ELECTRONIC TOTAL STATION
SET3
OPERATOR'S MANUAL

LIETZ/SOKKISHA

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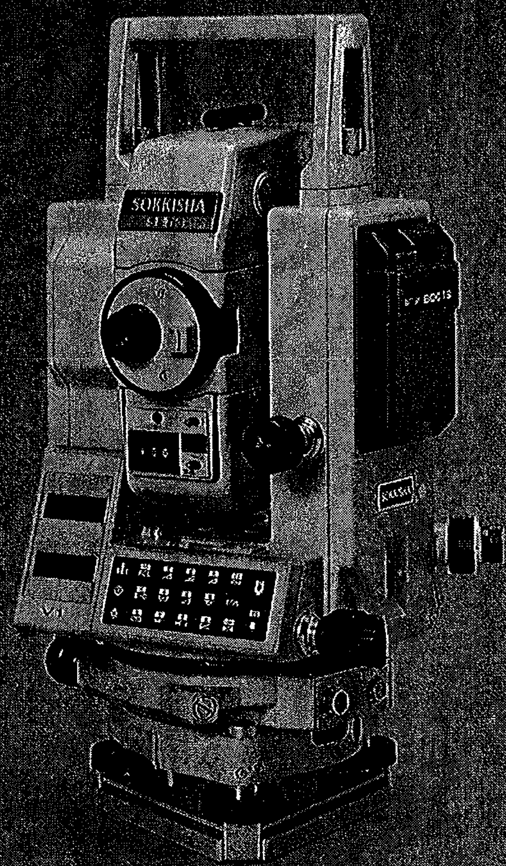

SOKKIA

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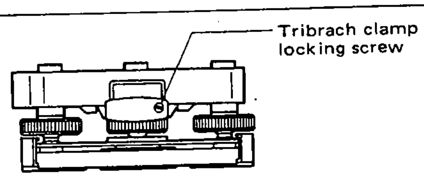
CONTENTS



IMPORTANT
When the new SET3 is shipped, the tribrach clamp is fixed with a screw. Loosen it and leave it loose.

1. PARTS OF THE INSTRUMENT

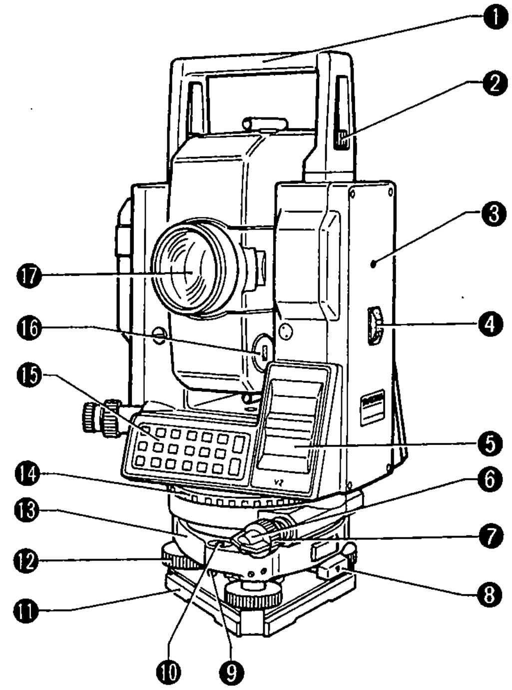


Fig. 1.1

- ❶ Handle
- ❷ Handle securing screw
- ❸ Instrument height mark
- ❹ Internal switch cover
- ❺ Display
- ❻ Lower clamp
- ❼ Lower fine motion screw
- ❽ Tribrach clamp
- ❾ Circular level adjusting screw
- ❿ Circular level
- ⓫ Base plate
- ⓬ Levelling foot screw
- ⓭ Tribrach
- ⓮ Horizontal circle positioning ring
- ⓯ Keyboard
- ⓰ Prism constant switch cover
- ⓱ Objective lens

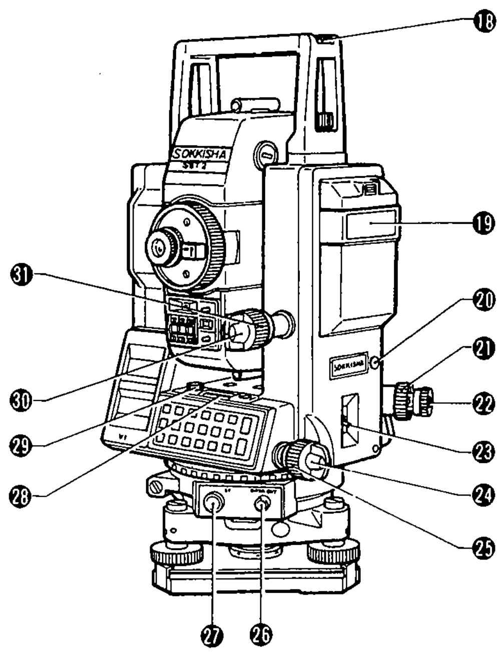


Fig. 1.2

⑱ Tubular compass slot
⑲ Battery, BDC18
⑳ Sensor index adjustment cover
㉑ Optical plummet focussing ring
㉒ Optical plummet eyepiece
㉓ Power switch
㉔ Horizontal clamp
㉕ Horizontal fine motion screw
㉖ Data output connector
㉗ External power source connector
㉘ Plate level
㉙ Plate level adjusting screw
㉚ Vertical clamp
㉛ Vertical fine motion screw

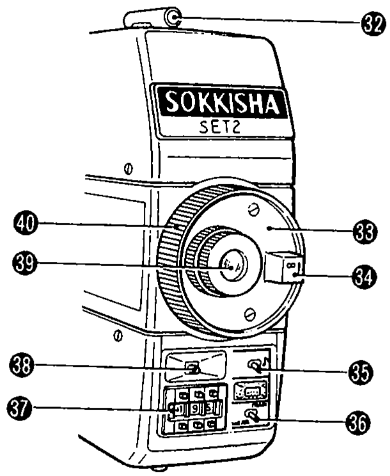


Fig. 1.3

32. Peep sight
33. Telescope reticle adjustment cover
34. Telescope plunging knob
35. Return signal audio switch
36. Measure/track switch
37. ppm switch
38. Return signal lamp
39. Telescope eyepiece
40. Telescope focussing ring

2. FEATURES

- Horizontal angle, zenith angle, slope distance, horizontal distance, height difference, N- and E-coordinates are displayed by key operation.
- Horizontal distance between two prism points and remote measurement of objects above and below a prism point are automatically calculated. A stake-out function by distance and N- and E-coordinates is standard.
- Self-diagnostic function. If, for any reason, the SET3 is not functioning correctly during use, an error code is displayed.
- Angle resolution can be set to 1" (0.2 mgon) or 5" (1 mgon).
- The tilt angle of the vertical axis can be measured by the internal sensor and displayed. By referring to the display, the SET3 can be levelled. The zenith angle is automatically compensated by the tilt sensor and the compensated angle displayed.
- Horizontal circle can be set to zero in any direction.
- The SET3 automatically switches off 30 minutes after the last operation to save battery power.
- An RS-232C data-out connector is standard.

3. SPECIFICATIONS

Distance measurement

Range: (When using Sokkisha standard reflecting prisms)

Average conditions:	(Slight haze, visibility about 20 km, sunny periods, weak scintillation) 1-prism 1,900 m (6,300 ft) 3-prism 2,600 m (8,600 ft)
Good conditions:	(No haze, visibility about 40 km, overcast, no scintillation) 1-prism 2,200 m (7,300 ft) 3-prism 3,000 m (9,900 ft)
Standard deviation	±(5 mm + 3 ppm · D)
Display:	LCD 8-digit Four display windows, two on each face Maximum slope distance 9,999.999 m (19,999.99 ft)
Minimum display:	MEAS. 1 mm (0.01 ft) TRACK. 10 mm (0.1 ft)

Measuring time:

	Mode	
	MEAS.	TRACK.
Slope distance	7 s + every 5 s	7 s + every 0.4 s
Horizontal distance		7 s + every 0.7 s
Height difference		
Coordinates		7 s + every 1 s
Remote elevation	1 s + every 0.5 s	
Horizontal distance between two points	8 s + every 5 s	8 s + every 1 s

Atmospheric correction:	-99 ppm to +199 ppm (1 ppm per step)
Prism constant correction:	-99 mm to +59 mm (1 mm per step)
Earth-curvature and refraction correction:	Selectable ON/OFF
Audio target aquisition:	Selectable ON/OFF
Signal source:	Infrared LED
Light intensity control:	Automatic

ıgle measurement

ːlescope

Length:	177 mm (7.0 inch)
Aperture:	45 mm (1.8 inch), EDM: 50 mm (2.0 inch)
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)

lorizontal circle

Type:	Incremental
Minimum display:	1" (0.2 mgon)

/ertical circle

Type:	Incremental with 0 index
Minimum display:	1" (0.2 mgon)
\ccuracy	Standard deviation of mean of measurement taken in positions I and II (DIN 18723)
H:	3" (0.9 mgon)
V:	3" (0.9 mgon)

Automatic compensator	Selectable ON/OFF
Type:	Liquid
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:	30"/2 mm
Circular level:	10'/2 mm
Optical plummet	
Image:	Erect
Magnification:	3x
Minimum focus:	0.1 m
Data 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:	About 600 measurement at 25°C, distance and angle measurement; 13 hours at 25°C, angle measurement only. (About 4,000 measurements, distance and angle measurement; 90 hours at 25°C, angle measurement only, with optional battery BDC12.)
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 (9.29 inch)
Size (without handle):	168 (W) x 177 (D) x 330 (H) mm (6.6 x 7.0 x 13.0 inch)
Weight:	7.6 kg (16.8 lbs) (w/internal battery)

4. STANDARD EQUIPMENT

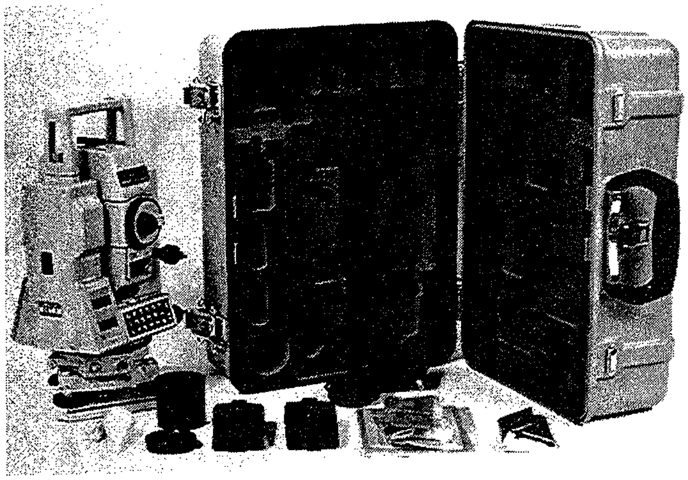


Fig. 4.1

SET3 main unit 1
Internal battery, BDC18 .. 2
Battery charger,
CDC11/CDC11D 1
Battery charging adaptor,
EDC11 1
Tubular compass, CP7
(accuracy: ±1°) 1
Lens cap 1
Lens hood 1
Vinyl cover 1

Plumb bob 1
Tool pouch 1
Screwdriver 1
Lens brush 1
Adjusting pin 2
Cleaning cloth 1
Atmospheric correction
chart 1
Operator's manual 1
Carrying case, SC46 1

5. POWER SUPPLIES

The SET3 can be operated with the following combinations:

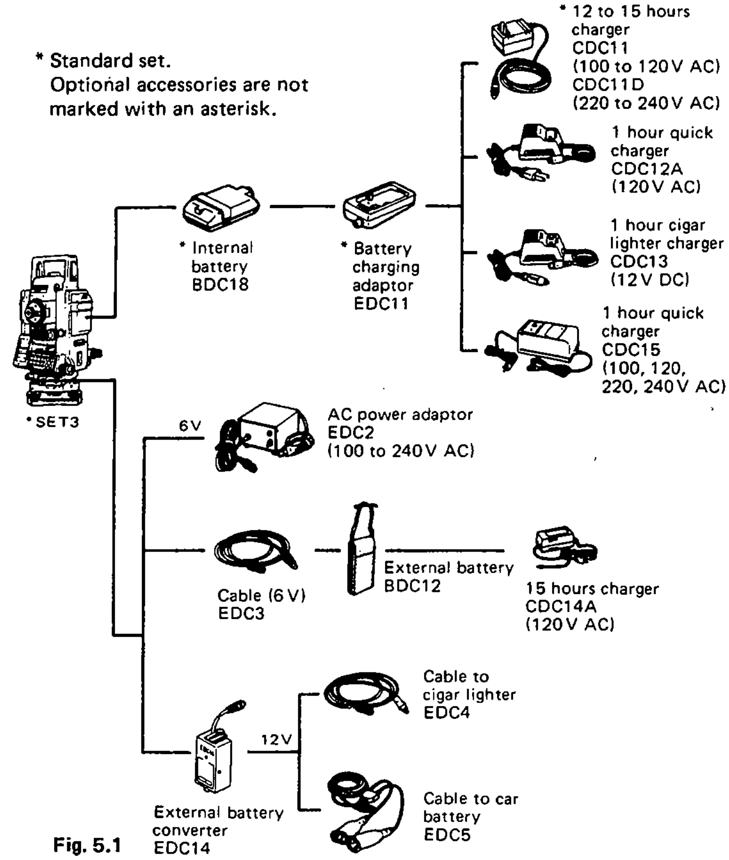


Fig. 5.1

Use the SET3 only with the combinations shown here.

Note: When using the SET3 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 12V 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.

6. REFLECTING PRISMS AND ACCESSORIES

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

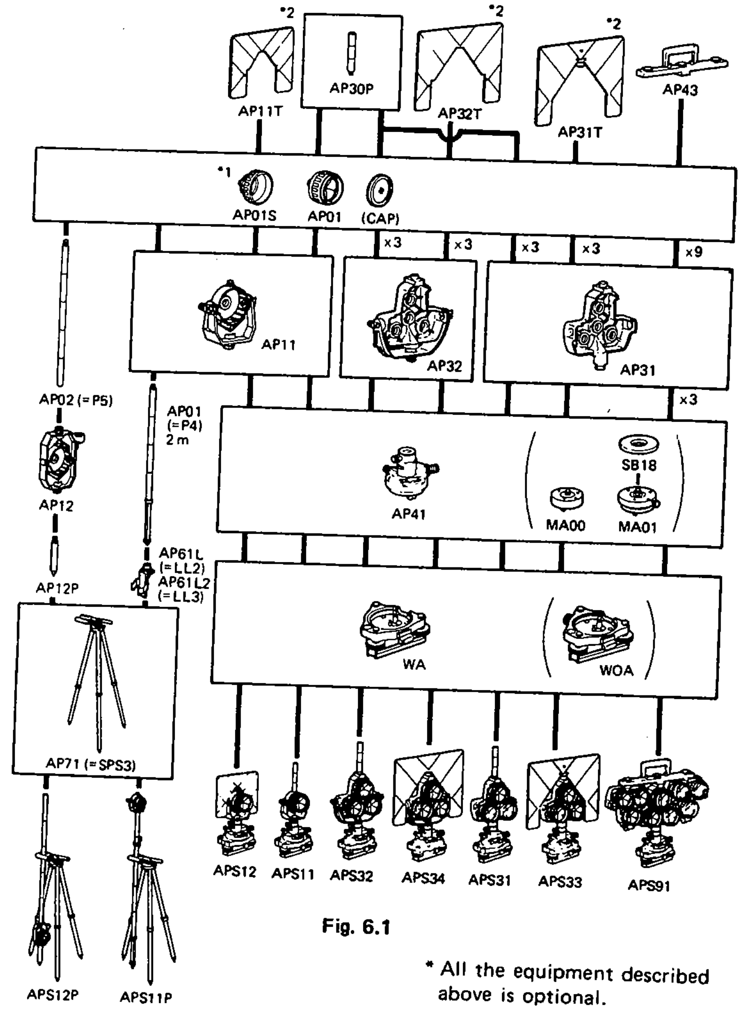


Fig. 6.1

* All the equipment described above is optional.

*1: See 10.3.1 Prism constant correction.
*2: 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 SET3) 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.

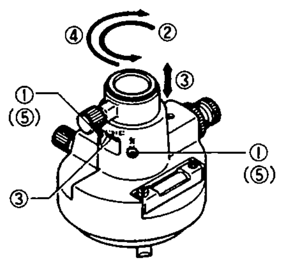


Fig. 6.2

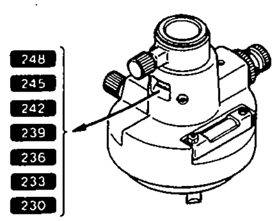


Fig. 6.3

   Note: SET3 instruments with a serial number less than 79301 have a height of 233 mm.

4) Use the plate level on the AP41 to adjust the tribrach circular level as in 13.1.2.
5) Check the optical plummet of the AP41 as in 13.1.7.
   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 SET3.

7. DISPLAY SYMBOLS

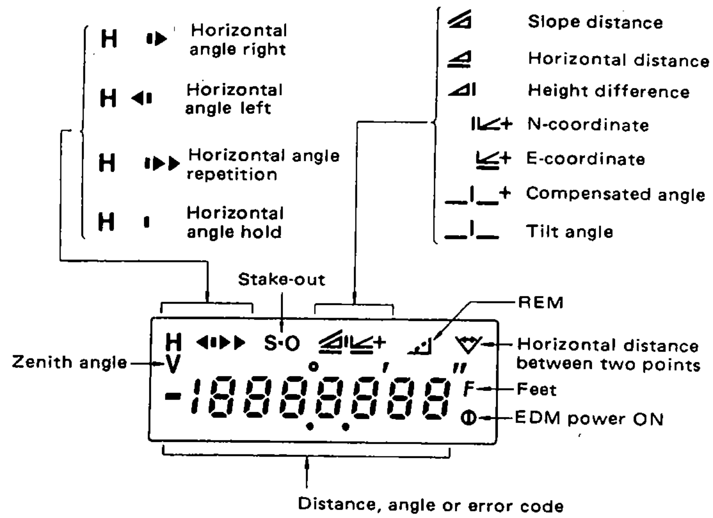


Fig. 7.1

8. KEY FUNCTIONS

SET3 has three measurement modes.
When it is switched on and the vertical circle is indexed by rotating the telescope, it is automatically in the theodolite mode.

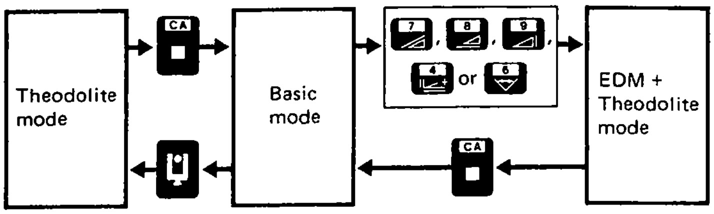


Fig. 8.1

Theodolite mode

Angle measurement.

SET3 accepts , , , , , or keys.

Basic mode

Prism sighting, data entry and recall.

SET3 accepts all keys except , , , or keys.

EDM + Theodolite mode

Angle and distance measurement.

SET3 accepts or keys.

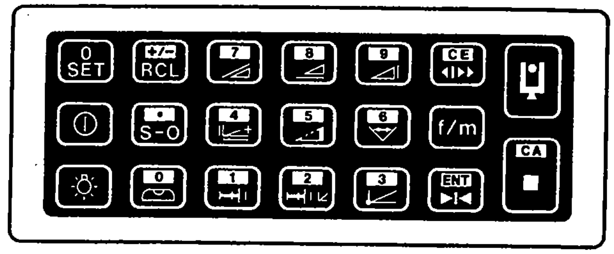


Fig. 8.2

- Select theodolite mode.

- Stop measurement and transfer to basic mode.
- Stop data entry or recall.

- Set horizontal angle to zero.
- Index vertical circle when manual indexing selected.

- Change the sign of data before entry.
- Recall data from memory.

- Enter "7".
- Measure slope distance.

- Enter "8".
- Measure horizontal distance.

- Enter "9".
- Measure height difference.

- Clear entry.
- Select horizontal angle to left, right or by repetition (accumulation).

- EDM power ON/OFF for locating prism.

- Enter decimal point.
- Measure stake-out distance.

- Enter "4".
- Measure N- and E-coordinates.

- Enter "5".
- Measure remote elevation.

- Enter "6".
- Measure horizontal distance between two prism points.

- Convert displayed distance to feet or meters for 5 seconds.

- Illuminate display and reticle of telescope for 30 seconds.

- Enter "0".
- Display vertical axis tilt angle ON/OFF.

- Enter "1".
- Enter stake-out distance.

- Enter "2".
- Enter stake-out N- and E-coordinates.

- Enter "3".
- Enter coordinates of instrument station.

- Transfer entered data to memory.
- Hold/release horizontal angle.

9. INTERNAL SWITCHES

Switches are located under internal switch cover ❹.

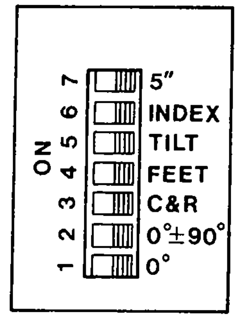


Fig. 9.1

Switch	Function
7	ON Angle resolution 5"/1 mgon * OFF Angle resolution 1"/0.2 mgon
6	ON Manually index vertical circle by V_1, V_2 * OFF Automatically index vertical circle by transitting telescope
5	ON Vertical circle compensator off * OFF Vertical circle compensator on
4	ON Display distance in feet * OFF Display distance in meters
3	ON Distance corrected for earth-curvature and refraction * OFF Distance not corrected for earth-curvature and refraction
2	ON Display vertical angle with 0° (0 gon) horizontal ±90° (100 gon) * OFF Vertical angle display controlled by switch 1
1	ON Display vertical angle with 0° (0 gon) horizontal on face V_1 * OFF Display zenith angle

(The asterisk indicates the position of each switch at the time of shipping from factory.)
Before changing switch settings, turn power switch OFF.

10. OPERATION

10.1 PREPARATION FOR ANGLE MEASUREMENT

10.1.1 Battery, BDC18: Mounting and check

1) Confirm that the power switch ㉓ is OFF.
2) Mount the battery BDC18 in the SET3.
   Hold the left standard when inserting the battery. Push it until a click is heard to indicate correct location. Confirm that the battery is fixed securely.

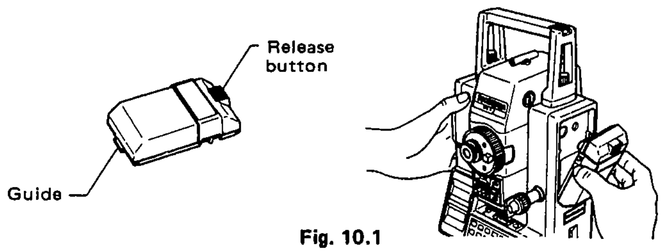


Fig. 10.1

(To remove the battery, turn the power switch OFF and push down the release button of the battery.)

3) Two short audio signals are heard when the power is switched ON. The display shown in ① and then ② indicate the instrument is in normal condition.

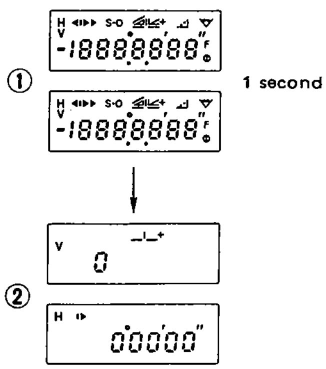


Fig. 10.2

If the battery voltage is too low, the display will appear as shown below. Set the power switch OFF and replace the battery with a charged one, or charge the battery.

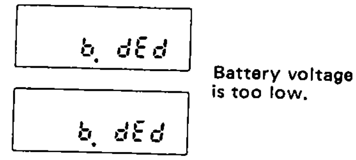


Fig. 10.3

10.1.2 Compensation of zenith angle

1) Remove the switch cover ❹.
2) To use zenith angle with compensation, set switch 5 to OFF with a screw driver. (The factory setting is OFF.)
3) Replace the cover.

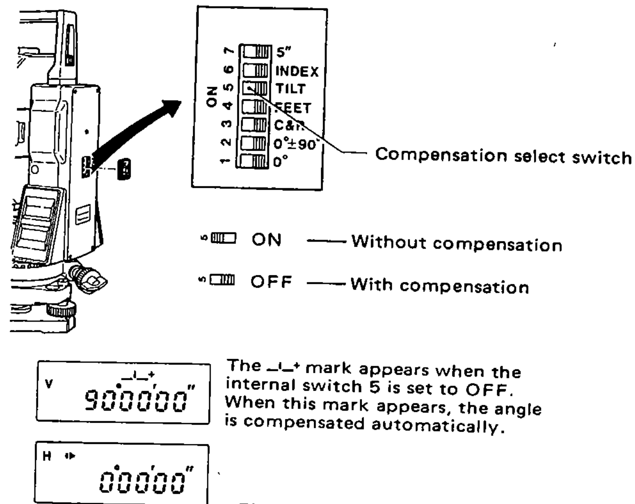


Fig. 10.4

The internal tilt sensor has a range of ±3' and a resolution of 1". Read the automatically compensated zenith angle when the display is steady. When the display is not steady due to vibration or strong wind, set switch 5 to ON to use the SET3 without compensation.

10.1.3 Centring the SET3 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 SET3 on the tripod head. Tighten the centring screw.
3) Focus on the surveying point:
   a. Turn the optical plummet eyepiece ㉒ to focus on the reticle.
   b. Turn the optical plummet focussing ring ㉑ to focus on the surveying point.
4) Turn the levelling foot screws ⑫ to centre the surveying point in the reticle.
5) Observe the off-centre direction of the bubble in the circular level ⑩. 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 ㉘ 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.

10.1.4 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 ㉚ and horizontal clamp ㉔.
   Bring the target into the field of view with the peep sight ㉜. Tighten both clamps.
3) Turn the focussing ring ㊵ and focus on the target.
   Sight the target with the vertical ㉛ and horizontal fine motion screws ㉕. 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.

10.2 ANGLE MEASUREMENT

> Make sure that:
> a. The SET3 is set up correctly over the surveying point.
> b. Battery voltage is adequate.

10.2.1 Automatically indexing vertical circle

1) Turn the power switch ㉓ ON.
   Make sure that the display appears as shown below.

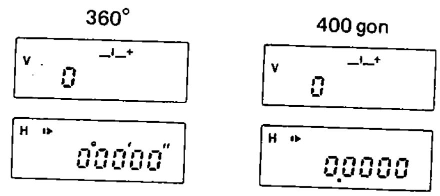


Fig. 10.5

2) Loosen the vertical clamp ㉚, and use the telescope plunging knob ㉞ to rotate the telescope completely.
   (Indexing occurs when the objective lens crosses the horizontal plane in position V1.)
   When the vertical circle is indexed, an audio signal is given and the display appears as below.

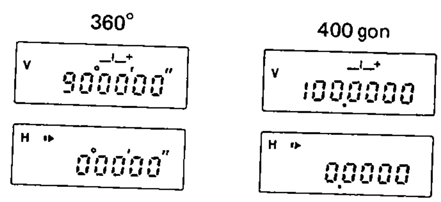


Fig. 10.6

Angle measurement can now begin.

Note: When the power switch is turned off for any reason, the vertical index is lost. When the power switch is turned back on, the vertical index must be redetermined.

10.2.2 Angle measurement

Before this procedure, index the vertical circle.

1) Select theodolite mode by pressing [key].
2) Select the horizontal angle right or left with [CE ◁▷] according to measuring method.

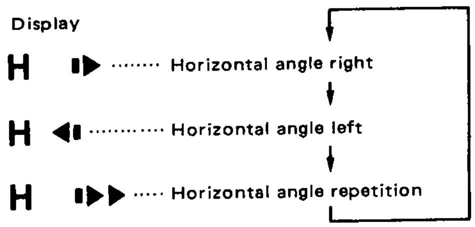


Fig. 10.7

When [CE ◁▷] is pressed, the display changes alternately as shown in Fig. 10.7.

3) Sight the first target A.
4) Press [0 SET] to set the horizontal angle display to 0° (0 gon).

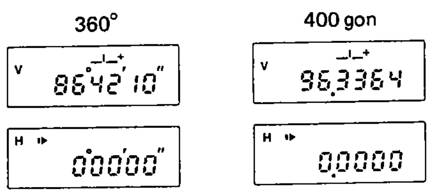


Fig. 10.8

5) Use the horizontal clamp ㉔ and the vertical clamp ㉚ to sight the second target B.

	360°	400 gon
Zenith angle	V 88°03'15"	V 97.8380
Horizontal angle	H 60°40'35"	H 67.4182

Fig. 10.9

The displayed horizontal angle is the angle between targets A and B.

10.2.3 Setting the horizontal circle to a required value

To set the horizontal circle to the reference target, for example 90°10'20" (100.1914 gon):

1) Loosen the horizontal clamp ㉔ and the lower clamp ❻ and hold the upper alidade lightly. Turn the circle positioning ring ⓮ until the display becomes about 90° (100 gon) and tighten both clamps. Turn the horizontal fine motion screw ㉕ until the desired angle is displayed.
2) Press [ENT/HOLD key].

H ▮······ Horizontal angle hold display

Fig. 10.10

360°	400 gon
V 87°12'40"	V 96.9012
H 90°10'20"	H 100.1914

Fig. 10.11

3) Turn the instrument and sight the target.
4) Press [ENT] to release the display hold.
   The required horizontal circle value is now set to the reference target.

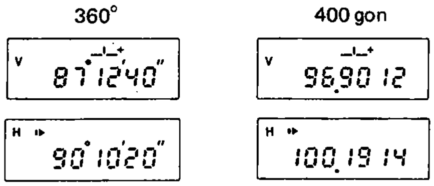


Fig. 10.12

10.2.4 Repetition of angles

Repetition of angles from -1,999°59'59" to 1,999°59'59" (-1,999.9998 gon to 1,999.9998 gon) is displayed by using [CE].

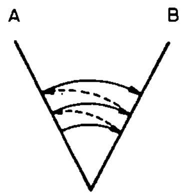


Fig. 10.13

1) Press [CE] to select repetition of angle.

Fig. 10.14

2) Sight target A, and press [0 SET].

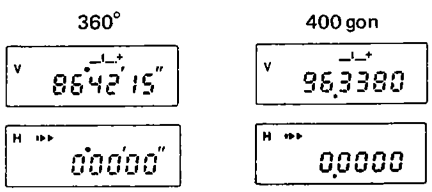


Fig. 10.15

3) Use the horizontal clamp ㉔ and the horizontal fine motion screw ㉕ to sight target B.

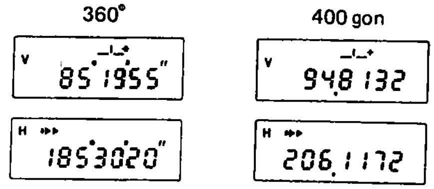


Fig. 10.16

4) Use the lower clamp ❻ and the lower fine motion screw ❼ to turn back to target A.
   Important: Do not turn the horizontal clamp or fine motion screw during this procedure.

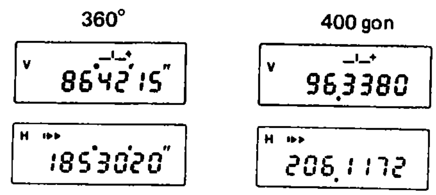


Fig. 10.17

5) Use the horizontal clamp and the horizontal fine motion screw to sight target B.

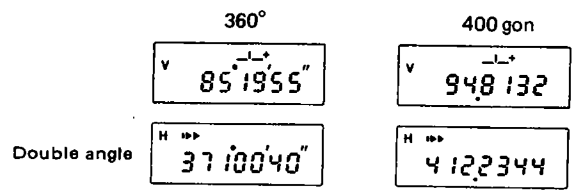


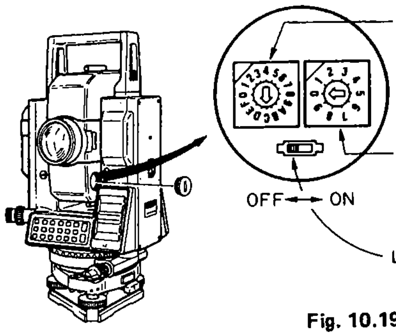
Fig. 10.18

6) Repeat 4), 5) steps to measure repetition of angles.
7) To release the repetition of angle display, press .

10.3 PREPARATION FOR DISTANCE MEASUREMENT

10.3.1 Prism constant correction

1) Remove the prism constant switch cover ⑯ with a coin.
2) Use the screwdriver to turn the x10 mm index and x1 mm index to match the reflecting prism constant correction value.
   Example: Apply a prism constant correction of -30 mm:
   -30 mm = -3 x 10 mm - 0 x 1 mm. Therefore, set the x10 index to C and the x1 index to 0.



SW x10	6	7	8	9	A	B	C	D	E	F
	-9	-8	-7	-6	-5	-4	-3	-2	-1	-0
	0	1	2	3	4	5				
	+0	+1	+2	+3	+4	+5				

SW x1	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

Sign +/- corresponds to SWx10 sign.

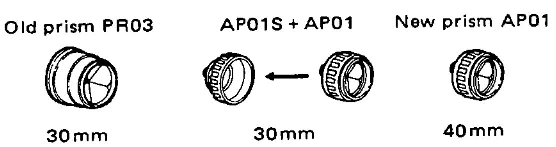
Leave this switch OFF.

Fig. 10.19A

3) Replace the cover.

Prism constant values of Sokkisha reflecting prisms.

The prism constant of the AP series prisms is 30 mm (the same value as the previous Sokkisha prism) using the prism spacer AP01S (standard accessory). The constant can be changed to 40 mm by removing the prism spacer.



Prism constant value

Fig. 10.19B

When using reflecting prisms with constant values other than the above, a prism constant correction of -99 mm to +59 mm can be set in steps of 1 mm using the x10 and x1 indices.

10.3.2 Atmospheric correction

The SET3 is designed so that the correction factor is 0 for a temperature of +15°C and an atmospheric pressure of 760 mmHg. The correction factor is obtained from the pressure and temperature as follows.

1) Measure the temperature and atmospheric pressure with a thermometer and a barometer.
   Pressure can be obtained from weather station sea level data by correcting for altitude. For altitude correction see 15.2.
   To convert millibars to mmHg, multiply by 0.75
   Example: 959 millibars
   0.75 x 959 = 719 mmHg

2) Read the correction factor from the atmospheric correction table on pages 70 and 71.
   Example: Temperature +25°C
   Atmospheric pressure 750 mmHg
   Correction factor is +13 ppm.

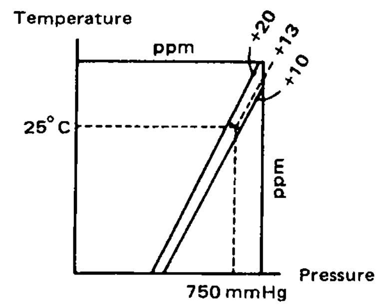


Fig. 10.20

3) Set the ppm switch ㊲ to +13.

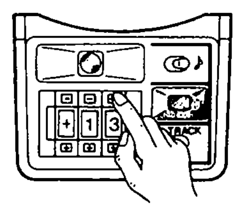


Fig. 10.21

4) To obtain the atmospheric correction factor by computation.
Example A: Using pressure in mmHg.

$$\text{Atmospheric correction factor } X = 278.96 - \frac{0.3872 \times P}{1 + 0.003661 \times t}$$

P: Atmospheric pressure in mmHg
t: Temperature in centigrade
Ex.: P = 912 mmHg, t = +20°C

$$ppm = 278.96 - \frac{0.3872 \times 912}{1 + 0.003661 \times 20}$$
$$= -50.07 \fallingdotseq -50$$

Therefore, set the ppm switch ㊲ to -50.

Example B: Using pressure in mbars.

$$\text{Atmospheric correction factor } X = 278.96 - \frac{0.2904 \times P}{1 + 0.003661 \times t}$$

P: Atmospheric pressure in mbars
t: Temperature in centigrade

Ex.: P = 1020 mbars, t = +50°C

$$ppm = 278.96 - \frac{0.2904 \times 1020}{1 + 0.003661 \times 50}$$
$$= 28.58 \fallingdotseq 29$$

Therefore, set the ppm switch ㊲ to 29.

5) The corrected slope distance is calculated by the formula:

$$D = d \times (1 + \frac{X}{1{,}000{,}000})$$

D: Corrected slope distance
d: The displayed slope distance when ppm is set to 0
X: Correction factor in ppm

Example: Slope distance 2,010.000 m
X = +5 ppm

$$D = 2{,}010.000 \times (1 + \frac{5}{1{,}000{,}000})$$
$$= 2{,}010.010 \text{ m}$$

10.3.3 Earth-curvature and refraction correction

1) Remove the internal switch cover ❹.
2) To correct horizontal distance and height difference for earth-curvature and refraction, set switch 3 to ON with a screw-driver.
3) Replace the cover.

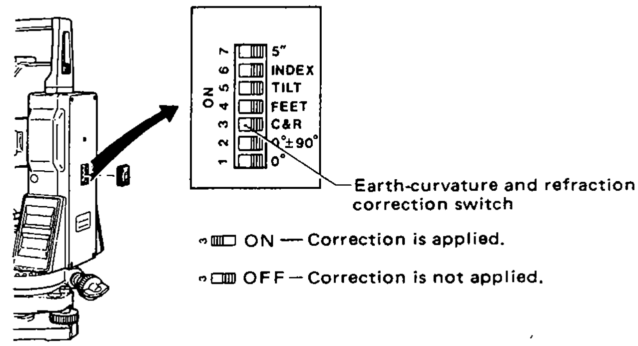


Fig. 10.22

- This correction is performed in the measurement of horizontal distance and height difference.
  The value displayed by the SET3 is computed by the following formula:

  When the switch is ON

  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 switch is OFF

  Horizontal distance $H = S \times \sin Z$

  Height difference $V = S \times \cos Z$

  S: Slope distance (value after atmospheric correction)

  Z: Zenith angle

  K: Atmospheric refraction constant (0.142)

  R: Radius of the earth (6.372×10^6 m)

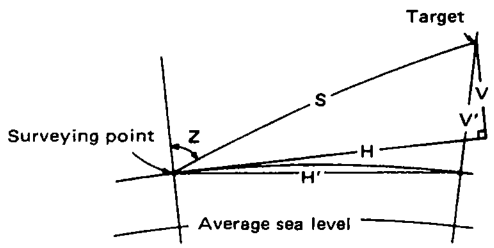


Fig. 10.23

Example: Amount of correction for a zenith angle of 70°

S (m)	200	500	1000	1500
H' - H (m)	-0.002	-0.012	-0.047	-0.105
V' - V (m)	0.002	0.015	0.059	0.134

Note that the horizontal distance is a distance measured at the height of the surveying point above the sea level. It is necessary to reduce this distance to the average sea level, and to apply the local projection correction.

10.3.4 Prism sighting

1) Sight the centre of the reflecting prism with the telescope.
2) Set the return signal audio switch ㉟ to ♪.
3) Set the power switch ㉓ to ON and press [⓪].
   [⓪] turns the power supplied to the EDM unit ON or OFF. Usually the power of the EDM unit turns OFF automatically after 1 second of inactivity and the power source mark disappears.
   But when [⓪] is pressed, power is supplied to the EDM unit for about 2 minutes to permit prism sighting.
   a. When power is supplied to the distance measurement unit (EDM unit), the power source mark ⓘ is displayed.

b. When the reflected light is received by the telescope, an audio signal is heard and the return signal lamp ㊳ lights up.

When the light intensity coming back from the prism is very high, the return signal lamp may light up, even for a slight mis-sighting. Make sure that the target centre is sighted correctly.

4) Switch off the audio target acquisition.

10.3.5 Mode selection

1) Select the mode switch ㊱ to MEAS. for fine measurement, or TRACK. for tracking.

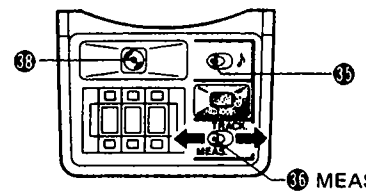


Fig. 10.24

MEAS.: Measures in mm units at first after 7 seconds and then every 5 seconds.

TRACK.: Measures in cm units at first after 7 seconds and then every 0.4 to 1 second.

10.4 DISTANCE MEASUREMENT

Make sure that:

a. The SET3 is set up correctly over the surveying point.
b. The prism constant switch, the earth-curvature refraction switch, and ppm switch are set correctly.
c. Battery voltage is adequate.
d. Indexing the vertical circle is complete.

10.4.1 Angle and distance measurement

1) Press to stop angle measurement.

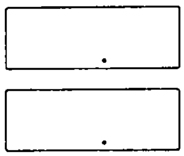


Fig. 10.25

2) Press and sight the centre of the reflecting prism. (See 10.3.4)
3) Press to measure slope distance.
   The following display appears showing that the slope distance measurement is being performed.

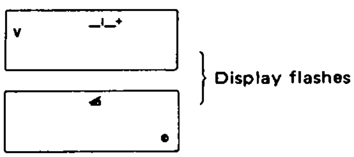


Fig. 10.26

4) The slope distance and the zenith angle will be displayed after about 7 seconds.

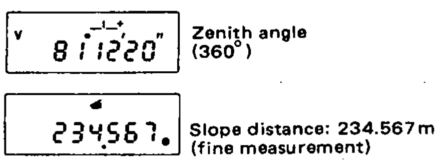


Fig. 10.27

Slope distance will continue to be measured every 5 seconds.

- When the following keys are pressed instead of in step 3), the measurement corresponding to each key is performed.

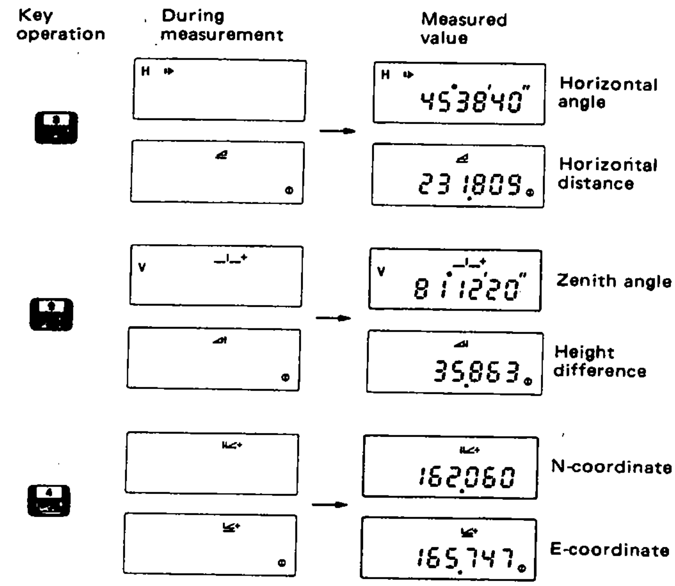


Fig. 10.28

5) Press to stop measurement.
If it is necessary to convert displayed metric distance to feet, press f/m. The feet value will be displayed for 5 seconds.
If the usual measurement is in feet, the display will be changed temporarily to meters.

6) After stopping, you can recall the following observational data, which are stored in the instrument, by pressing the appropriate keys.

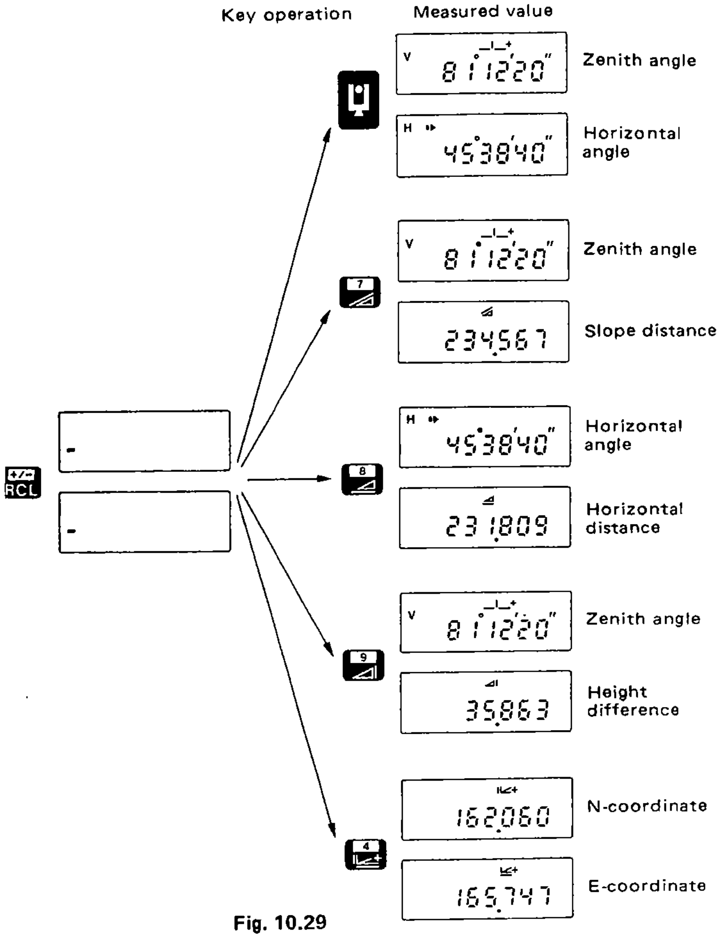


Fig. 10.29

- Each measured value displayed is the result obtained in the latest measurement.

7) To use as a theodolite after distance measurement, press [CA key] then [theodolite key].

10.4.2 Measurement of coordinates

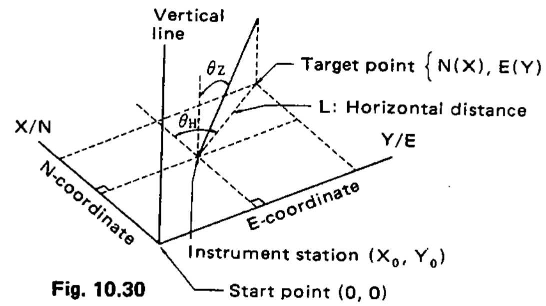


Fig. 10.30

1) The SET3 computes coordinates using the formulas:

$$\text{N(X)-coordinate} = X_0 + L\cos\theta_H$$
$$\text{E(Y)-coordinate} = Y_0 + L\sin\theta_H$$

2) The observation procedure is the same as 10.4.1. Because the N component is positive for north and the E component is positive for east in plane rectangular coordinates, you should select the horizontal angle right and set the horizontal circle to zero on north.
3) For example:

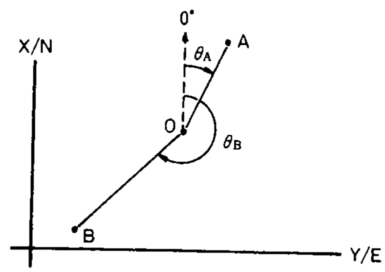


Fig. 10.31

Point No.	Horizontal distance	Horizontal angle	N-coordinate	E-coordinate
O	–	–	610.000	770.000
A	443.387	20°15'10" (22.5030 gon)	1,025.974	923.484
B	750.453	225°32'50" (250.6080 gon)	84.442	234.306

4) Press [■] to stop measurement. Measure coordinates as follows.

a. Entry of instrument station coordinates

[3] → Enter N-coordinate → [ENT] → Enter E-coordinate → [ENT]

- To clear the entry halfway, press [CE].
- To stop the entry halfway, press [■].
- The range of coordinates is between **-9,999.999 m (-9,999.99 ft)** and **9,999.999 m (9,999.99 ft)**.
- The coordinates are retained in the memory of the SET3 for about 5 days even when the power switch is turned OFF. After that, the coordinates become (0, 0).

Example: Entering the instrument station coordinates (610, 770)

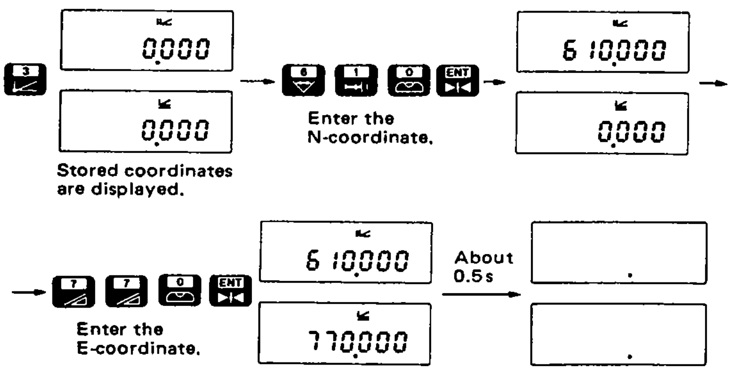


Fig. 10.32

b. Confirmation of instrument station coordinates

[3] → Confirm the displayed coordinates → [■]

- To correct the stored coordinates, re-enter them.

c. Measurement of target point coordinates

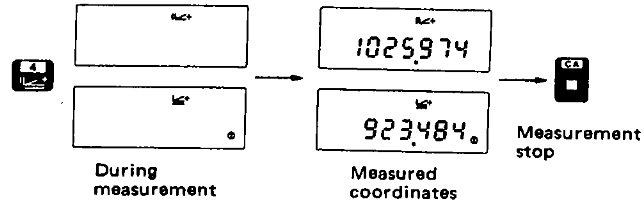


Fig. 10.33

10.4.3 Stake-out measurement

Distance stake-out measurement.

1) Stake-out distance
   The SET3 displays the measured distance minus the desired (stake-out) distance.
2) Entry of stake-out distance data
   The stake-out distance must be entered for slope distance, horizontal distance or height difference measurements.
   Press [CA] to stop measurement. Enter as follows.

   → Enter data →

   - To clear the entry halfway, press [CE].
   - To stop the entry halfway, press [CA].
   - The data once entered is stored until the power switch is turned OFF and then becomes 0.
3) Confirmation of stake-out distance data

   → Confirm the displayed data →

   - To correct the stored data, re-enter it.

4) Measurement

The following distance measurements can be performed with [S-O].

Key operation

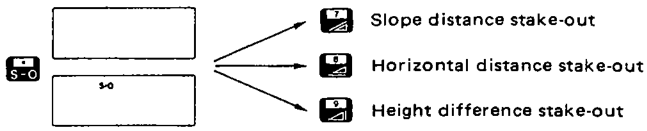


Fig. 10.34

Example: Horizontal distance stake-out measurement when stake-out distance is 90.5 m

a. Entry of stake-out distance data

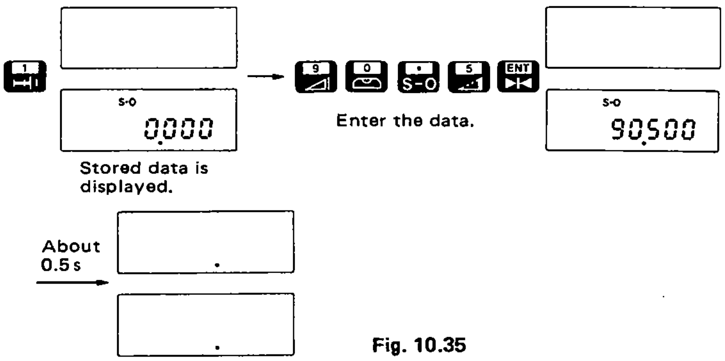


Fig. 10.35

b. Measurement

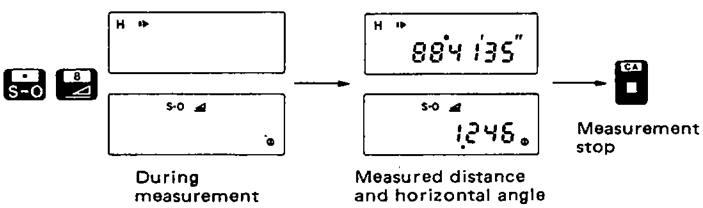


Fig. 10.36

The measured horizontal distance is 1.246 m longer than the stake-out distance (90.5 m).

Coordinates stake-out measurement.

5) Stake-out coordinates
The SET3 displays the measured coordinate values minus the desired (stake-out) coordinate values.

Displayed N-coordinate
= measured N-coordinate ($X_0 + L \cos \theta_H$)
- stake-out N-coordinate

Displayed E-coordinate
= measured E-coordinate ($Y_0 + L \sin \theta_H$)
- stake-out E-coordinate

6) Entry of instrument station coordinates
See 10.4.2.

7) Entry of stake-out coordinates data
Press [CA] to stop measurement. Enter as follows.

[2] → Enter N-coordinate data → [ENT] →

Enter E-coordinate data → [ENT]

- To clear the entry halfway, press [CE].
- To stop the entry halfway, press [CA].
- Stake-out coordinate values between -9,999.999 m (-9,999.99 ft) and 9,999.999 m (9,999.99 ft) can be entered.
- The data once entered is stored until the power switch is turned OFF and then becomes (0, 0).

8) Confirmation of stake-out coordinates data

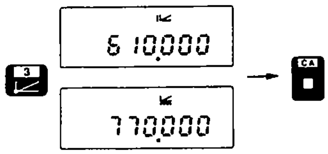
[2] → Confirm the displayed data → [CA]

- To correct the stored data, re-enter it.

9) Measurement

Example: Coordinates stake-out measurement when stake-out N-coordinate value is 1,000 m and stake-out E-coordinate value is 1,000 m.

a. Confirmation of the instrument station coordinates.



b. Entry of stake-out coordinates data

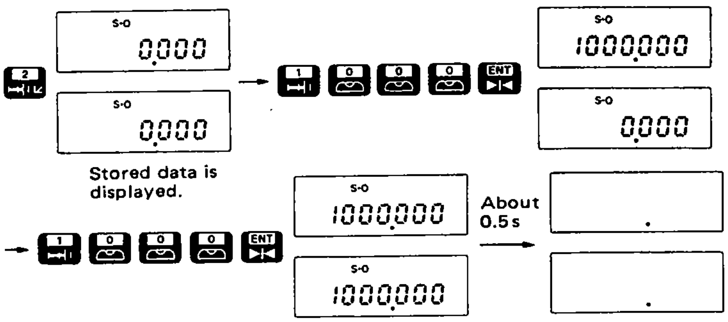


Fig. 10.37

c. Measurement

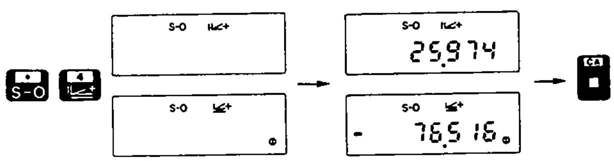


Fig. 10.38

The measured N-coordinate value is 25.974 m longer than the stake-out value (1,000 m) and the measured E-coordinate value is 76.516 m shorter than the stake-out value (1,000 m).

10.4.4 Remote elevation measurement

At certain surveying points e.g. power transmission lines or cables supporting bridges, etc., a reflecting prism cannot usually be positioned. In such cases the remote elevation measurement makes height differences easy to measure.

$$h = h_1 + h_2$$

$$h_2 = S\,(\sin\theta_{Z1} \times \cot\theta_{Z2} - \cos\theta_{Z1})$$

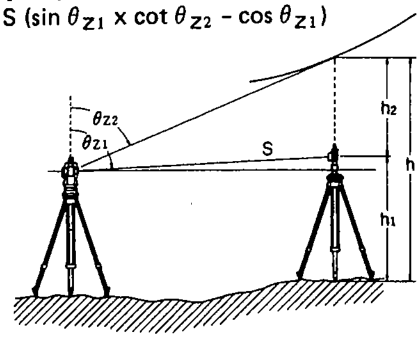


Fig. 10.39

1) Between the ground and the object
   a. Set up a reflecting prism under the object and measure the prism centre height from the ground with a tape measure.
      - Use an optical plummet to set the prism accurately.
   b. Enter the height, h_1 measured in step a., as a positive value, as stake-out data.
      Example: The prism centre height from the ground is 1.523 m

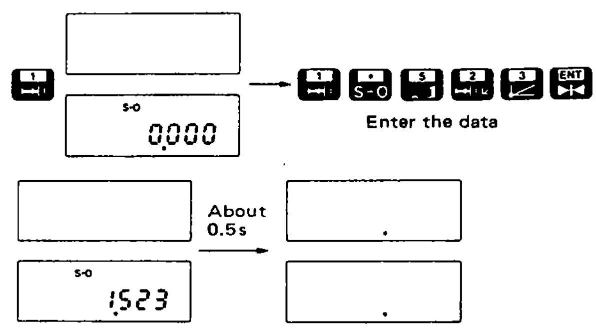


Fig. 10.40

c. Sight the reflecting prism and press [7].
Press [CA ■] after the distance measurement data is displayed.

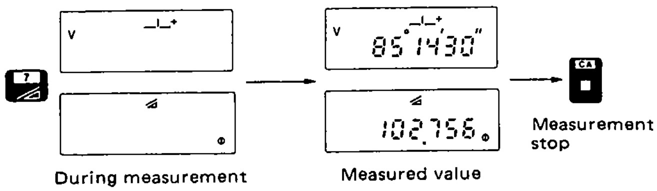


Fig. 10.41

- The measured value is stored in the SET3.

d. Press [S-O], then [5].

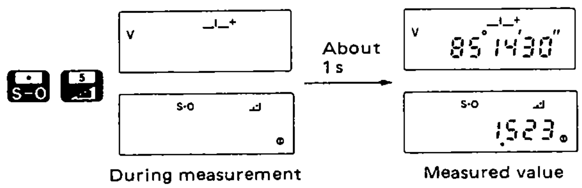


Fig. 10.42

- When the SET3 is sighted on the prism, the height, h_1, measured with a tape measure (the prism height from the ground) will be displayed.

e. Sight the object. The object height from the ground, h, will be displayed in the lower display.

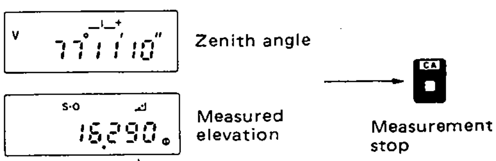


Fig. 10.43

- The range of measurement is between vertical angles of -89° (-98 gon) and 89° (98 gon).

10.4.5 Measurement of horizontal distance between two target points

Horizontal distance L and height difference H between two points can be measured.

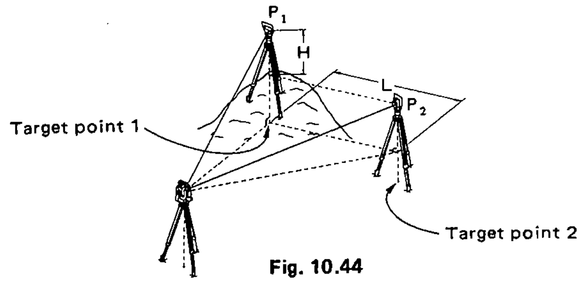


Fig. 10.44

1) Set up the reflecting prisms P_1, P_2, on target points 1, 2.
2) Sight the prism P_1 and press .
   Press after the distance measurement data is displayed.

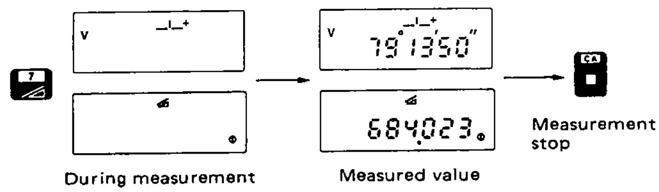


Fig. 10.45

- The measured value is stored in the SET3.

3) Sight the prism P_2 and press .

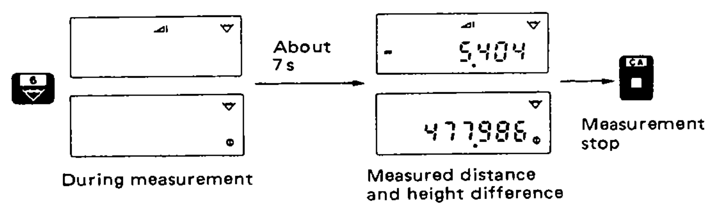


Fig. 10.46

11. SELF DIAGNOSIS

If there is any fault in the measuring function, the error codes shown in the following table will be displayed.

Display	Meaning	Action
b. dEd	Battery voltage is too low.	Replace the battery with a charged one, or charge the battery.
E 100	*Error when measuring a horizontal angle.	Reset to the horizontal angle 0° (0 gon).
E 101	*Error when measuring a zenith angle.	Index the vertical circle again.
E 115	Compensator range error. Tilt angle exceeds −3′.	Level the SET3 again.
E 117	Compensator range error. Tilt angle exceeds +3′.	
E 200	Incoming reflected light decreased during measurement. Incoming reflection was disturbed.	Sight the reflecting prism again. Increase the number of reflecting prisms for long distances. Measure the distance again confirming the condition with the return signal lamp or sound.
S. OFF E 201	Incoming reflection is totally absent when the instrument is ready for distance measuring.	

Display	Meaning	Action
E 206	Error when measuring the initial slope distance during either remote elevation or horizontal distance between two points measurement.	Sight the reflecting prism to perform slope distance measurement again.
E 207	During remote elevation measurement, the vertical angle is more than ±89° (±98 gon) or the measured distance is more than ±9,999.999 m.	Press to stop measuring.
E 208	The measured distance is more than ±19,999.999 m (±19,999.99 ft).	Press to stop measuring.
E 210	During horizontal distance between two points measurement, L^2 (horizontal dist.^{2}) is more than 10^7 m.	

* If the SET3 is rotated faster than four revolutions per second, the error indication "**E100**" or "**E101**" is displayed.

When the error indication "**E**" appears with any number other than the ones above, please contact our agent.

12. OPTIONAL ACCESSORIES

12.1 DIAGONAL EYEPIECE DE18

The diagonal eyepiece is convenient for steep observations and in places where space around the instrument is limited.
Remove the eyepiece ㊴ by loosening the mounting ring, and screw in the diagonal eyepiece.

Setting up the DE18

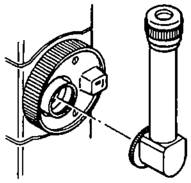


Fig. 12.1

12.2 ELECTRONIC FIELD BOOK SDR2

The SDR2 collects and stores slope distance, zenith and horizontal angle data from the SET3.
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.

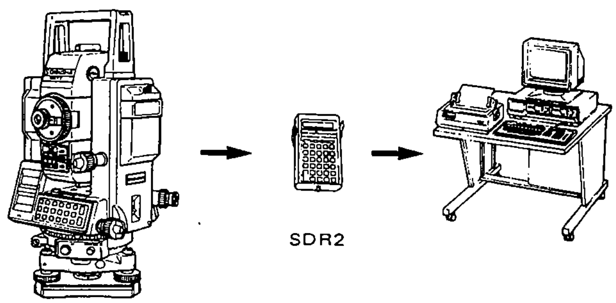


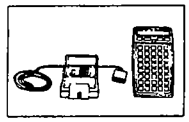
Fig. 12.2

SDR2 specifications

Power source:	"AA" (UM3) x 4
Memory type:	CMOS
RAM	16 K or 32 K
ROM	16 K
Keyboard:	33 keys
Display:	LCD
Baud rate:	300, 600, 1200, 2400, 4800 bps
Operating temperature range:	0 to 50°C
Weight:	450 g

12.3 INTERFACE IF1A FOR THE HP-41CV

Transfers data from the SET3 to the HP-41CV computer.



IF1A + HP-41CV

Fig. 12.3

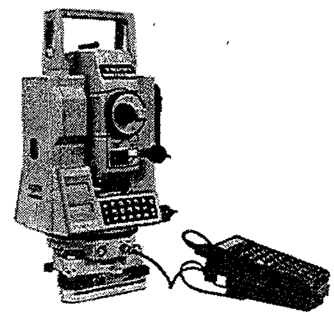


Fig. 12.4

IF1A specifications

Input voltage:	6V, 12V Supplied from the SET3
Input baud rate:	1200 bps
Operating temperature range:	0 to 45°C
Weight:	380 g

13. CHECKS AND ADJUSTMENTS

The SET3 may be affected by sudden changes in weather conditions and excessive vibration. This can result in inaccurate surveying. Therefore, IT IS IMPORTANT TO CHECK AND ADJUST THE SET3 BEFORE AND DURING USE in the following order.

13.1 ANGLE MEASURING FUNCTION

13.1.1 Plate level
13.1.2 Circular level
13.1.3 Index error of the tilt angle sensor
13.1.4 Reticle
13.1.5 Perpendicularity of the reticle to the horizontal axis
13.1.6 Coincidence of the distance measuring axis with the reticle
13.1.7 Optical plummet

13.1.1 Plate level

The glass tube of the plate level is sensitive to temperature change or shock. Be sure to check the plate level ㉘ before use.

1) See Figs. 13.1 and 13.2 for relation between bubble movement and rotation of the levelling foot screws.

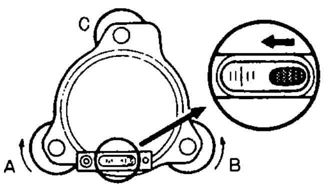


Fig. 13.1

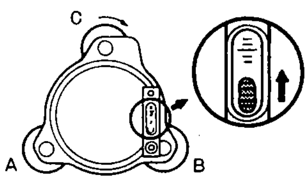


Fig. 13.2

2) Turn the upper part of the SET3 until the plate level is perpendicular to a line between levelling screws A and B. Then centre the bubble using the levelling screw C.

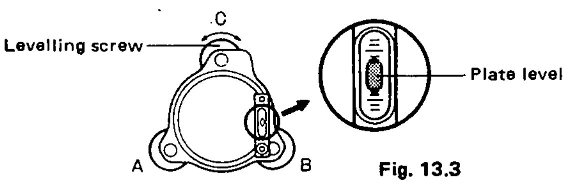


Fig. 13.3

3) Turn the upper part 90° (100 gon) until the plate level is parallel to the line between levelling screws A and B. Then centre the bubble by turning levelling screws A and B by the same amount and in the opposite direction.

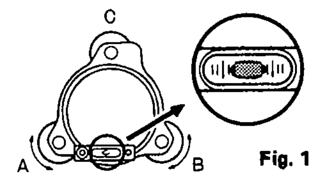


Fig. 13.4

4) Turn the upper part 180° (200 gon). Correct the bubble deviation, if any, by half the amount with levelling screws A and B, as in 3) above.

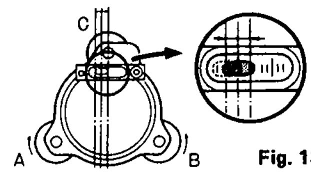


Fig. 13.5

5) Correct the remaining half deviation by turning the plate level adjusting screw ㉙ with the adjusting pin.

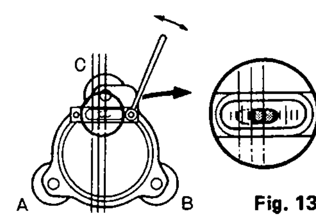


Fig. 13.6

6) Repeat 2) to 5) above until the bubble remains centred for all the positions of the upper part.

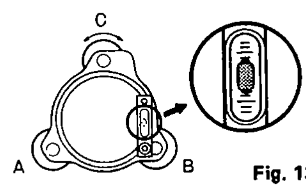


Fig. 13.7

13.1.2 Circular level

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

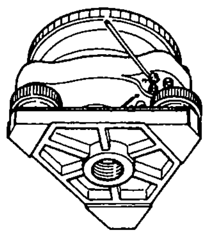
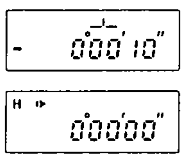


Fig. 13.8

13.1.3 Index error of the tilt angle sensor

When the circular level adjustment is complete, the index error should be checked.

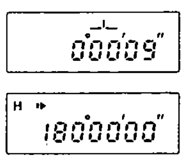
1) After indexing the vertical circle, tighten the vertical clamp ㉚.
2) Press [0 SET] to set the horizontal circle to zero, then press [0] to display the tilt angle.



Tilt angle a = -10″

Fig. 13.9

3) Loosen the horizontal clamp and turn the upper part through 180°±5′ (200 gon±0.1 gon).



Tilt angle b = 9″

Fig. 13.10

4) Calculate $\frac{a+b}{2}$ = index error c

Example: $\frac{-10'' + 9''}{2} = -0.5''$

5) If the index error is less than 5", no adjustment is necessary.

For adjustment remove the sensor index adjustment cover ⑳.
Return to 0° horizontal angle position.
Using a suitable flat screwdriver, adjust the internal screw until the upper display $d_{0°}$ = a - c.
Turn the upper part through 180°.
Adjust the internal screw until the upper display $d_{180°}$ = b - c.

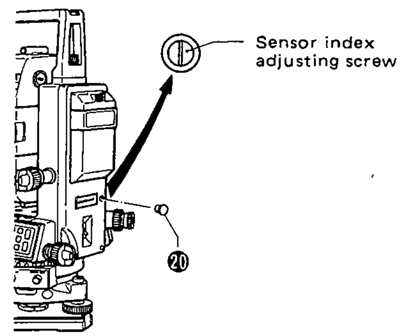


Fig. 13.11

Example:

If a = -12", b = -6", index error c = $\frac{-12'' + (-6'')}{2} = -9''$

$d_{0°}$ = a - c = -3"
$d_{180°}$ = b - c = +3"

13.1.4 Reticle

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

1) Level the SET3. Select a clear target at a horizontal distance of 50 to 100 m.

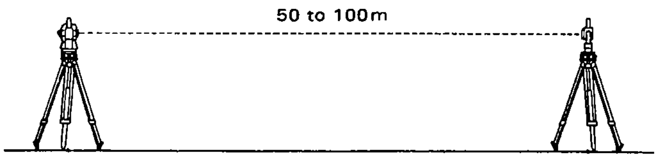


Fig. 13.12

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

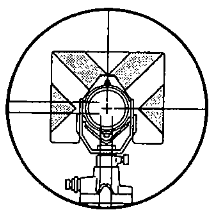


Fig. 13.13

3) Next in position V2, sight the same target. Take the horizontal angle reading, e.g. a_r = 198°34'10" (a_r = 220.6327 gon) and the zenith angle reading, e.g. b_r = 269°30'02" (b_r = 299.4451 gon).
4) Calculate $a_r - a_l$, $b_r + b_l$.
   $a_r - a_l$ = 198°34'10" - 18°34'00" = 180°00'10"
   ($a_r - a_l$ = 220.6327 gon - 20.6296 gon = 200.0031 gon)
   $b_r + b_l$ = 269°30'02" + 90°30'10" = 360°00'12"
   ($b_r + b_l$ = 299.4451 gon + 100.5586 gon = 400.0037 gon)

5) When the reticle is in the normal position, your results should show that $a_r - a_l$ is within 20" of 180° (200 gon) and $b_r + b_l$ is within 20" 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" or greater after several checks, adjust as follows.
6) While still in position 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 $a_l = 18°34'00''$ $\quad a_r = 198°34'26''$

$b_l = 90°30'12''$ $\quad b_r = 269°30'12''$

$$a_c = \frac{a_l + a_r}{2} + 90° = \frac{18°34'00'' + 198°34'26''}{2} + 90°$$
$$= 198°34'13''$$

$$b_c = \frac{b_r - b_l}{2} + 180° = \frac{269°30'12'' - 90°30'12''}{2} + 180°$$
$$= 269°30'00''$$

7) Look through the telescope. The target is seen shifted from the vertical and horizontal reticle lines.
8) Remove the reticle adjustment cover ㉝.

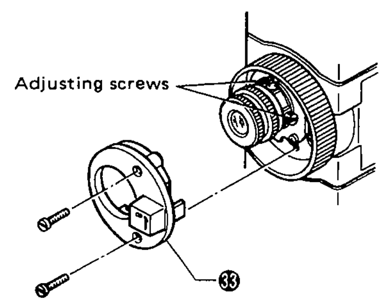


Fig. 13.14

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.

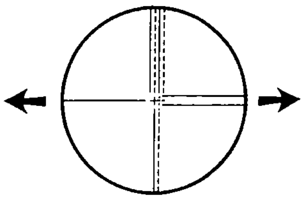


Fig. 13.15

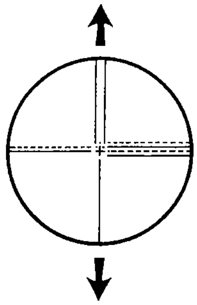


Fig. 13.16

10) Replace the cover.

The adjustment is very delicate. If it is difficult, please contact our agent.

N.B. If amount of the reticle shift is too large, distance measuring may be affected. Do not adjust the reticle more than 20" (0.006 gon).

13.1.5 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 Fig. 13.17.
2) Turn the telescope slowly upward with the vertical fine motion screw ㉛ until the target slides to the lower part B, Fig. 13.18. If the target is still centrally within the vertical lines no adjustment is necessary. If necessary, adjust as follows.

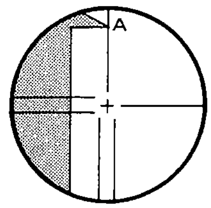


Fig. 13.17

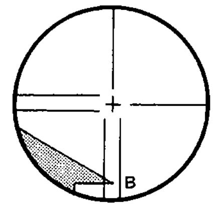


Fig. 13.18

3) If the target at B is not on the reticle, rotate the reticle plate by loosening the four adjusting screws.

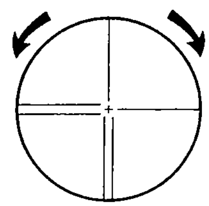


Fig. 13.19

13.1.6 Coincidence of the distance measuring axis with the reticle

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

1) Level the SET3. Set up the reflecting prism at a horizontal distance of 50 to 100 m.

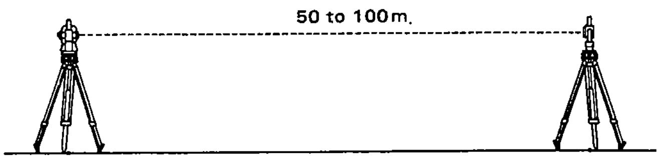


Fig. 13.20

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

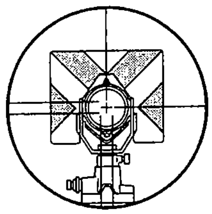


Fig. 13.21

3) Press ⓪ on the keyboard and make sure the return signal lamp ㊳ lights up.
4) Four more readings are necessary.
   Turn the horizontal or vertical fine motion screw slowly until the return signal lamp 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 larger than 2.5′ (0.046 gon), the coincidence is normal. If any of the differences obtained are less than 2.5′ (0.046 gon), please contact an authorized service facility for repair.

13.1.7 Optical plummet

1) Level the SET3. 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.

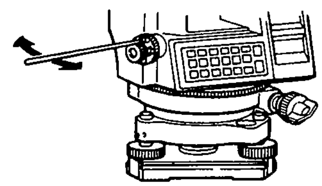


Fig. 13.22

3) Repeat the adjustment if necessary.

13.2 DISTANCE MEASURING FUNCTION

13.2.1 Check flow chart

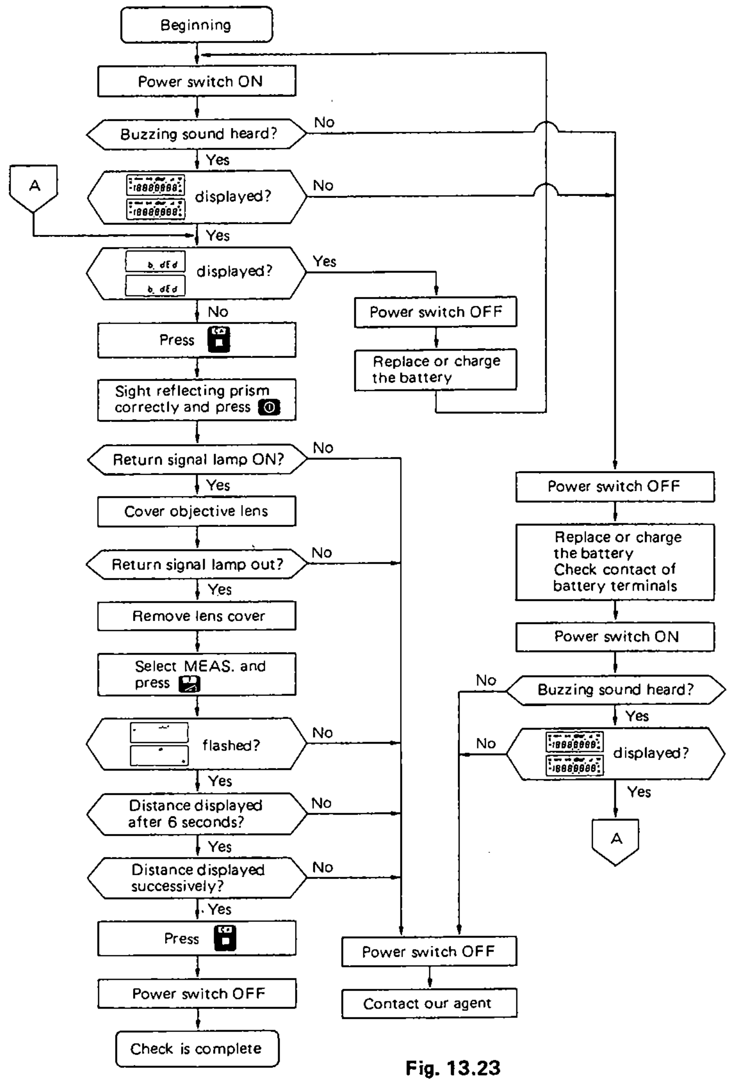


Fig. 13.23

13.2.2 Additive distance constant

The additive distance constant of the SET3 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 SET3 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. Measurements should be taken in all combinations of the 6 to 8 stations.

   If an additive distance constant of greater than 5 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 apart, and C in the middle.

   b. Set up the SET3 at A, and measure the distance AB.

      Note: Be sure prism height is the same as the height of the SET3 objective lens centre. If ground is not level, use an automatic level to set correct instrument heights of all points.

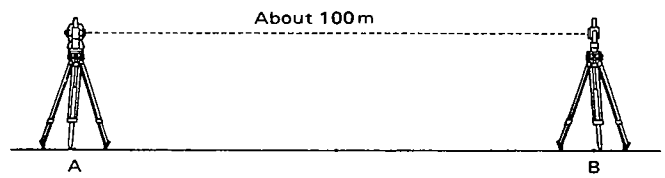


Fig. 13.24

c. Shift the SET3 to C, and measure the distance CA and CB.

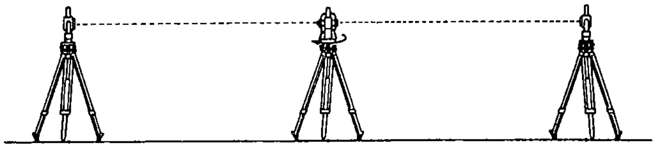


Fig. 13.25

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 K value three times. If all K are greater than 5 mm, contact our agent.

14. FOR ANGLE MEASUREMENT OF THE HIGHEST ACCURACY

14.1 LEVELLING BY REFERRING TO THE DISPLAY

For the most accurate measurement of horizontal angles, particularly for steep observations, the SET3 should be levelled using the tilt angle display. Index error of tilt angle can be eliminated by taking readings on 0° and 180°.

1) Level with the plate level ㉘.
2) Tighten the vertical clamp ㉚ with the telescope approximately horizontal.
3) Loosen the horizontal clamp ㉔ and turn the upper part of the SET3 until the plate level is parallel to the line between levelling screws A and B. Then press [0 SET] to set the horizontal angle 0° (0 gon).

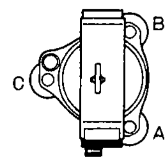


Fig. 14.1

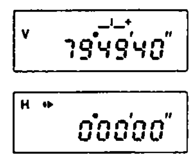


Fig. 14.2

4) Press [tilt] to display the tilt angle.

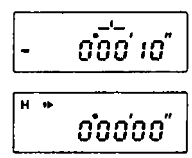


Fig. 14.3

5) Wait for 3 to 4 seconds until the tilt angle reading is steady. Then press [0 SET].

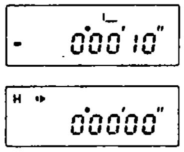


Fig. 14.4

6) Turn the upper part of the SET3 through 180° (200 gon).

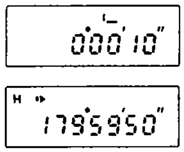


Fig. 14.5

7) Wait for 3 to 4 seconds until the tilt angle reading is steady. Then press [0 SET].

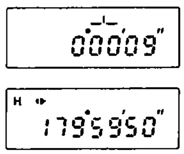


Fig. 14.6

8) Referring to the tilt angle reading, level the SET3 using levelling screws A or B until the value in the display is 0° ± 1".

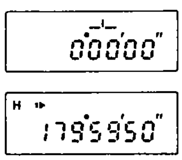


Fig. 14.7

9) Turn the upper part of the SET3 through 90° (100 gon).

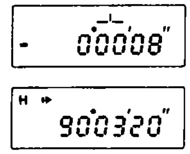


Fig. 14.8

10) Wait for 3 to 4 seconds until the tilt angle reading is steady. Then referring to the tilt angle reading, level the SET3 using the levelling screw C until the value in the display is 0°±1".

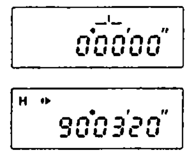


Fig. 14.9

11) Press to release the tilt angle display.

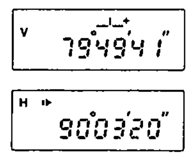


Fig. 14.10

The vertical axis error is now minimized.

14.2 MANUALLY INDEXING VERTICAL CIRCLE BY V1, V2

Like every theodolite, the SET3 will have a vertical index error. A vertical index error can be estimated as follows.

1) Turn the power OFF, remove the internal switch cover ❹ and set switch 6 to ON.
   (When switch 6 is ON, the automatic indexing of the vertical circle by transitting the telescope is inactive.)
2) After levelling the SET3, turn the power ON and make sure that the display appears as shown below.

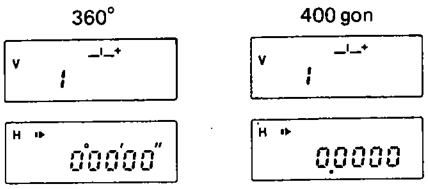


Fig. 14.11

3) In position V1, accurately sight a clear target at a horizontal distance of about 30 m.

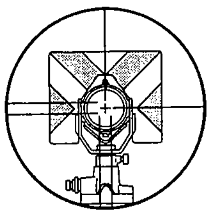


Fig. 14.12

4) Press [0 SET].

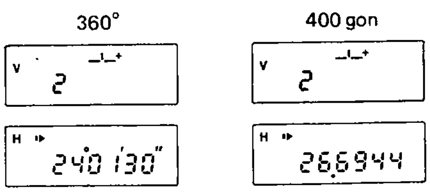


Fig. 14.13

5) Next in position V2, accurately sight the same target.

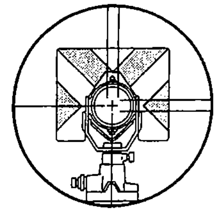


Fig. 14.14

6) Press 0SET. When the vertical circle is indexed, the display appears as below.

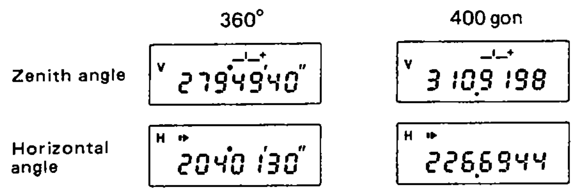


Fig. 14.15

- If the power switch has been turned OFF, the vertical circle must be indexed again.
  When moving the SET3 after measurement, turn the power OFF.

15. FOR DISTANCE MEASUREMENT OF THE HIGHEST ACCURACY

15.1 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.

15.2 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.
If flat terrain there is little variation in the atmospheric pressure.
In mountains, the following calculation should be used.

Example:

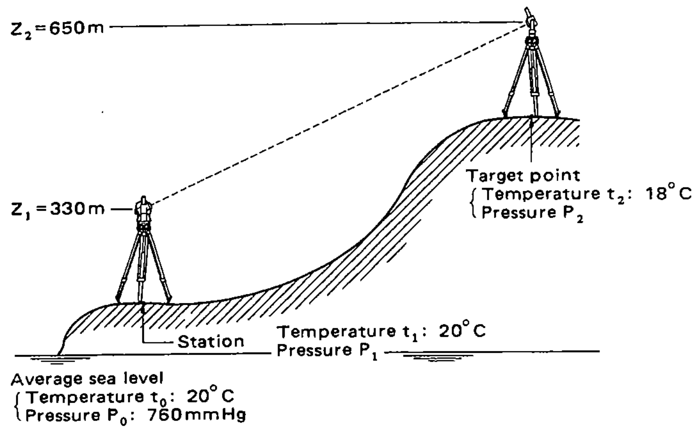


Fig. 15.1

By the Laplace formula

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

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

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

$P_0 = 760\ \text{mmHg}$ $\quad Z_1 = 330\ \text{m}$ $\quad Z_2 = 650\ \text{m}$

$t_0 = 20°C$ $\quad t_1 = 20°C$ $\quad t_2 = 18°C$

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

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

Average pressure: 717.5 mmHg

16. PRECAUTIONS AND MAINTENANCE

16.1 PRECAUTIONS

1) When the SET3 is not used for a long time, check it at least once every three months.
2) Handle the SET3 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 SET3 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 SET3 directly on the ground.
6) Never carry the SET3 on the tripod to another site.
7) Protect the SET3 with an umbrella against direct sunlight, rain and humidity.
8) When the operator leaves the SET3, 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 SET3 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 SET3 is placed in the carrying case, follow the layout plan.
14) Make sure that the SET3 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.

16.2 MAINTENANCE

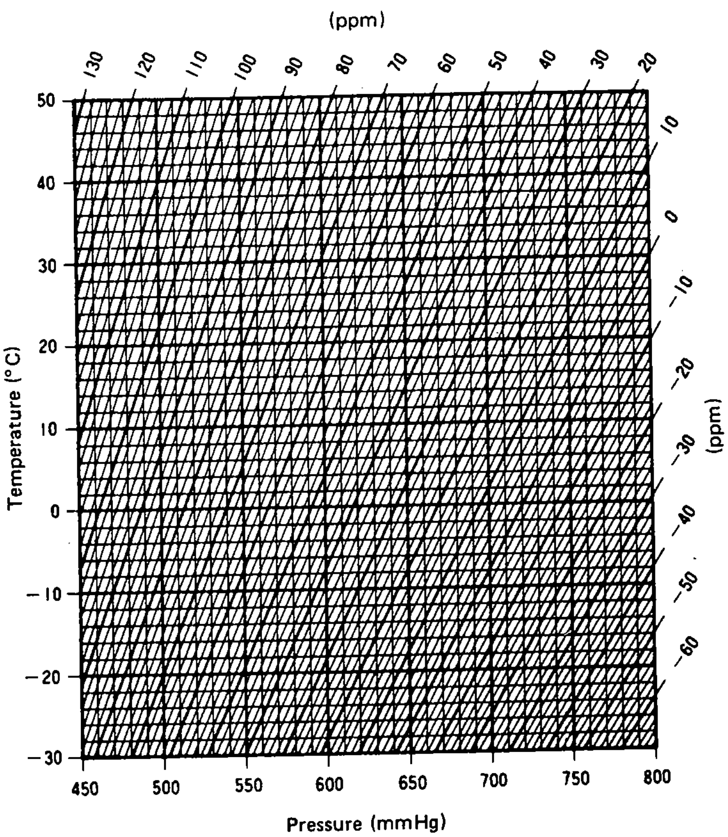
1) Wipe off moisture completely if the instrument gets wet during survey work.
2) Always clean the instrument before returning it to the case.

> 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 soft clean cloth or lens tissue.

3) Store the SET3 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.

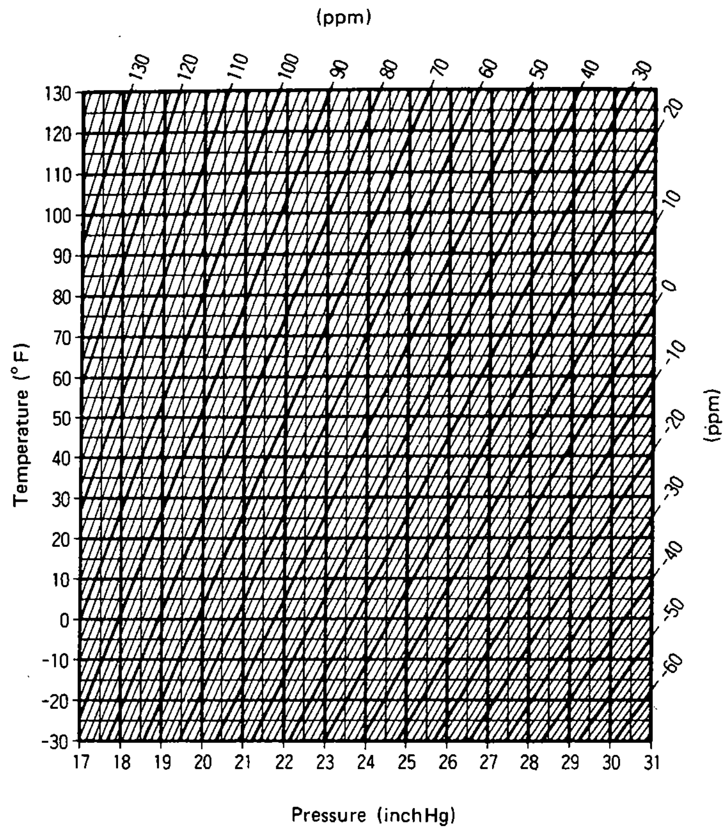
17. ATMOSPHERIC CORRECTION CHARTS

(Metric)



The chart shows the correction every two ppm, while the atmospheric correction can be applied to the SET3 for every ppm.

(English)



The chart shows the correction every two ppm, while the atmospheric correction can be applied to the SET3 for every ppm.

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

18. INDEX

MEMO