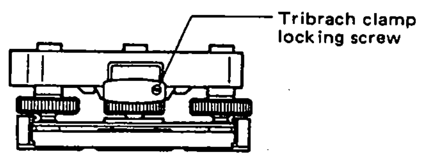
ELECTRONIC TOTAL STATION

SET4A

OPERATOR'S MANUAL

SOKKIA

CONTENTS



IMPORTANT

When the new SET4A is shipped, the tribrach clamp is fixed with a screw. Loosen it and leave it loose.

1. PARTS OF THE INSTRUMENT

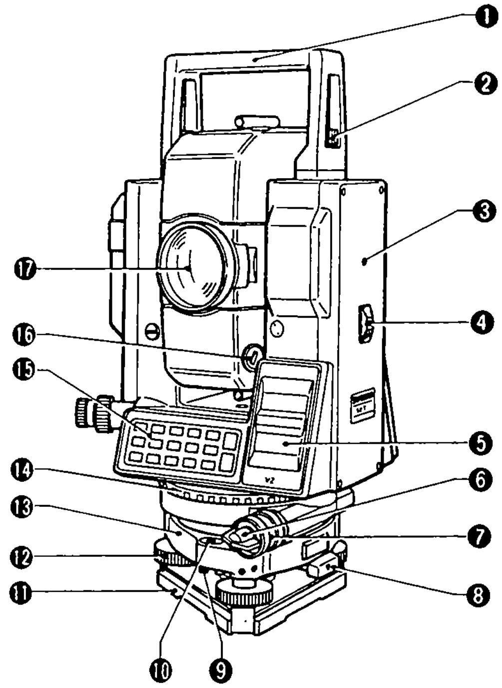


Fig. 1.1

1. Handle
2. Handle securing screw
3. Instrument height mark
4. Internal switch cover
5. Display
6. Lower clamp
7. Lower clamp cover
8. Tribrach clamp
9. Circular level adjusting screw
10. Circular level
11. Base plate
12. Leveling foot screw
13. Tribrach
14. Horizontal circle positioning ring
15. Keyboard
16. Prism constant switch cover
17. Objective lens

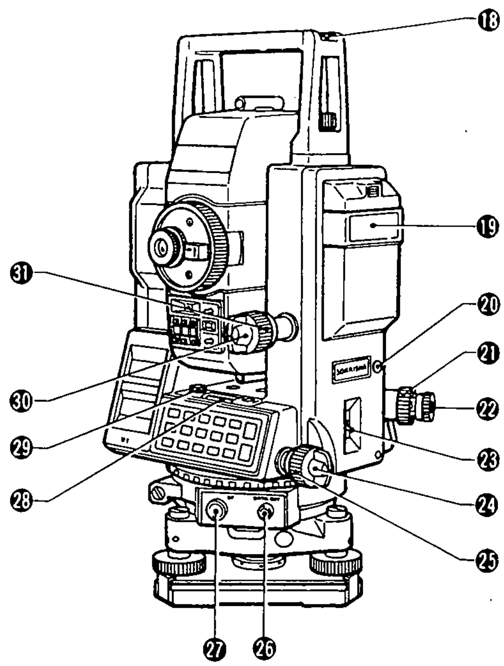


Fig. 1.2

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

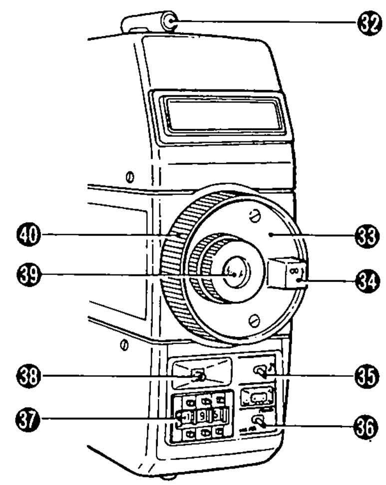


Fig. 1.3

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 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.
- Self-diagnostic function. If, for any reason, the SET4A is not functioning correctly during use, an error code is displayed.
- The tilt angle of the vertical axis can be measured by the internal sensor and displayed. By referring to the display, the SET4A 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 SET4A automatically switches off 30 minutes after the last operation to save battery power.
- A RS-232C data-out connector is standard.
- Measured data can be collected and stored by using a data collector.

3. SPECIFICATIONS

Distance measurement

Range: (When using Lietz/Sokkisha standard reflecting prisms

Average conditions:	(Slight haze, visibility about 12.5 miles, sunny periods, weak scintilla-tion)
	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:	MEAS. 0.01 ft (1 mm)
	TRACK. 0.1 ft (10 mm)

Measuring time:

	Mode	
	MEAS.	TRACK.
Slope distance	6 s + every 4 s	6 s + every 0.4 s
Horizontal distance	6 s + every 4 s	6 s + every 0.4 s
Height difference	6 s + every 4 s	6 s + every 0.4 s
Coordinates	6 s + every 1 s	
Remote elevation	1 s + every 0.5 s	
Horizontal distance between two points	8 s + every 4 s	8 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:	5"

Vertical circle

Type:	Incremental with 0 index
Minimum display:	5"
Accuracy	Standard deviation of mean of measurement taken in positions V1 and V2 (DIN18723)
H:	5"
V:	5"
Automatic compensator	Selectable ON/OFF
Type:	Liquid
Minimum display:	5"
Range of compensation:	±3'

Display

Range:	-1,999°59'55" to 1,999°59'55"

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 (6V)
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)
Instrument height:	9.29 inch (236 mm)
Size (without handle):	6.6 (W) x 6.7 (D) x 13.0 (H) inch (168 x 170 x 330 mm)
Weight:	16.7 lbs (7.6 kg) (w/internal battery)

4. STANDARD EQUIPMENT

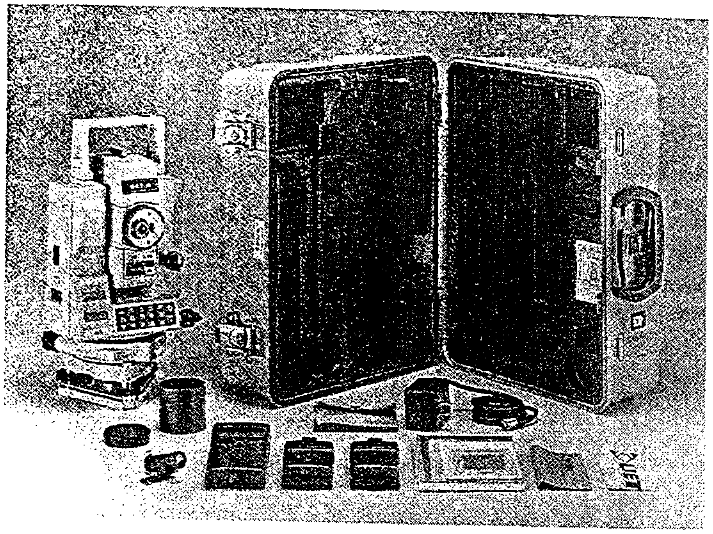


Fig. 4.1

SET4A main unit 1	Vinyl cover 1
Internal battery, No. 6651-01 2	Tool pouch 1
Battery charger, No. 6855-01 1	Screwdriver 1
Battery charging adaptor, No. 6660-00 1	Lens brush 1
Tubular compass, CP7 (accuracy: ±1°) 1	Adjusting pin 2
Lens cap 1	Cleaning cloth 1
Lens hood 1	Atmospheric correction chart 1
	Operator's manual 1
	Field guide 1
	Carrying case, SC46 1

5. LIETZ SYSTEM S3 STREAMLINED SURVEYING SOLUTIONS

The complete, proven system for field measurement, data collection, data processing, printing and plotting.

Start an all-day job and finish before noon?
When you work with the Lietz System S3, you'll find yourself doing just that. This proven field-to-office connection doubles your productivity and at the same time, actually improves your accuracy.
Using S3 components, you can be twice as competitive on every job. Twice as profitable.
One sighting with a SET Total Station gives you simultaneous distance and angle measurements. This data is then fed electronically into the SDR Electronic Field Book. Electronically capturing the data eliminates keying-in errors and the need for handwritten notes. From here, data can be electronically transmitted into SDR MAP or SDR LINK surveying software on your IBM-XT/AT or 100% compatible computer.

System S3 Software includes the following programs:

SDRLINK
Is an automated data communications program allowing for data to be transferred from the SDR Electronic Field Book to your computer. SDRLINK also has the ability to reduce field angles and distances to a coordinate database. ASCII files can be generated from the information that has been stored in the coordinate database.

SDRMAP
Is an automated plotting program which includes the SDRLINK program. SDRMAP uses the codes that were entered into the SDR Electronic Field Book to automatically generate a detailed plot of information. SDRMAP includes user-definable symbols, line types and code libraries. Plot files can be displayed on the computer screen, plotted on supported plotters, or may be sent to a CAD program using the DXF file creation.

SDRCONTOUR
Is an automated contour calculations module which generates contours from the information transferred from the SDR Electronic Field Book. Definition of break lines, boundaries and omitted areas may be selected from the SDR file or graphically at the computer using a mouse. All plotting is performed by SDRMAP.

SDRCALC*
Is the COGO module that allows for defining coordinate information using coordinate geometry routines. Routines include: Traverse entry and adjustment, bearing/bearing intersection, bearing/distance intersection, curve calculations, establishment of parallel and perpendicular lines, subdivide a line, and area calculations. All plotting is performed by SDRMAP.

SDRROAD*
Is a module of SDRMAP that performs the vertical geometry computations for road design. SDRROAD supports a range of methods for specifying the profile of vertical geometry, including the application of super elevation. Up to seven profile lines can be handled simultaneously.

SDRPROFILE*
Plots profiles and cross sections of natural and design surface data such as road cuts and fills, stockpiles, etc. Allows cross section data to be entered in the format of distance along the route (stationing), offset to the center line of the route, and height —either as reduced data or in level book format.

SDRVOLUME*
Is a module of SDRMAP that has the ability to calculate volumes in three different ways. 1. compute end areas between two surfaces at each cross section and multiply these by the distance between the sections. 2. compute volume between one or two planes and a surface from the areas of the triangles in the digital terrain model, multiplied by their average height above the planes. 3. Compute and plot the lines of no cut/fill after merging two triangulated digital terrain models.

SDRDIGITIZE*

Is a module of SDRMAP that allows for a quick and easy means of converting data in the form of plans and maps into data which can be computer processed for subdivision layout, contouring, area computation or road design.

* Contact your local Lietz Authorized dealer for availability and cost.

You and your Lietz System S3 can do it all with a minimum amount of training.

The Lietz nationwide organization of more than 50 Systems Centers backs System S3 to give you all the training, service and software support you need. The Lietz Warranty insures your satisfaction. Leasing plans are also available from your local Authorized Distributor.

THE LIETZ SYSTEM S3

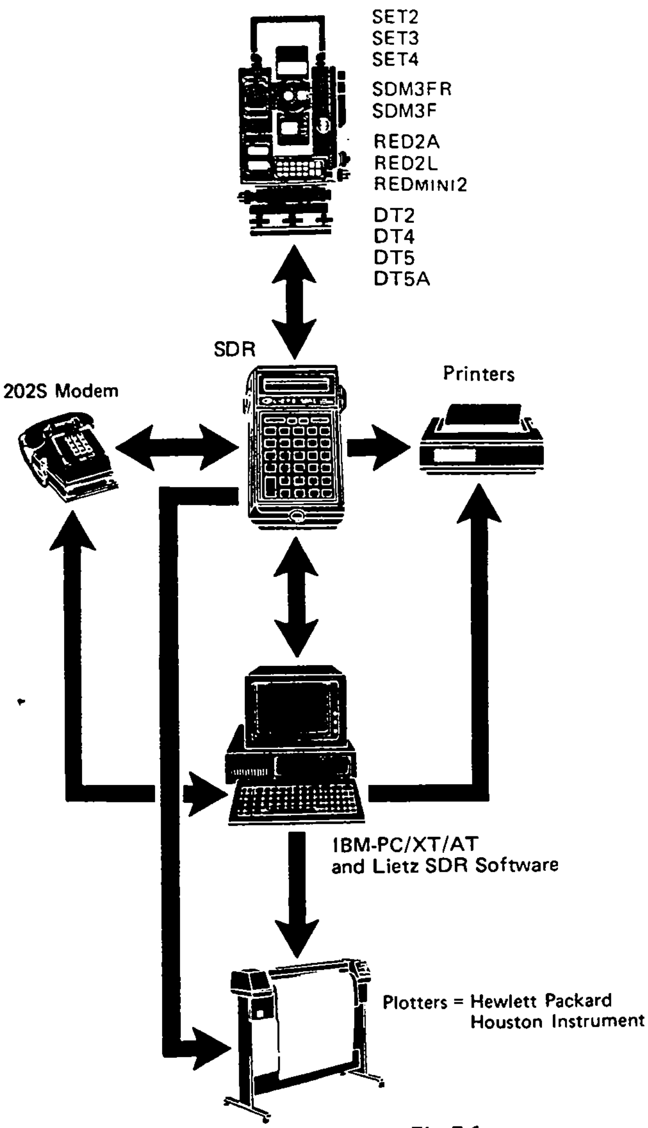


Fig. 5.1

SDR Surveying Software is designed to operate on your IBM PC/XT, IBM PC/AT, IBM System/2 or 100% IBM compatible computer. Listed below are the hardware requirements.

Configuration #1
IBM-Model 50
IBM-VGA Monitor
IBM-Pro Printer
HP or HI Pen Plotter
Serial Mouse

Configuration #2
IBM-AT (Enhanced)
IBM Enhanced Color Board
IBM Enhanced Color Screen
IBM Serial Port
IBM Pro Printer
HP or HI Pen Plotter
Serial Mouse

Configuration #3
IBM-XT with Hard Disk
IBM Enhanced Color Board
IBM Enhanced Color Screen
IBM Serial Port
IBM Parallel Port
IBM Pro Printer
HP or HI Pen Plotter
Serial Mouse

Note: When ordering, it is necessary to state which disk format you require. (3½" 720k or 5¼" 360k)

Lietz No. 5130-00	SDRMAP programs furnished on 5 ¼" diskettes.
Lietz No. 5130-01	SDRMAP programs furnished on 3 ½" diskettes.
Lietz No. 5140-00	SDRLINK programs furnished on 5 ¼" diskettes.
Lietz No. 5140-01	SDRLINK programs furnished on 3 ½" diskettes.
Lietz No. 5150-00	SDRCONTOUR programs furnished on 5 ¼" diskettes.
Lietz No. 5150-01	SDRCONTOUR programs furnished on 3 ½" diskettes.
Lietz No. 5155-00	SDRCALC programs furnished on 5 ¼" diskettes.
Lietz No. 5155-01	SDRCALC programs furnished on 3 ½" diskettes.
Lietz No. 5165-00	SDRVOLUMES programs furnished on 5 ¼" diskettes.
Lietz No. 5165-01	SDRVOLUMES programs furnished on 3 ½" diskettes.
Lietz No. 5170-00	SDRDIGITIZE programs furnished on 5 ¼" diskettes.
Lietz No. 5170-01	SDRDIGITIZE programs furnished on 3 ½" diskettes.
Lietz No. 5175-00	SDRROAD programs furnished on 5 ¼" diskettes.
Lietz No. 5175-01	SDRROAD programs furnished on 3 ½" diskettes.
Lietz No. 5180-00	SDRPROFILE programs furnished on 5 ¼" diskettes.
Lietz No. 5180-01	SDRPROFILE programs furnished on 3 ½" diskettes.

Note: Lietz guarantees your satisfaction with SDR Surveying Software. If, for any reason, you return the software within 30 days of receipt, you will be given a full refund.

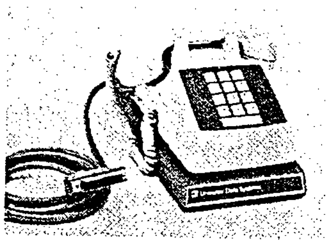


Fig. 5.2

202S MODEM

Universal Data system 202S LP Modem for use with SDR Electronic Field Book.

Note: SDR Electronic Field Books must be used with 202S modem to allow acoustic transmissions.

Lietz No. 5300-17

SDR ELECTRONIC FIELD BOOKS

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

Lietz No. 5300-20 SDR20 Electronic Field Book with 32 K memory complete with Sokkisha cable (5303-04), female DB-25 adaptor (5300-09), operation manual (5300-08) and field case (5290-15).

Lietz No. 5300-22 SDR22 Electronic Field Book with 64 K memory complete with Sokkisha cable (5303-04), female DB-25 adaptor (5300-09), operation manual (5300-08) and field case (5290-15).

Lietz No. 5300-24 SDR24 Electronic Field Book with 128 K memory. Data collection routines to support Wild, Topcon, Pentax and Elta 46R instruments. (Includes same accessories as SDR22.)

MOUNTING BRACKET

Fits on Lietz No. 7512-52 Tripods and holds SDR Electronic Field Books (or any hand-held calculator) in such a way that it rotates with the instrument for convenient and easy operation. Available in right hand or left hand configurations.

Lietz No. 5300-10 (Right hand)
Lietz No. 5300-11 (Left hand)

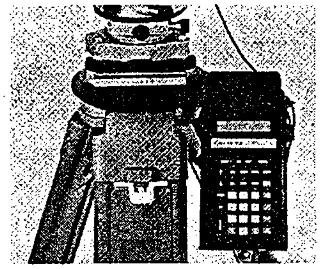


Fig. 5.3

6. POWER SUPPLIES

The SET4A can be operated with the following combinations:

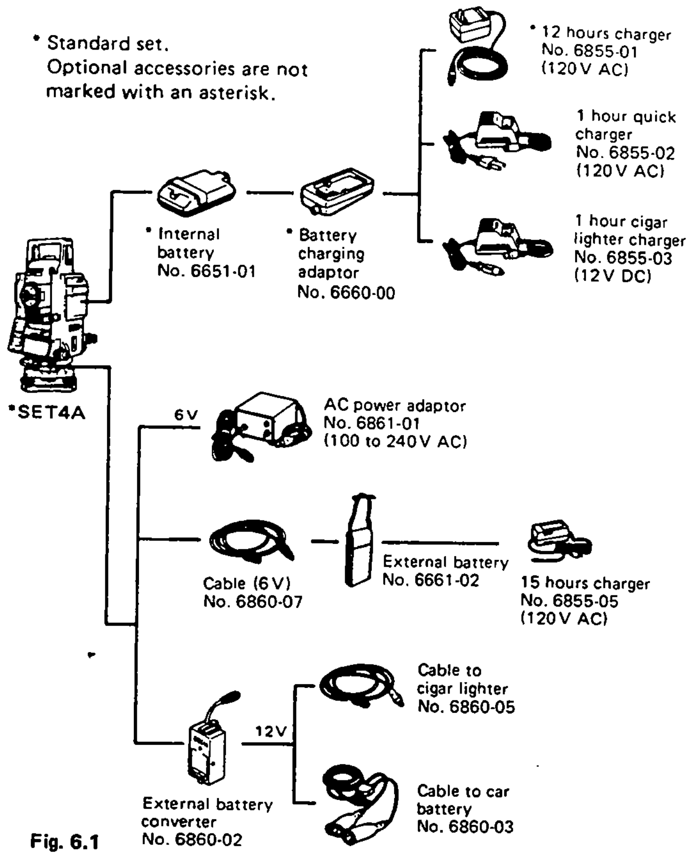


Fig. 6.1

Use the SET4A only with the combinations shown here.

Note: When using the SET4A 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

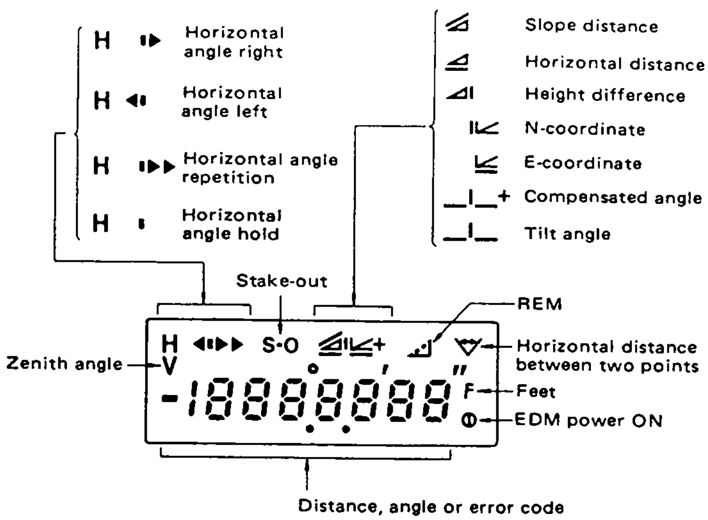


Fig. 7.1

8. KEY FUNCTIONS

SET4A has three measurement modes.
When it is switched on and the vertical circle is indexed by rot… ing the telescope, it is automatically in the theodolite mode.

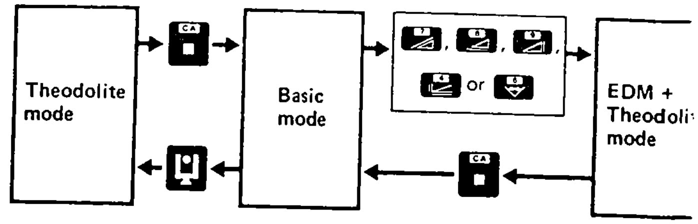


Fig. 8.1

Theodolite mode

Angle measurement.

SET4A accepts [CA], [key], [key], [key], [key], [key] or [0 SET] keys.

Basic mode

Prism sighting and recall.

SET4A accepts all keys except [CA], [key], [key], [key] or [0 SET] key…

EDM + Theodolite mode

Angle and distance measurement.

SET4A accepts [CA] or [key] keys only.

- When entering setting-out values, keys [key] ~ [key], [S-O], [RCL], [key] [key] and [CA] can be used.

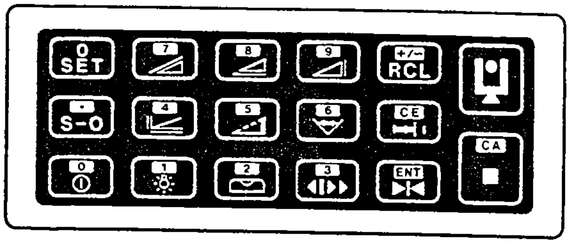


Fig. 8.2

- Select theodolite mode.

- Stop data entry before ENT has been pressed.
- Stop measurement and transfer to basic mode.

- Set horizontal angle to zero. To confirm zero setting, press ENT.

- Enter "7".
- Measure slope distance.

- Enter "8".
- Measure horizontal distance.

- Enter "9".
- Measure height difference.

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

- 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.

- Clear entry.
- Enter stake-out distance.

- Enter "0".
- EDM power ON/OFF for locating prism.

- Enter "1".
- Illuminate display and reticle of telescope for 30 seconds.

- Enter "2".
- Display vertical axis tilt angle ON/OFF.

- Enter "3".
- Select horizontal angle to left, right or by repetition (accumulation).

- Transfer entered data to memory.
- Confirm input of 0 SET (setting horizontal angle to zero).
- Hold/release horizontal angle.

9. INTERNAL SWITCHES

Switches are located under internal switch cover ❹.

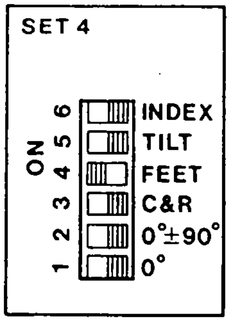


Fig. 9.1

Switch	Function
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 SET4A.
   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.

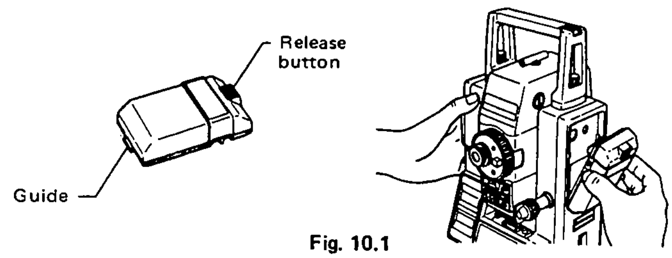


Fig. 10.1

(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.

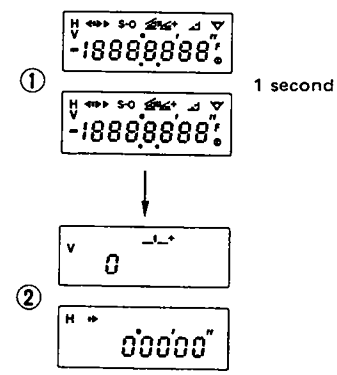


Fig. 10.2

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.

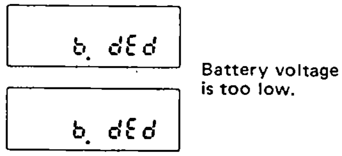


Fig. 10.3

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.

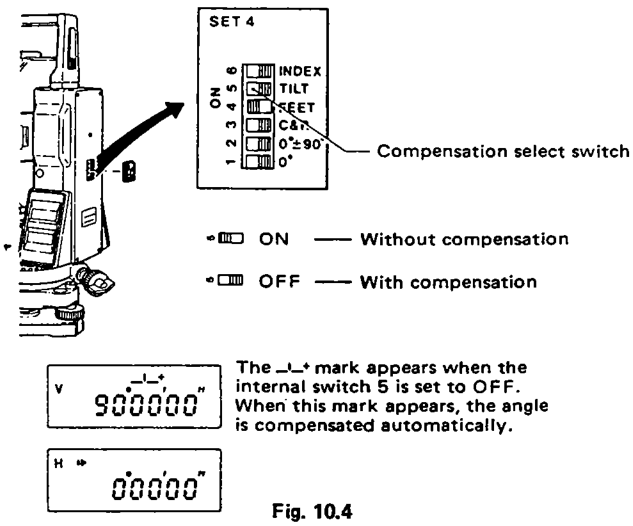


Fig. 10.4

The internal tilt sensor has a range of ±3' and a resolution of 5". 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 SET4A without compensation.

10.1.3 Centering the SET4A 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 SET4A 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 foot 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 ㉘ 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 fully clockwise, then anticlockwise until 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 SET4A 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.

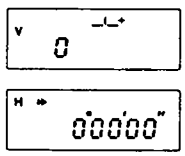


Fig. 10.5

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.

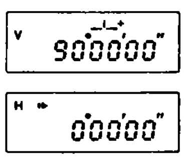


Fig. 10.6

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 the horizontal angle right or left with according to measuring method.

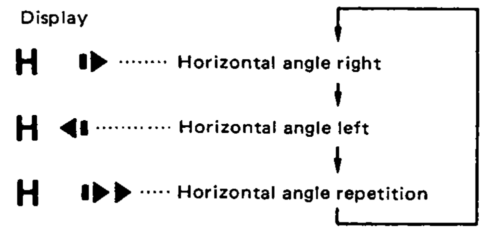


Fig. 10.7

When is pressed, the display changes alternately as shown in Fig. 10.7.

2) Sight the first target A.
3) Press then to set the horizontal angle display to 0°.

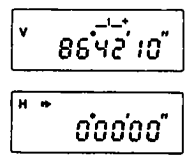


Fig. 10.8

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

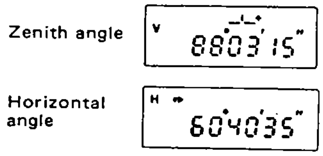


Fig. 10.9

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 ❻ and hold the upper alidade lightly. Turn the circle positioning ring ⓮ until the display becomes about 90° and tighten both clamps. Turn the horizontal fine motion screw ㉕ until the desired angle is displayed.

   Note: When using the lower clamp ❻, push in the cover ❼.

2) Press ENT.

Fig. 10.10

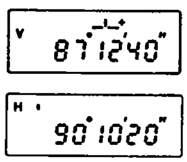


Fig. 10.11

3) Turn the instrument and sight the target.

4) Press to release the display hold.
   The required horizontal circle value is now set to the reference target.

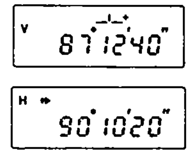


Fig. 10.12

10.2.4 Repetition of angles

Repetition of angles from −1,999°59'55" to 1,999°59'55" is displayed by using .

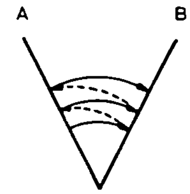


Fig. 10.13

1) Press to select repetition of angle.

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

Fig. 10.14

2) Sight target A, and press then .

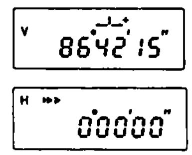


Fig. 10.15

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

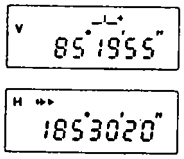


Fig. 10.16

4) Press [key] to hold the horizontal angle display.
5) Use the lower clamp ❻ and the horizontal fine motion screw ㉕ to turn back to target A.

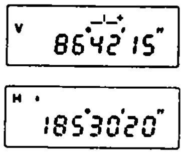


Fig. 10.17

6) Press [key] to release the display hold.
7) Use the horizontal clamp and the horizontal fine motion screw to sight target B.

Double angle

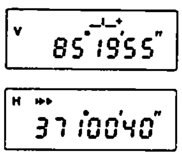


Fig. 10.18

8) Repeat 4) to 7) steps to measure repetition of angles.
9) To release the repetition of angle display, press [key].

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 prism constant setter to match the reflecting prism constant correction value.
   i.e. For a prism constant correction value of -3 cm, set the index to 3 (-3 cm).

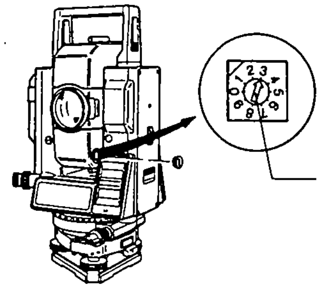


Fig. 10.19

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.

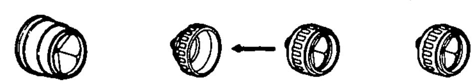


Fig. 10.20

When using reflecting prisms with constant values other than the above, a prism constant correction of 0 cm to -9 cm can be set in steps of 1 cm using the prism constant setter.

10.3.2 Atmospheric correction

The SET4A 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.

- To convert millibars to inchHg multiply by 0.0295.
- To convert mmHg to inchHg divide by 25.4.
- To convert temperature from Centigrade to Fahrenheit, use the formula:

$$°F = \frac{9}{5} °C + 32$$

2) Read the correction factor from the atmospheric correction table on pages 71 and 72.
   Example: Temperature +77°F (+25°C)
   Atmospheric pressure 29.5 inchHg (750 mmHg)
   Correction factor is +13 ppm.

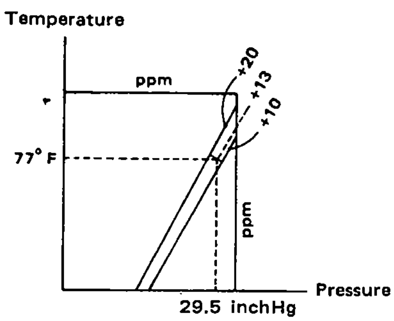


Fig. 10.21

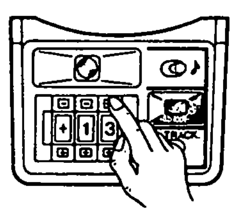


Fig. 10.22

3) Set the ppm switch ㊲ to +13.

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 the ppm switch to +10.

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)**), the 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 to 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 screw-driver.
3) Replace the cover.

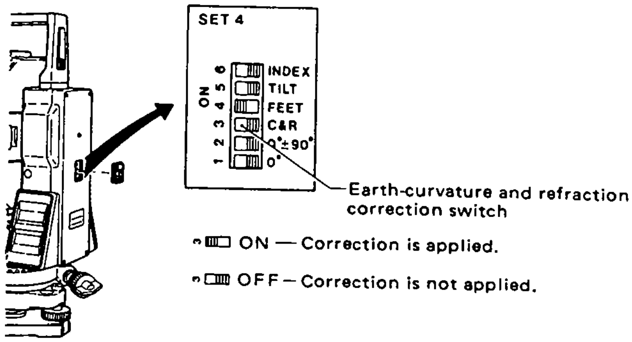


Fig. 10.23

- This correction is performed in the measurement of horizontal distance and height difference.
  The value displayed by the SET4A 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)

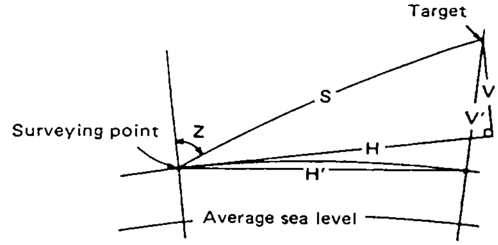


Fig. 10.24

Example: Amount of correction for a zenith angle of 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. If necessary, reduce this distance to the average sea level and apply the local projection correction.
Further, since the SET4A 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 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 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 fine measurement, or TRACK. for tracking.

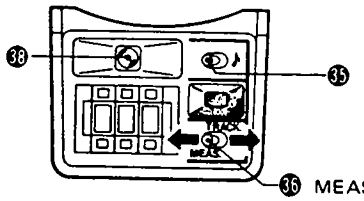


Fig. 10.25

MEAS.: Measures in hundredths of a foot, first after 6 to 8 seconds, then every 4 seconds.

TRACK.: Measures in tenths of a foot, first after 6 to 8 seconds, then every 0.4 to 1 second.

10.4 DISTANCE MEASUREMENT

Make sure that:
- a. The SET4A is set up correctly over the surveying point.
- b. The feet/meter switch, prism constant switch, 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, distance and coordinates measurement

1) Press [key] to change from angle measurement mode to basic mode.

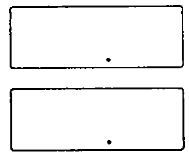
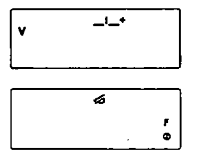


Fig. 10.26

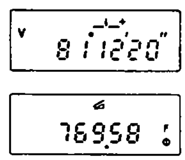
2) Press [key] and sight the center of the reflecting prism. (See 10.3.4)
3) Press [key] to measure slope distance.
The following display appears showing that the slope distance measurement is being performed.



Display flashes

Fig. 10.27

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



Zenith angle

Slope distance: 769.58 ft
(Fine measurement)

Fig. 10.28

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 [key] in step 3), the measurement corresponding to each key is performed.

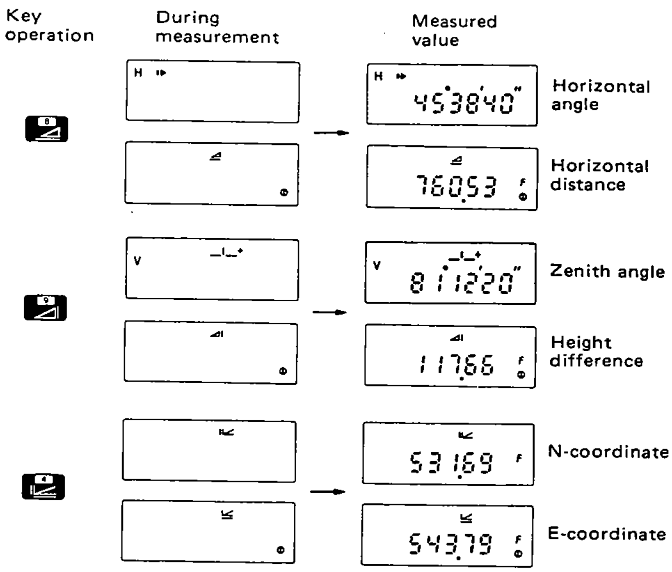


Fig. 10.29

5) Press [key] to stop measurement.

Note: The SET4A computes the coordinates using the following formulas:

N-coordinate = H cos θ_H

E-coordinate = H sin θ_H

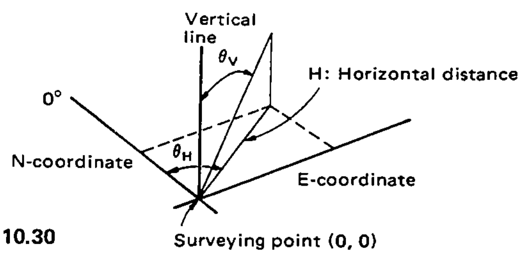


Fig. 10.30

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

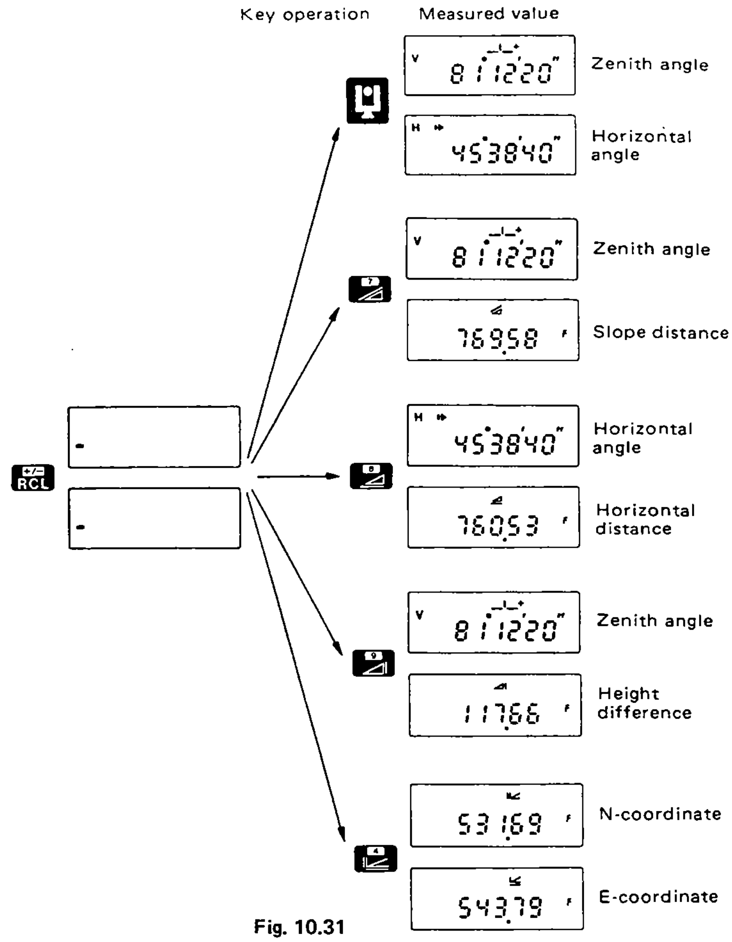


Fig. 10.31

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

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

10.4.2 Stake-out measurement

1) Stake-out data is a given distance where a stake is supposed to be driven into the ground.
   The SET4A displays the measured distance minus the given distance (stake-out data).

   Displayed value = Measured value - Stake-out data

2) Entry of stake-out data
   The stake-out data need to be entered once for the slope distance, horizontal distance, height difference or remote elevation measurement.
   The SET4A should be in the basic mode for data entry.

   → Enter data →

   - To clear the entry halfway, press .
   - To stop the entry halfway, press .
   - The range of stake-out data is between -9,999.99 ft (-9,999.999 m) and 9,999.99 ft (9,999.999 m).
   - The data once entered is stored until the power switch is turned OFF, then becomes 0.

3) Confirmation of stake-out data

   → Confirm the displayed data →

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

4) Measurement
   The following measurements can be performed with .

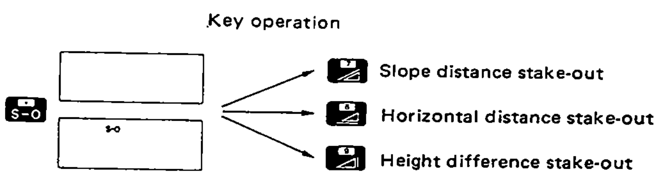


Fig. 10.32

Example: Horizontal distance stake-out measurement when stake-out data is 90.5 feet.

a. Entry of stake-out data

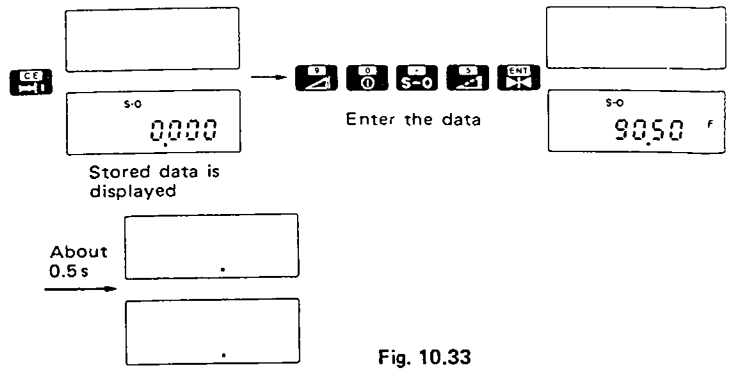


Fig. 10.33

b. Measurement

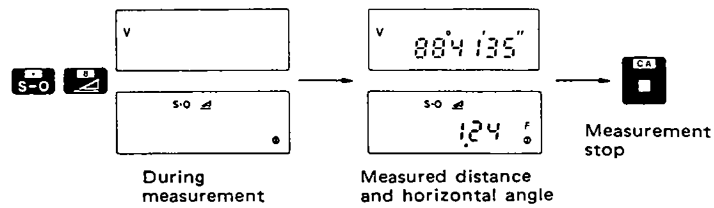


Fig. 10.34

The measured horizontal distance is 1.24 feet longer than the stake-out data (90.5 feet).

10.4.3 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.

$h = h_1 + h_2$

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

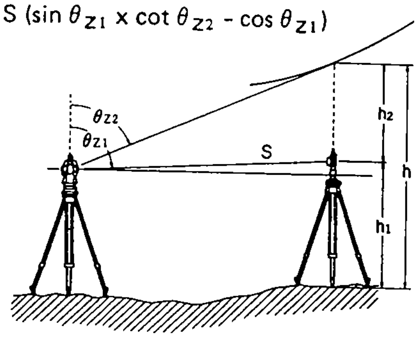


Fig. 10.35

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 5.20 ft.

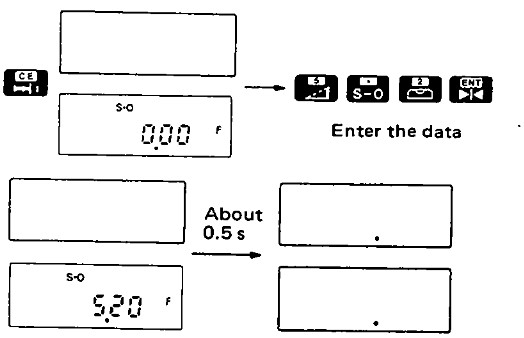


Fig. 10.36

c. Sight the reflecting prism and press .
Press after the distance measurement data is displayed.

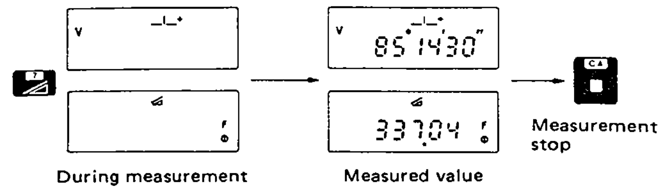


Fig. 10.37

- The measured value is stored in the SET4A.

d. Press , then .

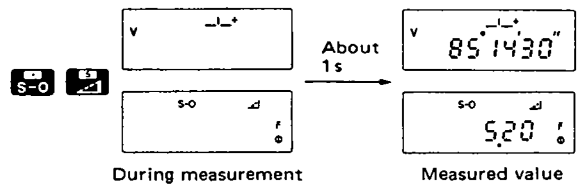


Fig. 10.38

- When the SET4A 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.

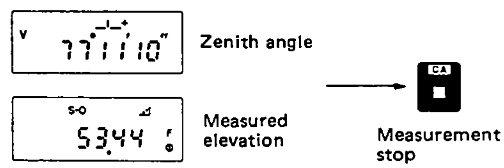


Fig. 10.39

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

10.4.4 Measurement of horizontal distance between two target points

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

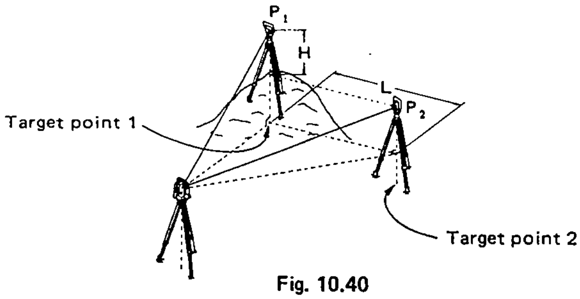


Fig. 10.40

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.

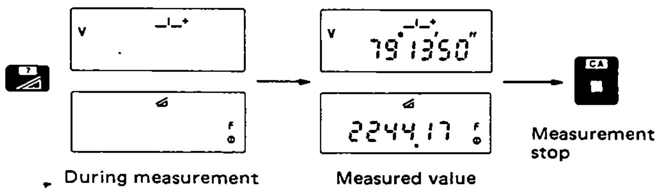


Fig. 10.41

- The measured value is stored in the SET4A.

3) Sight the prism P_2 and press .

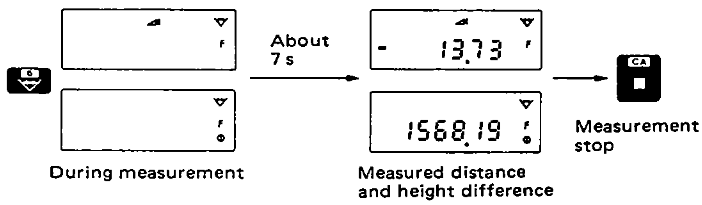


Fig. 10.42

11. SELF DIAGNOSIS

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

<table>
<tr><th>Display</th><th>Meaning</th><th>Action</th></tr>
<tr><td>b. dEd</td><td>Battery voltage is too low.</td><td>Replace the battery with a charged one, or charge the battery.</td></tr>
<tr><td>E 100</td><td>* Error when measuring a horizontal angle.</td><td>Reset the horizontal angle to 0° (0 gon).</td></tr>
<tr><td>E 101</td><td>* Error when measuring a zenith angle.</td><td>Index the vertical circle again.</td></tr>
<tr><td>E 115</td><td>Compensator range error. Tilt angle exceeds -3'.</td><td rowspan="2">Level the SET4A again.</td></tr>
<tr><td>E 117</td><td>Compensator range error. Tilt angle exceeds +3'.</td></tr>
<tr><td>E 200</td><td>Incoming reflected light decreased during measurement. Incoming reflection was disturbed.</td><td rowspan="2">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.</td></tr>
<tr><td>S. OFF
E 201</td><td>Incoming reflection is totally absent when the instrument is ready for distance measuring.</td></tr>
</table>

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 to stop measuring.
E 208	The measured distance is more than ±19,999.99 ft (±19,999.999 m).	Press to stop measuring.

* If the SET4A 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 PRISMS

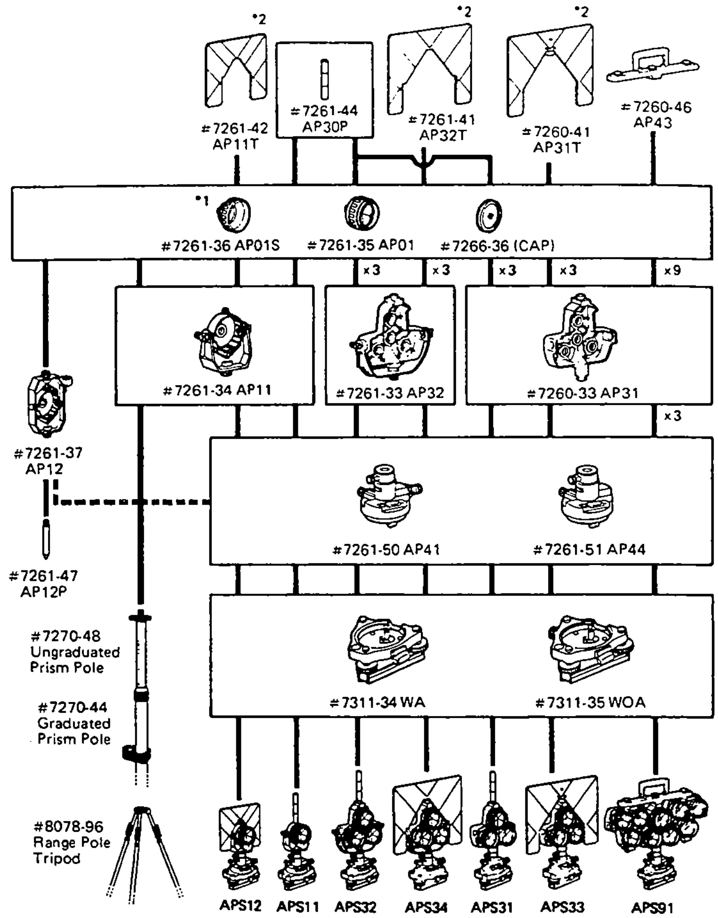


Fig. 12.1

* 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 center 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 center hole of the triple prism holder.
3) Check that "236" (the height of the SET4A) 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 center part counterclockwise to unlock it.
   ③ Move it up or down until "236" appears in the window.
   ④ Turn the center part clockwise to re-lock it.
   ⑤ Tighten the fixing screws.

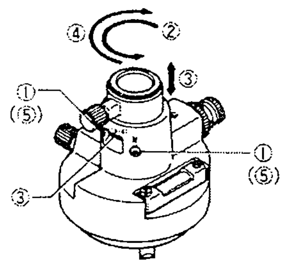


Fig. 12.2

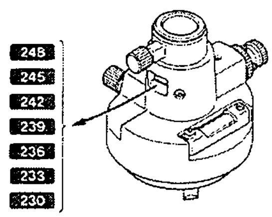


Fig. 12.3

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 13.1.6.
   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 SET4A.

12.2 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

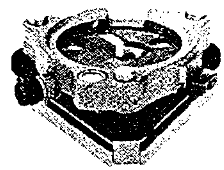


Fig. 12.4

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

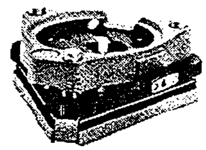


Fig. 12.5

TRIBRACH ADAPTOR
Adapts from 5/8 x 11 thread to Lietz or other brand tribrach.
Allows installation of Lietz prism or other 5/8 x 11 female-thread accessories into tribrach.
No. 7311-37

Fig. 12.6

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

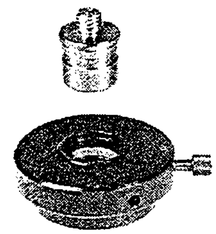


Fig. 12.7

TRIBRACH ADAPTOR
Accepts prisms with 24.8 mm bayonet-type base.
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

12.3 TARGETS

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

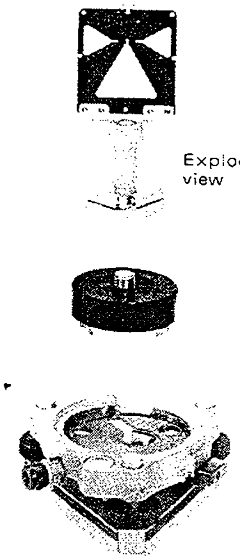


Fig. 12.8

LARGE TARGET

Large target 8¼" x 11¾" attaches to regular target (No. 7312-40) to provide increased sighting range.
No. 7312-42

12.4 POLES

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

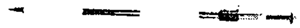


Fig. 12.9

HEAVY-DUTY GRADUATED TELESCOPING PRISM POLE

- Aluminum tubing with brass fittings; outside diameter 1¼ inches
- Positive collet-type locking system
- Male 5/8 x 11 prism mounting stud. Locking disc secures prism
- Replaceable point (8078-50)
- Adjustable heights — 54 to 100 inches
- Engraved graduations on extending member for measuring prism height (feet, tenths and metric)

No. 7270-44

Fig. 12.10

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)

PRISM POLE TRIPOD

- Easy-to-use, fully adjustable tripod for Lietz Nos. 7270-48 and 7270-44 Prism Poles
- Allows fast leveling while remaining centered on point
- Spring-action leg clamps work with one hand for rapid setup
- Lets you take foresights or backsights to a reliable, steady reference

No. 8078-96

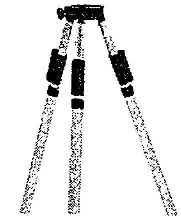


Fig. 12.11

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

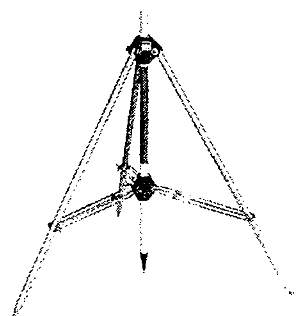


Fig. 12.12

12.5 THERMOMETER AND ALTIMETER

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

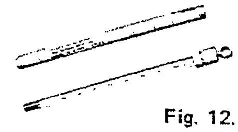


Fig. 12.13

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

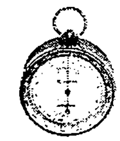


Fig. 12.14

12.6 DIAGONAL EYEPIECE #7311-18

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 7311-18

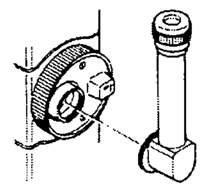


Fig. 12.15

13. CHECKS AND ADJUSTMENTS

It is important that the SET4A is periodically checked and adjusted. In addition, the instrument should be checked after transportation, long storage or when damage to the instrument is suspected to have occurred. The checks should be performed as follows:

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 adjustments
  a) Perpendicularity of the reticle to the horizontal axis
  b) Vertical and horizontal reticle line positions
13.1.5 Coincidence of the distance measuring axis with the reticle
13.1.6 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.

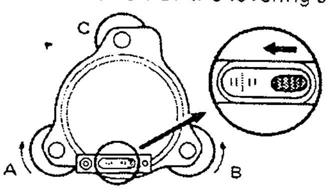


Fig. 13.1

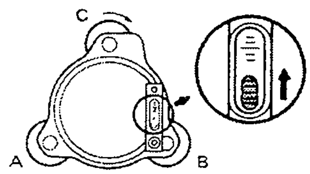


Fig. 13.2

2) Turn the upper part of the SET4A until the plate level is parallel to a line between leveling screws A and B. Then center the bubble using leveling screws A and B.

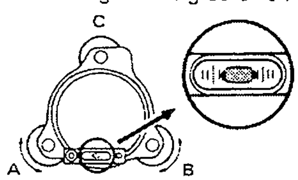


Fig. 13.3

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

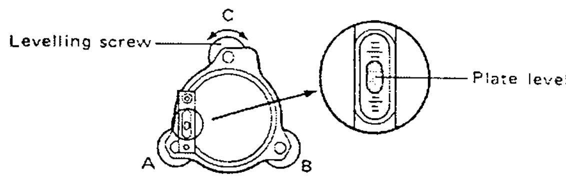


Fig. 13.4

4) Turn the upper part 180°. Correct any bubble deviation by half the amount with leveling screw C.

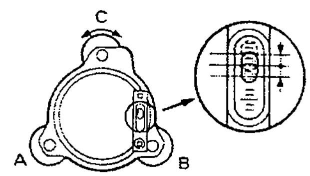


Fig. 13.5

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

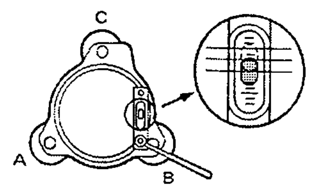


Fig. 13.6

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

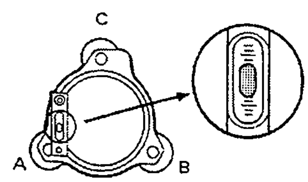


Fig. 13.7

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. Ensure that the tension of each screw tightening is the same after adjustment.

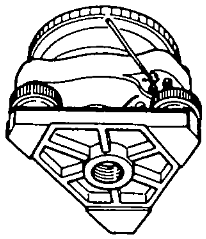
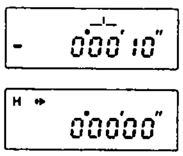


Fig. 13.8

13.1.3 Index error of the tilt angle sensor

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

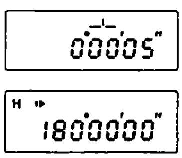
1) After indexing the vertical circle, tighten the vertical clamp ㉚.
2) Press [0 SET] then [ENT] to set the horizontal circle to zero, then press [ ] to display the tilt angle.



Tilt angle a = -10"

Fig. 13.9

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



Tilt angle b = 5"

Fig. 13.10

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

Example: $\frac{-10'' + 5''}{2} = -2.5''$

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 $d_{180°} = b - c$.

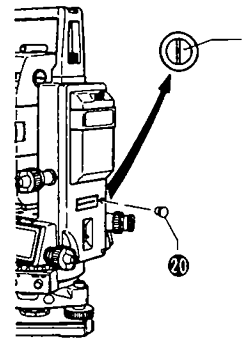


Fig. 13.11

Example:

If a = -20", b = -10", index error $c = \frac{-20'' + (-10'')}{2} = -15''$

$d_{0°} = a - c = -5''$
$d_{180°} = b - c = +5''$

13.1.4 Reticle adjustments

a) Perpendicularity of the reticle to the horizontal axis

1) Select and sight a clear target on the upper part A of the vertical reticle line, Fig. 13.12.
2) Turn the telescope slowly upward with the vertical fine motion screw ㉚ until the target slides to the lower part B, Fig. 13.13. If the target is still centrally within the vertical lines, no adjustment is necessary. If necessary, adjust as follows.

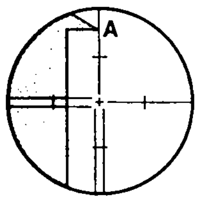


Fig. 13.12

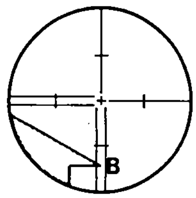


Fig. 13.13

3) Unscrew the reticle cover ㉝.
4) Slightly loosen one vertical and one horizontal adjusting screw by a certain amount.
5) Place a small piece of plastic or wood against one side of the top adjusting screw as a buffer.
6) Look through the eyepiece and gently tap the piece of plastic or wood to rotate the reticle slightly.
7) Re-tighten the two adjusting screws (loosened in 4)) by the same amount. Check the reticle perpendicularity again and readjust if necessary. Replace the reticle cover ㉝.

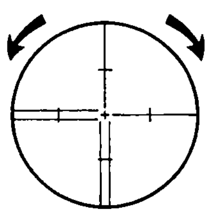


Fig. 13.14

b) Vertical and horizontal reticle line positions

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

1) Level the SET4A. Select a clear target at a horizontal distance of 200 to 300 feet.

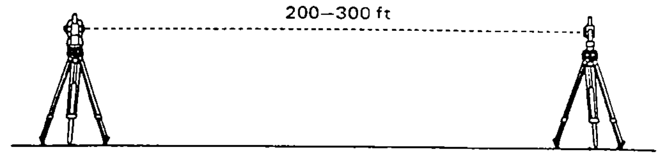


Fig. 13.15

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 vertical angle reading, e.g. $b_l = 90°30'10''$.

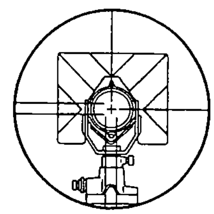


Fig. 13.16

3) Next in position V2, sight the same target. Take the horizontal angle reading, e.g. $a_r = 198°34'10''$ and the vertical angle reading, e.g. $b_r = 269°30'02''$.

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

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

$b_r + b_l = 269°30'02'' + 90°30'10'' = 360°00'12''$

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 $a_l = 18°34'00''$ $\quad a_r = 198°34'26''$

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

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

$$= 198°34'13''$$

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

$$= 269°30'00''$$

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

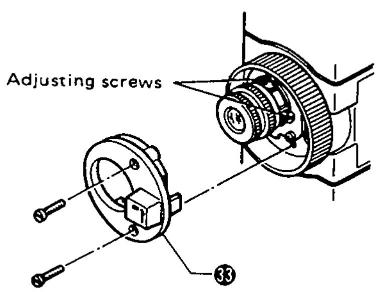


Fig. 13.17

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

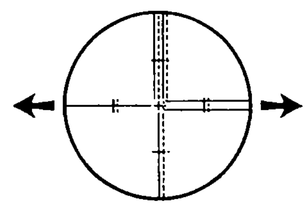


Fig. 13.18

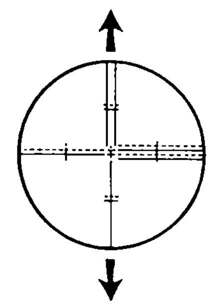


Fig. 13.19

10) Replace the reticle adjustment cover.

This adjustment is very delicate. If you find it 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 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 SET4A. Set up the reflecting prism at a horizontal distance of 160 to 330 ft (50 to 100 m).

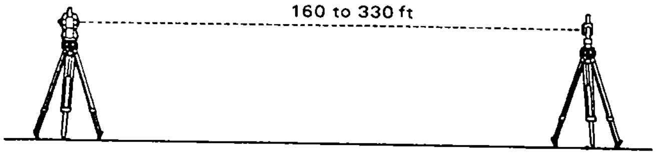


Fig. 13.20

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

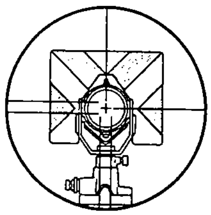


Fig. 13.21

3) Press [key] on the keyboard and make sure the return signal lamp ⓭ 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 3′, the coincidence is normal. If any of the differences obtained are less than 3′, please contact an authorized service facility for repair.

13.1.6 Optical plummet

1) Level the SET4A. 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 leveling screws and correct the remaining half with the four adjusting screws. The screw adjusting procedure is the same as the reticle adjustment 9) on page 59.

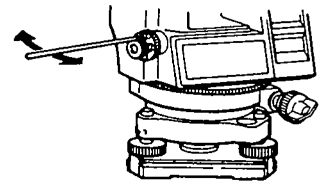


Fig. 13.22

3) Repeat the adjustment if necessary.

13.2 DISTANCE MEASURING FUNCTION

13.2.1 Check flow chart

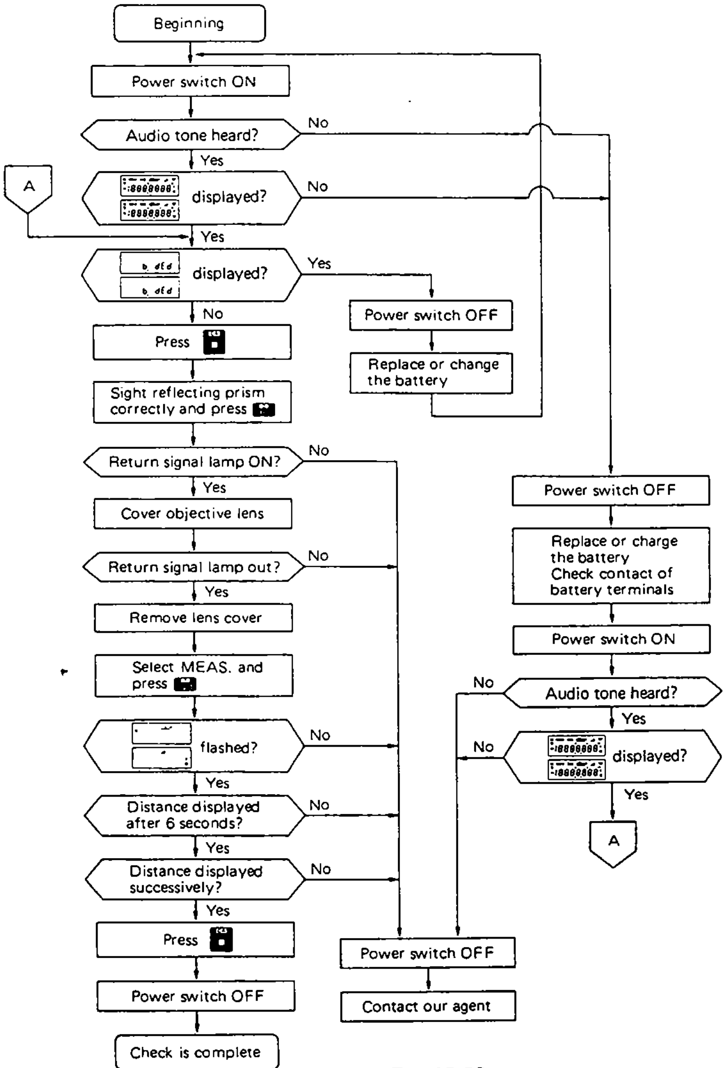


Fig. 13.23

13.2.2 Additive distance constant

The additive distance constant of the SET4A is adjusted to (
before delivery. However, the additive constant can change wit
time and so should be determined periodically and then used t
correct distances measured.

1) Determining the additive distance constant.
   The most reliable method of determining the additive distanc
   constant is to test the SET4A on an established base line wit
   a maximum range of approximately 1,000 m, and with 6 to
   intermediate stations spaced at multiples of the instrumen
   unit length, which is 10 m. Measurements should be taken i
   all combinations of the 6 to 8 stations.
   If an additive distance constant of greater than 5 mm is foun
   please contact our agent.
2) Confirmation of the additive distance constant K if a base lin
   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 SET4A at A, and measure the distance AB.
      Note: Be sure prism height is the same as the height of the
      SET4A objective lens center. If ground is not level
      use an automatic level to set correct instrumen
      heights of all points.

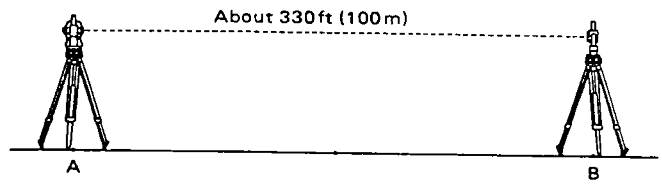


Fig. 13.24

c. Shift the SET4A to C, and measure the distance CA and CB.

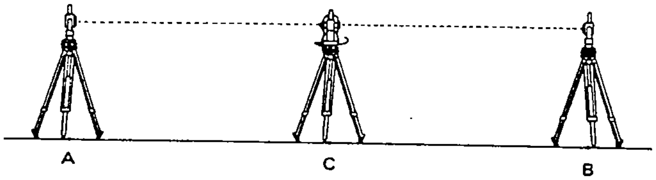


Fig. 13.25

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 MANUALLY INDEXING VERTICAL CIRCLE BY V1, V2

Like every theodolite, the SET4A 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 SET4A, turn the power ON and make sure that the display appears as shown below.

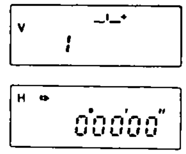


Fig. 14.1

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

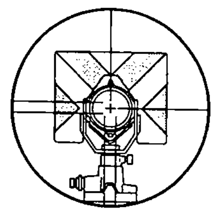


Fig. 14.2

4) Press then .

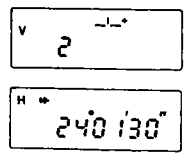


Fig. 14.3

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

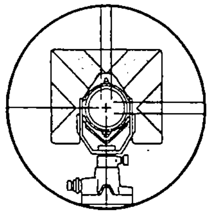


Fig. 14.4

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

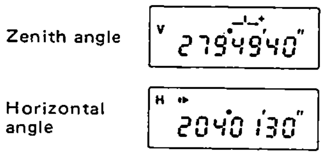


Fig. 14.5

- If the power switch has been turned OFF, the vertical circle must be indexed again.
  When moving the SET4A 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 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:

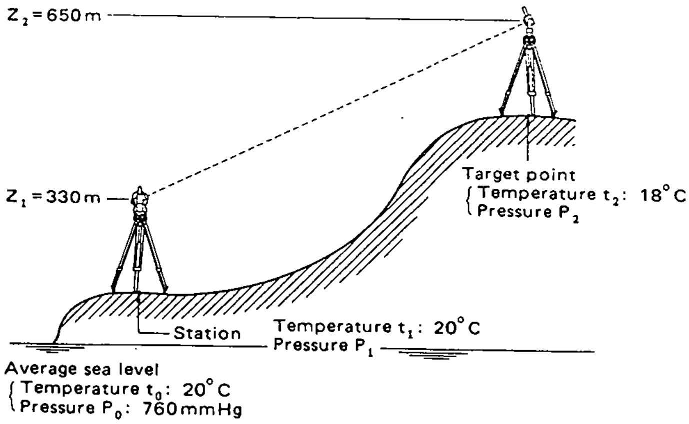


Fig. 15.1

By the Laplace formula

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

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

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

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

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

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

Average pressure: 717.5 mmHg

16. PRECAUTIONS AND MAINTENANCE

16.1 PRECAUTIONS

1) When the SET4A is not used for a long time, check it at least once every three months.
2) Handle the SET4A 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 SET4A 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 SET4A directly on the ground.
6) Never carry the SET4A on the tripod another site.
7) Protect the SET4A with an umbrella against direct sunlight, rain and humidity.
8) When the operator leaves the SET4A, 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 SET4A 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 SET4A is placed in the carrying case, follow the layout plan.
14) Make sure that the SET4A 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.

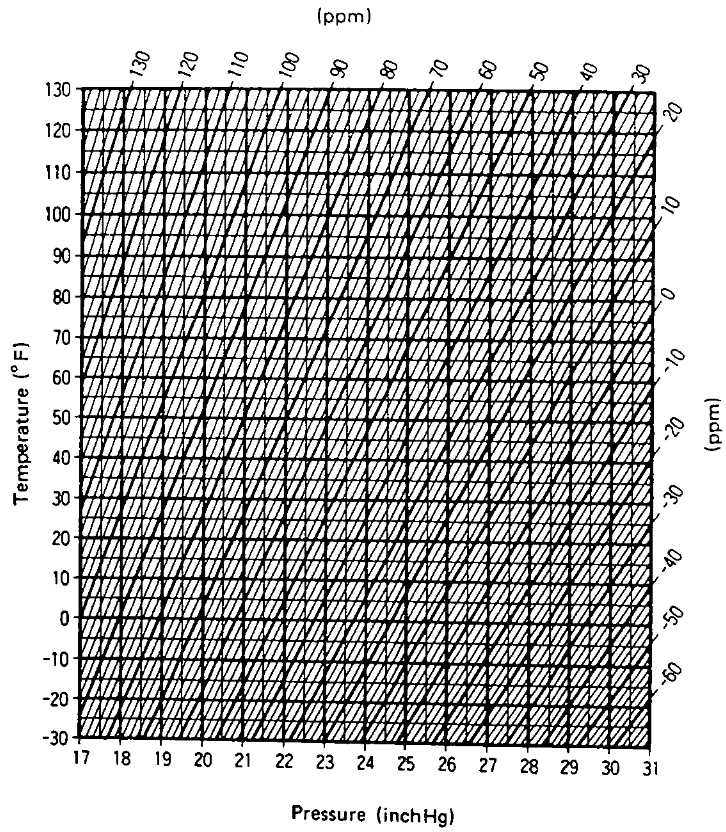
3) Store the SET4A in a dry room where the temperature remains fairly constant.

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.

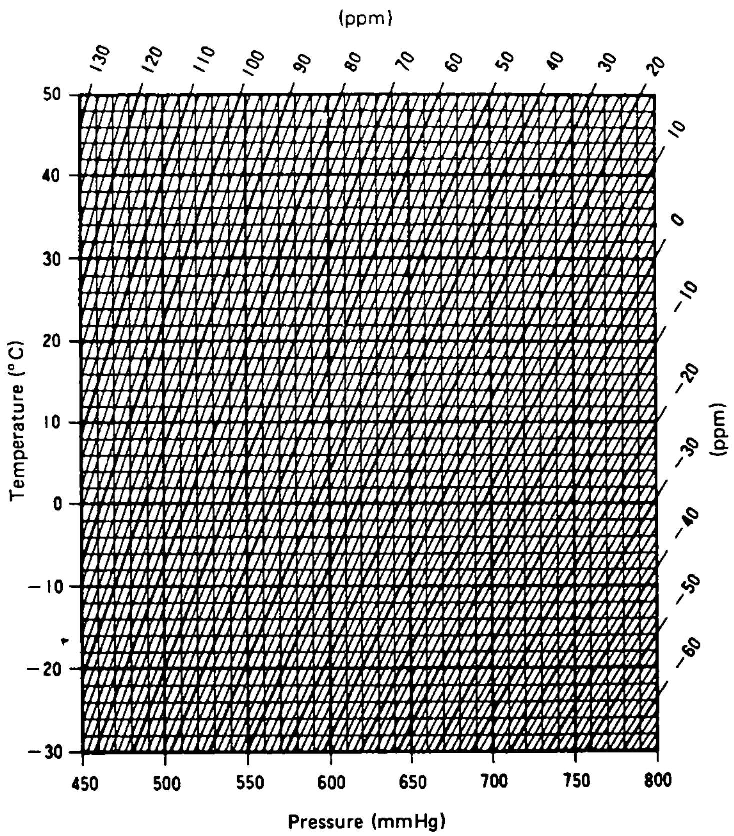
17. ATMOSPHERIC CORRECTION CHARTS

(English)



The chart shows the correction every two ppm, while the atmospheric correction can be applied to the SET4A for every ppm.

(Metric)



The chart shows the correction every two ppm, while the atmospheric correction can be applied to the SET4A 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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