

SOKKIA

DT2₁₀
DT5₁₀
DT5_{10S}
DT5_{10A}
DT5_{10AS}
DT6₁₀
DT6_{10S}

Electronic Digital Theodolite



OPERATOR'S MANUAL



This is the mark of the Japan Surveying Instruments Manufacturers Association.

SURVEYING INSTRUMENTS

DT210
DT510
DT510S
DT510A
DT510AS
DT610
DT610S

Electronic Digital Theodolite

OPERATOR'S MANUAL

- Thank you for selecting the DT210/510/510S/510A/510AS/610/610S.
- Before using the instrument, please read this operator's manual carefully.
- Verify that all equipment is included.  "14.1 Standard Equipment"
- The specifications and general appearance of the instrument may be altered at any time and may differ from those appearing in brochures and this manual.
- Some of the diagrams appearing in this manual may be simplified for easier understanding.



CONTENTS

1. PRECAUTIONS FOR SAFE OPERATION	1
2. PRECAUTIONS	4
3. HOW TO READ THIS MANUAL	6
4. PARTS OF THE INSTRUMENT	7
5. INSTALLING / REMOVING THE BATTERY	10
6. SETTING UP THE INSTRUMENT	12
6.1 Centering	12
6.2 Leveling.....	13
7. FOCUSING AND TARGET SIGHTING.....	16
8. POWER ON	17
9. MEASUREMENT	18
9.1 Measuring the horizontal angle between 2 points (H angle 0)	18
9.2 Set Horizontal Circle to a Required Value (Horizon- tal angle hold)	19
9.3 Changing Horizontal Angle Display Mode.....	20
9.4 Changing Vertical Angle Display Mode.....	20
9.5 Stadia Survey.....	21
10. DATA OUTPUT	23
10.1 Connecting a Computer	23
10.2 Communication Functions Command and Output	24
11. CHANGING INSTRUMENT OPTIONS	25
12. ERROR MESSAGES	33
13. CHECKS AND ADJUSTMENTS	34
13.1 Plate Level	34
13.2 Circular Level	35
13.3 Tilt Sensor	36
13.4 Reticle	39
13.5 Optical Plummet.....	41
14. STANDARD EQUIPMENT	44
14.1 Standard Equipment	44

CONTENTS

14.2 Optional Accessories	45
14.3 Layout Plan	47
15. APPENDICES	48
15.1 Battery Selection	48
16. SPECIFICATIONS	49
17. REGULATIONS	51

1. PRECAUTIONS FOR SAFE OPERATION

Read this manual before using the instrument.

For the safe use of the product and prevention of injury to operators and other persons as well as prevention of property damage, items which should be observed are indicated by an exclamation point within a triangle used with WARNING and CAUTION statements in this operator's manual.

The definitions of the indications are listed below. Be sure you understand them before reading the manual's main text.

Definition of Indication



WARNING

Ignoring this indication and making an operation error could possibly result in death or serious injury to the operator.



CAUTION

Ignoring this indication and making an operation error could possibly result in personal injury or property damage.

Definition of Symbols



This symbol indicates items for which caution (hazard warnings inclusive) is urged. Specific details are printed in or near the symbol.



This symbol indicates items which are prohibited. Specific details are printed in or near the symbol.



This symbol indicates items which must always be performed. Specific details are printed in or near the symbol.

1. PRECAUTIONS FOR SAFE OPERATION

General

WARNING

-  Do not use the unit in areas exposed to high amounts of dust or ash, in areas where there is inadequate ventilation, or near combustible materials. An explosion could occur.
-  Do not perform disassembly or rebuilding. Fire, electric shock or burns could result.
-  Never look at the sun through the telescope. Loss of eyesight could result.
-  Do not look at reflected sunlight from a prism or other reflecting object through the telescope. Loss of eyesight could result.
-  Direct viewing of the sun during sun observation will cause loss of eyesight.
-  When securing the instrument in the carrying case make sure that all catches, including the side catches, are closed. Failure to do so could result in the instrument falling out while being carried, causing injury.

CAUTION

-  Do not use the carrying case as a footstool. The case is slippery and unstable, so a person could slip and fall off it.
-  Do not place the instrument in a case with a damaged catch, belt or handle. The case or instrument could be dropped and cause injury.
-  Do not wield or throw the plumb bob. A person could be injured if struck.
-  Secure handle to main unit with locking screws. Failure to properly secure the handle could result in the unit falling off while being carried, causing injury.
-  Tighten the adjustment tribrach clamp securely. Failure to properly secure the clamp could result in the tribrach falling off while being carried, causing injury.

1. PRECAUTIONS FOR SAFE OPERATION

Power Supply

WARNING

-  Do not heat or throw batteries into fire. An explosion could occur, resulting in injury.
-  To prevent shorting of the battery in storage, apply insulating tape or equivalent to the terminals. Otherwise shorting could occur, resulting in fire or burns.
-  Do not use battery if wet. Resultant shorting could lead to fire or burns.

CAUTION

-  Do not touch liquid leaking from batteries. Harmful chemicals could cause burns or blisters

Tripod

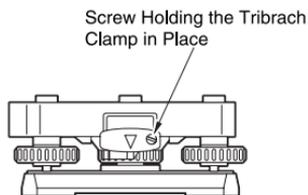
CAUTION

-  When mounting the instrument to a tripod, tighten the centering 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 on which the instrument is mounted. Failure to tighten the screws could result in the tripod collapsing, causing injury.
-  Do not carry the tripod with the tripod shoes pointed at other persons. A person could be injured if struck by the tripod shoes.
-  Keep hands and feet away from the tripod shoes when fixing the tripod in the ground. A hand or foot stab wound could result.
-  Tighten the leg fixing screws securely before carrying the tripod. Failure to tighten the screws could lead to the tripod legs extending, causing injury.

2. PRECAUTIONS

Tribrach Clamp (DT210/510/510A/610)

- When the instrument is shipped, the tribrach clamp is held firmly in place with a locking screw to prevent the instrument from shifting on the levelling base. Before using the instrument the first time, loosen this screw with a screwdriver. And before transporting it, tighten the locking screw to fasten the tribrach clamp in place so that it will not shift on the levelling base.



Precautions concerning water and dust resistance

DT conforms to IP66 specifications for waterproofing and dust resistance when the battery cover is closed and connector caps are attached correctly.

- Be sure to close the battery cover and correctly attach the connector caps to protect the DT from moisture and dust particles.
- Make sure that moisture or dust particles do not come in contact with the inside of the battery cover, terminal or connectors. Contact with these parts may cause damage to the instrument.
- Make sure that the inside of the carrying case and the instrument are dry before closing the case. If moisture is trapped inside the case, it may cause the instrument to rust.

Other precautions

- If the DT is moved from a warm place to an extremely cold place, internal parts may contract and make the keys difficult to operate. This is caused by cold air trapped inside the hermetically sealed casing. If the keys do not depress, open the battery cover to resume normal functionality. To prevent the keys from becoming stiff, remove the connector caps before moving the DT to a cold place.
- Never place the DT directly on the ground. Sand or dust may cause damage to the screw holes or the centering screw on the base plate.
- Protect the DT from heavy shocks or vibration.
- Never carry the DT on the tripod to another site.
- Turn the power off before removing the battery.
- When placing the DT in its case, first remove its battery and place it in the case in accordance with the layout plan.

 "14.3 Layout Plan"

Maintenance

- Always clean the instrument before returning it to the case. The lens requires special care. First, dust it off with the lens brush to remove tiny particles. Then, after providing a little condensation by breathing on the lens, wipe it with a soft clean cloth or lens tissue.
- If the display is dirty, carefully wipe it with a soft, dry cloth. To clean other parts of the instrument or the carrying case, lightly moisten a soft cloth in a mild detergent solution. Wring out excess water until the cloth is slightly damp, then carefully wipe the surface of the unit. Do not use any organic solvents or alkaline cleaning solutions.
- Store the DT in a dry room where the temperature remains fairly constant.
- Check the tripod for loose fit and loose screws.
- If any trouble is found on the rotatable portion, screws or optical parts (e.g. lens), contact your SOKKIA agent.
- When the instrument is not used for a long time, check it at least once every 3 months.

"13. CHECKS AND ADJUSTMENTS"

- When removing the DT from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.
- Check the DT for proper adjustment periodically to maintain the instrument accuracy.

3. HOW TO READ THIS MANUAL

The following conventions are used in this manual.

- Functions differ depending on the theodolite model used.
- Screens and illustrations appearing in this manual are of DT510S.

Symbols

The following conventions are used in this manual.



: Indicates precautions and important items which should be read before operations.



: Indicates the chapter title to refer to for additional information.

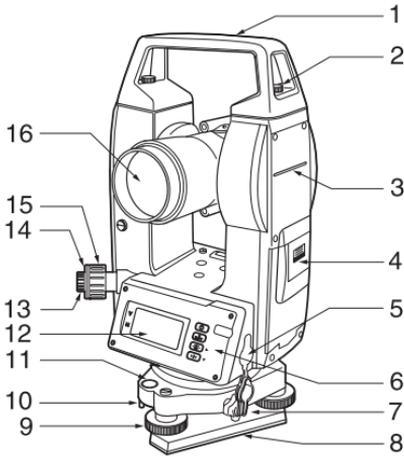


: Indicates supplementary explanation.

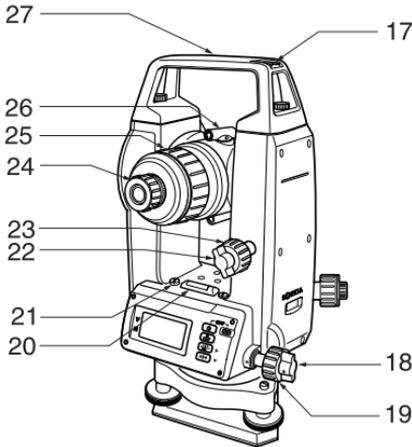


: Indicates an explanation for a particular term or operation.

4. PARTS OF THE INSTRUMENT



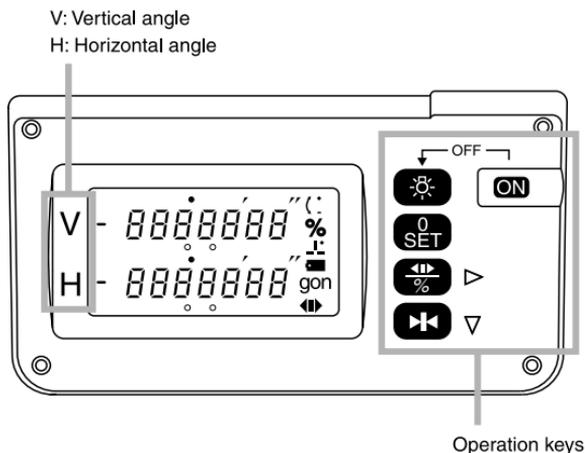
1. Handle
2. Handle securing screw
3. Instrument height mark
4. Battery cover
5. Data output connector (Not included on DT610/610S)
6. Operation panel
7. Shifting clamp (DT210/510/510A:Tribrach clamp, Tribrach clamp is not included on DT610)
8. Base plate
9. Leveling foot screw
10. Circular level adjusting screws
11. Circular level
12. Display
13. Optical plummet eyepiece screw
14. Optical plummet reticle cover
15. Optical plummet focusing ring
16. Objective lens



17. Tubular compass slot
18. Horizontal clamp
19. Horizontal fine motion screw
20. Plate level
21. Plate level adjusting screw
22. Vertical clamp
23. Vertical fine motion screw
24. Telescope eyepiece screw
25. Telescope focusing ring
26. Peep sight
27. Instrument center mark

4. PARTS OF THE INSTRUMENT

Operation panel ~ Display Functions ~



● Display symbols

(± 90) : Vertical angle ± 90

% : % vertical angle

\pm : Tilt angle compensation (DT210/510/510S only)

"11. CHANGING INSTRUMENT OPTIONS"

: Battery mark (displayed when batteries need to be replaced)

gon : gon angle units

: Horizontal angle right
 : Horizontal angle left
 : Horizontal angle hold

● Key Operation

ON : Power on

ON + : Power off

The ON/OFF power setting may be set so that **ON** by itself can be used to turn the power on and off.

"11. CHANGING INSTRUMENT OPTIONS"

: Select horizontal angle display mode / vertical angle display mode

"9.3 Changing Horizontal Angle Display Mode" and "9.4 Changing Vertical Angle Display Mode"



: Display illumination ON/OFF



(Hold for a moment):

Continue holding down the button until "the horizontal angle beep" has or has not been set.

The setting can also be changed with the setting screen.

"11. CHANGING INSTRUMENT OPTIONS"



: Set horizontal angle to 0

"9.1 Measuring the horizontal angle between 2 points (H angle 0)"



: Hold / release horizontal angle

"9.2 Set Horizontal Circle to a Required Value (Horizontal angle hold)"

5. INSTALLING / REMOVING THE BATTERY

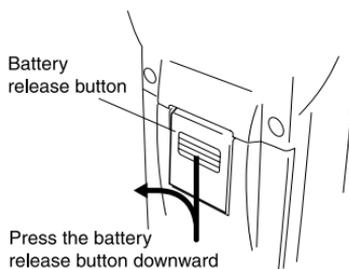
Mount the new batteries.



- When removing the battery, turn the power off.
- When installing / removing the battery, make sure that moisture or dust particles do not come in contact with the inside of the instrument.
- Use alkaline batteries. If batteries other than alkaline batteries are used, the battery reserve display and the 'Low' warning will not function properly.

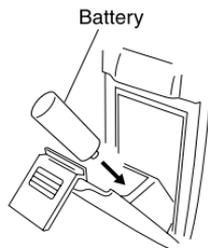
► PROCEDURE

1. Open the battery cover.



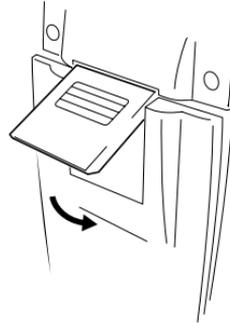
2. Insert 2 batteries (LR14/C).

Insert the batteries as depicted by the illustration on the inside of the battery cover.



Firmly insert the batteries after verifying the direction in which they go.

3. Close the battery cover.



Fit the cover into the catch at the top, and press it down until a click is heard.

Note

- Remaining battery power: When the instrument is turned on, remaining battery power is displayed for a few seconds.
 - 3:90 to 100 %
 - 2:50 to 90 %
 - 1:10 to 50 %
 - 0:0 to 10 % Battery mark is displayed. Replace all batteries. If you continue to use the instrument, the battery mark flashes and a beep sounds. Following this, the power will automatically shut off.
- Measuring cannot be properly performed when the batteries are 'Low' (the battery symbol is flashing and beeping).

6. SETTING UP THE INSTRUMENT



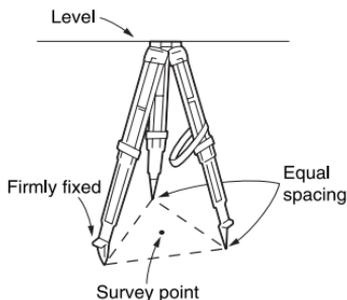
- Mount the battery in the instrument before performing this operation because the instrument will tilt slightly if the battery is mounted after leveling.

6.1 Centering

► PROCEDURE

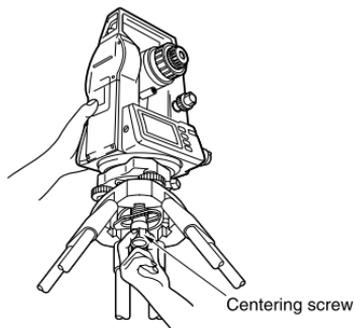
1. Set up the tripod.

Make sure the legs are spaced at equal intervals and the head is approximately level. Set the tripod so that the head is positioned over the surveying point. Make sure the tripod shoes are firmly fixed in the ground.



2. Install the instrument.

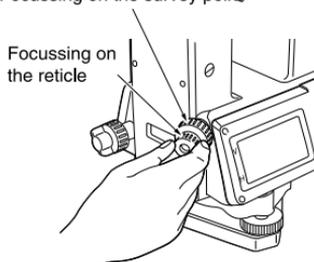
Place the instrument on the tripod head. Supporting it with one hand, tighten the centering screw on the bottom of the unit to make sure it is secured to the tripod.



3. Focus on the surveying point.

Looking through the optical plummet eyepiece screw, turn the optical plummet eyepiece to focus on the reticle. Turn the optical plummet focusing ring to focus on the surveying point.

Focussing on the survey point

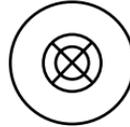


6.2 Leveling

► PROCEDURE

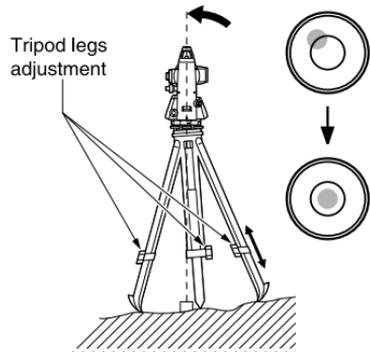
- Center the surveying point in the reticle.**

Adjust the leveling foot screws to center the surveying point in the optical plummet reticle.



- Center the bubble in the circular level.**

Center the bubble in the circular level by either shortening the tripod leg closest to the off-center direction of the bubble or by lengthening the tripod leg farthest from the off-center direction of the bubble. Adjust one more tripod leg to center the bubble.

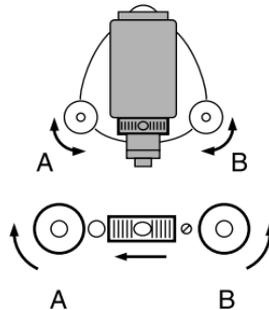


- Center the bubble in the plate level.**

Loosen the horizontal clamp to turn the upper part of the instrument until the plate level is parallel to a line between leveling foot screws A and B.

Center the air bubble using leveling foot screws A and B.

The bubble moves towards a clockwise rotated leveling foot screw.



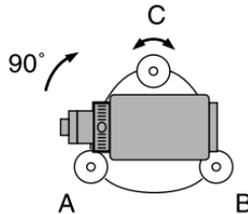
6. SETTING UP THE INSTRUMENT

4. Turn 90° and center the bubble.

Turn the upper part of the instrument through 90°.

The plate level is now perpendicular to a line between leveling foot screws A and B.

Center the air bubble using leveling foot screw C.



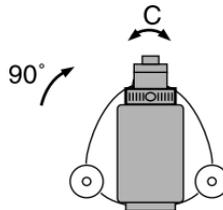
5. Turn another 90° and check bubble position.

Turn the upper part of the instrument a further 90° and check to see if the bubble is still in the center of the plate level. If the bubble is off-center, perform the following:

- Turn leveling foot screws A and B equally in opposite directions to remove half of the bubble displacement.
- Turn the upper part a further 90°, and use leveling foot screw C to remove half of the displacement in this direction.

Or adjust the plate level.

 "13.1 Plate Level"



6. Check to see if bubble is in same position in any direction.

Turn the instrument and check to see if the air bubble is in the same position in all directions.

If it is not, repeat the leveling procedure.

7. Center the DT over the Surveying point.

(DT210/510/510A/610):

Loosen the centering screw slightly.
Looking through the optical plummet eyepiece, slide the instrument over the tripod head until the surveying point is exactly centered in the reticle.
Retighten the centering screw securely.

(DT510S/510AS/610S):

Turn the tribrach shifting clamp counterclockwise.
Shifting tribrach can be adjusted up to $\pm 8\text{mm}$.
Looking through the optical plummet eyepiece, adjust the instrument position on the tribrach to center the surveying point.
Tighten the shifting clamp to fix the instrument in the center position.

8. Check again to make sure the bubble in the plate level is centered.

If not, repeat the procedure starting from step 3.

7. FOCUSING AND TARGET SIGHTING

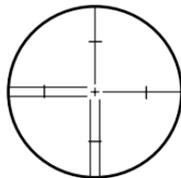
► PROCEDURE

1. Focus on the reticle.

Look through the telescope eyepiece at a bright and featureless background.

Turn the eyepiece screw clockwise, then counterclockwise little by little until just before the reticle image becomes focused.

Using these procedures, frequent reticle refocusing is not necessary, since your eye is focused at infinity.



2. Sight the target.

Loosen the vertical and horizontal clamps, then use the peep sight to bring the target into the field of view. Tighten both clamps.

3. Focus on the target.

Turn the telescope focusing ring to focus on the target.

Turn the vertical and horizontal fine motion screws to align the target with the reticle.

The last adjustment of each fine motion screw should be in the clockwise direction.

4. Readjust the focus until there is no parallax.

Readjust the focus with the focusing ring until there is no parallax between the target image and the reticle.



Eliminating parallax

This is the relative displacement of the target image with respect to the reticle when the observer's head is moved slightly before the eyepiece. Parallax will introduce reading errors and must be removed before observations are taken. Parallax can be removed by refocusing the reticle.

8. POWER ON

► PROCEDURE

Power on.

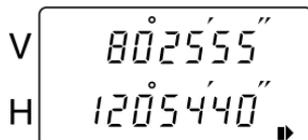
Press **ON**.

When the power is switched on, a self-check is run to make sure the instrument is operating normally.

Remaining battery power is displayed for a few seconds.

 "5. INSTALLING / REMOVING THE BATTERY"

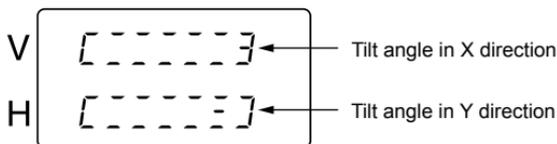
If everything is normal, the display is ready for measurement.



Note

- Out of range message

When the screen below is displayed on DT210/510/510S, the tilt sensor is indicating that the instrument is out of level. Level the instrument once again. When leveling is done on the screen, make sure to use Face 1. Center both " _ " in the bar.



- Set Item No.2 (Tilt correction) to "Off" or "On (V)" if the display is unsteady due to vibration or strong wind.

 "11. CHANGING INSTRUMENT OPTIONS"

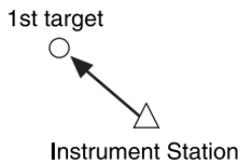
- The ON/OFF power setting may be set so that **ON** by itself can be used to turn the power on and off.

9. MEASUREMENT

9.1 Measuring the horizontal angle between 2 points (H angle 0)

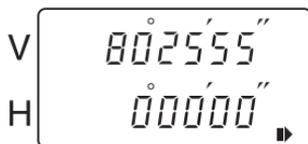
► PROCEDURE

1. Sight the first target as at right.



2. Set the horizontal angle of the first target to 0°.

Press **0 SET** twice. The horizontal angle at the first target becomes 0°.

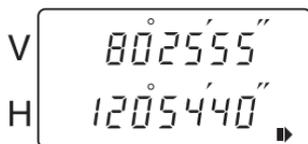


3. Sight the second target.

2nd Target



The displayed horizontal angle is the included angle between two points.



9.2

Set Horizontal Circle to a Required Value (Horizontal angle hold)

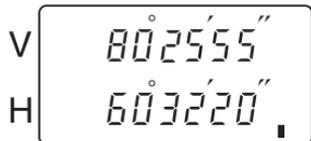
Horizontal angle hold function can be used to set the horizontal angle of the sighting direction to a required angle.

► PROCEDURE Horizontal angle hold

1. Turn the upper part of the instrument and display the horizontal angle you want to set.

2. Hold the displayed angle.

Press  twice. The horizontal angle is in hold status.



3. Set the horizontal angle that is in hold status to the direction you require.

Sight the direction that you want to set the horizontal angle to in step 2, and press  again.

The horizontal angle hold-status is released.

9.3 Changing Horizontal Angle Display Mode

► PROCEDURE Selecting horizontal angle display mode (Right / left)

- 1. Set Item No.5 ( function).**
Set Item No.5 ( function) to "Horizontal angle (Right/left)" in advance.
 "11. CHANGING INSTRUMENT OPTIONS"
- 2. Change the horizontal angle direction on measuring screen.**
Every time  is pressed, horizontal angle right / left is switched.

9.4 Changing Vertical Angle Display Mode

► PROCEDURE Selecting vertical angle display mode (Angle / slope in %)

- 1. Set Item No.5 ( function).**
Set Item No.5 ( function) to "Angle / slope in %" in advance.
 "11. CHANGING INSTRUMENT OPTIONS"
- 2. Change the vertical angle direction on measuring screen.**
Every time  is pressed, vertical angle / slope in % is switched.

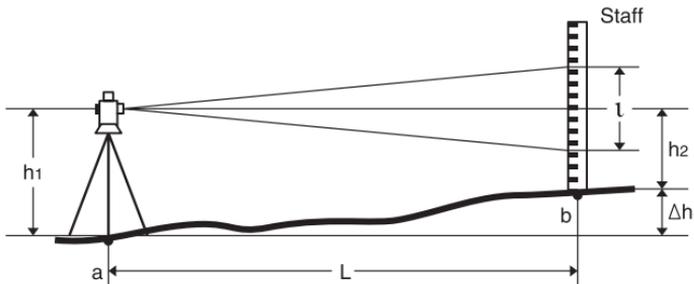
9.5 Stadia Survey

The telescope reticle is provided with stadia lines (two vertical and two horizontal) which can be used to measure the target distance and height difference as follows:

Stadia line separation = $1/100$ of the focal distance.



- When the telescope is horizontal
 Horizontal distance between a and b : $L = 100 \times t$
 Height difference between a and b : $\Delta h = h_1 - h_2$



9. MEASUREMENT

- When the telescope is slanted

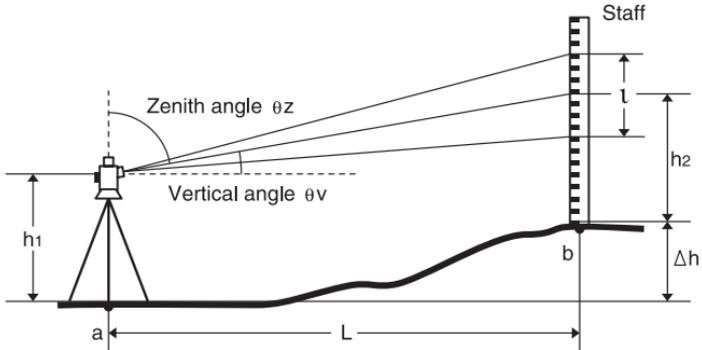
Horizontal distance between a and b : $L = 100 \times t \times \sin^2 \theta_z$, or

$$L = 100 \times t \times \cos^2 \theta_v$$

Height difference between a and b :

$$\Delta h = 50 \times t \times \sin 2\theta_z + h_1 - h_2,$$

$$\text{or } \Delta h = 50 \times t \times \sin 2\theta_v + h_1 - h_2$$



10. DATA OUTPUT

After connecting the data output connector on the DT with a computer, the measurement results can be output.



- Data output and command operation function are not included on DT610/610S.

10.1 Connecting a Computer

Choose the right interface cable for the computer you are connecting.

"14.2 Optional Accessories"



- DT will be in "Active Mode ON," when connected to an external instrument regardless of the setting,

"11. CHANGING INSTRUMENT OPTIONS"

- Data communication

External data collection from the DT uses RS-232C baseband signals.

Synchronization : Asynchronous

Baud rate : 1200 bps

Start bit : 1 bit

Data length : 8 bits

Parity : None

Stop bit : 1 bit

- Data output connector pin assignments

Pin No.	Signal name
1	SG (GND)
2	NC
3	SD (TXD)
4	RD (RXD)
5	NC
6	NC

10.2 Communication Functions Command and Output

- Formats for standard commands

Every time the command below is sent to the DT, a measurement result is output.

00H

- Format of output data

Measurement results are output in the following formats to a computer. "-" means space (20H).

$\frac{0855580}{a}$ - $\frac{1206540}{b}$ - CRLF

a) Horizontal angle

b) Vertical angle

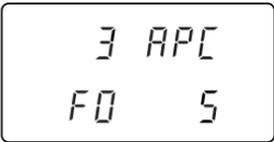
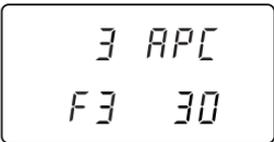
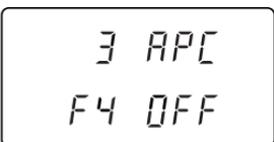
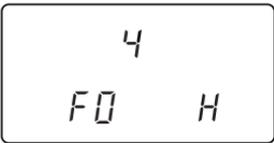
11. CHANGING INSTRUMENT OPTIONS

The following items can be changed to meet your measurement requirements.

- " * ": Factory setting

Item NO.	Parameter	Options	Display
1	Vertical angle display mode <input checked="" type="checkbox"/> " <input type="checkbox"/> Vertical angle display method"	Zenith 0°*	
		Horizontal 0°	
		Horizontal ±90°	
2	Tilt correction (only DT210/510/510S)	On (H, V)*	
		On (V)	
		Off	

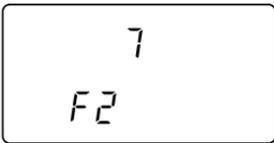
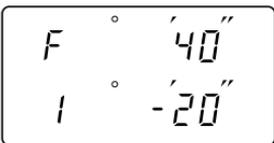
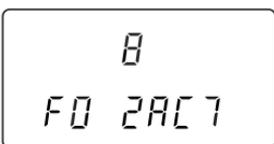
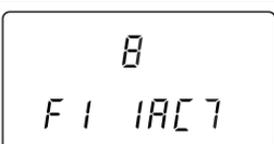
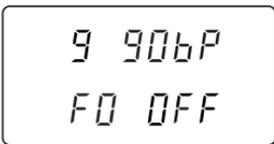
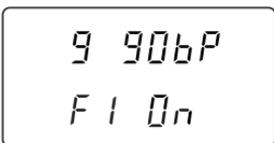
11. CHANGING INSTRUMENT OPTIONS

Item NO.	Parameter	Options	Display
3	Auto power cut-off	The power will automatically shut off 5 minutes after the last operation.	
		The power will automatically shut off 10 minutes after the last operation.	
		The power will automatically shut off 15 minutes after the last operation.*	
		The power will automatically shut off 30 minutes after the last operation.	
		Will not shut off.	
4	Reticle illumination (only DT210/510/510S/510A/510AS)	Bright*	

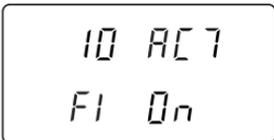
11. CHANGING INSTRUMENT OPTIONS

Item NO.	Parameter	Options	Display
		Dim	
5	function	Horizontal angle (Right/left)*	
		Angle/slope in %	
6	Minimum display	DT210/510/ 510S/510A/ 510AS: 5" DT610/610S: 5"	
		DT210/510/ 510S/510A/ 510AS: 1** DT610/610S: 10"	
7	Unit	Degree*	
		Gon	

11. CHANGING INSTRUMENT OPTIONS

Item NO.	Parameter	Options	Display
		Mil	
#	Instrument constant  "13.3 Tilt Sensor"		
8	Procedures for turning the power OFF	ON +  *	
		ON ON +  (Both methods are possible)	
9	Horizontal angle beeps	Beeps*	
		Does not beep	
10	Active mode	Off*	

11. CHANGING INSTRUMENT OPTIONS

Item NO.	Parameter	Options	Display
		On	

Note

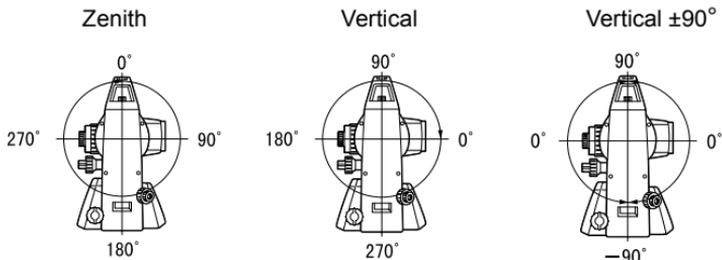
- Unit table

Degree	Gon	Mil
1	0.0002	0.005
5	0.0010	0.025
10	0.0020	0.050

11. CHANGING INSTRUMENT OPTIONS



Vertical angle display method



Horizontal Angle Beeps

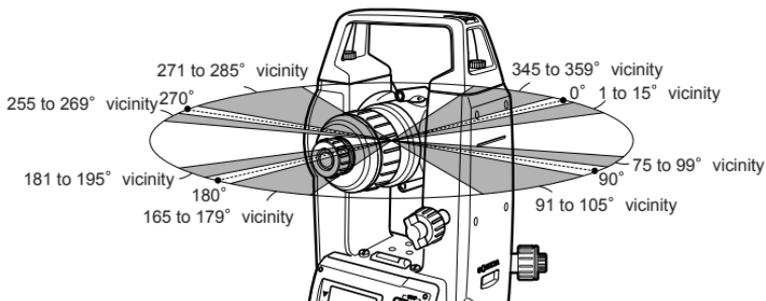
When the setting is set to "Beeps," current horizontal angle values will be announced with beeping.

This is useful when standard horizontal angle positions like 90° or 180° degrees are established from the DT 0 set position.

Beeping will occur in the  positions. So that horizontal angles can be differentiated, rapid and slow beeping alternates in the adjoining positions. Even if the position is beeping, it will stop 3 seconds after the horizontal angles have not been rotated.

The beeping sound can be set to beeps/does not beep by holding down the  as well.

 "4. PARTS OF THE INSTRUMENT"





Active Mode

Active mode is a setting that is concerned with the refreshing of displays and energy consumption.

The angle detector mechanism employs the use of a special absolute encoder, which enables the ON/OFF setting to be selected for active mode.

Active Mode OFF (default setting)

Since the display will refresh itself about every 1.5 seconds when the instrument has not been operated for more than 1 minute, energy consumption will be low. When operations are resumed, the display will switch from refreshing itself every 1.5 seconds to 0.5 seconds.

This is suitable for operations (setting out, alignment, etc.) whereas the instrument is fixed for a set period of time at a set angle.

Active Mode ON

The display is constantly refreshed about every 0.5 seconds. In comparison to Active Mode OFF, energy consumption is somewhat higher.

This is suitable for successive measuring (set collection etc.)

► PROCEDURE

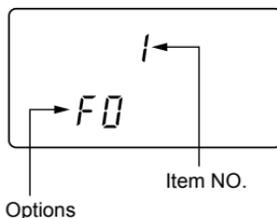
: Repeat steps 1 to 4 for every item setting.

1. Display the Item Screen.

Press and at the same time to display Item screen.

2. Select the item you want to change.

Press until the item you want to change is displayed. Details of the items are explained in the table above.



3. Select Option.

Press until the option you want to select is displayed. Details of the items are explained in the table above.

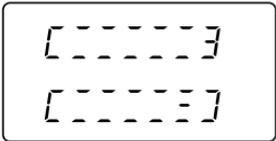
11. CHANGING INSTRUMENT OPTIONS

4. Set the option.

Press  and  at the same time to set the selected option. The measuring screen is restored.

12. ERROR MESSAGES

If there is a fault in the DT, the following messages are displayed.

Display messages	Meaning
---	Either the vertical circle or the horizontal circle is turned too fast to measure the value. After a brief interval the previous display is restored.
 <p>(DT210/510/510S only)</p>	The tilt of the instrument exceeds the tilt angle compensation range during measurement. Level the instrument again.

Note

- Error messages starting with "E" indicate trouble with the instrument. Contact your Sokkia agent.

If an error occurs when measurement results are being output, the following codes are displayed on the computer. (Only DT210/510/510S)

Coded messages	Meaning
E114	Out of tilt compensation range (- direction of Y-axis). Level the instrument again.
E115	Out of tilt compensation range (- direction of X-axis). Level the instrument again.
E116	Out of tilt compensation range (+ direction of Y-axis). Level the instrument again.
E117	Out of tilt compensation range (+ direction of X-axis). Level the instrument again.

13. CHECKS AND ADJUSTMENTS

A DT is a precision instrument that requires fine adjustments. It must be inspected and adjusted before use so that it always performs accurate measurements.

- Always perform checking and adjustment in the proper sequence beginning from "13.1 Plate Level" to "13.5 Optical Plummet".
- In addition, the instrument should be inspected with special care after it has been stored a long time, transported, or when it may have been damaged by a strong shock.

13.1 Plate Level

The bubble tube is made of glass, so it is sensitive to temperature changes or to shock. Check and adjust it as outlined below.

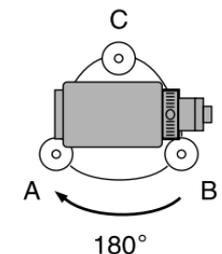
► PROCEDURE Checking and adjusting

1. **Level the instrument and check the position of the bubble in the plate level.**

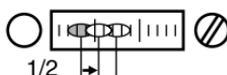
☞ "6.2 Leveling", steps 3 to 5.

2. **Turn the upper part through 180° and check the bubble position.**

If the bubble is still centered, no adjustment is necessary.
If the bubble is off-center, adjust as follows.

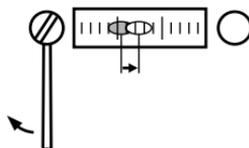


3. **Correct half of the bubble displacement using leveling foot screw C.**



4. **Correct the remaining half of the displacement by using the adjustment pin to rotate the plate level adjustment screw.**

When the plate level adjustment screw is tightened in the clockwise direction, the bubble moves in the right direction.



5. **Rotate the top of the instrument and continue adjustments until the bubble remains centered for any position of the upper part.**

If the bubble does not move to the center even when the adjustment has been repeated, have your Sokkia agent adjust it.

13.2 Circular Level

►PROCEDURE Checking and adjusting

1. **Perform the plate level inspection and adjustment.**

☞ "13.1 Plate Level"

2. **Check the position of the bubble in the circular level.**

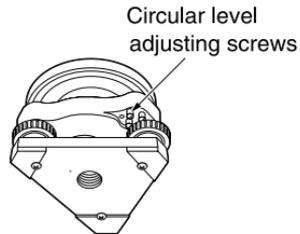
☞ "6.2 Leveling" step 1 to 2.

If the bubble is not off-center, no adjustment is necessary.

If the bubble is off-center, perform the following adjustment.

3. **First confirm the off-center direction.**

Use the adjusting pin to loosen the circular level adjustment screw on the side opposite to the direction the bubble is displaced to move the bubble to the center.



4. **Adjust the adjusting screws until the tightening tension of the three screws is the same to align the bubble in the middle of the circle.**

13. CHECKS AND ADJUSTMENTS



- Be careful that the tightening tension is identical for all the adjusting screws.
Also, do not over-tighten the adjusting screws as this may damage the circular level.

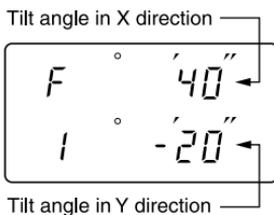
13.3 Tilt Sensor

If the tilt angle shown on the display shifts from tilt angle 0 (zero point), the instrument is not correctly levelled. This will adversely affect angle measurement. Perform the following procedure to cancel the tilt zero point error.

- Only DT210/510/510S include a tilt sensor function. Set Item NO.2 (Tilt corection) to "On (H, V)" or "On (V)" beforehand.
 "11. CHANGING INSTRUMENT OPTIONS"

► PROCEDURE Check

1. **Carefully level the instrument. If necessary, repeat the procedures to check and adjust the bubble levels.**
2. **In the Item display, select Item No.# (Instrument constant).**
Press  and  at the same time, to display the Item screen, and select Item No.# (Instrument constant).
Current correction constant is displayed.
3. **Accurately sight a clear target in face left.**
4. **Wait a few seconds for the display to stabilize, then read the automatically compensated angles X1 and Y1.**



5. **Rotate the top of the instrument through 180° and sight the same object in face right.**
Loosen the horizontal clamp and turn the instrument 180°, sight the object, then retighten the clamp.
6. **Wait a few seconds for the display to stabilize, then read the automatically compensated angles X2 and Y2.**

7. **In this state, calculate the following offset values (tilt zero point error).**

$$X \text{ offset} = (X1 + X2)/2$$

$$Y \text{ offset} = (Y1 + Y2)/2$$

If one of the offset values (X offset, Y offset) exceeds $\pm 20''$, adjust the value using the following procedure.

When the offset value falls within the range $\pm 20''$, adjustment is not necessary. Press  and  at the same time to return to the measuring screen.

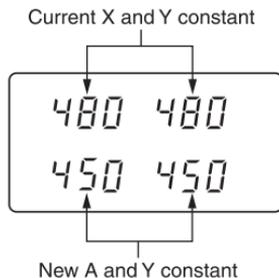
►PROCEDURE Adjustment

8. **Store values X2 and Y2.**
Press  to store the values.
9. **Rotate the top of the instrument through 180° and sight the same object accurately.**

13. CHECKS AND ADJUSTMENTS

10. Wait a few seconds for the display to stabilize, then store values X1 and Y1.

Press  to store the values. The new correction constant is displayed.



11. Confirm that the values are in the adjustment range.

If both correction angles are within the range 488 ± 36 , press  to renew the correction angle. Go to step 12.

If the value exceeds the adjustment range, stop the adjustment and contact your Sokkia agent to perform the adjustment.

► PROCEDURE Recheck

12. In the Item display, select Item No.# (Instrument constant) again.
13. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X3 and Y3.
14. Rotate the top of the instrument through 180° and sight the same object in face right.
15. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X4 and Y4.

16. In this state, calculate the following offset values (tilt zero point error).

$$X \text{ offset} = (X3 + X4)/2$$

$$Y \text{ offset} = (Y3 + Y4)/2$$

When the offset value falls within the range $\pm 20''$, adjustment is completed. Press  and  at the same time to return to the measuring screen.

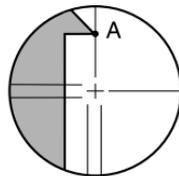
If one of the offset values (X offset, Y offset) exceeds $\pm 20''$, repeat the check and adjustment procedure from the beginning.

If the difference continues to exceed $\pm 20''$ after repeating the check 2 or 3 times, have your Sokkia agent perform the adjustment.

13.4 Reticle

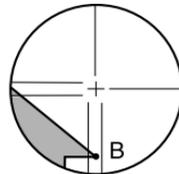
► PROCEDURE Check 1: Perpendicularity of the reticle to the horizontal axis

1. Carefully level the instrument.
2. Align a clearly visible target (the edge of a roof for example) on point A of the reticle line.



3. Use the telescope fine motion screw to align the target to point B on the vertical line.

If the target moves parallel to the vertical line, adjustment is unnecessary. If its movement deviates from the vertical line, have your Sokkia agent adjust it.



13. CHECKS AND ADJUSTMENTS

►PROCEDURE Check 2: Vertical and horizontal reticle line positions



- Perform the check procedure under slightly hazy and weakly scintillating conditions.

1. **Install a target at a point about 100 m in the horizontal direction from the DT.**



2. **Level the instrument carefully, turn on the instrument's power and index the vertical and horizontal circles.**

3. **While the Meas mode screen is displayed and the telescope is in face left, sight the center of the target and read out the horizontal angle A1 and the vertical angle B1.**

Example:

Horizontal angle $A1=18^{\circ}34' 00''$

Vertical angle $B1=90^{\circ}30' 20''$

4. **While the telescope is in face right, sight the center of the target and read out the horizontal angle A2 and the vertical angle B2.**

Example:

Horizontal angle $A2=198^{\circ}34' 20''$

Vertical angle $B2=269^{\circ}30' 00''$

5. Do the calculations:

A2-A1 and B2+B1

If A2-A1 is within $180^{\circ} \pm 20''$ and B2 + B1 is within $360^{\circ} \pm 40''$, adjustment is unnecessary.

Example: A2-A1 (Horizontal angle)

$$= 198^{\circ} 34' 20'' - 18^{\circ} 34' 00''$$

$$= 180^{\circ} 00' 20''$$

B2 + B1 (Vertical angle)

$$= 269^{\circ} 30' 00'' + 90^{\circ} 30' 20''$$

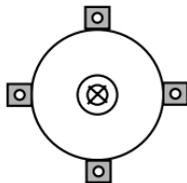
$$= 360^{\circ} 00' 20''$$

If the difference is large even after repeating the check 2 or 3 times, have your Sokkia agent perform the adjustment.

13.5 Optical Plummet

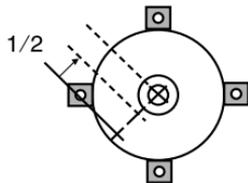
► PROCEDURE Checking

1. Carefully level the DT and center a surveying point precisely in the reticle of the optical plummet.
2. Turn the upper part through 180° and check the position of the surveying point in the reticle.
If the surveying point is still centered, no adjustment is necessary.
If the surveying point is no longer centered in the optical plummet, perform the following adjustment.

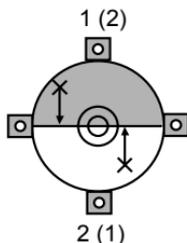


► PROCEDURE Adjustment

3. Correct half the deviation with the leveling foot screw.
4. Remove the optical plummet reticle cover.
5. Use the 4 adjusting screws of the optical plummet to adjust the remaining half of the deviation as shown below.

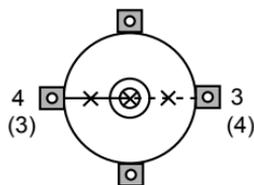


When the surveying point is on the upper or lower part of the illustration: Loosen the upper (lower) adjusting screw slightly, and tighten the lower (upper) adjusting screw the same amount to move the surveying point to a point directly under the center of the optical plummet.
(It will move to the line in the figure on the right.)



If the surveying point is on the solid line (dotted line):

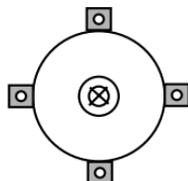
Loosen the right (left) adjusting screw slightly and, tighten the left (right) adjusting screw by the same amount to move the surveying point to a point in the center of the optical plummet.



- Be extremely careful to adjust all the adjustment screws by the same amount so that none will be over-tightened.

6. Check to make sure that the surveying point remains centered on the reticle even if the upper part of the instrument is rotated.

If necessary, perform the adjustment again.

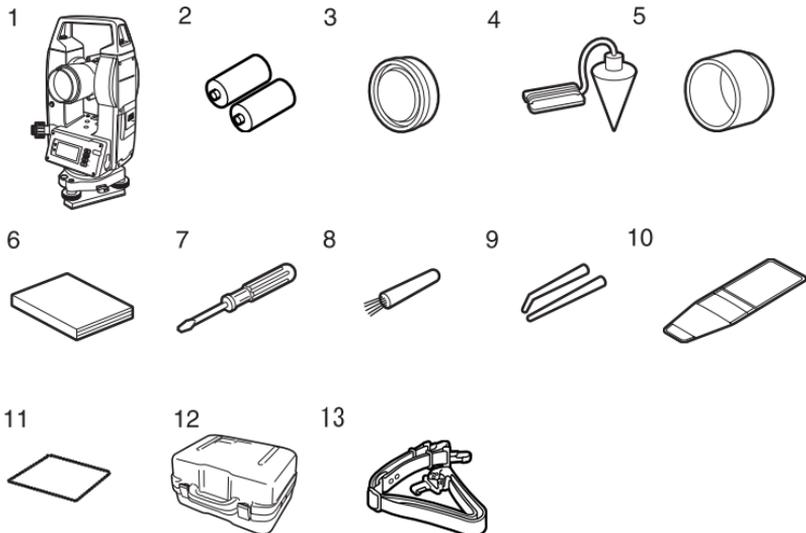


7. Replace the optical plummet reticle cover.

14. STANDARD EQUIPMENT AND OPTIONAL ACCESSORIES

14.1 Standard Equipment

Please verify that all equipment is included.

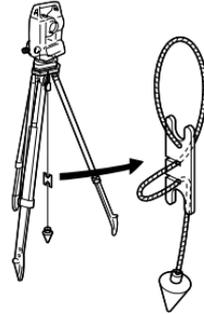


1	DT main unit	1	8	Lens brush	1
2	LR14/C alkaline battery	2	9	Adjusting pin	2
3	Lens cap	1	10	Tool pouch	1
4	Plumb bob	1	11	Cleaning cloth	1
5	Lens hood	1	12	Carrying case (SC196)	1
6	Operator's manual	1	13	Carrying straps	1
7	Screwdriver	1			

14. STANDARD EQUIPMENT AND OPTIONAL ACCESSORIES

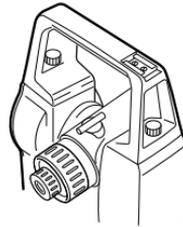
● Plumb bob

The plumb bob can be used to set up and center the instrument on days when there is little wind. To use the plumb bob, unwind its cord, pass it through the cord grip piece as shown in the figure to adjust its length, then suspend it from the hook attached to the centering screw.



● Handle

The carrying handle can be removed from the instrument. To remove it, loosen the handle securing screw.

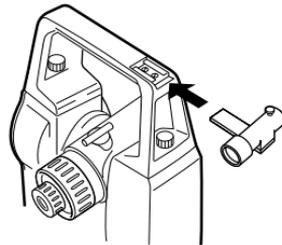


14.2 Optional Accessories

The following are optional accessories which are sold separately from the DT.

● Tubular compass (CP7)

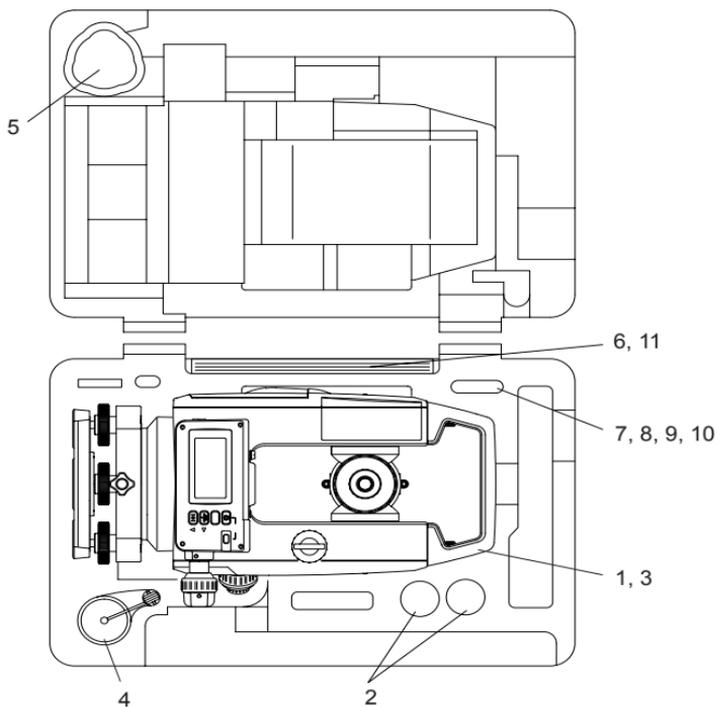
Slide the tubular compass into the tubular compass slot, loosen the clamp screw, then rotate the top part of the instrument until the compass needle bisects the index lines. The telescope's face left sighting direction in this position will indicate magnetic north. After use, tighten the clamp and remove the compass from the slot.



- The tubular compass is susceptible to the influence of nearby magnets or metal. Such influence could cause it to fail to accurately indicate magnetic north. Do not use magnetic north as indicated by this compass for base line surveying.

14.3 Layout Plan

The following numbers indicate the equipment listed in "14.1 Standard Equipment"



15. APPENDICES

15.1 Battery Selection

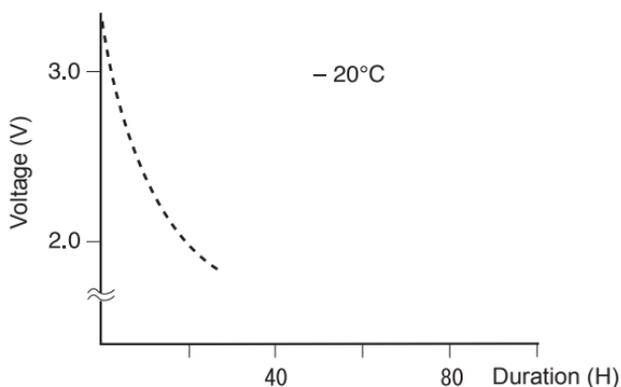
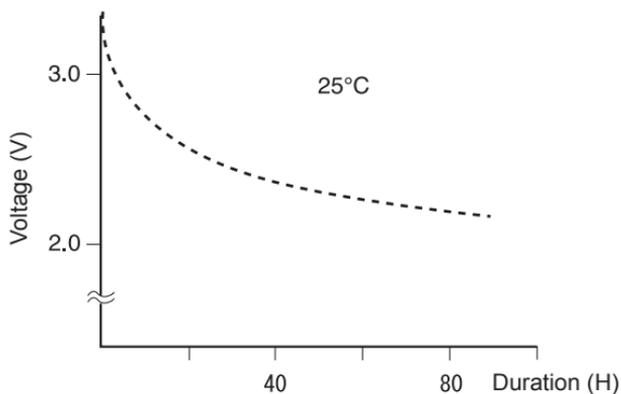
Use alkaline batteries.

However since their usage time is shortened when they are used in places with low temperatures, Ni-Cd batteries are recommended.



- If batteries other than alkaline batteries are used, the battery reserve display and the 'Low' warning will not function properly.

Electrical discharge of alkaline batteries (Active Mode OFF - default setting)



16. SPECIFICATIONS

Except where stated, the following specifications apply to all DTs.

Telescope

Length:	DT210/510/510S/510A/510AS:	165 mm
	DT610/610S:	160 mm
Aperture:	DT210/510/510S/510A/510AS:	45 mm
	DT610/610S:	35 mm
Magnification:	DT210/510/510S/510A/510AS:	30X
	DT610/610S:	26X
Image:	Erect	
Resolving power:	DT210/510/510S/510A/510AS:	3"
	DT610/610S:	3.5"
Field of view:	1°30'	
Minimum focus:	0.9 m	
Reticle illumination:	Bright or dim (Selectable with parameter) (only DT210/510/510S/510A/510AS)	
Stadia ratio:	1:100	
Additive constant:	0	

Angle measurement

Horizontal and Vertical circles type:	Rotary absolute encoder	
Minimum display:	DT210/510/510S/510A/510AS:	1" (0.2mg/0.005 mil)/5" (1 mg/0.02 mil)
	DT610/610S:	10" (2 mg/0.05 mil)/5" (1 mg/0.02 mil)
	(Selectable with parameter)	
Accuracy:	DT210:	2"
	DT510/510S/510A/510AS:	5"
	DT610/610S:	7"
	(ISO 12857-2: 1997)	
Measuring time:	(Active Mode ON)	
	Every 0.5 sec	
	(Active Mode OFF)	
	Non-operation:	Every 1.5 sec
	Operation:	Less than 0.5 sec
Automatic compensator:	On (V & H/V) / Off (Selectable with parameter) (only DT210/510/510S)	
Type:	Liquid 2-axis tilt sensor	
Minimum display:	Agrees with minimum displayed measurement angle	
Range:	±3'	
Measuring mode:		
Horizontal angle:	Right/Left (Selectable with parameter)	

16. SPECIFICATIONS

Vertical angle: Zenith, Vertical, Vertical \pm 90°(Selectable with parameter)
% (Selectable with parameter)

Power Supply

Power source: Battery type: LR14 / C X 2
Working duration : (alkaline batteries used at 25°C)
(Active Mode ON)
DT210/510/510S :about 48 hours
DT510A/510AS/610/610S:about 62 hours
(Active Mode OFF)
Uninterrupted cycles of 5 minutes of operation and 10 minutes of non-operation)
DT210/510/510S :about 75 hours
DT510A/510AS/610/610S:about 110 hours

General

Display: LCD (2 rows: 8-digits each) display with illumination
DT210/510/510S:1 LCD graphic display on each face
DT510A/510AS/610/610S:
1 LCD graphic display

Auto power-off: On (instrument powers off if not used for 5 min./10 min./15 min./30 min.)/Off (selectable with parameter)

Data output: asynchronous serial, RS232C

Sensitivity of levels: Plate level: DT210: 20"/2 mm
DT510/510S/510A/510AS:40"/2 mm
DT610/610S: 60"/2 mm
Circular level: 10"/2 mm

Optical plummet Image: Erect
Magnification: 3X
Minimum focus: 0.3 m (from base plate)

Operating temperature: -20 to 50°C
Storage temperature: -30 to 70°C
Dust and water resistance: IP66
Instrument height: 236 mm
Size: 165 (W) X 165 (D) X 341 (H) mm (with handle)
Weight: DT210/510: 4.7 kg (10.3 lb)
DT510S: 4.8 kg (10.51 lb)
DT510A: 4.5 kg (9.9 lb)
DT510AS/610S: 4.6 kg (10.2 lb)
DT610: 4.2 kg (9.3 lb)

17. REGULATIONS

Radio Frequency Interference

WARNING: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Notice for Canada

This Class A digital apparatus meets all requirements of Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Class A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

17. REGULATIONS

CE Conformity Declaration

CE Conformity Declaration

in accordance with EMC Directive 89/336/EEC of the European Community

We herewith declare that the undermentioned instrument, in view of its design and type of construction, fully complies with the relevant basic radio interference requirements of the EMC Directive.

Should the instrument be modified without agreement, this declaration becomes invalid.

Instrument Description: Digital Theodolite (Surveying Instruments)

Model Name : DT210,DT510,DT510S,DT510A,DT510AS,DT610,DT610S

Relevant EC Directive: EMC Directive (89/336/EEC)
Version: 92/31/EEC, 93/68/EEC

Applied

Harmonized Standard:	EMI	EN55022	1994+A1:1995+A2:1997
		EN55022	1998+A1:2000
	EMS	EN61000-6-2	1999
		EN61000-6-2	2001

Date: 13-06-2003

Firm: SOKKIA B.V.

Address: Industrieterrein De Vaart, Damsluisweg 1, NL-1332 EA Almere

Representative's Signature: _____

Name of Representative : Jan van der Weijden

Representative's position : Managing Director

SOKKIA Customer Service

SOKKIA CO.,LTD.

<http://www.sokkia.co.jp/english/>

INTERNATIONAL SALES DEPT.

260-63, HASE, ATSUGI, KANAGAWA, 243-0036

PHONE +81-46-248-7984 FAX +81-46-247-1731

SOKKIA CO.,LTD.

<http://www.sokkia.co.jp/english/>

260-63 HASE, ATSUGI, KANAGAWA, 243-0036 JAPAN
PHONE +81-46-248-0068 FAX +81-46-247-6866

3rd ed. 04-0406 Printed in Japan

©2003 SOKKIA CO., LTD.