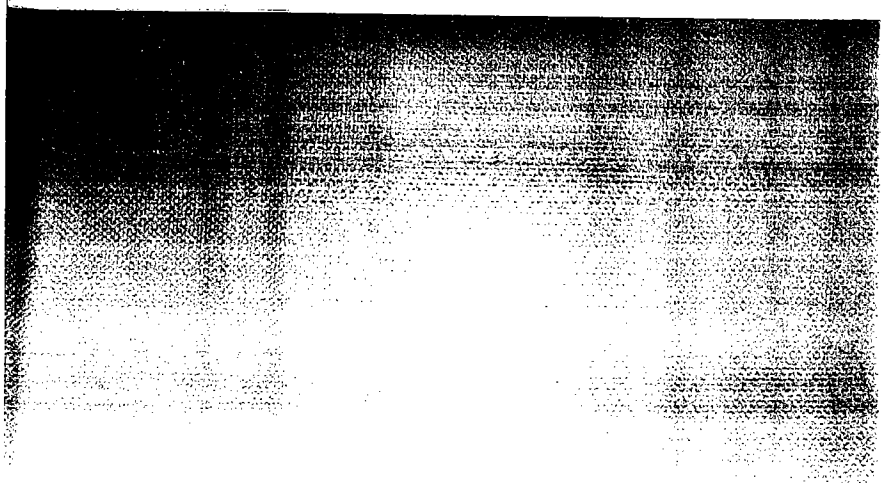
ELECTRONIC TOTAL STATION

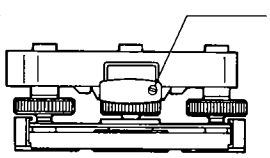
SET3

OPERATOR'S MANUAL

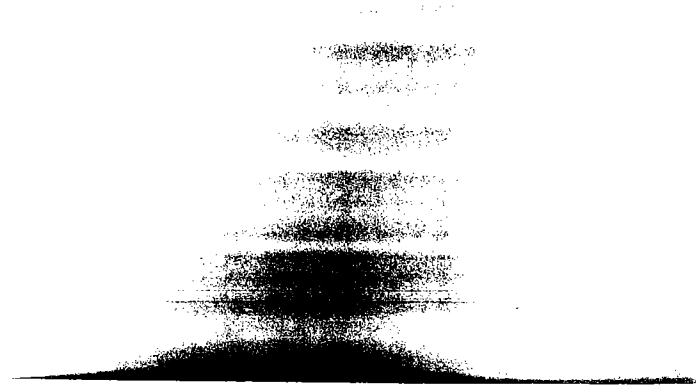
LIETZ/SOKKISHA

CONTENTS





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



1. PARTS OF THE INSTRUMENT

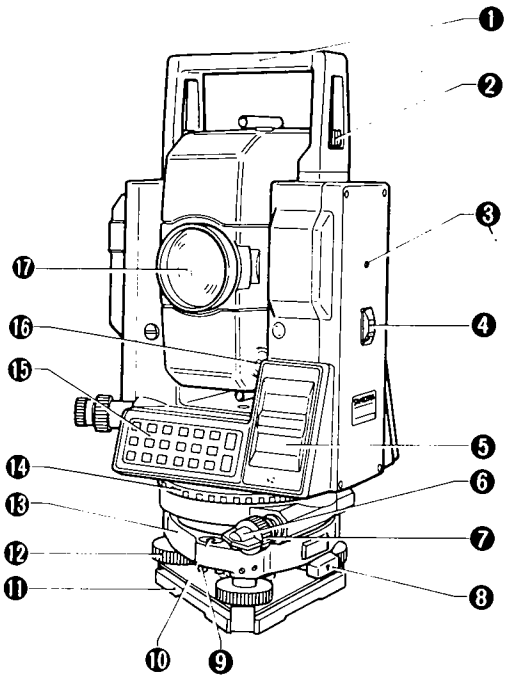


Fig. 1.1

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 Leveling screw
⓭ Tribrach
⓮ Circle positioning ring
⓯ Keyboard
⓰ Prism constant cover
⓱ Objective lens

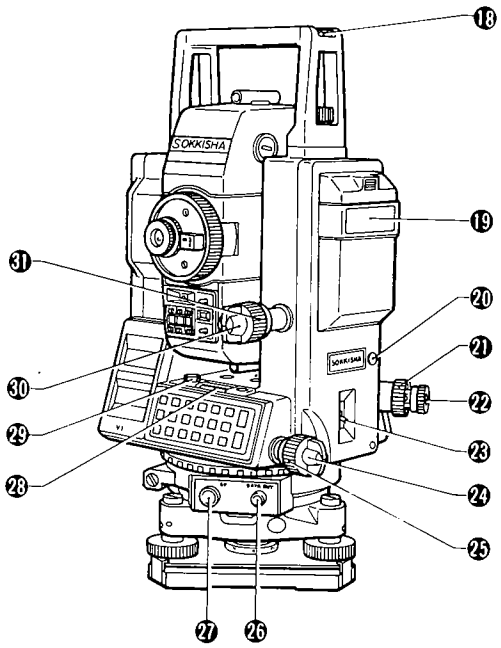


Fig. 1.2

⑱ Tubular compass slot
⑲ Battery
⑳ Sensor index adjustment cover
㉑ Optical plummet focusing 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

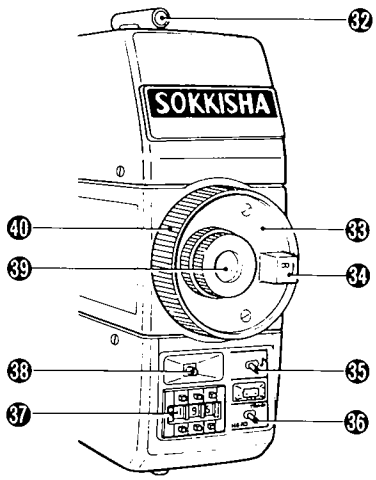


Fig. 1.3

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 focusing 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 bearing and 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" or 5".
- 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 leveled. 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.
- A RS-232C data-out connector is standard.

3. SPECIFICATIONS

Distance measurement

Range:

Average conditions: (Slight haze, visibility about 12.5 miles, sunny periods, weak scintillation)
1-prism 3,300 ft (1,000 m)
3-prism 5,300 ft (1,600 m)

Good conditions: (No haze, visibility about 25 miles, overcast, no scintillation)
1-prism 4,300 ft (1,300 m)
3-prism 6,900 ft (2,100 m)

Standard deviation: ±(5 mm + 3 ppm · D)

Display: LCD 8-digit four display windows, two on each face
Maximum slope distance
6,561.67 ft (1,999.999 m)

Minimum display: Successive 0.01 ft (1 mm)
Tracking 0.1 ft (10 mm)

Measuring time:

	Mode	
	Successive	Tracking
Slope distance	6 s + every 4 s	6 s + every 0.4 s
Horizontal distance		6 s + every 0.7 s
Height difference		
Coordinates		6 s + every 1 s
Remote elevation	1 s + every 0.5 s	
Horizontal distance between two points	7 s + every 4 s	7 s + every 1 s

Atmospheric correction: −99 ppm to +199 ppm
(1 ppm per step)

Prism constant correction: 0 to −9 cm (1 cm per step)

Earth-curvature and refraction correction: Selectable ON/OFF

Audio target aquisition: Selectable ON/OFF

Signal source: Infrared LED

Light intensity control: Automatic

Angle measurement

Telescope

Length:	6.7 inch (170 mm)
Aperture:	1.8 inch (45 mm)
Magnification:	30 x
Resolving power:	3"
Image:	Erect
Field of view:	1°30' (26 ft/1,000 ft)
Minimum focus:	4.3 ft (1.3 m)

Horizontal circle

Type:	Incremental
Minimum display:	1"

Vertical circle

Type:	Incremental with 0 index
Minimum display:	1"

Accuracy — Standard deviation of mean of measurement taken in positions V1 and V2

H:	4"
V:	5"

Automatic compensator — Selectable ON/OFF

Type:	Liquid
Minimum display:	1"
Range of compensation:	±3'

Display

LCD 8-digit:	Four display windows, two each face
Range:	-1,999°59'59" to 1,999°59'59"

Measuring mode

Horizontal angle:	Right/Left/Repetition of angles
Vertical angle:	Zenith 0° or Horizontal 0° or Horizontal 0° ±90°
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:	0.3 ft (0.1 m)
Data output:	Asynchronous serial, RS-232C compatible
Self-diagnostic function:	Provided
Power saving cut off:	30 minutes after operation
Operating temperature:	-4°F to +122°F (-20°C to +50°C)
Power source:	Ni-Cd battery, No. 6651-01 (6 V)
Working duration:	About 600 measurements at 77°F, distance and angle measurement; 13 hours at 77°F, angle measurement only. (About 4,000 measurements, distance and angle measurement; 90 hours at 77°F, angle measurement only, with optional battery No. 6661-02.)
Charging time:	12 hours, standard charger No. 6855-01 (1 hour, optional charger No. 6855-02, No. 6855-03)
Size (without handle):	6.6 (W) x 6.7 (D) x 12.9 (H) inch (168 x 170 x 327 mm)
Weight:	16.7 lbs (7.6 kg) (w/internal battery)

4. STANDARD EQUIPMENT

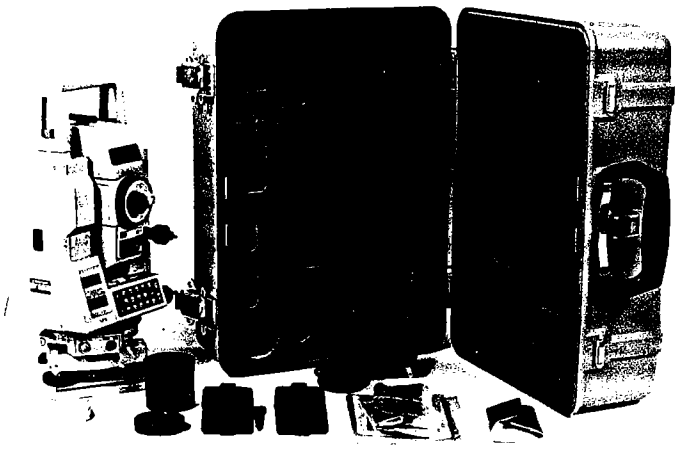


Fig. 4.1

SET3 main unit 1
Internal battery,
No. 6651-01 2
Battery charger,
No. 6855-01 1
Battery charging adaptor,
No. 6660-00 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
Field guide 1
Carrying case, SC46 1

5. ROUND OUT YOUR LIETZ EDM SYSTEM WITH THESE ACCESSORIES

POLYCARBONATE RETRO PRISMS

For use with all EDM systems recommending round retro prisms. Mounting system allows choice of -30 mm or 0 offset. Prisms hermetically sealed to prevent contamination of reflective surfaces. Prisms interchangeable on all mounts.

TRIPLE NON-TILTING PRISM ASSEMBLY
w/lens cover
No. 7265-31

TRIPLE TILTING PRISM ASSEMBLY
w/lens cover, similar to 7265-31, prism mount rotates 360°
No. 7266-31

SINGLE TILTING PRISM ASSEMBLY
w/lens cover, rotates 360°
No. 7266-32

PRISM ONLY IN MOUNTING CAN
w/lens cover, hermetically sealed
No. 7266-35

ACCESSORIES FOR PRISMS

NINE PRISM ADAPTOR
Joins 7266-31 and two 7265-31.

PEEP SIGHT
Fits on 7265 and 7266 mounts for easier aiming.
No. 7266-30

TARGET
Fits 7266-31 triple prism assembly, ideal for coaxial total stations.
No. 7266-41

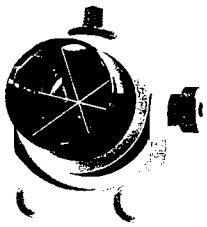
TARGET
Fits 7266-32 single prism assembly.
No. 7266-46

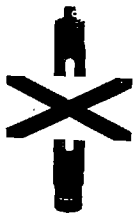
RETRO PRISM CARRYING CASES
Vinyl plastic carrying case w/full zipper for easy access and storage. Inside padded. Exterior is bright international orange color. Sizes for single or triple retro prisms.
No. 7270-50 Triple retro prisms
No. 7270-52 Single retro prisms

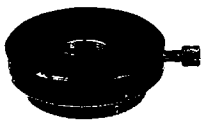
LIETZ SIGHTING TARGET SET

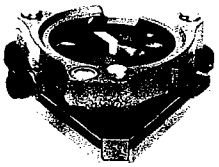
No. 7311-45 contains one each of the following:

7269-34 Single Round Tilting Prism Mount
7270-35 Round Prism w/container
7270-29 Sighting Target for Retro Prism
7311-38 Tribrach Adaptor w/removable, rotatable center
7311-35 Optical Plummet Tribrach



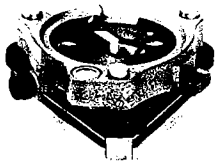




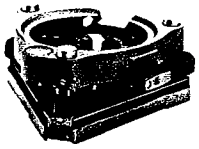


TRIBRACHS AND ADAPTORS

OPTICAL PLUMMET TRIBRACH
For precision plumbing. Has circular level vial with sensitivity of 10 minutes per 2 mm.
Optical plummet focus by push-pull slide. Range: 1.5 to 50 ft.
No. 7311-35

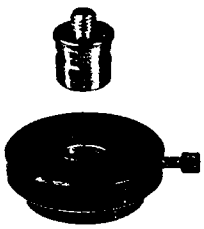


TRIBRACH LEVELING BASE
Same as above but without optical plummet.
For use with Azimuth Base (7150-41).
No. 7311-34



TRIBRACH ADAPTOR
Allows installation of retro prism or other accessories into tribrach.
5/8 x 11 thread.
No. 7311-37

TRIBRACH ADAPTOR
Similar to above except with removable, rotatable center.
No. 7311-38

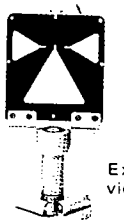


TRIBRACH ADAPTOR
Allows easy mounting of 7266-31 and other prism with bayonet type mount in tribrachs.
No. 7311-40

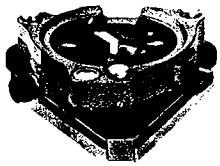
OPTICAL PLUMMET TRIBRACH ADAPTOR
Similar to above but with rotating vertical axis and optical plummet for precise positioning of prisms in tribrachs without optical plummet.
No. 7311-41

TRAVERSE SET

WITH CARRYING CASE. For precise triangulation surveys, day or night.
No. 7312-45 Set contains two each of the following:
7311-35 Optical Plummet Tribrachs
7311-37 Tribrach adaptors
7312-39 Illumination units
7312-40 Rotatable sighting targets mounted on a base



Exploded view



LARGE TARGET
Large target 8-1/4" x 11-3/4" attaches to regular target (No. 7312-40) to provide increased sighting range.
No. 7312-42

RANGE PLUMBING POLE

Aluminum tubing and brass fittings with hardened steel point. Height adjusts from 54" to 100". Upper section mounting stud accepts single or triple retro prisms; locking disc prevents prism rotation. Includes replaceable rod level (No. 8071-90).
No. 7270-48

TELESCOPING RANGE PLUMBING POLE

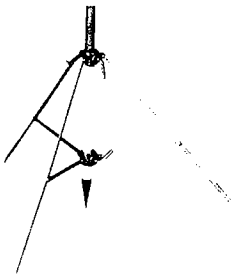
Ideal for EDM and traverse work. Made of quality aluminum tubing with brass fittings and hardened steel point. Positive chuck style twist lock permits height adjustment from 54" to 100". Replaceable rod level (No. 8071-90) and point (No. 8078-50). Upper section has 5/8 x 11 mounting stud to accept single or triple retro prisms.
No. 7270-46

TRIPODS

Tripods recommended for use with these accessories (not included in price):
No. 7512-52 Wide Frame, Extension Leg (wood)
No. 7536-75 Wide Frame, Extension Leg (aluminum)

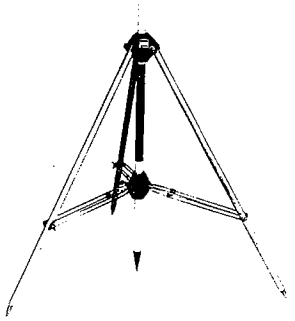
RANGE POLE SUPPORT

Made with metal center castings, rustproof steel legs w/one adjustable (hinged) leg for uneven ground.
No. 8078-90

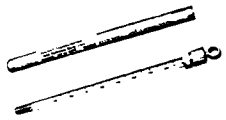


RANGE POLE TRIPOD

Heavy-duty. Made with metal center castings. Rustproof steel legs, adjustable for uneven ground.
No. 8078-95



POCKET THERMOMETER
Refillable metal case. Mercury filled. Range: -30° to 120°F in 2° increments.
No. 8006-12



BAROMETER/ALTIMETER
with watch-type case.
English-Range 0 to 15,000 ft.
No. 8001-70

6. POWER SUPPLIES

The SET3 can be operated with the following combinations:

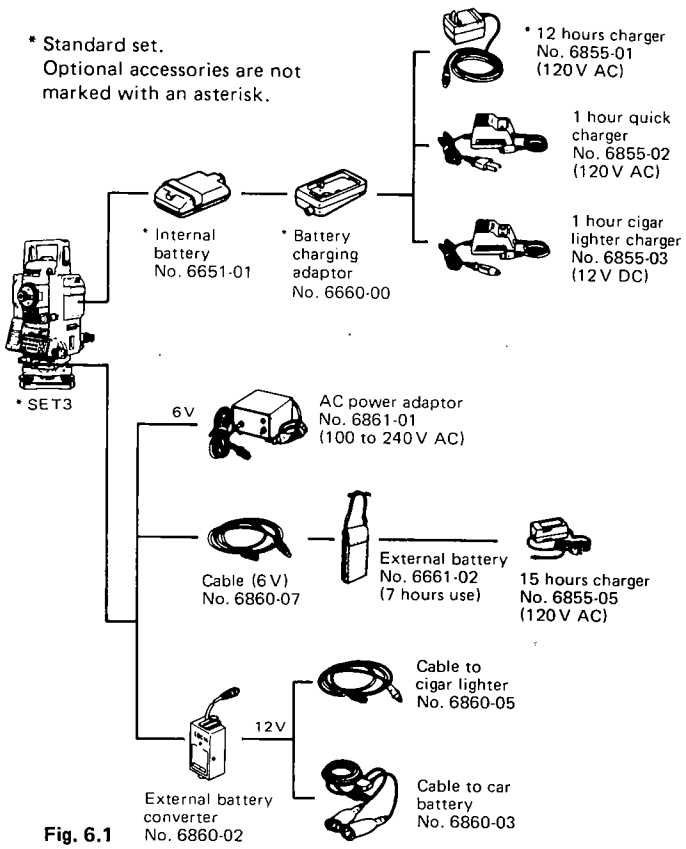


Fig. 6.1

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 No. 6651-01 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 50°F to 104°F (10°C to 40°C).
3) Before using No. 6861-01, set the voltage selector to the proper voltage.
4) No. 6860-02 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 32°F to 104°F (0°C to 40°C).
11) Battery operating life is shortened at extreme temperatures.

7. DISPLAY SYMBOLS

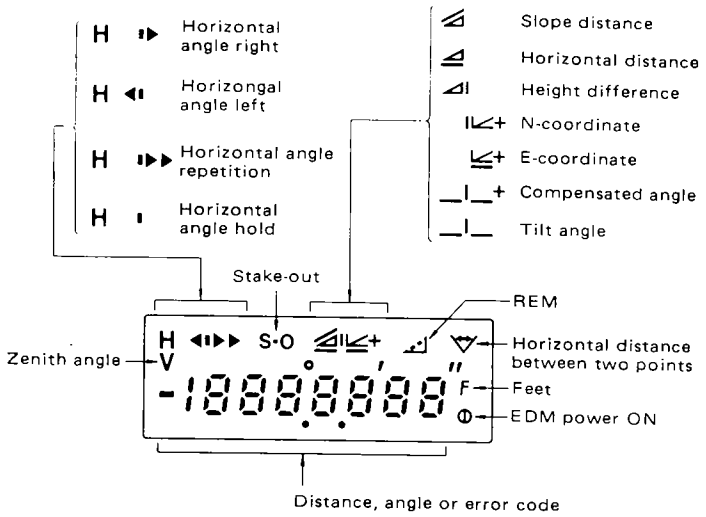


Fig. 7.1

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.

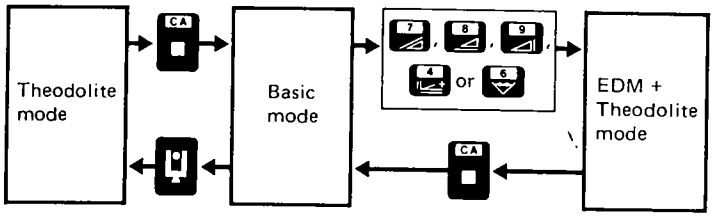


Fig. 8.1

Theodolite mode

Angle measurement.

SET3 accepts 0 SET, CE, ENT, ☼, ⌓, ⏻ or CA keys.

Basic mode

Prism sighting, data entry and recall.

SET3 accepts all keys except 0 SET, CE, ENT, ⌓ or CA keys.

EDM + Theodolite mode

Angle and distance measurement.

SET3 accepts CA or ☼ keys.

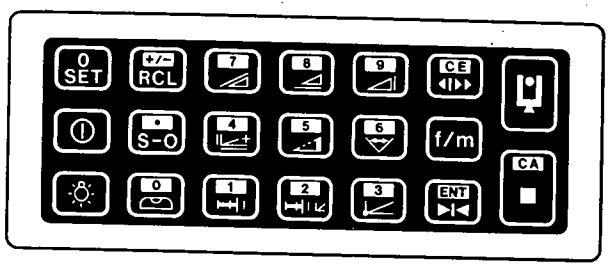


Fig. 8.2

- 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.

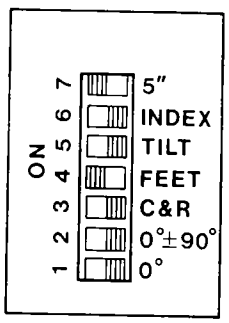


Fig. 9.1

Switch	Function
7	* ON Angle resolution 5" OFF Angle resolution 1"
6	ON Manually index vertical circle by V1, V2 * 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° horizontal ±90° * OFF Vertical angle display controlled by switch 1
1	ON Display vertical angle with 0° horizontal on face V1 * OFF Display zenith angle

(The asterisk indicates the position of each switch at the time of shipping.)

- Before changing switch settings, turn power switch OFF.

10. OPERATION

10.1 PREPARATION FOR ANGLE MEASUREMENT

10.1.1 Battery, No. 6651-01: Mounting and check

1) Confirm that the power switch ㉘ is OFF.
2) Mount the battery No. 6651-01 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.

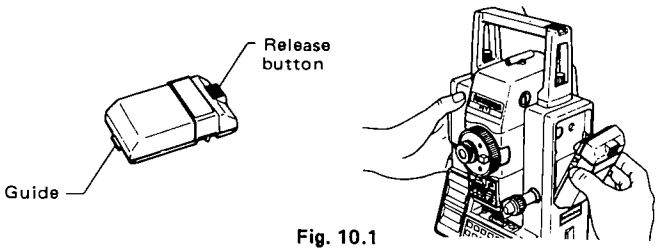


Fig. 10.1

(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.

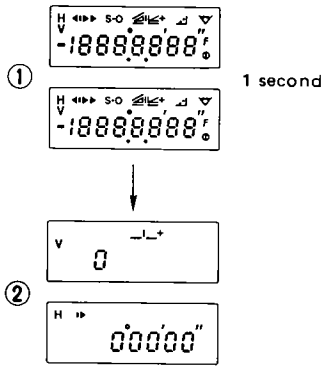
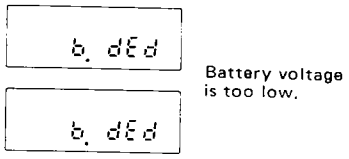


Fig. 10.2

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.

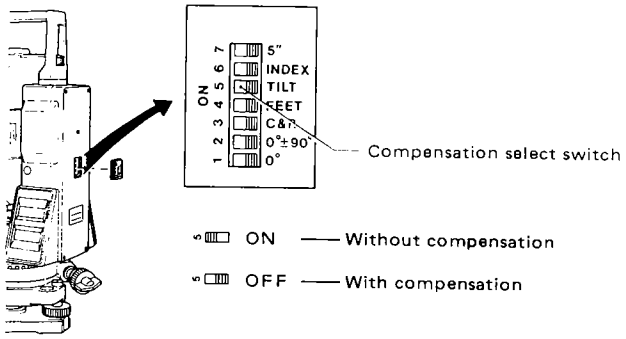


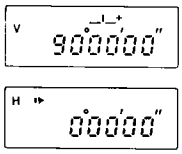
Battery voltage is too low.

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.





This mark appears when the internal switch 5 is set to OFF.
When this mark appears, the angle is compensated automatically.

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 Centering 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 centering screw.
3) Focus on the surveying point:
   a. Turn the optical plummet eyepiece ㉒ to focus on the reticle.
   b. Turn the optical plummet focusing ring ㉑ to focus on the surveying point.
4) Turn the leveling screws ⑫ to center the surveying point in the reticle.
5) Observe the off-center 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 center the bubble.
6) When centering of the circular level is completed, turn the leveling screws to center the plate level ㉓ bubble.
7) Look through the optical plummet again. If the surveying point is off-center, loosen the centering screw to center the surveying point on the reticle. Tighten the centering screw.
8) Repeat 6), 7) if the plate level bubble is off-center.

10.1.4 Focusing

1) Looking through the telescope, turn the eyepiece anticlockwise and stop turning just before the reticle image becomes blurred. In this way, frequent refocusing can be dispensed with, since your eye is focused 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 focusing 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 on the surveying point.
b. Battery voltage is adequate.

10.2.1 Automatically indexing vertical circle

1) Turn the power switch ㉘ ON.
Make sure that the display appears as shown below.

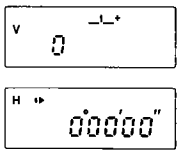


Fig. 10.5

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.

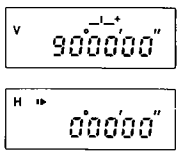


Fig. 10.6

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 [4].
2) Select the horizontal angle right or left with [CE/HP] according to measuring method.

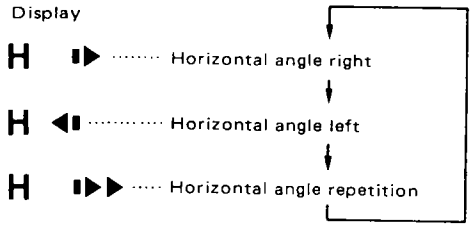


Fig. 10.7

When [CE/HP] 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°.

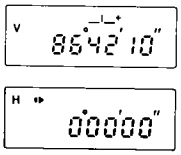


Fig. 10.8

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

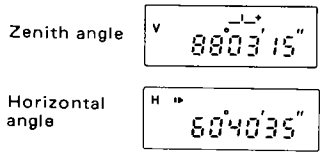


Fig. 10.9

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":

1) Loosen the horizontal clamp ㉔ and the lower clamp ⑥ and hold the upper alidade lightly. Turn the circle positioning ring ⑭ until the display becomes about 90° and tighten both clamps. Turn the horizontal fine motion screw ㉕ until the desired angle is displayed.
2) Press ENT.

Fig. 10.10

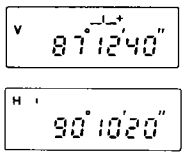


Fig. 10.11

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

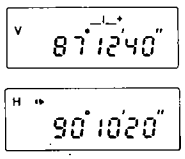


Fig. 10.12

10.2.4 Repetition of angles

Repetition of angles from -1,999°59'59" to 1,999°59'59" is displayed by using [CE/DIST].

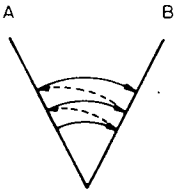


Fig. 10.13

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

H ▮▶▶ ····· Repetition of angle display

Fig. 10.14

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

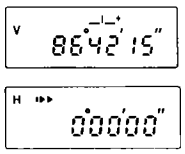


Fig. 10.15

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

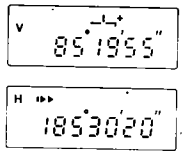


Fig. 10.16

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.

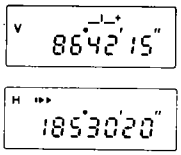


Fig. 10.17

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

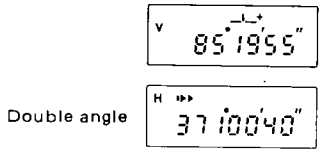


Fig. 10.18

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

10.3 PREPARATION FOR DISTANCE MEASUREMENT

10.3.1 Prism constant correction

1) Remove the prism constant cover ⑯ with a coin.
2) Turn the index to 3 with a screwdriver.
   The prism constant of a Lietz reflecting prism is -3 cm.
3) Replace the cover.

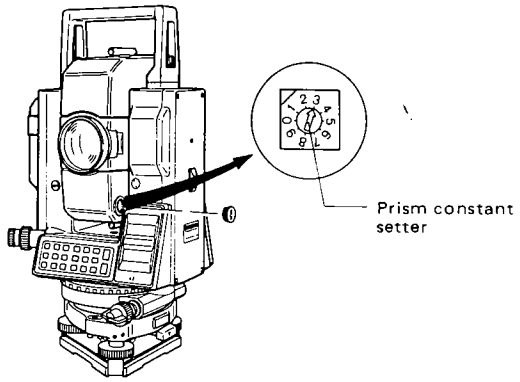


Fig. 10.19

- A prism constant of 0 to -9 cm can be set in steps of 1 cm.
  Example: When the prism constant is -2 cm, set the index to 2.

10.3.2 Atmospheric correction

The SET3 is designed so that the correction factor is 0 for a temperature of +59°F (+15°C) and an atmospheric pressure of 29.9 inchHg (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.

2) Read the correction factor from the atmospheric correction chart.
Example: Temperature +77°F (+25°C)
Atmospheric pressure 29.5 inchHg (750 mmHg)
Correction factor is +13 ppm.

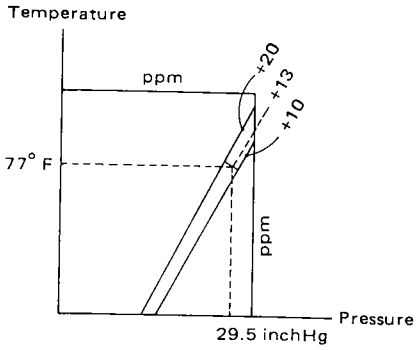


Fig. 10.20

- To convert millibars to mmHg multiply by 0.75.
  Example: 959 millibar
  $0.75 \times 959 \fallingdotseq 719$ mmHg
- To convert temperature in fahrenheits to centigrades by computation.

$$°C = \frac{5}{9}(°F - 32)$$

3) Set the ppm switch ㊲ to +13.

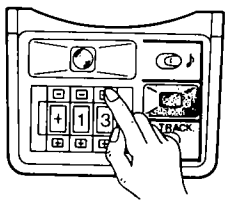


Fig. 10.21

4) To obtain the atmospheric correction factor by computation.

a. inchHg – °F system (english):

Atmospheric correction factor

$$X = 278.96 - \frac{10.5 \times P}{1 + 0.002175 \times t}$$

P: Atmospheric pressure in inchHg

t: Temperature in fahrenheit

Example: P = 29 inchHg, t = +60°F

$$ppm = 278.96 - \frac{10.5 \times 29}{1 + 0.002175 \times 60} = 9.61 \fallingdotseq 10$$

Set +10 to the ppm switch.

b. mmHg – °C system (metric):

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

5) For slope distances equal to or more than 6,561.68 ft (2,000.000 m) (exceeding the maximum display 6,561.67 ft (1,999.999 m)), ppm switch should be set to 0 and the corrected slope distance calculated by the formula:

$$D = (6{,}561.68 + d) \times (1 + \frac{X}{1{,}000{,}000})$$

D: Corrected slope distance

d: The display of slope distance when ppm is set at 0

X: Correction factor in ppm

Example: Slope distance 6,594.48 ft (displayed as 32.80 ft)

X = +5 ppm

$$D = (6{,}561.68 + 32.80) \times (1 + \frac{5}{1{,}000{,}000})$$

$$= 6{,}594.51 \text{ ft}$$

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 screwdriver.
3) Replace the cover.

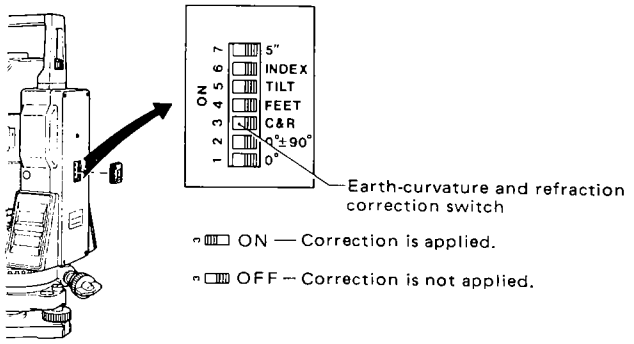


Fig. 10.22

- 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 (2.09×10^7 ft)

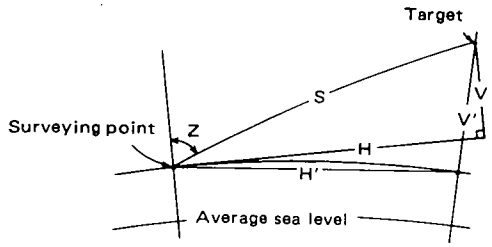


Fig. 10.23

Example: Amount of correction at a zenith angle 70°

S (ft)	500	1,500	3,000	5,000
H' - H (ft)	-0.00	-0.03	-0.13	-0.36
V' - V (ft)	0.00	0.04	0.16	0.45

Note that the horizontal distance is a distance measured at the height of the surveying point above the sea level so that to convert it to a distance above the average sea level, it is necessary to apply a projection correction additionally.
Further, since the SET3 does not apply the earth-curvature and refraction and atmospheric corrections when a slope distance is more than 6,561.67 ft, such corrections should be performed by computation.

10.3.4 Prism sighting

1) Sight the center 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 ⓘ.
   ⓘ 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 ⓘ 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 marking ⓫ 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 center is sighted correctly.

4) Switch off the audio target acquisition.

10.3.5 Mode selection

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

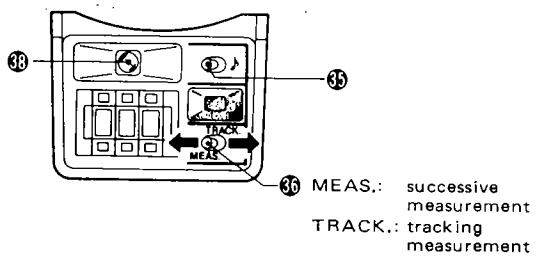


Fig. 10.24

MEAS.: Measures in hundredths of a foot, first after 6 seconds, then every 4 seconds.

TRACK.: Measures in tenths of a foot, first after 6 seconds, then every 0.4 to 1 second.

10.4 DISTANCE MEASUREMENT

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

10.4.1 Angle and distance measurement

1) Press [CA] to stop angle measurement.

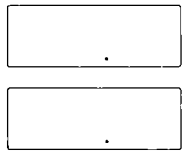


Fig. 10.25

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

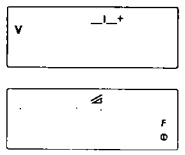


Fig. 10.26

4) The slope distance and the zenith angle will be displayed after about 6 seconds.

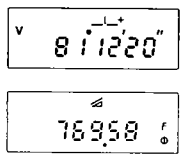


Fig. 10.27

Slope distance will continue to be measured every 4 seconds.

- Maximum display for slope distance is 6,561.67 ft (1,999.999 m). For longer slope distances, see 10.3.2.
- When the following keys are pressed instead of [2] in step 3), the measurement corresponding to each key is performed.

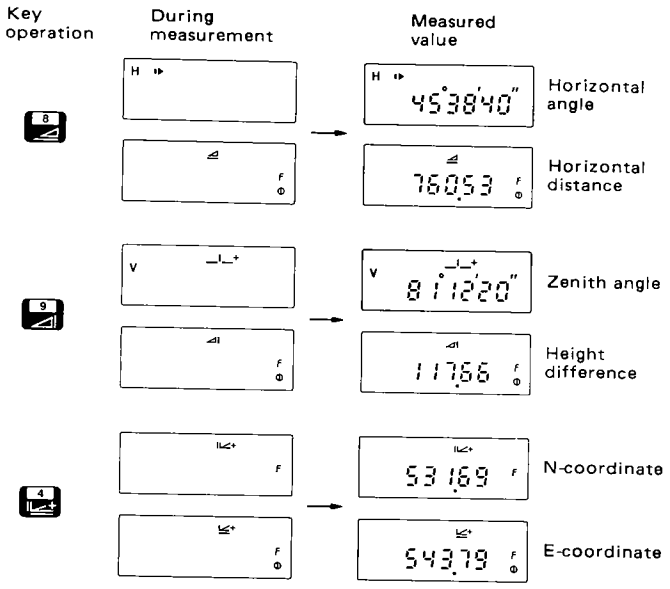


Fig. 10.28

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

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

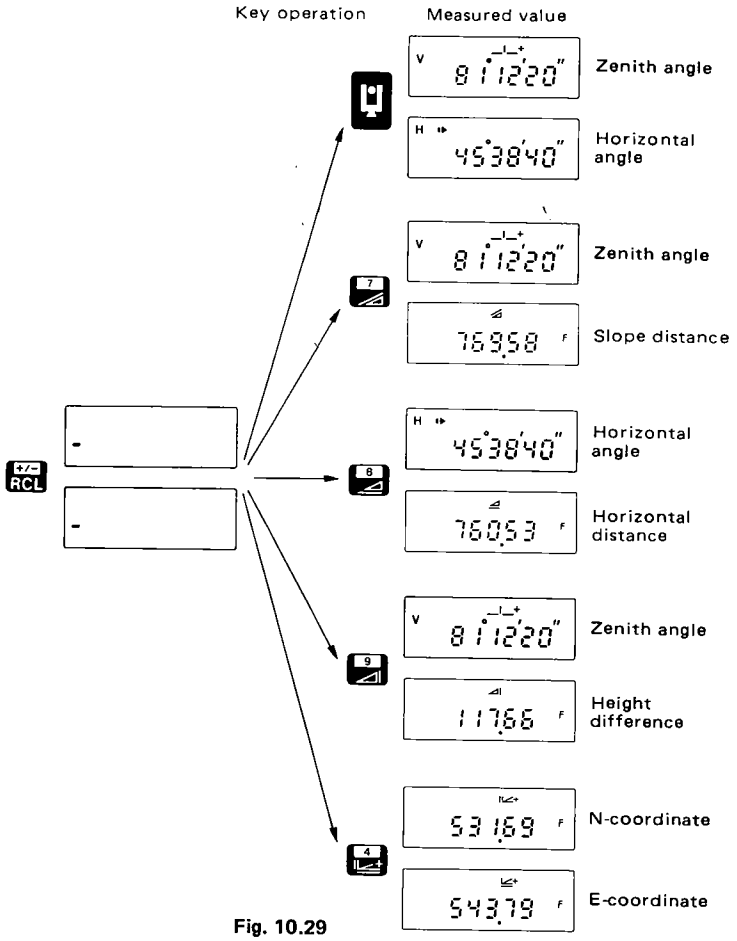


Fig. 10.29

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

7) To use as a theodolite after distance measurement, press CA then 4.

10.4.2 Measurement of coordinates

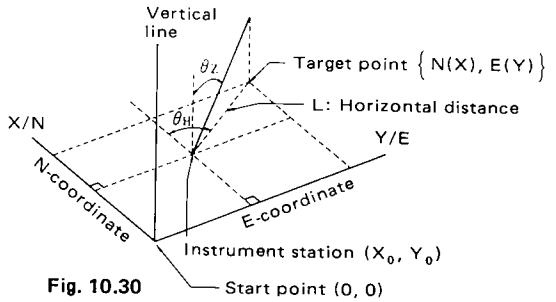


Fig. 10.30

1) The SET3 computes coordinates using the formulas:

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

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

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:

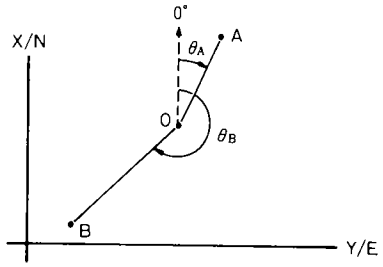


Fig. 10.31

Point No.	Horizontal distance	Horizontal angle	N-coordinate	E-coordinate
O	–	–	2,000.00	2,500.00
A	1,454.68	20°15'10"	3,364.74	3,003.56
B	2,462.11	225°32'50"	275.73	742.48

4) Press [CA] 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 [CA].
- The range of coordinates is between -9,999.99 ft (-9,999.999 m) and 9,999.99 ft (9,999.999 m).
- 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 (2,000, 2,500)

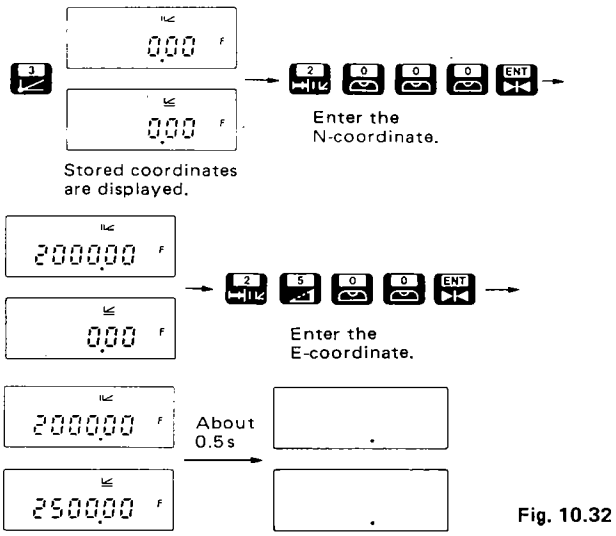


Fig. 10.32

b. Confirmation of instrument station coordinates

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

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

c. Measurement of target point coordinates

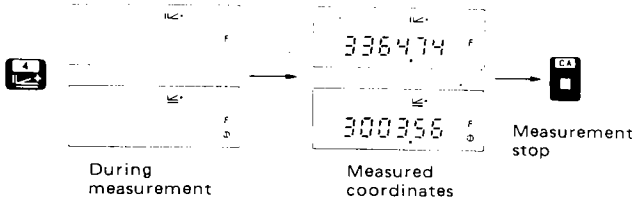


Fig. 10.33

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.

[1] → Enter data → [ENT]

- 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

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

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

4) Measurement

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

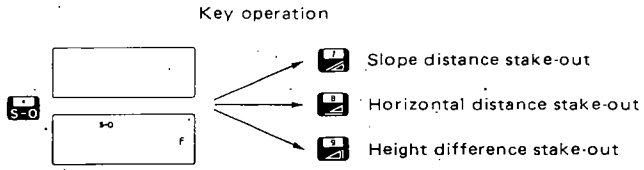


Fig. 10.34

Example: Horizontal distance stake-out measurement when stake-out distance is 295 ft

a. Entry of stake-out distance data

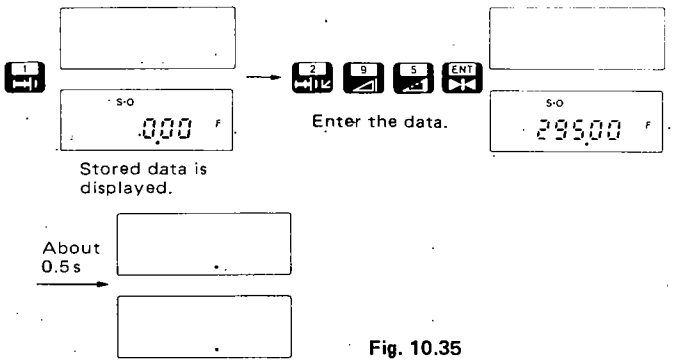


Fig. 10.35

b. Measurement

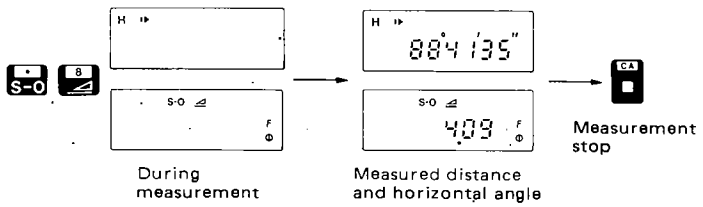


Fig. 10.36

The measured horizontal distance is 4.09 ft longer than the stake-out distance (295.00 ft).

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.

[F2] → 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 -9,999.99 ft (-9,999.999 m) and 9,999.99 ft (9,999.999 m) 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

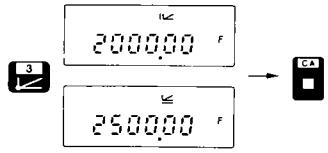
[F2] → Confirm the displayed data → [CA]

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

9) Measurement

Example: Coordinates stake-out measurement when stake-out N-coordinate value is 3,000 ft and stake-out E-coordinate value is 3,000 ft.

a. Confirmation of the instrument station coordinates.



b. Entry of stake-out coordinates data

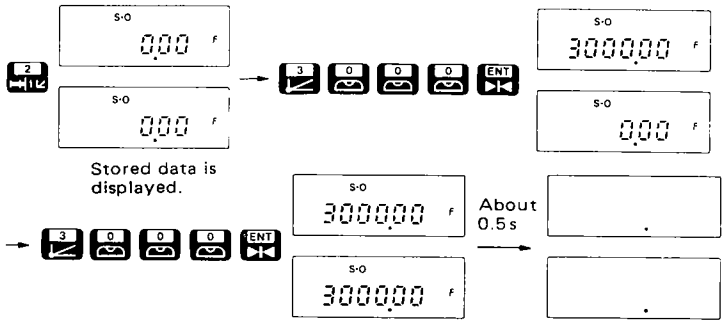


Fig. 10.37

c. Measurement

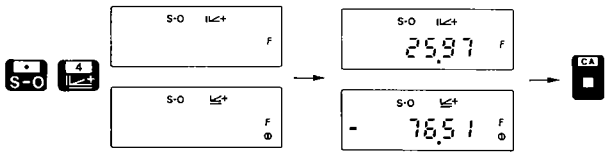


Fig. 10.38

The measured N-coordinate value is 25.97 ft longer than the stake-out value (3,000 ft) and the measured E-coordinate value is 76.51 ft shorter than the stake-out value (3,000 ft).

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.

$h = h_1 + h_2$

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

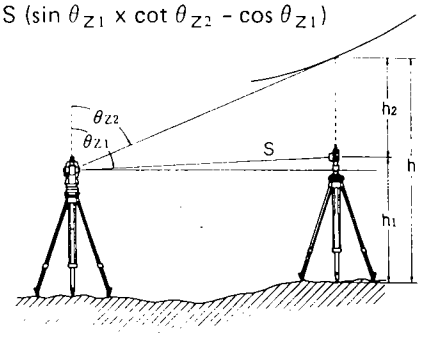


Fig. 10.39

1) Between the ground and the object
   a. Set up a reflecting prism under the object and measure the prism center 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 center height from the ground is 5.25 ft

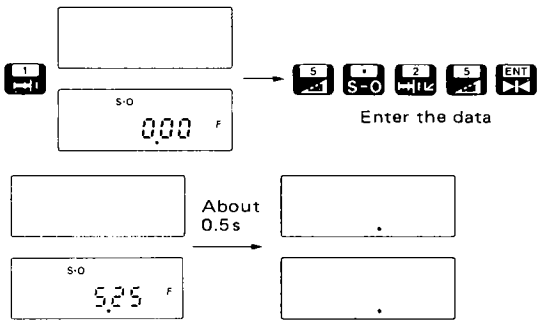


Fig. 10.40

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

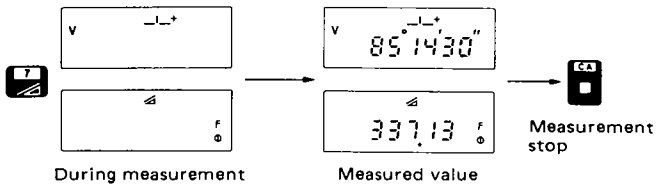


Fig. 10.41

- The measured value is stored in the SET3.

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

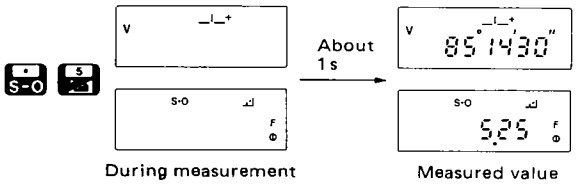


Fig. 10.42

- 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.

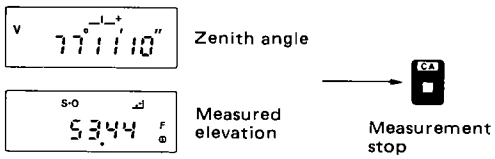


Fig. 10.43

- The range of measurement is between vertical angles of -89° and 89°.

10.4.5 Measurement of horizontal distance between two target points

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

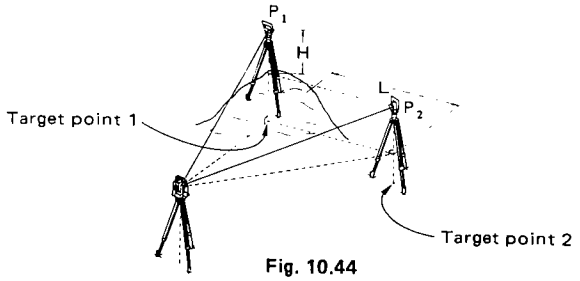


Fig. 10.44

1) Set up the reflecting prisms P_1, P_2, on target points 1, 2.
2) Sight the prism P_1 and press [7].
   Press [CA] after the distance measurement data is displayed.

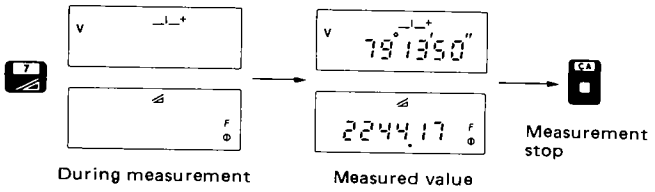


Fig. 10.45

- The measured value is stored in the SET3.

3) Sight the prism P_2 and press [8].

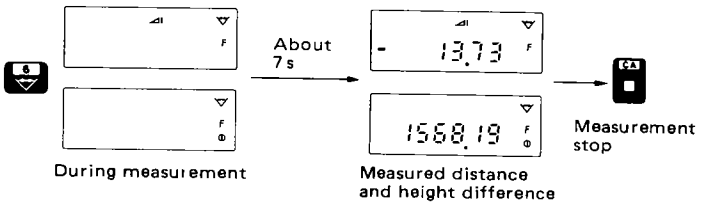


Fig. 10.46

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°.
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 the reflecting prisms for long distance. 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° or the measured distance is more than ±9,999.999 m.	Press CA to stop measuring.
E 208	The measured distance is more than ±19,999.99 ft (±19,999.999 m).	Press CA to stop measuring.

* 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 DE15

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 DE15

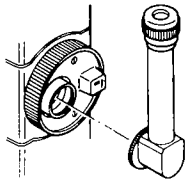


Fig. 12.1

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.

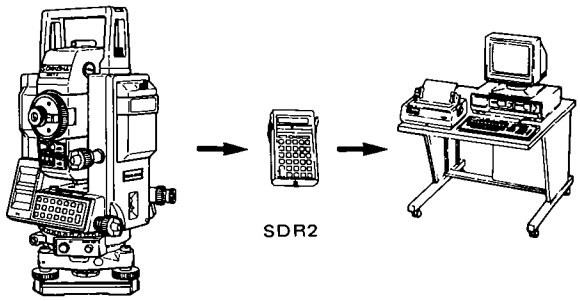


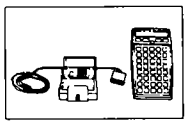
Fig. 12.2

SDR2 specifications

Power source:	"AA" (UM3) x 4
Memory type:	CMOS
RAM	16 K or 32 K
ROM	32 K
Keyboard:	33 keys
Display:	LCD
Baud rate:	300, 600, 1200, 2400, 4800 bps
Operating temperature range:	32 to 122°F (0 to 50°C)
Weight:	1 lb (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

IF1A specifications

Input voltage:	6V, 12V
Supplied from the SET3	
Input baud rate:	1200 bps
Operating temperature range:	32 to 113°F (0 to 45°C)
Weight:	0.84 lbs (380 g)

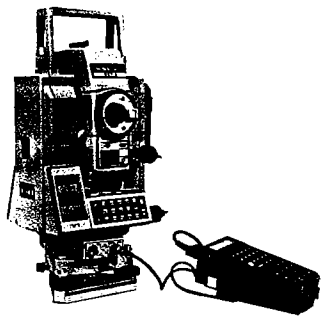


Fig. 12.4

12.4 DATA OUTPUT CABLE DOC1

Fitted with input plug for data output of SET3. Will accept output plug suitable for connection to your computer.

Length: 8.2 ft (2.5 m)

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 leveling screws.

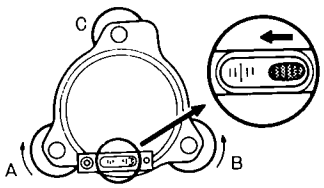


Fig. 13.1

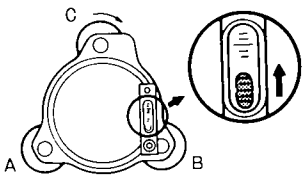


Fig. 13.2

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

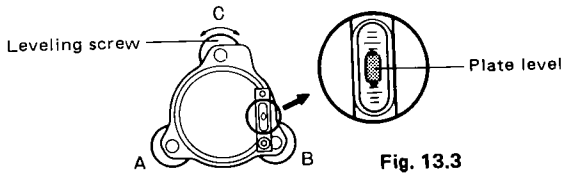


Fig. 13.3

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

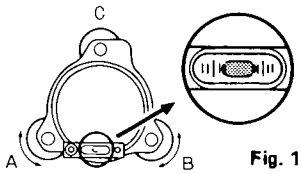


Fig. 13.4

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

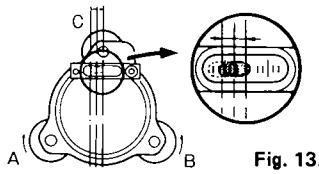


Fig. 13.5

5) Correct the remaining half deviation by turning the plate level adjusting screw ㉘ with the adjusting pin.

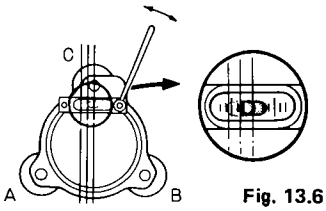


Fig. 13.6

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

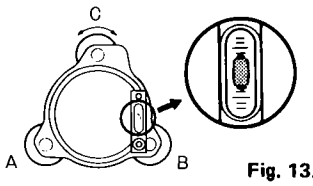


Fig. 13.7

13.1.2 Circular level

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

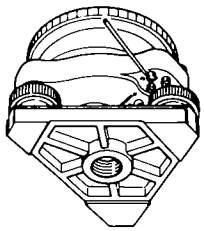
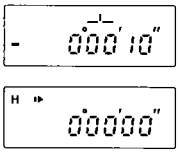


Fig. 13.8

13.1.3 Index error of the tilt angle sensor

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

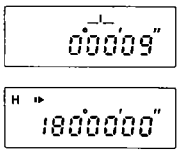
1) After indexing the vertical circle, tighten the vertical clamp ㉚.
2) Press [0 SET] to set the horizontal circle to zero, then press [⊂⊃] to display the tilt angle.



Tilt angle a = -10"

Fig. 13.9

3) Loosen the horizontal clamp and turn the upper part through 180°±5'.



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 $d_{180°} = b - c$.

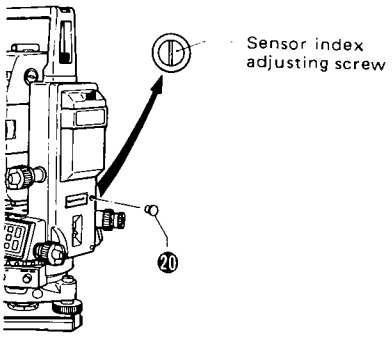


Fig. 13.11

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 160 to 330 ft (50 to 100 m).

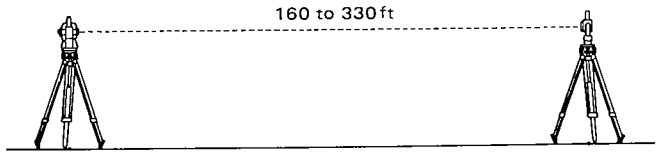


Fig. 13.12

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

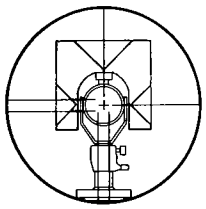


Fig. 13.13

3) Next in position V2, sight the same target. Take the horizontal angle reading, e.g. $a_r = 198°34'10''$ and the zenith angle reading, e.g. $b_r = 269°30'05''$.
4) Calculate $a_r - a_l$, $b_r + b_l$.

$a_r - a_l = 198°34'10'' - 18°34'00'' = 180°00'10''$

$b_r + b_l = 269°30'05'' + 90°30'10'' = 360°00'15''$

5) When the reticle is in the normal position, your results should show that $a_r - a_l$ is within 20" of 180° and $b_r + b_l$ is within 20" of 360°. If the difference of $a_r - a_l$ from 180° or $b_r + b_l$ from 360° 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 $a_l = 18°34'00"$ $a_r = 198°34'30"$
$b_l = 90°30'10"$ $b_r = 269°30'20"$

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

$$b_c = \frac{b_r - b_l}{2} + 180° = \frac{269°30'20" - 90°30'10"}{2} + 180°$$
$$= 269°30'05"$$

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

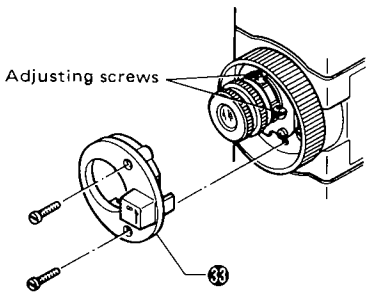


Fig. 13.14

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.

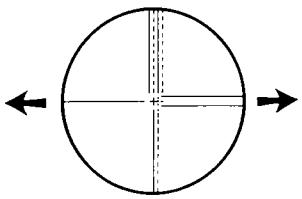


Fig. 13.15

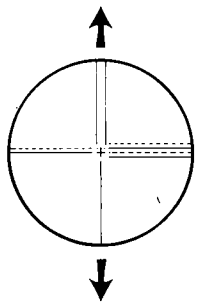


Fig. 13.16

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".

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.

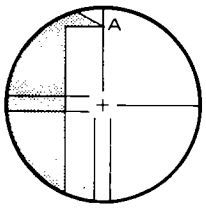


Fig. 13.17

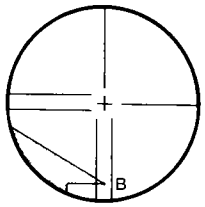


Fig. 13.18

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

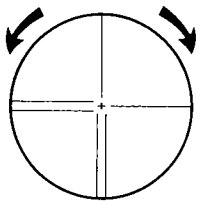


Fig. 13.19

13.1.6 Coincidence of the distance measuring axis with the reticle

When 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 160 to 330 ft (50 to 100 m).

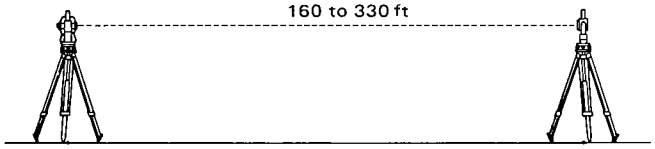


Fig. 13.20

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

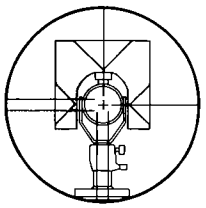


Fig. 13.21

3) Press ⓘ 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 4', the coincidence is normal. If the differences obtained are less than 3', please contact our agent.

13.1.7 Optical plummet

1) Level the SET3. Center a surveying point in the reticle of the optical plummet. Loosen the horizontal clamp and turn the upper part through 180°. If the surveying point is still centered, no adjustment is necessary.
2) If the surveying point is off-center, correct half the deviation with the four adjusting screws, and correct the remaining half with the leveling screws.

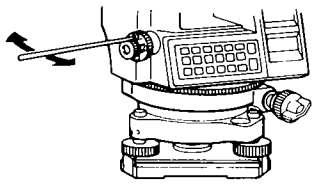


Fig. 13.22

3) Repeat the adjustment if necessary.

13.2 DISTANCE MEASURING FUNCTION

13.2.1 Check flow chart

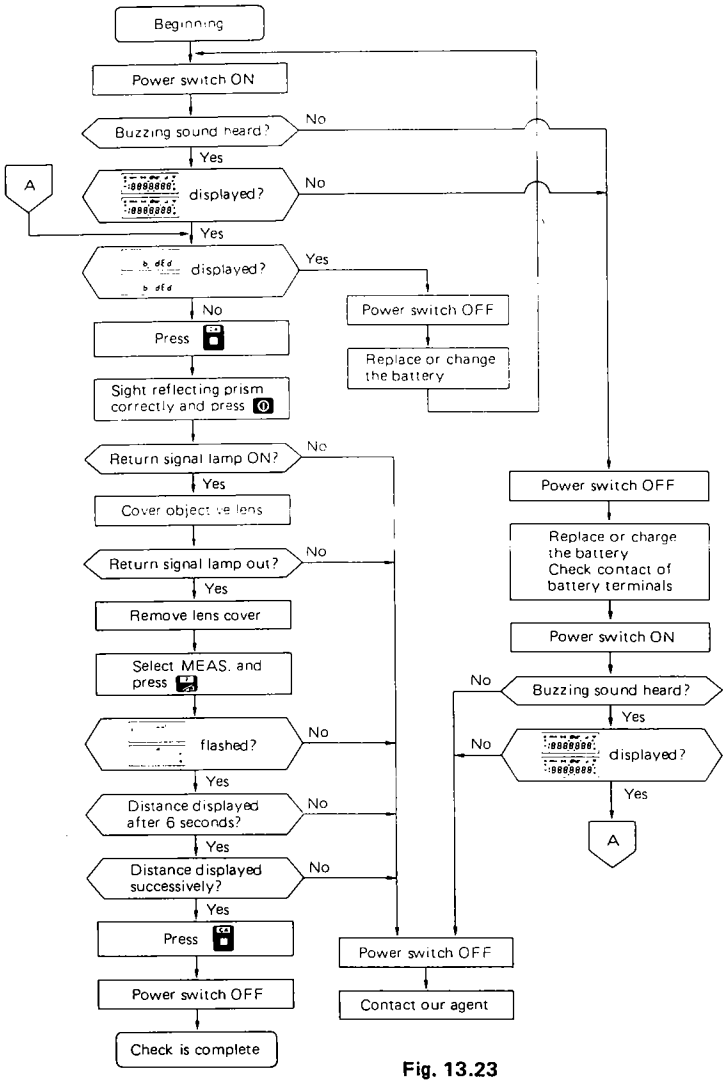


Fig. 13.23

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 center. If ground is not level, use an automatic level to set correct instrument heights of all points.

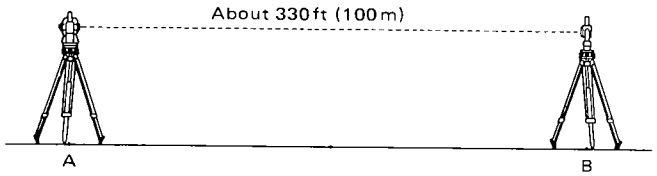


Fig. 13.24

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

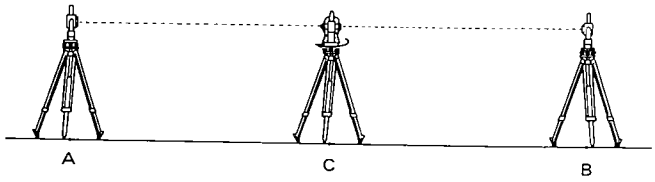


Fig. 13.25

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 LEVELING BY REFERRING TO THE DISPLAY

For the most accurate measurement of horizontal angles, particularly for steep observations, the SET3 should be leveled 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 leveling screws A and B. Then press [0 SET] to set the horizontal angle 0°.

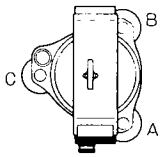


Fig. 14.1

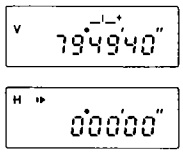


Fig. 14.2

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

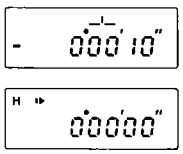


Fig. 14.3

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

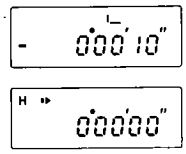


Fig. 14.4

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

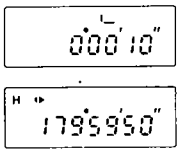


Fig. 14.5

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

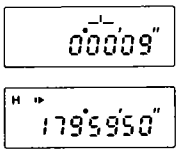


Fig. 14.6

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

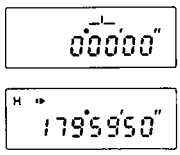


Fig. 14.7

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

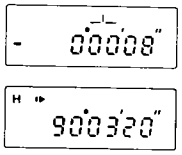


Fig. 14.8

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 leveling screw C until the value in the display is 0°±1".

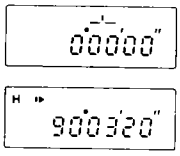


Fig. 14.9

11) Press [ ] to release the tilt angle display.

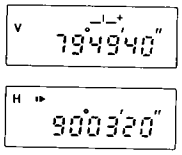


Fig. 14.10

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 leveling the SET3, turn the power ON and make sure that the display appears as shown below.

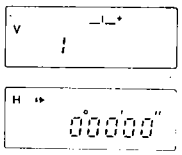


Fig. 14.11

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

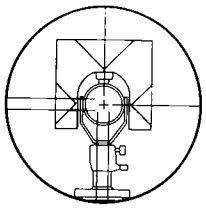


Fig. 14.12

4) Press [0 SET].

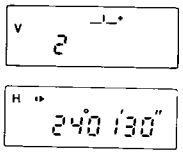


Fig. 14.13

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

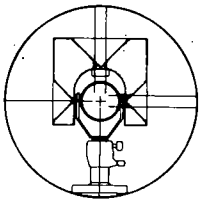


Fig. 14.14

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

Zenith angle V 279°49'40"

Horizontal angle H 204° 1'30"

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

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

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 2°F (1°C) and pressure to within 0.2 inchHg (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:

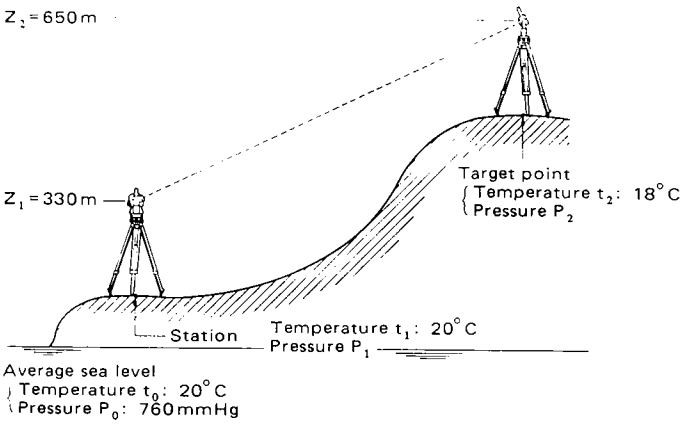


Fig. 15.1

By the Laplace formula

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

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

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 sun light, 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.

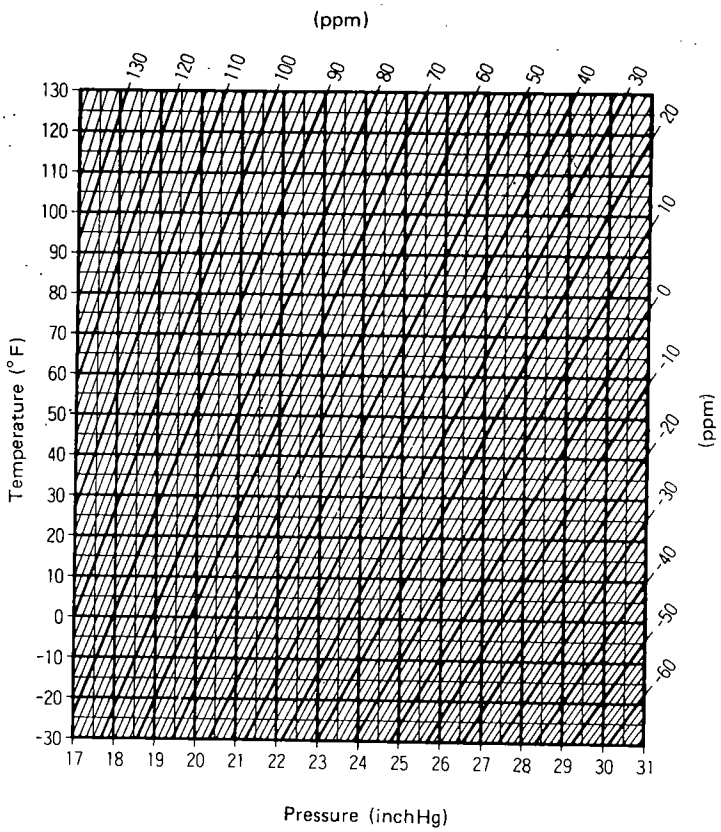
3) Store the SET3 in a dry room where the temperature remains fairly constant.

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.

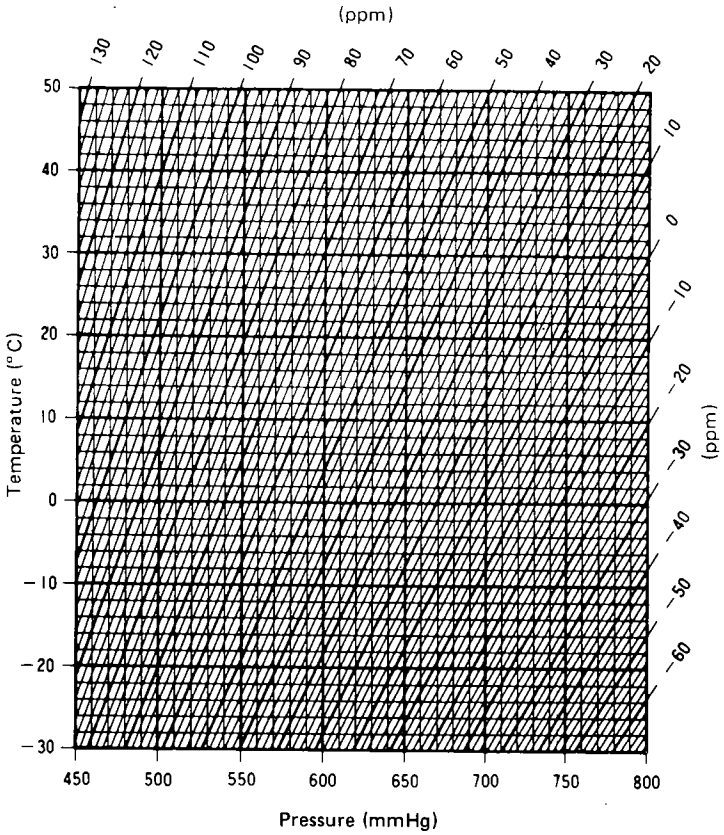
17. ATMOSPHERIC CORRECTION CHARTS

(English)



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

(Metric)



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

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