SURVEYING INSTRUMENTS

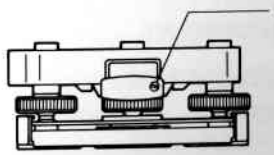
SOKKIA

SET2B II

Electronic Total Station

OPERATOR'S MANUAL

CONTENTS

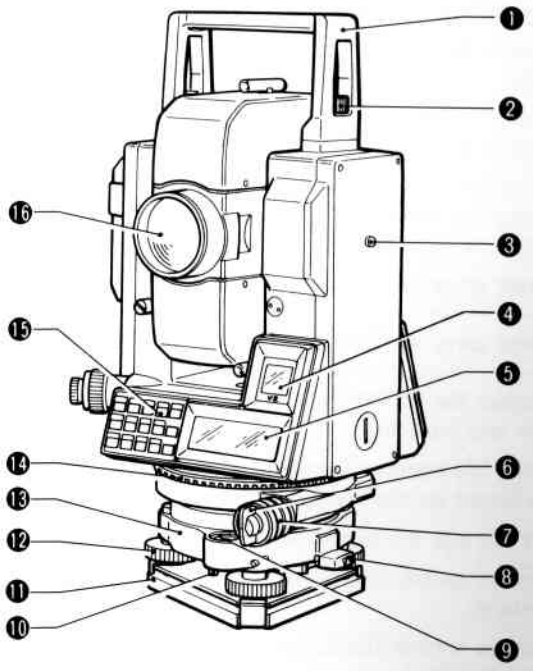


IMPORTANT
When the new SET2B is shipped, the tribrach clamp is fixed with a screw. Loosen it and leave it loose.

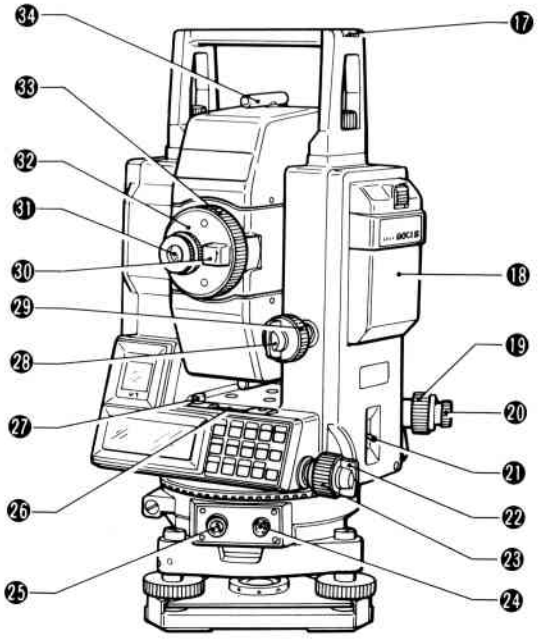
1. PRECAUTIONS

1) When the SET2B is not used for a long time, check it at least once every three months.
2) Handle the SET2B with care. Avoid heavy shocks or vibration.
3) If any trouble is found on the rotatable portion, screws or optical parts (e.g. lens), contact our agent.
4) When removing the SET2B from the carrying case, never pull it out by force. The empty carrying case should then be closed to exclude dust.
5) Never place the SET2B directly on the ground.
6) Never carry the SET2B on the tripod to another site.
7) Protect the SET2B with an umbrella against direct sunlight, rain and humidity.
8) When the operator leaves the SET2B, the vinyl cover should be placed on the instrument.
9) Do not aim the telescope at the sun.
10) Always switch the power off before removing the internal battery.
11) Always remove the battery from the SET2B when returning it to the case.
12) Do not wipe the display ❺, keyboard ⓯ or the carrying case with an organic solvent.
13) When the SET2B is placed in the carrying case, follow the layout plan.
14) Make sure that the SET2B 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



⓱ Tubular compass slot
⓲ Battery BDC18
⓳ Optical plummet focussing ring
⓴ 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

Note: Fine motion screws.
The horizontal and vertical fine motion screws have 2-speed (coarse and fine) motions. The motion is coarse when the screws feel heavy to rotate. The opposite turning direction gives a moveable fine motion "window".

3. FEATURES

- Distance and angle measurements are electronically measured and displayed on a main display located on both faces of the instrument. These 3-line, 48-character alphanumeric dot-matrix displays can simultaneously show measured or stored angle and distance data or N- and E-coordinates and height, or display prompts and messages. The 3-line, 12-character sub-display on each face of the instrument shows the atmospheric correction, prism constant value and instrument mode.

- Advanced software functions include the calculation of 3-dimensional coordinates, automatic calculation and setting of the azimuth angle from input coordinates, traverse-style measurement, and setting out from input coordinates, in addition to the standard functions of remote elevation measurement, missing line measurement and setting out by distance and angle. The distance measurement can be set to single or repeat readings with a choice of fine, coarse or tracking-type measurement modes. The Instrument parameter settings are stored in an internal memory which can be changed by key operation, and remain stored in the memory even after power off. The atmospheric correction ppm values are calculated by the instrument after input of the temperature and pressure values. A microcomputer constantly checks the instrument operation; if an error is detected, an error message or code is displayed.

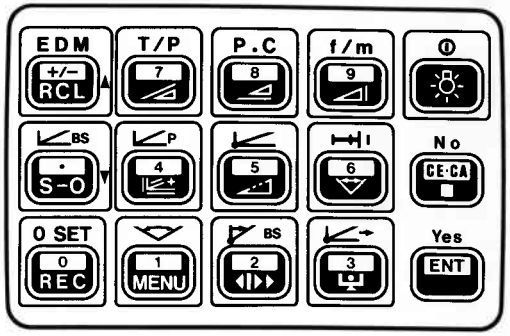
- Both the horizontal and vertical circles are provided with 0 index points. The horizontal index can be set to any direction and the value is stored in the short-term memory so that even after power is switched off (i.e. battery change), the previous index position can be recovered when the instrument is switched on and the circle is indexed again (in auto indexing mode).

- The tilt angles of the vertical axis are measured by an internal 2-axis tilt sensor. These tilt angles can be displayed for use in accurately levelling the instrument, and can also be used to automatically compensate the vertical and horizontal angles.

- The SET2B instruments have 2-speed horizontal and vertical fine motion screws for fast and precise target sighting.

- The SET2B RS-232C-compatible data output connector allows 2-way communication and output of data for recording with an external device.

4. KEY FUNCTIONS



- Select the distance measuring mode (ENT SHFT + EDM +/- RCL)
- Change the sign of the data input value
- Recall data from the memory
- Move to previous option (▲)

- Enter the Atmospheric correction (Temperature/Pressure values (ENT SHFT + T/P 7)
- Enter "7"
- Measure slope distance

- Enter the prism constant value (ENT SHFT + P.C 8)
- Enter "8"
- Measure horizontal distance

- Change meters ↔ feet for 5 seconds (ENT SHFT + f/m 9)
- Enter "9"
- Measure height difference

- EDM power ON/OFF for locating prism (ENT SHFT + ①)
- Display and reticle illumination ON

- Enter Backsight station coordinates (ENT SHFT + BS S-O)
- Enter "." (Decimal point)
- Setting out measurement (+ mode key)
- Move to next option (▼)

- Enter coordinates of point to be set out (ENT SHFT + P 4)
- Enter "4"
- Measure 3-dimensional coordinates

- Enter Instrument station coordinates (ENT SHFT + 5)
- Enter "5"
- Measure remote elevation

- Enter distance setting out data (ENT SHFT + 6)
- Enter "6"
- Missing line measurement

- Clear entered data
- Stop measurement and transfer to basic mode
- Exit from mode
- Enter "No"

- Set the horizontal angle to zero/In Missing line measurement, change the starting point (ENT SHFT + 0 SET 0 REC)
- Enter "0"
- Output data to an external device

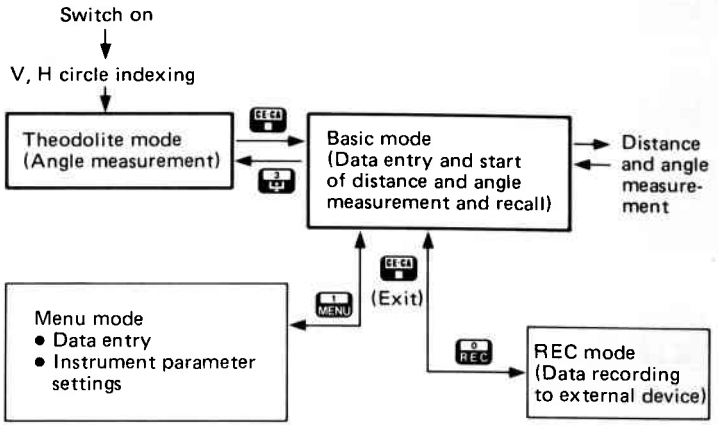
- Set horizontal circle to a required value (ENT SHFT + 1 MENU)
- Enter "1"
- Transfer to menu mode

- Set azimuth angle from Instrument and Backsight station coordinates (ENT SHFT + BS 2)
- Enter "2"
- Select horizontal angle right, left or repetition

- Set Instrument station coordinates and azimuth angle using data from previous station (ENT SHFT + 3)
- Enter "3"
- Transfer to theodolite mode
- Display tilt angle (When instrument is in Theodolite mode and the "Tilt correction" parameter is ON)

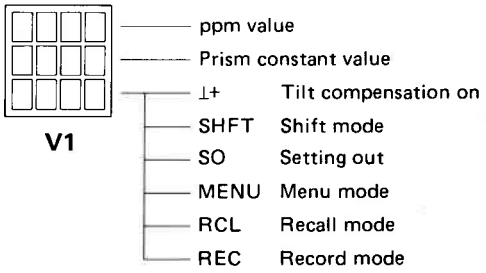
- Enter data into memory
- Select/release SHIFT mode (Upper key functions)
- Enter "Yes"

MODE DIAGRAM



DISPLAY SYMBOLS

Upper Display:



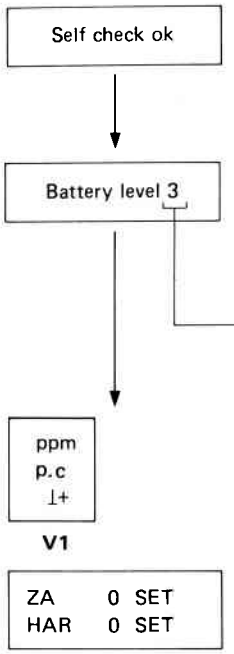
The main lower display shows program prompts, stored, entered and measured data, and error messages.

5. BATTERY BDC18: MOUNTING AND CHECK

1) Ensure that the SET2B power switch ㉑ is off.
2) Mount the BDC18 battery in the SET2B. Hold the left standard and push the battery until a click is heard. Confirm that the battery is securely mounted.
3) Level the SET2B instrument.
4) Instrument and battery check:
   Switch the SET2B power switch ㉑ on.

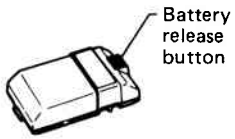
♪ The audio tone sounds and the instrument performs self-diagnostic checks. "**Self check ok**" is displayed for two seconds when the instrument has successfully completed the checks.

The remaining battery power is then displayed for three seconds in the format "**Battery level X**" where X represents the battery level as follows:



♪ The display of "**ZA/HAR 0 SET**" indicates that the instrument is ready for vertical and horizontal circle indexing. If "**HAR 0°00'00"**" or "**ZA Face 1**" is displayed, the Horizontal/Vertical indexing is set to "Manual". See "Instrument parameter settings" on page 43–.

Battery is low



If "**Battery is low**" is displayed and the audio tone sounds, the BDC18 battery should be recharged or replaced by a charged battery.
To remove the battery, ensure that the SET2B power switch is off, then push down the battery release button.

Memory error

A display of "**Memory error**" after more than 1 week of power off means that previously-entered data such as station and backsight coordinates, instrument and target heights and setting out information has been cleared from the short term memory.

ppm
P.C
⊥+
V1

- When the ⊥+ symbol is shown on the small display, the vertical and horizontal angles are automatically compensated for small tilt errors using the 2-axis tilt sensor. The tilt sensor has a range of ±3'.

Out of range

If "**Out of range**" is displayed, the SET2B tilt sensor is indicating that the instrument is off-level. The instrument should be re-levelled using the plate level bubble.

Instrument parameters: See page 43–.

The "Tilt correction (Dual axis)" parameter can be used to switch on (Yes) and off (No) the automatic angle compensation.
For example, the compensation should be switched off if the displayed values are unsteady due to vibration or strong wind.

6. SETTING UP THE INSTRUMENT

6.1 CENTRING THE SET2B BY ADJUSTING TRIPOD LEG LENGTH

1) Make sure that:
   a. The tripod head is approximately level.
   b. The tripod shoes are firmly fixed in the ground.
2) Set the SET2B on the tripod head. Tighten the centring screw.
3) Focus on the surveying point:
   a. Turn the optical plummet eyepiece ⓴ to focus on the reticle.
   b. Turn the optical plummet focussing ring ⓳ to focus on the surveying point.
4) Turn the levelling foot screws ⓬ to centre the surveying point in the reticle.
5) Observe the off-centre direction of the bubble in the circular level ❾. Shorten the leg nearest that direction, or extend the leg farthest from that direction.
   Generally, two legs must be adjusted to centre the bubble.
6) When centring of the circular level is completed, turn the levelling screws to centre the plate level ㉖ bubble.
7) Look through the optical plummet again. If the surveying point is off-centre, loosen the centring screw to centre the surveying point on the reticle. Tighten the centring screw.
8) Repeat 6), 7) if the plate level bubble is off-centre.

6.2 FOCUSSING

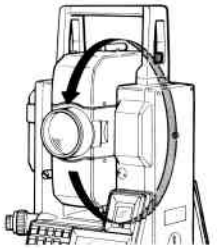
1) Looking through the telescope, turn the eyepiece fully clockwise, then anticlockwise until just before the reticle image becomes blurred. In this way, frequent refocussing can be dispensed with, since your eye is focussed at infinity.
2) Loosen the vertical ㉘ and horizontal clamp ㉒.
   Bring the target into the field of view with the peep sight ㉛.
   Tighten both clamps.
3) Turn the focussing ring ㉝ and focus on the target.
   Sight the target centre using the vertical ㉙ and horizontal fine motion screws ㉓. Focus on the target until there is no parallax between the target and the reticle.

Parallax:
Relative displacement of target image in respect to the reticle when observer's head is moved slightly before the eyepiece.
If sighting is carried out before parallax is eliminated, this will introduce errors in reading and will impair your observations.

7. INDEXING THE VERTICAL AND HORIZONTAL CIRCLES

Switch the SET2B on, and ensure that the display shows the "**ZA/HAR 0 SET**" prompt.
(If H and/or V circle indexing parameters are "Manual", this procedure is different.)

ZA	0 SET	---- **Waiting for vertical circle indexing**
HAR	0 SET	---- **Waiting for horizontal circle indexing**



1) Vertical circle indexing:
   Loosen the vertical clamp ㉘ and transit the telescope completely. (Indexing occurs when the objective lens crosses the horizontal plane in face left.)

ZA	81°38'45"
HAR	0 SET

♪ The audio tone sounds and the vertical angle (ZA) is displayed.

2) Horizontal circle indexing:
   Loosen the horizontal clamp ㉒ and rotate the upper part of the instrument through 360°.

ZA	81°38'45"
HAR	314°50'35"

♪ The audio tone sounds and the horizontal angle right (HAR) is displayed.

Measurement can now take place

The instrument is now in Theodolite (Angle measurement) mode.

Note: Each time the instrument is switched on, the vertical and horizontal indices must be re-determined. However, note that if the instrument was only switched off for a short time (less than 1 week), the previous horizontal 0° position will be recovered when the horizontal circle is indexed again.

Instrument parameters: See page 43–.

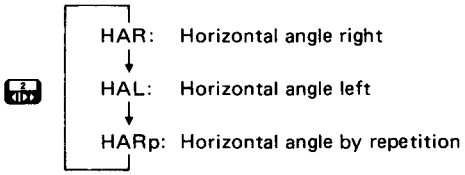
The "V indexing" parameter can be used to change the vertical circle indexing method. Options are indexing by transitting the telescope as above or indexing by face left, face right sightings. See page 71.
The "H indexing" parameter can be used to change the horizontal circle indexing method. Options are indexing by rotating the upper part as above or indexing and zero setting at power on.

8. ANGLE MEASUREMENT

Go to distance measurement: [DIST]
Return to angle measurement: [3]

8.1 SELECTION OF HORIZONTAL ANGLE DISPLAY

The [2] key can be used to select the required horizontal angle display.
The options are:



8.2 SETTING THE HORIZONTAL ANGLE TO ZERO

[ENT] + [0 SET]

ZA	81°38'45"
HAR	0°00'00"

Press [ENT] + [0 SET] to set the horizontal angle value to zero.
This zero position is memorized for up to a week after power off.

8.3 SET THE HORIZONTAL ANGLE TO A REQUIRED VALUE

e.g. Set 90°30'20" to reference target R.

[ENT] + [MENU]

H angle
HAR

1) Press [ENT] + [MENU]. The display prompts for the input of the horizontal angle value.

< Input value >

H angle
HAR 90.3020

[ENT]

2) Input the value as 90.3020 and press [ENT] to enter the value.
The display returns to the angle measurement display and the horizontal angle is set to 90°30'20".

ZA	81°38'45"
HAR	90°30'20"

- The input angle value should be between 0°00'00" and 359°59'59".
- To correct a mis-entered value, press [CE·CA] to clear the wrong value then input the correct value.
- To exit from the angle entry function, press [CE·CA] two times.

Instrument parameters: See page 43–.

The "Vertical angle display mode" parameter can be used to change the displayed vertical angle. Options are 0° at zenith, 0° horizontal on face left, and 0° horizontal ±90°.

8.4 TILT ANGLE DISPLAY AND TILT COMPENSATION OF MEASURED ANGLES

The SET2B is provided with a 2-axis (X, Y) tilt sensor which is used to automatically correct the vertical and horizontal angles for errors due to the non-verticality of the vertical axis. The tilt angle X and Y values can be displayed.
Note that the "Tilt correction (Dual axis)" parameter must be set to ON (⊥+ symbol shown in small display) to obtain tilt-corrected angles and the tilt angle display. See page 43–.

ZA	81°38'45"
HAR	314°50'35"

[3 ▽]

Tilt angle	
X	0°01'25"
Y	-0°00'45"

1) In the angle measurement mode, press [3 ▽].
The X and Y tilt angles are displayed.

----- X: **Tilt angle in sighting axis direction.**
----- Y: **Tilt angle in horizontal axis direction.**

To use the tilt angle display to level the instrument for the most accurate measurements, see section 19.1 on page 69.

To exit from the tilt angle display, press [3 ▽] again to return to theodolite mode, or press [CE·CA] to go to Basic mode.

- The range of the tilt sensor is ±3'. If the tilt angle is greater than this, "**Out of range**" is displayed.

Notes for horizontal angle tilt compensation

- The formula used for calculation of the tilt compensation value applied to the horizontal angle uses the tilt and vertical angles as shown below:

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

Therefore, when the instrument is not perfectly levelled, changing the vertical angle (i.e. 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.

8.5 DISPLAY AND RETICLE ILLUMINATION

For work in low-light conditions, the [☼] key can be used to switch on the display and reticle illumination.

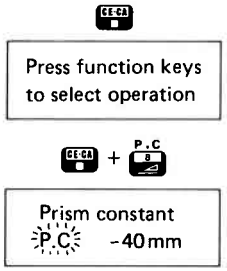
Instrument parameters: See page 43–.

The "Reticle illumination" and "Backlight control" parameters can be used to change the illumination function. "Reticle illumination" has the option of bright or dim illumination, and "Backlight control" allows the user to select a 30-second automatic cut-off function or to switch on/off by pressing [☼].

9. PREPARATION FOR DISTANCE MEASUREMENT

9.1 ENTRY OF PRISM CONSTANT VALUE

The prism constant value can be entered for correction of the measured distances.
The stored prism constant value is shown in the small upper display of the SET2B and is stored in the permanent memory.



1) Press CE·CA to enter the Basic mode from the Angle measurement mode.
"**Press function keys . . .**" is displayed.

2) Press ENT SHFT + P·C 8 to enter the prism constant setting display.

---- **The previous stored prism constant value is displayed.**

3) To change the prism constant, input the required value (taking care with the sign) and press ENT SHFT to enter the value in the memory. The instrument returns to the "**Press function keys . . .**" display.

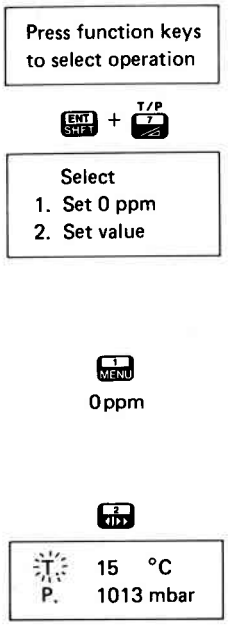
e.g. To input a prism constant correction value of -30 mm, enter:

+/- RCL 3 ↵ 0 REC ENT SHFT

- The prism constant value can be input as a value from -99 mm to +99 mm in 1 mm steps.
- To correct a mis-entered value, press CE·CA to clear the wrong value, then enter the correct value.
- To exit from the prism constant setting mode to the Basic mode, press CE·CA two times.

9.2 ATMOSPHERIC CORRECTION

In the SET2B it is possible either to set 0ppm, or to input the temperature and pressure from which the ppm correction will be automatically calculated and applied.
The stored ppm value is displayed on the small upper SET2B display and is stored in the temporary memory for about 1 week after power off.



1) From the SET2B Basic mode ("**Press function keys . . .**" displayed), press ENT SHFT + T/P 7 to enter the Atmospheric correction setting display.

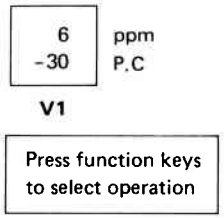
----- **Atmospheric correction not applied (ppm value = 0).**

--- **Enter temperature and pressure values for automatic ppm calculation and correction.**

2) Either:
Press 1 MENU to set 0ppm (no atmospheric correction). The SET2B returns to the basic mode after setting 0ppm.

3) Or:
a) Press 2 ◁▷ to input the temperature and pressure values. The display prompts for the input of the Temperature (T) value. Use the keyboard to input the value and press ENT SHFT to enter it.
The display prompts for the input of the Pressure (P).

b) Input the pressure value and press ENT SHFT to enter it.
The ppm value is calculated and displayed on the SET2B small upper display and this value is applied to all measured distance values. The instrument returns to the Basic mode.



- The entered values should be between -30°C and +60°C (-22°F and 140°F) for temperature, and between 500mb and 1400mb (375mmHg and 1050 mmHg) for pressure.
- To correct a mis-entered value, press [CE-CA] to clear the wrong value then input the correct value. The ppm value is memorized for about a week after power off.
- When temperature is known in °C and pressure is in mb, the following formula is used:

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

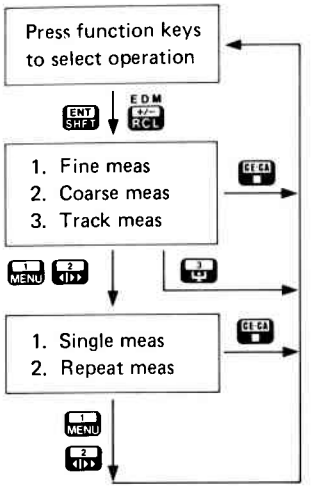
- For precise distance measurement, relative humidity should be taken into account together with atmospheric pressure and ambient temperature. See page 75.

Instrument parameters: See page 43–.

The "Temp & Press units" parameter can be used to change the units for temperature and pressure entry. Options are °C, °F, mb, mmHg, inchHg.

9.3 SELECTION OF THE MEASUREMENT MODE

The distance measurement mode can be set to fine or coarse, single or repeat measurements or tracking measurements using the [ENT SHFT] + [EDM +/- RCL] keys.



1. Fine measurement:
   Reading at first after 4.9 secs, then every 3.2 secs in mm units.
2. Coarse measurement:
   Reading at first after 1.8 secs, then every 0.8 sec in mm units.
3. Tracking measurement:
   Reading at first after 1.6 secs, then every 0.3 sec in cm units.

1. Single measurement:
   Takes one measurement.
2. Repeat measurement:
   Continues to take measurements until the [CE-CA] key is pressed.

1) From Basic mode ("**Press function keys . . .**" displayed), press [ENT SHFT] + [EDM +/- RCL] to enter the measurement mode setting menu. The cursor flashes at the currently-selected option.
2) Press [1 MENU], [2] or [3] to select the Fine, Coarse or Tracking modes. If Tracking mode is selected, the mode is set and the instrument returns to the "**Press function keys . . .**" display.
3) For Fine or Coarse measurements, the display prompts for the selection of 1) Single or 2) Repeat measurements. Input [1 MENU] or [2], then the instrument returns to the Basic mode.

- To exit from the measurement mode setting displays, press [CE-CA]. The previously-stored values are retained in the instrument memory.
- When tilt compensation and "C + R correction" are being applied, the coarse measurement time and the tracking measurement time are from 0.2 second to 1.5 seconds more.

9.4 EARTH-CURVATURE AND REFRACTION CORRECTION

The earth-curvature and refraction correction can be selected using the "C + R correction" Internal parameter. This correction is applied in the measurement of horizontal distance and height difference and the Atmospheric refraction constant K can be chosen as either 0.142 or 0.20.

When the correction is applied, the following formulas are used:

- Horizontal distance after correction:

$$H' = S \times \sin Z - \frac{1 - \frac{K}{2}}{R} \times S^2 \times \sin Z \times \cos Z$$

- Height difference after correction:

$$V' = S \times \cos Z + \frac{1 - K}{2R} \times S^2 \times \sin^2 Z$$

When the correction is not applied, the following formulas are used:

- Horizontal distance: $H = S \times \sin Z$
- Height difference: $V = S \times \cos Z$

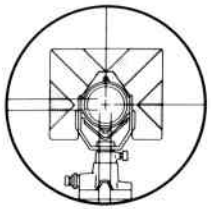
where:

S: Slope distance value (after atmospheric correction)
Z: Vertical angle (0° at zenith)
K: Atmospheric refraction constant (A value of 0.142 or 0.20 can be selected using the Internal parameters. See page 43–.)
R: Radius of the earth (6.372×10^6 m)

Instrument parameters: See page 43–.

The "C + R correction" parameter can be used to switch on and off the curvature and refraction correction and to select the refraction constant value. Options are: 1. Off, 2. On: K = 0.142, 3. On: K = 0.20.

9.5 PRISM SIGHTING FOR ANGLE AND DISTANCE MEASUREMENT



1) Sight the centre of the reflecting prism with the SET2B telescope.

Press function keys to select operation

2) To confirm the sighting, if required: From the Basic mode ("**Press function keys . . .**" displayed), press ENT SHFT + ⏻ to switch the EDM power on for about 2 minutes to allow prism sighting. "**Signal**" is displayed.

ENT SHFT + ⏻

Signal

Signal *

When the SET2B is correctly sighting the prism, and the returned beam strength is adequate for measurement, a "*" symbol appears on the display and an optional audio tone is output.

ENT SHFT + ⏻

Press function keys to select operation

3) Press ENT SHFT + ⏻ again to switch off the power to the EDM unit.

*Instrument parameters: See page 43–.

The "Return signal audio tone" parameter can be used to switch on and off the audio tone which is output when the EDM is correctly sighting the reflecting prism.

10. DISTANCE MEASUREMENT

Before distance measurement, ensure that:

① The SET2B is set up correctly over the surveying point.
② The remaining battery power is adequate.
③ The vertical and horizontal circles have been indexed.
④ The prism constant, curvature and refraction and atmospheric corrections have been correctly set. (See Section 9.)
⑤ The SET2B is correctly sighting the reflecting prism and the returned beam strength is adequate for measurement.

Press function keys to select operation

[7]

S dist

S	234.567m
ZA	81°12'35"
HAR	12°23'45"

1) From the Basic mode ("**Press function keys . . .**" displayed), press [7] to measure the slope distance.

"**S dist**" is displayed while the SET2B measures the distance.

After 5 seconds (fine measurement mode), the slope distance value and the vertical and horizontal angles are displayed.

2) In the repeat and tracking measurement modes, press [CE·Cl] to stop the distance measurement. (In single measurement mode, this step is unnecessary.)

Horizontal distance and height difference:

To measure horizontal distance or height difference, follow the same procedure as described above, but in step 1), press [8] for horizontal distance or press [9] for height difference.

[9]

H dist

H	231.812m
ZA	81°12'35"
HAR	12°23'45"

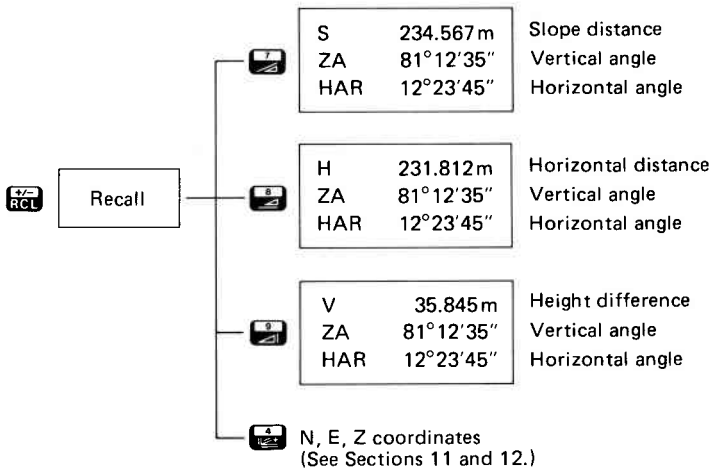
[9]

V dist

V	35.845m
ZA	81°12'35"
HAR	12°23'45"

Note: A display of "**Signal off**" or "**Timeout**" means that the returned beam strength has decreased during measurement. Ensure that the line of sight is free from obstruction, press [CE·Cl] to clear the "**Timeout**" display and re-start the measurement.

3) After distance measurement has been performed and stopped, the Recall [+/− RCL] key can be used to display the following data:



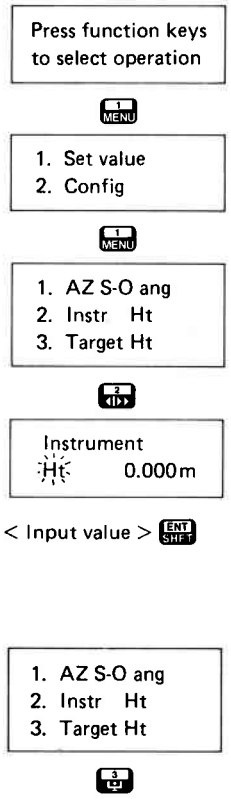
Each distance value displayed is the result calculated from the most recent measurement.

(To return to theodolite mode, press [0 ↵].)

11. PREPARATION FOR COORDINATE MEASUREMENT

The SET2B 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 entering the Backsight station coordinates, sighting the backsight station and pressing a key on the SET2B keyboard, the horizontal angle can be set to the azimuth value.

11.1 INPUT OF INSTRUMENT AND TARGET HEIGHTS



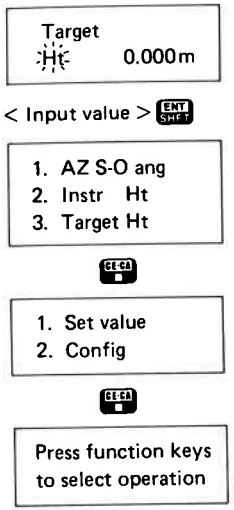
1) From the SET2B Basic mode, press [MENU] to enter the Menu mode. "**MENU**" is displayed in the small display.

2) Select the "**1. Set value**" option by pressing [MENU].

3) To input the Instrument height value, press [▷▷] to select the "**2. Instr Ht**" option.

4) Input the instrument height value and press [ENT] to enter it in the memory.
e.g. To input a height of 1.567 m, input
[MENU] [S-O] [5] [6] [7] [ENT]
The display returns to the Set value menu.

5) To input the Target height value, press [3] to select the "**3. Target Ht**" option.



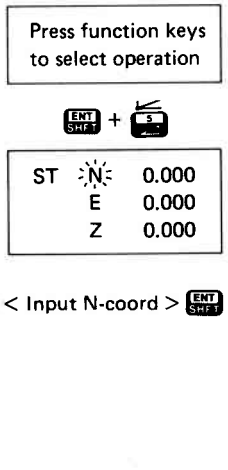
6) In the same way as described in part 4), input the target height value and enter it in the memory.
The display returns to the Set value menu.

7) Press [CE·CA] (exit) to return to the main menu display.

8) Press [CE·CA] again to exit from the Menu mode to the Basic mode ("**Press function keys . . .**" displayed).

- Entered data should be between -9999.999 and +9999.999.
- The instrument and target height values remain in the memory for about a week after the instrument power is switched off.
- During data entry, press [CE·CA] to clear a displayed value.

11.2 INPUT OF INSTRUMENT STATION COORDINATES



1) From the SET2B Basic mode, press [ENT] + [5] to enter the instrument station coordinate setting display. Previously-entered coordinate values are displayed, and the cursor flashes beside the N-coordinate.

2) Input the N-coordinate value and press [ENT] to enter this value in the memory. The cursor moves to the E-coordinate.

< Input E-coord > [ENT]
< Input Z-coord > [ENT]

Press function keys to select operation

3) In the same way, input and enter the E and Z-coordinate values in the memory. The display returns to the Basic mode.

- The instrument station coordinates are stored in the memory for about a week after the SET2B is switched off.
- The entered data should be between -9999.999 and +9999.999.
- During data entry, press [CE·CA] to clear a displayed value.

11.3 INPUT OF BACKSIGHT STATION COORDINATES

Press function keys to select operation

[ENT] + [BS S→O]

BS	N	0.000
	E	0.000
	Z	0.000

1) In the SET2B Basic mode, press [ENT] + [BS S→O] to enter the Backsight station coordinate setting display. Previously-entered backsight station coordinate values are displayed and the cursor flashes on the N-coordinate position.

< Input N-coord > [ENT]
< Input E-coord > [ENT]
< Input Z-coord > [ENT]

Press function keys to select operation

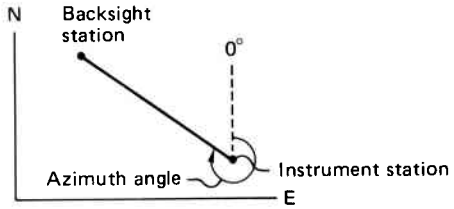
2) Input the N-coordinate value and press [ENT] to enter the value in the memory. The cursor moves to the E-coordinate position.

3) In the same way, input and enter the E- and Z-coordinate values. The display returns to the Basic mode.

- The entered values remain stored in the memory of the SET2B for about a week after the instrument is switched off.
- Entered values should be between -9999.999 and +9999.999.
- During data entry, press [CE·CA] to clear a displayed value.

11.4 SETTING THE AZIMUTH ANGLE FROM THE INSTRUMENT AND BACKSIGHT STATION COORDINATES

After input of the Instrument and Backsight station coordinates, the SET2B can calculate the azimuth angle and can set this value to the horizontal angle.



Press function keys to select operation

[ENT] + [BS 2 ◀▶]

Calculating

ZA	81°38'45"
HAR	304°20'10"

[CE·CA]

Press function keys to select operation

1) With the SET2B set up over the Instrument station and in the Basic mode, sight the Backsight station.

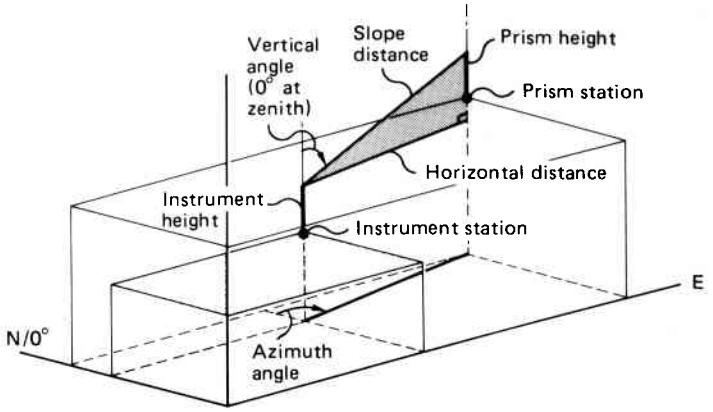
2) Press [ENT] + [BS 2 ◀▶] to calculate and set the azimuth angle to the horizontal angle.
"**Calculating**" is displayed during calculation.
The SET2B returns to the Angle measurement mode and displays the vertical and horizontal (azimuth) angle.

3) Press [CE·CA] to return to the Basic mode ("**Press function keys . . .**" displayed).

Note: If the azimuth angle is already known, it can be input directly using the "Set the horizontal angle to a required value" procedure described on page 15.

12. COORDINATE MEASUREMENT

12.1 3-DIMENSIONAL COORDINATE MEASUREMENT



The following formulas are used for calculation of the 3-dimensional coordinates:

$$N\text{-coordinate} = N_0 + S \times \sin\theta_Z \times \cos\theta_H$$

$$E\text{-coordinate} = E_0 + S \times \sin\theta_Z \times \sin\theta_H$$

$$Z\text{-coordinate} = Z_0 + Mh + S \times \cos\theta_Z - Ph$$

where:

N_0, E_0, Z_0: Instrument station coordinates
S: Slope distance
θ_Z: Vertical angle (0° at zenith)
θ_H: Azimuth angle
Mh: Instrument height
Ph: Prism height

- When measuring 3-dimensional coordinates, it is first necessary to enter the Instrument and prism heights, Instrument and Backsight station coordinates and calculate or input the azimuth angle (see previous pages).

Press function keys to select operation

1) Sight the centre of the reflecting prism.
2) From the SET2B Basic mode, press [4].

Coordinate

N	123.456
E	345.678
Z	34.567

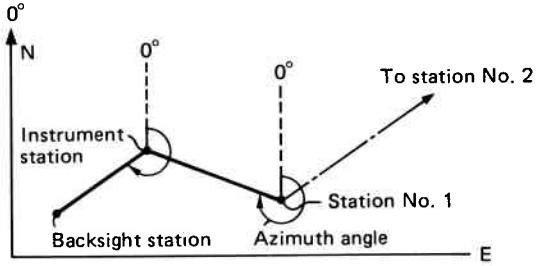
"**Coordinate**" is displayed during measurement.

After 5.3 seconds (fine measurement mode), the N-, E- and Z-coordinate values are displayed.

3) In the repeat and tracking measurement modes, press [CE•C] to stop the coordinate measurements. (In single measurement mode, this step is unnecessary.)

12.2 TRAVERSE-STYLE COORDINATE MEASUREMENT

At the first survey station, after entry of Instrument and Prism heights and Instrument and Backsight station coordinates, set the azimuth angle from the Instrument and Backsight coordinates and then measure the 3-dimensional coordinates of the next survey station. Switch off the SET2B and move it to the next station and set it up. By sighting back on the first survey station and pressing a key on the SET2B keyboard, the new Instrument station coordinates and azimuth angle are set in the instrument.



1) From the SET2B Basic mode, enter the Instrument and Prism heights and Instrument and Backsight station coordinates. Then set the azimuth angle from the Instrument and Backsight station coordinates. (See Sections 11.1, 11.2, 11.3, 11.4.)

2) From the Instrument station, measure the 3-dimensional coordinates of Station No. 1. (See Section 12.1.)

3) Switch the SET2B off, and move the instrument to station No. 1 and set it up over the survey point.

Press function keys to select operation

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

[ENT SHFT] + [3]

5) In the SET2B Basic mode, press [ENT SHFT] + [3] to set the new instrument station coordinates and azimuth angle in the instrument. The instrument asks whether the new station coordinates are to replace the previously-stored ones.

Stn pt replace?
Yes/No (Exit)

[Yes ENT SHFT]

6) To set the new instrument station coordinates, press [Yes ENT SHFT].

Replaced

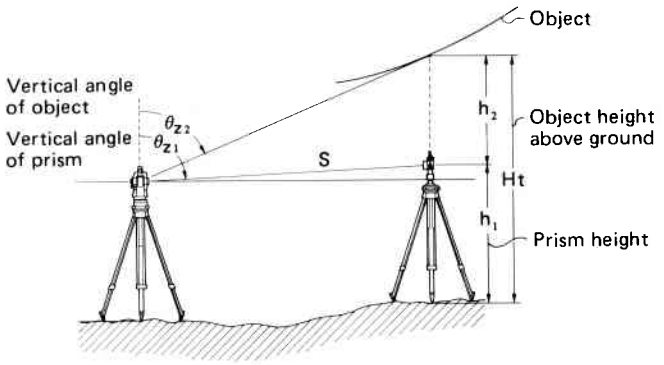
The display shows "**Replaced**" to signify that the coordinates of station No. 1 have been set in the instrument. The instrument then calculates and sets the azimuth angle and returns to the theodolite mode.

↓

ZA	88°12'35"
HAR	291°23'45"

13. REMOTE ELEVATION MEASUREMENT

When measuring the height of certain objects such as overhead power cables 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.



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

2) Measure the prism height above the ground and input it into the SET2B by using the "**Target Ht**" option in the Menu mode. See page 26 for procedures for entering the Target height value.

Press function keys to select operation

[7]

S	234.567 m
ZA	81°12'35"
HAR	12°23'45"

3) Sight the centre of the prism with the SET2B and, in Basic mode, press the [7] key to measure the slope distance. Press [CE ESC] to stop the measurement, if necessary. (For slope distance measurement procedures, see page 24.)
The measured values are stored in the instrument memory.

4) Accurately sight the object.

Ht	16.290m
ZA	77°11'10"
HAR	12°23'45"

5) Press [S] to measure the object height above the ground.

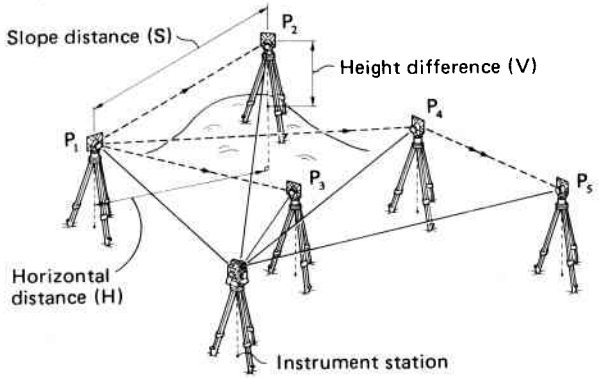
After 0.7 second, the object height above the ground is displayed.

6) Press [CE·CA] to stop the measurement.

Note that the vertical angle limit for this function is ±89° from the horizontal, and the Ht value limit is ±9999.999 m (±32808.33 ft).

14. MISSING LINE MEASUREMENT

This function allows the calculation of the slope distance, horizontal distance and height difference between the starting position (P_1) and any other points. It is also possible to change the starting position to that of the last-measured point.



Press function keys to select operation

[▽]

S	234.567m
ZA	81°12'35"
HAR	12°23'45"

[S]

Missing line

S	276.890m
H	234.567m
V	89.012m

1) Set up the reflecting prisms on the required number of target positions.

2) Sight the first prism P_1 (starting position) and, from the Basic mode, press [▽] to measure the slope distance. (For full description of slope distance measurement, see page 24.) Press [CE·CA] to stop the measurement, if necessary. The measured values are stored in the instrument memory.

3) Sight prism P_2 and press [S] to start the missing line measurement. "**Missing line**" is displayed while the SET2B performs the measurement.

After about 5.8 seconds (fine measurement mode), the Slope distance (S), Horizontal distance (H) and Height difference (V) between points P_1 and P_2 are displayed.

4) Press [CE·CA] to stop the Missing line measurement, if necessary.

5) To continue the missing line measurement between P_1 and other points, sight each reflecting prism in turn and press [▽] to start the measurement.

Change of starting position

The starting position (P_1) can be changed to the last-measured position (e.g. P_4), by pressing [ENT SHFT] + [0 SET / 0 REC]. Only the last-measured point can be used in this procedure.

6) After measurement to the prism point (e.g. P_4), press [ENT SHFT] + [0 SET / 0 REC] to use this point as the new starting point.
The instrument asks whether the last-measured point is to be used to replace the original starting point.

7) Press [Yes ENT SHFT] to set the new starting point. The display of "**Replaced**" confirms that the new starting point has been set. The display then returns to the Basic mode.

8) To continue measurement between the new starting point and other prisms, sight each prism in turn and press [▽].

S	231.812m
ZA	81°12'35"
HAR	12°23'45"

[ENT SHFT] + [0 SET / 0 REC]

Point replace?
Yes/No (Exit)

[Yes ENT SHFT]

Replaced

↓

Press function keys to select operation

15. SETTING OUT MEASUREMENT

In Setting out measurement, the instrument displays the difference between previously-entered setting out data and the measured value. In the SET2B, it is possible to set out a horizontal angle, distance, remote elevation measurement or coordinates.

15.1 HORIZONTAL ANGLE SETTING OUT MEASUREMENT

Entry of the horizontal angle value to be set out.

Press function keys to select operation

[1 MENU]

1. Set value
2. Config

[1 MENU]

1. AZ S-O ang
2. Instr Ht
3. Target Ht

[1 MENU]

AZ S-O ang
HAR 0°00'00"

< Input angle > [ENT SHFT]

1. AZ S-O ang
2. Instr Ht
3. Target Ht

[CE·CA] [CE·CA]

1) In Basic mode, press [1 MENU] to enter the Menu mode.
The menu options are displayed.

2) Press [1 MENU] to select the "**Set value**" option. The Set value options are displayed.

3) Press [1 MENU] to select the "**AZ S-O ang**" option. The previously-entered horizontal angle setting out value is displayed.

4) Input and enter the horizontal angle setting out data using the SET2B keyboard.

e.g. To enter a value of 123°45'55"

Press [1 MENU] [2] [3] [S-O] [4] [5] [5] [5] [ENT SHFT]

The display returns to the Set value options display.

5) Press [CE·CA] 2 times to return to the Basic mode.

Press function keys to select operation

[S-O]

Stakeout

[3]

dHA 3°45'55"
HAR 120°00'00"

dHA: Setting out data – Measured horizontal angle value

HAR: Measured horizontal angle

Horizontal angle setting out

6) Press the [S-O] (setting out) key. "**Stakeout**" is displayed.

7) Press [3] to start the Horizontal angle setting out measurement and sight the target.
The setting out data is displayed as follows:

When dHA becomes 0°00'00", the target is on-line.

- The dHA value is displayed ±180°.
- The entered setting out data should be between 0° to 359°59'59".
- The data is stored in the memory for about a week after power off.
- Press [CE·C] to clear a displayed value during data entry.
- Press [CE·C] to return to basic mode after completion of setting out.

15.2 DISTANCE SETTING OUT MEASUREMENT

In distance setting out mode, it is possible to set out a slope distance, horizontal distance, height difference or remote elevation value after inputting the required value.

Press function keys to select operation

[ENT SHFT] + [6]

S-O distance
0.000m

Entry of distance value to be set out

1) In Basic mode, press [ENT SHFT] + [6] to enter the distance setting out data display. The previously-entered distance setting out value is displayed.

< Input distance >

[ENT SHFT]

Press function keys to select operation

[S-O]

Stakeout

[7] [8] [9] [5]

Display of S-O S, H, V, Ht distance values

[CE·C]

Press function keys to select operation

2) Input and enter the distance setting out data using the SET2B keyboard.

e.g. To enter a value of 123.456m,

Press [1 MENU] [2] [3] [S-O] [4] [5] [6] [ENT SHFT]

(Entered values must be between -9999.999 and +9999.999.)
The display returns to the Basic mode.

Distance setting out

3) Sight the reflecting prism.

4) Press [S-O] to enter the Setting out mode. "**Stakeout**" is displayed.

5) Press: [7] for slope distance setting out.
[8] for horizontal distance setting out.
[9] for height difference setting out.
[5] for remote elevation setting out (after slope distance measurement).

After measurement, the setting out values are displayed as follows:

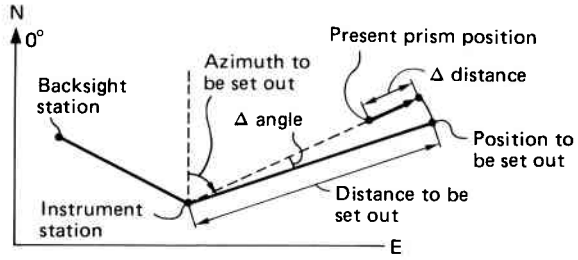
Displayed value
= Measured value – Setting out value

When the value becomes 0.000, the distance has been set out.

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

15.3 COORDINATES SETTING OUT MEASUREMENT

In coordinates setting out measurement, after entry of Instrument and Prism heights and Instrument and Backsight station coordinates and setting the azimuth angle, input the coordinates of the point to be set out. The SET2B 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.



Press function keys to select operation

ENT SHFT + 4

P	N	0.000m
	E	0.000m
	Z	0.000m

1) From the SET2B Basic mode, enter the Instrument and Prism heights and Instrument and Backsight station coordinates. Then set the azimuth angle from the Instrument and Backsight station coordinates. (For procedures, see Sections 11.1, 11.2, 11.3 and 11.4.)

2) From the SET2B Basic mode, press ENT SHFT + 4 to input and enter the coordinates of the point to be set out. Previously-entered setting out coordinate values will be displayed and the cursor flashes at the N-coordinate position.

< Input N-coord > ENT SHFT

3) Input the N-coordinate of the point to be set out and press ENT SHFT to enter it in the memory.

< Input E-coord > ENT SHFT

< Input Z-coord > ENT SHFT

4) In the same way, input and enter the E- and Z-coordinates. The instrument calculates the setting out horizontal angle and horizontal distance values, stores them in the AZ S-O and distance S-O memories, then returns to the Basic mode display.

Note: Always perform the procedures in the above order or the calculation may not be correctly done.

Press function keys to select operation

· S-O + 3 LU

< Set out horizontal angle >

5) Press · S-O + 3 LU to set out the horizontal angle. The display shows the angle between the prism position and the position to be set out.

dHA	0°00'00"
HAR	127°43'30"

6) When the displayed setting out angle value becomes 0°, the prism is on-line.

CE·CA

7) Press CE·CA to return to Basic mode.

Press function keys to select operation

· S-O + 8

< Set out horizontal distance >

8) Press · S-O + 8 to set out the horizontal distance. The display shows the distance between the prism position and the position to be set out.

H	0.000m
ZA	81°12'35"
HAR	127°43'30"

9) When the displayed setting out distance value becomes 0m, and the angle setting out value is still 0°, the prism is directly over the point to be set out. Press CE·CA to return to the Basic mode.

CE·CA

Press function keys to select operation

S-O + 4

6	
-30	
SO⊥+	

N	0.000
E	0.000
Z	0.000

To set the prism to the required height (Z-coordinate), press S-O + 4 to start the setting out coordinates measurement.
The N- and E-coordinate values should already be zero, therefore move the prism up or down at the correct N, E position until the ΔZ value is zero.

When the ΔN, ΔE and ΔZ values are all zero, the point has been set out at the required 3-dimensional coordinate position.

16. INSTRUMENT PARAMETER SETTINGS

16.1 ENTRY TO PARAMETER SETTING MODE

Press function keys to select operation

MENU

1. Set value 2. Config

2

◆ Recording Out Code Tgt ht

1) From the SET2B Basic mode, press MENU to enter the MENU mode. "MENU" is displayed in the small upper screen.

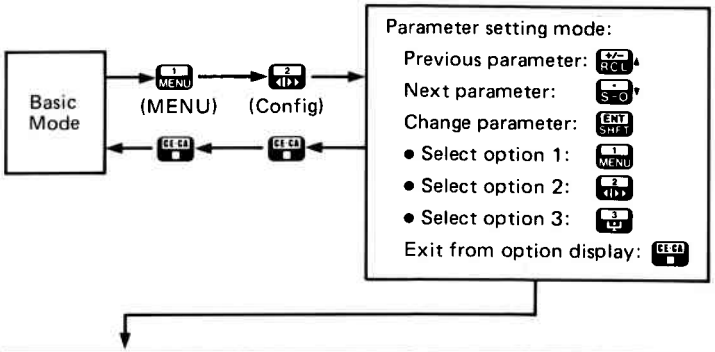
2) Press 2 to select "**2. Config**" to enter the Config (Instrument parameter setting) mode.
The first parameter "**Recording**" is displayed.

- The "◆" symbol means that the ±/RCL▲ and S-O▼ keys can be used to move up and down through the parameters.
- The parameter options currently selected are displayed on the bottom line of the screen.

In Parameter setting mode:

- To move to the previous parameter, press ±/RCL▲.
- To move to the next parameter, press S-O▼.
- To change the parameter options, press ENT SHIFT. The parameter options are displayed.
  Press 1 MENU to select option No. 1.
  Press 2 to select option No. 2.
  Press 3 to select option No. 3.
  After selection of the options, the display returns to the parameter display. The selected option is displayed on the bottom line of the screen. Each time the instrument parameter options are changed, the new settings replace the previous settings stored in the permanent memory.
- To exit from the option or parameter displays, press CE ESC. The previously-stored values are retained in the memory. Continue to press CE ESC to return to the Basic mode.

16.2 SUMMARY OF PARAMETER OPTIONS

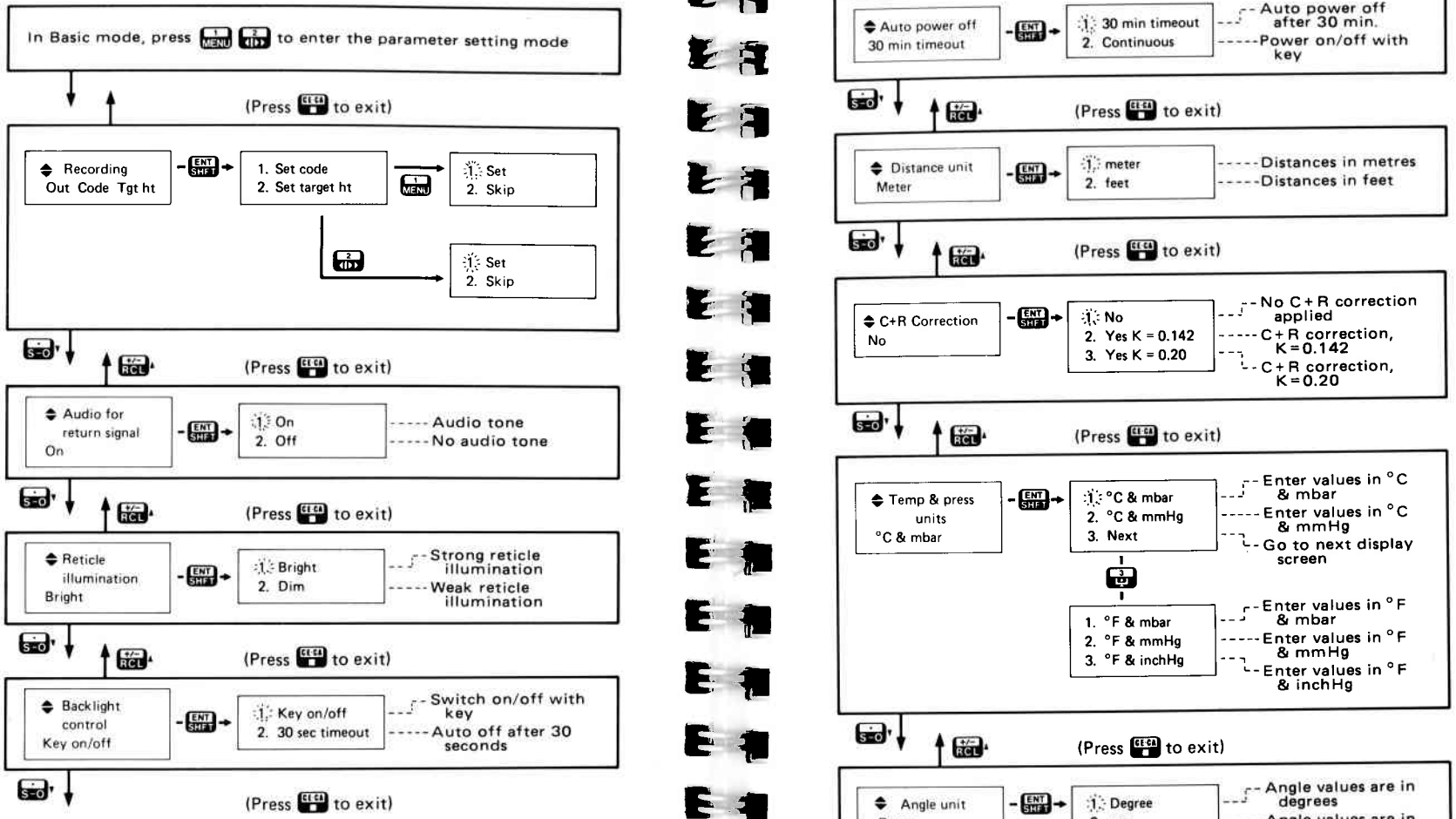


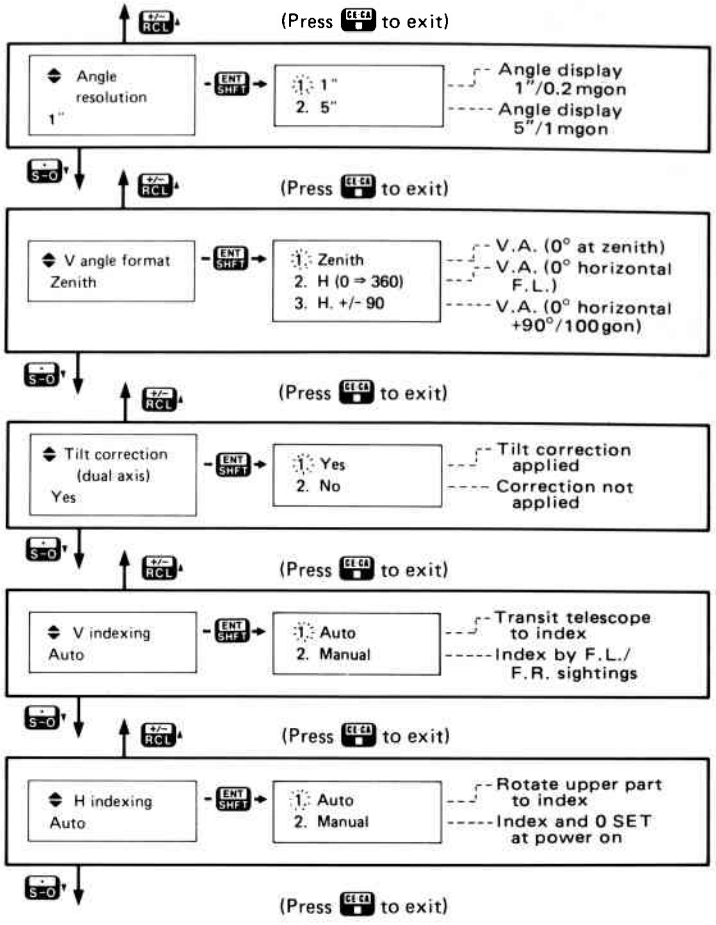
Parameter	Options
Recording	1. Set code (*1. Set 2. Skip) 2. Set target Ht (*1. Set 2. Skip)
Audio for return signal	*1. On 2. Off
Reticle illumination	*1. Bright 2. Dim
Backlight control	*1. On/Off by key operation 2. 30 seconds timeout
Auto power off	*1. 30 minutes timeout 2. Power On/Off with switch
Distance units	*1. Metres 2. Feet
C & R correction	*1. None 2. Applied, K = 0.142 3. Applied, K = 0.20
Temp & Pressure units	*1. °C + mbar 2. °C + mmHg 3. (1. °F + mbar 2. °F + mmHg 3. °F + inchHg)

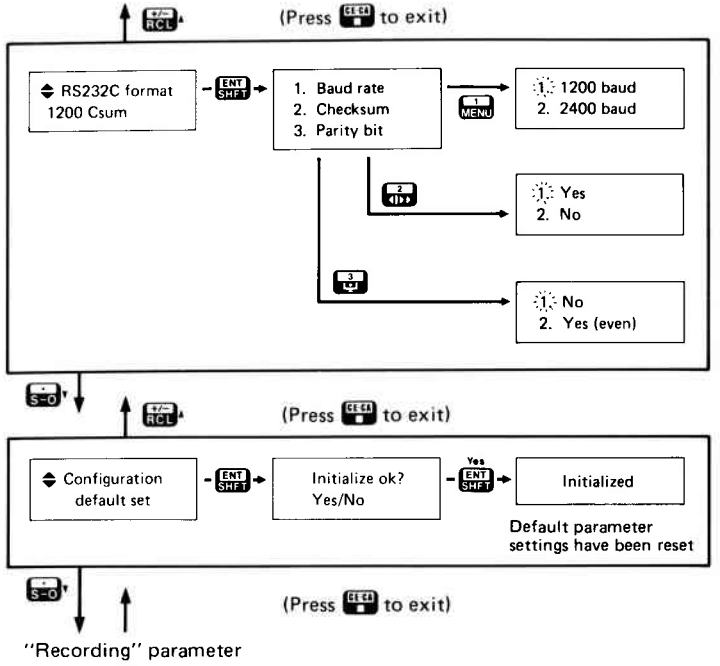
Parameter	Options
Angle units	*1. Degrees 2. gon
Angle resolution	*1. 1" (0.2 mgon) 2. 5" (1 mgon)
V angle format	*1. Zenith 0° 2. Horizontal 0°–360° (0–400 gon) 3. Horizontal ±90° (±100 gon)
Tilt correction	*1. Yes 2. No
V indexing	*1. Auto 2. Manual
H indexing	*1. Auto 2. Manual
RS-232C format	1. Baud rate (*1. 1200 2. 2400) 2. Checksum (*1. Yes 2. No) 3. Parity bit (*1. No 2. Even)
Configuration default set	Initialize: Yes/No

* Parameter options set at time instrument left the factory. These options are reset when "Configuration default set" is initialized.

16.3 CHANGING INSTRUMENT PARAMETER OPTIONS




(Press CE/CA to exit)
Angle resolution
1"
1. 1"
2. 5"
Angle display 1"/0.2 mgon
Angle display 5"/1 mgon
V angle format
Zenith
1. Zenith
2. H (0 ⇒ 360)
3. H. +/- 90
V.A. (0° at zenith)
V.A. (0° horizontal F.L.)
V.A. (0° horizontal +90°/100 gon)
Tilt correction (dual axis)
Yes
1. Yes
2. No
Tilt correction applied
Correction not applied
V indexing
Auto
1. Auto
2. Manual
Transit telescope to index
Index by F.L./F.R. sightings
H indexing
Auto
1. Auto
2. Manual
Rotate upper part to index
Index and 0 SET at power on

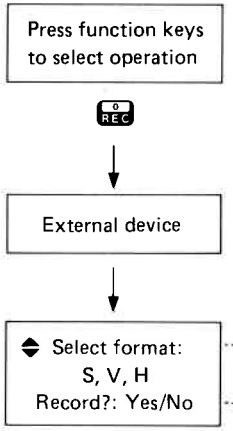

(Press CE/CA to exit)
RS232C format
1200 Csum
1. Baud rate
2. Checksum
3. Parity bit
1. 1200 baud
2. 2400 baud
1. Yes
2. No
1. No
2. Yes (even)
(Press CE/CA to exit)
Configuration default set
Initialize ok? Yes/No
Initialized
Default parameter settings have been reset
(Press CE/CA to exit)
"Recording" parameter

17. DATA RECORDING ON AN EXTERNAL DEVICE

Instrument and measured data can be output to an external device using the SET2B keyboard. Items which can be recorded include: Instrument identification (Name, Serial number and Program software version), Station point data (Date, Station point No., Optional point code, Instrument height, Atmospheric correction, Instrument N-, E- and Z-coordinates and Instrument parameters), and Measured point data (In various data formats with point number and optional point code and target height inputs).

Instrument parameters: See page 43–.

The **"Recording"** parameter can be used to select the data recording options.
These options are: 1. Input (1) or non-input (2) of target point code description, and 2. Input (1) or non-input (2) of target height for each measured point.

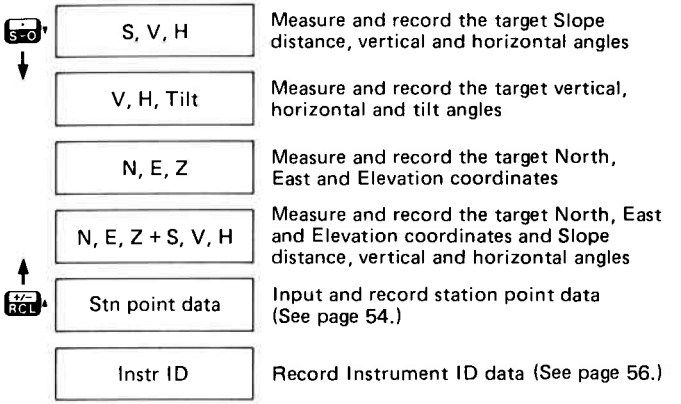


1) In the SET2B Basic mode, press REC to enter the REC (data recording) menu. "REC" is displayed on the small upper display, and the main display briefly shows that the data is being output to an external device.

Select data format/Record data display

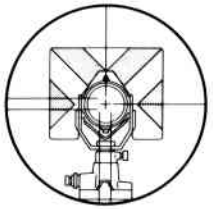
- Select the format of the data to be recorded, using the +/- RCL and S-O keys.
- Measure and record the data using Yes ENT SHFT.

1. Select data format (not necessary if required data format is displayed)
The displayed data format i.e. S, V, H can be changed, if required, using the +/- RCL and S-O keys.
The options available are:



2. Record the data

① For [S, V, H], [V, H, Tilt], [N, E, Z], and [N, E, Z+S, V, H] formats:



◆ Select format:
S, V, H
Record?: Yes/No

Yes ENT SHFT

Target point
No: 1001

ENT SHFT (Or input point No., then ENT SHFT.)

1) Sight the centre of the prism or target.

2) Press Yes ENT SHFT to start the data recording. (During the data entry and recording procedure, to exit press CE·CA.)

3) Enter or confirm the target point number. The number displayed is the last measured point number +1. To confirm this point number, press ENT SHFT. To enter a new point number (between 1 and 9999), use the SET2B keyboard numerical keys to input the point number, then press ENT SHFT.

- If the "**Set code**" and "**Set target Ht**" parameters have been set to "**Skip**", the SET2B measures and displays the selected data. (See 6) below.)

< Optional code entry >

4) If the "**Recording**" parameter "**Set code**" option is "**Set**", input the required code using the +/- RCL▲, S-O▼ and numerical keys as follows:

◆ ABCDEFGHIJ
Press 0123456789
Cd:

S-O▼ → A B C D E F G H I J
S-O▼ → K L M N O P Q R S T
S-O▼ → U V W X Y Z _ . — &
S-O▼ → 0 1 2 3 4 5 6 7 8 9
+/- RCL▲ → Clear/Exit

a. Use the +/- RCL▲ and S-O▼ keys to select the required block of characters: A–J, K–T, U–&, 0–9, or Clear/Exit.
b. Press the numerical key corresponding to the required character.
i.e. To select Z: (1) Select block U–& using +/- RCL▲, S-O▼.
(2) Press 5 JKL to select "Z".

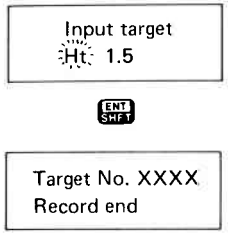
◆ UVWXYZ_.–&
Press 0123456789
Cd: Z

ENT SHFT

Press ENT SHFT to enter the point code.

- Point codes can be up to 20 characters long and can be used to describe the target feature.
e.g. TREE_SIZE_10
- The last-entered code value is stored in the memory and is displayed when the next code is to be entered.
- To delete one character to the left, press CE·CA.
- To clear the displayed code for re-entry, select the Clear/Exit option using +/- RCL▲, S-O▼ and press CE·CA. To exit, press CE·CA again.

< Optional target height entry >

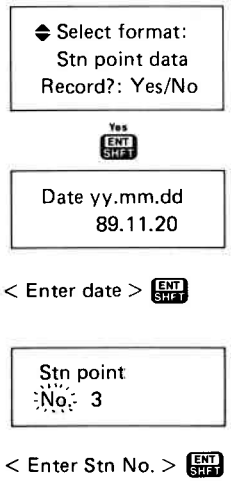


5) If the "**Recording**" parameter "**Set target Ht**" option is "**Set**", input the target Ht value and press ENT SHFT.

6) The SET2B measures and displays one set of the target point data in the selected format.
The measured values flash while the data is being recorded, then "**Target No. XXXX, Record end**" is displayed to show that the data has been successfully recorded. The display returns to the "**Select format/Record**" display.

- If there is some problem with the measured data, "**Data error**" is displayed and the data will not be recorded.
- If there is some problem with the data communication, the data error display "**Record error**" will be displayed and the data will not be recorded.

② For [Stn point data] format:



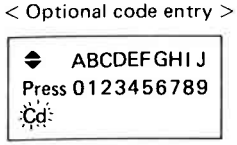
< Enter date > ENT SHFT

< Enter Stn No. > ENT SHFT

1) Press Yes ENT SHFT to start the data recording. (During the data entry and recording procedure, to exit, press CE-CA.)
The display prompts for the entry of the date in the format "**yy.mm.dd**" (Year.Month.Day).
Enter or confirm the date using the ENT SHFT key.

2) The display asks for the entry or confirmation of the station point number. The number displayed is the previous station point number +1.
Press ENT SHFT to confirm this number (or input a station number (between 1 and 9999) and enter it with ENT SHFT).

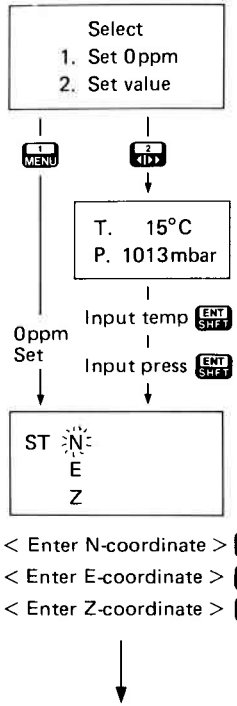
< Optional code entry >



3) If the "**Recording**" parameter "**Set code**" option is "**Set**", input the required code as described in 4) on page 53.

< Enter Instr Ht > ENT SHFT

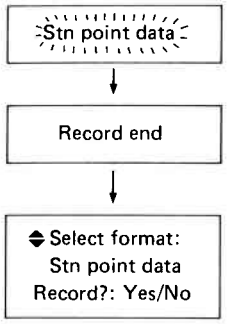
4) The display requests the instrument height value. Enter or confirm the instrument height using the ENT SHFT key.



5) The display now asks for the input of the atmospheric correction value. As in Section 9.2 on page 19, input 1 MENU to set 0 ppm, which is recorded as a temperature and pressure value, or press 2 then input the temperature and pressure, pressing ENT SHFT to enter each value.

6) The display asks for the confirmation or input of the station N-, E- and Z-coordinates. Confirm or enter the coordinate values, pressing ENT SHFT to enter each value.

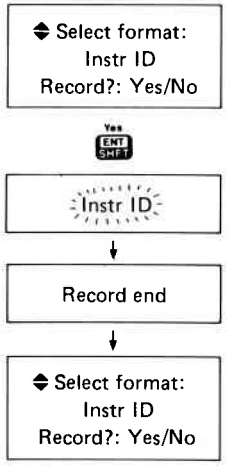
< Enter N-coordinate > ENT SHFT
< Enter E-coordinate > ENT SHFT
< Enter Z-coordinate > ENT SHFT



After entry of the Z-coordinate value, the display flashes "**Stn point data**" while the data is being recorded, then "**Record end**", and the display returns to the "**Select format**" display.

- If there is some problem with the data communication, the data error display "**Record error**" will be displayed and the data will not be recorded.

③ For [Instr ID] format:



1) Press Yes ENT SHFT to start the data recording. The display flashes "**Instr ID**" while the data is being recorded, then "**Record end**" and the display returns to the "**Select format**" display.

- If there is some problem with the data communication, the data error display "**Record error**" will be displayed and the data will not be recorded.

18. CHECKS AND ADJUSTMENTS

It is important that the SET2B is periodically checked and adjusted. In addition, the instrument should be checked after transportation, long storage or when damage to the instrument is suspected to have occurred. The checks should be performed as follows:

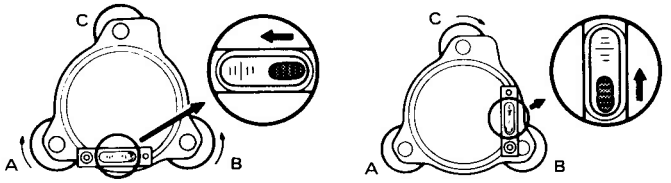
18.1 ANGLE MEASURING FUNCTION

18.1.1 Plate level
18.1.2 Circular level
18.1.3 Reticle adjustments
  a) Perpendicularity of the reticle to the horizontal axis
  b) Vertical and horizontal reticle line positions
18.1.4 Coincidence of the distance measuring axis with the reticle
18.1.5 Optical plummet

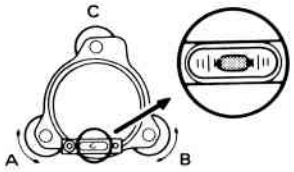
18.1.1 Plate level

The glass tube of the plate level is sensitive to temperature change or shock. Be sure to check the plate level ㉖ before use.

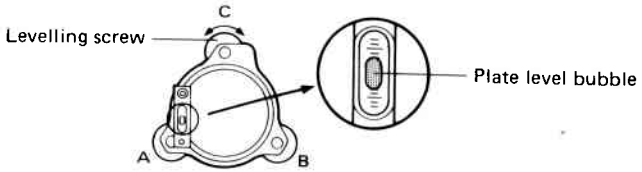
1) See the figures below for relation between bubble movement and rotation of the levelling screws.



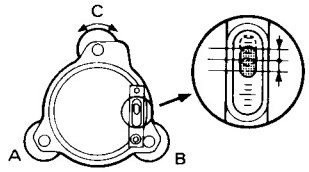
2) Turn the upper part of the SET2B until the plate level is parallel to a line between levelling screws A and B. Then centre the bubble using levelling screws A and B.



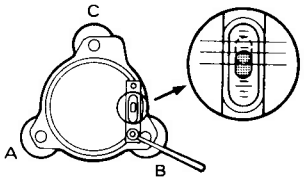
3) Turn the upper part 90° (100 gon) until the plate level is perpendicular to a line between levelling screws A and B. Then centre the bubble by turning levelling screw C.



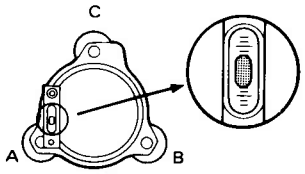
4) Turn the upper part 180° (200 gon). Correct any bubble deviation by half the amount with levelling screw C.



5) Correct the remaining half deviation by turning the plate level adjusting screw ㉗ with the adjusting pin.

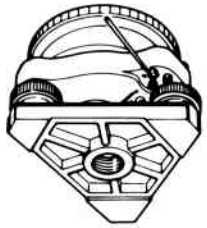


6) Repeat 2) to 5) above until the bubble remains in the same position for any position of the upper part.



18.1.2 Circular level

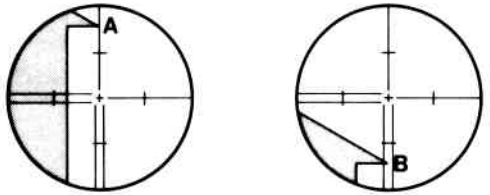
When the plate level adjustment is complete, the circular level ⑨ should be checked. Note the direction off-centre of the bubble. Loosen the adjusting screw ⑩ farthest from that direction and tighten the other adjusting screws to centre the bubble. Ensure that the tension of each screw tightening is the same after adjustment.



18.1.3 Reticle adjustments

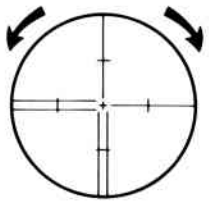
a) Perpendicularity of the reticle to the horizontal axis

1) Select and sight a clear target on the upper part A of the vertical reticle line.
2) Turn the telescope slowly upward with the vertical fine motion screw ㉙ until the target slides to the lower part B. If the target is still centrally within the vertical lines, no adjustment is necessary. If necessary, adjust as follows.



3) Unscrew the reticle cover ㉜.
4) Slightly loosen one vertical and one horizontal adjusting screw by a certain amount.
5) Place a small piece of plastic or wood against one side of the top adjusting screw as a buffer.
6) Look through the eyepiece and gently tap the piece of plastic or wood to rotate the reticle slightly.

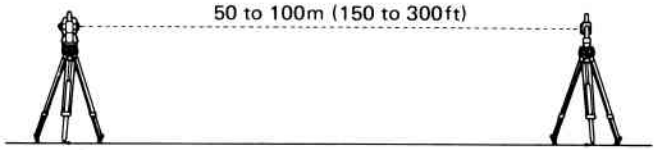
7) Re-tighten the two adjusting screws (loosened in 4)) by the same amount. Check the reticle perpendicularity again and readjust if necessary. Replace the reticle cover ⑫.



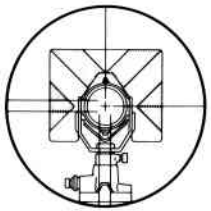
b) Vertical and horizontal reticle line positions

When the index error adjustment is complete, the position of the reticle should be checked.

1) Level the SET2B. Select a clear target at a horizontal distance of 50 to 100 m.



2) After indexing the vertical circle, sight the target and take the horizontal angle reading in face left (V1), **e.g. a_l = 18°34'00" (a_l = 20.6296 gon)** and the vertical angle reading, **e.g. b_l = 90°30'10" (b_l = 100.5586 gon)**.



3) Next, in face right (V2), sight the same target. Take the horizontal angle reading, **e.g. a_r = 198°34'10" (a_r = 220.6326 gon)** and the vertical angle reading, **e.g. b_r = 269°30'00" (b_r = 299.4444 gon)**.

4) Calculate $a_r - a_l$, $b_r + b_l$.

$a_r - a_l$ = 198°34'10" - 18°34'00" = 180°00'10"
($a_r - a_l$ = 220.6326 gon - 20.6296 gon = 200.0030 gon)
$b_r + b_l$ = 269°30'00" + 90°30'10" = 360°00'10"
($b_r + b_l$ = 299.4444 gon + 100.5586 gon = 400.0030 gon)

5) When the reticle is in the normal position, your results should show that $a_r - a_l$ is within 20" (0.0060 gon) of 180° (200 gon) and $b_r + b_l$ is within 20" (0.0060 gon) of 360° (400 gon). If the difference of $a_r - a_l$ from 180° (200 gon) or $b_r + b_l$ from 360° (400 gon) is 20" (0.0060 gon) or greater after several checks, adjust as follows:

6) While still in face right (V2), use the horizontal and vertical fine motion screws to adjust the lower display, a_c, and the upper display, b_c, to read:

$$a_c = \frac{a_l + a_r}{2} + 90°$$

$$b_c = \frac{b_r - b_l}{2} + 180°$$

Example:

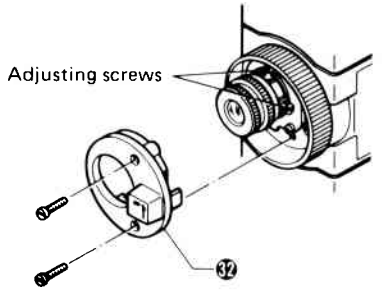
If a_l = 18°34'00" a_r = 198°34'30"
b_l = 90°30'10" b_r = 269°30'10"

$$a_c = \frac{a_l + a_r}{2} + 90° = \frac{18°34'00" + 198°34'30"}{2} + 90°$$
$$= 198°34'15"$$

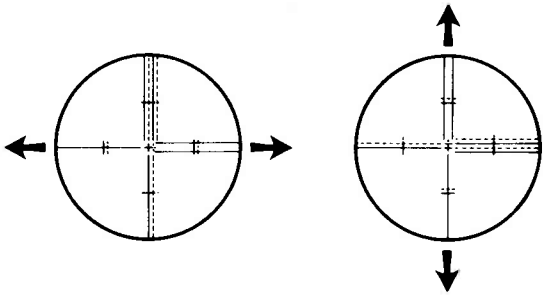
$$b_c = \frac{b_r - b_l}{2} + 180° = \frac{269°30'10" - 90°30'10"}{2} + 180°$$
$$= 269°30'00"$$

7) Look through the telescope. The target is seen shifted from the vertical and horizontal reticle lines.

8) Remove the reticle adjustment cover ㉜.



9) Adjust the reticle sideways with the adjusting screws until the target is centrally within the vertical lines, and then adjust it up or down with the screws until the target is centrally within the horizontal lines.
For example, to move the vertical reticle to the right (left) side, first slightly loosen the left (right) adjusting screw, then tighten the right (left) adjusting screw by the same amount. Repeat until the reticle comes close to the target centre.
In the same way, to move the horizontal reticle line down (up), slightly loosen the top (bottom) screw, then tighten the bottom (top) screw by the same amount and repeat until the reticle comes close to the target centre.



10) Replace the reticle adjustment cover.

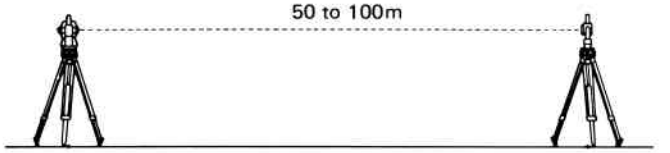
This adjustment is very delicate. If you find it difficult, please contact our agent.

> **After this adjustment, check the coincidence of the distance measuring axis with the reticle.**

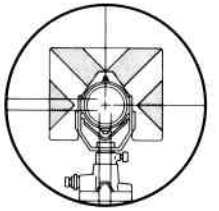
18.1.4 Coincidence of the distance measuring axis with the reticle

When the reticle has been checked, check the distance measuring axis relative to the reticle as follows.

1) Level the SET2B. Set up the reflecting prism at a horizontal distance of 50 to 100 m (150 to 300 ft).



2) Sight the reflecting prism centre and take the horizontal and vertical angle readings. (H and Z respectively)



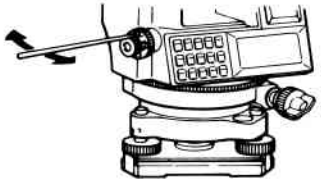
3) In Basic mode, press ENT SHFT + ·8· on the keyboard and check that "**Signal ∗**" is displayed.

4) Four more readings are necessary.
Turn the horizontal or vertical fine motion screw slowly until the return signal "✱" mark goes off. Then take readings.
Readings H_l, H_r: when the telescope is directed to the left (right) of the sighted direction in 2) above.
Readings Z_a, Z_b: when the telescope is directed above (below) the sighted direction in 2) above.

5) Check the differences of H_l (H_r) against H, and Z_a (Z_b) against Z.
When the four differences obtained are all larger than 2.5' (0.046 gon), the coincidence is normal. If the differences obtained are less than 2.5' (0.046 gon), please contact our agent.

18.1.5 Optical plummet

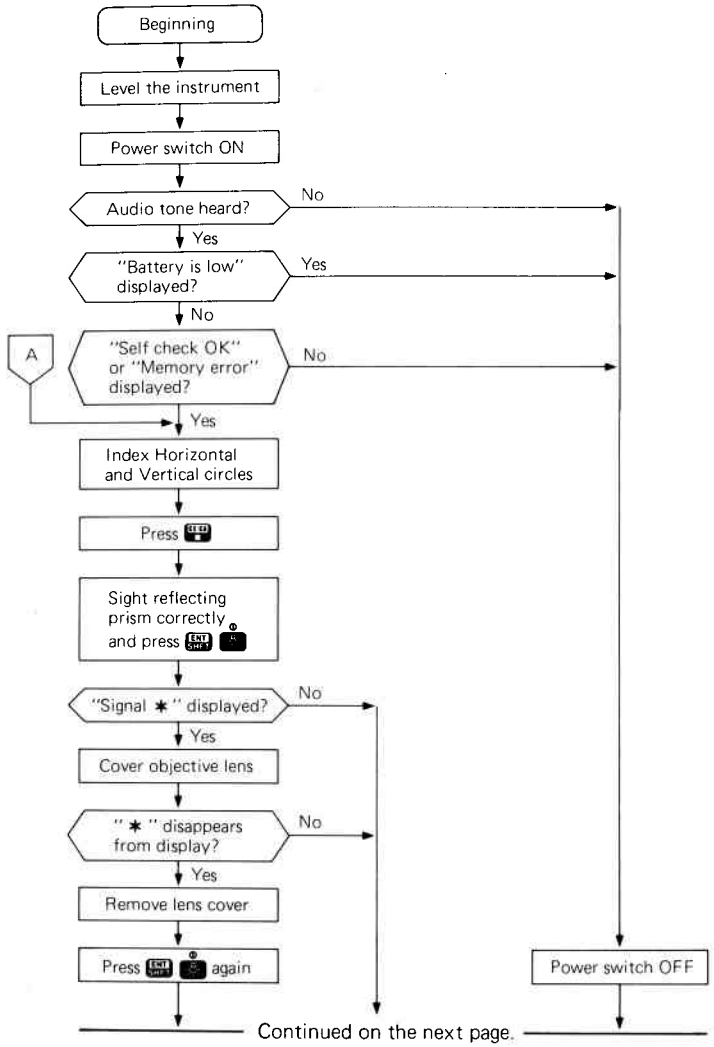
1) Level the SET2B. Centre a surveying point in the reticle of the optical plummet. Loosen the horizontal clamp and turn the upper part through 180° (200 gon). If the surveying point is still centred, no adjustment is necessary.
2) If the surveying point is off-centre, correct half the deviation with the four adjusting screws, and correct the remaining half with the levelling screws.

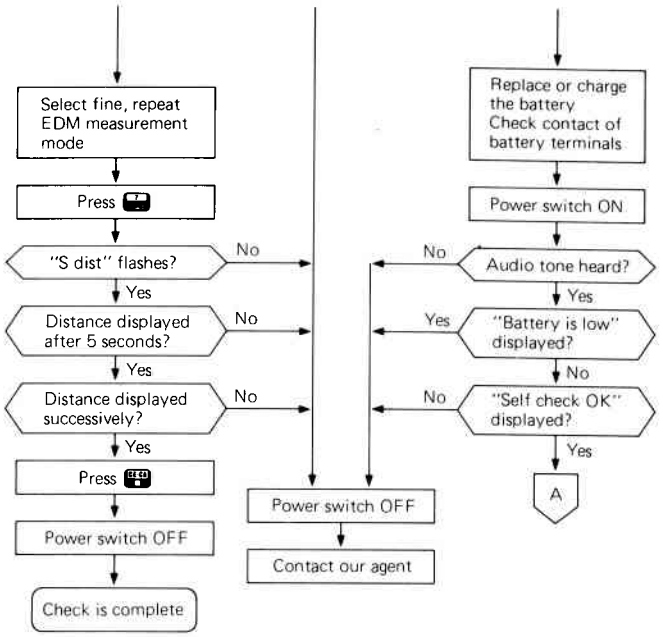


3) Repeat the adjustment if necessary.

18.2 DISTANCE MEASURING FUNCTION

18.2.1 Check flow chart





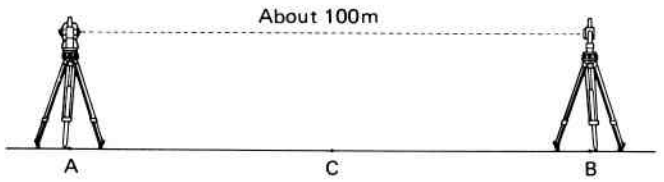
Note: If error codes EXXX are displayed, please contact your Sokkisha agent.

18.2.2 Additive distance constant

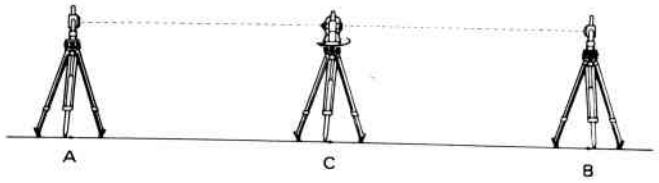
The additive distance constant of the SET2B is adjusted to 0 before delivery. However, the additive constant can change with time and so should be determined periodically and then used to correct distances measured.

1) Determining the additive distance constant.
   The most reliable method of determining the additive distance constant is to test the SET2B on an established base line with a maximum range of approximately 1,000 m, and with 6 to 8 intermediate stations spaced at multiples of the instrument unit length, which is 10 m. Fine measurement should be taken in all combinations of the 6 to 8 stations.
   If an additive distance constant of greater than 3 mm is found please contact our agent.
2) Confirmation of the additive distance constant K if a base line is not available.
   a. Select points A and B on flat ground about 100 m (300 ft) and C in the middle.
   b. Set up the SET2B at A, and measure (fine measurement) the distance AB.

   Note: Be sure prism height is the same as the height of the SET2B objective lens centre. If ground is not level, use an automatic level to set correct instrument heights of all points.



c. Shift the SET2B to C, and measure the distance CA and CB.



d. Compute the additive distance error K using the formula:

$$K = \overline{AB} - (\overline{CA} + \overline{CB})$$

$\overline{AB}, \overline{CA}, \overline{CB}$: Average of ten measurements.

e. Obtain the K value three times. If all K are greater than 3 mm, contact our agent.

19. FOR ANGLE MEASUREMENT OF THE HIGHEST ACCURACY

19.1 LEVELLING BY REFERRING TO THE DISPLAY

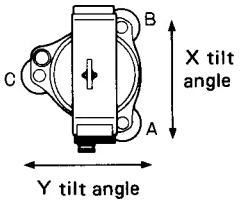
For the most accurate measurement of horizontal angles, particularly for steep observations, the SET2B should be levelled using the tilt angle display. The index error of the tilt angle can be eliminated by taking readings on 0° and 180°.

Note: To display the tilt angles, the "Tilt correction (dual axis)" parameter must be set to "On" (⊥+ symbol shown in small upper display). See page 43–.

1) Level the SET2B with the plate level ㉖.
2) Tighten the vertical clamp ㉘ with the telescope approximately horizontal.
3) Use the horizontal clamp ㉒ to turn the upper part of the SET2B until the plate level is parallel to a line between levelling screws A and B. Then, in theodolite mode, press ENT SHFT + 0 SET 0 REC to set the horizontal angle to 0° (0 gon).

ZA	89°12'34"
HAR	0°00'00"

4) Press 3 to display the X and Y tilt angle.



Tilt angle	
X	0°00'09"
Y	-0°00'10"

5) Wait for a few seconds until the tilt angle reading is steady. Then press ENT SHFT + 0 SET 0 REC.

Tilt angle Face 2	
HAR	0°00'00"

6) Turn the upper part of the SET2B through 180° (200 gon).

Tilt angle
Face 2
HAR 180°00'00"

7) Wait for a few seconds until the angle reading is steady. Then press ENT SHFT + 0 SET 0 REC to display the corrected X and Y tilt angle values.

Tilt angle	
X	0°00'13"
Y	-0°00'07"

8) Referring to the displayed tilt angle values, level the SET2B using levelling screws A and B until the displayed X value is 0°±1", then use levelling screw C until the displayed Y axis value is 0°±1".
The vertical axis levelling errors have now been minimized.

Tilt angle	
X	0°00'00"
Y	0°00'00"

9) Press CE·CA to return to theodolite mode, or press 3 to go to Basic mode.

Note: The index correction is lost when the SET2B is switched off.

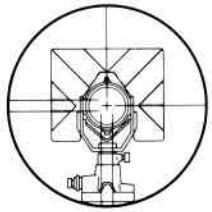
19.2 MANUALLY INDEXING VERTICAL CIRCLE BY FACE LEFT, FACE RIGHT READINGS

Like every theodolite, the SET2B will have a vertical index error. For angle measurement of the highest accuracy, the vertical index error can be removed as follows.

1) From the Basic mode, press 1 MENU + 2 ◁▷ to enter the instrument parameters mode. Select the "**V indexing**" parameter and change the setting to "**2. Manual**" (See page 43– for more information.). Press CE·CA to exit to the Basic mode, and switch off the instrument.
2) Ensure that the SET2B is level, switch on the instrument and make sure that the display appears as shown below:

ZA	Face 1
HAR	0 SET

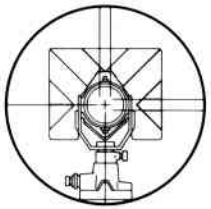
3) In face left (V1), accurately sight a clear target at a horizontal distance of about 30 m (100 ft).



4) Press ENT SHFT and 0 SET 0 REC.

ZA	Face 2
HAR	0 SET

5) Next, in face right (V2), accurately sight the same target.



6) Press [ENT SHFT] and [0 SET / 0 REC]. When the vertical circle is indexed, the display appears as below.

ZA	289°56'00"
HAR	0 SET

- If the power switch has been turned OFF, the vertical circle must be indexed again.
  When moving the SET2B after measurement, turn the power OFF.
- Index the horizontal circle.

20. FOR DISTANCE MEASUREMENT OF THE HIGHEST ACCURACY

20.1 ACCURACY OF MEASUREMENT OF ATMOSPHERIC CONDITIONS

The relation between measured distance and the velocity of light is given by

$$D = \frac{T}{2} C = \frac{T}{2} \frac{C_o}{n}$$

T: The period between light emission and reception.
C: The velocity of light in the air.
C_o: The velocity of light in a vacuum.
n: Refractive index of the air.

The measured distance is affected by variation in the refractive index

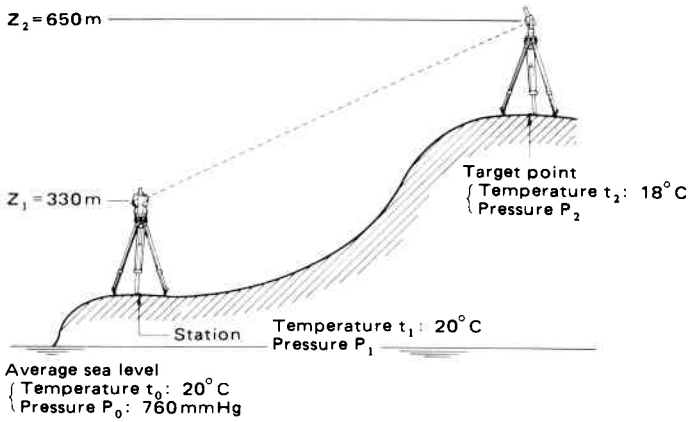
$$\frac{dD}{D} = -\frac{dn}{n} \fallingdotseq dn \text{ (or } dD \fallingdotseq D \cdot dn)$$

Therefore, the accuracy of measurement of the refractive index must be the same as that of the measured distance.
To calculate refractive index to an accuracy of 2 ppm, temperature must be measured to within 1°C and pressure to within 5 mmHg.

20.2 TO OBTAIN THE ATMOSPHERIC PRESSURE

To obtain the average refractive index of the air throughout the measured light path, you should use the average atmospheric pressure.
In flat terrain there is little variation in the atmospheric pressure. In mountains, the following calculation should be used.

Example:



By the Laplace formula

$$Z_n - Z_0 = 18{,}400 \left(1 + 0.00367 \frac{t_n + t_0}{2}\right) \text{Log} (P_0/P_n)$$

t: Temperature (°C)
Z: Height above sea level (m)
P: Pressure (mmHg)

$$P_n = 10^{\left\{\text{Log } P_0 - \frac{Z_n - Z_0}{18{,}400\left[1 + 0.00367\left(\frac{t_n + t_0}{2}\right)\right]}\right\}}$$

P_0 = 760 mmHg Z_1 = 330 m Z_2 = 650 m
t_0 = 20°C t_1 = 20°C t_2 = 18°C

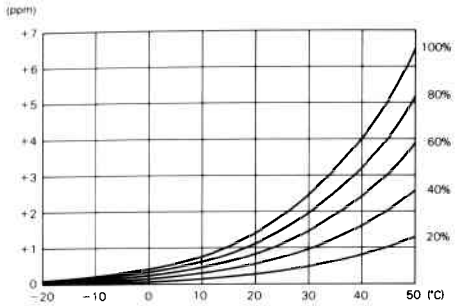
$$P_1 = 10^{\left\{\text{Log } 760 - \frac{330}{18{,}400\,(1 + 0.00367 \times 20)}\right\}} \fallingdotseq 731$$

$$P_2 = 10^{\left\{\text{Log } 760 - \frac{650}{18{,}400\,(1 + 0.00367 \times 19)}\right\}} \fallingdotseq 704$$

Average pressure: 717.5 mmHg

20.3 INFLUENCE OF RELATIVE HUMIDITY

The influence of humidity is very small.
It is mainly of importance in very hot and humid conditions.



Correction factor (ppm)

$$= \frac{0.0615 \times e\ (\text{mbar})}{1 + 0.003661 \times t\ (°\text{C})}$$

e: Partial water vapour pressure
t: Temperature

If you take the influence of relative humidity into account, please compute the distance D' by the following method.

1) Enter temperature and pressure values, the correction factor A is calculated and displayed on the sub display.
   And measure the distance.... D
2) Measure the relative humidity and read the correction factor B from above table.
3) Compute the distance D' using the following formula.

$$D' = \frac{1 + (A + B)\ 10^{-6}}{1 + A \times 10^{-6}} \times D\ (\text{m})$$

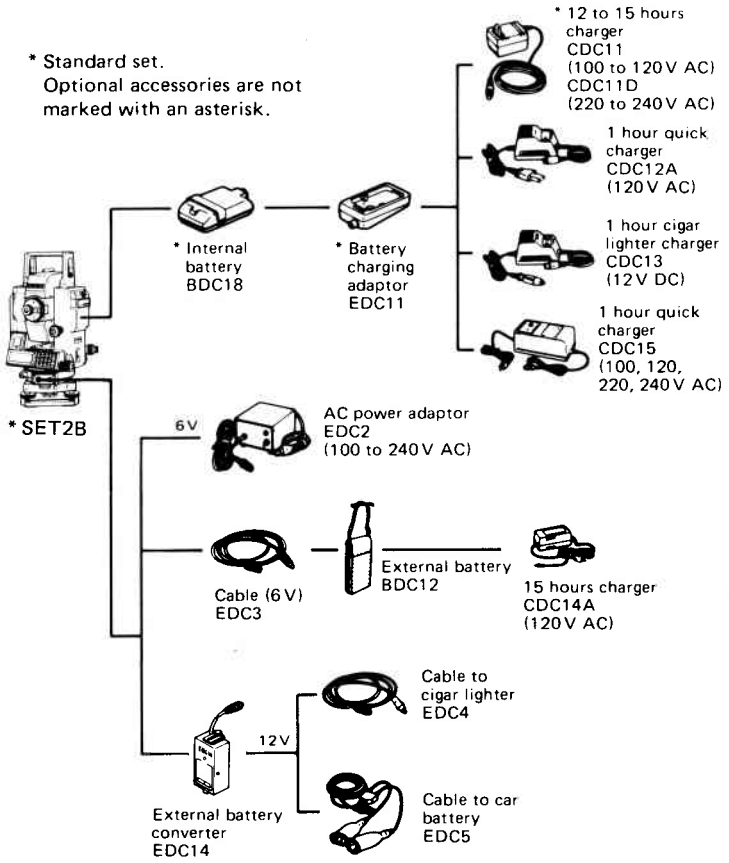
e.g. Temperature 30°C, Pressure 1,020 mbar,
Relative humidity 80%,
Measured distance displayed on SET2B, D = 3,000 m.

A = 12 (sub display), B = 2 (above table)

$$D' = \frac{1 + (12\ \text{ppm} + 2\ \text{ppm}) \times 10^{-6}}{1 + 12\ \text{ppm} \times 10^{-6}} \times 3{,}000\ \text{m}$$
$$= 3{,}000.0059\ \text{m}$$

21. POWER SUPPLIES

The SET2B can be operated with the following combinations:



Use the SET2B only with the combinations shown here.

Note: When using the SET2B with external power supplies, it is recommended that for the most accurate angle measurements, the BDC18 battery be left in place to balance the weight on the axes.

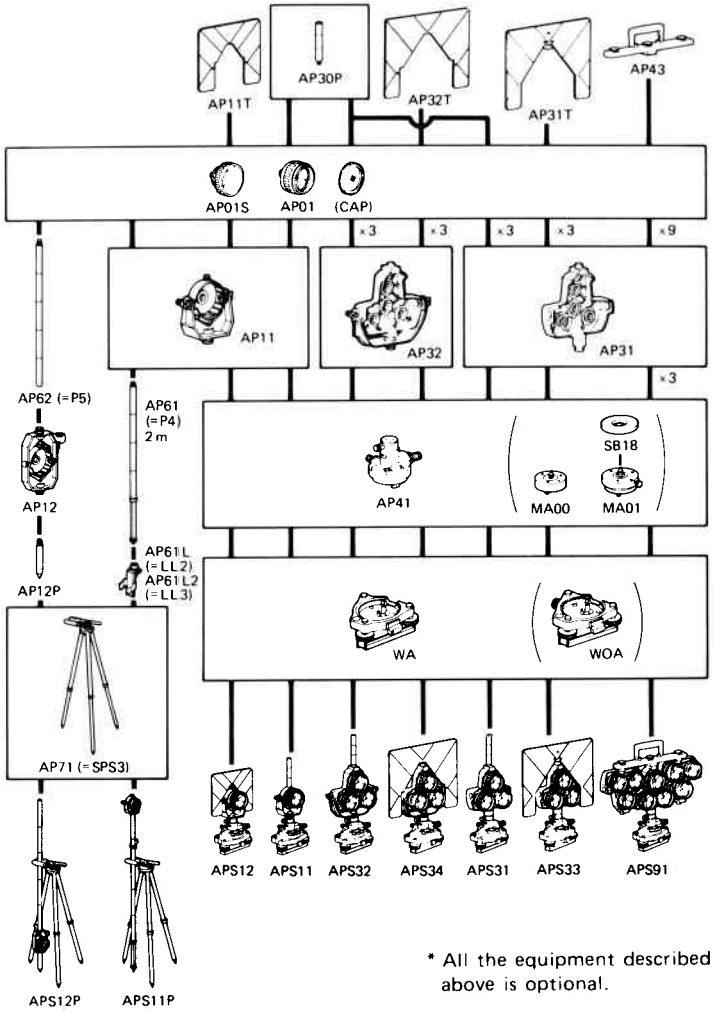
Battery charging precautions

To charge the battery, use only the recommended charger.

1) Charge the battery at least once a month if it is not used for a long time.
2) Charge the battery at a temperature between 10°C and 40°C.
3) Before using EDC2 or CDC15, set the voltage selector to the proper voltage.
4) EDC14 has a breaker switch. Normally the red mark appears on the breaker. If not, set the red mark in place.
5) When using a car battery, make sure that the polarity is correct.
6) Make sure that the cigar lighter has 12 V output and that the negative terminal is grounded.
7) When charging the battery, first connect it to the battery charger and then connect the charger to the power supply. Check that the battery charger light is on. If not switch power supply off and on again until the light comes on.
8) The battery charger may become warm while charging. This is normal.
9) Do not charge the battery for any longer than specified.
10) Store the battery in a place where the temperature is between 0°C and 40°C.
11) Battery operating life is shortened at extreme temperatures.

22. REFLECTING PRISMS AND ACCESSORIES

All SOKKIA reflecting prisms and their accessories have standardized screws (5/8" x 11 thread) for easy compatibility.

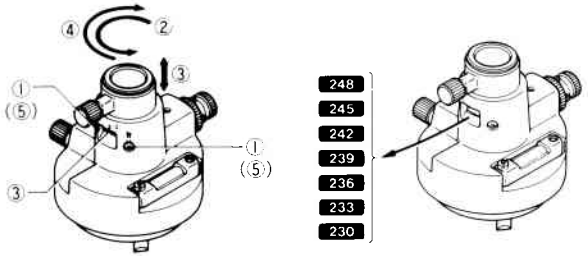


* All the equipment described above is optional.

Target fluorescent paint finishing allows clearer sighting in adverse observing conditions.

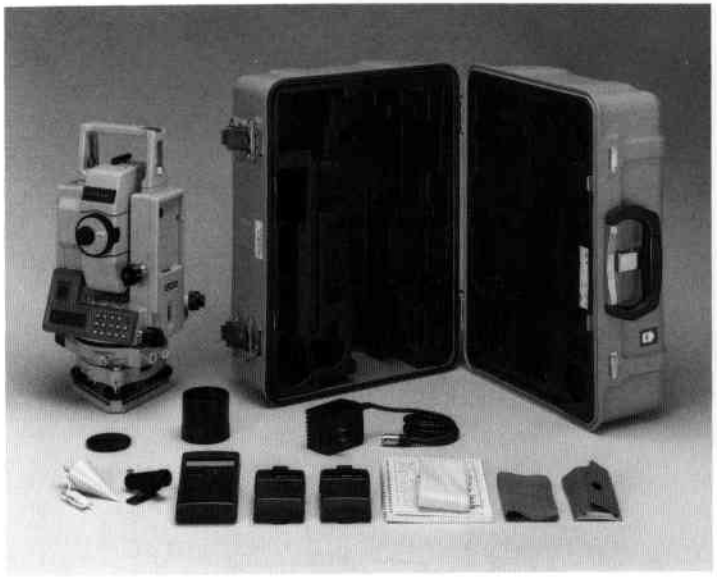
Precautions

1) Carefully face the reflecting prism towards the instrument; sight the target centre accurately.
2) 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 triple prism holder.
3) Check that "236" (the height of the SET2B) is displayed in the window of the instrument height adaptor AP41.
   The height of the AP41 can be adjusted as follows:
   ① Loosen the two fixing screws.
   ② Turn the centre part counterclockwise to unlock it.
   ③ Move it up or down until "236" appears in the window.
   ④ Turn the centre part clockwise to re-lock it.
   ⑤ Tighten the fixing screws.



4) Use the plate level on the AP41 to adjust the tribrach circular level as in 18.1.2.
5) Check the optical plummet of the AP41 as in 18.1.5.
   After all checks and adjustments have been completed, make sure that the AP41 optical plummet sights the same point as the optical plummet of the SET2B.

23. STANDARD EQUIPMENT



SET2B main unit	1	Vinyl cover	1
Internal battery, BDC18	2	Plumb bob	1
Battery charger, CDC11/CDC11D	1	Tool pouch	1
Battery charging adaptor, EDC11	1	Screwdriver	1
Tubular compass, CP7 (accuracy: ±1°)	1	Lens brush	1
Lens cap	1	Adjusting pin	2
Lens hood	1	Cleaning cloth	1
		Operator's manual	1
		Carrying case, SC78	1

24. OPTIONAL ACCESSORIES

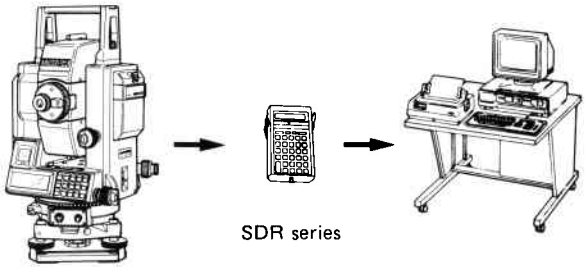
24.1 INTERFACE CABLES DOC1, DOC25/DOC26/DOC27

The interface cable DOC1 can be used for direct two-way communication between the SET2B 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

24.2 ELECTRONIC FIELD BOOK SDR SERIES

The SDR series collects and stores slope distance, zenith and horizontal angle data from the SET2B.
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.



SDR series

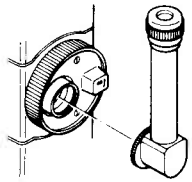
SDR series specifications

Power source:	"AA" (UM3) x 4
Memory type:	CMOS
RAM	32, 64 or 128 K
ROM	64 K
Keyboard:	33 keys
Display:	LCD
Baud rate:	300, 600, 1200, 2400, 4800, 9600 bps
Operating temperature range:	0 to 50°C (32 to 122°F)
Weight:	450 g (1 lb)

24.3 DIAGONAL EYEPIECE DE18

The diagonal eyepiece is convenient for steep observations and in places where space around the instrument is limited.
Remove the eyepiece ㉛ by loosening the mounting ring, and screw in the diagonal eyepiece.

Setting up the DE18



24.4 SOLAR FILTER OF2/OF2A

For observations to the sun, and where glare is present. The OF2 and OF2A (flip-up type) filters are mounted on the objective lens.

OF2

OF2A

25. SPECIFICATIONS

Distance measurement

Range:

Average conditions: (Slight haze, visibility about 20 km, sunny periods, weak scintillation)

Compact prism CP01: 1.3 m to 800 m (2,600 ft)
Standard prism APx1: 1.3 m to 2,400 m (7,800 ft)
Standard prism APx3: 1.3 m to 3,100 m (10,100 ft)
Standard prism APx9: 1.3 m to 3,700 m (12,100 ft)

Standard deviation: Fine meas.: ± (3 mm + 2 ppm•D)
Coarse meas.: ± (5 mm + 5 ppm•D)

Display: 2 LCD dot matrix displays; main display (48 characters) and sub display (12 characters) on each instrument face.
Maximum slope distance 9,999.999 m (32,808.33 ft).

Minimum display: Fine measurement: 1 mm (0.01 ft)
Coarse measurement: 1 mm (0.01 ft)
Tracking measurement: 10 mm (0.1 ft)

Measuring time:

	Mode		
	Fine measurement	Coarse measurement	Tracking measurement
Slope distance	4.9 s + every 3.2 s	1.8 s + every 0.8 s	1.6 s + every 0.3 s
Horizontal distance	4.9 s + every 3.3 s	2.0 s + every 0.8 s	1.8 s + every 0.3 s
Height difference			
Coordinates	5.3 s + every 3.3 s	2.5 s + every 0.8 s	2.2 s + every 0.7 s
Remote elevation	0.7 s + every 0.5 s		
Horizontal distance between two points	5.8 s + every 3.3 s	3.0 s + every 0.8 s	2.8 s + every 0.7 s

(When tilt compensation and "C + R correction" are not being applied.)

Atmospheric correction:	Input temperature and pressure for automatic ppm calculation to nearest 1 ppm.
Input temperature range:	-30°C to +60°C (°C/°F selectable)
Input pressure range:	500 mb to 1,400 mb (mb/mmHg/inchHg selectable)
Prism constant correction:	-99 mm to +99 mm (in 1 mm steps)
Earth-curvature and refraction correction:	Selectable ON/OFF
Audio target acquisition:	Selectable ON/OFF
Signal source:	Infrared LED
Light intensity control:	Automatic

Angle measurement

Telescope

Length:	177 mm (7 inches)
Aperture:	45 mm (1.8 inches)
Magnification:	30 x
Resolving power:	3"
Image:	Erect
Field of view:	1°30' (26 m/1,000 m)
Minimum focus:	1.3 m (4.3 ft)
Reticle illumination:	Bright or dim settings

Horizontal and Vertical circles

Type:	Incremental with 0 index
Minimum display:	1" (0.2 mgon)
Accuracy	Standard deviation of mean of measurement taken in positions I and II (DIN 18723)
H:	2" (0.6 mgon)
V:	2" (0.6 mgon)
Automatic compensator	Selectable ON/OFF
Type:	Liquid, 2-axis tilt sensor
Minimum display:	1" (0.2 mgon)
Range of compensation:	±3'

Display

Range:	-1,999°59'59" to 1,999°59'59" (-1,999.9998 gon to 1,999.9998 gon)

Measuring mode

Horizontal angle:	Right/Left/Repetition of angles
Vertical angle:	Zenith 0° (0 gon) or Horizontal 0° (0 gon) or Horizontal 0°±90° (0 gon ± 100 gon)
Measuring time:	Less than 0.5 s

Sensitivity of levels

Plate level:	20"/2 mm
Circular level:	10'/2 mm

Optical plummet

Image:	Erect
Magnification:	3 x
Minimum focus:	0.1 m (0.3 ft)
Data input/output:	Asynchronous serial, RS-232C compatible
Self-diagnostic function:	Provided
Power saving cut off:	30 minutes after operation
Operating temperature:	-20°C to +50°C (-4°F to +122°F)
Power source:	Ni-Cd battery, BDC18 (6V)
Working duration at 25°C (77°F):	Distance & Angle measurement: 2.3 hours (about 2,100 points) (Coarse measurement mode, Single measurement, Measurement interval = every 4 seconds) Angle measurement only at 25°C: 9 hours Using optional battery BDC12; Angle and distance: 16 hours
Charging time:	12 to 15 hours, standard charger CDC11/CDC11D (depending on input voltages) (1 hour, optional charger CDC12A, CDC13, CDC15.)
Instrument height:	236 mm
Size:	168 (W) x 177 (D) x 371 (H) mm (Without handle: H: 330 mm)
Weight:	7.4 kg (w/internal battery)

26. 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) Store the SET2B in a dry room where the temperature remains fairly constant.
4) If the battery is discharged excessively, its life may be shortened. Store it in a charged state.
5) Check the tripod for loose fit and loose screws.

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.

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B146 92.03.02.O Printed in Japan