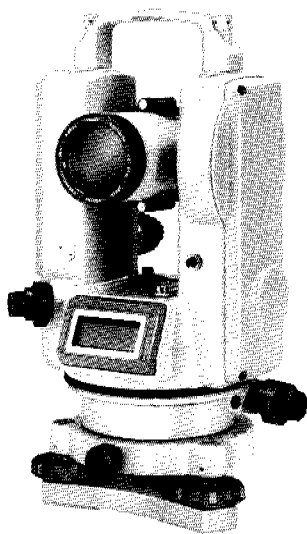


PENTAX®

ELECTRONIC THEODOLITE

TH-E10/TH-E10D/TH-E10C

INSTRUCTION MANUAL

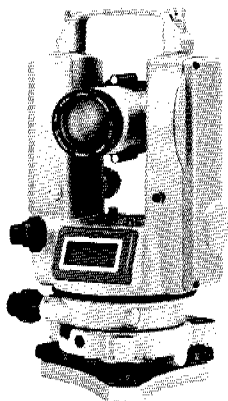


ASAHI PRECISION CO., LTD.

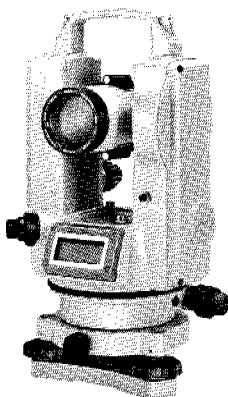
For Proper Use of Instrument

The PENTAX Electronic Theodolite is of the highest quality and design. We therefore, recommend that you read the instruction manual very carefully so that you will appreciate the full capabilities of your PENTAX precision instrument and ensure years of trouble-free operation.

To prevent accidental damage to your instrument please adhere to the following notes which have been constructed to help you in maintaining your instrument in a precise functioning condition.



TH E10C



TH-E10D

Battery

- Before going on the field work, be sure to check the remaining battery capacity. When the remaining capacity is not sufficient, be sure to carry the spare batteries.
- When no in use for extended periods, take the batteries out of the instrument.
- Be sure to turn the power off when replacing the batteries. As indicated, put the batteries in place remembering the polarity.
- It is recommended that the batteries with good quality be used. Usage of alkaline batteries provides 3 times longer operation than manganese batteries.
- Be sure to turn the power off when completing the work.

Environmental Conditions

- Avoid leaving it at high temperatures for a long time. High internal temperatures may cause deterioration and affect its angle measuring performance.
- Avoid using it on rainy days because it contains electrical parts, or keep it shielded from the rain as much as possible.
- Avoid subjecting it to rapid changes of temperature, i.e. do not suddenly carry it to the cold open air from a warm place. This causes distortion or generates condensation inside. This will cause temporary deterioration of angle measuring performance.

Shutdown

- After use, clean away dust and moisture and store in a dry place not subject to considerable temperature change.
- When not in use for extended periods, take it out of the case occasionally and expose it to the fresh air.

Transport

- Be careful not to subject it to impact or vibration during transport by a contractor, and use a good packaging material.
- Transport in carrying case supplied.

Attaching to Tripod

- When attaching or detaching the instrument to or from the tripod, be sure to hold it with one hand.
- The quality of tripod used is very important for measuring accuracy.

Other points

- It is recommended you make a inspection before starting the job. For the instrument, in particular not in use for a extended period or being transported long way, the inspection of the instrument is strongly recommended
- If repair is necessary, contact your dealer. Do not attempt to repair it by yourself.

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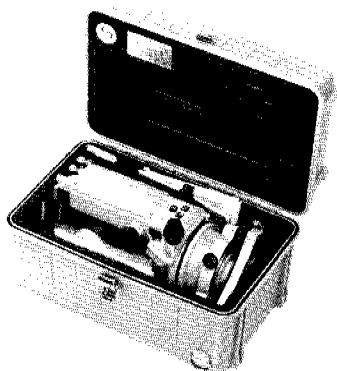
1. Features

- Rotary encoder provides fast and accurate angle measurement, minimizing reading error.
Measured angle is displayed on LCD panel on both sides of alidade.
- LCD panel provides display in two lines, providing simultaneous reading of both vertical and horizontal angles.
- Display panel employs back-light illumination with uniform brightness, providing one-minute illumination for LCD panel as well as the reticle.
- Turning the telescope automatically indexes 0 point of vertical angle. Internal switch allows selecting any of graduation modes, Zenith 0°, Horizontal 0°. Compass graduation and % graduation.
- Simple key operation provides 0 setting of horizontal angle at any position as well as clockwise and counter-clockwise readings. Buzzer sounds at every 90° (100G) for easy right angle setting.
- Double axis as employed for the conventional theodolites permits multiple angle measurement. Display of numbers of multiple measurement and averaging value is available.
- In combination with Pentax EDM MD-series, electronic theodolite works as a part of total station because measured angle data can be automatically transferred to EDM.
- Automatic vertical compensator with high accuracy provides fast and accurate vertical angle measurement. (TH-E10 only)
- AA dry batteries are used for power source. Being located in the standard, they can be easily replaced.
- Automatic power down prevents unnecessary battery drainage. The remaining battery capacity is indicated on the display to prevent the interruption of the work due to lack of capacity.
- Compact and light weight construction equipped with co-axial tangent screws provides easy operation.

2. Equipment

1 Standard Equipment

- Body (with objective cap) 1
- A Set of Tool (with case) 1
(cleaning brush, 2 drivers, hexagonal wrench, 2 adjusting pins)
- A Set of Plumb Bob 1
- Plumb Bob Hook (TH-E10C only) 1
- Hood 1
- Silicon Cloth 1
- Rain Cover 1
- AA Dry Battery 4
- Carrying Case 1



2 Optional accessories

- Tripod (TS3, TC3)
- Sun Filter (SE2)
- Auxiliary lens (A type)
- Diagonal Eyepiece (SB9)
- Eyepiece prism (SP2)
- Bar Compass (SC7)

3. Specifications

■ Telescope (Internal focusing anallactic optics with coated lens)

Image	Erect (Prism erect image)
Magnification	30×
Effective aperture	42mm
Resolving power	3"
Field of view	2.3% (1°20')
Minimum focusing distance	1.3m/4.3ft
Stadia ratio	100
Stadia constant	0

■ Angle Measurement

Type	Incremental rotary encoder
Detection mode	Horizontal angle: Diametrically opposite detection Vertical angle: Single detection
Minimum count	10" (20cc)
Measuring time	less than 0.2" (continuous)
Circle diameter	79mm

■ Display (Both sides of alidade)

Type	LCD Dot-Matrix
Display	Two lines (V/H)

■ Automatic vertical compensator (TH-E10 only)

Type	Inclinometer pendulum
Range	± 3'

■ Sensitivity of vials

Plate vials	60"/2mm (2 pcs.)
Circular vial	8'/2mm

■ Optical plummet

Image	Erect
Magnification	?
Focusing range	0.5m ~ 10m

■ Vertical Axis

Type Double axis

■ Tribrach

Type Detachable (TH-E10/TH-E10D)

Shifting (TH-E10C)

* Movable range: 16mm

■ Power Source (20 min. Auto power down function)

Type 4 × AA dry battery

Voltage DC 6V

Operation time Manganese battery 8hr. (TH-E10)

(Continuous) 10hr. (TH-E10D/TH-E10C)

Alkaline battery Appr. 20hr.

■ Ambient temperature -20°C ~ +50°C / -4°F ~ +122°F

■ Function

Vertical angle 0 point indexing function

Measurement mode Horizontal: 0 set at any position

Clock/Counter-clockwise reading

Multiple angle (w/averaging function)

■ Internal switches

Vertical angle mode Zenith 0°/Horizontal 0°

Compass/% (Selectable)

Graduation unit 360°DEG, 360°DEC

400GRAD, 6400MIL (Selectable)

On/Off function 90°Buzzer, Automatic power down

Vertical angle compensation (TH-E10 only)

Data output Output parameters setting

■ Tripod attaching screw 5/8" × 11 (TH-E10/TH-E10D)

1-3/8 × 13 (TH-E10C)

■ Dimensions

Instrument .. L156 × H318 × W153mm/L6.14 × H12.5 × W6.0in

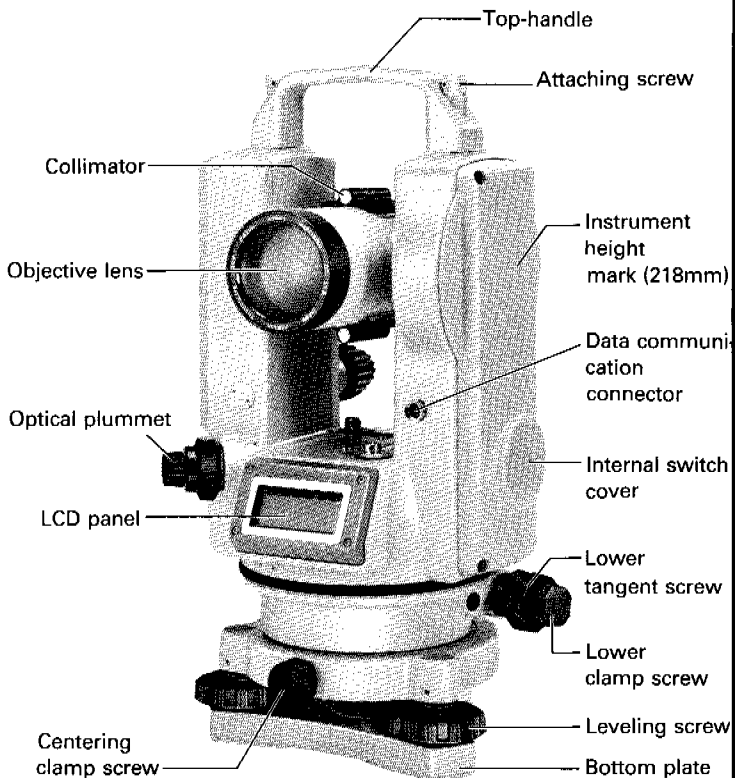
Case L240 × H380 × W210mm/L9.45 × H15.0 × W8.27in

■ Weight

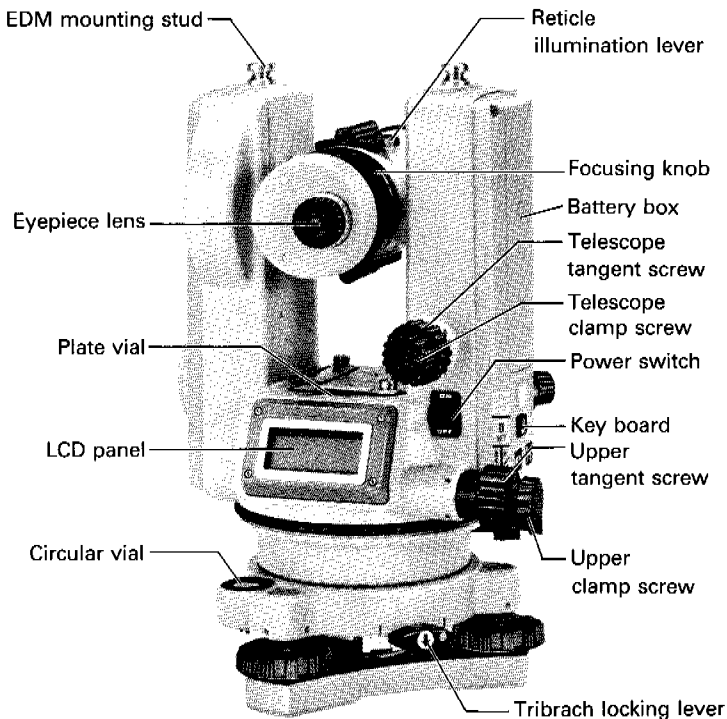
Instrument 4.7Kgs./10.4lbs

Weight 2.5Kgs./5.5lbs

4. Nomenclature of Parts



TH-E10C

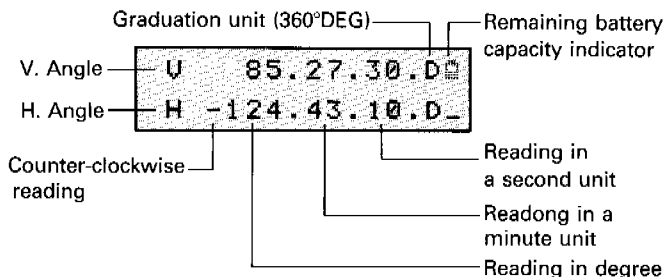


* When separating the instrument from the tribrach, loosen the fixing screw on the locking lever.

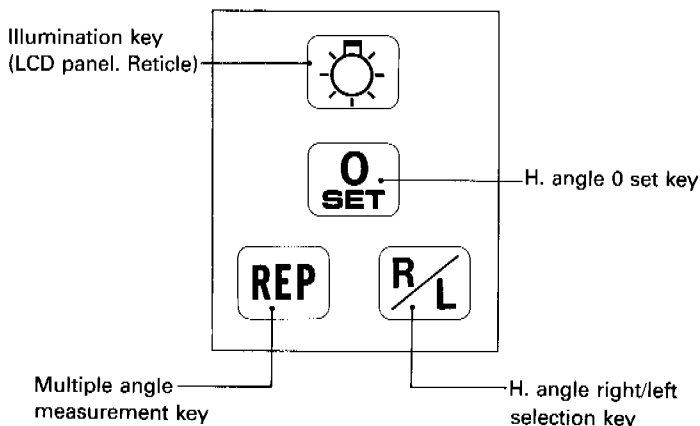
TH-E10D

5. Operation and Display

1 Display

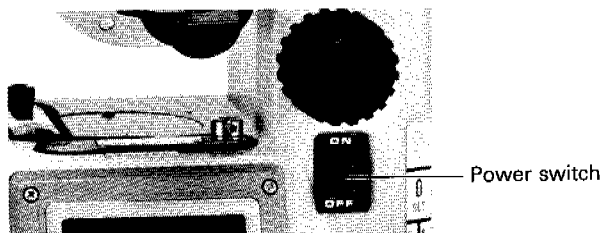


2 Key Board



3 Functions of switches and Display

1 Power switch



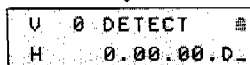
All the segments on the display light for 2 seconds after turning the power on.

After lighting up, prompt to index 0 point of vertical angle is displayed.

(Clockwise reading mode in horizontal angle is displayed.)



All segments light.

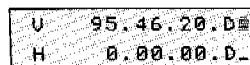


Standing by for vertical angle indexing.

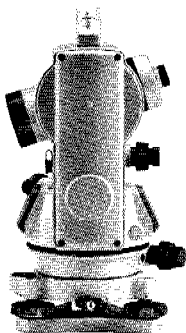


[Vertical angle 0 point indexing]

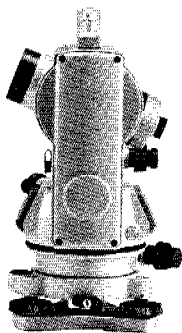
When indexing the vertical circle, the zero point is detected as the telescope is rotated in elevation from slightly depressed.



If the instrument is not accurately leveled, TILT OVER will be displayed to notify the operator that the vertical compensation function is out of range. Properly relevel the instrument. (TH-E10 only)



Downward



Upward

2 **0 SET** Key

Horizontal angle is set to $0^{\circ}00'00''$. This function is valid for both horizontal angle right and left as well as multiple angle measurement. The function of this key is not valid for vertical angle.

U	86.24.40.D
H	25.53.20.D



is pressed. The buzzer will sound for approximately 3 seconds.



is pressed again to set the horizontal angle to $0^{\circ}00'00''$ while buzzer is sounding.



U	86.24.40.D
H	0.00.00.D

- To prevent accidental misoperation, 0 set key will not work unless it is pressed twice.

3



Key

This key is used to select the angle reading mode of the horizontal angle, clockwise or counter-clockwise (indicated with “-” symbol). Clockwise or counterclockwise reading is alternately displayed each time the key is pressed.

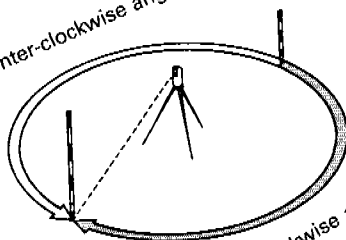
This key will not work for the vertical angle.

V	86.24.40.D
H	25.53.20.D



V	86.24.40.D
H	-334.06.40.D

Counter-clockwise angle



Clockwise angle

4 **REP** Key

This key is used to set the horizontal angle to multiple angle measurement mode. Multiple angle can be added and displayed up to 2700° (2700G) or -2700° (-2700 G). The buzzer will sound when the summed angle value exceeds 2000° (2000G) or -2000° (-2000 G).

U	95.46.20.D
H	0.00.00.D

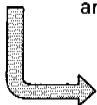
REP

is pressed. The buzzer will sound for approximately 3 seconds.



REP

is pressed again while the buzzer is sounding, to set the multiple angle measurement mode and display "RH".



U	95.46.20.D
RH	0.00.00.D

To cancel the multiple angle measurement mode, press

REP

Then, press

REP

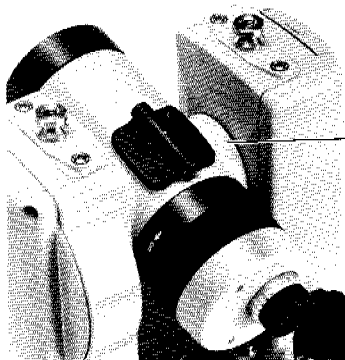
again while the buzzer is sounding.

(To prevent accidental misoperation, the multiple angle measurement mode can not be canceled unless it is pressed again while the buzzer is on.)

5**Key**

LCD panel and the reticle pattern are illuminated. The illumination is automatically turned off after one minute. Pressing key while on illumination immediately turns off the illumination.

■ Use the reticle illumination lever to adjust the brightness.



Reticle illumination lever

4 Other functions and display

1) The buzzer sounding at every 90°(100G)

In horizontal angle measurement, the buzzer sounds when the reading passes any of 0°(0G), 90°(100G), 180°(200G) and 270°(300G).

The buzzer starts sounding where the angle is $\pm 1'$ to respective value, and stops sounding where the angle is within $\pm 20''$ from the respective value.

Buzzer is sounding

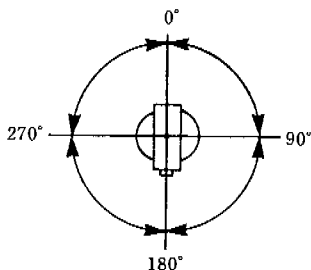
U	78.20.30.D	■
H	89.59.30.D	—

Buzzer stops sounding

U	78.20.30.D	■
H	90.00.00.D	—


Buzzer is sounding

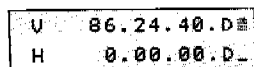
U	78.20.30.D	■
H	90.00.30.D	—



- The buzzer can be cut off by the internal switch.
- This function works for counter-clockwise measurement, too.

2) Remaining Battery

The status of the remaining battery capacity is displayed on the top right of the display with  symbolizing the battery.



← Remaining capacity indicator



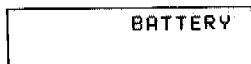
Operation possible



Get the battery ready for a standby



Operation is possible, but replacement is recommended.



"BATTERY" will disappear 5 seconds after it is displayed. Replace the batteries.

- The status of the remaining capacity mark is not proportional to the time during which the batteries are used.

3) Auto power down function

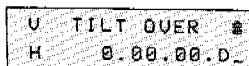
The power will be on for about 20 minutes and is automatically turned off if there is no operation of the instrument during that time. "No operation of the instrument" indicates any of:

1. no key operation
2. not turning the instrument more than 1°
3. not turning the telescope more than 1°

- Turn the switch off and turn it on again for turning the power on.
- This function will not operate by changing over the internal switch.

4) Error Message

- ① When being out of the automatic compensation range, vertical angle reading is impossible. Error message is displayed. (TH-E10)

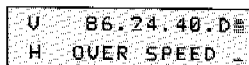


U TILT OVER H 0.00.00.D

* Relevel the instrument.

* If error message is still displayed, repair is needed.

- ② If the standard or the telescope is rotated faster than specified revolution (approx. 2 revolutions/second), reading of angles becomes impossible. Error message is displayed.



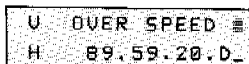
U 86.24.40.D H OVER SPEED

To indicate that horizontal revolution of the instrument is too fast



0
SET

is pressed to make measurement again.



U OVER SPEED H 89.59.20.D

To indicate that revolution of the telescope is too fast.


For making measurement again, refer to "0 point indexing of the vertical angle.

- ③ In multiple angle measurement mode (REP), error message is displayed when the summed angle value exceeds approx. $\pm 2700^\circ$ or $\pm 2700G$.

V	86.24.40.D
RH	OVER COUNT -



is pressed to restart the measurement.

- ④ When averaging measured values by pressing , error message will be displayed if the included angle measured is more than $\pm 60''$ different from previously measured value.

V	86.24.40.D
RH	AVE. ERROR -



is pressed to restart the measurement.

- ⑤ An error message will be displayed when a problem with components inside the instrument is detected.

Caution) Improper operation may let the error message appear in the display to maintain the stable measurement accuracy.



- Turn the switch off, and then turn it on again. Repair is necessary if error message is still on.
- Contact your dealer if abnormality is detected even following proper operating procedures.

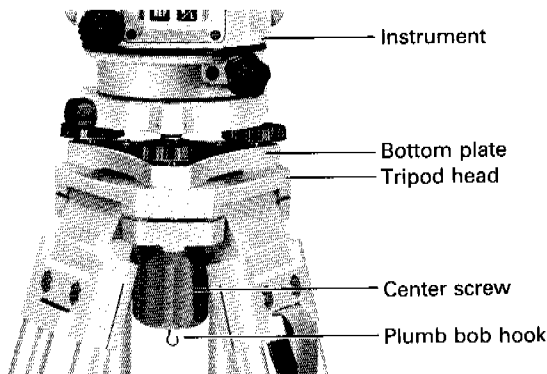
6. Operating Instructions

1 Preparation for Surveying

[1] When coarse centering using a plumb bob is performed

1 Setting up the instrument and the tripod

- ① Adjust the tripod legs so that a height suitable for surveying is obtained when the instrument is set on the tripod.
(For TH-E10/TH-E10D)
- ② Hang the plumb bob on the hook of the tripod, and carry out coarse centering to the station on the ground. At this time, set the tripod and fix the metal shoe firmly into the ground so that the tripod head is as level as possible, the center screw is at the center of its moving range, and the plumb bob coincides with the station on the ground.
- ③ If the tripod head is disturbed by the action of fixing the metal shoe into the ground, correct the level by extending or retracting each leg of the tripod.

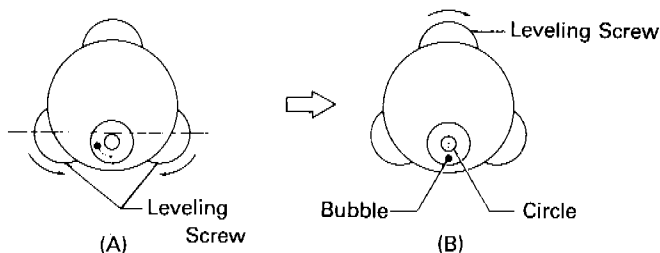


[For TH-E10C]

- ② Set the theodolite on the tripod head. Screw the center screw into the tripod clamp screw of the theodolite, finger tight.
- ③ Fix the shifting device after setting it to almost the center of the shifting range.
- ④ Pass the plumb bob hook through the hole in the center screw, and hang it on the ring located at the center of the theodolite lower end. Adjust the length of the string so that the tip of the plumb bob is close to the station center.
- ⑤ Move the theodolite by pushing the bottom plate with the fingertips. When the tip of the plumb bob coincides with the station, tighten the center screw securely.

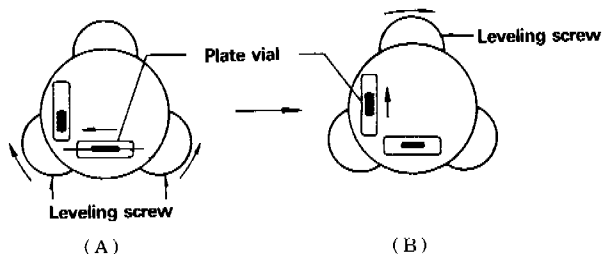
2 Leveling with the circular vial

- ① By adjusting any two leveling screws, position the bubble in the center of the vial (see (A)). (To adjust the screws at the same time, turn them in opposite directions).
- ② Adjust the remaining leveling screws, and position the bubble in the center of the circle (See (B)). For the relation between the screw adjusting direction and bubble moving direction, see the arrow marks in (A) and (B).



3 Leveling with the plate vials

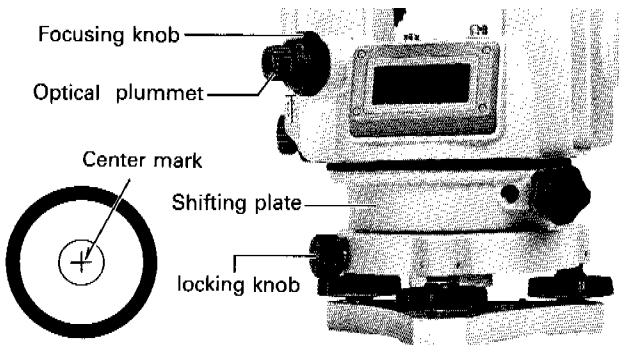
- ① Place the plate vial in parallel with a line joining any two of the leveling screws. Adjust the two screws, and position the bubble in the center of the level (A). (To adjust the screws at the same time, turn them in opposite directions.)
 - ② Adjust the remaining leveling screw so that the bubble in another plate vial comes to the center.
 - ③ Be sure that the bubbles of both plate vials stay at the center. If not, repeat 1 and 2.
 - ④ Rotate the instrument 180° around the vertical axis, and check the bubbles stay unmoved.
- See arrows in Fig. below for the relation between the direction of leveling screw rotation and the bubble shifting direction
 - If the bubble is not positioned stably, "Adjustment of the plate vial" is necessary.



④ Centering with the optical plummet

After ①, ② and ③ are completed, center correctly in the following manner using optical plummet.

- ① First remove the plumb bob. Look through the optical plummet eyepiece, and rotate the eyepiece knob until the center mark can be seen clearly.
- ② Rotate the focusing knob of the optical plummet and adjust the focus to the station on the ground.



[TH-E10C]

- ③ Loosen the shifting plate locking knob. Look through the optical plummet eyepiece, and push the alidade with the fingertips so that the center mark coincides with the station.
- ④ Tighten the shifting plate locking knob. Ascertain that the bubble stays positioned in the center when rotating the plate vial position in steps of 90° . If the bubble is not positioned in the center, adjust the leveling screw.

[TH-E10/TH-E10D]

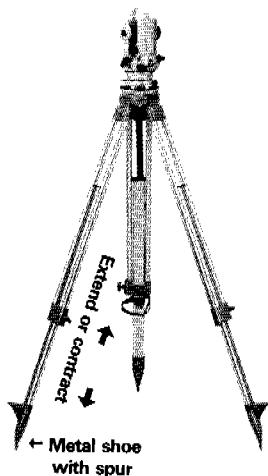
- ③ Loosen the center screw of the tripod. Look through the optical plummet, and move the bottom plate on the tripod head taking care to avoid rotating the instrument until the center mark coincides with the station.

- The focusing device permits focusing from 0.5m to ∞ with the optical plummet.
- Even if the bubble is shifted by one graduation in ④, deviation of centering is just 0.2mm at the instrument height of 1.4m, giving little effect on survey result.

[2] When coarse centering using a plumb bob is not performed

① Setting up the instrument and tripod

- ① Adjust the tripod so that a height suitable for surveying is obtained with enough extension/contraction margin left when the instrument is set on the tripod. Observing the station, extend the tripod legs and fix the metal shoe firmly into the ground so that the tripod center is positioned almost right above the station.
- ② Set the instrument on the tripod head.

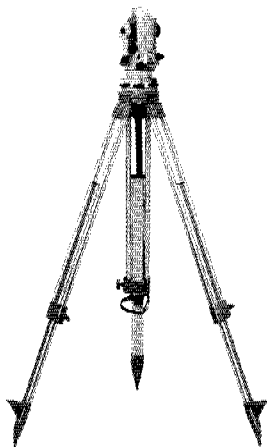


2 Centering and leveling with the optical plummet

- ① Look through the optical plummet eyepiece, and rotate the eyepiece until the center mark can be clearly seen.
- ② Rotate the focusing knob of the optical plummet and focus on the station.
- ③ Looking through the optical plummet, rotate the three leveling screws to tilt the instrument so that the center mark coincides with the station.
- ④ Adjust the length of each tripod leg by extending or contracting it, and position the bubble of the circular vial in the center of the circle. (When doing this, place a foot on the metal shoe of the tripod to hold it in that position.)

3 Leveling with the plate vial

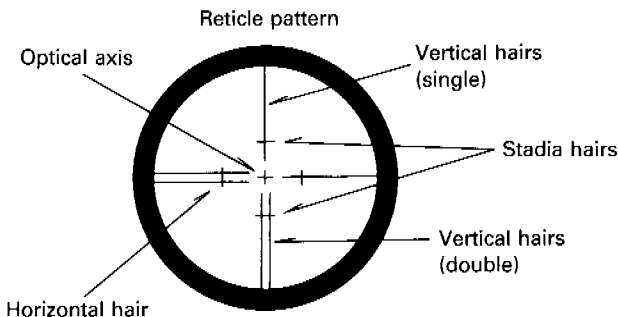
- ① Level the instrument as indicated in 3) "Leveling with the plate vial" on page 11.
- ② After leveling the instrument, re-adjust the center by moving the instrument on the tripod head if necessary.



2 Surveying


1 Eyepiece adjustment

- ① Remove the telescope lens cap, and attach the lens hood, if necessary.
- ② Point the telescope at a bright object, and rotate the eyepiece ring full counterclockwise.
- ③ Look through the eyepiece, and rotate the eyepiece ring clockwise until the reticle appears as its maximum sharpness.



2 Object sighting

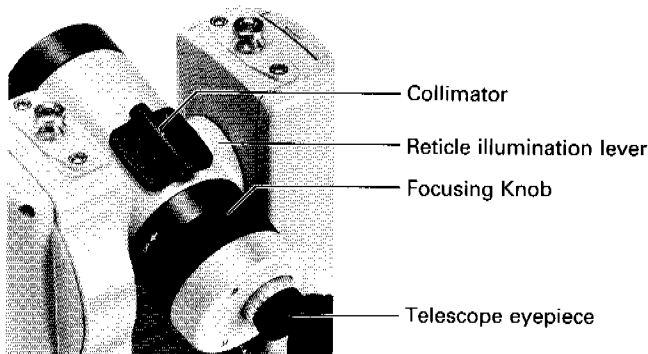
- ① Point the telescope at the object using the collimator sight. Tighten all clamp screws.
- ② Look through the telescope eyepiece and finely adjust the focusing knob until the object is perfectly focused. If focusing is correct, the cross hairs will not move in relationship to the object when you move your eye slightly left and right while looking through the eyepiece. This will eliminate any parallax.
- ③ Turn the focusing knob clockwise to focus on a near object. Turn the knob counterclockwise to focus on a far object.

- Turn the focusing knob clockwise to focus on a near object. Turn the knob counterclockwise to focus on a far object.
- In ②, parallax may ruin the relation between the object and cross lines, resulting in the survey error.
- When aligning to an object using the tangent screw, always align by rotating the screw clockwise. If the screw is turned past the object, turn it counterclockwise to the original position and then turn the screw clockwise to align the cross hair on the object.
- Even when vertical angle measurement is not required, it is recommended that the object in the reticle pattern be placed as close as to the center of the reticle pattern and that the bold object be placed between two vertical lines on the reticle pattern.
- Press  when measurement is to be taken at night or in

dark places such as tunnels.

Cross lines on the reticle is illuminated by internal illumination. Adjust the brightness with the reticle illumination lever.

- When no illumination is needed on the reticle, set the reticle illumination lever to the end on the eyepiece side.



3 Angle Measurement

[1] Angle Measurement

[1] Horizontal (clockwise) and vertical angle measurement

- ① Level the instrument, and turn the power on.

V	0	DETECT	■
H	0.00.00	D	—

- ② Tilt the telescope to index 0 point of the vertical angle.

V	95.46	20	D ■
H	0.00.00	D	—

- ③ Collimate the first object using the upper clamp and tangent screws as well as the telescope clamp and tangent screw.

V	86.24	40	D ■
H	30.47	20	D —

- ④ Press **0 SET** While the buzzer is sounding for about 3 seconds

continuously, press **0 SET** again to set the horizontal angle to 0°00'00".

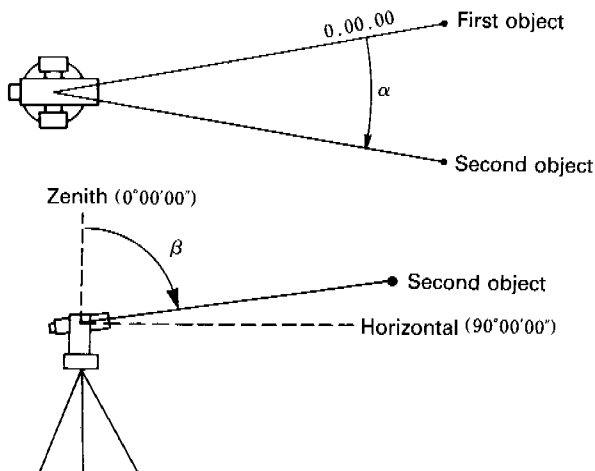
V	86.24	40	D ■
H	0.00.00	D	—

- ⑤ Collimate the second object using the upper clamp and tangent screws as well as the telescope clamp and tangent screws.


(Both horizontal and vertical angles are simultaneously displayed.)

U	78.20.30.D
H	34.47.20.D

← Vertical angle of the second object (β)
 ← Horizontal angle of the second object (α)




2 Horizontal angle (counter-clockwise) measurement

① Press 

U	78.20.30.D
H	-325.12.40.D

Horizontal angle measurement switches from horizontal right to horizontal left. - sign will appear for the indication.

- ② Subsequent operation will be done as in ① Horizontal (clockwise) and vertical angle measurement, except that the order of collimation is reversed. To switch the mode back to "clockwise", press  again.

3 Multiple angle measurement

- ① Press **REP** The buzzer will sound for approximately 3 seconds. Press **REP** again while the buzzer is sounding, to set the repeat measurement mode. RH will be displayed.

U	85.42.20.D
RH	0.00.00.D

- ② Collimate the first object.

U	86.24.40.D
RH	25.53.10.D

- ③ Press **0 SET** to set the zero point.

U	86.24.40.D
RH	0.00.00.D

- ④ Collimate the second object using the upper clamp and tangent screw as well as telescope clamp and tangent screw.

U	78.20.30.D
RH	120.15.10.D

- ⑤ Press **R/L** to display the averaged angle on the upper line.


1	120.15.10.D
RH	120.15.10.D

- ⑥ Collimate the first object using the lower clamp and tangent screws as well as telescope clamp and tangent screws.
- Do not disturb the upper clamp knob and upper tangent screw.

1	120.15.10.D
RH	120.15.10.D

- ⑦ Recollimate the second object using the upper clamp and tangent screws, as well as telescope clamp and tangent screws.

1	120.15.10.D
RH	240.30.20.D

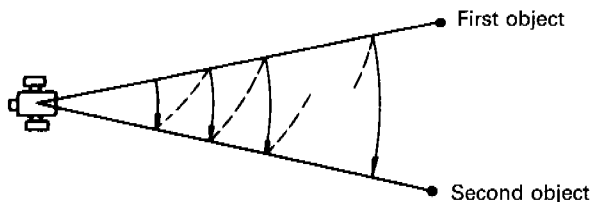
- ⑧ Press  to terminate the 2 multiple angle measurement.


Number of multiple
(Number of repetition)

2	120.15.10.D
RH	240.30.20.D

 ← Averaged value of 2 multiple angles.

- ⑨ Repeat ⑥ ⑦ ⑧ to get the multiple angles of desired number of repetition.



- The averaged angle of up to 9 times repetition can be obtained.
- When the averaged angle is not needed,  does not have to be pressed.

[2] Setting up

1 Setting up the horizontal angle

Setting up a specific angle (Ex: 90°) from a base point in civil engineering and other work:

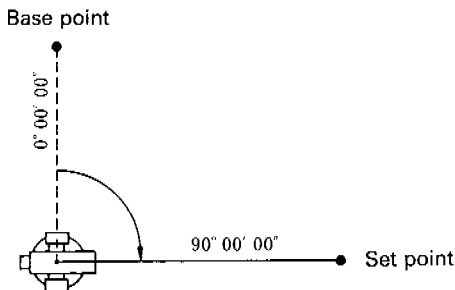
- ① Point the telescope to the base point accurately, and set the horizontal angle at 0° by pressing the 0 set key.

U	86.24.40.D
H	0.00.00.D

- ② Loosen the upper clamp knob, and rotate the instrument around the vertical axis. Tighten the clamp knob when the displayed number comes close to the specific angle.
- ③ Operate the upper tangent screw, and precisely set the displayed number to the specific angle.

U	86.24.40.D
H	90.00.00.D

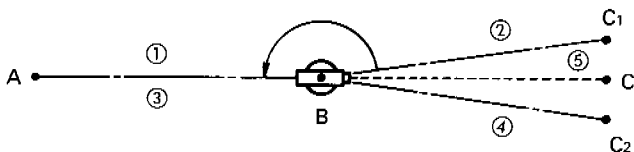
- ④ The point the telescope is targeting is called a set point.



2 Setting up straight lines

A line joining points collimated to an object, near or distant, is a straight line. This fact is used in setting up straight lines. Setting up a point C on the extension of the straight line AB is carried out as follows.

- ① Set up the instrument at point B on the straight line and level it. Then, sight point A.
- ② Loosen the telescope clamp screw and reverse the telescope about its horizontal axis. Set a point on the line of sight and call it point C₁.

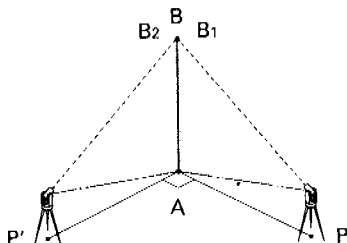


- ③ Loosen the upper clamp screw and rotate the instrument about its vertical axis and sight on point A again.
 - ④ Loosen the telescope clamp screw and reverse the telescope on its horizontal axis again. Set a point on the line of sight and call it point C₂.
 - ⑤ Set point C in the center of points C₁ and C₂. This point B and C is an extension of the straight line AB.
- When extending the straight line in a rather long distance, repeat the extension of the straight line in a way that distance of AB and BC is limited up to about 100m, respectively.

3 Setting up vertical lines

When the instrument is leveled and the telescope is rotated about its horizontal axis, the line of sight generates a vertical plane, and a vertical line can thus be set up. Setting up a point B on the perpendicular at point A is carried out as follows.

- ① Set the instrument on a point P at a distance equal to or longer than AB. Level the instrument and sight point A.
- ② Loosen the telescope clamp screw. Point the telescope upward at the same angle as point B and set a point on the line (point B₁).
- ③ Move the instrument to point which is at right angles to line AP and at the same distance as AP from point A. Level the instrument and sight point A.



- ④ Loosen the telescope clamp screw, and point the telescope upward at the same angle as point B and set a point on the line (point B₂).
- ⑤ Set the point B at the crossing point of the extended lines of B₁ and B₂. The line joining A and B is perpendicular.

- When sighting point A in procedures ① and ③, be sure that the bubble is in the center of the plate vial.
- When more precise results are required, repeat ① ② and ③ ④ respectively using the telescope in the normal and reverse positions. And set B₁ and B₂ at the centers of the points obtained using the telescope in the normal and reverse positions.

- The telescope normal position means the state where the vertical circle is positioned on the left of the telescope eyepiece. The reverse position is the state where the vertical circle is positioned on the right of the eyepiece.

[3] Stadia surveying

The stadia hairs on the reticle provide the method of measuring distance and height from the instrument center to a leveling rod.

- Calculations are easy since the stadia constant is 0.

When the line of sight is inclined

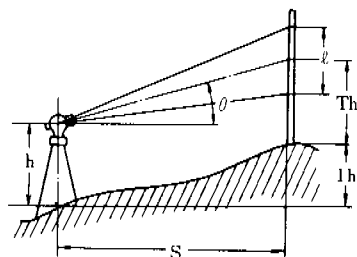


Fig. 19

$$S = 100\ell \cos 2\theta$$

$$h = 50\ell \sin 2\theta$$

$$(Ih = Th)$$

When the line of sight is horizontal

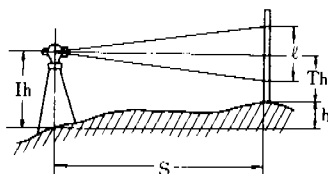


Fig. 20

$$S = 100\ell$$

$$h = Ih - Th$$

S : Horizontal distance

h : Difference in elevation

θ : Vertical angle

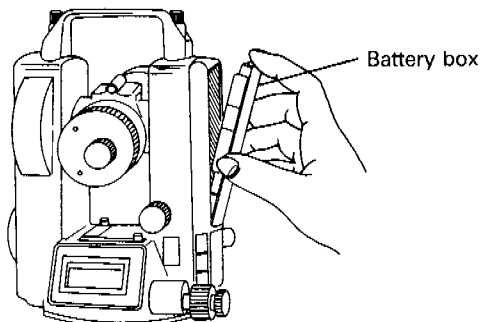
ℓ : Difference in top and bottom stadia hair readings

Ih : Instrument height

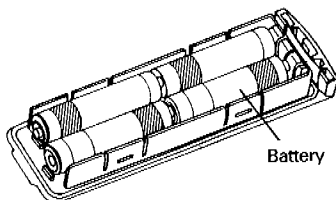
Th : Line of sight reading

7. Replacement of the batteries

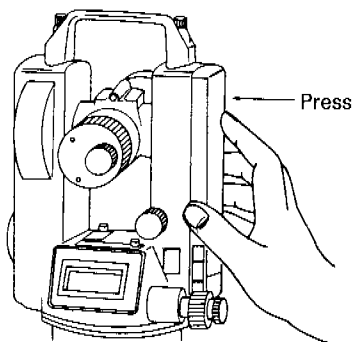
- ① Be sure that the power switch is off.
- ② Take off the battery box, pressing the button on it.



- ③ Take the used batteries out of the box and put in it the new ones.
- Place the batteries properly as indicated in the back of the cover, taking care of its polarity. When replacing the batteries, do all of four batteries at the same time.



- ④ Reinstall the battery box on the instrument.
- Put the button of the box into the slot on the standard cover, and press it until it clicks.



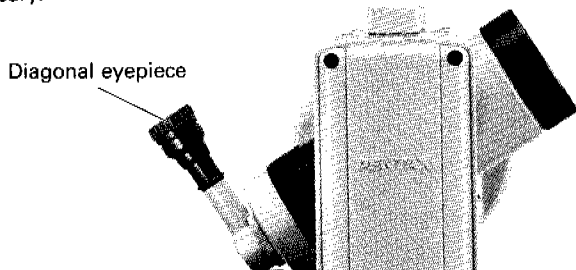
- ⑤ Turn the power on to make sure if the instrument works.
- When the instrument is not in use for a extended period, remember to take the batteries out.

8. Optional Accessories

1 Diagonal Eyepiece [SB9]

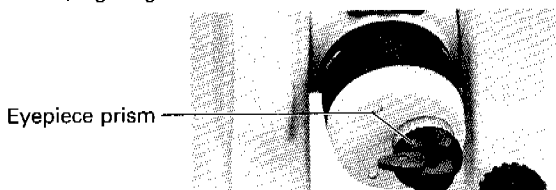
The diagonal eyepiece can be attached to the telescope eyepiece for convenience in observing the zenith or surveying in confined spaces. To attach the diagonal eyepiece to the telescope, turn the telescope eyepiece ring counterclockwise to remove the eyepiece, and attach the diagonal eyepiece by turning its ring clockwise. The eyepiece can be rotated through 360°.

When sighting is made through the telescope with the diagonal eyepiece attached, the reticle may be seen deflected vertically or horizontally, but this has no influence upon accuracy. It can be corrected with three adjusting screws if necessary.



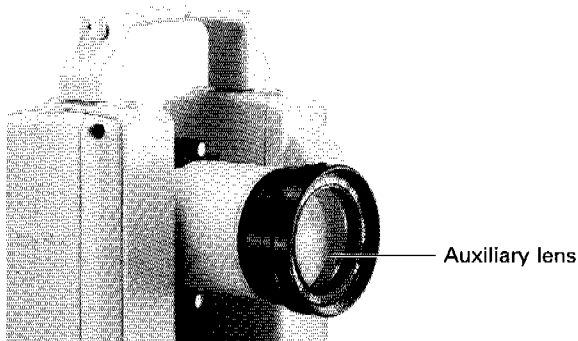
2 Eyepiece Prism [SP2]

For the same purpose in usage of diagonal eyepiece, Eyepiece prism can be attached to the telescope eyepiece. However, sighting the due zenith is not available.



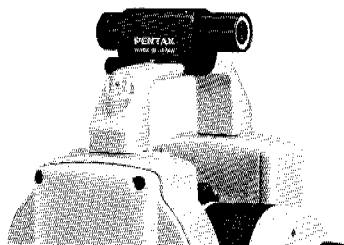
3 Auxiliary Lens [Type A]

Minimum focus distance shortens to 85cm by attaching the lens to objective lens.



4 Bar Compass [SC7]

Magnetic north can be obtained by mounting the bar compass onto the top handle.



9. Maintenance and Storing

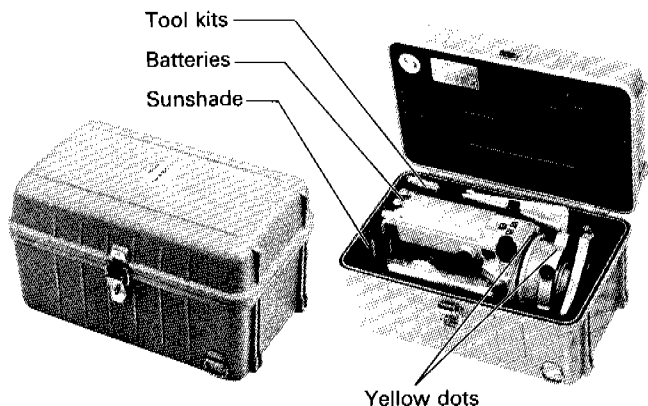
1 Maintenance

- ① After using the instrument, wipe off dust and moisture and store it in its case.
- ② When cleaning the exposed parts, first remove dust with the cleaning brush, then gently wipe with a soft cloth.
- ③ To clean the lens surfaces, first remove dust with cleaning brush, then gently wipe with a clean cotton cloth to which a small amount of alcohol has been applied. Be sure the cloth used is clean.

2 Storing

Store the instrument in the plastic case as follows.

- ① Set the telescope almost horizontal, and tighten the upper clamp screw and telescope clamp screw lightly.
- ② Align the yellow dots, and tighten lower clamp screw lightly.
- ③ Store the instrument correctly into the case with the yellow dots towards you.
- ④ Close the case lid and lock the clamp.

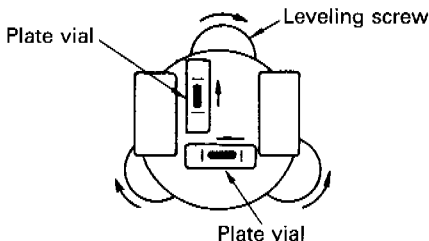


10. Inspection and Adjustment

1 Perpendicularity of Plate Vial to Vertical Axis.

1 Inspection

- ① Align the plate vial in parallel with a line joining any two of the leveling screws. Then, adjust the two screws to center the bubble in the vial.
- ② Adjust the remaining leveling screw to center the bubble of the other plate vial.
- ③ Repeat 1 and 2 to place the bubble of both vials in the center.
- ④ Loosen the upper clamp screw and rotate the instrument 180° around the vertical axis.
- ⑤ No adjustment is needed if the bubbles stay in the center.



2 Adjustment

- ① If bubble of the plate vial moves from the center, bring it half way back to the center by adjusting the leveling screw which is parallel to the plate vial.
- ② Correct the remaining half by adjusting the bubble adjusting nuts with the adjusting pin.
- ③ Confirm that the bubble does not move from the center when the instrument is rotated by 180° .
- ④ When the bubble moves, start from ① once again.

Bubble adjusting nut

Plate vial

Plate vial



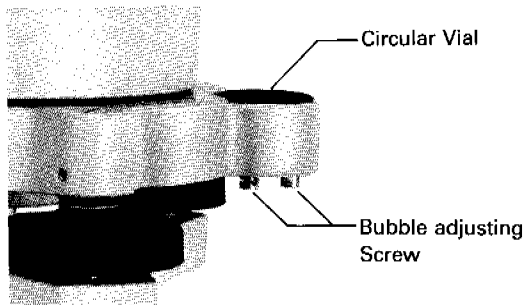
2 Perpendicularity of Circular Vial to Vertical Axis

1 Inspection

No adjustment is necessary if the bubble of the circular vial is in the center after inspection and adjustment of "Perpendicularity of the Plate Vial to the Vertical Axis".

2 Adjustment

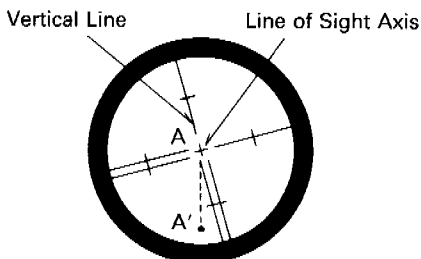
If the bubble of the circular vial is not in the center, bring the bubble to the center by turning the bubble adjusting screw with the adjusting pin.



3 Inclusion of Reticle Pattern Cross Hairs

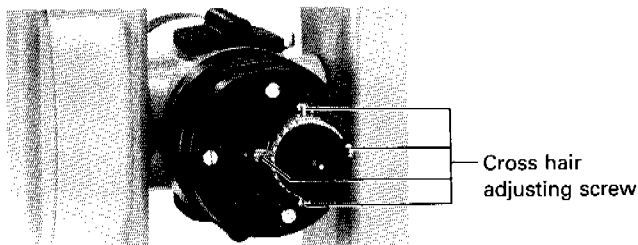
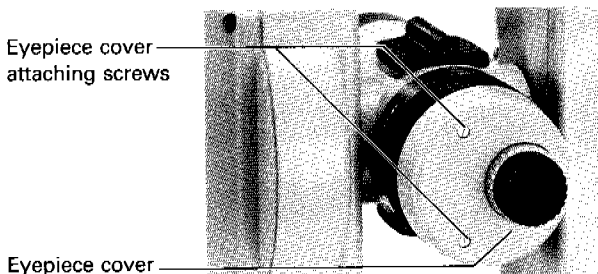
Inspection

- ① Set an object point A on the line of sight through the telescope.
- ② Move point A to the edge of the field of view by adjusting the telescope tangent screw (point A').
- ③ No adjustment is necessary if point A moves along the vertical line of the reticle.



2 Adjustment

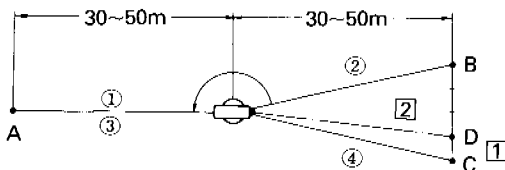
- 1** If the point A does not move along the vertical line, first remove the eyepiece cover with a screwdriver.
- 2** Loosen the four cross hair adjusting screws uniformly with the adjusting pin. Rotate the cross hair around the sight axis, and align the vertical line of the cross hairs with point A'.
- 3** Tighten the cross hairs adjusting screws uniformly. Repeat the inspection and check that the adjustment is correct.



4 Perpendicularity of Line of Sight to Horizontal Axis

Inspection

- ① Set an object point A at a distance of 30 to 50m away from the instrument, and sight it through the telescope.
- ② Loosen the telescope clamp screw and reverse the telescope around the horizontal axis. Mark a point set on the line of sight at about the same distance to the object point A, and call it point B.
- ③ Loosen the upper clamp screw, and rotate the instrument around the vertical axis. Sight point A again.
- ④ Loosen the telescope clamp screw, and reverse the telescope around the horizontal axis. Mark a point on the line of sight at about the same distance as point B, and call it mark C. (The telescope has now returned to its normal position.)
- ⑤ No adjustment is necessary if points B and C coincide.



2 Adjustment

- 1** If points B and C do not coincide, set up a point C located $\frac{1}{4}$ of the length BC from the point C toward B.
- 2** Turn the two cross hairs adjusting screws opposed horizontally by first loosening one, then tightening the other with the adjusting pin. Move the cross hair so that point D is set on the line of sight.
- 3** Repeat the inspection and check that the adjustment is correct.

5 Vertical Angle Reading with line of sight horizontal

1 Inspection

- ① Set up as usual and turn the power on.
 - ② Sight the telescope at any reference target A. Obtain vertical angle (r).
 - ③ Reverse the telescope and rotate the alidade. Sight again at A and obtain vertical angle (ℓ)
 - ④ If $r + \ell = 360^\circ$, no further adjustment is required.
 - * If difference d ($r + \ell - 360^\circ$) is greater than the rated value, adjustment is required.
- If the horizontal 0° mode is used, $r + \ell = 180^\circ$ or 540° .

2 Adjustment

Adjust the vertical scale zero offset. For TH-E10, turn the vertical compensation off (set the internal vertical compensation switch OFF) and repeat ① ~ ④ for reinspection. Depending value, d' ($r + \ell - 360^\circ$), the adjustment method is differentiated.

(If d' is greater than specifications)

The vertical scale zero offset (including vertical compensation offset) value needs to be adjusted.

Adjust the vertical scale zero offset.

When adjustment is completed, turn the internal vertical compensation switch ON and recheck. If d' still exceeds specifications, the vertical compensation offset needs to be adjusted.

- If d and d' are approximately equal, the vertical scale zero offset is probably seriously out of alignment and the vertical compensation offset deviation is probably small.
- If d' is approximately half of d , vertical scale zero offset deviation and vertical compensation offset deviation are most likely approximately equal, and both can be adjusted together.

(If d' is less than specifications)

If d' is well less than specifications, vertical compensation offset needs to be adjusted.

Adjust the vertical compensation offset.

In case that d' is close to the specifications although it is still less than specification, follow the adjustment procedure when the d' is greater than the specification. In this case, vertical scale zero offset and vertical compensation offset can be adjusted together.

[Vertical scale zero offset adjustment]

- 1 Turn the power off and open the internal switch cover.
- 2 Set the zero offset switch ON.
- 3 Turn the power on and index the vertical angle 0 point.

OFFSET MODE V.-
STEP 1

- 4 Sight at object A and press



OFFSET MODE V.-
STEP 2

- 5 Reverse the telescope and turn the instrument, and sight at object A again with the telescope reversed.

Press



U -0.30.12.
C 0.35.

← Zero offset value is displayed


↑
The current vertical compensation offset value is simultaneously displayed. (TH-E10 only)

- 6 Reset the zero offset switch to OFF. Adjustment is completed.

Note: Do not turn the power off at this time.
The normal V/H mode will be resumed.

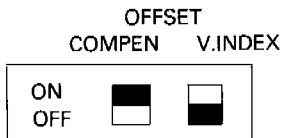
V	86.24.40.D
H	0.00.00.D

- When collimating with the telescope, do not use a target $\pm 10^\circ$ of the zenith. Adjustment is not possible within this range.

- Pressing  in [5] will resume "STEP 1" when the collimation of the telescope is more than $\pm 5^\circ$ off the original collimation point
Properly reset the telescope, and proceed again from step 4.
- Be sure to collimate precisely.

[Vertical compensation offset adjustment]

- 1 Set the instrument up on a stable surface and turn the vertical compensation offset switch ON.



- 2 Turn the power on and perform the vertical angle zero indexing operation.

OFFSET MODE V.-
STEP 1

- 3 Wait approximately 5 sec. and then press



OFFSET MODE V.-
STEP 2

- 4 Rotate the instrument 180° on the vertical axis.

- 5 Wait approximately 5 sec. and then press



V -0.30.12.
C 0.43.

← The new vertical compensation offset value is displayed.

- 6 Turn the vertical compensation offset switch OFF again.
Adjustment is completed.

Note: Do not turn the power off at this time.
The normal V/H mode will be resumed.

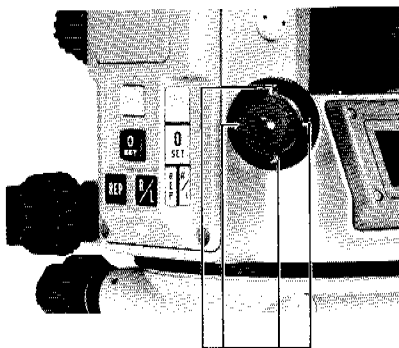
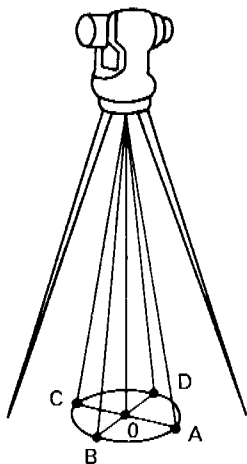
V 86.24.40.D#
H 0.00.00.D-

- Be sure to re-inspect to assure proper adjustment after the above procedure is completed.

6 Coincidence of Line of Sight of Optical Plummet with Vertical Axis

1 Inspection

- ① Set the instrument on the tripod, and place a piece of white paper with a cross drawn on it right under the instrument.
- ② Look through the optical plummet, and move the paper so that the intersecting point of the cross comes to the center of the field of view.
- ③ Adjust the leveling screw so that the center mark of the optical plummet coincides with the intersection point of the cross.
- ④ Rotate the instrument around the vertical axis. Look through the optical plummet each steps of 90° rotation, and observe the center mark position against the intersection point of the cross.
- ⑤ If the center mark always coincides with the intersection point, no adjustment is necessary.



O.P. adjusting screws

2 Adjustment

- ① If the center mark does not coincide with the intersection point, rotate counter-clockwise the cap put on focussing knob of optical plummet and then remove it.
- ② Mark the point set on the line of sight at each step of 90° on the white paper and call them A, B, C and D.
- ③ Join the opposed points (A, C and B, D) with a straight line, and set intersecting point O.
- ④ Turn four optical plummet adjusting screws with a adjusting pin so that the center mark coincides with the intersecting point O.
- ⑤ Repeat the intersection procedures starting with Inspection ④, and confirm if the adjustment is correct or not.

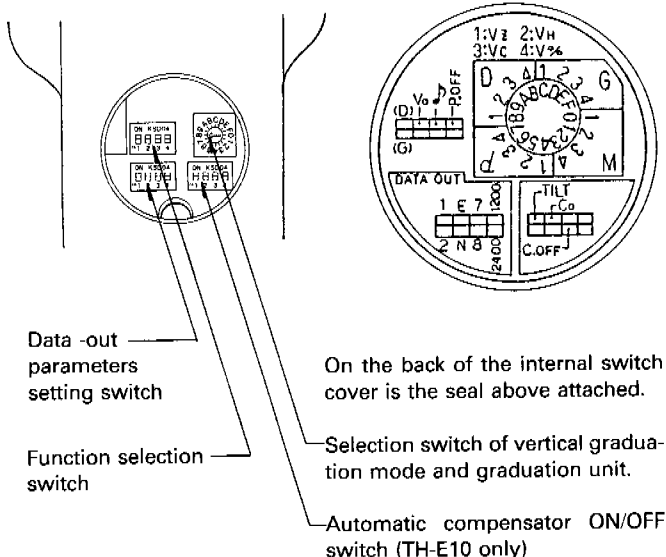
7 Instructions on Inspection and Adjustment

- ◇ When inspecting and adjusting the instrument, take steps in numerical order as much as possible.
- ◇ Pay special attention to articles ③ ④ and ④ ⑤ so that steps for adjustment and inspection may be taken in numerical order.
- ◇ When adjustment is completed, be sure that adjusting screws are firmly tightened. Tighten the adjusting screw by turning the screw to the direction for tightening. When turning the screw back, tighten the screw after it is rotated too much.
- ◇ Repeat inspection after adjustment, and check if the instrument has been adjusted properly.

11. Internal switches

1 Operation of internal switches

- Operation of internal switches**
- ① Turn counterclockwise the internal switch cover on the left of the instrument to remove it.
■ For easily removing it, use the rubber sheet or similar.
 - ② Change over the desired switch visible inside with the tip of a driver to set it to the new mode.
■ Be sure to turn the power off when changing the mode.



2 Function selection switches



* Figure left shows factory-setting.

P.OFF

Auto Power down Function OFF switch.

Switch is set to the OFF to make the auto power down function invalid.



Right angle buzzer off switch

Switch is set to OFF to be silent even when passing 0°, 90°, 180° or 270° on the horizontal circle.

Vo

Vertical 0 point offset switch

Refer to [10. Inspection and Adjustment 5]

D/G

Setting switch for angle unit transmitted to EDM

When the angle unit is in either 6400MIL or 360°DEC, angle data is transmitted in 360°DEG unit. (For transmitting angle data in 400G unit, set the switch to OFF.)

3 Data-out parameters setting switch



* Figure left shows factory-setting.

1200/2400 Buad Rate Selection Switch
(ON: 1200 OFF: 2400)

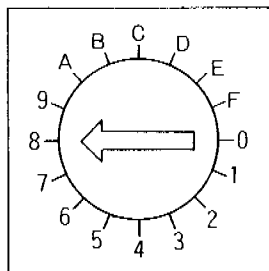
7/8 Data-length Selection Switch
(ON: 7 OFF: 8)

E/N Parity ON/OFF Switch
(ON: E OFF: N)

1/2 Stop Bit Selection Switch
(ON: 1 OFF: 2)

4 Selection Switch of Vertical graduation mode and graduation unit

Rotary switch is used to set the graduation mode and unit to desired one.



When rotary switch is set to the No. 8. (360°DEG Zenith 0°)

Rotary switch No.

No.	Vertical graduation mode	Graduation unit	
8	Zenith 0°	360° DEG	← To be displayed in a unit of 360° (°, ', ")
9	Horizontal 0°		
A	Compass graduation		
B	% graduation		
C	Zenith 0°	400GRAD	← To be displayed in a unit of 400G (90°=100g)
D	Horizontal 0°		
E	Compass graduation		
F	% graduation		
0	Zenith 0°	6400MIL	← To be displayed in a unit of mill (90°=1600mil)
1	Horizontal 0°		
2	Compass graduation		
3	% graduation		
4	Zenith 0°	360° DEC	← To be displayed in a decimal system converted from 60 decimal system (°, ', ")
5	Horizontal 0°		
6	Compass graduation		
7	% graduation		

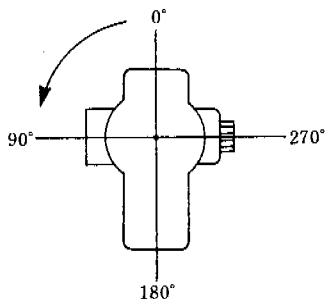
- In civil engineering or construction works, % graduation mode is useful for setting a specified grade extended from the control point.

% graduation is obtained following equation below mentioned.

$$\% \text{ graduation} = (\text{height/horizontal distance}) \times 100$$

This mode is effective for any of angle unit with the display unchanged.

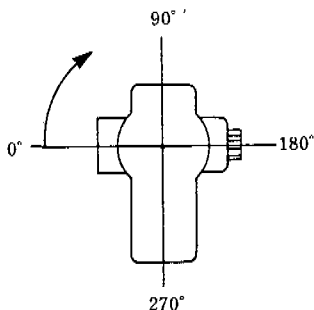
① Example: Zenith 0°/360DEG (Switch No. 8)



Exa: Reading (V) : 86°24'40"

U	86.24.40.D
H	0.00.00.D

② Example: Horizontal 0°/360DEG (Switch No. 9)

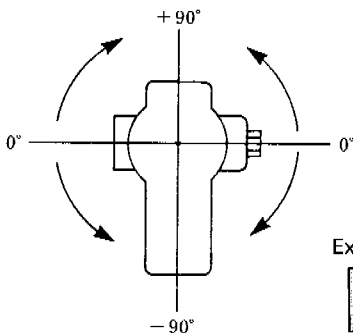


Exa: Reading (V) : 25°53'20"

U	25.53.20.D
H	0.00.00.D

■ In horizontal 0° mode, the value of reading is incremented in a reversed direction different from the zenith 0° mode.

③ Example: Compass graduation/360°DEG (Switch No. A)



Exa: Reading (V) : +25°53'20"

V	+25.53.20.0
H	0.00.00.0

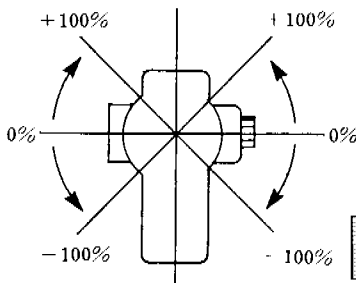
- Symbols, +, -, indicates up-turned or down-turned position of the telescope

+ Up-turned

- Down-turned

Even with the telescope in a reverse position, symbols, +, -, are effective.

④ Example: % graduation/360°DEG (Switch No. B)



Exa: Reading +82,32%

V	+82.32.%
H	0.00.00.0

- In % graduation mode, when elevated or depressed angle of the telescope exceeds 45° (100% in display), error message [V RANGE OVER] is displayed.

PENTAX®

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