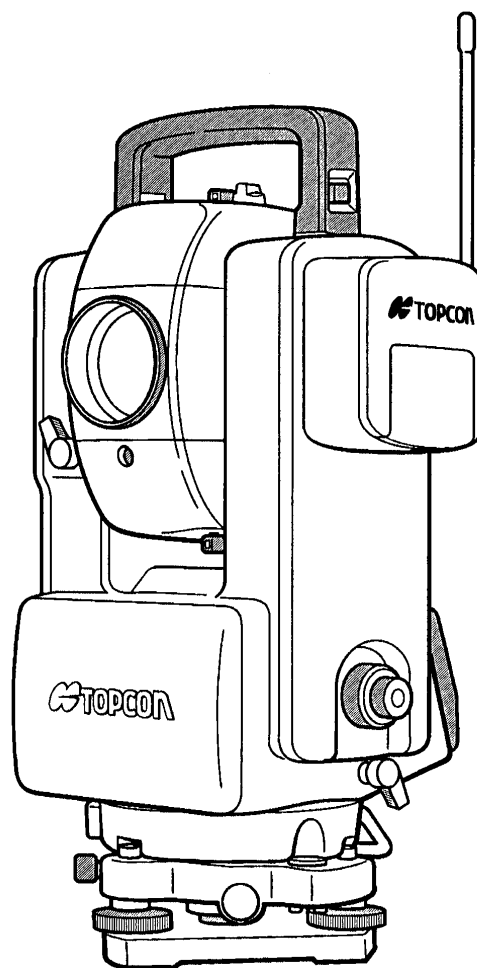


AUTOMATIC TRACKING TOTAL STATION**AP-L1A
AP-L1AN**

Foreword

Thank you for purchasing the TOPCON Automatic Tracking Total Station, AP-L1A series. For the best performance of the instruments, please carefully read these instructions and keep them in a convenient location for future reference.

General Handling Precautions

Prism constant value

Input the offset compensation value according to the prism constant value to be used. Precaution is needed when using Pin-pole prism set L1 type, Pin-pole prism holder L1 type, Prism unit A2 type, or a prism other than Topcon's. Each prism constant value is potentially different.

Please refer to Chapter 10 "Setting the prism constant value".

On tripod

When mounting the instrument on the tripod, use a wooden tripod when possible. If you use a metallic tripod, vibration may occur or measuring precision may be effected. Screws on each leg of the tripod must be tightened firmly.

On tribrach

If tribrach is not installed correctly, measuring precision may be effected. Occasionally check adjusting screws of the tribrach. Lock the base fixing lever, and tighten the Base Fixing Screw.

Guarding the instrument against shocks

When transporting the instrument, provide some protection to minimize risk of shocks. Heavy shocks may cause the measurement to be faulty.

Carrying the instrument

When carrying the instrument at the site, always grip its handgrip.

Do not expose the instrument directly to the sunlight

Never leave the instrument in extreme heat (+122 degrees F) longer than necessary. It could adversely affect its performance. Never expose the instrument's objective lens to direct sunlight without a filter. It may damage the components inside the instrument.

Sudden changes of temperature

Any sudden change of temperature to the instrument or prism may result in a reduction of measuring distance range, i.e when taking the instrument out from a heated vehicle. Let instrument acclimate itself to ambient temperature.

Rotating the instrument and telescope

When rotating instrument or telescope manually use telescope rotating free lever or horizontal free lever. Rotation of the instrument or telescope is driven electrically in normal operation.

Storage in the case

Keep the telescope horizontally and turn the instrument to align its mark with the lower base mark (Storage mark) . Remove the antenna of Wireless modem (or keep the antenna down for folding, type antenna), then store it in the case. Keep its objective lens side downward. Storing it in the case in any other way may cause damage. Hold upper and lower hand grips with both hands, when taking the instrument out of the case, or putting the equipment in the case.

Battery level check

Confirm battery level remaining before operating.

Memory back up



The instrument has a built in battery for memory back up. If the battery power is low, "E" will display. If the battery power is too low to back up the memory, error code "E98" will display. Contact your dealer, to replace the back up battery.

Maintenance for driving parts.

Every 4,000~5,000 hours operation in total, change grease of driving parts.
Contact your dealer or TOPCON Head Office for the maintenance.


Display for Safe Use


In order to encourage the safe use of products and prevent any danger to the operator and others or damage to properties, important warnings are put on the products and inserted in the instruction manuals. We suggest that everyone understand the meaning of the following displays and icons before reading the "Safety Cautions" and text.

Display	Meaning
 WARNING	Ignoring or disregard of this display may lead to the danger of death or serious injury.
 CAUTION	Ignoring or disregard of this display may lead to personal injury or physical damage.

- Injury refers to hurt, burn, electric shock, etc.
- Physical damage refers to extensive damage to buildings or equipments and furniture.

Safety Cautions

 WARNING
<ul style="list-style-type: none"> ● Aiming the instrument directly into the sun can result in serious damage to your eye. Do not aim the instrument directly into the sun. ● There is a danger that may cause eye injury on blindness. <ol style="list-style-type: none"> 1) Never look at the laser beam directly. 2) Disassemble, reconstruct, or repair of the instrument is only to be performed by Topcon or its authorized dealer. ● AP-L1A/L1AN is not explosion proof. Avoid using in an area that produces explosive gases.

 CAUTION
<ul style="list-style-type: none"> ● There is a risk of leakage and electric shock if you take out or insert the power plug or cable with wet hands. Avoid when hands are wet. ● There is a risk of hurt if you pinch fingers between telescope and body of instrument or telescope and hand grip during automatic rotation. Do not place fingers near telescope during automatic rotation. ● There is a risk of hurt if the unit come down by less tighten condition of tripod screw. Tight firmly when you are going to set up the unit to the tripod. ● There is a risk of hurt by overturn the carrying case. Do not ride on the carrying case.

The user of this product is expected to follow all operating instructions and make periodic checks of the product's performance. The manufacturer or its representatives assumes no responsibility for results of misuse including any direct, indirect, consequential damage, and loss of profits.

Laser Safety

Safety Information

AP-L1A/AP-L1AN uses the visible laser beam to track automatically. The AP-L1A/L1AN products are manufactured and sold in accordance with "Radiation Safety of Laser Products, Equipment Classification, Requirements and User's Guide" (IEC Publication 825) or "Performance Standards for Light-Emitting Products" (FDA/BRH 21 CFR 1040) provided on the safety standards for laser beam.

As per the said standards, AP-L1A/L1AN is classified as "Class 2 (CLASS II) Laser Products".

The laser beam belongs not very dangerous type but we request you to keep and understand Safety standard for users" as mentioned in the manual instruction.

In case of any failure, do not disassemble the instrument. Contact TOPCON or your TOPCON dealer.

Caution

- Use of controls or adjustments or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.
- In auto-tracking mode, the laser beam emits from the center of the objective lens.
Do not stare into the objective lens or do not aim at the other people's eyes in the auto-tracking mode.

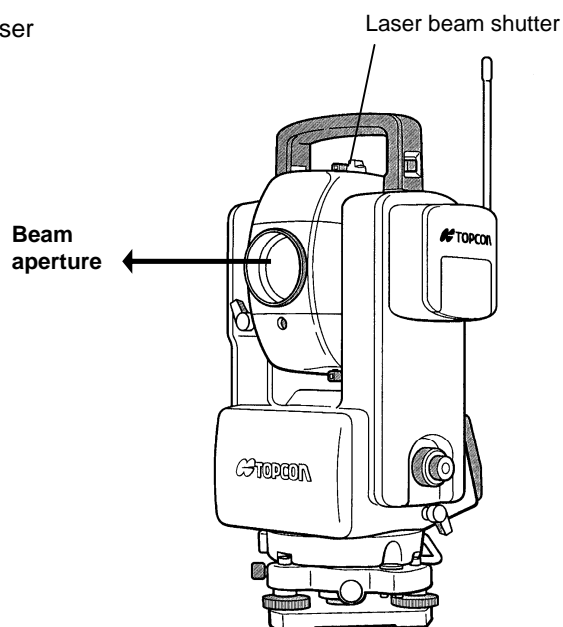
Laser beam shutter

The laser beam shutter permits interrupting the laser beam.

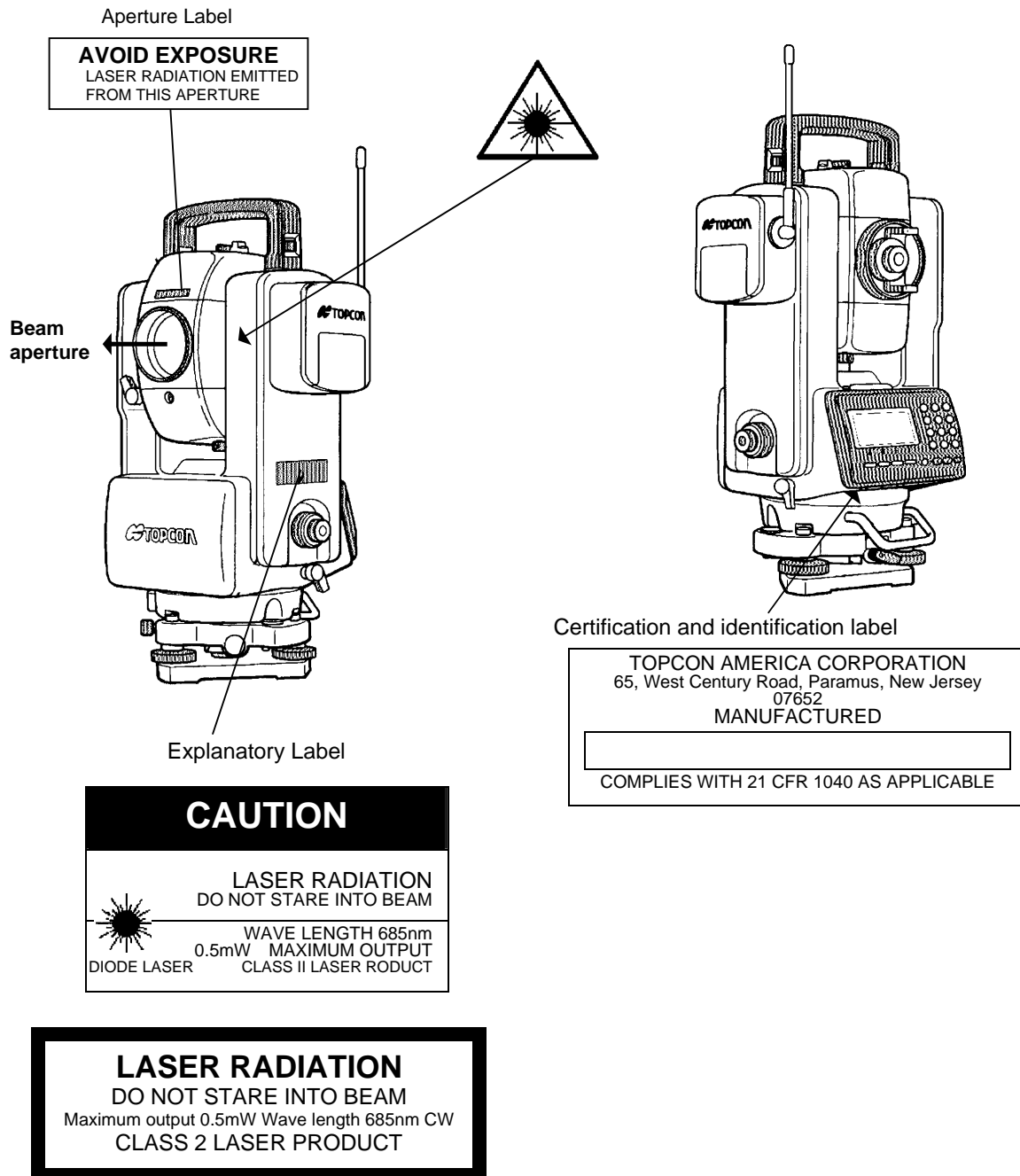
The beam mark of the laser beam shutter

 : Emitting the laser

 : Interrupting the laser



Labels



* Each label is differed by the market.

CONTENTS

General Handling Precautions	1
Display for Safe Use	3
Safety Cautions	3
Laser Safety	4
Standard Set composition	10
 1. NOMENCLATURE AND FUNCTIONS	1-1
1.1 Nomenclature	1-1
1.2 Display Marks	1-3
1.3 Operating Key	1-4
1.4 Function Key (Soft Key)	1-5
1.5 Connection with Computer	1-7
1.6 Installing Wireless Terminal WT-1A/1B & Data Terminal FS/2 (Optional Accessories)	1-8
1.6.1 Setting Wireless Modem (AP-L1A only)	1-8
1.6.2 Setting Place of AP-L1A and Wireless Terminal WT-1A/1B	1-9
1.7 Data Output	1-9
1.8 Rotating Method of AP-L1A	1-10
1.8.1 Rotating of AP-L1A by H/V Shuttle and H/V Jog	1-10
1.8.2 Using Software Key to Rotate AP-L1A	1-10
1.8.3 Auto Inversion Key	1-11
1.8.4 Telescope Rotating Free Lever and Horizontal Rotating Free Lever	1-11
○ Attaching Precaution Label	1-11
 2. PREPARATION FOR MEASUREMENT	2-1
2.1 Setting instrument up for measurement	2-1
2.2 Connecting Power Supply	2-1
2.3 POWER Switch Key ON	2-3
2.4 Battery Power Remaining Display	2-4
2.5 Vertical and Horizontal Angle Tilt Correction	2-5
2.6 The Lay Position of Multiple Prisms	2-7
2.7 Inclination of Prism and Measuring Error	2-7
 3. AUTOMATIC TRACKING MODE	3-1
 4. ANGLE MEASUREMENT	4-1
4.1 Measuring Horizontal Angle Right and Vertical Angle	4-1
4.2 Switching Horizontal Angle Right/Left	4-2
4.3 Measuring from the Required Horizontal Angle	4-3
4.4 Rotating automatically to a required Horizontal and Vertical angle	4-4

5. DISTANCE MEASUREMENT	5-1
5.1 Setting of the Atmospheric Correction	5-1
5.2 Setting of the Correction for Prism Constant	5-1
5.3 Distance Measurement (Continuous Measurement)	5-1
5.4 Fine Mode and Coarse Mode	5-2
 6. COORDINATE MEASUREMENT	 6-1
6.1 Setting a Direction Angle for Horizontal Orientation	6-1
6.2 Setting Coordinate of Instrument Point	6-2
6.2.1 How to Input Instrument Coordinate Value Directly	6-2
6.2.2 Resection Method	6-4
● Auto Collimating method	6-4
● Manual Operation	6-8
6.3 Setting Height of Target (Prism Height)	6-12
6.4 Execution of Coordinate Measuring	6-13
 7. APPLICATION FUNCTIONS	 7-1
7.1 How to Cancel Error of Automatic Tracking Optical Axis	7-1
● One Set of Inverted Observation	7-1
7.2 Area Setting	7-2
7.2.1 Setting Area	7-3
7.2.2 Area Set Function ON, and Set Effective Area No.	7-6
7.3 Setting Tracking Parameter	7-7
7.3.1 Setting Tracking Speed	7-7
7.3.2 Setting of Tracking Detecting Sensitivity	7-7
7.3.3 Setting Scanning Range	7-8
7.3.4 Search Range	7-9
7.3.5 Search Patterns	7-9
7.4 Tracking Indicator	7-10
7.5 Available Time Data Function	7-11
7.6 Setting AP-L1A Wireless Modem	7-12
7.6.1 Setting Wireless Communication Channels	7-12
● How to Select the Communication Channels	7-12
● How to Set the Communication Channels	7-13
7.7 Secret Mode	7-14
7.8 Remote Mode	7-16
7.8.1 How to Switch Remote Mode	7-16
7.8.2 How to Switch Remote Mode to Normal Mode (Manual mode)	7-16

8. APPLICATION MEASUREMENT	8-1
8.1 One Person Surveying and Stake Out	8-1
8.2 Teach Measurement (Fixed Point Observation.)	8-3
8.2.1 Setting and deleting control points for Teach Measuring	8-3
8.2.2 Setting Teach Measurement Parameters	8-5
8.2.3 Execution of Teach Measuring	8-6
9. SET AUDIO MODE	9-1
10. SETTING THE PRISM CONSTANT VALUE	10-1
11. SETTING ATMOSPHERIC CORRECTION	11-1
11.1 Calculation of Atmospheric Correction	11-1
11.2 Setting of Atmospheric Correction Value	11-1
12. CORRECTION FOR REFRACTION AND EARTH CURVATURE	12-1
12.1 Distance Calculation Formula	12-1
13. POWER SOURCE AND CHARGING	13-1
13.1 External Battery (Mark Light Battery)	13-1
14. DETACH/ATTACH OF TRIBRACH	14-1
15. SPECIAL MODE (MENU KEY OPERATION)	15-1
15.1 PARAMETERS	15-2
15.1.1 TRK : Setting for Tracking functions	15-2
15.1.2 MEAS : Setting Measurement	15-4
15.1.3 COM : Setting communication	15-5
15.2 PROGRAMS	15-7
15.2.1 TEACH: Setting functions of Teach Measurement	15-7
15.2.2 AREA SET: Setting Area Range	15-9
15.3 REMOTE	15-9
15.3.1 REMOTE : Remote mode (Wireless communication mode)	15-9
15.4 Setting Special Mode	15-10
16. SELECTING MODE	16-1
16.1 Items of the Selecting Mode	16-1
16.2 How to Set Selecting Mode	16-2

17. CHECK AND ADJUSTMENT	17-1
17.1 Checking Accuracy of the Distance Measurement	17-1
17.2 Checking the Optical Axis	17-2
17.3 Checking/Adjusting the Theodolite Functions	17-4
17.3.1 Checking /Adjusting the Plate Level	17-5
17.3.2 Checking /Adjusting the Circular Level	17-5
17.3.3 Adjustment of the Vertical Cross-hair	17-6
17.3.4 Collimation of the Instrument	17-7
17.3.5 Checking / Adjusting the Optical Plummet Telescope	17-8
17.3.6 Adjustment of Vertical Angle 0 Datum	17-9
17.4 How to Set the Instrument Constant Value	17-10
17.5 Inspection and Adjustment of Optic Axis for Auto -Tracking	17-11
1) Auto Adjustment Procedure	17-11
2) Manual Adjustment Procedure	17-13
18. PRISM SYSTEM	18-1
19. SPECIAL ACCESSORIES	19-1
20. STORAGE PRECAUTIONS	20-1
21. ERROR DISPLAYS	21-1
22. SPECIFICATIONS	22-1

STANDARD SET COMPOSITION

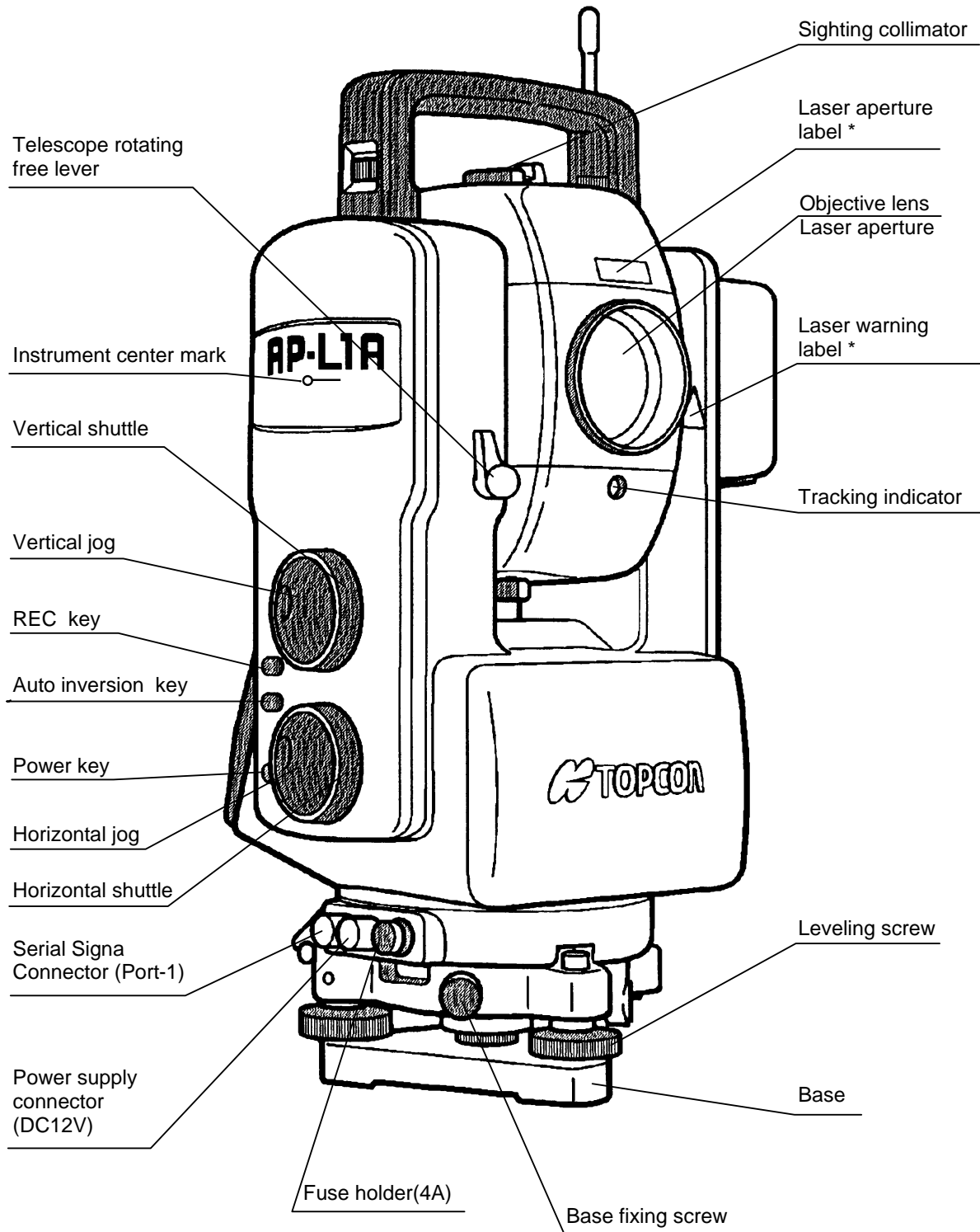
①	AP-L1A or AP-L1AN (with lens cap)	1 pc.
②	Cable PC-11	1 pc.
③	Tool kit case	1 pc.
④	Plastic rain cover	1set
⑤	Plumb bob set	1pc.
⑥	Carrying case	1pc.
⑦	Instruction manual	1vol.
⑧	Field chart	1vol.
⑨	Precaution label	1set

* The plumb bob hook, rod pins, screwdrivers, cleaning brush, fuse(4A) and silicone cloth are contained in the tool kit case.

* Make sure that all of the above items are with the instrument when purchased.

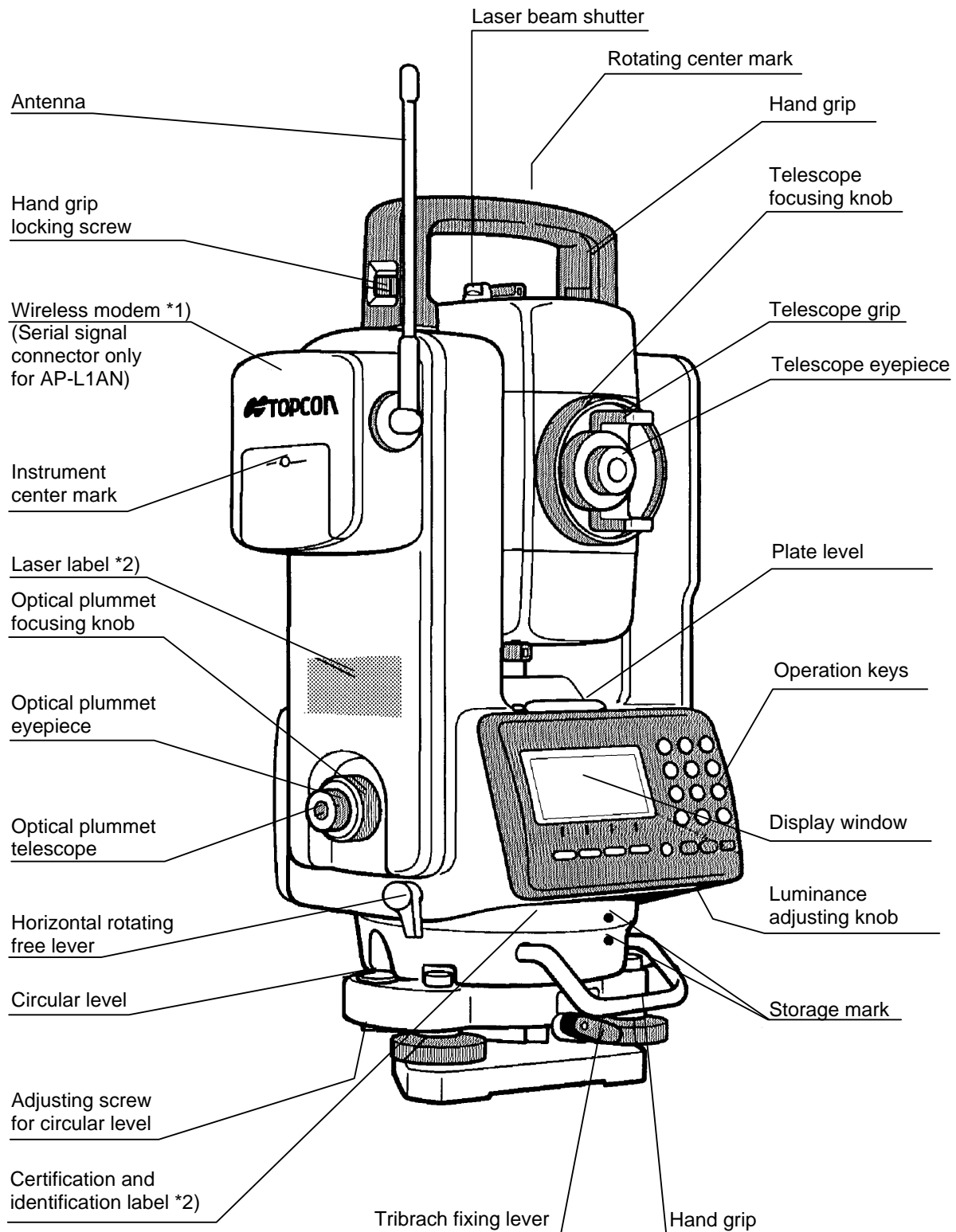
1. NOMENCLATURE AND FUNCTIONS

1.1 Nomenclature



* Laser aperture label and laser warning label are supplied for certain markets.

1. NOMENCLATURE AND FUNCTIONS



*1) Wireless Modem will be differed by the market.

*2) The details of label will be differed by the market.

1.2 Display Marks

- **Display**

The Display uses a dot matrix LCD which has 4 lines and 16 characters per line. In general, the upper three lines display measured data, and the bottom line displays the soft key function which changes with the measuring mode.

- **Luminance adjusting knob**

The luminance of display window is adjusted by turning "Luminance adjusting knob".

- **Heater (Automatic)**

The built-in automatic heater functions when the temperature is below 0 °C. This keeps the display's speed up at temperatures lower than 0 degrees C.

- **Example:**

V	:	90° 10' 20"
HR	:	120° 30' 40"
0SET	HSET	R/L 1↓

Angle measurement mode

V-angle : 90° 10' 20"
H-angle : 120° 30' 40"

HR	:	120° 30' 40"
HD *	:	65.4321 m
VD	:	12.3456 m
0SET	HSET	R/L 1↓

Distance measurement mode

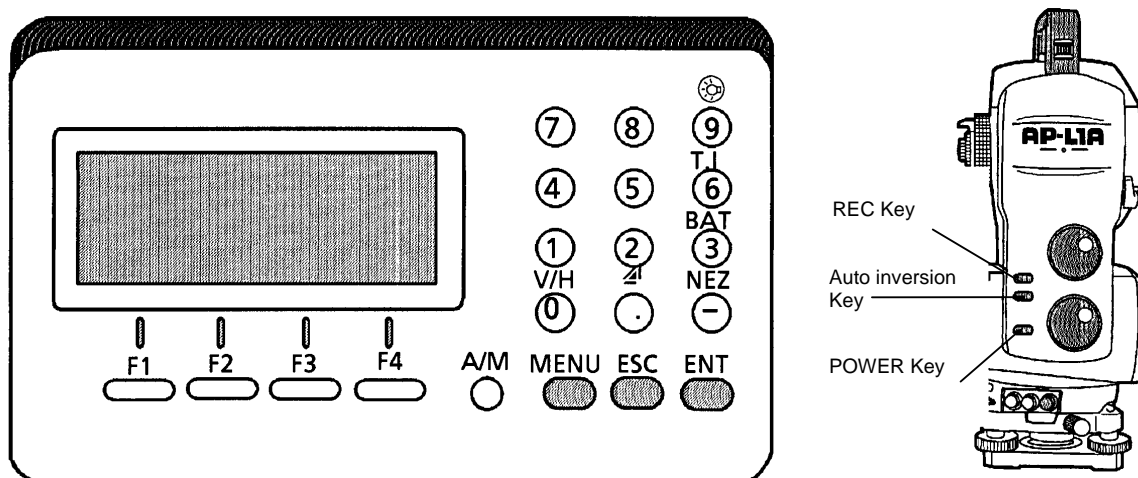
Horizontal-angle : 120° 30' 40"
Horizontal distance : 65.4321m
Relative elevation : 12.3456m

V	:	90° 10' 20"
HR	:	120 ° 30' 40"
0SET	HSET	R/L * ↓. Auto Tracking
0SET	HSET	R/L ! ↓ Waiting
0SET	HSET	R/L ? ↓ Searching

- **Display mark**

Display	Contents	Display	Contents
V	V-angle	*	EDM working
HR	H-angle right	m	Meter in unit
HL	H-angle left	f	Feet in unit
HD	Horizontal distance	*	Auto tracking
VD	Relative elevation	!	Waiting
SD	Slope distance	?	Searching
N	N coordinate		
E	E coordinate		
Z	Z coordinate		

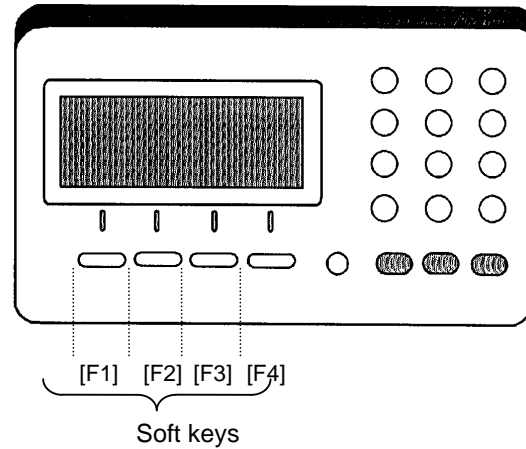
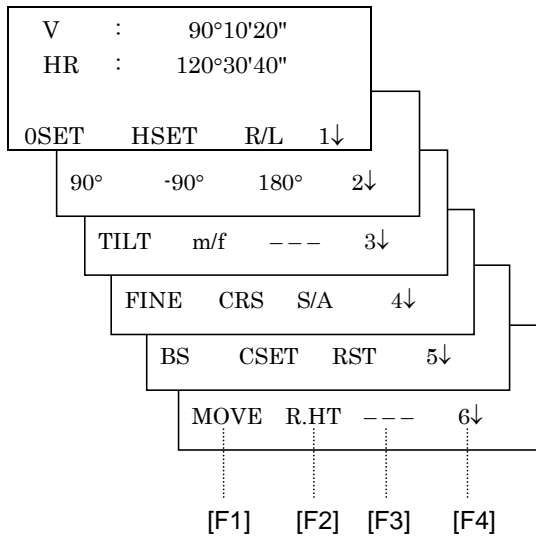
1.3 Operating Key



Keys	Name of key	Function
	Luminance key	ON/OFF of Illumination for display and reticle of telescope
T.I	Tracking indicator	On / Off of tracking indicator . It is possible to confirm tracking status or sighting direction of the equipment from the prism side.
BAT	Battery key	This indicates the external battery level .
V/H	Angle meas.key	Angle measurement key
	Distance meas.key	Distance measurement mode. Pressing this key switches [V,HR,SD] / [HR,HD,VD] .
NEZ	Coordinate meas.key	Coordinate measurement mode
A/M	Auto/Manual key	Switches auto tracking and manual mode
MENU	Menu key	Switches menu mode and normal mode. It is enable to set an application measurement in auto tracking by menu mode.
ESC	Escape key	Returning to the measurement mode or previous layer mode from the mode set.
ENT	Enter key	Press at the end of inputting values.
0~9	Numeric key	Input values
F1~F4	Soft key	Responds to the message displayed.
REC	Record key	Used to memorize measured data temporarily.
	Auto inversion key	Turning telescope in both faces forward and reverse automatically.
POWER	Power source key	ON/OFF of power source

1.4 Function Key (Soft Key)

Soft key message is displayed at the bottom line of display. Functions are according to the displayed message.



Page	Display mark	Soft key	Name	Function
1	0SET	F1	Horizontal angle of 0°set	Angle of Horizontal is set to 0°00'00"
	HSET	F2	Setting H-angle	Sets horizontal angle by input value.
	R/L	F3	Right/Left rotation in Horizontal angle	Switches R/L rotation of horizontal angle.
	1↓	F4	Page	The function of soft keys shown in the next page.
2	90°	F1	90°Rotation	Instrument rotates 90° horizontally to the clockwise direction .
	-90°	F2	-90°rotation	Instrument rotates 90° horizontally to the counter-clockwise direction .
	180°	F3	180°Rotation	Instrument rotates 180° horizontally to the clockwise direction.
	2↓	F4	Page	The function of soft keys shown in the next page.
3	TILT	F1	TILT	Switches ON/OFF of auto tilt correction for vertical and horizontal angle. It also displays both axis correction values in mgons or degrees.
	m/f	F2	Distance unit	Switches meter or feet in unit.
	3↓	F4	Page	The function of soft keys shown in the next page.
4	FINE	F1	FINE	Fine measuring mode. 0.2mm / 1mm
	CRS	F2	Coarse	Coarse measuring mode. 1mm / 10mm
	S/A	F3	Set audio	To be set audio mode
	4↓	F4	Page	The function of soft keys shown in the next page.

1. NOMENCLATURE AND FUNCTIONS

5	BS	F1	Setting direction angle	Sets the direction angle from the coordinate of instrument point and known point.(Backsight Point)
	CSET	F2	Setting an instrument point	Sets an instrument coordinate point by input values.
	RST	F3	Resection	Sets instrument coordinate point from two known points and their measured values.
	5↓	F4	Page	The function of soft keys shown in the next page.
6	MOVE	F1	Rotation	Rotates desired H and V angle.
	R.HT	F2	Setting target height	Allows the user to input the target height. (Prism Height)
	6↓	F4	Page	The function of soft keys shown in the next page.

1.5 Connection with Computer

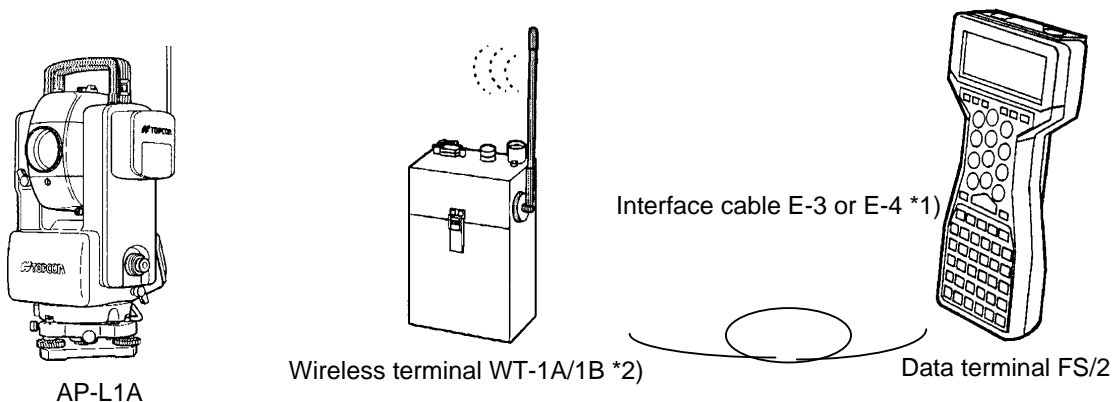
Serial signal connector port1 is used for connecting the AP-L1A/L1AN with a computing device. This enables the computer to receive measurement data from the instrument or to set H-angle, coordinate data and so forth to the instrument or control it from the computer.

The followings are the main communication commands and explanations. How to communicate or more informations of communication command, you can see the interface manual which provided optionally.

Commands		Action of AP-L1A / L1AN
Transmit command	Transmit command for measured data	Each measured data will be out put according to the command type.
	Transmit command for tracking mode	The status of Automatic Tracking mode will be out put.
	Transmit command for battery level	The battery level will be out put.
	Transmit command for coordinate of instrument point	Setting coordinate of instrument point will be out put.
	Transmit command for tracking parameter	Each setting tracking parameter of instrument will be out put according to the command type.
Mode setting	Setting of angle measurement	Each selecting mode in horizontal angle or angle measurement can be decided according to the purpose of command.
	Setting of distance measurement	Setting the measurement mode for distance measurement.
	Setting coordinate of instrument point	Setting the coordinate of instrument point.
	Setting the tracking parameter	Setting each tracking parameter according to the command.
	T.I. ON / OFF	ON / OFF of Tracking indicator.
	Error recovery	Recovery from E01, E02.
Action	Rotating command	Rotating of setting angle.
	Inversion	Inversion movement.
	Setting tracking mode	Setting from automatic tracking mode to each command mode.

1.6 Installing Wireless Terminal WT-1A/1B & Data Terminal FS/2 (Optional Accessories)

Applying wireless terminal WT-1A/1B and data terminal FS/2 enables the user to receive measurement data from AP-L1A by remote control. It also allows the setting of a H-angle, coordinate data, and control over the AP-L1A. This is the single person surveying or stake out operating system. Refer to instruction manual "gData terminal".



*1) The type of interface cable will differ by the market.

*2) The wireless terminal WT-1A/1B shape will differ by the market.

1.6.1 Setting Wireless Modem (AP-L1A only)

To perform cordless communication between wireless terminal WT-1A/1B and wireless modem of AP-L1A, it is required to set the communication channel and condition of AP-L1A to meet with WT-1A/1B. Refer to Chapter 7.6 "Setting AP-L1A Wireless Modem" to set the communication condition or channels.

It is not necessary to change of shipping time mode in normal use.

* There is no setting function for the communication channels in some markets.

1.6.2 Setting Place of AP-L1A and Wireless Terminal WT-1A/1B

AP-L1A and wireless terminal WT-1A/1B are using very low power for wireless communication. Precaution is needed to use WT-1A/1B under the following conditions because the communication distance will be shorter, or impossible.

- When the height of setting position from the ground is too low.
AP-L1A will be set at the height of 1.3~1.5 m or more from the ground and a man who is carrying wireless terminal with carrying belt should be higher than his waist or more.
- In case the road is constructed by concrete or asphalt .
- Where along with building or concrete wall.
Set AP-L1A as far as possible from the wall.
- Where near metals such as automobiles, motor cycles or bridges.
Set AP-L1A as far as possible from metals.
- Near antennas of radio or television or power supply.
- Near a dynamo
Set AP-L1A as far as possible from them.

According to the atmosphere condition such as rain or fog, or the presence of another type of radio wave or magnetic noise, the communication distance can be shortened.

- **Antennas for AP-L1A and wireless terminal WT-1A/1B, operate best when positioned vertically.**
- **When you are using more than 2 sets of AP-L1A(WT-1A/1B), keep them apart more than 2 meters to avoid interference a radio wave of each other.**

1.7 Data Output

When AP-L1A receives data output command from an external connected device, the measured data will be output by AP-L1A. Select from the following 2 ways for the output. (For setting, refer to " 16. SELECTING MODE")

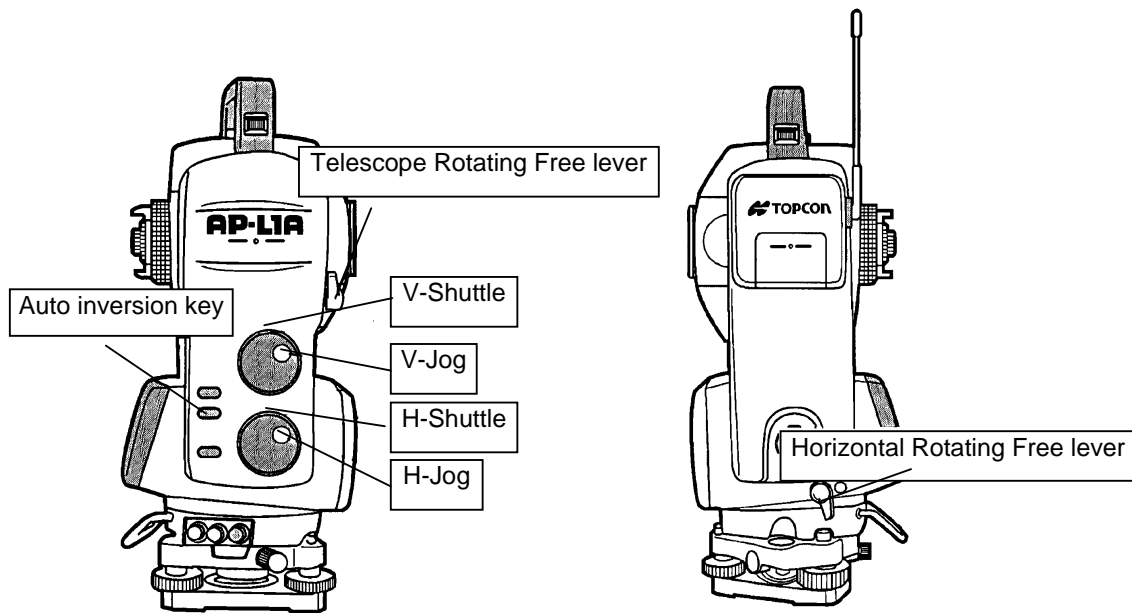
- REC-A : The measurement is started and new data is output.
- REC-B : The data being displayed is output.

However the measured data will be output every time the measurement is completed in Teach Measuring mode whatever the setting is done.

The data will be output from Port-1 in normal mode and from Port-2 in REMOTE mode. The details of the data is controlled by the data transmit command.

It is also possible to carry out continuously high baud rate out put (REC-C) to control the moving objects. (For more information, refer to Interface manual.)

1.8 Rotating Method of AP-L1A



1.8.1 Rotating of AP-L1A by H/V Shuttle and H/V Jog

H/V shuttle or H/V jog can be used to rotate the instrument manually. The shuttle movement or displacement is proportional in speed and size of angle desired. A small, slow turn of the shuttle will result in a slow small angle displaced. Likewise, a larger abrupt turn of the shuttle will result in a coarse angle displacement. H/V jog can be used for accurate collimating of the target much like a standard tangent screw.

1.8.2 Using Software Key to Rotate AP-L1A

The instrument can be rotated in the directions of $+90^\circ$, -90° , 180° by operating soft keys. This function can be used to level the instrument very accuracy with plate level after power ON.

- ① Go to page two of the options by pressing [F4] key .
- ② Select the required rotating angle by [F1] to [F3] key respectively.

V	:	90° 10' 20"	
HR	:	120° 30' 40"	
0SET	HSET	R/L	1↓
90°	-90°	180°	2↓
[F1]	[F2]	[F3]	[F4]

- During auto rotating by soft keys, other operation keys or function keys do not function. Press any keys except power key to stop rotation in progress.
- During auto rotating the instrument, don't disturb it by touching the instrument. Such action may cause trouble or harm to the instrument or operator.

- AP-L1A is able to rotate automatically to a required horizontal angle or vertical angle set. Refer to Chapter 4.4 "Rotating automatically to a required Horizontal and Vertical angle".

1.8.3 Auto Inversion Key

Pressing the inversion key causes the instrument to reverse and turn the telescope and instrument automatically.

- To stop auto rotating by auto inversion key in case of emergency, press any keys except POWER key.
- During auto rotation, don't disturb the instrument.(Stopping the rotation with a touch of the hand). Such action may cause trouble or harm to instrument or operator.

1.8.4 Telescope Rotating Free Lever and Horizontal Rotating Free Lever

In storing the instrument, the power is off or disconnected, rotate these rotating free levers to counterclockwise certainly to match the storage marks or to rotate the telescope before loading into the case.

Insufficient use of levers may cause damage to the drive unit.

- Do not use these levers except for storing.
- Never touch these levers while the instrument is rotating electrically.
- The horizontal rotating free lever is designed idle running in clockwise to protect accident in rotating time of instrument.

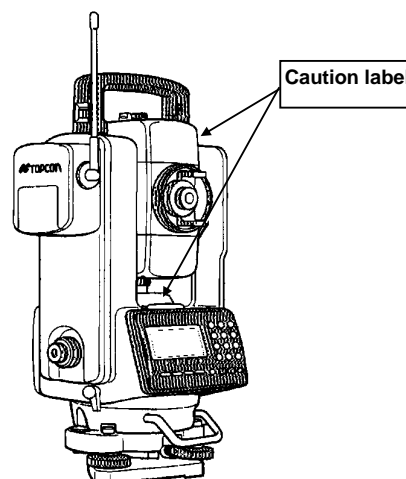
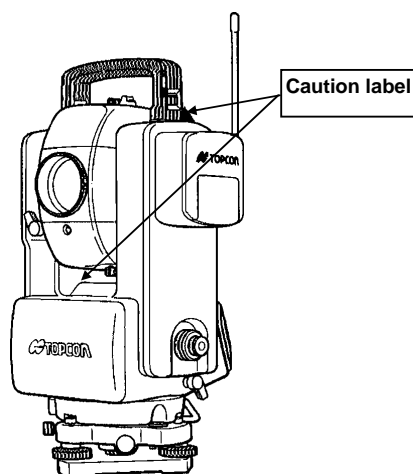
○ Attaching Precaution Label

Attach 4 precaution labels to the instrument in specified places to avoid the unexpected accident such as pinching fingers between telescope and body of instrument or telescope and hand grip during automatic rotation.

Caution label



- Attach upper side of instrument and on the front cover.
- Attach upper side of instrument and near the plate level.



2. PREPARATION FOR MEASUREMENT

2.1 Setting instrument up for measurement

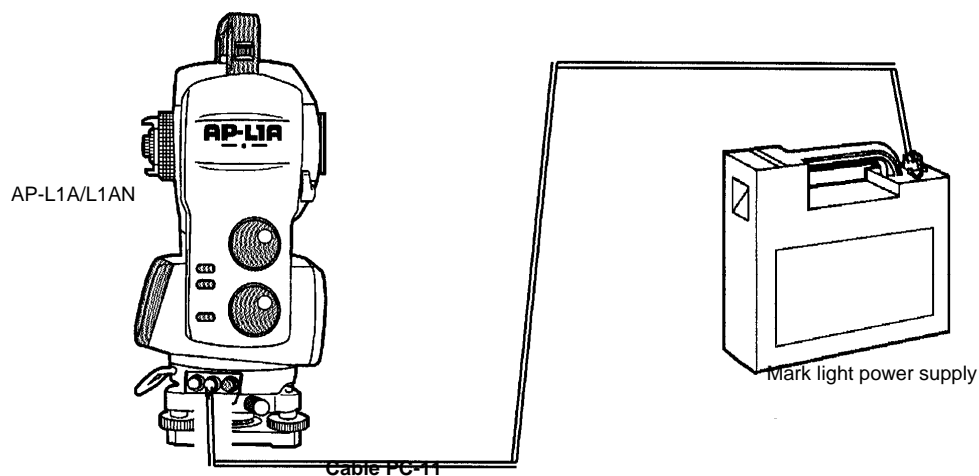
Mount the instrument to the tripod or the surveying base the way you would a standard type of surveying instrument. When leveling the instrument with plate level, connect with power supply and power up. All the rotating functions requires power.

Level and center the instrument precisely to insure the best performance. It is recommended to use the Topcon Wide Frame Wooden tripod, such as TP-10 (Type-E).

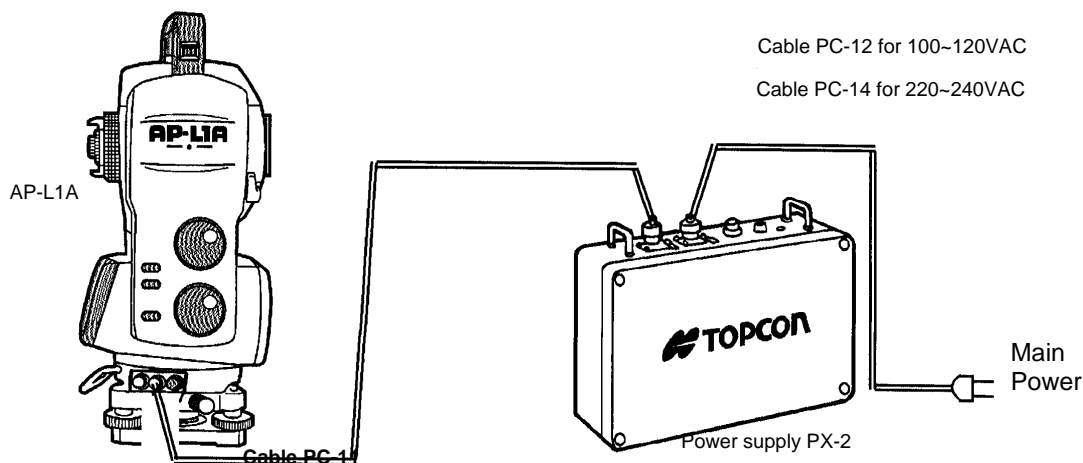
2.2 Connecting Power Supply

Use mark light power supply (special accessory) or Power supply PX-2 (special accessory) as a power source.

In case using mark light power supply



In case using Power supply PX-2



Reference: Leveling and Centering the Instrument

1. Setting up the Tripod

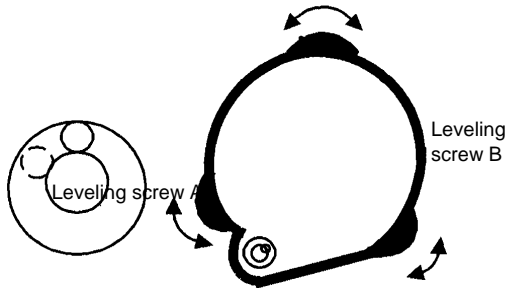
First, extend the extension legs to suitable lengths and tighten the screws on their midsections.

2. Attaching the Instrument on the Tripod Head

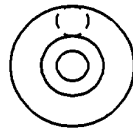
Place the instrument carefully on the tripod head and slide the instrument by loosening the tripod screw. If the plumb bob is positioned right over the center of the point, slightly tighten the tripod screw.

3. Roughly Leveling the Instrument by Using the Circular Level

- ① Turn the leveling screws A and B to move the bubble in the circular level. The bubble is now located on a line perpendicular to a line running through the centers of the two leveling screws being adjusted.

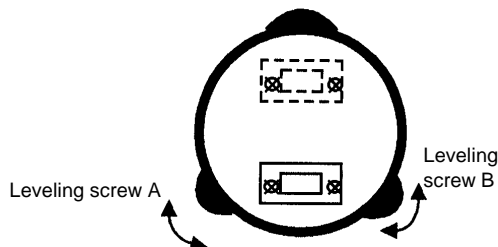


- ② Turn the leveling screw C to bring the bubble to the center of the circular level.

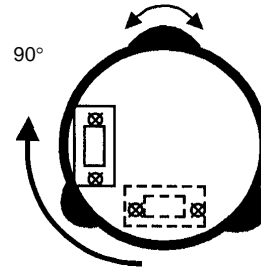


4. Centering by Using the Plate Level

- ① Rotate the instrument horizontally by using the Horizontal Shuttle and place the plate level parallel with the line connecting leveling screws A and B, and then bring the bubble to the center of the plate level by turning leveling screws A and B.



- ② Rotate the instrument 90° (100g) around its vertical axis and turn the remaining leveling screw or C to center the bubble once more.



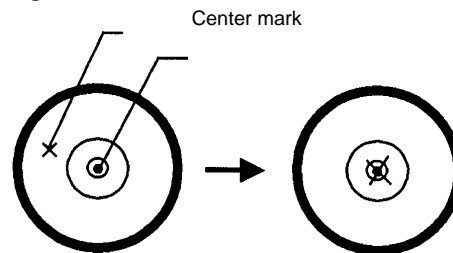
- ③ Repeat the procedures ① and ② for each 90° (100g) rotation of the instrument and check whether the bubble is correctly centered for all four points.

* It is possible to control by soft key to rotate. Select the required angle in 2 pages of the soft key functions. (Refer to "1.8 Rotation of the Instrument")

5. Centering by Using the Optical Plummet Telescope

Adjust the eyepiece of the optical plummet telescope to your eyesight.

Slide the instrument by loosening the tripod screw, place the point on the center mark, and then tighten the tripod screw. Sliding the instrument carefully not to rotate that allows you to get the least dislocation of the bubble.



6. Completely Leveling the Instrument

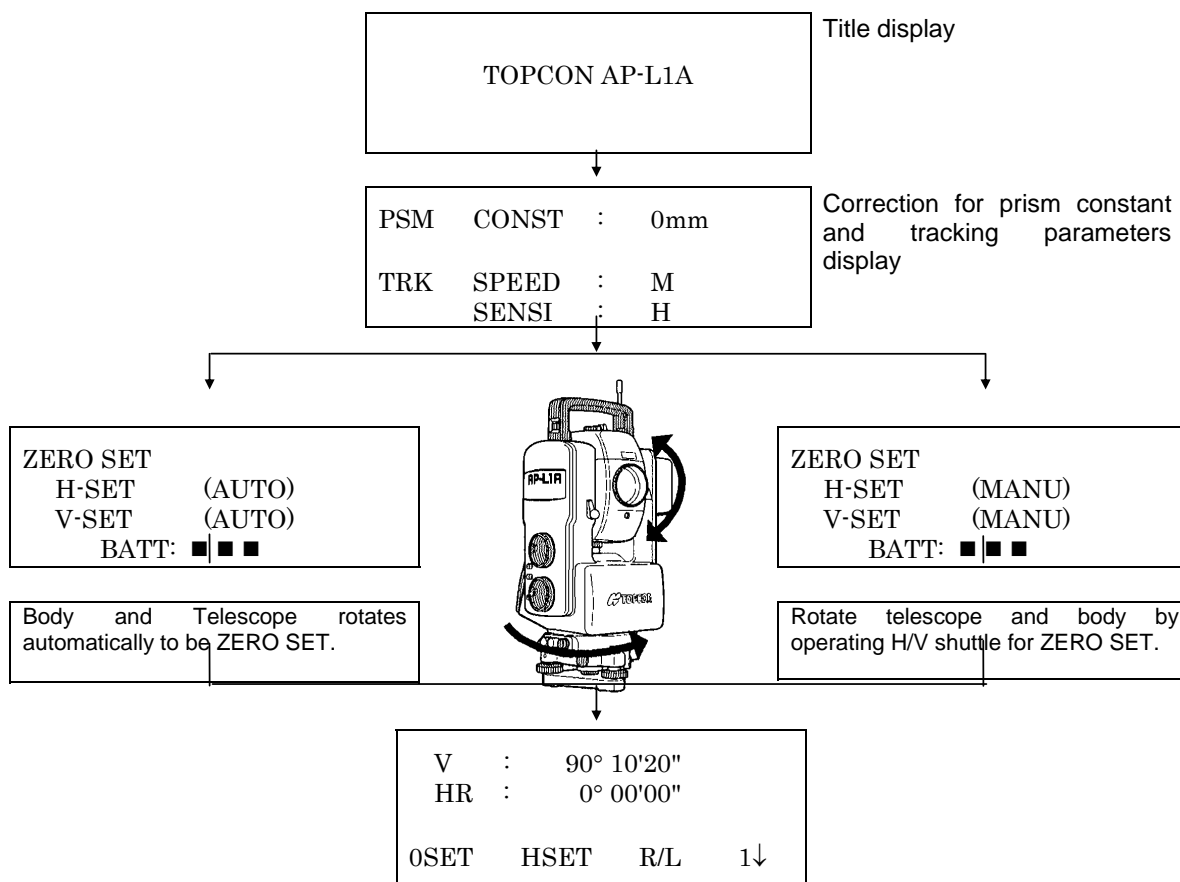
Leveling the instrument precisely in the similar way to 4. Rotate the instrument and check to see that the bubble is in the center of the plate level regardless of telescope direction, then tighten the tripod screw hard.

2.3 POWER Switch Key ON

- ① Turn the power switch key ON.

Display initializes for two seconds and shows current prism constant value, tracking speed and tracking detecting sensitivity. This allows you to confirm the setting prism constant value is correct to the using prism, or setting tracking speed is correct to the moving speed of measuring object or detecting sensitivity is correct to the measuring distance.

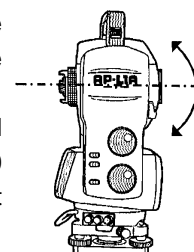
- ② Screen displays ZERO SET. Body and Telescope rotates automatically through 90 degrees from zenith to index vertical circle. When in manual mode, rotate telescope and body by operating H/V shuttle for to index vertical circle (ZERO SET).



- To change Auto/Manual for ZERO SET, refer to Chapter 16 "How to set special mode"
- See chapter 16 "how to set special modes" for horizontal angle zero set feature.
- Confirm battery level after Zero set . Replace with charged battery or charge when battery level is low or indicates "Battery empty". Refer to chapter 2.4 "Battery power remaining display".

Note : For setting the vertical angle at 0°, an electronic datum 0 is provided on the vertical angle circle. If the telescope is turned and the sensor passes the datum 0, angle measurement begins.


The datum 0 is placed near the level position of the telescope, the vertical angle setting of 0 can easily be set by rotating the telescope. The datum 0 for horizontal angle is placed near the storage mark located in the lower part of the instrument.

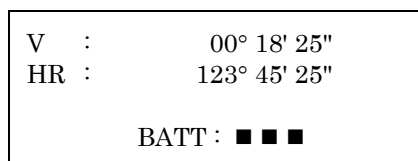


2.4 Battery Power Remaining Display

- Battery mark

Battery mark in the display indicates the power condition.

Press the **BAT**  key.



Remaining battery mark indicates while pressing BAT key.

BATT : ■■■



BATT : ■■



BATT : ■



〈 Battery empty 〉

- Replace with charged battery or charge when battery level is low or indicated "Battery empty".

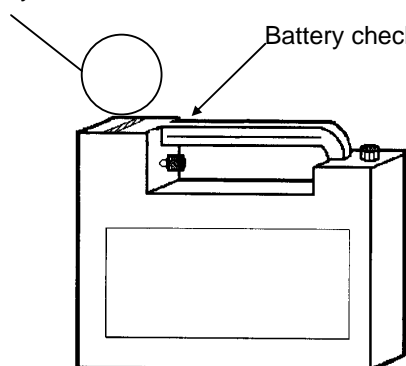
- Mark Light Battery

The remaining light and battery mark for battery indicates the level of power for the Mark Light power source .

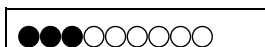
Press Battery check switch.
Remaining battery mark light to show the battery level.

Battery mark

Battery check switch



Battery mark



Decreasing ↓

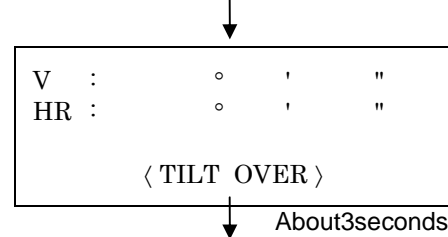
Note : 1) The battery operating time will vary depending on the environmental conditions as in ambient temperature, charging time, the number of times of charging and dis-charging etc. It is recommended for safety to charge the battery beforehand or to prepare spare full charged batteries.

2) For general usage of battery, see chapter 13" Power source and charging".

2.5 Vertical and Horizontal Angle Tilt Correction

When the tilt sensors (dual) are activated, automatic correction of horizontal and vertical angle for mislevelment is displayed. To ensure a precise angle measurement, tilt sensors must be turned on. The display can also be used to fine level the instrument. If the (TILT OVER) display appears the instrument is out of automatic compensation range and must be leveled manually.

When AP-L1A tilted over correction range.(TILT OVER)



TILT	
X	: 〈 OVER! 〉
Y	: 0° 01' 41"
[ON]	[OFF]

- * Rotate the leveling screws and manually level the instrument. When the vertical axis tilt is within $\pm 30''$, the display changes to the previous mode after display holds tilt correction for about 2 seconds.

TILT [ON]	
X	: -0° 00' 25"
Y	: 0° 00' 0"
[ON]	[OFF]

- * Pressing [F2] key to answer OFF, automatic tilt correction is canceled, and returns to the previous mode. It does not memorized this setting after power OFF.
To set auto tilt correction from the moment that power is on, refer to chapter 16." Selecting Mode".
- * The display of Vertical or Horizontal angles is unstable when instrument is on an unstable stage or in a windy day. You can turn off the auto tilt correction function of H/V angle in this case.
- * If the instrument is not precisely leveled, the tilt correction on the angle data may include errors during the rotation. (Though the tilt sensor properly corrects angle readings if the rotation is completed and the instrument is in stationary condition.)
If the instrument is precisely leveled, however, the tilt sensor properly corrects angle readings even during the rotation. Therefore, when accuracy is required during the rotation, level the instrument as precise as possible.

● Setting Tilt Correction by Soft Key.

Enable to select tilt ON/OFF function.

[Example] Setting V/H Tilt ON

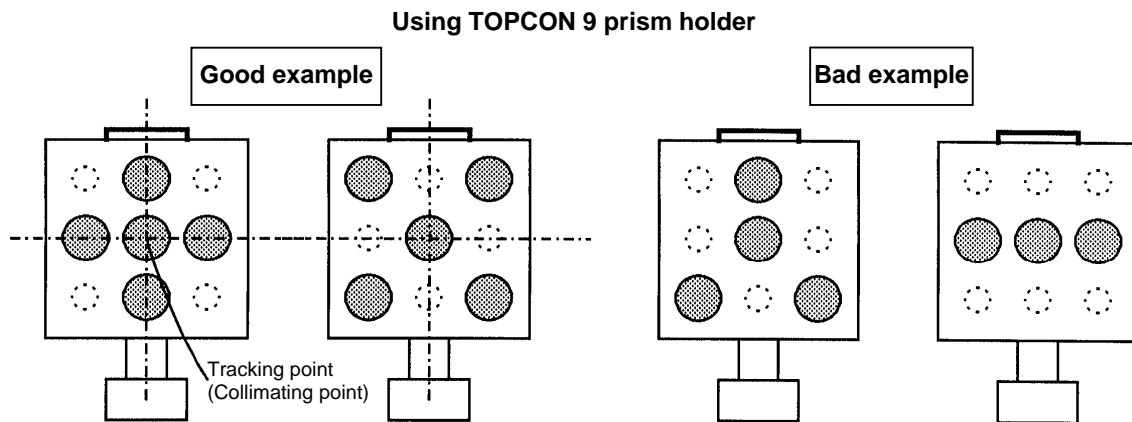
Operating procedure	Operating key	Display												
① Press [F4] 2 times to open function page 3.	[F4] Press twice	<table border="1" style="margin: auto; border-collapse: collapse;"> <tr> <td style="padding: 5px;">V</td><td style="padding: 5px;">:</td><td style="padding: 5px;">80° 10' 20"</td></tr> <tr> <td style="padding: 5px;">HR</td><td style="padding: 5px;">:</td><td style="padding: 5px;">120° 30' 40"</td></tr> <tr> <td style="padding: 5px;">0SET</td><td style="padding: 5px;">HSET</td><td style="padding: 5px;">R/L 1↓</td></tr> <tr> <td style="padding: 5px;">TILT</td><td style="padding: 5px;">m/f</td><td style="padding: 5px;">--- 3↓</td></tr> </table>	V	:	80° 10' 20"	HR	:	120° 30' 40"	0SET	HSET	R/L 1↓	TILT	m/f	--- 3↓
V	:	80° 10' 20"												
HR	:	120° 30' 40"												
0SET	HSET	R/L 1↓												
TILT	m/f	--- 3↓												

2. PREPARATION FOR MEASUREMENT

② Press [F1] (Tilt) to select tilt ON/OFF function. In case already selected ON, the display shows tilt correction value.	[F1]	<div>Tilt [OFF]</div> <div>[ON] [OFF] -- --</div>
③ Press [F1](ON) key.	[F1]	<div>1 : V TILT ON</div> <div>2 : V/H TILT ON</div> <div>[1] [2] --- EXIT</div>
④ Press [F2](2) key. TILT correction value is displayed.	[F2]	<div>TILT [ON]</div> <div>X : -0° 00' 25"</div> <div>Y : 0° 00' 25"</div> <div>[ON] [OFF] -- --</div>
⑤ Press [F1](ON) key. *1)	[F1]	<div>1 : V TILT ON</div> <div>[2 : V/H TILT ON]</div> <div>[1] [2] --- EXIT</div>
⑥ Press [F4](EXIT) key after confirming that gV/H TILT ON" is selected.	[F4]	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>TILT m/f --- 3↓</div>
<ul style="list-style-type: none"> The setting mode performed here will not be memorized after power OFF. To set TILT correction in the initialize setting (it is memorized after power OFF) refer to Chapter 16 "Selecting Mode". <p>*1) When the vertical axis tilted more than $\pm 30''$, adjust the level of the instrument by rotating leveling screws, because TILT function is not able to be ON.</p>		

2.6 The Lay Position of Multiple Prisms

To increase measurement range, multiple prisms can be used. Arrange prism position to be symmetrical horizontally and vertically. All prisms must be of the same type. AP-L1A tracks to a point where it finds the greatest signal strength. (See diagram below)

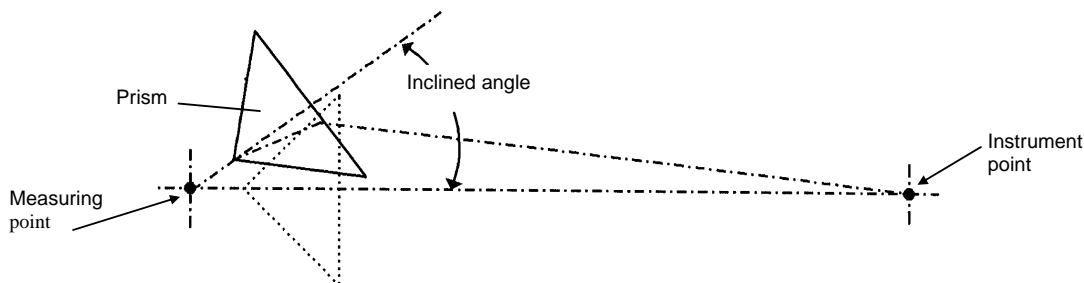


2.7 Inclination of Prism and Measuring Error

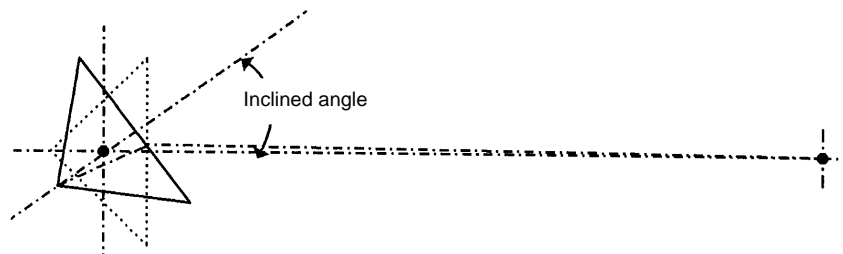
For the best results, aim or point prisms in the direction of the AP-L1A so that maximum signal can be returned to the instrument. Sighting prism obliquely because of inclined settings, may result in measuring errors. These errors will be proportional to the misalignment as showing in following graphs. The more misalignment of the prism, the more error in measurement.

Measured data can be different according to the prism constant value. This can occur when a prism is moving. Pin-pole prism set L1 (for one-person surveying) and pin-pole prism holder L1 (for fixed point observation) are designed to minimize measuring error in such case. Make the best use of them. In case you are forced to use the normal prism in inclined state because there is no other way possible, we recommend to use switching holder, prism constant value (0 or 30mm), and set to 30mm (Compensation value of -30mm).

- Prism constant value : 0mm

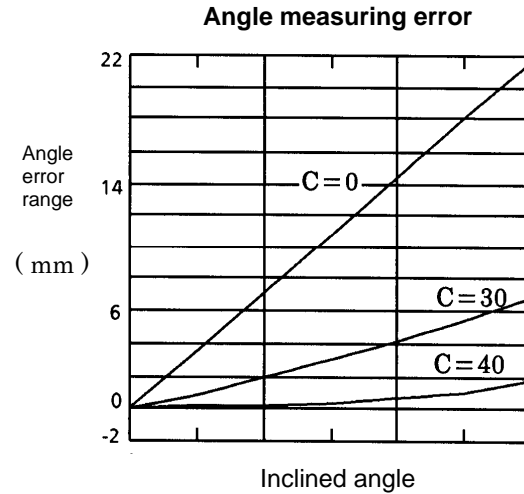
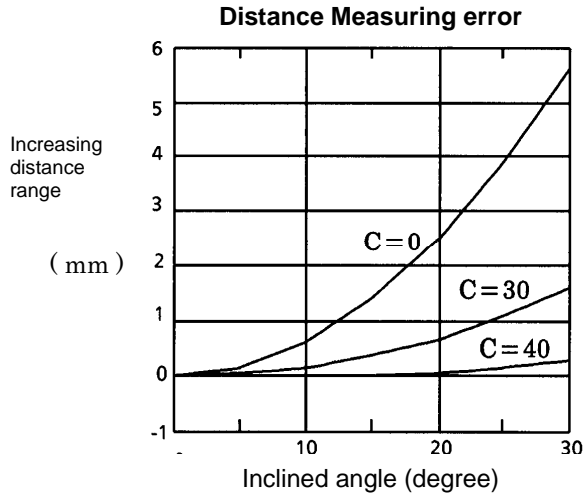


- Prism constant value : 30mm

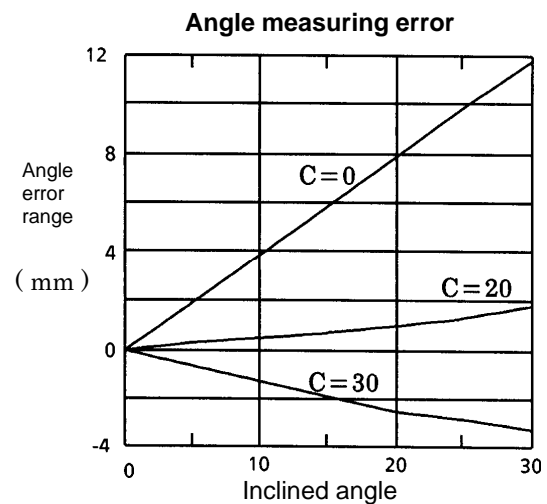
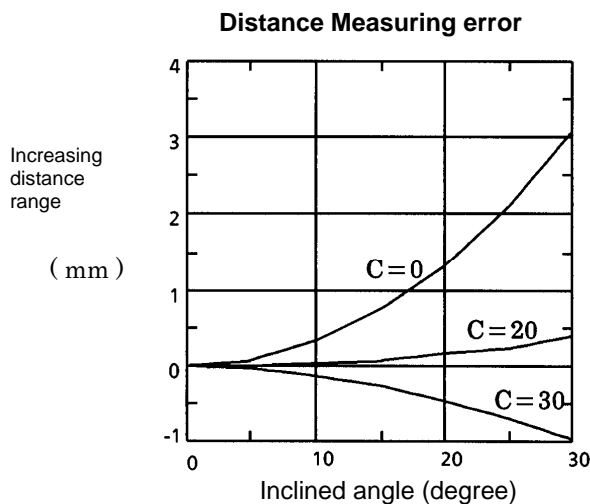


2. PREPARATION FOR MEASUREMENT

- Prism type-2 (Normal prism)



- Prism type - 3 or 5 (Prism unit A2/A3)



(Example) In case Prism constant value (C) = 0mm, Prism inclination = 20°, Measuring distance = 100m by Prism type-2 :

- Distance error is :

From the graph prism type-2, the distance error shows in increasing range quantity 2.5mm along curved line of C=0 when prism inclination is 20°.

- Angle error is :

From the graph prism type-2, along curved line of C=0 with prism inclination of 20°, find angle error quantity (14.2mm) and calculate angle error by the following formula.

$$\text{Angle error} = \tan^{-1} \left(\frac{\text{Angle error range}}{\text{Measuring distance}} \right)$$

$$\begin{aligned} \text{Angle error} &= \tan^{-1} \left(\frac{14.2}{100 \times 10^3} \right) \\ &= 29'' \end{aligned}$$

3. AUTOMATIC TRACKING MODE

Caution : In auto- tracking mode, the laser beam emits from the center of the objective lens.
Do not stare into the objective lens or do not aim at the other people's eyes in the auto-tracking mode.

Measuring the moving target in automatic tracking mode.

Operating procedure	Operating key	Display
① Manually collimate the target prism using V/H jog/shuttle.		<div> V : 90° 10' 20" HR : 120° 30' 40" OSET HSET R/L 1↓ </div>
② Press the [A/M] key. The mode be automatic tracking mode. In this mode, the instrument tracks automatically to the target prism.*1),2)	[A/M]	<div> V : 90° 10' 20" HR : 120° 30' 40" OSET HSET R/L *↓ </div>
③ Choose different measuring modes by pressing the appropriate function keys. *3)	[4]	<div> V : 90° 10' 20" HR : 120° 30' 40" SD : << < m OSET HSET R/L *↓ </div>
<p>● If the target prism is lost during auto tracking status, the instrument will automatically change to Waiting status and symbol mark will be switched to "!". If the target is found during Waiting status, tracking resumes *4), and if not, status changes to Searching status. When the target prism is found, tracking will resume.*5)</p> <div style="text-align: center;"> <p>- - Automatic tracking mode - - - - -</p> <pre> graph TD subgraph "Automatic tracking mode" T["Tracking status *"] W["Waiting status !"] S["Searching status ?"] T -- "The target prism is lost" --> W W -- "The target prism is not found for some time" --> S S -- "The target prism is found" --> T S --> T end MM["Manual mode"] T <--> "A/M key" MM </pre> </div>		
<p>● The following symbol marks are indicated at the corner of right bottom of display.</p> <p>* : symbol of Tracking status ! : symbol of Waiting status ? : symbol of Searching status</p>		

- *1) Auto tracking mode should be used only after powering up and instrument fully acclimated to the atmospheric surroundings.
- *2) Auto tracking status sometimes can be unstable for a few seconds after the optical path is disturbed by a passing car or person.
- *3) There are fine and coarse modes in distance measuring mode. The coarse mode is used for moving or unstable objects. The fine mode is for objects which are fixed and/or for precise measurements.
Please refer to chapter 5.4 "Fine Mode and Coarse Mode".
- *4) While the instrument is in the Waiting status retracking function will resume when target is within scanning area.
- *5) For setting the parameters for auto tracking mode, refer to chapter 15 "Special mode (Menu key operation)" The following are the parameters available to set.
 - 1) Setting Search Range 2) Setting Search Pattern 3) Setting Waiting Time
 - 4) Setting Scan Width 5) Setting Tracking Speed 6) Setting Detecting Sensitivity

4. ANGLE MEASUREMENT

4.1 Measuring Horizontal Angle Right and Vertical Angle

Make sure the mode is in Angle measurement.

Operating procedure	Operating key	Display
① Collimate the 1st target (A).		<div>V : 90° 10 '20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div>
② Set horizontal angle of target A at 0° 00' 00". Press [F1](0 set)key, [F3](YES) key.	[F1]	<div>H-0SET</div> <div>> OK?</div> <div>-- -- [YES][NO]</div>
	[F3]	<div>V : 90° 10 '20"</div> <div>HR : 0° 00' 00"</div> <div>0SET HSET R/L 1↓</div>
③ Collimate the 2nd target (B). The required H/V angle to target B will be displayed.		<div>V : 98°10'20"</div> <div>HR : 160°40'20"</div> <div>0SET HSET R/L 1↓</div>
Note : From a known coordinate value of the instrument point and the backsight point, the AP-L1A can set a directional angle. See chapter 6.1, "Setting a Direction Angle for Horizontal Orientation".		

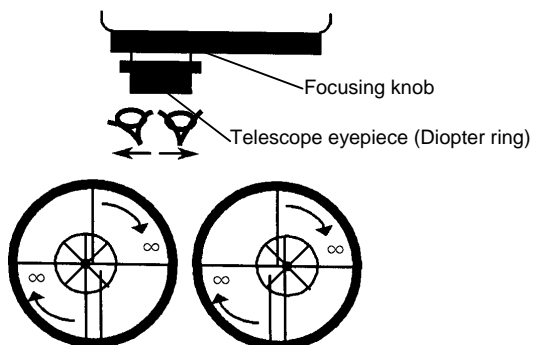
Reference

How to Collimate

- ① Point the telescope toward the light. Turn the diopter ring and adjust the diopter so that the cross hairs are clearly observed.
(Turn the diopter ring toward you first and then backward to focus.)
- ② Aim the target at the peak of the triangle mark of the sighting collimator. Allow a certain space between the sighting collimator and yourself for collimating.
- ③ Focus the target with the focusing knob.

4. ANGLE MEASUREMENT

- * If parallax is created between the crosshairs and the target when viewing vertically or horizontally while looking into the telescope, focusing is incorrect or diopter adjustment is poor. This adversely affects precision in measurement or survey. Eliminate the parallax by careful focusing and diopter adjustment.



4.2 Switching Horizontal Angle Right/Left

Make sure the mode is Angle measurement

Operating procedure	Operating key	Display
<p>① Press [F3](R/L) key</p> <p>The mode Horizontal angle Right (HR) switches to (HL) mode.</p> <p>② Measure as HR mode.</p>	[F3]	<div> V : 90° 10 '20" HR : 120° 30' 40" 0SET HSET R/L 1↓ </div> <div> V : 90° 10 '20" HR : 239° 29' 20" 0SET HSET R/L 1↓ </div>
<p>● Every time pressing [F3](R/L) key is pressed, HR/HL mode switches.</p>		

4.3 Measuring from the Required Horizontal Angle

Make sure the mode is angle measurement

Operating procedure	Operating key	Display
① Sight the target for the which the Horizontal angel is to be set .		<div> V : 90° 10' 20" HR : 120° 30' 40" 0SET HSET R/L 1↓ </div>
② Press [F2](HSET) key.	[F2]	<div> H-SET HR : EXIT --- CLR ← - </div>
③ Input value of Horizontal angle to be set. For example :70° 40' 20" *1)	<div> 7 0 . 4 0 2 0 </div>	<div> H-SET HR : 70.4020 EXIT --- CLR ← - </div>
④ Press [ENT] key .	[ENT]	<div> H-SET HR : 70° 40' 20" ↓ SET! </div>
When completed, normal measuring from the required Horizontal angle is possible.*2)		<div> V : 90° 10' 20" HR : 70° 40' 20" 0SET HSET R/L 1↓ </div>
* 1) To revise wrong value, move cursor with [F4](←)or input from the beginning by [F3](CLR) key to correct value. * 2) With wrong input value(for example 70'), setting will not be completed. Input again from the step ③.		

4.4 Rotating automatically to a required Horizontal and Vertical angle

Operating procedure	Operating key	Display
① Press [F4](↓)key 5 times to page 6. ② Press [F1](MOVE) Key .	[F4] 5 times [F1]	<div> V : 90° 10' 20" HR : 120° 30' 40" 0SET HSET R/L 1↓ MOVE R. HT - - - 6↓ </div>
③ Input the vertical angle to be rotated and press [ENT] key.*1) For example : 93° 10' 40"	<div> 9 3 . 1 0 4 0 [ENT] 1 6 0 . 2 0 1 0 [ENT] </div>	<div> MOVING V : 93° 10' 20" HR : 120° 30' 40" EXIT ↑ CLR ← </div> <div> MOVING V : 93° 10' 40" HR : 160° 20' 10" EXIT ↑ CLR ← </div>
④ Input the horizontal angle to be rotated, and press [ENT] key. For example : 160° 20' 10"		
The instrument will start to rotate. *2)		<div> MOVING V : 93° 10' 40" HR : 160° 20' 10" < MOVING! > </div>
When the instrument has finished rotating *3), the instrument will return to the previous mode.		<div> V : 93° 10' 40" HR : 160° 20' 10" MOVE R. HT - - - 6↓ </div>
*1) Setting range for rotation is ; $0^{\circ} 00' 00'' \leq HR \leq +359^{\circ} 59' 59''$ $0^{\circ} 00' 00'' \leq V \leq +359^{\circ} 59' 59''$ *2) Press any key except power key to stop rotating in emergency during operation. *3) The actual stopping angular positions will be within $\pm 3''$ (1mgon) to the each set angles.		

5. DISTANCE MEASUREMENT

5.1 Setting of the Atmospheric Correction

When setting the atmospheric correction, obtain the correction value by measuring the temperature and pressure. Refer to Chapter 11.2 "Setting of Atmospheric Correction Value".

5.2 Setting of the Correction for Prism Constant

Generally, Topcon's prism constant value is 0. Set correction for prism at 0. Using Pin pole prism set L1 type, Pin pole prism holder L1 type, prism unit A2, near distance prism for AP-S1, or any other manufacture other than TOPCON's may need a different prism constant value. Refer to Chapter 10 "Setting the Prism Constant".

5.3 Distance Measurement (Continuous Measurement)

Make sure the mode displays angle measurement.

Operating procedure	Operating key	Display
① Sight the center of prism.		<div>V : 90° 10 '20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div>
② Press [Δ]key. Distance measurement starts.1),2)	[Δ]	<div>V : 90° 10 '20"</div> <div>HR : 120° 30' 40"</div> <div>SD* <<< m</div> <div>0SET HSET R/L 1↓</div>
The measured slope distances show every 0.2 to 4.5 seconds according to setting of distance measuring mode. *3) ~ *6)		<div>V : 90° 10 '20"</div> <div>HR : 120° 30' 40"</div> <div>SD* 12.3456 m</div> <div>0SET HSET R/L 1↓</div>
● Pressing [Δ] key again, the mode changes to Horizontal and vertical distance measuring mode.	[Δ]	<div>V : 90° 10 '20"</div> <div>HD * 11.2345m</div> <div>VD : 6.5432m</div> <div>0SET HSET R/L 1↓</div>
<p>*1) When EDM is working, the "*" mark appears in the display.</p> <p>*2) To change mode from Fine to Coarse, refer to Chapter 5.4 "Fine Mode and Coarse Mode". To set the distance measurement on when the instrument is powered up, refer to Chapter 16 "Selecting Mode".</p> <p>*3) The distance unit indicator "m" (for meter) or "f" (for feet) appears and disappears alternatively with buzzer sounds at every renewal of distance data.</p> <p>*4) The measurement times are not same according to the measuring mode. Refer to "5.4 Fine mode and Coarse mode".</p> <p>*5) Measurement may repeat automatically if the result is affected by shimmer etc..</p> <p>*6) To return to the normal measuring angle mode from a distance measuring mode, press (V/H) key.</p>		

5.4 Fine Mode and Coarse Mode

The Coarse mode is used for the objects which may be slightly unstable. The fine mode is for those objects which are still for precise applications.

○ Fine mode : This is a normal distance measuring mode.

The unit to be displayed is 0.2mm or 1mm. (0.001ft or 0.005ft)

Measurement time 0.2mm mode : approx.4.5 seconds

1 mm mode : approx.2 seconds

Measurement accuracy : $\pm(3\text{mm}+2\text{ppm})\text{m.s.e.}$

○ Coarse mode : This mode measures in shorter time than in fine mode.

The unit to be displayed is 1mm or 1cm. (0.001ft or 0.002ft)

Measurement time 1mm mode : approx.0.5 seconds

1 cm mode : approx.0.2 seconds

Measurement accuracy : $\pm(10\text{mm}+2\text{ppm})\text{m.s.e.}$

Use this mode for auto tracking measurement.

Operating example : Operator chooses to change from the Fine to Coarse mode with a 1cm measuring unit.

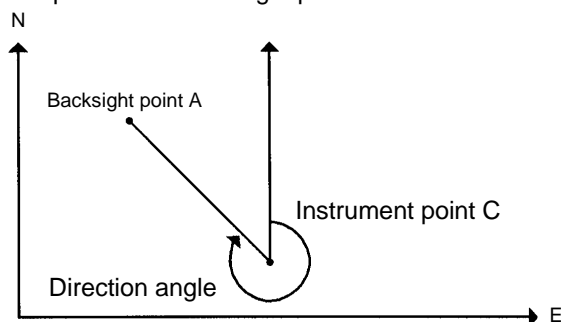
Operating procedure	Operating key	Display
① Press [F4](↓)key 3 times in distance measuring mode to get the function as in page 4.	[F4] 3-times	<div> V : 90° 10 '20" HR : 120° 30' 40" SD : 123.4567m 0SET HSET R/L 1↓ FINE CRS S/A 4↓ </div>
② Press [F2](CRS) key. Measuring starts in Coarse mode in unit of 1mm.	[F2]	<div> V : 90° 10 '20" HR : 120° 30' 40" SD : 123.4567m FINE CRS S/A 4↓ </div>
③ Press once again [F2](CRS) key, the display unit will be in 1cm of Coarse mode. *1)	[F2]	<div> V : 90° 10 '20" HR : 120° 30' 40" SD : 123.46m FINE CRS S/A 4↓ </div>
*1) Every time pressing [F2](CRS) key, the display unit will be changed. Pressing [F1](FINE) key returns to Fine mode, and every time pressing [F1](FINE) key switches unit display.		

6. COORDINATE MEASUREMENT

6.1 Setting a Direction Angle for Horizontal Orientation

(Setting from the coordinate of backsight point and instrument point)

From the coordinate value of backsight point (bearing point) and instrument point, the direction angle from the instrument point to the backsight point can be set.



Confirm instrument mode is angle or distance measurement.

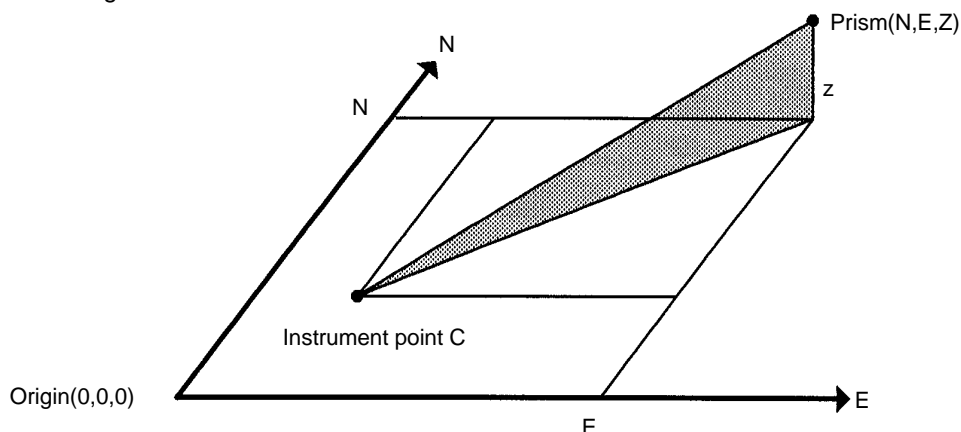
Example: Backsight point A : N coordinate 54.321m, E coordinate 12.345m

Operating procedure	Operating key	Display
① Set N and E coordinate value of instrument point. Refer to Chapter 6.2, "Setting coordinate of instrument point".		<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div>
② Press [F4](↓) key 4 times to be function as in page 5.	[F4] 4 times	<div>0SET HSET R/L 1↓</div> <div>BS CSET RST 5↓</div>
③ Press [F1](BS) key. Screen is displays INPUT of Backsight point.	[F1]	<div>BRG. POINT</div> <div>N : *.**** m</div> <div>E : *.**** m</div> <div>EXIT ↑ CLR ←</div>
④ Input N and E coordinate of backsight point A. Example : N coordinate;54.321m : E coordinate;12.345m Display shows direction/angle of backsight point A, calculated from the coordinates of instrument point and backsight point.	<div>5 4 .</div> <div>3 2 1</div> <div>[ENT]</div> <div>1 2 .</div> <div>3 4 5</div> <div>[ENT]</div>	<div>BRG. POINT</div> <div>N : 54.3210 m</div> <div>E : 12.3450 m</div> <div>EXIT ↑ CLR ←</div>
⑤ Sight backsight point A, and press [F3](YES)key.	[F3]	<div>BRG. POINT</div> <div>HR= 257° 59' 20"</div> <div>SET OK > [YES] [NO]</div>
After setting, the mode returns to previous setting.		<div>V : 70° 10' 20"</div> <div>HR : 257° 59' 20"</div> <div>BS CSET RST 5↓</div>

6.2 Setting Coordinate of Instrument Point

Set the coordinates of AP-L1A/L1AN according to the coordinate original point, and AP-L1A/L1AN automatically measures, converts, and displays the unknown point (prism point) coordinates. It is possible to retain the coordinate of the instrument point after turning power switch OFF. Refer to Chapter 15 "Special mode (Menu key operation)".

However, when the instrument is powered off, the value of the instrument height will be erased. Instrument height will need to be reentered.



6.2.1. How to Input Instrument Coordinate Value Directly

Confirm the mode is set in angle or distance measuring mode.

Example: N coordinate 12.345m, E coordinate 54.321m, Z coordinate 2.345m,
Instrument height 1.3m

Operating procedure	Operating key	Display
① Press [F4](↓)key 4 times to be function as in page 5.	[F4] 4 times	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div> <div>BS CSET RST 5↓</div>
② Press [F2](CSET)key.	[F2]	<div>OCC. POINT</div> <div>N : 0.0000 m</div> <div>E : 0.0000 m</div> <div>EXIT ↑ CLR ←</div>
③ Input N coordinate. Example: N coordinate: 12.345m	<div>[1] [2]</div> <div>[.]</div> <div>[3] [4] [5]</div> <div>[ENT]</div>	<div>OCC. POINT</div> <div>N : 12.3450 m</div> <div>E : 0.0000 m</div> <div>EXIT ↑ CLR ←</div>
④ Input E coordinate. Example:E coordinate: 54.321m	<div>[5] [4]</div> <div>[.]</div> <div>[3] [2] [1]</div>	<div>OCC. POINT</div> <div>N : 12.3450 m</div> <div>E : 54.3210 m</div> <div>EXIT ↑ CLR ←</div>

6. COORDINATE MEASUREMENT

	[ENT]	
<p>⑤ Input Z coordinate. *1) Example: Z coordinate 2.345m</p>	<p>[2] [.]</p> <p>[3] [4] [5]</p> <p>[ENT]</p>	<div>OCC. POINT Z : 2.3450 m INS. HT : 0.0000 m EXIT ↑ CLR ←</div>
<p>⑥ Input instrument height. *2 Example: INS.HT 1.3m</p>	<p>[1] [.] [3]</p> <p>[ENT]</p>	<div>OCC. POINT Z : 2.3450 m INS. HT : 1.3000 m EXIT ↑ CLR ←</div> <div>SET OK > [YES] [NO]</div>
<p>⑦ Press [F3](YES)key.</p> <p>At the end of setting, the mode returns to the previous setting.</p>	[F3]	<div>V : 90° 10' 20" HR : 120° 30' 40"</div> <div>BS CSET RST 5↓</div>
<p>*1) When Z coordinate is not input, press [ENT] key only.</p> <p>*2) When instrument height is not input, press [ENT] key only.</p> <p>Input range:</p> <p>Coordinate of the instrument</p> <p>−130,000.0000m ≤ N ≤ +130,000.0000m (130km)</p> <p>" ≤ E ≤ "</p> <p>" ≤ Z ≤ "</p> <p>Instrument height</p> <p>−10.0000m ≤ INS.HT ≤ +10.0000m</p>		

6.2.2. Resection Method

The coordinate value of the instrument point can be set from the coordinate value and measured data of 2 known points. There is 2 setting methods that is auto collimating method and manual collimating method. It is also available to select 2 Dimensional or 3 Dimensional measurement and the setting which measured by normal telescope position or normal/inverted telescope positions.

* For the selection of auto or manual methods requires preset of "15. special mode (menu key operation)"

● Auto collimating method

[Example] Setting 3 Dimensional measurement, 1 set at the position of telescope normal / inverted measurement.

Confirm mode is angle or distance measurement.

Operating procedure	Operating key	Display
① Press [F4](↓) key 4 times to be a function as in page 5.	[F4] 4 times	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div> <div>BS CSET RST 5↓</div>
② Press [F3](RST) key.	[F3]	<div>RESECTION</div> <div>F1 : 2D</div> <div>F2 : 3D</div>
③ Press [F2](3D) key. *1) (The instrument height which already entered by the soft key (CSET) will be displayed.)	[F2]	<div>INS . HT INPUT</div> <div>0.0000 m</div> <div>EXIT ↑ CLR ←</div>
④ Enter the instrument height and press [ENT] key. (If the value is accepted, press [ENT] key as it is.)	Input Inst.HT [ENT]	<div>INS . HT INPUT</div> <div>1.3000 m</div> <div>EXIT ↑ CLR ←</div> <div>SET OK > [YES] [NO]</div>
⑤ Confirm the instrument height, press [F3](YES) key. *2)	[F3]	<div>POINT A</div> <div>N : *.*** m</div> <div>E : *.*** m</div> <div>EXIT ↑ CLR ←</div>
⑥ Enter the coordinate value of known point A and Prism height, and press [ENT] key.	Input N data [ENT] Input E data [ENT] Input Z data [ENT] Input Prism R.HT [ENT]	<div>POINT A</div> <div>Z : *.*** m</div> <div>R . HT : *.*** m</div> <div>EXIT ↑ CLR ←</div> <div>POINT B</div> <div>N : *.*** m</div> <div>E : *.*** m</div> <div>EXIT ↑ CLR ←</div>

6. COORDINATE MEASUREMENT

- ⑦ Enter the coordinate value of known point B and Prism height, and press [ENT] key.

Input N data
[ENT]

Input E data
[ENT]

Input Z data
[ENT]

Input Prism R.HT
[ENT]

- ⑧ Press [F3](YES) key.

[F3]

- ⑨ Sight the instrument at the known point A by operating Horizontal / Vertical jog / shuttle, auto tracking to the known point A starts by pressing [A/M] key.

- ⑩ After tracking to the known point A is confirmed, press [F3](SET) or [REC] key.

[F3]
or
[REC]

Measurement will be done 2 times after checking the tracking condition automatically. *3)

When measurement of the known point A is completed, measurement of the known point B starts.

- ⑪ Sight the instrument at the known point B by operating Horizontal/ Vertical jog / shuttle, auto tracking to the known point B starts by pressing [A/M] key.

[A/M]

- ⑫ After tracking to the known point B is confirmed, press [F3](SET) or [REC] key. Measurement will be done 2 times after checking the tracking condition automatically. *3)

[F3]
or
[REC]

When the measurement of known point B completed, the screen displays for the selection of measurement in inverted position.

POINT B			
Z :		*.****	m
R . HT :		*.****	m
EXIT	↑	CLR	←

SET	OK >	[YES]	[NO]
-----	------	---------	--------

V :	90° 10' 20"
HR :	120° 30' 40"

POINT A	[SET]
---------	---------

V :	90° 10' 20"
HR :	10° 20' 30"

POINT A	[SET]
---------	---------

POINT A	[SET] *
---------	-----------

V :	90° 10' 20"
HR :	10° 20' 30"

< CHECKING >	*
--------------	---

< MEASURING >	*
---------------	---

SET !!



V :	90° 10' 20"
HR :	10° 20' 30"

POINT B	[SET]
---------	---------

V :	90° 20' 30"
HR :	70° 30' 40"

POINT B	[SET]
---------	---------

POINT B	[SET] *
---------	-----------

V :	90° 10' 20"
HR :	70° 30' 40"

< CHECKING >	*
--------------	---

< MEASURING >	*
---------------	---

SET !!



MEASURING
FACE 2 ?

—	—	[YES] [NO]
---	---	----------------

6. COORDINATE MEASUREMENT

- ⑬ Press [F3](YES) key. *4)

[F3]

The instrument rotates and the telescope turns to inverted position automatically and the measurement of the known point B starts. *3)

When the measurement of point B is completed, the instrument rotates and starts the measurement of known point A in inverted position. *3)

When the measurement of known point A is completed, the instrument rotates and the telescope turns to the normal position automatically.

Vertical angle error (dVA,dVB) and horizontal angle discrepancy (dH) will be displayed. *5)

V	:	269° 39' 15"
HR	:	250° 30' 40"
< POINT B (2) >		
< CHECKING >		*
< MEASURING >		*
SET !!		

V	:	269° 49' 50"
HR	:	190° 20' 35"
< POINT A (2) >		
< CHECKING >		*
< MEASURING >		*
SET !!		

< RETURN A>		
-------------	--	--

dVA :	0° 00' 10"
dVA :	-0° 00' 15"
dH :	0° 00' 05"
SET OK >	[YES][NO]

- ⑭ Confirm the vertical angle error and horizontal angle discrepancy and press [F3](YES) key. *6)

[F3]

Discrepancy (dHD) and discrepancy (dZ) will be displayed. *7)

dHD & dZ	
dHD :	-0.0012 m
dZ :	0.0023 m
SET OK >	[YES][NO]

- ⑮ Confirm the discrepancy, and press [F3](YES) key. *8)

[F3]

The coordinate of the instrument point will be displayed.

N :	1.2345
E :	2.3456
Z :	-3.4567
SET OK >	[YES][NO]

- ⑯ Confirm the coordinate of instrument point, and press [F3](YES) key.

[F3]

Setting coordinate value of the instrument is completed, the display returns to the previous measurement mode. *9)

V	:	90° 10' 20"
HR	:	10° 20' 30"
BS	CSET	RST 5↓

*1) Selecting 2D, will be omitted following input of instrument height, Z-Coordinate value, and prism height.

*2) In order to set value of the instrument height, use the soft key (CSET).

*3) Measuring takes time when the path of laser is disturbed frequently or the weather condition is not suitable.

*4) Press [F4](NO) key when the measurement in inverted position of telescope is not required, the procedure goes to step ⑤.

*5) Error message will be displayed when the vertical angle error or horizontal angle discrepancy is exceeded 60", and returns to the procedure ④ automatically.

Vertical angle error (dVA) of the known point A

$$dVA = [\text{Measured value in normal position}] + [\text{Measured value in inverted position}] - 360^\circ \quad (\text{at zenith})$$

Vertical angle error (dVB) of the known point B

$$dVB = [\text{Measured value in normal position}] + [\text{Measured value in inverted position}] - 360^\circ \quad (\text{at zenith})$$

Horizontal angle discrepancy (dH)

$$dH = [\text{Measured angle value between 2 points in normal position}] - [\text{Measured angle value between 2 point in inverted position}]$$

*6) When [F3](NO) key is pressed, the procedure returns to step ④.

*7) Error will be displayed when the angle of dHD or dZ is exceeded $\pm 999\text{mm}$, and the display changes to select for remeasurement. Press [F3](YES) key to select remeasurement and start from the procedure ④.

Horizontal distance discrepancy (dHD)

$$dHD = [\text{Horizontal distance between known point A and B based on measured value}] - [\text{Horizontal distance between known point A and B based on inputted coordinate value of known point A and B}]$$

Z coordinate discrepancy (dZ)

$$dZ = [\text{Z coordinate value of the instrument calculated from measured value of known point A}] - [\text{Z coordinate value of the instrument calculated from measured value of known point B}]$$

- In selecting 2 Dimensional measurement, Z coordinate discrepancy (dZ) will not be displayed.

*8) The screen displays selecting for remeasurement when [F4](NO) keys is pressed. Press [F3](YES) key to start remeasurement and returns to the procedure ④.

*9) In selecting 2 Dimensional measurement, N and E coordinate only will be set newly.

* Press [ESC] key or [F1](EXIT) key to cancel the setting mode on the way.

6. COORDINATE MEASUREMENT

● Manual Operation

[Example] : Setting 3 Dimensional measurement, 1 set of inverted measurement at the position of telescope in normal and inverted.

Confirm instrument mode is angle or distance measurement mode.

Operating procedure	Operating key	Display
① Press [F4](↓) key 4 times to be a function as in page 5.	[F4] 4 times	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div> <div>BS CSET RST 5↓</div>
② Press [F3](RST) key.	[F3]	<div>RESECTION</div> <div>F1 : 2D</div> <div>F2 : 3D</div>
③ Press [F2](3D) key. *1) (The instrument height which already entered by the soft key (CSET) will be displayed.)	[F2]	<div>INS. HT INPUT</div> <div>0.0000 m</div> <div>EXIT ↑ CLR ←</div>
④ Enter the instrument height and press [ENT] key. (If the value is accepted, press [ENT] key as it is.)	Input Inst.HT [ENT]	<div>INS. HT INPUT</div> <div>1.3000 m</div> <div>EXIT ↑ CLR ←</div> <div>SET OK > [YES][NO]</div>
⑤ Confirm the instrument height, press [F3](YES) key. *2)	[F3]	<div>POINT A</div> <div>N : ***** m</div> <div>E : ***** m</div> <div>EXIT ↑ CLR ←</div>
⑥ Enter the coordinate value of known point A and Prism height, and press [ENT] key.	Input N data [ENT] Input E data [ENT] Input Z data [ENT] Input Prism HT [ENT]	<div>POINT A</div> <div>Z : ***** m</div> <div>R . HT : ***** m</div> <div>EXIT ↑ CLR ←</div>
⑦ Enter the coordinate value of known point B and Prism height, and press [ENT] key.	Input N data [ENT] Input E data [ENT] Input Z data [ENT] Input Prism HT [ENT]	<div>POINT B</div> <div>N : ***** m</div> <div>E : ***** m</div> <div>EXIT ↑ CLR ←</div>
		<div>POINT B</div> <div>N : ***** m</div> <div>E : ***** m</div> <div>EXIT ↑ CLR ←</div> <div>SET OK > [YES][NO]</div>
⑧ Press [F3](YES) key.	[F3]	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>POINT A [SET]</div>

6. COORDINATE MEASUREMENT

- ⑨ Sight the instrument at the known point A properly by operating H/V jog/ shuttle.

- ⑩ Press [F3](SET) or [REC] key.

Measurement will be done 2 times.

When measurement of the known point A is completed, measurement of the known point of B starts.

- ⑪ Collimate the known point B properly by operating H/V jog/shuttle.

- ⑫ Press [F3](SET) or [REC] key.

Measurement will be done 2 times.

The screen displays for the selection of measurement in inverted position after measurement of the known point B is completed.

- ⑬ Press [F3](YES) key. *3)

- ⑭ Sight the instrument at the known point B properly in the inverted position by operating auto inversion key and H/V jog/shuttle.

- ⑮ Press [F3](SET) or (REC) key.

Measurement will be done 2 times.

- ⑯ Sight the instrument at the known point A properly in the inverted position by operating H/V jog/shuttle.

[F3]
or
[REC]

[F3]
or
[REC]

[F3]

[F3]
or
[REC]

V	:	90° 10' 20"
HR	:	10° 20' 30"
POINT B [SET]		

V	:	90° 10' 20"
HR	:	10° 20' 30"
SD*		< < <
< MEASURING >		

SET !!

V	:	90° 10' 20"
HR	:	10° 20' 30"
POINT B [SET]		

V	:	90° 20' 30"
HR	:	70° 30' 40"
POINT B [SET]		

V	:	90° 20' 30"
HR	:	70° 30' 40"
SD*		< < <
< MEASURING >		

SET !!

MEASURING		
FACE	2	?
--	--	[YES][NO]

V	:	269° 39' 15"
HR	:	250° 30' 40"
POINT B [SET]		

V	:	269° 39' 15"
HR	:	250° 30' 40"
SD*		< < <
< MEASURING >		

SET !!

V	:	269° 49' 50"
HR	:	190° 20' 35"
POINT A [YES][NO]		

6. COORDINATE MEASUREMENT

<p>⑰ Press [F3](SET) or (REC) key.</p> <p>Measurement will be done 2 times.</p> <p>Vertical angle error (dVA,dVB) and horizontal angle discrepancy (dH) will be displayed. *4)</p>	<p>[F3] or [REC]</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> V : 269° 49' 15" HR : 190° 20' 35" SD* < < < < MEASURING > </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; text-align: center;"> SET !! </div> <div style="text-align: center;">↓</div> <div style="border: 1px solid black; padding: 5px;"> dVA: : 0° 00' 10" dVA: -0° 00' 15" dH: 0° 00' 05" SET OK > [YES][NO] </div>
<p>⑱ Vertical angle error (dVA,dVB) and horizontal angle discrepancy (dH) will be displayed. *4)</p>	<p>[↔]</p>	
<p>⑲ Confirm the vertical angle error and horizontal angle discrepancy, and press[F3](YES)key. *5)</p> <p>Discrepancy (dHD) and discrepancy (dZ) will be displayed. *6)</p>	<p>[F3]</p>	<div style="border: 1px solid black; padding: 5px;"> dHD & dZ dHD: -0.0012 m dZ: 0.0023 m SET OK > [YES][NO] </div>
<p>⑳ Confirm the value, and press [F3](YES) key *7)</p> <p>The coordinate value of instrument point will be displayed.</p>	<p>[F3]</p>	<div style="border: 1px solid black; padding: 5px;"> N : 1.2345 E : 2.3456 Z : 3.4567 SET OK > [YES][NO] </div>
<p>㉑ Confirm the value, and press [F3](YES) key.</p> <p>Setting the coordinate of instrument point is completed, the display returns to the previous measurement mode. *8)</p>	<p>[F3]</p>	<div style="border: 1px solid black; padding: 5px;"> V : 90° 10' 20" HR : 10° 20' 30" BS CSET RST 5↓ </div>
<p>*1) Selecting 2D, will be omitted following input of instrument height, Z-Coordinate value, and prism height.</p> <p>*2) Use soft key (CSET) to set value of the instrument height.</p> <p>*3) Press [F4](NO) key when the measurement by inverted position of telescope is not required,the procedure goes to step ㉑.</p> <p>*4) Error message will be displayed when the vertical angle error or horizontal angle discrepancy is exceeded 60", and returns to the procedure ⑨ automatically.</p> <p>Vertical angle error (dVA) of the known point A</p> $dVA = [\text{Measured value in normal position}] + [\text{Measured value in inverted position}] - 360^\circ \quad (\text{at zenith})$ <p>Vertical angle error (dVB) of the known point B</p> $dVB = [\text{Measured value in normal position}] + [\text{Measured value in inverted position}] - 360^\circ \quad (\text{at zenith})$ <p>Horizontal angle discrepancy (dH)</p> $dH = [\text{Measured angle value between 2points in normal position}] - [\text{Measured angle value between 2point in inverted position}]$ <p>*5) [F3](NO) key is pressed,the procedure returns to step ⑨.</p>		

- *6) Error message will be displayed when the angle of dHD or dZ is exceeded $\pm 999\text{mm}$, and the display changes to select for remeasurement. Press [F3](YES) key to select remeasurement and start from the procedure ⑥.

Horizontal distance discrepancy (dHD)

$$\text{dHD} = [\text{Horizontal distance between known point A and B based on measured value}] - [\text{Horizontal distance between known point A and B based on inputted coordinate value of known point A and B}]$$

Z coordinate discrepancy (dZ)

$$\text{dZ} = [\text{Z coordinate value of the instrument calculated from measured value of known point A}] - [\text{Z coordinate value of the instrument calculated from measured value of known point B}]$$

- In selecting 2 Dimensional measurement, Z coordinate discrepancy (dZ) will not be displayed.
- *7) The screen displays selecting for remeasurement when [F4](NO) keys is pressed. Press [F3](YES) key to start remeasurement and returns to the procedure ⑥.
- *8) In selecting 2 Dimensional measurement, N and E coordinate only will be set newly.
- * Press [ESC] key or [F1](EXIT) key to cancel the setting mode on the way.

6.3 Setting Height of Target (Prism Height)

This mode can be used to obtain Z coordinate values . The value of target height (prism height) in this mode will be eliminated when power is OFF.

Confirm instrument mode is angle or distance measurement mode.

[Example] Target height : 1.3m

Operating procedure	Operating key	Display
① Press [F4](↓) key 5 times to be a function as in page 6.	[F4] 5 times	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div> <div>MOVE R. HT -- 6↓</div>
② Press [F2](R.HT) key.	[F2]	<div>REFLECTOR HIGHT</div> <div>R. HT : 0.0000 m</div> <div>EXIT --- CLR ←</div>
③ Input the value of target height and press [ENT] key.	[1] [.] [3] [ENT]	<div>REFLECTOR HIGHT</div> <div>R. HT : 1.3000 m</div> <div>SET OK > [YES][NO]</div> <div>SET !!</div>
④ Press [F3](YES) key.	[F3]	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>MOVE R. HT -- 6↓</div>
Setting is completed, the display returns to the previous measurement mode .		
Setting range: $-10.0000\text{m} \leq \text{Target height} \leq +10.0000\text{m}$		

6.4 Execution of Coordinate Measuring

Operating the coordinate measuring by setting coordinate of the instrument point, the instrument height and prism height enables the operator to obtain the coordinates of the measuring point.

- For the setting of coordinate of the instrument point and instrument height refer to "6.2 Setting Coordinate of Instrument Point"
- Setting for Prism height, refer to "6.3 Setting Target height (Prism height)".
- The coordinates of unknown point (N_1, E_1, Z_1) can be calculated as following formula.

Coordinates of instrument point : (N_0, E_0, Z_0)

Instrument height : INS.HT

Prism height : R.HT

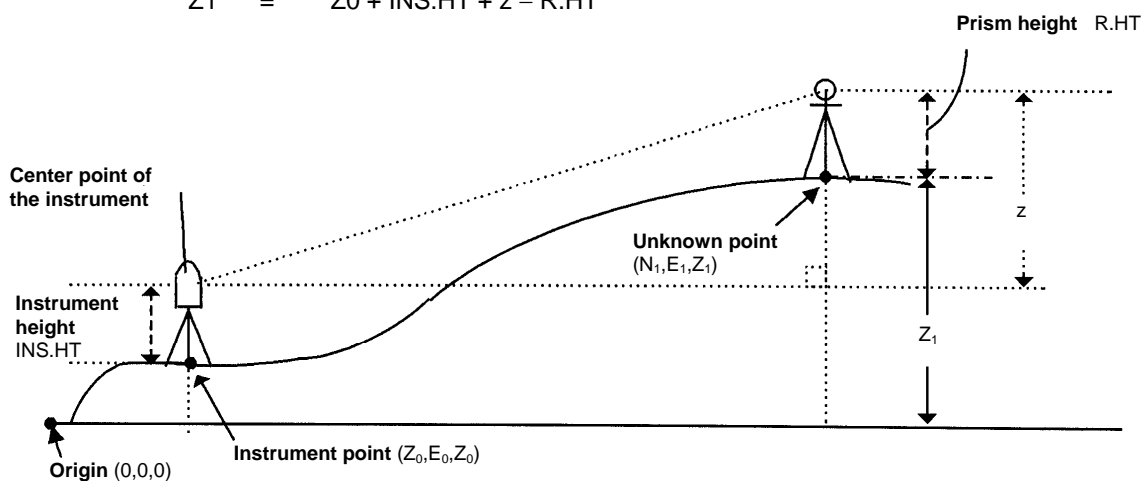
The coordinates of prism center, originated from the center point of the instrument : (n, e, z)

That is:

$$N_1 = N_0 + n$$

$$E_1 = E_0 + e$$

$$Z_1 = Z_0 + \text{INS.HT} + z - \text{R.HT}$$



Confirm the mode is set in angle measurement

Operating procedure	Operating key	Display
① Set instrument coordinate point and instrument height. *1	[F2]	<div>V : 90° 10' 20"</div> <div>HR : 120° 30' 40"</div> <div>0SET HSET R/L 1↓</div>
② Collimate bearing point A.		
③ Press [F2](HSET)key. Set direction angle of backsight point A. *2)		<div>H-SET</div> <div>HR :</div> <div>EXIT --- CLR ←</div>

6. COORDINATE MEASUREMENT

<p>④ Input the value of H angle to be set, and press [ENT] key. Example: 70°40'20"</p>	<div>7 0 .</div> <div>4 0</div> <div>2 0</div> <div>[ENT]</div>	<div> H-SET HR : 70.4020 EXIT --- CLR ← </div> <div>< SET! ></div> <div> V : 90° 10' 20" HR : 70° 40' 20" 0SET HSET R/L 1↓ </div>
<p>⑤ Set the prism height of the unknown point B. *3) ⑥ Collimate the target prism B.</p>	<div>[NEZ]</div>	<div> V : 91° 45' 20" HR : 62° 09' 20" 0SET HSET R/L 1↓ </div> <div> N : 35.678 m E : 67.543 m Z : 2.354 m 0SET HSET R/L 1↓ </div>
<p>*1) In case the coordinate of instrument point is not entered, (0,0,0) will be used as the default for the instrument point. The instrument height will be calculated as 0 when the instrument height is not entered.</p> <p>*2) To set a direction angle to a coordinate value of a backsight point A and instrument point, refer to Chapter 6.1. "Setting a Direction Angle for Horizontal Orientation".</p> <p>*3) The prism height will be calculated as 0 when the prism height is not set.</p>		

7. APPLICATION FUNCTIONS

7.1 How to Cancel Error of Automatic Tracking Optical Axis

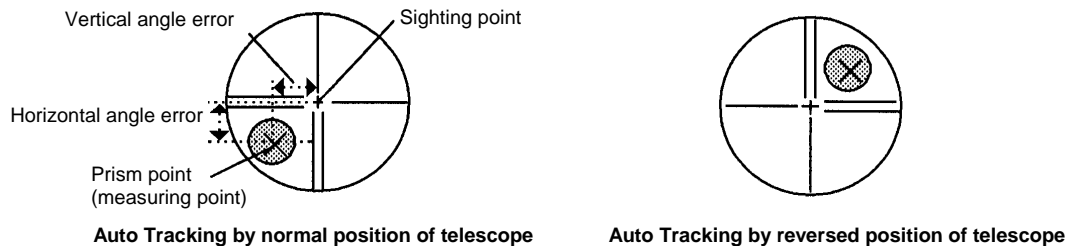
When measuring in Automatic Tracking mode, there is a possibility for angular error due to misalignment of the telescope axis and auto tracking optical axis. Precaution is required for accurate measurement under the sunny days in summer or very cold days in winter.

The errors of Auto Tracking Optical Axis can be canceled using the following procedure.

● One Set of Inverted Observation

When the target prism is still, it is possible to cancel error of Auto Tracking Optical Axis by calculating the measured data in each the face 1 (normal position) and face 2 (reversed position) of the telescope.

The theory for canceling is the same as used for compensating for vertical axis error or horizontal axis error. The calculations and procedures are similar.



[Calculation example]

Horizontal angle observation

Observation value of Target-1

Normal Telescope position $r1 = 0^\circ 02' 25''$

Reversed Telescope position $l1 = 180^\circ 02' 15''$

Observation value of Target-2

Normal Telescope position $r2 = 51^\circ 17' 30''$

Reversed Telescope position $l2 = 231^\circ 17' 20''$

The included angle of Target 1 and 2 is ;

$$\frac{(r2 + l2) - (r1 + l1)}{2} = 51^\circ 15' 05''$$

Vertical angle observation (Zenith 0)

Normal Telescope position $r = 87^\circ 11' 20''$

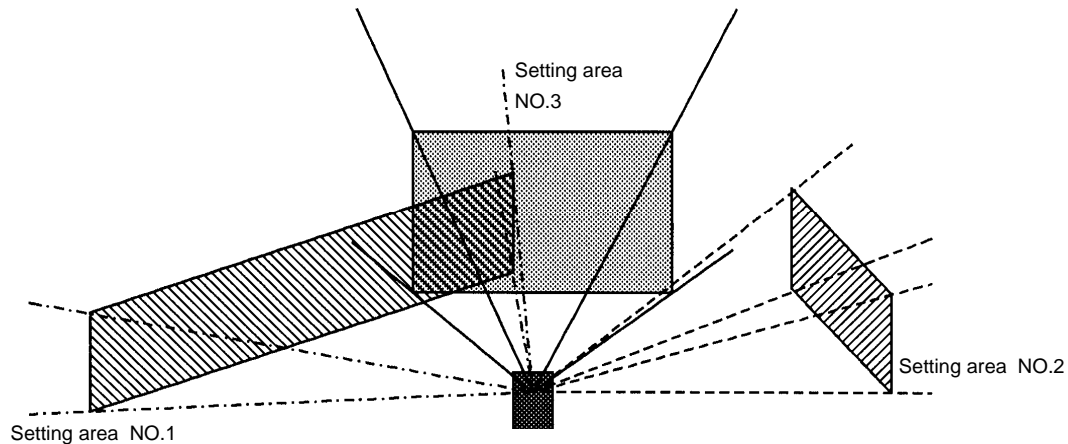
Reversed Telescope position $l = 272^\circ 48' 50''$

Vertical angle is ;

$$\frac{r - l}{2} + 180^\circ = 87^\circ 11' 15''$$

7.2 Area Setting

Setting a predetermined surveying area to AP-L1A beforehand, AP-L1A sights and tracks set area only. This function protects mistracking to the other prisms that might be near the measuring site or the refraction off objects running near the site. This function is also effective for finding a lost prism.



To set specified area, input vertical and horizontal area by sighting or entering a coordinate value

- The maximum setting area is 4, [and specified area can be doubled each other.]
- Specifying a number to each area, enables user to change effective areas by numbers.

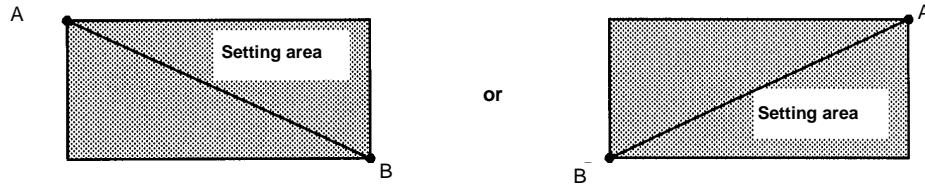
- * When area set is On, you can not sight outside the area set even in manual mode.
- * Reversing the telescope is possible with set area by auto inversion key or turn over command.
- * Don't use telescope rotating free lever or instrument rotating free lever when Area set is being ON.
- Operating procedure
 - ① Set area range (see 7.2.1 Setting Area")
 - ② Turn Area set ON, and set effective area No. (see 7.2.2. Area set function ON, and set effective area Number.")
 - ③ Sight specified area by the manual mode.
- * When collimating to the effective area is done once after area setting is ON, it is impossible to collimate to the other area which already is set.
 To collimate to the out of setting area, change the setting of effective area to another area or make area setting function OFF.

7.2.1 Setting Area

Point out 2 opposite angle points for area to be set. There are two methods as follows:

- ① Sighting directly to the 2 opposite angle points A & B.
- ② Input coordinate value.

The set value of each area is memorized after power is shut OFF.



- Input range To the horizontal : The angle in between A and B should be within 180°
To the vertical : From zenith to nadir
- Changing or resetting of, 0 set , coordinate of instrument point and direction angle or horizontal angle after setting the area range will not effect area range. No need to input area range again.

1) Setting by sighting directly

Operating procedure	Key Operation	Display
① Press [MENU] key in the normal measurement mode.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F2:PROGRAMS].	[F2]	<div>PROGRAMS 1/1</div> <div>F1 : TEACH</div> <div>F2 : AREA SET</div>
③ Select [F2:AREA SET].	[F2]	<div>AREA SET</div> <div>F1 : INPUT NEZ</div> <div>F2 : MOVED SET</div> <div>F3 : SETTING AREA</div>
④ Select [F2:MOVED SET]	[F2]	<div>AREA SET A [1]</div> <div>V : ° ° ' " *</div> <div>H : ° ° ' " *</div> <div>EXIT ← → ENT</div>
⑤ Select a setting area Number. Press [F2](←) or [F3](→), and select the number of right upper corner in the screen display and press [F4](ENT) key.	[F2] or [F3] [ENT]	<div>AREA SET A [1]</div> <div>V : 83° 56' 30"</div> <div>H : 250° 40' 50"</div> <div>EXIT ↑ --- SET</div>
⑥ Sight Point A by telescope.		<div>AREA SET A [1]</div> <div>V : 95° 45' 10"</div> <div>H : 140° 30' 20"</div> <div>EXIT ↑ --- SET</div>

7. APPLICATION FUNCTIONS

⑦ Confirm the sighted point and press [F4](SET) key. Point A is now set. Next set point B.	[F4]	<div> <div>AREA SET B [1]</div> <div>V : 110° 38' 40"</div> <div>H : 200° 20' 15"</div> <div>EXIT ↑ --- SET</div> </div>
⑧ Sight the point B with telescope.		<div> <div>AREA SET B [1]</div> <div>V : 140° 16' 10"</div> <div>H : 250° 28' 45"</div> <div>EXIT ↑ --- SET</div> </div> <div> <div>SET OK > [YES] [NO]</div> </div>
⑨ Confirm the sighted point and press [F4](SET) key.	[F4]	<div> <div>AREA SET A [1]</div> <div>V : 95° 45' 10"</div> <div>H : 140° 30' 20"</div> <div>EXIT ← → ENT</div> </div>
⑩ Press [F3](YES) key. The area range to be set is diagonal setting area between Points A and B (area No.1). To set another area, repeat from the step of ⑤.	[F3]	<div> <div>AREA SET</div> <div>F1 : INPUT NEZ</div> <div>F2 : MOVED SET</div> <div>F3 : SETTING AREA</div> </div>
⑪ Press [F1](EXIT) key. Menu returns to AREA SET . *1)		
*1) Pressing [ESC] key from the AREA SET menu returns you to PROGRAMS menu, and to return to normal mode, press [MENU] key.		

2) Setting by inputting coordinate values

Operating procedure	Key Operation	Display
① Press [MENU] key in the normal measurement mode.	[MENU]	<div> <div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div> </div>
② Select [F2:PROGRAMS].	[F2]	<div> <div>PROGRAMS 1/1</div> <div>F1 : TEACH</div> <div>F2 : AREA SET</div> </div>
③ Select [F2:AREA SET].	[F2]	<div> <div>AREA SET 1/1</div> <div>F1 : INPUT NEZ</div> <div>F2 : MOVED SET</div> <div>F3 : SETTING AREA</div> </div>
④ Select [F1:INPUT NEZ].	[F1]	<div> <div>AREA SET A [1]</div> <div>V : ***,***m</div> <div>H : ***,***m</div> <div>EXIT ← → ENT</div> </div>

7. APPLICATION FUNCTIONS

<p>⑤ Select a setting area Number. Press [F2](←) or [F3](→), and select the number of right upper corner in the screen display and press [F4](ENT) key.</p>	<p>[F2] or [F3] [ENT]</p>	<pre> AREA SET A [2] N : ***.*** m E : ***.*** m EXIT ↑ CLR ← - </pre>
<p>⑥ Input coordinate value of point A, and press [ENT] key.</p> <p>The displays changes to input point B.</p>	<p>N Coord. [ENT] E Coord. [ENT] Z Coord. [ENT]</p>	<pre> AREA SET A [2] Z : 3.4567 m EXIT ↑ CLR ← - </pre>
<p>⑦ Input coordinate value of point B, and press [ENT] key.</p>	<p>N Coord. [ENT] E Coord. [ENT] Z Coord. [ENT]</p>	<pre> AREA SET B [2] N : ***.*** m E : ***.*** m EXIT ↑ CLR ← - </pre>
<p>⑧ Press [F3](YES) key. The area range to be set is diagonal area range between Points A and B (area No.2). To set another area, repeat from the step of ⑤.</p>	<p>[F3]</p>	<pre> AREA SET B [2] Z : 4.5678 m EXIT ↑ CLR ← - SET OK) [YES] [NO] </pre>
<p>⑨ Press [F1](EXIT) key. The menu returns to AREA SET. *1)</p>	<p>[F1]</p>	<pre> AREA SET A [2] N : 1234.5678 m E : 6543.4321 m EXIT ← → ENT </pre>
<pre> AREA SET 1/1 F1 : INPUT NEZ F2 : MOVED SET F3 : SETTING AREA </pre>	<p>*1) Pressing [ESC] key from the AREA SET menu returns you to PROGRAMS menu, and to return to normal mode, press [MENU] key.</p>	

7.2.2 Area Set Function ON, and Set Effective Area No.

ON / OFF of area set function and effective area Number is specified. Whenever instrument is powered up, these functions are set automatically in the OFF position.

Operating procedure	Key Operation	Display
① Press [MENU] key in the normal measurement mode.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F2:PROGRAMS].	[F2]	<div>PROGRAMS 1/1</div> <div>F1 : TEACH</div> <div>F2 : AREA SET</div>
③ Select [F2:AREA SET].	[F2]	<div>AREA SET</div> <div>F1 : INPUT NEZ</div> <div>F2 : MOVED SET</div> <div>F3 : SETTING AREA</div>
④ Select [F2:SETTING AREA].	[F2]	<div>AREA MODE</div> <div>OFF</div> <div>EXIT ↑ ↓ ENT</div>
⑤ Press [F2](↑), [F3](↓) key, and select ON .Press [F4](ENT) key.*1)	[F2] or [F3] [ENT]	<div>AREA MODE</div> <div>AREA 1</div> <div>EXIT ↑ ↓ ENT</div>
⑥ Select effective setting area Number [F2](↑), [F3](↓) key is to select, and press [F4](ENT) key.	[F2] or [F3] [ENT]	<div>AREA MODE</div> <div>AREA 2</div> <div>EXIT ↑ ↓ ENT</div>
Effective area is set, and returns to AREA SET menu.		<div>AREA SET 1/1</div> <div>F1 : INPUT NEZ</div> <div>F2 : MOVED SET</div> <div>F3 : SETTING AREA</div>
To return to normal mode, press [MENU]key.		
*1) Selecting OFF returns to AREA SET menu.		

7.3 Setting Tracking Parameter

A proper setting for each parameter such as, travel speed of prism, layout of prisms at job site, minimum tracking distance, and required measuring accuracy are necessary for custom use.

See how to set to "15.1.1 TRK-SET : Setting for Tracking Functions" for each items.

7.3.1 Setting Tracking Speed

The tracking accuracy (aiming accuracy) shall be determined in the best condition by the relationship of moving speed of the prism and the distance between AP-L1A and the prism at the field. Since the tracking speed represents the rotating speed of AP-L1A, if the prism's traveling speed is high, yet the distance of the prism is far from the AP-L1A, the tracking speed can be low.

Each setting (Low/Medium/High) has each characteristic, typically tracking accuracy (aiming accuracy). See Chapter 22 "Specifications".

Although High speed setting is suitable for tracking prism which is moving in higher speed, Medium speed setting does not have significant disadvantage in tracking ability except the mentioned tracking accuracy.

Typical situation that each setting is recommended for are as in followings.

LOW (Low speed)	<ul style="list-style-type: none"> ● In case requiring auto aiming in high accuracy to the prism which is still or almost still. ● Required measuring accuracy in still condition but not tracking performance during traveling prism. ● Suitable for fixed point observation, management of landslides, surveying displacement of dam or bridge and control work for sealed machine.
MEDIUM (Medium speed)	<ul style="list-style-type: none"> ● This setting mode is in good balance both for tracking performance of traveling objects and sighting accuracy in still condition. ● Suitable for one person surveying or stake out work. ● Used when accuracy is as important as continuous relative position data of the prism which is traveling in high speed.
HIGH (High speed)	<ul style="list-style-type: none"> ● Measuring accuracy is prior to high speed tracking than low. ● Suitable for controlling of construction machinery in high speed or real time surveying of variety traveling objects.

7.3.2 Setting of Tracking Detecting Sensitivity

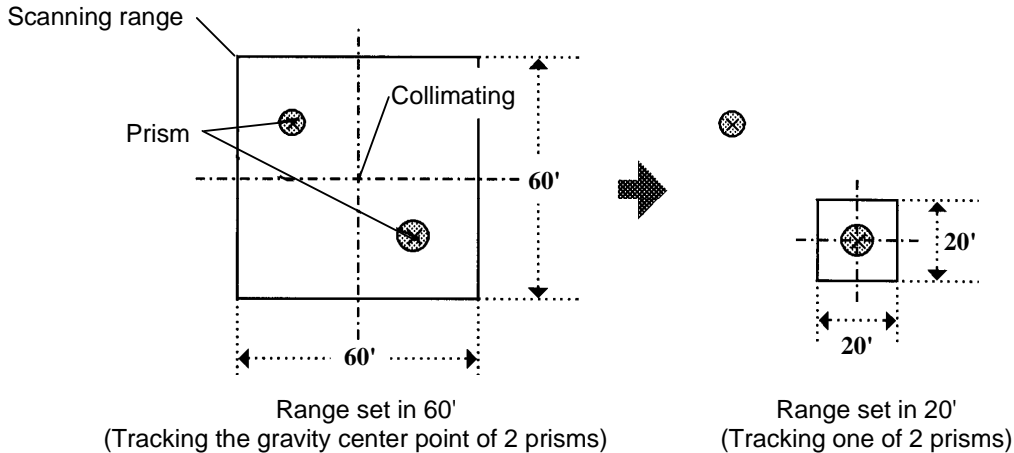
In the case of relatively near distance surveying, setting in low or medium sensitivity is effective to avoid measuring error come from extra reflectors except prism such as cars or motorcycles. In the same time, you have to know when you set in low or medium, the tracking possible distance also will be short. Normal setting is in high sensitivity.

	Tracking possible distance (in normal atmospheric condition)	
	Prism type 2 1p	Pin-pole prism 1p
HIGH	1,000m (3,300ft)	700m (2,300ft)
MEDIUM	about 400m (1,300ft)	about 400m (1,300ft)
LOW	about 200m (650ft)	about 200m (650ft)

7.3.3 Setting Scanning Range

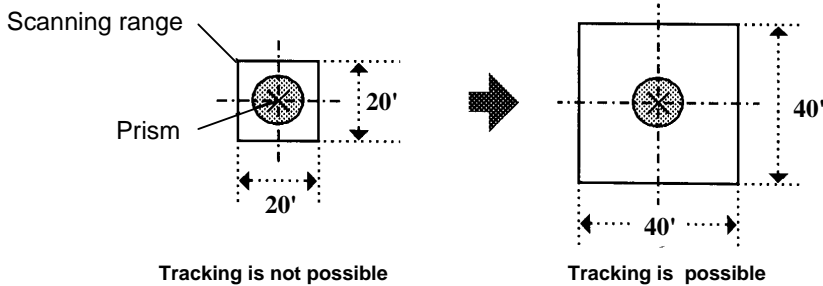
By scanning laser beam, AP-L1A detects the prism position. In case of multiple prisms are set near each other, can be within scanning range of laser beam, tracking will be done by gravity center point (see Chapter 2.6 "Layout of Prism") of multiple prisms. And this can be caused measuring error. Setting is required to be a smaller range for scanning in this case.

[Example]



The minimum effective distance between the prism and the AP-L1A in auto tracking mode is the distance when prism size shows half of scanning range. If the prism size is bigger than half of the scanning range, set scanning range bigger.

[Example]



The following table shows minimum tracking distance by each scanning range and a prism type, in auto tracking mode.

Prism type	Scanning range		
	WIDE (60'×60')	MIDDLE (40'×40')	NARROW (20'×20')
Prism type-2 , 1 pc (Normal prism)	7m (23ft)	10m (33ft)	20m (66ft)
Prism type-3 or type-5, 1 pc	4m (13ft)	6m (20ft)	12m (39ft)
Prism unit type-A2/A3, all round type 6 pcs	10m (33ft)	15m (49ft)	30m (98ft)

- When scanning range is changed, check the optical axis of auto tracking as shown in chapter 17.5 "Inspection and Adjustment of Optic axis for Auto-Tracking" .
- It is recommended not to set of scanning range NARROW (20'×20') in the long distance more than 500m as possible.

7.3.4 Search Range

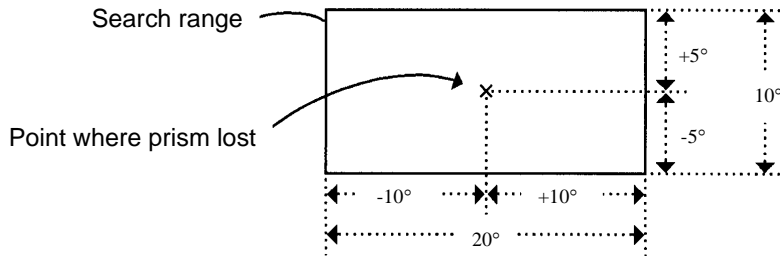
The search range is the area to be searched for the prism by rotating the telescope and body in SEARCH mode. The SEARCH range is decided from the point where the prism is lost, and the values will be set to plus and minus directions in horizontal and vertical.

Select search pattern first, and set the search area to the selected search pattern.

(Refer to "15.4 Setting Special Mode")

Also it is possible to set each search pattern separately in normal and high speed pattern.

[Example] SEARCH range : 10° in horizontal, 5° in vertical



Setting Search range requires consideration. The items to think about: optical path interrupted by passing cars or passengers; collimated point from AP-L1A to prism is shifted after Turning and Searching Command; possible other prisms, targets, or other objects to interfere with tracking the desired prism; and many other examples all play a role in determining the search range.

7.3.5 Search Patterns

The search pattern is the rotating method of telescope and instrument to find the target prism in search mode. Search pattern includes the following 2 ways that can be selected.

High speed	<p>This pattern can be selected to search for the prism. The search pattern tries to locate the prism in a very short time.</p> <p>Instrument searches from up to down. The search range is in high speed.</p> <p>The searching is arranged to 10 times until the prism is found. The auto tracking mode changes to manual mode when the prism could not be found out within 10 times searching, and returns to the point where the prism is lost.</p>
Normal speed	<p>This pattern can be selected to search the prism at the point where the prism is lost.</p> <p>Instrument searches in up down direction gradually from the point where the prism is lost.</p> <p>The searching continues until the prism is found.</p>

* Precaution in selection of high speed pattern

- 1) Things like heat haze might interfere with the tracking system in the long distance, near limit of auto tracking range, in search mode.
- 2) Reaction by rotating of instrument in search mode is serious. Be sure of each connection part of the tribrach or tripod are firmly.

7.4 Tracking Indicator

A man who is staying on line with the direction of AP-L1A or automatic tracking status by emitted LED light (orange color) from AP-L1A.

● Operation

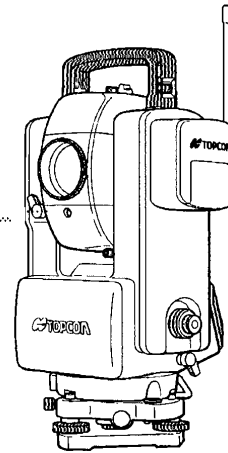
Pressing [T.I.] key functions Tracking Indicator.

The tracking indicator status will be changed according to the type of auto tracking mode and its conditions. A man from the prism side can recognize the status of instrument.

When angle measuring value turns stable during tracking still object, the tracking indicator changes from quick continuous flashing to quick intermittent flashing. So you can decide from the sign of flashing for recording data timing at one person surveying.

Meaning of Tracking Indicator ON or Flashing

Tracking Indicator	Status of instrument
Continuous ON	"Search" or "Wait" status (in auto mode)
Slow flashing	Manual mode
Quick continuous flashing	In case angle measuring value is instable during auto tracking mode.
Quick intermittent flashing	In case angle measuring value is stable during auto tracking mode.



- * The function of the Tracking Indicator will be used as a guide to know the status of AP-L1A from the prism side. This is not a function to determine precise collimating for measuring.
- * The effectiveness of the Tracking Indicator depends on the relative visibility and one's eyesight. The range of the Tracking indicator could reach about 100 m.
- * Using Tracking Indicator mode will result shorter in reduced time out of the external battery.

7.5 Available Time Data Function

The data measured can be output at specific measured time by AP-L1A. (For more information, refer to AP-L1A/AP-L1AN interface manual.) This timed data function is helpful for the purpose of analyzing or comparing data collected in large volumes, and also available for post processing connected with computer or other measuring device. For more information, refer to AP-L1A/AP-L1AN interface manual.

- Tracking and analyze traveling object.
- Comparison between three dimensional coordinate of traveling object measured by AP-L1A and measured data measured by other instrument.
- Analyzing changes over long period of time.

Understand that the time mentioned may experience a time shift specially in distance measurement when tracking a traveling object moving at high rates of speed as following:

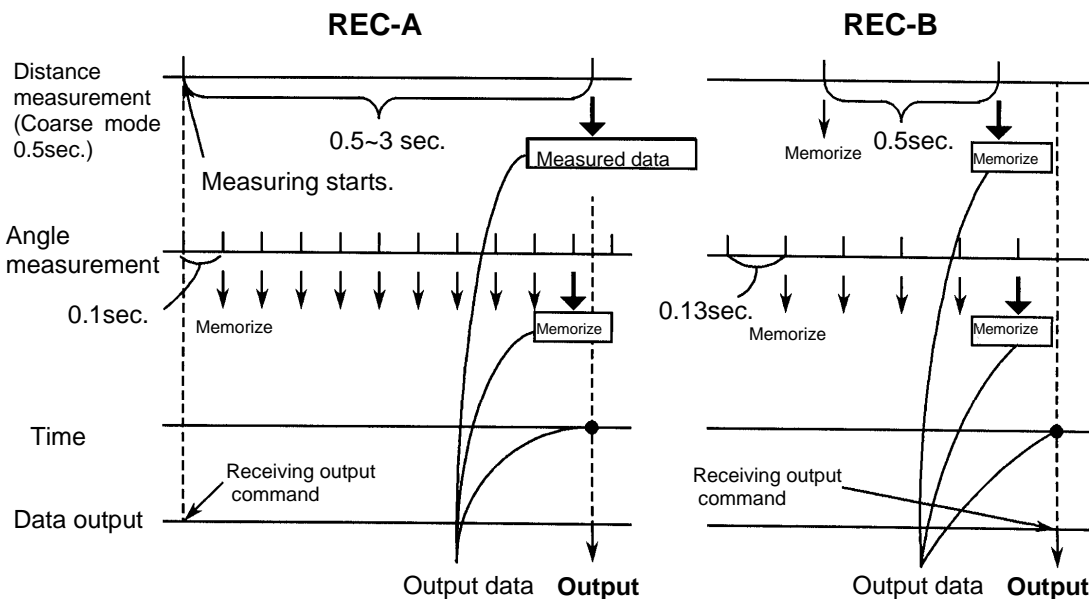
- It takes 0.5 or 0.2 second for distance measurement in Tracking mode, and the measured value is an average distance value within a period of time. The measured data will be memorized in AP-L1A every 0.5 (0.2) second. (In the case of traveling objects moving fast, measurement in fine mode can not be performed. Also, if unstable measuring light quantity is experienced, this can be the cause of automatic remeasuring so that the period of 0.5 (0.2) second is not fixed period.)
- The measured data for angle measurement will be memorized in the instrument every 0.01 second by REC-A type or every 0.13 second by REC-B type.

Timing of output data by REC-A :

Distance measurement starts when data output command is received and measured distance data will be output with memorized angle data when distance measurement is completed. The mentioned time data is the time of output. The time data is almost synchronized with angle and distance data.

Timing of output data by REC-B :

The latest measured distance and angle data which were memorized in the AP-L1A, will be output with time data when data output command is received. The time shows output time. So the time data is not synchronized with distance and angle data.



7.6 Setting AP-L1A Wireless Modem

The wireless modem specifications will differ by market. The setting function of following communication channels is not consistent in some markets.

7.6.1 Setting Wireless Communication Channels

In the case where multiple AP-L1A's with wireless terminal WT-1A/1B's or using other wireless terminals are being used, avoid mixture of information by changing the setting of the communication channels of AP-L1A and wireless terminal WT-1A/1B.

Set the channels to be same for AP-L1A and wireless Terminal WT-1A/1B.

● How to Select the Communication Channels

To select channel number to be used, consider following 2 items.

- (1) To avoid radio interference, select the channel number of frequency as far as possible to the frequency of other AP-L1A and WT-1A/1B, or other radio transmitter.

(For example) : Select not 7CH and 8CH, but 7CH and 46CH in case using 2 sets of AP-L1A and WT-1A/1B.

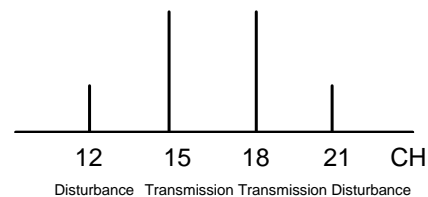
- (2) Avoid radio disturbance by tertiary intermodulation in case using 3 radio sets or more.

Radio disturbance by tertiary intermodulation meaning that if radio wave of more than two different frequencies are transmitted in the same time, a discrepancy (or sum) of these frequencies will be produced. This affects as interrupt of radio wave on the 3rd receiver. That is why you should avoid from using the channel which a discrepancy produced between 2 channels.

(For example) Transmitting in the same time at 15CH and 18CH

12CH and 21CH is equal to a discrepancy produced by 15CH and 18CH frequencies.

So they shall get disturbance.



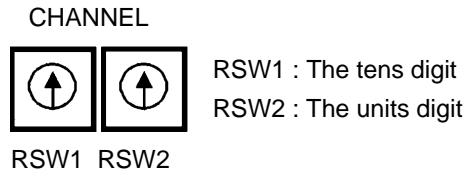
The following are good selecting sample for 3 to 6 sets. Of course this table is supposed radio wave only in case of AP-L1A and WT-1A/1B used. If you are using other radio transmitter, it is necessary to be considered in such frequencies.

Sets number	Sample of available channel number					
3	8,	21,	46			
4	8,	14,	28,	46		
5	8,	12,	18,	26,	46	
6	8,	12,	18,	26,	33,	46

● How to Set the Communication Channels

1. Open the cover of wireless modem of AP-L1A, pulling bottom of cover to forward.
2. Set the channel rotary switch using accessory screw driver as in the following drawing, and close the cover.

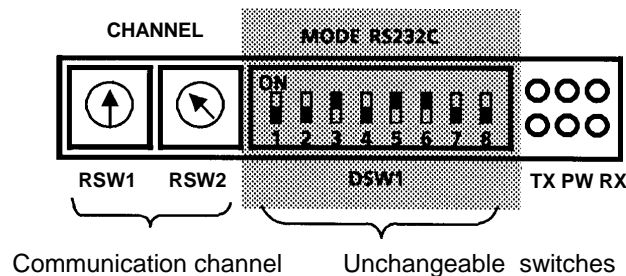
The communication channel for the wireless modem will be set according to the position of RSW1 and RSW2.



[Example]



- Select the one of the channel number from 07 to 46.
- All other DSW1 switches should be left alone UNTOUCHED. If the position changed, communication may be disabled.



- In case to change channel number, carry out in normal mode or power off state. Whatever the rotary switch is changed in remote mode (wireless communication mode), the actual channel is not changed.

Same as WT-1A/1B, it is required to carry out in power off state.

- Note
- 1) Do not use the channel 00 to 06 and 47 to 99. Even if you select one of these numbers, the channel is set to 07 or 46 by force.
 - 2) The transfer frequency for channel 7 is 429.2500MHz, and increases 12.5 kHz every 1 channel, and it is 429.7375MHz at channel 46.
For some markets, wireless modem with fixed radio frequency may be attached to AP-L1A, and is built in WT-1A/1B.
 - 3) Set position at shipping time is ; It is set to channel 8 with wireless modem.
RSW1 0
RSW2 8
DSW1 (Unchangeable switches)
..... "OFF, OFF, ON, OFF, ON, ON, OFF, OFF"

7.7 Secret Mode

Setting secret code (4 digit number) and activating ON of Secret mode can be helpful to avoid miss operation by unauthorized operator. This function is effective when measuring is performed in remote mode by one person surveying.

Operating Procedure

- 1) Set 4 digits number as a secret code, and select secret mode ON.
- 2) When secret mode is ON and user powers up and returns to normal mode from remote mode, the secret code is needed to be input.

Note) Never forget the secret code which you set.

If forgotten you can not operate any function on the AP-L1A and it must be returned to an authorized Topcon dealer for repair.

○ How to Set Secret Code and ON/OFF Switches for Secret Mode

- For example : Setting 7373 as secret code and select secret mode ON

Operating procedure	key Operation	Display
① While pressing [F2] key, power ON. <ul style="list-style-type: none"> ● If the secret code is already set, input the secret code. *1) 	[F2] + POWER ON	<div style="border: 1px solid black; padding: 5px; text-align: center;">[PARAMETERS SET]</div> <div style="text-align: center;">↓</div> <div style="border: 1px solid black; padding: 5px;"> PARAMETERS 1/1 F1 : ANGLE F2 : DIST F3 : SECRET </div>
② Select [F3:SECRET] .	[F3]	<div style="border: 1px solid black; padding: 5px;"> SECRET F1 : SECRET M ODE F2 : SECRET CODE </div>
③ Select [F2:SECRET CODE].	[F2]	<div style="border: 1px solid black; padding: 5px;"> SECRET CODE : **** EXIT --- CLR ← - </div>
④ Input secret number 7373.	7 3 7 3	<div style="border: 1px solid black; padding: 5px;"> SECRET CODE : 7373 EXIT --- CLR ← - </div>
⑤ Press [ENT] key.	[ENT]	<div style="border: 1px solid black; padding: 5px; text-align: center;"> < SET! > </div>

7. APPLICATION FUNCTIONS

<p>Display returns to SECRET MENU.</p> <p>⑥ Select [F1:SECRET MODE].</p> <p>⑦ Press [F2] (↑), [F3] (↓) key, select ON, and press [F4] (ENT) key.</p> <p>⑧ Power OFF</p>	<p>[F1]</p> <p>[F4]or[F3] [F4]</p>	<pre> graph TD A["SECRET F1 : SECRET MODE F2 : SECRET CODE"] --> B["SECRET EXIT ON ENT ↑ ↓ < SET! >"] B --> C["SECRET F1 : SECRET MODE F2 : SECRET CODE"] </pre>
<p>*1) If the secret code that is already set is mis-input 4 times continuously, the power will be automatically OFF.</p>		

7.8 remote mode

The remote mode is the mode to communicate between AP-L1A and wireless terminal WT-1A/1B. It enables the receiving of measured data or control of AP-L1A by data terminal FS/2 . This is the only mode for mode for wireless communication (remote mode).

- Except the key return to normal mode, no other keys on AP-L1A function in remote mode. However , it is available to make jog shuttle function ON by communication form data terminal.

7.8.1 How to Switch Remote Mode

Operating procedure	Operating key	Display
① Press [MENU] key from the normal mode.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F3:REMOTE]	[F3]	<div>REMOTE 1/1</div> <div>F1 : REMOTE</div>
③ Select [F1:REMOTE] Mode changes to remote mode.	[F1]	<div>REMOTE</div> <div>EXIT --- --</div>

7.8.2 How to Switch Remote Mode to Normal Mode (Manual mode)

Operating procedure	Operating key	Display
① Press [F1] (EXIT) key of remote mode.	[F1]	<div>REMOTE</div> <div>EXIT --- --</div>
② Input secret code when secret mode is ON, and press [ENT] key. *1)	Input secret code [ENT]	<div>REMOTE</div> <div>SECRET :</div> <div>EXIT --- --</div>
③ Press [ESC] key, and press [MENU] key. Mode will be changed to normal mode.	[ESC] [MENU]	<div>REMOTE 1/1</div> <div>F1 : REMOTE</div>
*1) If the secret code that is already set is mis-input, it is not possible to change to normal mode.		

8. APPLICATION MEASUREMENT

8.1 One Person Surveying and Stake Out

Using AP-L1A with wireless terminal (WT-1A/1B), and Data terminal enables a single operator to perform surveying and stake out jobs alone. The following is the procedure on how to perform these tasks alone. Refer to "Data Terminal" instruction manual for detail.

① **Preparation**

- Set all necessary parameters and configuration for data terminal .
- Confirm settings of wireless channel between AP-L1A and wireless terminal.
- Up load coordinate value of the stake out point into the data terminal or hand input data in field prior to the stake out work.

② **Setting AP-L1A**

- Set AP-L1A to a known or random point. Prepare wireless terminal, data terminal, and prism.

③ **Confirming the optics axis alignment for auto tracking**

- Set prism faced to AP-L1A located 30~50m far away from AP-L1A. Confirm that the instrument is in the center of prism when tracking. When there is any error, adjust according to Chapter 17.5 "Inspection & Adjustment of Optic Axis for Auto-Tracking".

④ **Setting area**

- A set area can be used in survey or stake out in AP-L1A . Setting an area is not always necessary but may prove to be convenient to, find the lost prism, for re-tracking, or to avoid unnecessary tracking to the other reflective objects. Please refer to Chapter 7.2 "Setting area" .

⑤ **Change mode in AP-L1A to wireless communication and confirm this communication**

- Operating AP-L1A in remote mode.
- Carry wireless terminal (WT-1A/1B) away from the AP-L1A and confirm the communication status. The wireless communication between AP-L1A and wireless terminal can be done only if AP-L1A is in the remote mode. To change to remote mode, refer to Chapter 7.8 "Remote mode".

All operating procedures by AP-L1A are rendered useless. Operation hereafter will be controlled by the Data Terminal side.

⑥ **Tracking of prism**

- Set prism to a valid point (within range of the maximum possible tracking distance), and operate the data terminal to track the prism with the AP-L1A.

The status of tracking can be confirmed by the tracking indicator of AP-L1A or the display of data terminal.

- Confirm if the setting of each tracking parameter is suitable to the situation of measuring field. Setting of tracking speed is very important. In usual one person surveying / stake out work, the tracking speed in "Medium Speed" is suitable.

⑦ **Setting instrument coordinate and direction angle**

- When AP-L1A is set at a random position, by method of resection, sight the known points and determine the instrument coordination with the data terminal.
- Sight the known point and set the direction angle of AP-L1A with the data terminal.

⑧ **Start of surveying**

- After all settings for AP-L1A and data terminal are complete, move prism and data terminal to the first point.

In stake out operation, input identification of first point in the data terminal for tracking status. Display shows the distance and direction between AP-L1A and target .

- Execute survey or stake out.

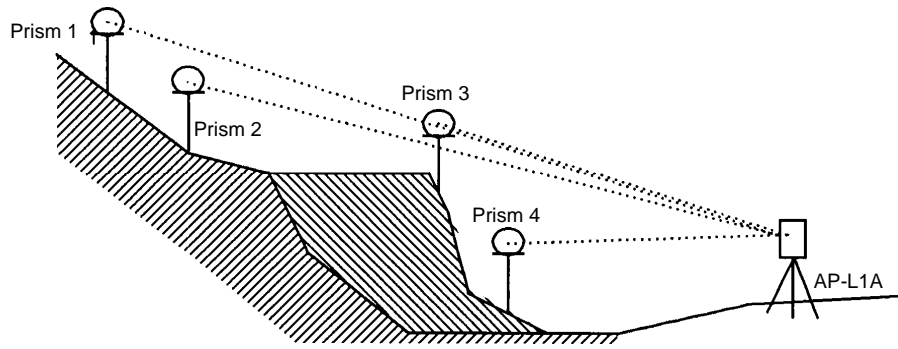
When surveying or stake out is completed the first point, move to second point for tracking status, and repeat survey as above.

- Set coarse measurement mode for a moving prism and change to fine mode for collection or stake out purposes. These can be changed in Distance measurement mode.
- Data measured and displayed after optical path from instrument and prism is disturbed by a person or car will be unstable for few seconds. Do not employ these measured data.
- When tight accuracy is desired, it is recommended that an averaging option be used with the measured data repeated 5 ~ 10 times.

8.2 Teach Measurement (Fixed Point Observation.)

This is explanation of Teach measuring function provided with AL - L1A and its operation method. Teach measuring is the function used to monitor fixed points over an extended period of time and at specific intervals of time. This function is suitable to survey the displacement, sinking, or sliding of a bridge, dam, or wall, protecting and other construction. In general this option was designed to monitor defamation.

Example : In the case of four control (known) points with fixed prisms



- Up to fifty points can be programmed into the "Teach" function.

● Operating guide

- 1) Connect computing device for data recording to the serial signal connector (port 1) of AP-L1A.
- 2) Place AP-L1A on the known point or random point and set direction angle.
 - Confirm if the setting of each tracking parameter is suitable to the situation of measuring field. Setting of tracking speed is very important. In Teach measurement mode, the tracking speed in "LOW Speed" is suitable.
- 3) Set each control point, measuring parameter, and parameter concerning Teach Measuring. Measuring parameter of each point (setting each control point) .
 - ① Selecting r / r_l
 - ② Setting N -times (measuring time)
 Teach measuring parameter.
 - ① Setting cycle time
 - ② Setting search function ON/OFF
 - ③ Setting distance measuring mode (EDM mode)
 - * Refer to Chapter 15.2.1 "Teach Measuring" for details of each measuring parameter.
- 4) Select execute Teach Measuring, and programmed cycle begins.
 - * Timing of data output : The data will be output every time the measurement is completed.
 - * In teach measurement, area setting will be set and ON automatically.(Refer to P.8-6)

8.2.1 Setting and deleting control points for Teach Measuring

Operating procedure	Operating key	Display
① Press [MENU] key from the Angle measuring or Distance Measuring mode.	[MENU]	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> MENU 1/1 F1 : PARAMETERS F2 : PROGRAMS F3 : REMOTE </div>

8. APPLICATION MEASUREMENT

② Select [F2 : PROGRAMS].	[F2]	<div>PROGRAMS F1 : TEACH F2 : AREA</div>
③ Select [F1:TEACH].	[F1]	<div>TEACH 1/1 F1 : SET POINT F2 : PARAMETERS F3 : GO</div>
④ Select [F1:SET POINT]	[F1]	<div>SET TEACH F1 : WRITE F2 : DELETE</div>
⑤ Select [F1:WRITE]	[F1]	<div>TEACH POINT [1] V : *° ** '***" H : *° ** '***" EXIT ← → ENT</div>
⑥ Select Measuring point number. Press [F2](←), [F3](→), and select number displayed at the right top, and press [F4](ENT) key.	[F2] or [F3] [ENT]	<div>TEACH POINT [1] V : *° ** '***" H : *° ** '***" EXIT RL MEAS ENT</div>
⑦ Select, if desired, option for multiple observations of same point in both faces of AP-L1A. Press [F2](↑), [F3](↓) key, and select ON/ OFF , and press [F4](ENT) key.	[F2] [F2] or [F3] [ENT]	<div>R/1 [1] ON EXIT ↑ ↓ ENT</div>
		<div>TEACH POINT [1] V : 98° 46' 55" H : 210° 55' 25" EXIT RL MEAS ENT</div>
⑧ Press [F3](MEAS) key. Set the number of observations of the same point per set. Input number using numeric key, and press [ENT] key, [For example, 3 times.]	[F3] [3] [ENT]	<div>DATA COUNT [1] 3 EXIT --- CLR ← -</div>
⑨ Collimate the control point to be set, and press [F4](ENT) key..	[ENT]	<div>TEACH POINT [1] V : 65° 45' 20" H : 123° 40' 50" EXIT RL MEAS ENT</div>
		<div>SET OK > [YES] [NO]</div>
⑩ PRESS [F3](YES) key. The control point of number 1 is set.	[F3]	<div>TEACH POINT [1] V : 65° 45' 20" H : 123° 40' 50" EXIT ← → ENT</div>

● To delete a control point, select [F2:DELETE] in procedure ⑤

8.2.2 Setting Teach Measurement Parameters

Operating procedure	Operating key	Display
① Press [MENU] key from the angle or distance measuring mode.	[MENU]	MENU 1/1 F1 : PARAMETERS F2 : PROGRAMS F3 : REMOTE
② Select [F2:PROGRAMS]	[F2]	PROGRAMS F1 : TEACH F2 : AREA
③ Select [F1:TEACH]	[F1]	TEACH 1/1 F1 : SET POINT F2 : PARAMETERS F3 : GO
④ Select [F2:PARAMETERS]	[F2]	PARAMETERS F1 : SEARCH F2 : EDM MODE F3 : CYCLE TIME
⑤ Select [F1: SEARCH]	[F1]	SEARCH ON/OFF ON EXIT ↑ ↓ ENT
⑥ Press [F2](↑), [F3](↓), to select ON / OFF SEARCH function and press [F4](ENT) key	[F2] or [F3] [ENT]	PARAMETERS F1 : SEARCH F2 : EDM MODE F3 : CYCLE TIME
⑦ Select [F2:EDM MODE]	[F2]	EDM MODE FINE 1mm EXIT ↑ ↓ ENT
⑧ Press [F2](↑), [F3](↓), to select mode and press [F4](ENT) key.	[F2] or [F3] [ENT]	PARAMETERS F1 : SEARCH F2 : EDM MODE F3 : CYCLE TIME
⑨ Select [F3:CYCLE TIME]	[F3]	CYCLE TIME TIME :00 : 00 EXIT --- CLR ← -
⑩ Input cycle time by numeric keys, and press [ENT] key. [Example] 2 hours 30 minutes. The display returns to parameter menu.	2 . 3 0 [ENT]	PARAMETERS F1 : SEARCH F2 : EDM MODE F3 : CYCLE TIME

- Setting cycle time is 1 minute in unit, max.24 hours.

8.2.3 Execution of Teach Measuring

Operating procedure	Operating key	Display
① Press [MENU] key from the angle or distance measuring mode.	[MENU]	<div style="border: 1px solid black; padding: 5px;"> MENU 1/1 F1 : PARAMETERS F2 : PROGRAMS F3 : REMOTE </div>
② Select [F2:PROGRAMS]	[F2]	<div style="border: 1px solid black; padding: 5px;"> PROGRAMS F1 : TEACH F2 : AREA </div>
③ Select [F1:TEACH]	[F1]	<div style="border: 1px solid black; padding: 5px;"> TEACH 1/1 F1 : SET POINT F2 : PARAMETERS F3 : GO </div>
④ Select [F3:GO] AP-L1A tracks to the first measuring point. When the target is found, measuring starts.	[F3]	<div style="border: 1px solid black; padding: 5px;"> <div style="display: flex; justify-content: space-between;"> TEACH POINT [1]? </div> <div style="display: flex; justify-content: space-between;"> V : 65° 45' 20" </div> <div style="display: flex; justify-content: space-between;"> H : 123° 40' 50" </div> <div style="display: flex; justify-content: space-between;"> SD : < </div> </div>
<ul style="list-style-type: none"> ● Teach Measuring is carried out by order of control points (from small to large). ● If data is not ready to be measured, the specific point will be disregarded. ● Press [ESC] key to cancel measurement. 		

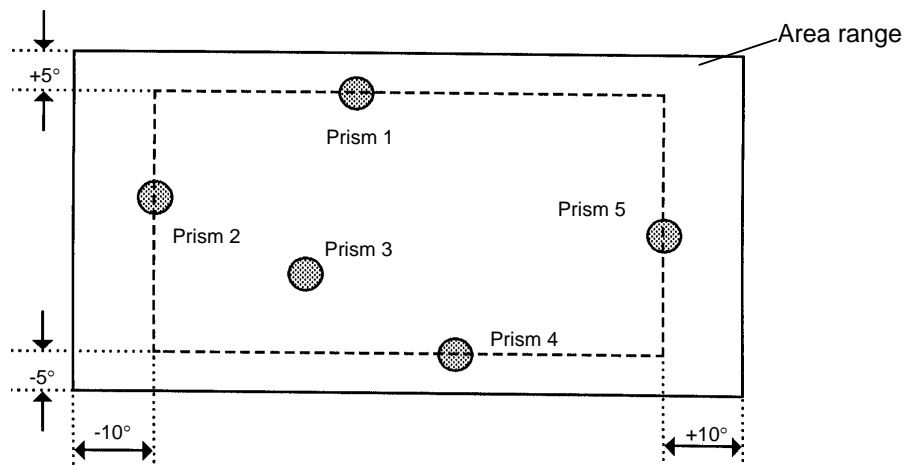
● Auto Area Setting in Teach Measuring

The area contains on the outside of measuring points (prisms) of up-down/right-left. shapes a rectangular area.

The area range in teach measuring is the expanded search range (which is set by selecting mode 1) to the said rectangular.

The area range will be automatically set and ON.

[Example] When search range setting is 10° in horizontal / 5° in vertical, setting area in teach measurement is as follows.



9. SET AUDIO MODE

The light acceptance quantity level (SIG), the atmospheric correction value (PPM) and correction value of prism constant (PSM) are displayed in this mode.

When reflected light from the prism is received, buzzer sounds. This function is good for easy collimation when the target is difficult to find.

- ① Press [F4](↓)key in the angle or distance measuring mode as in page 4.
- ② Pressing [F3](S/A) key, mode changes to set audio mode. The display indicates correction value of prism constant (PSM), atmospheric correction (PPM) and reflection light level (SIG).

FINE	TRK	S/A	4↓
------	-----	-----	----

S/A			
PSM:	14	SIG:	60
PPM:	00		
EXIT	PSM	PPM	T-P

- When receiving reflected light quantity, buzzer sounds.
- The [F2] ~ [F4] keys are used for setting atmospheric correction and prism constant.
- To return to normal measuring mode, press [F1](EXIT) key.

10. SETTING THE PRISM CONSTANT VALUE

The prism constant value of Topcon is set to zero. When using Pin-pole prism set L1 type, Pin-pole prism holder L1 type, Prism unit A2 type, or a prism other than Topcon's, it is necessary to set the prism constant correction value specific prism.

Once you set the correction value for prism constant, it is retained after power OFF.

Prism type (TOPCON)	Prism constant value	Prism constant correction value
Pin-pole prism set L1 type Pin-pole prism holder L1 type	+22mm or 0mm	-22mm or 0mm
Prism unit A2-type	-14mm	+14mm
Near distance prism for AP-S1	+22mm	-22mm
Normal Topcon prism	0mm	0mm

- Setting example : The prism constant value, +22mm.

Operating procedure	Operating key	Display
① Set mode as Set Audio mode.	[F3]	<div>S/A</div> <div>PSM: 00 SIG : 60</div> <div>PPM: 83</div> <div>EXIT PSM PPM T-P</div>
② Press [F2](PSM)key.	[F2]	<div>PRISM SET</div> <div>PSM: 0mm</div> <div>EXIT --- CLR ← -</div>
③ Input the Prism constant correction value. [Example] When prism constant value is +22mm, prism constant correction value will be -22mm.	<input type="text" value="-"/> <input type="text" value="2"/> <input type="text" value="2"/>	<div>PRISM SET</div> <div>PSM: -22mm</div> <div>EXIT --- CLR ← -</div>
④ Press [ENT] key. Returns to set audio mode.	[ENT]	<div>S/A</div> <div>PSM: -22 SIG : 60</div> <div>PPM: 83</div> <div>EXIT PSM PPM T-P</div>
<ul style="list-style-type: none"> ● Input range : -99mm ~ +99mm in 1mm step. ● The normal prism so called "prism constant value 30mm" (or sometimes be called -30mm) will be set -30mm as a correction value. 		

11. SETTING ATMOSPHERIC CORRECTION

The velocity of light through air is not constant and depends on the atmospheric temperature and pressure. The atmospheric correction system of this instrument corrects automatically when the correction value is set. 15°C, and 760mmHg (56°F, and 29.6 inHg / 1013hPa) is as a standard value for 0ppm in this instrument. The values are kept in the memory even after power is OFF.

11.1 Calculation of Atmospheric Correction

The following is the correction formulas.

○ Unit; meter

$$Ka = \left\{ 279.66 - \frac{106.033 \times P}{273.15 + t} \right\} \times 10^{-6}$$

Ka : Atmospheric correction value
 P : Ambient atmospheric pressure(mmHg)
 t : Ambient Atmospheric temperature(°C)

The distance L(m) after atmospheric correction is obtained as follow.

$$L = I (1 + Ka)$$

I : Measured distance when atmospheric correction is not set.

Example : In case Temperature +20°C , Air pressure 635mmHg, $L=1000$ m

$$Ka = \left\{ 279.66 - \frac{106.033 \times 635}{273.15 + 20} \right\} \times 10^{-6}$$

$$= 50 \times 10^{-6} (50ppm)$$

$$L = 1000 (1 + 50 \times 10^{-6}) = 1000.05m$$

11.2 Setting of Atmospheric Correction Value

● How to Set Temperature and Pressure Value Directly

Measure the temperature and air pressure surrounding AP-L1A beforehand.

Example : Temperature: +26 °C, Pressure:760mmHg

Operating procedure	Operating key	Display
① After pressing [F4](↓) key 3 times to be function as in page 4 in distance or angle measurement mode, press [F3](S/A) key to set "Set Audio Mode".	[F3]	<div style="border: 1px solid black; padding: 5px;"> S/A PSM : 00 SIG:60 PPM : 83 EXIT PSM PPM T-P </div>
② Press [F4](T-P) key.	[F4]	<div style="border: 1px solid black; padding: 5px;"> T-P SET TEMP : 15 °C PRES : 760mmHg EXIT -- CLR ← -- </div>
③ Input Temp.value and press [ENT]key. [Example] +26°C	<div style="border: 1px solid black; padding: 2px; display: inline-block;">2</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">6</div> [ENT]	<div style="border: 1px solid black; padding: 5px;"> T-P SET TEMP : 26 °C PRES : 760mmHg EXIT ↑ CLR ← -- </div>
④ Input Pressure value, and press [ENT]. Mode returns to Set Audio mode. [Example] 760mmHg	<div style="border: 1px solid black; padding: 2px; display: inline-block;">7</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">6</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">0</div> [ENT]	

11. SETTING ATMOSPHERIC CORRECTION

<ul style="list-style-type: none"> Range to be input : TEMP. -30°C to +60 °C, in unit 1 °C (-22°F to +140°F, in unit 1°F) PRES. 420mmHg to 800mmHg, in unit 1mmHg (16.5inHg to 31.5inHg, in unit 0.1inHg) 315hPa to 1066hPa, in unit 1hPa When the atmospheric correction value which is calculated from the input temperature and pressure values exceeds the range ± 99ppm, the operating procedure returns to step ③ automatically. Input values again. 		

● How to Set the Atmospheric Correction Value Directly

Measure the temperature and air pressure to find atmospheric correction value (PPM) from the chart or correction formula.

Example * Atmospheric correction value, -6 (ppm)

Operating procedure	Operating key	Display
① After pressing [F4](↓) key 3 times to be function as in page 4 in distance or angle measurement mode, press [F3](S/A) key to set "Set Audio Mode".	[F3]	<div> S/A PSM : 00 SIG:60 PPM : 83 EXIT PSM PPM T-P </div>
② Press [F3](PPM)key. Current setting value is displayed.	[F3]	<div> PPM SET PPM : 00PPM EXIT --- CLR ← - </div>
③ Input atmospheric correction value and press [ENT] key. Mode returns to Set Audio Mode.	<div>[-] [6]</div> [ENT]	<div> PPM SET PPM : -6 PPM EXIT --- CLR ← - </div>
<ul style="list-style-type: none"> Range to be input : -99ppm~+99ppm, 1 ppm step 		

11. SETTING ATMOSPHERIC CORRECTION

Atmospheric Correction Chart (For your reference)

The atmospheric correction value is obtained easily with the atmospheric correction chart. Find the measured temperature in horizontal, and pressure in vertical on the chart.

Read the value from the diagonal line, which represents the required atmospheric correction value.

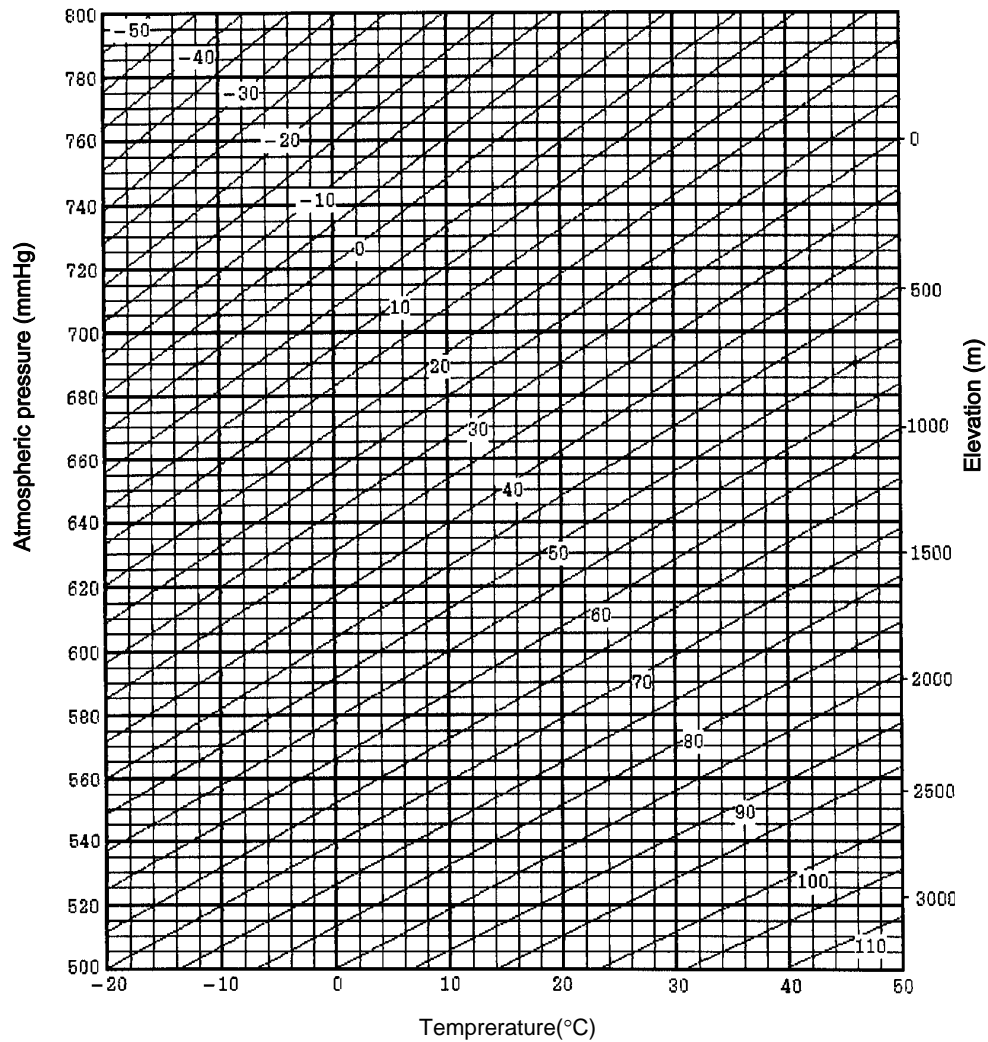
Example:

The measured temperature is +26 °C

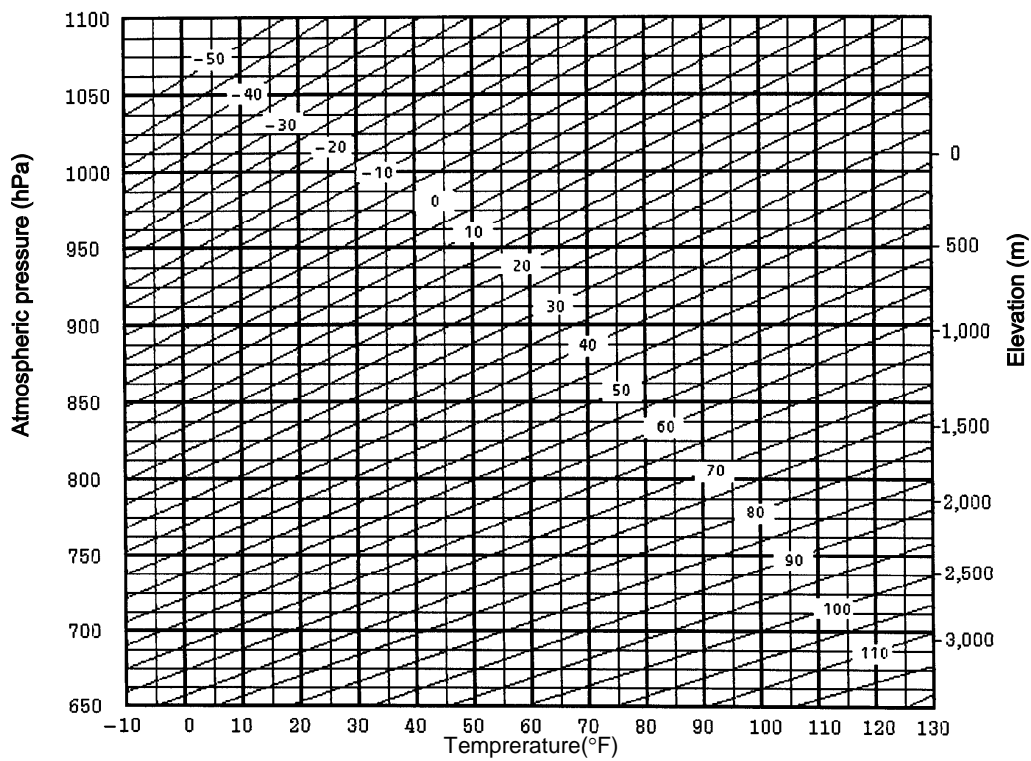
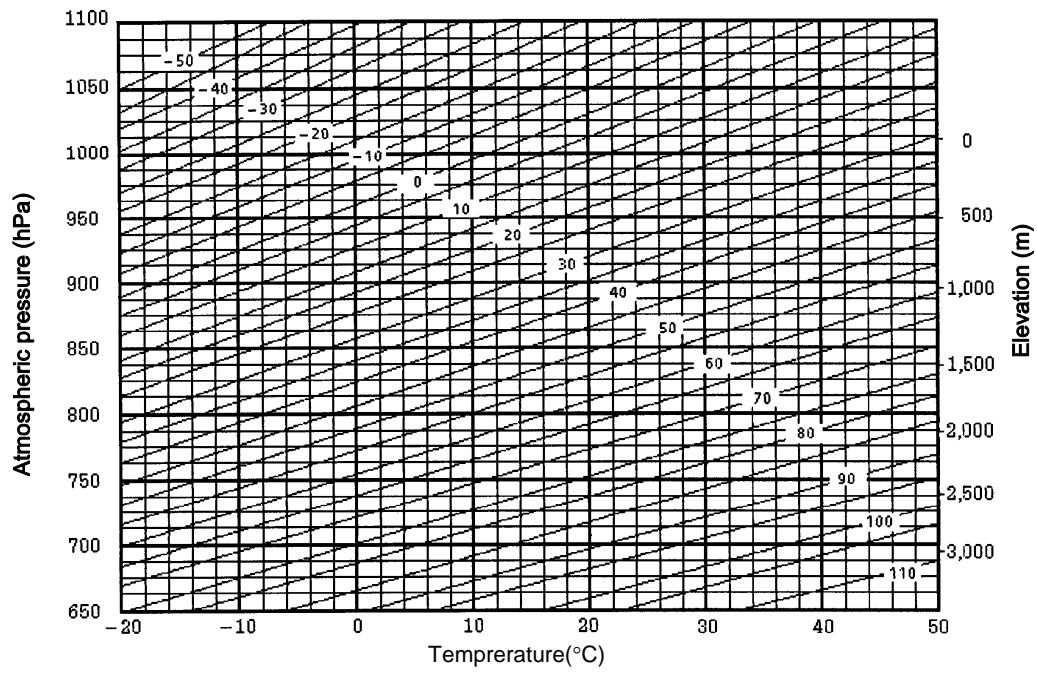
The measured pressure is 760mmHg

There fore,

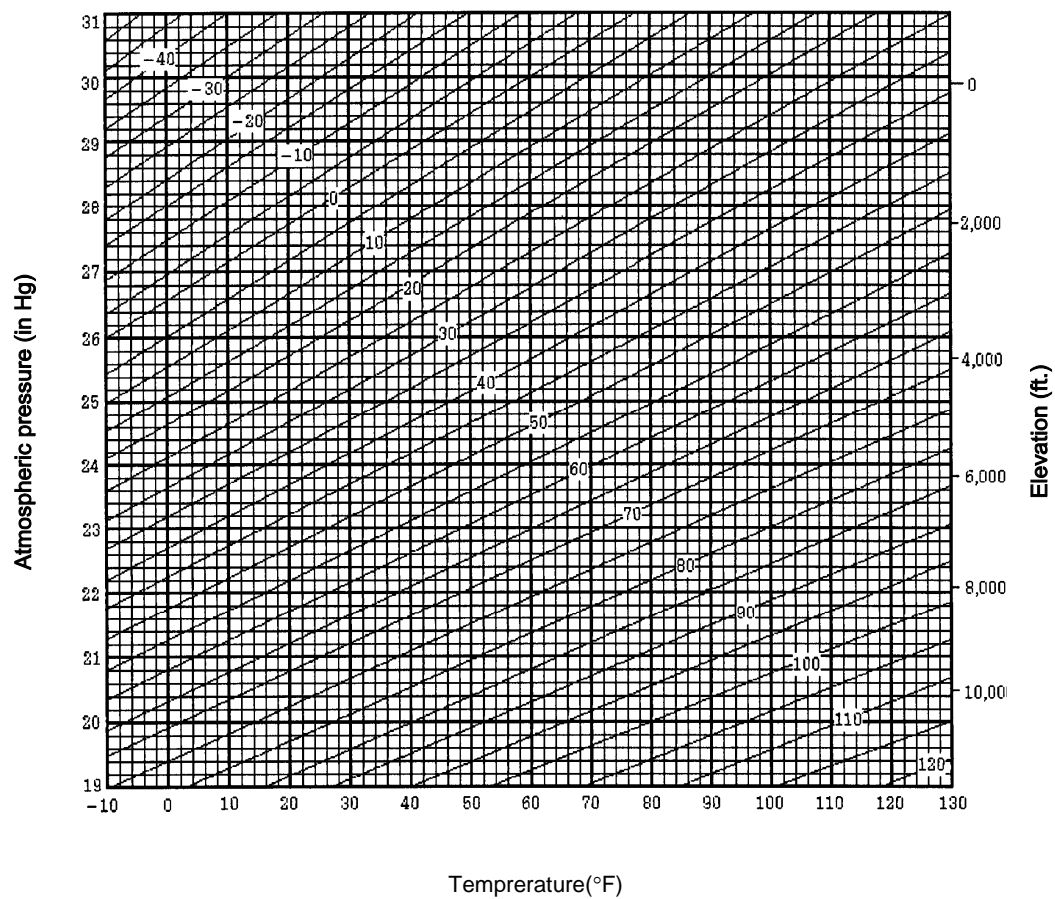
The correction value is +10ppm



11. SETTING ATMOSPHERIC CORRECTION



11. SETTING ATMOSPHERIC CORRECTION



12. CORRECTION FOR REFRACTION AND EARTH CURVATURE

AP-L1A series measures distance, taking into account correction for refraction and earth curvature.

Note : If the telescope is positioned within $\pm 9^\circ$ from the nadir or zenith, no measurement will result even if the correction function for refraction and earth curvature works.
The display shows "W/C OVER".

12.1 Distance Calculation Formula

Distance Calculation Formula; with correction for refraction and earth curvature taken into account.
Follow the Formula below for the converting horizontal and vertical distances.

Horizontal distance $D=AC(\alpha)$ or $BE(\beta)$

Vertical distance $Z=BC(\alpha)$ or $EA(\beta)$

$D=L\{\cos\alpha \cdot (2\theta - \gamma)\sin\alpha\}$

$Z=L\{\sin\alpha \cdot (\theta - \gamma)\cos\alpha\}$

$\theta = L \cdot \cos\alpha / 2R$ Earth curvature
correcting item

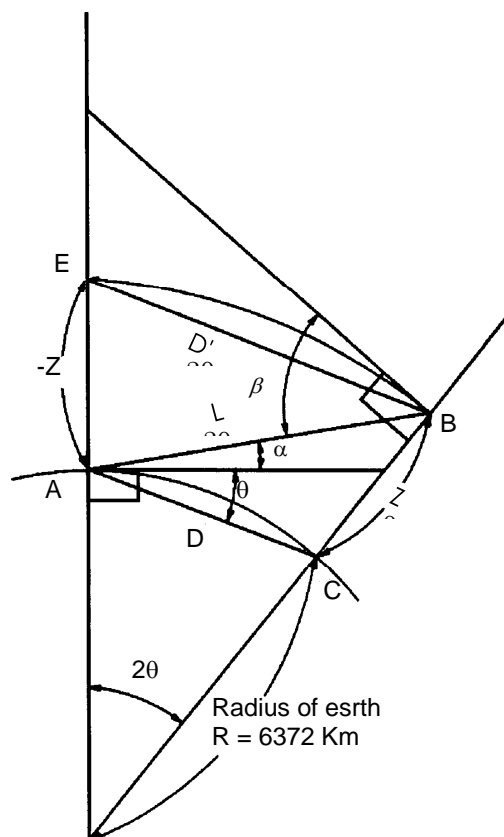
$\gamma = K \cdot L \cdot \cos\alpha / 2R$ Atmospheric
refraction
correcting item

$K=0.14$ or 0.2 Coefficient of
refraction

$R=6372\text{km}$ Radius of earth

α (or β) Altitude angle

L Slope distance



- The conversion formula for horizontal and vertical distances is as follows when correction for refraction and earth curvature is not applied.

$$D = L \cdot \cos \alpha$$

$$Z = L \cdot \sin \alpha$$

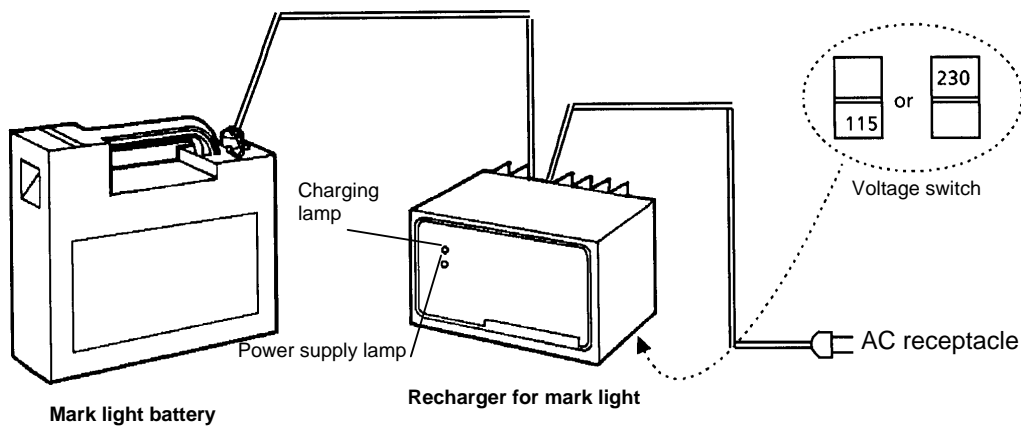
Note : The coefficient of AP-L1A has been set at 0.14 before shipment ($K=0.14$).
if the "K" value is to be changed, refer to "16. Selecting mode".

13. POWER SOURCE AND CHARGING

13.1 External Battery (Mark Light Battery)

- **Recharging**

- ① Connect recharger of mark light connector to mark light battery.
Be sure the switch of voltage value on the backside is working properly.
- ② Connect power cable of mark light recharger to an electrical receptacle of matching voltage.
Charging starts and recharging lamps light.
- ③ It takes about 4 hours for recharging. Charging lamp will turn OFF when recharging is completed 80%. Recharging another 4 hours continuously makes charging level to 90%.
- Operating time with 1-time charged (90%) mark light battery is approx. 4 ~ 7 hours. It changes according to operating conditions. It will be however shorter than this specified time depending upon recharging condition of mark light battery or ambient temperature of operation especially in a low temperature.



Notes 1 : Recharging should take place in a room with an ambient temperature range of 10°C to 40°C (50°F to 104°F).

2 : Exceeding the specified charging time may shorten the life of the battery and should be avoided if possible.

3 : The battery source will discharge when stored and should be checked before using with instrument .

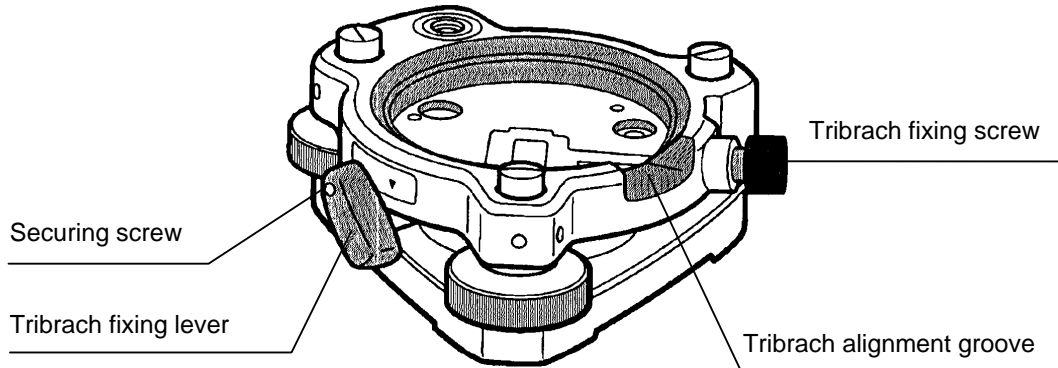
4 : Be sure to charge the battery source every 3 or 4 months and store in a place at 30°C and below when it will not be used for a long period.

The battery quality will be decreased if the condition reached to over discharged state even once, the sufficient charging can not be expected after that. Precaution is needed to be taken.

If the battery is left in empty condition, it will be impossible to charge well. The battery should be recharged after use as soon as possible.

14. DETACH/ATTACH OF TRIBRACH

The instrument is easily detached from or attached to the tribrach



● Detachment

- ① Loosen the tribrach fixing screw.
- ② Loosen the tribrach fixing lever by turning counterclockwise.
- ③ Lift the instrument straight upwards and off.

● Attachment

- ① Coincide the white alignment piece on the lower part of the instrument with the tribrach alignment groove.
- ② Tighten the tribrach fixing lever firmly by turning clockwise.
- ③ Tighten the tribrach fixing screw.

● Locking the Tribrach Fixing lever

The tribrach fixing lever can be locked from being moved accidentally. This is useful if the upper instrument section is not being detached very often. Simply tighten the securing screw on the fixing lever with the accessory screw driver.

15. SPECIAL MODE (MENU KEY OPERATION)

15. SPECIAL MODE (MENU KEY OPERATION)

Special mode is used for each presetting or measuring as menu shows below.
The settings here will be memorized after power OFF.

1st layer MENU	2nd layer MENU	3rd layer MENU	4th layer MENU
F1: PARAMETERS	F1: TRK	F1: SEARCH	F1: PATTERN
			F2: AREA
		F2: WAIT TIME	——
		F3: SCAN WIDTH	——
		F1: ADJ AXIS(M)	——
		F2: ADJ AXIS(A)	——
		F3: TRK SPEED	——
		F1: TRK SENSITIV	——
	F2: MEAS	F1: TILT ON/OFF	——
		F2: DATE & TIME	——
		F3: OCC. POINT	——
		F1: RST A/M	——
	F3: COM	F1: COM1	F1: BIT FORMAT
			F2: TRANS SPEED
			F3: TERMINATE
		F2: COM2 (REMOTE) Only for AP-L1AN	F1: BIT FORMAT
			F2: TRANS SPEED
			F3: PROTOCOL
F2: PROGRAMS	F1: TEACH	F1: SET POINT	F1: WRITE
			F2: DELETE
		F2: PARAMETERS	F1: SEARCH
			F2: EDM MODE
			F3: CYCLE TIME
		F3: GO	——
	F2: AREA SET	F1: INPUT NEZ	——
		F2: MOVED SET	——
		F3: SETTING AREA	——
F3: REMOTE	F1: REMOTE	——	——

15.1 PARAMETERS

15.1.1 TRK : Setting for Tracking Functions

1) SEARCH

- **PATTERN :** Setting search pattern (Refer to Chapter 7.3 "Setting Tracking Parameter")
Set the searching method in search mode.

Selecting items	Contents
HIGH	Search in high speed
NORMAL	Search in normal speed

- Setting value at shipping time from factory is NORMAL
- **AREA :** Setting search range (Refer to Chapter 7.3 "Setting Tracking Parameter")
When the prism is lost during tracking mode, the seeking range can be set which is rotating the range for telescope and body to search for the lost prism.
Set search pattern first, then set search range to the each search pattern.

Set range	
$0^{\circ} \leq H \text{ angle} \leq 180^{\circ}$	
$0^{\circ} \leq V \text{ angle} \leq 180^{\circ}$	From the point lost the prism

- Setting value at shipping time from factory is
Normal H :10° V :2°. High H :10° V :10°.

2) WAIT TIME: Setting the waiting time

The time the prism is lost before AP-L1A starts the SEARCH during Tracking mode.
If the mode is set in "HOLD", mode will not change to SEARCH mode.

Setting time
0:00 (0minute 0second) ≤ TIME ≤ 60:00 (60minutes 0second)

- Setting value at shipping time from factory is 5 seconds

3) SCAN WIDTH : Setting scan width(Refer to Chapter 7.3 "Setting Tracking Parameter".) Set a laser scanning range during tracking mode

Selecting items	Setting scanning range
NARROW (20'×20')	20'×20'
MIDDLE (40'×40')	40'×40'
WIDE (60'×60')	60'×60'

- Setting value at shipping time from factory is MIDDLE.

4) ADJ.AXIS: Setting compensation of Tracking optical axis

This is the adjusting mode for the error between sighting axis and tracking target. There is two adjusting methods. One for auto mode one for manual (Refer to Chapter 17.5 "Inspection & Adjusting of Optic axis for Auto-Tracking").

Setting range
-5'00" H angle ≤ +5'00"
-5'00" V angle ≤ +5'00"

15. SPECIAL MODE (MENU KEY OPERATION)

- 5) TRK SPEED:** Setting tracking speed(Refer to Chapter 7.3 "Setting tracking parameter").
Setting automatic aiming accuracy or tracking function to the traveling objects in Tracking mode.

Selecting items	Setting speed
LOW	Low speed
MEDIUM	Medium speed
HIGH	High speed

- Setting value at shipping time from factory is MEDIUM.

- 6) TRK SENSITIV:** Setting Tracking detecting sensitivity(Refer to Chapter 7.3 "Setting tracking parameter").

Select "Medium" or "Low" sensitivity to avoid affection extra reflectors other than prism.

Selecting items	Setting speed
HIGH	High sensitivity (Normal setting)
MEDIUM	Medium sensitivity
LOW	Low sensitivity

- Setting value at shipping time from factory is HIGH.

15. SPECIAL MODE (MENU KEY OPERATION)

15.1.2 MEAS : Setting Measurement

1) TILT ON/OFF : Vertical and Horizontal Angle Tilt Correction

Selecting functions for automatic Tilt correction.

Selecting items	Description
OFF	Auto correction will not be done.
V TILT ON	Auto correction for Vertical angle only.
V/H TILT ON	Auto correction for both H and V angles.

The display of Vertical or Horizontal angle is unstable when AP-L1A is on an unstable stage or in a windy day. You may decide to turn OFF of auto tilt correction function of H/V angle in this case. You are required to level precisely. Tilt correction is now disabled.

- Setting at shipping time from factory is V/H TILT ON.

2) DATE & TIME: Setting date and time

Setting clock function of the instrument.

Set items
year/month/date/week/24 hours/60 minutes/60 seconds

[Example] : 1993/09/01/WED/13:10:30

Procedure	Operation
① Press [MENU] key from the distance or angle measuring mode.	[MENU]
② Select [F1:PARAMETERS].	[F1]
③ Select [F2:MEAS].	[F2]
④ Select [F2:DATE & TIME].	[F2]
The display shows date and time which is already set.	
⑤ Press [F3:YES] key.	[F3]
⑥ Input year/month/date, then press [ENT]key.	19930901 [ENT]
⑦ Input hours/ minutes/ seconds , then press [ENT]key.	131030 [ENT]
⑧ Select a day of the week with [F2:↑]or [F3:↓] key.	[F2] or [F3]
Pressing [ENT] key, the clock will start.	[ENT]

3) OCC.POINT: Setting ON/OFF for instrument point coordinate

Setting ON or OFF to memorize the instrument point coordinate which will be or is preset by the function operating key.

Selecting items	Description
OFF	The instrument point will not be memorized.
ON	The instrument point will be memorized even after power is off.

- Setting value at shipping time from factory is OFF.

4) RST A/M: Setting Auto/Manual mode for resection method (refer to "6.2.2.Resection Method.")

Set sighting mode in auto or manual for resection method.

Selecting items	Description
AUTO	Auto sighting
MANUAL	Manual sighting

- Setting value at shipping time from factory is MANUAL

15. SPECIAL MODE (MENU KEY OPERATION)

15.1.3 COM : Setting Communication

- 1) **COM. 1:** Setting Bit format, Transmission speed (Baud rate) and Terminate for COM-1.
Setting AP-L1A and external devices to match each other when performing communication.

- 1-1) **BIT FORMAT:** This is communication format for COM-1. Select the communication format such as data length, stop-bit, and parity-bit of COM-1.

Selecting items				Contents
D8	S1	NONE		8bit, stop 1, NONE
D8	S2	NONE		8bit, stop 2, NONE
D7	S1	NONE		7bit, stop 1, NONE
D7	S2	NONE		7bit, stop 2, NONE
D8	S1	EVEN		8bit, stop 1, EVEN
D8	S2	EVEN		8bit, stop 2, EVEN
D7	S1	EVEN		7bit, stop 1, EVEN
D7	S2	EVEN		7bit, stop 2, EVEN
D8	S1	ODD		8bit, stop 1, ODD
D8	S2	ODD		8bit, stop 2, ODD
D7	S1	ODD		7bit, stop 1, ODD
D7	S2	ODD		7bit, stop 2, ODD

- Setting value at shipping time from factory is D7 S1 EVEN.

- 1-2) **TRANS SPEED:** Communication Speed for COM-1

Select the baud rate of COM-1

Selecting items	Set items
38400	38,400 baud rate
19200	19,200 baud rate
9600	9,600 baud rate
4800	4,800 baud rate
2400	2,400 baud rate
1200	1,200 baud rate

- Setting value at shipping time from factory is 9600 Baud.

- 1-3) **TERMINATE:** Terminal Code of COM-1

Selecting CR (carriage return,) or LF (line feed) will be added at the end of data.

Selecting items	Set items
ETX	ETX
ETX+CR	ETX+CR
ETX+CRLF	ETX+CRLF

- Setting mode at shipping time from factory is ETX+CRLF.

15. SPECIAL MODE (MENU KEY OPERATION)

- 2) **COM 2:** Setting Bit format , Transmission Speed (Baud rate) and so forth of COM-2
Set AP-L1AN and external device to match each other when performing communication.

AP-L1A (with wireless modem) does not have this setting item.

- 2-1) **BIT FORMAT:** This is Communication Format for COM-2.

Select the communication format, such as data length, stop- bit/parity of COM-2.

Selecting items			Set items
D8	S1	NONE	8bit, stop 1, NONE
D8	S2	NONE	8bit, stop 2, NONE
D7	S1	NONE	7bit, stop 1, NONE
D7	S2	NONE	7bit, stop 2, NONE
D8	S1	EVEN	8bit, stop 1, EVEN
D8	S2	EVEN	8bit, stop 2, EVEN
D7	S1	EVEN	7bit, stop 1, EVEN
D7	S2	EVEN	7bit, stop 2, EVEN
D8	S1	ODD	8bit, stop 1, ODD
D8	S2	ODD	8bit, stop 2, ODD
D7	S1	ODD	7bit, stop 1, ODD
D7	S2	ODD	7bit, stop 2, ODD

- 2-2) **TRANS SPEED:** Communication Speed for COM-2

Select the baud rate of COM-2.

Selecting items	Set items
9600	9,600 baud rate
4800	4,800 baud rate
2400	2,400 baud rate
1200	1,200 baud rate

- Setting value at shipping time from factory is 2,400 Baud.

- 2-3) **PROTOCOL:** Setting Protocol of COM-2

Selecting items	Set items
SERIAL	Based on RS-232C. (3 lines system)
MODEM	Based on RS-232C.

- 2-4) **TERMINATE:** Terminal Code of COM-2

Selecting CR (carriage return), or LF (line feed) will be added at the end of data.

Selecting items	Set items
ETX	ETX
ETX+CR	ETX+CR
ETX+CRLF	ETX+CRLF

- Setting mode at shipping time from factory is ETX+CRLF.

15.2 PROGRAMS

15.2.1 TEACH: Setting functions of Teach Measurement

1) **SET POINT:** Set point

1-1) **WRITE:** Input of measuring (control) point

Input measuring point by sighting the points one by one with AP-L1A to memorize in Teach Measurement mode. See Chapter 8.2 "Teach measurement " how to operate.

Setting range
1point ≤ measuring points ≤ 50points

1-1-1) **rl:** Setting telescope inversion measurement (Set each measuring point)

Selecting items	Set items
OFF	Measure at the normal position (direct) of telescope only.
ON	Measure at the normal (direct) and reverse position of telescope.

Initial value:OFF

1-1-2) **MEAS:** Setting of measurement times (Set each measuring point)

This is to set measuring times for each single sight.

Setting times
1 ≤ Measuring time ≤ 100

Initial value:1

1-2) **DELETE:** Deleting a measuring point

Delete useless measured point among measuring points. See Chapter 8.2 "Teach measurement" how to operate.

2) **PARAMETERS:** Setting Parameter for Teach measurement

2-1) **SEARCH:** Setting SEARCH mode

When collimating a prism on memorized point and AP-L1A losses the prism (in the case where the prism is not within the scanning area), the Search function will be activated.

Selecting items	Set items
ON	Search function ON Search area and pattern are set by special mode (menu key operation). Measuring goes to next step when prism is not found after searching all the search area.
OFF	Search function OFFMeasuring goes to next step when prism is not found during wait time (WAIT) which is set by special mode (5 seconds in setting Hold).

Initial Value:ON

Note : When setting search On, be sure that there is not another target or prism within the search area.

15. SPECIAL MODE (MENU KEY OPERATION)

2-2) EDM MODE : Setting Distance Measuring Mode

Setting distance measuring mode in Teach measuring .

Selecting items	Set items
FINE 1mm (0.005ft)	Measure minimum display unit of 1 mm (0.005ft) in Fine mode.
FINE 0.2mm (0.001ft)	Measure minimum display unit of 0.2mm (0.001ft) in Fine mode.
COARSE 1cm (0.02ft)	Measure minimum display unit of 1cm (0.02ft) in Coarse mode.
COARSE 1mm (0.005ft)	Measure minimum display unit of 1mm (0.005ft) in Coarse mode.

Initial value : Fine 0.2 mm (0.001ft)

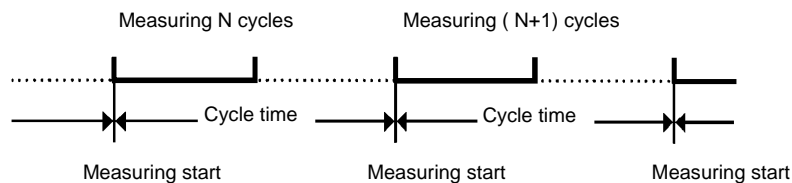
2-3) CYCLE TIME: Setting Cycle Time

Set the cycle time. The cycle time represents the elapsed time from the start of Teach measuring through to the last point and to when user wants to repeat the process with the same points all over again.

Setting numbers
$1\text{minute} \leq \text{CYCLE TIME} \leq 24\text{hours}$

Setting unit : 1 minute

Initial value : 60 minutes



Whenever the set cycle time is over regardless if the AP-L1A has completed measuring to all memorized points, the cycle will begin again with the first point.

3) GO: Executing of Teach Function

Teach measurement will execute according to the order of measuring point number.

Refer how to operate to Chapter 8.2 "Teach measurement".

To stop measurement, press [ESC] key.

15.2.2 AREA SET: Setting Area Range

(See Chapter 7.2 "Area Setting")

- 1) INPUT NEZ : Input coordinate value for setting area.
- 2) MOVED SET : Setting area by collimating.
- 3) SETTING AREA : Select ON / OFF function for setting area.
User may set from one to four set areas.

15.3 REMOTE

15.3.1 REMOTE : Remote Mode (Wireless communication mode)

The remote mode is to communicate between AP-L1A and wireless terminal WT-1A/1B. It enables AP-L1A to be controlled for data collection or stakeout by data terminal FS/2. This is only possible when remote mode is activated.

- Selecting [F1:REMOTE] , Mode changes to remote mode. See Chapter 7.8 "Remote Mode".

15. SPECIAL MODE (MENU KEY OPERATION)

15.4 Setting Special Mode

[Example 1]: Search Pattern : High

Search Range : Horizontal angle 20°, Vertical angle 10°

Operating procedure	Operating key	Display
① Press [MENU] key from the distance or angle display.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F1:PARAMETERS]	[F1]	<div>PARAMETERS 1/1</div> <div>F1 : TRK</div> <div>F2 : MEAS</div> <div>F3 : COM</div>
③ Select [F1:TRK]	[F1]	<div>TRK 1/3</div> <div>F1 : SEARCH</div> <div>F2 : WAIT TIME</div> <div>F3 : SCAN WIDTH</div>
④ Select [F1:SEARCH]	[F1]	<div>SEARCH PATTERN</div> <div>HIGH</div> <div>EXIT ↑ ↓ ENT</div> <div>SET!!</div>
⑤ Select [F1:PATTERN].	[F1]	<div>SEARCH</div> <div>F1 : PTTERN</div> <div>F2 : AREA</div>
⑥ Select pattern by pressing [F2](↑)key or [F3](↓)key, and press [ENT] key. [Example] HIGH	[F2] or [F3] [ENT]	<div>SEARCH</div> <div>F1 : PATTERN</div> <div>F2 : AREA</div>
The display returns to search menu.		<div>SEARCH</div> <div>F1 : PATTERN</div> <div>F2 : AREA</div>
⑦ Select [F2:AREA]. Displays current setting value. *1)	[F2] [2] [0]	<div>SEARCH SET HIGH</div> <div>H : 20°</div> <div>V : 10°</div> <div>EXIT ↑ CLR ←</div> <div>SET!!</div>
⑧ Input Search range and press [ENT] key [Example] H20°,V10°	[ENT] [1] [0] [ENT]	<div>SEARCH</div> <div>F1 : PATTERN</div> <div>F2 : AREA</div>
The display returns to search menu after setting . *2)		<div>SEARCH</div> <div>F1 : PATTERN</div> <div>F2 : AREA</div>
<p>*1) To cancel setting , press [F1](EXIT) key or [ESC] key.</p> <p>*2) Pressing [ESC] key, returns to TRK-SET menu. Pressing [MENU] key, returns to normal mode.</p>		

15. SPECIAL MODE (MENU KEY OPERATION)

[Example 2]: To set transfer speed of 9600 baud rate for COM-1

Operating procedure	Operating key	Display
① Press [MENU] key from the distance or angle display.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F1:PARAMETERS]	[F1]	<div>PARAMETERS 1/1</div> <div>F1 : TRK</div> <div>F2 : MEAS</div> <div>F3 : COM</div>
③ Select [F3:COM]	[F3]	<div>COM 1/2</div> <div>F1 : COM1</div> <div>F2 : COM2(REMOTE)</div>
④ Select [F1:COM1]	[F1]	<div>COM1</div> <div>F1 : BIT FORMAT</div> <div>F2 : TRANS SPEED</div> <div>F3 : TERMINATE</div>
⑤ Select [F2:TRANS SPEED] *1)	[F2]	<div>TRANSMIT SPEED 1</div> <div>4800</div> <div>EXIT ↑ ↓ ENT</div>
⑥ Press [F2](↑)or [F3](↓) key and select "9600".	[F2] or [F3]	<div>TRANSMIT SPEED 1</div> <div>9600</div> <div>EXIT ↑ ↓ ENT</div>
⑦ Press [F4](ENT) key	[F4]	<div>SET !</div> <div>COM1</div> <div>F1 : BIT FORMAT</div> <div>F2 : TRANS SPEED</div> <div>F3 : TERMINATE</div>
*1) To cancel setting , press [ESC] key or [F1](EXIT) key. *2) Pressing [ESC] key, returns Menu mode, and pressing [MENU] key returns to normal mode.		

16. SELECTING MODE

16.1 Items of the Selecting Mode

By operating the keys, the following modes are available.

Menu	Items	Selecting item	Contents
F1: ANGLE	F1: UNIT	DEG (360°)	Choose degree, gon or mil unit for measuring angle.
		GON (400G)	
		MIL (6,400M)	
	F2: V-0	LEVEL	Choose the vertical angle reading from zenith or from level.
		ZENITH	
	F3: HA-0-INDEX	OFF	Horizontal angle can have zero position same as vertical angle. OFF : Function of zero set to detect zero position is not required. ON : Function required. MEMORY ON : Zero set function required and also memorized function even after power OFF
		ON	
		MEMORY ON	
	F1: 0 SET MODE	V/H MANUAL	Selecting zero set mode by auto or manual. V/H MANUAL : Manual 0 set is both in V and H angles. V AUTO : Auto 0 set is in vertical only H AUTO : Auto 0 set is in horizontal only V/H AUTO : Auto 0 set is both in V and H angles. • For Auto H angle 0 set, it is needed to set " ON or MEMORY ON " in F3 : HA-0-INDEX
		V AUTO	
		H AUTO	
		V/H AUTO	
	F2: MIN. ANGLE	1" / 0.2mgon / 0.01mil	Selecting minimum unit for angle measurement DEG : 1"/5" GRAD : 0.2mgon/1mgon MIL : 0.01mil/0.1mil
		5" / 1mgon / 0.1mil	
F2: DIST	F1: UNIT	METER	Choose measuring unit for distance meter or feet
		FEET	
	F2: W-CORR	OFF	Set correction for refraction and earth curvature, coefficient of refraction as ; K=0.14, K=0.20 or no correction.
		K=0.14	
		K=0.20	
	F3: EDM MODE	FINE 1mm (0.005ft)	Selecting distance measurement mode.
		FINE 0.2mm (0.001ft)	
		COARSE 1cm (0.02ft)	
		COARSE 1mm (0.005ft)	
	F1: OFFSET	Instrument constant value	Setting instrument constant value . See Chapter 17 "CHECK AND ADJUSTMENT".
	F2: PRESS	hPa/mmHg/inHg	Select the unit of air pressure of atmospheric correction.
	F3: TEMP	°C/ °F	Select the unit of temperature of atmospheric correction.
	F1: REC TYPE	REC-A	Select REC-A or REC-B for data output. REC-A : The measurement is started and new data is output. REC-B : The data being displayed is output.
		REC-B	
	F2: FEET	International	Select the meter/feet conversion factor. INTL. FEET : 1m=3.280839895013123ft. US. SUR. FEET : 1m=3.280833333333333ft.
		US. Survey	
F3: SECRET	F1: SECRET MODE	OFF	Selecting secret mode ON or OFF.
		ON	

16. SELECTING MODE

	F2: SECRET CODE	Set Secret code	Setting secret code in 4 digits for SECRET function .
--	-----------------	-----------------	-------------------------------------------------------

16.2 How to Set Selecting Mode

●<Example> Setting unit in DEG:Degree,minute,second , EDM mode: Coarse mode 1cm

Operating procedure	Operating key	Display
① While pressing [F2] key, power ON.	[F2] + Power ON	[PARAMETERS SET]
② Input the same secret code which was set previously. ● In case the secret code is not set, the selecting menu is displayed.	(Secret code already set)	AP-L1A SECRET: EXIT --- CLR ← -
③ Select [F1:Angle]	[F1]	PARAMETERS F1 : ANGLE F2 : DIST F3 : SECRET
④ Select [F1:UNIT]	[F1]	PARAMETERS 1/2 F1 : UNIT F2 : V - 0 F3 : HA- 0 - INDEX
⑤ Press [F2](↑) or [F3](↓), set angle unit in DEG.	[F2] or [F3]	ANGLE GRAD EXIT ↑ ↓ ENT
⑥ Press [F4](ENT) key. Returns to parameters 1/1 menu.	[F4]	ANGLE DEG EXIT ↑ ↓ ENT ⟨ SET! ⟩ ↓ PARAMETERS 1/1 F1 : ANGLE F2 : DIST F3 : SECRET
⑦ Select [F2:DIST]	[F2]	DIST 1/2 F1 : UNIT F2 : W- CORR F3 : EDM MODE

<p>⑧ Select [F3: EDM MODE]</p> <p>⑨ Press [F2](↑) or [F3](↓), set COARSE 1 cm mode.</p> <p>⑩ Press [F4](ENT) key.</p> <p>Display returns to PARAMETERS 1/1 menu.</p> <p>⑪ Power supply OFF.</p>	<p>[F3]</p> <p>[F2] or [F3]</p> <p>[F4]</p> <p>Power OFF</p>	<div data-bbox="951 252 1365 394"> EDM MODE FINE 0.2mm EXIT ↑ ↓ ENT </div> <div data-bbox="951 422 1365 564"> EDM MODE CRS 1cm EXIT ↑ ↓ ENT </div> <div data-bbox="951 564 1365 625"> < SET! > </div> <div data-bbox="1143 625 1170 688"> ↓ </div> <div data-bbox="951 688 1365 831"> PARAMETERS 1/1 F1 : ANGLE F2 : DIST F3 : SECRET </div>
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

17. CHECK AND ADJUSTMENT

17.1 Checking Accuracy of the Distance Measurement

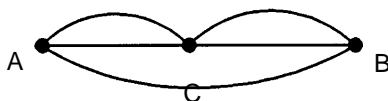
Normally, the instrument constant does not have discrepancy. It is recommended you measure and compare with an accurately measured distance at a location where the precision is specifically monitored on a consistent basis. If such a location is not available, establish your own base line over 20m (when purchasing the instrument) and compare with the data measured with newly purchased instrument.

In both cases note that the setup displacement of the instrument position over the point), the prism, baseline precision, poor collimation, atmospheric correction, and correction for refraction and earth curvature determine the inspection precision. Please keep in mind these points.

Also, when providing a base line in a building, please note that the difference in temperature greatly changes the length measured in the building.

If a difference of 5mm or over is the result from the comparative measurement, the following procedure as shown below could be used to change the instrument constant.

- ① Provide point C on a straight line, connecting straight line AB which is almost horizontal and about 100m long, and measure straight lines AB, AC and BC.



- ② Obtain the instrument constant by repeating ① above several times.
Instrument constant=AC+BC-AB
- ③ When there is error between written instrument constant value and calculated value, review the Chapter 17.4 "How to set the instrument constant" procedure. The instrument constant value set at shipping time is attached on label at the bottom of the AP-L1A .
- ④ Once again, measure at a calibrated baseline and compare with AP-L1A baseline length.
- ⑤ If using above procedure and no difference is found from the instrument constant at the factory or a difference of over 5mm is found, contact TOPCON or your TOPCON dealer.

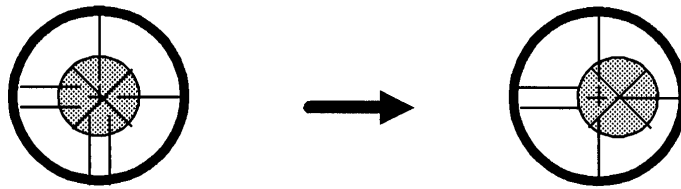
17.2 Checking the Optical Axis

To check if the optical axis of EDM and theodolite are matched, follow the procedure below. It is especially important to check after adjustment of the eyepiece reticle is carried out.

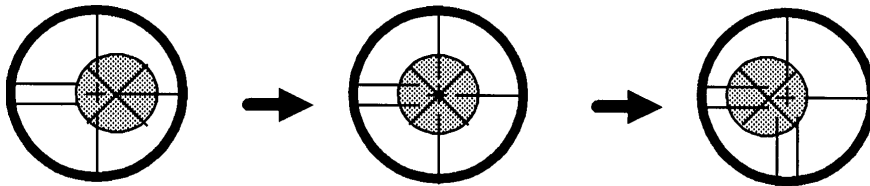
- ① Position a prism about 30 to 50m apart from AP-L1A .
- ② After the power switch ON of AP-L1A, collimate the center of the prism.
- ③ After pressing the [F4](↓) key 3 times to be function as in page 4, press the [F3](S/A) key to set "Set Audio Mode".
Buzzer sounds continuously.

H direction confirmation (Do not move V direction).

- ④ Turn the horizontal jog counterclockwise slowly, move the collimating point to the left side of prism gradually until buzzer sound stops.



- ⑤ Turn the horizontal jog clockwise slowly, and move the collimating point to the prism center gradually until at the position buzzer starts.
Confirm the value of SIG (light quantity level) in display to adjust at the level of 1 to 20 by turning the horizontal jog.
- ⑥ Press the [ESC] or [F1](EXIT) key to be angle measurement mode, and note the horizontal angle displayed. Or you can do 0-set of horizontal angle.
- ⑦ Press the [F3](S/A) key to return to "Set Audio Mode".
- ⑧ Turn the horizontal jog clockwise, move the collimating point to the right side of prism gradually until buzzer sound stops.

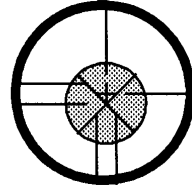
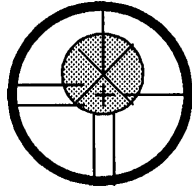


- ⑨ Move the collimating point to the center of prism gradually until buzzer sound starts.
Turning the horizontal jog to be 1 to 20 level of SIG value to adjust the collimating point same as ⑤ procedure.
- ⑩ Note horizontal angle same as ⑥ procedure.
- ⑪ Calculate the average value of ⑥ and ⑩.
[Example] ⑥0° 00' 00"
 ⑩0° 08' 20"

 Average value 0° 04' 10"
- ⑫ Climate to the center of prism. Compare the reading horizontal angle value and calculated value in ⑪. If the difference is within 1' 30", no problem for use.

Vertical direction confirmation (Do not move Horizontal direction).

- ⑬ Carry out as Horizontal direction confirmation.
 Compare the reading Vertical angle value and calculated value.
 If the difference is within 1' 30", no problem for use.



[Example]

90° 12' 30"

90° 04' 30"

Average

90° 08' 30"

Reading to
prism center

90° 08' 50"

} Difference 20"

If the difference is more than mentioned value, contact with your Topcon dealer or Topcon.

17.3 Checking/Adjusting the Theodolite Functions

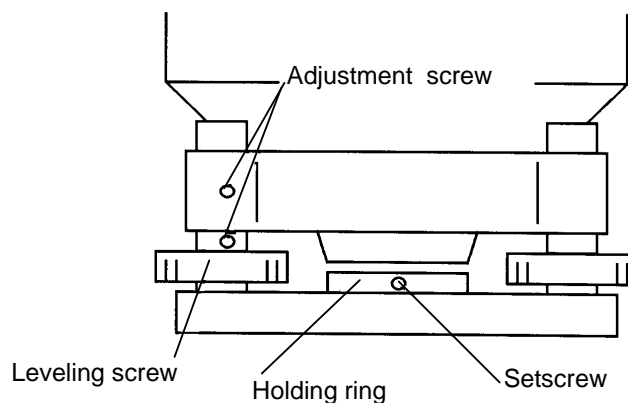
● Pointers on the Adjustment

- ① Adjust the eyepiece of the telescope properly prior to any checking operation which involves sighting through the telescope.
Remember to focus properly, with parallax completely eliminated.
- ② Carry out the adjustments in the order of item numbers, as the adjustments are dependent one upon another. Adjustments carried out in the wrong sequence may even nullify previous adjustment.
- ③ Always conclude adjustments by tightening the adjustment screws securely (but do not tighten them more than necessary, as you may strip the threads, twist off the screw or place undue stress on the parts).
Furthermore, always tighten by revolving in the direction of tightening tension.
- ④ The attachment screws must also be tightened sufficiently, upon completion of adjustments.
- ⑤ Always repeat checking operations after adjustments are made, in order to confirm results.

● Notes on the Tribrach

Note that the angle measuring precision may be effected directly if the tribrach has not been installed firmly.

- ① If any leveling screw becomes loose and slack or if collimation is unstable due to the looseness of leveling screws, adjust by tightening the adjusting screws (in 2 places) installed over each leveling screw with a screwdriver
- ② If there is any slack between the leveling screws and the base, loosen the set screw of the holding ring and tighten the holding ring with adjusting pin, until it is properly adjusted. Retighten the set screw on completing the adjustment.

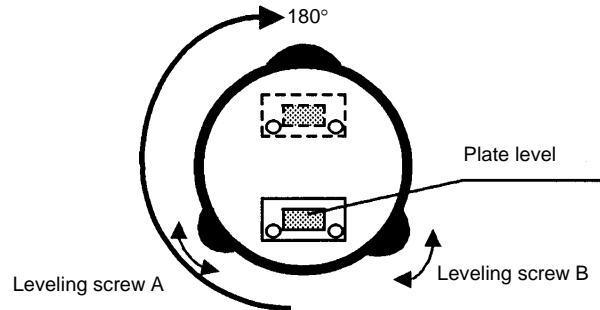


17.3.1 Checking /Adjusting the Plate Level

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

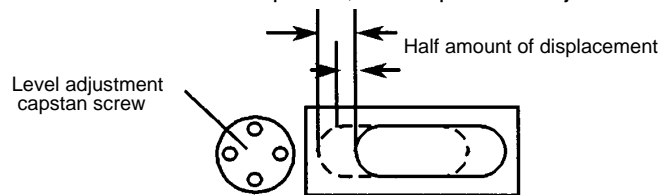
● Check

- ① Place the plate level parallel to a line running through the centers of two leveling screws, say, A and B. Use these two leveling screws only and place the bubble in the center of the plate level.
- ② Rotate the instrument 180° or 200g around the vertical axis and check bubble movement of the plate level. If the bubble has been displaced, then proceed with the following adjustment.



● Adjustment

- ① Adjust the level adjustment capstan screw, with the accessory adjusting pin and return the bubble towards the center of the plate level. Correct only one-half of the displacement by this method.
- ② Correct the remaining amount of the bubble displacement with the leveling screws.
- ③ Rotate the instrument 180° or 200g around the vertical axis once more and check bubble movement. If the bubble is still displaced, then repeat the adjustment.



17.3.2 Checking /Adjusting the Circular Level

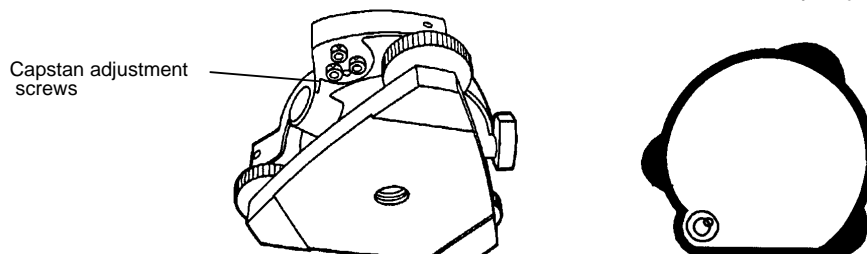
Adjustment is required if the axis of the circular level is also not perpendicular to the vertical axis.

● Check

- ① Carefully level the instrument with the plate level only. If the bubble of the circular level is centered properly, adjustment is not required. Otherwise, proceed with the following adjustment.

● Adjustment

- ② Shift the bubble to the center of the circular level, by adjusting three capstan adjustment screws on the bottom surface of the circular level, with the accessory adjusting pin.

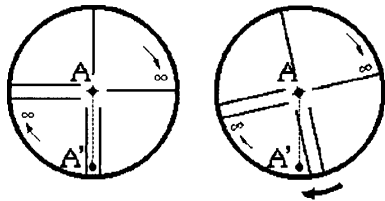


17.3.3 Adjustment of the Vertical Cross-hair

Adjustment is required if the vertical cross-hair is not in a plane perpendicular to the horizontal axis of the telescope (since it must be possible to use any point on the hair for measuring horizontal angles or running lines).

● Check

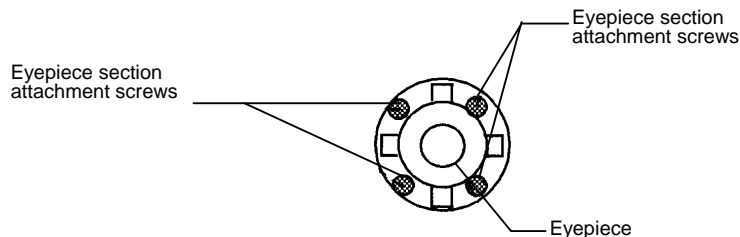
- ① Set the instrument up the tripod and carefully level it.
- ② Sight the cross-hairs on a well defined Point A at a distance of, at least, 50 meters (160ft.) .
- ③ Next swing the telescope vertically using the vertical jog and shuttle, and check whether the point travels along the length of the vertical cross-hair.



- ④ If the point appears to move continuously on the hair, the vertical cross-hair lies in a plane perpendicular to the horizontal axis (and adjustment is not required).
- ⑤ However, if the point appears to be displaced from the vertical cross-hair, as the telescope is swung vertically, adjustment is required in the reticle plate.

● Adjustment

- ① Unscrew the cross-hair adjustment section cover, by revolving it in the counterclockwise direction, and take it off. This will expose four eyepiece section attachment screws.



- ② Loosen all four attachment screws slightly with the accessory screw-drive (while taking note of the number of revolutions).
Then revolve the eyepiece section so that the vertical cross-hair coincides to Point A e.
Finally, re-tighten the four screws by the amount that they were loosened.
- ③ Check once more and if the point travels the entire length of the vertical cross-hair, further adjustment is not required.

Note : Perform following adjustment after complete above adjustment .

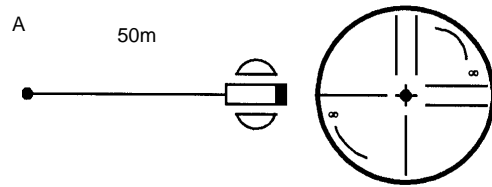
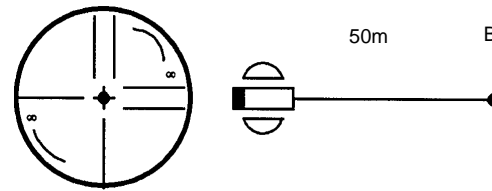
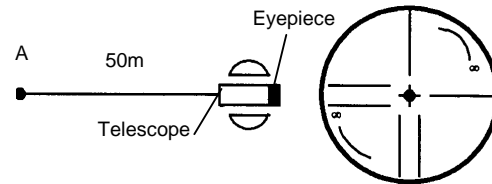
Chapter 17.3.4 "Collimation of the Instrument", Chapter 17.3.6 "Adjustment of Vertical Angle Zero Datum" , Chapter 17.5 "Inspection and Adjustment of Optic Axis for Auto -Tracking"

17.3.4 Collimation of the Instrument

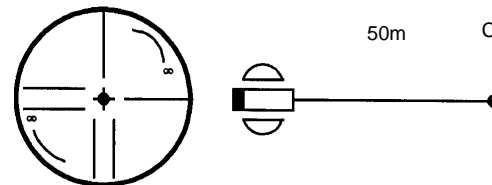
Collimation is required to make the line of sight of the telescope perpendicular to the horizontal axis of the instrument, as otherwise, it will not be possible to extend a straight line by direct means.

● Check

- ① Set the instrument up with clear sights of about 50 to 60 meters (160 to 200 ft.) on both sides of the instrument.
- ② Level the instrument properly with the plate level.
- ③ Sight Point A at approximately 50 meters (160 t.) distance.
- ④ Use the vertical jog and shuttle only and rotate the telescope 180° or $200g$ around the horizontal axis, so that the telescope is pointed in the opposite direction.
- ⑤ Sight Point B, at equal distance as Point A.
- ⑥ Use the horizontal jog and shuttle and rotate the instrument 180° or $200g$ around the vertical axis. Fix a sight on Point A once more.

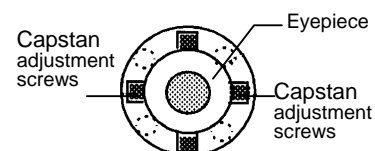
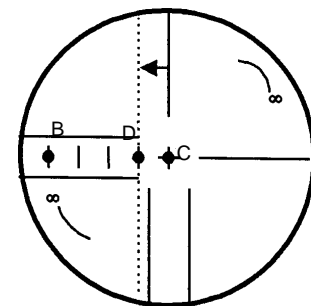


- ⑦ Use the vertical jog and shuttle only and rotate the telescope 180° or $200g$ around the horizontal axis once more and fix a sight on Point C, which should coincide with previous Point B.
- ⑧ If Points B and C do not coincide, adjust in the following manner.



● Adjustment

- ① Unscrew the cross-hair adjustment section cover.
- ② Find Point D at a point between Points C and B, which should be equal to $1/4$ th the distance between Points B and C and measured from Point C. This is because the apparent error between Points B and C is four times the actual error since the telescope has been reversed twice during the checking operation.
- ③ Shift the vertical cross-hair line and coincide it with Point D, by revolving the left and right capstan adjustment screws with the adjusting pin. Upon completing the adjustment, repeat the checking operation once more. If Points B and C coincide, further adjustment is not required. Otherwise, repeat the adjustment.



Note 1): First, loosen the capstan adjustment screw on the side to which the vertical cross-hair line must be moved. Then tighten the adjustment screw on the opposite side by an equal amount which will leave the tension of the adjustment screws unchanged.

Revolve in the counterclockwise direction to loosen and in the clockwise direction to tighten, but revolve as little as possible.

Note 2): Perform following adjustment after complete above adjustment . Chapter 17.3.6 "Adjustment of Vertical Angle 0 Datum", Chapter 17.2 "Checking the Optical Axis", Chapter 17.5 "Inspection and Adjustment of Optic Axis for Auto-Tracking".

17.3.5 Checking / Adjusting the Optical Plummet Telescope

Adjustment is required to make the line of sight of the optical plummet telescope coincide with the vertical axis (as otherwise the vertical axis will not be in the true vertical when the instrument is optically plumbed).

● Check

- ① Coincide the center mark and the point.

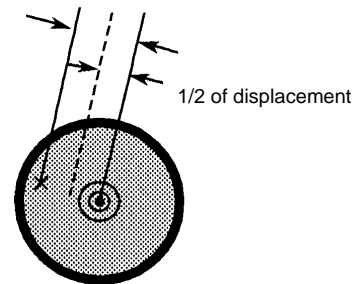
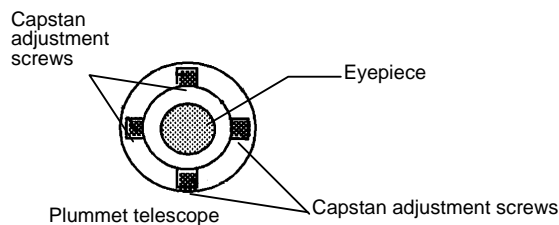
(See Chapter 2 "PREPARATION OF MEASUREMENT".)

- ② Rotate the instrument 180° or 200g around the vertical axis and check the center mark.

If the point is properly centered in the center mark, adjustment is not required. Otherwise, adjust in the following manner.

● Adjustment

- ① Unscrew the adjustment section cover of the optical plummet telescope eyepiece, by revolving it in the counterclockwise direction, and take it off. This will expose four capstan adjustment screws which should be adjusted with the accessory adjusting pin to shift the center mark to the point. However, correct only one-half of the displacement in this manner.



- ② Use the leveling screws and coincide the point and center mark.
- ③ Rotate the instrument 180° or 200g around the vertical axis once more and check the center mark. If it is coincided to the point, then further adjustment is not required. Otherwise, repeat the adjustment.

Note: First, loosen the capstan adjustment screw on the side to which the center mark must be moved. Then tighten the adjustment screw on the opposite side by an equal amount which will leave the tension of the adjustment screws unchanged.

Revolve in the counterclockwise direction to loosen and in the clockwise direction to tighten, but revolve as little as possible.

17.3.6 Adjustment of Vertical Angle 0 Datum

If when measuring the vertical angle of target A at telescope position normal (direct) and reverse settings, the amount of normal and reverse measurements combined is other than 360° (ZENITH-0), half of the difference from 360° is the error amount from corrected 0 setting. Carry out adjustment. As adjustment for vertical angle 0 setting is the criteria for determining instrument coordinate origin, use special care for adjustment.

Operating procedure	Operating key	Display
<p>① Level the instrument properly with the plate level.</p> <p>② While pressing [F1]key, turn power switch ON. Input code when secret code is ON. In case mode is set in Auto 0-set, AP-L1A rotates automatically to do zero set for H and V angle. When mode is set in manual 0-set, turn jog / shuttle of H or V 0-set.</p> <p>③ Operate jog / shuttle of H and V, and collimate target A from the telescope properly in normal setting.</p> <p>④ Press [F4](SET) key.</p> <p>⑤ Press Auto inversion key or operate jog / shuttle of H and V, and reverse the telescope.</p> <p>⑥ Collimate target A in reverse telescope setting with H/V jog/shuttle.</p> <p>⑦ Press [F4](SET)key. Measured value is set and carry out normal angle measurement.</p> <p>⑧ Check that the total amount of normal and reverse angular travel is 360° collimating the target A by normal and reverse positions.</p>	<p>[F1] + POWER ON</p> <p>[F4]</p> <p>[F4]</p>	<div>[V0 – ADJUST]</div> <div> ZERO SET H - SET (AUTO) V - SET (AUTO) </div> <div> VO – ADJUST < STEP-1 > FRONT V 0°00'00" -- -- -- SET </div> <div> VO – ADJUST < STEP-2 > REAR V 0°00'00" -- -- -- SET </div> <div> V : 90° 10' 20" HR : 120° 30' 40" 0SET HSET R/L 1↓ </div>
<ul style="list-style-type: none"> Any misoperating and an error display appears. Repeat the above procedure from the start. In step ⑦, if the measure value in normal and reverse is more than set value, error will be displayed. Repeat from beginning. 		

17.4 How to Set the Instrument Constant Value

To set the Instrument constant which obtained at Chapter 17.1 "Check and adjusting of instrument constant", follow as below.

Operating procedure	Operating key	Display
① While pressing [F2]key, turn power switch ON. Input the same secret code which was set previously. <ul style="list-style-type: none"> In case the secret code is not set, the selecting menu is displayed. 	[F2] + POWER ON	<div>[PARAMETERS SET]</div> <div>PARAMETERS F1 : ANGLE F2 : DIST F3 : SECRET</div>
② Select [F2:DIST].	[F2]	<div>DIST 1/3 F1 : UNIT F2 : W-CORR F3 : EDM MODE</div>
③ Press [F4] key. DIST 2/3 menu will be displayed.	[F4]	<div>DIST 2/3 F1 : OFFSET F2 : PRESS F3 : TEMP</div>
④ Select [F1:OFFSET].	[F1]	<div>OFFSET = 00.0 mm EXIT --- CLR ←</div>
⑤ Input the constant value Example : 1.3mm	[1] [.] [3]	<div>OFFSET = 1.3 mm EXIT --- CLR ←</div>
⑥ Press [ENT] key.	[ENT]	<div>< SET! ></div> <div>↓</div> <div>DIST 2/3 F1 : OFFSET F2 : PRESS F3 : TEMP</div>
⑦ Turn power switch OFF	Power OFF	
<ul style="list-style-type: none"> Instrument constant value input limit is $\pm 99.9\text{mm}$, 0.1mm step. The instrument constant value at shipping time is written on a label and attached to the bottom of the AP-L1A. 		

17.5 Inspection and Adjustment of Optic Axis for Auto -Tracking

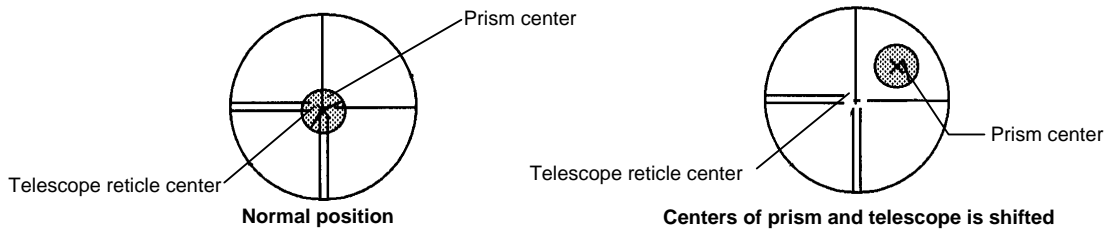
Pressing [A/M]key activates auto tracking to the prism.

Confirm if the center of telescope reticle and the center of the prism is coincided .

Any error between them requires adjustment according to the following procedure.

- There are two ways to adjust error; one is auto adjusting and the other is manual adjusting .
- Adjustment normally will be done manually.

Before to do adjustment by auto, it is needed to do Chapter 17.3.4 "Collimation of the Instrument" and Chapter 17.3.6 "Adjustment of Vertical Angle 0 Datum". Also auto adjustment is not possible when error is exceeding 1'. You must adjust manually.



1) Auto Adjustment Procedure

After doing Chapter 17.3.4 "Collimation of the Instrument" and Chapter 17.3.6 "Adjustment of Vertical Angle 0 Datum", do as following.

Operating procedure	Operating key	Display
Level the instrument properly with the plate level.	[MENU]	MENU 1/1 F1 : PARAMETERS F2 : PROGRAMS F3 : REMOTE
① Press [MENU] key, from normal measurement mode.		
② Select [F1:PARAMETERS].	[F1]	PARAMETERS 1/1 F1 : TRK F2 : MEAS F3 : COM
③ Select [F1:TRK]	[F1]	TRK 1/3 F1 : SEARCH F2 : WAIT TIME F3 : SCAN WIDTH
④ Press [F4]key, TRK menu 2/3 will be displayed.	[F1]	TRK 2/3 F1 : ADJ AXIS(M) F2 : ADJ AXIS(A) F3 : TRK SPEED


17. CHECK AND ADJUSTMENT

<div>⑤ Select [F2:ADJ.AXIS(A)].</div>	<div>[F2]</div>	<div><table><tr><td>ADJ</td><td>AXIS</td><td>AUTO</td></tr><tr><td>V :</td><td>90°10'20"</td><td></td></tr><tr><td>H :</td><td>160°40'20"</td><td></td></tr><tr><td>START</td><td>--</td><td>-- --</td></tr></table></div>	ADJ	AXIS	AUTO	V :	90°10'20"		H :	160°40'20"		START	--	-- --																																
ADJ	AXIS	AUTO																																												
V :	90°10'20"																																													
H :	160°40'20"																																													
START	--	-- --																																												
<div>⑥ Operate H / V jog shuttle to collimate the prism in the normal (direct) position of telescope .</div>	<div>A/M</div>																																													
<div>⑦ Press (A / M) key to obtain auto tracking mode.</div>																																														
<div>⑧ Press [F1](START).*1)</div> <div>The measured data will be checked at the normal position of telescope internally.</div> <div>Instrument and also telescope turns in reverse and tracks prism automatically at the reverse position of telescope.</div> <div>The measured data will be checked at the reverse position of telescope internally.</div> <div>Instrument and also telescope turns and return at the normal (direct) position of telescope.</div> <div>The shifted quantity between H angle and V angle measured from the normal and reverse position of telescope will be calculated internally, and the error will be displayed *2)</div>	<div>[F1]</div>	<div><table><tr><td>ADJ</td><td>AXIS</td><td>AUTO</td></tr><tr><td>V :</td><td>90° 00' 00"</td><td></td></tr><tr><td>H :</td><td>60° 40' 20"</td><td></td></tr><tr><td></td><td>DATA</td><td>CHECK</td></tr></table><div>Instrument and also telescope turns in reverse</div><div>↓</div><table><tr><td>ADJ</td><td>AXIS</td><td>AUTO</td></tr><tr><td>V :</td><td>270° 00' 00"</td><td></td></tr><tr><td>H :</td><td>240° 40' 20"</td><td></td></tr><tr><td></td><td>DATA</td><td>CHECK</td></tr></table><div>Instrument and also telescope turns in reverse</div><div>↓</div><table><tr><td>ADJ</td><td>AXIS</td><td>AUTO</td></tr><tr><td>HOFF :</td><td>0' 10"</td><td></td></tr><tr><td>VOFF :</td><td>0' 20"</td><td></td></tr><tr><td>SET</td><td>OK ></td><td>[YES][NO]</td></tr></table><div>SET!!</div><div><table><tr><td>TRK</td><td>2/3</td></tr><tr><td>F1 : ADJ AXIS(M)</td><td></td></tr><tr><td>F2 : ADJ AXIS(A)</td><td></td></tr><tr><td>F3 : TRK SPEED</td><td></td></tr></table></div></div>	ADJ	AXIS	AUTO	V :	90° 00' 00"		H :	60° 40' 20"			DATA	CHECK	ADJ	AXIS	AUTO	V :	270° 00' 00"		H :	240° 40' 20"			DATA	CHECK	ADJ	AXIS	AUTO	HOFF :	0' 10"		VOFF :	0' 20"		SET	OK >	[YES][NO]	TRK	2/3	F1 : ADJ AXIS(M)		F2 : ADJ AXIS(A)		F3 : TRK SPEED	
ADJ	AXIS	AUTO																																												
V :	90° 00' 00"																																													
H :	60° 40' 20"																																													
	DATA	CHECK																																												
ADJ	AXIS	AUTO																																												
V :	270° 00' 00"																																													
H :	240° 40' 20"																																													
	DATA	CHECK																																												
ADJ	AXIS	AUTO																																												
HOFF :	0' 10"																																													
VOFF :	0' 20"																																													
SET	OK >	[YES][NO]																																												
TRK	2/3																																													
F1 : ADJ AXIS(M)																																														
F2 : ADJ AXIS(A)																																														
F3 : TRK SPEED																																														
<div>⑨ Press [F3] (YES) key.</div> <div>The compensation value will be set and memorized to AP-L1A.</div> <div>The display returns TRK menu 2/2.</div>	<div>[F3]</div>																																													
<div>⑩ Confirm if the center of telescope reticle and the center of prism coincide.</div>																																														

*1) The display shows "NOT TRACKING" when tracking mode is not set, or the target prism is not found.

*2) The display shows "OFF SET OVER" when the calculated compensation value is exceeded than limited value of ±1'. Press [F4] (CLR) key to carry out from the step ⑧ or adjust by manual.

2) Manual Adjustment Procedure

Operating procedure	Operating key	Display
① Press the [MENU] key from normal measurement mode.	[MENU]	<div>MENU 1/1</div> <div>F1 : PARAMETERS</div> <div>F2 : PROGRAMS</div> <div>F3 : REMOTE</div>
② Select [F1:PARAMETERS].	[F1]	<div>PARAMETERS 1/1</div> <div>F1 : TRK</div> <div>F2 : MEAS</div> <div>F3 : COM</div>
③ Select [F1:TRK] .	[F1]	<div>TRK 1/3</div> <div>F1 : SEARCH</div> <div>F2 : WAIT TIME</div> <div>F3 : SCAN WIDTH</div>
④ Press the [F4] key, TRK menu 2/3 will be shown.	[F4]	<div>TRK 2/3</div> <div>F1 : ADJ AXIS(M)</div> <div>F2 : ADJ AXIS(A)</div> <div>F3 : TRK SPEED</div>
⑤ Select [F1:ADJ AXIS(M)].	[F1]	<div>ADJ AXIS (M)</div> <div>PRISM</div> <div>COLLIMATE</div> <div>SET OK > [YES] ---</div>
⑥ Adjust H/V jog shuttle until collimating proper prism center.		
⑦ Press the [F3] (YES) key.	[F3]	<div>ADJ AXIS (M)</div> <div>AUTO</div> <div>TRACKING</div> <div>SET OK > [YES] ---</div>
⑧ Press [A/M] key, tracking the prism.	[A/M]	<div>ADJ AXIS (M) *</div> <div>AUTO</div> <div>TRACKING</div> <div>SET OK > [YES] ---</div>
⑨ Confirm that tracking the prism, and press the [F3] (YES) key. *1)	[F3]	<div>ADJ AXIS (M) *</div> <div>AUTO</div> <div>TRACKING</div> <div>DATA CHECK</div>
The measured data will be checked by AP-L1A.		

17. CHECK AND ADJUSTMENT

The error quantity between H and V angle calculated from manual collimating and auto tracking will be displayed. *2)

- ⑩ After confirming the display value, press [F3] (YES) key.
The compensation value will be set and memorized to AP-L1A.

- ⑪ Confirm if the center of telescope reticle and the center of prism is coincided. If not, repeat from the procedure ⑤.

[F3]

↓

ADJ	AXIS	(M)	*
V	:	0' 10"	
H	:	0' 20"	
SET	OK >	[YES]	[NO]
SET!!			

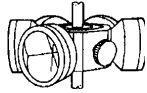
↓

TRK	2/3
F1 : ADJ AXIS(M)	
F2 : ADJ AXIS(A)	
F3 : TRK SPEED	

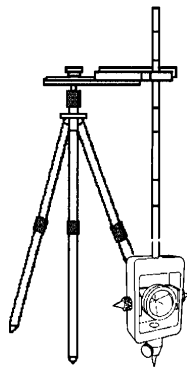
- *1) The display shows "NOT TRACKING" when tracking mode is not set, or the target prism is not found. Repeat the procedure ⑧.
- *2) The display shows "OFF SET OVER" when the calculated compensation value is exceeded than limited value of $\pm 5'$. Press [F4] (CLR) key to carry out from the step ⑥. Even "OFF SET OVER" displays, the instrument is required repair.
- * In case to stop adjusting procedure on half way, press the [ESC] key.

18. PRISM SYSTEM

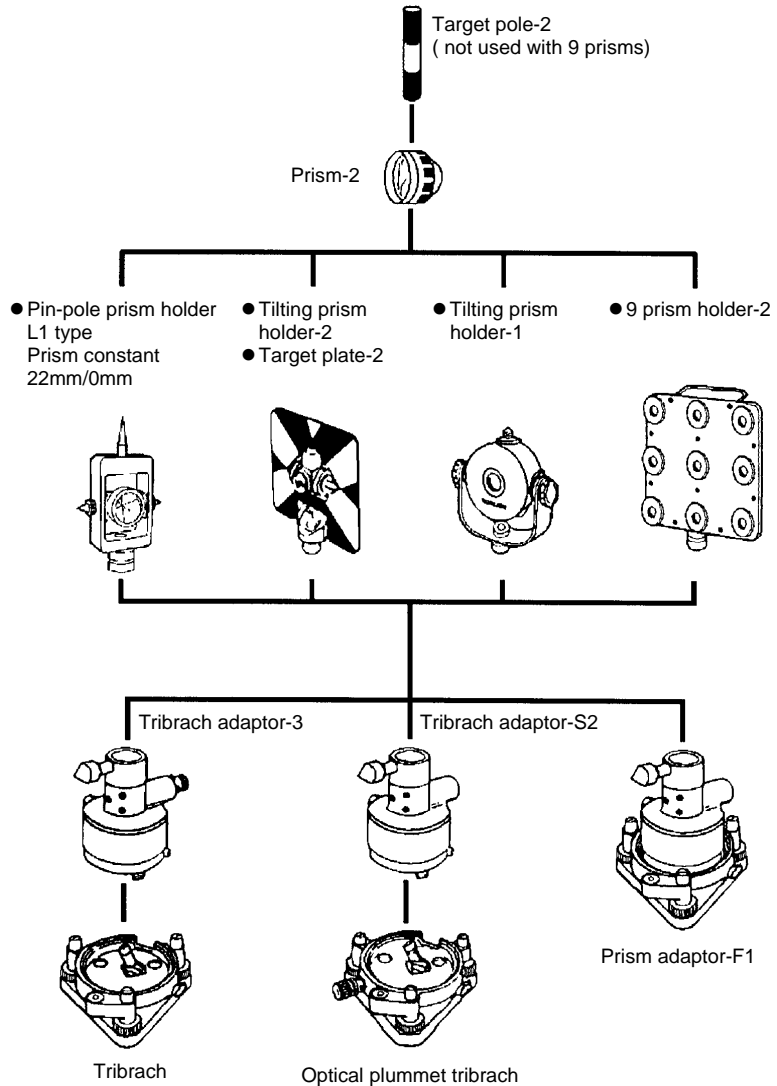
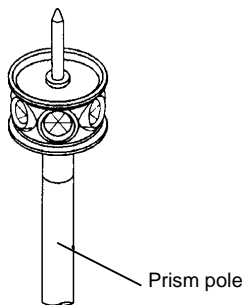
- Prism unit A5 type
Prism constant -18mm



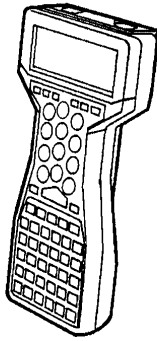
- Pin-pole prism set L1 type
Prism constant 22mm/0mm



- Prism unit A3 type
Prism constant 0mm

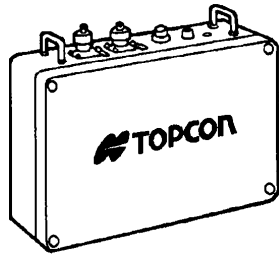


19. SPECIAL ACCESSORIES



Data terminal FS/2

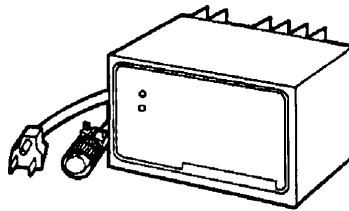
This is multi terminal for the purpose of control AP-L1A, operating of application, transmission and receiving of measured data.



Power supply PX-2

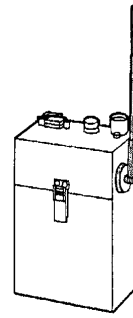
This is AC-DC converter for continuous use. With waterproof and dustproof.

- Input voltage : AC100~120V/220~240V
- Output voltage : DC12V 8A
- External dimensions:
260(L)×91(W)×184(H) mm
- Weight : 3.2kg



Battery charger for mark light battery

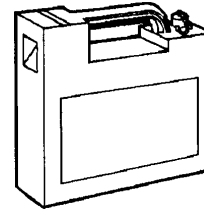
- Input voltage : Changeable
AC100~120V/220~240V
- External dimensions:
139(L)×143(W)×83(H) mm
- Weight : 2.4kg



Wireless terminal WT-1A/1B

This is available to make communication with AP-L1A and control of , on a radio.

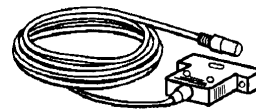
Carrying belt to waist gives much help to carry, with battery and battery charger.



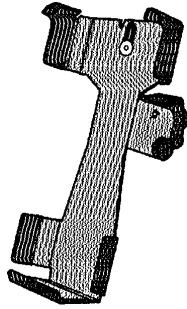
Mark light battery (12V)

Shield type lead accumulator (with light)

- Output voltage : DC12V
- Capacity : 8000mAh
- External dimensions:
220(L)×69(W)×192(H) mm
- Weight : 3.8kg



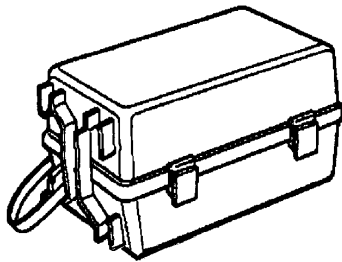
Inter face cables



Data terminal holder type 1 for FS/2

This is exclusive holder to set FS/2 to commercial pole.

- Pole diameter : 26-30mm



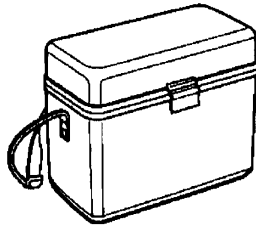
Prism unit case, Model 3

This is the plastic case to store and carry various sets of prisms.

The case covers one of the following prism sets:

- 1) Tilt single prism set
- 2) Tilt single prism set with a target plate

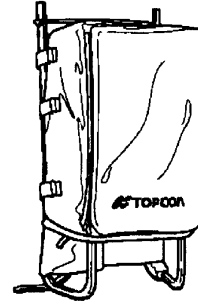
- External dimensions:
427(L) × 254(W) × 242(H) mm
- Weight: 3.1kg



Gadget case, Model 1

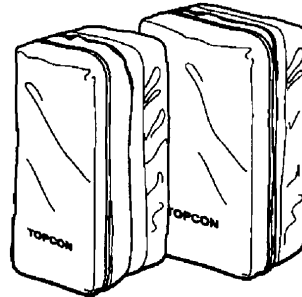
A case to store and carry accessories.

- External dimensions:
300(L) × 145(W) × 220(H) mm
- Weight: 1.4kg



Back pack, Model 2

Convenient for use in mountainous terrain.



Prism unit case, Model 6

Fixed 9 prisms unit can be stored in this case.

Especially, this is a very easy case to carry. Soft material is used.

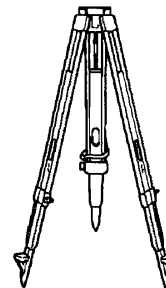
- External dimensions:
250(L) × 120(W) × 400(H) mm
- Weight: 0.5kg

Prism unit case, Model 5

1 prisms unit can be stored in this case.

Especially, this is a very easy case to carry. Soft material is used.

- External dimensions:
200(L) × 200(W) × 350(H) mm
- Weight: 0.5kg



Wide-frame extension leg tripod, Type E (Wood)

- Flat head 5/8" × 11 threads with adjustable legs.

20. STORAGE PRECAUTIONS

1. Clean the instrument after using.
 - ① When sea water is splashed on instrument during operation, clean salty water with wet cloth at first, and dry with dry cloth. Never store wet or damp instrument in case. Leave out in dry area to "air dry" instrument and case.
 - ② Sweep away dust from the instrument with cleaning brush, and wipe the dirt with soft cloth. Never use compressed air or gas.
 - ③ Use cleaning brush to clean lens also use cleaning brush to sweep away dust. Mixed liquid, alcohol and ether, can be used to cleaning lens surface. Repeat many times swabbing lightly with washed cloth such as cotton without any oil or paste moistened with mixed liquid.
2. For the dirt on plastic parts, avoid to use of volatile material such as thinner or benzene, but use neutralized detergent or water.
3. Keep the telescope horizontal and turn the instrument to match its mark with the horizontal turning Storage Mark. Remove the antenna of Wireless modem (or keep the antenna down for fold type antenna), then store it in the case keeping its objective lens side downward. Storing AP-L1A in any other way other than its case, may cause damage or failure. Hold upper and lower hand grips with both hands, and move directly in or out of its case.

After power OFF, turn the Telescope Rotating Free lever or Horizontal Rotating Free lever positively to rotate telescope or main body of AP-L1A.

4. Check each part of the tripod after extended use. Parts (screws or clamps) may work themselves free.

21. ERROR DISPLAYS

Error code	Description	Countermeasures
Tilt Over	Displayed when instrument is out of level beyond compensation range.	Level the instrument properly
W/C OVER	Displayed when measurement carried out within $\pm 9^\circ$ from zenith or nadir at the Earth curvature and refraction correction mode is ON.	Set correction for refraction and earth curvature mode OFF or measure out of $\pm 9^\circ$ from the zenith or Nadir.
E01	Displayed when the instrument rotated abnormally.	Pressing [F1](0set) key, returns to measuring mode.
E02	Displayed when the telescope rotated abnormally.	Press [F1](0set) key, and after display of "V-0 set", set vertical angle zero by rotating telescope.
E03	Displayed when a internal problem exists with the angle measuring system.	Switch OFF the power , then ON again. Sometimes error occurs when vibrates, clear the vibration.
E11	Displayed when the input value for instrument constant value exceeds the input range.	Input properly.
E14	Displayed when the input value for prism constant value exceeds the input range.	Input properly.
E15	Displayed when the input value for atmospheric correction value exceeds the input range.	Input properly.
E18	Displayed when the area set is not set yet.	Set the area set.
E19	While setting instrument coordinate by resection method, the discrepancy of H or V distance exceeds its range.	Input proper value of known point coordinate and collimate again.
E20	Displayed when invalid value is input for sighting direction of rotating command.	Input proper value again.
E21	Displayed when search range exceeds the input range.	Input proper value again.
E22	Displayed when input value for waiting time exceeds the input range.	Input proper value again.

E23	Displayed when adjusting automatic tracking for optical axis , if the input value exceeds the input range.	Adjust properly once again.
E24~E29	Displayed when setting the clock, if the input value is not valid.	Input proper value again.
E32	Displayed when the coordinate value of points A and B which set by resection method or measured data is same.	Execute input of known point and proper sighting again.
E36~E38	Displayed when the input value of each parameter exceeds its range in teach mode.	Input proper input value.
E47	Abnormality in OS of the instrument.	Power switch OFF, then ON again.
E50's	Abnormality in internal communication system.	Instrument in need of attention from authorized repair facility.
E60's	Abnormality in distance measuring system.	Instrument in need of attention from authorized repair facility.
E71	Displayed when vertical angle 0 position is set with incorrect procedure.	After confirmation procedure, readjust vertical angel 0-set.
E72	Displayed when error of Vertical angle zero set is remarkable.	Instrument in need of attention by authorized repair facility.
E73, E74	In adjusting vertical angle zero set if the instrument is not leveled or something has failed with tilt sensors.	Level the instrument and readjust .
E80's	Abnormality in internal communication system.	Instrument in need of attention by authorized repair facility.
E90's	Abnormality in internal memory system.	When the error message [E98] is displayed, back up battery is too low to back up the memory. Ask your dealer or head office to replace the back up battery.

- If errors still persist after attempting to clear them, contact your local TOPCON dealer or TOPCON Head office.

22. SPECIFICATIONS

Telescope

Length	: 173mm
Objective lens	: 50mm
Magnification	: 30 ×
Image	: Erect
Field of view	: 1° 30'
Resolving power	: 3.5"
Minimum focus	: 1.5m

Automatic Tracking

Automatic Tracking speed range *1	: Angular speed	: 10°/sec
	: Angular acceleration	: 10°/sec ²

Automatic Tracking range *2

Prism	Scanning range NARROW(20'×20')	Scanning range MIDDLE(40'×40')	Scanning range WIDE(60'×60')
Prism type 2, with 1 prism	20 ~ 1,000 m (66 ~ 3,300ft)	10 ~ 1,000 m (33~3,300ft)	7 ~ 1,000 m (23~3,300ft)
Prism type 2, with 5 prisms *3	75 ~ 1,300 m (250~4,300ft)	38 ~ 1,300 m (125~4,300ft)	25 ~ 1,300m (82~4,300ft)
Prism type 2, with 9 prisms *3	75 ~ 1,600 m (250~5,250ft)	38 ~ 1,600 m (125~5,250ft)	25 ~ 1,600m (82~5,250ft)
Prism type 3 or 5, with 1 prism	12 ~ 700 m (40~2,300ft)	6 ~ 700m (20~2,300ft)	4 ~ 700m (13~2,300ft)
Prism Unit Type A2/A3 (Prism type 3, 6 in all direction)	30 ~ 500 m (100~1650ft)	15 ~ 500m (50~1650ft)	10 ~ 500m (33~1650ft)

Collimation accuracy (Repeatability of collimation by Automatic Tracking) 4 :

Setting	Prism staying	Prism moving (Angular speed / acceleration)
LOW speed	3"(1mgon)	_____
MEDIUM speed	5"(1.5mgon)	2'(37mgon) (8°/sec, 4°/sec ²)
HIGH speed	10"(3mgon)	2'(37mgon) (8°/sec, 8°/sec ²)

Search pattern	: High / Normal
Search range	: Any value can be set, able to set (1° step)
Scanning range	: NARROW / MIDDLE / WIDE
Safety standard for Laser Beam	: Class 2(IEC Publication 825),ClassII(FDA/BRH 21 CFR 1040)

*1 In scanning range: MIDDLE, except around zenith.

*2 Condition : Normal(Visibility about 20km), except high humidity time.

*3 In case using 9 prism holder fixing type 2.

*4 The standard deviation in the condition of stable air and the scanning range is set MIDDLE.

Manual Driving

Maximum rotating speed *5 : 45°/sec
 Coarse movement : Shuttle driving (in 7 steps)
 Fine movement : Jog driving (minimum step about 1 second)

*5 By reverse, rotating instruction

Distance Measurement

Measurement range :

Prism	Normal condition *6
Prism type 2, with 1 prism	1,000 m (3,300ft)
Prism type 2, with 5 prisms	1,300 m (4,300ft)
Prism type 2, with 9 prisms	1,600 m (5,250ft)
Prism type 3 or 5, with 1 prism	700 m (2,300ft)
Prism Unit Type A2/A3 (Prism Type 3, 6 prisms in all direction)	500 m (1,650ft)

*6 Normal condition : Slight haze with visibility about 20km (12.5 miles) moderate sunlight with light heat shimmer.

Measurement range : *7

FINE measurement : $\pm(3\text{mm}+2\text{ppm})\text{m.s.e.}$
 COARSE measurement : $\pm(10\text{mm}+2\text{ppm})\text{m.s.e.}$

Possible measurement max. prism moving

speed (in direction of near to far) : 20 km/h (12.5miles/h) (COARSE measurement)

Least count in measurement

FINE measurement : 0.2mm / 1mm (0.001ft / 0.005ft)
 COARSE measurement : 1mm / 10mm (0.005ft / 0.02ft)

Measuring interval time

FINE measurement

0.2mm mode : approx.4.5 seconds (providing 9~12 seconds for first time)
 1mm mode : approx.2 seconds (providing 3~5 seconds for first time)

COARSE measurement

1mm mode : approx.0.5 second(providing 1~3 seconds for first time)
 10mm mode : approx.0.2 second(providing 1~3 seconds for first time)

Atmospheric correction range : -99 ~ + 99ppm (1 ppm step)

Prism constant correction range : -99 ~ + 99mm (1 mm step)

*7 The prism is staying

Angle Measurement

Method	: Incremental reading
Detecting system	:
Horizontal angle	: 2 sides
Vertical angle	: 2 sides
Minimum reading	: 1"/5" (0.2mgon/1mgon,0.01mil/0.1mil) reading
Accuracy	: 2"(Standard deviation based on DIN 18723 in 1"reading)
Diameter of circle	: 71mm

Tilt Correction (H/V angle)

System	: Automatic correction in 2 axis (Correction On / OFF)
Method	: Liquid type
Compensating Range	: $\pm 3'$
Correction unit	: 1"

Wireless Communication

Method	: Depends on the market.
Communication range*8	: Depends on the market.
*8 The communication distance will be determined by the circumstances of instrument occupation and/or radio condition. Refer to the instruction manual in detail.	

Others

Operating Temperature limit	: -20 ~+50°C (Avoid not to be condensed drops) (-4 ~+122°F)
Storage Temperature limit	: -20 ~+60°C (Avoid not to be condensed drops) (-4 ~+140°F)
Instrument height	: 242mm (9.53in) Base unit detachable (Height from the tribrach dish to the center of telescope)
Level sensitivity	
Circular level	: 10'/2mm
Plate level	: 30"/2 mm
Optical Plummet Telescope	
Magnification	: 3×
Focusing range	: 0.5m to infinity
Image	: Erect
Field of view	: 4°(91mm ϕ /1.3m)
Communication system	:
COM.1	: Based on RS-232C (3 lines system)
COM.2	: Based on RS-232C (AP-L1AN)

Dimension	:	
AP-L1A	:	405(H) ×216(W) ×180(L) mm(except antenna) *9 (15.9(H) ×8.5(W) ×7.1in(L))
AP-L1AN	:	405(H) ×210(W) ×180(L) mm (15.9(H) ×8.3(W) ×7.1in(L))
Weight	:	
AP-L1A	:	9.4kg (20.7 lbs) (with Tribach) *9
AP-L1AN	:	8.9kg (19.6 lbs) (with Tribach)
Input Voltage	:	DC 12V
Power consumption *10	:	5 ~ 18W
Operating time (Using 90% charged Mark light battery) *9, *11		
Only for Distance and Angle measuring	:	approx.7 hours
Auto-Tracking of a still object	:	approx.5 hours
Auto-Tracking of a moving object		approx.4 hours

*9 Differs with the type of wireless modem.

*10 Differs with operation condition of AP-L1A.

*11 Differs with the conditions of operating, recharging mark light battery or temperature.