

PENTAX

ELECTRONIC THEODOLITES

ETH-205

5 sec. Angle Accuracy
Detachable Tribrach

ETH-210/210C

10 sec. Angle Accuracy
Detachable Tribrach Shifting Tribrach

ETH-220/220C

20 sec. Angle Accuracy
Detachable Tribrach Shifting Tribrach

INSTRUCTION MANUAL

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Safety Precautions (Must be followed)

The following items are intended to prevent possible injury to the user or other people and/or damage to the instrument before it occurs. These safety precautions are important to the safe operation of this product and should be observed at all times.

■ Distinctive Displays

The following displays are used to distinguish precautions by the degree of injury or damage that may result if the precaution is ignored.



WARNING

Items indicated by this display are precautions which if ignored could result in death or serious injury.



CAUTION

Items indicated by this display are precautions which if ignored may result in injury or material damage.

* Here "injury" refers to injuries such as cuts, burns or electric shock the treatment of which will not likely require hospitalization or long-term attention.

* "Material damage" refers to the damage to facilities, buildings, acquired data, etc.



WARNING

- Never look at the sun through the telescope as this may result in loss of sight.
- Do not use at a place near flammable materials as there is a risk of explosion.



CAUTION

- Secure the handle to the main unit with handle locking screws. Failure to properly secure the handle could result in the unit falling off while being carried, causing injury.
- Tighten the tribrach clamp knob securely. Failure to properly secure the handle could result in the unit falling off while being carried, causing injury.
- Do not use the carrying case as a footstool as it is slippery and unstable and may cause you to fall, resulting in possible injury.
- When mounting the instrument to the tripod, tighten the center screw securely. Failure to tighten the screw properly could result in the instrument falling off the tripod causing injury.
- Tighten securely the leg fixing screws of the tripod. The extended tripod shoes due to loose screw could injure a person.
- Do not carry a tripod with the metal shoes pointing toward another person as the person may be injured if they strike him or her.
- Make sure that your hands and feet are not in the vicinity of the tripod legs when installing the tripod, or a hand or foot stab would occur.
- Do not wield or throw the plumb bob, or a person could be injured if struck.

This device complies with protection requirement for residential and commercial areas. If this device is used close to industrial areas or transmitters, the equipment can be influenced by electromagnetic fields

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1. General

1.1 Precautions

Battery

- The insulation tape is put on the electrode when shipping so take off it before using.
- Replace with a new battery before operation because the shipped battery is sometimes discharged naturally.
- Use the same type 5 pieces battery.
- Do not use the batteries whose residual differ each other.

Storing and environmental conditions

- Avoid operation of the instrument under extremely high and low temperatures and do not subject the instrument to rapid temperature changes. (Refer to ambient temperature range specification.) Instrument may not operate properly when used at other than temperature range specified.
- Be sure to store instrument in the case. Avoid storing in a place, which is subject to vibration, high humidity or dust.
- When storage and usage temperatures are widely different, leave the instrument in the case until it can adjust to the surrounding temperature.

Transportation

- Do not subject to impact or vibration during transportation.
- Transport in carrying case. It is recommended that cushioning material be used around the case.

Others

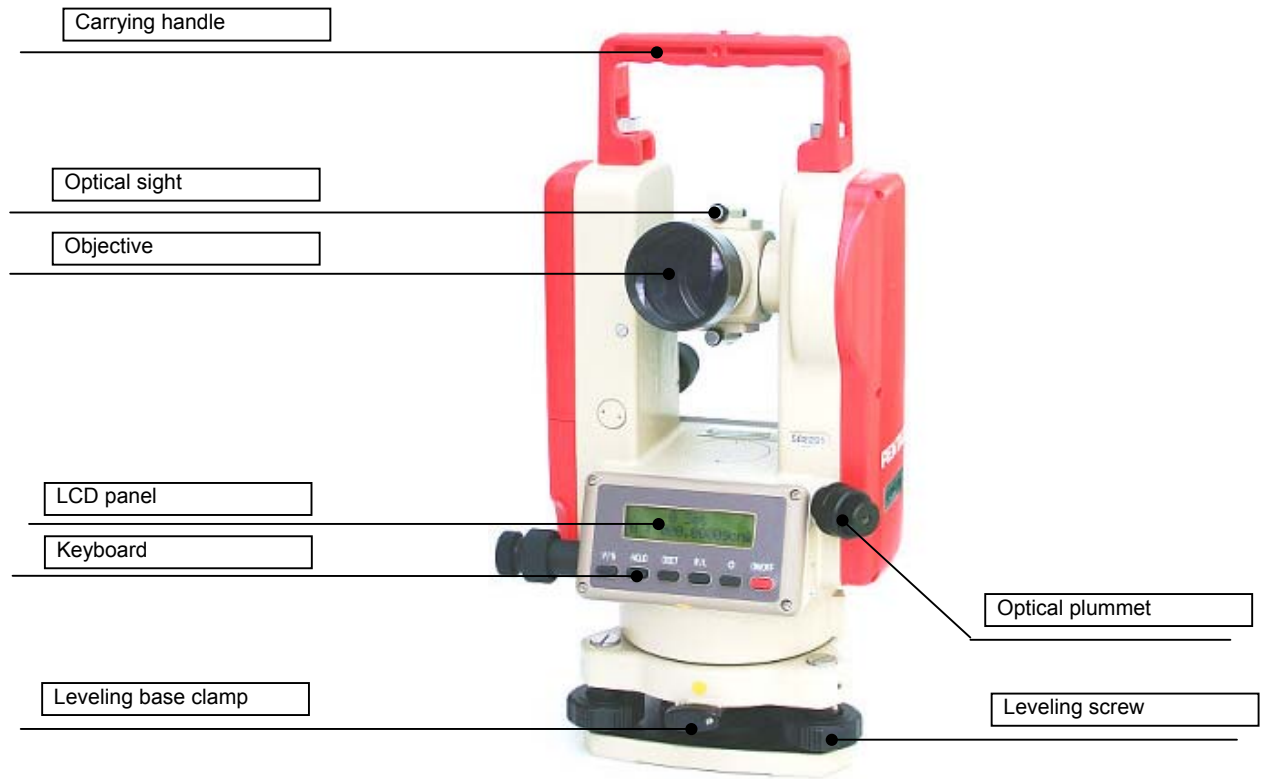
- When not in use for extended periods or having been subjected to impact or vibration, be sure to check the instrument adjustments before starting a job.
- If repair is necessary, contact your local dealer. Do not attempt to repair it by yourself.
- To realize full capability of the instrument, adhere to cautions described in each chapter of this manual.

1.2 Standard equipment

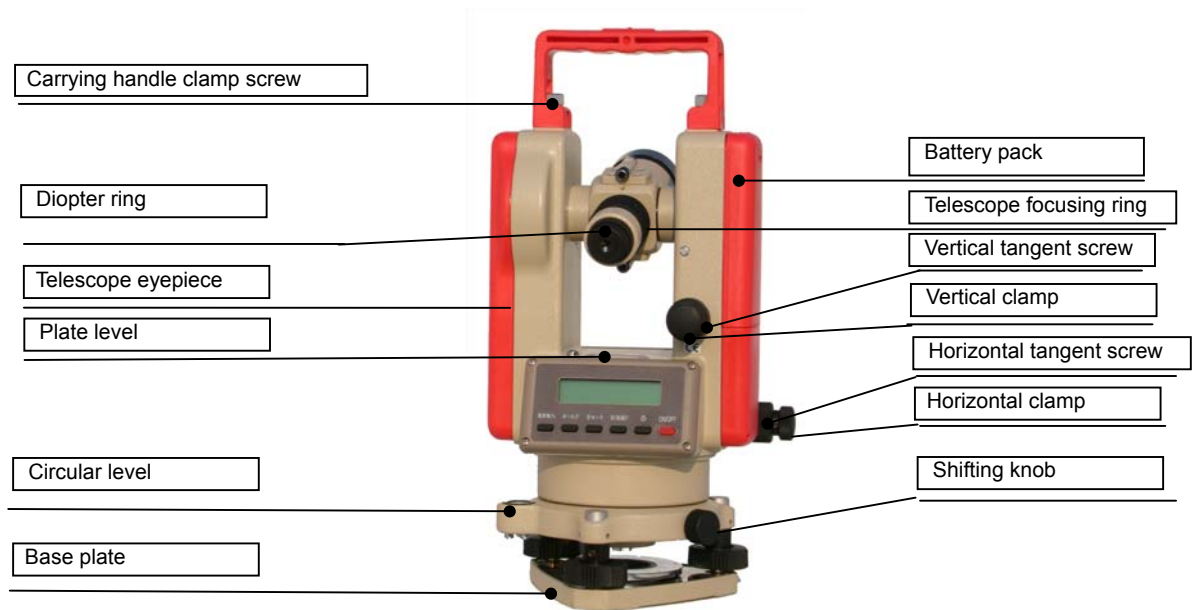
Body (with objective cap)	1
Battery box (Another box is attached to the instrument)	2
AA Dry Battery(in the battery box)	5
Hexagonal wrench	1
Adjusting pin	2
Screw	1
Plumb Bob	1
Rain Cover	1
Carrying Case	1
Instruction Manual	1

* The attached AA batteries are the sample ones, which were placed at factory shipment. Please prepare new batteries before your operation because there is a risk of low battery due to the spontaneous discharge.

1.3 Nomenclature of parts



ETH-205/210/220



ETH-210C/220C

1.4 Battery insertion

- ① Take off the battery box, pressing the button on it.
- ② Place the batteries properly as indicated in the back of the cover, taking case of its polarity.
- ③ Put the button of the box into the slot on the standard cover, and press it until it clicks.


NOTE

- Pay attention to the battery holder's (+) and (-) marks for proper battery insertion.
- Five 1.5V batteries (type AA) can also be used, but reliable high quality ones must be used.
- Batteries must be of the same type.
- Do not use a combination of batteries whose remaining capacity differs, or mix standard and rechargeable types.

2. Key Operations and Display

2.1 Display

Vertical angle: V, V%, VH, Vc,
V: Zenith 0, VH: Horizontal 0, Vc: Compass

V: 090° 35' 20"	
H: 025° 53' 40"	

Horizontal angle: H, HL
H: Clockwise, HL: Counterclockwise

Battery indicator: 

2.2 Keyboard

[V/%] key

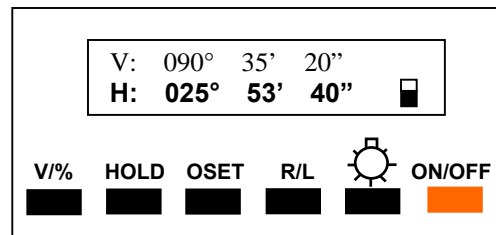
[HOLD] key

[OSET] key

[R/L] key

[] Illumination and Unit key


[ON/OFF] key




2.3 Function of each key

[ON/OFF key]

Pressing the ON/OFF key turns on the power supply and the "0 Set" is displayed.

0 Set		
H: 123° 45' 00"		

After the "0 Set" of Vertical angle is performed, Horizontal and Vertical angles are displayed and it enters into the angle measurement mode.

V: 090° 35' 20"	
H: 025° 53' 40"	

[0 Set of vertical angle]

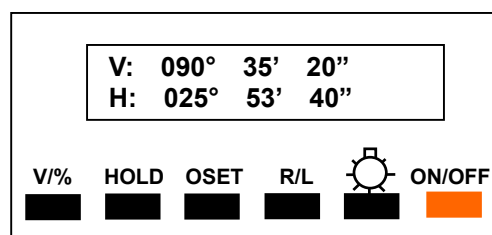
You can set the vertical angle zero by turning the telescope upward or downward only at the Left Circle standard position.

[Power supply Off]

To turn the power supply off, pressing the ON/OFF key for more than 1 second and then releasing it turns the power supply off.

Note:

The error "!! Over range" is displayed when the telescope angle exceeds plus minus 45° (100%) at % display.



[V/% key]

Pressing the [V/%] key can select the Vertical angle display as V, V%, Vc, and VH.

[HOLD key]

1. Pressing the [HOLD] key displays the blink of horizontal angle for 3 seconds.
2. Press the [HOLD] key during this 3 sec. and then "Hold status !" is viewed.
3. Aim at any Target.
4. Press the [HOLD] key.



[0SET key]

1. Pressing the [0SET] key displays the blink of horizontal angle for 3 seconds.
2. Press the [0SET] key during this 3 sec. and then the Horizontal angle is changed to 000° 00' 00".

[R/L key]


Pressing the [R/L] key can select the Clockwise/Counterclockwise of Horizontal angle.

[Illumination key]

1. Pressing the  key can illuminate the display.
Pressing this key one more can turn the illumination off.
2. Pressing this key changes from DMS, Degree Minute Second, to gon and vice versa.
"To DMS" or "To gon" is viewed and the unit is changed by pressing the  key..

2.4 Other functions

Remaining battery indicator

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

Operation possible 

Get the battery ready for a stand by 

Replacement is recommended. 

Automatic Power-off function

If any key is not operated for 10 min. the power supply is turned off automatically.
10 min. or Nil can be selected as follows.

How to set:

Turning the power on → Turn the telescope while pressing the [HOLD] key. The Selection display is viewed. → Select 1. or 2.

1. can be selected by pressing the [V/%] key.
2. can be selected by pressing the [HOLD] key.

- The selection of attached * mark number is valid.
- When 2. is selected, the power is turned off automatically.
- Pressing the other keys is not valid for the selection.

0 Set H: 025° 53' 40"

1. Auto off (10M) * 2. Not auto off
--

Minimum angle display

Minimum angle can be selected by 1"/5"/10"/20" as follows.

How to set:

Turning the power on → Turn the telescope while pressing the [V/%] key. The Selection display 1"/5"/10"/20" is viewed and turned off. The 1"/5"/10"/20" depends on the instrument type.

	0 Set
H:	025° 53' 40"

	10"
H:	025° 53' 40"

3. Preparation for Surveying

3.1 Positioning and centering

- ① Adjust the tripod legs so that a height suitable for surveying is gained when the instrument is set on the tripod.
- 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 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.
- ④ Put the instrument on the head and attach it to the base plate by the center screw.

3.2 Leveling with the Circular level

After positioning the instrument, level it by the Circular level.

- ① By adjusting any two leveling screws, position the bubble in the center of the vial.
To adjust the screws, turn them in opposite directions at the same time.
- ② Adjust the remaining leveling screws, and position the bubble in the center of the circle.
- ③ Confirm if the bubble is in the center of the circle by turning the instrument at every angle.

For the relation between the screw adjusting direction and bubble moving direction, bubble moves in the same direction of the movement of a thumb on the left hand or in the opposite direction on the right hand.

3.3 Leveling with the Plate level

After leveling by the Circular level, level the instrument precisely by the Plate level.

- ① Place the Plate level 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. To adjust the screws, turn them in opposite directions at the same time.
- ② Rotate the Plate level through 90° around the vertical axis. Adjust the remaining leveling screw so that the bubble comes to the center of Plate level.
- ③ Rotate the instrument 180° around the vertical axis, and check the bubbles stay unmoved.

■ If the bubble is not positioned stable. "Adjustment of the Plate level" is necessary.

3.4 Centering with the optical plummet

After precise leveling by the Plate level, coincide the instrument center with the Point.

- 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 Point.

[ETH-205/210/220: Detachable type]

- ③ Loosen the center screw of the tripod. Look through the optical plummet, and move the base plate on the tripod head until the center mark coincides with the Point.
- ④ Ascertain that the bubble stays positioned in the center when rotating the Plate level position in steps of 90° . If the bubble is not positioned in the center, adjust the leveling screws.

[ETH-210C/220C: Shifting base type]

- 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 point.
- ④ Tighten the shifting plate locking knob. Ascertain that the bubble stays positioned in the center when rotating the Plate level position in steps of 90° . If the bubble is not positioned in the center, adjust the leveling screws.

■ 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.

3.5 Eyepiece adjustment

After centering with the optical plummet, coincide the eyepiece lens focus with the hairs.

- ① Remove the telescope lens cap.
- 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 reticule appears as its maximum sharpness.

■ When looking into the eyepiece, avoid intense look to prevent the parallax and eye fatigue.

3.6 Object sighting

After eyepiece adjustment, aim at the target.

- ① Aim the telescope at the object using the optical sight. Tighten the 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 Accurately align the cross hairs with the object, using each tangent screws.

■ Turn the focusing knob clockwise to focus on a near object. Turn the knob counterclockwise to focus on a far object.

4. Measurement

4.1 Horizontal angle measurement (Clockwise)

- ① Place the instrument at the Station point and level it, and turn the power on.
- ② Sight the first object using the upper clamp and tangent screws as well as the telescope clamp and tangent screws.
- ③ Press the [0SET] key to set the horizontal angle to 0° 00' 00".
- ④ Sight the second object using the Horizontal clamp and tangent screws as well as the telescope clamp and tangent screws.
- ⑤ Read the displayed value (α).

V: 090° 35' 20"	
H: 025° 53' 20"	■

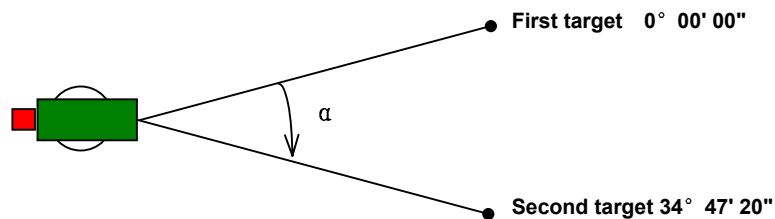
First object: Zero setting (0° 00' 00")

V: 090° 35' 20"	
H: 000° 00' 00"	■

Second object (34° 47' 20")

V: 090° 35' 20"	
H: 034° 47' 20"	■

Horizontal angle (α) = 34° 47' 20"



4.2 Horizontal angle measurement (Counterclockwise)

- ① Place the instrument at the Station point and level it, and turn the power on.
Press the [R/L] key to change the Horizontal angle display to HL.
- ② Subsequent operation will be done as in 5.1 Horizontal angle measurement (Clockwise), except that the order of collimation is reversed.

■ To switch the mode back to "Clockwise", press the [R/L] key again.

4.3 Vertical angle measurement

- ① Place the instrument at the Station point and level it, and turn the power on.
- ② Sight the Target A using the Horizontal clamp and tangent screws as well as the telescope clamp and tangent screws.
- ③ Read the displayed angle (θ).

Vertical angle (θ) = 86° 24' 40"

V: 086° 24' 40"	
H: 034° 47' 20"	■

■ Press the [V/%] key to view the Vv and V%.

5. Check and adjustment

5.1 Instructions on Check and adjustment

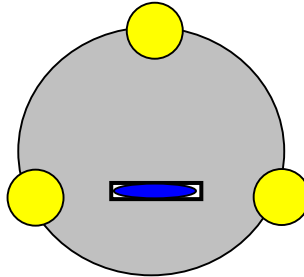
- When inspecting and adjusting the instrument, perform it on the tripod or adjusting stand.
- Pay special attention to articles from 5.2 to 5.7 and so that steps for adjustment and Check may be taken in numerical order.
- When adjustment is completed, be sure that adjusting screws are firmly tightened. Tighten the adjusting screw by turning the screw to the direction for tightening.
- Repeat Check after adjustment, and check if the instrument has been adjusted properly.

5.2 Plate level

Adjustment is required if the axis of the plate level is not perpendicular to the vertical axis.

Check

- ① Perform the “3.3 Leveling with the Plate level”.
Place the plate level parallel to a line of two leveling screws.
- ② Turn the Plate level through 180° around the vertical axis.
- ③ Confirm if the bubble is in the center.
- ④ No adjustment is necessary if the bubble of the Plate level is in the center. If the bubble moves, then proceed with the following adjustment.



Adjustment

- ① If bubble of the Plate level moves from the center, bring it half way back to the center by adjusting the leveling screw which is parallel to the Plate level.
- ② Adjust the remaining half by adjusting the bubble adjusting nuts with the adjusting pin.
- ③ Confirm if the bubble moves from the center by rotating the instrument.
- ④ No adjustment is necessary if the bubble of the Plate level is in the center. If the bubble moves, repeat the same procedures.

5.3 Circular level

Adjustment is required if the axis of the circular level is not perpendicular to the vertical axis.

Check

- ① Confirm if the bubble of the Circular level is in the center after Check and adjustment of “5.2 Plate level”.
- ② No adjustment is necessary if the bubble of the Plate level is in the center. If the bubble moves, proceed with the following adjustment.

Adjustment

- ① Shift the bubble to the center by turning the bubble adjusting 3 screws with the adjusting pin.
- ② Confirm if the bubble of the Circular level is in the center.

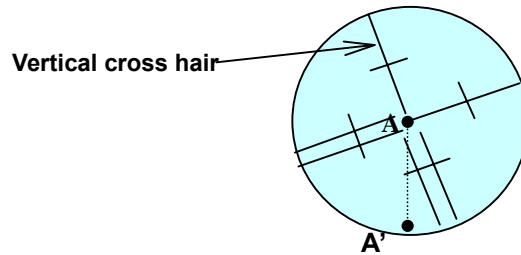
5.4 Inclination of vertical cross hair

Adjustment is required if the vertical cross hair is not perpendicular to the horizontal axis of the telescope.

Check

- ① Set the instrument on the tripod and carefully level it.
- ② Aim at the cross hair on the target A.
- ③ Move the point A to the edge of the field of view using the telescope tangent screw (point A').

Following adjustment is necessary if point A does not move along the vertical cross hair.



Adjustment

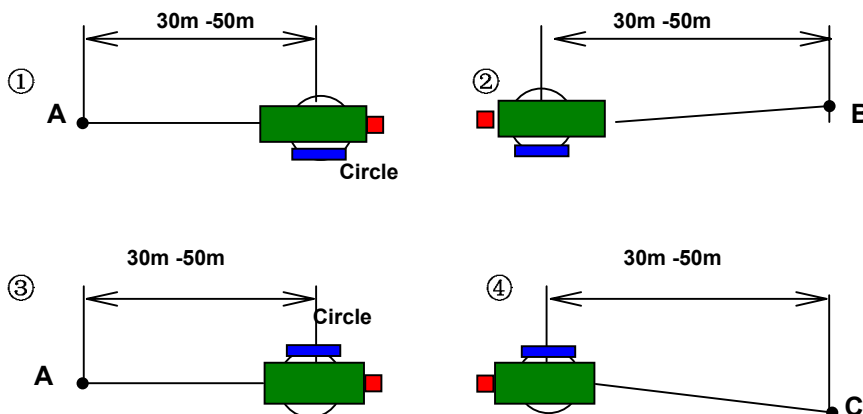
- ① Remove the eyepiece cover.
- ② Loosen the four cross hair adjusting screws uniformly with the adjusting pin. Rotate the cross hair around the sight axis, and align the vertical cross hair with point A'.
- ③ Tighten the cross hair adjusting screws uniformly. Repeat the check.

5.5 Perpendicularity of line of sight to horizontal axis

This is required to make the line of sight of the telescope perpendicular to the horizontal axis of the instrument.

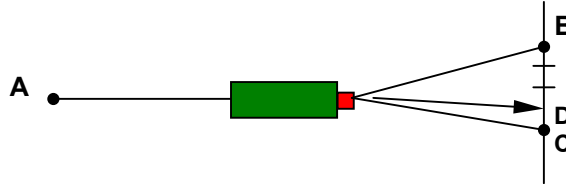
Check

- 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 turn the telescope only around the horizontal axis. Mark a point 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 only around the vertical axis. Sight point A again.
- ④ Loosen the telescope clamp screw, and turn the telescope only 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 point B and C coincide. If point B and C do not coincide, proceed with following adjustment.



Adjustment

- ① If point B and C do not coincide, set up a point D located 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 check.



5.6 Vertical angle reading with line of sight horizontal

Check

- ① Sight the telescope at any reference target A. Read the vertical angle (VI).
- ② Turn the telescope and rotate the instrument. Sight the target A again and read the vertical angle (Vr).
- ③ When the zenith angle zero:

$$I = (VI + Vr - 360^\circ) / 2$$

When horizontal angle zero:


$$I = (VI + Vr - 180^\circ) / 2$$

If $I \leq 15''$


Further adjustment is required if I is bigger than 15''.

Adjustment


- ① Turn the power on.
Press the [ON/OFF key].

0 Set
H: 000° 00' 00" 


- ② While pressing the [0SET] key, turn the telescope upward or downward and release it.

Modify Index
sel. a target (I) 

- ③ Aim at the target P which is 10° over the horizontal line and press any key.

turn 180 ← (I)
aim it again 

- ④ Loosen the telescope and horizontal clamp screws and then turn the telescope at back state.
Aim at the target P and press any key.

2 I is OK!
Turn off the ins 

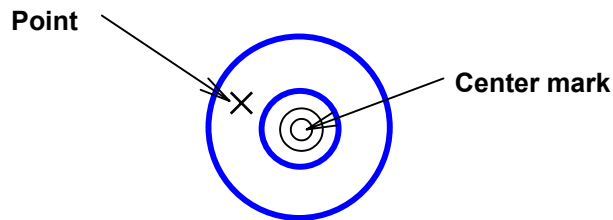
- ⑤ Press the any key to turn the power off and terminate the adjustment.

5.7 Optical plummet

Adjustment is required to make the line of sight of the optical plummet coincide with the vertical axis.

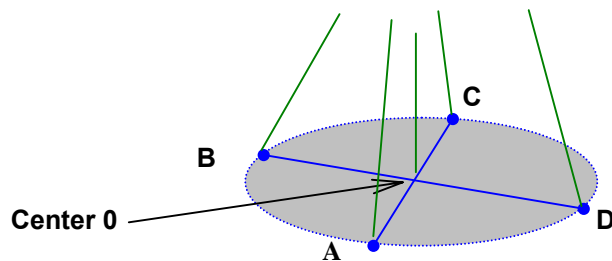
Check

- ① Set the instrument on the tripod, and place a piece of white paper with a Point drawn on it right under the instrument.
- ② Look through the optical plummet, and move the paper so that the Point of the paper almost comes to the center of the field of view and fix it.
- ③ Adjust the leveling screws so that the center mark coincides with the Point.
- ④ Rotate the instrument around the vertical axis and look through the optical plummet each steps of 90° rotation, and observe the Point against the center mark.
- ⑤ If the Point always does not coincide with the center mark, proceed with following adjustment.



Adjustment

- ① Rotate the Cap of optical plummet counterclockwise and then remove it.
- ② Put the center mark 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 mark the center 0.
- ④ Turn the four optical plummet adjusting screws with the minus screw driver so that the center mark coincides with the center 0.
- ⑤ Check again.



Optical plummet knob

6. Optional Accessories

6.1 Diagonal Eyepiece [SB13]

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. The diopter ring is easily removed so take care of not falling down the ring. And attach the diagonal eyepiece by turning its ring clockwise.

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

7. Specifications

■ Telescope

Image	Erect
Magnification	30 x
Effective aperture	40 mm
Resolving power	3.5"
Field of view	1° 20'
Minimum focus distance	2.0 m

■ Angle measurement

Type	Incremental rotary encoder
Detection mode	V.angle: Single H.angle: Dual

Minimum display

ETH-205	1"/5"/10"/20"
ETH-210(C)	5"/10"/20"
ETH-220 (C)	10"/20"

Accuracy (DIN18723 Standard deviation)

ETH-205	5"
ETH-210(C)	10"
ETH-220 (C)	20"

■ Display

Type	LCD in two lines
Display panel	Dual

■ Vertical axis

Single

■ Sensitivity of vials

Plate level	30"/2mm
Circular level	8'/2mm

■ Tribrach type

ETH-205/210/220 : Detachable
ETH-210C/220C : Shifting

■ Optical Plummet

Magnification	2x
Focusing range	0.5m~∞

■ Power source

Type	5 x AA dry battery
Voltage	7.5 V
Operation time	(Alkaline) 15 hrs.

■ Ambient temperature

-20° C~ +45° C

■ Water protection

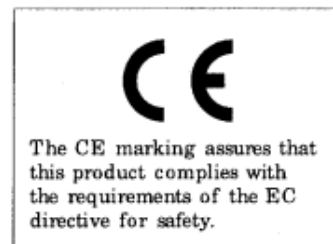
IPX2

■ Dimensions

Instrument	L165 x H325 x W174mm/4.3kg
Carrying case	L440 x H250 x W270mm/2.54kg

PENTAX

CERTIFIED ISO 9001 & 14001



Member symbol of the Japan Surveying Instruments Manufacturers' Association representing the high quality surveying products.

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