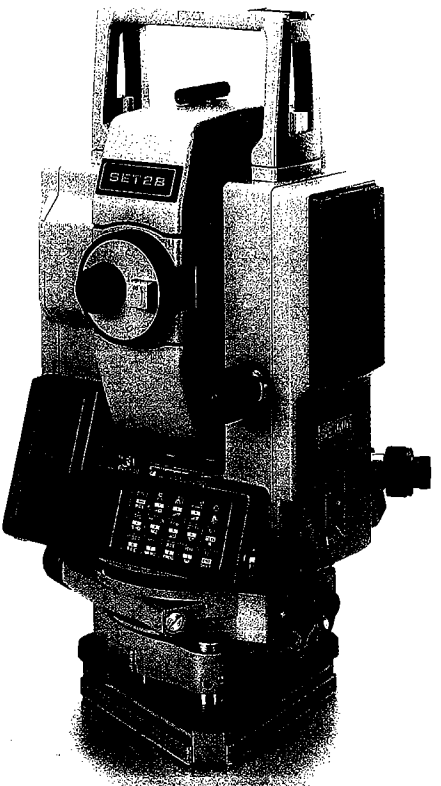
SOKKIA

SET2BII
SET3BII
SET4BII

Electronic Total Station



OPERATOR'S MANUAL

Ni-Cd

- **[English]** CONTAINS NICKEL-CADMIUM BATTERY. MUST BE RECYCLED OR DISPOSED OF PROPERLY.
- **[Deutsch]** MIT NiCd AKKU. EFORDERT RECYCLING ODER FACHGERECHTE ENTSORGUNG.
- **[Français]** CONTIENT UNE BATTERIE AU CADMIUM NICKEL. DOIT ÊTRE RECYCLÉE OU DONNÉE A UN ORGANISME DE RETRAITEMENT.
- **[Italiano]** CONTIENE NiCd BATTERIA. DEVE QUINDI ESSERE RICICLATA O ELIMINATA IN MODO APPROPRIATO.
- **[Nederlands]** BEVAT EEN NiCd BATTERIJ. DIENT GERECYCLEERD TE WORDEN OF OP EEN CORRECTE MANIER VERNIETIGD TE WORDEN.
- **[Español]** CONTIENE UNA NiCd BATERÍA. DEBE RECICLARSE O ELIMINARSE ADECUADAMENTE.
- **[Português]** CONTEM BATERIA DE NÍQUEL CÁDMIO. DEVERÁ SER RECICLADA OU DECARTADA CONVENIENTEMENTE.
- **[Svensk]** INNEHÅLLER NiCd BATTERI. BÖR ÅTERVINNAS ELLER FÖRSTÖRAS PÅ ETT SÄKERT SÄTT.
- **[Suomi]** SISÄLTÄÄ NIKKELI-KADMIUM AKUN. HÄVITETTÄESSÄ KÄSITELTÄVÄ ONGELMAJÄTTEENÄ.
- **[Norsk]** NiCd BATTERIER MÅ RESIRKULERES ELLER KASTES PÅ EN FORSVARLIG MÅTE.
- **[Dansk]** INDEHOLDER NiCd BATTERI. SKAL GENVINDES ELLER KASSERES PÅ FORSVARLIG MÅDE.
- **[Ελληνικα]** ΠΕΡΙΕΧΕΙ ΜΠΑΤΑΡΙΑ ΝΙΚΕΛΙΟΥ–ΚΑΔΜΙΟΥ. ΠΡΕΠΕΙ ΝΑ ΑΝΑΚΥΚΛΩΝΕΤΑΙ Η ΝΑ ΚΑΤΑΣΤΡΕΦΕΤΑΙ ΜΕ ΤΟΝ ΚΑΤΑΛΛΗΛΟ ΤΡΟΠΟ.

For U.S.A. ATTENTION:
The product that you have purchased contains a rechargeable battery. The battery is recyclable. At the end of it's useful life, under various state and local laws, it may be illegal to dispose of this battery into the municipal waste stream. Check with your local solid waste officials for details in your area for recycling options or proper disposal. Use the standard battery charger.

Die Schweiz: Nach Gebrauch der Verkaufsstelle zurückgeben.
La Suisse: Après usage à rapporter au point de vente.
Swizzera: Ritornare la pila usate al negozio.

SURVEYING INSTRUMENTS

SET2BII
SET3BII
SET4BII

Electronic Total Station

OPERATOR'S MANUAL

Congratulations on your purchase of the SET BII Series!
Before using the instrument, please read this operator's manual and verify that all equipment is included, refer to P. 196 "STANDARD EQUIPMENT".

A version

CONTENTS

CONTENTS

MEASUREMENT

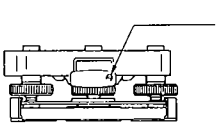
CONTENTS

CONTENTS

<Important>

The battery has not been charged at the factory.
Please charge the battery fully before using.

<Important>



When the new SET B is shipped, the tribrach clamp is fixed with a screw.
Loosen it and leave it loose.
And if the SET B is again shipped, fix the tribrach clamp with the screw to stop the tribrach becoming detached from the instrument.

The specifications and general appearance of the instrument may be altered at any time and may differ from those appearing in catalogues and this operator's manual.

QUICK GUIDE TO THIS MANUAL

● Ensure that the battery is charged before measurement.

Preparation for measurement 1

- Battery mounting ⑰
- Setting up Instrument <Centring ⑱/Levelling ⑲> ● Power on ㉑
- Indexing V & H circles ㉓ ● Focussing & target sighting ㉖
- Display & Reticle illumination ㉘ ● Setting instrument options ㉙

Angle & Distance measurement 2

- Angle <Set H angle to 0 ㉝/Set H circle to a required value ㉟/ H angle right/left/repetition/hold ㊲>
- Distance <Measurement mode ㊷/Prism constant correction ㊺/ Atmospheric correction ㊽/Return signal checking ㊿/Measurement ㊾>

Coordinate measurement 3

- Measurement mode ㊻ ● Instrument height & Target height input ㊼
- Instrument station & Backsight station coordinates input ㊵
- Setting the azimuth angle ㊺
- 3-Dimensional coordinate measurement ㊻

Advanced measurement functions 4

- Resection measurement ㊶ ● Traverse-style measurement ㊵
- Offset measurement ㊹ ● REM measurement ㊿
- Missing line measurement ㊾
- Setting-out measurement ㊿

Coordinate data input and using 5

- Coordinate data input/deleting ⑪⑧
- Coordinate data using ⑪⑧
- Coordinate data reviewing ⑫⑤

Troubleshooting… ● Error messages ⑭⑨ 6

FEATURES

< SET BII ADVANCED MEASUREMENT FUNCTIONS >

- Resection measurement
- Traverse-style coordinate measurement
- Offset measurement
- REM measurement
- Missing line measurement
- Setting-out measurement

< COORDINATE DATA CAN BE STORED IN AN INTERNAL MEMORY >

- 100 coordinate data can be stored in an internal memory for about a week.
- These coordinate data can be used as instrument station coordinates, backsight station coordinates, known station coordinates (for the resection measurement), and setting-out coordinates.
- These coordinate data can be displayed.

< TILT ANGLE COMPENSATION >

- Dual axis tilt sensor
- The index error of the tilt angle can be eliminated

< COLLIMATION PROGRAM >

- The collimation error between the centre of the telescope reticle and the sighting line can be calculated, and the correction value specified is set. (for angle measurement of high accuracy.)

< DATA OUTPUT >

- The SET B RS232C-compatible data output connector allows 2-way communication with an external device.

INTRODUCTION

1. PRECAUTIONS

- **Never place the SET B directly on the ground.**
  Avoid damaging the tripod head and centring screw with sand or dust.

- **Do not aim the telescope at the sun.**
  Avoid damaging the LED of the EDM.

- **Protect the SET B with an umbrella.**
  against direct sunlight, rain and humidity.

- **Never carry the SET B on the tripod to another site.**

- Handle the SET B with care. Avoid heavy shocks or vibration.

- When the operator leaves the SET B, the vinyl cover should be placed on the instrument.

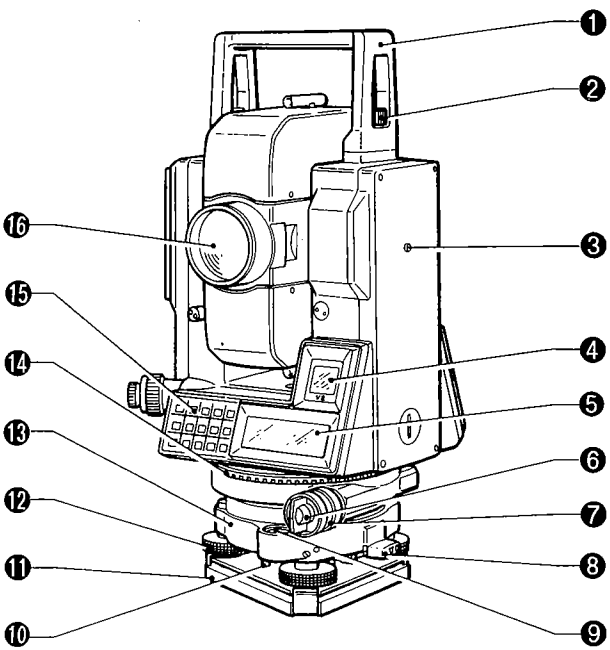
- Always switch the power off before removing the standard battery.

- Remove the standard battery from the SET B before putting it in the case.

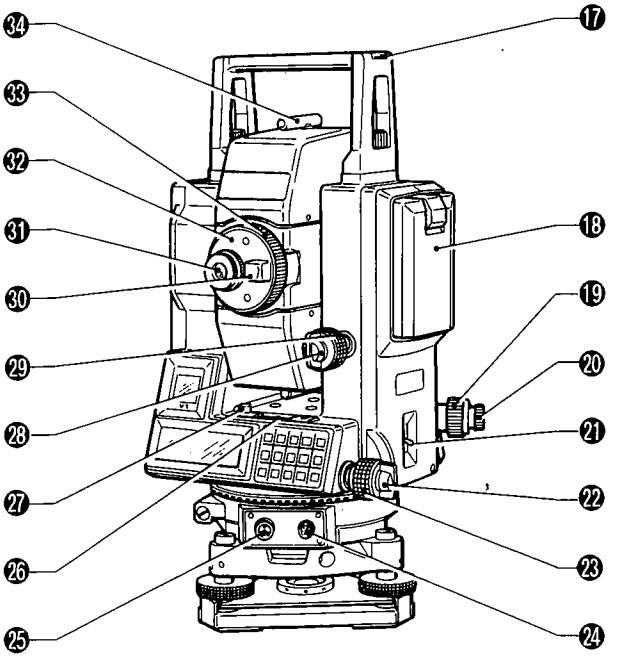
- When the SET B is placed in the carrying case, follow the layout plan.

- Make sure that the SET B and the protective lining of the carrying case are dry before closing the case. The case is hermetically sealed and if moisture is trapped inside, damage to the instrument could occur.

2. PARTS OF THE INSTRUMENT

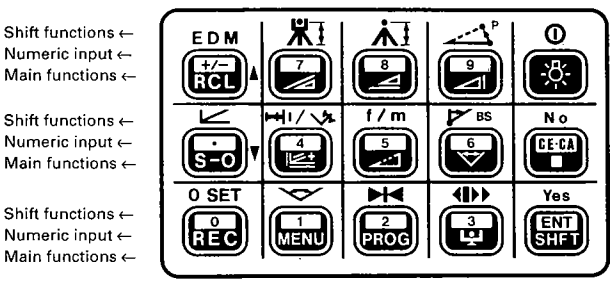


❶ Handle
❷ Handle securing screw
❸ Instrument height mark
❹ Sub display
❺ Main display
❻ Lower clamp
❼ Lower clamp cover
❽ Tribrach clamp
❾ Circular level
❿ Circular level adjusting screws
⓫ Base plate
⓬ Levelling foot screw
⓭ Tribrach
⓮ Horizontal circle positioning ring
⓯ Keyboard
⓰ Objective lens

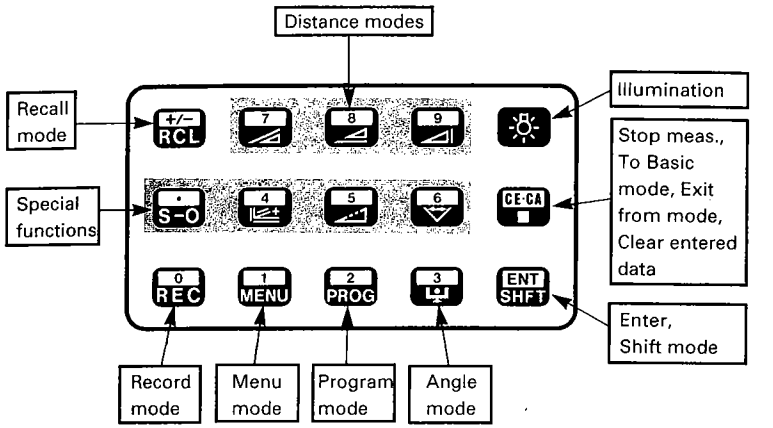


⑰ Tubular compass slot
⑱ Battery BDC25
⑲ Optical plummet focussing ring
⑳ Optical plummet eyepiece
㉑ Power switch
㉒ Horizontal clamp
㉓ Horizontal fine motion screw
㉔ Data output connector
㉕ External power source connector
㉖ Plate level
㉗ Plate level adjusting screw
㉘ Vertical clamp
㉙ Vertical fine motion screw
㉚ Telescope transitting knob
㉛ Telescope eyepiece
㉜ Telescope reticle adjustment cover
㉝ Telescope focussing ring
㉞ Peep sight

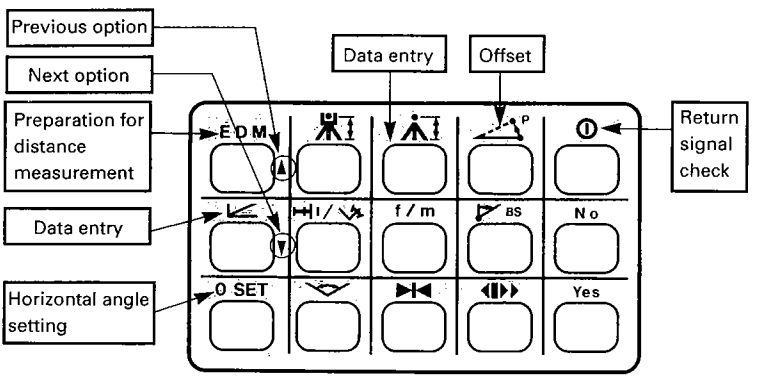
3. KEY FUNCTIONS



<Main functions>



<Shift functions>



○ < ENT SHFT + > : Distance mode/Prism constant/ppm
● (Data input mode): Change the sign of the data input value
(Parameter/Input mode): Move to previous option
● **Recall data from the memory**

○ < ENT SHFT + > : Input Instrument station coordinates/
Input Backsight station coordinates/
Input coordinates of point to be set out
● (Data input mode): Input "." (Decimal point)
(Parameter/Input mode): Move to next option
● **Setting out measurement (+ mode key)**

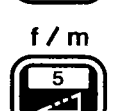
○ < ENT SHFT + > : Set Horizontal angle to 0/
In Missing line measurement, change the starting point
● (Data input mode): Input "0"
● **Output data to an External device**

○ < ENT SHFT + > : Input Instrument height
● (Data input mode): Input "7"
● **Measure Slope distance**

○ < ENT SHFT + > : Input distance & horizontal angle
Setting-out data
● (Data input mode): Input "4"
● **Measure 3-Dimensional coordinates**

○ < ENT SHFT + > : Set horizontal angle to the required value
● (Data input mode): Input "1"
● **Menu mode: Configuration/Coordinate data settings**

○ < ENT SHFT + > : Input target height
● (Data input mode): Input "8"
● **Measure Horizontal distance**



○ < ENT SHFT + > : Change metres ↔ feet for 5 seconds
● (Data input mode): Input "5"
● **Measure remote elevation**

○ < ENT SHFT + > : Hold/Release Horizontal angle

● (Data input mode): Input "2"

● **Program mode: Resection/Correction/ Set Instrument station coordinates and azimuth angle**

○ < ENT SHFT + > : Offset measurement

● (Data input mode): Input "9"

● **Measure Height difference**

○ < ENT SHFT + > : Set Azimuth angle from Instrument station and Backsight station coordinates

● (Data input mode): Input "6"

● **Missing line measurement**

○ < ENT SHFT + > : Select horizontal angle right/left/repetition

● (Data input mode): Input "3"

● **Transfer to Theodolite mode / Display tilt angle (when instrument is in Theodolite mode and: "Tilt correction" parameter is on)**

○ < ENT SHFT + > : Return signal check(stop: CE·CA)

● **Display and Reticle illumination ON/OFF**

● Input "No"

● (Data Input mode): Clear input data

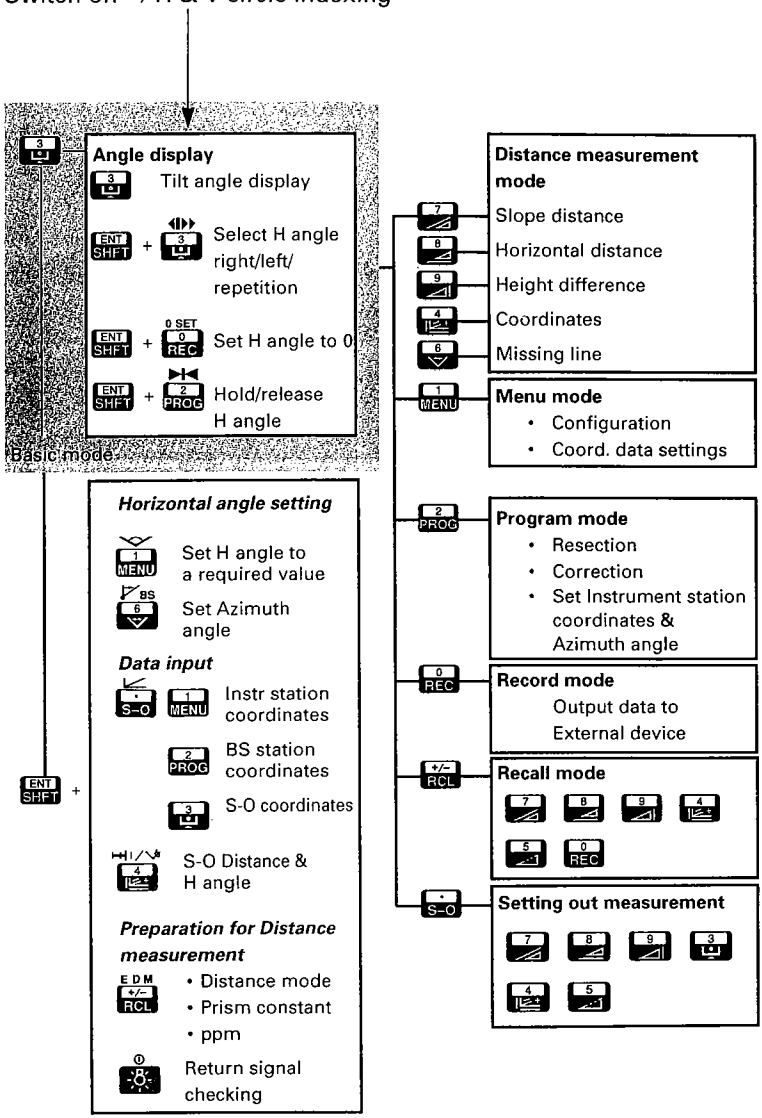
● **Stop measurement and transfer to Basic mode/ Exit from mode**

● Input "Yes"

● (Data input mode): Input data into memory

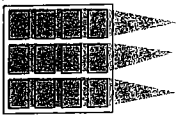
● **Select/Release Shift mode**

4. MODE DIAGRAM



5. DISPLAY SYMBOLS

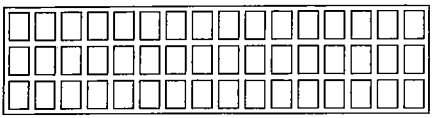
<Sub display>



ppm(Atmospheric correction value)
P.C.(Prism constant correction value)

⊥+	:	Tilt angle compensation on
SHFT	:	Shift
SO	:	Setting-out measurement mode
MENU	:	Menu mode
PROG	:	Program mode
REC	:	Record mode
RCL	:	Recall mode
Stn	:	Instrument station coordinates
BS	:	Backsight station coordinates
Pt	:	Coordinate setting-out data

<Main display>



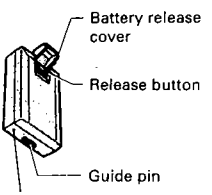
▲▼	:	Select options
ZA	:	Zenith angle (Z 0°)
VA	:	Vertical angle (H 0°) Vertical angle (H 0°±90°)
HAR	:	Horizontal angle right
HAL	:	Horizontal angle left
HARp	:	Horizontal angle repetition
HAh	:	Horizontal angle hold
dHA	:	Horizontal angle from setting-out data
X	:	Tilt angle in sighting direction
Y	:	Tilt angle in horizontal axis direction
S	:	Slope distance
H	:	Horizontal distance
V	:	Height difference
Ht	:	REM value/Instrument height/Target height
D	:	Distance setting-out data/ Offset distance

PREPARATION FOR MEASUREMENT

6. MOUNTING THE BATTERY

- Charge the battery fully before measurement. ☞ P.177

Note: Turn off the power supply switch ㉑ before replacing the battery.



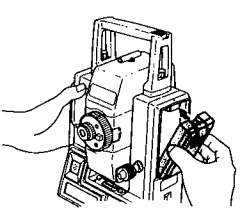
BDC25/25A

< Mounting the battery >

1) Close the battery release button cover.

2) Match the battery guide with the hole in the instrument battery recess.

3) Press the top of the battery until a click is heard.



< Removing the battery >

1) Open the battery release cover.

2) Press the release button downward.

3) Remove the battery.

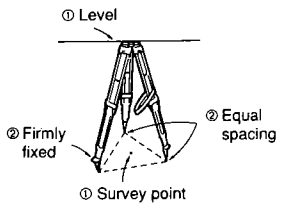
- If the power is to be turned on immediately after replacing the battery, please refer to P. 21.

7. SETTING UP THE INSTRUMENT

- Mount the battery in the instrument before performing this operation, because the instrument will tilt slightly if the battery is mounted after levelling.

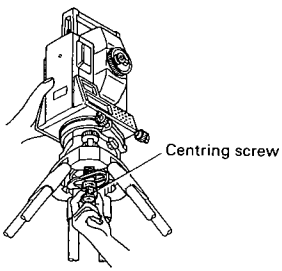
7.1 Centring

Set up the tripod



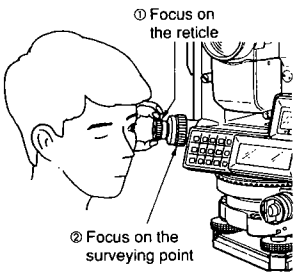
1) Make sure the legs are spaced at equal intervals and the head is approximately level.
2) Set the tripod so that the head is positioned over the surveying point.
3) Make sure the tripod shoes are firmly fixed in the ground.

Install the instrument



4) Place the instrument on the tripod head.
5) Supporting it with one hand, tighten the centring screw on the bottom of the unit to make sure it is secured to the tripod.

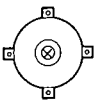
Focus on the surveying point



6) Looking through the optical plummet eyepiece, turn the optical plummet eyepiece ⑳ to focus on the reticle.
7) Turn the optical plummet focussing ring ⑲ to focus on the surveying point.

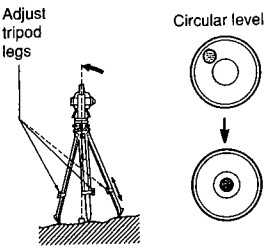
7.2 Levelling

Centre the surveying point in the reticle



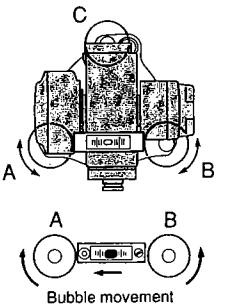
1) Adjust the levelling foot screws ⑫ to centre the surveying point in the optical plummet reticle.

Centre the bubble in the circular level



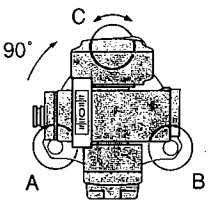
2) Observe the off-centre direction of the bubble in the circular level ⑨, and shorten the nearest tripod leg, or extend the leg farthest from that direction to centre the bubble.
3) One more tripod leg must be adjusted to centre the bubble.

Centre the bubble in the plate level



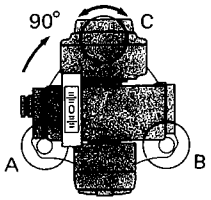
4) Loosen the horizontal clamp ㉒ to turn the upper part of the instrument until the plate level ㉖ is parallel to a line between levelling screws A and B.
5) Centre the air bubble, using levelling screws A and B.
Note : The bubble moves towards a clockwise rotated foot screw.

Turn 90° and centre the bubble



6) Turn the upper part of the instrument through 90°.
The plate level is now perpendicular to a line between levelling screws A and B.
7) Centre the air bubble, using levelling screw C.

Turn another 90° and check bubble position

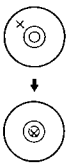


8) Turn the upper part of the instrument a further 90° and check to see if the bubble is in the centre of the plate level ㉕.
If the bubble is off-centre, perform the following:
① Adjust levelling screws A and B in equal and opposite directions, to remove half of the bubble displacement.
② Turn the upper part a further 90°, and use levelling screw C to remove half of the displacement in this direction.
Or try the adjustment described on P.149, under "22.1 Plate level".

Check to see if bubble is in same position in any direction

9) Turn the instrument and check to see if the air bubble is in the same position for any position of the upper part.
If it is not, repeat the levelling procedure.

Focus on the centre of the reticle again



10) Loosen the centring screw slightly.
11) Looking through the optical plummet eyepiece, slide the instrument over the tripod head until the surveying point is exactly centred in the reticle.
12) Retighten the centring screw securely.

Check plate level bubble again

13) Check again to make sure the bubble in the plate level is centred. (If not, repeat the procedures starting from step 4).)

8. POWER ON

- When the power is turned on, a self-check is run to make sure the instrument is operating normally.

Turn on the power

SET B model 2
No. 88132
Ver. 70-xx

Self check ok

or

Memory cleared

Battery level 3

0: less than 20%
1: less than 50%
2: less than 80%
3: less than 100%

Battery is low

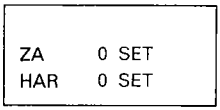
1) Turn on the power switch ㉑ after completing sections 6 and 7.

2) The instrument name, instrument number, and software version are displayed for several seconds, an audio tone sounds, and the instrument performs self-diagnostic checks.
On successful completion of the checks, "Self check ok" is displayed for 2 secs.

Note: After power-off for more than 1 week, the previously stored data have been cleared from the short-term memory and "Memory cleared" is displayed.

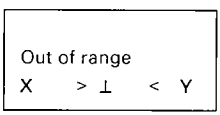
3) The remaining battery power is then displayed for 3 seconds as a numeric value.
(BDC25, Coarse meas. mode, Single meas., Temperature 25°C.)

If the battery is at the "low" level, the message "Battery is low" will be displayed, and an audio tone sounds. Turn the power off and charge the battery.
If the battery power becomes low during surveying, the same message will be displayed.



4) This display indicates that the instrument is ready for vertical and horizontal circle indexing.

- If the parameter horizontal indexing is set to "Manual", a horizontal angle of 0° is displayed, when the power is turned on.



If this error message is displayed, the instrument tilt sensor is indicating that the instrument is off-level. Relevel the instrument once again, using the plate level bubble.

- When "Face 1" is displayed for the vertical angle, please refer to P.183 (Appendix 1: Manually indexing the vertical circle).

Instrument parameter No.8 ☞ P.167

Parameter No.8 can change the indexing method. Options are indexing by transitting the telescope or indexing by face left, face right sightings.

[Note: Changing the brightness of the display]

- If the display appears too dim or too bright, the keyboard can be used to adjust the brightness level (6 levels).
  For a brighter display → Press [ENT SHFT] and [+/- RCL] at the same time .
  For a dimmer display → Press [ENT SHFT] and [· S-O] at the same time .

[Note: Power-saving cut-off]

- SET B switches off automatically 30 minutes after the last key operation.

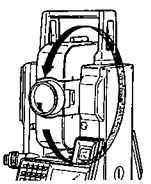
Instrument parameter No.12 ☞ P.167

- Parameter No.12 can be changed so that the SET B will not switch off automatically after 30 minutes.

9.1 Indexing the vertical and horizontal circles

(H and V circle indexing parameters - "Auto")

Vertical circle indexing

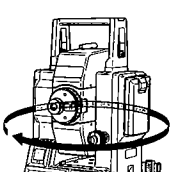


ZA	91° 04' 30"
HAR	0 SET

1) Loosen the vertical clamp ㉘ and transit the telescope completely. (Indexing occurs when the objective lens crosses the horizontal plane in face left.)
2) An audio tone sounds, and the vertical angle (ZA) is displayed.

   Vertical indexing has been completed.

Horizontal circle indexing



ZA	91° 04' 30"
HAR	350° 39' 00"

3) Loosen the horizontal clamp ㉒ and rotate the upper part of the instrument completely. (Indexing occurs when the plate level ㉖ passes the 0 mark of the horizontal positioning ring.)
4) The audio tone sounds, and the horizontal angle (HAR) is displayed. Horizontal indexing has been completed.

Note : Each time the instrument is switched on, the vertical and horizontal indexes must be redetermined.

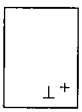
[Note: Horizontal angle back-up]

- The parameter No.9 default setting allows for the memorization of the previous horizontal 0 position at power-off for about 1 week. ("Memory cleared" is displayed after more than 1 week of power off.) H and V circles are each provided with a 0 index. When next switching on the SET B and indexing the horizontal circle again, the horizontal angle is recovered at the previously-memorized 0 position. This feature is useful when the battery voltage becomes low during measurement or after automatic power-off has occurred.

Instrument parameter No. 9 ☞ P.167

- Parameter No.9 can be used to change the horizontal circle indexing method. Options are indexing by rotating the upper part or indexing and zero setting at power-on.

[Note: Automatic tilt angle compensation]



- When the ⊥+ symbol is shown on the sub-display, the vertical and horizontal angles are automatically compensated for small tilt errors using the 2-axis tilt sensor.

- Read the compensated angle after the displayed angle value becomes steady.
- The formula used for calculation of the compensation value applied to the horizontal angle uses the tilt and vertical angles as shown below:

$$\text{Compensated horizontal angle} = \text{Measured horizontal angle} + \frac{\text{Tilt in angle Y}}{\tan(\text{Vertical angle})}$$

Therefore, when the SET B is not perfectly levelled, changing the vertical angle by rotating the telescope will cause the displayed (compensated) horizontal angle value to change. (The displayed horizontal angle value will not change during telescope rotation when the instrument is correctly levelled.)

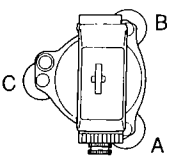
- When the measured vertical angles are within ±1° of the zenith or nadir, tilt compensation is not applied to the horizontal angle. In this situation, the displayed horizontal angle value flashes to show that the tilt compensation is not being applied.

Instrument parameter No.3 ☞ P.167

- Parameter No.3 can be used to switch off and on the automatic tilt angle compensation; for example, the automatic compensation should be switched off if the display is unsteady due to vibration or strong wind.

[Note: Levelling using the tilt angle display]

- For levelling, the tilt angle X and Y values can be displayed for use as a 2-axis (X,Y) tilt sensor. The tilt angle values are used to automatically correct the vertical and horizontal angles for error due to the non-verticality of the vertical axis. The measurement range is ±3'. The "Tilt correction (Dual axis)" parameter must be set to "Yes".



[3] Tilt angle display

Tilt angle	
X	0° 01' 20"
Y	–0° 00' 40"

X: Levelling foot screws AB
Y: Levelling foot screw C
(in above illustration)

Tilt angle minimum display unit
SET2B:1"
SET3B:1"
SET4B:5"

Out of range	
X	> ⊥ < Y

[3] To Theodolite mode
[CE•CA] To Basic mode

1) In Theodolite mode, turn the upper part of the instrument until the telescope is parallel to a line between levelling foot screws A and B and tighten the horizontal fine motion screw ㉓.

2) Press [3].

3) The X and Y tilt angles are displayed.

   X : Tilt angle in sighting axis direction
   Y : Tilt angle in horizontal axis direction

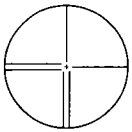
4) Set both tilt angles to 0° by turning the levelling screws A and B for the X direction and C for the Y direction.

- "Out of range" indicates that the tilt angle exceeds the ±3' measurement range.

5) To exit from the tilt angle display, press [3] to return to Theodolite mode or press [CE•CA] to go to Basic mode.

9.2 Focussing and target sighting

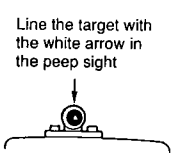
Focus on the reticle



1) Look through the telescope eyepiece ㉛ at a bright and featureless background.

2) Turn the eyepiece clockwise, then counterclockwise little by little until just before the reticle image goes out of focus.
Using this procedure, frequent reticle refocussing is not necessary, since your eye is focussed at infinity.

Sight the target



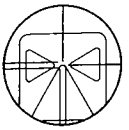
3) Loosen the vertical ㉘ and horizontal ㉒ clamps, and use the peep sight ㉞ to bring the target into the field of view.

4) Tighten both clamps.

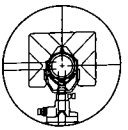
5) Turn the focussing ring ㉝ to focus on the target.

6) Turn the vertical ㉙ and horizontal ㉗ fine motion screws to align the target object with the reticle.

The last adjustment of each fine motion screw should be in the clockwise direction.



< Target centre>



<Prism centre>

- The relation between the target and the reticle is shown in the illustration at the left.

7) First, align the measuring point precisely with the centre of the target.
Then align the reticle precisely with the centre of the target.

8) Readjust the focus with the focusing ring ㉓ until there is no parallax between the target image and the reticle.

Note: Observe to the same point of the reticle when the telescope face is changed.

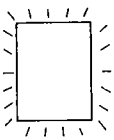
[Note:Parallax]

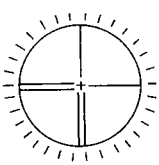
- This is the relative displacement of the target image with respect to the reticle when the observer's head is moved slightly before the eyepiece.
Parallax will introduce reading errors and must be removed before observations are taken. Parallax can be removed by refocussing.

9.3 Display and reticle illumination

Illuminate the display and reticle

- Press the to turn the display and reticle illumination on and off.





Instrument parameter No.13 ☞ P.167

- Parameter No.13 can be used to switch ON/OFF the 30-second illumination automatic cut-off facility.

Instrument parameter No.15 ☞ P.167

- Parameter No.15 can be used to change the brightness of the reticle illumination.

9.4 Setting the Instrument options

- Confirm that these parameters, indispensable for measurement, are set according to your required measurement.
- Data storage period : Until next changing (Power-off possible)
- To confirm or change the parameter options, please refer to P.167 "23. CHANGING INSTRUMENT PARAMETERS".

No.	Parameter		Options
3	Tilt correction		Correction YES* / Correction NO
4	Coordinate format		N, E, Z*/E, N, Z
5	Vertical angle format		Zenith angle (zenith 0°) * / Vertical angle (horizontal 0°) / Vertical angle (horizontal 0° ± 90°)
6	Angle resolution	SET2B	1" (0.2 mgon) * / 5" (1 mgon)
		SET3B	1" (0.2 mgon) * / 5" (1 mgon)
		SET4B	5" (1 mgon) * / 10" (2 mgon)
10	C + R correction		No correction * / Yes K = 0.142 Yes K = 0.20 ☞ P. 191
11	1	Distance unit	metres*/feet
	2	Angle unit	360°* / 400gon
	3	Temperature/Pressure units	°C & hPa * / °C & mmHg / °F & hPa/ °F & mmHg/ °F & inchHg

* Factory setting

- For other parameters, please refer to P.167 "23. CHANGING INSTRUMENT PARAMETERS".

MEASUREMENT

10. ANGLE MEASUREMENT

Check! before measurement :

1. SET B is set up correctly over the surveying point. ☞ P.18
2. The V and H circles have been indexed. ☞ P.23
3. The instrument parameters have been set. ☞ P.29

10.1 Measure the horizontal angle between two points

< Horizontal angle 0 >

- Set the horizontal angle of the target direction.

Note: **Horizontal angle 0 set**

Theodolite mode

↓

ENT SHFT 0 SET 0 REC : Set H angle to zero

↓

```
ZA
HAR      0° 00' 00"
```

e.g. • Measure the angle between two points.

Sight the first target

1) Using the horizontal clamp ㉒ and fine motion screw ㉓.
Sight the first point.

Set the horizontal angle to 0°

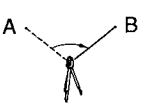
ENT SHFT 0 SET 0 REC

ZA	92° 36' 40"
HAR	0° 00' 00"

2) In Theodolite mode, press ENT SHFT and 0 SET 0 REC.

The horizontal angle display has been set to "0°".

Sight the second target



3) Using the horizontal clamp ㉒ and fine motion screw ㉓.
Sight the second point.

ZA	90° 30' 20"
HAR	140° 44' 20"

The displayed horizontal angle is the angle between the two points.

10.2 Set Horizontal circle to a required value

- Set the horizontal circle of the target direction to a required value.

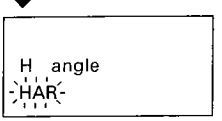
Note: **Set Horizontal circle to a required value**

Theodolite mode or Basic mode

↓

[ENT SHFT] [1 MENU] : For H angle input mode

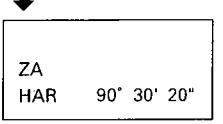
↓



↓

Input H angle value [ENT SHFT]

↓



- Input range
  SET 2B : 0° to 359°59'59"
  SET 3B : 0° to 359°59'59"
  SET 4B : 0° to 359°59'55"
- Least input
  SET 2B : 1"
  SET 3B : 1"
  SET 4B : 5"

◆ Correct the value : [CE·CA]

◆ Exit from the input : [CE·CA] [CE·CA]
(To Theodolite mode)

e.g. Setting 90° 30' 20"
→ Input value of 90.302

e.g. • Set the horizontal angle of reference target R to 60° 00′20″.

Sight target R

1) Using the horizontal clamp ㉒ and fine motion screw ㉓.
Sight target R.

From Theodolite mode or Basic mode to H Angle Input mode

ENT SHFT 1 MENU

```
      H  angle
-HAR-
```

2) In Theodolite mode or Basic mode, press ENT SHFT 1 MENU .

The display appears as at left, and "HAR" flashes to prompt for the input of the horizontal angle value.

Input the horizontal angle

6 0 REC · S-O 0 REC 0 REC 2 PROG

```
      H  angle
-HAR-  60.002
```

3) Input "60.002".

ENT SHFT

```
ZA    90° 30' 00"
HAR   60° 00' 20"
```

4) Press ENT SHFT to finish inputting.
The instrument returns to Theodolite mode.
Here, the horizontal angle for target R has been set to 60° 00′20″.

10.3 Horizontal angle display

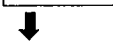
< Horizontal angle right/left/repetition/hold >

Note: **Horizontal angle right/left/repetition**

Theodolite mode (angle right)

ZA
HAL 260° 20' 40"

ZA
HARp 99° 39' 20"



ZA
HAR 99° 39' 20"

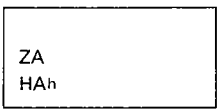
- Repetition display range
  SET 2B : ±1999°59'59"
  SET 3B : ±1999°59'59"
  SET 4B : ±1999°59'55"

Note: In repetition mode, the displayed horizontal angle is not corrected by the tilt sensor and by the stored collimation error values.

Note: Horizontal angle Hold/release

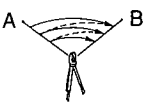
Theodolite mode (right/left/repetition)

: H angle hold



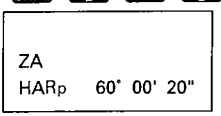
:H angle hold release

e.g. • Horizontal angle repetition mode.



For higher accuracy horizontal angle measurement, the average horizontal angle should be measured by repetition.
By selecting "repetition", the horizontal angle over 360° (400 gon) can be displayed.

In Theodolite mode, select H angle right by repetition

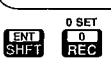


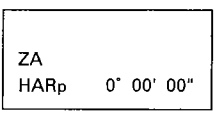
1) In Theodolite mode, press ENT SHFT, 3, ENT SHFT, 3. The horizontal angle is displayed by repetition.

Sight the first target

2) Sight the first target A.

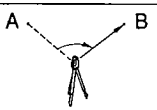
Set the horizontal angle to 0°

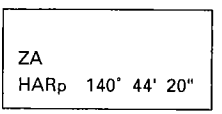




3) Press ENT SHFT, 0 SET 0 REC to set the horizontal angle display to zero.

Sight the second target





4) Use the horizontal clamp ㉒ and fine motion screw ㉓ to sight target B.

The displayed horizontal angle indicates the angle between points A and B. (First measurement)

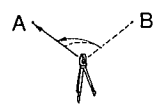
Hold the horizontal angle display

ENT SHIFT 2 PROG

```
ZA
HAh   140° 44' 20"
```

5) Press ENT SHIFT 2 PROG .
The horizontal angle display is held.

Sight the first target



6) At the second measurement, use the lower clamp ⑥ and horizontal fine motion screw ㉓ to sight back on target A.

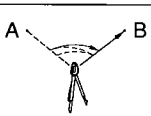
Release the horizontal angle hold

ENT SHIFT 2 PROG

```
HARp  140° 44' 20"
```

7) Press ENT SHIFT 2 PROG .
The horizontal angle display hold is released.

Sight the second target




```
ZA
HARp  281° 28' 40"
```

8) Use the horizontal clamp ㉒ and fine motion screw ㉓ to sight target B again.

The displayed horizontal angle indicates the angle between points A and B. (Second measurement)

Hold the horizontal angle display

ENT SHIFT 2 PROG

```
HAh   281° 28' 40"
```

9) Press ENT SHIFT 2 PROG .
The horizontal angle display is held.

Sight the first target

10) At the third measurement, use the lower clamp ⑥ and horizontal fine motion screw ㉓ to sight back on target A again.

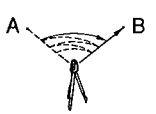
Release the horizontal angle hold

ENT SHFT ▶|◀ 2 PROG

HARp 281° 28' 40"

11) Press ENT SHFT ▶|◀ 2 PROG .
The horizontal angle display hold is released.

Sight the second target



ZA
HARp 422° 13' 00"

12) Use the horizontal clamp ㉒ and screw ㉓ to sight target B again.

The displayed horizontal angle indicates the angle between points A and B.
(Third measurement)

Repeat 9)-12) to measure the angle for the required number of times.

Divide the displayed horizontal angle by the number of measurements

e.g. 422° 13' 00" / 3 measurements
= 140° 44' 20"

13) The displayed horizontal angle should be divided by the number of measurements to find the average value.

- Press ENT SHFT ◀|▶ 3 one more time to exit from the repetition display.

11. DISTANCE MEASUREMENT

- The following preparations are required for Distance measurement.

  11.1 Measurement mode selection
  11.2 Prism constant input
  11.3 Atmospheric correction
  11.4 Return signal checking

11.1 Measurement mode selection

- Select the measurement mode from the following according to your required measurement.

Measurement mode		Measurement time (slope distance)	Units
Fine meas.	Single	4.7 secs	1mm
	Repeat	First 4.7 secs & every 3.2 secs	
Coarse meas.	Single	1.7 secs	
	Repeat	First 1.7 secs & every 0.7 secs	
Tracking meas.		First 1.6 secs & every 0.3 secs	10mm

Note: Measurement mode selection

Theodolite mode or Basic mode

↓

ENT SHIFT EDM +/− RCL : For preperation mode

↓

1. Meas mode
2. Prism const.
3. ppm

↓

1 MENU : For selection mode of Distance measurement

↓

1. Fine meas
2. Coarse meas
3. Track meas

1 MENU : Select Fine meas

2 PROG : Select Coarse meas

3 : Select Tracking meas

↓

Preparation mode

↓

1. Single meas
2. Repeat meas

↓

1 MENU : Select Single meas

2 PROG : Select Repeat meas

↓

Preparation mode

- Data storage period : Until next changing (Power-off possible)
- ◆ Exit from the selection : CE·CA CE·CA (to Basic mode)

e.g. • Selecting the "Repeat" option under Fine measurement

From Theodolite mode or Basic mode to Preparation mode

ENT SHFT EDM +/- RCL

1. Meas mode
2. Prism const.
3. ppm

1) In Theodolite mode or Basic mode, press ENT SHFT EDM +/- RCL .

The display appears as at left, showing Preparation mode.

To Selection mode of Distance measurement mode

1 MENU

1. Fine meas
2. Coarse meas
3. Track meas

2) Press 1 MENU .
The display appears as at left, and the previously selected measurement type flashes.

Select Fine measurement

1 MENU

1. Single meas
2. Repeat meas

3) Press 1 MENU .
The display appears as at left, and the previously selected measurement type flashes.

Select Repeat measurement

2 PROG

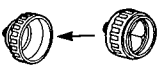
1. Meas mode
2. Prism const.
3. ppm

4) Press 2 PROG .
Fine and Repeat measurement modes are set, and the instrument returns to Preparation mode.

- To return to the Basic mode after this , press CE·CA ⏻ .

11.2 Prism constant input

- Each reflecting prism type has a different prism constant value. Here, we will input the constant correction value for the reflecting prism being used.
- The prism constant correction values for reflecting prisms made by Sokkia are as follows:

AP01S+AP01	AP01	CP01
		
30 mm → Input"–30".	40 mm → Input "–40".	0 mm → Input "0"

Note: Prism constant input

Theodolite mode or Basic mode

↓

ENT SHFT EDM ±/– RCL : For Preparation mode

↓

2 PROG : Prism constant input mode

↓

Prism constant
p.c 0 mm

↓

Input corrected value ENT SHFT

↓

Preparation mode

- Input range : –99mm to +99mm
- Least input :1mm
- Data storage period : Until next changing (Power-off possible)

- ◆ Retain the displayed value : ENT SHFT (to Basic mode)
- ◆ Correct the value : CE·CA (set value to 0)
- ◆ Exit from the input : CE·CA ESC (to Basic mode)

e.g. • Set a prism constant of 40 mm (correction value: –40)

From Theodolite mode or Basic mode to Preparation mode

ENT SHFT EDM +/– RCL

1) In Theodolite mode or Basic mode, press ENT SHFT EDM +/– RCL .
The display appears as at left, showing Preparation mode.

1. Meas mode
2. Prism const.
3. ppm

Prism Constant Setting mode

2 PROG

2) Press 2 PROG .

0
p.c ← Sub-display

Prism constant
p.c 0mm

The previously stored correction value is displayed, and "p.c" flashes to prompt for the input of the correction value.

Input the prism constant correction value

+/– RCL 4 0 REC

3) Input "–40".

Prism constant
p.c – 40

A prism constant correction value of –40 is input.

ENT SHFT

```
0
-40
```
← Prism constant correction value

```
1. Meas mode
2. Prism const.
3. ppm
```

4) Press ENT SHFT .

The correction value is input, and the instrument returns to Preparation mode.
The entered value is displayed on the second line of the sub-display.

CE·CA : To Basic mode

- To return to Basic mode after this, press CE·CA .

11.3 Atmospheric correction

- The atmospheric correction is necessary for accurate distance measurement, because the velocity of light in air is affected by the temperature and atmospheric pressure. ☞ P.189, Appendix 3

Note: To obtain the average refractive index of the air throughout the measured light path, you should use the average atmospheric pressure and temperature. Take care when calculating the correction factor in mountainous terrain.
☞ P.189, Appendix 3

- The SET B is designed so that the correction factor is 0 ppm for a temperature of +15°C (+59°F) and an atmospheric pressure of 1013 hPa (29.9 inch Hg).

- By inputting the temperature and pressure values, the correction value is calculated and set into the memory. The formula used is as follows:

$$ppm = 278.96 - \frac{0.2904 \times P\ (hPa)}{1+0.003661 \times T\ (°C)}$$

- To input ppm value, read the correction factor from the table on P.202.

- For precise distance measurement, relative humidity should be taken into account together with atmospheric pressure and ambient temperature. See P.189.

Note: ppm setting mode

- T. input range : –30°C to +60°C
  T. least input : 1°C
- P. input range : 500hPa to 1400hPa
  P. least input : 1hPa
- ppm input range : –499ppm to 499ppm
  ppm least input : 1ppm
- Data storage period :
  About a week
  (Power-off possible)

◆ Retain the displayed value : [ENT SHFT] [ENT SHFT]
◆ Correct the value : [CE·CA] (set value to 0)
◆ Exit from the input : [CE·CA] [CE·CA]
(to Basic mode)

Theodolite mode or Basic mode

↓

[ENT SHFT] [EDM +/- RCL] : For Preparation mode

↓

[3] : For ppm setting mode

↓

1. 0 set
2. Temp & Press
3. ppm value

↓

[1 MENU] : Set 0ppm

↓

Basic mode

[2 PROG] : Set Temperature & Pressure

↓

T 15°C
P. 1013 hPa

↓

Input Temperature [ENT SHFT]

↓

Input Pressure [ENT SHFT]

↓

Basic mode

[3] : Set ppm value

↓

ppm value
ppm 0

↓

Input ppm value [ENT SHFT]

↓

Basic mode

e.g. • Temperature of 20°C and
Atmospheric pressure of 1010 mbar

From Theodolite mode or Basic mode to Preparation mode

ENT SHIFT EDM +/- RCL

1. Meas mode
2. Prism const.
3. ppm

1) In Theodolite mode or Basic mode,
press ENT SHIFT EDM +/- RCL .
The display appears as at left, showing Preparation mode.

To ppm setting mode

3

ppm
– 40

← Sub-display

1. 0 set
2. Temp & Press
3. ppm value

2) Press 3 .

The display appears as at left, showing the ppm setting mode.

Select the input of Temperature and (atmospheric) Pressure

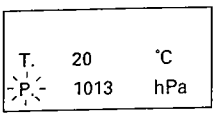
2 PROG

T.	15	°C
P.	1013	hPa

3) Press 2 PROG .
The previously stored values are displayed.
"T" flashes to prompt for the input of the temperature.

Input Temperature and Pressure

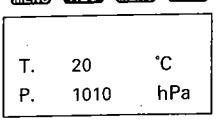
[2 PROG] [0 REC] [ENT SHFT]



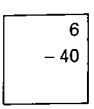
4) Input "20" and press [ENT SHFT].

The temperature "20°C" is input. "P" flashes to prompt for the input of the pressure.

[1 MENU] [0 REC] [1 MENU] [0 REC] [ENT SHFT]

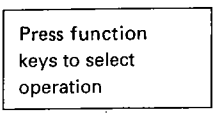


5) Input "1010" and press [ENT SHFT].
The pressure "1010 hPa" is input, and the instrument returns to Basic mode.



← Atmospheric correction value

The atmospheric value coefficient is calculated, and is displayed on the first line of the sub-display.



11.4 Return signal checking

- Especially for long distances, it is useful to check that the returned signal is adequate for measurement.

Note : When the light intensity coming back from the reflecting prism is very high (short distance) an asterisk "*" may be displayed, even for a slight mis-sighting. Therefore make sure that the target centre is sighted correctly.

Note: **Return signal checking**

Sight the centre of the target with Telescope

↓

Theodolite mode or Basic mode

↓

ENT SHFT ⑦ : For Return signal checking mode

↓

Signal *

- If "*" does not appear, sight the centre of the target correctly.

↓

CE·CA : Finish Checking mode (to Basic mode)

↓

7 8 9 : Start measurement

Instrument parameter No. 14 ☞ P.167

Parameter No. 14 can be used to switch on / off the returned signal audio tone.

11.5 Slope distance / Horizontal distance / Height difference measurement

- The slope distance, the horizontal distance, and the height difference are measured simultaneously with the angle.

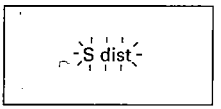
Check! before measurement :

1. SET B is set up correctly over the surveying point. ☞ P.18
2. The V and H circles have been indexed. ☞ P.23
3. The instrument parameters and the units have been set. ☞ P.29
4. The distance measurement mode is selected. ☞ P.42
5. The prism constant correction value is set. ☞ P.45
6. The atmospheric correction is set. ☞ P.48
7. The centre of the target is correctly sighted and the return signal is adequate for measurement. ☞ P.52

Start the measurement from Theodolite mode or Basic mode

[7] , [8] , [9]

1) In Theodolite mode or Basic mode, press [7] , [8] or [9] .



This accesses the Distance measurement mode, and the distance measurement is started. The display appears as at left and flashes. (The illustration at the left shows an example of slope distance measurement.)

S	234.567m
ZA	81° 12' 30"
HAR	12° 23' 40"

After about 4.7 seconds (Fine measurement mode) , the distance value, the vertical angle and the horizontal angle are displayed.

Stop the measurement

[CE·CA] : Stop

2) Press [CE·CA]. (The display does not change.)

- If the single measurement mode has been selected, measurement stops automatically.

Signal off

Note: If "Signal off" is displayed, the return signal strength has become inadequate for measurement. Verify the target sighting. If within 2 minutes the return signal becomes sufficient, the measurement is restarted.

After 2 minutes

S	Timeout
ZA	81° 12' 30"
HAR	12° 23' 40"

After 2 minutes, the measurement is stopped automatically and the display appears as at left:

In this case, sight the target again and restart the measurement. (The same display appears during measurement if the return signal is too weak. Press [CE·CA] to stop measurement and sight the target again.)

[ENT SHFT] [f/m 5] : Change metre ↔ feet

- Press [ENT SHFT] [f/m 5] to change the distance unit for 5 seconds.

S	769.57 ft
ZA	81° 12' 30"
HAR	12° 23' 40"

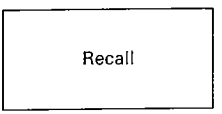
11.6 Review of measured data

- The distance and angle measured most recently are stored in the memory until the power is turned off. The stored slope distance, horizontal distance and height difference can be displayed in Recall mode as follows.

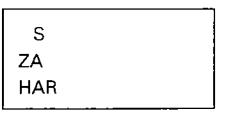
Note: **Data recall**

Theodolite mode or Basic mode or when measured data is displayed

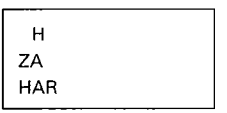
: For Recall mode



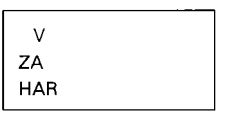
: Display the stored Slope distance



: Display the stored Horizontal distance

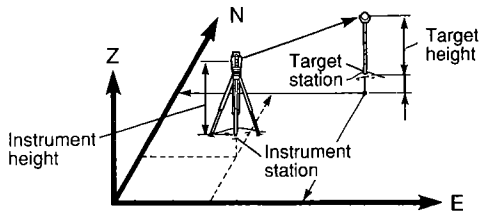


: Display the stored Height difference



12. COORDINATE MEASUREMENT

- The SET B calculates the 3-Dimensional coordinates of the prism position. To calculate the Z (Height) coordinate, first enter the instrument and target heights, then the Instrument station coordinates.



- By inputting the Backsight station coordinates, sighting the backsight station and pressing a key on the SET B keyboard, the horizontal angle can be set to the azimuth value.
- The following preparations are required for Coordinate measurement.

12.1 Measurement mode selection
12.2 Instrument height and target height input
12.3 Instrument station coordinates and Backsight station coordinates input
12.4 Setting of azimuth angle from the instrument and backsight station coordinates.

12.1 Measurement mode selection

- Select the measurement mode from the following according to your required measurement.
See P.42 "11.1 Measurement mode selection " for key operation.

Measurement mode		Measurement time (slope distance)	Units
Fine meas.	Single	5.1secs	1mm
	Repeat	First 5.1 secs & every 3.3 secs	
Coarse meas.	Single	2.4 secs	
	Repeat	First 2.4 secs & every 0.7 secs	
Tracking meas.		First 2.2 secs & every 0.7 secs	10mm

12.2 Instrument height and target height input

- As preparation for coordinate measurement, the instrument height (the height difference between the surveying point and the instrument station height mark ❸) and target height (the height difference between the surveying point and the centre of the target) should be input to the SET B before the measurement.

- The heights of the instrument and the target are measured manually beforehand, using a measuring tape, etc.

Note: Instrument height & Target height input

- Input range: –9999.999 to 9999.999m
- Least input : 0.001 m
- Data storage period : About a week (Power-off possible)

- ◆ Retain the displayed value : [ENT SHFT] (to Basic mode)
- ◆ Correct the value : [CE•CA] (set value to 0)
- ◆ Exit from the input : [CE•CA] [CE•CA] (to Basic mode)

Theodolite mode or Basic mode

[ENT SHFT] , [7] : For Instr. height setting mode

[ENT SHFT] , [8] : For Target height setting mode

Instr Ht	0.000m

Input Instrument height [ENT SHFT]

Basic mode

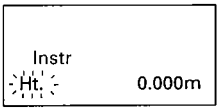
Target Ht	0.000m

Input Target height [ENT SHFT]

Basic mode

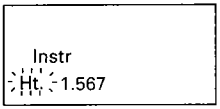
e.g. • Input Instrument height of 1.567 m and Target height of 1.234 m

From Theodolite mode or Basic mode to Instrument Height Input mode



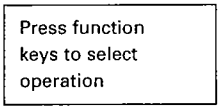
1) In Theodolite mode or Basic mode, press ENT SHFT 7 .
The previously stored value is displayed.
"Ht" flashes to prompt for the input of the instrument height.

Input the instrument height



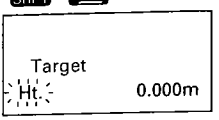
2) Input "1.567".
An instrument height value of 1.567 is input.

Press function keys to select operation



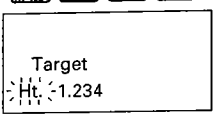
3) Press ENT SHFT .
The instrument turns to Basic mode.

To Target Height Input mode

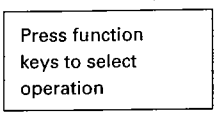


4) Press ENT SHFT 8 .
The previously stored value is displayed.
"Ht." flashes to prompt for the input of the target height.

Input the target height



5) Input "1.234".
A target height value of 1.234 is input.



6) Press ENT SHFT .
The instrument turns to Basic mode.

12.3 Instrument station coordinates and Backsight station coordinates input

- The coordinates of the instrument setting surveying point (instrument station) and those of a point whose coordinates are already known (backsight station) can be input to the SET B.

- The coordinates of the backsight station are input in order to set the horizontal angle in the X-axis direction to 0°.
  If the azimuth angle is already known, the following steps are carried out:

  1) Input only the coordinates of the instrument station.
  2) Sight the backsight station.
  3) Press [3] to turn Theodolite mode, and set the horizontal angle to the azimuth value.

  Then skip the instructions in Section 12.4 and go directly to Section 12.5.

- To recall the instrument station coordinates and backsight station coordinates from coordinate data stored in the memory, please refer to P.118.

Note: Instrument & Backsight station coordinates input

Theodolite mode or Basic mode

↓

ENT SHFT , S-O :For Coordinate data input mode

↓

1 MENU : For Instr. station coordinates input mode

2 PROG : For Backsight station coordinates input mode

↓

N
E
Z

↓

Input N-coordinate value ENT SHFT

↓

Input E-coordinate value ENT SHFT

↓

Input Z-coordinate value ENT SHFT

↓

Basic mode

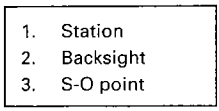
- Input range : –9999999.999 to 9999999.999
- Least input : 0.001
- Data storage period : About a week (Power-off possible)

- ◆ Retain the displayed value : ENT SHFT
- ◆ Correct the value : CE·CA (set value to 0)
- ◆ Exit form the input : CE·CA (to Basic mode)

e.g. • Instrument station coordinates are N = 31.1, E = 21.2, and Z = 1.3, and Backsight station coordinates are N = 10.1, E = 20.2, and Z = 3.3

From Theodolite mode or Basic mode to Instrument station coordinate input mode

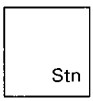
[ENT SHFT] [S-O] : For Coordinates data input mode



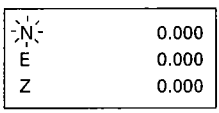
1) In Theodolite mode or Basic mode, press [ENT SHFT] and [S-O].

The display appears as at left, showing Coordinates Input mode.

[1 MENU] : For Instrument station



2) Press [1 MENU] for Instrument station coordinates input mode.

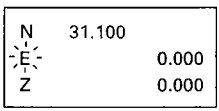


The previously stored values are displayed.
"N" flashes to prompt for the input of the N coordinate.

Input Instrument station coordinates

[3] [1 MENU] [S-O] [1 MENU] [ENT SHFT]

: Input N coordinate



3) Input "31.1" and press [ENT SHFT].

The N coordinate is input.
"E" flashes to prompt for the input of the E coordinate.

[2 PROG] [1 MENU] [· S-O] [2 PROG] [ENT SHFT]

: Input E coordinate

N	31.100	
E	21.200	
Z		0.000

4) Input "21.2" and press [ENT SHFT].

The E coordinate is input.
"Z" flashes to prompt for the input of the Z coordinate.

[1 MENU] [· S-O] [3] [ENT SHFT]

: Input Z coordinate

N	31.100	
E	21.200	
Z	1.300	

5) Input "1.3" and press [ENT SHFT].

The Z coordinate is input, and the instrument returns to Coordinate input mode.

1. Station
2. Backsight
3. S-O point

To Backsight station coordinate input mode

[2 PROG]

6) Press [2 PROG].

The previously stored values are displayed.
"N" flashes to prompt for the input of the N coordinate.

BS

N	20.200
E	20.200
Z	0.000

Input Backsight station coordinates

[1 MENU] [0 REC] [· S-O] [1 MENU] [ENT SHFT]

: Input N coordinate value

N	10.100	
E		20.200
Z		0.000

7) Input "10.1" and press [ENT SHFT].

The N coordinate is input.
"E" flashes to prompt for the input of the E coordinate.

ENT SHFT : Retain displayed E coordinate

N	10.100	
E		20.200
Z		0.000

3 · 3 ENT SHFT
: Input Z coordinate

N	10.100	
E		20.200
Z	3.300	

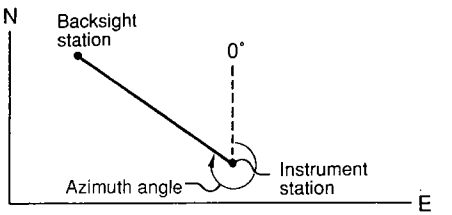
1. Station
2. Backsight
3. S-O point

8) The displayed value is retained, so simply press ENT SHFT .
"Z" flashes to prompt for the input of the Z coordinate.

9) Input "3.3" and press ENT SHFT .
The Z coordinate is input, and the instrument returns to Coordinate input mode.

- Press CE·CA to return to Basic mode.

12.4 Setting the azimuth angle from Instrument and Backsight station coordinates



- With the SET B, the azimuth angle of the backsight can be automatically calculated from the input instrument station and backsight station coordinates. This means the horizontal angle is set to zero in the N direction.

Note: Setting the azimuth angle

Theodolite mode or Basic mode

⬇

Sight Backsight station

⬇

ENT SHFT BS 6 : Calculate Azimuth angle

⬇

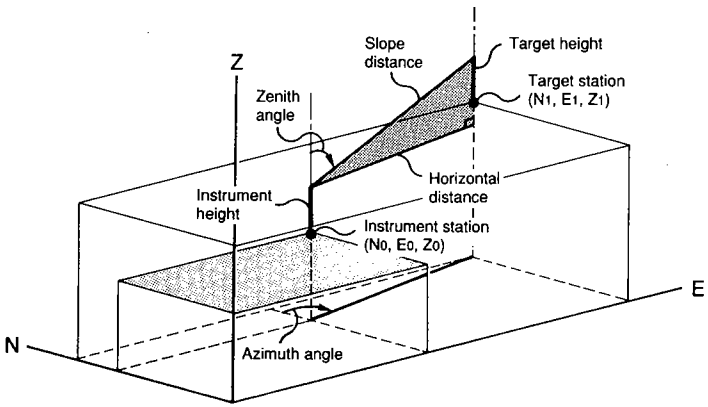
ZA
HAR ← Azimuth angle

12.5 3- Dimensional coordinate measurement

- The coordinates of the target are calculated using the following formulas and the results are then displayed. It is first necessary to input the Instrument and prism heights, Instrument and Backsight station coordinates and calculate or input the azimuth angle (see previous pages).

$$N1 = N_0 + S \times \sin\theta z \times \cos\theta h$$
$$E1 = E_0 + S \times \sin\theta z \times \sin\theta h$$
$$Z1 = Z_0 + Mh + S \times \cos\theta z - Ph$$

Instrument station coordinates: (N_0, E_0, Z_0)
Slope distance : S
Zenith angle : θz
Azimuth angle : θh
Instrument height : Mh
Target height : Ph



Check! before measurement :

1. SET B is set up correctly over the surveying point. ☞ P.18
2. The V and H circles have been indexed. ☞ P.23
3. The instrument parameters and the units have been set. ☞ P.29
4. The distance measurement mode is selected. ☞ P.42
5. The prism constant correction value is set. ☞ P.45
6. The atmospheric correction is set. ☞ P.48
7. The centre of the target is correctly sighted and the return signal is adequate for measurement. ☞ P.52
8. The instrument height and target height have been input. ☞ P.57
9. The instrument station and the backsight station coordinates have been input. ☞ P.60
10. The azimuth angle is set. ☞ P.65

Sight the target

1) Sight the centre of the reflecting prism correctly. (It is also recommended to check the returned signal by pressing ENT SHFT ☼ ☞ page 52.)

In Theodolite mode or Basic mode, start the coordinate measurement

[4]

N	123.456
E	345.678
Z	3.456

2) In Theodolite mode or Basic mode, press [4].
This accesses Coordinate Measurement mode, and measurement of the 3-Dimensional coordinates is started. The display appears as at left and flashes.

After about 5.1 seconds (Fine measurement mode), the 3-Dimensional coordinates are displayed.

Stop the measurement

[CE·CA] : Stop the measurement

3) Press [CE·CA] (display does not change).

- If the single measurement mode has been selected, the measurement stops automatically.

[7] [8] [9] [4]

: Start next measurement

[CE·CA] : To Basic mode

[3] : To Theodolite mode

- Press [7], [8], [9] or [4] to start the next measurement.
  Pressing [CE·CA] returns to Basic mode, or press [3] to go to Theodolite mode.

- To measure the next target point, check the prism constant correction, ppm values, and target height.

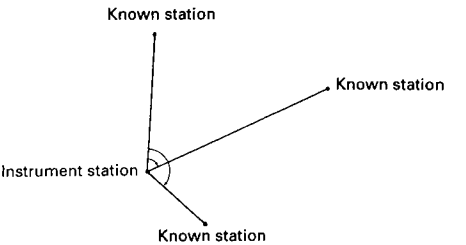
[+/-] [RCL] [4] : Review the measured data

- If [+/-] [RCL] and [4] are pressed, the last measured coordinate data can be displayed. ☞ P.55

ADVANCED MEASUREMENT FUNCTIONS

13 RESECTION MEASUREMENT

- The "Resection measurement" is used to determine the instrument station coordinates by observing 2 or more known stations.



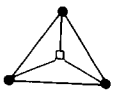
- SET B can calculate the instrument station coordinates by method of least squares by observing 2 to 5 known stations.
  To calculate the instrument station coordinates;
  when measuring distances, observe at least 2 known stations.
  or
  when unable to measure distances, observe at least 3 known stations.
  However, the greater the number of known stations and the greater the number of measured distances, the more precise the results will be.

- The Z coordinate can be calculated by inputting the Z coordinate of at least 1 known station and measuring the distances of 2 or more points. (The Z coordinate cannot be determined using only angle measurement.) Before the resection measurement, input the instrument height.

Note: For the Resection measurement of highest accuracy, please adjust the collimation error beforehand.
See P.184 "Appendix 2: For Angle measurement of the highest accuracy, <Adjusting the collimation error by collimation program>".

- To recall the known station's coordinates from coordinate data stored in the memory, please refer to P.118.

- It is best to avoid a situation where the unknown station (Instrument station) lies on the same circle as the known stations (in the case of 3 more known stations). Nullification of calculation will result. The figure below describes the better arrangement.

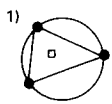


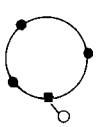
□■: Unknown station (Instrument station)
○●: Known station

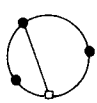
Note : When calculating the instrument station coordinates by only measuring the angles of three known stations, if a station is on the same circle as the known stations, the calculated station coordinate will not be correct.

If this situation is expected, the following action is suggested.

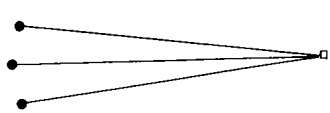
1) If possible move the station to the near centre of the triangle or
2) Observe other known stations which are not on the circle or
3) Measure the distance of one of 3 stations along with the angles.







- If the angle between 2 known stations is narrow, the observing condition is not sufficient to calculate the instrument station coordinates. When the distances between the instrument station and the known stations are long, it is difficult to determine that the angles are narrow thereby avoiding that the instrument station being on the same circle as the known points.



Note: Resection measurement

- Backsight number input range : 1~ 99999999
  Least input : 1
- Coordinate input range : -9999999.999 to 9999999.999 (m)
  Least input : 0.001
- Instr. station coordinate storage period : About a week (Power-off possible)

◆ Retain the displayed value : ENT SHFT
◆ Correct the value : CE·CA (set value to 0)
◆ Exit from the input : CE·CA CE·CA
(to Basic mode)

Theodolite mode or Basic mode

↓

2 PROG : To Program mode

↓

1 MENU : Select Resection measurement

↓

Target / Coord.
No. 1

↓

Input Known station No. ENT SHFT

↓

Input Known station coordinate value ENT SHFT

↓

Measure dist?
Yes / No

↓

Yes ENT SHFT : Measure distance

No CE·CA : Not measure distance

↓

Input Target height ENT SHFT

↓

More point?
Yes / No

↓

No CE·CA : No more point

Yes ENT SHFT : More point

↓

A

A

↓

Pt. 1
measure ?
Yes / No (exit)

↓

Sight Target

↓

Yes ENT SHFT : Start measurement

↓

The measured data is displayed

↓

Instrument station coordinate is displayed and set

↓

Basic mode

e.g. • The instrument station coordinates will be determined from the following data:

Instrument height : 1.5m

Known Station A: Point number = 1
N = 2042.104, E = 1376.491, Z = 116.720.
Measure angle and distance
Target height is 1.5 m

Known Station B: Point number = 2
N = 1608.521, E = 2426.262, Z = 251.200.
Measure angle

Known Station C: Point number = 3
N = 862.988, E = 1554.186, Z = 101.240.
Measure angle and distance
Target height is 1.5 m

From Theodolite mode or Basic mode to Program mode

[2 PROG] : To Program mode

PROG

1. Resection
2. Correction
3. Pt. replace

1) In Theodolite mode or Basic mode, press [2 PROG].

The display appears as at left, showing Program mode.

Select "Resection"

[1 MENU]

Target / Coord.
No. 1000

2) Press [1 MENU].
The previously stored value +1 is displayed.
"No." flashes to prompt for the input of the point number.

Input data for Known Station A

[1 MENU] [ENT SHFT] : Input Target No.

N	0.000
E	0.000
Z	0.000

3) Press [1 MENU] [ENT SHFT].
Target number "1" is input.
"N" flashes to prompt for the input of the N coordinate.

N = 2042.104 [ENT SHFT]
E = 1376.491 [ENT SHFT]
Z = 116.72 [ENT SHFT]

4) Input the coordinates for Known Station A.
N = 2042.104 [ENT SHFT]
E = 1376.491 [ENT SHFT]
Z = 116.72 [ENT SHFT]

Measure dist?
Yes / No

The display then asks whether to measure its distance or not.

[Yes ENT SHFT] : Measure distance

5) Press [Yes ENT SHFT].
The display appears as at left.
"Ht" flashes to prompt for the input of the target height.
If measuring angle only, press [No CE·CA].

Target	
Ht	0.000m

[1 MENU] [· S–O] [5 ▲] [ENT SHFT]
: Input Target height

6) Press [1 MENU], [· S–O], [5 ▲], [ENT SHFT].
When the data for the first station has been input, "No." flashes to prompt for the input of the point number of the next known station.
(The previously stored value +1 is displayed.)

Target / Coord.	
No.	2

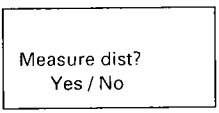
Input data for Known Point B

[ENT SHFT] : Input Target No.

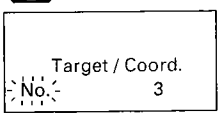
N	0.000
E	0.000
Z	0.000

7) The displayed value is retained, so simply press [ENT SHFT].
The point number "2" is input, and "N" flashes to prompt for the input of the N coordinate.

N = 1608.521 [ENT SHFT]
E = 2426.262 [ENT SHFT]
Z = 251.2 [ENT SHFT]



[No CE·CA] : Not measure distance



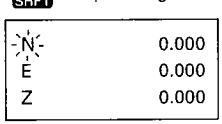
8) Input the coordinates for Known Station B.
N = 1608.521 [ENT SHFT]
E = 2426.262 [ENT SHFT]
Z = 251.2 [ENT SHFT]

The display then asks whether to measure its distance or not.

9) Press [No CE·CA].
When the data for the second station has been input, "No." flashes to prompt for the input of the point number of the next known station.
(The previously stored value +1 is displayed.)
If measuring distance,
press [Yes ENT SHFT].

Input data for Known Station C

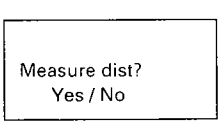
[ENT SHFT] : Input Target No.



10) The displayed value is retained, so simply press [ENT SHFT].
The point number "3" is input, and "N" flashes to prompt for the N coordinate.

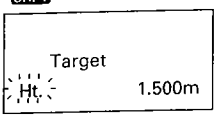
N = 862.988 [ENT SHFT]
E = 1554.186 [ENT SHFT]
Z = 101.24 [ENT SHFT]

11) Input the coordinates for Known Station C.
N = 862.988 [ENT SHFT]
E = 1554.186 [ENT SHFT]
Z = 101.24 [ENT SHFT]



The display then asks whether to measure its distance or not.

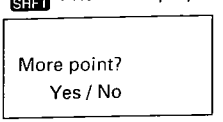
Yes ENT SHFT : Measure distance



12) Press Yes ENT SHFT .

The display appears as at left. "Ht" flashes to prompt for the input of the target height.
(The previously stored target height is displayed.)
If measuring angle only,
press No OE·CA .

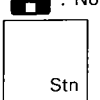
ENT SHFT : Retain displayed value

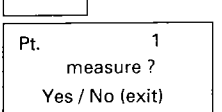


13) Press ENT SHFT .

When the data for the third station has been input, if the conditions for calculating the instrument station coordinate have been satisfied, the display asks whether you want to observe any further stations. (Observation can be carried out up to 5 stations.)

No OE·CA : No more stations





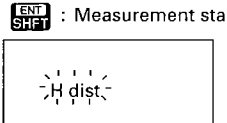
14) Press No OE·CA .

The display asks whether you want to observe the first station (Known Station A).

Observe Known Stations A to C

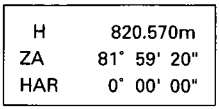
Sight Known Station A

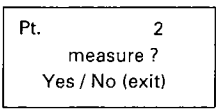
Yes ENT SHFT : Measurement start



15) Sight the centre of the reflecting prism of Known Point A correctly.
Press Yes ENT SHFT .

The horizontal distance measurement is started.





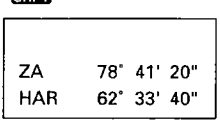
When the measurement has been finished, the measured values are displayed, and the display asks whether you want to observe the second station (Known Station B).

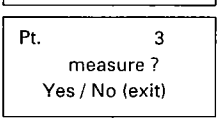
Sight Known Station B

16) Sight the centre of the reflecting prism of Known Station B correctly ,
and press Yes ENT SHFT .

Yes ENT SHFT : Measurement start

The measurement is started.
When the measurement has been finished, the measured values are displayed, and the display asks whether you want to observe the third station (Known Station C).



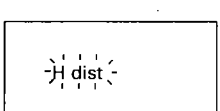


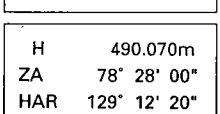
Sight Known Station C

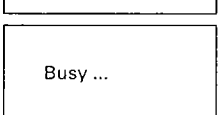
17) Sight the centre of the reflecting prism of Known Point C accurately,
and press Yes ENT SHFT .

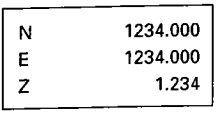
Yes ENT SHFT : Measurement start

The measurement is started.
When the measurement has been finished, the measured values are displayed. "Busy" will appear on the display while the instrument station coordinates are being calculated.

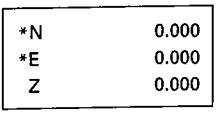


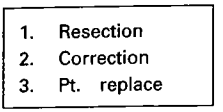




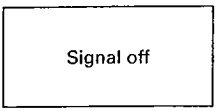


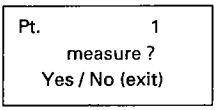
The instrument station coordinates are calculated and displayed.
This value is input as the instrument station coordinate. (Basic mode)





If, for some reason, the instrument station cannot be calculated, the display is as at left. After that the instrument returns to Program mode.
Nullification may be caused by poor layout of the known points, an error in the known station data input, or an inability to measure the distance or angle, etc.
Check the observation conditions and try the procedure again from Step 1).



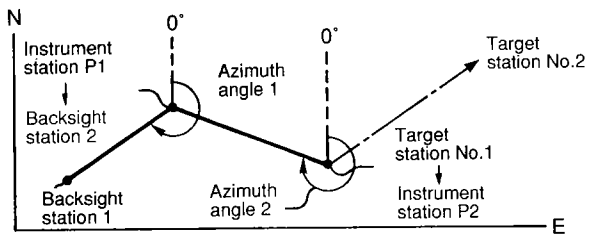


Note: If "Signal off" is displayed, the return signal strength has become inadequate for measurement. Verify the target sighting. If within 2 minutes the return signal becomes sufficient, the measurement is restarted. After 2 minutes, the measurement is stopped automatically and the display appears as at left.
After that the display asks whether to observe the first station or not.

14. TRAVERSE-STYLE COORDINATE MEASUREMENT

- The traverse-style coordinate measurement is used to measure the second survey station (No.2) coordinate after moving the instrument to the first survey station (No.1) and setting it up.

- The measured coordinate data is stored in the memory for up to about 1 week after power-off. Even after power-off it is possible to set new instrument station coordinates and the azimuth angle for the instrument by sighting back on the first instrument station and pressing a key on the SET B keyboard.



Note: Replacing Instrument station coordinates

After Coordinate measurement and Instr. station movement, sight back on the previous Instr. station

↓

Theodolite mode or Basic mode

↓

[2 PROG] : To Program mode

↓

1. Resection 2. Correction 3. Pt. replace

↓

[3] : Replace Instrument station

↓

Stn pt replace? Yes / No (exit)

↓

[Yes ENT SHFT] : Verify

↓

Replaced

↓

New azimuth angle (HAR) is displayed

↓

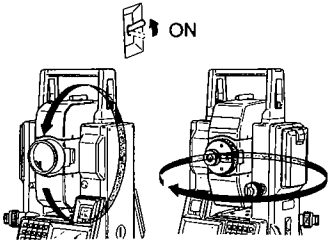
ZA HAR

After measuring Station 1, switch off and move the SET B

1) After measuring the coordinates of Station No.1 (12.1 ~ 12.5), switch the SET B off.

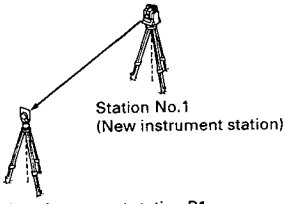
2) Move the instrument to Station No.1 and set it up over the survey point.

Switch on and index V and H circles

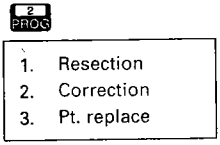


3) Switch the SET B on, and index the vertical and horizontal circles after the self-check.

4) From Station No.1, sight back on the original instrument station P1.



From Theodolite mode or Basic mode to Program mode



5) Press 2 PROG.
The display appears as at left, showing Program mode.

Set the instrument station movement in SET B

3

```
Stn pt replace?
   Yes / No (exit)
```

6) Press 3 .
The display appears as at left and asks whether the new station coordinates are to replace the previously stored ones.

Yes ENT SHFT

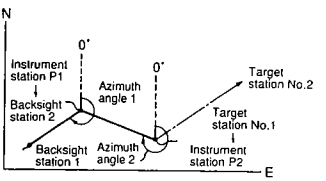
```
Replaced
```

7) Press Yes ENT SHFT .
The display appears as at left after the coordinates of Instrument station P1 have been set as the new Backsight station 2, and the measured coordinates of Station No.1 have been set as the new instrument station P2.

```
ZA     81° 12' 30"
HAR   145° 00' 00"
```

Azimuth angle 2

The instrument then calculates. The measured coordinates are displayed and the azimuth angle is set.



- To interrupt the movement, press CE·CA .

8) Measure and input the instrument height of instrument station P2 and the target height of Station No.2. (Refer to P.57 12.2)

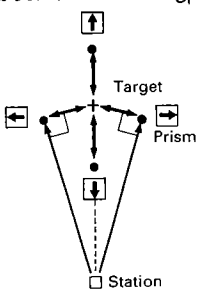
9) Sight the centre of the reflecting prism of Station No.2 correctly.

10) Press 4 to go to coordinate measurement mode and start 3-Dimensional coordinate measurement.

15. OFFSET MEASUREMENT

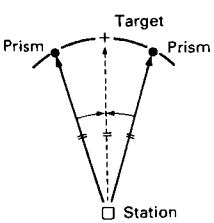
- The Offset measurement is used to measure the distance to point where it is not possible to set a reflecting prism directly, or where the reflecting prism cannot be sighted directly, in order to determine the angle.
- SET B can determine the distance and angle of the target point by setting the reflecting prism at a point (offset point) at a distance from the point to be measured (target point) and measuring the distance and angle of the offset point.
- There are two methods to determine the distance and angle of the target point.

① The target point is determined by inputting the distance between the target point and the offset point.



- When the offset point is positioned to the left or right of the target point, the offset point and target point should both be approximately 90°.
- When the offset point is in front of or behind the target point, the offset point should be on a line connecting the instrument station point and the target point.

② The target point is determined by sighting the direction of the target point.



- The offset point should be positioned to the right or left of the target point, as close to the target point as possible.

Note: Offset measurement

- Distance Input range : -9999.999 to 9999.999m
- Least input : 0.001 m
- Data storage period : About a week (Power-off possible)

- ◆ Retain the displayed value : [ENT SHFT]
- ◆ Correct the value : [CE·CA] (set value to 0)
- ◆ Exit from the input : [CE·CA] [CE·CA] (to Basic mode)

Sight Prism of Offset point

↓

Theodolite mode or Basic mode

↓

[7] [8] [9]

: Start Distance measurement (Stop the measurement)

↓

[ENT SHFT] , [9] : To Offset meas. mode

↓

Offset
1. distance
2. angle

↓

[1 MENU] : Select "Input distance"

↓

▲▼Direction
prism : →
Yes / No(exit)

↓

[· S-O], [+/- RCL]: Select the direction from Prism to Target

↓

Yes [ENT SHFT] : Set the direction

↓

Offset distance
-D- 0.000m

↓

Input H distance between Target and Prism [ENT SHFT]

↓

The Slope distance, Vertical angle and Horizontal angle between Measuring point and Target are displayed

[2 PROG] : Select "Sight target direction"

↓

Sight target pt.
Yes / No (exit)
HAR 0°00'00"

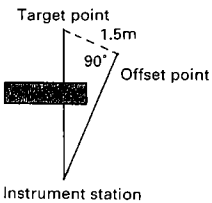
↓

Sight target direction

↓

Yes [ENT SHFT] : Verify

e.g.



- The positions of the target point and the offset point are shown at the left. In this case, determine the slope distance to the target point when the horizontal distance is 1.5m.

Note: The offset point should be positioned so that the line connecting the target point and offset line is at a 90° angle to the line connecting the instrument station and offset point.

Sight the offset point and measure

[7] [8] [9]

: Starts the distance measurement

```
S dist
```

```
S          3.210m
ZA
HAR
```

1) Set the reflecting prism at the offset point, sight the centre of it correctly, and in Theodolite mode or Basic mode, press either [7], [8], or [9]. After about 4.7 seconds (Fine measurement mode), the distance value, the vertical angle and the horizontal angle are displayed and stored in the instrument memory.

[CE·CA] : Stop the measurement

2) For Repeat measurement mode, press [CE·CA].

To Offset Measurement mode

[ENT SHIFT] [9]P

```
Offset
1. distance
2. angle
```

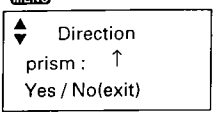
3) Press [ENT SHIFT] and [9]P.

The display appears as at left.
The display asks you to select one of the following options:

1. Input the horizontal distance between the target point and the offset point.
2. Sight the direction of the target point.

Select "Input horizontal distance"

MENU



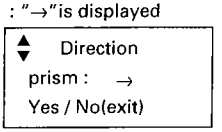
4) Press MENU.

The display appears as at left and prompts to select the direction from target point to reflecting prism.

Select the offset point direction

+/- RCL ↓ or S-O ↑

: "→"is displayed

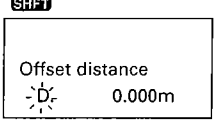


5) Press +/- RCL ↓ or S-O ↑ to display "→".

Note:

→ : Prism is right of target
← : Prism is left of target
↑ : Prism is behind target
↓ : Prism is in front of target

Yes ENT SHFT

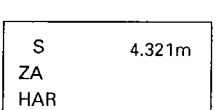


When → is displayed, press Yes ENT SHFT.

"D." flashes to prompt for the input of the horizontal distance between the target point and the offset point.

Input horizontal distance between target point and offset point

MENU S-O 5 ENT SHFT



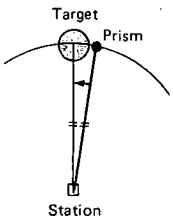
6) Input a horizontal distance of 1.5 metres and press ENT SHFT.

The slope distance from the instrument station to the target point and the vertical and horizontal angles are calculated and the results are displayed.

+/- RCL 8 : Display the horizontal distance

- To display the horizontal distance, press +/- RCL 8.

e.g.



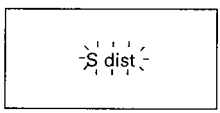
- The positions of the search point and the offset point are shown at the left. In this case, determine the slope distance to the centre point of a telephone pole.

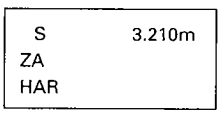
  Note: The offset point should be positioned to the right or left of the target point, as close to the target point as possible.

Sight the offset point and measure

[7] [8] [9]

: Starts the distance measurement





1) Set the reflecting prism at the offset point, sight the centre of it correctly, and in Theodolite mode or Basic mode press either [7], [8], or [9].

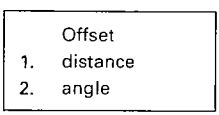
   After about 4.7 seconds (Fine measurement mode), the distance value, the vertical angle and the horizontal angle are displayed and stored in the instrument memory.

[CE·CA] : Stop the measurement

2) For Repeat measurement mode, press [CE·CA].

To Offset Measurement mode

[ENT SHFT] [P 9]



3) Press [ENT SHFT] and [P 9].

   The display appears as at left.
   The display prompts to select one of the following options:

   1. Input the horizontal distance between the target point and the offset point.
   2. Sight the direction of the target point.

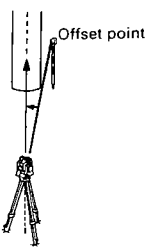
Select "Sight target point direction"

2 PROG

```
Sight target pt.
 Yes / No (exit)
HAR      0°00'00"
```

4) Press 2 PROG.
The display appears as at left and prompts to sight the direction the target point.

Sight the search point direction



5) Sight the direction of the target point correctly.

Yes ENT SHFT

```
S          3.210m
ZA
HAR
```

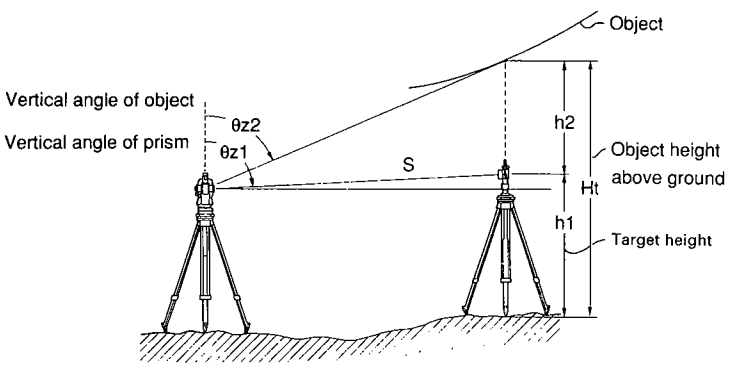
6) When the direction of the centre of the telephone pole has been sighted, press Yes ENT SHFT.
The slope distance from the instrument station to the target point and the vertical and horizontal angles are calculated and the results are displayed.

+/- RCL 8 : Display the horizontal distance

- To display the horizontal distance, press +/- RCL 8.

- When measuring the height of certain objects such as overhead power cables or bridge supports where the reflecting prism cannot usually be positioned, the Remote Elevation Measurement function can be used to calculate the height above the ground using a point directly above or below the object.

- The height of the target is calculated using the following formulas.
  $Ht = h1 + h2$
  $h2 = S\sin\theta z1 \times \cot\theta z2 - S\cos\theta z1$



- The measured values are first displayed after 0.7 seconds and then every 0.5 seconds for all measurement modes.

Note: Remote elevation measurement

- The maximum vertical angle : ±89° from the horizontal (Measuring value limit (Ht) : ±9999.999m)

Input the target height (h1) (☞P. 57)

⬇

Sight the prism above or below the object

⬇

Theodolite mode or Basic mode

⬇

[7] [8] [9]

: Start Distance measurement (Stop the measurement)

⬇

Sight the object

⬇

[5] : Start REM

⬇

The object height is displayed

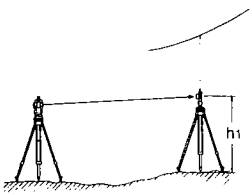
Ht	16.290m
ZA	77° 11' 10"
HAR	123° 45' 50"

⬇

[CE·CA] : Stop measurement

e.g. • Measure the height to a suspended cable

Set up the prism below the object and input the target height



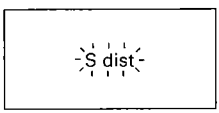
1) Set up the reflecting prism directly below the object to be surveyed using an optical nadir or plummet for accurate setting.

2) Measure the target height (h1) with a measuring tape, and input the target height.
☞ P.57

Measure the distance

3) Sight the centre of the reflecting prism with the SET B correctly.

[7] [8] [9]
: Start the measurement



4) In Theodolite mode or Basic mode,
press either [7], [8], or [9].
This accesses the Distance Measurement mode, and the measurement is started. The display appears as at left and flashes.
(The illustration at the left shows an example of slope distance measurement.)

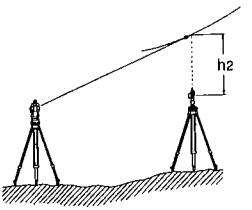
After about 4.7 seconds (Fine measurement mode), the distance value, the vertical angle and the horizontal angle are displayed and stored in the instrument memory.

S	50.432m
ZA	89° 45' 20"
HAR	123° 45' 50"

[CE•CA] : Stop the measurement

- For Repeat the measurement mode, press [CE•CA] to stop the measurement.

Sight the object and start REM measurement



5) Sight the object.

[S] : Start the REM measurement

6) Press [S].

Ht	16.290m	h1+h2
ZA	77° 11' 10"	
HAR	123° 45' 50"	

The REM measurement is started. After about 0.7 seconds, the height from the ground to the object Ht (h1 + h2) is displayed.

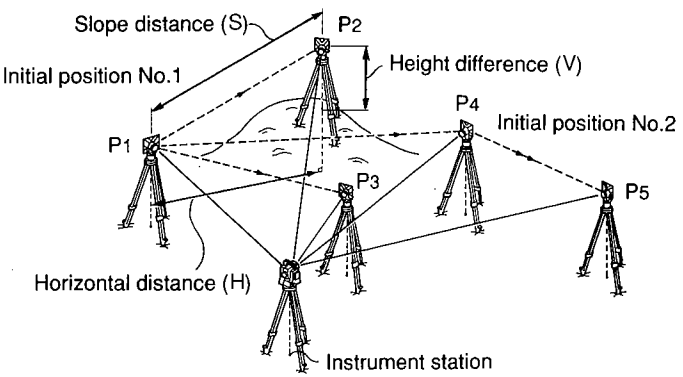
[CE·CA] : Stop the measurement

- Press [CE·CA] to stop the measurement.

17 MISSING LINE MEASUREMENT

- The Missing line measurement is used to measure the slope distance, the horizontal distance, and the height difference between the starting position (P1) and any other points without moving the instrument itself.

- The SET B can measure the distances to many points continuously. It is also possible to change the starting position to that of the last-measured point. ☞ P.98



17.1 Measurement mode selection

- Select the measurement mode from the following according to your required measurement.
  See P.42 "11.1 Measurement mode selection" for key operation.

Measurement mode		Measurement time	Units
Fine meas.	Single	5.6 secs	1mm
	Repeat	First 5.6 secs & every 3.3 secs	
Coarse meas.	Single	2.9 secs	
	Repeat	First 2.9 secs & every 0.7 secs	
Tracking meas.		First 2.8 secs & every 0.7 secs	10mm

17.2 Measuring the distance between two or more points

Note: **Missing line measurement**

Sight the prism on the initial position

⬇

Theodolite mode or Basic mode

⬇

: Start Distance measurement (Stop the measurement)

⬇

Sight the prism on the target station

⬇

: Start Missing line meas.

⬇

Stop distance, Horizontal distance and Height difference between the initial position & the target station is displayed

⬇

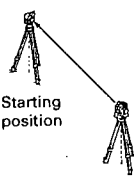
S	m
H	m
V	m

⬇

: Stop measurement

e.g. • Measure the distances between the starting position and many points consecutively.

Set up the prism on the starting position and start the distance measurement



1) Set up the reflecting prisms on the required number of target points, sight the centre of the reflecting prism on the starting position. In Theodolite mode or Basic mode press either [7], [8], or [9].

[7] [8] [9]
: Starts the distance measurement

This accesses the Distance Measurement mode, and the distance measurement is started. The display appears as at left and flashes. (The illustration at the left shows an example of slope distance measurement.)

```
S dist
```

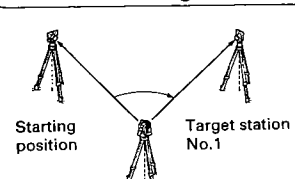
After 4.7 seconds (Fine measurement mode), the distance value, the vertical angle and the horizontal angle are displayed and stored in the instrument memory.

```
S          3.210m
ZA
HAR
```

[CE·CA] : Stop the measurement

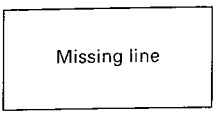
2) For Repeat the measurement mode, press [CE·CA].

Sight the prism on the target station and start the missing line measurement



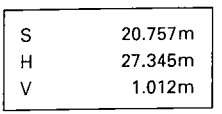
3) Sight the centre of the reflecting prism on the target station No.1. If the prism constant and ppm correction for Target Station No.1 are different from those of the starting position, reset these values now.

[6] : Start the missing line measurement



4) Press [6].

This accesses the Distance Measurement mode and the Missing line measurement is started. The display appears as at left and flashes.



Slope distance
Horizontal distance
Height differ.

After about 5.6 seconds (Fine measurement mode), the slope distance, the Horizontal distance and the height difference are displayed.

[CE•CA] : Stop the measurement

5) For Repeat the measurement mode, press [CE•CA] to stop the measurement.

Sight Target Station No.2

[6] : Start the missing line measurement

- After this measurement, to measure the distance between the starting position and Target station No.2 (or between the starting position and Target station No.3), sight the required reflecting prism and press [6] to start the missing line measurement.

17.3 Change of the starting position

- The last measured target station can be changed to become the next starting position.

Note: **Change of the initial starting position**

Missing line measurement has finished

S	m
H	m
V	m

: Change the initial starting position

Point replace?
Yes / No (exit)

: Verify

Replaced

Basic mode

e.g. • Changing the last measured target station No.4, to become the next starting position

After missing line measurement of the last target station is finished, set the next starting position

S	20.757m
H	27.345m
V	1.012m

1) After the missing line measurement of target station No.4 has been finished, the measured values are displayed.
Press [ENT SHFT] and [0 SET / 0 REC] at this point.

[ENT SHFT] [0 SET / 0 REC]

Point replace?
Yes / No (exit)

The display appears as at left and asks whether the starting position is to be moved.

[Yes ENT SHFT]

Replaced

2) Press [Yes ENT SHFT].
The data for Target station No.4 is set as the data for the new starting position, and the display appears as at left. The instrument returns to Basic mode.

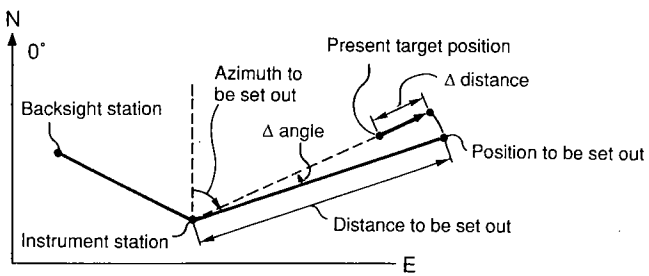
Press function keys to select operation

- To continue missing line measurement from the new starting position to the next target stations, sight each target station and press [6 ▽].

18. SETTING-OUT MEASUREMENT

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

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



18.1 Horizontal angle and distance setting-out measurement

- This measurement is used to set out the point from a certain direction (horizontal angle) and a certain distance away from a reference point (the instrument station).
- It is possible to set out a slope distance, horizontal distance, height difference or remote elevation value after inputting the required value.

Note: **Horizontal angle & Distance setting-out data input**

Theodolite mode or Basic mode

⬇

[ENT SHFT] [4 H/∠]

: For Distance & H angle setting out data input mode

⬇

S-O data	
D	0.000m
HAR	0° 00' 00"

⬇

Input Distance setting out data [ENT SHFT]

⬇

Input H angle setting out data [ENT SHFT]

⬇

Basic mode

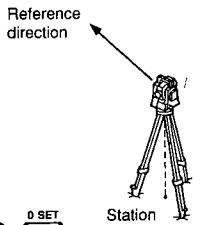
- Distance input range :
  –9999.999 to 9999.999m
  Least input : 0.001m
- Angle input range :
  SET2B:0° to 359°59'59"
  SET3B:0° to 359°59'59"
  SET4B:0° to 359°59'55"
  Least input
  SET2B:1"
  SET3B:1"
  SET4B:5"
  Display range : ±180°
  (difference between target direction and setting out data)
- Data storage period :
  About a week (Power-off possible)

- ◆ Retain the displayed value : [ENT SHFT]
- ◆ Correct the value : [CE·CA] (set value to 0)
- ◆ Exit from the input : [CE·CA] [CE·CA]
  (to Basic mode)

e.g. Setting 123° 45' 50"
→ Input value of 123.455

e.g. • Setting-out a horizontal angle right 90°55'40" from the reference object and
setting-out a horizontal distance of 12.345 m.

Sight the reference direction from the reference point, and set Horizontal angle to 0°



1) Sight the reference direction from the reference point (the instrument station).

ENT SHFT 0 SET 0 REC

2) In Theodolite mode, press ENT SHFT and 0 SET 0 REC.
The horizontal angle display has been set to 0°.

ZA	92° 36' 40"
HAR	0° 00' 00"

To Setting-out Data Input mode

ENT SHFT HI/↗ 4

3) Press ENT SHFT and HI/↗ 4.
The previously input values are displayed. "D" flashes to prompt for the input of the distance setting-out data.

S-O data	
D	0.000m
HAR	0° 00' 00"

Input distance setting-out data

1 MENU 2 PROG · S-O 3 4 5

ENT SHFT

4) Input "12.345" and press ENT SHFT.
The distance setting-out data is input. "HAR" flashes to prompt for the input of the horizontal angle setting-out data.

S-O data	
D.	12.345
HAR	0° 00' 00"

Input horizontal angle setting-out data

9 0 REC ·S-O 5 5 4

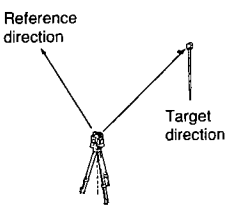
ENT SHFT

```
S-O data
D      12.345
HAR -      90.554
```

```
Press function
keys to select
operation
```

5) Input "90.554" and press ENT SHFT.
The horizontal angle setting-out data is input, and the display returns to Basic mode.

Set the reflecting prism and start S-O measurement



6) Set the reflecting prism at a position about 90°55'40" from the reference direction and about 12.345 metres from the reference point (the instrument point), and sight the reflecting prism.

·S-O 3 : Start H angle S-O measurement

```
        6
      −40
SO  ⊥+
```

7) Press ·S-O and 3.
The setting-out measurement is started, and the horizontal angle "dHA" from the setting-out data is displayed.

```
Setting out
D.          12.345m
HAR    90° 55' 40"
```

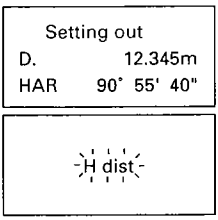
```
dHA    −3° 45' 50"
HAR    94° 41' 30"
```

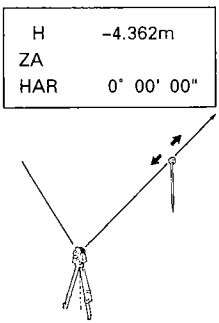
8) Move the reflecting prism right or left in the correct direction until the "dHA" becomes 0°00'00".
Sighting the moving reflecting prism again changes the "dHA" without key operation.

S-O 8 : Start H distance S-O measurement

9) When "dHA" has become 0°00'00",
press S-O and then 8 .
The setting-out measurement is started, and then the horizontal distance measurement is started.

After about 4.7 seconds (Fine measurement mode), the distance from the setting-out data to the reflecting prism is displayed.





10) Move the reflecting prism towards or away from the instrument until the horizontal distance becomes 0.000 m to determine the point.
If minus data is displayed, move the prism away from the instrument, and if plus data is displayed, move the prism towards the instrument.
When the Repeat measurement is selected, sighting the moving reflecting prism again changes the distance without key operation.

- At Step 9), the following setting-out measurements are possible:
  Slope distance, by pressing S-O and 7
  Height difference, by pressing S-O and 9
  REM, by pressing S-O and 5 (after slope distance measurement).

– data : from the instrument
+ data : towards the instrument

18.2 Coordinates setting-out measurement

- This measurement is used to set out the point of a certain coordinate away from the reference point (the instrument station).
- After input of the coordinates for the point to be set out, the SET B calculates the setting out horizontal angle and horizontal distance and stores the values in the memory. By selecting the horizontal angle and then the horizontal distance setting out functions, the required coordinate location can be set out. The Z-coordinate can also be set out using the setting out coordinate function.
- To recall the setting-out coordinate data from coordinate data stored in the memory, please refer to P.118.

Note: **Coordinate setting-out data input**

Theodolite mode or Basic mode
↓
[ENT SHFT] [S-O]
: For Coordinate data input mode
↓
[3 DIST] : For setting out data input mode
↓

```
-N-
E
Z
```

↓
Input N-coordinate setting-out data [ENT SHFT]
↓
Input E-coordinate setting-out data [ENT SHFT]
↓
Input Z-coordinate setting-out data [ENT SHFT]
↓
Basic mode

- Input range : -9999999.999 to 9999999.999
- Least input : 0.001
- Data storage period : About a week (Power-off possible)

◆ Retain the displayed(N,E and Z) value: [ENT SHFT]
◆ Correct the value : [CE·CA] (set value to 0)
◆ Exit from the input : [CE·CA] [CE·CA] (to Basic mode)

e.g. • In this case, the values are as follows:
Instrument station coordinates: N = 20, E = 20, Z = 3
Backsight station coordinates : N = 10, E = 10, Z = 3
Setting out a point : N = 40, E = 30, Z = 4

• The following preparations must be completed before beginning measurement:

12.1 Measurement mode selection
12.2 Instrument height and target height input
12.3 Inputting instrument station and backsight station coordinates
12.4 Setting the azimuth angle

• To set out the Z coordinate, set the reflecting prism on a fixed height object, such as a pole.

From Theodolite mode or Basic mode to Coordinate Setting-out Data Input mode

ENT SHFT S-O : For Coordinate data input mode

1) In Theodolite mode or Basic mode, press ENT SHFT and S-O.
The display appears as at left, showing Coordinate data input mode.

1. Station
2. Backsight
3. S-O point

3 : For S-O data

2) Press 3
for S-O data input mode.

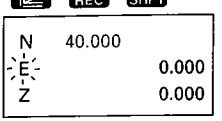
6
–40
Pt

The previously stored values are displayed.
"N" flashes, to prompt for the input of the N coordinate setting-out data.

N	0.000
E	0.000
Z	0.000

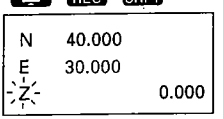
Input the setting-out data

[4] [0 REC] [ENT SHFT]



3) Input "40" and press [ENT SHFT].
The N coordinate is input. "E" flashes to prompt for the input of the E coordinate setting-out data.

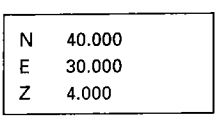
[3] [0 REC] [ENT SHFT]

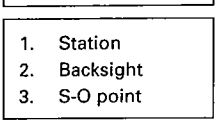


4) Input "30" and press [ENT SHFT].

The E coordinate is input. "Z" flashes to prompt for the input of the Z coordinate setting-out data.

[4] [ENT SHFT]





5) Input "4" and press [ENT SHFT].
The Z coordinate is input, and the instrument returns to Coordinate data input mode.

The setting-out horizontal distance and horizontal angle from the instrument station coordinates are calculated and the values are stored in the memory.

Note: Input the instrument station coordinates before inputting the setting-out data. Calculations may not be carried out correctly if the data is input in the reverse order.

[CE·CA] : To Basic mode

6) Press [CE·CA] to return to Basic mode.

Set the prism and start H angle S-O measurement.

Sight the reflecting prism.

7) Set the reflecting prism in the appropriate position, and sight its centre.

[S-O] [3]

8) Press [S-O] and [3].
The setting-out measurement is started, and the horizontal angle "dHA" from setting-out data to the sighted direction is displayed.

Setting out	
D.	22.361m
HAR	26° 33' 54"

dHA	-3° 00' 00"
HAR	94° 41' 30"

9) Move the reflecting prism right or left until the "dHA" value becomes 0°00'00".

Start H distance S-O measurement

[S-O] [8]

10) When "dHA" has become 0°00'00",
press [S-O] and then [8].

Setting out	
D.	22.361m
HAR	26° 33' 54"

-H dist-

The setting-out measurement is started, and then the horizontal distance measurement is started.

H	0.000m
ZA	
HAR	0° 00' 00"

After about 4.7 seconds (Fine measurement mode), the distance from the setting-out data to the reflecting prism is displayed.

H	0.000m
ZA	
HAR	0° 00' 00"

11) Move the reflecting prism towards or away from the instrument on the sighting line to determine the point until the horizontal distance becomes 0.000 m.

- If the Repeat measurement mode has been selected, press CE·CA to stop the measurement.

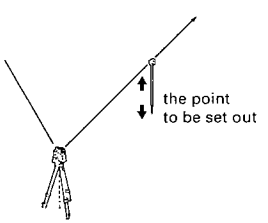
Start coordinates S-O measurement, and determine the height

S-O 4

Setting out	
D.	22.361m
HAR	26° 33' 54"

Coordinate

N	0.000
E	0.000
Z	0.234



12) When "H" has become 0.000 m, press S-O and then 4 .

The setting-out measurement is started, and then the coordinate measurement is started.

After about 5.1 seconds (Fine measurement mode), the coordinates from the setting-out data to the reflecting prism are displayed.
Since the horizontal angle and horizontal distance have already been determined, the N and E coordinates are "0".

13) Move the reflecting prism up or down until the Z coordinate becomes 0.000, and determine the height.
The tip of the pole is the point to be set out.

- If the Repeat measurement mode has been selected, press CE·CA to stop the measurement.

USING THE COORDINATE DATA MEMORY FUNCTION

19. COORDINATE DATA MEMORY FUNCTION ☞ P.113

19. COORDINATE DATA MEMORY FUNCTION

- The SET B can store coordinate data into the memory. The coordinate data can be used as instrument station coordinates, backsight station coordinates, known point coordinates, and setting-out coordinates.

19.1 Coordinate data input / deleting

Note : Coordinate data input

- Up to 100 points of coordinate data can be input
- Coordinate data input range : -9999999.999~9999999.999 (m) Coordinate data least input : 0.001
- Point number input range : 1~99999999
- Data storage period : About a week (Power-off possible)

◆ Retain the displayed value : [ENT SHFT]
◆ Correct the value : [CE·CA]
(set value to 0)
◆ Exit from the input : [CE·CA] [CE·CA]
(to Menu mode)

In Theodolite mode or Basic mode

↓

[1 MENU] : For Menu mode

↓

[2 PROG] : Select "Coord. data"

↓

[1 MENU] : Select Coordinate data "Input"

↓

The space available for input of coordinate data is displayed

↓

Input N-coord. data [ENT SHFT] Input E-coord. data [ENT SHFT] Input Z-coord. data [ENT SHFT]

↓

Input the point number [ENT SHFT]

↓

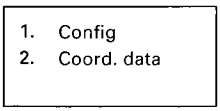
[Yes ENT SHFT] : Verify

↓

[CE·CA] [CE·CA] : Input end and back to Menu mode

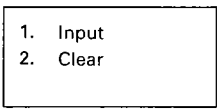
e.g. • To input the coordinate data,
Point number : 201
N coordinate : 35
E coordinate : 67
Z coordinate : 48

From Theodolite mode or Basic mode to Menu mode



1) In Theodolite mode or Basic mode, press [1 MENU]
The display appears as at left, showing Menu mode.

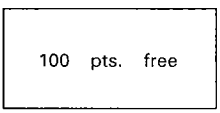
Select "Coord. data"

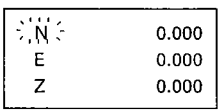


2) Press [2 PROG].

The display asks whether the coordinate data is to be input or deleted.

Select Coordinate data "Input"





3) Press [1 MENU].

The available space for coordinate data inputting is displayed.

Then, the display appears as at left and "N" flashes to prompt for the input of the N coordinate data.

Input the coordinate data

N = 35 [ENT SHFT]
E = 67 [ENT SHFT]
Z = 48 [ENT SHFT]

4) Input coordinate data.

N = 35 [ENT SHFT]
E = 67 [ENT SHFT]
Z = 48 [ENT SHFT]

"No." flashes to prompt for the input of the point number.
(The previously input number +1 is dislayed.)

```
Point
No.                1
```

Input the point number

201 [ENT SHFT]

5) Input the point number "201" and press [ENT SHFT].
Note: Different coordinate data can share the same point number.

The display asks whether the coordinate data is input into the memory.

```
Data OK ?
Yes/No
```

[Yes ENT SHFT] : OK

6) Press [Yes ENT SHFT].
When the inputting is confirmed, the display returns to step 3), so that the next coordinate data can be input.

- To input the next coordinate data, go back to step 4) and input the data.
(Up to 100 points of coordinate data can be input into the memory.)

[CE·CA] [CE·CA]
: To Menu mode

7) Press [CE·CA] [CE·CA].
The display returns to Menu mode.

- All the coordinate data stored in the memory can be cleared.

Note : Coordinate data deleting

In Theodolite mode or Basic mode

↓

1 MENU : For Menu mode

↓

2 PROG : Select "Coord. data"

↓

2 PROG : Select "Clear"

↓

Yes ENT SHFT : Clear the memory of the coordinate data

↓

1 MENU : Verify

↓

Menu mode

Note: When the memory has been cleared, all the data in the memory is deleted.

From Theodolite mode or Basic mode to Menu mode

[1 MENU]

```
1. Config
2. Coord. data
```

1) In Theodolite mode or Basic mode, press [1 MENU].
The display appears as at left, showing Menu mode.

Select "Coord. data"

[2 PROG]

```
1. Input
2. Clear
```

2) Press [2 PROG].

The display asks whether the coordinate data is to be input or deleted.

Select "Clear"

[2 PROG]

```
Clear OK ?
Yes/No(exit)
```

3) Press [2 PROG].

The display asks whether the memory is to be cleared of the coordiante data.

Clear the memory of the coordinate data

[Yes ENT SHFT]

```
Start ?
Yes=>press "1"
Exit=>press "No"
```

4) Press [Yes ENT SHFT].

The display asks whether you want to start clearing the memory or not.

[1 MENU]

```
1. Config
2. Coord. data
```

5) Press [1 MENU].

All the data stored in the memory has been deleted and the instrument returns to Menu mode.

19.2 Coordinate data stored in the memory input to Instrument

- The coordinate data stored in the memory can be used as follows:
  - Instrument station coordinates
  - Backsight station coordinates
  - Known point coordinates for Resection measurement
  - Setting-out coordinates

- Before using the data from the instrument, the following parameter should be set to "Memory".
  To change the paramenter, please refer to P.167 "23. CHANGING INSTRUMENT PARAMETERS".

No.	Parameter	Options
1	Coordinate data from	Keyboard/Memory

e.g. **<Input instrument station coordinates by using the coordinate data in the memory>**

- To input the coordinate data stored in the memory, Point No.401, as the instrument station coordinates

From Theodolite mode or Basic mode to Instrument station coordinates input mode

ENT SHIFT S-O : For Coordinate data input mode

1.	Station
2.	Backsight
3.	S-O point

1 MENU : For Instrument Station

Stn	point	
No.		201

Input the point number

401 ENT SHIFT

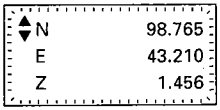
N	98.765
E	43.210
Z	1.456

1) In Theodolite mode or Basic mode, press ENT SHIFT S-O .
The display appears as at left, showing Coordinate data input mode.

2) Press 1 MENU for Instrument Station coordinate data input mode.

"No." flashes to prompt for the input of the point number.

3) Input the point number "401" and press ENT SHIFT .
The coordinate data for 401 is displayed and is input as the instrument station coordinates.
(Basic mode)



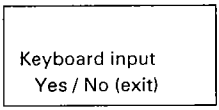
Note: If more than one stored coordinate data record has the same point number, the display flashes to prompt for the selection of the required coordinate data.

Press [S-O]↑ or [+/- RCL]↓ to display the coordinates to be recalled. And then press [ENT SHFT] to recall the displayed coordinates.

Note: When the coordinate data is not found, the display appears as at left and asks whether you will input the coordinate data from keyboard or input the point number again.

Press [Yes ENT SHFT] to input the Instrument station coordinates from keyboard.

Press [No CE·CA] to input the point number again.



[CE·CA]: To Basic mode

• Press [CE·CA] to return to Basic mode.

e.g. **<Input Known station coordinates for Resection measurement by using the coordinate data in the memory>**

- To input the following coordinate data stored in the memory as the known station coordinates for Resection measurement:

  Known station A: Point No.=501, Measure angle & distance, Target height = 1.5m
  Known station B: Point No.=503, Measure angle
  Known station C: Point No.=507, Measure angle & distance, Target height = 1.5m

From Theodolite mode or Basic mode to Program mode

[2 PROG]

```
1. Resection
2. Correction
3. Pt. replace
```

1) In Theodolite mode or Basic mode, press [2 PROG].
The display appears as at left, showing Program mode.

Select Resection measurement

[1 MENU]

```
Target / Coord.
No.      400
```

2) Press [1 MENU].
"No." flashes to prompt for the input of the point number.

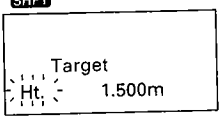
Input the data of Known station A

501 [ENT SHFT]

```
Measure dist ?
Yes / No
```

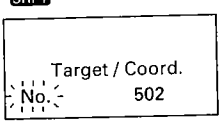
3) Input the point number "501" and press [ENT SHFT].
The display asks whether to measure the distance or not.

Yes ENT SHFT : Measure distance



4) Press Yes ENT SHFT .
The previously stored target height is displayed.
"Ht." flashes to prompt for the input of the target height.
If measuring angle only, press No CE·CA .

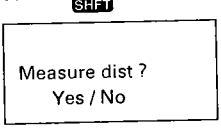
ENT SHFT : Retain displayed value



5) Press ENT SHFT .
When the data for the first station has been input, "No." flashes to prompt for the input of the point number of the next known station. (The previously stored value +1 is displayed.)

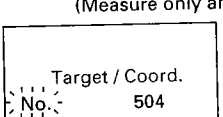
Input the data of Known station B

503 ENT SHFT



6) Input the point number "503" and press ENT SHFT .
The display asks whether to measure the distance or not.

No CE·CA : Distance not measured (Measure only angle)



7) Press No CE·CA .
When the data for the second station has been input, "No." flashes to prompt for the input of the point number of the next known station. (The previously stored value +1 is displayed.)
If measuring distance, press Yes ENT SHFT .

Input the data of Known station C

507 [ENT SHFT]

```
Measure dist ?
   Yes / No
```

[Yes ENT SHFT] : Measure distance

```
    Target
Ht.    1.500m
```

[ENT SHFT] : Retain displayed value

```
More point ?
   Yes / No
```

[No CE·CA] : No more station

```
Pt.        501
   measure ?
Yes / No (exit)
```

8) Input the point number "507" and press [ENT SHFT].
The display asks whether to measure the distance or not.

9) Press [Yes ENT SHFT].
The previously stored target height is displayed.
"Ht." flashes to prompt for the input of the target height.
If measuring angle only,
press [No CE·CA].

10) Press [ENT SHFT].
When the data for the third station has been input, "No." flashes to prompt for the input of the point number of the next known station. (The previously stored value +1 is displayed.)

11) Press [No CE·CA].
The display asks whether you want to observe the first station (Known station A) or not.

• See P.77 from 15) to continue the resection measurement.

e.g. **<Input Coordinate setting-out data by using the coordinate data in the memory>**

- To input the coordinate data in the memory, Point No. 701, as the Coordinate setting-out data
- The following preparations must be completed before beginning measurement:
  - 12.1 Measurement mode selection ☞ P.56
  - 12.2 Instrument height and Target height input ☞ P.57
  - 12.3 Instrument station coordinates and Backsight station coordinates input ☞ P.60
  - 12.4 Setting the azimuth angle from the instrument and backsight station coordinates ☞ P.65

From Theodolite mode or Basic mode to Coordinate setting-out data input

ENT SHFT S-O : For Coordinate data input mode

1.	Station
2.	Backsight
3.	S-O point

3 : For S-O data input mode

SO	point
No.	1000

1) In Theodolite mode or Basic mode,
press ENT SHFT S-O .
The display appears as at left, showing Coordinate data input mode.

2) Press 3
for Setting-out data input mode.
"No." flashes to prompt for the input of the point number.

Input the point number

701 ENT SHFT

N	20.000
E	50.000
Z	0.000

3) Input the point number "701" and press ENT SHFT .
The coordinate data for 701 is displayed and is input as the instrument station coordinates.

- See P.103 from 5) to continue the coordinate setting-out measurement.

19.3 Reviewing the coordinate data stored in the memory

- The SET B can display the coordinate data stored in the memory.

Note: Reviewing coordinate data stored in the memory

In Theodolite mode or Basic mode

↓

[+/− RCL] [0 REC] : For Recall mode

↓

[· S→O] ↑ or [+/− RCL] ↓: Display the required point number (possible to scroll)

↓

Yes
[ENT SHFT] : Select the point number

↓

Review the data

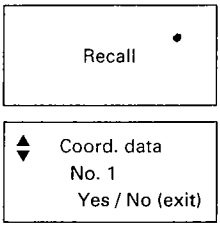
- Use [· S→O] ↑ or [+/− RCL] ↓ to display the required coordinate data.
- Press [ENT SHFT] to display the next point's coordinate data (possible to scroll)

[CE·CA] , [CE·CA] : To Basic mode

e.g. • To review the coordinate data for point number 1008

From Theodolite mode or Basic mode to Recall mode

[+/- RCL] [0 REC]



1) In Theodolite mode or Basic mode, press [+/- RCL] [0 REC].

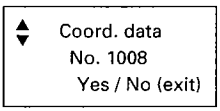
The display appears as at left, showing Recall mode.

After, the display prompts for the selection of the point number.

Select "No.1008"

[· S-O]▼ or [+/- RCL]▲

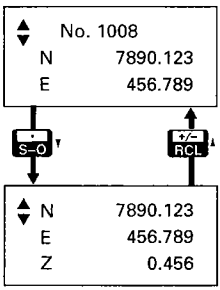
: Display "No.1008"



2) Press [· S-O]▼ or [+/- RCL]▲ to display "No.1008". (possible to scroll)
When the last point number is displayed, the message "<END>" is displayed at the next line.

Yes [ENT SHFT]

: Display the coordinate data



3) Press Yes [ENT SHFT].
The stored data is displayed.

- Press [· S-O]▼ to display the Z coordinate data.
  Press [+/- RCL]▲ to display the point number.
- Press [ENT SHFT] to display the next point data. (possible to scroll)
- Press [CE-CA] [CE-CA] to return to Basic mode.

20. DATA OUTPUT AN EXTERNAL DEVICE ☞ P.129

20 DATA OUTPUT TO AN EXTERNAL DEVICE

- Key operations allow the SET B to output measured data via the data output connector to an external device using an interface cable. (For more information, see the Series B 2-way communication manual.)

- The contents of data which can be output are as follows.
  When measurement data is output, the target number, target code, target height, distance unit, angle unit, vertical indexing, horizontal indexing, and atmospheric correction value can be output, along with the following data.

S, V, H	→	Slope distance, vertical angle, horizontal angle
S, V, H (offset)	→	Prism direction and distance from target (only if input through offset measurement) Slope distance, vertical angle, horizontal angle
V, H, Tilt	→	Vertical angle, horizontal angle, X direction tilt angle, Y direction tilt angle
N, E, Z	→	N coordinate (E coordinate), E coordinate (N coordinate), Z coordinate
N, E, Z+S, V, H	→	N coordinate (E coordinate), E coordinate (N coordinate), Z coordinate Slope distance, vertical angle, horizontal angle
Note	→	Note
Station data	→	Date, instrument station number, code, instrument height, temperature, atmospheric pressure, curvature and refraction correction ON/OFF, prism constant correction, automatic tilt angle correction ON/OFF, instrument station N coordinate (E coordinate), E coordinate (N coordinate), Z coordinate
Instr ID	→	Instrument name, instrument number, software version number

20.1 Changing the Instrument options

- Confirm that following parameters are set according to your required measurement and the data output to an external device condition.
- To confirm or change the parameter options, see P.167 "23. CHANGING INSTRUMENT PARAMETERS".

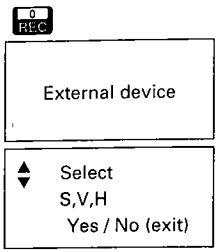
No.	Parameter		Options	
2	Recording	1. Set code	*1. Input	2. Non-input & skip
		2. Set target height	*1. Input	2. Non-input & skip
3	Tilt correction		*1. Applied	2. Not applied
5	V angle format		*1. Zenith 2. Horizontal 0°—360° (0—400gon) 3. Horizontal ±90° (±100gon)	
6	Angle resolution	SET2B / 3B	*1.1" (0.2mgon)	2. 5" (1mgon)
		SET4B	*1.5" (1mgon)	2. 10" (2mgon)
7	RS-232C format	1. Baud rate	*1.1200 baud	2. 2400 baud
		2. Checksum	*1. No	2. Yes
		3. Parity bit	*1. No	2. Yes (even)
8	V indexing		*1. Auto	2. Manual
9	H indexing		*1. Auto	2. Manual
10	C+R correction		*1. No 2. Yes K=0.142	3. Yes K=0.20
11	Units	1. Distance	*1. metres	2. feet
		2. Angle	*1. Degrees	2. Gon
		3. Temperature & pressure	*1. °C & hPa	2. °C & mmHg
			3. Next	1. °F & hPa 2. °F & mmHg 3. °F & inchHg

* Factory settings

20.2 Instrument data output

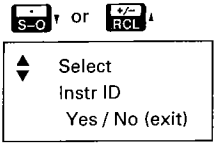
- With the SET B, the following items can be output to an external device as instrument data:
  - Instrument name
  - Instrument number
  - Software version number

From Theodolite or Basic mode to Record mode



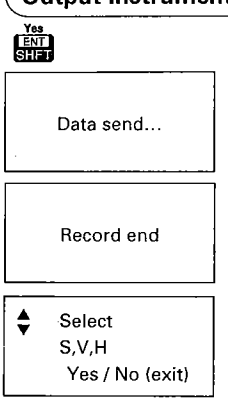
1) In Theodolite mode or Basic mode, press 0 REC .
The display shows Record mode. And the display prompts for selection of the data format.

Display "Instr ID"



2) Press S-O or +/- RCL . to display "Instr ID".

Output Instrument data



3) Press Yes ENT SHFT .
Output of the instrument data is started.
When output of the instrument data has been finished, the message "Record end" is displayed, and the display returns to the Record mode.

20.3 Instrument station data output

- The SET B can output the following items as instrument station data;
  Date, instrument station number, instrument station code, instrument height, temperature, atmospheric pressure, instrument station coordinates, curvature and refraction correction, prism constant, and automatic tilt angle correction.

Procedure: Instrument station data output

- Station number input range : 1~99999999
- Code can be up to 13 characters long
- Date, Station number and Code storage period : About a week (Power-off possible) Station number displayed is the last-input station number +1.

◆ Retain the displayed value or code: ENT SHFT
◆ Correct the value of 1 character : CE·CA
(set value to 0)
◆ Exit from the input : CE·CA CE·CA
(to Record mode)

e.g. Setting a date of 6th September 1991.
→ Input value of "91.9.6"

0 REC : For Record mode

↓

· S-O ↑ or +/- RCL ↓
:Display "Station data"

↓

Yes
ENT SHFT : Select to start output

↓

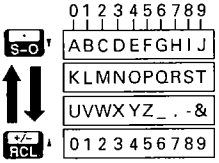
Input date ENT SHFT

↓

Input Station number ENT SHFT

↓

(Input code ENT SHFT)



- Use · S-O ↑ or +/- RCL ↓ to select the required block of characters. Press the numerical key (0-9) corresponding to the required character.

↓

Input Instrument height ENT SHFT

↓

1 MENU : Set 0ppm

2 PROG : Set Temperature & Pressure

↓

Input Temperature ENT SHFT

↓

Input Pressure ENT SHFT

3 : Set ppm value

↓

Input ppm value ENT SHFT

↓

Input N-coordinate ENT SHFT Input E-coordinate ENT SHFT Input Z-coordinate ENT SHFT

↓

Output end

↓

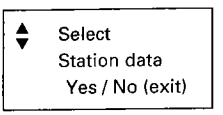
Record mode

e.g.

- To output the following instrument station data:
  Date: October 4, 1992
  Instrument station number: No.100
  Code: "HOME"
  Instrument height: 1.45m
  Temperature: 25°C
  Atmospheric pressure: 980 hPa
  Instrument station coordinates:
  N = 30, E = 30, Z = 10

In Record mode, display "Station data"

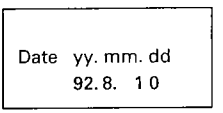
S-O or +/- RCL



1) In Record mode,
press S-O or +/- RCL
to display "Station data".

Select the "Station data"

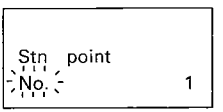
Yes ENT SHFT



2) Press Yes ENT SHFT .
The previously input date is displayed.

Input the date

92.10.4 ENT SHFT



3) Input "92.10.4" and
press ENT SHFT .
The date "92.10.4" is input, and "No." flashes to prompt for the input of the station number.

Input the station number

100 [ENT SHFT]

▲ ▼	ABCDEFGHIJ
press	0123456789
Cd	ABC

4) Input "100" and press [ENT SHFT].
"100" is input for the station number. "Cd" flashes to prompt for the input of the instrument station code.

Note: If the parameter of the code setting is set to Non-input, this procedure is omitted. Instead, go directly to step 6).

Input the code

[CE·CA] : Single-character delete

[7] : Input "H"

[S–O] : Display K to T

[4] : Input "O"

[2 PROG] : Input "M"

[+/– RCL] : Display A to J

[4] : Input "E"

[ENT SHFT] : Input finished

Instr	
Ht	0.000m

5) Input the code.

Press [CE·CA] to delete one character to the left.

Press [7] to input "H".

Press [S–O] to display "K ~ T".

Press [4] to input "O".

Press [2 PROG] to input "M".

Press [+/– RCL] to display "A ~ J".

Press [4] to input "E".

Press [ENT SHFT].

The code "HOME" is input, and "Ht" flashes to prompt for the input of the instrument height.

Input the instrument height

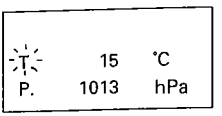
1.45 [1 MENU]

1. 0 set
2. Temp & Press
3. ppm value

6) Input "1.45" and press [ENT SHFT].
An instrument height value of "1.45" is input, and the display turns to the ppm setting mode.

Select the temperature and pressure input

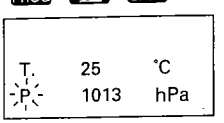
[2 PROG]



7) Press [2 PROG].
The previously stored values are displayed.
"T" flashes to prompt for the input of the temperature.

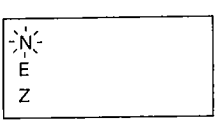
Input the temperature and pressure

[2 PROG] [5] [ENT SHFT]



8) Input "25" and press [ENT SHFT].
A temperature 25°C is input.
"P" flashes to prompt for the input of the pressure.

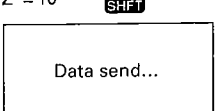
[9] [8] [0 REC] [ENT SHFT]

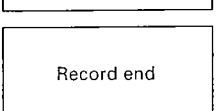


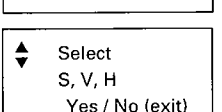
9) Input "980" and press [ENT SHFT].
A pressure "980 hPa" is input.
"N" flashes to prompt for the input of instrument station coordinates.

Input the instrument station coordinates

N = 30 [ENT SHFT]
E = 30 [ENT SHFT]
Z = 10 [ENT SHFT]







10) Input the instrument station coordinates.
N = 30 [ENT SHFT]
E = 30 [ENT SHFT]
Z = 10 [ENT SHFT]

Output of the station data is started. When the data has been output, the message "Record end" is displayed and the display returns to Record mode.

20.4 Measured data output

- The SET B can output the following items as measured data: Target number, target code, target height, distance unit, angle unit, vertical indexing, horizontal indexing, atmospheric correction measured data.

- The distance is measured in accordance with the selected distance measurement mode, but the measurement is done only once (single measurement).

Check! before recording the data:

S, V, H	→ Check No.1, 2, 3, 6 below.
S, V, H (offset)	→ Check No. 1, 2, 3, 6 below.
V, H, Tilt	→ Check No.1 below.
N, E, Z	→ Check No.1, 2, 4, 5, 6 below.
N, E, Z + S, V, H	→ Check No.1, 2, 4, 5, 6 below.

1. The instrument parameters have been set. ☞ P.29
2. The correct prism constant has been set. ☞ P.45
3. The instrument station data has been output or else atmospheric correction has been set. ☞ P.132 ☞ P.48
4. The instrument station data has been output or else the instrument height, atmospheric correction and instrument station coordinates have been set. ☞ P.132 ☞ P.57 48,60
5. The azimuth angle has been set. ☞ P.65
6. The centre of the reflecting prism is being sighted and the return signal is adequate for measurement. ☞ P.52

Procedure: Measured data output

- Target number input range : 1~99999999
- Code can be up to 13 characters long
- Target number, Code and Target height storage period : About a week (Power-off possible)
  Target number displayed is the last-Input station number +1.

◆ Retain the displayed value or code: ENT SHFT
◆ Correct the value of 1 character : CE·CA
(set value to 0)
◆ Exit from the input : CE·CA CE·CA
(to Record mode)

0 REC : For Record mode

↓

Sight the target

↓

S-O ▼ or +/- RCL ▲
:Display "Measured data"

↓

Yes
ENT SHFT : Select to start output

↓

(Input Target height ENT SHFT)

↓

The SET B measures and displays one set of the target point data in the selected format.

- In Offset measurement, the SET B measures and displays the offset point data.
  Select Distance inputting or Target sighting.
  Select the direction of offset point from the Target and input the distance between the offset point and Target, or sight the target.

↓

Input Target number ENT SHFT

↓

(Input code ENT SHFT)

- Use S-O ▼ or +/- RCL ▲ to select the required block of characters. Press the numerical key (0-9) corresponding to the required character.

↓

Output end

↓

Record mode

e.g. • To output the following offset measurement data
Target number : No. 2001
Code : "TREE1".
Target height : 1.23 m
Horizontal distance from target point to offset point : 1.8 m
Direction of prism from target : Front

In Record mode, display "S, V, H (offset)"

[S-O]▼ or [+/-RCL]▲

▲▼ Select
S. V. H (offset)
Yes / No (exit)

1) In Record mode, press [S-O]▼ or [+/-RCL]▲ to display "S, V, H (offset)".

Select "S, V, H (offset)"

Yes [ENT SHFT]

Target
Ht

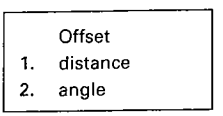
2) Press Yes [ENT SHFT].
The previously stored values are displayed. "Ht" flashes to prompt for the input of the target height.

Note: If the target height setting parameter is set to "Non-input", this procedure is omitted. Instead, go directly to step 4).

Sight reflection prism for offset point and input target height

1.23 [ENT SHIFT]

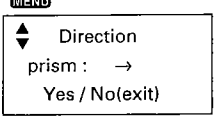
3) Sight the reflection prism for the offset point.
Input "1.23" and press [ENT SHIFT].
A target height value of 1.23 m is input, and the Distance mode is accessed. Distance measurement is started. The display appears as at left and flashes.
After about 4.7 seconds (Fine measurement mode), the distance value, the vertical angle and horizontal angle are displayed.



The display prompts you to select one of the following options:
1. Input of the horizontal distance from the target point to the offset point.
2. Sight the direction of the target point.

Select "distance"

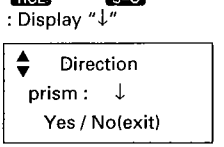
[1 MENU]



4) Press [1 MENU].
The display appears as at left and prompts for the selection of the direction from the target point to the reflecting prism.

Select offset point direction

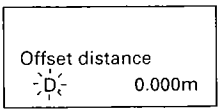
[+/- RCL] or [. S-O]
: Display "↓"



5) Press [+/- RCL] or [. S-O] to display "↓".

Note:
→ Prism is right of target
← Prism is left of target
↑ Prism is behind target
↓ Prism is in front of target

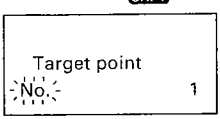
Yes ENT SHFT



When "↓" appears, press Yes ENT SHFT.
"D" flashes to prompt for the input of the horizontal distance between the target point and offset point.

Input the horizontal distance from the target point to the offset point

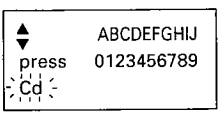
1.8 ENT SHFT



6) Input horizontal distance of "1.8" and press ENT SHFT.

Input the target point number

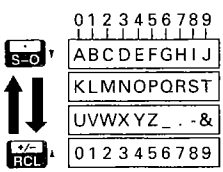
2001 ENT SHFT



7) Input a target number of "2001" and press ENT SHFT.
A target number value of "2001" is input. "Cd" flashes to prompt for the input of the target point code.

Note: If the parameter of the code setting is set to "Non-input", this procedure is omitted.

Input the target point code



8) If the displayed code is the required one, press ENT SHFT and go to step 9).
Press CE·CA to delete one character to the left.

: Display K to T — Press S-O to display "K to T".
: Input "T" — Press 8 to input "T".
: Input "R" — Press 7 to input "R".
: Display A to J — Press +/- RCL to display "A to J".
: Input "EE" — Press 4 to input "EE".
: Display 0 to 9 — Press +/- RCL to display "0 to 9".
: Input "1" — Press 1 MENU to input "1".
: Input finished — And press ENT SHFT .

When the code has been input, the output is started.

```
Data send...
```

9) When the target number is displayed, the output is finished.

```
Target          2001
 Record end
```

The display then returns to Record mode.

```
▲ Select
▼ S,V,H (offset)
   Yes / No (exit)
```

```
Record
```

Note: If the display returns to Record mode following a display like that at the left, there is an error in the output. Please check to see if there are any abnormalities in cables or external device, or if there is a problem with the program.

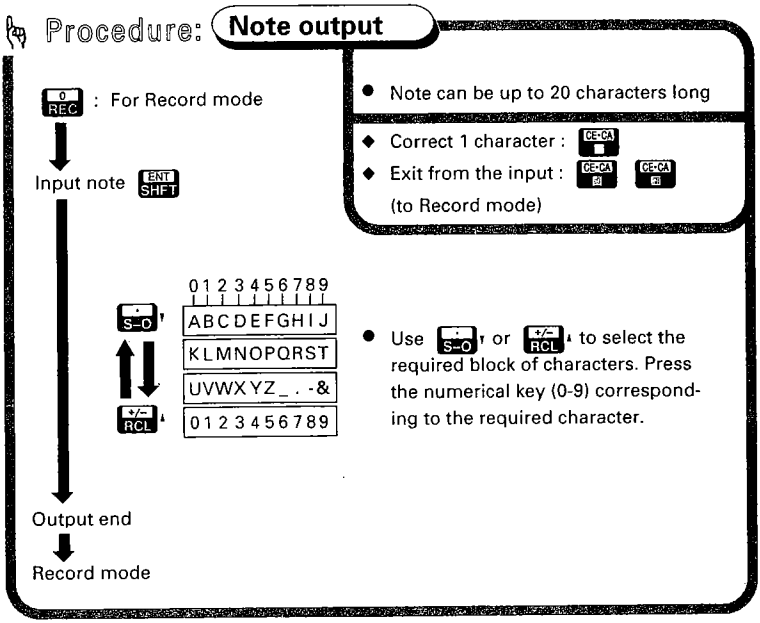
```
Data error
```

If the display returns to Record mode following a display like that at the left, there is an error in the measurement. Try levelling the instrument again, or sight the reflecting prism once again and start over from step 1).

20.5 Note output

- The SET B can output notes.

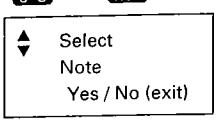
Procedure: Note output



e.g. • To output "CLOUDY" as a note

In Record mode, display "Note"

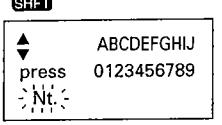
S-O or +/- RCL



1) In Record mode, press +/- RCL or S-O to display "Note".

Select the "Note"

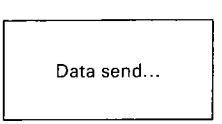
Yes ENT SHFT

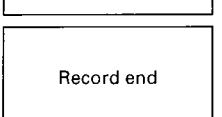


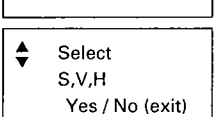
2) Press Yes ENT SHFT.
"Nt." flashes to prompt for the input of the note.

Input the note

CLOUDY ENT SHFT







3) Input "CLOUDY" and press ENT SHFT.
When the note has been output, the display returns to Record mode.

TROUBLESHOOTING

21. ERROR MESSAGES

- If the following error messages are shown during measurement, see the table below.
- If the same error message is repeated or if other messages are shown, please contact your Sokkia agent.

Display	Meaning	Action
Bad cond.	Prism sight is bad.	Sight the target again. Measure again after confirming the returned signal using the signal checking mode.
Battery is low	Battery voltage is too low.	Charge the battery or replace it with a charged one.
Confirm 0 set	Reset is not performed.	Index the V and H circles again.
Data error	An error has occurred during outputting.	Level the SET B again or sight the reflecting prism.
	Error when measuring the initial slope distance during either REM or horizontal distance between two points measurement.	Sight the reflecting prism to perform slope distance measurement again.
Memory cleared	After 1 week, data stored in the short term memory has been cleared.	
Memory is full	There is no area to input coordinate data in the memory.	
No data	There is no data for the specified point number.	

Display	Meaning	Action
Out of range	During REM, the vertical angle is more than ±89° or the measured distance is more than 9999.999m.	Press CE·CA to stop measuring.
Out of range X > ⊥ <Y	Tilt sensor range error. Tilt angle exceeds ±3'.	Level the SET B again.
Record error	External device does not reply with ACK/NAK. (when "recording" parameter is set to "out".)	Check to see if there are any abnormalities in cables or external equipment, or if there is a problem with the program.
Signal off	At start of measurement, the returned signal was totally absent or disturbed.	Sight the target again. Measure again after confirming the returned signal using the signal checking mode.
Tilt error	While setting the azimuth angle, tilt angle exceeds ±3'.	Level the SET B again.
Tilt Out of range	During distance measurement, tilt angle exceeds ±3'.	Level the SET B again.
Time out	No measured distance data is received within 2 minutes of starting the measurements, or the measured distance data cannot be obtained for a total of one minute.	Sight the target again. Measure again after confirming the returned signal using the signal checking mode.
E 100	Error when measuring a horizontal angle*.	Index the horizontal circle again.
E 101	Error when measuring a vertical angle*.	Index the vertical circle again.

* If the SET B telescope or upper part is rotated faster than four revolutions per second, the error indication "E 100" or "E 101 is displayed.

22. CHECKS AND ADJUSTMENTS

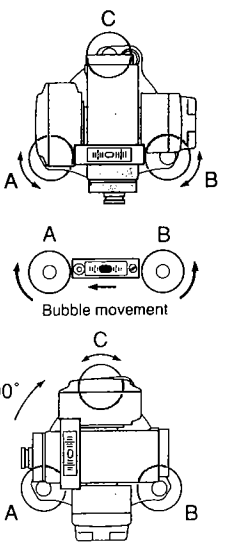
- Periodically, checks and adjustments should be performed before and after measurement. In addition, the instrument should be checked after long storage, transportation or when damage to the instrument is suspected to have occurred due to a strong shock.

- The checks should be performed in the following order.

22.1 Plate level

- The glass tube of the plate level is sensitive to temperature changes or shock.

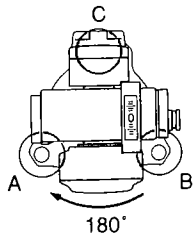
Check



1) Turn the upper part of the instrument until the plate level is parallel to a line between levelling foot screws A and B.
Centre the plate level bubble using levelling screws A and B.

Note: The bubble moves towards a clockwise rotated foot screw.

2) Loosen the horizontal clamp ㉒ and turn the upper part 90°.
The plate level is perpendicular to a line between levelling screws A and B.
Centre the plate level bubble using levelling screw C.



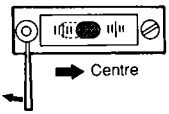
3) Turn the upper part through 180° and check the bubble position.
If the bubble is still centred, no adjustment is necessary.
If the bubble is off-centre, adjust as follows:

Adjustment

4) Use levelling screws

4) Correct half of the bubble displacement using levelling screw C.

5) Use adjusting pin



5) Correct the remaining half of the displacement by adjusting the screw ㉗ with the adjusting pin.

Note: The bubble moves away from a clockwise rotation of the adjusting screw.

6) Repeat the procedures from 1) to 5) until the bubble remains centred for any position of the upper part.

If the bubble can not be centred, please contact your Sokkia agent.

22.2 Circular level

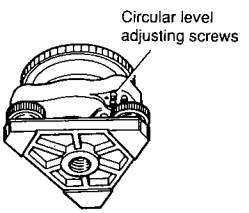
Check

1) Perform the plate level adjustment or level the instrument carefully using the plate level.

2) Check the position of the circular level bubble.

   If the bubble is off-centre, adjust as follows:

Adjustment



3) Verify the off-centre direction of the bubble.

4) Loosen the adjusting screw farthest from that direction to centre the bubble.

5) Adjust all 3 adjusting screws until the tightening tension of each screw is the same, and the bubble is centred.

Note: Over-tightening the adjusting screws may damage the circular level. Unequal tightening of the screws may mean that the bubble will go out of adjustment.

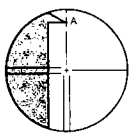
If the bubble can not be centred, please contact your Sokkia agent.

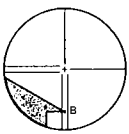
22.3 Reticle

- This adjustment is very delicate. If you have any difficulties, please contact your Sokkia agent.

Perpendicularity of the reticle to the horizontal axis

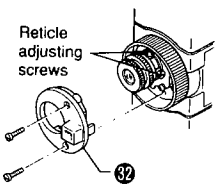
Check



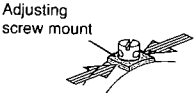


1) Level the SET B carefully. Select and sight a clear target on the upper part A of the reticle line.
2) Turn the telescope vertical fine motion screw ㉙ until the target is on the lower part of the reticle B. If the target is still positioned centrally within the reticle lines, no adjustment is necessary. If the target is off-centre, adjust as follows:

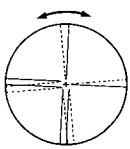
Adjustment



3) Remove the telescope reticle cover ㉜ .
4) Slightly loosen one vertical and one horizontal adjusting screw by a certain amount using the adjusting pin.
5) Place a small piece of plastic or wood against one side of the top adjusting screw mount as a buffer.



6) Look through the eyepiece and gently tap the piece of plastic or wood to rotate the reticle slightly.
7) Retighten the two adjusting screws loosened in step 4) by the same amount.



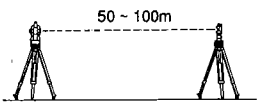
Note: Over-tightening the adjusting screws may damage the reticle. Unequal tightening of the adjusting screws may mean that the reticle will go out of adjustment.

8) Check the reticle perpendicularity again using procedures 1) and 2) above and repeat the adjustment if necessary. Replace the reticle cover.

Note : After this adjustment, perform the check and adjustment of the reticle position as follows:

Vertical and horizontal reticle line positions

Check



ZA	90° 30' 10"
HAR	18° 34' 00"

ZA	269° 30' 00"
HAR	198° 34' 10"

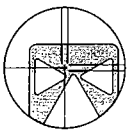
1) Set up a clear target 50 - 100m from the SET B. Level the instrument carefully, switch on, and index the vertical and horizontal circles.
2) Sight the target on face left. Read the vertical and horizontal angles.
   e.g. HAR 18°34'00".....a1
   ZA 90°30'10".....b1
3) Now sight the target on face right. Read the vertical and horizontal angles.
   e.g. HAR 198°34'10"....a2
   ZA 269°30'00"....b2
4) Calculate a2 - a1 = 180°00'10". The difference should be within 180° ± 20"
5) Calculate b1+ b2 = 360°00'10". The sum should be within 360° ± 20"
   If a difference of more than ± 20" still remains after repeating these procedures several times, adjust as follows:

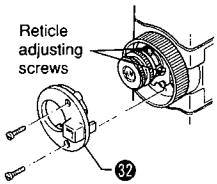
Note : Moving the reticle line effects the distance measurement. Do not move the reticle more than 20".

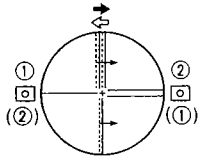
Adjustment

e.g. a1 = 18° 34′ 00"
b1 = 90° 30′ 10"
a2 = 198° 34′ 20"
b2 = 269° 30′ 10"

ZA	296° 30′ 00"
HAR	198° 34′ 10"







6) Calculate Horizontal angle A and Vertical angle B,

A = (a2+a1)/2+90°=198°34′10"

B = (b2–b1)/2+180° = 269°30′00"

7) While still sighting the target on face right, use the horizontal and vertical fine motion screws to adjust the displayed horizontal and vertical angles to the above values.

8) Look through the telescope. The reticle is now slightly shifted from the target.

9) Unscrew the two fixing screws and remove the telescope reticle cover 32.

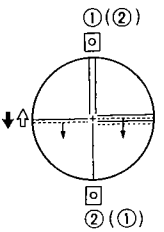
10) To move the vertical reticle line towards the target centre, use the adjusting pin to adjust the left and right adjusting screws as follows: Slightly loosen the top and bottom adjusting screws by the same amount.
To move the reticle to the **right** (left), first very slightly loosen the **left** (right) adjusting screw, then tighten the **right** (left) adjusting screw by this same amount.
[( ) for opposite direction]

Finally tighten the top and bottom adjusting screws as before.

Check the reticle position and repeat the procedure until the reticle comes close to the target centre.

11) To move the horizontal reticle line towards the target centre, adjust the top and bottom adjusting screws as follows:

Slightly loosen the right and left adjusting screws by the same amount.



To move the reticle **down** (up), first slightly loosen the **top** (bottom) adjusting screw, then tighten the **bottom** (top) adjusting screw by this same amount.

Finally tighten the right and left adjusting screws as before.

Check the reticle position and repeat the procedure until the reticle comes close to the target centre.

12) Replace the reticle cover.

Note: Over-tightening the adjusting screws may damage the reticle. Unequal tightening of the adjusting screws may mean that the reticle will go out of adjustment.

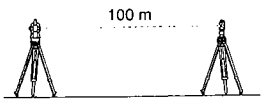
After this adjustment, please adjust the collimation error referring to P.186 "Appendix 2:<Adjusting the collimation error by collimation program>".

22.4 Coincidence of distance measuring axis with reticle

- After the reticle check, verify that the distance measuring axis is matched with the reticle.

Note: Do not adjust the reticle in this step.

Check



1) Set up a clear prism 50 - 100m from the SET B on flat ground.

ZA	89° 50' 40"
HAR	

2) In Theodolite mode, sight the prism centre and read the vertical angle.

c = 89°50'40"

CE·CA : To Basic mode

3) Press CE·CA to go to Basic mode.

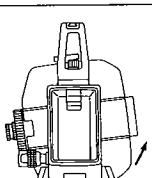
Press function keys to select operation

ENT SHFT ⏻ : To signal checking mode

4) Press ENT SHFT , ⏻ to go to signal checking mode.

Signal *

"Signal *" is displayed.



5) With the vertical fine motion screw ㉙, elevate the telescope slowly until the "*" symbol disappears.

Signal

CE·CA : Finish checking

Press function keys to select operation

3 : To Theodolite mode

ZA 89° 47' 00"
HAR

6) Press CE·CA at this position ("*" not displayed) to return to Basic mode, then press 3 to go to Theodolite mode and read the vertical angle.

a = 89°47'00"

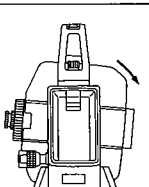
CE·CA : To Basic mode

Press function keys to select operation

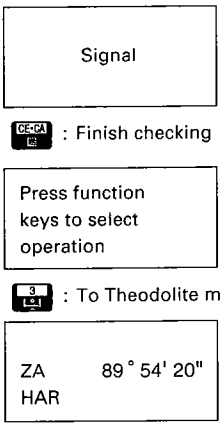
ENT SHFT , ☼ : To signal checking mode

7) Press CE·CA again to return to Basic mode, then press ENT SHFT , ☼ to go to the return signal checking mode.

Signal *



8) Lower the telescope slowly with the vertical fine motion screw until the "*" symbol disappears.



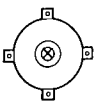
9) Press CE·CA at this position ("*" not displayed) to return to Basic mode, then press 3 to go to Theodolite mode and read the vertical angle.

b = 89°54'20"

10) There is no problem if the difference of a and b against c is more than 2'30" (SET4B: 3'). The right and left directions require the same check. If any of the differences are less than 2'30" (SET4B: 3'), please contact your Sokkia agent.

22.5 Optical plummet

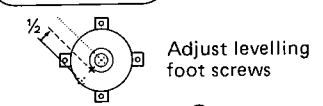
Check



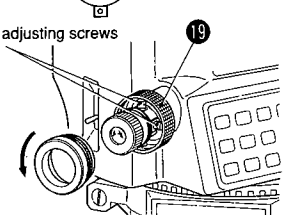
1) Level the SET B and exactly centre a surveying point in the reticle of the optical plummet.

2) Turn the upper part 180°.
If the surveying point is still centred, no adjustment is necessary.
If the surveying point is off-centre, adjust as follows:

Adjustment



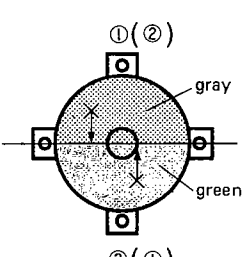
3) Correct half the deviation with the levelling foot screws ⑫.

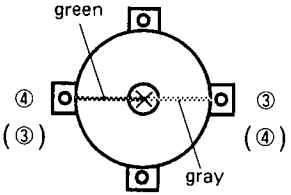


4) Unscrew the optical plummet focussing ring ⑲.

5) Adjust the remaining half of the displacement with the 4 adjusting screws to centre the reticle exactly on the surveying point.
When surveying point is seen as a green (gray) area:
① Loosen the upper (lower) screw slightly.

② Tighten the lower (upper) screw by the same amount.





Next, if the surveying point is seen to be on the green line (gray line):

③ Loosen the right (left) screw slightly.
④ Tighten the left (right) screw by the same amount.

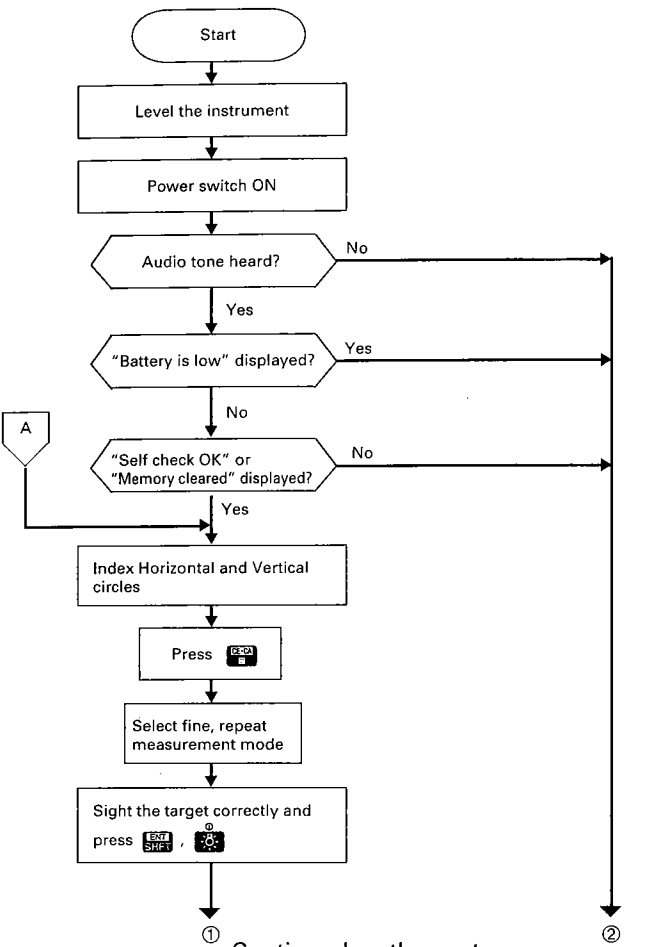
Note: Over-tightening the adjusting screws may mean that the reticle will go out of adjustment.

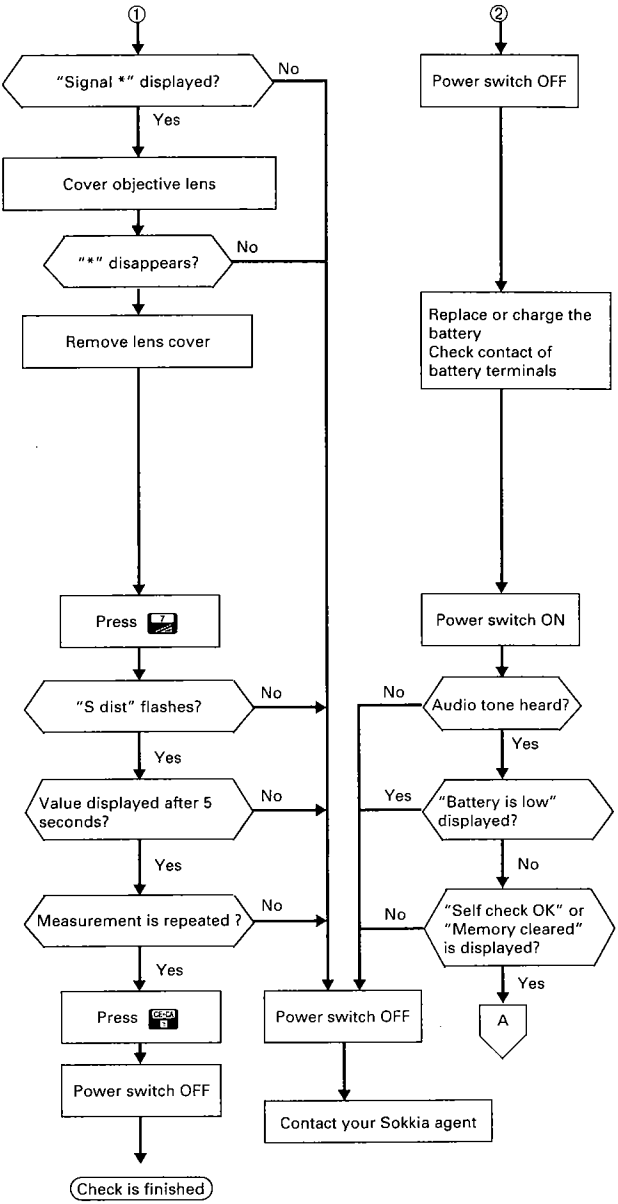
6) Check the adjustment by rotating the upper part of the instrument. The survey point should remain centred in the reticle. If necessary, repeat the adjustment.

7) Reattach the optical plummet focussing ring.

22.6 Distance measurement check flow chart

- If error codes EXXX are displayed, please contact your Sokkia agent.




①
"Signal *" displayed?
No
Yes
Cover objective lens
"*" disappears?
No
Remove lens cover
Press
"S dist" flashes?
No
Yes
Value displayed after 5 seconds?
No
Yes
Measurement is repeated ?
No
Yes
Press
Power switch OFF
Check is finished
②
Power switch OFF
Replace or charge the battery
Check contact of battery terminals
Power switch ON
No
Audio tone heard?
Yes
Yes
"Battery is low" displayed?
No
No
"Self check OK" or "Memory cleared" is displayed?
Yes
A
Power switch OFF
Contact your Sokkia agent

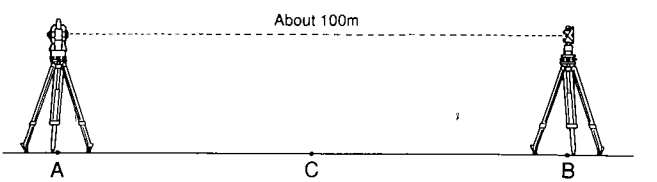
22.7 Additive distance constant

- The additive distance constant K of the SET B is adjusted to 0 before delivery. However, it may change over time and so should be determined periodically and then used to correct distances measured.

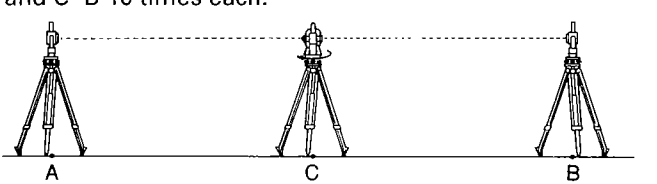
Check

1) Select points A and B on flat ground about 100 m (328ft) apart, and C in the middle.

Note: Ensure that the target height is the same as the instrument height of the SET B objective lens centre. If the ground is not flat, use an automatic level to set the correct instrument heights of all points.



2) Set up the SET B at A, the target at B and measure (fine measurement) the distance A-B 10 times.
3) Shift the SET B to C, and measure (fine measurement) the distance C-A and C- B 10 times each.



4) Calculate the averages of $\overline{A\text{-}B}$, $\overline{C\text{-}A}$ and $\overline{C\text{-}B}$.
5) Compute the additive distance K using the formula:

$$K = \overline{A\text{-}B} - (\overline{C\text{-}A} + \overline{C\text{-}B})$$

Obtain the K value several times. If all K values are greater than ±3mm (SET4B:±5mm), please contact your Sokkia agent.

Note: Errors in setting up the instrument and sighting the target will affect the determination of the additive distance constant, therefore perform these procedures as carefully as possible.

MEASUREMENT OPTIONS SELECTION

23. CHANGING INSTRUMENT PARAMETERS

- The instrument parameter settings can be changed by key operations to match the required measurement.

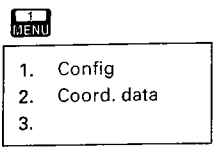
- The selected options are stored in the memory until they are changed.
  The factory set options are reset when the "Configuration default set" is initialized.

No.	Parameter			Options	
1	Coordinate data from			*1.	Keyboard
				2.	Memory
2	Recording	1. Set code		*1.	Input
				2.	Non-input
		2. Set target height		*1.	Input
				2.	Non-input
3	Tilt correction			*1.	Tilt correction applied
				2.	Correction not applied
4	Coordinate format			*1.	N, E, Z
				2.	E, N, Z
5	V angle format			*1.	Zenith
				2.	Horizontal 0° –360° (0 – 400gon)
				3.	Horizontal ±90° (±100gon)
6	Angle resolution		SET2B, SET3B	*1.	1" (0.2mgon)
				2.	5" (1mgon)
			SET4B	*1.	5" (1mgon)
				2.	10" (2mgon)
7	RS-232C format	1. Baud rate		*1.	1200 baud
				2.	2400 baud
		2. Checksum		*1.	No
				2.	Yes
		3. Parity bit		*1.	No
				2.	Yes (even)
8	V indexing			*1.	Auto
				2.	Manual
9	H indexing			*1.	Auto
				2.	Manual

No.	Parameter		Option		
10	C + R correction		*1.	No	
			2.	Yes K=0.142	
			3.	Yes K=0.20	
11	Units	1. Distance	*1.	metre	
			2.	Feet	
		2. Angle	*1.	Degree	
			2.	Gon	
		3. Temperature & pressure	*1.	°C & hPa	
			2.	°C & mmHg	
			3.	Next	1. °F & hPa
					2. °F & mmHg
					3. °F & inchHg
12	Auto power off		*1.	30 minutes timeout	
			2.	Power On/Off with switch	
13	Backlight control		*1.	On/Off by key operation	
			2.	30 seconds timeout	
14	Audio for return signal		*1.	Audio tone	
			2.	No audio tone	
15	Reticle illumination		*1.	Strong reticle illumination	
			2.	Weak reticle illumination	
16	Configuration default set		Initialize : Yes / No		

*Parameter options set at the time the instrument left the factory.

From Theodolite mode or Basic mode to Menu mode

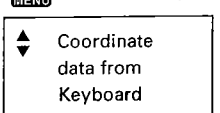


- In Theodolite mode or Basic mode, press [1 MENU]. The display turns to Menu mode.

To Parameter setting mode

[1 MENU] : Select configuration setting

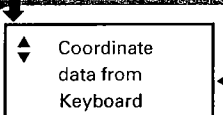
- Press [1 MENU]. The first parameter "Coordinate data from" is displayed.



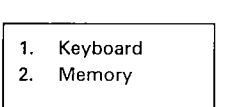
Change options: [ENT SHFT]
Next parameter: [· S–O]
Previous parameter: [+/– RCL]
To Menu mode: [CE·CA]

- Select option 1: [1 MENU]
- Select option 2: [2 PROG]
- Select option 3: [3]
- Retain the previous selection: [CE·CA]

No.1 Coordinate data from



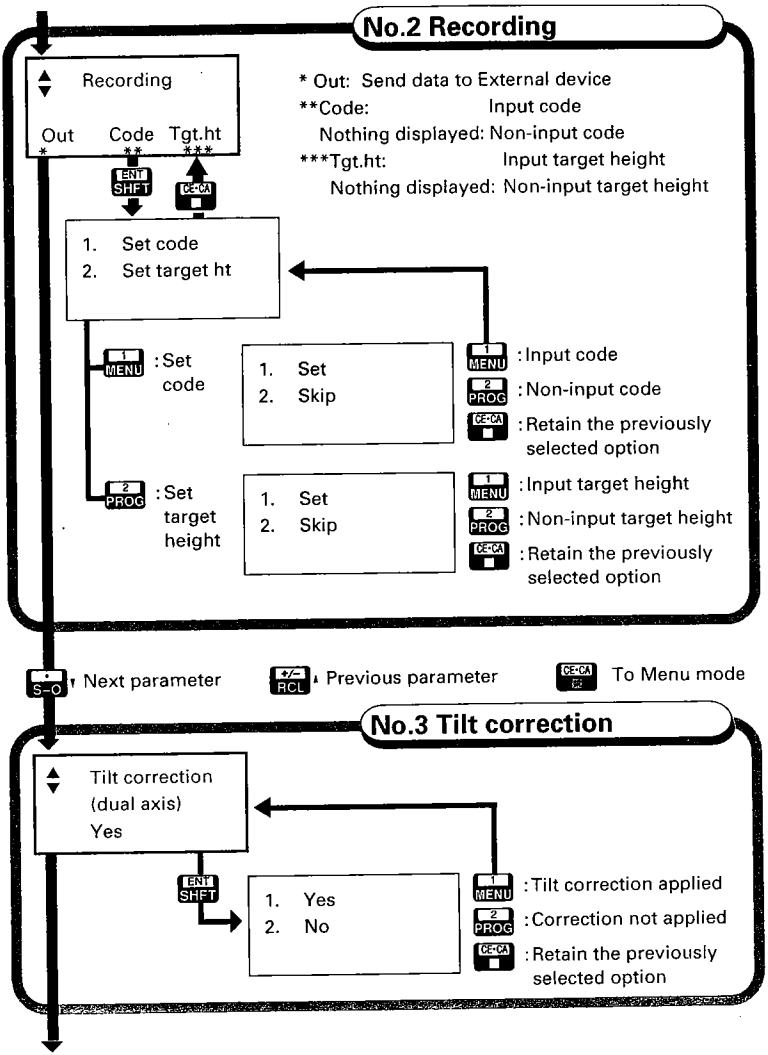
[ENT SHFT]



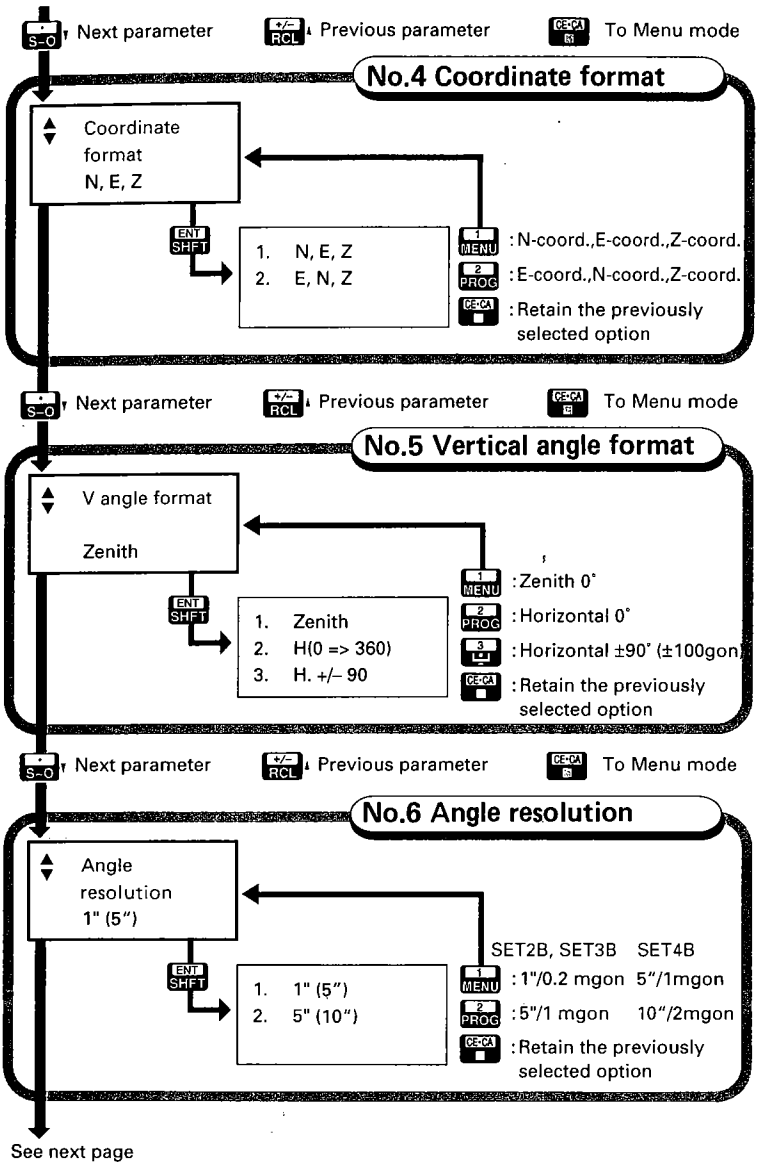
[1 MENU] : Enter from keyboard
[2 PROG] : Read from Memory
[CE·CA] : Retain the previously selected option

[· S–O] Next parameter [+/– RCL] Previous parameter [CE·CA] To Menu mode

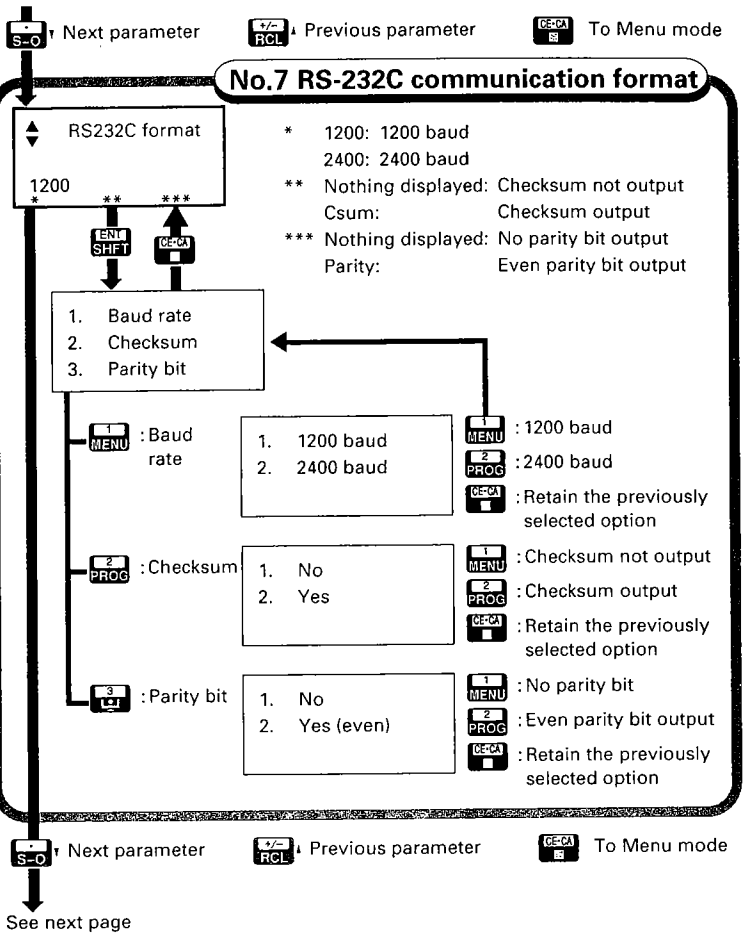
See next page



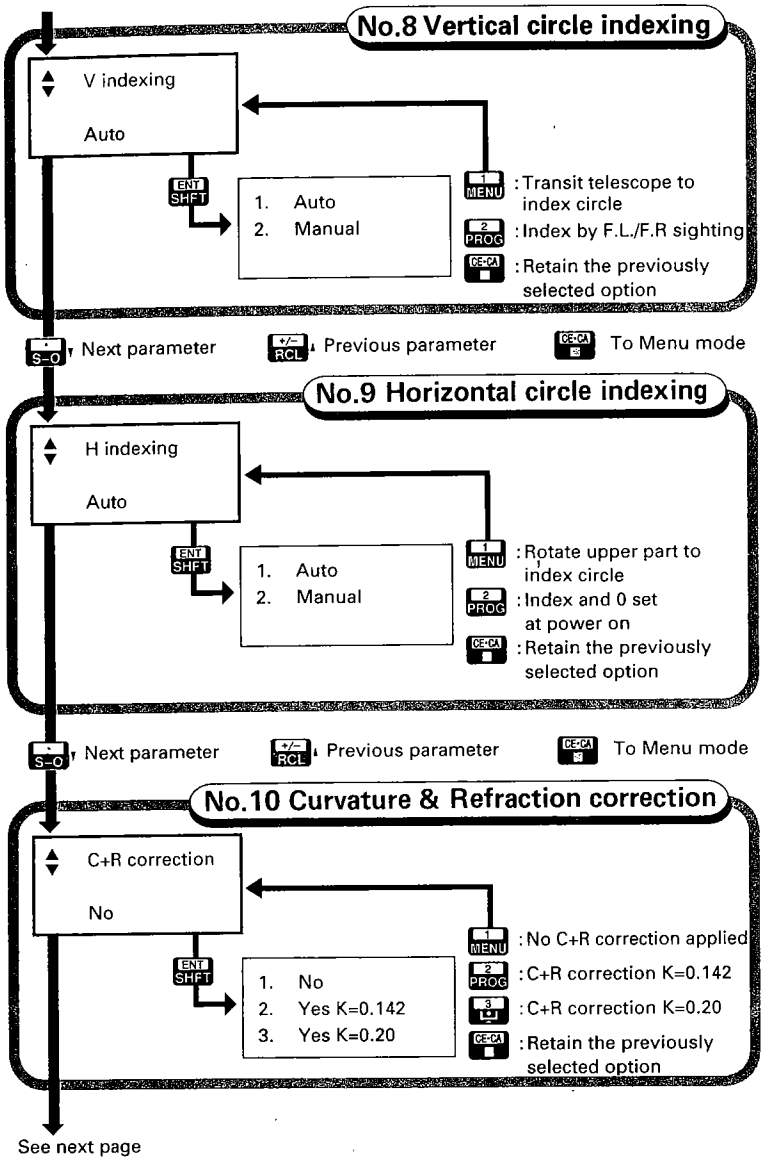
See next page



See next page



See next page



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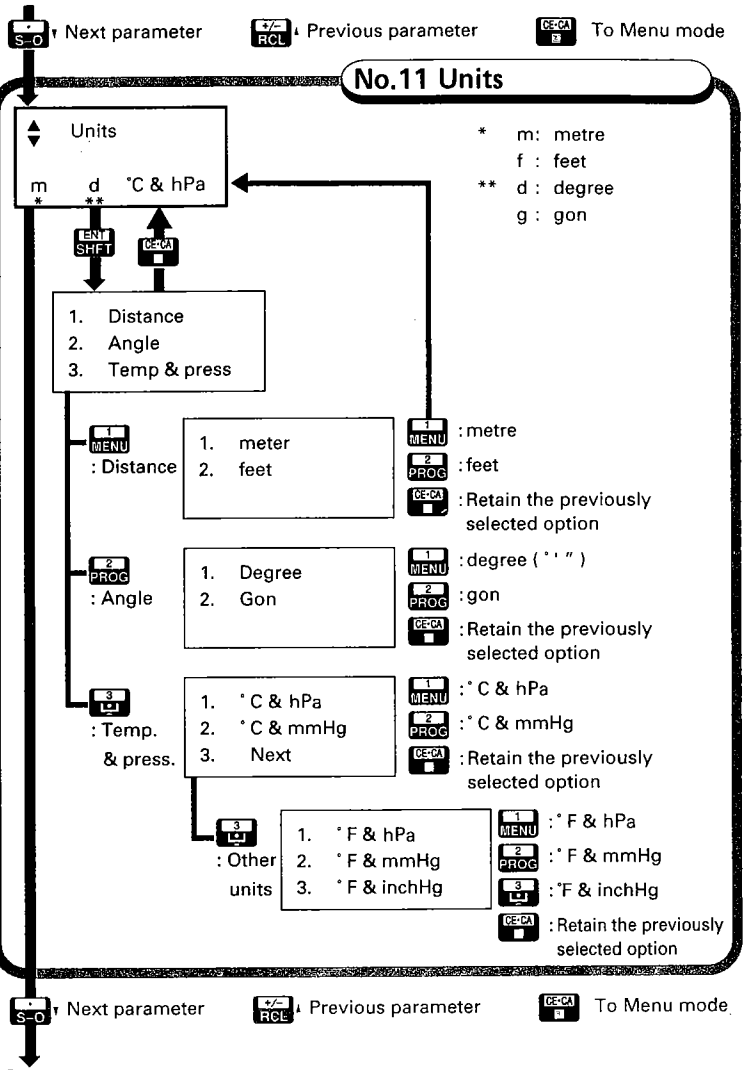

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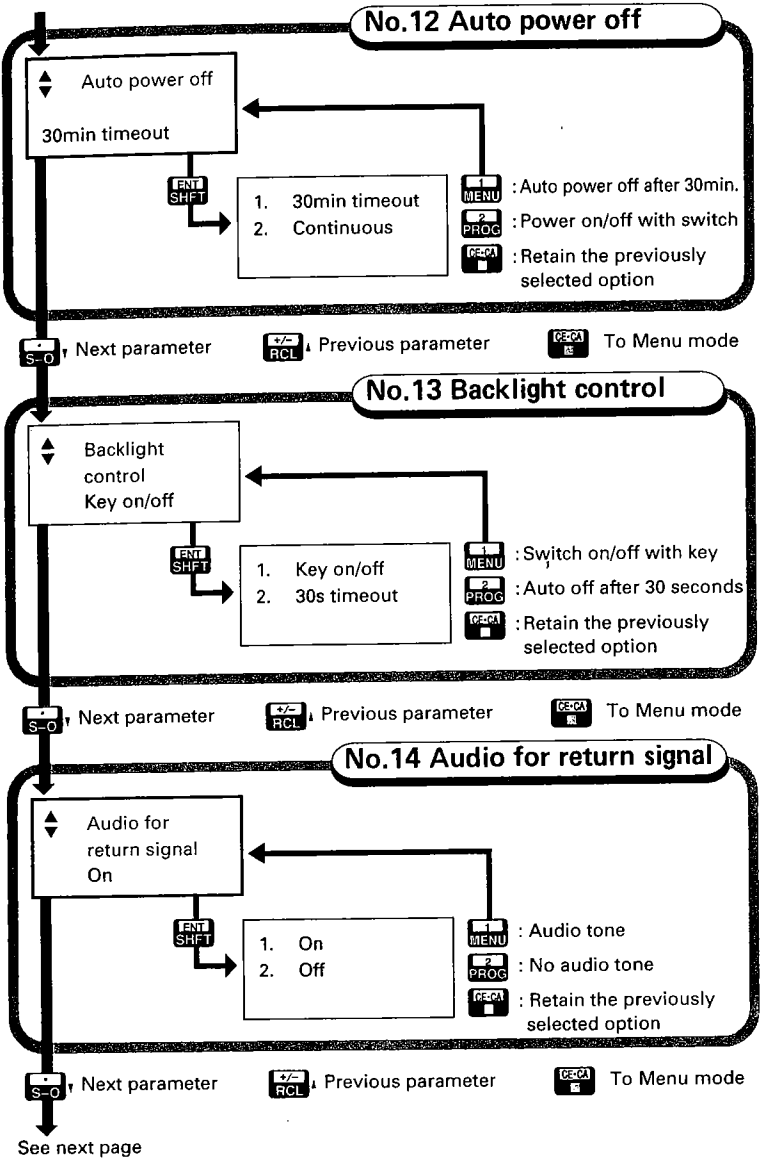

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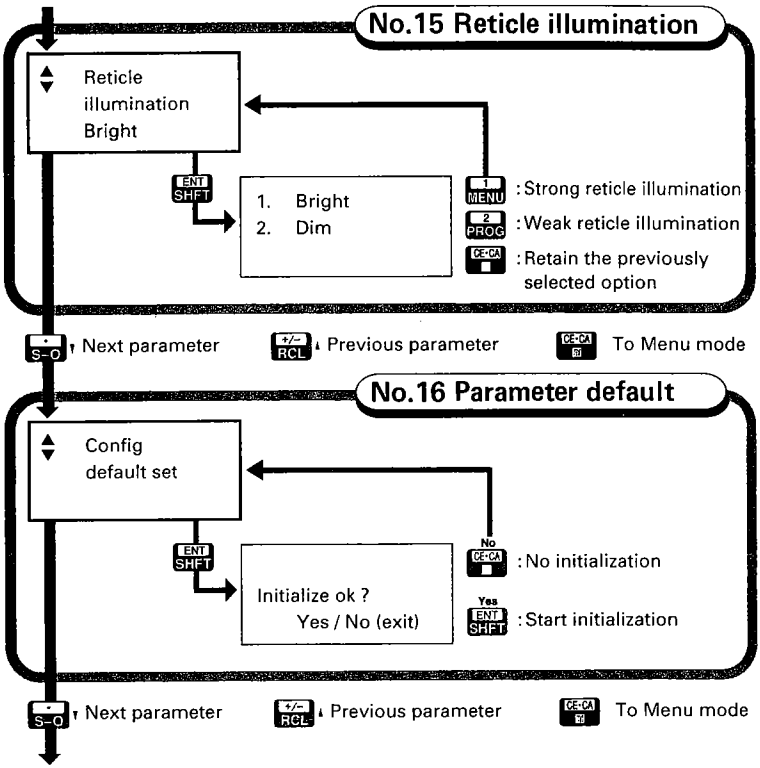
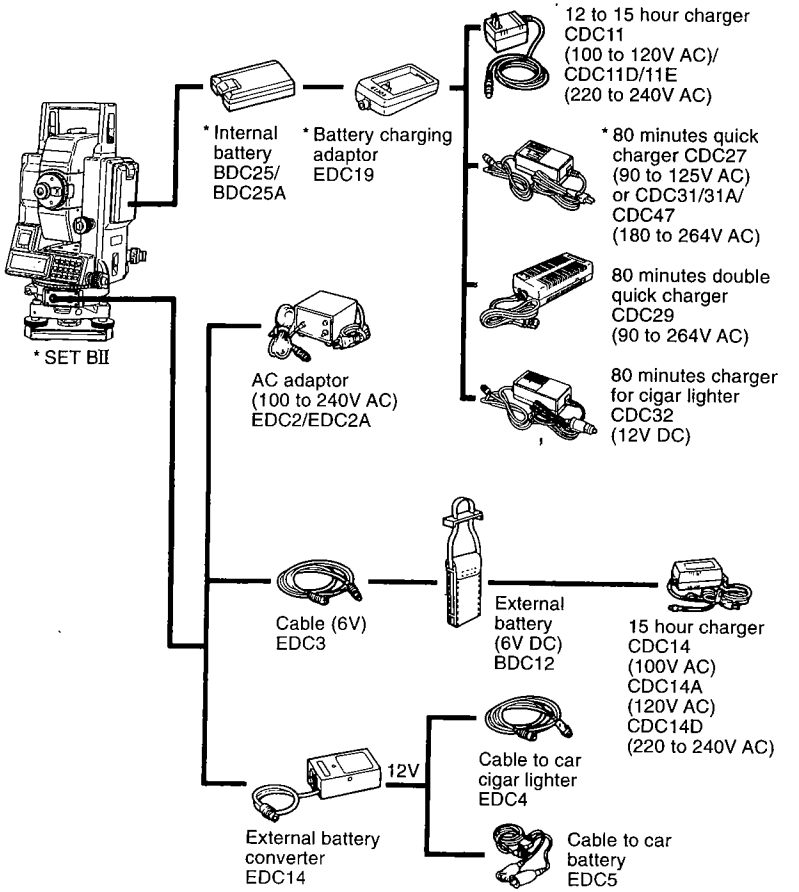


No.1 "Coordinate data from" parameter

24. POWER SUPPLIES

- The SET B can be operated with the following combinations.



* Standard equipment. Items not marked with * are optional accessories.

Note: When using any external power supply, it is recommended that the BDC25/25A battery be left in place to balance the weight on the axes.

Use the SET B only with the combinations shown here.

1) Battery BDC25/BDC25A

- Battery operating life is shortened at extreme temperatures because of its property of Ni-Cd battery.
- The battery can be recharged about 300 times under the ordinary use (Temperature = 20°C, Humidity = 65%).

Note:
- The storage temperature is between 0°C and 40°C.
- Do not use the battery for any other equipment or purpose.
- Remove the battery from SET B to avoid damaging the battery when not in use.

Specifications:

Output voltage: DC6V Capacity: 1200mAh
Size: 58 x 23 x 92mm Weight: 0.2kg

2) Battery charger CDC27/CDC31/CDC31A/CDC47

- The battery charger normally becomes warm while charging.
- How to charge: Connect the charger to the power supply, connect the adaptor to the battery charger and mount the battery in the adaptor. Then;
  - the charging light flashes during charging and it becomes lighting on when the charging is finished. (CDC27/CDC31/CDC47)
  - the charging lamp lights on during charging and it flashes when the charging is finished. (CDC31A)

Note:
- The charging temperature is between 10°C and 40°C.

Specifications:

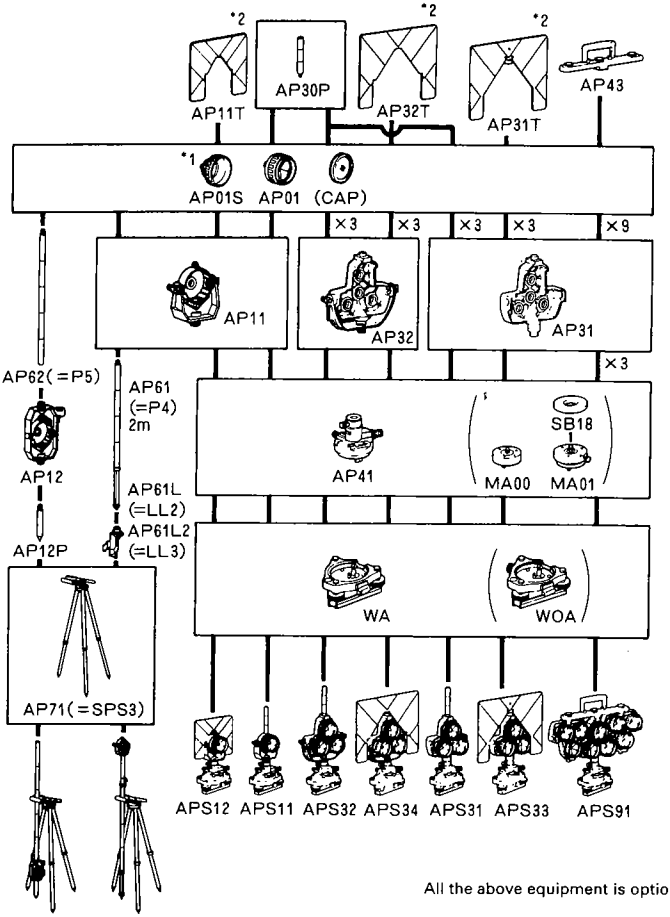
Input: CDC27: AC90V ~ AC125V, 50/60Hz, 20VA
CDC31/CDC31A/CDC47: AC180V ~ AC264V, 50/60Hz, 20VA
Output: DC7.5V, 1.2A
Charging time at 25°C: about 80minutes (BDC25/25A)
Size: 66 x 124 x 45mm
Weight: CDC27: 0.35kg CDC31/CDC31A/CDC47: 0.38kg

3) Precautions for the use of external power supplies

- Ensure that the car cigarette lighter has DC12V output and that the negative terminal is grounded. Leave the engine running during the car cigarette lighter using.
- Before using EDC2/2A, set the voltage selector to the correct voltage.
- EDC14 has a breaker switch. When you short circuit the battery or the polarity is not correct, the breaker will switch off the power. When the breaker switches off the power, remove the rubber cover and set the breaker switch to see the red mark in place.

25 REFLECTING PRISMS AND ACCESSORIES

- All Sokkia reflecting prisms and accessories have standardized screws (5/8" x 11 thread) for ease of use.



All the above equipment is optional.

*1: To change the stored prism constant value, see page 45.

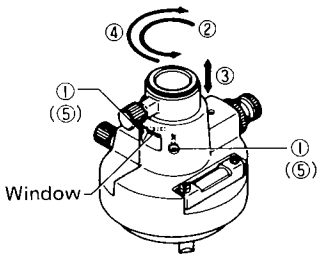
*2: Fluorescent target paint finishing allows clearer sighting in adverse observing conditions.

1) Precautions for use of reflecting prisms

- Carefully face the reflecting prism towards the instrument; sight the prism target centre accurately.
- To use the triple prism assembly AP31 or AP32 as a single prism (e.g. for short distances), mount the single prism AP01 in the centre hole of the prism holder.

2) Precautions for use of the instrument height adapter AP41

- Check the Plate level of the AP41 as described in Section 22.1. Check that the optical plummet of the AP41 sights the same point as that of the SET B.
- Check that 236 (the height of the SET B in mm) is displayed in the window of the instrument height adapter AP41. The height of the AP41 can be adjusted as follows:



① Loosen the 2 fixing screws.
② Turn the centre part counter-clockwise to unlock it.
③ Move it up or down until "236" appears in the window.
④ Turn the centre part clockwise to lock it.
⑤ Tighten the fixing screws.

3) Precautions for use of tribrach

- Use the plate level on the AP41 to adjust the tribrach circular level as described in Section 22.2.

APPENDICES

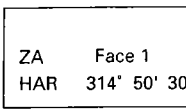
Appendix 1: MANUALLY INDEXING THE VERTICAL CIRCLE

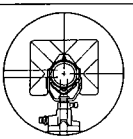
- Like all theodolites, the SET B will have a small vertical index error. For angle measurement of the highest accuracy, the vertical index error can be removed as follows:

1) In parameter setting mode, select the "V indexing" parameter and set to "2. Manual".

2) In Basic mode, press [3 L.I.] after step 1), or switch off and on again. "ZA Face 1" is displayed.

3) In face left (Face 1), accurately sight a clear target at a horizontal distance of about 30 m.



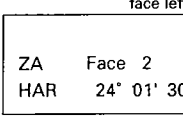


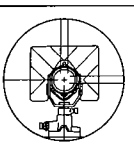
[ENT SHFT] , [0 SET 0 REC] : Index V circle in face left

Press [ENT SHFT] , [0 SET 0 REC] .

"ZA Face 2" is displayed.

4) Loosen the horizontal clamp ㉒ and rotate the upper part of the SET B through 180°. In face right (Face 2), accurately sight the same target.





[ENT SHFT] [0 SET 0 REC] : Index V circle in face right

Press [ENT SHFT] , [0 SET 0 REC] .

- The vertical circle has been indexed.

Note: If the power switch is turned off, the vertical circle should be indexed again.

Appendix 2: FOR ANGLE MEASUREMENT OF THE HIGHEST ACCURACY

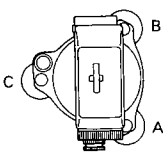
<Adjusting the tilt zero point error>

- The tilt zero point error can be adjusted by the following procedures.
  (The "Tilt correction" parameter should be set to "Yes".)

- The range of the tilt sensor is ±3'.

- Tilt offset data storage period: Until the next adjustment is made (Power-off possible)

1) Level the SET B with the plate level ㉖.
   Tighten the vertical clamp ㉘ with the telescope approximately horizontal.



2) Use the horizontal clamp ㉒ to turn the upper part of the SET B until the telescope is parallel to a line between levelling screws A and B.

ENT SHFT 0 SET 0 REC : Set H angle to zero

ZA	89° 12' 30"
HAR	0° 00' 00"

3) In Theodolite mode,
   press ENT SHFT , 0 SET 0 REC .
   The horizontal angle is set to 0°.

2 PROG : For Program mode

1.	Resection
2.	Correction
3.	Pt. replace

4) Press 2 PROG
   for Program mode.

[2 PROG] : For Correction mode

```
Select
1.  Collimation
2.  Tilt offset
```

5) Press [2 PROG] for Correction mode.

[2 PROG] : For Tilt offset mode

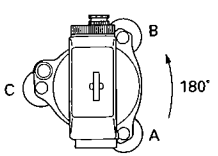
```
        Tilt angle
X        0° 00' 10"
Y       -0° 00' 10"
```

6) Press [2 PROG] for Tilt offset mode.
Minimum display unit
SET2B : 1"
SET3B : 1"
SET4B : 5"

[ENT SHFT] [0 SET 0 REC] : Memorize tilt angle

```
        Tilt angle
          Face 2
HAR      0° 00' 00"
```

7) Wait for a few seconds until the tilt angle reading is steady.
Then press [ENT SHFT] , [0 SET 0 REC] .
(X and Y tilt angles will be memorized.)



8) Turn the upper part of the SET B through 180°.

```
        Tilt angle
          Face 2
HAR     180° 00' 00"
```

[ENT SHFT] [0 SET 0 REC] : Memorize tilt angle and store the tilt offset data

```
1.  Resection
2.  Correction
3.  Pt. replace
```

9) Wait for a few seconds until the tilt angle reading is steady,
then press [ENT SHFT] , [0 SET 0 REC] .
The tilt zero point error has been adjusted and the display has returned to Program mode.

- Press [CE·DA] to go to Basic mode.
- If there is no response when the key is pressed, the range in which adjustment is possible has been exceeded. Please contact your Sokkia agent and request adjustment.

<Adjusting the collimation error by Collimation program>

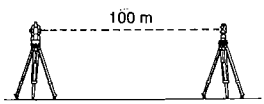
- The displayed angles are corrected automatically by the stored collimation errors.
  These collimation error values can be adjusted and stored by following the relevant procedures.
  The observation can be carried out up to 5 times, so if an accurate sighting can be made, increasing the number of times the observation is carried out will result in a more precise determination of the collimation error values.

Note: In Tracking measurement mode, the displayed horizontal angle is not corrected by the stored collimation error values.

- If angle measurements are to be made in only one position (e.g. Resection measurement), it is advisable to adjust the correction values accurately.

- Collimation error values storage period:
  Until next adjustment (Power-off possible)

Note: Sight the target **carefully** to determine the collimation error accurately.
Ensure that the target height is the same as the instrument height. If the ground is not flat, use an automatic level to set the correct instrument height of all points.



1) Set up a clear target at a horizontal distance of a bit longer than 100m from SET B.

2 PROG : For Program mode

1. Resection
2. Correction
3. Pt. replace

2) In Theodolite mode or Basic mode,
press 2 PROG
for Program mode.

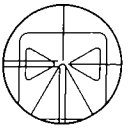
2 PROG : For Correction mode

Select
1. Collimation
2. Tilt offset

3) Press 2 PROG
for Correction mode.

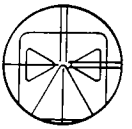
[1 MENU] : For Collimation mode

Pt. face 1
Yes / No (exit)
HAR 359° 59' 55"



[Yes ENT SHFT] : Memorize H & V angle in face left

Pt. face 2
Yes / No (exit)
HAR 359° 59' 55"



[Yes ENT SHFT] : Memorize H & V angle in face right

Observe end?
Yes / No (repeat)

[Yes ENT SHFT] : To end observation and calculate the collimation error value

Vcoll	0° 00' 15"
Hcoll	0° 00' 05"

New value set?
Yes / No (exit)

4) Press [1 MENU] for Collimation mode.

A display prompts for the vertical angle and horizontal angle for the telescope face 1 to be stored in the memory.

5) In face left (face 1), sight the target correctly and press [Yes ENT SHFT] .

A display prompts for the vertical angle and horizontal angle for the telescope face 2 to be stored in the memory.

6) In face right (face 2), sight the same target correctly, and press [Yes ENT SHFT] .

The display asks whether the observation is ended or not. (Observation can be carried out up to 5 times.)

7) To end the observation process, press [Yes ENT SHFT] .

The collimation error value is calculated and displayed.

Following that, the display asks whether a new collimation error value is to be set.

No CE·CA : To continue the observation

```
Pt.    face    1-2
Yes/No (exit)
HAR 179° 59' 55"
```

Yes ENT SHFT : Set the new collimation error

```
1. Resection
2. Correction
3. Pt. replace
```

```
Vcoll    *0° 00' 15"
Hcoll    *0° 00' 05"
```

```
Re-observe ?
Yes / No (exit)
```

Yes ENT SHFT : Re-observe

```
Pt.          face 1
    Yes / No (exit)
HAR   179° 59' 55"
```

or

No CE·CA : End

```
1. Resection
2. Correction
3. Pt. replace
```

- To continue the observation, press No CE·CA .

  Repeat the procedures from step 5).

8) To set a new collimation error value, press Yes ENT SHFT .
   The collimation error has been adjusted and the display has returned to Program mode.

- Press CE·CA to go to Basic mode.

- If the range in which adjustment is possible has been exceeded, an asterisk (*) is displayed, and a confirmation message is displayed, the display asks whether you begin observation once again, from the beginning.

  To redo the observation, press Yes ENT SHFT . The procedure reverts to Step 5).

  To end the observation process, press No CE·CA . The display returns to Program mode.

  If an asterisk is still displayed after repeated attempts at observation, the allowable adjustment range has been exceeded. Please contact your Sokkia agent and request adjustment.

Appendix 3: FOR DISTANCE MEASUREMENT OF THE HIGHEST ACCURACY

1) Atmospheric correction

- The SET B uses a beam of infrared light to measure the distance. The velocity of this light in the atmosphere varies according to the temperature and pressure.
  The distance will be changed by 1 ppm by:
  – a variation in temperature of 1°C
  – a variation in pressure of 3.6 hPa
  (A 1 ppm change means a 1mm difference for every 1km of measured distance).
  To obtain distance measurement, of the highest accuracy, the temperature and pressure must be carefully measured by accurate equipment.

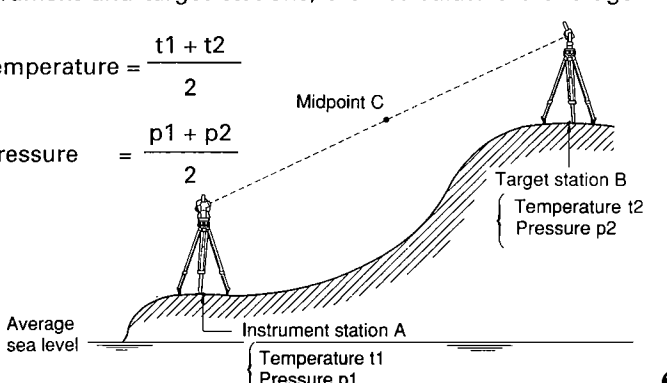
- The ppm correction should be applied when the calculated ppm value is over ±5ppm or if the slope distance is more than 200m.

2) Average temperature and pressure between 2 points in different atmospheric conditions:

- In flat terrain: measure the temperature and pressure at the midpoint of the line as there is little variation in the values.
- In mountainous terrain: midpoint values should be used. If those values cannot be measured, take the temperature and pressure at the instrument and target stations, then calculate the average values.

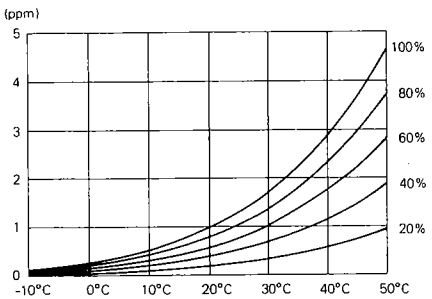
$$\text{Average temperature} = \frac{t1 + t2}{2}$$

$$\text{Average pressure} = \frac{p1 + p2}{2}$$



3) Influence of relative humidity

- The influence of humidity is very small.
  It is mainly of importance in very hot and humid conditions.
  The graph below is for atmospheric pressure of 1013hPa.



(1013hPa)

$$\text{Correction factor (ppm)} = \frac{0.045 \times e\ (\text{hPa})}{1 + 0.003661 \times t\ (^{\circ}\text{C})}$$

e: Partial water vapour pressure
t: Temperature

- If you take the influence of relative humidity into account, please set the Correction factor (ppm) by the following method.

① Input the temperature and pressure values. The correction factor A is calculated and displayed on the sub display.
② Measure the relative humidity and read the correction factor B from above table.
For pressure between 500hPa and 1400hPa, if instead of the formula, the graph above is used to look up the correction factor, a difference of less than 0.1ppm will be present.
③ Calculate A plus B. (C)
④ Input C in ppm mode.
(Refer to P.48"13.3 Atmospheric correction")
⑤ Measure the distance. The displayed distance is corrected by the correction factor C.

e.g. Temperature: 30°C, Pressure: 1020hPa
Relative humidity: 80%
Measured distance corrected by only the correction factor A: 3000m
A=12 (sub display), B=1.4 (above table)

$$D = \frac{1 + (12\ \text{ppm} + 1.4\text{ppm}) \times 10^{-6}}{1 + 12\ \text{ppm} \times 10^{-6}} \times 3{,}000\text{m}$$

$$= 3{,}000.0042\ \text{m}$$

Appendix 4: EARTH-CURVATURE AND REFRACTION CORRECTION

- When measuring the Horizontal distance and Height difference, the earth-curvature and refraction correction can be selected by the parameter "C & R correction". The Atmospheric refraction constant K can be set to either 0.142 or 0.20.

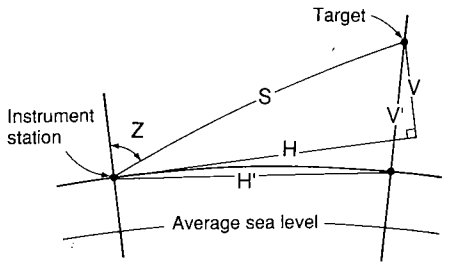
<No correction>

Horizontal distance: $H = S \times \sin Z$
Height difference: $V = S \times \cos Z$

<Applied correction>

Horizontal distance: $H' = S \times \sin Z - \frac{1 - \frac{K}{2}}{R} \times S^2 \times \sin Z \times \cos Z$

Height difference: $V' = S \times \cos Z + \frac{1 - K}{2R} \times S^2 \times \sin^2 Z$



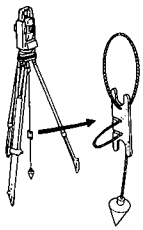
S: Slope distance (atmospheric corrected value)
Z: Vertical angle (0° at zenith)
K: Atmospheric refraction constant
R: Radius of the earth (6.372×10^6 m)

e.g. Correction value at Z=70° (K=0.142)

S (m)	500	1000	1500
H'–H (m)	– 0.012	– 0.047	– 0.105
V'–V (m)	0.015	0.059	0.134

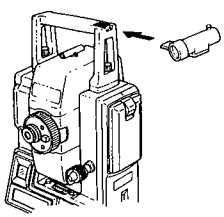
Note: The horizontal distance is the distance measured at the height of the surveying point above sea level. If required, reduce this distance to the average sea level and apply the local projection correction.

Appendix 5: STANDARD ACCESSORIES



1) Plumb bob

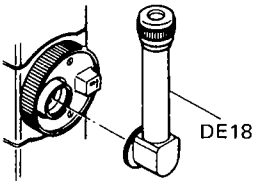
If the weather is calm, or for initial tripod centring, the plumb bob can be used for centring. To use, unwind the plumb bob and attach it to the hook inside the centring screw. Use the cord grip piece to adjust the cord length.



2) Tubular compass CP7

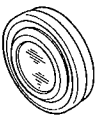
To mount the CP7,slide it into the tubular compass slot ⓱. To use,loosen the clamping screw to free the compass needle. Turn the instrument in the face left position until the compass needle bisects the index lines. The telescope will be nearly aligned with magnetic north. After use,tighten the clamp and remove the compass from the slot. Replace it in the specified position in the carrying case.

Note: Magnetism and metal will influence the tubular compass,making it incapable of projecting true magnetic north. Do not use the magnetic north indicated by this compass for base line surveying.



1) Diagonal eyepiece DE18

The diagonal eyepiece is convenient for near-vertical observations and in places where space around the instrument is limited. Remove the handle and the telescope eyepiece by unscrewing the mounting ring, and screw in the diagonal eyepiece.

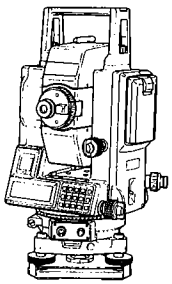

OF2/OF1


OF2A/OF1A

2) Solar filter OF2/OF2A, OF1/OF1A

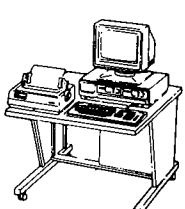
For observations made facing the sun, and where glare is present. The OF2/OF1 and OF2A/OF1A (flip-up) filters are mounted on the objective lens.

OF2, OF2A:for SET2B, SET3B
OF1, OF1A:for SET4B



SET BII

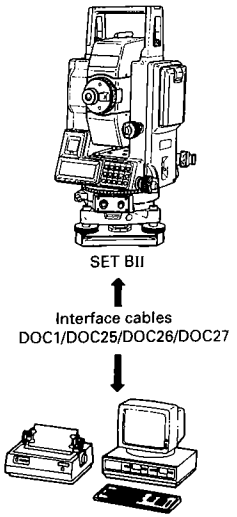
SDR series



Host computer

3) Electronic field book SDR series

The SDR series collects and stores slope distance, zenith and horizontal angle data from the SET B.
Calculations can be performed on the data so that the measurements can be verified in the field. The stored data can be transmitted to a data processing system.



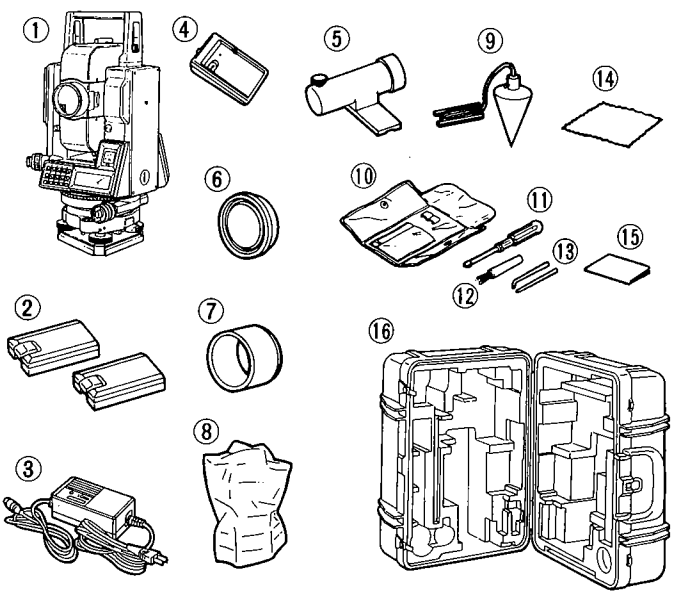
4) Interface cables DOC1, DOC25/DOC26/DOC27

The interface cable DOC1 can be used for direct two-way communication between the SET B and a host computer.
This cable is not provided with a connector on the computer end of the cable.
Also available are:

DOC25: NEC connector
DOC26: IBM connector
DOC27: Toshiba J3100

STANDARD EQUIPMENT

- Please verify that all equipment is included.



① SET B main unit	1
② Internal battery, BDC25/25A	2
③ Battery charger, CDC27/31/31A/47	1
④ Battery charging adaptor, EDC19	1
⑤ Tubular compass, CP7	1
⑥ Lens cap	1
⑦ Lens hood	1
⑧ Vinyl cover	1
⑨ Plumb bob	1
⑩ Tool pouch	1
⑪ Screwdriver	1
⑫ Lens brush	1
⑬ Adjusting pin	2
⑭ Cleaning cloth	1
⑮ Operator's manual	1
2-way communication manual	1
Field guide	1
Atmospheric correction chart	1
⑯ Carrying case	1

MAINTENANCE

1) Wipe off moisture completely if the instrument gets wet during survey work.

2) Always clean the instrument before returning it to the case.

   The lens requires special care. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it with a soft clean cloth or lens tissue.

3) Do not wipe the displays ❹ , ❺ and keyboard ⓯ or carrying case with an organic solvent.

4) Store the SET B in a dry room where the temperature remains fairly constant.

5) If the battery is discharged excessively, its life may be shortened. Store it in a charged state.

6) Check the tripod for loose fit and loose screws.

7) If any trouble is found on the rotatable portion, screws (⓬ , ⓲ , ⓴ , ㉒ , ㉓ , ㉘ , ㉙) or optical parts (e.g. lens), contact your Sokkia agent.

8) When the instrument is not used for a long time, check it at least once every 3 months.

9) When removing the SET B from the carrying case, never pull it out by force. The empty carrying case should then be closed to protect it from moisture.

10) Check the SET B for proper adjustment periodically to maintain the instrument accuracy.

Telescope

Length:	SET2B:177mm
	SET3B:177mm
	SET4B:170mm
Aperture:	45mm
Magnification:	30X
Resolving power:	3"
Image:	Erect
Field of view:	1°30' (26m/1000m)
Minimum focus:	1.3m (4.3 ft)
Reticle illumination:	Bright or dim settings
	(Selectable with parameter)

Angle measurement

Horizontal and Vertical circles type :	Incremental with 0 index
Display range:	SET2B:–1999° 59' 59" to 1999° 59' 59"
	(–1999.9998gon to 1999.9998gon)
	SET3B:–1999° 59' 59" to 1999° 59' 59"
	(–1999.9998gon to 1999.9998gon)
	SET4B:–1999° 59' 55" to 1999° 59' 55"
	(–1999.999gon to 1999.999gon)
Minimum display:	SET2B:1" (0.2mgon)/5" (1mgon)
	SET3B:1" (0.2mgon)/5" (1mgon)
	SET4B:5" (1mgon)/10" (2mgon)
	(Selectable with parameter)
Angle units:	Degree/Gon
	(Selectable with parameter)
Accuracy:	Standard deviation of mean of measurement taken in positions I and II (DIN18723)
	SET2B:2" (0.6mgon)
	SET3B:3" (1mgon)
	SET4B:5"(1.5mgon)
Measuring time:	Less than 0.5sec

Automatic compensator:	Selectable ON/OFF with parameter
Type:	Liquid, 2-axis tilt sensor
Minimum display:	SET2B:1" (0.2mgon)
	SET3B:1" (0.2mgon)
	SET4B:5" (1mgon)
Range of compensation:	±3'
Measuring mode:	
Horizontal angle:	Right/Left/Repetition/Hold
	(Selectable with keyboard)
Vertical angle:	Zenith 0° (0gon)/Horizontal 0° (0gon)/ Horizontal 0°±90° (0gon ±100gon) (Selectable with parameter)

Distance measurement

Measuring range:		(Slight haze, visibility about 20km, sunny periods, weak scintillation)
	SET2B:	Compact prism CP01:1.3m to 800m (2600ft)
		Standard prism APx1:1.3m to 2400m (7800ft)
		Standard prism APx3:1.3m to 3100m (10100ft)
		Standard prism APx9:1.3m to 3700m (12100ft)
	SET3B:	Compact prism CP01:1.3m to 700m (2200ft)
		Standard prism APx1:1.3m to 2200m (7200ft)
		Standard prism APx3:1.3m to 2900m (9500ft)
		Standard prism APx9:1.3m to 3500m(11400ft)
	SET4B:	Compact prism CP01:1.3m to 600m(1900ft)
		Standard prism APx1:1.3m to 1200m(3900ft)
		Standard prism APx3:1.3m to 1700m(5500ft)
		Standard prism APx9:1.3m to 2200m(7200ft)
Accuracy:		
Fine measurement:		SET2B: ±(3+2ppm×D)mm (unit:mm)
		SET3B: ±(3+3ppm×D)mm (unit:mm)
		SET4B: ±(5+3ppm×D)mm (unit:mm)
Coarse measurement:		±(5+5ppm×D)mm (unit:mm)
Minimum display:		
Fine measurement:		1mm (0.01 ft)
Coarse measurement:		1mm (0.01 ft)
Tracking measurement:		10mm (0.1 ft)
Maximum slope distance:		9999.999m (32808.33 ft)
Distance unit:		metres/feet
		(Selectable with parameter)
		(Changeable for 5 seconds with keyboard)

Measuring time: (When "C+R correction" is not being applied.)

	Fine meas.	Coarse meas.	Tracking meas.
Slope distance	4.7 + every 3.2s	1.7 + every 0.7s	1.6 + every 0.3s
Horizontal distance Height difference	4.7 + every 3.3s	1.9 + every 0.7s	1.8 + every 0.3s
Coordinates	5.1+ every 3.3s	2.4 + every 0.7s	2.2 + every 0.7s
REM	0.7s + every 0.5s		
Horizontal distance between two points	5.6 + every 3.3s	2.9 + every 0.7s	2.8 + every 0.7s

Atmospheric correction:

Temperature input range:	–30°C to 60°C (in 1°C steps)/ –22°F to 140°F (in 1°F steps) (Selectable with parameter)
Pressure input range:	500hPa to 1400hPa (in 1hPa steps) 375mmHg to 1050mmHg (in 1mmHg steps) 14.8inchHg to 41.3inchHg (in 0.1inchHg steps) (Selectable with parameter)
ppm input range:	–499 to 499ppm (in 1ppm steps)
Prism constant correction:	–99mm to 99mm (in 1mm steps)
Earth–curvature and refraction correction:	ON (K=0.142/K=0.20)/OFF (Selectable with parameter)
Audio target acquisition:	ON/OFF (Selectable with parameter)
Signal source:	Infrared LED
Light intensity control:	Automatic

Power supply

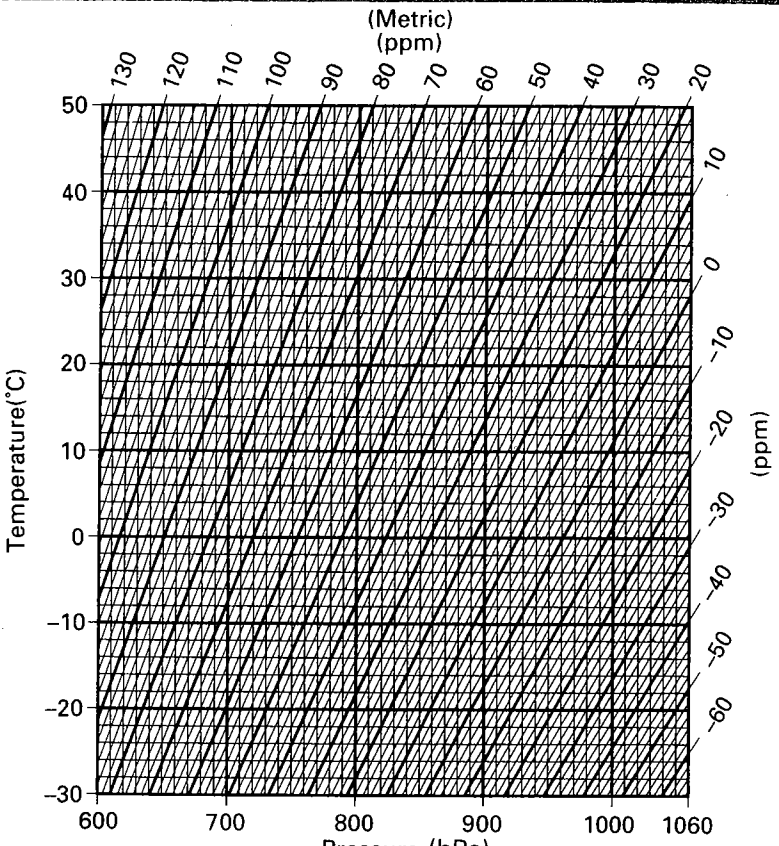
Power source:	Ni-Cd rechargeable battery, BDC25/25A (6V)
Working duration at 25°C (77°F):	Distance & Angle measurement: 2.5 hours (2500 to 2600 points) (Coarse and Single measurement, Measurement interval=every 4 secs) Angle measurement only: 9.5 hours Using optional battery BDC12 Angle and distance: 15 hours

Charging time:	
CDC11/11D/11E:	15 hours
CDC27/31/31A/47:	80 minutes

General

Display:	2LCD dot matrix displays on each face
	Main display: 16 characters x 3 lines
	Sub display: 4 characters x 3 lines
Sensitivity of levels:	
Plate level:	SET2B:20" /2mm
	SET3B:30" /2mm
	SET4B:30" /2mm
Circular level:	10'/2mm
Optical plummet:	
Image:	Erect
Magnification:	3x
Minimum focus:	0.1m (0.3ft)
Self-diagnostic function:	Provided
Power saving cut off:	30minutes after operation/
	ON/OFF with switch
	(Selectable with parameter)
Operating temperature:	–20°C to 50°C (–4°F to 122°F)
Data recording:	100 coordinate data can be stored in an internal memory
Data input/output:	Asynchronous serial, RS–232C compatible
Size:	236mm (9.3inch) from tribrach bottom,
	193mm (7.6inch) from tribrach dish
	SET2B:168(W)X177(D)X371(H)mm
	SET3B:168(W)X177(D)X371(H)mm
	SET4B:168(W)X170(D)X371(H)mm
	(Without handle: H:330mm)
Weight:	SET2B:7.0Kg
	SET3B:7.0Kg
	SET4B:7.0Kg
	(with internal battery)

ATMOSPHERIC CORRECTION CHART



- This chart shows the correction every 2 ppm, while the atmospheric correction can be input to the SET B for every ppm.

To convert a pressure in mmHg to one in hPa, divide by 0.75
To convert a pressure in inchHg to one in hPa, multiply by 33.87.
hPa = mmHg ÷ 0.75 = 33.87 x inchHg

To convert a temperature in°F to one in°C,
compute using the following formula:
°C = 0.56 x (°F – 32)

Radio Frequency Interference

WARNING: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Notice for Canada

This Class A digital apparatus meets all requirements of Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Class A respecte toutes les exigences du Réglement sur le matériel brouilleur du Canada.

CE Conformity Declaration

CE Conformity Declaration
in accordance with EMC Directive 89/336/EEC of the European Community

We herewith declare that the undermentioned instrument, in view of its design and type of construction, fully complies with the relevant basic radio interference requirements of the EMC Directive.
Should the instrument be modified without agreement, this declaration becomes invalid.

Instrument Description: Total Station (Surveying Instrument)

Model Name : SET2B, SET3B, SET4B, SET2C, SET3C, SET4C, SET-XL

Relevant EC Directive: EMC Directive (89/336/EEC)
Version: 91/263/EEC, 92/31/EEC, 93/68/EEC

Applied
Harmonized Standard: EN50081-1 1992 , and EN50082-2 1995

Date: Dec. 95
Firm: SOKKIA B.V.
Address: Industrieterrein De Vaart, Damsluisweg 1, NL-1332 EA Almere

Representative's Signature:

Name of Representative : Stephen Blaikie
Representative's position : European vice President

CE Conformity Declaration

in accordance with EMC Directive 89/336/EEC of the European Community

We herewith declare that the undermentioned instrument, in view of its design and type of construction, fully complies with the relevant basic radio interference requirements of the EMC Directive.
Should the instrument be modified without agreement, this declaration becomes invalid.

Instrument Description: Power Supply (Battery Charger)

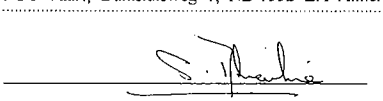
Model Name : CDC31

Relevant EC Directive: EMC Directive (89/336/EEC)
Version: 91/263/EEC, 92/31/EEC, 93/68/EEC

Applied
Harmonized Standard: EN50081-1 1992 , and EN50082-2 1995

Date: Dec. 95
Firm: SOKKIA B.V.
Address: Industrieterrein De Vaart, Damsluisweg 1, NL-1332 EA Almere

Representative's Signature:



Name of Representative : Stephen Blaikie
Representative's position : European vice President

MEMO