div style="text-align: right; border: 1px solid black; padding: 2px;">MEAS <span style="float: right;">SET</span></div> </div>
④ Collimate prism P ⑤ Press [F1] (MEAS) key . Measurement starts .	Collimate prism P [F1]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="border: 1px solid black; display: inline-block; width: 10px; height: 10px;"></span></span>            (2) Horizontal distance            HD* <input style="width: 50px;" type="text"/> m  <div style="text-align: right; border: 1px solid black; padding: 2px;">MEAS <span style="float: right;">SET</span></div> </div>

<p>⑥ Horizontal distance (HD) between the instrument and prism will be shown.</p>		
<p>⑦ Press [F6] (SET) key The prism position will be decided ※1)</p>	[F6]	
<p>⑧ Collimate target K. Vertical distance (VD) will be shown. ※2)</p>	Collimate K	
<p>※1) Press [F2] (PH) key to return to procedure ③</p> <p>※2) Press [F1] (EXIT) key to return to main menu .</p>		<p>Press [F3] (HD) key to return to procedure ④</p>

## 2) Without prism height input



Operating Procedures	Operation	Display
① Press [F4] (REM) key.	[F4]	<div style="border: 1px solid black; padding: 2px;">           Programs <span style="float: right;">5/9 <span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            F1 STDSVYp            F2 BS p            F3 STOREp            F4 REMp            F5 MLMp  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">P2</div>           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            Prism Height            1. YES            2. NO         </div>
② Press [F2] (NO) key.	[F2]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            (1) Horizontal distance            HD: <span style="margin-left: 100px;">m</span>  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">MEAS <span style="float: right;">SET</span></div> </div>
③ Collimate prism ④ Press [F1] (MEAS) key. Measurement starts.	Collimate prism [F1]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            (1) Horizontal distance            HD* <span style="margin-left: 100px;">&lt; m</span>  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">MEAS <span style="float: right;">SET</span></div> </div>
⑤ Horizontal distance (HD) between the instrument and prism will be shown.		<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            (1) Horizontal distance            HD: <span style="margin-left: 100px;">123.456 m</span>  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">MEAS <span style="float: right;">SET</span></div> </div>
⑥ Press [F6] (SET) key The prism position will be decided .	[F6]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            (2)Vertical angle            V: <span style="margin-left: 100px;">120° 30' 40"</span>  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">SET</div> </div>
⑦ Collimate ground point G ⑧ Press [F6] (SET) key, the position of point G will be decided ※1)	Collimate G [F6]	<div style="border: 1px solid black; padding: 2px;">           REM <span style="float: right;"><span style="display: inline-block; width: 10px; height: 10px; background-color: black;"></span></span>            (2)Vertical angle            V: <span style="margin-left: 100px;">95° 30' 40"</span>  <div style="text-align: right; border-top: 1px solid black; border-bottom: 1px solid black;">SET</div> </div>



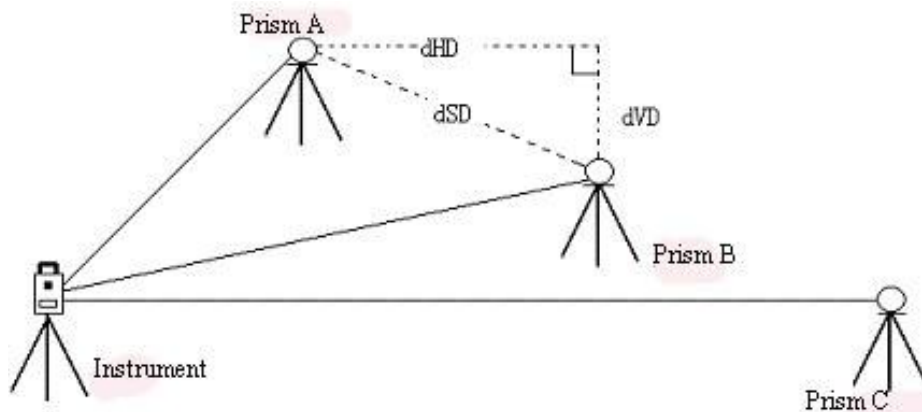
⑧ Collimate K. The vertical distance (VD) will be shown. ※2)	Collimate K	<div style="border: 1px solid black; padding: 5px;"> <div style="text-align: right; border-bottom: 1px solid black;">REM <span style="float: right;">▬</span></div> <div style="text-align: center; padding: 10px;">VD: 1.734m</div> <div style="border-top: 1px solid black; display: flex; justify-content: space-between; padding: 2px;"> <span>EXIT</span> <span>HD</span> <span>V</span> </div> </div>
※1) Press [F2] (HD) key to return to procedure ③ Press [F3] (V) key to return to procedure ⑦ ※2) Press [F1] (EXIT) to return to main menu .		

## 5.4 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]

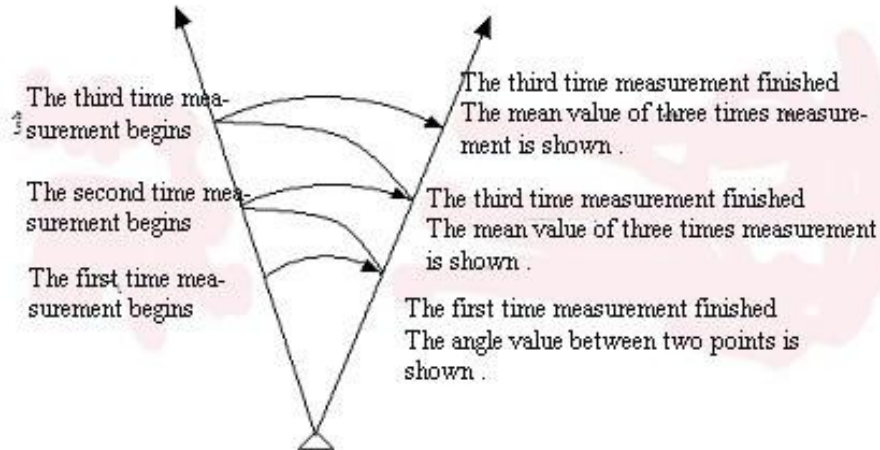
1. (A-B, A-C)
2. Procedure of 2 (A-B, B-C) is completely same as MLM-1 mode . (A-B , A-C)

Operating Procedures	Operation	Display
<p>Press [F6] (MORE) key in the programs menu, to get the function in page 2.</p> <p>① Press [F1] (MLM) key.</p>	[F1]	<div style="border: 1px solid black; padding: 2px;">           Programs <span style="float: right;">5/9 </span> <hr/>           F1 STDSVYp            F2 BS p            F3 STOREp            F4 REM p            F5 MLMp           <div style="text-align: right; border-top: 1px solid black; border-left: 1px solid black; border-right: 1px solid black; padding-top: 2px;">P2</div> </div> <div style="border: 1px solid black; padding: 2px; margin-top: 2px;">           Missing Line Measurement <span style="float: right;"></span> <hr/>           F1. MLM1 (A-B, A-C)            F2. MLM2 (A-B, B-C)         </div>
<p>② Press [F1] MLM1: (A-B,A-C) key</p>	[F1]	<div style="border: 1px solid black; padding: 2px;">           Missing Line Measurement <span style="float: right;"></span> <hr/>           MLM1 HD 1            HD:                    m           <div style="text-align: right; border-top: 1px solid black; border-left: 1px solid black; border-right: 1px solid black; padding-top: 2px;">MEAS                    SET</div> </div>
<p>③ Collimate prism A , then press [F1] (MEAS) key, horizontal distance (HD) between the instrument and prism A will be displayed.</p>	Collimate A [F1]	<div style="border: 1px solid black; padding: 2px;">           Missing Line Measurement <span style="float: right;"></span> <hr/>           MLM1 HD 1            HD:                    m           <div style="text-align: right; border-top: 1px solid black; border-left: 1px solid black; border-right: 1px solid black; padding-top: 2px;">MEAS                    SET</div> </div> <div style="border: 1px solid black; padding: 2px; margin-top: 2px;">           Missing Line Measurement <span style="float: right;"></span> <hr/>           MLM1 HD 1            HD*                    123.678 m           <div style="text-align: right; border-top: 1px solid black; border-left: 1px solid black; border-right: 1px solid black; padding-top: 2px;">MEAS                    SET</div> </div>
<p>④ Press [F6] (SET) key</p>	[F6]	<div style="border: 1px solid black; padding: 2px;">           Missing Line Measurement <span style="float: right;"></span> <hr/>           MLM1 HD 2            HD:                    m           <div style="text-align: right; border-top: 1px solid black; border-left: 1px solid black; border-right: 1px solid black; padding-top: 2px;">MEAS                    SET</div> </div>

<p>⑤ Collimate prism B, press [F1] (MEAS) key Horizontal distance (HD) between the instrument and prism B will be displayed.</p>	<p>Collimate B [F1]</p>	<div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1 HD 2  HD* &lt; m  <hr/> MEAS <span style="float: right;">SET</span> </div> <div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1 HD 2  HD* 223.678 m  <hr/> MEAS <span style="float: right;">SET</span> </div>
<p>⑥ Press [F6] (SET) key Horizontal distance (dHD), vertical difference (dVD) and slope distance (dSD) between A and B will be shown. ※1)</p>	<p>[F6]</p>	<div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1  12.658 m  dVD: 12.345 m  dSD: 12.478 m  <hr/> EXIT HD </div>
<p>⑦ To measure the distance between points A and C, press [F2] (HD) key.</p>	<p>[F2]</p>	<div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1 HD 2  HD: m  <hr/> MEAS <span style="float: right;">SET</span> </div>
<p>⑧ Collimate prism C, press [F1] (MEAS) key, horizontal distance (HD) between the instrument and prism C will be shown.</p>	<p>Collimate C [F1]</p>	<div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1 HD 2  HD* &lt; m  <hr/> MEAS <span style="float: right;">SET</span> </div> <div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1 HD 2  HD* 223.678 m  <hr/> MEAS <span style="float: right;">SET</span> </div>
<p>⑨ Press [F6] (SET) key. Horizontal distance (dHD), vertical difference (dVD) and slope distance (dSD) between A and C will be shown.</p>	<p>[F6]</p>	<div style="border: 1px solid black; padding: 2px;"> Missing Line Measurement <span style="float: right;"> ■■■ </span>  MLM1  dHD: 13.678 m  dVD: 10.045 m  dSD: 20.400 m  <hr/> EXIT HD </div>
<p>※1) Press [F1] (EXIT) key to return to main menu .</p>		

## 5.5 REPETITION ANGLE MEASUREMENT (REP)

Repetition Angle Measurement program accumulates horizontal angles and shows the total angle (Ht) and the mean (Hm) of all the angles measured.



Operating Procedures	Operation	Display
① Press [F6] (P1) key from programs menu to get to the next page of programs.	[F6]	<pre> Programs          5/9 F1 STDSVYp F2 BS p F3 STOREp F4 REMp F5 MLMp P2 Programs          9/9 F1 REPp F2 LAYOUTp F3 LINEp F4 OFFSETp P1 </pre>
② Press [F1] (REP) key.	[F2]	<pre> Repetition        CNT[0] Ht:  160° 30' 28" Hm: EXIT  OSET  REL  HOLD </pre>
③ Collimate the first target A.	Collimate A	<pre> Repetition        CNT[0] Ht:  189° 45' 28" Hm: EXIT  OSET  REL  HOLD </pre>

<p>④ Press [F2] (OSET) and [F5] (YES) key.</p>	<p>[F2]</p> <p>[F5]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Repetition <span style="float: right;">▶</span></p> <p>OSET ?</p> <p style="text-align: right;"><input type="button" value="YES"/> <input type="button" value="NO"/></p> <hr/> <p>Repetition <span style="float: right;">CNT[0] ▶</span></p> <p>Ht: 0° 00' 00"</p> <p>Hm:</p> <p style="text-align: right;"><input type="button" value="EXIT"/> <input type="button" value="OSET"/> <input type="button" value="REL"/> <input type="button" value="HOLD"/></p> </div>
<p>⑤ Collimate the second target B by using the horizontal motion clamp and the horizontal tangent screw.</p>	<p>Collimate B</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Repetition <span style="float: right;">CNT[1] ▶</span></p> <p>Ht: 120° 20' 00"</p> <p>Hm: 120° 20' 00"</p> <p style="text-align: right;"><input type="button" value="EXIT"/> <input type="button" value="OSET"/> <input type="button" value="REL"/> <input type="button" value="HOLD"/></p> </div>
<p>⑥ Press [F6] (HOLD) key.</p>	<p>[F6]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Repetition <span style="float: right;">CNT[1] ▶</span></p> <p>Ht: 120° 20' 00"</p> <p>Hm: 120° 20' 00"</p> <p style="text-align: right;"><input type="button" value="EXIT"/> <input type="button" value="OSET"/> <input type="button" value="REL"/> <input type="button" value="HOLD"/></p> </div>
<p>⑦ Recollimate the first target A by using the horizontal motion clamp and the horizontal tangent screw.</p> <p>⑧ Press [F5] (REL) key.</p>	<p>Recollimate A</p> <p>[F5]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Repetition <span style="float: right;">CNT[1] ▶</span></p> <p>Ht: 120° 20' 00"</p> <p>Hm: 120° 20' 00"</p> <p style="text-align: right;"><input type="button" value="EXIT"/> <input type="button" value="OSET"/> <input type="button" value="REL"/> <input type="button" value="HOLD"/></p> </div>
<p>⑨ Recollimate the second target B by using the horizontal motion clamp and the horizontal tangent screw.</p> <p>⑩ Press [F6] (HOLD) key.</p> <p>The total of angle (Ht) and the mean value of angle (Hm) are shown.</p>	<p>Recollimate B</p> <p>[F6]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Repetition <span style="float: right;">CNT[2] ▶</span></p> <p>Ht: 240° 40' 00"</p> <p>Hm: 120° 20' 00"</p> <p style="text-align: right;"><input type="button" value="EXIT"/> <input type="button" value="OSET"/> <input type="button" value="REL"/> <input type="button" value="HOLD"/></p> <p style="text-align: center;">Doubled angle</p> </div>

<p>(11) Repeat ⑦ ~ ⑩ to measure the desired number of repetition .</p>		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" style="text-align: left;">Repetition</td> <td style="text-align: right;">CNT[ 2 ]</td> <td style="text-align: right;"></td> </tr> <tr> <td style="width: 15%;">Ht:</td> <td colspan="3">481° 20' 00"</td> </tr> <tr> <td>Hm:</td> <td colspan="3">120° 20' 00"</td> </tr> <tr> <td style="text-align: center;">EXIT</td> <td style="text-align: center;">OSET</td> <td style="text-align: center;">REL</td> <td style="text-align: center;">HOLD</td> </tr> </table> <p style="text-align: center;">Quadrupled angle</p>	Repetition		CNT[ 2 ]		Ht:	481° 20' 00"			Hm:	120° 20' 00"			EXIT	OSET	REL	HOLD
Repetition		CNT[ 2 ]																
Ht:	481° 20' 00"																	
Hm:	120° 20' 00"																	
EXIT	OSET	REL	HOLD															
<p>● To stop the repetition angle measurement mode, press [F1] (EXIT) key.</p>																		

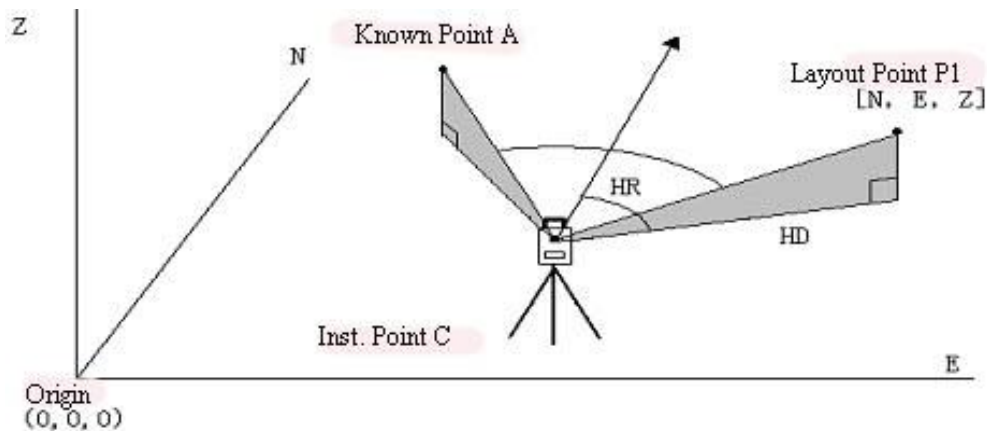
## 5.6 LAYOUT

The layout program will assist the user to stake out point numbers with coordinate values (NEZ) on the work site. The coordinate points can be transferred to and from the internal memory of instrument by using PC. The communication parameters are selectable on the NTS-660 series for baud rate, parity, stop bit and protocol.

Coordinate data consists of a point number with north, east and elevation coordinate. The coordinate data is stored in job names. A job name can be up to 8 characters. A maximum of 10 job names can be stored in memory. Job names can be alphabets and numerals, and job can be renamed within the job manager option. If point numbers are not found in a job during the layout setup procedures, the software will prompt the user for the coordinate values. When using duplicate point numbers in a job, the last duplicate point stored in memory will be used. All other points having the same number will be ignored .

A job name must be created or selected to store coordinate values for the side shot or resection routine. The instrument will automatically create a default job ID as (LAY001). The default job consists of three question marks followed by a numeric value starting with (LAY001) for the first default job. When there are multiple jobs in the internal memory, the current job or the last job selected is where the coordinate are stored. 2 programs, side shot and resection, are available under the new point option that will calculate coordinate and store them in the current job. The side shot program calculates the coordinate (NEZ) from the angle and distance measured. Instrument height and prism height are used to calculate the (Z) coordinate.

In the resection program the angle and distance measured from the occupied point to two known points, stored in the job, are used to measure and calculate the coordinate values for the new occupied point value.



### 5.6.1 OPTIONS

The option routines provide features for selecting jobs, job maintenance and transferring jobs to and from the instrument. In the routine “Create or Select a job”, the user can scroll through memory to select a job by pressing the soft key assigned to the job .

In the job manager option, the user can View jobs in memory, Erase Points in a job, Create jobs , Transfer jobs, Delete and Rename jobs.

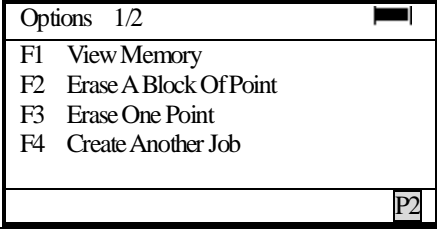
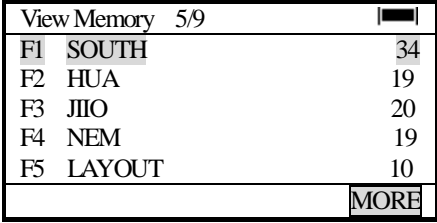
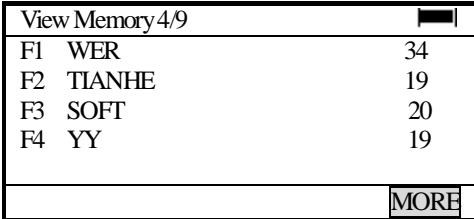
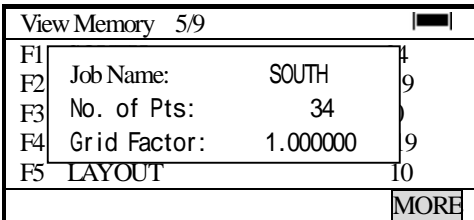
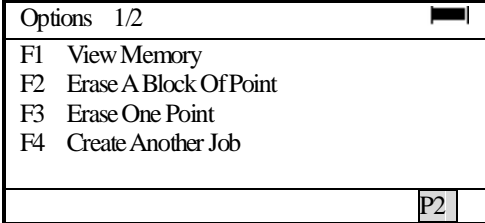
Examples are provided below for all the routines for the Options.

#### OPTIONS ( Page 1)

##### View Memory

The routine “View Memory” shows all the jobs stored in memory. There can be multiple pages of jobs. Press [F6] key, each pages will be shown .

Operating Procedures	Operation	Display
From the programs menu, press [F6] key, to get to page 2, then press [F2] key to enter LAYOUT menu.	[F6]  [F3]	<div style="border: 1px solid black; padding: 5px;"> <p>LAYOUT <span style="float: right;">▬</span></p> <p>F1 Setting Direction Angle</p> <p>F2 Setting Layout Point</p> <p>F3 Coordinate Data</p> <p>F4 Options</p> </div>

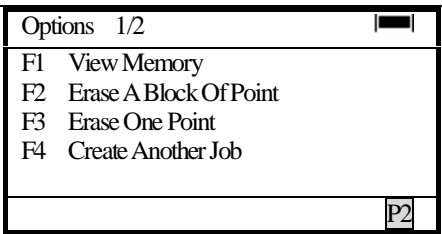
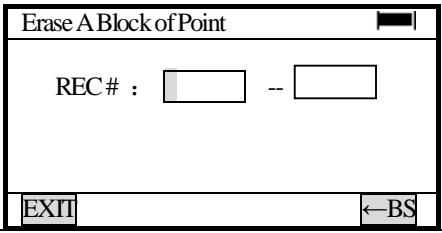
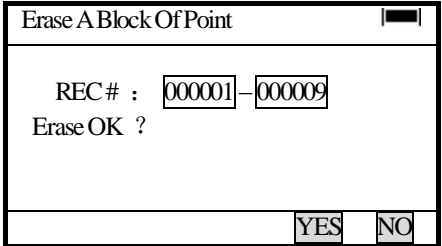
<p>① In the layout display, press [F4] (Options).</p>	<p>[F4]</p>	
<p>② In the [Options] menu, press [F1] (View Memory) key, the display shows all the jobs in memory on the first page. The job situated in [F1] will be highlighted, to be shown as current job, press [F2] to [F5] key to select the required job; Press [F6] key, other jobs in memory will be shown . The record amounts of jobs are display behind job names. 5/9 means the menu has two pages, current page is page 1.</p>	<p>[F1]</p>	
<p>③ The jobs that are in memory will show on the screen, if there are more than 5 jobs, press [F6] (MORE) will get to other pages.</p>	<p>[F6]</p>	
<p>④ To select a job, press the soft key that represents. Example : to select the job, SOUTH , press [F1] key.</p>	<p>[F1]</p>	
<p>⑤ The current job information appears in front of the LAYOUT screen . Once the job information disappears from the display , the layout menu appears on the display and that job becomes the current job.</p>		



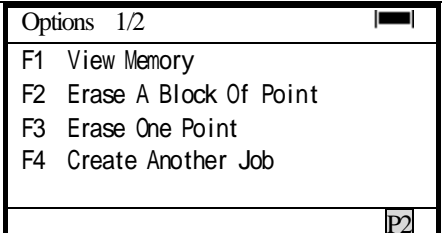
## ERASE A BLOCK OF POINT OR ERASE ONE POINT

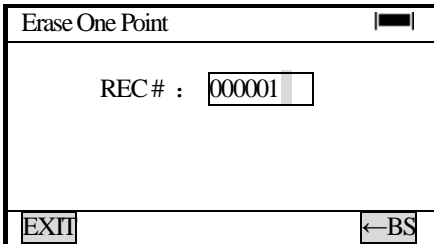
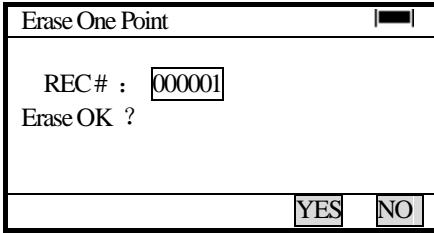
A block of point numbers can be erased within a job. To erase a block of points , the record numbers of the points are entered .After inputting a block of record numbers , press [ENT] key , the software will prompt the user to answer the question (YES) or (NO) . If (YES) is selected , the block of record numbers will be erased . If (NO) is selected , the display will returns to **【Options】** Menu . Another option in **【Option】** menu is **【to erase one point】**, the routine works the same as erasing a block of points , but only one record is erased at a time .

### ERASE A BLOCK OF POINT

Operating Procedures	Operation	Display
① In the [Options] menu, press [F2] key, Erase A Block Of Point	[F2]	
② The next screen allows the user to input the record number. Press [ENT] key after inputting the record number. If a wrong number is input, press [F6] backspace key. To exit, press [F1] key.	[ENT] [F6] or [F1]	
③ The next screen allows the user to continue erasing the record or cancel the routine without erasing the record. Press [F5] to erase the record or press [F6] key not to erase the record. Press [F6] key will cancel the routine and return back to the [Options] menu.	[F5] or [F6]	

### ERASE ONE POINT

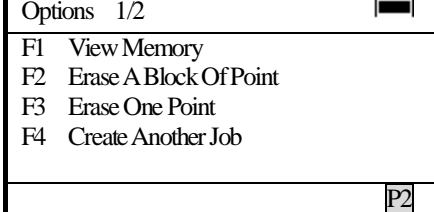
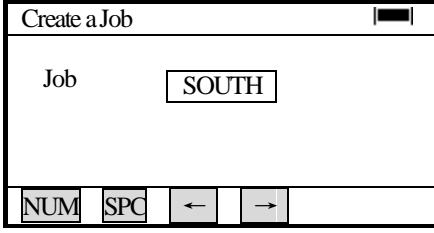
Operating Procedures	Operation	Display
① In the [Options] menu press [F3] key, Erase One Point.	[F3]	

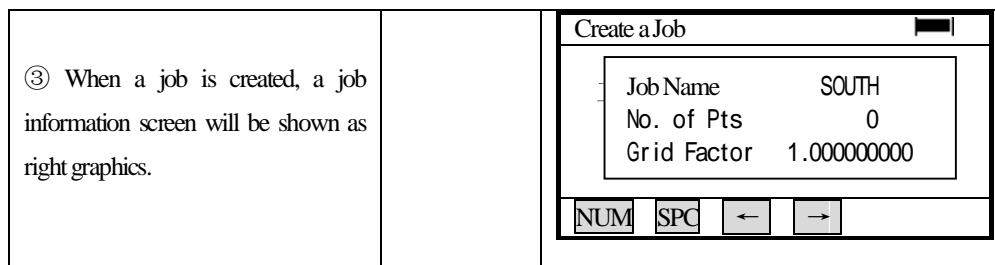
<p>② The next screen allows the user input the record numbers to erase. Press [ENT] key after inputting each record number. If a wrong number is typed in, press [F6] backspace key to correct it. To exit, press [F1].</p>	<p>[ENT] [F6] or [F1]</p>	
<p>③ The next screen allows the user to continue erasing the record or cancel the routine without erasing the record. Press [F5] to erase the record or press [F6] key not to erase the record. Press [F6] key will cancel the routine and return to the [Options] menu .</p>	<p>[F5] or [F6]</p>	

### CREATE ANOTHER JOB

This option enables the user to create a new job and store the job in memory. The job name can be alphabets or numerals. If a job name is not typed in, a default job name will be consisted of three alphabets and three numbers. After entering the job name, press [ENT] key, the job name will be stored in memory.

### HOW TO CREATE A JOB NAME

Operating Procedures	Operation	Display
<p>① In the [Options] menu, press [F4] key, Create Another Job.</p>	<p>[F4]</p>	
<p>② The current screen appears to type in a job name, input a job name and press [ENT] key to accept the name (Refer to section 3.12 Alpha and Numeric input)</p>	<p>Enter a job name + [ENT]</p>	



●To input coordinate in the job, refer to “LAYOUT → Coordinate Data → Input Coordinate Value”.

### OPTIONS (Page 2)

Page two of the **【Options】** menu provides the following options: Transfer Jobs, Rename Jobs, Delete a Job or Delete All Job.

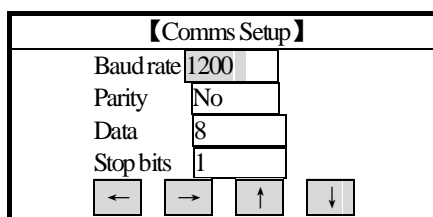
The option “Transfer Job” sends and receives coordinate to and from computer. The communication parameters are set by user for: Baud rate, Protocol, Parity and Stop bits. SOUTH’s cable CE-203 from the NTS-660 to Computer is used for data transfer.

Job names can be renamed by using the option “Rename Jobs”. When the rename option is selected, the current job will be renamed unless you select a different job when applying option “View Memory”.

There are two options to delete jobs in memory, delete a job or delete all jobs . The option “Delete a Job” will delete one job from memory. The current job is erased unless another job is not selected. The option “Delete All Job” will erase all the jobs in memory .

### TRANFER JOBS

The protocol default parameters are highlighted on the NTS-660 series .



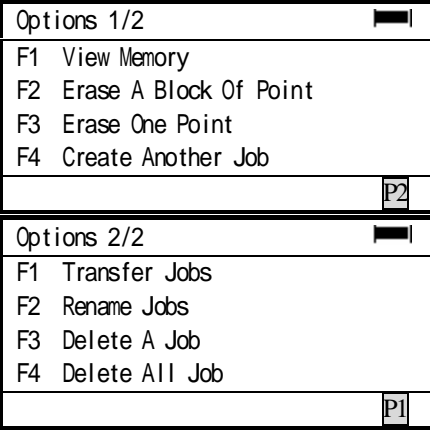
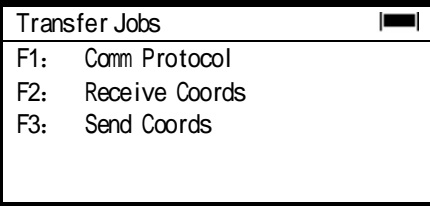
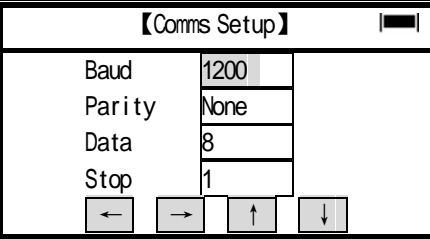
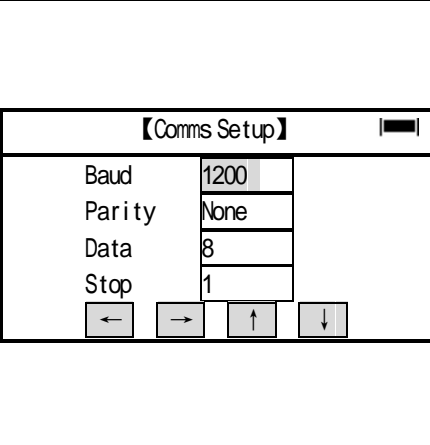
The option “Transfer Jobs” will send and receive jobs to and from the PC. The received data will be stored in current job.

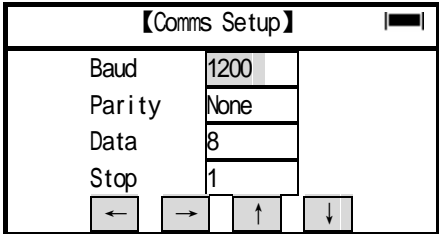
The “Send Coords” option will transfer jobs from the instrument to PC. The current job will be sent to PC unless you select another job.

### COMMUNICATION PROTOCOL

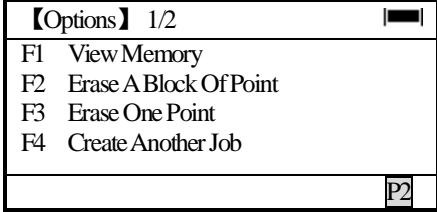
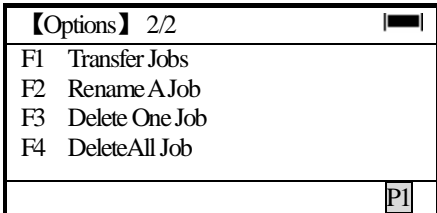
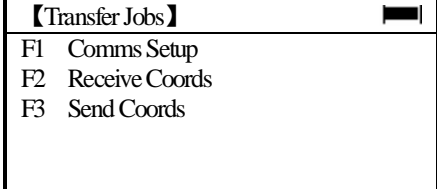
Before sending and receiving jobs to the instrument, the protocol parameters on the instrument should be well checked. Make sure the protocol parameters suit the PC software.

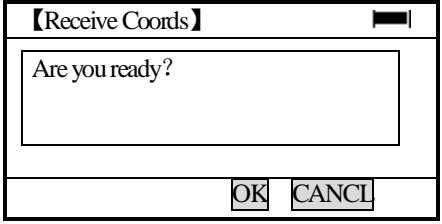
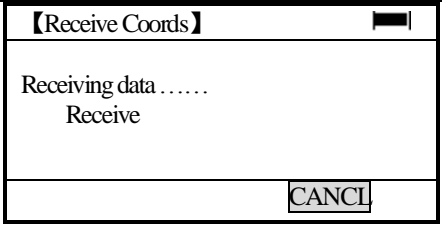
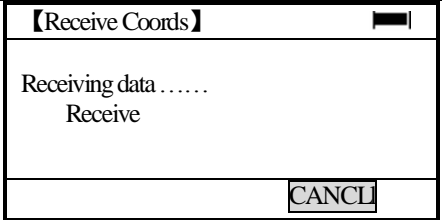
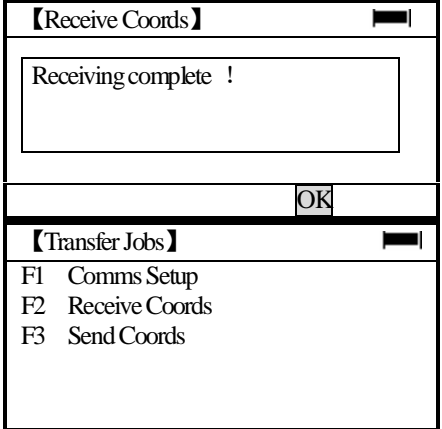
### Select the Protocol Parameters

Operating Procedures	Operation	Display
<p>① From the [Options] menu, page 1, press [F6] key, select page 2.</p>	<p>[F6]</p>	
<p>② Press [F1] (Transfer Jobs) key</p>	<p>[F1]</p>	
<p>③ To select the protocol parameters, press [F1] (Comms Setup) key</p>	<p>[F1]</p>	
<p>④ To change a parameter, the cursor must be blinking on the parameter, to move the cursor to each parameter, press [F4] (↓) or [F5] (↑) key to change communication parameters, press [F2] (←) or [F3] (→) key. The default parameter will be highlighted. Press [ESC] key to exit to the Transfer Coordinate data menu.</p>		

<p>⑤ Example : To select a new Baud rate, press [F3] (→) key, then press [ENT] key to store new Baud rate. Move cursor to the next parameter (not to change parameter, press [ENT] key. Press [F2] (←) or [F3] (→) key to change all the parameters, then press [ENT]). When the cursor is over the baseline of screen, press [ENT] to store and exit. To quit without saving, press [ESC]. The previous setting will remain as default.</p>		
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**RECEIVE COORDINATE** The option “Receive Coords” receives jobs from PC to the instrument. Before receiving any jobs, make sure that the communication parameters in the instrument match the software parameters on the PC.

Operating Procedures	Operation	Display
<p>① From the [Options] menu, press [F6] key to go to page 2.</p> <p>② Press [F1] (Transfer Jobs) key</p>	<p>[F6]</p> <p>[F1]</p>	 
<p>③ To receive a job press [F2] key</p>	<p>[F2]</p>	

<p>④ Start the program on computer. When computer is ready, press [F4] (YES) key to start transfer. Press [F5] (NO) key, the screen will return to the previous menu.</p>	<p>[F4]</p>	
<p>⑤ Waiting for PC to transfer data, press [F5] (Cancel) key to cancel previous operation.</p>	<p>[F5]</p>	
		
<p>⑥ Once transfer is finished, it will shows "Sending complete!" Press [F5] (YES) to return to Transfer Jobs menu.</p>	<p>[F5]</p>	

※ The data received from computer will be stored into current job file, the user can also create a new file to store this data.

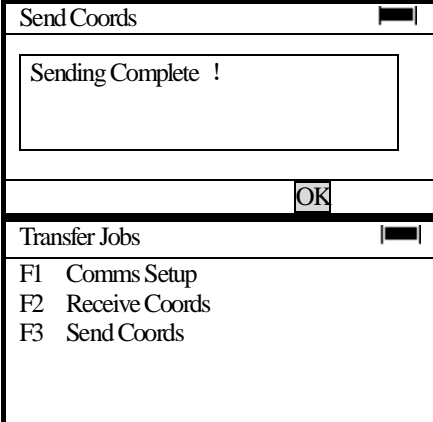
### SEND COORDINATE

The option "Send Coords" will transfer a job from the instrument to PC. If the current job is not the one you want to send, change the current job by turning to the "View Memory" option of the "Options" menu. Refer to the "View Memory" option for instructions of selecting a job.

After confirming the job you want to send, check the communication parameters on the instrument and the PC software to ensure they match. Setup your PC to receive a job, when it is ready, choose the "Send Coords" option on the "Transfer Job" menu.

## SEND A JOB TO PC

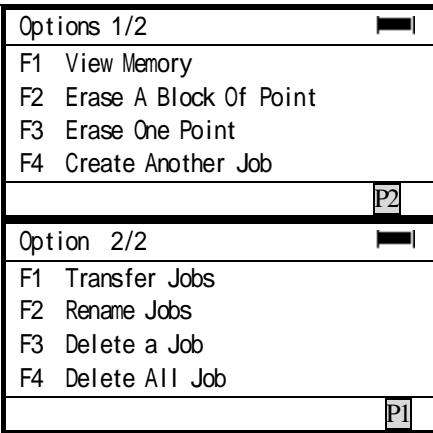
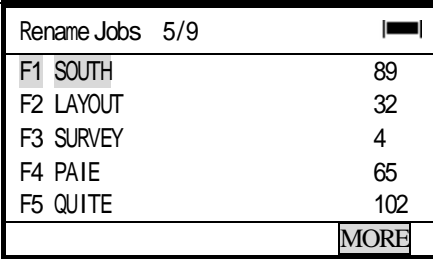
Operating Procedures	Operation	Display
① From the [Options] menu, press [F6] key to go to page 2.	[F6]	<p>Option 1/2</p> <p>F1 View Memory F2 Erase A Block Of Point F3 Erase One Point F4 Create Another Job</p> <p>P2</p> <p>Option 2/2</p> <p>F1 Transfer Jobs F2 Rename A Job F3 Delete One Job F4 Delete All Job</p> <p>P1</p>
② Press [F1] ( Transfer Jobs ) key.	[F1]	<p>Transfer Jobs</p> <p>F1 Comms Setup F2 Receive Coords F3 Send Coords</p>
③ Press [F3] ( Send Coords ) key, the screen shows as right graphic.	[F3]	<p>Send Coords</p> <p>Are you ready ?</p> <p>OK CANCL</p>
④ Start the program in PC. When PC is ready, press [F4] (YES) key to start transfer. To return to Transfer Jobs menu, press [F5] (CANCEL) key.	[F5]	<p>Send Coords</p> <p>Sending data ..... Send</p> <p>CANCL</p>
⑤ The next screen waits for PC to start sending the job. To abort the Send Jobs option, press [5] key .		<p>Send Coords</p> <p>Sending data ..... Send</p> <p>CANCL</p>

<p>⑥ Once the job is sent the screen shows “Complete ! ” , press [F5] (OK) return to Transfer Jobs menu.</p>	<p>[F5]</p>	
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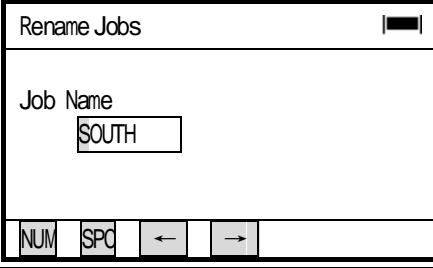
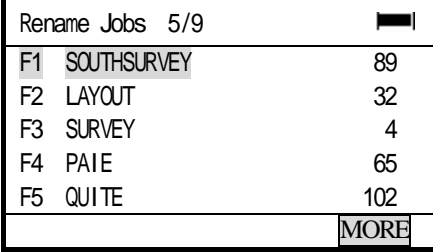
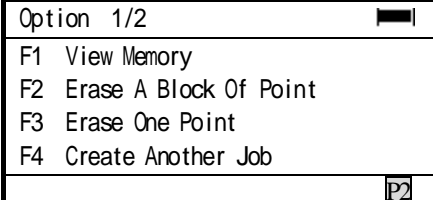
### RENAME A JOB

This option enables the user to rename a current job. If the current job is not the one you want to rename, refer to the option “View Memory” to select another job.

#### Example:

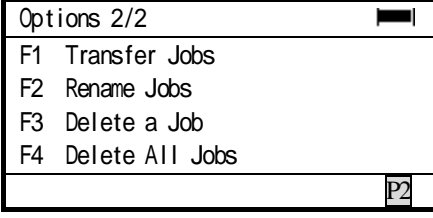
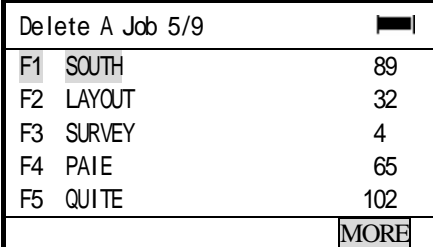
Operating Procedures	Operation	Display
<p>① From the [Options] menu, press [F6] key to go to page 2.</p>	<p>[F6]</p>	
<p>② Press [F2] key to rename a job. Press the corresponding soft keys to make sure the highlighted job is the one to be renamed ( Example: rename SOUTH 's Job name, press[F1] ).</p>	<p>[F2]  [F1]</p>	

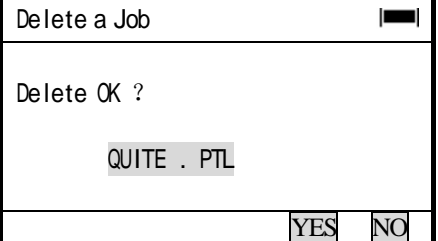
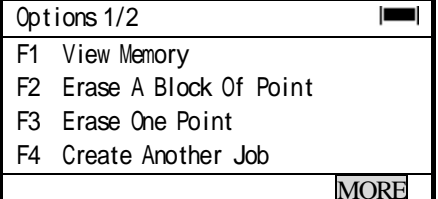


<p>③ The current job is shown with the cursor blinking on the first character. Input the new job name and press [ENT] key (Refer to Section 3.12 “Alpha/numeric entry”)</p>	<p>Input Job name [ENT]</p>	
<p>④ Press [ENT] key, correct job menu appears. The user can see the new job name here.</p>	<p>[ENT]</p>	
<p>⑤ Press [ESC] to return to [Options] menu.</p>	<p>[ESC]</p>	

## DELETE A JOB

The option “Delete A Job” deletes the current job or the job selected from memory. Make sure that the selected job is the one you want to delete .

Operating Procedures	Operation	Display
<p>① From the [Options] menu, page 2 , press [F3] (Delete A Job), make sure that you want to delete the current job.</p>	<p>[F3]</p>	
<p>② The next screen shows all jobs .Press the corresponding soft key, if not to delete, press [ESC] key to exit.</p>	<p>[F5]</p>	

<p>③ The next screen shows Delete a Job menu, press [F5] (YES) key to delete that job. If not to delete it, press [F6] (NO) key.</p>	<p>[F5] or [F6]</p>	
<p>④ The job is deleted, the screen returns to [Options] menu, page 1.</p>		

- **【Delete All Job】** option deletes all the jobs in memory.

### 5.6.2 COORDINATE DATA

There are 4 options in the Coordinate data option: Input Coordinate data, Search Data, New Point, Grid Factor.

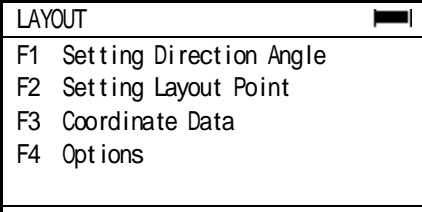
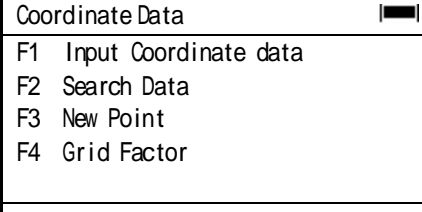
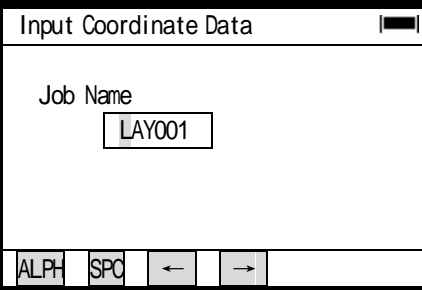
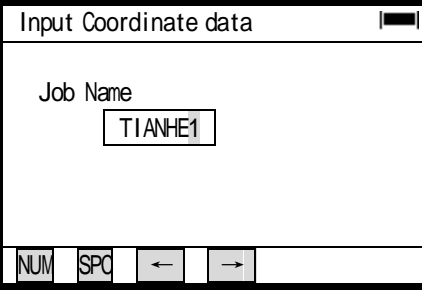
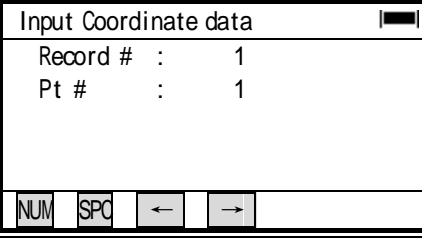
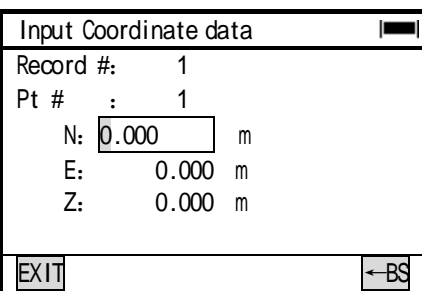
#### INPUT COORDINATE DATA

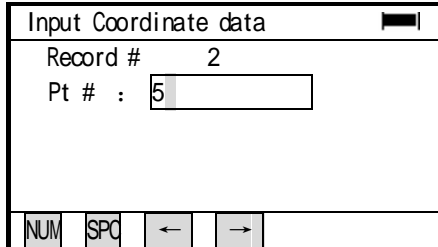
The Input Coordinate data routine is used to manually type in point numbers and coordinate values. If there are no job names found in memory, the software will ask to create one. If there is a job in memory, the coordinate will be stored in the current job or another selected job. Select a job name before choosing the Input Coordinate option. A job name can be a total of 8 characters, alpha and numeric.

The first prompt screen is to input the point number. The (REC#) in the upper left corner of the display, represents the record number for the point number and its coordinate. Once the point number entered, the next prompt screen allows the user to input the north, east and elevation. The [F6] is backspace (BS) key to move the cursor from left to right to revise data, press [F1] key to return to the Coordinate data main menu. Press [ENT] key to store each field of data. After entering the elevation data, the point number prompt display appears and increased the last point number (+1). Press [ESC] key to cancel the coordinate data input option.

The instruction below show how to create a job name from the Coordinate data input option and manually type in a point number with coordinate values. (Assume that there are no job names memory for this example)

Operating Procedures	Operation	Display
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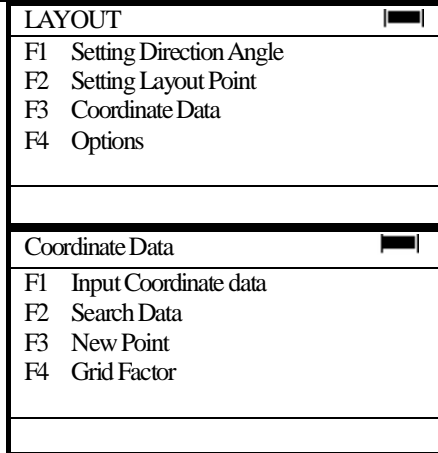
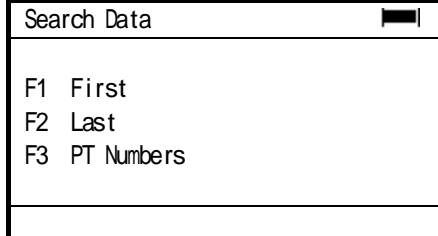
<p>① From the LAYOUT menu , press [F3] for the Coordinate data option .</p>	<p>[F3]</p>	 
<p>② Press [F1] key to input coordinate value . ③ The default job name is LAY001 . Input a job name. The name can be alpha or numeric; To type in a numeric, press [F1] key and the NUM appears .</p>	<p>[F1] Enter Job name</p>	
<p>④ After typing in the job name , press [ENT] key .</p>	<p>[ENT]</p>	
<p>⑤ When a job is created , you should type in point number , the cursor will blink in the rectangle box , after typing the point number press [ENT]key .</p>	<p>[ENT]</p>	
<p>⑥ The next screen is to type in the Coordinate and press [ENT] key after each entry. After typing in the elevation (Z) press [ENT] key, the job name , point number and coordinate are stored in memory</p>	<p>[ENT]</p>	

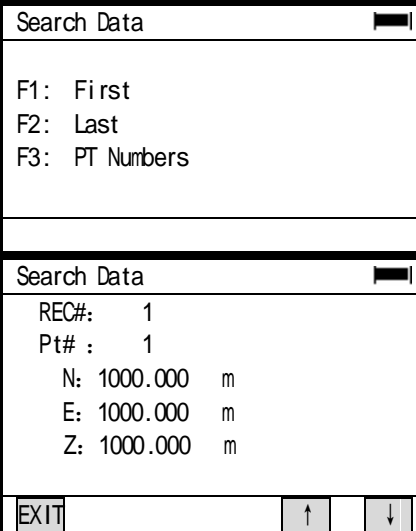
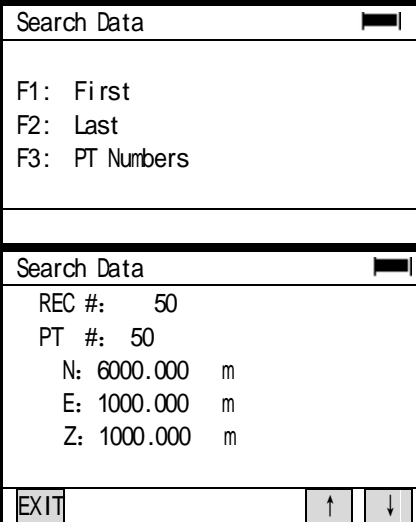
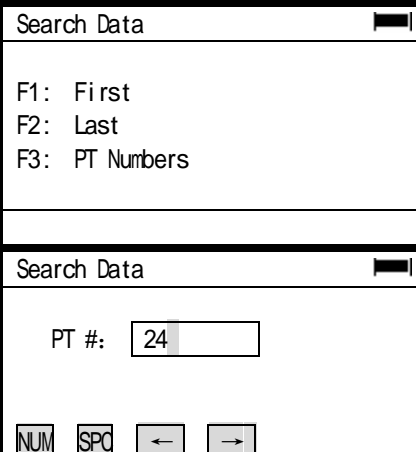
<p>⑦The point number and Coordinate will be shown on the display . Now it allows to type in point numbers again .</p>		
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### 5.6.3 SEARCH DATA

The Search Data option can find point numbers with coordinate values. The options for the search feature are [F1] search first point number , [F2] search last point number , [F3] to view any point number. Point numbers and coordinate values can be edited in any view .

#### Follow the instructions below for the Search Data option

Operating Procedures	Operation	Display
<p>①From the LAYOUT menu , press [F3] key for the Coordinate data option .</p>	<p>[F3]</p>	
<p>②Press [F2] for the Search Data option .</p>	<p>[F2]</p>	

<p><b>First:</b></p> <p>③ Press [F1] (First) key to view the data of the first point</p> <p>④ The first point number with Coordinate appear on the display , press [F6] (↓) key to view more point numbers on the display , press [F1] to exit</p>	<p>[F1]</p>	
<p><b>Last:</b></p> <p>③ Press [F2] (Last) key to view another point .</p> <p>④ The last point number with coordinate value will be shown , press [F5] (↑) key to view another point data . Press [F1] to exit .</p>	<p>[F2]</p>	
<p><b>PT#:</b></p> <p>③ To search by the point number , press [F3] key .</p> <p>④ Type in a point numbers, press [ENT] key , press [F1] key to exit .</p>	<p>[F3]</p> <p>Type point number in [ENT]</p>	

<p>⑤The point number and Coordinate are shown on the display . Press [F1] key to return to the Search Data menu .</p>		<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right; margin: 0;">Search Data <span style="float: right;">▢</span></p> <hr/> <p>REC #: 24</p> <p>PT # : 24</p> <p>N: 1020.000 m</p> <p>E: 1200.000 m</p> <p>Z: 1080.000 m</p> <hr/> <p>EXIT <span style="float: right;">↑</span> <span style="float: right;">↓</span></p> </div>
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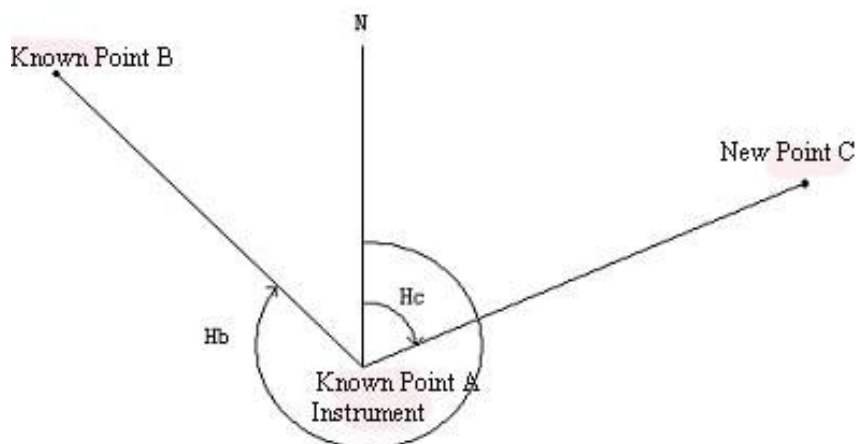
#### 5.6.4 NEW POINT

In the New Point option there are two features available to collect coordinate. Side Shot and Resection. When collecting a Side Shot point , Side Shot and Resection . When collecting a Side Shot point, The point number and the coordinate are stored in a job . When collecting a resection point , the software provides the user with the option to set the direction angle or to skip this option .

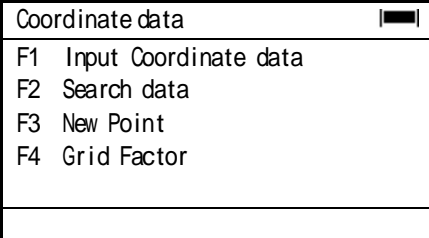
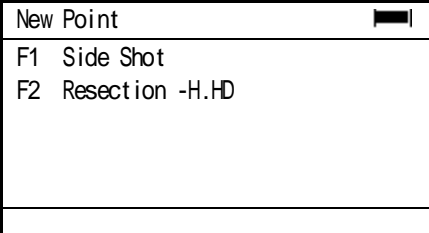
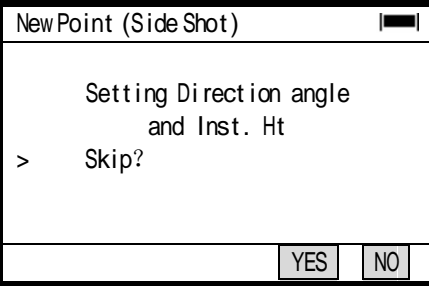
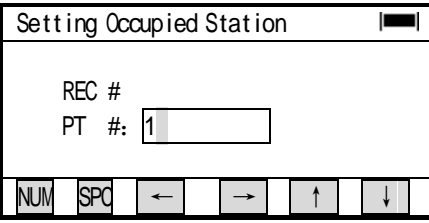
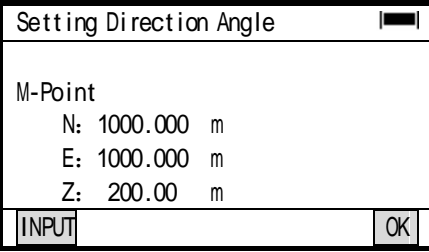
NOTE: If the back sight direction angle was established during the LAYOUT feature, and you haven't turned off the instrument, you can skip the Setting a Direction Angle feature in side shot collection. But, you are suggested to check the direction angle to back sight before collecting side shot points .

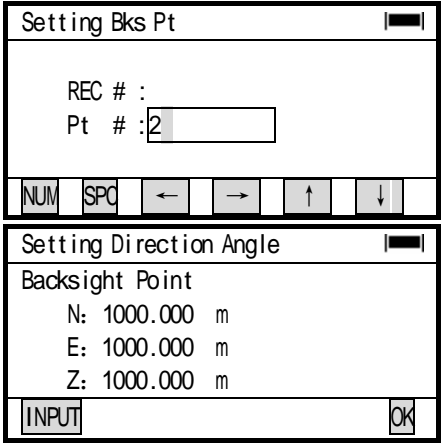
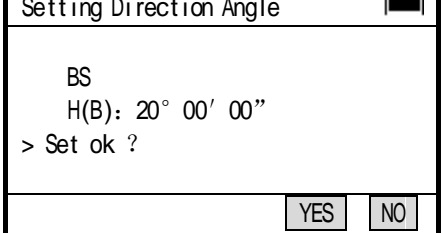
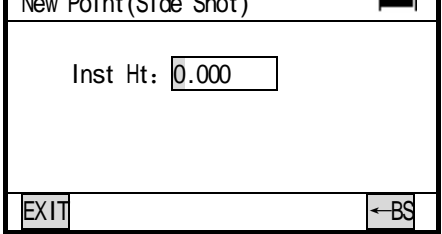
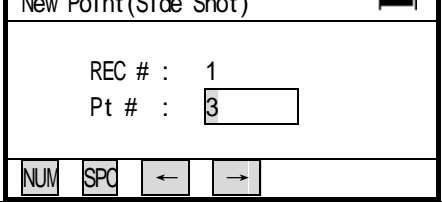
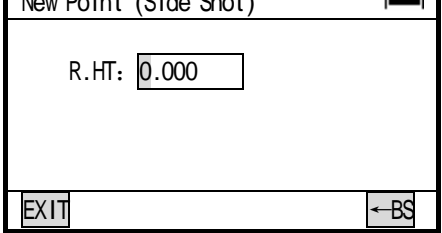
Once the direction to the back sight is completed, after typing the side shot point number and prism height, collimate the prism now, collection can be started .

**Follow the instruction below to collect a side shot point .**

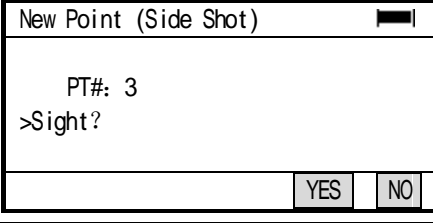
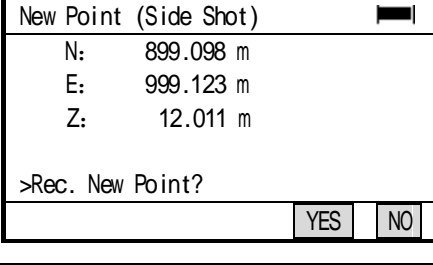
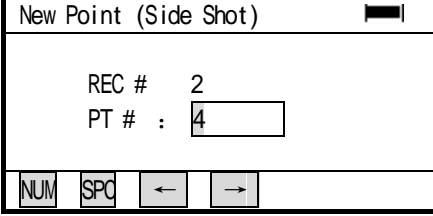


Operating Procedures	Operation	Display
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<p>①From the Coordinate data option , press [F3] key for New Point option .</p>	<p>[F3]</p>	 <p>Coordinate data</p> <p>F1 Input Coordinate data F2 Search data F3 New Point F4 Grid Factor</p> <hr/>  <p>New Point</p> <p>F1 Side Shot F2 Resection -H.HD</p>
<p>②Press [F1] (Side Shot) key wo collect side shot .</p>	<p>[F1]</p>	 <p>New Point (Side Shot)</p> <p>Setting Direction angle and Inst. Ht &gt; Skip?</p> <p>YES NO</p>
<p>③This screen allows you to set a direction or you can skip the Setting a Direction Angle feature in side shot collection . But , we suggest you to check the direction angle to back sight before collecting side shot points .Press [F6] key to set the direction .</p>	<p>[F6]</p>	 <p>Setting Occupied Station</p> <p>REC # PT #: 1</p> <p>NUM SPC ← → ↑ ↓</p>
<p>④To continue setting the direction angle , input the occupied point number . if the coordinate is not stored in the job , the soft ware will remind you to input the coordinate. The Coordinate can be changed by typing in the new values . If the point number with Coordinate are stored in the job , the software will continue to the backsight point number input screen , step 5 .</p>	<p>Input Point Number</p>	 <p>Setting Direction Angle</p> <p>M-Point N: 1000.000 m E: 1000.000 m Z: 200.00 m</p> <p>INPUT OK</p> <p>If the point number is not stored in the job, this screen appears. Press [F6] key to accept coordinate value. Press [F1] to input new Coordinate</p>

<p>⑤The next screen appears to type in the backsight point number , if the point number is not stored in the job , an input screen appears to type in the Coordinate . If the point number with Coordinate are stored in the job , the next screen will appears with the backsight direction .step 6 .</p>	<p>Input backsight Point number</p>	 <p>If the point number is not stored in the job, this screen appears. Type in the coordinate values.</p>
<p>⑥If the backsight direction is correct , sight the instrument on the backsight point and press [F5] (YES) key to set the direction . Press [F6] (NO) key to back to step 5 “Setting Backsight Point” .</p>	<p>[F5]</p>	
<p>⑦The next screen is to input the instrument height, input then press [ENT] key .</p>	<p>Input Inst. Height [ENT]</p>	
<p>⑧This screen is to input the occupied point number , type in the number and press [ENT] key</p>	<p>[ENT]</p>	
<p>⑨Type in the prism height and press [ENT] key .</p>	<p>Input the prism height [ENT]</p>	



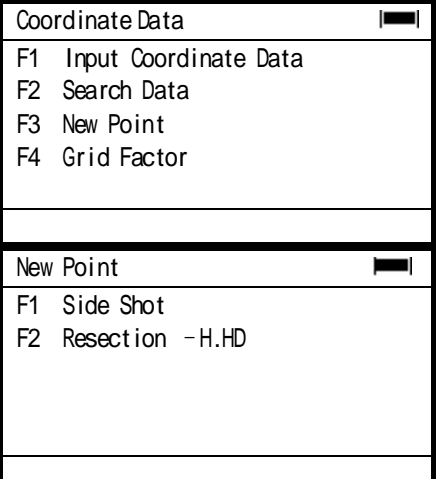
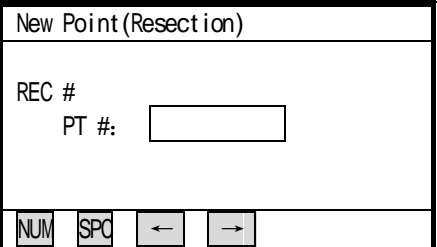
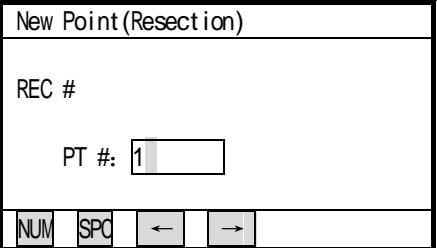
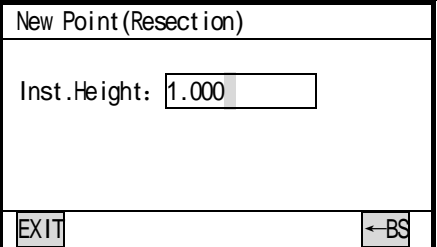
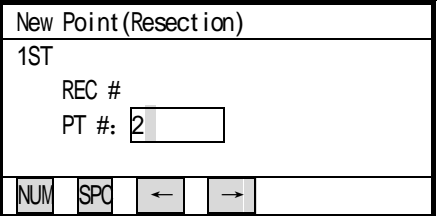
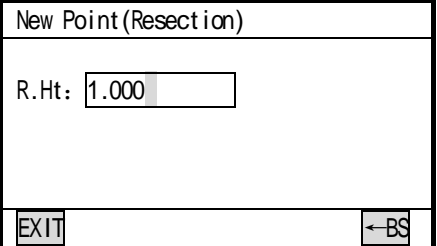
<p>⑩Sight the instrument on the side shot point, press [F5] (YES) key to measure and collect the data. Press [F6] (NO) key to return to the screen to input the side shot point number .</p>	<p>Type Shot Point Number</p>	
<p>(11)After pressing [F5] key , theinstrument will measure the side shot point. When the measurement complete, the screen shows the Coordinate and allows the user to store or not to store the data.</p>	<p>[F5]</p>	
<p>(12)Press [F5] (YES) key to save Coordinate. After the data is stored, the screen to input another side shot point number appears, (step ⑧) , point number increments (+1)</p>	<p>Input Shot Point Number</p>	

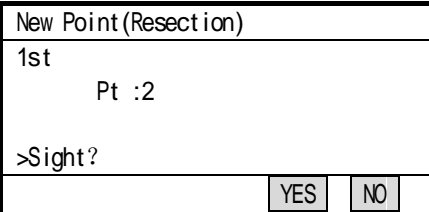
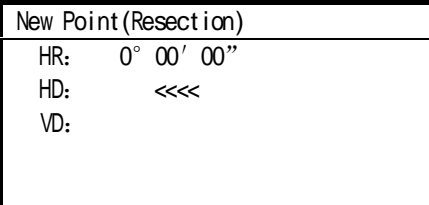
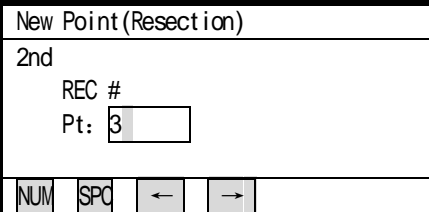
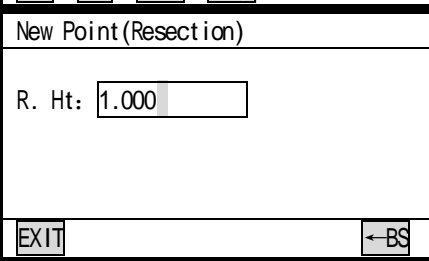
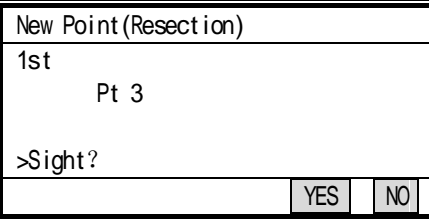
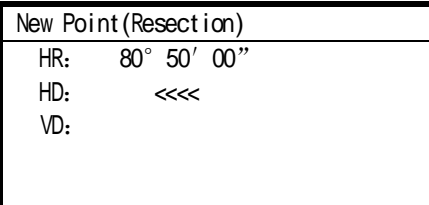
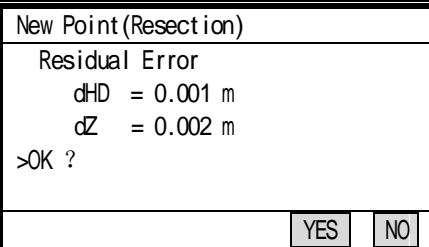
## RESECTION

The resection program calculates the new point (occupied point ) Coordinate from two known point numbers that stored in a job. The angle and distance is measured to each known point and the residual error for the horizontal distance and vertical distance are shown on the display. If the coordinate for the new point can not be calculated by software, the “ERROR!” message will be shown. Once the residual error is accepted , the next display shows the coordinate for the new point .

**The instructions below shows how to calculate the resection point .**

Operating Procedures	Operation	Display
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<p>①From the Coordinate Data menu , press [F3] key for the New Point option .</p>	<p>[F3]</p>	
<p>②Press [F2] key to compute a resection point .</p>	<p>[F2]</p>	
<p>③This screen allows the usertotype in a point number for the new resection point . After typing it , press [ENT] key</p>	<p>Type point number [ENT]</p>	
<p>④Input the instrument height , press [ENT] key .</p>	<p>Input the instrument height [ENT]</p>	
<p>⑤Input the first point number to measure that will be used to calculate the resection point .</p>	<p>Type First point number</p>	
<p>⑥Enter the prism height and press [ENT] key</p>	<p>Type Prism height [ENT]</p>	

<p>⑦Sight the instrument on to the first point , once the instrument is locked on the point , press [F5] key to measure the angle and the distance . Press [F6] key to back to the step ⑤</p>	<p>[F5]</p>	
<p>⑧measurement starts , the horizontal angle , horizontal distance and elevation will be shown .</p>		
<p>⑨Input the Second point number and press [ENT] key .</p>	<p>Type Second Point Number</p>	
<p>⑩Input the prism height of the second point, and press [ENT] key .</p>	<p>Type Prism height [ENT]</p>	
<p>(11) Sight the instrument on the second point , once the instrument is locked , press [F5] yes) to measure the angle and the distance, press [F6] key back to the previous step .</p>	<p>Sight Second Point</p>	
<p>(12)Measurement starts , the horizontal angle, horizontal distance and elevation will be shown .</p>		
<p>(13)When the measurement complete , the residual error will be shown. Press [F5] key to continue with the resection , or press [F6] key to restart the resection , step ③ .</p>		

<p>(14)After press [F5] (YES) key , the new coordinate will be shown . Press [F5] key to store the coordinate in the job , press [F6] key to back to the step ③ .</p>	<p>[F5]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>New Point (Resection)</p> <p>N: 456.285 m</p> <p>E: 123.894 m</p> <p>Z: 52.123 m</p> <p>&gt;REC . New Point ?</p> <p style="text-align: right;"> <input type="button" value="YES"/> <input type="button" value="NO"/> </p> </div>
<p>(15)The Coordinate are stored and the screen returns back to the Coordinate Data menu .</p>		<div style="border: 1px solid black; padding: 5px;"> <p>Coordinate Data</p> <p>F1 Input Coordinate Data</p> <p>F2 Search Data</p> <p>F3 New Point</p> <p>F4 Grid Factor</p> </div>

### 5.6.5 GRID FACTOR

A grid factor can be set when doing Layout , Resection or Side Shot. The formula below shows how the grid factor is calculated for the distance .

#### Calculation Formula

$$1. \text{ Elevation Formula} = \frac{R}{R + ELEV}$$

R : The average radius of the earth

ELEV: The elevation above mean sea level

#### 2. Scale Factor

Scale Factor : Scale factor at the surveying station

#### 3. Grid Factor

Grid Factor = Elevation Factor × Scale Factor

#### Distance Calculation

##### 1. Grid Distance

$$HDg = HD \times \text{Grid Factor}$$

HDg: Grid Distance

HD : Ground Distance

##### 2. Ground Distance

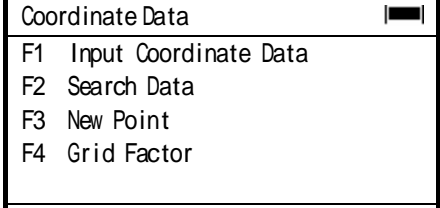
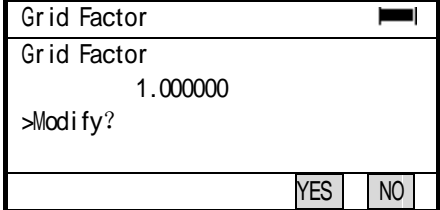
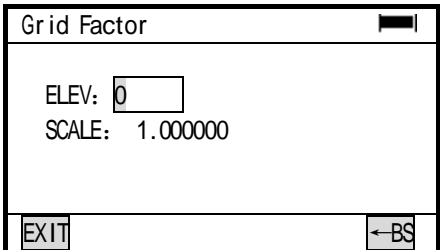
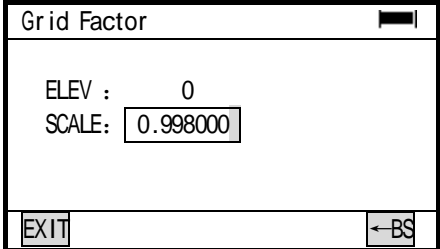
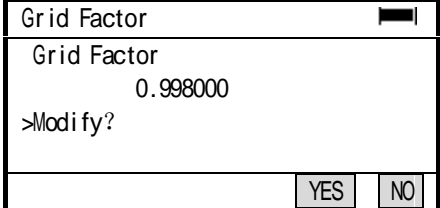
$$HD = \frac{HDg}{\text{Grid Factor}}$$

**NOTE** : 1. Input Range (Scale Factor) : 0.900000 ~ 1.100000 .

default value : 1.00000

2.Input Range (Elevation) : -1000.000 ~ 10000.000 .

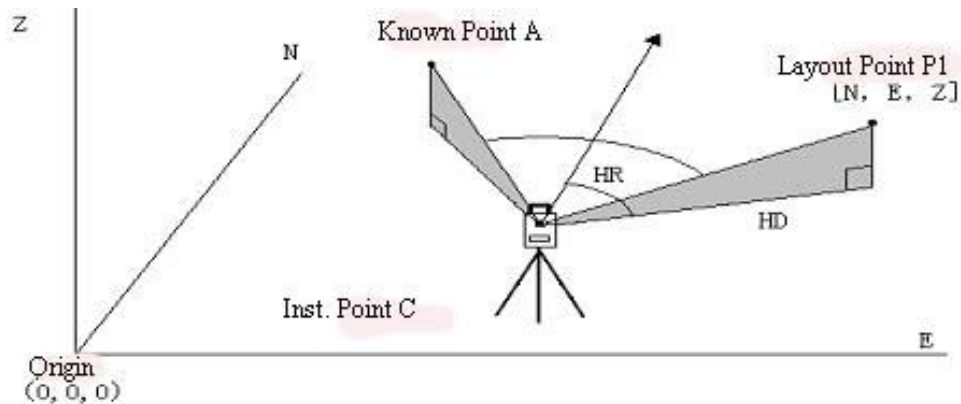
default value : 0

Operating Procedures	Operation	Display
①From the Coordinate Data menu , press [F4] key for Grid Factor option .	[F4]	
② Press [F5] key to modify the Grid Factor, if you press [F6] key , the screen will returns back to the Coordinate Data menu .	[F5]	
③Type in the elevation and press [ENT] key .	Type Elevation [ENT]	
④Next type in the grid factor and press [ENT] key .	Type grid factor [ENT]	
⑤Press [ESC] or [F6] (NO) key to accept the grid factor	[ESC] or [ENT]	

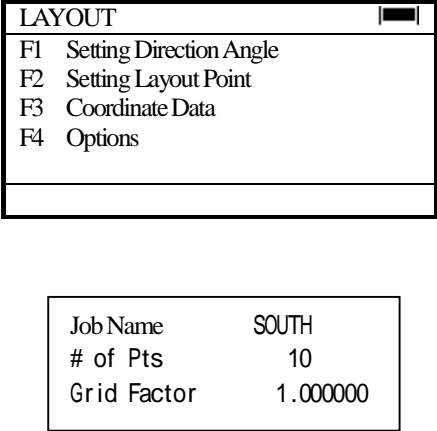
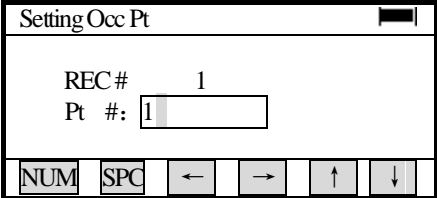
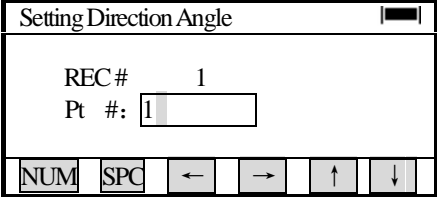
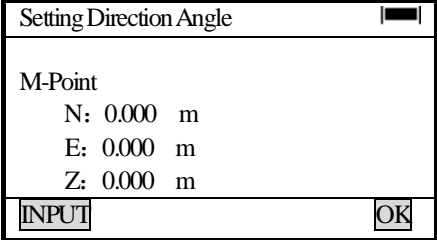
⑥ Press [ESC] key, the coordinate data menu will be shown .	[ESC]	<div style="border: 1px solid black; padding: 5px;">           Coordinate Data <span style="float: right;">▬</span>            F1 Input Coordinate Data            F2 Search Data            F3 New Point            F4 Grid Factor         </div>
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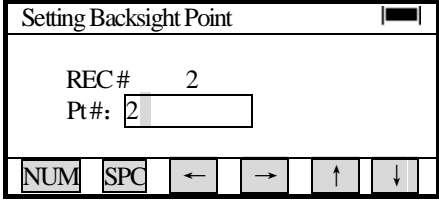
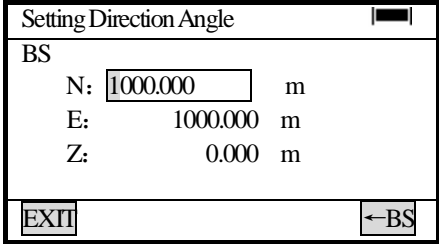
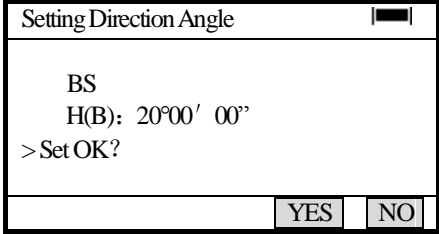
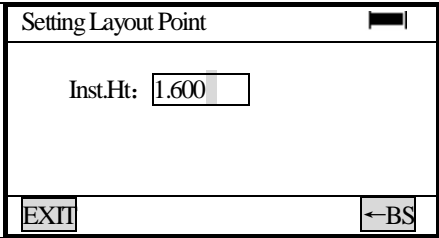
### 5.6.6 SETTING A DIRECTION ANGLE AND A LAYOUT POINT

The direction angle option compute the backsight angle by using the occupied and backsight point coordinate. Once the backsight angle is set, you can safely layout points.

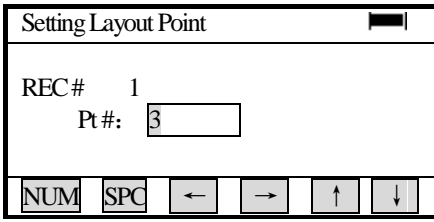
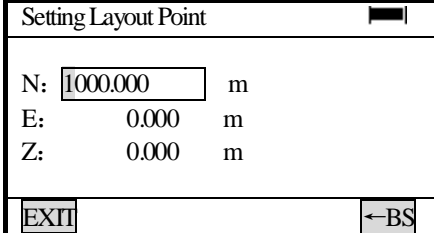
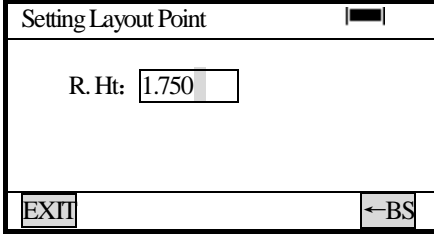
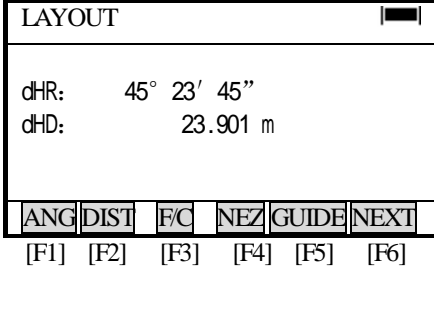


Operating Procedures	Operation	Display
① From the main menu, press [F1] (Prog) key	[F1]	<div style="border: 1px solid black; padding: 5px;">           Programs <span style="float: right;">5/9 ▬</span>            F1 STDSVYp            F2 BS p            F3 STORE p            F4 REM p            F5 MLM p  <div style="text-align: right; border: 1px solid black; padding: 2px;">P2</div> </div>
② Press [F6] key to get to page 2 .	[F6]	<div style="border: 1px solid black; padding: 5px;">           Programs <span style="float: right;">9/9 ▬</span>            F1 REpp            F2 LAYOUTp            F3 LINEp            F4 OFFSETp  <div style="text-align: right; border: 1px solid black; padding: 2px;">P1</div> </div>

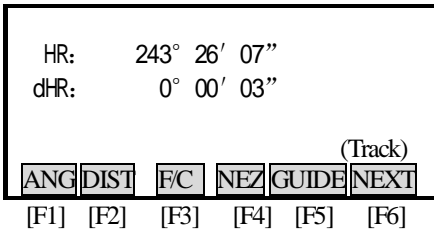
<p>③ Press [F3] (LAYOUT) key The LAYOUT menu screen will be shown.</p> <p>If a job was created, the information screen about the job will appear.</p>	<p>[F3]</p>	
<p>④ Press [F1] key for the Setting Direction Angle option.</p>	<p>[F1]</p>	
<p>⑤A Type in the occupied point number. The number can be alpha or numeric character. If the point number begins with an alpha character. Press [F1] (Alpha) key to enter numeric, Refer to Section 3.12 "How To Enter Alpha and Numeric".</p> <p>⑤B If the occupied number is not stored in memory, the display prompts for the coordinate values. Press [F1] (INP) key to input the occupied Coordinate. If zero is the desired value, press [F6] (OK) key. If the desired coordinate is other value than zero, type the coordinate and press [ENT] key to accept it.</p> <p>● NOTE: The point number and coordinate are not stored in memory after input.</p>	<p>[F1] Type point number</p> <p>[F1] Input Coordinate value</p> <p>[F6]</p>	<p>A</p>  <p>B</p> 

<p>⑥A The next screen will prompt for the backsight point number . The point number can be alpha or numeric . If the point number and Coordinate are stored in memory , the display will advance to step ⑦ , if they are not in memory , follow step ⑥ .</p> <p>⑥B If the point number and its Coordinate are not stored in memory , , the display will prompt for the coordinate value. Type the Coordinate and press [ENT] key to accept each value .</p> <p>●NOTE: Press [F1] (EXIT) toback to step ④ .</p> <p>Press [F6] key to move the cursor to left to edit the previous character .</p>		<p>A</p>  <p>B</p> 
<p>⑦ The next display shows the backsight angle . If the angle correct , sight and lock the instrument on the backsight point. Press [F5] (YES) key to accept the angle .</p> <p>If you are not satisfied with the backsight angle , press [F6] (NO) key to return to step ⑥ A</p> <p>●NOTE : Be sure you are sighted on the correct backsight point and answer (yes) , the layout points will be incorrectly set .</p>		
<p>⑧ Typing the instrument height and press [ENT] .</p>	<p>Type Inst. Height [ENT]</p>	



<p>⑨A Type in the point number to layout . If the point number and its coordinate is stored in memory , the display will advance to step ⑩ . If the point number is not stored in memory , follow step ⑨ B .</p> <p>⑨B Type in the Coordinate for the layout point . Press [ENT] key after inputting each values . The program will continue to step ⑩ .</p>	<p>Type in Point Number</p> <p>Type in Coordinate [ENT]</p>	<p>A</p>  <p>B</p> 
<p>⑩Type in the prism height for the layout point .</p>	<p>Type in Prism Height</p>	
<p>(1)The angle and distance to the layout point is shown on the display . From the backsight point , the instrument must be turned 45° 23' 45" to be online with the layout point , the horizontal distance of 23.901 m is the distance from instrument to layout point .</p>		

### Explanation of Options [F1] to [F6]

<p>[F1] (ANG) — This option will display the actual horizontal angle (HR) and the layout horizontal angle (dHR) . When tuning the instrument towards the layout point , the (HR) will count up to the layout angle and the (dHR) will count down to (0° 00' 00" ) .</p>	
<p>The angle option can be selected from any option [F2]~[F5] .</p>	

<p>[F2] (DIST) — Once the rod person is online with the instrument , the distance to set the layout point can be accomplished , The (HD) is the actual measured distance . The (dHD) is the amount of distance the rod person must move top be on the point . The default distance measurement is the fine repeat mode .</p>	<p>(Tracking Screen)</p> <div style="border: 1px solid black; padding: 5px;"> <p>HD:            25.364 m dHD:           2.045 m</p> <p style="text-align: right;">(Track)</p> <p>ANG DIST F/C NEZ GUIDE NEXT</p> <p>[F1] [F2] [F3] [F4] [F5] [F6]</p> </div>
<p>[F3] (F/C) — The [F3] key allows the instrument person to change the distance measurement mode from the Tracking mode to Fine mode . Pressing the key once will change the mode . The vertical distance is only shown on the display in the Fine mode . Pressing [F3]key 2 timeswill change the current measurement mode to the previous mode .</p>	<p>(Fine Repeat Screen)</p> <div style="border: 1px solid black; padding: 5px;"> <p>HD:            25.364 m dHD:           2.045 m dZ:            -0.800 m</p> <p style="text-align: right;">(Fine)</p> <p>ANG DIST F/C NEZ GUIDE NEXT</p> <p>[F1] [F2] [F3] [F4] [F5] [F6]</p> </div>
<p>[F4] (NEZ) — This option allows the instrument person to measure the Coordinate after laying out the point .</p>	<p>N:            0.002 m E:            -0.001 m Z:            0.001 m</p> <p style="text-align: right;">(Track)</p> <div style="border: 1px solid black; padding: 5px;"> <p>ANG DIST F/C NEZ GUIDE NEXT</p> <p>[F1] [F2] [F3] [F4] [F5] [F6]</p> </div>
<p>[F5] (GUIDE) — This option has distance features for the instrument person , to pass along instructions to the rod person , to layout the point . One option shows the distance to either move (BACK) towards the instrument or (GO) away from the instrument and (RIGHT) or (LEFT) distance to move onto the layout point in case the rod person might have strayed offline .</p> <p>The cut or fill information is also shown on the display . This allows the instrument person to see the amount of dirt to cut or fill using the previous rod height . Refer to the Guide Option of this chapter for detailed instructions .</p>	<div style="border: 1px solid black; padding: 5px;"> <p>→ RIGHT    1.562 m ↑ GO        0.895 m ↑ UP        1.009 m</p> <p style="text-align: right;">(Track)</p> <div style="border: 1px solid black; padding: 2px;"> <p>ANG DIST F/C NEZ GUIDE NEXT</p> <p>[F1] [F2] [F3] [F4] [F5] [F6]</p> </div> </div>
<p>[F6] (NEXT) — This option allows the instrument person to layout another point .</p>	<p>Setting Layout Point</p> <div style="border: 1px solid black; padding: 5px;"> <p>REC#    2 Pt#: <input style="width: 50px;" type="text" value="5"/></p> <p>NUM   SPC   ←   →   ↑   ↓</p> </div>

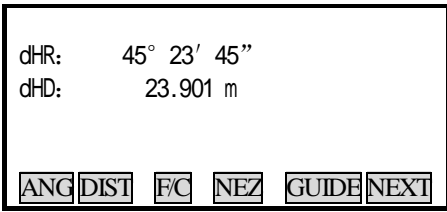
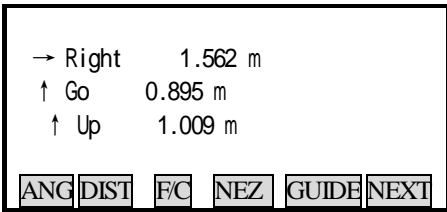
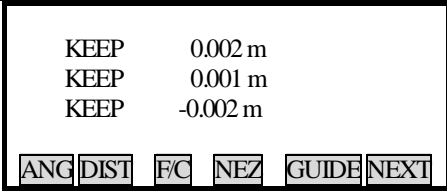
### 5.6.7 GUIDANCE FEATURE

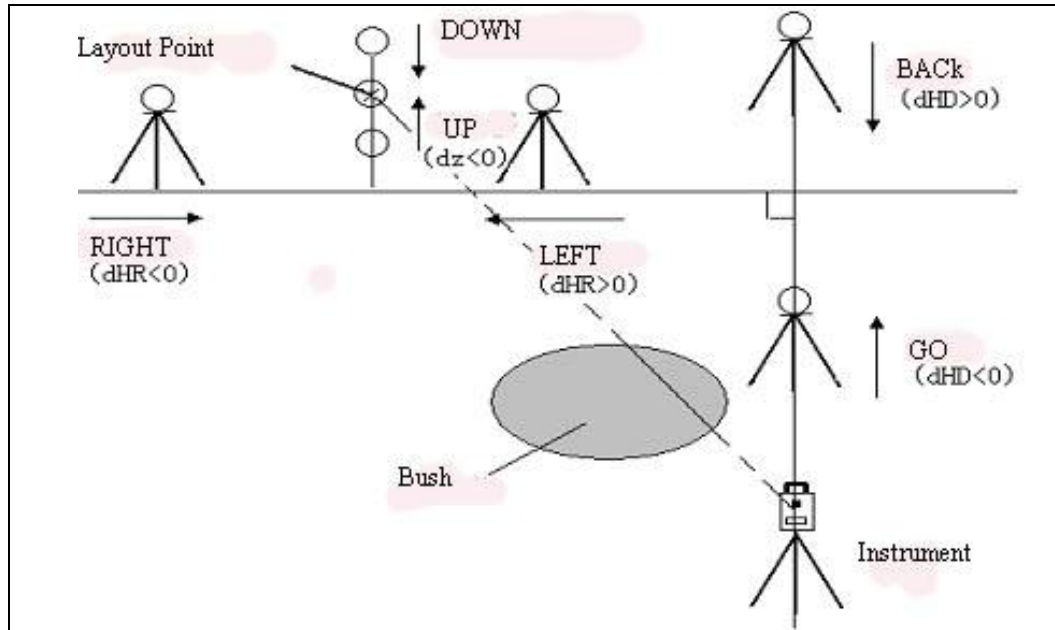
The Guide feature can serve two purposes in the field for layout .

One use for the Guide feature is to help get the rod person on the layout point faster and more accurately . This is accomplished by showing the instrument person distance instructions which are then passed on to the rod person .The distance instructions are to move (BACK) , towards the instrument , (Go) away from the instrument , and to move (RIGHT) or (LEFT) to get back online with the layout point . The (RIGHT) or (LEFT) instructions are helpful when the rod person is very close to the layout point . Please refer to the diagram and instructions below .

Another feature that layout accomplishes is the cut or fill information . Using the last rod height previously entered , the Total Station will display the cut (DOWN) or fill (UP) information to the instrument person .

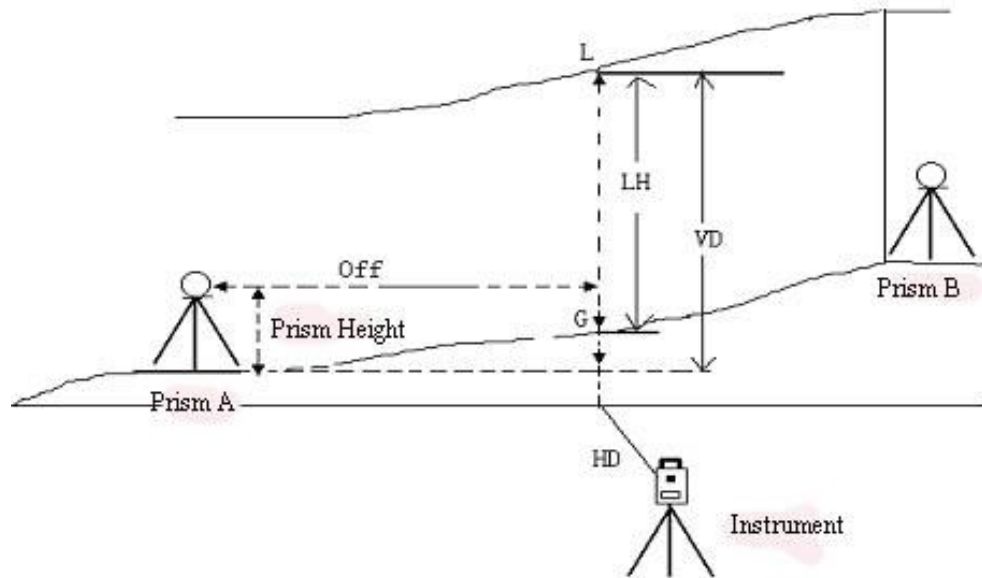
#### Layout with Guide Feature

Operating Procedures	Operation	Display
① From the angle and distance layout screen , press [F5] ( Guide )	[F5]	
②The next screen will display the distance to move right or left to the layout point and to move back toward the instrument or away from the instrument . The cut (DOWN) or fill (UP) , on the last line of information , is calculated using the rod height previously entered .		
③When the measuring point is within $\pm 5$ mm, the word "KEEP" and (+) or (-) are displayed .		
<p><b>●Function of Guidance</b></p> <p>Using the function of guidance , it is possible to guide a person of prism side as shown below .</p> <p>This function is useful when it is difficult to collimate the layout point (P1) directly during executing a layout mode.</p>		



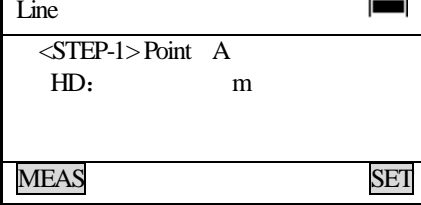
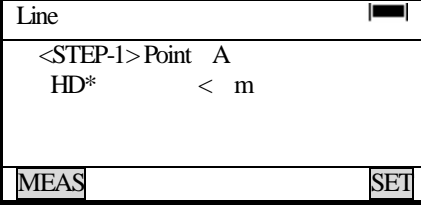
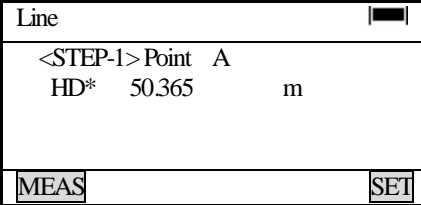
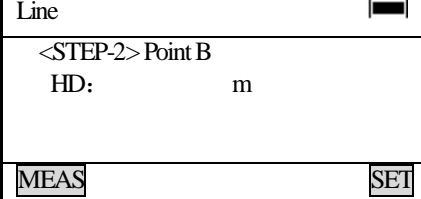
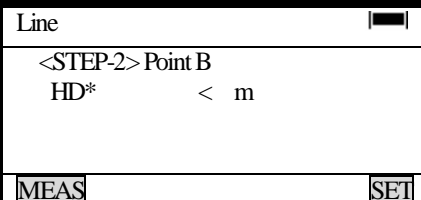
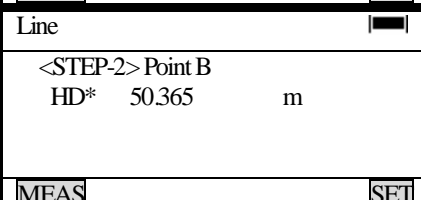
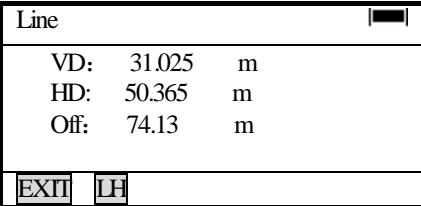
## 5.7 LINE MEASUREMENT (LINE)

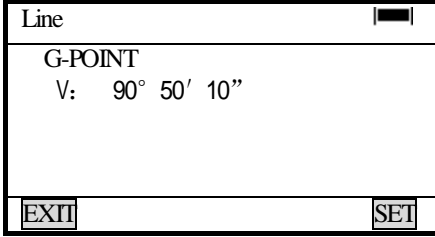
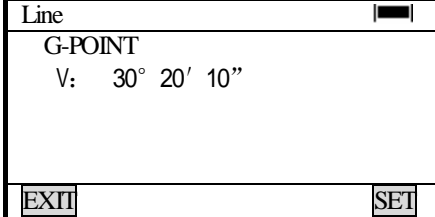
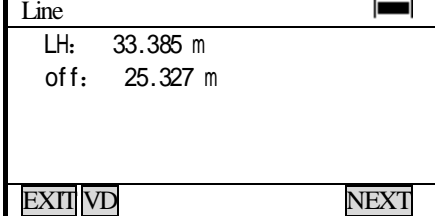
The Line Measurement program allows the user to measure the height of an inaccessible object above a point. Both the inaccessible object and the point are located along an established base line. Two prisms, A and B, are set up apart from each other below the object to established the base line. The horizontal 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.



**[Example : Input of prism height]**

Operating Procedures	Operation	Display
①From Programs menu , press [F6] key , to get the next page of programs .	[F6]	<pre> Programs          5/9 F1 STDSVYp F2 BS p F3 STOREp F4 REMp F5 MLMp P1 </pre>
②Press [F4] (LINE) key .	[F4]	<pre> Programs          9/9 F1 REPp F2 LAYOUTp F3 LINEp F4 OFFSETp P1 </pre>
③Press [F1] (YES) key .	[F1]	<pre> Line Prism Height F1. YES F2. NO </pre>
④Input the prism height and press [ENT] key .	Input P.h [ENT]	<pre> Line Prism Height P.H: 1.800 m EXIT ←BS </pre>

<p>⑤ Collimate prism A , press [F1] (MEAS) key , the distance measurement will start .</p>	<p>Collimate A</p> <p>[F1]</p>	 
<p>⑥ Press [F6] (SET) key , the horizontal distance will be recorded .</p>	<p>[F6]</p>	
<p>⑦ Collimate prism B and press [F1] (MEAS) key , the distance will start .</p> <p>Horizontal distance is displayed .</p> <p>⑧ Press [F6] (SET) key , the horizontal distance will be recorded .</p>	<p>[F1]</p> <p>[F6]</p>	  
<p>⑨ Sight line point L , Measured data to the line point L is displayed .</p> <p>VD : Vertical distance</p> <p>HD: Horizontal distance from the instrument to L</p> <p>Off: Horizontal distance from A to L</p>	<p>Collimate L</p>	

<p>⑩ Press [F2] (LINE) key</p> <p>This function is used when measuring the line height from the ground .</p> <ul style="list-style-type: none"> <li>●Sight the point on the line before pressing [F2] key</li> <li>●Don't move the horizontal tangent screw by setting ground point G .</li> </ul>	<p>[F2]</p>	
<p>(1)Rotate the vertical tangent screw and sight ground point G</p>	<p>Collimate G</p>	
<p>(2)Press [F6] (SET) key , line height LH (LH) and horizontal distance (Off) are displayed</p>	<p>[F6]</p>	
<ul style="list-style-type: none"> <li>●To finish the measurement , press [F1] (EXIT) or [ESC] key .</li> <li>●To return to operation procedure ⑨ press [F2] (VD) key .</li> <li>●To return to operation procedure (1) press [F6] (NEXT) key .</li> </ul> <p>The NEXT key is used when the ground point G is not clear and you would like to check another ground point G on the same vertical line .</p>		

## 5.8 OFFSET MEASUREMENT (OFFSET)

There are four offset measurement modes in the Offset Measurement .

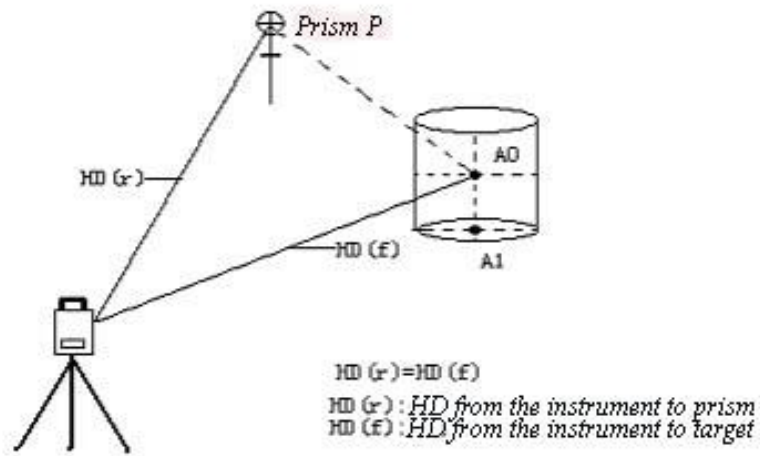
1. Angle offset
2. Distance offset
3. Plane offset
4. Column offset

### 5.8.1 ANGLE OFFSET

This mode is useful when it is difficult to set up the prism directly, for xample at the center 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 center position, operate the offset measurement after setting the instrument height/prism height.

When measuring coodinates of ground point A1: Set the strument height/prism height .

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

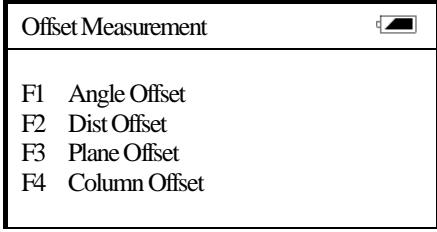
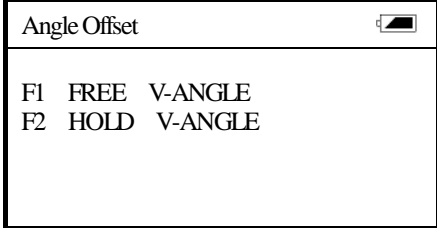
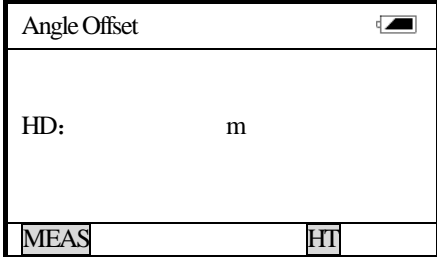
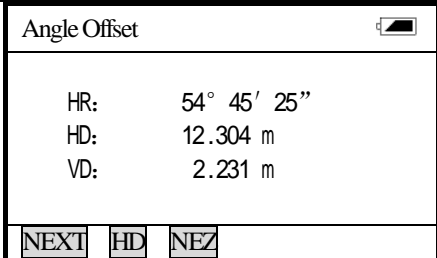
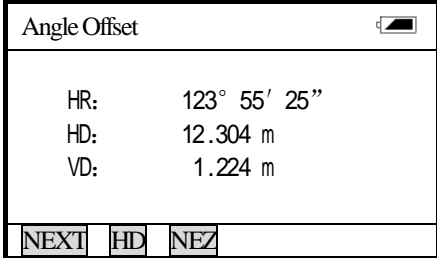
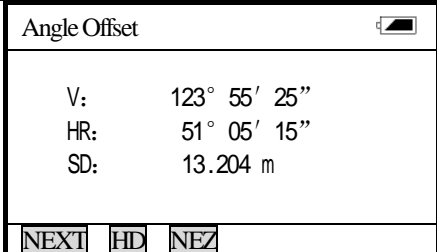


In the Angle Offset Measurement Mode , there are two setting methods for the vertical angle .

- 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 .

Operating Procedures	Operation	Display
① Press [F6] key from programs menu to get to the next page of programs .	[F6]	Programs 5/9 F1 STDSVYp F2 BS p F3 STOREp F4 REMp F5 MLMp P2
		Programs 9/9 F1 REpp F2 LAYOUTp F3 LINEp F4 OFFSETp P1



<p>② Press [F4] to enter OFFSET measurement mode .</p>	<p>[F4]</p>	
<p>③ Press [F1] FREE V-ANGLE or [F2] HOLD V-ANGLE to start measurement</p>	<p>[F1] or [F2]</p>	
<p>④ Collimate prism P , press [F1] (MEAS) to measure . ( If using the continuous measurement mode, when measurement is finished ,press [F5] (SET) .</p>	<p>Collimate prism P [F1]</p>	
<p>⑤ Collimate point A0 by using the horizontal motion clamp and horizontal tangent screw .</p>	<p>Sight A0</p>	
<p>⑥ The vertical distance from the instrument to point A0 will be shown .</p>		
<p>⑦ Press [F2] (SD) , the slope distance of point A0 will be shown .</p>	<p>[F2]</p>	

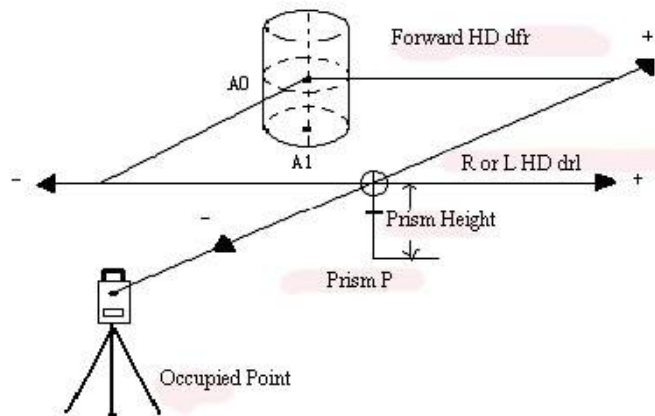
⑧ Press [F3] (NEZ) to show the Coordinate .	[F3]	<table border="1"> <tr> <th colspan="2">Angle Offset</th> </tr> <tr> <td>N:</td> <td>12.369 m</td> </tr> <tr> <td>E:</td> <td>45.325 m</td> </tr> <tr> <td>Z:</td> <td>13.204 m</td> </tr> <tr> <td colspan="2"> <div style="display: flex; justify-content: space-around;"> <span>NEXT</span> <span>HD</span> <span>NEZ</span> </div> </td> </tr> </table>	Angle Offset		N:	12.369 m	E:	45.325 m	Z:	13.204 m	<div style="display: flex; justify-content: space-around;"> <span>NEXT</span> <span>HD</span> <span>NEZ</span> </div>	
Angle Offset												
N:	12.369 m											
E:	45.325 m											
Z:	13.204 m											
<div style="display: flex; justify-content: space-around;"> <span>NEXT</span> <span>HD</span> <span>NEZ</span> </div>												
※ 1) Press <b>NEXT</b> to return to step ④      ※ 2) Press <b>ESC</b> to exit OFFSET MEASUREMENT												

Set Inst. Height/Prism Height before starting measurement .

To set the coordinate of occupied point , refer to SECTION 4.3.1 “Setting Coordinate Values of Occupied Point”.

### 5.8.2 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 .

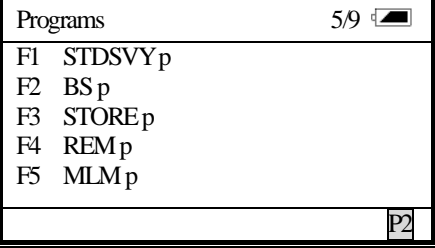
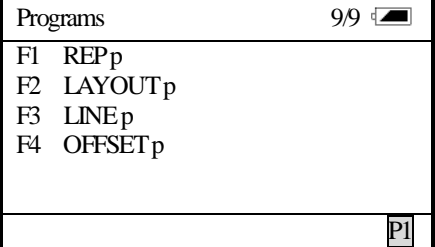
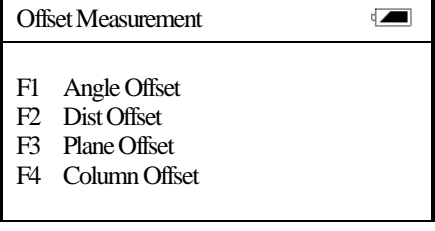
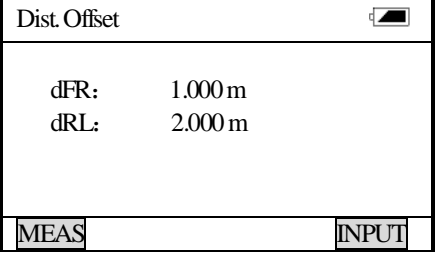
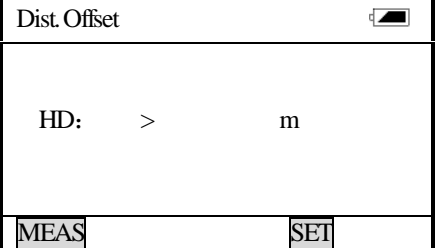
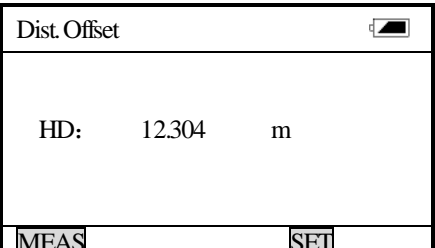


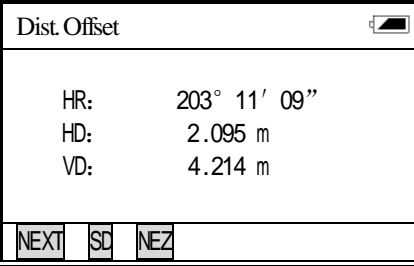
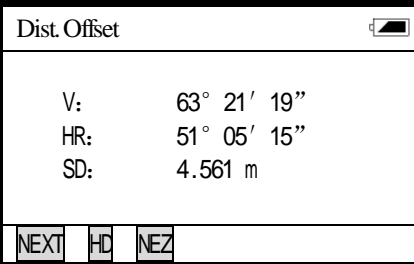
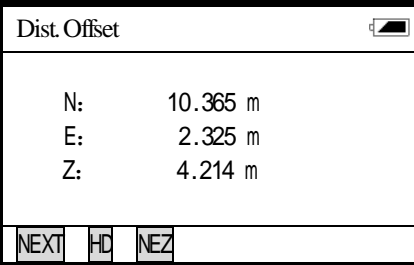
When measuring Coordinate of ground point A1 : Set the instrument height / prism height

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

Setting the coordinate of occupied point , refer to SECTION 4.3.1 “Setting Coordinate Values of Occupied Point”.

Operating Procedures	Operation	Distance
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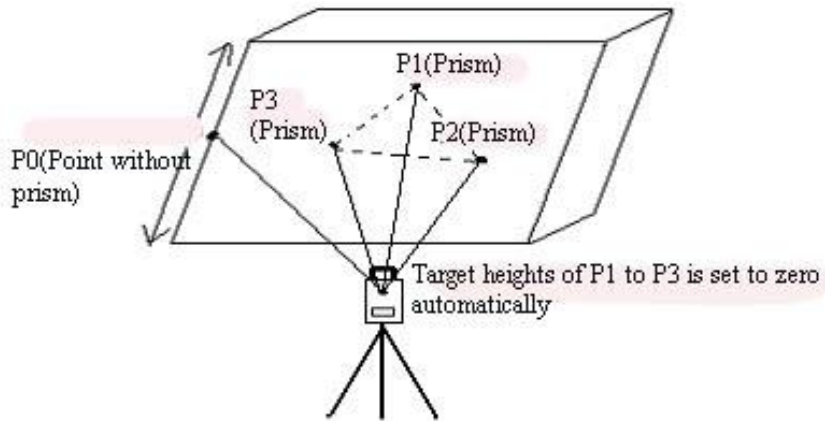
<p>① Press [F6] key from programs menu to get to the next page of programs.</p>	<p>[F6]</p>	 <p>Programs 5/9</p> <p>F1 STDSVYp F2 BS p F3 STOREp F4 REMp F5 MLMp</p> <p>P2</p>  <p>Programs 9/9</p> <p>F1 REPp F2 LAYOUTp F3 LINEp F4 OFFSETp</p> <p>P1</p>
<p>② Press [F4] (OFFSET) key</p>	<p>[F4]</p>	 <p>Offset Measurement</p> <p>F1 Angle Offset F2 Dist Offset F3 Plane Offset F4 Column Offset</p>
<p>③ Press [F6] to input offset distance , when each value is inputted , press [ENT] key</p>	<p>[F6] [ENT]</p>	 <p>Dist. Offset</p> <p>dFR: 1.000 m dRL: 2.000 m</p> <p>MEAS INPUT</p>
<p>④ Collimate prism, press [F1] (MEAS) to start measuring . (If using the continuous measurement mode, when measurement is finished, press [F5] (SET) key ). When the measurement is finished, the result will be shown and is corrected by adding offset value.</p>	<p>Collimate P [F1]</p>	 <p>Dist. Offset</p> <p>HD: &gt; m</p> <p>MEAS SET</p>  <p>Dist. Offset</p> <p>HD: 12.304 m</p> <p>MEAS SET</p>

<p>⑤The horizontal distance and vertical distance from the instrument to Point A0 is shown</p>		
<p>⑥Press [F2] (SD) , the slope distance from the instrument to A0 will be shown .</p>	<p>[F2]</p>	
<p>⑦Press [F3] (NEZ) , the coordinate of target point will be displayed .</p>	<p>[F3]</p>	
<p>※ 1) Press <b>NEXT</b> to return to step ④      ※ 2) Press <b>ESC</b> to exit OFFSET MEASUREMENT</p>		

### 5.8.3 PLANE OFFSET

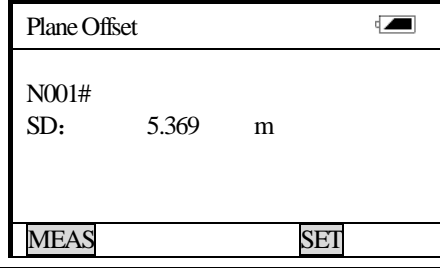
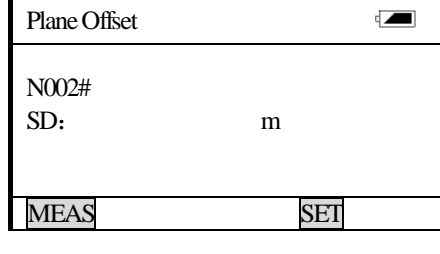
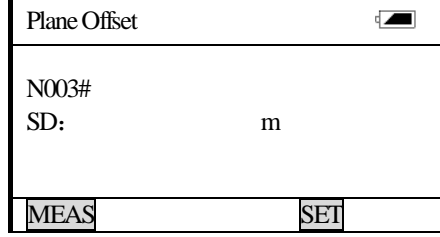
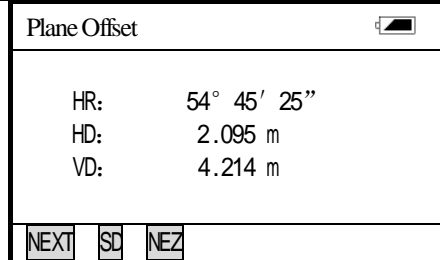
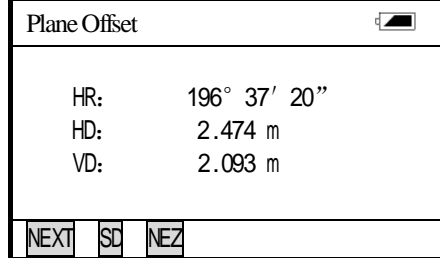
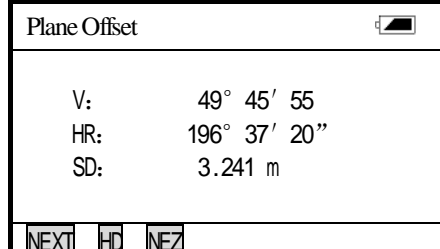
Measuring will be taken for the place where direct measuring can not be done . For example distance or coordinate measuring for a edge of a plane .

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 SECTION 4.3.1 “ Setting Coordinate Values of Occupied Point “

Operating Procedures	Operation	Display
① Press [F6] key from programs menu to get to the next page of programs .	[F6]	<div style="border: 1px solid black; padding: 2px;">           Programs 5/9 <span style="float: right;">▶</span>            F1 STDSVYp            F2 BS p            F3 STOREp            F4 REM p            F5 MLMp  <div style="text-align: right; border-top: 1px solid black; padding-top: 2px;">P2</div> </div> <div style="border: 1px solid black; padding: 2px; margin-top: 2px;">           Programs 9/9 <span style="float: right;">▶</span>            F1 REPp            F2 LAYOUTp            F3 LINEp            F4 OFFSETp  <div style="text-align: right; border-top: 1px solid black; padding-top: 2px;">P1</div> </div>
② Press [F4] to get to the Offset menu display .	[F4]	<div style="border: 1px solid black; padding: 2px;">           Offset Measurement <span style="float: right;">▶</span>            F1 Angle Offset            F2 Dist Offset            F3 Plane Offset            F4 Column Offset         </div>
③ Press [F3] to start Plane Offset Measurement .	[F1]	<div style="border: 1px solid black; padding: 2px;">           Plane Offset <span style="float: right;">▶</span>            N001#            SD: m  <div style="display: flex; justify-content: space-between; border-top: 1px solid black; padding-top: 2px;"> <span>MEAS</span> <span>SET</span> </div> </div>

<p>④Sight prism P1, press [F1] (MEAS) to measure . ( If using the continuous measurement mode , when measurement is finished ,press [F5] (SET) key )</p>	<p>Collimate P1 [F1]</p>	
<p>⑤Measure the points P2 , P3in the same way .</p>	<p>Collimate P2 [F1]</p>	
	<p>Collimate P3 [F1]</p>	
<p>⑥ The instrument calculates and displays coordinate and distance value of cross point between collimation axis and of the plane .</p>		
<p>⑦Collimate P0 by using the horizontal motion clamp and horizontal tangent screw . The vertical distance and horizontal distance from the instrument to P0 will be shown</p>	<p>Collimate P0</p>	
<p>⑧To show the Slope Distance , press [F2] (SD)</p>	<p>[F2]</p>	

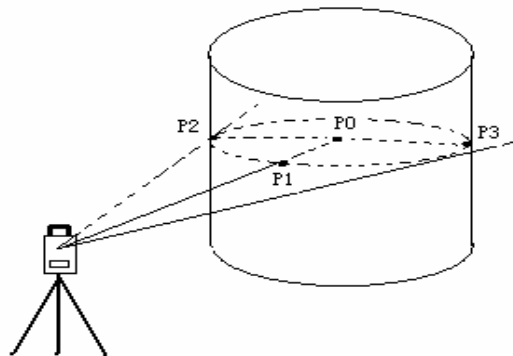
<p>⑨ Press [F3] (NEZ) to show the Coordinate of target point .</p>	<p>[F3]</p>	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right;">Plane Offset <span style="float: right;">▢</span></p> <hr/> <p>N: 10.365 m</p> <p>E: 2.325 m</p> <p>Z: 4.214 m</p> <hr/> <p style="text-align: right;">NEXT HD NEZ</p> </div>
<p>※ 1) Press <b>NEXT</b> to return to step ④      ※ 2) Press <b>ESC</b> to exit OFFSET MEASUREMENT</p>		

- 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 .

### 5.8.4 COLUMN OFFSET

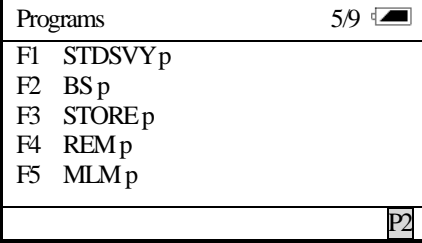
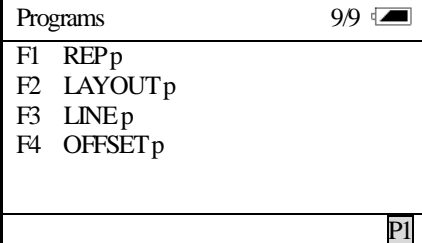
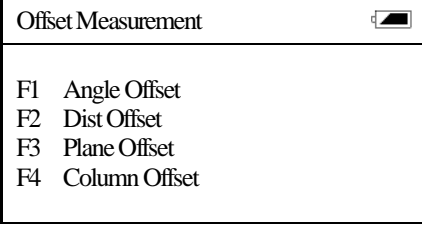
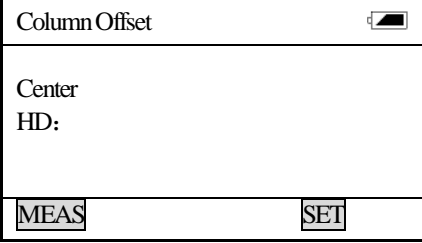
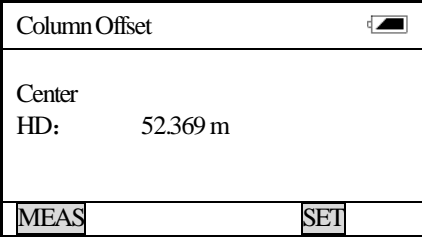
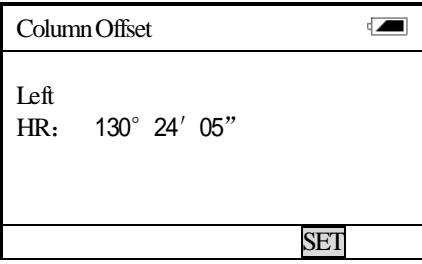
If it is possible to measure circumscription point (P1) of column directly , the distance to the center of the column (P0) , coordinate and direction angle can be calculated by measured circumscription points (P2) and (P3) .

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



Setting the coordinate of occupied point , refer to SECTION 4.3.1 “ Setting Coordinate Values of Occupied Point “

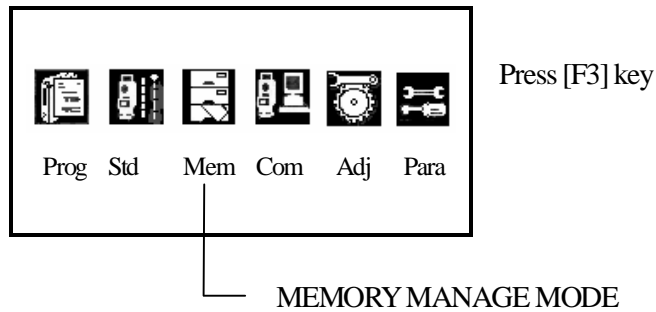
Operating Procedures	Operation	Display
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<p>① Press [F6] key from the programs menu to get to the next page of programs .</p>	<p>[F6]</p>	 <p>Programs 5/9</p> <p>F1 STDSVYp F2 BS p F3 STOREp F4 REMp F5 MLMp</p> <p>P2</p>  <p>Programs 9/9</p> <p>F1 REPp F2 LAYOUTp F3 LINEp F4 OFFSETp</p> <p>P1</p>
<p>② Press [F4] to enter the Offset Measurement menu .</p>	<p>[F4]</p>	 <p>Offset Measurement</p> <p>F1 Angle Offset F2 Dist Offset F3 Plane Offset F4 Column Offset</p>
<p>③ Press [F4] to start Column Offset Measuring .</p>	<p>[F4]</p>	 <p>Column Offset</p> <p>Center HD:</p> <p>MEAS SET</p>
<p>④ Collimate the center of the column (P1) and press [F1] (MEAS) . ( If using the continuous measurement mode, when measurement is finished, press [F5] (SET) key ). After the measurement, angle measuring display of the left side (P2) will be shown .</p>	<p>Collimate P1 [F1]</p>	 <p>Column Offset</p> <p>Center HD: 52.369 m</p> <p>MEAS SET</p>
<p>⑤ Collimate the point (P2) on the left side , press [F6] (SET) key . After the measurement, angle measuring display of the right side (P3) will be shown .</p>	<p>Collimate P2 [F6]</p>	 <p>Column Offset</p> <p>Left HR: 130° 24' 05"</p> <p>SET</p>



<p>⑥ Collimate the right side of the column (P3), press [F6] (SET) key, after the measurement, the distance between the instrument and center of the column (P0) will be calculated and displayed.</p>	<p>Collimate P3 [F6]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Column Offset <span style="float: right;">▢</span></p> <hr/> <p>Right HR: 50° 20' 55"</p> <hr/> <p style="text-align: right;">SET</p> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"> <p>Column Offset <span style="float: right;">▢</span></p> <hr/> <p>HR: 203° 11' 09" HD: 2.095 m VD: 4.214 m</p> <hr/> <p>NEXT SD NEZ</p> </div>
<p>⑦ Press [F2] (SD), the slope distance of point P0 will be shown.</p>	<p>[F2]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Column Offset <span style="float: right;">▢</span></p> <hr/> <p>V: 203° 11' 09" HR: 51° 05' 15" SD: 4.561 m</p> <hr/> <p>NEXT HD NEZ</p> </div>
<p>⑧ To show the Coordinate, press the [F3] (NEZ) key.</p>	<p>[F3]</p>	<div style="border: 1px solid black; padding: 5px;"> <p>Column Offset <span style="float: right;">▢</span></p> <hr/> <p>N: 10.365 m E: 2.325 m Z: 4.214 m</p> <hr/> <p>NEXT HD NEZ</p> </div>
<p>※ 1) Press <b>NEXT</b> to return to step ④      ※ 2) Press <b>ESC</b> to exit OFFSET MEASUREMENT</p>		

## 6 MEMORY MANAGEMENT MODE



The following items are available in this mode:

- 1、 Display Internal Memory and Card Memory Status
- 2、 Protecting a File
- 3、 Deleting a File
- 4、 Renaming a File Name
- 5、 Initialization

### 6.1 VIEW INTERNAL MEMORY STATUS

The NTS-660 series will display the memory size , the amount of free memory and the expiration date for the internal lithium battery .

Operating Procedures	Operation	Display
① Press [F3] key to view the memory size, the amount of free memory	[F3]	<pre> Memory Manage ----- Momery size      16384Kbyte Memory free      16384Kbyte ----- [INIT]          [FILE]                     </pre>
② Press [F6] (File) key . Each File status (File name , File name extension , Used memory capacity, Date ) are shown . Press [ESC] to return to the main menu icons .	[F6]	<pre> Memory Manage ----- CONFIG.SYS      1567      01-25 DEFAULT.RAW 09-02           1025 DEFAULT.PTS 10-05           2014 FIXED .LYR      12558      11-11 SOUTH .LIB      2563       12-26 ----- [PRO] [REN] [DEL] [↑] [↓]                     </pre>

**The File format is explained as below :**

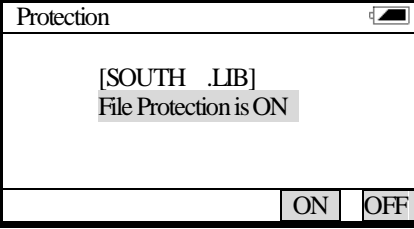
CONFIG .SYS	System File
DEFAULT .LYR	Pcode Layer File
DEFAULT .LIB	Pcode Library File
FIXED .PTS	Fixed Points Data File
***** .RAW	Raw Data File
***** .PTS	Coordinate Data File
***** .HAL	Horizontal Alignment Data File
***** .VCL	Vertical Curve Data File
***** .XDE	Cross Section Data File
***** .STK	Fill/Cut Data File
***** .PTL	Layout Data File

**6.2 PROTECTING A FILE**

Protecting one or more files can be accomplished with the file protection mode .When a file is protected , an asterisk appears after the file name extension . If a file is protected , you can not delete the file unless you remove the file protection .

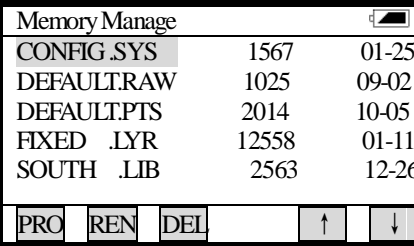
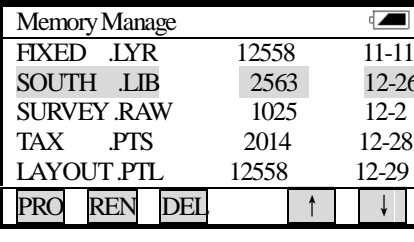
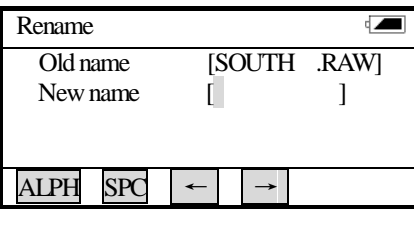
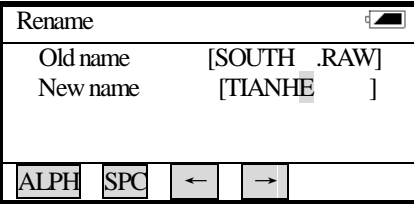
●NOTE : All the files stored will be erased by initializing the memory, even if the files are protected .

Operating Procedures	Operation	Display
①Enter the Memory Manage menu .		
②Press [F5] (↑) or [F6] (↓) key to select a file.	Select A File	
③ Press [F1] (Pro) key.	[F1]	

<p>⑤ Press [F5] (ON) key ※1) The file is protected and display will return to file name</p>	<p>[F5]</p>	
<p>※1) When you cancel the protection , repeat the procedure above mentioned and select [F6] (OFF) key . ※2) If a file is protected , an asterisk will be displayed in the end of the file name</p>		

### 6.3 RENAMING A FILE

Files can be renamed in internal memory . When renaming a file , the old file name appears above the input line for the new file name . When typing the new name , you do not have to input the file extension . (CONFIG .SYS is a system file , can not be renamed )

Operating Procedures	Opeation	Display
<p>① Enter the Memory Manage menu</p>		
<p>② Press [F5] (↑) or [F6] (↓) key, to select a file .</p>	<p>Select A File</p>	
<p>③ Press [F2] (REN) key</p>	<p>[F2]</p>	
<p>④ Enter a new file name within 8 characters . Press [ENT] key ※1)</p>		
<p>※1) Refer to Section 3.12 “How to Enter Numerals and Alphabet Letters “</p>		

## 6.4 DELETING A FILE

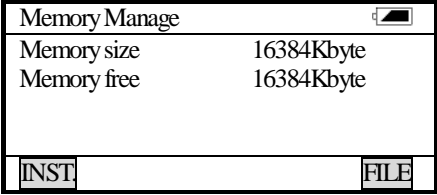
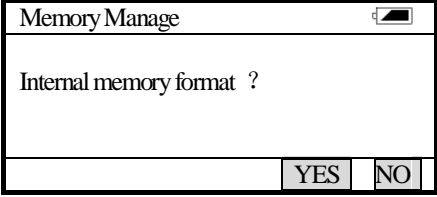
The delete mode erases a file from internal memory. If a file is protected, the file can not be erased. File protection must be removed before you can delete a file. (CONFIG .SYS is a system file, and it can not be erased.)

Operating Procedures	Operation	Display
① Enter the Memory Manage menu		
② Press [F5] (↑) or [F6] (↓) key, to select a file.	Select A File	
③ Press [F3] (DEL) key	[F3]	
④ Confirm the file name, press [F5] (YES) key.	[F5]	
<p>● If a file is protected, the file can not be erased. File protection must be removed before you can delete a file.</p>		

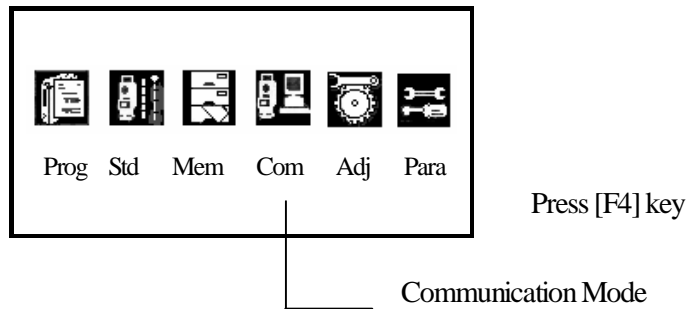
## 6.5 INITIALIZING INTERNAL MEMORY

The initialize memory option will erase ALL FILES in the internal memory and all files can not be retrieved.

Operating Procedures	Operation	Display
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<p>① Press [F3] key from the programs menu icons , the memory capacity and free memory space will be displayed .</p>	<p>[F3]</p>	
<p>② Press [F1] (INIT.) key ③ Confirm the display and press [F5] (YES) key . Internal memory formatting begins .</p>	<p>[F1]  [F5]</p>	

## 7 COMMUNICATION MODE



The communication modes are used for setting the Baud rate (Protocol), receiving a file (Data file in )and sending a file (Data file out). A data transfer program on your PC that supports (YMODEM) will be necessary to send of receive data files .

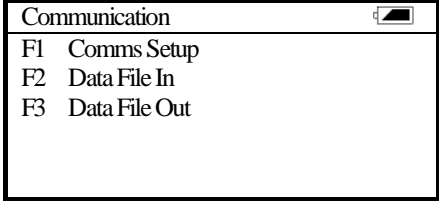
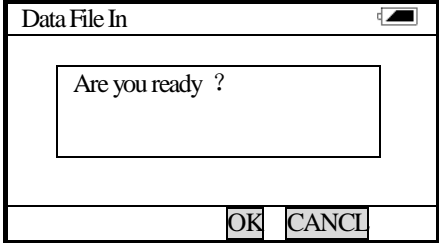
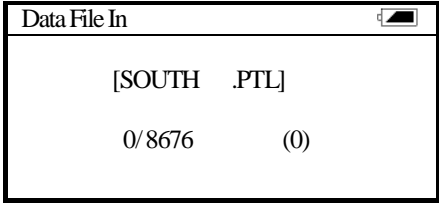
### 7.1 SETTING PROTOCOL

To transfer data files to and from the NTS-660 series and a PC , the baud ratemustbe the same .The baud rade sections are 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 .

Operating Procedures	Opeation	Display
①Press [F1] (Protocol) key .	[F1]	<div style="border: 1px solid black; padding: 5px;"> <p>Communication</p> <p>F1 Comms Setup</p> <p>F2 Data File In</p> <p>F3 Data File Out</p> </div>
②Use the arrow keys [F3]~[F6] to highlight your choosed Baud rate , when the correct Baud rate is highlighted ,press [ENT] key .	[F3] to [F6] [ENT]	<div style="border: 1px solid black; padding: 5px;"> <p><b>【Communication Port Setting】</b></p> <p>Baud 2400</p> <p>Parity NONE</p> <p>Data 8</p> <p>Stop 1</p> <p style="text-align: center;">← → ↑ ↓</p> <hr/> <p>Communication</p> <p>F1 Comms Setup</p> <p>F2 Data File In</p> <p>F3 Data File Out</p> </div>

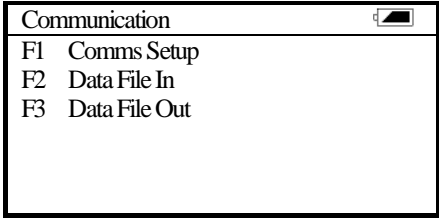
## 7.2 DATA FILE IN

You can transfer data files from a PC to the NTS-660 Series .

Operating Procedures	Operation	Display
<p>Make sure the instrument is ready and waiting for the data file before you command the PC to send the file .</p> <p>① Press [F2] (Data file in) key</p>	[F2]	
<p>② There is a prompt on the display , press [F5] (YES) to receive data .</p>	[F5]	
<p>③ Command the PC to send the file at this time . File name , amount of received data (Byte)/Capacity of the file (Byte) and procentage will be shown . When the transfer is complete, the display will return to the main menu icons .</p>		

## 7.3 DATA FILE OUT

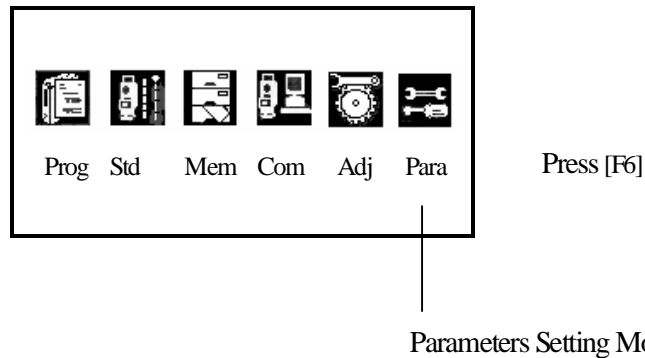
You can transfer data files from the NTS-660 Series to PC .

Operating Procedures	Operation	Display
<p>Make sure the PC is ready and waiting for the data file before you command the NTS-660 series to send the file .</p> <p>① Press [F3] ( Data file out) key</p>	[F3]	



<p>② Press [F5] (↑) or [F6] (↓) key and [ENT] key to select a file .</p> <p>File name , amout of received data (Byte) / Capacity of the file (Byte) and procentage will be shown .When the transfer is complete , the display will return to the main menu icons .</p>	<p>Select</p> <p>A</p> <p>File</p> <p>[ENT]</p>	
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## 8. PARAMETERS SETTING MODE



In this mode, setting of parameters regard with measuring, displaying and communications will be done .

When a parameter is changed and set, the new value is stored into memory.

Press [F6] key from the main menu icons, the following display will be shown.

The parameter modes is classified in Measurement and Communication.

Parameters	
F1	Measurement
F2	Communication
F3	Password
F4	System

### 8.1 PARAMETER SETTING OPTIONS

#### 8.1.1 PARAMETER FOR MEASUREMENT AND DISPLAY

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. Tilt	OFF/1axis/2axis	Select the tilt sensor option for OFF, (1axis) vertical only or (2axis) vertical and horizontal
3. W-Corr.	OFF/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
4. Pres.Unit	mmHg/ inHg/ hpa	Select the air pressure unit for the atmospheric correction
5. Date	m/d/y, d/m/y y/m/d	Select the date format shown on the display Date/Month/Year, Month/Day/Year , Year/Month/Day

6. Light	OFF/ON	Turn ON/OFF the backlight NOTE : Resume MODE ON/OFF option is given priority to regardless of the setting of this item
7. S/Abuzz	OFF/ON	Select the audio tone OFF/ON for the Set Audio Mode
8. V-0	Zenith/Level	Select the vertical angle reading for Zenith 0 or Horizontal 0 .
9. HAmem	OFF/Mem.ON	It is able to retain presetting angle after turning power off . (MEM.ON) NOTE: After changing this parameter , turn the power switch off once .
10. NEZ mem	OFF/MEM. ON	Select the option to store the coordinate (NEZ) for the occupied point when power is turned off .
11. Dist.Unit	meter/feet	Select the distance measuring unit Meter or Feet
12. C.Fm/ft	Us.f/Intl.f	Select the Feet type . US survey feet : 1m = 3.2808333333333333 ft International Feet: 1m = 3.280839895013123 ft
13. R/L lock	OFF/ON	Prohibit switching angle right or left by soft key in angle measurement mode . OFF : Switching is possible      ON:Prohibition
14. m/ft Lock	OFF/ON	Prohibit switching meter unit or feet unit OFF: Switching is possible      On: Prohibition
15. N/E-Ord	NEZ/ENZ	Select the display format in the coordinate measurement mode for NEZ or ENZ
16. Temp.Unit	°C/ °F	Select the temperature unit for the atmospheric correction
17. Min. Ang.	OFF/ON	Select the minimum angle reading OFF/ ON . [ON: 1'' or OFF: 5'' ]
18. A.P. OFF	OFF/ON (30)	The auto power off function can be turned OFF or set ON . OFF: not use      ON: 30 minutes (numeric key)
19. EDM wait	OFF/ON (10)	(EDM) cut off time after distance measurement is completed can be changed . OFF: EDM never cut off      ON: Edm is cut off after 10 minutes .

### 8.1.2 PARAMETER FOR COMMUNICATION

Factory default settings are indicated with underlines .

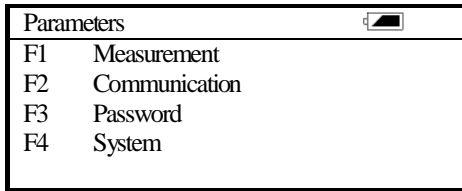
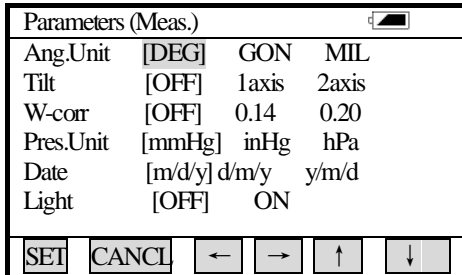
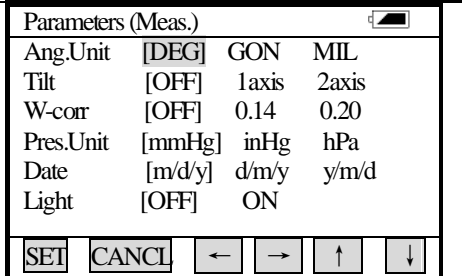
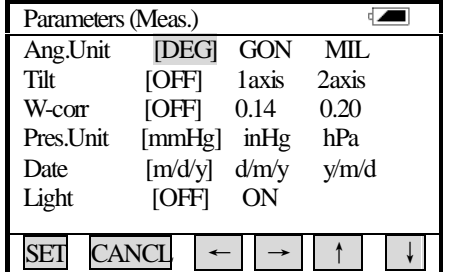
Menu	Selecting Item	Contents
1. Baud Rate	<u>1200</u> /2400/4800/ 9600/19200/38400/57600	Select the baud rate
2. Parity	None/Odd/ <u>Even</u>	Select the parity bit .

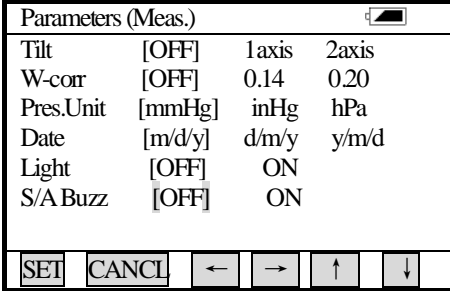
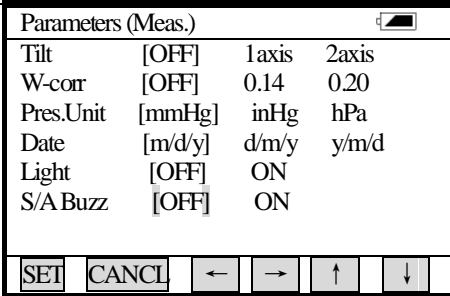
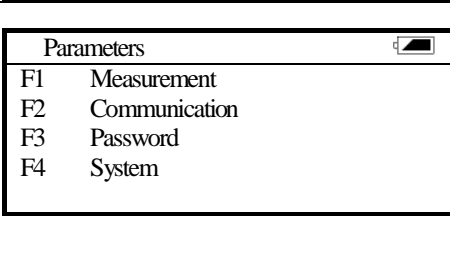
3. Data.L	<u>7</u> /8	Select the data length seven digits or eight digits
4. Stop Bit	<u>1</u> /2	Select the stop bit .
5. Protocol	OFF/ <u>ON</u>	When communicating to an external device , the protocol for handshaking can omit the [ACK] coming from the external device so data is not send again . OFF: Omit the [ACK] ON : Standard

## 8.2 SETTING PARAMETER

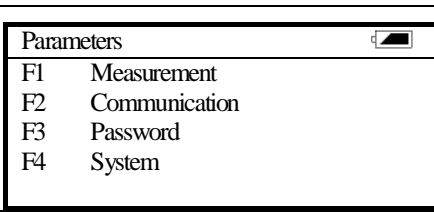
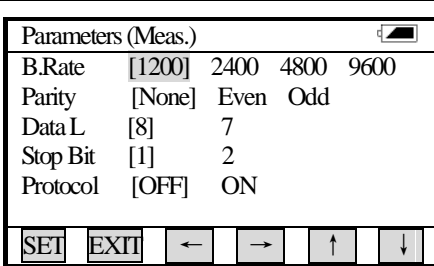
### 8.2.1 PARAMETER FOR MEASUREMENT AND DISPLAY

**[Example Setting]** Atmospheric pressure : hpa , S/A BUZZER : ON

Operating Procedures	Operation	Display
① Press [F6] from the main menu icons to access the parameter option menu.	[F6]	
② Press the [F1] (Measurement) key.	[F1]	
③ Press [F6] (↓) to select the menu. (Example: Pres.Unit)	[F6]	
④ Press [F3] (→) key to select hpa .	[F3]	

<p>⑤Select the S/A buzz by press [F6] (↓) key</p>	<p>[F6]</p>	 <p>Parameters (Meas.)</p> <p>Tilt [OFF] 1axis 2axis W-corr [OFF] 0.14 0.20 Pres.Unit [mmHg] inHg hPa Date [m/d/y] d/m/y y/m/d Light [OFF] ON S/A Buzz [OFF] ON</p> <p>SET CANCL ← → ↑ ↓</p>
<p>⑥Press [F4] (→) key and select [ON]</p>	<p>[F4]</p>	 <p>Parameters (Meas.)</p> <p>Tilt [OFF] 1axis 2axis W-corr [OFF] 0.14 0.20 Pres.Unit [mmHg] inHg hPa Date [m/d/y] d/m/y y/m/d Light [OFF] ON S/A Buzz [OFF] ON</p> <p>SET CANCL ← → ↑ ↓</p>
<p>⑦Press [F1] (SET) key.※1)</p>	<p>[F1]</p>	 <p>Parameters</p> <p>F1 Measurement F2 Communication F3 Password F4 System</p>
<p>※1) To cancel the setting ,press [F2] (CANCL) key .</p>		

## 8.2.2 PARAMETER FOR COMMUNICATION

Operating Procedures	Operation	Display
<p>①From the main menu icons, press [F6] key to access the parameters option menu .</p>	<p>[F6]</p>	 <p>Parameters</p> <p>F1 Measurement F2 Communication F3 Password F4 System</p>
<p>②Press [F2] (Communication)key  To select a higher Baud Rate,move the cursor to the end of Baud Rate and press [F4] (→) key .</p>	<p>[F2]</p>	 <p>Parameters (Meas.)</p> <p>B.Rate [1200] 2400 4800 9600 Parity [None] Even Odd Data L [8] 7 Stop Bit [1] 2 Protocol [OFF] ON</p> <p>SET EXIT ← → ↑ ↓</p>

③The next steps are same as section 8.2.1 “Parameters for Measurement and Display”, refer to the Section 8.2.1.※1)		
※1) Press [F2] (EXIT) key to reset to the factory default settings (SOUTH total station current fixed protocol). Factory default settings are indicated with underlines in Section 8.1.2 “Parameters for Communication”.		

### 8.2.3 PASSWORD OPTION

#### Default Password (888888)

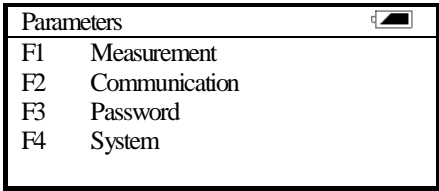
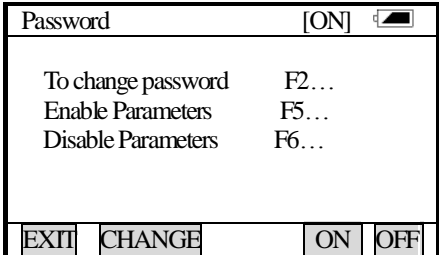
A password can be set in the NTS-660 series to secure the use of the instrument. The default password is 888888. Once a password is established the user can disable the option or change the password . Once a password established and the option is turned off , the password will always retain in memory . When turning on the instrument after a password-input screen appears before the self-test mode. Type in your password and press [ENT] to continue.

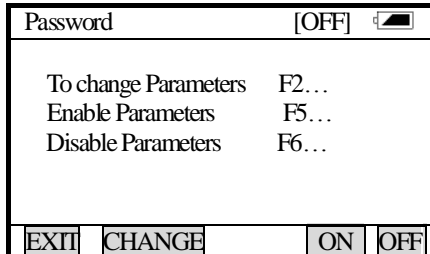
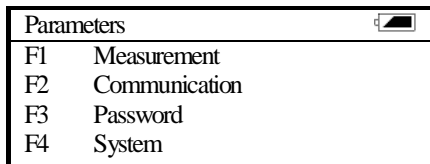
A maximum of 6 digits can be entered as a password. If 3 unsuccessful attempts are made to input a password, the instrument will shut off automatically.

#### Disable the password

After a password is established , you can disable the password option . Once you disable the option , the password-input screen will not appear every time you turn on the instrument .

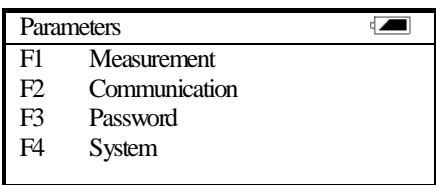
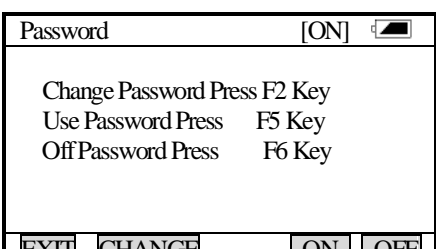
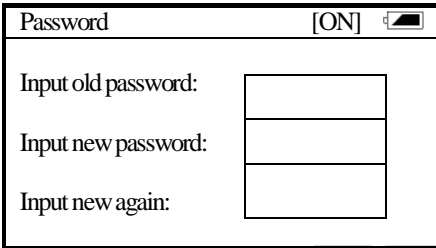
#### Disable Password Option

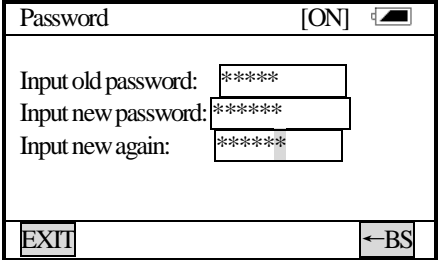
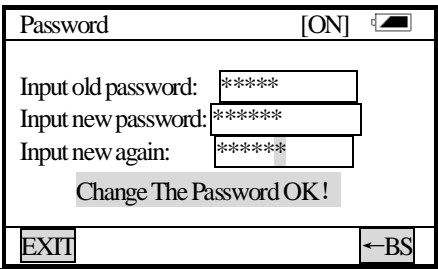
Operating Procedures	Operation	Display
①From the main menu, press [F6] key to access the parameters option menu .	[F6]	
②Press [F3] (Pasword) key to access Password Option screen .	[F3]	

<p>③ Press [F6] key to turn off the password option . The indicator on the upper left side of the screen will show [ON].</p>	<p>[F6]</p>	 <p>Password [OFF] </p> <p>To change Parameters F2...  Enable Parameters F5...  Disable Parameters F6...</p> <p>EXIT CHANGE ON OFF</p>
<p>④ Press [ESC], the screen will back to the Parameters Setting menu .</p>	<p>[ESC]</p>	 <p>Parameters </p> <p>F1 Measurement  F2 Communication  F3 Password  F4 System</p>

### Changing a Password

It allows you to change the original password, the new password will take place of the original password in memory.

Operating Procedures	Operation	Display
<p>① From the main menu, press [F6] key to access the parameters option menu.</p>	<p>[F6]</p>	 <p>Parameters </p> <p>F1 Measurement  F2 Communication  F3 Password  F4 System</p>
<p>② Press [F3] (password) key to access Password Option screen .</p> <p>③ Input the password and press [ENT] .</p>	<p>[F3]  Type  password  [ENT]</p>	 <p>Password [ON] </p> <p>Change Password Press F2 Key  Use Password Press F5 Key  Off Password Press F6 Key</p> <p>EXIT CHANGE ON OFF</p>
<p>④ Password Option screen will appear .</p> <p>To change the current password press [F2] (CHANGE) key .</p>	<p>[F2]</p>	 <p>Password [ON] </p> <p>Input old password: <input type="text"/></p> <p>Input new password: <input type="text"/></p> <p>Input new again: <input type="text"/></p> <p>EXIT CHANGE ON OFF</p>

<p>⑤The password input screen will appear . Input the current password and the new one, press [ENT] , then type in new password to confirm .</p>	<p>Input password [ENT]</p>	
<p>⑥The screen shows “Change The Password OK!”; the instrument automatically returns to Parameters Option screen .</p>		



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# STANDARD SURVEY SOFTWARE

## 9 MAIN FEATURE OF STANDARD SURVEY SOFTWARE:

### ●Multiple Job Files

Standard Survey Software uses named jobs with separate files for raw data, coordinates and strings. The job is given alpha numeric names with up to eight characters. You may have many jobs on the system. You may have many jobs on the system. You may create a new job for storing data, or you may open an existing job for data storage. The currently selected job is used for storing observed data. You may also 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 single key 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

Separate 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 NTS-660 series.

### ●Download to Serial Port

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

●**Upload Point Code from Serial Port**

The point code of NTS-660 may be created by uploading codes from a computer.

●**Upload Roads Design data from serial port**

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

●**Point Setting Out**

The standard Setting out program computes bearing and distance, displays offsets to setout point after each measurement. Coordinates of points as set out can be saved and differents downloaded in the cut/fill report.

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 Design.

●**Traverse Adjustment**

The Bowditch adjustment method is used to adjust a recored 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 dependenton 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**

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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 SETUP function will be used in the calculation of distances.

● **Area Calculation**

Area calculation of a series 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.

● **Batterboards**

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

● **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.

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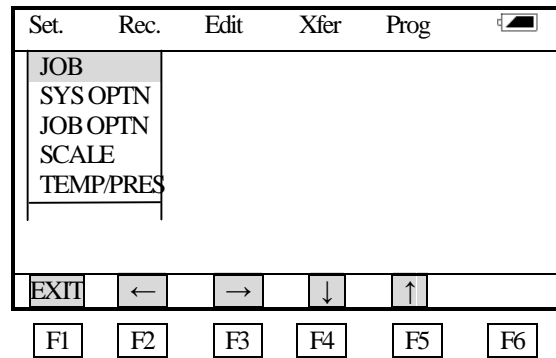
## 10 GENERAL INFORMATION

### 10.1 SPECIAL KEY

The **【ENT】** key is the most commonly used key. It is used to record measurements, complete screen input, continue processing after a warning or prompt has been displayed. The **【ESC】** key can be used to break out of any function. It will allow you to exit a screen without saving input, exit a menu and return to a higher level menu.

Function keys are used to access extended screens when a label is displayed on the bottom row of the screen.

### 10.2 MENU DISPLAY



The main menu is displayed across the top line of the screen. Sub menus are displayed as pop down menus. Use **【←】** and **【→】** key, as defined on the bottom of the screen, to move between main menu options. Use **【↑】** and **【↓】** key to move the highlight bar on the sub menu. Press **[ENT]** key to select the highlighted sub menu option.

If the sub menu has further options they will be displayed on the side. The side menu will be displayed when Enter key is pressed. Use **【↑】** and **【↓】** key to move the highlight bar, then press **[ENT]** key to select the option.

Press **[ESC]** key to return to the higher level menu.

### 10.3 KEY INPUT



All keys are entered into screens.

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Use the cursor keys to move from one field to another.

When the cursor is on the bottom of screen, press [ENT] key to save data, then exit screen.


When in a measure option screen, the measurement can be initiated; point codes can be accepted as displayed by pressing [ENT] key.

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

When an input field is larger than the screen, the field scrolls to the left. When the field is full, further input is not accepted.

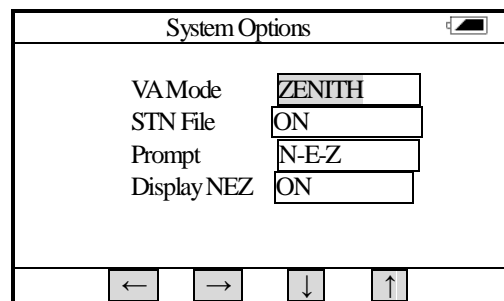
Some screens will display function keys labels, press the corresponding function keys to access the additional screen.

Alpha characters may be entered by first pressing the function key [F1] when labeled [Alpha]. This will make the Alpha character set active on the numeric keyboard. In any measuring screen or any screen that requires manually input, the [F1] will toggle between [Alpha] mode and [Num] mode on the keypad.

There are 3 letters defined on each key, once press it, one letter will be appeared. When the required letter is displayed, press  to move the cursor to next position.

For example, input "ABS" :: enter "A", press [7] key once. Move the cursor to right, input "B", press [7] key twice, ("C" requires three [7] key presses). Press [1] key, input "S".

## 10.4 OPTION SCREEN



Option screens have fixed input values, to change the options use the [←] and [→] keysto scroll through the values. When the cursor is on the bottom of the screen, press [ENT], it will be exited and all the changed parameters will be saved.

Press [ENT] key, the highlight bar will be moved to further option.

When the highlight bar is on the bottom line of screen, press [ENT] to exit and save the changes.

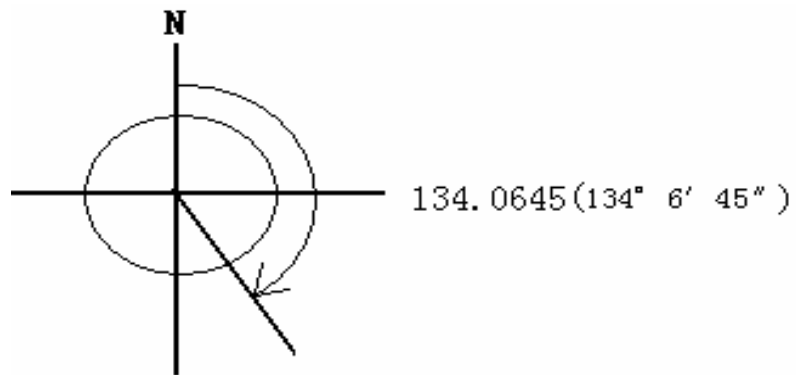
Press [ESC] to exit without saving the changes.

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## 10.5 HORIZONTAL ANGLE INPUT

The horizontal angle can be entered in Whole Circle Bearing.

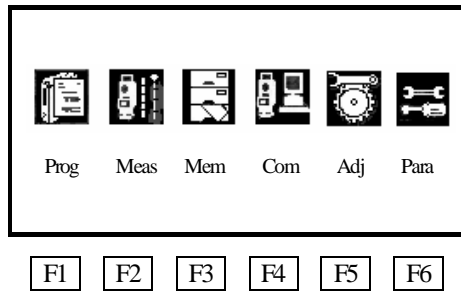
Whole Circle Bearing



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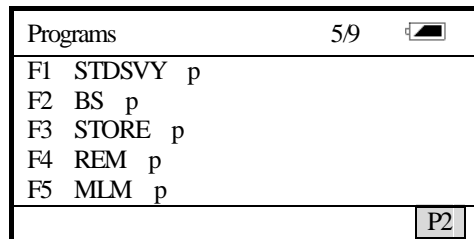
## 11 GETTING STARTED

Turn on the machine, below screen will be showed.

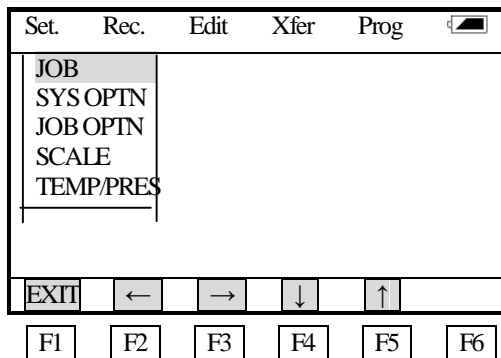


### Program Menu

Press [F1] key to enter program menu, information will be shown below.



Press [F1] key to enter standard measuring program.



EXIT (F1) : Exit the standard measuring program. (F1)

← →(F2/F3): Move the cursor to left or right.

↓ ↑(F4/F5): Move the cursor up or down.

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## 12 SETUP

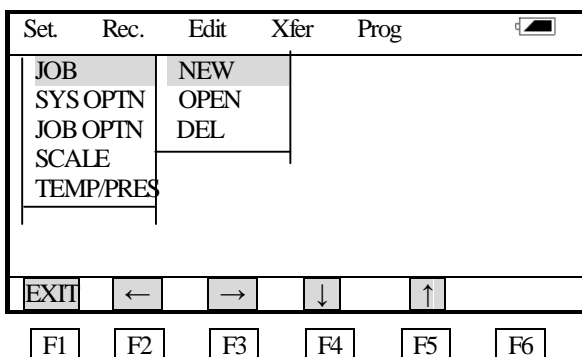
This menu allows following functions be performed :

- (1) Create, open, delete job file.
- (2) Set system
- (3) Select job
- (4) Set scale factor
- (5) Input temperature and pressure

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.

### 12.1 JOB

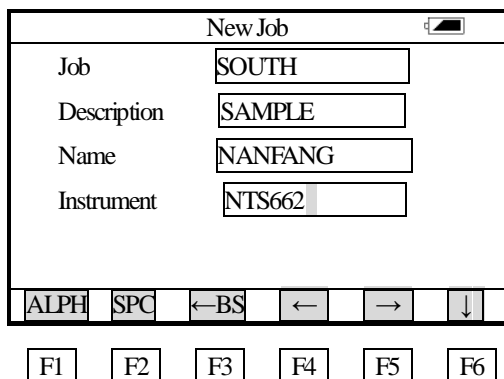
In the **【Setup】** menu, use **【↑】** or **【↓】** to select **【Job】** , press **[ENT]** key, below screen will be displayed.



Three options can be selected.

- (1) NEW : Create a job file name.
- (2) OPEN : Open an existed job file name.
- (3) DEL : Delete a job file name.

**(1) When [NEW] is selected, press [ENT] key, neither screen will be shown.**





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**ALPH (F1):** Letter locking key. Press it, it will turns to numerals locking key.

**BS (F3):** Backspace key. Use it to delete previous letter.

**Job: Job name.** All the measurement data will be stored in this file.

**Description:** Information of the project. (Can be default)

**Name:** Operator's name (Can be default)

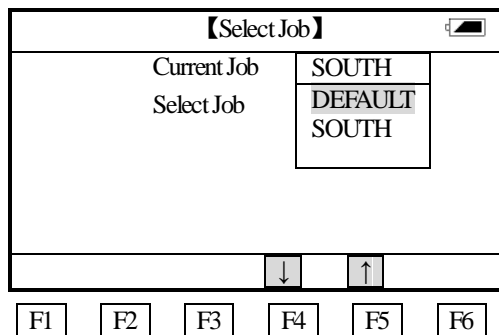
**Instrument:** The instrument model(Can be default)

A job name has a maximum of 8 characters and should be made up from the letters A-Z, numbers 0-9 and the minus sign (\_# \$ @ % + -), but the first character can not be a space.

After entering a new job name, press [ENT] key to move the cursor to the next option. Enter the instrument model, press [ENT] key when the cursor is on the bottom line of the screen to exit and save the setting. Press [ESC] key to exit the screen without saving the settings.

The new job will become the current job. If the job name already exists, the message "Job Already Exists" is displayed. Select OPEN option to see a list of current jobs before creating the new job if you are not sure which jobs currently exist.

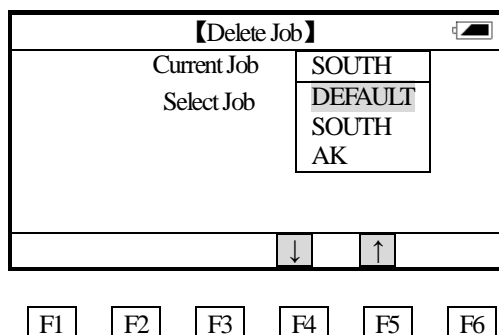
(2) When [OPEN] is selected, press [ENT] key, the screen is displayed as following.



Current job: Current job file name is displayed.

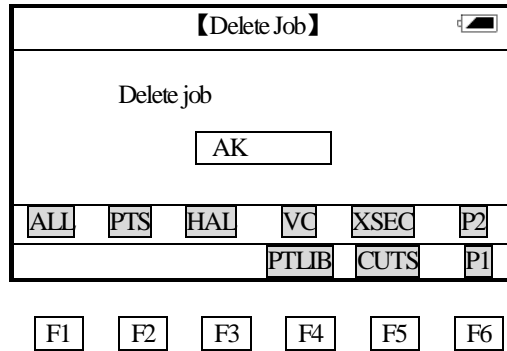
Select job: All the job file name in memory are displayed, it allows to use arrow keys to move cursor to select a file to open, press [ENT] key, the file will be opened as Job file. Press [ESC] key to abandon current selection and return to last screen.

(3) When [DEL] is selected, press [ENT] key, the screen is displayed as following.



---

To delete a job from the internal memory, move the cursor to the required file and press [ENT] key.



**Page 1:**

All (F1): Delete all files of the job which named AK (Fixed data is not included)

PTS (F2): Delete all coordinates of the job which named AK

HAL (F3): Delete the horizontal alignment data of the job which named AK

VC (F4): Delete the vertical curve data of the job which named AK

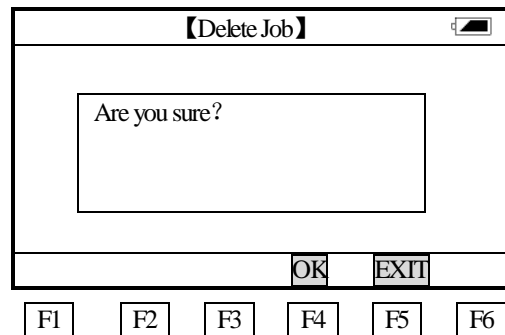
XSEC (F5): Delete the section data of the job which named AK

**Page 2:**

PTLIB (F4): Delete the fixed points data of the job which named AK (All the fixed points are stored in fixed files)

CUTS (F5): Delete the cut/fill data of the job which named AK

When the data is not existed, the screen will not be changed. Otherwise the prompt "Are you sure?" will be displayed.



Press [F4] (OK) key to delete the data to be deleted. To restore last screen, press [F5] (EXIT) key.

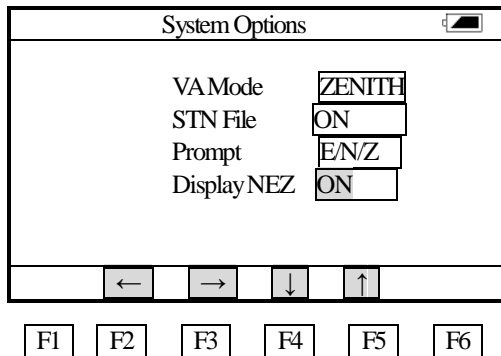
Note: (1) Current job name can not be deleted.

(2) Press [ESC] key to exit from any submenu and return to upper menu.

---

## 12.2 SYSTEM OPTIONS

In **【SETUP】** menu, choose **【Sys Optn】** by using **【↓】** or **【↑】** key, press [ENT] key to access System Options screen.



**VA Mode** : This mode specifies where vertical angles are read from, select by using (←) or (→) arrow key.

- (1) (ZENITH) The vertical angle is 90 degree face left to horizontal and decreasing towards Zenith.
- (2) (LEVEL) The vertical angle is 0 degree face left to horizontal and decreasing towards Zenith.

**Note that use** [ENT] key or up and down arrow keys to enter next setting.

**Station File (STN File)** : Set station file ON or OFF by using (←) or (→) arrow keys.

(1) If the station file option is ON when the fixed point file will be scanned for coordinates before prompting for the coordinates. When the same point number is saved in POINT or PTLIB data base, the data in POINTS is recalled and used.

(2) If the station file option is OFF, the fixed point file is not searched.

**Prompt** : Using (←) or (→) keys to set the order of coordinates : N/E/Z or E/N/Z

**Display XYZ** : If the Display XYZ is ON the coodinates are displayed.

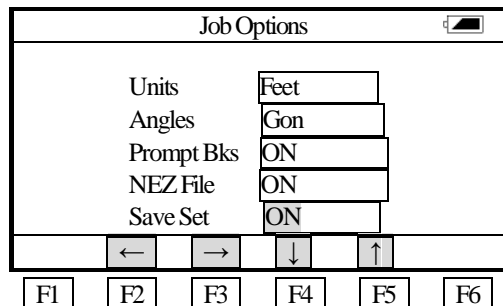
If the Display XYZ is OFF the coodinates are not displayed.

Press [ENT] key when the cursor is staying on the bottom of the screen, the selected setting will be saved in memory, then it will returns to last screen. Press [ESC] key to return to last screen without saving current setting.

**※Note that System Setting apply to all jobs, when it is changed, all jobs will be effected.**

## 12.3 JOB OPTIONS (JOB OPTN)

In the **【SETUP】** menu, using **【↑】** or **【↓】** key to select, when **【JOB OPTN】** is selected, the screen shows as below.



---

**UNITS** Set distance units : meter, feet, select by using (←) or (→) keys.

**ANGLES** Set angle units : degree, Gon, Mil, select by using (←) or (→) keys.

[Degrees] : Angles are displayed in Degrees, Minutes, Seconds.

[Gon] : : Angles are displayed and saved in Gon.

[Mil] : Angles are displayed and saved in Mil.

**PROMPT BKS** Select ON or OFF by using (←) or (→) keys. If this option is ON, the user is forced to enter a backsight point after each new occupied station, before a foresight or side shot can be taken.

**XYZ FILE** Set to calculate and store coordinates, Select ON or OFF by using (←) or (→) keys.

ON : When the measuring mode is H/V/SD or H/HD/VD mode, the coordinates will be automatically calculated and stored.

OFF : Coordinates will not be stored.

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

**SAVE SETOUT** The setting of storing setout point coordinates, Select ON or OFF by using (←) or (→) keys.

When the coordinates be saved, each point setout with design coordinates and setout coordinates and cut or fill height will be listed.

Press [ENT] key when the cursor is staying in the end of the screen, the selected setting will be saved in memory, then it will returns to last screen. Press [ESC] key to return to last screen without saving current setting.

## 12.4 SCALE FACTORS (SCALE)

In SETUP menu, choose SCALE by using 【↑】 or 【↓】 keys, press [ENT] key, scale factors inputting menu will be showed.

The screenshot shows a screen titled "Grid Factors". It has two input fields: "Scale" with the value "1.000000" and "Elevation (m)" with the value "0". Below the input fields is a row of navigation keys: a left arrow, a right arrow, a down arrow, and a left arrow with "BS". At the very bottom of the screen, there are six function keys labeled F1, F2, F3, F4, F5, and F6.

Measured horizontal distance are 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 f' is used to calculate coordinates.

---

$$f' = f \times R(R+h)$$

f: scale

h: elevation

R: The Radius of the Earth (=6372.000 m)

Press [ENT] key when the cursor is staying on the bottom of the screen, the selected setting will be saved in memory, then it will be exited. Press [ESC] key to exit without saving current setting.

**NOTE :** 1. Scale can be entered in following ranges : 0.900000 ~ 1.100000

The default value is 1.00000

2. Mean elevation can be entered in following ranges : -1000.000 ~ 10000.000

Elevation is rounded to 3 decimal places. The default value is 0.

## 12.5 TEMPERATURE & PRESSURE INPUT (TEMP/PRES)

To enter temperature and pressure select the TEMP/PRES option in the SETUP menu.

Temp/Press

TEMP (°C)

PRESS (hPa)

← → ↓ ←BS

F1 F2 F3 F4 F5 F6

Enter temperature value and press [ENT] to move the cursor to next option, enter pressure value and press [ENT] key to store the setting and exit. Press [ESC] key to exit without saving the settings.

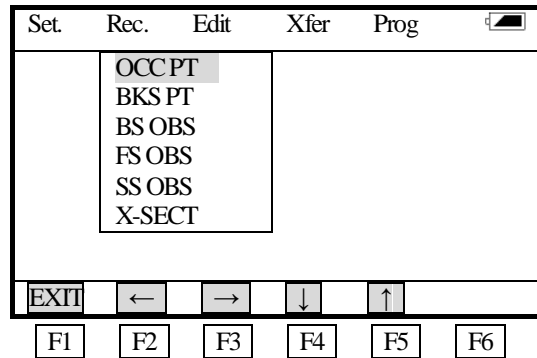
**Note :** Temperature and pressure are just stored in the raw data and never affect the PPM calculation.

If the temperature and pressure are not entered, the default temperature and pressure values will be used, their units are degree and millibar.

## 13 RECORD MENU

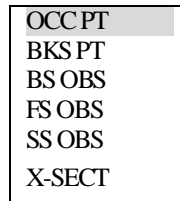
The RECORD menu allows setting occupied point and backsight bearing, start backsight observation, foresight observation, sideshot observation and cross section observation. It mainly used for collecting and recording raw data.

From standard measurement program main menu, using (←) or (→) arrow keys to select RECORD menu.



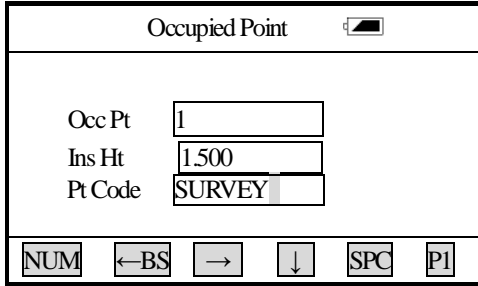
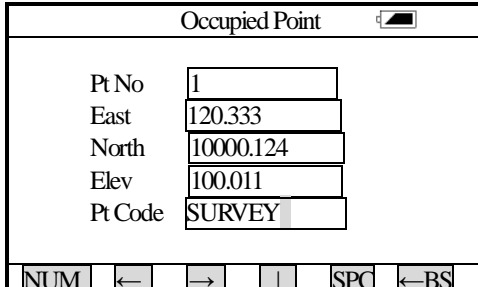
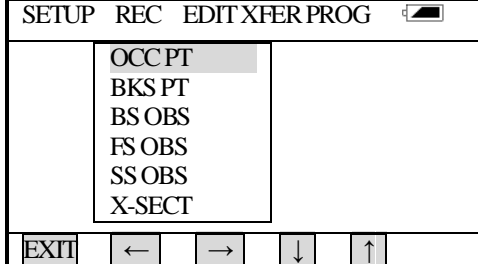
### 13.1 OCCUPIED POINT INPUT SCREEN

RECORD



#### ► Procedure

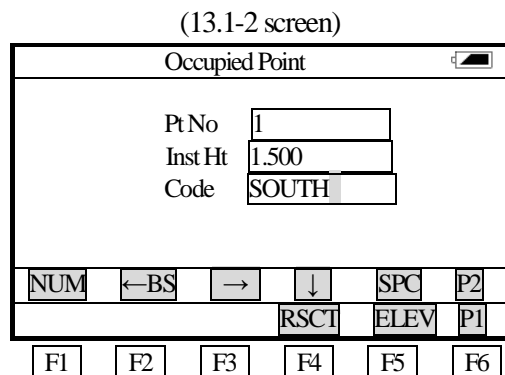
Operating Procedures	Operation	Display
① From the [RECORD] menu, select [OCC PT] and press [ENT] key to enter Occupied Point Input Screen.	OCC PT + [ENT]	

<p>② Input the point number, instrument height, point code of the occupied point and press [ENT] key, the point will be saved.</p> <p>A: If the coordinate of the point exists in the file, its coordinate will be used automatically.</p> <p>B: If the coordinate of this point is not in the point file or fixed point file, coordinates input screen will be shown: Input N(North), E(East), Z(Elevation) coordinate.</p>	<p>Input the point number, instrument height, point code of the occupied point [ENT]</p> <p>Input N, E, Z coordinate and code. [ENT]</p>	<p>A: (13.1-1 Screen)</p>  <p>B:</p> 
<p>③ Press [ENT] key when the cursor is in the bottom of the screen, the selected setting will be saved in memory. Press [ESC] key to exit without saving current setting.</p>	<p>[ENT] or [ESC]</p>	

If the point exists both in the point file and fixed point file, then coordinates from the point file will be used.

### 13.1.1 RSCT (Resection)

After inputting Pt No, Inst Ht, Pt Code in 13.1-1 screen, press [P2] (F6) key, following screen will be shown.



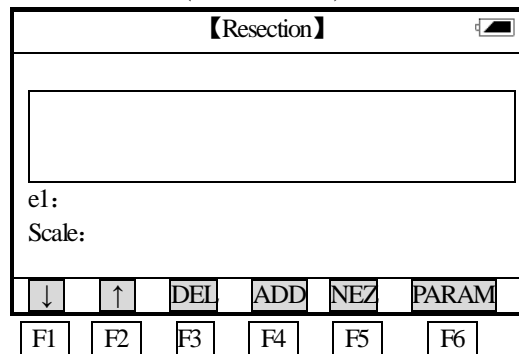
ELEV (F5): The function key for measuring the elevation of a point

RSCT (F4): The resection function key which is used to calculate the occupied point coordinate.

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.

Press [F4] (RSCT) key to access the resection screen.

(13.1-3 screen)

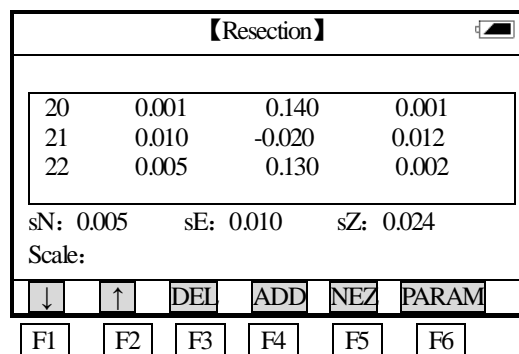


On the lower side of the screen discrepancies (e1) or the standard deviation in N, E, Z direction (sN, sE, sZ) of the occupied point will be displayed. Discrepancies will be shown in case two distance measurements have been performed. They are calculated using the following equations.

$$e1 = HD12 \text{ (Calculated using measurements)} - HD12 \text{ (Calculated using known coordinates)}$$

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

On the upper side of the screen a box is shown, which will contain the number of the points to which measurements have been performed and the residuals of these measurements. The box is empty since no measurements have yet been performed.



Press [ADD] to add a new measurement to the list of resection measurements. The following screen



will be shown. Enter the correct point number, by pressing [MODE] the measuring mode can be changed.

【Resection】

Pt No	20	HA	123.4563
R Ht	1.336	VA	46.8723
		SD	>>

NUM ←BS → ↓ MODE MEAS

F1 F2 F3 F4 F5 F6

By selecting [MEAS] a measurement will be performed, but this measurement will not be saved and will not be used for the resection calculation. In order to perform a measurement which will be added to the list of measurements, press [ENT] key. If the coordinates of this point are still unknown, the user will be asked to enter these coordinates. Again the main resection screen will be shown, but now the point number to which has been measured is shown in the box.

In case 3 angle measurements or 2 angle and distance measurements have been performed, the coordinates of the occupied point can be displayed by pressing [NEZ]. The box on the right will contain point numbers as well as residuals.

【Resection】

N	4.469	0.140	0.001
E	0.020	-0.020	0.012
Elev	0.106	0.130	0.002
		0.010	sZ: 0.024

Scale:

↓ ↑ DEL ADD NEZ PARAM

F1 F2 F3 F4 F5 F6

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 selecting [PARAM], the parameters which are calculated during resection can be selected. The following screen will be shown.

【Resection】	
Calculate level	OFF
Store res meas	OFF
Calculate scale	OFF
Store scale	OFF
Calculate Bkb	OFF
<input type="button" value="←"/> <input type="button" value="→"/> <input type="button" value="↓"/> <input type="button" value="↑"/>	
<input type="button" value="F1"/> <input type="button" value="F2"/> <input type="button" value="F3"/> <input type="button" value="F4"/> <input type="button" value="F5"/> <input type="button" value="F6"/>	

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. Pressing [ENT] key when the cursor is at the bottom line results in returning to the main resection screen, saving the changes made and (re)calculation of the occupied point, residuals and the required parameters. Press [ENT] in case the main resection screen is shown will result in leaving this screen and saving of 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.

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:

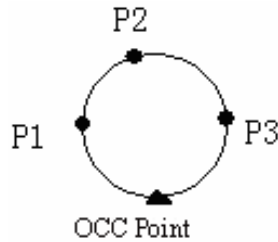
- 1) The residuals of the horizontal angle should have low values.
- 2) The user shouldn't change the horizontal angle when leaving the main resection screen.

**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."

Eg: If p1, p2, p3 and OccPt fall on the circle, the result can not be computed. 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 is always displayed in decimals. Eg : 3°49'50" shows as 3.830.

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

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.

$\Delta H$ : the residual of horizontal angle.  $\Delta V$ : the residual of vertical angle

$\Delta SD$ : the residual of slope distance.

**NOTE: The residuals which will be shown depend on the measuring mode and whether elevation is calculated.**

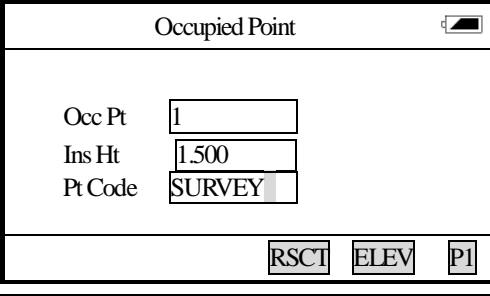
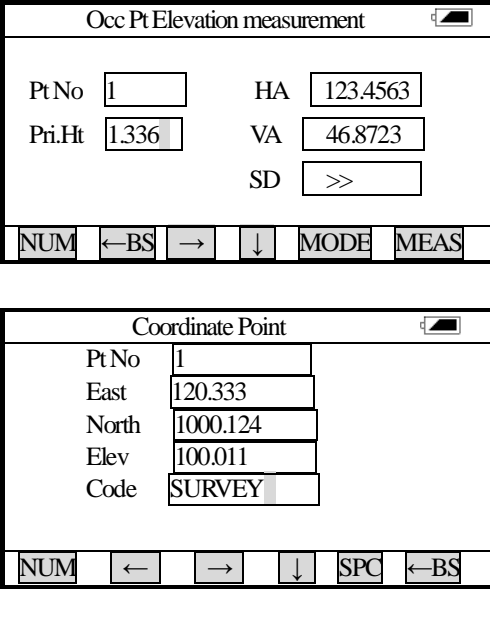
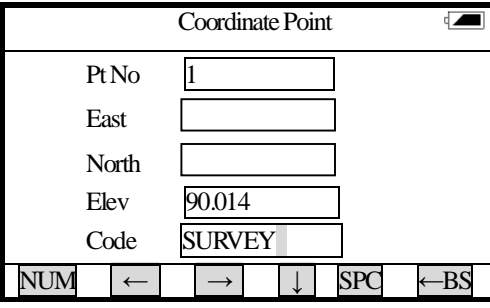
	Calc. Elevation : ON	Calc. Elevation : OFF
Meas Mode : H/V/SD	$\Delta H$ , $\Delta V$ , $\Delta SD$	$\Delta H$
Meas Mode : H/V	$\Delta H$ , $\Delta V$	$\Delta H$

### 13.1.2 ELEV (Station Elevation)

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.

#### ► Procedure

Operating Procedures	Operation	Display
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<p>①After setting Occ Pt num, inst height, Pt Code in Occupied Point screen, press [F6](P1) key.</p>	<p>[F6]</p>	
<p>② Press [F5] (RSCT) to access right screen. Input the Pt Num of the known point and target height, press [ENT] key to start measuring.</p> <p>If the coordinate of this point is not known, coordinate input screen will be shown, enter the coordinate and press [ENT] key to store it.</p>	<p>[F5]</p>	
<p>③The result shows on the screen.</p>		

### 13.2 BACKSIGHT POINT INPUT SCREEN

After inputting the occupied point details, you can enter your backsight station details. The Backsight Point Input Screen is used to set the backsight point, and backsight bearing.

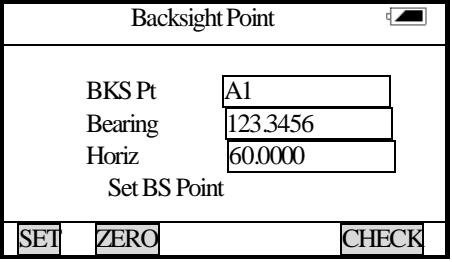
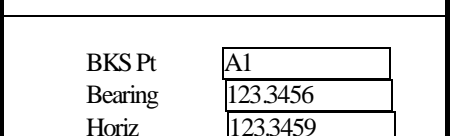
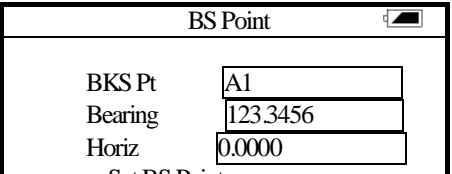
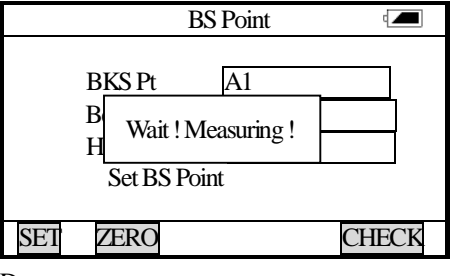
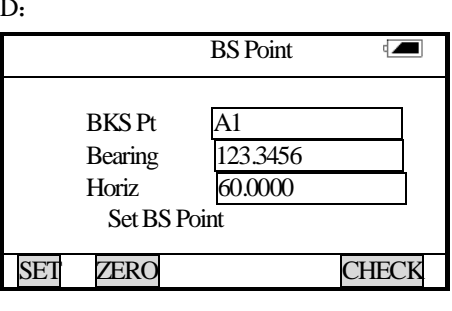
#### RECORD

OCC PT
BKS PT
BS OBS
FS OBS
SS OBS
X-SECT

Select BKS PT from the RECORD menu and press [ENT] key. After setting occupied point, Backsight Point Input Screen will be shown.

► **Procedure**

Operating Procedures	Operation	Display
<p>① Input the backsight point number and press [ENT], if store the coordinate of this point, it will shows to calculate the bearing.</p> <p>A: If the coordinate of the point does not exist in memory, the backsight point input screen will be shown, then input coordinate.</p> <p>Or when the A screen is shown.</p> <p>B: press [ESC] key to skip this screen to enter the bearing manually input screen.</p> <p>Enter the backsight point number and back bearing, as right screen.</p>	<p>Input the backsight point number and prism height.</p> <p>[ENT]</p> <p>Input the N, E coordinates of backsight point.</p> <p>Input the backsight point number and bearing.</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Backsight Point <span style="float: right;">☰</span></p> <hr/> <p>Pt No <input style="width: 50px;" type="text" value="A1"/></p> <p>Pris.Ht <input style="width: 50px;" type="text" value="1.500"/></p> <p style="text-align: center;">NUM ← → ↓ SPC ←BS</p> </div> <p>A:</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p style="text-align: center;">Backsight Point <span style="float: right;">☰</span></p> <hr/> <p>Pt No <input style="width: 50px;" type="text" value="1"/></p> <p>East <input style="width: 50px;" type="text" value="120.333"/></p> <p>North <input style="width: 50px;" type="text" value="10000.124"/></p> <p>Elev <input style="width: 50px;" type="text" value="100.011"/></p> <p>Code <input style="width: 50px;" type="text" value="SURVEY"/></p> <p style="text-align: center;">NUM ← → ↓ SPC ←BS</p> </div> <p>B:</p> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Backsight Point <span style="float: right;">☰</span></p> <hr/> <p>Pt No <input style="width: 50px;" type="text" value="A1"/></p> <p>Bearing <input style="width: 50px;" type="text" value="123.3456"/></p> <p style="text-align: center;">NUM ← → ↓ SPC ←BS</p> </div>

<p>②After inputting backsight bearing, press [ENT] key to access following screen. (In the backsight point coordinate input screen, after inputting the coordinate, press [ENT]key, the screen also will be shown.)</p>	<p>[ENT]</p>	
<p><b>Bearing:</b> it is calculated bearing or manually inputted bearing.</p>		<p>A:</p>
<p><b>HorizontalAngle:</b> It is current horizontal angle shows on instrument.</p>	<p>[F1]</p>	
<p>A: Press [F1](set) key to set the back bearing on the instrument,</p>		<p>B:</p>
<p>B: Press [F2](Zero) to set Zero on the instrument.</p>	<p>[F2]</p>	
<p>Press [ENT] key to exit the screen and set the back direction to 0. Press [ESC] key to return to last screen.</p>		<p>C:</p>
<p>C: If press [F3](Check) key, backsight point coordinate will be checked by measuring the slope distance of backsight point.</p>	<p>[F2]</p>	
<p>D: When [ENT] key is pressed, the current horizontal angle is recorded as the initial backsight direction, and use for coordinates calculation.</p>	<p>[ENT]</p>	<p>D:</p> 

<p>③Set backsight point, the screen return to main menu. Press [ESC] key to exit current program without saving.</p>	<p>[ENT] or [ESC]</p>	
--	-------------------------------	--

Once you have set the backsight point number and the back bearing, the instrument will be orientated and ready to measure,

### 13.3 BACKSIGHT OBSERVATION (BS OBS)

Use to record the raw data of backsight point.

#### RECORD

OCC PT
BKS PT
BS OBS
FS OBS
SS OBS
X-SECT

From RECORD menu, select BS OBS, press [ENT] key, following screen will be shown.

BS OBS			
PtNo	R01	HA	123.4563
Prism Ht	1.336	VA	46.8723
NUM	←BS	→	↓
MEAS	P2		
F1	F2	F3	F4
F5	F6		

After inputting correct prism height of baksight point, (Prism height is needed only in elevation measuring), press [ENT] key, the angle and Pt No of BS OBS will be stored, when backsight angle is recorded, this angle will be used in after coordinate calculation, it will return to RECORD menu screen.

[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.

---

## 13.4 FORESIGHT OBSERVATION (FS OBS)

The data of Foresight Observations mainly used for the traverse adjustment calculation.

### RECORD

OCC PT
BKS PT
BS OBS
FS OBS
SS OBS
X-SECT

After setting Occ point and Bs point, the measuring should begin. From the RECORD menu, select FS OBS, press [ENT] key to enter FS OBS screen.

Foresight Point OBS			
PtNo	<input type="text"/>	HA	<input type="text" value="123.4563"/>
Pr. Ht	<input type="text"/>	VA	<input type="text" value="46.8723"/>
Code	<input type="text"/>	SD	<input type="text" value="1.2300"/>
NUM	←BS	→	↓
MEAS	P2		
LIB		NOTE	MODE
P1			

F1   F2   F3   F4   F5   F6

After entering foresight point number, press [F4] (↓) key, enter prism height, press [ENT] key to start foresight observations and record the result. If press [F5](MEAS) key, measuring also will be started but the result will not be stored in memory.

Function keys: [F1] used to switch [NUM]/ [ALPHA], [F2] to [F4] are arrow keys, [F5] is measuring key, when [F6]([P2]) is pressed, you can get menu page 2.

Measuring screen switch function [P2](Page 2) presented following function keys :

### 1) LIB

The LIB function allows codes to be selected from the point code lib. (Refer to 14.4). Press the related function keys, select a code from codes lib, the stored codes list will be shown. Use arrow keys to select the required codes. When the code you wish to use is highlighted, press [ENT] key to select it and return to measuring screen. The code will be placed in point codes area.

### 2) NOTE

Press this key to enter NOTE screen.



NOTE Input					
NOTE <input type="text" value="GFG"/>					
ALPH	←	→	↓	SPC	←BS
F1	F2	F3	F4	F5	F6

Use to note the details of the point.

### 13.5 SIDESHOT OBSERVATION (SS OBS)

#### RECORD

OCC PT
BKS PT
BS OBS
FS OBS
SS OBS
X-SECT

After setting Occ point and Bs point, the measuring should begin. From the RECORD menu, select SS OBS, press [ENT] key to enter SS OBS screen.

SS OBS					
Pt No	<input type="text" value="2"/>	HA	<input type="text" value="123.4563"/>		
Pr. Ht	<input type="text" value="1.600"/>	VA	<input type="text" value="46.8723"/>		
Code	<input type="text" value="STN"/>	SD	<input type="text" value="1.2300"/>		
String	<input type="text" value="001"/>				
NUM	←BS	→	↓	MEAS	P2
EDIT	CTRL	OFFS	NOTE	LIB	P3
HV.R	MODE	PLANE	PTL	P1	
F1	F2	F3	F4	F5	F6

After entering the point number, prism height, code, string number, press [ENT] key to start measuring, the data of the point will be stored. If press [MEAS](F5) key, the measurement also can be started, but the point data will not be recorded. If now press [ENT] key, the coordinate of this point will be calculated, displayed and recorded. If the point exists, it will prompts you if to overwrite the point. Press [ENT] key to overwrite the point and record, then back to SS OBS screen, the point number will be added 1 automatically, press [ESC] key to exit SS OBS screen.

[P2 (F6)]: This function key used to turn to the page 2 of the menu.

EDIT [F1]: This function is similar to [Raw Data] in [edit] menu. Refer to 14.1.

CTRL [F2]: This function key is used to edit the string number and the additional code of the point.

---

### 13.5.1 OFFS ([F3] key)

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

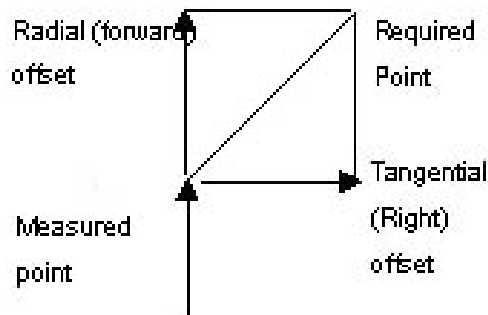
Record an observation as close as possible to the required point. Press the key [OFFS] key from the measurement screen, the offset measurement screen will be shown.

OFFSET	
Away	2.000
Right	0.000
Vertical	1.000
HORZ	VERT
→	↓
←BS	

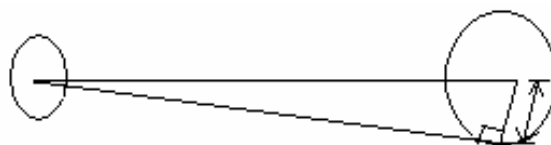
F1   F2   F3   F4   F5   F6

Offsets may be entered manually if measured by tape, or computed by measuring a second angle to the required point. Press [ENT] key to move the cursor to the next option. When the cursor is on the bottom line of the screen, press [ENT] key to record the setting and exit. Press [ESC] key to exit without saving.

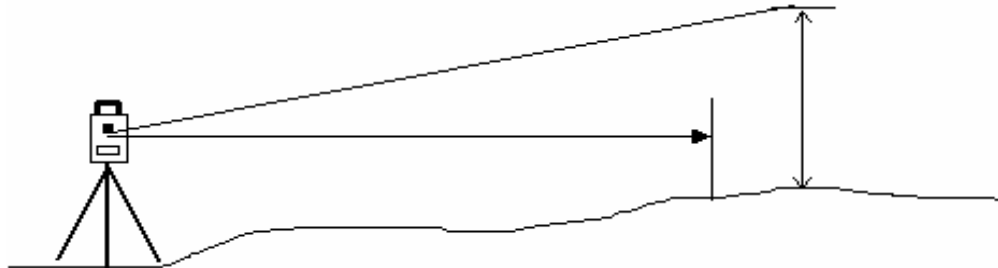
A radial (forward) offset is along the line of sight, with positive away from the instrument, and a tangential (right) offset is perpendicular to the line of sight with positive to the right, as viewed from the instrument. A vertical offset is positive upwards.



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 [HORZ] to read the horizontal angle. A perpendicular offset from the original line of sight will be computed and entered to the screen.



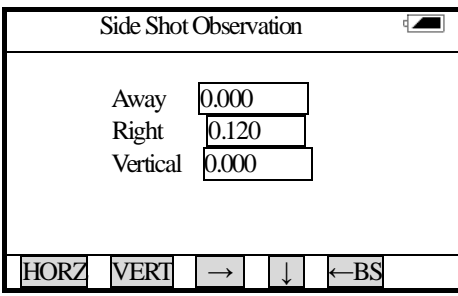
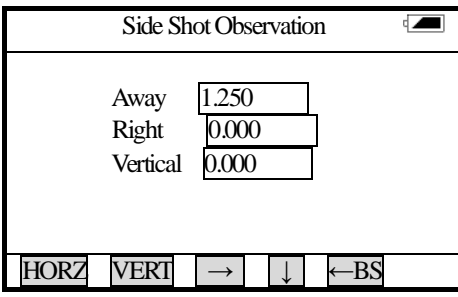
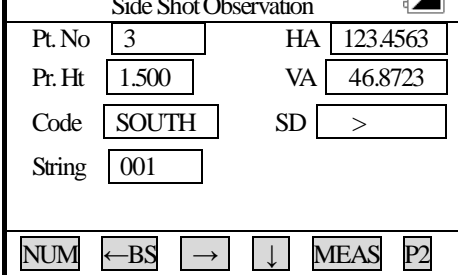
To compute a vertical offset (remote elevation), make an observation to an accessible point above or below the point required. When in the offset screen, sight the point required, and press [VERT]. The vertical angle will be used to compute the difference in elevation from the ground to the point above 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 [OFFS].



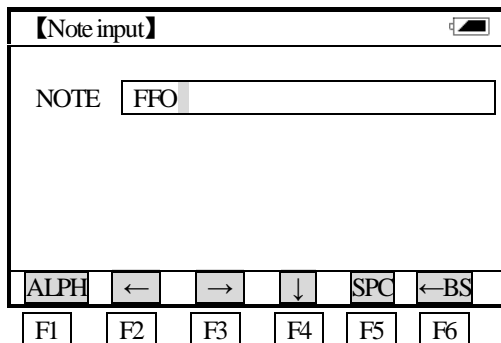
**[OFFS] (F3):** The function key used to add an offset to record. To record offset observation, use [MEAS] key to record the point (don't press [ENT] key ), then press [P2] key to show the page 2 of the menu, press [OFFS] key, the procedure is as follows :

► **Procedure**

Operating Procedures	Operation	Display
① From RECORD, select [SS OBS], right screen will be shown. Sight to prism, press [F5](MEAS), the slope distance from occupied point to prism point will be shown.	Choose [SS OBS] [F5]	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right;">Side Shot Observation <span style="float: right;">☰</span></p> <hr/> <p>Pt. No <input type="text" value="2"/>      HA <input type="text" value="123.4563"/></p> <p>Pr. Ht <input type="text" value="1.500"/>      VA <input type="text" value="46.8723"/></p> <p>Code <input type="text" value="SOUTH"/>      SD <input type="text" value="&gt;"/></p> <p>String <input type="text" value="001"/></p> <hr/> <p>NUM   ←BS   →   ↓   MEAS   P2</p> </div>
② Keep the instrument still, press [F6](P2), [OFFS] key is shown, press [F3](OFFS) key, right screen will be shown.	[F6] [F3]	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right;">Side Shot Observation <span style="float: right;">☰</span></p> <hr/> <p>Away <input type="text" value="0.000"/></p> <p>Right <input type="text" value="0.000"/></p> <p>Vertical <input type="text" value="0.000"/></p> <hr/> <p>HORZ   VERT   →   ↓   ←BS</p> </div>

<p>③</p> <p>A: Collimate offset target point, press [F1](HORZ) key or [F2] (VERT) key, the offset value will be computed and displayed on screen. (If the offset value is input manually, you don't need to sight target point)</p> <p>B: Manually input away value (along instrument sight line). Press [F1] (HORZ) key or [F2] (VERT) key to show the corresponding offset value.</p> <p>Right : The offset value for right/left direction. (corresponding [HORZ] key).</p> <p>Vertical: the offset value for vertical direction. (Corresponding [Vert ] key).</p>	<p>Collimate</p> <p>Offset</p> <p>Target</p> <p>Point</p> <p>[F1] (or F2)</p> <p>Input away</p> <p>[F1] (or F2)</p>	<p>A:</p>  <p>B:</p> 
<p>④ Press [ENT]key to complete offset measurement.</p> <p>Press [ENT] key again, the measuring result will be shown.</p>	<p>[ENT]</p>	

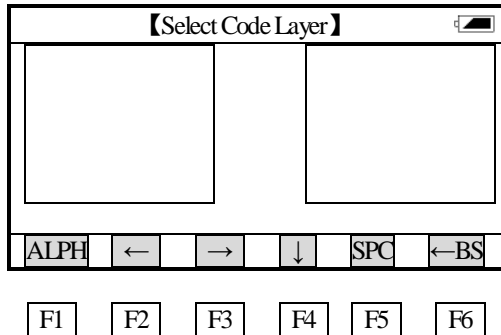
**NOTE (F4):** This function key is used to note some man-made information of the point.



---

After entering the information, press [ENT] key to record and restore the “Side Shot measurements screen.”

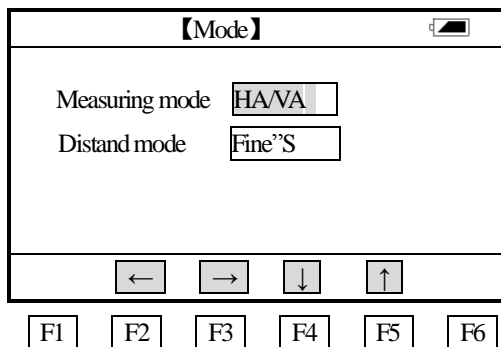
**CODE (F5):** This function key is used to select codes in code library or a layer.



**MORE (F6):** Display the function keys in the page 3 of the menu, the screen shows [HVR], [MODE], [PLAN], [PTL].

**HVR (F1):** This function key is used to record the angle data of original measurement.

**MODE (F4):** This function key is used for setting measurement mode, after pressing it, the screen displays as following.



**Using arrow keys to set mode:**

There are 3 distance measurement methods:

HA/VA/SD (Horizontal angle/vertical angle/slope distance)

HA/VA (Horizontal angle/vertical angle)

HA/HD/VD (Horizontal angle/horizontal distance/height difference)

There are 3 distance measurement modes: Fine single, Fine repeat, Tracking.

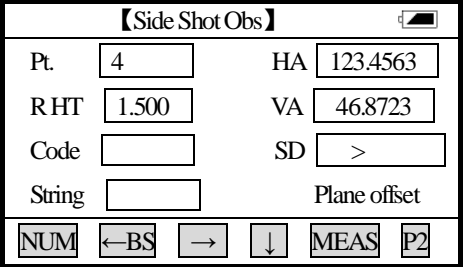
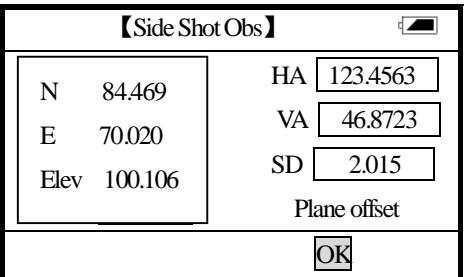
After selecting mode, when the cursor is on the bottom line, press [ENT] key to save the setting and exit. To exit without saving, press [ESC] key.

### 13.5.2 Plane ([F4] key)

This mode is similar with **【PROG】** → **【OFFSET】** → **【PLANE】** .

#### ►Procedure

Operating Procedures	Operation	Display
①Select [SS OBS] in [Record], and press [F6] (MORE) key, the page 3 menu is displayed.	Select [SS OBS] [F6]	
②Press [F4] (PLAN). Press [REF] to determine the reference plane. Press [Cancel] to restore the “Side Shot screen.”	[F4]	
③Press [F3] (REF). The [Plane Offset] menu is displayed, measure any 3 point on the plane to determine the plane to be measured. The procedure is same as [Plane Offset] in [Offset Measurement], refer to 5.8.3.	[F3]	
④When the three points are measured, press [F3] (REF) to define the reference plane again.		
⑤Press [ON] or [ENT] to determine that the reference plane has been defined, now begin the “plane offset measurement.” (The screen is same with the “Side Shot Measurement screen”, but there is a “Plane offset” displayed)	[ENT]	

<p>⑥ Sight the target point, press [ENT] key to perform plane offset measurement. If press [MEAS] key, the plane offset measurement function will be cancelled. To turn the function off, press [PLAN], and press [OFF]. “plane offset” will never be displayed in the “Side Shot Measurement screen.”</p>	<p>Sight target point [ENT]</p>	
<p>⑦ The results is displayed on the left side of the screen, press [F5] (OK) to accept it. To measure it again, press [ESC].</p>	<p>[F5] or [ESC]</p>	

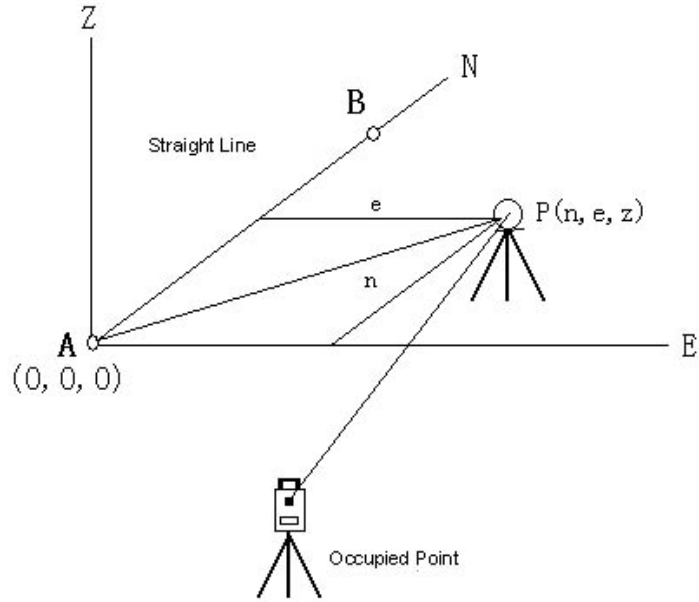
See the functions of [ON], [OFF] in the step 4 screen:

[ON] (F5): This function key is used for showing “plane offset” in the “Side Shot Measurement screen.”

[OFF] (F6): This function key is used for turning “plane offset” off in the “Side Shot Measurement screen.”

### 13.5.3 PTL (For Measurement from Point to Line) ([F5] key)

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



A: reference point 1

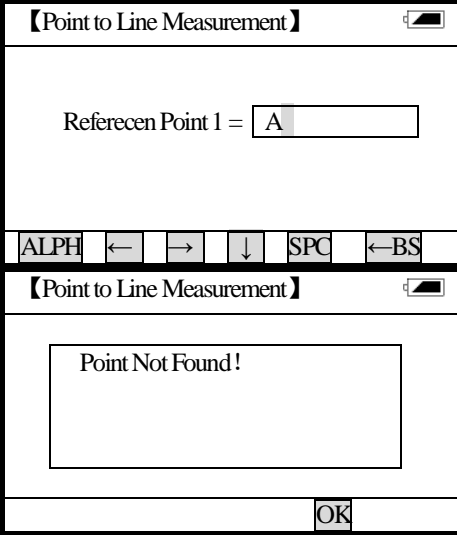
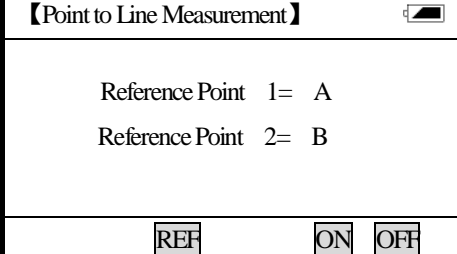
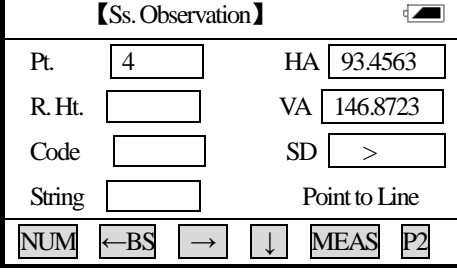
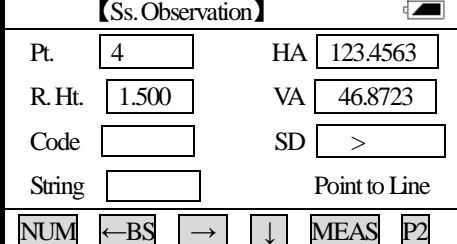
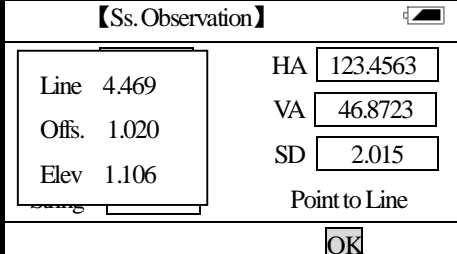
B: reference point 2

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.)

► Procedure

Operating Procedures	Operation	Display
① Measure coordinates of Point A, B, record in the memory. Select Ss. Obs. → Point & Line.	Select [Ss. Obs.] Then [F6] (Next) [F5] (PL)	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right;"><b>【Ss. Observation】</b> <span style="float: right;">☰</span></p> <p>Pt. <input type="text" value="4"/> HA <input type="text" value="123.4563"/></p> <p>R. Ht. <input type="text"/> VA <input type="text" value="46.8723"/></p> <p>Code <input type="text"/> SD <input type="text" value="&gt;"/></p> <p>String <input type="text"/></p> <p style="text-align: center;">[HVR] [MODE] [PLANE] [PL] [P2]</p> </div>
② Enter PL Measurement Mode, press [F3] (REF), determine the reference points.	[F3]	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: right;"><b>【Point to Line Measurement】</b> <span style="float: right;">☰</span></p> <p style="text-align: center;">Reference Point 1=</p> <p style="text-align: center;">Reference Point 2=</p> <p style="text-align: center;">[REF] [ON] [OFF]</p> </div>



<p>③ Enter the point number of reference point 1 (here A is referred to reference point), and this point should exist in the memory.</p> <p>If the point does not exist, it displays "Point Not Found!" Press [OK], input the point again; press [ENT] and save the point in memory then do the same with the second point, input the point number then press [ENT].</p>	<p>Enter point number of reference point</p> <p>[ENT]</p>	 <p>The screenshot shows two screens. The top screen is titled '【Point to Line Measurement】' and displays 'Referecen Point 1 = A' with a text box containing 'A'. Below it is a control bar with buttons: ALPH, left arrow, right arrow, down arrow, SPC, and left arrow+BS. The bottom screen is also titled '【Point to Line Measurement】' and displays 'Point Not Found!' in a large box, with an OK button at the bottom right.</p>
<p>④ It will display the defined reference points. (Press [F3](REF) and define new reference points.</p>		 <p>The screenshot shows the '【Point to Line Measurement】' screen with 'Reference Point 1= A' and 'Reference Point 2= B' displayed. At the bottom, there are buttons for REF, ON, and OFF.</p>
<p>⑤ Press [ENT] and set the defined reference points. Return to the Pooint to Line Measurement Mode, this screen is just the same as that of Side Shot Observation, except for an addition of Point to Line Mode</p>	<p>[ENT]</p>	 <p>The screenshot shows the '【Ss. Observation】' screen with the following fields: Pt (4), HA (93.4563), R. Ht. (empty), VA (146.8723), Code (empty), SD (&gt;), String (empty), and Point to Line. The control bar at the bottom includes NUM, left arrow+BS, right arrow, down arrow, MEAS, and P2.</p>
<p>⑥ Collimate the prism, press [ENT] then conduct the measurement of point to line.</p>	<p>[ENT]</p>	 <p>The screenshot shows the '【Ss. Observation】' screen with the following fields: Pt (4), HA (123.4563), R. Ht. (1.500), VA (46.8723), Code (empty), SD (&gt;), String (empty), and Point to Line. The control bar at the bottom includes NUM, left arrow+BS, right arrow, down arrow, MEAS, and P2.</p>
<p>⑦ The result will display in the left side of screen. Press [F5] (OK), keep the result; if for re-measurement, press [ESC].</p> <p>Line: parallel to the reference line Offs: vertical to the reference line.</p>	<p>[F5] or [ESC]</p>	 <p>The screenshot shows the '【Ss. Observation】' screen with the following fields: Line (4.469), Offs. (1.020), Elev. (1.106), HA (123.4563), VA (46.8723), SD (2.015), and Point to Line. An OK button is at the bottom right.</p>

---

Regarding procedure 4, check below:

[ON](F5): it is used to activate Point to Line Mode.

[OFF](F6): it is used to disable the Point to Line Mode.

## 13.6 CROSS SECTION SURVEY

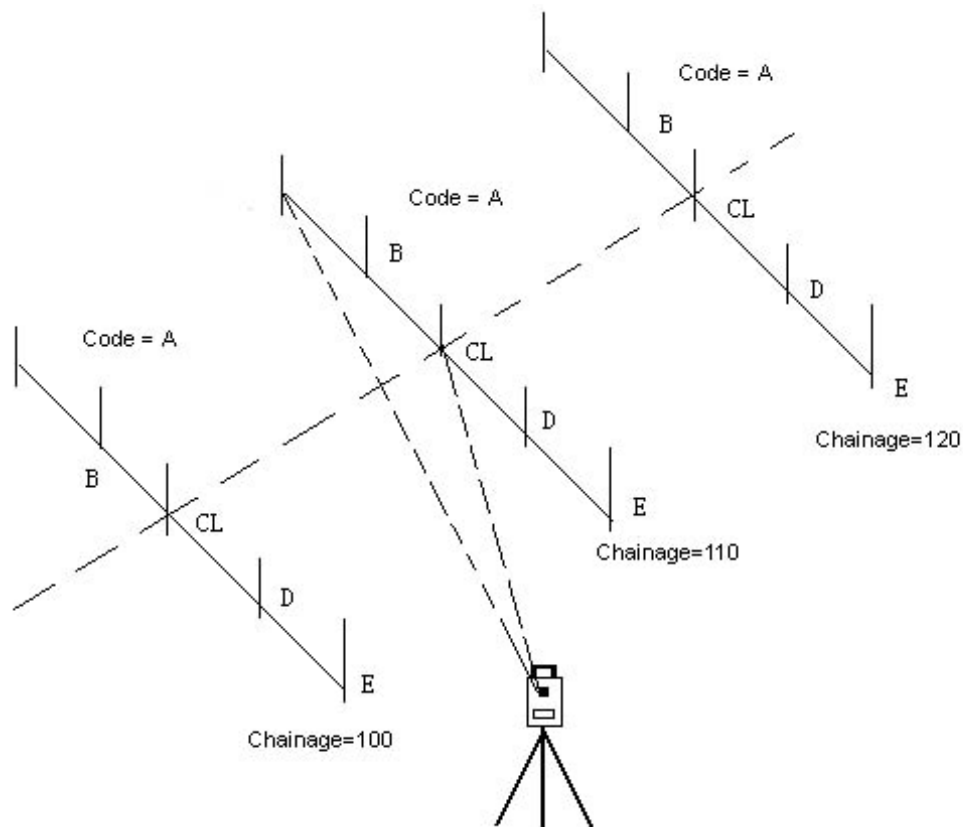
The cross section survey allow points on a cross section to be surveyed and downloaded in chainage, offset and level format.

It operates similar to the side shot observation. Every cross section must have a center line point to compute the chainage and offsets.

From the **RECORD** menu using arrow keys to select **X-sect**.

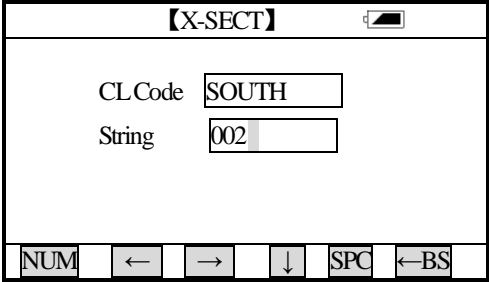
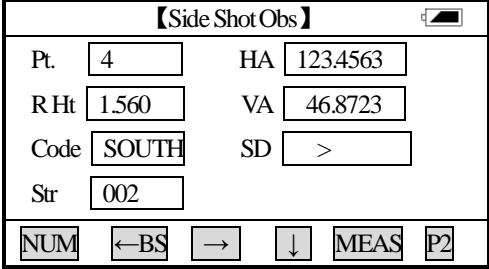
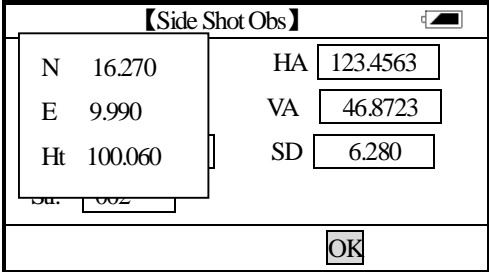
**RECORD**

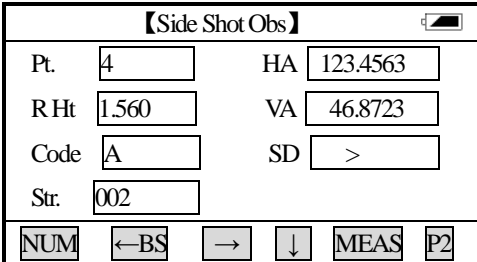
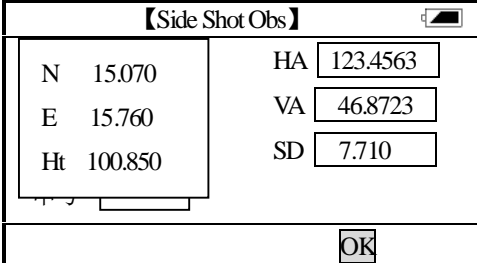
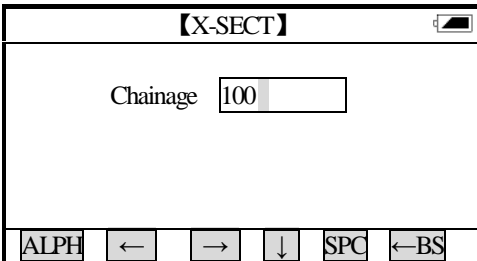
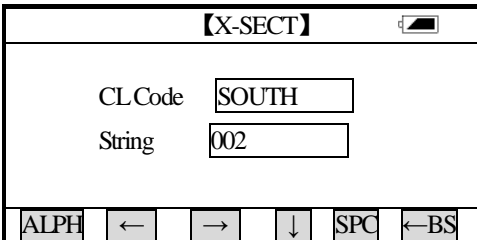
OCC PT
BKS PT
BS OBS
FS OBS
SS OBS
<b>X-SECT</b>



**►PROCEDURE**

Set occupied point and backsight point.

Operating Procedures	Operation	Display
<p>①From RECORD, select X-SECT, refer to right screen. Input the center line code, press [ENT] to move the cursor to next option, input the string number of center line. When the cursor is in the bottom of the screen, press [ENT] to exit and save the setting. Press [ESC] to exit without saving.</p>	<p>Input mid-line point and string</p>	
<p>②The screen shows as right diagram, X-section measuring is started. The point on the center line will be firstly measured, input the center line code ( This code must be same as the code in last screen ). Press [ENT] key to start measuring. This screen is the same as that of the Side Shot Observation. Press [ENT] and start Cross Section Measurement, keep the data. If pressing the MEAS key only, the data will not be stored in memory.</p>		
<p>③Display the point result of mid-line. Press [F5](OK) to save the result.</p>	<p>[F5]</p>	

<p>④ Input the required codes of every point on the cross section, press [ENT] to start measurement.</p>	<p>[ENT]</p>	
<p>⑤ Display the measured result, press [F5] (OK) and record the cross section; if for re-measurement, press [ESC].</p>	<p>[F5]</p>	
<p>⑥ Use the same way to record the points on the cross section, record then press [ESC] to finish Cross Section Measurement, it will display the Chainage number. (The first chainage number must be input by hand, the following chainages can be calculated.) Press [ENT] to keep the value.</p>		
<p>⑦ When the cross section is saved, the screen will display the code of mid-line and string. Press [ENT] to record the same code or input new code, press [ESC] to exit Cross Section record option), then enter cross section measurement mode. Refer to procedures 4.</p>		

**[NOTE]:**

- (1) The maximum point number for each cross section is 60.
- (2) The chainage number automatically displayed is calculated as the horizontal distance from its occupied point to its center.

---

## 14 EDIT DATA

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

### 14.1 RAW DATA

To edit the raw data from the current job select **RAW** from the **EDIT** menu. Then press [ENT] key.

EDIT

RAW
POINTS
PTLIB
CODE
CUTS

The last point recorded will be displayed.

Edit Raw Data					
FsPt	12	HR	140.1541		
Tgt. h	1.500	VR	65.2013		
Code	SOUTH	SD	12.354		
STRT	END	FIND	PREV	NEXT	P1
NUM	←BS	→	↓	SPC	P2
F1	F2	F3	F4	F5	F6

Press [PREV] to display the previous record, and [NEXT] to go to the next record.

To go to the beginning of the file press the function [START].

To return to the end of the file press the function key [END].

To find a specific point, code or string in the file, press the function key [FIND].

To return to the main menu of the file press the function key [ESC].

Press [ENT] key to move to cursor to the next option. Press [ENT] key when the cursor is on the bottom line of the screen to exit and save the settings. Press [ESC] key to exit the screen without saving the settings. Date, Time and measurement data cannot be changed.

Edited data is kept in the raw data file. It can not be accessed by the EDIT function.

- 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.

### 14.2 POINT DATA

The coordinates generated from the current job may be edited or point coordinates may be manually entered using the edit points function.

---

## EDIT

RAW
POINTS
PT LIB
CODE
CUTS

The last point of the file will be displayed. If there is no point, the blank screen will be displayed and points can be entered manually. The Edit-points screen of a NEZ point has the following structure:

【Edit Points】					
PtNo	A1				
N	1004.662				
E	1213.521				
Z	35.451				
Pt Code	PT				
START	END	FIND	PREV	NEXT	P1
NUM	←BS	→	↓	SPC	P2
F1	F2	F3	F4	F5	F6

Press [PREV] and [NEXT] to move through existing points in the file. When [NEXT] or [ENT] key is pressed at the last point of the file, a new point can be created and the following screen will be shown:

【Edit Points】	
Add a new point?	
OK	CANCEL
F4	F5

Press [OK] or [ENT] to input new coordinates. [NEXT] or [ENT] key after inputting a new record will save the data and increment the point number ready for the next point.

To go to the beginning of the file press the function [START].

To return to the end of the file press the function key [END].

To find a specific point, code or string in the file, press the function key [FIND].

To return to the main menu of the file press the function key [ESC].

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

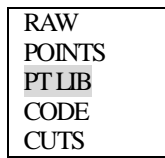
2. Coordinates that are entered or changed are rounded to 3 decimal places.

---

### 14.3 FIXED POINT DATA

To edit the coordinates of control point.

EDIT

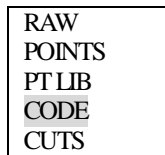


To edit the fixed point library select Pt-LIB from the EDIT menu. Editing the fixed point data is similar to editing POINTS in the EDIT menu.

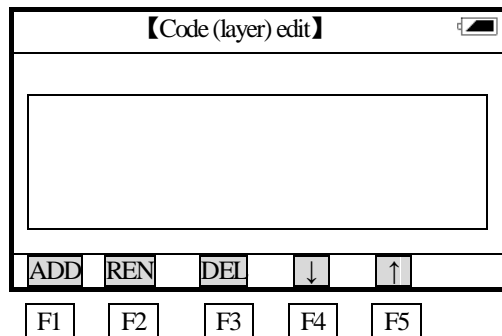
### 14.4 CODE LIBRARY

To edit the code library select CODE from the EDIT menu.

EDIT



To create a new layer, first select [ADD] and enter the layer name.



[ADD](F1): Add a layer.

[REN](F2): Rename a layer.

[DEL](F3): Delete a layer.

### Create new layer

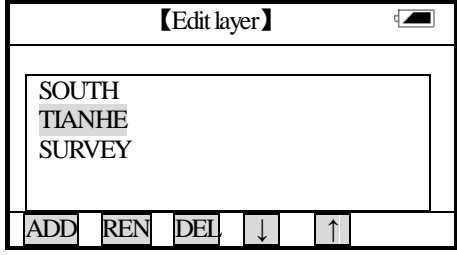
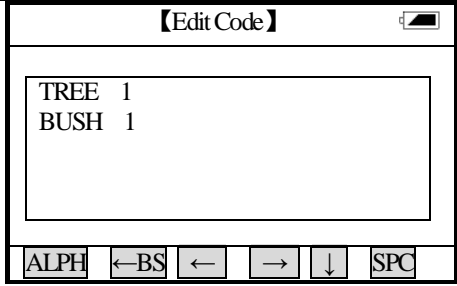
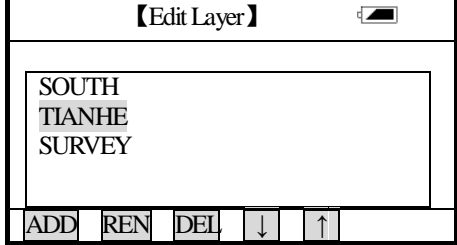
Operating Procedures	Operation	Display
① Select the key [F1] (Add).	[F1]	
② Enter layer name and press [ENT].	Enter layer name [ENT]	
③ The new layer name is displayed. To create new layer, operate again from step 1.		

### Rename a layer:

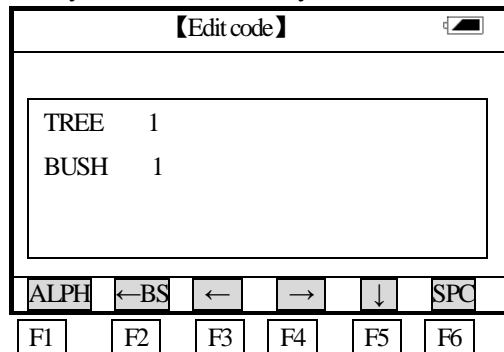
Operating Procedures	Operation	Display
① Use ↓, ↑ to select the layer to be renamed, press [F2](REN).	Select the layer to be renamed [F2]	
② Enter a new layer name, press [ENT] key, the layer name is changed to be new name.	Enter new name [ENT]	
③ The new name is displayed. To rename layer more, repeat above steps.		



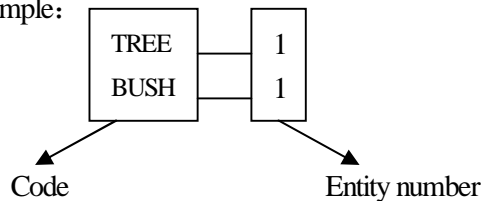
**EDIT (inputting code):**

Operating Procedures	Operation	Display
① Use ↓, ↑ to select the layer to be edited, press [ENT].	Select the layer to be edited [ENT]	
② Enter code and press [ENT]. The cursor moves to next line, now it is possible to enter more code.	Enter code + [ENT]	
③ After entering code, press [ESC] to save code, the screen restore the "Code Data menu."	[ESC]	

Every code consists of a entity code number and layer.



Example:



To delete the layer, first select [DEL]. A layer may be deleted after all codes in that layer have been deleted. The message "Layer XXX is not empty!" is displayed when an attempt is made to delete a

---

layer which contains codes.

Press [OK] to return to the main screen of layer EDIT.

- NOTE:
1. A maximum of 128 codes can be entered for each layer.
  2. The maximum length of the code is 16 characters, and layer is 8 characters.
  3. The default entity is "1".
  4. If [SPC] is entered at the start of the line, the code is deleted.

## 14.5 CUT/FILL DATA

The cut/fill data generated by the setout option can be viewed by the EDIT CUTS option.

EDIT

RAW
POINTS
PT LIB
CODE
CUTS

The process is similar to EDIT POINTS.

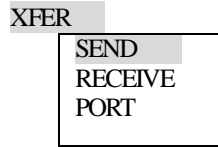
【Edit Cut/Fill Data】		
Ptno	A1	DIFF
North	1002.2589	0.000
East	1235.3585	0.000
Elev	23.5841	0.000
Code	PT	
STRI	END	FIND
PREV	NEXT	
F1	F2	F3
F4	F5	F6

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

NOTE: Cut/fill data can not be edited.

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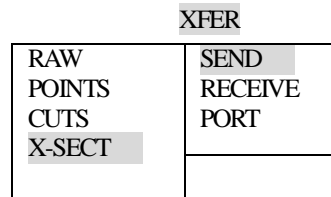
## 15 FILE TRANSFER



The transfer menu contains options to send files to a computer, receive files from a computer, and to set the communication port parameters.

### 15.1 DOWNLOAD FILES TO A COMPUTER (SEND)

The raw data, coordinates, DXF files and cross sections may be downloaded to a computer.



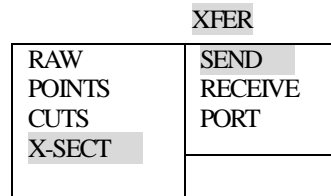
Before starting to download make sure the port parameters of both sending and receiving computer software programs are set the same.

A file name has a maximum of 8 characters, and should be made up from the letters A-Z, numbers 0-9 and signs (\_# \$ @ % + -), but the first character can not be space.

Please refer to Appendix A for the data format.

#### 15.1.1 RAW DATA

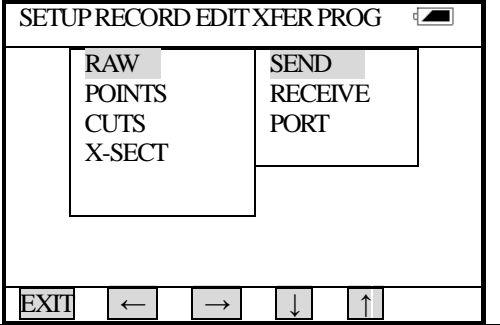
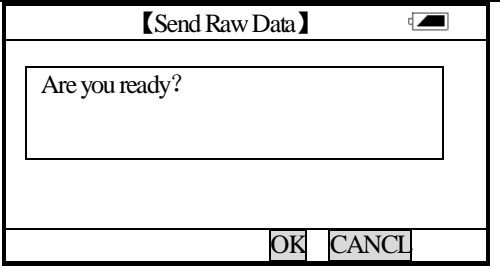
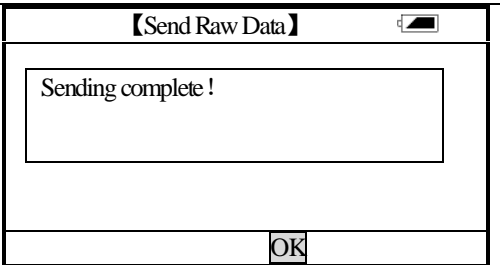
Select RAW from the SEND side bar menu to download raw data.



#### ► Procedure

At first set the communication parameter and connect the cable.

Operating Procedures	Operation	Display
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<p>① Select [XFER] → [SEND] → [RAW] and press [ENT].</p>	<p>Select sending raw data [ENT]</p>	
<p>② A short prompt is displayed, “Are you ready?”, press [F5] key (OK), data transfer will be performed. (Press [F6] (CANCL) key to restore main menu screen.)</p>	<p>[F5]</p>	
<p>③ Data transfer begins. When the sentence “Sending complete” is displayed, press [F5](OK) key to restore the main menu screen.</p>	<p>[F5]</p>	

### 15.1.2 COORDINATES

To download generated coordinates select the POINTS option from the SEND menu.

XFER

RAW	SEND
POINTS	RECEIVE
CUTS	PORT
X-SECT	

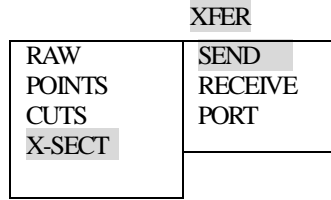
### 15.1.3 CUTS/FILL

To download generated cut/fill coordinates select the CUTS option from the SEND menu.

RAW	SEND
POINTS	RECEIVE
CUTS	PORT
X-SECT	

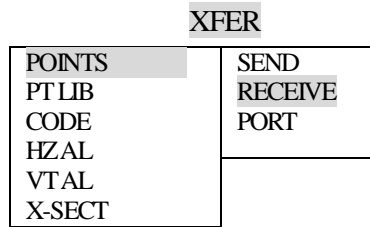
### 15.1.4 CROSS SECTIONS

To download cross-sections select the X-SECT option from the SEND menu.



## 15.2 UPLOAD FILES TO INSTRUMENT (RECEIVE)

Coordinate files for set out, fixed point and code library files, alignments and cross section files for set out may be uploaded from a computer to the total station by series port.

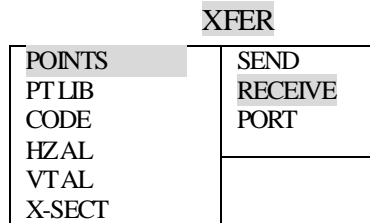


Before starting to upload make sure the port parameters of both sending and receiving computer software programs are set the same.

In order to receive data from the computer you must have a suitable program, which can provide the data in the required format with the communication port parameters set with the PORT option. Each format is described in Appendix A.

### 15.2.1 UPLOAD SETTING-OUT COORDINATE (COORDINATE DATA)

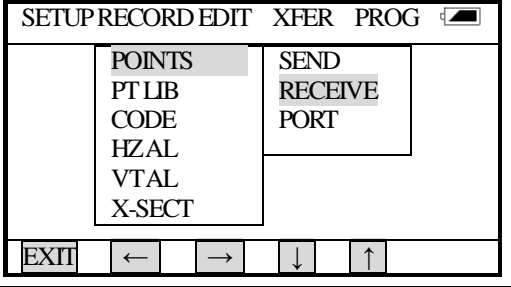
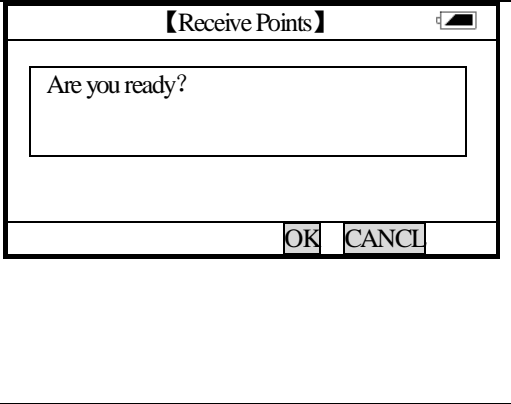
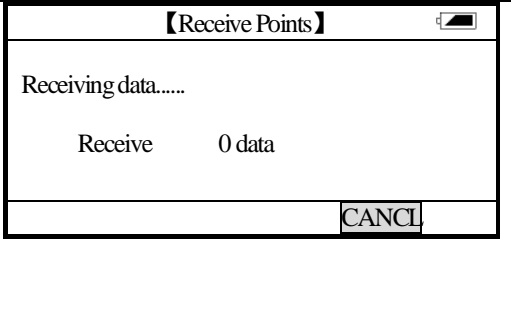
To upload coordinates for setout select POINTS from the RECEIVE menu.



#### ► Procedure

Firsrtly set communication parameters and connecting cable.

Operating Procedures	Operation	Display
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<p>① Select [XFER] → [RECEIVE] → [POINTS], press [ENT].</p>	<p>[ENT]</p>	 <p>SETUP RECORD EDIT XFER PROG</p> <table border="1"> <tr> <td>POINTS</td> <td>SEND</td> </tr> <tr> <td>PT LIB</td> <td>RECEIVE</td> </tr> <tr> <td>CODE</td> <td>PORT</td> </tr> <tr> <td>HZAL</td> <td></td> </tr> <tr> <td>VTAL</td> <td></td> </tr> <tr> <td>X-SECT</td> <td></td> </tr> </table> <p>EXIT ← → ↓ ↑</p>	POINTS	SEND	PT LIB	RECEIVE	CODE	PORT	HZAL		VTAL		X-SECT	
POINTS	SEND													
PT LIB	RECEIVE													
CODE	PORT													
HZAL														
VTAL														
X-SECT														
<p>② Start receiving software in computer. When a short prompt "Are you ready?" is displayed, if press [F5] key (OK), data transfer will be started. (To return to the main menu screen press [F6] (CANCL) key)</p>	<p>[F5]</p>	 <p>【Receive Points】</p> <p>Are you ready?</p> <p>OK CANCL</p>												
<p>③ It begins to receiving data, the receiving status will be displayed on screen. (If press [F5] (CANCL) key, it will restore the main menu screen).</p>	<p>[F5]</p>	 <p>【Receive Points】</p> <p>Receiving data.....</p> <p>Receive 0 data</p> <p>CANCL</p>												

### 15.2.2 POINT LIBRARY

To upload a fixed point library file select PT LIB from the RECEIVE menu.

#### XFER

POINTS	SEND
PT LIB	RECEIVE
CODE	PORT
HZAL	
VTAL	
X-SECT	

### 15.2.3 CODE LIBRARY

To upload the code library select CODE from the RECEIVE menu.

#### XFER

POINTS	SEND
PT LIB	RECEIVE
CODE	PORT
HZAL	
VTAL	
X-SECT	

---

### 15.2.4 HORIZONTAL ALIGNMENTS

Select HZ AL to upload a horizontal alignment for road design setout. Data format is described in Appendix A.

**XFER**

POINTS	SEND
PT LIB	RECEIVE
CODE	PORT
HZ AL	
VT AL	
X-SECT	

NOTE: There is only one start point can be exsited in a block of horizontal alignment data, otherwise it may cause some mistakes.

### 15.2.5 VERTICAL ALIGNMENTS

**XFER**

POINTS	SEND
PT LIB	RECEIVE
CODE	PORT
HZ AL	
VT AL	
X-SECT	

Select VT AL to upload a vertical alignment for road alignment setout. Data format is described in Appendix A.

[NOTE]: If there is no data in [HZ AL], the setout option can not be used.

### 15.2.6 DESIGN CROSS SECTIONS

Select X-SECT to upload a design cross section file for road design setting out. The uploaded cross sections cannot be edited nor downloaded.

**XFER**

POINTS	SEND
PT LIB	RECEIVE
CODE	PORT
HZ AL	
VT AL	
X-SECT	

### 15.3 COMMUNICATION PORT PARAMETERS

The communication port parameters for uploading and downloading files should be set before starting the transfer. Once set the parameters need not be changed wulless the parameters on the computer are set differently.

To display the port parameter screen select PORT from the XFER menu., then press [ENT] key.

---

XFER

SEND
RECEIVE
PORT

【Comms Setup】		☰	
Baud	9600		
Parity	NONE		
Data	8		
Stop	1		
		←	→
		↓	←
		F2	F5

Baud rate: 1200 – 115200

Parity: NONE or ODD or EVEN

Data bits: 7 or 8

Stop bits: 1 or 2

To change above options use the → and ← arrow keys to scroll through the values.

Press [ENT] key to move the cursor to the next option; Press [ENT] key when the cursor is on the bottom line of the screen to exit and save the changes. Press [ESC] key to exit the screen without saving the changes.



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## 16 PROGRAMS MENU

The menu includes below functions :

- (1) SETOUT
- (2) ROADS
- (3) TRAV
- (4) COGO
- (5) Batter Boards
- (6) TAPE DIMSION

### 16.1 SET OUT

To show the SET OUT menu, from the **【Prog】** 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.

The setout coordinates may be saved in the CUT/FILL file, if the option is set in the JOB OPTN, and printed for checking in the office.

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.

The setout routine uses two windows. The Angle screen and the Offset screen.

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).

SET OUT	
Req	65.3510
Turn	123.2135
Away	35.531
Cut	-3.25
(Fine Single)	ANGLE MODE MEAS
	F4 F5 F6

(Angle display)

**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.

**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 cut/fill data value.

Press [F4] (Angle) key on the lower screen, following OFFSET display will be shown :

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

SET OUT		
↑	65.3510	
→	123.2135	
Cut	-3.25	
(Fine Single)	ANGLE	MODE MEAS
	F4	F5 F6

(OFFSET display)

- ↑ : 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.
- : 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.

Anytime you press [ESC] key to return to Pt No screen, you can input a new point and set out next point. If the data of that point is stored in memory, system will use it automatically. If the point is a new point, system will recommends you to input its coordinate. From Pt No menu, press [ESC] key to return to last screen.

#### 16.1.1/2 OCCUPIED POINT & BACKSIGHT POINT

The occupied point and the backsight point should be set before setting out.

##### 1) Setting occupied point

From the **【Prog】** menu, select **【SET OUT】** and press [ENT] to access Setout menu.

PROG	
OCC PT	SET OUT
BKS PT	ROAD
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARD
X-SECTS	TAPE DIM

From the Set Out menu, select **【OCC pt】** to set the occupied point, the setting procedure is similar to those in [RECORD] menu.

## 2) Setting backsight point

PROG	
OCC PT	SET OUT
<b>BKS PT</b>	ROAD
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARD
X-SECTS	TAPE DIM

From the Set Out menu, select **【BKS pt】** to set the occupied point, the setting procedure is similar to those in [RECORD] menu.

Occupied Point	
Occ Pt	1
Ins Ht	1.500
Pt Code	SVY
NUM	← → ↓
	RSCT SPC P2
	ELEV P1

F1 F2 F3 F4 F5 F6

**No Alignment**

Occupied Point	
Occ Pt	1
Chainage	100.000
Offset	23.500
Ins Ht	1.500
Pt Code	SVY
NUM	← → ↓
	RSCT SPC P2
	ELEV P1

F1 F2 F3 F4 F5 F6

**When Alignment Exists**

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.

### NOTE:

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

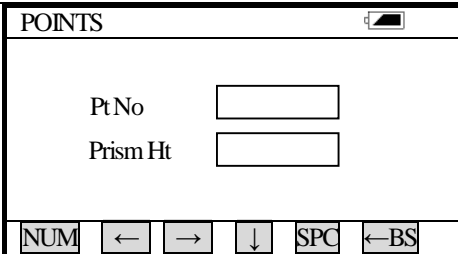
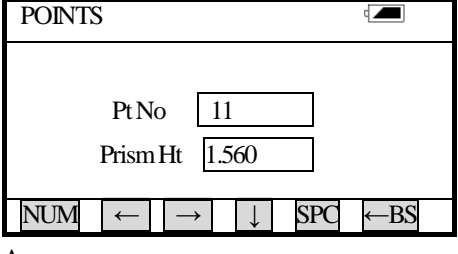
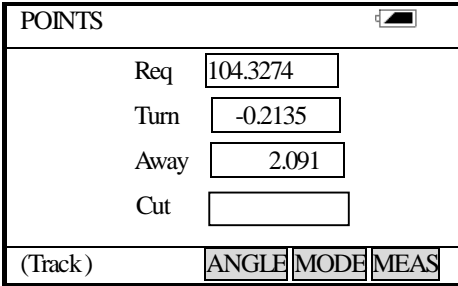
If alignment exists, you can enter the occupied point and backsight point by “Chainage and Offset.”. In this case the OCC Pt field should be left blank.

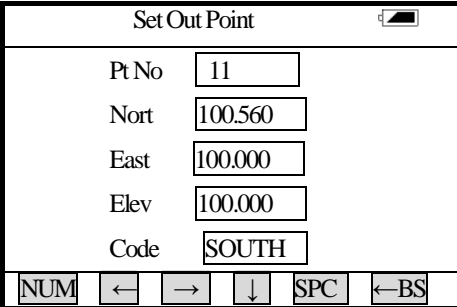
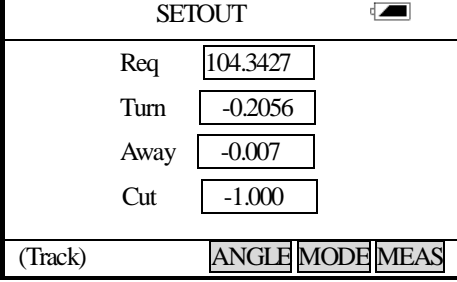
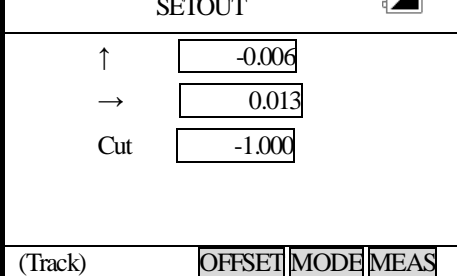
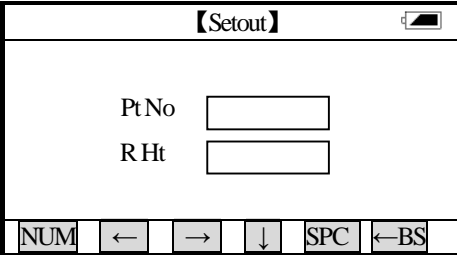
### 16.1.3 POINT SETOUT

When selecting POINTS from the SETOUT menu, the following screen will be displayed:

PROG	
OCC PT	SETOUT
BKS PT	ROADS
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARDS
X-SETS	TAPE DIM

#### ► Procedure

Operating Procedures	Operation	Display
① select POINTS key	select POINTS key	
② Enter the set out point number and press [ENT] key. After entering the prism height, press [ENT] key.  A If the coordinates of the point number exists in memory, the horizontal angle from Occ point to setout point (Req), the horizontal angle from the current to the setout point (Turn), the distance from the prism to the setout point (Away)(Negative sign means that the prism should be moved away from instrument along the instrument sight line. The required distance is the displayed value. If positive sign is displayed, it is opposite) will be shown.	Enter the set out point number  [ENT]	 

<p>B</p> <p>If the coordinate data of the point is not stored in memory, system will recommends that to input setout point. After inputting its coordinate, press [ENT] to enter the screen which mentioned in A part,</p>		<p>B</p> 
<p>③ Press [F6](Meas) key, the [Height difference] of the set out point (Negative sign means the point is lower than the calculated elevation, positive sign means the point is higher than calculated elevation) and the distance between prism and the set out point.</p>	<p>[F6]</p>	
<p>④ Press [F4] (Angle) key to switch to OFFSET display. Press [Meas] key, instrument will measure again and update the data.</p>	<p>[F4]</p>	
<p>⑤ Move the prism according to the screen, until the difference reaches 0 and that's the targeted layout point. Press [ENT] and continue with next layout point; input the point number and prism height, repeat the procedures above to carry out the multi-point layout based on the same occupied point. (To exit the program, press [ESC])</p>	<p>[ENT]</p>	

### Explanation:

The setout routine uses two windows. The Angle screen and the Offset screen.

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).

SET OUT	
Req	65.3510
Turn	123.2135
Away	35.531
Cut	-3.25
(Fine Single)	ANGLE MODE MEAS
	F4 F5 F6

(ANGLE display)

**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.

**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 cut/fill data value.

**Press [F4](Angle) key on the lower screen, following OFFSET display will be shown :**

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

SET OUT	
↑	65.3510
→	123.2135
Cut	-3.25
(Fine Single)	ANGLE MODE MEAS
	F4 F5 F6

(OFFSET display)

↑ : 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.

→ : 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.

Anytime you press [ESC] key to return to Pt No screen, you can input a new point and set out next point. If the data of that point is stored in memory, system will use it automatically. If the point is a new point, system will recommends you to input its coordinate. From Pt No menu, press [ESC] key to return to last screen.

※**Note** Following keys on the lower screen at step 3.

**Angle (F4):** Press this key to switch “Angle”and“OFFSET”.

**Mode (F5):** Press this key to switch “track”, “Fine single”and “Fine Repetition”. Once you press this key, the measuring mode will be changed.

#### 16.1.4 STRING SETOUT

After setting occupied point and backsight point, you can begin STRING SETOUT measuring.

Prog	
OCC PT	SETOUT
BKS PT	ROAD
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARDS
X-SECTS	TAPE DIM

Select STRINGS from the SETOUT menu by using up key and down key, and press [ENT] key to enter the point code screen. Enter the required code and string number, then press [ENT] key. If the string is found, the point number screen will be displayed containing the point number of the first point of the string. Input the required point number and the target height, press [ENT] key, the bearing and the distance to the SETOUT point will be shown, Press[Meas] key to begin measuring, press [ENT] key to enter the next setout point.

**[NOTE]:** A stable point data file can not be used in String Setout.

#### 16.1.5 ALIGNMENT SETOUT

Select ALIGN from the SETOUT menu.

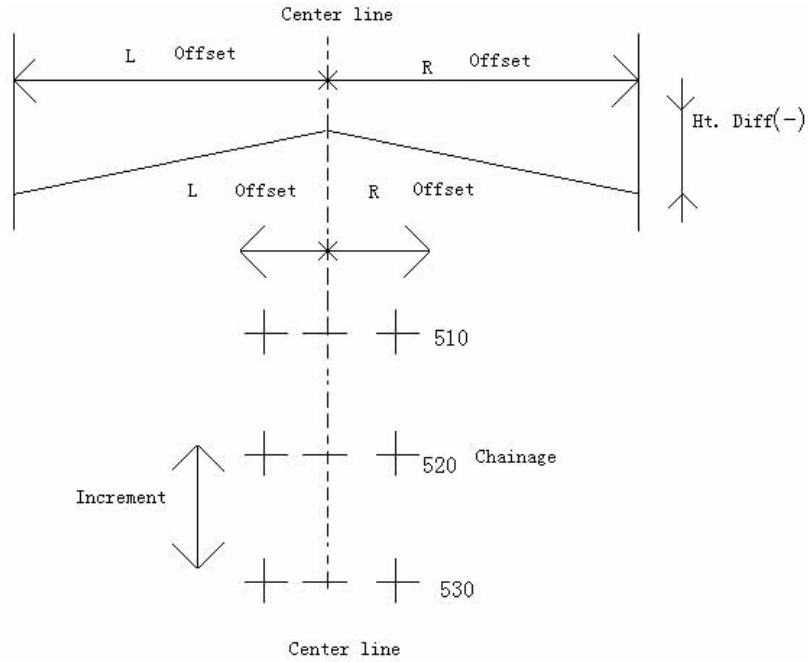
Prog	
OCC PT	SETOUT
BKS PT	ROADS
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARDS
X-SECTS	TAPE DIM

For an alignment setout a horizontal alignment must have been uploaded from computer by using [HZ AL] in the [Receive] function, or entered it manually in the [ROADS] program.

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.

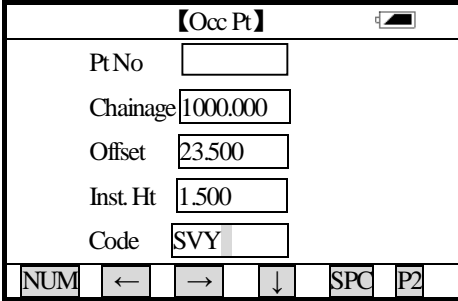
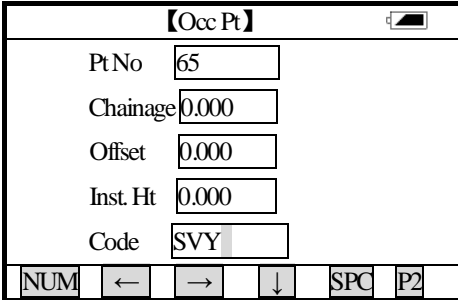
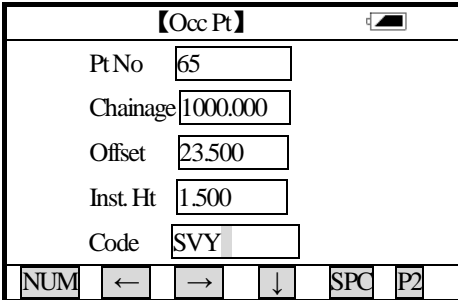


16-1-5

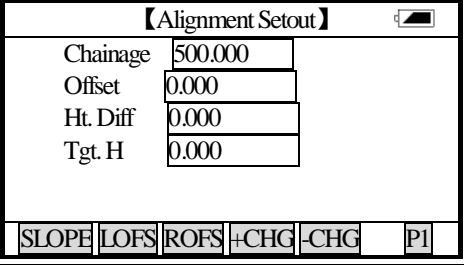
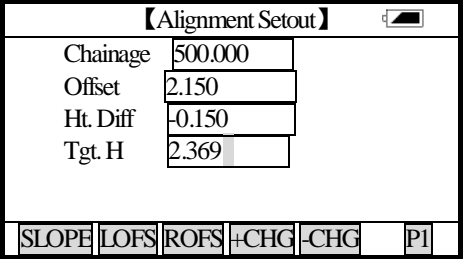
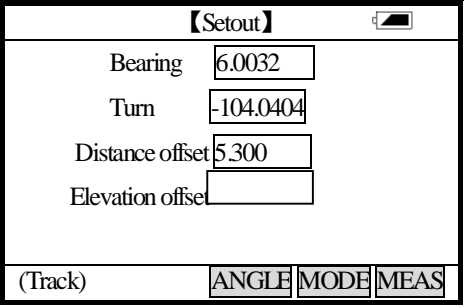
► Procedure

Operating Procedures	Operation	Display
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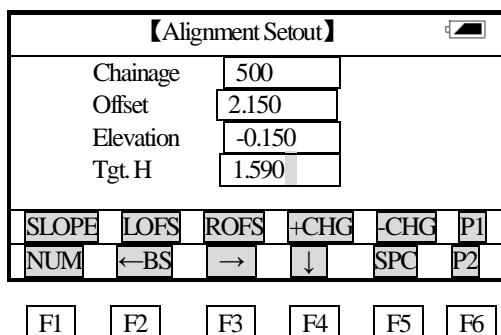


<p>①Select [ALIGN], then the Occ Pt. Setting screen will appear., like</p> <p>A. Input point number or chainage number and difference value to set occupied point. If they are input at the same time, point number will be prior to the others.</p> <p>A: Enter chainage, offset, instrument height and code data.</p> <p>B: Enter the occupied point No.</p> <p>C: When enter the point number, chainage, offset at a same time. Point number would be used firstly. The point coordinates will be recalled by program. If the point does not exist, the point coordinates should be entered.</p>	<p>Select [ALIGN].</p> <p>Set the occupied point</p> <p>Enter the chainage, offset of the occupied point</p> <p>Enter the occupied coordinate</p> <p>Enter the point No, chainage and offset</p>	<p>A:</p>  <p>B:</p>  <p>C:</p> 
---	--	---

<p>②A: The point coordinate is calculated on the basis of the entered chainage and offset. If the vertical curve data of the chainage exists in memory, the elevation of the point will be displayed. If the curve does not exist, the elevation display with 0.</p> <p>B: If the point coordinates does not exist in memory, it would be used by program. Then, the “Backsight Point Setting Screen” will be shown. If the point coordinates does not exist, it should be entered manually.</p> <p>C: Same with B.</p>		<p>A:</p> <div data-bbox="846 247 1304 548"> <p style="text-align: center;"><b>【Occupied point】</b></p> <table border="1" style="width: 100%;"> <tr><td>East</td><td>28.822</td></tr> <tr><td>North</td><td>198.629</td></tr> <tr><td>Elevation</td><td>100.000</td></tr> </table> <p>NUM ← → ↓ SPC ←BS</p> </div> <p>B:</p> <div data-bbox="846 600 1304 898"> <p style="text-align: center;"><b>【Occupied Point】</b></p> <table border="1" style="width: 100%;"> <tr><td>Pt</td><td>65</td></tr> <tr><td>East</td><td></td></tr> <tr><td>North</td><td></td></tr> <tr><td>Elevation</td><td></td></tr> <tr><td>Code</td><td></td></tr> </table> <p>NUM ← → ↓ SPC ←BS</p> </div>	East	28.822	North	198.629	Elevation	100.000	Pt	65	East		North		Elevation		Code	
East	28.822																	
North	198.629																	
Elevation	100.000																	
Pt	65																	
East																		
North																		
Elevation																		
Code																		
<p>③Set backsight point, enter the point number or chainage and offset. If the point does not exist in memory, its coordinates should be be entered, see step ② B.</p>	<p>Set Backsight Point</p>	<div data-bbox="846 909 1304 1199"> <p style="text-align: center;"><b>【Backsight Point】</b></p> <table border="1" style="width: 100%;"> <tr><td>Pt</td><td>2</td></tr> <tr><td>Chainage</td><td>200.000</td></tr> <tr><td>Offset</td><td>20.500</td></tr> </table> <p>NUM ←BS → ↓ SPC</p> </div>	Pt	2	Chainage	200.000	Offset	20.500										
Pt	2																	
Chainage	200.000																	
Offset	20.500																	
<p>④When the backsight point is set, the “Alignment Setout Screen” will be shown. Enter the start chainage, chainage increment, the horizontal distance from side stake point to center line. (Offset Left: the horizontal distance from left side stake point to center line. Offset Right: the horizontal distance from left side stake point to center line.) and the height difference between side stake and center line point.</p>		<div data-bbox="846 1241 1304 1499"> <p style="text-align: center;"><b>【Alignment Setout】</b></p> <table border="1" style="width: 100%;"> <tr><td>Start Chainage</td><td>500.000</td></tr> <tr><td>Chainage Increment</td><td>10.000</td></tr> <tr><td>Offset Left</td><td>2.150</td><td>Offset Right</td><td>2.150</td></tr> <tr><td>Ht. Diff Left</td><td>-0.150</td><td>Ht. Diff Right</td><td>-0.150</td></tr> </table> <p>NUM ← → ↓ SPC ←BS</p> </div>	Start Chainage	500.000	Chainage Increment	10.000	Offset Left	2.150	Offset Right	2.150	Ht. Diff Left	-0.150	Ht. Diff Right	-0.150				
Start Chainage	500.000																	
Chainage Increment	10.000																	
Offset Left	2.150	Offset Right	2.150															
Ht. Diff Left	-0.150	Ht. Diff Right	-0.150															

<p>⑤ Press [ENT] key, the chainage and offset screen will be shown.</p>	<p>[ENT]</p>	
<p>⑥ Press [LOFS] (or [ROFS]) to set out left (right) side stake, corresponding chainage, offset, elevation difference will be displayed on the screen. The chainage and offset can be entered manually. 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.</p>		
<p>⑦ When the chainage and offset to be setout are appeared, press [F5] (OK) to access the "Setout Screen." The operation procedure is same with Point Setting out. When current point setting out is finished, press [ESC] key to access the input screen for next chainage data. So all the character points can be set out.</p>	<p>[F5]</p>	

**Explanation for the main setout screen:**



F1
F2
F3
F4
F5
F6

**SLOPE:** The key is used in slope set out. (Press **FUNC** key)

**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.

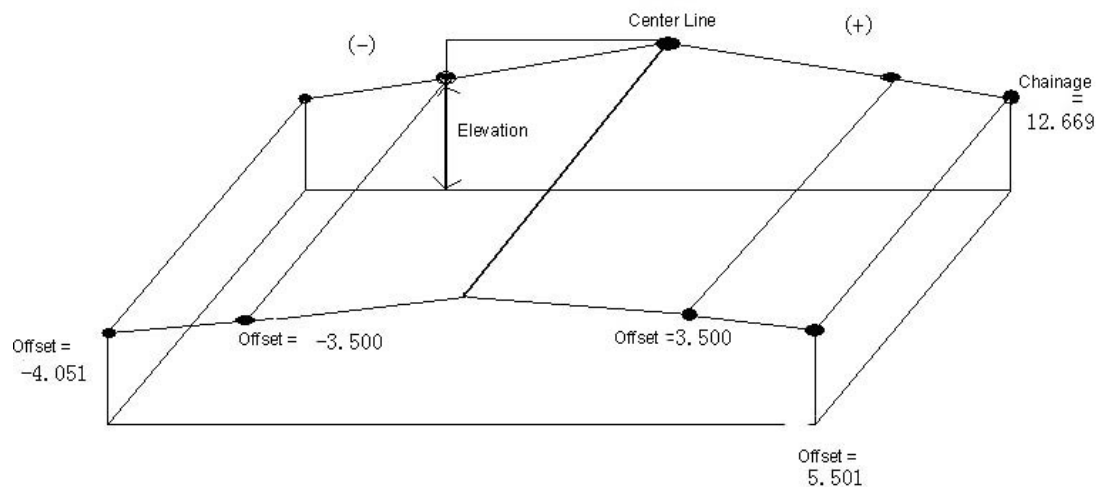
**-CHG:** The key is use in decreasing the chainage.

### 16.1.6 CROSS SECTION SETOUT

To set out design cross sections select X-SECTS from the SETOUT menu.

PROG	
OCC PT	SETOUT
BKS PT	ROAD
POINTS	TRAV
STRINGS	COGO
ALIGN	B.BOARDS
X-SECTS	TAPE DIM

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.



#### Sample data

<Chainage>	<offset>	<elevation>	
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	

### Main Cross Section Setout screen

【X-Sects】					
Chainage	100				
Offset	-4.501				
Ht. Diff	18.527				
Tgt. H	1.258				
SLOPE	LOFS	ROFS	+CHG	-CHG	P1
NUM	←BS	→	↓	SPC	P2
F1	F2	F3	F4	F5	F6

When the chainage offset and level screen are displayed, +CHG and -CHG will advance or back up to the next stored cross section. LOFS and ROFS will display the offset and level for the adjacent points on the cross section.

※ **The Ht.Diff value is elevation value here. (Different to Horizontal Alignment Setting out)**

[NOTE]:

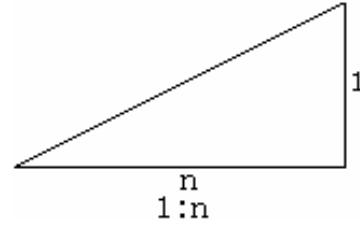
- 1) Cross Section data can not be entered nor edited by manual input. To create the data, you must select X-SECT options in XFER. (See Appendix B)
- 2) The specified chainage data is displayed with LOFS and ROFS. The data is displayed in order entered by communication. Enter the data in the order of 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.

#### 16.1.7 SLOPE SETOUT

Slope setting-out can be performed as part of the Alignment setout option. After defining vertical curve and horizontal alignment in the "Define Roads Menu", it is possible to perform slope setting-out. Press **F1** (SLOPE) key, Slope Setout will be displayed.

【Slope Setout】		
	Left (1:n)	Right (1:n)
Cut	2.150	2.150
Fill	0.000	0.000

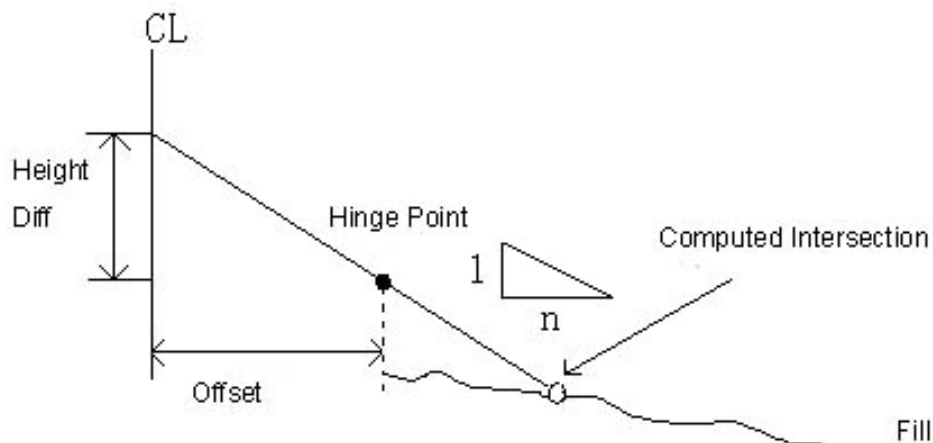
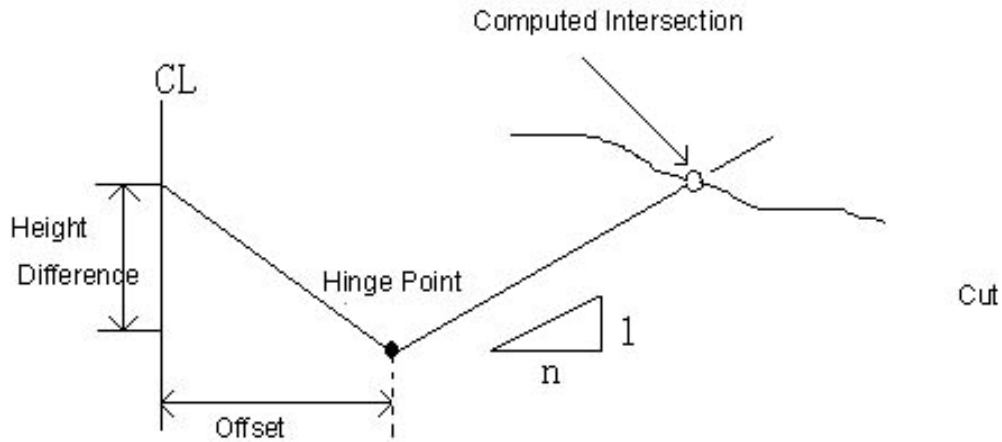
NUM   ←   →   ↓   SPC   ←BS



F1   F2   F3   F4   F5   F6

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 cut or fill.

Cut 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.



After entering cut/fill, press [ENT] key to record the data, then use function key to select [Left] or

[Right].

【Slope Setout】			
Select (Left) or (Right)			
Cut	2.150	2.150	
Fill	0.000	0.000	
		LEFT	RIGHT
		F4	F5

The “Setout Menu” will be shown.

【Slope Setout】	
↑	
→	
(Fine'r')	MODE MEAS
F5 F6	

Sight a point near where it is estimated the slope will intercept and press [MEAS] to take the first trial shot. The appropriate slope is selected from the data entered in the preceding step. The appropriate 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 setting out method of slope is same with point setting out. When the data which display in [→] and [↑] is 0, the setting out point is found.

【Slope Setout】	
↑	0.001
→	0.003
(Fine'r')	MODE MEAS
F5 F6	

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.

## 16.2 ROAD DESIGN

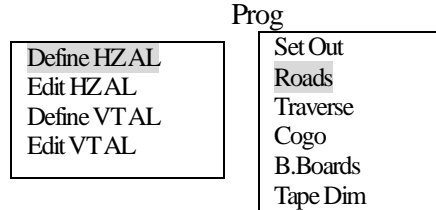
The Road Design menu contains the alignment design functions.

- Define horizontal alignment and vertical curve
- Edit horizontal alignment and vertical curve

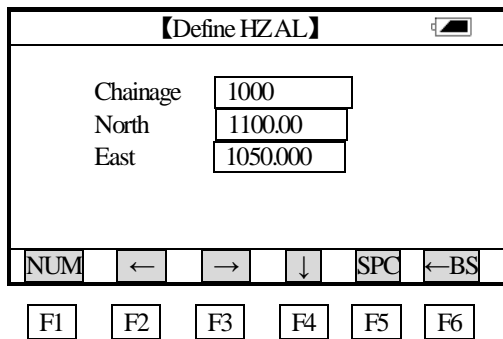
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### 16.2.1 DEFINE HORIZONTAL ALIGNMENT (Maximum data quantity: 100)

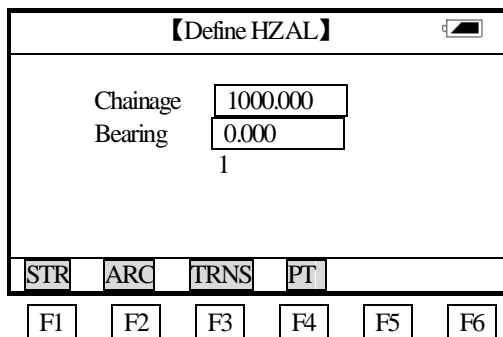
To define an alignment select DEF AL from the ROADS menu.To know how to calculate an alignment, see appendix B.



Horizontal alignment consisted of following elements: start point, straight line, circular curve and transition curve. The define option will prompt for the start details and then continue to the main input routine.



The start element consists of the starting chainage and the easting and northing of the start point. Enter these details in the screen, press [ENT] key to show the mail input routine screen.

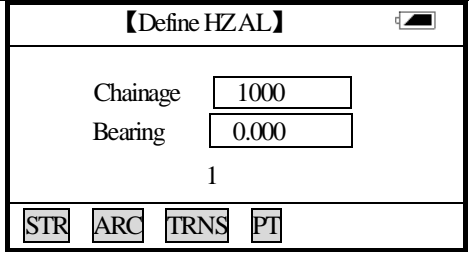
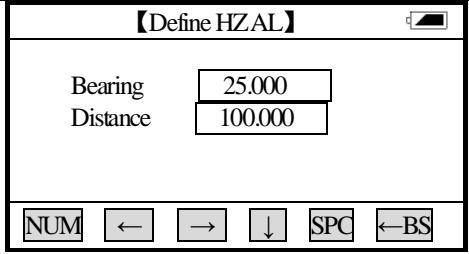
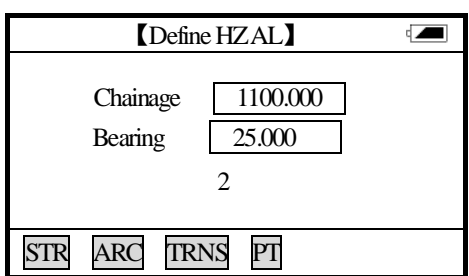


The main line input screen displays current chainage and the bearing angle (the tangent line from the chainage) and the function key (For creating new line). System provides four functions: defining straight line, circular curve, transition curve, point. Select a function key, enter the detailed information of the chainage, the alignment elements will be created. Press **[ENT]** key, 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.

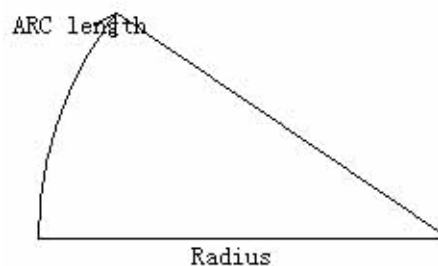


## Straight line

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

Operating Procedures	Operation	Display
① Press [F1] (STR) key, the "Define Straight Line screen" will be shown.	Select [F1]	
② After entering the bearing angle, press [ENT] key to get the next input option, after entering the length of the line, press [ENT] key.	Enter the bearing [ENT] Enter the length [ENT]	
③ Record this alignment data, and display the bearing angle and the chainage in the end of straight line. Now, other alignments can be defined. When the straight line is in the middle of the road, the bearing is calculated from the original elements. To change this bearing angle, input a new angle manually.		

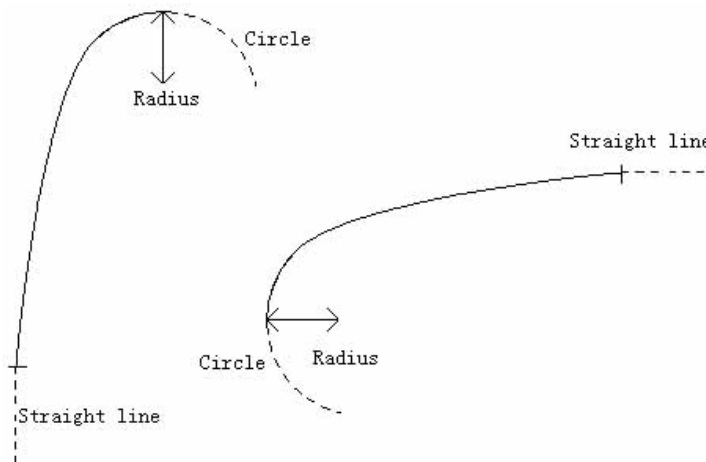
## Circular Curve



Press **ARC** key in the "Main line Input Screen", 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.

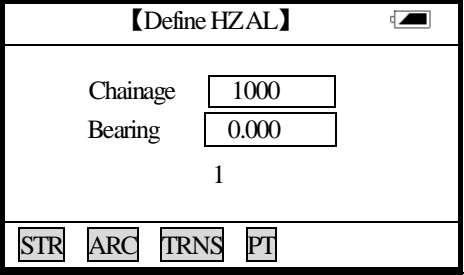
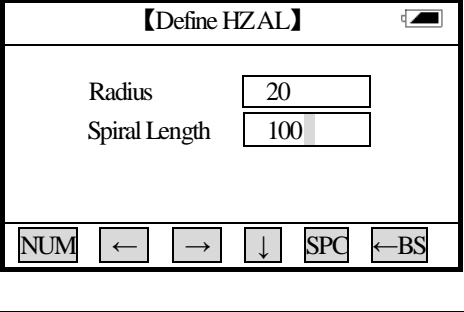
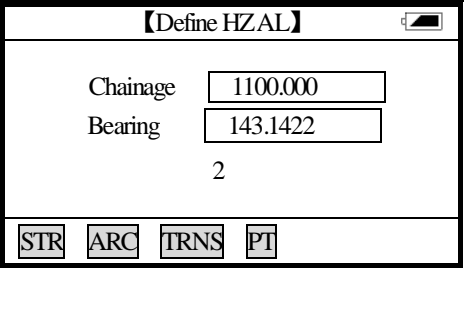
Operating Procedures	Operation	Display
① Press [F2] (ARC) key, the "Define Arc Screen" will be shown.	Select [F2]	
② Enter radius and arc length, then press [ENT] to record this data.	Enter radius and arc length [ENT]	
③ The screen returns to "the main input screen."		

### Transition curve

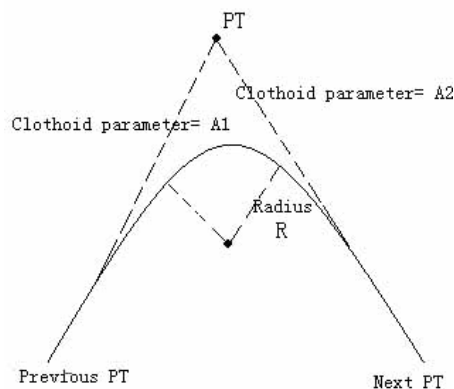


Press **[TRNS]** key in the "Main Line Input Screen", the transition curve can be defined. Transition curve consists of the minimum radius and arc length. The rule of radius value: along the forward direction of the curve. When the curve rotates to right, the radius value is positive. When the curve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

Operating Procedures	Operation	Display
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<p>① Press TRNS key in the “Input Process Screen.”</p>	<p>Select [F3]</p>	
<p>② Enter the minimum radius and arc length of transition curve</p>	<p>Enter the minimum radius and arc length of transition curve</p>	
<p>③ Press [ENT] to record the data and restore the main screen. If press [ESC] key, it will restores the main input screen without saving.</p>	<p>[ENT] Or [ESC]</p>	

### PT (Point)



Press F4 **PT** key in the “Main line input screen”, the point can be defined. A point element consists of coordinates, radius and clothoid 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 clothoid parameter A1 or A2 is entered, a clothoid is inserted between straight and arc with the specified length.

Operating Procedures	Operation	Display
① Press f4 [PT] key in the "Main line input screen"	[F4]	
② Enter N, E coordinates, radius and A1, A2 manually, and press [ENT].	Enter N, E coordinate, radius and A1, A2 [ENT]	
③ Press ENT to record data, and restore the main screen. Press [ESC] to restore the main screen without saving.	[ENT]	

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

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

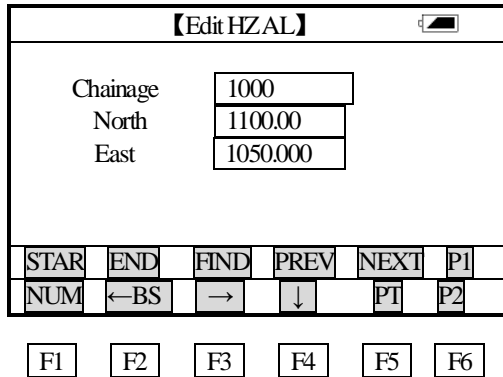
$$A_2 = \sqrt{L_2 \text{ Radiu}}$$

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

### 16.2.2 EDIT ALIGNMENT

Prog	
Define HZAL	Set Out
Edit HZAL	Roads
Define VTAL	Traverse
Edit VTAL	Cogo
	B.Boards
	Tape Dim

To edit the alignment select Edit Alignment from the ROADS menu.



STAR [F1]: Press this key to go to the start of the file.

END [F2]: Press this key to go to the end of the file.

FIND [F3]: Press this key to search for data, after pressing this key, enter the required chainage and press **[ENT]**, the data for the chainage will be displayed.

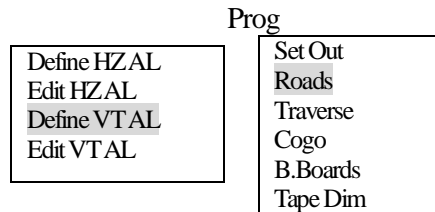
PREV [F4]: Press this key to display the previous point data.

NEXT [F5]: Press this key to display the previous point data.

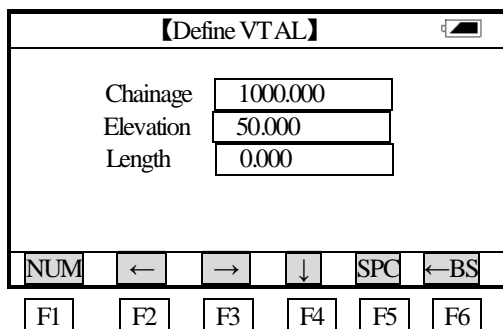
P2 [F6] : Press this key to go to page 2.

It is possible to edit data and modify raw data by using above function keys. After entering the data to be modified, press **[ENT]** key to record the modified data and enter the input screen of next point. To exit without saving data, press **[ESC]** key.

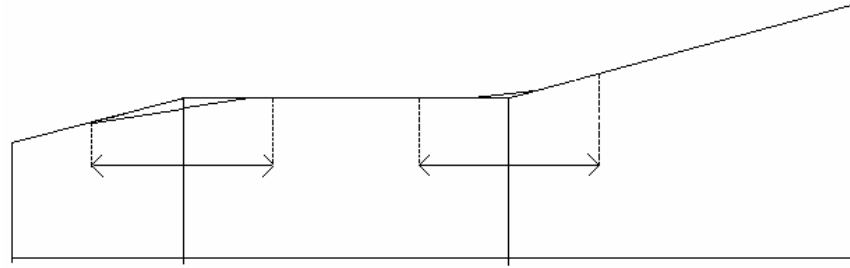
### 16.2.3 DEFINE VERTICAL CURVE (Maximum 100 data)



In the PROG menu, select **[Roads]** and press **[ENT]** key, enter “the Road menu screen”. Select **[Define VTAL]** and press **[ENT]** key to access the “Define VTAL screen.”



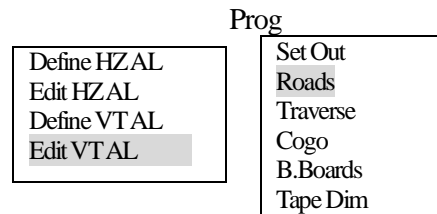
A vertical curve consists of series of intersection points. The intersection point consists of a chainage, elevation and curve length. The start and end intersection points must be a zero curve length.



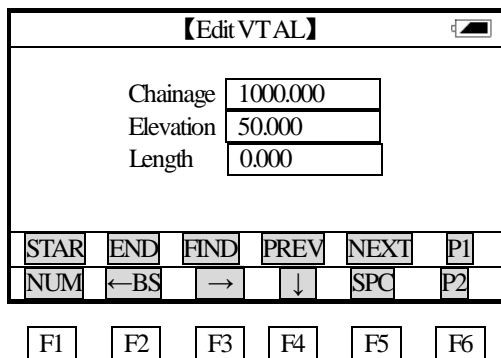
Chainage	1000	1300	1800	2300
Elevation	50	70	60	90
Curve length	0	300	300	0

Intersection points can be entered in any order. After entering a point data, press **ENT** to save it and go to enter next one. Press **ESC** to exit without saving.

#### 16.2.4 EDIT VERTICAL CURVE



In the PROG menu, select **Roads** and press **ENT** key, enter “the Road menu screen”. Select **EditVTAL** and press **ENT** key to access the “Edit VTAL screen.”



To modify the curve data, the procedure is same with editing alignment data. See 16.2.2.

#### 16.3 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

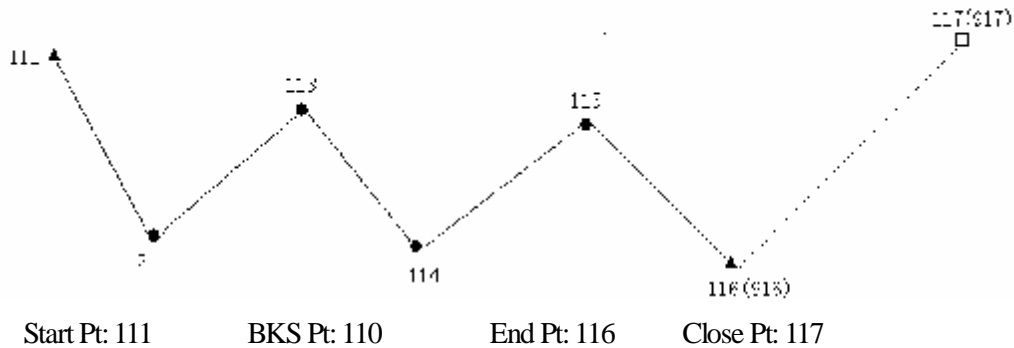
observations. The XYZ file should be ON for the TRAV calculation. (See JOB OPTN). The coordinates for the start and end points must be known. If the traverse is a loop traverse then the start point will also be the end point. If the coordinates of the initial BKS PT are known, the software calculates 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 also.

PROG

- SETOUT
- ROADS
- TRAV
- COGO
- B.BOARDS
- TAPEDIM

Known Pt: 110 111 916 917

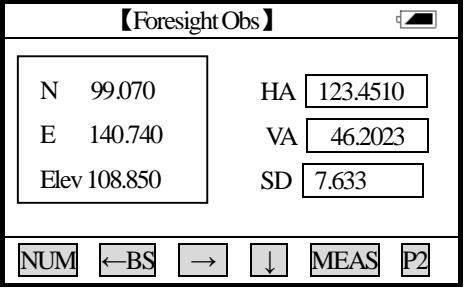
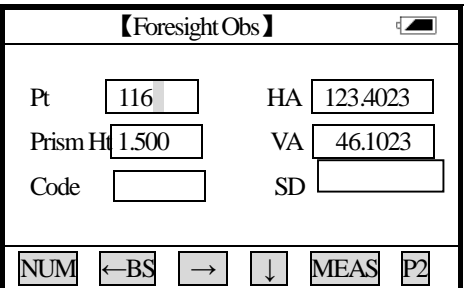
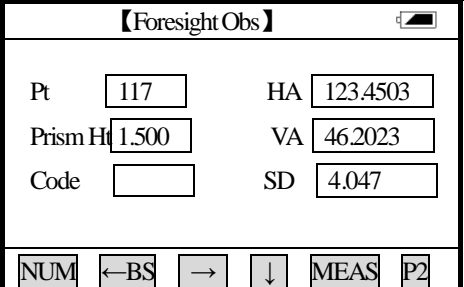
□



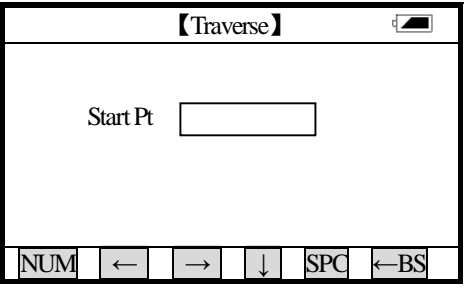
► Procedure

1. Measurement

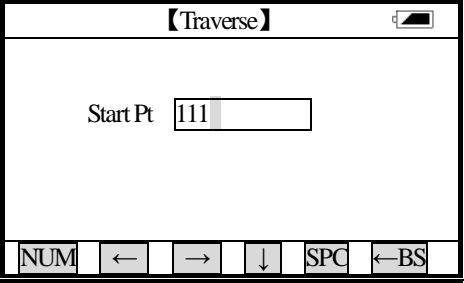
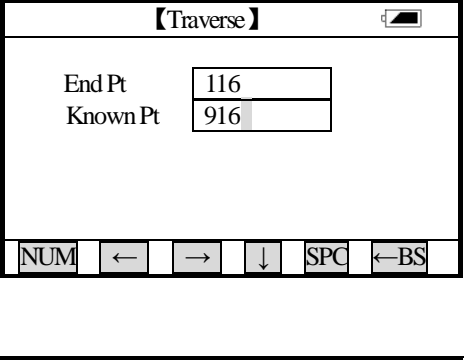
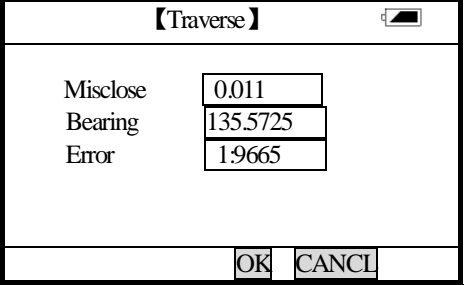
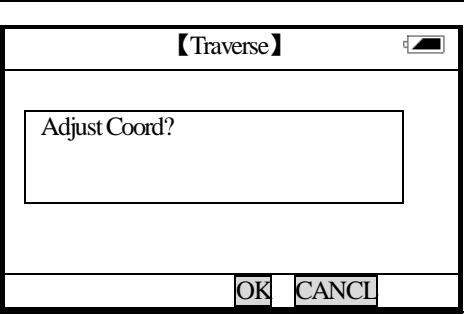
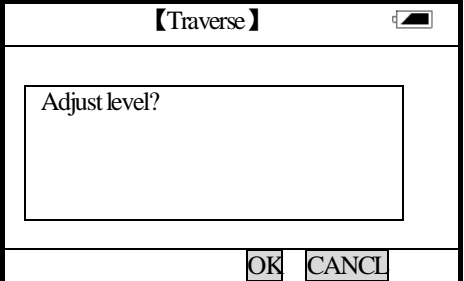
Operating Procedures	Operation	Display
① Select a known point and set up the instrument on the point. (For example Pt 111) Set pt 110 to be back sight point, sight the traverse point pt 112, use [FS OBS] to record the measured coordinates.	Select [FS OBS]	<div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;"><b>【Foresight Obs】</b></p> <p>Pt No <input type="text" value="112"/> HA <input type="text" value="123.0053"/></p> <p>Prism Ht <input type="text" value="1.500"/> VA <input type="text" value="46.0023"/></p> <p>Code <input type="text"/> SD <input type="text" value="5.344"/></p> <p style="text-align: center;"> <input type="button" value="NUM"/> <input type="button" value="←BS"/> <input type="button" value="→"/> <input type="button" value="↓"/> <input type="button" value="MEAS"/> <input type="button" value="P2"/> </p> </div>

<p>② Move the instrument to pt 112. Turn on the machine, select [REC], reset the occupied point (Pt 112), backsight point (pt 111), sight the traverse point (Pt 113), use [Fs Obs] to record the measured coordinates.</p>		
<p>③ Do measurement and record coordinates in the same procedures with step ②. (The traverse point amount is determined by the traverse length and the required accuracy.)</p>		
<p>④ Move the instrument to Pt 115, and measure the point 916, record the data as point 116.</p>		
<p>⑤ To calculate the closure error, set the occupied point on Pt 116 (Pt 916), set another known point (for example Pt 917), measure and record the coordinates as 117. Now point 117 is the closure point.</p>		

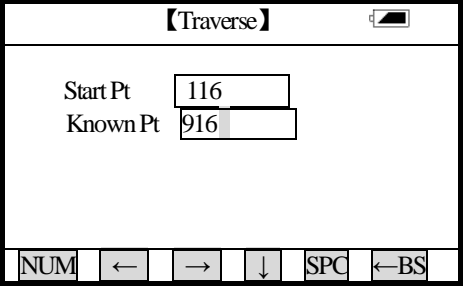
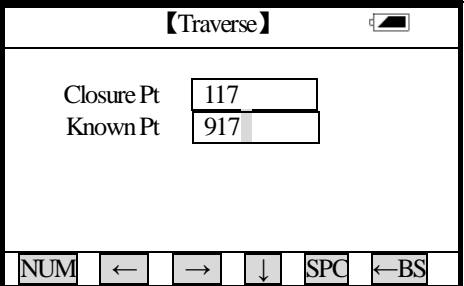
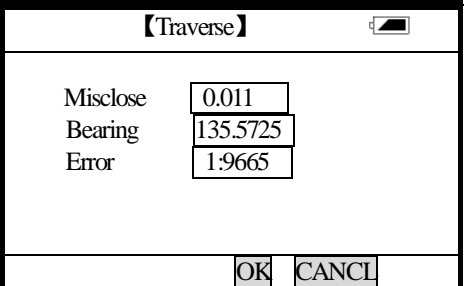
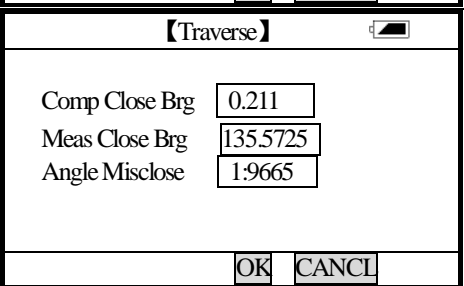
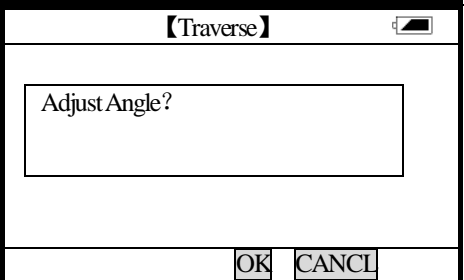
## 2. Adjustment:

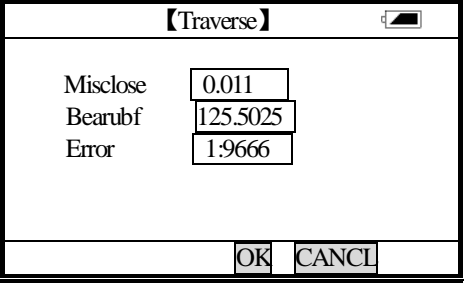
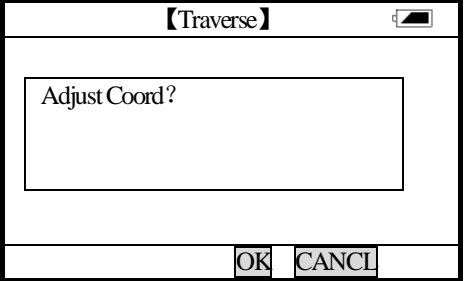
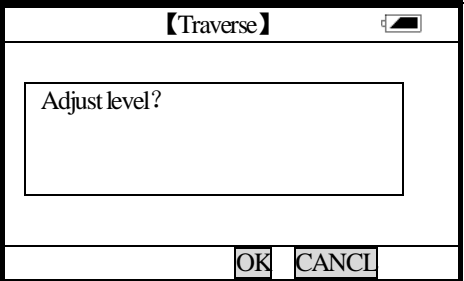
Operating Procedures	Operation	Display
<p>① In the Prog menu, select [Traverse] by using arrow keys and press [ENT] key to enter “the traverse adjustment screen.”</p>	<p>Select [Traverse] [ENT]</p>	



<p>② Enter the start point number and press ENT.</p>	<p>Enter the start point [ENT]</p>	
<p>③ When the entered start point is same with the start point which exists in memory, the screen will indicates to enter end point. Enter the end point of the traverse (measured point number) and the known point. These two point can not be same.</p>		
<p>④ After entering end point and known point, press [ENT] key to perform closure error calculation. The right diagram will be showed, press [F4] (OK) to accept this data.</p>		
<p>⑤ The screen indicates that "Adjust Coord?" Press [F4] (OK) or ENT to perform coordinates adjustment, press [F5] (Cancel) or [ESC] to do not change the data.</p>	<p>[F4] Or [F5]</p>	
<p>⑥ The screen indicates that "Adjust level?" Now, press [F4] (OK) or ENT to perform level adjustment. Press [F5] (CANCEL) or [ESC] to return to the main menu screen.</p>	<p>[F4] Or [F5]</p>	

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

Operating Procedures	Operation	Display
③After entering the start point number, it is possible to enter the end point number (the measured point) and known point. These two points should be different.	Enter the start point [ENT]	 <p>【Traverse】</p> <p>Start Pt 116 Known Pt 916</p> <p>NUM ← → ↓ SPC ←BS</p>
④Enter the closure point number (measured point number) and known point number, these two point number should be not different.	Enter the closure point [ENT]	 <p>【Traverse】</p> <p>Closure Pt 117 Known Pt 917</p> <p>NUM ← → ↓ SPC ←BS</p>
⑤Start to calculate closure error, press [F4] (OK) to accept the data.	[F4]	 <p>【Traverse】</p> <p>Misclose 0.011 Bearing 135.5725 Error 1.9665</p> <p>OK CANCEL</p>
⑥The adjustment result is displayed. If the angle is in the acceptance range, press [F4] (OK) to accept the data.	[F4]	 <p>【Traverse】</p> <p>Comp Close Brg 0.211 Meas Close Brg 135.5725 Angle Misclose 1.9665</p> <p>OK CANCEL</p>
⑦Now the screen indicates that "Adjust angle?" Press [F4] (ok) or [ENT] to perform angle adjustment, press [F5] (CANCEL) or [ESC] to do not change the data.	[F4] or [F5]	 <p>【Traverse】</p> <p>Adjust Angle?</p> <p>OK CANCEL</p>

<p>⑧The adjustment result is displayed.</p>		
<p>⑨The screen indicates that “Adjust Coord?” Press [F4] (OK) or ENT to perform coordinates adjustment, press [F5] (Cancel) or [ESC] to do not change the data.</p>	<p>[F4] or [F5]</p>	
<p>⑩The screen indicates that “Adjust level?” Now, press [F4] (OK) or ENT to perform level adjustment. Press [F5] (CANCEL) or [ESC] to return to the main menu screen.</p>	<p>[F4] or [F5]</p>	

## 16.4 COGO

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

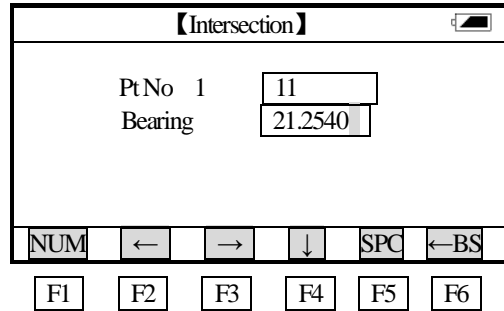
- 1) Intersection
- 2) 4-points intersections
- 3) Inverse
- 4) Area
- 5) Radiation
- 6) Missing line Measurement

### 16.4.1 INTERSECTION

Select INTSECT from the COGO menu and press [ENT] key.

PROG	
INTSECT 4-INTSCT INVERSE AREA RADIATE MLM	SET OUT ROADS TRAV COGO B.BOARDS TAPE DIM

The coordinate for a point can be computed by the intersection of two known bearings.  
 From [PROG] menu, select [COGO] and press [ENT]. Then select [INTSECT] and press [ENT], below screen will be displayed.



Pt No 1: the number of intersection point.

Bearing: the bearing angle from occupied point to intersection point direction.

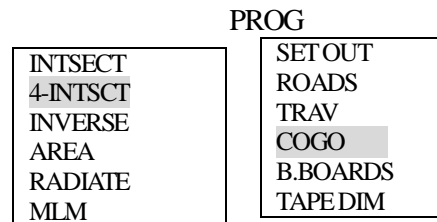
Enter above data and press [ENT] key, the “next known point input screen” will displayed. The screen is same with above screen. After entering the second known point data, press [ENT] to calculate the intersection point coordinate and display it (When there is a intersection that exists). Press [ENT] key or arrow key to move the cursor to the bottom and press [ENT] to save the coordinate, press [ESC] to cancel the saving; If there is no intersection, it displays “No intersection!”

[NOTE]:

- 1) If intersection is not in the specified bearing, the software creates the intersection point backward.
- 2) The intersection point can not be saved, if the coordinates are not in the range of -9999999.999 to 9999999.999.

## 16.4.2 POINTS INTERSECTION

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



From the [PROG] menu, select [COGO] and press [ENT] key, it shows the COGO screen. Then select [4-INTSCT] and press [ENT] key, below screen is displayed.

【4 intersection】	
Pt No (Line) A-1	11
A-2	12
Pt No (Line) B-1	13
B-2	14
NUM	← → ↓ SPC ←BS

F1 F2 F3 F4 F5 F6

Enter the point number in the Pt No field. Press ENT key to move the cursor to the next option. Press ENT key when the cursor is on the bottom line of the screen to exit and save the setting.

If the entered point number does not exist, following screen will be displayed and prompt to enter the point coordinates.

【Input Point】	
Pt No	11
North	122.036
East	85.364
Elev.	25.670
Code	SOUTH
NUM	← → ↓ SPC ←BS

F1 F2 F3 F4 F5 F6

Enter the coordinates of inexisting point, the calculated point is displayed.

【Point】	
Pt No	15
North	123.254
East	20.357
Elev.	0.000
Code	SOUTH
NUM	← → ↓ SPC ←BS

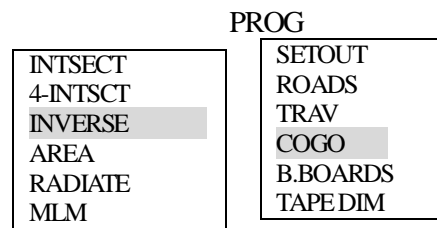
F1 F2 F3 F4 F5 F6

**[NOTE]:**

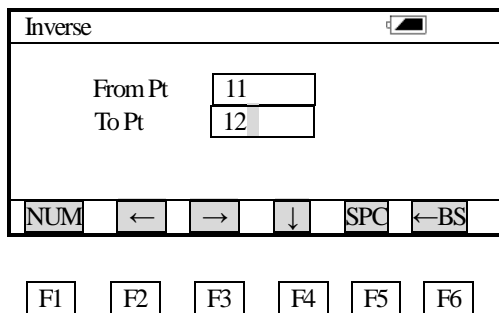
- 1) If there is no intersection point, the message “No Intersection” will be displayed.
- 2) If intersection is not in the specified bearing, the software creates the intersection point backward.
- 3) The intersection point can not be saved, if the coordinates are not in the range of -9999999.999 to 9999999.999.

### 16.4.3 INVERSE

To compute an inverse select INVERSE from the COGO menu.

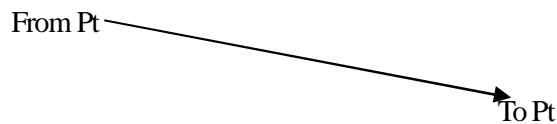


Select the INVERSE option and press ENT key, the inverse screen will be shown.

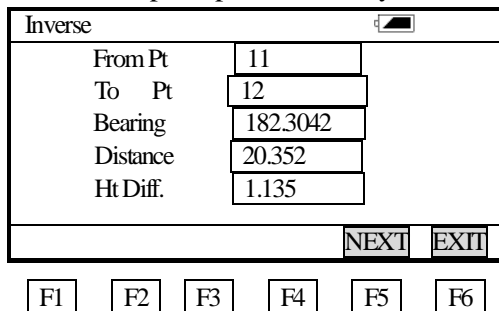


From Pt shows start from which point.

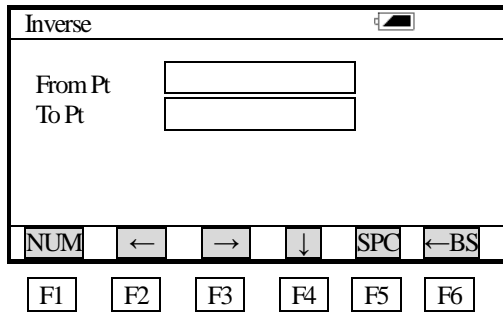
To Pt shows finish at which point.



Enter the From Point number and press [ENT] key, the To Pt input option will be shown. After entering the To point, press [ENT] key, inverse calculating will start, the result will be shown. (If the points data exist in memory). If the data is not in memory, the coordinates of this point should be inputted. After entering all the data of the point, press [ENT] key to calculate, the result will be shown.

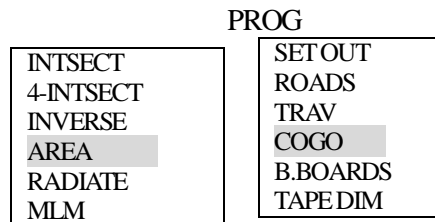


Press [EXIT] key or [ESC] key to return to the COGO menu, press [next] (F5) key, the From Pt and the To Pt should be entered to start other calculation.

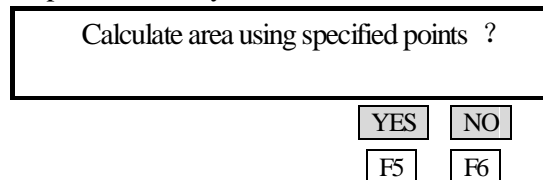


#### 16.4.4 AREA

Select the AREA from the COGO menu.



Select the AREA and press [ENT] key, the below screen will be shown.



Press YES in case you want to specify which points should be used for the area calculation. Refer to 16.4.4-1; Press [F6] (NO) in case you want to compute the area of a figure enclosed by points with a common coding. Refer to 16.4.4-2.

#### 16.4.4-1 AREA USING SPECIFIED POINTS

An area can be calculated by marking at least 3 points, the follow screen is shown:

Area calculation					
Pt No	11				
North	253.210				
East	352.254				
Elev	25.314				
Pt code	SOUTH				
[FND M]	[FND]	[PREV]	[NEXT]	[MARK]	[P2]
		[CLR M]	[STRT]	[END]	[P1]

[F1] [F2] [F3] [F4] [F5] [F6]

Press [NEXT] (F3) key or [PREV] (F3) key, it allows you to find all the stored coordinates in memory. If the point is to be area calculated, press [MARK] (F5) key to mark it. (There will be a "M" displayed behind the point); Press [NEXT] or [PREV] to mark the points to be calculated, and press [ENT], area calculation will be performed, the number and the enclosed area of the points which has been used in calculation will be displayed (If less than three points are found which have been marked the software will show the message "3 pts required")

FND M (F1): Press this key to find next marked point.

**[NOTE]: This function key is only available for search in data files, that's to search the point name of the data followed in the current display only. When the last data is shown in the display, press the key, the system would show the the said data info only.**

FND (F2): Press this key to search the required point number data in data file.

PREV (F3): Press this key to display previous point data.

NEXT (F4): Press this key to display next point data.

MARK (F5): Press this key to mark the points to be used in area calculation.

STRT (F4): Press this key to display the first point data in data file.

END (F5): Press this key to display the last point data in data file.

After at least 3 points have been marked, the Area calculation screen will be shown.

Area calculation	
Pt code	<input type="text"/>
String	<input type="text"/>
Points	3
Area	20.352 m.sq
	[OK]

[F1] [F2] [F3] [F4] [F5] [F6]

Points: The number of the points which is used in area calculation

Area: The enclosed area of the points which is used in area calculation

Press [OK] to exit and return to COGO menu.



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.

#### 16.4.4-2 AREA USING CODE

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

**From the Area calculation screen, press [F6] (NO) key, the follow screen will be shown:**

Area calculation	
Pt code	1100
String	01
NUM   ←   →   ↓   SPC   ←BS	

[F1]   [F2]   [F3]   [F4]   [F5]   [F6]

Enter the required point code, press [ENT] to access the next input option, then enter the string and press [ENT] key, the computed area will then be shown.

Area calculation	
Pt code	1100
String	01
Points	3
Area	20.352 m.sq
OK	

[F1]   [F2]   [F3]   [F4]   [F5]   [F6]

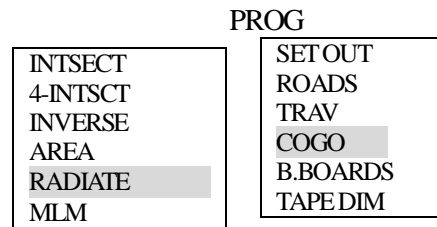
Usually ( $m^2$ ) or ( $ft^2$ ) is used as a unit for an area. If the area is larger than 10000m.sq then the unit is changed to Ha (hectare). The unit is changed to AC (acre) if the closed area is 43560ft.sq or more.

**[NOTE]:**

- 1) Area is not calculated correctly if enclosed lines cross each other.
- 2) If less than three points are found in the raw file with the specified Pt Code and String, the soft shows the message “**3 Pts required**”.
- 3) Data in fixed files can not be used by using this program.

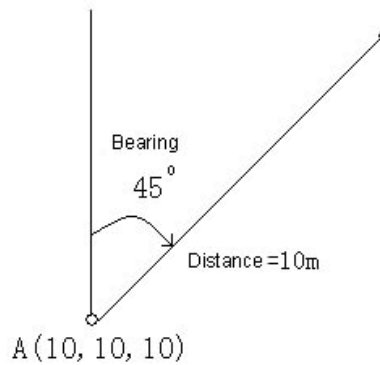
**16.4.5 RADIATION.**

Select RADIATE from the COGO menu.

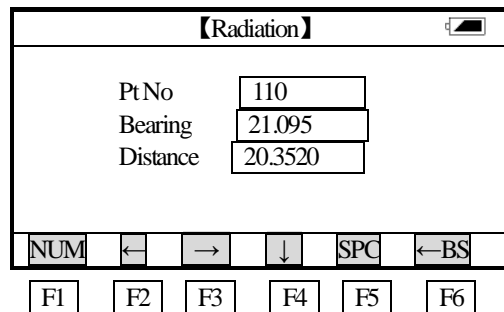


The coordinate for a point can be computed by entering the Bearing and Distance.

Example :



In case of the above, enter as follows :



Enter the radiation point name and press [ENT] to access Bearing Angle Input option. After entering

bearing angle, press [ENT] key, it access the Distance Input option, after entering it, press [ENT], the new point coordinate will be calculated and be displayed.

【Radiation】	
PtNo	111
North	28.979
East	17.348
Elev	0.000
Pt Code	PT
NUM	← → ↓ SPC ←BS
F1	F2 F3 F4 F5 F6

Elevation value can not be calculated, only can be manually input , the results is stored in coordinates data files.

[Note]: When the inputted Point number can not be found in coordinate data, the system will prompt user to type in the coordinate value. After inputting the coordinate, press [ENT] key, the coordinate of current point will be computed.

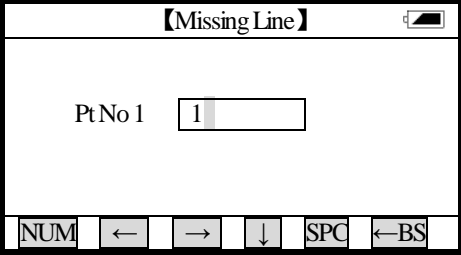
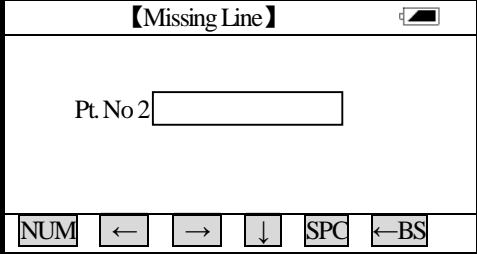
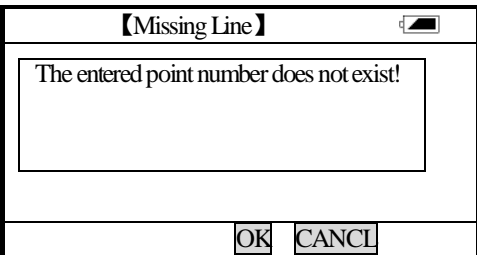
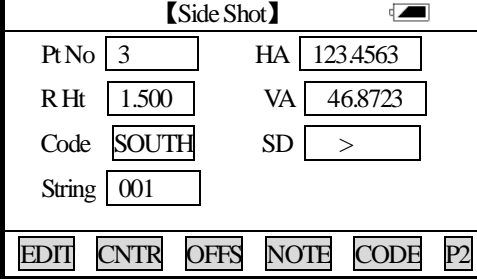
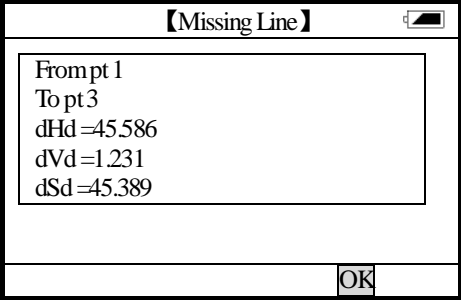
#### 16.4.6 Missing Line Measurement

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

Select MLM from the COGO menu and press [ENT] key to access the MLM menu.

PROG	
INTSECT	SET OUT
4-INTSCT	ROADS
INVERSE	TRAV
AREA	COGO
RADIATE	B.BOARDS
MLM	TAPE DIM

Operating Procedures	Operation	Display						
① From COGO menu, select [MLM] and press [ENT] key. (If the occupied point (or backsight point) is not defined, the “Occupied point input screen” will be displayed.)	Select [MLM] → [set occupied point]	<table border="1"> <thead> <tr> <th colspan="2">【Missing Line】</th> </tr> </thead> <tbody> <tr> <td>MLM point 1</td> <td><input type="text"/></td> </tr> <tr> <td>NUM</td> <td>← → ↓ SPC ←BS</td> </tr> </tbody> </table>	【Missing Line】		MLM point 1	<input type="text"/>	NUM	← → ↓ SPC ←BS
【Missing Line】								
MLM point 1	<input type="text"/>							
NUM	← → ↓ SPC ←BS							

<p>② Enter the number of the start point of the line and press [ENT] key</p>	<p>Type in Pt No 1 [ENT]</p>	
<p>③</p> <p>A If the point data exist in memory, it will prompts to enter the second point number</p> <p>B If the point data does not exist in memory, it will prompt “The point number does not exist?” Press [F4] (OK), the “Side Shot screen” will be displayed, it allows to measure the point.</p>		<p>A</p>  <p>B</p>  
<p>④ Enter the second point number and press [ENT] key. (the coordinate exists in memory).The MLM calculation will be performed. (If the point data does not exist, the point will be measured)</p> <p>dHd: horizontal distance between two points. dVd: height difference between two points. dSd: slope distance between two points.</p>		

⑤ press [F5] (OK) key or [ESC] key to return to the menu.	[F5] or [ESC]	
---	------------------	--

※ **Note:** 1. 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.

2. The calculated data is stored in the raw data file.

## 16.5 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.

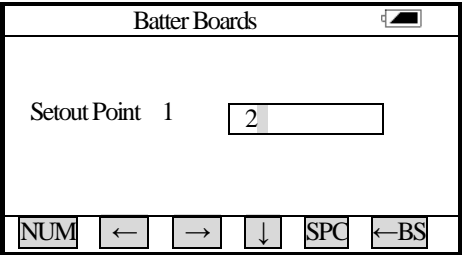
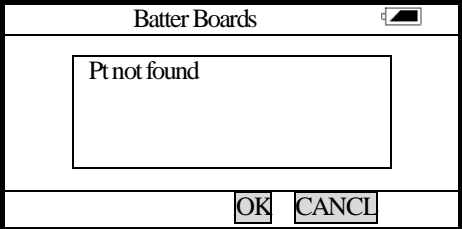
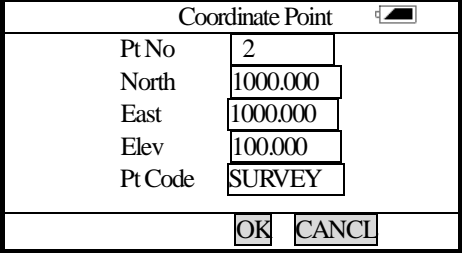
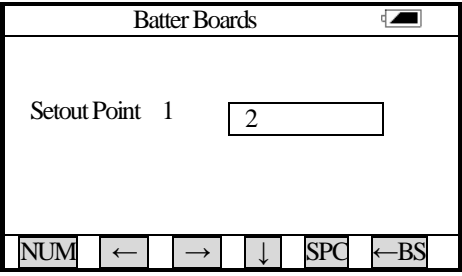
From the **PROG** menu, select **B. BOARD** ,

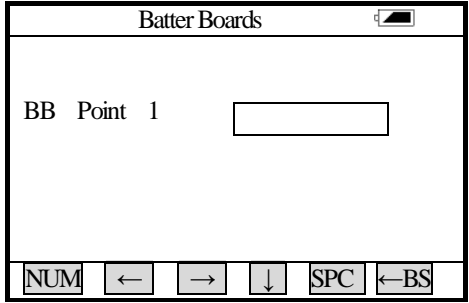
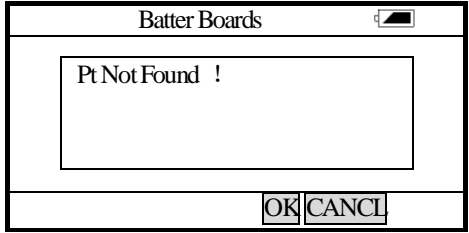
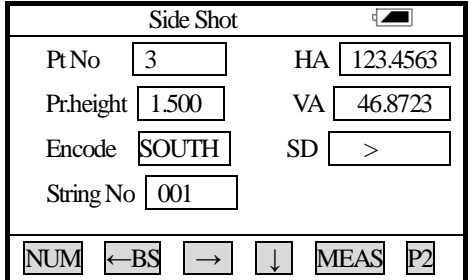
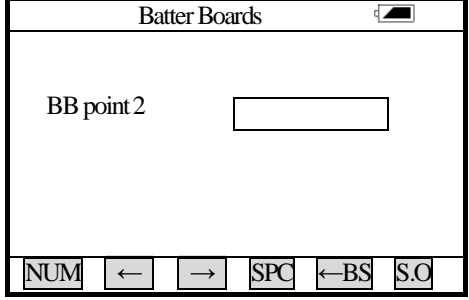
PROG

SET.OUT
ROADS
TRAV
COGO
<b>B.BOARD</b>
TAPE DIM



Operating Procedures	Operation	Display
① Select [Prog] → [B.BOARD]. Press [ENT], (In case the occupied point has not been defined, the program will automatically show the Occupied Point Input Screen. If the backsight point has not been defined, the program will automatically show the Backsight Point Input screen).	Select [B. BOARD]	

<p>②</p> <p>A</p> <p>Enter the first setout point number and press [ENT]</p> <p>B</p> <p>If this point is not known, the program will ask for its coordinate.</p>	<p>Enter the first setout point number and press [ENT]</p>	<p>A</p>  <p>B</p>  <p>Press OK, access the coordinate input menu screen. Press cancel to re-type the first setout point number.</p> 
<p>③After entering the first point number, the second setout number is required, enter it and press [ENT]. (If this point is not known, the program will ask for the coordinates of the second setout point.)</p>	<p>Type in the second point number</p>	

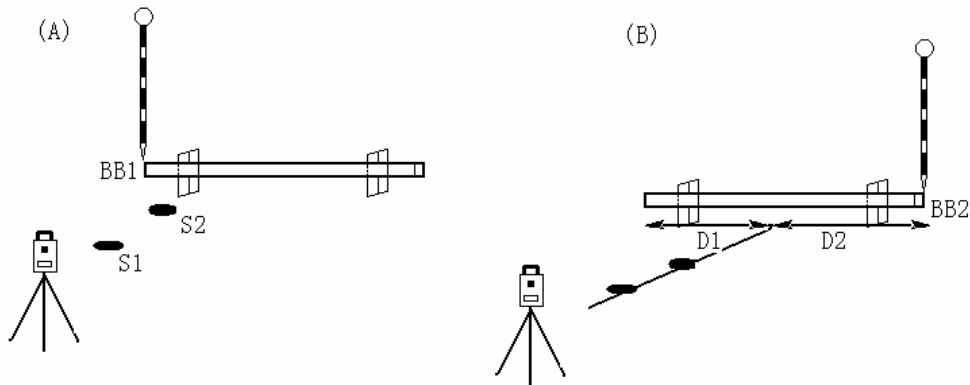
<p>④</p> <p>A</p> <p>Now one side of the batterboard should be measured (The Right side and the left side of the batterboard all are ok). Position the reflector above this side of the batterboard, enter a number for this point (BB point 1) and press [ENT]</p> <p>B</p> <p>If this point is not known, the text 'Pt not found' is displayed. The screen will shows the Side Shot Measurement screen.</p>	<p>A</p>  <p>B</p>  <p>Press OK to access the side shot screen; Or press CANCEL to re-enter the first batterboard point number.</p> 
<p>⑤ Press [ENT] to measure the first batterboard point. After measuring the first point, program will advise the user to enter the second Batter board point.</p>	

**There are two ways to proceed:**

- 1) A method 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 16.5.1.
- 2) A method using one side of the batterboard. The user is advised to use this method in case a quick method is required. Refer to Chapter 16.5.2.

### 16.5.1 Method 1 : Batterboard using two sides

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



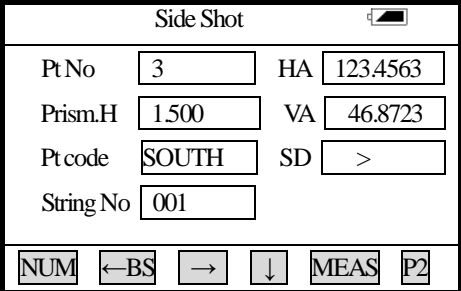
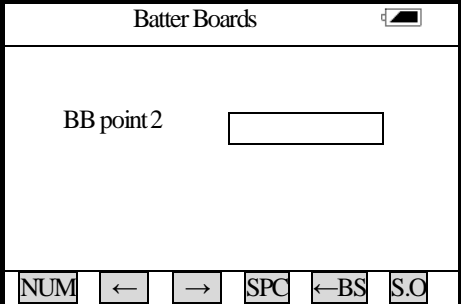
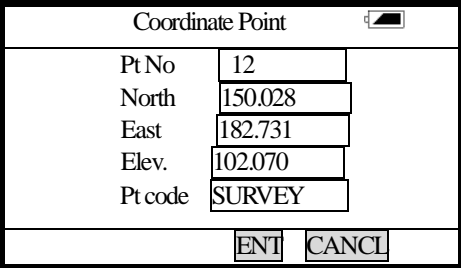
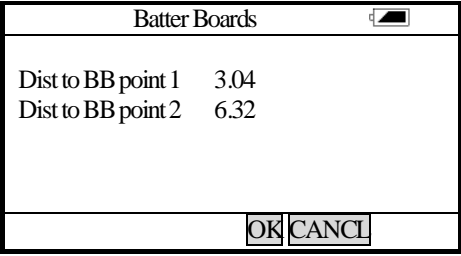
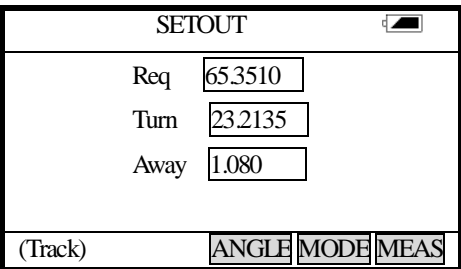
Operating Procedure:

- (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.

#### ► Procedure

Operating Procedures	Operation	Display
① A Now two measure one of the sides of the batterboard (both sides are ok). Position the reflector above the batterboard, input the point number and press [ENT] key.		<p>A</p> <p>Batterboard</p> <p>BB. point 1</p> <p>NUM ← → ↓ SPC ←BS</p>
B		<p>B</p> <p>Batterboards</p> <p>Pt not found !</p> <p>OK CANCEL</p>



<p>If the point is not known, the text "Pt Not Known !" is displayed. The side shot measurement screen will be shown.</p>		<p>按 Press OK to access the side shot screen ; Or press CANCEL to re-enter the first batterboard point number.</p>  <p>The screenshot shows the 'Side Shot' screen with the following fields: Pt No: 3, HA: 123.4563, Prism.H: 1.500, VA: 46.8723, Pt code: SOUTH, SD: &gt;, and String No: 001. The bottom navigation bar includes NUM, ←BS, →, ↓, MEAS, and P2.</p>
<p>② Press [ENT] to measure the first BB point 1, the program will prompt the user to input the second BB point number.</p>		 <p>The screenshot shows the 'Batter Boards' screen with a prompt for 'BB point 2' and an input field. The bottom navigation bar includes NUM, ←, →, SPC, ←BS, and S.O.</p>
<p>③ The coordinate of the intersection point (The intersection point of the batterboard and the line connecting S1 and S2) will be shown on the screen.</p>		 <p>The screenshot shows the 'Coordinate Point' screen with the following data: Pt No: 12, North: 150.028, East: 182.731, Elev.: 102.070, and Pt code: SURVEY. The bottom navigation bar includes ENT and CANCEL.</p>
<p>④ If DISPLAY XYZ is ON, these coordinates are shown and [ENT] key should be pressed. Next the distance from this intersection point to the first BB point and the distance from the intersection to the second BB point are shown.</p>	<p>[ENT]</p>	 <p>The screenshot shows the 'Batter Boards' screen displaying distances: 'Dist to BB point 1: 3.04' and 'Dist to BB point 2: 6.32'. The bottom navigation bar includes OK and CANCEL.</p>
<p>⑤ If [F4] (OK) is pressed, the intersection point can be setout. If [F5] (Cancel) is pressed, the current Batterboard program will be closed.</p>	<p>[F4]</p>	 <p>The screenshot shows the 'SETOUT' screen with the following data: Req: 65.3510, Turn: 23.2135, and Away: 1.080. The bottom navigation bar includes (Track), ANGLE, MODE, and MEAS.</p>

※ The distance measurement mode can be changed by pressing [F5](MODE) key. The current distance measurement mode shows on the left side of the underside of the screen.

※ The setout of this intersection point is identical to Point Setout, which is discussed in paragraph 16.1.3, except for two differences.

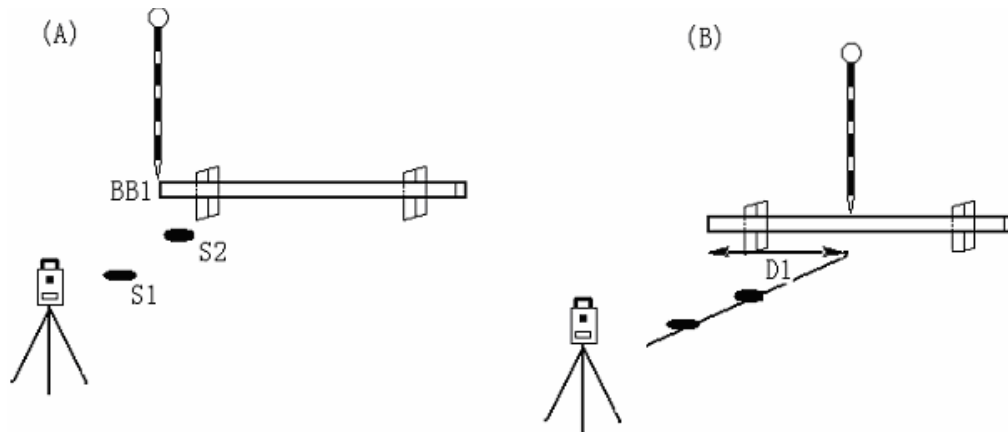
- 1) Automatically the intersection point is chosen for setting out.
- 2) CUT is not shown at the screen.

**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.
- 4) 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 by one.

**16.5.2 Method 2 : Batterboards using one side**

Press **【S.O】** (F6) key in case you want to measure only one side of the batterboard.

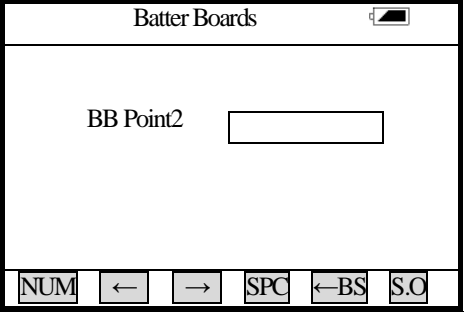
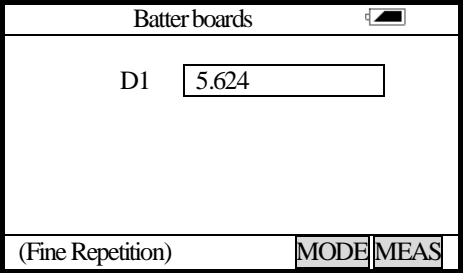


Operating procedure :

- (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.

**►Procedure**

Operating Procedures	Operation	Display
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<p>① Press [F6] (S.O) key on the lower screen when inputting the second BB point number.</p>	<p>[F6]</p>	
<p>② The right screen will be shown. D1 indicates the distance from the pole to the intersection point. Move the pole along the batterboard and press [F6] (Meas) key, D1 now indicates a precise distance. The intersection point is found when D1 equals zero.</p>		

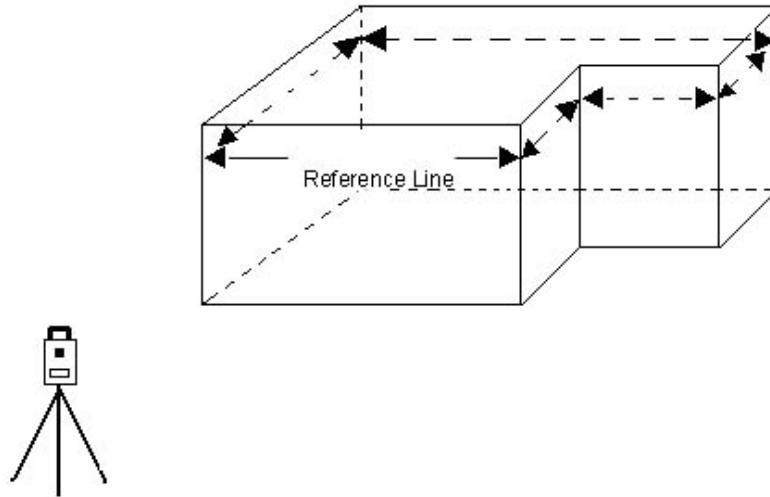
※ Press [F5] (mode) key to change measuring mode, current measuring mode is shown on the left side of lower screen.

**NOTE :**

- 1) After the first side of the Batterboard has been measured and [S.O.] has been selected, it is assumed that the orientation of the batterboard is perpendicular to the line connecting the two setout points. The distance D1 is calculated using this assumption. Next a second point on the batterboard 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 batterboard 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 by one.

**16.6 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 of measuring an object using 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 can be shown.

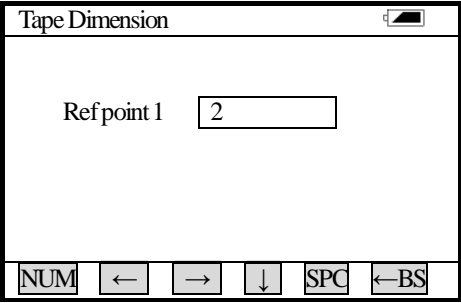
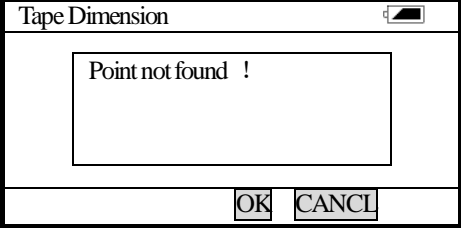
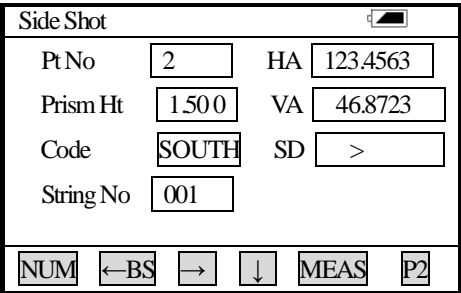
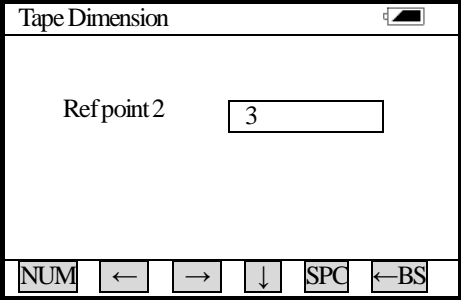
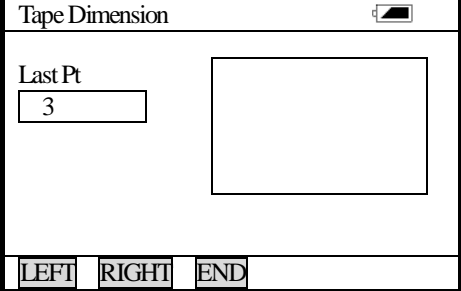
Select TAPE DIM from the PROG menu.

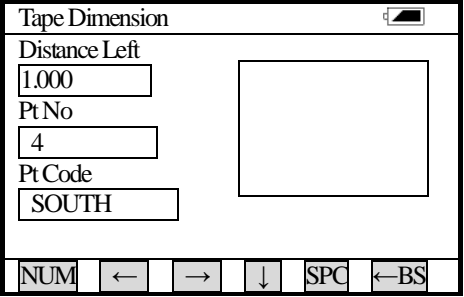
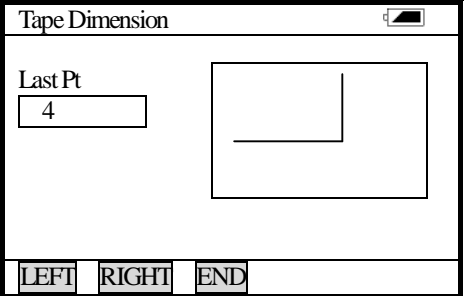
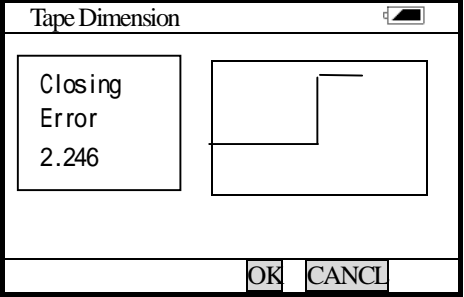
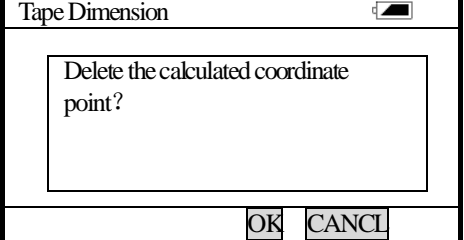
Prog

- SET OUT
- ROADS
- TRAV
- COGO
- B.BOARDS
- TAPE DIM

### ►PROCEDURE

Operating Procedures	Operation	Display
<p>① Select TAPE DIM from the PROG menu and press [ENT] key.</p> <p>If the occupied point is not defined, the program will remind you to input occupied point. If the backsight point is not defined, the program will also remind you to input backsight point.</p>	<p>Select Tape Dimensions</p>	

<p>②Enter the number of the first reference point and press ENT key.</p> <p>A If this point exists in memory, the screen will ask you to input the end of reference line.</p> <p>B If the point does not exist, the prog will recommends that “ point not found !”, the side shot screen will be shown,the point must be measured,Now inout the end of reference line, the screen shows as A part.</p>	<p>Input the ref point.</p>	<p>A</p>  <p>B</p>  <p>Press OK to enter Side Shot screen; Press Cancel to input the start point of reference line again.</p> 
<p>③Input the end point of Ref line and press ENT key.(If the point does not exist, the side shot screen will be shown,the point must be measured)</p>	<p>Input the end point of Ref line.</p>	
<p>④The reference line is defined, now use a tape to measure the line which perpendicular to the reference line, start from both sides of reference line.If the line is at the left hand side, press [ LEFT ] key.If the line is at the right hand side of reference line, press [RIGHT] key.</p>		

<p>⑤ Press [LEFT] or [RIGHT], a screen will be shown, in which the distance can be entered (In metres), also the number of the point that will be created and its code can be defined. (Distance Range: 0.01~1000)</p>	<p>[LEFT] or [RIGHT]</p>	
<p>⑥ If [ENT] key is pressed, the new line plus the reference line are graphically displayed. Again [LEFT] or [RIGHT] can be pressed to create another point.</p>	<p>[ENT]</p>	
<p>⑦ After measuring the last point, press [F3] (End), closing error will be shown.</p>	<p>[F3]</p>	
<p>⑧ Press [F4] (OK) to return to [Prog] menu screen; Press [F5] (Cancel), the screen will recommend that if delete the last coordinate point, now user can process the data on his need.</p>	<p>[F4] or [F5]</p>	

**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) Press [END] key 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. Press [OK] key to store all points defined and to return to main menu. Press [Cancel] in case the closing error is too large. The question "Delete calculated points?" will be shown. Press [YES] if you want to return

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to the main menu without storing the coordinates.

NOTE :

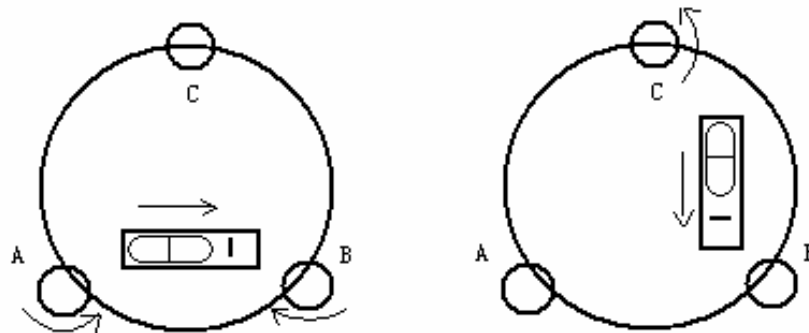
- 1) The reference line and the lines defined by offsets are graphically shown only in case at least one offset has been entered.
- 2) To use [Tape Dimension] program,[Prompt BKS] and [XYZ File] in [JOB OPTN] should be turned ON.

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## 17 CHECK AND ADJUSTMENT

If the bubble of the circular vial is not in the center, bring the bubble to the center by using the adjusting pin or hexagon wrench to adjust the bubble adjusting screw. First loosen the screw opposite to the offset side, and then tighten the other adjusting screw on the offset side, bringing the bubble to the center. After the bubble stays in the center, keep the tightness of the three screws in uniform.

### 17.1 PLATE VIAL



#### Inspection

Refer to Section 3.2 “Leveling by using the plate vial”.

#### Adjustment

1. If the bubble of the plate vial moves from the center, bring it half way back to the center by adjusting the leveling screw, which is parallel to the plate vial. Correct the remaining half by adjusting the screw of plate vial with adjusting pin.
2. Confirm whether the bubble does is in the center by rotating the instrument 180°. If not, repeat Procedure (1).
3. Turn the instrument 90°and adjust the third screw to center the bubble in the vial.

Repeat inspection and adjustment steps until the bubble remains in center with the vial in any direction.

### 17.2 CIRCULAR VIAL

#### Inspection

No adjustment is necessary if the bubble of the circular vial is in the center after inspection and adjustment of the plate vial.

#### Adjustment

If the bubble of the circular vial is not in the center, bring the bubble to the center by using the adjusting pin or hexagon wrench to adjust the bubble adjusting screw. First loosen the screw opposite



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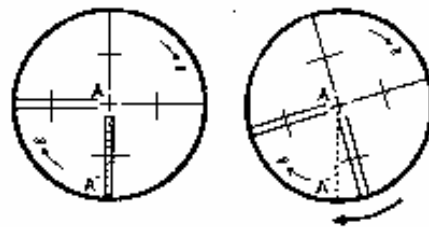
to the offset side, and then tighten the other adjusting screw on the offset side, bringing the bubble to the center. After the bubble stays in the center, keep the tightness of the three screws in uniform.

### 17.3 INCLINATION OF RETICLE

#### Inspection

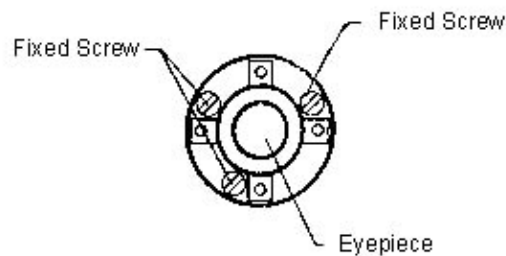
1. Sight object A through the telescope and lock the horizontal and vertical clamp screws.
2. Move object A to the edge of the field of view with the vertical tangent screw (point A')
3. No adjustment is necessary if object A moves along the vertical line of the reticle and point A' still in the vertical line.

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



#### Adjustment

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



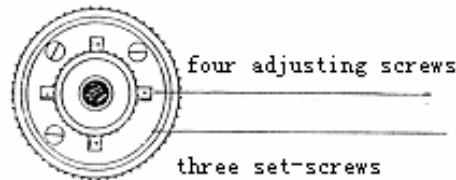
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## 17.4 PERPENDICULARITY OF LINE OF SIGHT TO HORIZONTAL AXIS

(2c)

### Inspection

1. Set object A at a far distance the same height as the instrument, then level and center the instrument and turn on the power (horizontal angle  $L=10^{\circ}13'10''$ ).
2. Sight object A in left position and read the horizontal angle value (horizontal angle  $R=190^{\circ}13'40''$ ).
3. Loosen the vertical and horizontal clamp screws and rotate the telescope. Sight object A in right position and read the horizontal angle value.
4.  $2C=L-R\pm 180^{\circ}=\pm 30''\geq \pm 20''$ , adjustment is necessary.



### Adjustment

1. Use the tangent screw to adjust the horizontal angle reading.
2. Take off the cover of the reticle between the eyepiece and focusing screw. Adjust the two adjusting screws by loosening one and tightening the other. Move the reticle to sight object A exactly.
3. Repeat inspection and adjustment until  $|2C| < 20''$ .
4. Replace the cover of reticle.

## 17.5 VERTICAL INDEX DIFFERENCE COMPENSATION

### Inspection

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 has increased to more than  $3'$  at this time and exceed the designated compensation range.

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.

### Adjustment

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

## 17.6 ADJUSTMENT OF VERTICAL INDEX DIFFERENCE ( i angle) AND VERTICAL ANGLE 0 DATUM

Inspect the item after finishing after finishing the inspection and adjustment of Item 17.3 and 17.5.

### Inspection

1. Power on after leveling the instrument. Sight object A in left position and read the Vertical angle value L.
2. Rotate the telescope. Sight object B in right position and read the Vertical angle value R.
3. If the vertical angle is  $0^\circ$  in zenith,  $i = (L + R - 360^\circ) / 2$   
If the vertical angle is  $0^\circ$  in horizon,  $i = (L + R - 180^\circ) / 2$  or  $(L + R - 540^\circ) / 2$ .
4. If  $|i| \geq 10''$  shall set the Vertical Angle 0 Datum again.

### Adjustment:

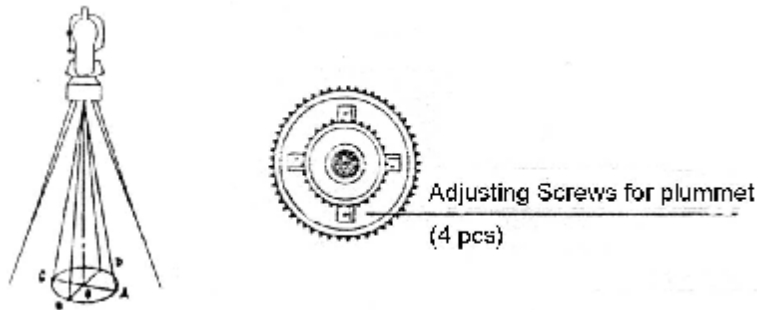
Operating Procedures	Operation	Display
①After leveling the instrument, press <b>POWER</b> key to turn on the instrument, press [F5](adjust) to access the Adjustment menu.	<b>POWER</b> + [F5]	<div style="border: 1px solid black; padding: 5px;">                     Adjustment <span style="float: right;">▢</span>                      F1 Index Difference                      F2 Instrument Constant                      F3 Date                      F4 LCD Contrast                 </div>
②Select [F1] (Index Difference), the screen shows as follow :	[F1]	<div style="border: 1px solid black; padding: 5px;">                     Vertical Angle 0 set Adjustment <span style="float: right;">▢</span>                      &lt;Step 1&gt; Normal Left                      V: 92°42'19"  <div style="text-align: right;">YES NO</div> </div>
③In left position rotate the telescope. Precisely sight the any target A in same height with the instrument until the vertical angle displayed. Press <b>F5</b> key.	[F5]	<div style="border: 1px solid black; padding: 5px;">                     Vertical Angle 0 set Adjustment <span style="float: right;">▢</span>                      &lt;Step 2&gt; Reverse Right                      V: 267°1809"  <div style="text-align: right;">YES NO</div> </div>
④Rotate the telescope, and sight the same target A precisely in the right position. Press <b>F5</b> YES key. Setting is finished and the instrument return to the ADJUSTMENT mode.	[F5]	<div style="border: 1px solid black; padding: 5px;">                     Vertical Angle 0 set Adjustment <span style="float: right;">▢</span>                      Set !                      V: 267°1809"  <div style="text-align: right;">YES NO</div> </div>

- 
- Note: 1. Repeat the inspection steps to measure the Index Difference (I angle). If the Index Difference cannot meet the requirement, you should check whether the three steps of the adjustment are right, the sight is right and etc. Then set again according to the requirement.
2. If Index Difference is still meet the requirement after the repeated operation, the instrument should be returned to factory for inspection and repair.

## 17.7 OPTICAL PLUMMET

### Inspection

1. Set the instrument on the tripod and place a piece of white paper with two perpendicular lines, then intersect drawn on it directly under 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 at every  $90^\circ$  observe whether the center mark position coincides with the intersection point of the cross.
5. If the center mark always coincides with intersection point, no adjustment is necessary. Otherwise, the following adjustment is necessary.



### Adjustment

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 fall of the center of optical plummet on the paper at every  $90^\circ$ . As illustrated: Point A, B, C, 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 be sure the adjustment is correct.
6. Replace the protective cover.

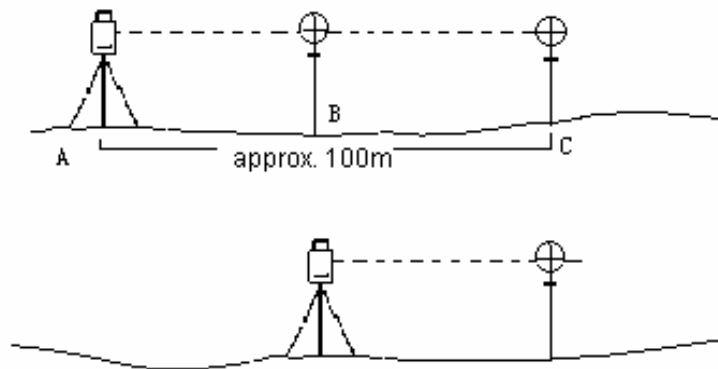
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## 17.8 INSTRUMENT CONSTANT (K)

Instrument constant has been checked and adjusted in the factor,  $K=0$ . It changes seldom 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.

### Inspection

1. Mount and level the instrument on Point A in a plain place. Use the vertical hair to mark Point B and Point C on the same line with the distance of 50m on the same line, and set the reflector accurately.
  2. After setting temperature and air pressure in the instrument, 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 you can get the Instrument Constant:  $K = AC - (AB + BC)$
- K should be closed to 0, If  $|K| > 5 \text{ mm}$ , the instrument should be strictly inspected in the standard baseline site, and adjusted according to the inspection value.



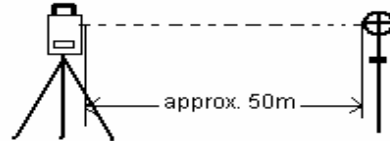
### Adjustment

If strict inspection approves that the Instrument Constant K has changed and is not closed to 0. If the operator wants to adjust, should set Stadia Constant according to the Constant K (Power On pressing [F1]).

- Set the direction by using the Vertical Hair to make Point A,B,C on the same line strictly. On Point there must be fixed and clear centering mark.
- Whether the prism center of Point B coincide with the Instrument Center is the B is the important tache to inspect the accuracy. So on Point B Tripod or tribrach compatible should be used. That will decrease the difference.

---

## 17.9 PARALLEL BETWEEN LINE OF SIGHT AND EMITTING PHOTOELECTRIC AXIS



### ·Inspection

1. Set the reflector 50m from the instrument.
2. Sight the center of the reflector prism with reticle.
3. Power on and enter Distance Measurement Mode. Press [MEAS] to measure.  
Rotate the Horizontal Tangent Screw and Vertical Tangent Screw, to do electric collimation and make the light route of EDM unblocked. In the bight zone find the center of emitting photoelectric axis.
4. Check whether the center of reticle coincides with the center of emitting photoelectric axis. If so, the instrument is up to grade.

## 17.10 TRIBRACH LEVELLING SCREW

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

## 17.11 RELATED PARTS FOR REFLECTOR

### 1. The Tribrach and Adapter for Reflector

The plate vial and optical plummet in the adapter and tribrach should be checked, refer to Chapter 17.1 and 17.7.

### 2. Perpendicularity of the prism pole

As illustrated, 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 Point E and F on the cross lines. Adjust the two legs to make the bubble on the prism pole centered.

---

Set and level the instrument on Point A near the cross. Sight line 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 on another cross lines. With the same way flexing the Leg f to make Point C and D are on the central line of reticle.

Through the inspection by the instrument on Point A and B, Prism pole has been perpendicular. If then the bubble offset from the center, adjust the three screws under circularial to make the bubble centered, refer to Chapter 13.2.

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

## 18 SPECIFICATION

		NTS-662	NTS-663	NTS-665
<b>Distance Measurement</b>				
Measuring Range (under fair weather condition)	Single prism	1.8 Km	1.6 Km	1.6 Km
	Triple prism	2.6 Km	2.3 Km	2.3 Km
Display		Max: 999999.999 m    Min : 1 m		
Accuracy		2+2 ppm		
Unit		m / ftselectable		
Measuring time		Fine single shot: 3S Tracking: 1S		
Average measuring times		The average value of 1~99 times		
Meteorologic Correction		Manual input, Auto correction		
Atmospheric refraction and earth curvature correction		Manual input, Auto correction, K=0.14/0.2		
Reflection prism correction		Manual input, Auto correction		
<b>Angle Measurement</b>				
Measuring method		Photoelectric detection by incremental encoder		
Dia of circle (vertical, horizontal)		79 mm		
Minimum reading		1"/5"Selectable		
Detection method		Horizontal: Dual Vertical : Dual		
Accuracy		2"	3"	5"
<b>Telescope</b>				
Image		Erect		
Telescope Length		154 mm		
Effective aperture		45 mm (EDM 50 mm)		
Magnification		30×		
Field of view		1° 3 0'		
Minimum focus		1m		
Resolving power		3"		
Minimum focus		1m		
<b>Vertical Compensator</b>				
System		Liquid-electric detection/plate vial		
Compensation range		± 3'		



Resolving power	1 "
<b>Vial</b>	
Plate vial	30" / 2 mm
Circular vial	10' / 2 mm
<b>Optical Plummet</b>	
Image	Erect
Magnification	3×
Focusing range	0.5 m ~ ∞
Field of view	5°
<b>Display</b>	
Type	Double LCD, Graphic
<b>Data Communication</b>	
Port	RS-232C
<b>On-board Battery</b>	
Power resource	Rechargeable Ni-H battery
Voltage	DC 6V
Continuous operation time	8 hours
<b>Size &amp; weight</b>	
Dimension	200×180×350 mm
Weight	6.0 kg

---

## 19 ACCESSORIES

Carrying Case	1 pc
Main Body	1 pc
On-board Battery	1 pc
Backup Battery	1 pc
Charger	1 pc
Plummet	1 pc
Correction Pin	2 pcs
Fur Brush	1 pc
Screwdriver	1 pc
Hexagon Wrench	2 pcs
Cloth	1 pc
Dryer	1 pc
Operation Manual	1 pc

---

## 【APPENDIX A】 DATA FORMAT

### 1、 Original Data Format

NTS-660	
(ID)	(Information)
JOB	Job name, description
DATE	Date, time
NAME	Surveyor's name
INST	Instrument ID
UNITS	m/feet, degree, gon, mil
SCALE	grid factor, scale factor, elevation
ATMOS	temp(°C), pressure (hPa)
STN	Pt No, Ins Ht, Stn id
XYZ	X(easting), Y(Northing), Z(elevation)
BKB	Pt No, backsight bearing, backsight angle
BS	Pt No [Target height]
FS	Pt No, Target height, Pt code, [string number ]
SS	Pt No, Target height, Pt code, [string number ]
CTL	Control code, [Pt code 2[String number]](optional)
HV	HA(Horizontal angle ), VA(vertical angle)
SD	HA(Horizontal angle), VA(vertical angle), SD(slope distance)
HD	HA(horizontal angle), HD(horizontal distance), VD(vertical distance)
NOTE	comments
RES_OBS	Pt No, target height, observation count.

### 2、 Coordinate Data Format

The format of downloaded coordinates is as follows :

Pt No , E, N, Z, pt 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

---

It is also possible to download coordinates which are given with respect to a reference line :

Pt no, Line, Offset, Z(elevation), from reference ptno, to reference ptno

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

112,394.248,18.295,100.904,PT,101,104

### 3. Cross Section Format

The format for downloaded and uploaded cross sections is as follows :

Chainage, offset, level,[, 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

### 4. Point Code Format

Code files for uploading to the point code library, should have a single code per line with optional entity number and layer time,i.e. each entry is terminated by pressing ENTER.

Code [, ENTITY[, LAYER]]

The default entity is "1", and the layer is "0", when the code is not defined in the CODE LIB.

e.g :

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

## 5. Alignments (AL)

Alignments are uploaded as elements, and must start with the START definition which includes the starting chainage and a coordinate. The element are : PT, STRAIGHT, ARC or TRANSITION.

The general format for each record is :

KEYWORD nnn,nnn[,nnn]

where:

START	chainage , E, N
STRAIGHT	bearing, distance
ARC	radius, length
SPIRAL	radius, length
PT	E, N[, A1, A2] (A1, A2:clothoid length)

Ex 1:

START	1000.000, 1050.000, 1100.000
STRAIGHT	25.000, 48.420
SPIRAL	20.000, 20.000
ARC	20.000, 23.141
SPIRAL	20.000, 20.000
STRAIGHT	148.300, 54.679

Ex 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

---

## 6. Vertical Curves (VC)

Vertical curves are uploaded as IP's and require chainage, level and curve length.

The format is :

Chainage, level, length

e.g.

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】 HOW TO CALCULATE ROAD ALIGNMENT

The road alignment set out program can set out the alignment including straight, arc and spiral transition.

NOTE :

- 1) Road alignment data can be uploaded from COMPUTER or can be entered manually. Cross section elements are uploaded from COMPUTER only.
- 2) Both road alignment and cross section data are managed by chainage.
- 3) Though SAVE SETOUT is ON, the data can not be printed out and will not be stored.
- 4) One job name for one alignment can be registered. You may create different job names for many alignments.

### 1. ROAD Alignment Elements

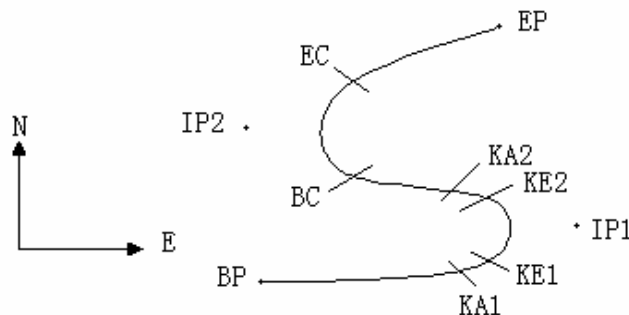
There are two ways to enter the alignment elements :

- 1) Download from PC.
- 2) Manually entered on the NTS-660 series.

How to enter the alignment data is explained below :

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

NOTE : When downloading from COMPUTER or by entering PT option, you do not have to calculate the Parameter.



---

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

Example :

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

Chainage	<input type="text" value="0"/>
N	<input type="text" value="1100.000"/>
E	<input type="text" value="1050.000"/>

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

N	<input type="text" value="1300.000"/>
E	<input type="text" value="1750.000"/>
R	<input type="text" value="100.000"/>
A1	<input type="text" value="80.000"/>
A2	<input type="text" value="80.000"/>

Enter the following data in the above way :

N	<input type="text" value="1750.000"/>
E	<input type="text" value="1400.000"/>
R	<input type="text" value="200.000"/>
A1	<input type="text" value="0.000"/>
A2	<input type="text" value="0.000"/>

N	<input type="text" value="2000.000"/>
E	<input type="text" value="1800.000"/>
R	<input type="text" value="0.000"/>
A1	<input type="text" value="0.000"/>
A2	<input type="text" value="0.000"/>

The following data is downloaded in the above example :

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 of clothoid length

(1) Calculation of clothoid length

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

$A_{1,2}$  : Parameter of clothoid

$R$  : Radius

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

(2) Calculation of Spiral Angle

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

$$t_1 = \frac{64^2}{2 \cdot 80^2} = 0.32 \text{ rad} \quad \Rightarrow \quad \text{deg} \quad \Rightarrow \quad 0.32 \frac{180}{\pi} = 18^\circ 20' 06''$$

$$\therefore t_1 = -t_2$$

(3) Calculation of transition coordinates

$$N = A \cdot \sqrt{2t} \left( 1 - \frac{t^2}{10} + \frac{t^4}{216} - \frac{t^6}{9360} \dots \right)$$

$$E = A \cdot \sqrt{2t} \left( \frac{t}{3} - \frac{t^3}{42} + \frac{t^5}{1320} - \frac{t^7}{7560} \dots \right)$$

$$\begin{aligned} N &= 80 \cdot \sqrt{2 \cdot 0.32} \left( 1 - \frac{(0.32)^2}{10} + \frac{(0.32)^4}{216} - \frac{(0.32)^6}{9360} \dots \right) \\ &= 64 \left( 1 - \frac{0.01024}{10} + \frac{0.01048576}{216} - \frac{0.00107341824}{9360} \right) \\ &= 64 (1 - 0.01024 + 0.00004855 - 0.00000011) \\ &= 64 * 0.98981 \\ &= 63.348 \end{aligned}$$

as well as E :

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

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

$$= 6.777$$

This example is symmetry spiral transition  $N_1=N_2$ ,  $E_1=E_2$

(4) Calculation of shift value  $\Delta R$

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

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

$$= 1.700$$

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

(5) Calculation of Spiral Transition coordinate

$$N_m = N - R \sin t = 63.348 - 100 \sin 18^\circ 20' 06'' = 31.891$$

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

(6) Calculation of Tangent Distance

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

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

$$D_1 = 100 * \tan(111^\circ 55' 47'' / 2) + 1.7(1 / \sin 111^\circ 55' 47'')$$

$$- 1.7(1 / \tan 111^\circ 55' 47'') + 31.891$$

$$= 148.06015 + 1.8326 + 0.6844 + 31.891$$

$$= 182.468$$

$$D_1 = D_2$$

(7) Calculation of the coordinate KA1

$$N_{KA1} = N_{IP1} - D_1 \cdot \cos a_1$$

$$E_{KA1} = E_{IP1} - D_1 \cdot \sin a_1$$

Bearing from BP to IP1  $\Rightarrow a_1 = 74^\circ 03' 16.6''$

$$N_{KA1} = 1300 - 182.468 * \cos 74^\circ 03' 16.6'' = 1249.872 \text{ m}$$

$$E_{KA1} = 1750 - 182.468 * \sin 74^\circ 03' 16.6'' = 1574.553 \text{ m}$$

(8) Calculation of Arc Length

$$L = R(LA - t_1 + t_2)$$

$$= R(111^\circ 55' 47'' - 2 * 18^\circ 20' 06'')$$

$$=100\left(75^{\circ}15'35'' \frac{P}{180^{\circ}}\right)$$

$$=131.353 \text{ m}$$

(9) Calculation of the coordinate KA2

$$N_{KA2} = N_{IP1} - D_2 \cdot \cos a_2$$

$$E_{KA2} = E_{IP1} - D_2 \cdot \sin a_2$$

Bearing from IP1 to IP2  $\Rightarrow a_2 = 322^{\circ}07'30.1''$

$$N_{KA2} = 1300 - (-182.468) * \cos 322^{\circ}07'30.1'' = 1444.032 \text{ m}$$

$$E_{KA2} = 1750 - (-182.468) * \sin 322^{\circ}07'30.1'' = 1637.976 \text{ m}$$

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

Arc length  $CL = R \cdot IA$

$$IA = 95^{\circ}52'11''$$

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

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

Each coordinates are computed :

$$N_{BC} = N_{IP2} - TL \cdot \cos a_2$$

$$E_{BC} = E_{IP2} - TL \cdot \sin a_2$$

$$N_{EC} = N_{IP2} - TL \cdot \cos a_3$$

$$E_{EC} = E_{IP2} - TL \cdot \sin a_3$$

:

$$a_2 \text{ (Bearing from IP1 to IP2)} = 322^{\circ}07'30.1''$$

$$a_3 \text{ (Bearing from IP2 to EP)} = 57^{\circ}59'40.6''$$

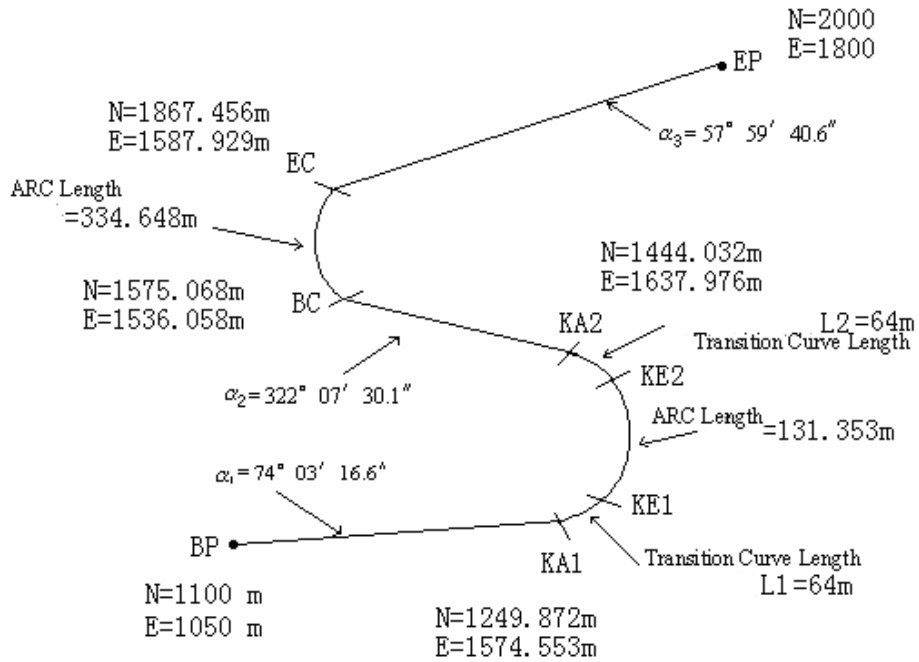
$$N_{BC} = 1750 - 221.615 * \cos 322^{\circ}07'30.1'' = 1575.068 \text{ m}$$

$$E_{BC} = 1400 - 221.615 * \sin 322^{\circ}07'30.1'' = 1536.058 \text{ m}$$

$$N_{EC} = 1750 - (-221.615) * \cos 57^{\circ}59'40.6'' = 1867.456 \text{ m}$$

$$E_{EC} = 1400 - (-221.615) * \sin 57^{\circ}59'40.6'' = 1587.929 \text{ m}$$

The results are calculated below :



The coordinates and the distance are calculated as below :

- 1) Compute the length of straight line

Straight line

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

$$\text{straight line } KA2 \cdot BC = \sqrt{(1575.068 - 1444.032)^2 + (1536.058 - 1637.976)^2} = 166.005$$

m

straight line

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

Start point coordinate (BP)

N 1100.000 m

E 1050.000 m

straight line ( between BP and KA1 )

Bearing 74°03'16.6"

Distance 545.543 m

Transition clothoid (between KA1 and KE1)

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

Length 64 m

---

ARC (between KE1 and KE2)

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

Length 131.354 m

Transition (Between KE2 and KA2)

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

Length 64 m

Straight line (between KA2 and BC)

Bearing  $322^{\circ}07'30.1''$

Distance 166.004 m

Arc (between BC and EC)

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

Length 334.648 m

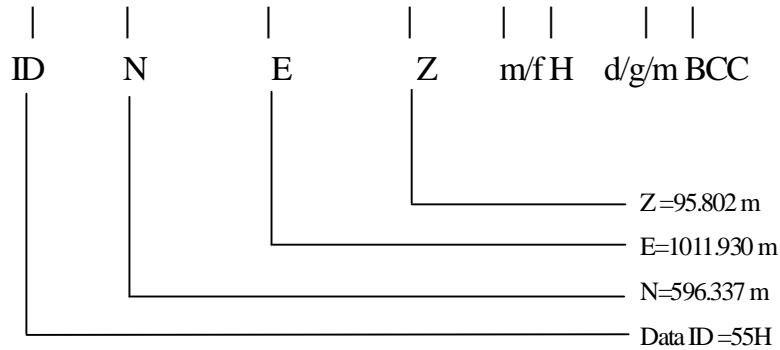
Straight line (between EC and EP)

Bearing  $57^{\circ}59'40.6''$

Distance 250.084 m



U-00596337+01011930+00095802m+1203040d 110EXT(CRLF)



## 2. Operating Commands and its format

1 : Start up measuring and send data to the computer.

C 067 ETX CRLF

ASCII code : 43H 30H 36H 37H 03H 0DH 0AH

2 : To answer if the received data is available

ACK 006 ETX CRLF.....available

ASCII code : 06H 30H 30H 36H 03H 0DH 0AH

NAK 021 ETX CRLF.....invalid

ASCII code : 14H 30H 32H 31H 03H 0DH 0AH

3 : To change measuring mode.

Command

Mode

Z10 091 ETX CRLF

H/V Angle measurement

ASCII code : 5AH 31H 30H 30H 39H 31H 03H 0DH 0AH

Z12 089 ETX CRLF

HR Right angle

ASCII code : 5AH 31H 32H 30H 38H 39H 03H 0DH 0AH

Z13 088 ETX CRLF

HL Left angle

ASCII code : 5AH 31H 33H 30H 38H 38H 03H 0DH 0AH

Z32 091 ETX CRLF

SD Coarse

ASCII code : 5AH 33H 32H 30H 39H 31H 03H 0DH 0AH

Z34 093 ETX CRLF

SD Fine

ASCII code : 5AH 33H 34H 30H 39H 33H 03H 0DH 0AH

Z35 092 ETX CRLF

SD Coarse Repetition

ASCII code : 5AH 33H 35H 30H 39H 32H 03H 0DH 0AH

Z42 092 ETX CRLF

HD Coarse

ASCII code : 5AH 34H 32H 30H 39H 32H 03H 0DH 0AH

Z44 090 ETX CRLF

HD Fine

---

ASCII code : 5AH 34H 34H 30H 39H 30H 03H 0DH 0AH  
 Z45 091 ETX CRLF HD Fine Repetition

ASCII code : 5AH 34H 35H 30H 39H 31H 03H 0DH 0AH  
 Z62 094 ETX CRLF NEZ Coarse

ASCII code : 5AH 36H 32H 30H 39H 34H 03H 0DH 0AH  
 Z64 088 ETX CRLF NEZ Fine

ASCII code : 5AH 36H 34H 30H 38H 38H 03H 0DH 0AH  
 Z65 089 ETX CRLF NEZ Fine Repetition

ASCII code : 5AH 36H 35H 30H 38H 39H 03H 0DH 0AH

### 3. Communication Process

This is the communication process from the NTS-660 series total stations to the computer.

#### 3.1 The Process of Activating and Receiving Measured Data in Single Measurement Mode and Repeat Measurement Mode

- 1) Send the first type instruction (Command "C") from computer to instrument.
- 2) The instrument checks the BCC of instruction "C". If the instruction is correct, the instrument will send a signal "ACK" to computer within 0.05 second; otherwise, no answer signal to computer.
- 3) If the computer can't receive the signal "ACK" within 0.05 second, send again the same instruction "C" from computer.
- 4) The maximum for step 3) is only 10. After 10 times, computer will stop communication and display error message.
- 5) When the instrument receive the instruction "C", the measurement starts; after the measurement finishes, the data will be sent.
- 6) When computer receives data properly and checks BCC, you must send the signal "ACK" to instrument within 0.3 second. After the instrument receives "ACK", the communication is completed.
- 7) If the received data has problems in communication, computer will not send the signal "ACK". Then the instrument will send again the same data to PC.
- 8) The maximum for step 7) is only 10. After 10 times, computer will stop communication and display error message.

```

                Computer
<--- C 067 ETX
      ACK 006 ETX      -->
      Measured Data
<--- ACK 006 ETX      : Communication OK
  
```



---

```

<--- C 067 ETX
      (No Reply)          --->
<--- C 067 ETX
      (No Reply)          --->
      |
      |
      Max. 10 Times          : Communication Fails

```

---

```

      Measured Data  --->
<--- (No Reply)
      Measured Data  --->
<--- (No Reply)
      |
      |
      Max. 10 Times          : Communication Fails

```

---

### 3.2 The Communication Process of Changing Measurement Mode

- 1) Send the fifth type instruction (Command “C”) from computer to instrument.
- 2) The instrument checks the BCC of instruction “C”. If the instruction is correct, the instrument will send a signal “ACK” to computer within 0.05 second; otherwise, no answer signal to computer.
- 3) If the computer can’t receive the signal “ACK” within 0.05 second, send again the same instruction from computer.
- 4) The maximum for step 3) is only 10. After 10 times, computer will stop communication and display error message.

```

NTS Series          Computer
<--- The FifthType Instruction
      ACK 006 ETX          ---> : Communication OK!

```

---

```

<--- The FifthType Instruction
      (No reply)          --->
<--- The FifthType Instruction
      (No reply)          --->
      |
      |
      Max. 10 Times          : Communication fails

```

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