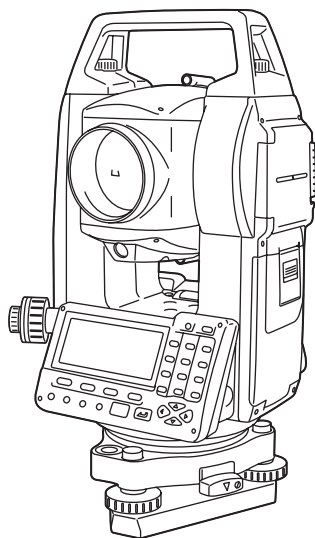# SOKKIA Series50RX

SET250RX
SET350RX
SET550RX
SET650RX

Reflectorless Total Station

CLASS 3R Laser Product

CLASS 2 Laser Product

CLASS 1 LED Product

OPERATOR'S MANUAL

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

SOKKIA **Series50RX**
SET250RX
SET350RX
SET550RX
SET650RX
Reflectorless Total Station

CLASS 3R Laser Product

CLASS 2 Laser Product

CLASS 1 LED Product

OPERATOR'S MANUAL

- Thank you for selecting the SET250RX/350RX/550RX/650RX.
- Please read this operator's manual carefully before using this product.
- Verify that all equipment is included.
  ☞ "35. STANDARD EQUIPMENT"
- SET has a function to output data saved in the SET to a connected host computer. Command operations from a host computer can also be performed. For details, refer to "Interfacing with the SOKKIA SDR Electronic Field Book" and "Command Explanations" manuals and ask your local dealer.
- The specifications and general appearance of the instrument are subject to change without prior notice and without obligation by Sokkia Topcon Co., Ltd. and may differ from those appearing in this manual.
- The content of this manual is subject to change without notice.
- Some of the diagrams shown in this manual may be simplified for easier understanding.

HOW TO READ THIS MANUAL

Symbols

The following conventions are used in this manual.

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

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

[Note] : Indicates supplementary explanation.

📖 : Indicates an explanation for a particular term or operation.

[DIST] etc. : Indicates softkeys on the display.

{ESC} etc. : Indicates operation keys on the SET or wireless keyboard.

<S-O> etc. : Indicates screen titles.

Notes regarding manual style

• Except where stated, "SET" means SET250RX/350RX/550RX/650RX in this manual.
• The Series 50RX is available in both "standard" and "Low Temperature" models. Users with a "Low Temperature Model" should read the additional precautions specific to use under low temperatures.

   ● **Low Temperature Model**
   Low Temperature Models display the seal shown at right.

   ☝
   • Do not remove the Low Temperature Model seal from the instrument. This seal is used for model recognition by our engineers during maintenance.
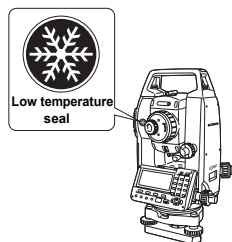
• Screens and illustrations appearing in this manual are of SET250RX (standard model).
• Location of softkeys in screens used in procedures is based on the factory setting. It is possible to change the allocation of softkeys in Meas mode.
☞ What are softkeys: "4.1 Parts of the Instrument", Softkeys allocation: "30.3 Allocating Key Functions"
• Learn basic key operations in "5. BASIC OPERATION" before you read each measurement procedure.

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- For selecting options and inputting figures, see "5.1 Basic Key Operation".
- Measurement procedures are based on continuous measurement. Some information about procedures when other measurement options are selected can be found in "Note" ($\boxed{\text{Note}}$).

- KODAK is a registered trademark of Eastman Kodak Company.
- *Bluetooth*® is a registered trademark of Bluetooth SIG, Inc.
- All other company and product names featured in this manual are trademarks or registered trademarks of each respective organization.

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1. PRECAUTIONS FOR SAFE OPERATION

For the safe use of the product and prevention of injury to operators and other persons as well as prevention of property damage, items which should be observed are indicated by an exclamation point within a triangle used with WARNING and CAUTION statements in this operator's manual.
The definitions of the indications are listed below. Be sure you understand them before reading the manual's main text.

Definition of Indication

⚠ WARNING	Ignoring this indication and making an operation error could possibly result in death or serious injury to the operator.
⚠ CAUTION	Ignoring this indication and making an operation error could possibly result in minor injury or property damage.

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

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

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

General

⚠Warning

○ Do not use the unit in areas exposed to high amounts of dust or ash, in areas where there is inadequate ventilation, or near combustible materials. An explosion could occur.

○ Do not perform disassembly or rebuilding. Fire, electric shock, burns or hazardous radiation exposure could result.

○ Never look at the sun through the telescope. Loss of eyesight could result.

○ Do not look at reflected sunlight from a prism or other reflecting object through the telescope. Loss of eyesight could result.

❶ Direct viewing of the sun using the telescope during sun observation will cause loss of eyesight. Use solar filter (option) for sun observation.
☞ 36. OPTIONAL ACCESSORIES

❶ When securing the instrument in the carrying case make sure that all catches, including the side catches, are closed. Failure to do so could result in the instrument falling out while being carried, causing injury.

⚠Caution

○ Do not use the carrying case as a footstool. The case is slippery and unstable so a person could slip and fall off it.

○ Do not place the instrument in a case with a damaged catch, belt or handle. The case or instrument could be dropped and cause injury.

○ Do not wield or throw the plumb bob. A person could be injured if struck.

❶ Secure handle to main unit with locking screws. Failure to properly secure the handle could result in the unit falling off while being carried, causing injury.

❶ Tighten the adjustment tribrach clamp securely. Failure to properly secure the clamp could result in the tribrach falling off while being carried, causing injury.

Power Supply

⚠️Warning

🚫 Do not use voltage other than the specified power supply voltage. Fire or electrical shock could result.

🚫 Do not use damaged power cords, plugs or loose outlets. Fire or electric shock could result.

🚫 Do not use power cords other than those designated. Fire could result.

🚫 Do not place articles such as clothing on the battery charger while charging batteries. Sparks could be induced, leading to fire.

🚫 Do not use the battery or charger for any other equipment or purpose. Fire or burns caused by ignition could result.

❗ Use only the specified battery charger to recharge batteries. Other chargers may be of different voltage rating or polarity, causing sparking which could lead to fire or burns.

🚫 Do not heat or throw batteries into fire. An explosion could occur, resulting in injury.

❗ To prevent shorting of the battery in storage, apply insulating tape or equivalent to the terminals. Otherwise shorting could occur resulting in fire or burns.

🚫 Do not use batteries or the battery charger if wet. Resultant shorting could lead to fire or burns.

🚫 Do not connect or disconnect power supply plugs with wet hands. Electric shock could result.

⚠️Caution

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

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Tripod

⚠️Caution

🛇 When mounting the instrument to the tripod, tighten the centering screw securely. Failure to tighten the screw properly could result in the instrument falling off the tripod, causing injury.

🛇 Tighten securely the leg fixing screws of the tripod on which the instrument is mounted. Failure to tighten the screws could result in the tripod collapsing, causing injury.

🚫 Do not carry the tripod with the tripod shoes pointed at other persons. A person could be injured if struck by the tripod shoes.

🛇 Keep hands and feet away from the tripod shoes when fixing the tripod in the ground. A hand or foot stab wound could result.

🛇 Tighten the leg fixing screws securely before carrying the tripod. Failure to tighten the screws could lead to the tripod legs extending, causing injury.

Bluetooth **wireless technology**

⚠️Warning

🚫 Do not use within the vicinity of hospitals. Malfunction of medical equipment could result.

🛇 Use the instrument at a distance of at least 22 cm from anyone with a cardiac pacemaker. Otherwise, the pacemaker may be adversely affected by the electromagnetic waves produced and cease to operate as normal.

🚫 Do not use onboard aircraft. The aircraft instrumentation may malfunction as a result.

🚫 Do not use within the vicinity of automatic doors, fire alarms and other devices with automatic controls as they may be adversely affected by the electromagnetic waves produced resulting in malfunction and injury.

Use under low temperatures (Low Temperature Model only)

⚠️Caution

🚫 In temperatures around -30°C do not touch metal parts on the main unit, the accessories and the carrying case with bare hands. Exposed skin may stick to parts and cause burns and loss of skin.

2. PRECAUTIONS

Tribrach Clamp

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

Screw Holding the Tribrach Clamp in Place
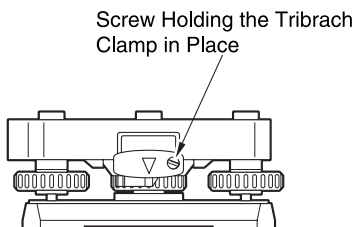
Precautions concerning water and dust resistance

SET conforms to IP66 specifications for waterproofing and dust resistance when the battery cover and external interface hatch are closed and connector caps are attached correctly.
• Be sure to close the battery cover and external interface hatch, and correctly attach the connector caps to protect the SET from moisture and dust particles.
• Make sure that moisture or dust particles do not come in contact with the inside of the battery cover, terminal or connectors. Contact with these parts may cause damage to the instrument.
• Make sure that the inside of the carrying case and the instrument are dry before closing the case. If moisture is trapped inside the case, it may cause the instrument to rust.

Vertical and horizontal clamps

• Always fully release the vertical/horizontal clamps when rotating the instrument or telescope. Rotating with clamp(s) partially applied may adversely affect accuracy.

Backing up data

• Data should be backed up (transfered to an external device etc.) on a regular basis to prevent data loss.

Use under low temperatures (Low Temperature Model only)

- Do not use force to scrape off frost from the lens or display screen. Frost is an abrasive material and may scratch the instrument.
- If ice or snow attaches itself to the unit, wipe it off with a soft cloth, or place the unit in a warm room until the ice melts, and then wipe off the meltwater. Operating the unit with ice or snow attached may cause operation errors to occur.
- Wipe off condensation with a soft cloth before using the instrument. Not doing so may cause operation errors to occur.
- The working duration of battery BDC46B will rapidly decline in cold temperatures. When using the instrument in temperatures around -30°C, we recommend that you use external battery BDC60 or BDC61 (optional accessories) and dedicated cables EDC119. However, if you unavoidably must use battery BDC46B for measurements in temperatures around -30°C, recharge the battery in a warm room and keep the battery in a warm place such as your pocket until it is used. (Working duration of battery will change with environmental conditions.)
- The operating temperature range of Wireless Keyboard SF14 is -20 to 50°C.
- Use nickel-cadmium batteries to power the Wireless Keyboard in low temperatures. When keyboard is not being used, keep it in a warm place such as a pocket.
- The lens cap and lens hood may become difficult to attach in low temperatures. Keep them in a warm place such as a pocket until attached.
- If the unit is carried between locations that have extreme temperature differences, protect the unit from rapid temperature change by placing it in the carrying case.
- Please use the tribrach supplied as standard. If a different tribrach is used, angle measurement errors may occur.

Other precautions

- Close the external interface hatch before starting measurement. Otherwise, ambient light entering the SD card/USB slot may adversely affect measurement results.
- If the SET is moved from a warm place to an extremely cold place, internal parts may contract and make the keys difficult to operate. This is caused by cold air trapped inside the hermetically sealed casing. If the keys do not depress, open the battery cover to resume normal functionality. To prevent the keys from becoming stiff, remove the connector caps before moving the SET to a cold place.
- Never place the SET directly on the ground. Sand or dust may cause damage to the screw holes or the centering screw on the base plate.

- Do not aim the telescope at the sun. Use the Solar filter to avoid causing internal damage to the instrument when observing the sun.
  ☞ "36. OPTIONAL ACCESSORIES"
- Protect the SET from heavy shocks or vibration.
- Never carry the SET on the tripod to another site.
- Turn the power off before removing the battery.
- When placing the SET in its case, first remove its battery and place it in the case in accordance with the layout plan.
- Consult your local dealer before using the instrument under special conditions such as long periods of continuous use or high levels of humidity. In general, special conditions are treated as being outside the scope of the product warranty.

Maintenance

- Always clean the instrument before returning it to the case. The lens requires special care. First, dust it off with the lens brush to remove tiny particles. Then, after providing a little condensation by breathing on the lens, wipe it with the wiping cloth.
- If the display is dirty, carefully wipe it with a soft, dry cloth. To clean other parts of the instrument or the carrying case, lightly moisten a soft cloth in a mild detergent solution. Wring out excess water until the cloth is slightly damp, then carefully wipe the surface of the unit. Do not use any organic solvents or alkaline cleaning solutions.
- Store the SET in a dry room where the temperature remains fairly constant.
- Check the tripod for loose fit and loose screws.
- If any trouble is found on the rotatable portion, screws or optical parts (e.g. lens), contact your local dealer.
- When the instrument is not used for a long time, check it at least once every 3 months.
  ☞ "32. CHECKS AND ADJUSTMENTS"
- When removing the SET from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.
- Check the SET for proper adjustment periodically to maintain the instrument accuracy.

Exceptions from responsibility

- The user of this product is expected to follow all operating instructions and make periodic checks (hardware only) of the product's performance.

- The manufacturer, or its representatives, assumes no responsibility for results of faulty or intentional usage or misuse including any direct, indirect, consequential damage, or loss of profits.
- The manufacturer, or its representatives, assumes no responsibility for consequential damage, or loss of profits due to any natural disaster, (earthquake, storms, floods etc.), fire, accident, or an act of a third party and/or usage under unusual conditions.
- The manufacturer, or its representatives, assumes no responsibility for any damage (change of data, loss of data, loss of profits, an interruption of business etc.) caused by use of the product or an unusable product.
- The manufacturer, or its representatives, assumes no responsibility for any damage, and loss of profits caused by usage different to that explained in the operator's manual.
- The manufacturer, or its representatives, assumes no responsibility for damage caused by incorrect operation, or action resulting from connecting to other products.

3. LASER SAFETY INFORMATION

SET is classified as the following class of Laser Product and LED Product according to IEC Standard Publication 60825-1 ED.2.0: 2007 and United States Government Code of Federal Regulation FDA CDRH 21CFR Part 1040.10 and 1040.11 (Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No.50, dated June 24, 2007.)

• EDM device in objective lens: Class 3 Laser Product (Class 1 Laser Product when prism or reflective sheet is selected in Config mode as target)
• Laser plummet (option): Class 2 Laser Product
• Guide light: Class 1 LED Product

✍

• EDM device is classified as Class 3R Laser Product when reflectorless measurement is selected. When the prism or reflective sheet is selected in Config mode as target, the output is equivalent to the safer class 1.

⚠Warning
• Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
• Follow the safety instructions on the labels attached to the instrument as well as in this manual to ensure safe use of this laser and LED product.

Laser beam emitted from here
LED beam emitted from here
Laser beam emitted from here*
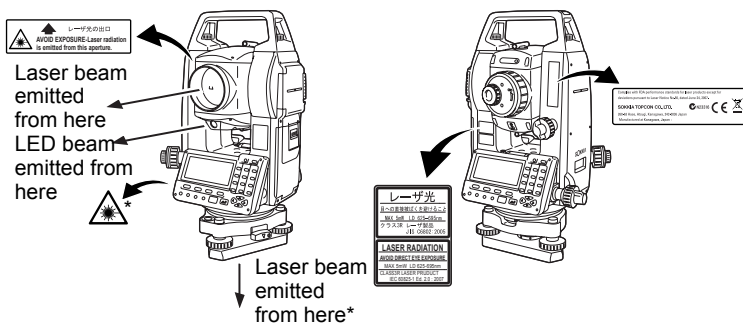
*: only for instruments with laser plummet option

• Never point the laser beam at another person. If the laser beam strikes skin or an eye, it could cause serious injury.
• Do not look directly into the laser beam source. Doing so could cause permanent eye damage.

- Do not stare at the laser beam. Doing so could cause permanent eye damage.
- If an eye injury is caused by exposure to the laser beam, seek immediate medical attention from a licensed ophthalmologist.
- Never look at the laser beam through a telescope, binoculars or other optical instruments. Doing so could cause permanent eye damage.
- Sight the targets so that laser beam does not stray from them.

⚠Caution

- Perform checks at start of work and periodic checks and adjustments with the laser beam emitted under normal conditions.
- When the instrument is not being used, turn off the power.
- When disposing of the instrument, destroy the battery connector so that the laser beam cannot be emitted.
- Operate the instrument with due caution to avoid injuries that may be caused by the laser beam unintentionally striking a person in the eye. Avoid setting the instrument at heights at which the path of the laser beam may strike pedestrians or drivers at head height.
- Never point the laser beam at mirrors, windows or surfaces that are highly reflective. The reflected laser beam could cause serious injury.
- When using the Laser-pointer function, be sure to turn OFF the output laser after distance measurement is completed. Even if distance measurement is canceled, the Laser-pointer function is still operating and the laser beam continues to be emitted. (After turning ON the Laser-pointer, the laser beam is emitted for 5 minutes, and then automatically switches OFF. But in the Status screen and when target symbol (ex. 🔆) is not displayed in the Measurement mode, the laser beam is not automatically turned off.)
- Only those who have been received training as per the following items shall use this product.
    - Read the Operator's manual for usage procedures for this product.
    - Hazardous protection procedures (read this chapter).
    - Requisite protective gear (read this chapter).
    - Accident reporting procedures (stipulate procedures beforehand for transporting the injured and contacting physicians in case there are laser induced injuries).
- Persons working within the range of the laser beam are advised to wear eye protection which corresponds to the laser wavelength of the instrument being used.
- Areas in which the lasers are used should be posted with laser warning notices.

4. SET FUNCTIONS

4.1　Parts of the Instrument
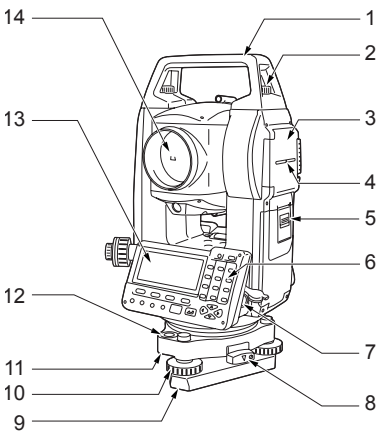
1　Handle
2　Handle securing screw
3　External interface hatch
　　SD card slot
　　USB port
4　Instrument height mark
5　Battery cover
6　Operation panel
7　Data input/output connector
　　(SET350RX/550RX/650RX)
8　Tribrach clamp
9　Base plate
10　Levelling foot screw
11　Circular level adjusting screws
12　Circular level
13　Display
14　Objective lens (Includes Laser-pointer function)
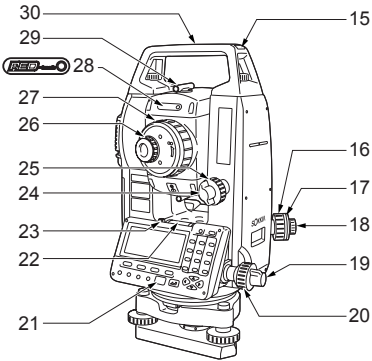
15　Tubular compass slot
16　Optical plummet focussing ring
17　Optical plummet reticle cover
18　Optical plummet eyepiece
　　(16-18: Not included on instruments with optional laser plummet)
19　Horizontal clamp
20　Horizontal fine motion screw
21　Beam detector for wireless keyboard
　　(Not included on SET650RX)
22　Plate level
23　Plate level adjusting screw
24　Vertical clamp
25　Vertical fine motion screw
26　Telescope eyepiece screw
27　Telescope focussing ring
28　Laser radiation warning indicator
29　Peep sight
30　Instrument center mark
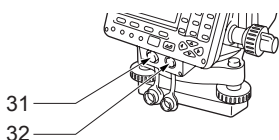
SET250RX and Low Temperature
Models only
31   Data input/output connector
32   External power source connector

31 ———
32 ———

📖 **Peep sight**
Use peep sight to aim the SET in the direction of the measurement point.
Turn the instrument until the triangle in the peep sight is aligned with the
target.

📖 **Instrument height mark**
The height of the SET is as follows:
• 192.5mm (from tribrach mounting surface to this mark)
• 236mm (from tribrach dish (WA200) to this mark)
  "Instrument height" is input when setting instrument station data and is the
  height from the measuring point (where SET is mounted) to this mark.

📖 **Laser-pointer Function**
A target can be sighted with a red laser beam in dark locations without the
use of the telescope.

📖 **SOKKIA original Independent Angle Calibration System (IACS)
technology**
This revolutionary technology provides an even higher level of stability and
reliability for angle measurement. With IACS technology, the SET
independently calibrates angle to a high degree of accuracy, and eliminates
the need for a reference standard instrument when performing calibration.
☞ Independent angle calibration cannot be performed by the user.
   Consult your local dealer.

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Operation panel

ℂℑ "5.1 Basic Key Operation"

{☼} {ON}

Display

Softkeys

{1} to {9}

{0}, {●},{+/-}

{ESC} {SFT}
{BS} {FUNC}

{↵}

{◄} {►} {▲} {▼}

Beam detector for wireless keyboard
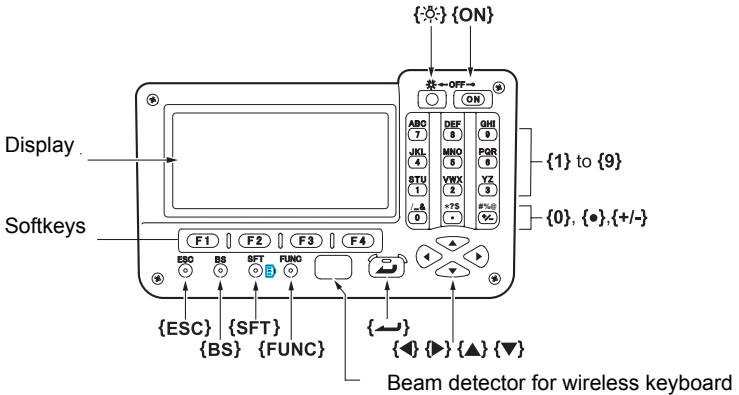
Laser radiation warning indicator

Laser radiation warning indicator is red when laser beam is emitted or laser-pointer is used, and laser beam status can be known from the telescope eyepiece side.

Laser radiation warning indicator

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Wireless keyboard
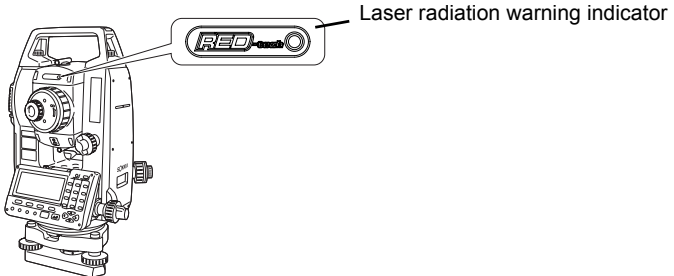
☞ "36. OPTIONAL ACCESSORIES"

• Wireless keyboard cannot be used on SET650RX.

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Guide light

Guide light
indicator
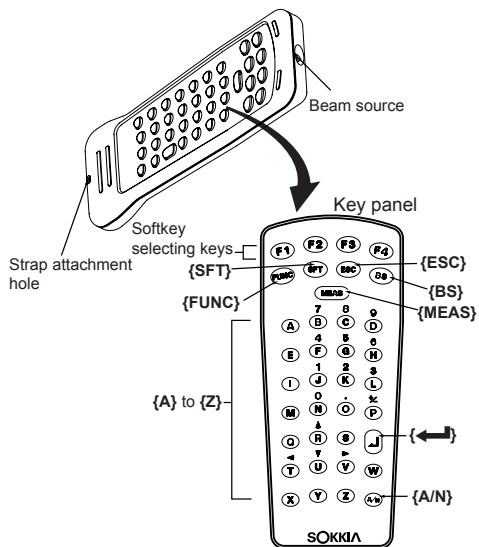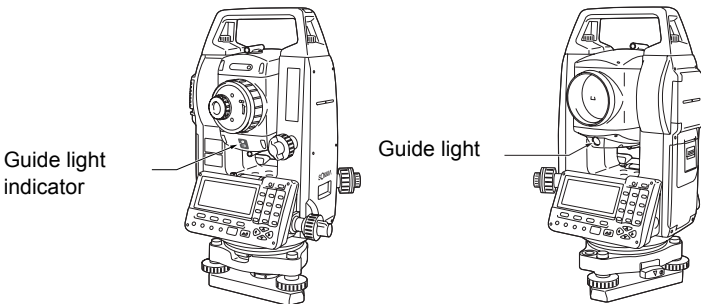
Guide light

📖 **Guide light and Guide light indicator**
Setting-out measurement etc. can be carried out effectively using the Guide light. The Guide light is composed of a light that is divided into a red and a green light. A poleman can ascertain the present position by checking the Guide light color.

green | red
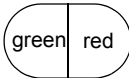
Guide light status

Light status	Meaning
Red	(From position of poleman) Move target left
Green	(From position of poleman) Move target right
Red and Green	Target is at correct horizontal position

The Guide light indicator is lit when the Guide light is ON.

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4.2   Mode Diagram
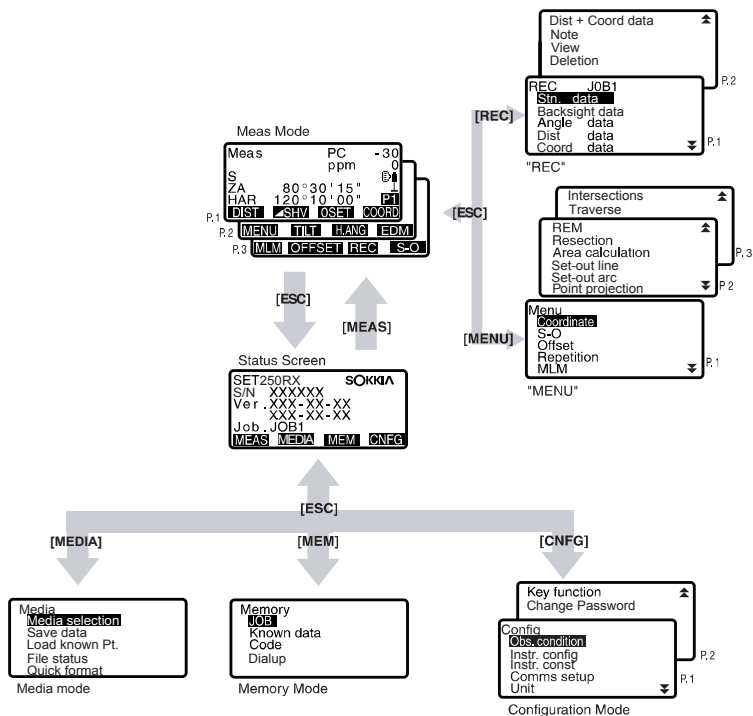
4.3   *Bluetooth* Wireless Technology

• *Bluetooth* communication is only possible with instruments incorporating the *Bluetooth* module.
• Use of this technology must be authorized according to telecommunications regulations of the country where the instrument is being used. Contact your local dealer in advance.

  ☞ "39. REGULATIONS"
• Sokkia Topcon Co., Ltd. is not liable for the content of any transmission nor any content related thereto. When communicating important data, run tests beforehand to ascertain that communication is operating normally.
• Do not divulge the content of any transmission to any third party.

Radio interference when using *Bluetooth* technology

Bluetooth communication with the SET uses the 2.4 GHz frequency band. This is the same band used by the devices described below.

  •Industrial, scientific, and medical (ISM) equipment such as microwaves and pacemakers.

  • portable premises radio equipment (license required) used in factory production lines etc.

   • portable specified low-power radio equipment (license-exempt)

  •IEEE802.11b/IEEE802.11g standard wireless LAN devices

The above devices use the same frequency band as *Bluetooth* communications. As a result, using the SET within proximity to the above devices may result in interference causing communication failure or reduction of transmission speed.

Although a radio station license is not required for this instrument, bear in mind the following points when using *Bluetooth* technology for communication.

● Regarding portable premises radio equipment and portable specified low-power radio equipment:
• Before starting transmission, check that operation will not take place within the vicinity of portable premises radio equipment or specified low-power radio equipment.
• In the case that the instrument causes radio interference with portable premises radio equipment, terminate the connection immediately and take measures to prevent further interference (e.g. connect using an interface cable).
• In the case that the instrument causes radio interference with portable specified low-power radio equipment, contact your local dealer.

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● When using the SET in proximity to IEEE802.11b or IEEE802.11g standard wireless LAN devices, turn off all devices not being used.
• Interference may result, causing transmission speed to slow or even disrupting the connection completely. Turn off all devices not being used.

● Do not use the SET in proximity to microwaves.
• Microwave ovens can cause significant interference resulting in communication failure. Perform communication at a distance of 3m or more from microwave ovens.

● Refrain from using the SET in proximity to televisions and radios.
• Televisions and radios use a different frequency band to *Bluetooth* communications.
  However, even if the SET is used within proximity to the above equipment with no adverse effects with regard to *Bluetooth* communication, moving a *Bluetooth* compatible device (including the SET) closer to said equipment may result in electronic noise in sound or images, adversely affecting the performance of televisions and radios.

Precautions regarding transmission

● For best results
• The usable range becomes shorter when obstacles block the line of sight, or devices such as PDAs or computers are used. Wood, glass and plastic will not impede communication but the usable range becomes shorter. Moreover, wood, glass and plastic containing metal frames, plates, foil and other heat shielding elements as well as coatings containing metallic powders may adversely affect *Bluetooth* communication and concrete, reinforced concrete, and metal will render it impossible.
• Use a vinyl or plastic cover to protect the instrument from rain and moisture. Metallic materials should not be used.
• The direction of the *Bluetooth* antenna can have adverse effects upon usable range.

● Reduced range due to atmospheric conditions
The radio waves used by the SET may be absorbed or scattered by rain, fog, and moisture from the human body with the limit of usable range becoming lower as a result. Similarly, usable range may also shorten when performing communication in wooded areas. Moreover, as wireless devices lose signal strength when close to the ground, perform communication at as high a position as possible.

5. BASIC OPERATION

5.1　Basic Key Operation

Learn basic key operations here before you read each measurement procedure.
☞ Location of operation keys on the panel and Location of operation keys on the wireless keyboard : "4.1 Parts of the Instrument"

- Wireless keyboard (SF14) (Optional accessory) makes key operation easier and speedier.
☞ Specification of the keyboard: "36. OPTIONAL ACCESSORIES"

● Power ON / OFF

{ON}	Power On
{ON} (while pressing)+ **{☼}**	Power Off

● Lighting up the display and key

{☼}	Switch the screen/key backlight On / Off

● Switching target type

Target type can be switched only on the screen where the target symbol (ex. ▯) is displayed.

{SFT}	Switches between target types (Prism/Sheet/None(reflectorless))

☞ Target symbol displayed: "5.2 Display Functions", Switching the target type in Config mode": "30.1 EDM Settings"

● Switching the Laser-pointer/Guide light ON/OFF

{☼} (Press and hold)	To turn the laser-pointer/guide light ON/OFF, press and hold until a beep sounds.

☞ Selecting laser-pointer/guide light: "30.1 EDM Settings"

Note

- After turning ON the laser-pointer/guide light, the laser beam is emitted for 5 minutes, and then automatically switches OFF. But in the Status screen and when target symbol (ex. ▯) is not displayed in the Meas mode, the laser beam is not automatically turned off.

● **Softkey operation**

Softkeys are displayed on the bottom line of the screen.

{F1} to {F4}	Select the function matching the softkeys
{FUNC}	Toggle between Meas mode screen pages (when more than 4 softkeys are allocated)

● **Inputting letters/figures**

{SFT}	Switch between numeric and alphabetic characters.
{0} to {9}	During numeric input, input number of the key. During alphabetic input, input the characters displayed above the key in the order they are listed.
{.}/{±}	Input a decimal point/plus or minus sign during numeric input. During alphabetic input, input the characters displayed above the key in the order they are listed.
{◀}/{▶}	Right and left cursor/Select other option.
{ESC}	Cancel the input data.
{BS}	Delete a character on the left.
{◀┘}	Select/accept input word/value.

Example :Entering "JOB M" in the JOB name field

1. Press **{SFT}** to enter the alphabet
   input mode
   Alphabet input mode is indicated
   by an "A" on the right of the screen.

2. Press **{4}**.
   "J" is displayed.

3. Press **{5}** three times.
   "O" is displayed.

4. Press **{7}** twice.
   "B" is displayed.

5. Press **{▶}** once.
   Input a blank space.

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6. Press **{5}** once.
   "M" is displayed. Press {◄█} to
   complete inputting.

```
JOB name edit          A
JOB M
```
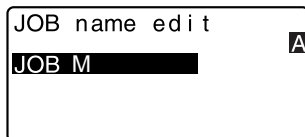
● **Selecting options**

{▲}/{▼}	Up and down cursor
{▶}/{◄}	Right and left cursor/Select other option
{◄█}	Accept the option

Example: Select a reflector type
1. Press **[EDM]** in page 2 of Meas mode.

2. Move to "Reflector" using **{▲}/{▼}**.

3. Display the option you want to
   select using **{▶}/{◄}**.
   Switches between "Prism", "Sheet"
   and "None."

```
EDM
Mode    :Fine"r"
Reflector:Prism
PC    :-30            ▶
Illum.hold: Laser     ▼
```
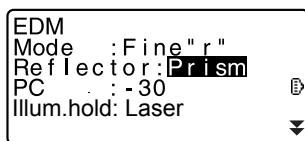
4. Press **{◄█}** or **{▼}** to move to
   the next option.
   The selection is set and you can
   set the next item.

● **Switching modes**

[CNFG]	From Status mode to Config Mode (Configuration Mode)
[MEAS]	From Status mode to Meas Mode (Measurement Mode)
[MEDIA]	From Status mode to Media mode
[MEM]	From Status mode to Memory Mode
{ESC}	Return to the Status mode from each Mode

☞ "4.2 Mode Diagram"

● **Other operation**

{ESC}	Return to the previous screen

5.2 Display Functions

Status screen

Instrument name

SET250RX **SOKKIA**
S/N XXXXXX
Ver.XXX-XX-XX
    XXX-XX-XX
Job.JOB1
MEAS MEDIA MEM CNFG

— Application software version
— JOB

Meas Mode screen

Target *5

Meas   PC -30
       ppm   0
S
ZA
HAR
DIST SHV 0SET COORD

Distance *1
Vertical angle *2
Horizontal angle *3

Prism constant value
Atmospheric correction factor
Remaining battery power *4
Tilt angle compensation *6
Page number

Laser-pointer function / Guide light On *7

Bluetooth communication status *8

Measuring screen

Dist
Fine"r" PC -30
      ppm   0

  ✳   STOP

Laser is emited *9

Input screen

Code
:
Operator:
:SOKKIA
OK

Previous page
Input mode *10

Next page

* 1 Distance

☞ Switching distance display status: "30.2 Configuration -Config Mode-"
    S : Slope distance
    H : Horizontal distance
    V : Height difference

* 2 Vertical angle

℡ Switching vertical angle display status: "30.2 Configuration -Config Mode-"

   ZA : Zenith angle (Z=0)

   VA : Vertical angle (H=0/H=±90)

   To switch vertical angle/slope in %, press **[ZA/%]**

* 3 Horizontal angle

   Press **[R/L]** to switch the display status.

   HAR: Horizontal angle right

   HAL: Horizontal angle left

* 1,2,3

   To switch usual "S, ZA, HAR" display to "S, H, V", press **[◢ SHV]**.

* 4 Remaining battery power (Temperature=25°C, EDM on)

Using BDC46B	Using external battery	Battery level
▌	▟	level 3 Full power
▐	▟	level 2 Plenty of power remains.
▯	▟	level 1 Half or less power remains.
▯	▟	level 0 Little power remains. Charge the battery.
▭ (This symbol is displayed every 3 seconds)		No power remains. Stop the measurement and charge the battery.

℡ "6.1 Battery Charging"

*5 Target display

   Press **{SFT}** to switch the selected target. This key function can be used only on the screens on which the target symbol is displayed.

   ▷   :prism

   ⊞   :reflective sheet

   ⇥   :reflectorless

* 6 Tilt angle compensation

   When this symbol is displayed, the vertical and horizontal angles are automatically compensated for small tilt errors using 2-axis tilt sensor.

   ℡ Tilt compensation setting: "30.2 Configuration -Config Mode-"

*7 Laser-pointer/Guide light display

   ℡ Selecting Laser-pointer/Guide light: "30.1 EDM Settings", Switching Laser-pointer/Guide light ON/OFF : "5.1 Basic Key Operation"

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☀ :Laser-pointer is selected and ON

🔦 :Guide light is selected and ON

*8 *Bluetooth* communication status

|◣ :   Connection established ("Mode" is set to "Slave")

|▜ :   Connection established ("Mode" is set to "Master")

|◣ (flashing):   Connecting ("Mode" is set to "Slave")

|▜ (flashing):   Connecting ("Mode" is set to "Master")

| (flashing):   Waiting

|ₓ (flashing):   Disconnecting ("Mode is set to "Slave")

|ˣ (flashing):   Disconnecting ("Mode" is set to "Master")

|ₓ :   *Bluetooth* device is OFF ("Mode" is set to "Slave")

|ˣ :   *Bluetooth* device is OFF ("Mode" is set to "Master")

*9 Appears when laser beam is emitted for distance measurement

*10 Input mode

A :Inputting capital letters and figures.

a :Inputting small letters and figures.

6. USING THE BATTERY

6.1   Battery Charging

The battery has not been charged at the factory.

✍

• Do not short circuit. Heat or ignition could result.
• Batteries cannot be charged, even when the charging lamp is flashing, when the temperature is outside the charging temperature range. Always charge batteries within the charging temperature range.
• Do not leave the battery in places exposed to high temperatures (more than 35°C). Doing so may reduce the life of the battery.
• Charge the battery once a month to maintain its quality when not in use for long periods.
• Do not charge the battery just after charging is completed. Battery performance may decline.
• Do not use to charge batteries other than those specified.
• If you allow the battery level to get too low, the battery may not be rechargeable or operating time may decline. Keep the battery always charged.
• The charger will become rather hot during use. This is normal.

PROCEDURE

1. Connect the power cable to the CDC68 charger and plug the charger into the wall outlet.

2. Mount the battery (BDC46B) in the charger (CDC68) by matching the grooves on the battery with the guides on the charger.
   When charging starts, the lamp starts blinking.

3. Charging takes approximately 2.5 hours (25°C).
   The lamp lights when charging is finished.

4. Remove the battery and unplug the charger.

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Note
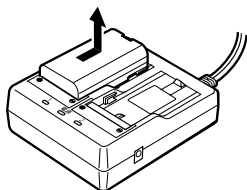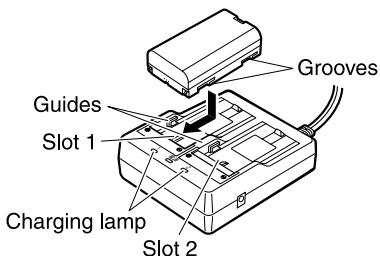
• Slots 1 and 2:   The charger starts charging the battery mounted first. If you
                    place two batteries in the charger, the battery in slot 1 is
                    charged first, and then the battery in slot 2. (step 2)
• Charging lamp: The charging lamp is off when the charger is outside the
                    charging temperature range or when the battery is mounted
                    incorrectly. If the lamp is still off after the charger falls within
                    its charging temperature range and the battery is mounted
                    again, contact your local dealer. (steps 2 and 3)
• Charging time: Charging can take more than 2.5 hours when temperatures
                    are either especially high or low.

6.2   Installing/Removing the Battery

Mount the charged battery.

• When removing the battery, turn the power off.
• When installing/removing the battery, make sure that moisture or dust particles
  do not come in contact with the inside of the instrument.

PROCEDURE

1.

Battery
release button
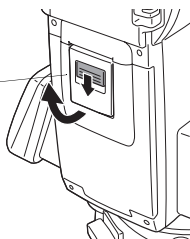
Open the battery cover:
Press the battery release
button downward

2.

Battery

Insert and press
down on the top
of the battery until
a click is heard.

Terminal
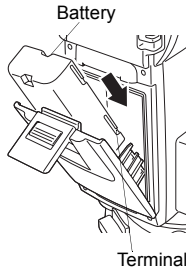
3.

Close the battery cover:
Insert the lip on the top of the battery
release button into the groove on the SET
and press until a click is heard.
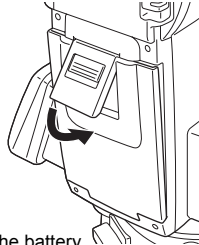
Note

• Battery cover
  If the battery cover is open during power on, SET notifies you by displaying the
  screen below and beeping.
  When the battery cover is closed, the previous screen is restored.
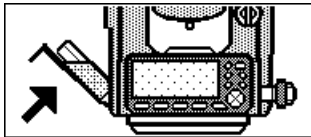
7. SETTING UP THE INSTRUMENT

✍

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

7.1   Centering

PROCEDURE Centering with the optical plummet eyepiece

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

Level

Firmly fixed

Equal spacing

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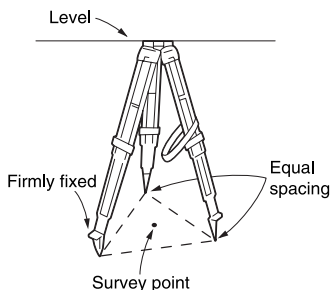
2. Place the instrument on the tripod head.
    Supporting it with one hand, tighten the centering screw on the bottom of the unit to make sure it is secured to the tripod.

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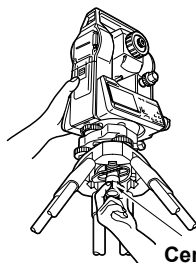
3. Looking through the optical plummet eyepiece, turn the optical plummet eyepiece to focus on the reticle.
    Turn the optical plummet focusing ring to focus on the survey point.

Focussing on the survey point

Focussing on the reticle
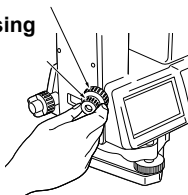
PROCEDURE Centering with the laser plummet (option)

1. Set up the tripod and affix the instrument on the tripod head.
   ☞ "PROCEDURE Centering with the optical plummet eyepiece" steps 1 and 2

2. Press **{ON}** to power on
   ☞ "POWER ON/OFF"

3. Press **[TILT]** in the second page of Meas Mode to display the circular level on the screen.

4. Press **[L-ON]**.
   The laser plummet beam will be emitted from the bottom of the instrument.

```
Tilt           X
   X -1'40"
   Y  2'20"  (·-·)-Y
L-ON
```
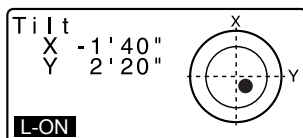
5. Use **{▶}**/**{◀}** to adjust the brightness of the laser.

```
Tilt           X
   X -1'40"
   Y  2'20"  (·-·)-Y
L-lev. ▶▶▶▷▷
L-OFF
```
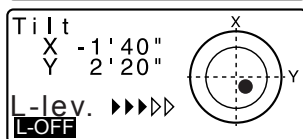
6. Adjust the position of the instrument on the tripod until the laser beam is aligned with the center of the survey point.

7. Press **[L-OFF]** to turn the laser plummet off.
   Alternatively, press **{ESC}** to return to the previous screen. The laser plummet will switch off automatically.

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<table>
<tr><td>**7.2**</td><td>**Levelling**</td></tr>
</table>

Instrument can be levelled using the screen.
☞ "[Note] Levelling on the screen"

PROCEDURE

1. Adjust the levelling foot screws to center the survey point in the optical plummet reticle.

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

   Turn the levelling foot screws while checking the circular level until the bubble is centered in the center circle.

   Tripod legs adjustment
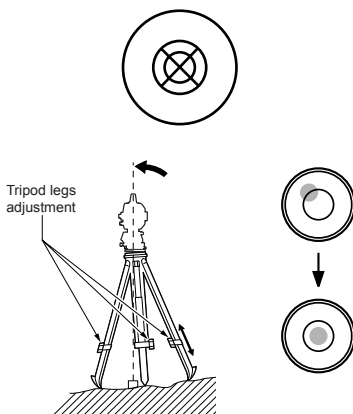
3. Loosen the horizontal clamp to turn the upper part of the instrument until the plate level is parallel to a line between levelling foot screws A and B.
   Center the air bubble using levelling foot screws A and B simultaneously.
   The bubble moves towards a clockwise rotated levelling foot screw.
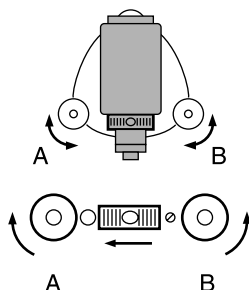
4. Turn the upper part of the instrument though 90°. The plate level is now perpendicular to a line between levelling foot screws A and B. Center the air bubble using levelling foot screw C.
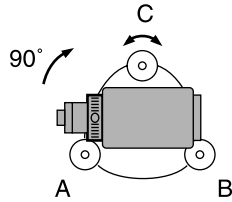
5. Turn the upper part of the instrument a further 90° and check to see if the bubble is still in the center of the plate level. If the bubble is off-center, perform the following:
   a. Turn levelling foot screws A and B equally in opposite directions to remove half of the bubble displacement.
   b. Turn the upper part a further 90°, and use levelling foot screw C to remove half of the displacement in this direction.
   Or adjust the plate level.
   ☞ "32.1 Plate Level"
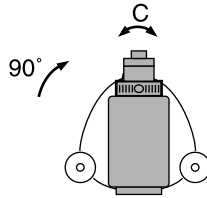
6. Turn the instrument and check to see if the air bubble is in the center position in all directions. If it is not, repeat the levelling procedure.

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

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    • When the instrument was
      centered using the laser
      plummet, emit the plummet
      beam again to check position
      over the survey point.
        ☞ "PROCEDURE Centering
            with the laser plummet
            (option)"

8. Check again to make sure the
    bubble in the plate level is
    centered
    If not, repeat the procedure starting
    from step 3.

PROCEDURE Levelling on the screen

1. Press **{ON}** to power on
    ☞ "9. POWER ON/OFF"

2. Press **[TILT]** in the second page of
    Meas Mode to display the circular
    level on the screen.
    "●" indicates bubble in circular
    level. The range of the inside circle
    is ±4' and the range of the outside
    circle is ±6'.
    Tilt angle values X and Y are also
    displayed on the screen.

3. Center "●" in the circular level
    ☞ "7.2 Levelling" steps 1 to 2


```
Tilt              X
    X  -1'40"   ┌─┴─┐
    Y   2'20"   (·+·●·)─Y
              └───┘
L-ON
```
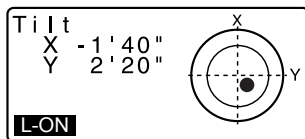
4. Turn the instrument until the
    telescope is parallel to a line
    between levelling foot screws A
    and B, then tighten the horizontal
    clamp.
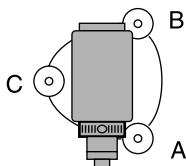
5. Set the tilt angle to 0° using foot screws A and B for the X direction and levelling screw C for the Y direction.

6. When levelling is completed, press **{ESC}**.

8. FOCUSSING AND TARGET SIGHTING

⚠

• When sighting the target, strong light shining directly into the objective lens may cause the instrument to malfunction. Protect the objective lens from direct light by attaching the lens hood.
Observe to the same point of the reticle when the telescope face is changed.

PROCEDURE

1. Look through the telescope eyepiece at a bright and featureless background.
   Turn the eyepiece screw clockwise, then counterclockwise little by little until just before the reticle image becomes focussed.
   Using these procedures, frequent reticle refocussing is not necessary since your eye is focussed at infinity.

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

3. Turn the telescope focussing ring to focus on the target.
   Turn the vertical and horizontal fine motion screws to align the target with the reticle.
   The last adjustment of each fine motion screw should be in the clockwise direction.
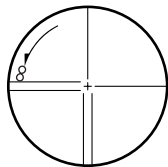
4. Readjust the focus with the
    focussing ring until there is no
    parallax between the target image
    and the reticle.

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

9. POWER ON/OFF

ℭℱ Setting "V manual": "30.2 Configuration -Config Mode-", Setting/changing password: "30.4 Changing Password"

PROCEDURE Power ON

1. Press **{ON}**.
   When the power is switched on, a self-check is run to make sure the instrument is operating normally.

   • When password is set, the display appears as at right. Input password and press **{◄━━}**.

   ```
                            A
   Password: ********
   ```

   • When "V manual" is set to "Yes", the display appears as at right.
   ℭℱ Manually indexing the vertical circle by face left, face right measurements: "38. EXPLANATION"

   ```
   0 Set

         Take F1
   ZA        V1
   HAR    0°00'00"
                  OK
   ```

   • If the Tilt screen is displayed, the instrument tilt sensor is indicating that the instrument is out of level. Level the instrument once again and the horizontal and vertical angles will be displayed.
   ℭℱ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"
   Press **{ESC}** to skip levelling.
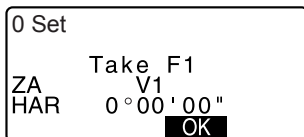
   ```
   Tilt            X
      X  ****      •
      Y  2'20"         Y

   L-ON
   ```
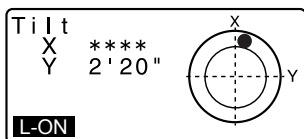
   After that, Meas Mode screen appears.

   ```
   Meas      PC    -30
              ppm     0
   S
   ZA    80°30'15"
   HAR  120°10'00"    P1
    DIST  ◢SHV  0SET  COORD
   ```
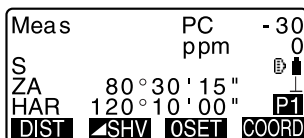
   If "Out of range" or the Tilt screen is displayed, level the instrument again.

Note
• When "Resume" in "Instr. config" is set to "On", the screen previous to power off is displayed (except when missing line measurement was being performed).
  ☞ "30.2 Configuration -Config Mode-"
• "Tilt crn" in "Obs. condition" should be set to "No" if the display is unsteady due to vibration or strong wind.
  ☞ "30.2 Configuration -Config Mode-"

PROCEDURE Power OFF

Press **{ ⏻ }** while pressing **{ ☼ }**.

• When there is almost no battery power remaining, the ⊟ symbol will be displayed every 3 seconds. In this event, stop measurement, switch off the power and charge the battery or replace with a fully charged battery.
• To save power, power to the SET is automatically cut off if it is not operated for a fixed period of time. This time period can be set in "Power off" in <Instr.config.>.
  ☞ "30.2 Configuration -Config Mode-"

10.1 Necessary settings for *Bluetooth* communication

Bluetooth wireless technology allows the SET to communicate wirelessly with other *Bluetooth* devices. *Bluetooth* wireless communication settings are performed in "Comms setup" in Config Mode.

PROCEDURE Basic Settings

1. Select "Comms setup" in Config mode

2. Set "Wireless" to "Yes".

```
Wireless       : Yes
Bluetooth setup
Link device list
My device info
```

3. Select "*Bluetooth* setup".

```
Wireless       : Yes
Bluetooth setup
Link device list
My device info
```

4. Set "Mode" to either "Master" or "Slave".
   ☞ "🔟 *Bluetooth* connections"

```
Mode           : Slave

Authentication : No
Passkey
:****
Check sum      : No
```

5. Set "Link".
   Select a companion device from among the *Bluetooth* devices registered in the SET using {◀}/{▶}.
   ☞ Registering devices: "PROCEDURE Registering Bluetooth companion devices"

   • "Link" setting is not necessary when "Mode" is set to "Slave".

```
Mode           : Master
Link    DEVICE1
Authentication : No
Passkey
:****
Check sum      : No
```

6. Set "Authentication". Select "Yes" or "No".

7. Set "Passkey". Set the same passkey as that for your *Bluetooth* device.

   • Up to 16 numeral characters can be input. "0123" is the factory setting. Input characters will be displayed as asterisks (e.g. "******").

8. Set check sum setting.

Note

• Even when "Authentication" is set to "No", a passkey is requested when authentication is set on the *Bluetooth* device being used.
• When "Wireless" is set to "Yes", communication settings will not be displayed. It is recommended that the check sum setting is set to correspond with those of the *Bluetooth* device.

Bluetooth connections
• Communication between a pair of *Bluetooth* devices requires one device to be set as the "Master" and the other as the "Slave". To initiate connections from the SET side, set the SET as the "Master" device. To initiate connections from the paired device side, set the SET as the "Slave" device.
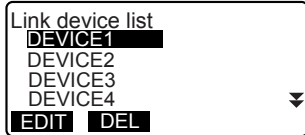
PROCEDURE Registering *Bluetooth* companion devices

1. Select "Comms setup" in Config mode.
2. Set "Wireless" to "Yes".

3. Select "Link device list".

```
Wireless      : Yes
Bluetooth setup
Link device list
My device info
```

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4. Register your *Bluetooth* device(s). Select a device and press **[EDIT]** to update related information.
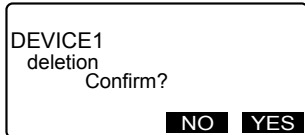
    Link device list
    DEVICE1
    DEVICE2
    DEVICE3
    DEVICE4
    EDIT   DEL

    • Select a device and press **{◀━}** to show details.
      Press **[PREV]**/**[NEXT]** to display details of the previous/next device.

    Device (Details)
      Name:
        DEVICE2
      BD_ADDR:
        0123456789AB
    PREV   NEXT

    • Press **[DEL]** to delete information for the selected device.

    DEVICE1
      deletion
          Confirm?

              NO   YES

5. Input "Name" (device name) and "BD ADDR" (address) and press **[REG]**.

    Device registration
      Name:
        DEVICE1
      BD_ADDR:
        0123456789AB
    INQ   REG

    • 12 hexadecimal digits can be input.

    • By pressing **[INQ],** it is also possible to inquire about devices in the immediate vicinity and register their address.
      Select an address from the list of devices discovered and press **[OK]**. The address is displayed "BD ADDR". (If SET cannot find any devices within 30 sec., the inquiry will be canceled.)

    Inquiry...
      0123456789AB
      123456789ABC
      23456789ABCD
      3456789ABCDE
              STOP   OK

PROCEDURE Displaying *Bluetooth* information for the SET

1. Select "Comms setup" in Config mode.

2. Set "Wireless" to "Yes".

3. Select "My device info".
   The *Bluetooth* information for the
   SET is displayed. The "BD ADDR"
   for the SET must be registered on
   your *Bluetooth* device.

```
Wireless    : Yes
Bluetooth setup
Link device list
My device info
```

```
Bluetooth ID:B02706
Firmware:VerX.X.X

BD_ADDR:
    ABCDEF012345
```

📖 *Bluetooth* **Device Address**

This is a number unique to one particular *Bluetooth* device used to identify
devices during communication. This number consists of 12 characters
(numbers 0 to 9 and letters from A to F). Some devices may be referred to
by their *Bluetooth* device address.

10.2 Establishing a connection between the SET and paired *Bluetooth* device

When "Wireless" is set to "Yes" in "Comms setup" in Config mode [￥○]/
[￥×] is display*ed* in Meas mode.

PROCEDURE

1. Complete the necessary settings
   for *Bluetooth* communication.
   ☞ "10.1 Necessary settings for
      Bluetooth communication"

2. Press **[￥○]** in the fourth
   page of Meas mode screen.
   The *Bluetooth* module in the SET
   powers on and connection starts.

   The *Bluetooth* icon indicates
   communication status.
   ☞ "5.2 Display Functions"

```
Meas         PC    -30
             ppm     0
S                 ⌊ₓ🖩▮
ZA    80°30'15"      ⊥
HAR  120°10'00"   P4
                  ￥○
```

```
Meas         PC    -30
             ppm     0
S                 ⌊🖩▮
ZA    80°30'15"      ⊥
HAR  120°10'00"   P4
                  ￥×
```

Note

- When "Mode" in "*Bluetooth* setup" is set to "Slave", the establishing of a connection can only be initiated from the "Master" *Bluetooth* device.
- When "Mode" in "*Bluetooth* setup" is set to "Master", SET will attempt to establish a connection with the designated *Bluetooth* device (specified in "Link" in "*Bluetooth* setup").
- Softkeys (in Meas mode and <Aiming>)

    [⃝]:Press to enter waiting status ("Mode" is set to "Slave")/establish a connection ("Mode" is set to "Master")

    [⤬]:Press to cancel the connection/exit waiting status ("Mode" is set to "Slave")/stop establishing or cancel a connection ("Mode" is set to "Master")

- Audio tones

    (While connecting/disconnecting)

Start paging/waiting:	short beep
Connection successfully established:	long beep
Connection canceled/being canceled:	two short beeps
Paging failed/waiting time out:	two short beeps

    (While inquiring about other *Bluetooth* devices)

New device discovered:	short beep
Inquiry complete:	long beep

10.3   Measurement using *Bluetooth* communication

Data collectors can also be set as companion devices for wireless communication and can be used to initiate measurement.

PROCEDURE Performing measurement using a data collector

1. Complete the necessary settings for *Bluetooth* communication.
    ☞ "10.1 Necessary settings for Bluetooth communication"

2. Verify the current connection status by checking the *Bluetooth* icon in the Meas mode screen.
   ☞ "10.2 Establishing a connection between the SET and paired Bluetooth device"

3. Initiate measurement using your *Bluetooth* device (e.g. a data collector). SET will respond and measurement will start. Measured values are then displayed in the Meas mode screen.

10.4 Registering/Outputting data using *Bluetooth* communication

It is possible to set a computer as the companion device and register known point data or output JOB data via wireless communication.

PROCEDURE Entering known point coordinate data from an external instrument

1. Complete the necessary settings for *Bluetooth* communication.
   ☞ "10.1 Necessary settings for Bluetooth communication"

2. Verify the current connection status by checking the *Bluetooth* icon in the Meas mode screen.
   ☞ "10.2 Establishing a connection between the SET and paired Bluetooth device"

3. Register known point data in Memory mode.
   ☞ "26.1 Registering/Deleting Known Point Data PROCEDURE Entering known point coordinate data from an external instrument"
   Coordinate data starts being entered from the external instrument.

   • If a connection has not yet been established, the screen at right is displayed. (Screens differ depending on the "Mode" setting. The displayed screen appears when "Mode" is set to "Slave".)
   After a connection has been established, the data is entered.

   ```
   Comms input
   Waiting for
     connection...
   ```

PROCEDURE Outputting JOB data to a host computer

1. Complete the necessary settings
   for *Bluetooth* communication.
   ☞ "10.1 Necessary settings for
      Bluetooth communication"

2. Verify the current connection
   status by checking the *Bluetooth*
   icon in the Meas mode screen.
   ☞ "10.2 Establishing a
      connection between the SET
      and paired Bluetooth device"

3. Output JOB data in Memory
   mode.
   ☞ "27.1 Outputting JOB Data to
      Host Computer"
   SET starts outputting data.

```
Comms output

 Format      SDR33

  Sending      12
```

• If a connection has not yet been
  established, the screen at right is
  displayed. (Screens differ depending
  on the "Mode" setting. The displayed
  screen appears when "Mode" is set
  to "Slave".)
  After a connection has been
  established, the data is output.

```
Comms output
Waiting for
  connection...
```

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10.5　Connecting via Communication Cable

PROCEDURE Basic cable settings

1. Connect the SET to the external
   device using the cable.
   ☞ Cables: 36. OPTIONAL
       ACCESSORIES

2. Select "Comms setup" in Config
   mode.
   Set communication conditions.
   ☞ "30.2 Configuration -Config

      Mode-"

11. ANGLE MEASUREMENT

This section explains the procedures for basic angle measurement.

11.1   Measuring the Horizontal Angle between Two Points (Horizontal Angle 0°)

Use the "0SET" function to measure the included angle between two points. The horizontal angle can be set to 0 at any direction.

PROCEDURE

1. Sight the first target as at right.

    1st target
    ○

    △
    Instrument Station
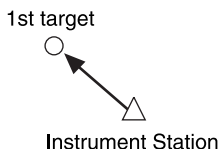
2. In the first page of the Meas mode screen, press **[0SET]**.
    [0SET] will flash, so press **[0SET]** again.
    The horizontal angle at the first target becomes 0°.

    ```
    Meas          PC     - 30
                  ppm       0
    S
    ZA      89°59'50"
    HAR      0°00'00"      P1
    DIST   SHV   0SET  COORD
    ```

3. Sight the second target.

    2nd Target
    ○

    ○
    △
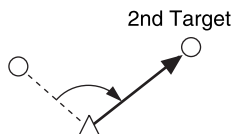
    The displayed horizontal angle (HAR) is the included angle between two points.

    ```
    Meas          PC     - 30
                  ppm       0
    S
    ZA      89°59'50"
    HAR    117°32'20"      P1
    DIST   SHV   0SET  COORD
    ```

11.2 Setting the Horizontal Angle to a Required Value (Horizontal Angle Hold)

You can reset the horizontal angle to a required value and use this value to find the horizontal angle of a new target.

PROCEDURE

1. Sight the first target.

2. In the second page of the Meas mode screen, press **[H.ANG]**. Select "Angle".

3. Enter the angle you wish to set, then press **[OK]**. The value that is input as the horizontal angle is displayed.

   • When **[REC]** is pressed, backsight angle can be set and recorded in the current JOB.
   ⌐ʒ "24.2 Recording Backsight Point"

```
Set H angle
Take BS
ZA       89° 59 ' 50 "
HAR    347° 23 ' 46 "
HAR:    125.3220
 REC                    OK
```

```
Meas          PC    - 30
              ppm       0
S
ZA       89° 59 ' 50 "
HAR    125° 32 ' 20 "   P1
 DIST   SHV  OSET  COORD
```

4. Sight the second target. The horizontal angle from the second target to the value set as the horizontal angle is displayed.

Note

• Pressing **[HOLD]** performs the same function as above.
• Press **[HOLD]** to set the displayed horizontal angle. Then, set the angle that is in hold status to the direction you require.
  ⌐ʒ Allocating **[HOLD]**: "30.3 Allocating Key Functions"

11.3 Horizontal Angle Repetition

To find the horizontal angle with greater precision, perform repetition measurement.

1st Target (BS)   2nd Target (FS)

3rd meas. Starts   3rd meas. end (average of three measurements is displayed)
2nd meas. Starts   2nd meas. end (average of two measurements is displayed)
1st meas. Starts   1st meas. end (the angle between 2 points is displayed)

Station
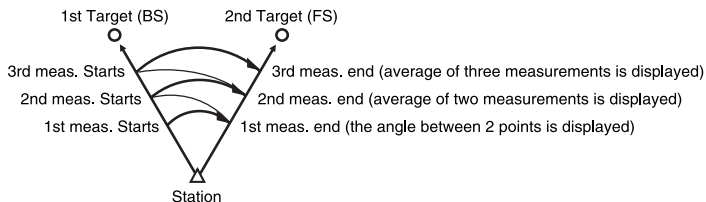
• The maximum number of angle measurements that can be made is 10.

PROCEDURE

1. In the second page of Meas mode screen, press **[MENU]**, then select "Repetition".

```
Menu
  Coordinate
  S-O
  Offset
  Repetition
  MLM            ⊠
```

2. Sighting the first target, press **[OK]**.

```
Repetition
HARp     0°00'00"
Reps.    0
Ave.     0°00'00"
 Take BS
 CE              OK
```

3. Sighting the second target, press **[OK]**.

4. Sighting the first target a second time, press **[OK]**.

5. Sighting the second target a second time, press **[OK]**.
The added value of the horizontal angle is displayed on the second line "HARp" and the average value of the horizontal angle is displayed on the fourth line "Ave.".

```
Repetition
HARp   110°16'20"
Reps.    2
Ave.    50°38'10"
 Take BS
 CE              OK
```

• Return to the previous
measurement of the first target
and redo it: **[CE]**.
(Effective when the display
shows "Take BS")

6. When continuing the repetition
measurement, repeat steps 4 to 5.

7. When the repetition measurement
is completed, press **{ESC}**.

Note

• It is also possible to perform repetition measurement by pressing **[REP]** when
allocated to the Meas mode screen.

☞ Allocating **[REP]**: "30.3 Allocating Key Functions"

11.4   Angle Measurement and Outputting the Data

The following explains angle measurement and the features used to output
measurement data to a computer or peripheral equipment.

☞ Bluetooth communication: "10. CONNECTING TO EXTERNAL DEVICES"
Communication cables: "36. OPTIONAL ACCESSORIES"
Output format and command operations: "Interfacing with the SOKKIA SDR
Electronic Field Book" and "Command Explanations" manuals.

PROCEDURE

1. Connect SET and host computer.

2. Allocate the **[D-OUT]** softkey to
the Meas mode screen.
☞ "30.3 Allocating Key
Functions"

3. Sight the target point.

4. Press **[D-OUT]** and select "Angle
Data".
Output measurement data to
peripheral equipment.

12. DISTANCE MEASUREMENT

Perform the following settings as preparation for distance measurement.
• Distance measurement mode
• Target type
• Prism constant correction value
• Atmospheric correction factor
• EDM ALC

☞ "30.1 EDM Settings"/"30.2 Configuration -Config Mode-"

⚠ CAUTION
• When using the Laser-pointer function, be sure to turn OFF the output laser after distance measurement is completed. Even if distance measurement is canceled, the Laser-pointer function is still operating and the laser beam continues to be emitted. (After turning ON the Laser-pointer, the laser beam is emitted for 5 minutes, and then automatically switches OFF. But in the Status screen and when target symbol (ex. 🔋) is not displayed in the Meas mode, the laser beam is not automatically turned off.)

🚫

• Make sure that the target setting on the instrument matches the type of target used. SET automatically adjusts the intensity of the laser beam and switches the distance measurement display range to match the type of target used. If the target does not correspond to the target settings, accurate measurement results cannot be obtained.
• Accurate measurement results cannot be obtained if the objective lens is dirty. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it off with the wiping cloth.
• During reflectorless measurement, if an object with a high reflective factor (metal or white surface) is positioned between the SET and the target, accurate measurement results may not be received.
• Scintillation may affect the accuracy of distance measurement results. Should this occur, repeat measurement several times and use the averaged value of the obtained results.

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12.1 Returned Signal Checking

• Check to make sure that sufficient reflected light is returned by the reflective prism sighted by the telescope. Checking the returned signal is particularly useful when performing long distance measurements.

�

• When the light intensity is sufficient even though the center of the reflective prism and the reticle are slightly misaligned (short distance etc.), "*" will be displayed in some cases, but in fact, accurate measurement is impossible. Therefore make sure that the target center is sighted correctly.

PROCEDURE

1. Allocate the **[AIM]** softkey to the Meas mode screen.
   ☞ "30.3 Allocating Key Functions"

2. Accurately sight the target.

3. Press **[AIM]**.
   <Aiming> is displayed.
   The intensity of the light of the returned signal is displayed by a gauge.
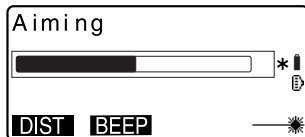
   • The more ▬▬▬▬ displayed, the greater the quantity of reflected light.
   • If "*" is displayed, only enough light for the measurement is returned.

   • When "*" is not displayed, accurately resight the target. Press **[BEEP]** to make a buzzer sound when measurement is possible. Press **[OFF]** to shut off the buzzer.
   • Press **[DIST]** to start distance measurement.

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4. Press **{ESC}** to finish signal
   checking and return to Meas
   Mode.

Note

• When ▬▬▬▬▬ is displayed persistently, contact your local dealer.
• If no key operations are performed for two minutes, the display automatically
  returns to the Meas mode screen.

12.2   Distance and Angle Measurement

An angle can be measured at the same time as the distance.

PROCEDURE

1. Sight the target.

2. In the first page of Meas Mode,
   press **[DIST]** to start distance
   measurement.

```
Meas        PC    -30
            ppm     0
S                  ⓑ▮
ZA     80°30'15"    ⊥
HAR   120°10'00"   P1
 DIST  ◢SHV  OSET COORD
```

   When measurement starts, EDM
   information (distance mode, prism
   constant correction value,
   atmospheric correction factor) is
   represented by a flashing light.

```
Dist
Fine"r"     PC    -30
            ppm     0
                    ⓑ
 ──※            STOP
```

   A short beep sounds, and the
   measured distance data (S),
   vertical angle (ZA), and horizontal
   angle (HAR) are displayed.

```
Meas        PC    -30
            ppm     0
S      525.450m    ⓑ▮
ZA     80°30'10"
HAR   120°10'00"   P1
 ──※            STOP
```

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3. Press **[STOP]** to quit distance measurement.

   • Each time **[SHV]** is pressed, S (Slope distance), H (Horizontal distance) and V (Height difference) are displayed alternately.

```
Meas          PC      -30
                ppm        0
S        525.450m       🔋▮
H        518.248m       ⊥
V         86.699m      P1
 DIST   SHV   OSET  COORD
```

Note

• If the single measurement mode is selected, measurement automatically stops after a single measurement.
• During fine average measurement, the distance data is displayed as S-1, S-2, ... to S-9. When the designated number of measurements has been completed, the average value of the distance is displayed in the [S-A] line.
• The distance and angle that are most recently measured remain stored in the memory until the power is off and can be displayed at any time.
  ☞ "12.3 Recalling the Measured Data"

12.3   Recalling the Measured Data

The distance and angle that are most recently measured remain stored in the memory until the power is off and can be displayed at any time.

The distance measurement value, vertical angle, horizontal angle, and the coordinates can be displayed. Distance measurement values converted into the horizontal distance, elevation difference, and the slope distance can also be displayed.

PROCEDURE

1. Allocate the **[RCL]** softkey to the Meas mode screen.
   ☞ "30.3 Allocating Key Functions"

2. Press **[RCL]**.
   The stored data that is most
   recently measured is displayed.

   • If you have pressed **[◢ SHV]**
     beforehand, the distance values
     are converted into the horizontal
     distance, elevation difference,
     and the slope distance and
     recalled.

```
S      525.450m
ZA      80°30'10"
HAR   120°10'10"
N     -128.045
E     -226.237
Z       30.223
```

3. Press **{ESC}** to return to Meas mode.

12.4   Distance Measurement and Outputting the Data

The following explains distance measurement and the features used to output
measurement data to a computer or peripheral equipment.
☞ Communication cables: "36. OPTIONAL ACCESSORIES"
   Output format and command operations: "Interfacing with the SOKKIA SDR
   Electronic Field Book" and "Command Explanations" manuals.

PROCEDURE

1. Connect SET and host computer.

2. Allocate the **[D-OUT]** softkey to
   the Meas mode screen.
   ☞ "30.3 Allocating Key
       Functions"

3. Sight the target point.

4. Press **[D-OUT]**, and select "Dist
   data" to measure the distance and
   output the data to peripheral
   equipment.

5. Press **[STOP]** to stop outputting
   data and return to Meas Mode.

12.5　REM Measurement

An REM measurement is a function used to measure the height to a point where a target cannot be directly installed such as power lines, overhead cables and bridges, etc.
The height of the target is calculated using the following formula.

$Ht = h1 + h2$

$h2 = S \sin \theta z1 \times \cot \theta z2 - S \cos \theta z1$
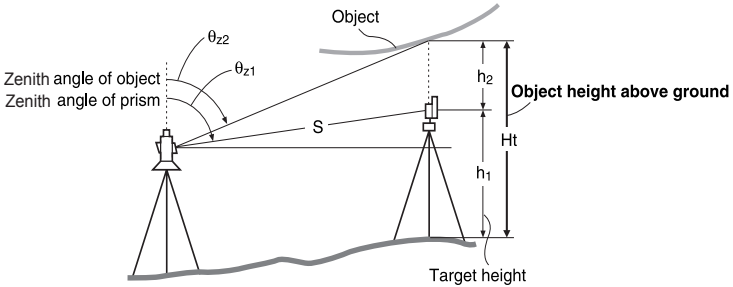
PROCEDURE

1. Set the target directly under or directly over the object and measure the target height with a tape measure etc.
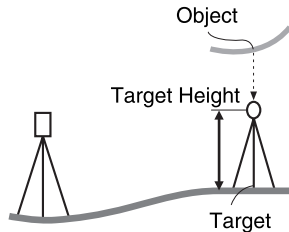
2. After inputting the target height, accurately sight the target.
   ☞ "Note"
   Press **[DIST]** in page 1 of Meas Mode to carry out measurement.

The measured distance data (S), vertical angle (ZA), and horizontal angle (HAR) are displayed. Press **[STOP]** to stop the measurement.

3. In the second page of Meas mode screen, press **[MENU]**, then select "REM".

```
REM                        ▲
 Resection
 Area calculation
 Set-out line
 Set-out arc
 Point projection
```
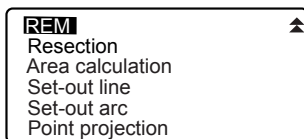
4. Press **[OBS]**. The REM measurement is started and the height from the ground to the object is displayed in "Ht.".

```
REM
    Need Prism obs
S
ZA      89°59'50"
HAR    117°32'20"
        REM          OBS
```

```
REM
Ht.       6.255m
S        13.120m
ZA      89°59'50"
HAR    117°32'20"
                    STOP
```

Object

Ht.
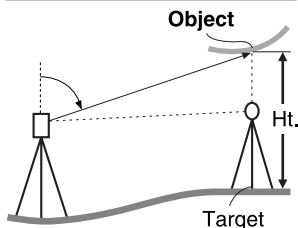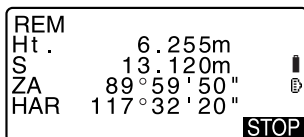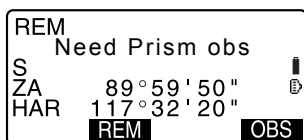
Target

5. Press **[STOP]** to terminate the measurement operation.

   • To re-observe the target, sight the target, then press **[OBS]**.
   • When **[REC]** is pressed, REM data is saved.
     ☞ "24. RECORDING DATA - RECORD MENU -"

```
REM
Ht.       6.255m
S        13.120m
ZA      89°59'50"
HAR    117°32'20"
        REM   REC   OBS
```

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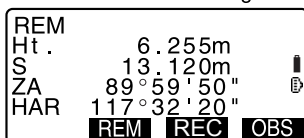
6. Press **{ESC}** to finish
   measurement and return to the
   Meas mode screen.

Note

• It is also possible to perform REM measurement by pressing **[REM]** when
  allocated to the Meas mode screen.
  "30.3 Allocating Key Functions"
• Inputting instrument and target height: Press **[HT]** to set instrument and target
  height. It can be set also in "Stn. Orientation" of coordinate measurement.
  "13.1 Entering Instrument Station Data and Azimuth Angle"

13. COORDINATE MEASUREMENT

By performing coordinate measurements it is possible to find the 3-dimensional coordinates of the target based on station point coordinates, instrument height, target height, and azimuth angles of the backsight station which are entered in advance.
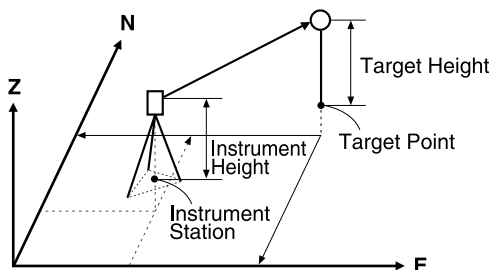
• EDM setting can be done in coordinate measurement menu.
  ☞ Setting items: "30.1 EDM Settings"

13.1 Entering Instrument Station Data and Azimuth Angle

Before coordinate measurement, enter instrument station coordinates, the instrument height, target height, and azimuth angle.

PROCEDURE

1. First measure the target height and instrument height with a tape measure, etc.

2. Press **[COORD]** in the first page of the Meas mode screen to display <Coord.>.

3. Select "Stn. Orientation".
   Input the following data items.
   (1) Instrument station coordinates
   (2) Point number
   (3) Instrument height
   (4) Code
   (5) Operator
   (6) Date
   (7) Time
   (8) Weather
   (9) Wind
   (10)Temperature
   (11)Air pressure
   (12)Atmospheric correction factor

```
Coord.
  Stn. Orientation
  Observation
  EDM
```

```
N0 :            0.000
E0 :            0.000
Z0 :            0.000
Pt.
Inst.h          0.000m
READ  ANGLE  COORD
```

4. Press **[ANGLE]** in the screen of step 3 to proceed to azimuth angle input.

   • Press **[COORD]** to calculate azimuth angle from backsight coordinates.
   ☞ "13.2 Setting Azimuth Angle from Backsight Coordinates"

   • When you wish to read in the registered coordinate data, press **[READ]**.
   ☞ "PROCEDURE Reading in Registered Coordinate Data"

5. Input azimuth angle and press **[OK]** to set the input values. <Coord> is displayed again.

   • Press **[REC]** to record code, target height, and point number values. Press **[OK]** to set the input values and return to <Coord>.

```
ZA       90°00'00"
HAR      30°00'00"
Cd
Tgt.h         0.000m
 OK   ADD  LIST  SRCH
```

Note

- Maximum point number size: 14 (alphanumeric)
- Input range of instrument height: -9999.999 to 9999.999 (m)
- Maximum code/operator size: 16 (alphanumeric)
- Weather selection: Fine, Cloudy, Light rain, Rain, Snow
- Wind selection: Calm, Gentle, Light, Strong, Very strong
- Temperature range: -30 to 60 (°C) (in 1°C step)/-22 to 140 (°F) (in 1°F step)
- Air pressure range: 500 to 1400 (hPa) (in 1 hPa step)/375 to 1050 (mmHg) (in 1mmHg step)/14.8 to 41.3 (inch Hg) (in 0.1 inch Hg step)
- Atmospheric correction factor range (ppm): -499 to 499

PROCEDURE Reading in Registered Coordinate Data

Known point data, coordinate data and instrument station data in the current JOB and Coordinate Search JOB can be read in.
Confirm that the correct JOB containing the coordinates you want to read in is already selected in Coordinate Search JOB in Memory Mode.
☞ "26.1 Registering/Deleting Known Point Data", "25.1 Selecting a JOB"

1. Press **[READ]** when setting Instrument Station.
   The list of registered coordinates is displayed.

   Pt. : Known point date saved in the current JOB or in the Coordinate Search JOB.

   Crd./ Stn : Coordinate data saved in the current JOB or in the Coordinate Search JOB.

```
Pt.   11111111    ▲
Pt.   1
Crd.  2
Stn   12345679
Stn   1234          ▼
↑↓‥P   TOP   LAST   SRCH
```

2. Align the cursor with the required point number and press {◄━━┛}.
   The point number that was read and its coordinates in are displayed.

```
N0:        370.000
E0:         10.000
Z0:        100.000   ▮
Pt.    PNT-001
Inst.h        0.000 m▼
        ANGLE  COORD
```

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- **[↑↓...P]** = Use **{▲}/{▼}** to move
 from page to page.
- **[↑↓...P]** = Use **{▲}/{▼}** to select
 individual point.
- Press **[TOP]** to move to the first
 point number on the first page.
- Press **[LAST]** to move to the last
 point number on the last page.
- Press **[SRCH]** to move to the
 "Coordinate Data Search
 Screen." Input the point number
 you want to search in "Pt. no."
 The search may take time if
 many data are registered.

3. Press **[OK]**.
 <Instrument Station Data Setting>
 is restored.

 - You can edit the coordinate data
 that was read in. Editing does
 not affect the original coordinate
 data. After editing, the point
 number is no longer displayed.

Note

- The point number that was read in is displayed until the current JOB is changed.
- When **[SRCH]** is pressed, SET searches data in the current JOB first, then in
 the Coordinate Search JOB.
- If more than two points with the same point name exist in the current JOB, SET
 finds the newer data only.

13.2 Setting Azimuth Angle from Backsight Coordinates

Set the azimuth angle of the backsight station by calculating by the coordinates.
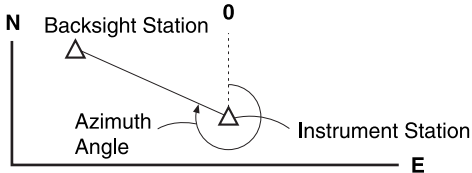
PROCEDURE

1. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle " steps 1 to 3

2. Press **[COORD]** to proceed to backsight coordinate input.

```
N0 :          0.000
E0 :          0.000
Z0 :          0.000
Pt.
Inst.h        0.000m
READ  ANGLE  COORD
```

3. Input the backsight station coordinates and press **[OK]**. Angle measurement values are displayed in real time. Calculated Azimuth angle is also displayed.

```
Backsight
NBS :     1.000
EBS :     1.000
ZBS :    <Null>
READ              OK
```

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• Press **[DIST]** to perform a horizontal distance check.

```
Backsight
Take BS
ZA          90°12'34"
HAR        123°12'34"
Azmth       45°00'00"
 REC   DIST   NO   YES
```

• Press **[HT]** to set instrument and target height.
• Press **[REC]** to store check data in the current JOB

```
BS Hdist check

calc H              0.000m
obs H               0.000m
dH                  0.000m
 REC    HT              OK
```

```
S           100.000m
ZA          90°00'00"
HAR         30°00'00"
Cd
Tgt.h         0.000m
 OK   ADD   LIST  SRCH
```

• When you wish to read in the registered coordinate data, press **[READ]**.
  ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

4. Press **[YES]** in the screen of step 3 to set azimuth angle. <Coord> is displayed again.

• When storing the azimuth angle in the current JOB, press **[REC]**.
  ☞ 24.2 Recording Backsight Point, PROCEDURE Inputting azimuth angle"

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13.3   3-D Coordinate Measurement

The coordinate values of the target can be found by measuring the target based on the settings of the instrument station and backsight station.

The coordinate values of the target are calculated using the following formulae.

N1 Coordinate = $N0 + S \times \sin Z \times \cos Az$

E1 Coordinate = $E0 + S \times \sin Z \times \sin Az$

Z1 Coordinate = $Z0 + S \times \cos Z + ih - fh$

N0: Station point N coordinate   S: Slope distance   ih: Instrument height
E0: Station point E coordinate   Z: Zenith angle   fh: Target height
Z0: Station point Z coordinate   Az: Direction angle

✍

Z (zenith angle) is calculated as 360° -Z when the telescope is in the face left position if either the horizontal angle has been set to 0 by pressing **[0SET]** or the required horizontal angle has been set by pressing **[H.ANG]**.
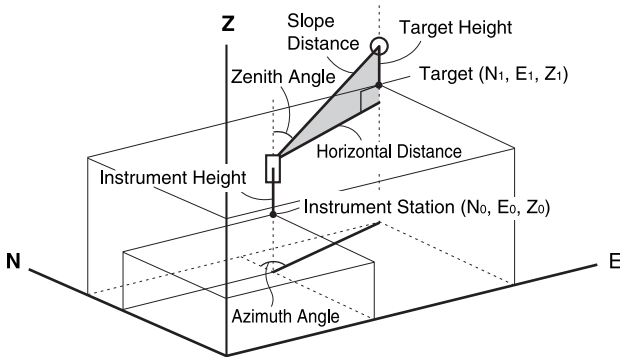
• If not measured or the space is left blank "Null" will be displayed.
  If station point Z coordinate is set to "Null" the observation result for the Z coordinate is automatically set to "Null".

PROCEDURE

1. Sight the target at the target point.

2. In <Coord>, select "Observation"
   to start measurement.
   The coordinate value of the target
   is displayed.
   Press **[STOP]** to quit
   measurement.
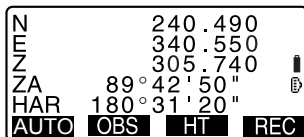
```
Coord.
  Stn. Orientation
  Observation
  EDM
```

   • The tilt screen is displayed if the
     instrument is out of level.
     Level the instrument.
     ☞ "7. SETTING UP THE
     INSTRUMENT PROCEDURE
     Levelling on the screen"

   • By pressing **[HT]**, the instrument
     station data can be reset. When
     the target height of the next
     target is different, reenter the
     target height before beginning
     the observation.

```
N        240.490
E        340.550
Z        305.740
ZA     89°42'50"
HAR   180°31'20"
AUTO  OBS   HT   REC
```

   • **[REC]**: records measurement
     results
   • **[AUTO]**: starts measurement
     and automatically records
     results after **[STOP]** has been
     pressed.
   ☞ Recording method:
      "24. RECORDING DATA -
      RECORD MENU -"

3. Sight the next target and press
   [OBS] or **[AUTO]** to begin
   measurement. Continue until all
   targets have been measured.

   • When coordinate measurement
     is completed, press **{ESC}** to
     return to <Coord>.

13.4 Coordinate Measurement and Outputting the Data

The following explains coordinate measurement and the features used to output measurement data to a computer or peripheral equipment.

☞ Communication cables: "36. OPTIONAL ACCESSORIES"
   Output format and command operations: "Interfacing with the SOKKIA SDR Electronic Field Book" and "Command Explanations" manuals

PROCEDURE

1. Connect SET and host computer.

2. Allocate the **[D-OUT]** softkey to the Meas mode screen.
   ☞ "30.3 Allocating Key Functions"

3. Sight the target point.

4. Press **[D-OUT]**, and select "Coord data" to output measurement data.

   ```
   Data out
    Dist data
    Angle data
    Coord data
   ```

5. Press **[STOP]** to stop outputting data and return to Meas Mode

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14. RESECTION MEASUREMENT

Resection is used to determine the coordinates of an instrument station by performing multiple measurements of points whose coordinate values are known. Registered coordinate data can be recalled and set as known point data. Residual of each point can be checked, if necessary.

Entry

Coordinates of known point : (X_i, Y_i, Z_i)

Observed horizontal angle : H_i

Observed vertical angle : V_i

Observed distance : D_i

Output

Station point coordinates : (X_0, Y_0, Z_0)
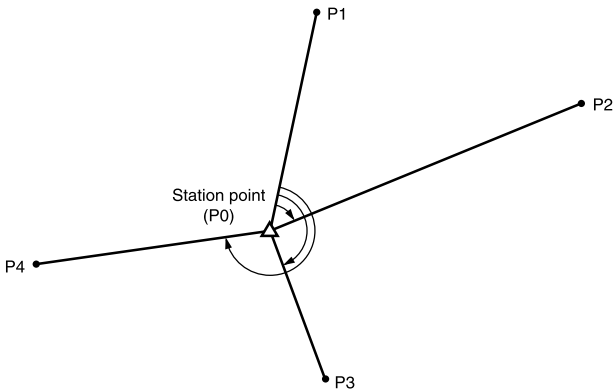
• All the N, E, Z or only Z data of an instrument station is calculated by measuring the known points.
• Coordinate resection measurement overwrites the N, E and Z data of the instrument station, but height resection does not overwrite N and E. Always perform resection measurement in the sequence described in "14.1 Coordinate Resection Measurement" and "14.2 Height Resection Measurement".
• Input known coordinate data and calculated instrument station data can be recorded in the current JOB.
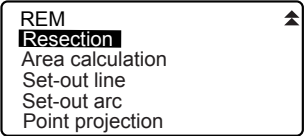
14.1   Coordinate Resection Measurement

N, E, Z of an instrument station is determined by the measurement.

• Between 2 and 10 known points can be measured by distance measurement, and between 3 and 10 known points by angle measurement.

PROCEDURE

1. In the second page of Meas mode screen, press **[MENU]**, then select "Resection".

```
REM                          ▲
Resection
Area calculation
Set-out line
Set-out arc
Point projection
```

2. Select "NEZ".

   • The tilt screen is displayed if the instrument is out of level.
     Level the instrument.
     ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
Resection.
NEZ
Elevation
```
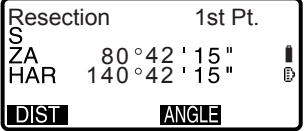
3. Sight the first known point and press **[DIST]** to begin measurement.
   The measurement results are displayed on the screen.

   • When **[ANGLE]** has been selected, the distance cannot be displayed.
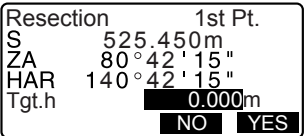
```
Resection          1st Pt.
S
ZA      80°42'15"     🔋
HAR   140°42'15"     🔋
 DIST            ANGLE
```

4. Press **[YES]** to use the measurement results of the first known point.

   • You can also input target height here.

```
Resection          1st Pt.
S        525.450m
ZA       80°42'15"
HAR    140°42'15"
Tgt.h            0.000m
              NO    YES
```

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5. Input coordinates for the first known point and press **[NEXT]** to move to the second point.

   • When **[READ]** is pressed, registered coordinates can be recalled and used.

   ℃ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

   • Press **{ESC}** to return to the previous known point.

```
        1st Pt.
Np :        20.000
Ep :        30.000
Zp :        40.000
Tgt.h :     10.000m
READ   REC   NEXT
```

6. Repeat procedures 3 to 5 in the same way from the second point. When the minimum quantity of observation data required for the calculation is present, **[CALC]** is displayed.

7. Press **[CALC]** to automatically start calculations after observations of all known points are completed.
   Instrument station coordinate and standard deviation, which describes the measurement accuracy, are displayed.

```
        3rd Pt.
Np :        20.000
Ep :        30.000
Zp :        40.000
Tgt.h :     10.000m
READ   REC   NEXT  CALC
```

8. Press **[RESULT]** to check the result.
   If there are no problems with the result, press **{ESC}** and go to step 10.

   • **[REC]**: records measurement results

   ℃ Recording method:
      "24. RECORDING DATA - RECORD MENU -"

```
N          100.001
E          100.000
Z            9.999
σN         0.0014m
σE         0.0007m
RESULT         REC    OK
```

```
        σN        σE
 1st  -0.001    0.001
*2nd   0.005    0.010
 3rd  -0.001    0.001
 4th  -0.003   -0.002  ▼
 BAD   RE CALC  RE OBS   ADD
```

• Press **[ADD]** when there is a
known point that has not been
measured or when a new known
point is added.

9. If there are problems with the
results of a point, align the cursor
with that point and press **[BAD]**.
"*" is displayed on the left of the
point. Repeat for all results that
include problems.

10. Press **[RE CALC]** to perform
calculation again without the point
designated in step 9. The result is
displayed.
If there are no problems with the
result, go to step 11.
If problems with the result occur
again, perform the resection
measurement from step 3.

• Press **[RE OBS]** to measure the
point designated in step 9.
If no points are designated in
step 9, all the points or only the
final point can be observed
again.

```
Resection
Start point
Last point
```

11. Press **[OK]** in the screen of step 8
to finish resection measurement.
The instrument station coordinate
is set.
Press **[YES]** when you want to set
the azimuth angle of the first
known point as the backsight
point.

• Press **[NO]** to return to Meas
Mode without setting the
azimuth angle.

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Note
- It is also possible to perform resection measurement by pressing **[RESEC]** when allocated to the Meas mode screen.

  ☞ Allocating **[RESEC]**: "30.3 Allocating Key Functions"
- Even if "inch" is selected in Config mode, standard deviation is displayed in "feet" or "US feet" depending on the feet unit selected.

14.2 Height Resection Measurement

Only Z (height) of an instrument station is determined by the measurement.

• Known points must be measured by distance measurement only.
• Between 1 and 10 known points can be measured.

PROCEDURE

1. In the second page of Meas mode
   screen, press **[MENU]**, then select
   "Resection".

2. Select "Elevation".

   • The tilt screen is displayed if the
     instrument is out of level.
     Level the instrument.
     ☞ "7. SETTING UP THE
         INSTRUMENT
         PROCEDURE Levelling on
         the screen"

```
Resection.
 NEZ
 Elevation
```
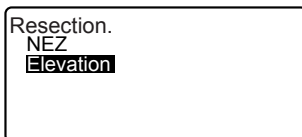
3. Sight the first known point and
   press **[OBS]** to begin
   measurement. Press **[STOP]**.
   The measurement results are
   displayed on the screen.

```
Resection  1st Pt.
S
ZA      80°42'15"
HAR    140°49'15"

OBS
```
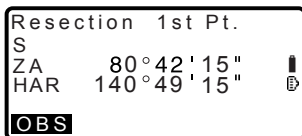
4. Press **[YES]** to use the
   measurement results of the first
   known point.

5. Input the known point. After
   setting the elevation for the first
   known point, press **[NEXT]** to
   move to the second point.

```
           1st Pt.

Zp:            11.891
Tgt.h:          0.100m
READ   REC   NEXT  CALC
```

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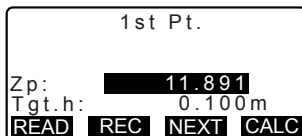
6. If measuring two or more known points, repeat procedures 3 to 4 in the same way from the second point.

   • Press **{ESC}** to return to the previous known point.

7. Press **[CALC]** to automatically start calculations after observations of all known points are completed. Instrument station elevation and standard deviation, which describes the measurement accuracy, are displayed.

8. Press **[RESULT]** to check the result.
   If there are no problems in the result, press **{ESC}** and go to step 11.

```
Z              10.000

σ Z           0.0022m
RESULT              REC    OK
```

9. If there are problems with the results of a point, align the cursor with that point and press **[BAD]**. "*" is displayed on the left of the point.

```
            σZ
 1st  -0.003
 2nd  -0.003
 3rd   0.000
 4th   0.002           ▼
 BAD   RE CALC  RE OBS   ADD
```

10. Press **[RE CALC]** to perform calculation again without the point designated in step 9. The result is displayed.
    If there are no problems with the result, go to step 11.
    If problems with the result occur again, perform the resection measurement from step 3.

11. Press **[OK]** to finish resection measurement. Only Z (elevation) of the instrument station coordinate is set. N and E values are not overwritten.

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Resection calculation process
The NE coordinates are found using angle and distance observation
equations, and the instrument station coordinates are found using the
method of least squares. The Z coordinate is found by treating the average
value as the instrument station coordinates.

```
┌─────────────────────────────────┐
│        Calculation begins       │
└─────────────────────────────────┘
                 ▼
┌─────────────────────────────────┐
│  Hypothetical coordinates are found │
└─────────────────────────────────┘
                 ▼◄───────────────────────────────┐
┌─────────────────────────────────┐                │
│  The observation equation for the │                │
│  angle is prepared              │                │
└─────────────────────────────────┘                │
                 ▼                                  │
┌─────────────────────────────────┐   ┌────────────────────────────┐
│  The observation equation for the │   │  Calculated instrument     │
│  distance is prepared           │   │  station coordinates set   │
└─────────────────────────────────┘   │  as hypothetical coordinates │
                 ▼                     └────────────────────────────┘
┌─────────────────────────────────┐
│  The normal equation is prepared │      Repeated 3 times
└─────────────────────────────────┘
                 ▼
┌─────────────────────────────────┐
│  Instrument station coordinates are │
│  calculated                     │
└─────────────────────────────────┘
                 ▼
╱─────────────────────────────────╲   No
╲ Difference from the hypothetical co-
  ordinates less than 0.5 mm     ╱
                 ▼  Yes
┌─────────────────────────────────┐
│  Calculation of the Z coordinate │
└─────────────────────────────────┘
                 ▼
┌─────────────────────────────────┐
│         Calculation ends        │
└─────────────────────────────────┘
```

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Precaution when performing resection
In some cases it is impossible to calculate the coordinates of an unknown point (instrument station) if the unknown point and three or more known points are arranged on the edge of a single circle.

An arrangement such as that shown below is desirable.
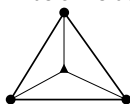
△ ▲ : Unknown point
○ ● : Known point

It is sometimes impossible to perform a correct calculation in a case such as the one below.
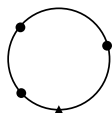
When they are on the edge of a single circle, take one of the following measures.

(1) Move the instrument station as close as possible to the center of the triangle.

(2) Observe one more known point which is not on the circle

(3) Perform a distance measurement on at least one of the three points.
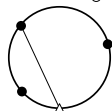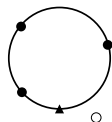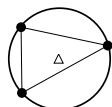
• In some cases it is impossible to calculate the coordinates of the instrument station if the included angle between the known points is too small. It is difficult to imagine that the longer the distance between the instrument station and the known points, the narrower the included angle between the known points. Be careful because the points can easily be aligned on the edge of a single circle.

15. SETTING-OUT MEASUREMENT

Setting-out measurement is used to set out the required point.
The difference between the previously input data to the instrument (the setting-out data) and the measured value can be displayed by measuring the horizontal angle, distance or coordinates of the sighted point.

The horizontal angle difference and distance difference are calculated and displayed using the following formulae.

Horizontal angle difference
dHA = Horizontal angle of setting-out data - measured horizontal angle

Distance difference
Distance   Displayed item
Sdist: S-O S =measured slope distance - slope distance of setting-out data
Hdist: S-O H =measured horizontal distance - horizontal distance of setting-
                      out data
Vdist: S-O V =measured height difference - height difference of setting-out
                      data

- Setting out data can be input in various modes: coordinates, horizontal distance, slope distance, height difference and REM measurement.
- In slope distance, horizontal distance, height difference, and coordinate mode, registered coordinates can be recalled and used as setting-out coordinates. In slope distance, horizontal distance and height difference, S/H/V distances are calculated from the read in setting-out coordinate, instrument station data, instrument height, and target height.
- Setting-out measurement can be carried out effectively using the Guide light.
  📖 "4.1 Parts of the Instrument" and "5.1 Basic Key Operation"
- EDM settings can be set in the Setting-out measurement menu.
- If not measured or the space is left blank "Null" will be displayed.
  If distance or angle of setting-out data is set to "Null" the Distance difference is automatically set to "Null"

15.1 Coordinates Setting-out Measurement

After setting the coordinates for the point to be set out, the SET calculates the setting-out horizontal angle and horizontal distance. By selecting the horizontal angle and then the horizontal distance setting-out functions, the required coordinate location can be set out.
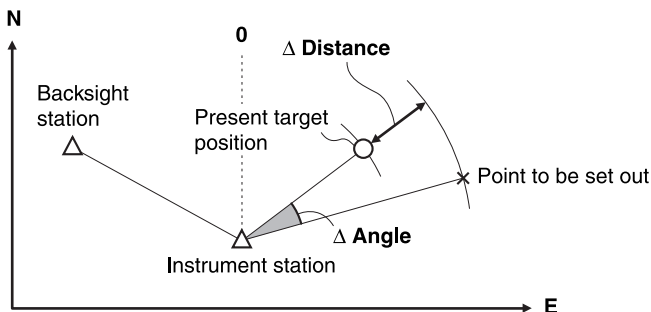
• To find the Z coordinate, attach the target to a pole etc. with the same target height.

PROCEDURE

1. Press **[S-O]** on the third page of the Meas mode screen to display <S-O>.

2. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

3. Set the azimuth angle of the backsight point.
   ☞ "13.2 Setting Azimuth Angle from Backsight Coordinates" steps 2 to 6

4. Select "S-O data". <S-O Coord> is displayed.

```
S-O
 Stn. Orientation
 S-O data
 Observation
 EDM
```

5. Enter the coordinates of the setting-out point.

    • When **[READ]** is pressed, registered coordinates can be recalled and used as setting-out coordinates.
    ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

```
S-O  Coord
Np :      100.000
Ep :      100.000
Zp :       50.000
Tgt. h :    1.400m
READ  ▲S-O        OK
```

    • When **[▲S-O]** is pressed, input coordinates are calculated and displayed in "H dist" and "H ang".

```
S-O  H

Hdist :      3.300m
H ang :     40.0000
                   P1
READ  ▲S-O        OK
```

6. Press **[OK]** to set the setting-out data.

    • The tilt screen is displayed if the instrument is out of level.
      Level the instrument.
    ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

7. Rotate the top of the instrument until "dHA" is 0° and place the target on the sight line.

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8. Press **[OBS]** to begin setting-out measurement.
   The target and the distance of the point to be set out is displayed (S-O△ H).

```
S-O△H         0.820m
dHA        0°09'40"
H           2.480m
ZA      75°20'30"
HAR     39°05'20"
 OBS   ↥S-O   ←  →   REC
```

```
S-O△H         0.820m
dHA        0°09'40"
H           2.480m
ZA      75°20'30"
HAR     39°05'20"
 ─※                  STOP
```

9. Move the prism forward and backward until the setting-out distance is 0m. If S-O△H is "+", move the prism toward yourself, if it is "-", move the prism away from yourself.

   • By pressing **[← →]**, an arrow pointing to the left or right displays which direction the target should be moved.

```
  ↓           1.988m
  →           2.015m
 ☰          -1.051m
ZA      89°52'50"
HAR    150°16'10"
 OBS   ↥S-0   ←  →   REC
```

   ← : Move the prism to left.
   → : Move the prism to right.
   ↓ : Move the prism forward.
   ↑ : Move the prism away.
   ☰ : Move the prism upward.
   ☷ : Move the prism downward.

   When the target is within measurement range, all four arrows are displayed.

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10. Press **{ESC}** to return to <S-O>.

    • When **[READ]** was used in step
      5, the list of registered
      coordinates is restored.
      Continue setting-out
      measurement.

    • **[REC]**: records measurement
      results
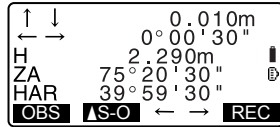
11. ☞ Recording method:
    "24. RECORDING DATA -
    RECORD MENU -"

```
↑  ↓          0.010m
←  →        0°00'30"
H          2.290m
ZA     75°20'30"
HAR    39°59'30"
 OBS   ▲S-O  ←  →   REC
```

15.2   Distance Setting-out Measurement

The point to be found based on the horizontal angle from the reference direction
and the distance from the instrument station.
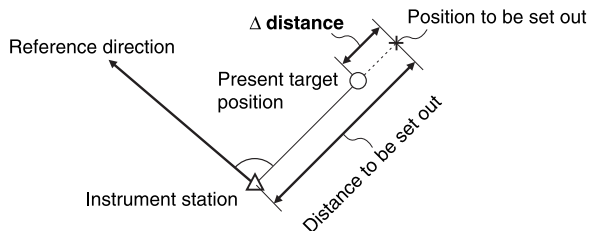
PROCEDURE

1. Press **[S-O]** in the third page of
    the Meas mode screen to display
    <S-O>.

2. Enter the instrument station data.
    ☞ "13.1 Entering Instrument
        Station Data and Azimuth
        Angle PROCEDURE Reading
        in Registered Coordinate
        Data"

3. Set the azimuth angle of the
    backsight point.
    ☞ "13.2 Setting Azimuth Angle
        from Backsight Coordinates"
        steps 2 to 6

4. Select "S-O data."

5. Press **[▲S-O]** untill <S-O H> is
    displayed.

```
S-O  Coord
Np:        100.000
Ep:        100.000
Zp:         50.000
Tgt.h:       1.400m P1
READ   ▲S-O        OK
```

6. Press **[▲S-O]** to select distance input mode.
   Each time **[▲S-O]** is pressed: S-O Coord (coordinates), S-O H (horizontal distance), S-O S (slope distance), S-O V (height difference), S-O Ht. (REM measurement).
   ☞ "15.1 Coordinates Setting-out Measurement", "15.3 REM Setting-out Measurement"
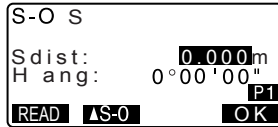
   • When **[READ]** is pressed, registered coordinates can be recalled and used. Distance and angle are calculated using the coordinate value.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

```
S-O S

Sdist:        0.000m
H ang:     0°00'00"
                    P1
 READ   ▲S-O          OK
```

7. Set the following items.
   (1) Sdist/Hdist/Vdist: distance from the instrument station to the position to be set out.
   (2) H ang: included angle between the direction of the reference and the point to be set out.
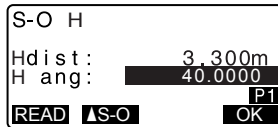
   • Pressing **[COORD]** in the second page allows you to enter the coordinates of the point to be set out.

```
S-O H

Hdist:        3.300m
H ang:       40.0000
                    P1
 READ   ▲S-O          OK
```
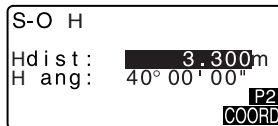
8. Press **[OK]** to set the input values.

```
S-O H

Hdist:        3.300m
H ang:   40°00'00"
                    P2
                 COORD
```

• The tilt screen is displayed if the
instrument is out of level.
Level the instrument.
☞ "7. SETTING UP THE
INSTRUMENT PROCEDURE
Levelling on the screen"

9. Rotate the top of the instrument
until "dHA" is 0° and place the
target on the sight line.

10. Press **[OBS]** to start distance
measurement. The target and the
distance of the point to be set out
is displayed (S-OΔH).

```
S-O△H        0.820m
dHA        0°09'40"
H          2.480m
ZA        75°20'30"
HAR       39°05'20"
 OBS  ▲S-O  ←  →  REC
```

11. Move the prism to find the point to
be set out.

12. Press **{ESC}** to return to <S-O>.

• When **[READ]** was used in step
5, the list of registered
coordinates is restored.
Continue setting-out
measurement.
• **[REC]**: records measurement
results
☞ Recording method:
"24. RECORDING DATA -
RECORD MENU -"

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15.3   REM Setting-out Measurement

To find a point where a target cannot be directly installed, perform REM setting-out measurement.

☞ "12.5 REM Measurement"

PROCEDURE

1. Install a target directly below or directly above the point to be found, then use a measuring tape etc. to measure the target height (height from the survey point to the target).

2. Press **[S-O]** in the Meas mode screen to display <S-O>.

3. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

4. Select "S-O data" and press **[▲S-O]** until <S-O Ht.> is displayed.

5. Input height from the survey point to the position to be set out in "SO dist".

```
S-O Ht.
Height:          3.300 m

        ▲S-O              OK
```

6. After inputting the data, press **[OK]**.

   • The tilt screen is displayed if the instrument is out of level. Level the instrument.
   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

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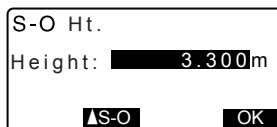
7. Press **[REM]** to begin REM setting-out measurement. Move the telescope to find the point to be set out.
   ☞ "15.2 Distance Setting-out Measurement" steps 9 to 10
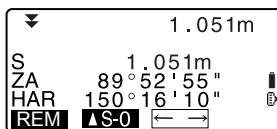
   ☎ : Move the telescope near the zenith.
   ☎ : Move the telescope near the nadir.

8. When the measurement is completed, press **{ESC}** to restore <S-O>.

```
 ⏬              1.051m
S          1.051m
ZA     89°52'55"      ▌
HAR   150°16'10"      🔋
 REM   ▲S-O   ←  →
```

16. SETTING-OUT LINE

Setting-out line is used for setting out a required point at a designated distance from the baseline and for finding the distance from the baseline to a measured point.
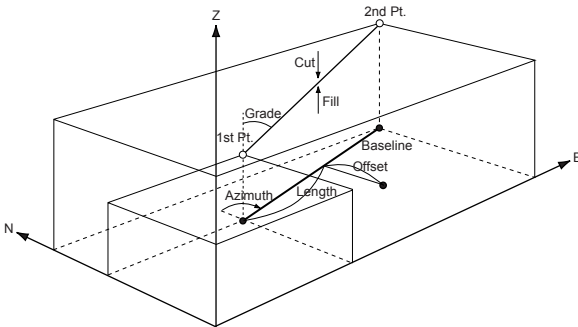
16.1   Defining Baseline

To perform setting-out line measurement, first, define the baseline. The baseline can be defined by inputting the coordinates of, or by observing the two points. The scale factor value is the difference between the input coordinates and the observed coordinates.

Scale (X, Y) = Hdist' (horizontal distance calculated from the measured value)

Hdist (horizontal distance calculated from the input coordinates)

- When not observing first or second points, scale factor is set to "1".
- Defined baseline can be used in both setting-out line measurement and point projection.

PROCEDURE Defining by inputting coordinates

1. In the second page of Meas mode screen, press **[MENU]**, then select "Set-out line".

```
REM                      ▲
 Resection
 Area calculation
 Set-out line
 Set-out arc
 Point projection
```

2. Enter the instrument station data.
   ☞ "13.1 Entering Instrument
   Station Data and Azimuth
   Angle PROCEDURE Reading
   in Registered Coordinate
   Data"

3. Select "Define baseline" in <Set-
   out line>.

```
Set-out line
  Stn. Orientation
  Define baseline
  Set-out line
```

4. Enter the first point data and press
   [OK].

   • When **[READ]** is pressed,
     registered coordinates can be
     recalled and used.
   ☞ "13.1 Entering Instrument
     Station Data and Azimuth
     Angle PROCEDURE Reading
     in Registered Coordinate
     Data"

```
     Define 1st Pt.
Np:      113.464
Ep:       91.088
Zp:       12.122
READ  REC   OBS   OK
```

5. Enter the second point data.

```
     Define 2nd Pt.
Np:      112.706
Ep:      104.069
Zp:       11.775
                     P1
READ  REC   OBS   OK
```

6. Press **{FUNC}**.
   [MEAS] is displayed.

   • When not observing the first
     point and the second point, go to
     step 12.

```
     Define 2nd Pt.
Np:      112.706
Ep:      104.069
Zp:       11.775
                     P2
                   MEAS
```

7. Press **[MEAS]** on the screen of
   step 6 to move to observation of
   the first point.

8. Sight the first point and press
    [OBS].
    The measurement results are
    displayed on the screen.
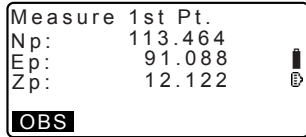
    • Press **[STOP]** to stop the
      measurement.
    • You can input target height here.
    • The tilt screen is displayed if the
      instrument is out of level.
      Level the instrument.
    ☞ "7. SETTING UP THE
        INSTRUMENT PROCEDURE
        Levelling on the screen"

```
Measure 1st Pt.
Np:      113.464
Ep:       91.088
Zp:       12.122
 OBS
```

9. Press **[YES]** to use the
    measurement results of the first
    point.

    • Press **[NO]** to observe the first
      point again.

```
Measure        1st Pt.
S       525.450m
ZA       80°30'15"
HAR    120°10'00"
Tgt.h          1.400m
              NO   YES
```
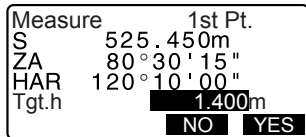
10. Sight the second point and press
    [OBS].
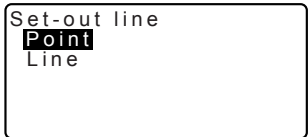
11. Press **[YES]** to use the
    measurement results of the
    second point.
    The distance between the two
    measured points, the distance
    calculated from inputting the
    coordinates of two points and the
    scale factors are displayed.

```
Azmth 93°20'31"
Hcalc    13.003m
Hmeas
ScaleX  1.000091
ScaleY  1.000091
 Sy=1  Sy=Sx        OK
```

```
Grade    %-2.669
 1:**    %    OK
```

12. Press **[OK]** on the screen of step
    11 to define the baseline. <Set-out
    line> is displayed. Move to setting-
    line measurement.

    ☞ "16.2 Setting-out Line Point"/
       "16.3 Setting-out Line Line"

```
Set-out line
 Point
 Line
```

    • Press **[Sy=1]** to set scale factor
      y to "1".
    • Press **[1 : **]** to change the
      grade display mode to "1 : * * =
      elevation : horizontal distance".

Note

• It is also possible to perform setting-out line measurement by pressing **[S-O
  LINE]** when allocated to the Meas mode screen.

    ☞ Allocating **[S-O LINE]**: "30.3 Allocating Key Functions".

PROCEDURE Defining by observation

1. In the second page of Meas mode
   screen, press **[MENU]**, then select
   "Set-out line".

2. Enter the instrument station data.
   ☞ "13.1 Entering Instrument
      Station Data and Azimuth
      Angle PROCEDURE Reading
      in Registered Coordinate
      Data"

3. Select "Define baseline" in <Set-
   out line>.

4. Sight the first point and press
   [OBS].

    • Press **[STOP]** to stop the
      measurement.

```
   Define 1st Pt.
Np:        0.000
Ep:        0.000
Zp:        0.000
READ  REC  OBS  OK
```

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• The tilt screen is displayed if the instrument is out of level.
Level the instrument.
☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

5. Press **[OK]** to use the measurement results of the first point.

   • Press **[OBS]** to observe the first point again.
   • Press **[HT]** to input instrument and target height.

```
Np:            113.464
Ep:             91.088
Zp:             12.122
ZA       90°00'00"
HAR    120°10'00"
 HT    REC    OBS    OK
```

6. Sight the second point and press **[OBS]**.

```
     Define 2nd Pt.
Np:             0.000
Ep:             0.000
Zp:             0.000

READ   REC    OBS    OK
```

7. Press **[OK]** to use the measurement results of the second point.

   • Press **[OBS]** to observe the second point again.
   • Press **[HT]** to input instrument and target height.
   • Scale factor settings can be set in the screen shown at right.

```
Np:            113.464
Ep:            145.874
Zp:             13.212
ZA       90°00'00"
HAR    121°10'00"
 HT    REC    OBS    OK
```
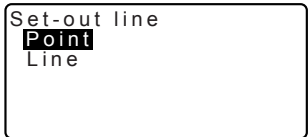
```
Azmth 93°20'31"
Hcalc     13.003m
Hmeas
ScaleX  1.000091
ScaleY  1.000091
 Sy=1  Sy=Sx          OK
```

```
Grade     %-2.669

 1:**     %      OK
```

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8. Press **[OK]** on the third screen of step 7 to define the baseline. <Set-out line> is displayed. Move to setting-line measurement.

    ☞ "16.2 Setting-out Line Point"/ "16.3 Setting-out Line Line"

```
Set-out line
Point
Line
```

   • Press **[Sy=1]** to set scale factor y to "1".
   • Press **[1 : **]** to change the grade display mode to "1 : * * = elevation : horizontal distance".

Note

• It is also possible to perform setting-out line measurement by pressing **[S-O LINE]** when allocated to the Meas mode screen.

    ☞ Allocating **[S-O LINE]**: "30.3 Allocating Key Functions".

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16.2   Setting-out Line Point

Setting-out line point measurement can be used to find the required point coordinate by inputting the length and offset based on the baseline.

• Before performing setting-out line point, the baseline must be defined.
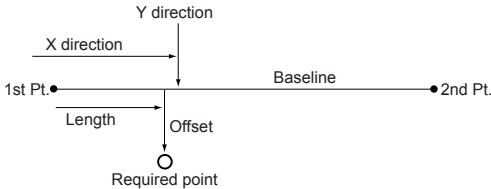
PROCEDURE

1. Select "Point" in <Set-out line>

```
Set-out line
Point
Line
```

2. Set the following items.
   (1) Incr: Increment by which line length and offset can be increased/decreased using the arrow softkeys.
   (2) Line: Distance along the baseline from the first point to the position at which a line extending from the required point intersects the baseline at right angles (X direction).
   (3) Offset: Distance from the required point to the position at which a line extending from the required point intersects the baseline at right angles (Y direction).
   • **[◀━]/[━▶]**: Press to decrease/ increase the value by the amount set in "Incr".

```
Set-out line
Incr            1.000m
Line            0.000m
Offset          0.000m
OFFSET  ◀━   ━▶    OK
```

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3. Press **[OK]** on the screen of step 2. The coordinate value of the required point is calculated and displayed.

```
Set-out line
N        111.796
E         94.675
Z         12.024

     REC          ▲S-O
```

• **[REC]**: records the coordinate value as a known point data.
  ☞ Recording method:
     "26.1 Registering/Deleting Known Point Data"
• Press **[▲ S-O]** to move to setting-out measurement of the required point.
  ☞ "15. SETTING-OUT MEASUREMENT"

4. Press **{ESC}**. Continue the measurement (repeat steps from 2).

PROCEDURE Offsetting the baseline

The baseline can be offset in three dimensions using four methods: lengthwise offset, lateral offset, height offset ,and rotation angle offset.

Lateral offset

Rotation angle offset

30°

N
E

N
E

Lengthwise offset

Height offset

N
E
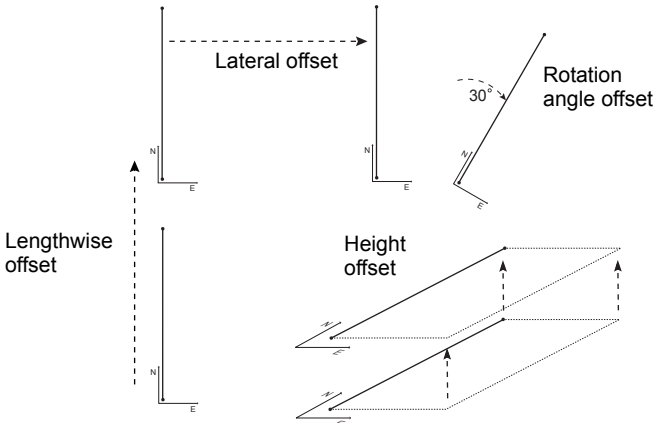
1. Select "Point" in <Set-out line>

```
Set-out line
Point
Line
```

2. Press **[OFFSET]** to display <Baseline offset>.

```
Set-out line
Incr          1.000m
Line          0.000m
Offset        0.000m
OFFSET  ←    →    OK
```

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3. Set the following items.
   (1) Incr: Increment by which offsets can be increased/ decreased using the arrow softkeys.
   (2) Length: Lengthwise offset
   (3) Lateral: Lateral offset
   (4) Height: Elevation offset
   (5) Rt.ang: Rotation angle offset
   • **[◄━]/[━►]**: Press to increase/ decrease the value by the amount set in "Incr".

```
Baseline offset
Incr          1.000m
Length        0.000m
Lateral       0.000m
Height        0.000m ⯆
MOVE    ◄━    ━►   OK
```

```
Rt.ang        0.0000  ⯅


MOVE                  OK
```

4. Press **[OK]** to return to the screen in step 2.
   • **[MOVE]**: Permanently moves the baseline coordinates by the amount set in <Baseline offset>.
5. Press **[OK]** on the screen of step 2. The coordinate value of the required point is calculated, taking into account the movement of the baseline, and displayed.

```
Set-out line
N        185.675
E        102.482
Z          9.662
         REC       ⯅S-O
```

16.3   Setting-out Line Line

Setting-out line line measurement tells how far horizontally the measured point is from the baseline and how far vertically the measured point is from the connected line. The baseline can be offset in a horizontal direction if necessary.
• Before performing setting-out line line, the baseline must be defined.

Profile View
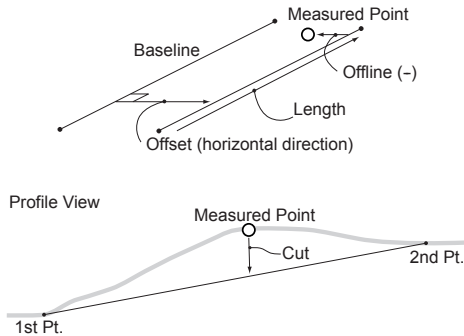
PROCEDURE

1. Select "Line" in <Set-out line>.

```
Set-out line
 Point
 Line
```
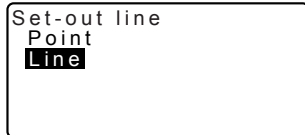
2. Enter the offset value.

   • Offset: How much to move the baseline.
     A positive value indicates right side and a negative value indicates left side.
   • When not setting offset value, go to step 3.

```
Set-out line

Offset   0.000 m

                    OBS
```

97
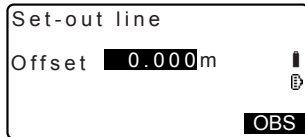
3. Sight the target and press **[OBS]** on the screen of step 2. The measurement results are displayed on the screen. Press **[STOP]** to stop the measurement.

   • The tilt screen is displayed if the instrument is out of level.

   Level the instrument.

   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

4. Press **[YES]** to use the measurement results. Displays the difference between the measured point and the baseline.

```
Set-out line
S       525.450m
ZA       80°30'15"
HAR     120°10'00"
Tgt.h           1.400m
              NO   YES
```

   • Offline: A positive value indicates the point is on the right of the baseline and a negative value indicates it is on the left.
   • "Cut" indicates that the point is below the baseline.
   • "Fill" indicates that the point is above the baseline.
   • Length: Distance along the baseline from the first point to the measured point.
   • Press **[NO]** to observe the target again.

5. Sight the next target and press **[OBS]** to continue the measurement.

```
Set-out line
Offline    -0.004m
Cut         0.006m
Length     12.917m
         REC       OBS
```

   • Press **[REC]**: records measurement results.
   ☞ Recording method: "24. RECORDING DATA - RECORD MENU -"

17. SETTING-OUT ARC

This mode allows the operator to define an arc from various arc parameters, such as From Pt. coordinates, and set out this arc as well as points (offsets) along it.
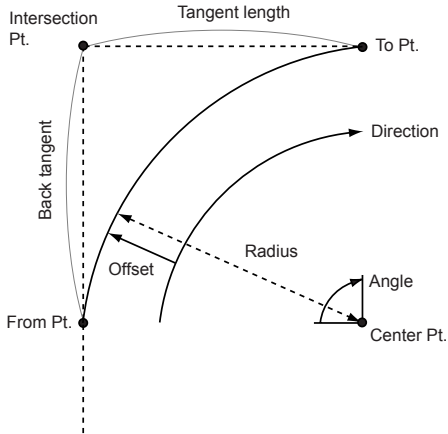
17.1 Defining an Arc

An arc can be defined by inputting arc parameters such as arc radius, angle, coordinates for the From point, Center point, To point etc. An arc can also be defined by observation of the From point, Center point, To point etc.

PROCEDURE Defining by inputting coordinates

1. In the second page of the Meas mode screen, press **[MENU]**, then select "Set-out arc".

```
REM                          ▲
Resection
Area calculation
Set-out line
Set-out arc
Point projection             ▼
```

2. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"
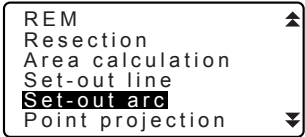
3. Select "Define arc" in <Set-out arc>.
   • When **[READ]** is pressed, registered coordinates can be recalled and used.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

```
Set-out arc
 Stn.Orientation
 Define arc
 Set-out arc
```

```
      From Pt.
Np :           0.000
Ep :           0.000  ▯
Zp :           0.000  ▯
READ   REC   OBS   OK
```

4. Enter the arc From point data and press **[OK]**.

5. Press **{▶}**/**{◀}** to select coordinates then press **[OK]**.

```
Select Pt.
 To



              OK
```

To   : Enter arc To point.
To/Center   : Enter arc To point and Center point.
To/Intersect : Enter arc To point and Intersect point (intersection of the tangents).
Center   : Enter arc Center point.
Intersect   : Enter arc Intersect point.
Center/Intersect: Enter arc Center point and Intersect point (intersection of the tangents).
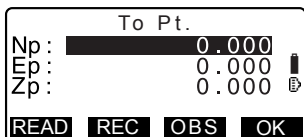
6. Enter the coordinates specified in step 5.

7. Press **[OK]** to proceed to arc parameter input.

```
      To Pt.
Np :           0.000
Ep :           0.000  ▯
Zp :           0.000  ▯
READ   REC   OBS   OK
```

• When entering multiple coordinates, **[NEXT]** is displayed instead of **[OK]**. Press **[NEXT]** to input data for the next point.

8. Enter other arc parameters.
   (1) Direction (whether the arc turns right/left from the From point)
   (2) Radius (radius of the arc)
   (3) Angle (subtended angle)
   (4) Arc (distance along the arc)
   (5) Chord (straight line distance between the From and To points)
   (6) Tan In (tangent length)
   (7) Bk tan (back tangent length)

```
Direction:Left
Radius:      <Null>
Angle :      <Null>
Arc   :      <Null>
Chord :  141.421m      ▼
                    OK
```

```
Tan In:    <Null>      ▲
Bk tan:        <Null>


                    OK
```

✍   Parameters that can be entered may be restricted depending on the coordinates specified in step 5.

☞ "📖 Specifying coordinates and curve parameters"

9. Enter curve parameters then press {◀━━}. Other parameters will be calculated.
   • **[TO]**: Calculated coordinates for To point can be recorded.
   [CENTER]: Calculated coordinates for Center point can be recorded.
   [INTSCT]: Calculated coordinates for Intersect point can be recorded.

```
Direction:Right
Radius:  100.000m
Angle : 90°00'00"
Arc   :  157.080m
Chord :  141.421m      ▼
INTSCT              OK
```

10. Press **[OK]** on the screen of step 9 to define the arc. <Set-out arc> is displayed. Move to setting-out arc measurement.

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CF "17.2 Setting-out Arc" step 2

Note

• It is also possible to perform setting-out arc measurement by pressing **[S-O ARC]** when allocated to the Meas mode screen.
CF Allocating **[S-O ARC]**: "30.3 Allocating Key Functions"

PROCEDURE Defining by observation

1. In the second page of Meas mode screen, press **[MENU]**, then select "Set-out arc".
2. Enter the instrument station data.
   CF "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

3. Select "Define arc" in <Set-out arc>.

4. Sight the From point and press **[OBS]**.

   • Press **[STOP]** to stop the measurement.

   • The tilt screen is displayed if the instrument is out of level.
     Level the instrument.
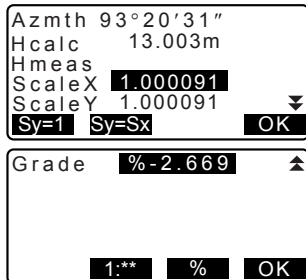   CF "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
         From Pt.
Np :            0.000
Ep :            0.000
Zp :            0.000
READ   REC   OBS    OK
```
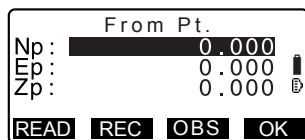
5. Press **[OK]** to use the measurement results of the From point.

   • Press **[OBS]** to observe the first point again.

   • Press **[HT]** to input instrument and target height.

```
Np :          113.464
Ep :           91.088
Zp :           12.122
ZA        90°00'00"
HAR     120°10'00"
 HT    REC   OBS    OK
```

6. Press **{▶}**/**{◀}** to select coordinates then press **[OK]**.

```
Select Pt.
    To


                    OK
```

7. Sight the To/Center/Intersect point and press **[OBS]**.

```
          To Pt.
Np :              0.000
Ep :              0.000
Zp :              0.000
READ   REC   OBS    OK
```

8. Press **[OK]** to use the measurement results of the To/ Center/Intersect point.

   • Press **[OBS]** to observe the second point again.

   • Press **[HT]** to input instrument and target height.

   • When entering multiple points, **[NEXT]** is displayed instead of **[OK]**. Press **[NEXT]** to observe the next point.

```
Np :          113.464
Ep :           91.088
Zp :           12.122
ZA        90°00'00"
HAR     120°10'00"
 HT    REC   OBS    OK
```

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9. Enter other arc parameters.
   (1) Direction (whether the arc turns right/left from the From point)
   (2) Radius (radius of the arc)
   (3) Angle (subtended angle)
   (4) Arc (distance along the arc)
   (5) Chord (straight line distance between the From and To points)
   (6) Tan In (tangent length)
   (7) Bk tan (back tangent length)

```
Direction:Left
Radius:       <Null>
Angle :       <Null>
Arc   :       <Null>
Chord :  141.421m    ▼
                    OK
```

```
Tan In:      <Null>    ▲
Bk tan:      <Null>



                    OK
```

   ✖ Parameters that can be entered may be restricted depending on the coordinates specified in step 5.

   ☞ "▯ Specifying coordinates and curve parameters"

10. Enter curve parameters then press {◄──┘}. Other parameters will be calculated.
    • **[TO]**: Observation data for To point can be recorded.

      [CENTER]: Observation data for Center point can be recorded.
      [INTSCT]: Observation data for Intersect point can be recorded.

```
Direction:Right
Radius :  100.000m
Angle  : 90°00'00"
Arc    :  157.080m
Chord  :  141.421m    ▼
INTSCT              OK
```

11. Press **[OK]** on the screen of step 10 to define the arc. <Set-out arc> is displayed. Move to setting-out arc measurement.
    ☞ "17.2 Setting-out Arc" step 2

Note
• It is also possible to perform setting-out arc measurement by pressing **[S-O ARC]** when allocated to the Meas mode screen.
  ☞ Allocating **[S-O ARC]**: "30.3 Allocating Key Functions"

📖 **Specifying points and curve parameters**

Parameters that can be entered may be restricted depending on the points specified in step 5/6. Parameters that can be entered are marked with a circle (○). Those that cannot are marked with a cross (×).

Parameters / Set coord	Radius	Angle	Arc	Chord	Tan In	Bk tan	Direction
To pt / Center pt	×	×	×	×	×	×	○
To pt / Intersect pt	×	×	×	×	×	×	○
Center pt / Intersect pt	×	×	×	×	×	×	○
To pt	○	○	○	×	○	○	○
Center pt	×	○	○	○	○	×	○
Intersect pt	○	○	×	○	×	×	○

📖 **Precaution when performing setting-out arc**

In the following cases parameters cannot be calculated:

when Radius< $\dfrac{\text{Chord}}{2}$

When Arc<Chord

When Tan In × 2<Chord

When the included angle between the back tangent and the azimuth angle between the From Pt. and To Pt is 0°, or exceeds 180°.

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17.2   Setting-out Arc

Setting-out arc measurement can be used to find the coordinates of required points along the arc by inputting the arc (or chord) length and offset based on the arc.

Offset

Chord   Arc
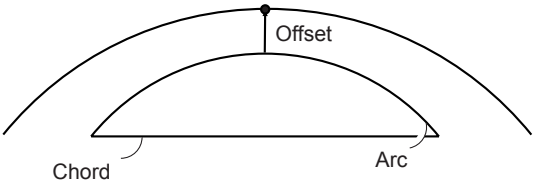
• Before performing setting-out arc, the arc must be defined.

PROCEDURE

1. Select "Set-out arc" in <Set-out arc>.

```
Set-out arc
 Stn.Orientation
 Define arc
 Set-out arc
```

2. Set the following items.
   (1) Incr: Increment by which values can be increased/ decreased using the arrow softkeys.
   (2) Arc: Distance along the defined arc from the From point to the required point.
   (2)' Chord: Distance along the chord of the defined arc from the From point to the required point.
   (3) Offset: Distance from the required point to the position on a curve parallel to the original defined arc. A positive value indicates an offset arc to the right, and a negative value indicates an arc to the left.

```
Set-out arc
Incr  :    1.000m
Arc   :   20.000m
Offset:    5.000m
                      P1
CHORD   ←     →    OK
```
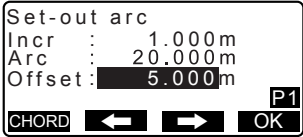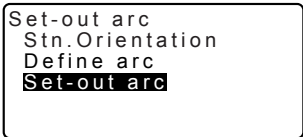
• Press **[CHORD]** to switch to Chord input.
• **[◀━]/[━▶]**: Press to decrease/ increase the value by the amount set in "Incr".

```
Set-out arc
Incr  :    1.000m
Chord :    0.000m
Offset:    0.000m
                    P1
 ARC    ◀━   ━▶    OK
```

3. Press **[OK]** on the screen of step 2. The coordinate value of the required point is calculated and displayed.

```
Set-out arc
N      118.874
E      106.894
Z       12.546
        REC        ▲S-O
```

• **[REC]**: records the coordinate value as a known point data.
  ☞ Recording method: "26.1 Registering/Deleting Known Point Data"
• Press **[▲ S-O]** to move to setting-out measurement of the required point.
  ☞ "15. SETTING-OUT MEASUREMENT"

4. Press **{ESC}**. Continue the measurement (repeat steps from 2).

PROCEDURE Offsetting the arcline

The arcline can be offset in three dimensions using four methods: lateral offset, rotation angle offset, lengthwise offset, and height offset.

Lateral offset

Rotation angle offset

Lengthwise offset

Height offset
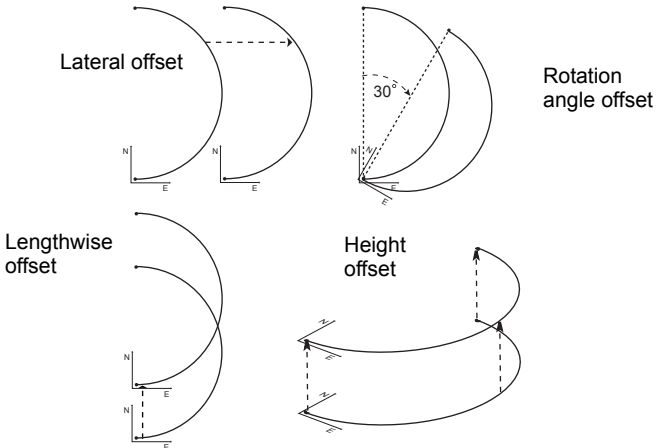
1. Select "Set-out arc" in <Set-out arc>.

2. Press **{FUNC}**, and then press **[OFFSET]** to display <Arcline offset>.

```
Set-out arc
Incr   :    1.000m
Arc    :   20.000m
Offset:    5.000m
                    P2
                OFFSET
```

3. Set the following items.
   (1) Incr: Increment by which offsets can be increased/ decreased using the arrow softkeys.
   (2) Length: Lengthwise offset
   (3) Lateral: Lateral offset
   (4) Height: Elevation offset
   (5) Rt.ang: Rotation angle offset
   • **[←]/[→]**: Press to decrease/ increase the value by the amount set in "Incr".

```
Arcline offset
Incr          1.000m
Length        0.000m
Lateral       0.000m
Height        0.000m  ▼
MOVE   ←    →     OK
```

```
Rt.ang        0.0000  ▲

MOVE              OK
```

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4. Press **[OK]** to return to the screen in step 2.
   • **[MOVE]**: Permanently moves the baseline coordinates by the amount set in <Arcline offset>.

5. Press **[OK]** on the screen of step 2. The coordinate value of the required point is calculated, taking into account the movement of the arcline, and displayed.

```
Set-out arc
N        118.874
E        106.894
Z         12.546
         REC        S-O
```

18. POINT PROJECTION

Point projection is used for projecting a point onto the baseline. The point to project can be either measured or input. Displays the distances from the first point and point to project to the position at which a line extending from point to project intersects the baseline at right angles.
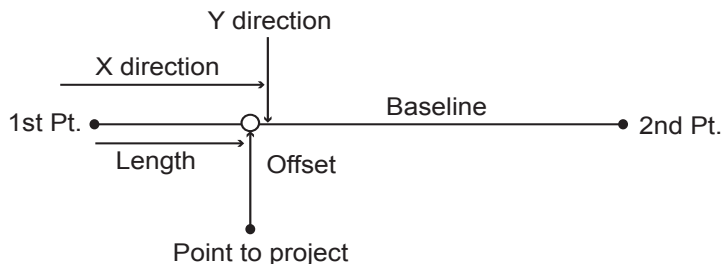
18.1 Defining Baseline

• Defined baseline can be used in both setting-out line measurement and point projection.

PROCEDURE

1. In the second page of Meas mode screen, press **[MENU]**, then select "Point Projection".

```
REM                        ▲
 Resection
 Area calculation
 Set-out line
 Set-out arc
 Point projection          ▼
```

2. Enter the instrument station data then define the baseline.
   ☞ "16.1 Defining Baseline" step 2 to 13

3. Press **[OK]** to define the baseline. <Point projection> is displayed. Move to point projection measurement.
   ☞ "18.2 Point Projection"

```
Point projection
Np:      103.514
Ep:      101.423        ▐
Zp:       12.152        ▬
READ    REC    OBS    OK
```

Note
• It is also possible to perform setting-out line measurement by pressing
  [P-PROJ] when allocated to the Meas mode screen.
    ☞ Allocating the function key: "30.3 Allocating Key Functions"

18.2   Point Projection

Before performing point projection, the baseline must be defined.

PROCEDURE

1. Define the baseline.
   ☞ "18.1 Defining Baseline"

2. Select "Point Projection" in <Point
   Projection>.

```
Point projection
  Stn. Orientation
  Define baseline
  Point projection


```
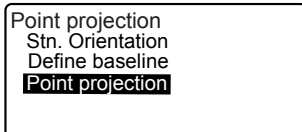
3. Enter the point coordinate.

   • Press **[OBS]** to observe the
     point to project.
   • The tilt screen is displayed if the
     instrument is out of level.
     Level the instrument.
   ☞ "7. SETTING UP THE
       INSTRUMENT PROCEDURE
       Levelling on the screen"
   • Press **[REC]** to record the data
     as a known point.
   ☞ Recording method:
       "26.1 Registering/Deleting
       Known Point Data"

```
Point projection
Np:    103.514
Ep:    101.423
Zp:     12.152
                    P1
READ  OBS        OK
```
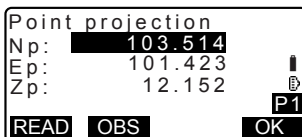
4. Press **[OK]** on the screen of step 3.
   The following items are calculated and displayed.

   • Length: Distance along the baseline from the first point to the projected point (X direction).

   • Offset: Distance from point to project to the position at which a line extending from point of project intersects the baseline at right angles. (Y direction).

   • d.Elev: Elevation between the baseline and the projected point.

   • Press **[XYZ]** to switch the screen display to coordinate values.

   • Press **[OFFSET]** to switch the screen display to distance values.

   • Press **[REC]**: records the coordinate value as a known point data.

   ☞ Recording method: "26.1 Registering/Deleting Known Point Data"

   • Press **[▲ S-O]** to move to setting-out measurement of the projected point.

   ☞ "15. SETTING-OUT MEASUREMENT"

5. Press **{ESC}**. Continue the measurement (repeat steps from 3).

```
Point projection
Length      10.879m
Offset       9.340m
d.Elev       0.321m
 XYZ   REC          ▲S-O
```

19. INTERSECTIONS

It is possible to find an intersection point between 2 reference points by specifying the length or azimuth angle of either point.
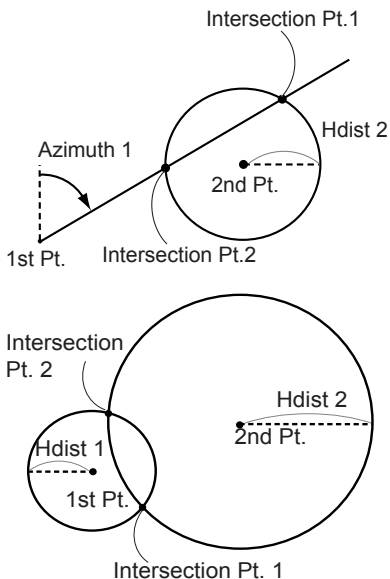
PROCEDURE

1. In the second page of the Meas mode screen, press **[MENU]**, then select "Intersections".

2. Enter the 1st point data and press **[NEXT]**.
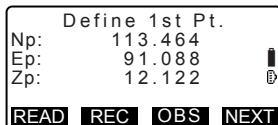
• When **[READ]** is pressed, registered coordinates can be recalled and used.

☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

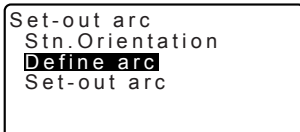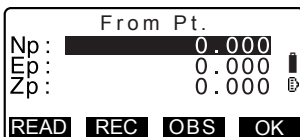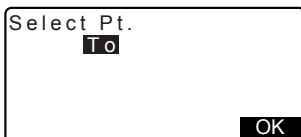• **[REC]**: records the coordinate value as a known point data.

```
                  rec 3991
N           113.464
E            91.088
Z            12.122
Pt. 5
```

• Press **[OBS]** to observe the selected point.
• The tilt screen is displayed if the instrument is out of level.
  Level the instrument.
☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

3. Enter the 2nd point data and press **[OK]**.

   • Press **[OBS]** to observe the selected point.

```
     Define 2nd Pt.
Np:     112.706
Ep:     104.069
Zp:      11.775
READ  REC  OBS   OK
```

4. Enter azimuth angle (or horizontal distance) of the 1st point and 2nd point.

❤:
Both the azimuth angle and horizontal distance of the 1st (or 2nd) point cannot be input.

```
Azmth1:  45°00'00"
H.dist1:   <Null>
Azmth2:
H.dist2:   50.000m

COORD           OK
```

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- When the cursor is on "Azmth1" or "Azmth2", **[COORD]** is displayed. Press **[COORD]** to set the azimuth angle for each point by inputting coordinates.

```
         1st Pt.
Np:         0.000
Ep:         0.000
Zp:       <Null>
READ  REC   OBS  NEXT
```
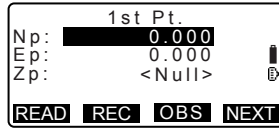
- Press **[OBS]** to observe the selected point.

5. Press **[OK]**. The coordinate value of the intersection point is calculated and displayed.

```
Azmth1:  45°00'00"
H.dist1:   <Null>
Azmth2:   <Null>
H.dist2:  50.000m
                    OK
```

```
Intersection1
N       176.458
E       176.458
Z        <Null>
OTHER  REC       ▲S-O
```
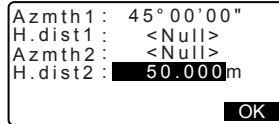
- When there are 2 intersections, **[OTHER]** is displayed.
  ☞ "🗐 2 Intersections"

- Press **[▲ S-O]** to move to setting-out measurement of the required point.
  ☞ "15. SETTING-OUT MEASUREMENT"
6. Press **{ESC}**. Continue the measurement (repeat steps from 2).
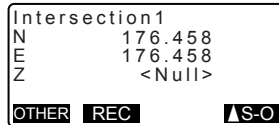
Note

- It is also possible to perform intersection measurement by pressing **[INTSCT]** when allocated to the Meas mode screen.
  ☞ Allocating **[INTSCT]**: "30.3 Allocating Key Functions"

🗐 **2 Intersections**
  2 intersections are defined according to 1st Pt. and 2nd Pt. as shown below Intersections created from Azmth 1 and H.dist 2 (or H.dist 1 and Azmth 2):

An azimuth angle has already been set for a point. The furthest point from this point is set as Intersection Pt. 1, and the closest point set as Intersection Pt. 2.

• Intersections created from H.dist 1 and H.dist 2:
Intersection to the right of the straight line between 1st point and 2nd point set as Intersection Pt. 1 and the point to the left set as Intersection Pt. 2.

Precaution when performing intersection measurement
In the following cases the coordinates of intersection points cannot be calculated.

When Azimuth 1 = Azimuth 2.
When Azimuth 1 – Azimuth 2 = ±180°.
When H.dist 1 = 0, or H.dist 2 = 0.
When the coordinates for 1st Pt. and 2nd Pt are the same.

20. TRAVERSE ADJUSTMENT

Measurement of a traverse begins with observation of the backsight station and foresight station. The instrument station is then moved to the foresight station and the previous instrument station becomes the backsight station. Observation is performed again at the new position. This process is repeated for the length of the route.

This adjustment function is used to calculate the coordinates of such a sequence of consecutively-observed points (traverse points and points observed from traverse points (see P3-1 to P3-3 below)). When calculation is complete, the SET displays the precision of the traverse and, when necessary, traverse adjustment can be performed.

☞ For types of traverse that can be calculated with the SET, see "⬚ Types of traverse"
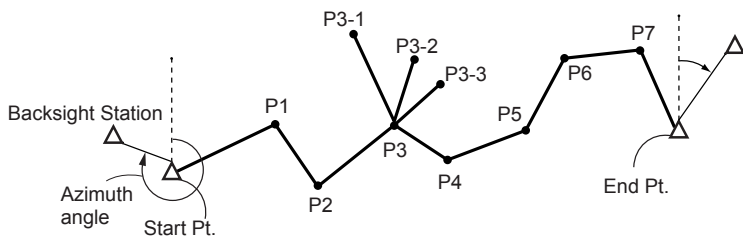
PROCEDURE

1. Before starting traverse calculation, observe the sequence of traverse points and record the results.
   ☞ "24.4 Recording Distance Measurement Data"/
      "24.6 Recording Distance and Coordinate Data"

2. In the second page of the Meas mode screen, press **[MENU]**, then select "Traverse".

```
Intersections        ▲
Traverse
```

3. Enter the start point name and press {◄──}.

```
Traverse start pt.

Stn:
Bs :
Azmth:     <Null>
 LIST                OK
```

• When **[LIST]** is pressed, a list of instrument stations saved in the current JOB is displayed. A point from this list can be recalled and used.

```
Stn   T-0001
Stn   T-0002
Stn   T-0003
Stn   T-0004
Stn   T-0005        ▼
 ↑↓...P  TOP  LAST SRCH
```

☞ For using softkeys in this screen, see "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

• Enter values manually when there are no coordinates saved for the specified instrument station.
   Press **[OK]** to proceed to step 4.

```
Stn:
   N          0.000
   E          0.000
   Z          <Null>
   Pt. T-0001
READ  REC         OK
```

4. Enter the point name of the backsight station for the start point and press {◄──}.

```
Traverse start pt.

Stn:T-0001
Bs : BS
Azmth:     <Null>
 LIST                OK
```

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When there are saved coordinates
for the backsight station, the
calculated azimuth angle is
displayed.

```
Traverse start pt.

Stn:T-0001
Bs :T-000Z
Azmth:   357°27'46"
                   OK
```
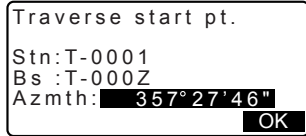
• Enter values manually when
  there are no coordinates saved
  for the specified start point
  backsight station.
  Press **[OK]** to display the
  calculated azimuth angle.

• To enter azimuth angle without
  entering backsight station
  coordinates, press **{▼}** to move
  the cursor down to "Azmth" then
  enter an angle value.

5. When **[OK]** is pressed in the
   screen in step 4, the SET will
   search for a traverse route. The
   points from step 1 will be
   displayed in the order in which
   they were observed.

```
001:T-0001

      Searching
```
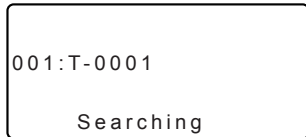
• This search can be stopped by
  pressing **{ESC}**. If **{ESC}** is
  pressed, a route can be
  computed using only the points
  found prior to the search being
  stopped.

```
Exit Searching

confirm?

          NO    YES
```
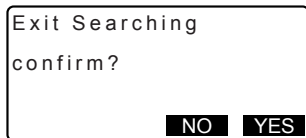
• When a traverse point with
  recorded known point
  coordinates is found, or there
  are multiple foresight stations for
  a point, the automatic route
  search will stop. Press **[LIST]**
  and select which foresight
  station to use as the next point.
  ☞ "🔟 Automatic route search"

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6. Press **[OK]** to confirm the traverse route.

```
006:T-0006              ⬒
007:T-0007
008:T-0001
009:▐
 LIST                   OK
```

7. Enter the point name of the backsight station for the end point and press **{◄▬}**.
   The calculated azimuth angle is displayed.

```
Traverse end pt.

Stn:T-0001
Fs :T-0002
Azmth:   335°27'46"
 LIST                   OK
```

Enter the azimuth angle when there are no recorded coordinates for the end point backsight station.

8. When **[OK]** is pressed in the screen in step 7, the SET will display the precision of the traverse.

```
Traverse precision

 d.Ang :   0°00'20"
 d.Dist :     0.013
 Precision:   42714   ⬇
OPTION              ADJUST
```

```
Traverse precision      ⬒

 d.North:     0.013
 d.East :     0.000
 d.Elev :    -0.002
OPTION              ADJUST
```

d.Ang:	Angular closure error
d.Dist:	Horizontal closure distance
Precision:	Precision of the traverse as a ratio of the total horizontal distance traversed to the closure distance
d.North:	Closure distance in Northing coordinates
d.East:	Closure distance in Easting coordinates
d.Elev:	Closure distance in elevation

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• Press **[OPTION]** to change the method by which the traverse adjustments are distributed.

```
Adjustment options

Method  :Compass
Angular :Weighted
Elev    :Weighted
```

(*:Factory setting)

   (1) Method (coordinate adjustment):

   Compass*, Transit

   (2) Angular:

   Weighted*, Linear, None

   (3) Elev (Elevation):

   Weighted*, Linear, None

   ☞ For all options, see "📖 Adjustment methods"

9. Angular adjustment will be performed first. Press **[ADJUST]** to start adjustment using the method selected in "(2) Angular" in step 8.

   • When "None" is selected in "(2) Angular" in step 8, only coordinate and elevation adjustment will be performed.

```
After angle adjust

d.Ang     :  0°00'00"
d.Dist    :     0.006
precision :     89788  ▼
OPTION              ADJUST
```

10. After confirming the results, press **[ADJUST]** again to start coordinate and elevation adjustment using the methods selected in "(1) Method" and "(3) Elev" respectively. All adjusted instrument data will be in saved in the currently selected JOB and traverse adjustment will be finished.

```
Traverse adjustment

Recording...      7
```

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Note

• It is also possible to perform traverse adjustment by pressing **[TRAVER]** when allocated to the Meas mode screen.

    ☞ Allocating **[TRAVER]**: "30.3 Allocating Key Functions"

• Traverse adjustment results of traverse points, points observed from traverse points and traverse adjustment data will be saved in the currently selected JOB as Notes data. Data including the distributed closure error will also be saved in the currently selected JOB as ordinary coordinate data.

Traverse line record (3):	1. point names of start and end points
	2. backsight station name and azimuth to said backsight station
	3. foresight station name and azimuth to said foresight
Adjustment setting record (1):	The selected method for distributing closure error.
Closure error record (2x2):	1. precision and closure error for angle/distance
	2. coordinate closure error

Coordinate adjustment record
(No. of included points between start and end points):

                        Coordinates

Types of traverse
SET can calculate closed-loop and closed traverses. In both cases, the azimuth for the start point (and for the end point in the case of a closed traverse) must be set.

closed-loop traverse
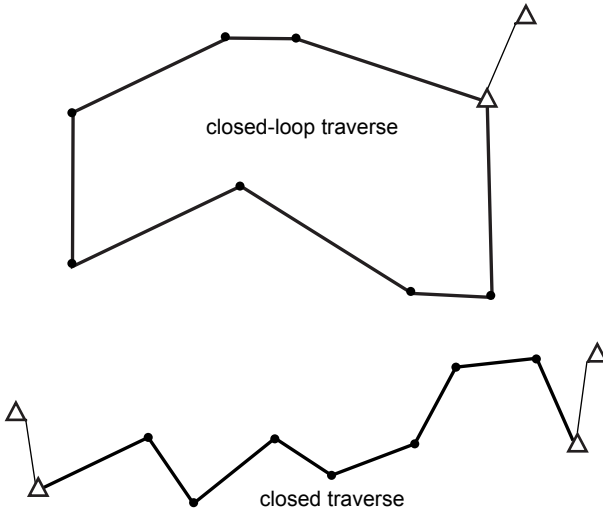
closed traverse

Automatic route search
This function searches for consecutively-observed traverse points already stored on the SET and presents them as potential traverse routes.

This function is activated when the following conditions are met. When a point has been observed more than once, the most recent data will be used for the search.

• At least one backsight station and one foresight station are observed from an instrument station.
• The foresight station becomes the instrument station for the subsequent measurement.
• The instrument station becomes the backsight station for the subsequent measurement.

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If one of the following conditions is met, the automatic route search will terminate. The same search can be resumed by specifying the name of the next point in the route.

• There is more than one potential foresight station for an instrument station. (Route search terminates as a juncture appears in the route.)
• The foresight station for the previous measurement was the Start pt. (Route search terminates as this measurement is judged to have closed a closed-loop traverse.)
• The most recently measured point has the same point name as a recorded known point. (Route search terminates as this point is judged to be the End pt.)

The automatic route search function cannot be used in the following case.
• The final measurement is to a traverse point on the traverse route other than the Start pt.

Adjustment methods
Adjustment is applied to results for traverse points and points observed from traverse points.
Adjustment methods and distribution options selected in step 8 are described below.

Method
Compass: The Compass method distributes the coordinate error in proportion to the length of the traverse lines.

Northing adjustment = $\dfrac{L}{TL} \times$ closure north

Easting adjustment = $\dfrac{L}{TL} \times$ closure east

Where: L =length of the traverse line to the point
TL = sum of the traverse line lengths

Transit: The Transit method distributes the coordinate error in proportion to the northing and easting ordinates of each traverse line.

Northing adjustment =$\dfrac{|\Delta N|}{\Sigma |\Delta N|} \times$ closure north

Easting adjustment = $\dfrac{|\Delta E|}{\Sigma |\Delta E|} \times$ closure east

Where: ΔN =   change in northing for the traverse line
ΔE =   change in easting for the traverse line
            $\Sigma|\Delta N|$ = sum of the absolute value of all the
            changes in northings of all the traverse lines
$\Sigma|\Delta E|$ =   sum of the absolute value of all the changes in
            eastings of all the traverse lines

Angular adjustment

Weighted: Any angular closure is distributed among the angles of the traverse route based on the sum of the inverses of the forward and back traverse line lengths at each angle. The backsight and foresight lines are considered to have infinite lengths for the purposes of this weighting computation.

$$\angle\text{adjustment} = \frac{\left(\dfrac{1}{\text{todist}} + \dfrac{1}{\text{fromdist}}\right)}{\Sigma\left(\dfrac{1}{\text{todist}} + \dfrac{1}{\text{fromdist}}\right)} \times \angle\text{closure}$$

Linear: Any angular closure is distributed evenly among the angles of the traverse route.

None: No angular adjustment performed.

Elev adjustment

Weighted: Any closure in the elevations is distributed in proportion to the length of the traverse line leading to the point (like the Compass method for coordinate adjustment).

Linear: Any closure in the elevations is distributed evenly in each leg of the traverse route.

None: No elevation adjustment performed.

21. OFFSET MEASUREMENT

Offset measurements are performed in order to find a point where a target cannot be installed directly or to find the distance and angle to a point which cannot be sighted.

• It is possible to find the distance and angle to a point you wish to measure (target point) by installing the target at a location (offset point) a little distance from the target point and measuring the distance and angle from the survey point to the offset point.

• The target point can be found in the three ways explained below.

21.1   Single-distance Offset Measurement

Finding it by entering the horizontal distance from the target point to the offset point.
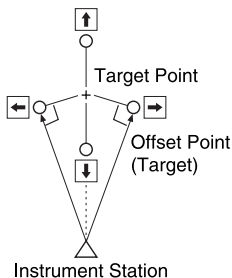
• When the offset point is positioned to the left or right of the target point, make sure the angle formed by lines connecting the offset point to the target point and to the instrument station is almost 90°.

• When the offset point is positioned in front of or behind the target point, install the offset point on a line linking the instrument station with the target point.

PROCEDURE

1. Set the offset point close to the target point and measure the distance between them, then set up a prism on the offset point.

2. Sight the offset point and press
   [DIST] in the first page of the
   Meas mode screen to begin
   measurement.
   The measurement results are
   displayed. Press **[STOP]** to stop
   the measurement.

3. Press **[OFFSET]** in page three of
   Meas mode to display <Offset>.

4. Enter the instrument station data.
   ☞ "13.1 Entering Instrument
      Station Data and Azimuth
      Angle PROCEDURE Reading
      in Registered Coordinate
      Data".

5. Select "Offset/Dist".

   • The tilt screen is displayed if the
     instrument is out of level.
     Level the instrument.
   ☞ "7. SETTING UP THE
      INSTRUMENT PROCEDURE
      Levelling on the screen"

```
Offset
  Stn. Orientation
  Offset/Dist
  Offset/Angle
  Offset/2D
```
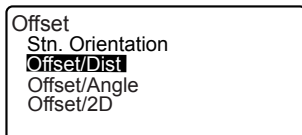
6. Input the following items.
   (1) Horizontal distance from the
       target point to the offset point.
   (2) Direction of the offset point.
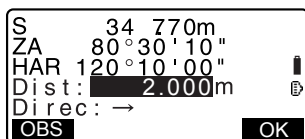
   • Direction of offset point

     ← : On the left of the target point.

     → : On the right of the target
         point.

     ↓ : Closer than the target point.

     ↑ : Beyond the target point.

   • Press **[OBS]** to re-observe the
     offset point.

```
S        34 770m
ZA   80°30'10"
HAR 120°10'00"
Dist:        2.000m
Direc: →
 OBS              OK
```

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7. Press **[OK]** on the screen of step 5 to calculate and display the distance and angle of the target point.

```
Offset/Dist
S            34.980m
ZA       85°50'30"
HAR     125°30'20"
 REC   XYZ   NO   YES
```

8. Press **[YES]** to return to <Offset>.

   • Press **[XYZ]** to switch the screen display from distance values to coordinate values. Press **[HVD]** to return to distance values.
   • Press **[NO]** to return to the previous distance and angle.
   • To record the calculation result, press **[REC]**.
   ☞ "24. RECORDING DATA - RECORD MENU -"

21.2   Angle Offset Measurement

Sighting the direction of the target point to find it from the included angle.
Install offset points for the target point on the right and left sides of and as close as possible to the target point and measure the distance to the offset points and the horizontal angle of the target point.

Target Point

Offset Point (Target)   Offset Point (Target)

Instrument Station
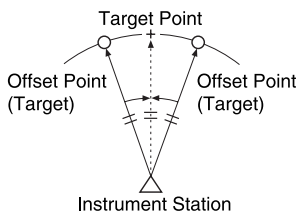
PROCEDURE

1. Set the offset points close to the target point (making sure the distance from the instrument station to the target point and the height of the offset points and the target point are the same), then use the offset points as the target.

2. Sight the offset point and press **[DIST]** in the first page of the Meas mode screen to begin measurement.
   The measurement results are displayed. Press **[STOP]** to stop the measurement.

3. Press **[OFFSET]** in page three of Meas mode to display <Offset>.

4. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

5. Select "Offset/Angle" in <Offset>.

   • The tilt screen is displayed if the instrument is out of level. Level the instrument.
   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
Offset
  Stn. Orientation
  Offset/Dist
  Offset/Angle
  Offset/2D
```

6. Accurately sight the direction of the target point and press **[OK]**. The distance and angle of the target point are displayed.

```
S        34.770m
ZA    80°30'10"
HAR  120°10'00"

     2nd obs.OK?
 OBS              OK
```

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7. After finishing measurement,
    press **[YES]** to return to <Offset>.

```
Offset/Angle
S            34.980m
ZA      85°50'30"
HAR   125°30'20"

 REC    XYZ    NO    YES
```

21.3   Two-distance Offset Measurement

By measuring the distances between the target point and the two offset points.
Install two offset points (1st target and 2nd target) on a straight line from the target
point, observe the 1st target and 2nd target, then enter the distance between the
2nd target and the target point to find the target point.

• It is possible to make this measurement easily using the optional equipment:
  the 2-point target (2RT500-K). When using this 2-point target, be sure to set
  prism constant to 0.
  ℂ⨍ "30.1 EDM Settings"

Target Point
Offset Point (Target)
Offset Point
(Target)
Instrument Station
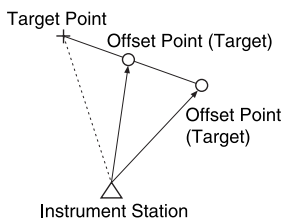
How to use 2-point target (2RT500-K)

Offset Points

2nd   1st
Target Target
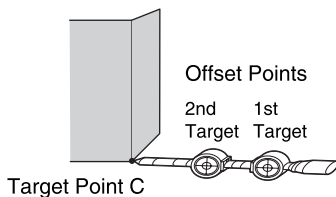
Target Point C

• Install the 2-point target with its tip at the target point.
• Face the targets toward the instrument.
• Measure the distance from the target point to the 2nd target.
• Set the reflector type to "sheet".

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PROCEDURE

1. Install two offset points (1st target, 2nd target) on a straight line from the target point and use the offset points as the target.

2. Press **[OFFSET]** in page three of Meas mode to display <Offset>.

3. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

4. Select "Offset/2D" in <Offset>.

   • The tilt screen is displayed if the instrument is out of level. Level the instrument.
   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
Offset
  Stn. Orientation
  Offset/Dist
  Offset/Angle
  Offset/2D
```

5. Sight the 1st target and press **[OBS]**.
   Observation begins and the measurement results are displayed.
   Press **[YES]**. The "2nd Target Observation Screen" is displayed.

```
Observe  1st  o/s

ZA      73°18'00"
HAR   250°12'00"
                OBS
```

6. Sight the 2nd target and press **[OBS]**.
   The measurement results are displayed. Press **[YES]**.

```
N          10.480
E          20.693
Z          15.277
 Confirm?
            NO   YES
```

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7. Enter the distance from the 2nd target to the target point and press **{◄━━}**. The coordinates of the target point are displayed.

```
B-C:      1.2000m



```

```
Offset/2D
N            10.480
E            20.693
Z            15.277
 REC    HVD    NO    YES
```

8. Press **[YES]**. <Offset> is restored.

   • When **[HVD]** is pressed, display mode is switched from coordinates to S, ZA, HAR.

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22. MISSING LINE MEASUREMENT

Missing line measurement is used to measure the slope distance, horizontal distance, and horizontal angle to a target from the target which is the reference (starting point) without moving the instrument.

• It is possible to change the last measured point to the next starting position.
• Measurement result can be displayed as the gradient between two points.

Starting Position (P1)

Target (P2)

Target (P3)

Instrument Station
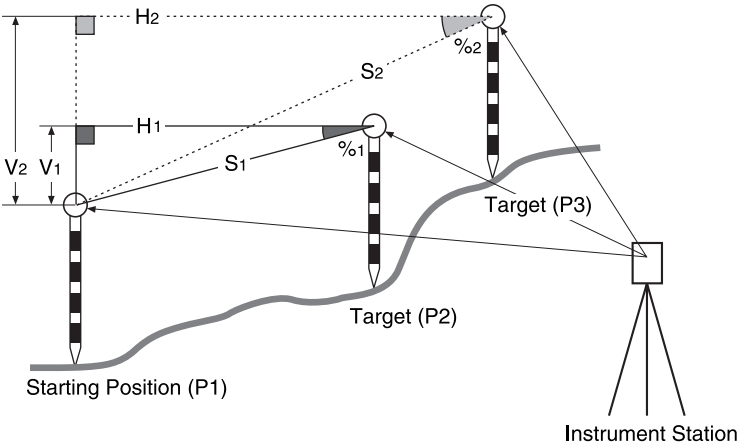
22.1 Measuring the Distance between 2 or more Points

The distance between two or more points can either be measured by observing the targets in question or calculating from input coordinates. A combination of these two methods (e.g. observing the 1st target and inputting 2nd target coordinates) is also possible.

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PROCEDURE Measuring using observation

1. In the third page of Meas mode screen, press **[MLM]**, then select "MLM".

```
MLM
 Stn.Orientation
 MLM
```
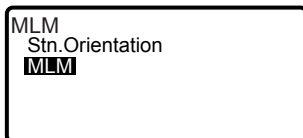
2. Sight the 1st target and press **[OBS]**.

   • The tilt screen is displayed if the instrument is out of level.
   Level the instrument.
   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
MLM
       Set Pt.1
S
ZA     80°42'15"
HAR   140°42'15"            P1
 MLM   MOVE            OBS
```
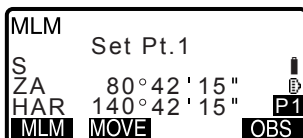
3. Sight the second target and press **[MLM]** to begin observation.

   • **[REC]**: records 1st target measurement results.

   The following values are displayed:
   S : Slope distance of the starting position and 2nd target.
   H : Horizontal distance of the starting position and 2nd position.
   V : Height difference of the starting position and 2nd target.
   • Target height of the starting position and 2nd target can be input.
   Press **[TARGET]** on the second page.

   Input the target heights and press **[OK]**.

```
MLM
     Set Pt.2
S           0.123m
ZA     80°42'15"
HAR   140°42'15"            P1
 MLM   MOVE  REC   OBS
```

```
MLM
S       20.757m
H       27.345m
V        1.012m
                           P1
 MLM   MOVE  REC   OBS
```

```
MLM
S       20.757m
H       27.345m
V        1.012m
                           P2
     COORD  S/%  TARGET
```

```
Target height
Pt.1            1.500m
Pt.2            1.500m
                       OK
```
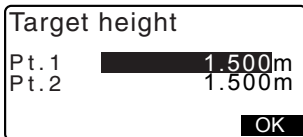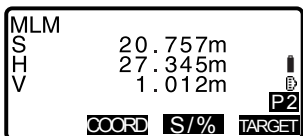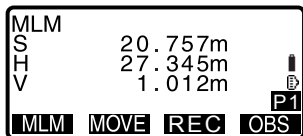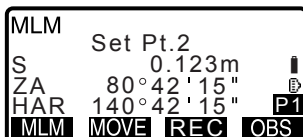
- Press **[COORD]** to input coordinates.
  ☞ "PROCEDURE Calculating from input coordinates"

- Press **[REC]** to record 2nd target measurement results and display the screen at right.

```
N          10.000
E          20.000
Z          30.000
Cd  1010
Tgt.h        1.500m  ▼
 OK   ADD  LIST SRCH
```

Press **[OK]** to record missing line measurement results and return to the results screen.

Press **{ESC}** to continue measurement without saving 2nd target or missing line measurement results.

```
H          27.345m
V           1.012m
Cd  1010
Pt.1             2
Pt.2             3
 OK   ADD  LIST SRCH
```

```
MLM
S       20.757m
H       27.345m    █
V        1.012m    ▯
                 P1
 MLM   MOVE      OBS
```

✍

- Missing line measurement results cannot be recorded when point names for 1st and/or 2nd target are null. Always input point names for both targets.

4. Sight the next target and press **[MLM]** to begin observation. Slope distance, horizontal distance and height difference between multiple points and the starting position can be measured this way.

   • When **[S/%]** is pressed, the distance between two points (S) is displayed as the gradient between two points.
   • Press **[OBS]** to re-observe the starting position. Sight the starting position and press **[OBS]**.
   • When **[MOVE]** is pressed, the last target measured becomes the new starting position to perform missing line measurement of the next target.
   ⌁ "22.2 Changing the Starting Point"

5. Press **{ESC}** to end missing line measurement.

PROCEDURE Calculating from input coordinates

1. In the third page of Meas mode screen, press **[MLM]**, then select "MLM".

```
MLM
  Stn.Orientation
  MLM
```
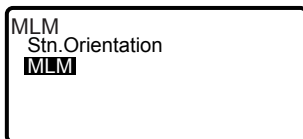
2. Press **[COORD]** on the second page.

```
MLM
        Set Pt.1
S
ZA    80°42'15"
HAR  140°42'15"         P2
      COORD  S/%  TARGET
```

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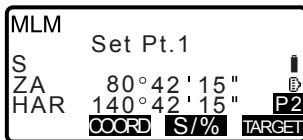
3. Input coordinates for the 1st target and press **[OK]**.
   - When you wish to read in and set coordinate data from memory, press **[READ]**.
     ☞ "13.1 Entering Instrument Station Data and Azimuth Angle"

```
        Pt.1
N            20.000
E            30.000
Z            40.000
READ  REC           OK
```

4. Select "Pt.2" and press **{◄◄}** to proceed to 2nd target input.

```
MLM
  Pt.1
  Pt.2
```

5. Input coordinates for the 2nd target and press **[OK]**.
   The following values are displayed:
   - S : Slope distance of the starting position and 2nd target.
   - H : Horizontal distance of the starting position and 2nd position.
   - V : Height difference of the starting position and 2nd target.
   - Target height of the starting position and 2nd target can be input.
     Press **[TARGET]** on the second page.

     Input the target heights and press **[OK]**.

```
MLM
S       20.757m
H       27.345m
V        1.012m
                    P1
 MLM  MOVE  REC  OBS
```

```
Target height
Pt.1         1.500m
Pt.2         1.500m
                  OK
```

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- Press **[COORD]** to re-input coordinates for the first or 2nd targets.

- **[REC]**: records missing line measurement results.

- When **[S/%]** is pressed, the distance between two points (S) is displayed as the gradient between two points.

- Press **[OBS]** to observe the starting position.
  ☞ "PROCEDURE Measuring using observation"

- When **[MOVE]** is pressed, the last target measured becomes the new starting position to perform missing line measurement of the next target.
  ☞ "22.2 Changing the Starting Point"

Press **{ESC}** to end missing line measurement

✍

Missing line measurement results cannot be recorded when point names for 1st and/or 2nd target are null. Always input point names for both targets.

22.2 Changing the Starting Point

It is possible to change the last measured point to the next starting position.
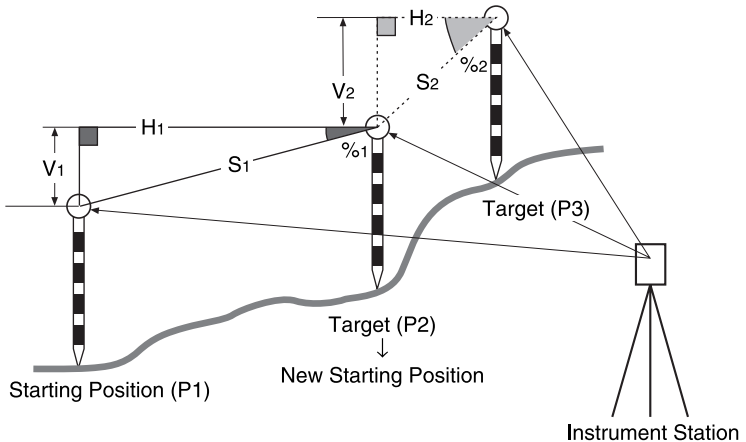
PROCEDURE

1. Observe the starting position and target.
   ☞ "22.1 Measuring the Distance between 2 or more Points"

2. After measuring the targets, press **[MOVE]**.
   Press **[YES]**.

   • Press **[NO]** to cancel measurement.

```
MLM
S        20.757m
H        27.345m
V         1.012m
 MLM  MOVE  REC  OBS
```

```
MLM
      Move 1st obs ?
S        34.980m
ZA     85°50'30"
HAR   125°30'20"
            NO  YES
```

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3. The last target measured is
    changed to the new starting
    position.
    Perform missing line
    measurement.
    ☞ "22.1 Measuring the
        Distance between 2 or more
        Points".

23. SURFACE AREA CALCULATION

You can calculate the area of land (slope area and horizontal area) enclosed by three or more known points on a line by inputting the coordinates of the points.

Input

Coordinates : P1 (N1, E1, Z1)
      ...
      P5 (N5, E5, Z5)

Output

Surface area: S (slope area and horizontal area)
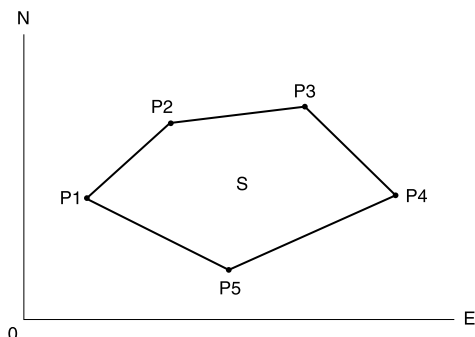
- Number of specified coordinate points: 3 or more, 50 or less
- Surface area is calculated by observing the points on a line enclosing an area in order or reading in the previously registered coordinates in order.

🚫

- If two or less points are used to measure an area, an error will occur.
- Be sure to observe (or recall) points on an enclosed area in a clockwise or counterclockwise direction. For example, the area specified by entering (or recalling) point numbers 1, 2, 3, 4, 5 or 5, 4, 3, 2, 1 implies the same shape. However, if points are not entered in numerical order, the surface area will not be calculated correctly.

📖 **Slope area**

> The first three points specified (measured/read-in) are used to create the surface of the slope area. Subsequent points are projected vertically onto this surface and the slope area calculated.

PROCEDURE Surface area calculation by observing points

1. In the second Meas mode screen, press **[MENU]**, then select "Area calculation".
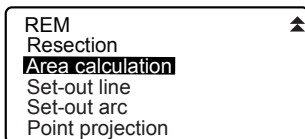
```
REM                    ▲
Resection
Area calculation
Set-out line
Set-out arc
Point projection
```

2. Enter the instrument station data.
   ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

3. Select "Area calculation" in <Area calculation>.

```
Area calculation
  Stn. Orientation
  Area calculation
```

4. Sight the first point on the line enclosing the area, and press **[MEAS]**.

   • The tilt screen is displayed if the instrument is out of level. Level the instrument.
   ☞ "7. SETTING UP THE INSTRUMENT PROCEDURE Levelling on the screen"

```
01 :
02 :
03 :
04 :
05 :
READ              MEAS
```

5. Press **[OBS]** to begin observation. The measured values are displayed.

```
N          12.345
E         137.186
Z           1.234
ZA      90°01'25"
HAR    109°32'00"
  OK    REC         OBS
```
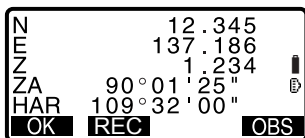
6. Press **[OK]** to enter the value of
   the first point in "01".
   • Press **[REC]** in the second
     screen of step 4 to record code,
     target height, and point number.
     The point number recorded here
     will be displayed in "01".

```
01:Pt_01
02:
03:
04:
05:
              MEAS
```

7. Repeat steps 4 to 5 until all points
   have been measured. Points on
   an enclosed area are observed in
   a clockwise or counterclockwise
   direction.
   For example, the area specified by
   entering point numbers 1, 2, 3, 4, 5
   or 5, 4, 3, 2, 1 implies the same
   shape.
   After all known points necessary to
   calculate the surface area have
   been observed, **[CALC]** is
   displayed.
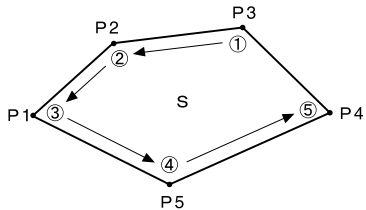
8. Press **[CALC]** to display the
   calculated area.
   Pt.:   number of set points
   SArea: slope area
   HArea: horizontal area

```
01:Pt_01
02:Pt_02
03:Pt_03
04:Pt_04
05:
      CALC      MEAS
```

```
Pt.5
SArea      468.064m²
            0.0468ha
HArea      431.055m²
            0.0431ha
      REC          OK
```

9. Press **[REC]** in the screen of step
   7 to record results and return to
   <Menu>.
   Press **[OK]** to return to <Menu>
   without recording results.

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PROCEDURE Surface area calculation by reading in the points' coordinates

1. In the second Meas mode screen, press **[MENU]**, then select "Area calculation".

2. Enter the instrument station data.

3. Select "Area calculation" in <Area calculation>.

4. Press **[READ]** to display the list of coordinate data.
   Pt.   : Known point date saved in the current JOB or in the Coordinate Search JOB.
   Crd./ Stn : Coordinate data saved in the current JOB or in the Coordinate Search JOB.

```
01:
02:
03:
04:
05:
READ              MEAS
```

5. Select the first point in the list and press **{◄━}**.
   The coordinates of the first point is set as "Pt.001".

```
Pt.   Pt.001
Pt.   Pt.002
Pt.   Pt.004
Pt.   Pt.101
Pt.   Pt.102
↑↓··P   TOP   LAST  SRCH
```

6. Repeat steps 4 to 5 until all points have been read in.
   Points on an enclosed area are read in a clockwise or counterclockwise direction.
   After all known points necessary to calculate the surface area have been observed, **[CALC]** is displayed.

```
01:Pt.004
02:
03:
04:
05:
READ
```

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7. Press **[CALC]** to display the calculated area.

```
Pt.3
SArea      468.064m²
            0.0468ha
HArea      431.055m²
            0.0431ha
          REC        OK
```

8. Press **[REC]** in the screen of Step 7 to record results and return to <Menu>.
    Press **[OK]** to return to <Menu> without recording results.

[Note]

• It is also possible to perform area measurement by pressing **[AREA]** when allocated to the Meas mode screen.
    ☞ Allocating **[AREA]**: "30.3 Allocating Key Functions"

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24. RECORDING DATA - RECORD MENU -

In Record menu, you can store the measurement data (distance, angle, coordinates), station point data, backsight station data, and note in the current JOB.

☞ "25. SELECTING/DELETING A JOB"

• A total of 10000 data can be stored inside the instrument. Recording instrument station data and backsight station data is an exception.

Note

• If the same point number is input, the following screen is displayed.

```
N          5.544
E        -0.739
Z          0.245
Pt. PNT-001
       Overwrite ?
ADD         NO    YES
```

Press **[ADD]** to record the point as another record with the same name.
Press **[NO]** to input a new name.
Press **[YES]** to overwrite the present point.

24.1   Recording Instrument Station Data

Instrument station data can be stored in the current JOB.
• The items that can be recorded are the instrument station coordinates, point number, instrument height, codes, operator, date, time, weather, wind, temperature, air pressure and atmospheric correction factor.
• If instrument station data is not stored for the current JOB, the previously stored instrument data settings will be used.

PROCEDURE

1. Press **[REC]** in the third page of Meas mode to display <REC>.

    • Current JOB name is displayed.

2. Select "Stn. data".

   • Select **[READ]** to recall and use
     the registered coordinates.
   ☞ "13.1 Entering Instrument
        Station Data and Azimuth
        Angle PROCEDURE Reading
        in Registered Coordinate
        Data".

```
REC  JOB1
 Stn. data
 Backsight data
 Angle data
 Dist data
 Coord data              ⯯
```

3. Set the following data items.
   (1) Instrument station coordinates
   (2) Point number
   (3) Instrument height
   (4) Code
   (5) Operator
   (6) Date
   (7) Time
   (8) Weather
   (9) Wind
   (10)Temperature
   (11)Air pressure
   (12)Atmospheric correction factor

   • When inputting code, **[ADD]**,
     [LIST] and **[SRCH]** are
     displayed.
     Press **[ADD]** to save input codes
     in memory.

     Press **[LIST]** to display saved
     codes in reverse chronological
     order.

     Press **[SRCH]** to search for a
     saved code.

   ☞ For reviewing and saving
      codes in Memory mode, see
      "26.3 Registering/Deleting
      Codes" and "26.4 Reviewing
      Codes"

```
N0:          56.789
E0: -1234567.789
Z0:           1.234   🔋
Pt. Pt.004
Inst.h       1.234m ⯯
 OK            READ
```

```
Code                 ⮃
:pole                A
Operator:
: SOKKIA
                     ⯯
 OK   ADD   LIST  SRCH
```

```
Date  :Jan/28/2009⯅
Time  :17:02:33
Weath:Fine           🔋
Wind  :Calm
                     ⯯
 OK
```

```
Temp. : 12 °C        ⮃
Press.:1013hPa
ppm   :  -3          🔋

 OK   0ppm
```

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• To set the atmospheric correction factor to 0ppm, press **[0ppm]**. The temperature and air pressure are set to the default setting.

4. Check the input data, then press **[OK]**.

5. Press **{ESC}** to restore <REC>.

Note

• Maximum point number size: 14 (alphanumeric)
• Input range of instrument height: -9999.999 to 9999.999 (m)
• Maximum code/operator size: 16 (alphanumeric)
• Weather selection: Fine, Cloudy, Light rain, Rain, Snow
• Wind selection: Calm, Gentle, Light, Strong, Very strong
• Temperature range: -30 to 60 (°C) (in 1°C step)/-22 to 140 (°F) (in 1°F step)
• Air pressure range: 500 to 1400 (hPa) (in 1 hPa step)/375 to 1050 (mmHg) (in 1mmHg step)/14.8 to 41.3 (inch Hg) (in 0.1 inch Hg step)
• Atmospheric correction factor range (ppm): -499 to 499

| Date: Entry example | July 20, 2009 → 20090720 |
| Time:Entry example: | 2:35:17 p.m. → 143517 |

24.2   Recording Backsight Point

Backsight station data can be stored in the current JOB. Azimuth angle setting method can be selected from "inputting azimuth angle" or "calculating coordinates".

PROCEDURE Inputting azimuth angle

1. Press **[REC]** in the third page of Meas mode to display <REC>.

2. Select "Backsight data".

```
REC  JOB1
 Stn. data
 Backsight data
 Angle data
 Dist data
 Coord data          ▼
```

3. Select "Angle".
   Angle measurement values are
   displayed in real time.
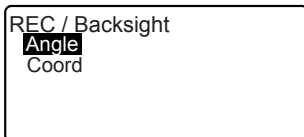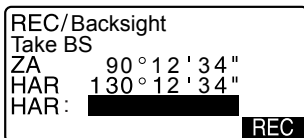
```
REC / Backsight
 Angle
 Coord
```

4. Input Azimuth angle.

```
REC/Backsight
Take BS
ZA      90°12'34"
HAR    130°12'34"
HAR:
                    REC
```

5. Sight the backsight and press
   [REC] in the screen of step 4, and
   set the following items.

   (1) Code
   (2) Target height
   (3) Point number

```
ZA      90°12'34"    A
HAR      0°00'00"
Cd
Tgt.h         0.000m ≵
 OK   ADD  LIST  SRCH
```

```
Pt.              1   ≵
                     A


 OK
```
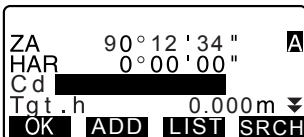
6. Check the input data, then press
   [OK] to set the backsight station.
   <REC> is restored.

PROCEDURE Calculating azimuth angle by coordinates

1. Press **[REC]** in the third page of
   Meas mode to display <REC>.

2. Select "Backsight data".

3. Select "Coord".

```
REC / Backsight
 Angle
 Coord
```

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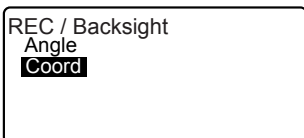
4. Input the backsight station coordinates.

    • When you wish to read in and set coordinate data from memory, press **[READ]**.
    ☞ "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

```
REC/Backsight
NBS :        1.000
EBS :        1.000
ZBS :      <Null>
 READ                   OK
```

5. Press **[OK]** in the screen of step 4. Angle measurement values are displayed in real time. Calculated Azimuth angle is also displayed.

```
REC/Backsight
Take BS
ZA       90°12'34"
HAR    123°12'34"
Azmth:    45°00'00"
                      REC
```

6. Sight the backsight and press **[REC]** in the screen of step 4, and set the following items.

    (1) Code
    (2) Target height
    (3) Point number

```
ZA       90°12'34"    A
HAR      45°00'00"
Cd
Tgt.h      0.000m     ⬇
 OK    ADD   LIST  SRCH
```

7. Check the input data, then press **[OK]** to set the backsight station. <REC> is restored.

```
Pt.             1    ⬆
                      A


 OK
```

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24.3   Recording Angle Measurement Data

Angle measurement data can be stored in the current JOB.

• It is convenient to use **[AUTO]** to perform automatic operation from angle measurement to recording.

PROCEDURE

1. Press **[REC]** in the third page of Meas mode to display <REC>.

2. Select "Angle data" and sight the point to be recorded. Angle measurement values are displayed in real time.

```
REC  JOB1
 Stn. data
 Backsight data
 Angle data
 Dist data
 Coord data            ⯯
```

```
REC/Angle    rec 2922
ZA     60°15'40"      ▮
HAR  110°30'45"
Pt . Pt.002
AUTO          0 SET  REC
```

3. Press **[REC]** in the screen of step 2, and set the following items.
    (1) Code
    (2) Target height
    (3) Point number

```
ZA     60°15'40"      Ⓐ
HAR  110°30'45"
C d 1010
Tg t . h      1.234m  ⯆
 OK   ADD  LIST  SRCH
```

```
Pt .        Pt.002   ⯅
                     Ⓐ


 OK
```

4. Check the input data, then press **[OK]**.

5. To continue measurement, sight the next point, then perform steps 3 and 4 above.

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• Press **[AUTO]** to perform angle measurement and automatically record the results. **[AUTO]** is convenient for recording measurement data when point number, code, and target height are not set.

```
REC/Angle      rec 2923

ZA      80°30'15"    ▮
HAR   120°10'00"
Pt. Pt.001
    Recorded
```

6. Press **{ESC}** to quit measurement and restore <REC>.

24.4   Recording Distance Measurement Data

Distance measurement data can be stored in the current JOB.

PROCEDURE

1. Press **[DIST]** in the first page of Meas mode to perform distance measurement.
   ☞ "12.2 Distance and Angle Measurement"

2. Press **[REC]** in the third page of Meas mode. <REC> is displayed. Select "Dist data" to display the measurement results.

```
REC   JOB1
  Stn. data
  Backsight data
  Angle data
  Dist data
  Coord data          ▼
```

```
REC/Dist      rec 2922
S        123.456m
ZA      80°30'15"    ▮
HAR   120°10'00"     ▯
Pt.     1
 AUTO   DIST  OFFSET  REC
```

3. Press **[REC]** in the screen of step 2, and set the following items.
   (1) Code
   (2) Target height
   (3) Point number

```
S        123.456m
ZA      80°30'15"
HAR   120°10'00"
Cd
Tgt.h           1.234m ▼
  OK    ADD   LIST  SRCH
```

4. Check the input data, then press
   [OK].
5. To continue measurement, sight
   the next point, press **[DIST]**, then
   perform steps 3 and 4 above.
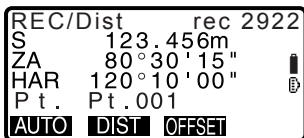
   • Press **[OFFSET]** to offset
     measurement in Record Mode.

```
REC/Dist      rec 2922
S       123.456m
ZA     80°30'15"
HAR   120°10'00"
Pt.   Pt.001
AUTO   DIST   OFFSET
```

6. Press **{ESC}** to quit measurement
   and restore <REC>.

Note

• Once the data has been recorded, **[REC]** is not displayed in order to prevent
  double recording.

24.5   Recording Coordinate Data

Coordinate data can be stored in the current JOB

PROCEDURE

1. Perform coordinates
   measurement in the Meas mode
   screen.
   ☞ "13. COORDINATE
      MEASUREMENT"

2. Press **[REC]** in the third page of
   Meas mode to display <REC>.
   Select "Coord data" to display the
   measurement results.

```
REC  JOB1
 Stn. data
 Backsight data
 Angle data
 Dist data
 Coord data              ▼
```

```
REC/Coord    rec 2923
N         344.284
E         125.891    ▯
Z          15.564    ▯
Pt.   Pt.003
AUTO  OBS  OFFSET  REC
```

3. Press **[REC]** in the screen of step
   2, and set the following items.
   (1) Code
   (2) Target height
   (3) Point number

```
N         344.284
E         125.891    A
Z          15.564
Cd ▮
Tgt.h       2.000m   ▼
 OK   ADD  LIST  SRCH
```

4. Check the input data, then press
   [OK].

5. To continue measurement, sight
   the next point, press **[OBS]**, then
   perform steps 3 and 4 above.

6. Press **{ESC}** to quit measurement
   and restore <REC>.

24.6   Recording Distance and Coordinate Data

Distance measurement data and coordinate data can be stored in the current JOB
at the same time.

• Both distance measurement data and coordinate data are recorded as the
  same point number.
• Distance measurement data is recorded first, then coordinate data is recorded.

PROCEDURE

1. Press **[REC]** in the third page of
   Meas mode to display <REC>.

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2. Select "Dist + Coord data" to display <REC/DIST + C>.

```
Dist + Coord data        ▲
Note
View
Deletion
```
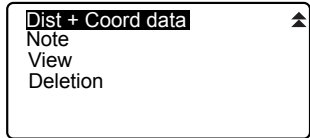
3. Sight the point and press **[OBS]** to begin the measurement.
The measurement results are displayed.

```
REC/DIST+C  rec 3970
N           0.051
E          -0.004
Z           1.486
Pt. PNT-1234
AUTO  OBS  OFFSET  REC
```
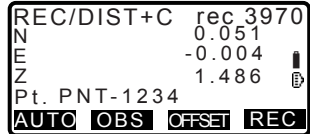
4. Press **[REC]** in the screen of step 3, and set the following items.
   (1) Code
   (2) Target height
   (3) Point number

```
N           0.051
E          -0.004    A
Z           1.486
Cd
Tgt.h      0.000m ▼
OK   ADD  LIST  SRCH
```
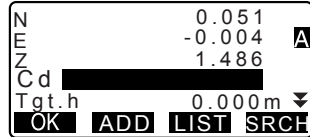
5. Check the input data, then press **[OK]**.

6. Press **{ESC}** to quit measurement and restore <REC>.

24.7   Recording Notes

This procedure prepares notes data and records it in the current JOB.

PROCEDURE

1. Press **[REC]** in the third page of
    Meas mode to display <REC>.
    Select "Note".

    ```
    Dist + Coord data        ▲
    Note
    View
    Deletion
    ```

2. Enter the note data.

    ```
    REC/Note     rec 2823
    Tree 01 Left


                             A
     OK
    ```
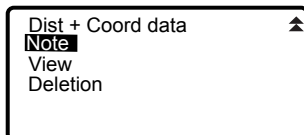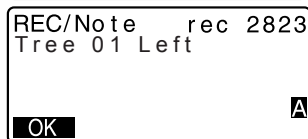
3. After inputting the note data, press
    [OK] to return to <REC>.

Note

• Maximum note length: 60 characters (alphanumeric)

24.8   Reviewing JOB Data

It is possible to display the data within the current JOB that is selected.

- It is possible to search for data within the JOB to be displayed by point number. But the note data cannot be searched.
- Known point data that are entered from an external instrument are not reviewed.

PROCEDURE   Reviewing JOB data

1. Press **[REC]** in the third page of Meas mode to display <REC>. Select "View" to display the list of recorded points.

```
Dist + Coord data      ⬆
Note
View
Deletion
```

```
Stn    1
RED    2
Bkb    2
Ang.   2
Dist   3
⇅··P   TOP   LAST  SRCH
```

2. Select the point number to be displayed in detail and press **[◄─]**.
   Details of the data are displayed. This screen contains distance measurement data.

```
S     123.456m
ZA   20°31'21"
HAR  117°32'21"
Cd   1010
Tgt.h    12.345m ⬇
NEXT  PREV  EDIT  RED
```

   - To display previous data item, press **[PREV]**.
   - To display next data, press **[NEXT]**.
   - Press **[EDIT]** to edit code/target height/point number of the selected point number. Items that can be edited depend on the type of data selected. Press **[OK]** to confirm changes and return to the previous screen.
   - **[⇅...P]** = Use **{▲}/{▼}** to move from page to page.

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- **[↑↓...P]** = Use **{▲}/{▼}** to select individual point.
- Press **[TOP]** to display first data.
- Press **[LAST]** to display last data.
- Press **[SRCH]** to search for point number. Input the point number after "Pt. No".
  The search may take time if many data are registered.
- Press **[RED]** to display the reduced data screen shown at right.
  Press **[OBS]** to return to the previous screen.

```
H       1234.456m
V       -321.123m
Azmth  12°34'56"
Cd       1010
Tgt. h      12.345m ▼
NEXT  PREV        OBS
```

3. Press **{ESC}** to conclude detailed display and restore the list of points.
   Press **{ESC}** again to restore <REC>.

Note

- If more than two points with the same point name exist in the current JOB, SET finds the newer data only.

24.9   Deleting Recorded JOB Data

It is possible to delete data from the currently selected JOB.

PROCEDURE   Deleting Recorded JOB data

1. Press **[REC]** in the third page of
   Meas mode to display <REC>.
   Select "Deletion" to display the list
   of recorded points.

```
Dist + Coord data          ⮝
Note
View
Deletion
```

```
Stn     1
RED     2
Bkb     2
Ang.    2
Dist    3                   ⯯
↑↓‥P    TOP   LAST  SRCH
```

2. Select the data item to be
   displayed in detail and press
   [←].
   Details of the data are displayed.

```
S      123.456m
ZA     20°31'21"
HAR   117°32'21"
Cd     1010
Tgt.h      12.345m  ⯯
NEXT  PREV         DEL
```

   • To display previous data item,
     press **[PREV]**.
   • To display next data, press
     [NEXT].
   • **[↑↓...P]** = Use **{▲}**/**{▼}** to move
     from page to page.
   • **[↑↓...P]** = Use **{▲}**/**{▼}** to select
     individual point.
   • Press **[TOP]** to display first data.
   • Press **[LAST]** to display last
     data.
   • Press **[SRCH]** to search for point
     number. Input the point number
     after "Pt. No".
     The search may take time if
     many data are registered.

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3. Press **[DEL]** to display the screen
   at right.
   Press **[YES]** to delete and return to
   the second screen in step 1.
   • Press **[NO]** to return to the
     second screen in step 1 without
     deleting.

```
┌─────────────────────────┐
│RED          Pt.2        │
│                         │
│   Deletion              │
│        Confirm?         │
│              ▐NO▌ YES   │
└─────────────────────────┘
```

✍
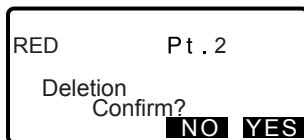
• Check data items before deleting to avoid losing important data.
• Deleting an important data item, such as instrument station coordinates, can
  prevent successul completion of software operations that require such data
  after outputting to an external device.

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25.SELECTING/DELETING A JOB

25.1　Selecting a JOB

Select the current JOB and Coordinate Search JOB.

- A total of 10 JOBs have been prepared, and JOB1 was selected when your SET was shipped from the factory.
- The names of the JOBs have been preset as JOB1 to JOB10; you can change them to any names you wish.
- Scale factor can be set for each JOB. Only scale factor of the current JOB can be edited.

📖 **Current JOB**

Measurement results, instrument station data, known points data, notes and coordinate data are recorded in the current JOB.

☞ Registering known point data: "26.1 Registering/Deleting Known Point Data".

📖 **Coordinate Search JOB**

The registered coordinate data in the JOB selected here can be read into coordinate measurement, resection measurement, setting-out measurement, etc.

📖 **Scale correction**

SET calculates horizontal distance and coordinates of a point using measured slope distance. If scale factor has been set, scale correction is carried out during calculation.

Corrected horizontal distance (s) = Horizontal distance (S) ×
Scale factor (S.F.)

- When scale factor is set to "1.00000000", the horizontal distance is not corrected.

PROCEDURE JOB selection and scale factor setting

1. Select "JOB" in Memory Mode.

```
Memory
 JOB
 Known data
 Code
 Dialup
```

2. Select "JOB selection".
   <JOB selection> is displayed.

```
JOB
 JOB selection
 JOB name edit
 JOB deletion
 Comms output
 Comms setup
```

```
JOB selection
: JOB1
S.F.=1.00000000
Coord search JOB
: JOB
LIST          S.F.
```

3. Press **[LIST]**.

   • JOB can also be selected by
     pressing **{▶}**/**{◀}**.
   • The numbers to the right
     represent the number of data
     items in each JOB.
   • "*" means that the JOB has not
     been output to an external
     device yet.

```
JOB selection
 JOB01         46
*ATUGI        254
 JOB03          0
 JOB04          0
 JOB05          0
```

4. Align the cursor with the desired
   JOB as the current JOB and press
   {◀━━}.
   The JOB is determined.

5. Press **[S.F.]**.
   Enter the scale factor for the
   current JOB.

```
JOB 1
S.F.=1.00000000
```

6. Press **{◀━━}**.
   <JOB selection> is restored.

7. Align the cursor with "Coord
   search JOB" and press **[LIST]**.
   <Coord search JOB> is displayed.

8. Align the cursor with the desired
   JOB as the coordinate search
   JOB and press {◀━}.
   The JOB is determined and
   <JOB> is restored.

Note

• The list of JOB names is contained on up to 2 pages.
• Scale factor input range : 0.50000000 to 2.00000000 (*1.00000000)
"*" : Factory setting

PROCEDURE Inputting a JOB name

1. Select "JOB" in Memory mode.

2. Select in advance the JOB whose
   name to be changed.
   ☞ "PROCEDURE JOB selection
      and scale factor setting"

3. Select "JOB name edit" in <JOB>.
   Input the new JOB name and
   press {◀━}.
   <JOB> is restored.

```
JOB
  JOB selection
  JOB name edit
  JOB deletion
  Comms output
  Comms setup
```

```
JOB name edit            A
JOB03
```

Note

• Maximum length of JOB name: 12 (alphanumeric)

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25.2   Deleting a JOB

It is possible to clear the data within a designated JOB. After the data has been cleared, the JOB name returns to the name allocated when the SET was shipped.

Note
• A JOB that has not been output to an auxiliary device (displayed with *) cannot be deleted.

PROCEDURE

1. Select "JOB" in Memory Mode.

2. Select "JOB deletion".
   <JOB deletion> is displayed.

   • The numbers to the right represent the number of data items in each JOB.

```
JOB
  JOB selection
  JOB name edit
  JOB deletion
  Comms output
  Comms setup
```

```
JOB deletion
  JOB01          46
 *ATUGI         254
  JOB03           0
  JOB04           0
  JOB05           0
```

3. Align the cursor with the desired JOB and press {◄━━}.

4. Press **[YES]**. The data within the JOB selected is deleted and <JOB deletion> is restored.

```
JOB03
   deletion
     Confirm ?
              NO   YES
```

26. REGISTERING/DELETING DATA

26.1   Registering/Deleting Known Point Data

It is possible to register or delete coordinate data of the known points in the current JOB.
The coordinate data that has been registered can be output during setting for use as instrument station, backsight station, known point, and setting-out point coordinate data.

• It is possible to register 10000 items of coordinate data, including the data inside the JOBs.
• There are two registration methods: key entry and entry from an external instrument.

   ☞ Communication cables: "36. OPTIONAL ACCESSORIES"
      Output format and command operations: "Interfacing with the SOKKIA SDR Electronic Field Book" and "Command Explanations" manuals.
• When entering known point data from an external device, SET does not check the repeated point number.
• Communication setup can be performed in the known data as well. Select "Comms Setup" in <Known data>.

✍

• When "inch" is selected as the distance unit, the value must be input in "feet" or "US feet".

PROCEDURE Using the key entry method to register known point coordinate data

1. Select "Known data" in Memory Mode.

   • Current JOB name is displayed.

   ```
   Memory
    JOB
    Known data
    Code
   ```

2. Select "Key in coord" and input known point coordinates and point number.

   ```
   Known data
   Job.JOB1
    Key in coord
    Comms input
    Deletion
    View                    ⯆
   ```

   ```
                      rec 3991
   N      567.950
   E   -200.820
   Z    305.740
   Pt.  5
   ```

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3. After setting the data, press
   {◄━━┛}.
   The coordinate data is recorded in
   the current JOB and screen in step
   2 is restored.

```
                rec 2641
N   567.950
E  -200.820
Z   305.740
Pt. 5
    Recorded
```

4. Continue to enter other known
   point coordinate data.

5. After the registration of all the
   coordinate data has been
   completed, press **{ESC}** to restore
   <Known data>.

PROCEDURE Entering known point coordinate data from an external instrument

1. Connect SET and host computer.

2. Select "Known data" in Memory
   Mode.

   • Current JOB name is displayed.

3. Select "Comms input" to display
   <Comms input>.
   Coordinate data starts to be
   entered from an external
   instrument and the number of
   received items is displayed on the
   screen. When data reception is
   completed, <Known data> is
   displayed.

   • Press **{ESC}** to stop data
     reception in progress.

```
Known data
Job.JOB1
  Key in coord
  Comms input
  Deletion
  View                    ≛
```

```
Comms input

  Format     SDR33

   Receiving    12
```

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PROCEDURE   Deleting designated coordinate data

1. Select "Known data" in Memory Mode.

2. Select "Deletion" to display the list of known point data.

```
Known data
Job.JOB1
 Key in coord
 Comms input
 Deletion
 View                    ▼
```

```
Pt. 0
Pt. 1
Pt. 12345678
Pt. 12345679
Pt.            SOKKIA▼
[↕··P] [TOP] [LAST] [SRCH]
```

3. Select the point number to be deleted and press **{◀━━┛}**.

   • **[↕↓...P]** = Use **{▲}/{▼}** to move from page to page.
   • **[↑↓...P]** = Use **{▲}/{▼}** to select individual point.
   • Press **[TOP]** to display top of point number list.
   • Press **[LAST]** to display end of point number list.
   • Press **[SRCH]** to search for point number. Input the point number after "Pt. No."
     The search may take time if many data are registered.

```
N  567.950
E -200.820
Z  305.740
Pt. 5
[NEXT] [PREV]        [DEL]
```

```
Pt.no.              A
:
```

4. Press **[DEL]** to delete the selected point number.

   • Press **[PREV]** to display previous data.
   • Press **[NEXT]** to display next data.

5. Press **{ESC}** to quit the point number list and return to <Known data>.

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PROCEDURE Clearing all coordinate data at once (initialization)

1. Select "Known data" in Memory
   Mode.
2. Select "Clear" and press **{◄━━┛}**.

```
Known data               ▲
Job.JOB1
 Clear
 Comms setup
```

3. Press **[YES]**.
   <Known data> is restored.

```
Clear
   Confirm ?
                   NO   YES
```

26.2   Reviewing Known Point Data

It is possible to display all the coordinate data within the current JOB.

PROCEDURE

1. Select "Known data" in Memory
   Mode.

   • Current JOB name is displayed.

2. Select "View".
   The point number list is displayed.

```
Known data
Job.JOB1
 Key in coord
 Comms input
 Deletion
 View                     ▼
```

3. Select the point number to be
   displayed and press **{◄━━┛}**.
   The coordinates of the selected
   point number are displayed.

```
Pt.  0
Pt.  1
Pt.  12345678
Pt.  12345679
Pt.            SOKKIA▼
 ↑↓··P   TOP   LAST  SRCH
```

```
N    567.950
E   -200.820
Z    305.740
Pt.  5
 NEXT  PREV          DEL
```

4. Press **{ESC}** to restore the point
   number list.
   Press **{ESC}** again to restore
   <Known data>.

26.3   Registering/Deleting Codes

It is possible to save codes in memory. You can also read in codes registered in
memory when recording instrument station data or observation data.

PROCEDURE Inputting Codes

1. Select "Code" in Memory Mode.

```
Memory
 JOB
 Known data
 Code
 Dialup
```

2. Select "Key in code".
   Enter the code and press **{◄──┘}**.
   The code is registered and
   <Code> is restored.

```
Code
 Key in coord
 Deletion
 Code view
 Clear list
```

Note

- Maximum code size: 16
  (alphanumeric)
- Maximum number of codes
  registered: 60

```
Code               A
:Pole
```

PROCEDURE Deleting codes

1. Select "Code" in Memory Mode.

2. Select "Deletion". The registered code list is displayed.

```
Code
 Key in coord
 Deletion
 Code view
 Clear list
```

```
Pole
A001
TREE01LEFT
POINT01
POINT02
↑↓··P    TOP   LAST   DEL
```

3. Align the cursor with the code to be deleted and press **[DEL]**. The designated code is deleted.

4. Press **{ESC}** to restore <Code>.

Note

• If you select "Clear list" in step 2 and then press **[YES]**, all registered codes are deleted.

26.4   Reviewing Codes

PROCEDURE

1. Select "Code" in Memory Mode.

2. Select "Code view". The registered code list is displayed.

```
Code
 Key in coord
 Deletion
 Code view
 Clear list
```

```
Pole
A001
Point 001
TREE01LEFT
POINT01
↑↓··P    TOP   LAST
```

3. Press **{ESC}** to restore <Code>.

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27. OUTPUTTING JOB DATA

It is possible to output JOB data to a host computer or printer.

☞ Communication cables: "30.2 Configuration -Config Mode-"

Output format and command operations: "Interfacing with the SOKKIA SDR Electronic Field Book" and "Command Explanations" manuals.

• Measurement results, instrument station data, known point data, notes, and coordinate data in the JOB is output.
• Known point data entered from an external instrument is not output.
• Communication setup can be performed in the JOB menu as well. Select "Comms Setup" in <JOB>.

🚫

• When "inch" is selected as the distance unit, data is output in "feet" or "US feet" depending on the feet unit selected.

27.1 Outputting JOB Data to Host Computer

PROCEDURE

1. Connect SET and host computer.

2. Select "JOB" in Memory Mode.

```
Memory
 JOB
 Known data
 Code
```

3. Select "Comms output" to display the JOB list.

```
JOB
 JOB selection
 JOB name edit
 JOB deletion
 Comms output
 Comms setup
```

4. Select the JOB to be output and press {◄──│}.
   "Out" appears to the right of the JOB selected. You can select as many JOBs as you want.

   • "*" means the JOB has not been output to an external device yet.

```
* JOB01          Out
  ATUGI          254
  JOB03          Out
  JOB04            0
  JOB05            0▼
                  OK
```

5. Press **[OK]**.

6. Select the output format and press **{◄━━}**.

```
Comms output
 SDR33
 SDR2X
 Printed output
```

7. Select the output data and press **{◄━━}**.
   Output starts. When the output is complete, the JOB list is restored. It is possible to continue output of the next JOB.
   • Select "Obs data" to output distance measurement data.
   • Select "Reduced data" to output distance measurement data and reduced data.
   • To stop output, press **{ESC}**.

```
Comms output
 Obs data
 Reduced data
```

27.2 Outputting JOB Data to Printer

PROCEDURE

1. Select "JOB" in Memory Mode.

2. Select "Comms output" to display the JOB list.

```
JOB
 JOB selection
 JOB name edit
 JOB deletion
 Comms output
 Comms setup
```

3. Select the JOB to be output and press **{◄━━}**.
   "Out" appears to the right of the JOB selected. You can select as many JOBs as you want.

4. Press **[OK]**.

5. Connect SET and printer.

6. Turn ON the printer.

7. Select "Printed output" and press
    {◀━}.

8. Select the output data and press
    {◀━}.
    Output starts. When the output is
    complete, the JOB list
    is restored. It is possible to
    continue output of the next
    JOB.
    • Select "Obs data" to output
      distance measurement data.
    • Select "Reduced data" to output
      distance measurement data and
      reduced data.
    • To stop output, press **{ESC}**.

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28. TRANSFERRING DATA WITH SFX FUNCTION

The SFX Dial-up program allows the operator to connect the SET to a cellular phone in order to exchange data by connecting to an FTP server or to transfer data as email attachments between the SET and a computer, while in the field. Coordinate data transferred to the SET in this way can be added into JOB data.

All data needed for surveying can be exchanged at the worksite.

Ex.1   As data can be sent to a computer via e-mail, there is no need to return to the office to hand over surveyed data.

Ex. 2   All data needed for surveying can be transferred via e-mail so there is no need to waste time downloading before heading for the worksite.

Ex. 3   Surveyed data can be sent promptly back to the office for processing allowing the operator to get feedback on the quality of the surveyed data quickly and without having to leave the worksite. The operator can respond to deficiencies in the data much faster as a result.

Ex. 4   Coordinate data can be exchanged between Total Stations using the SFX function allowing greater flexibility when allocating tasks in the field.

• A program designed to allow Internet provider information, e-mail address, and FTP server information to be set on an operator's PC is available free of charge. For details, ask your local dealer.

28.1   Necessary items

The following item are necessary in order to use the SFX dial-up program with the SET.

● Cellular phone equipped with *Bluetooth* wireless technology (DUN profile) and supporting GPRS (General packet radio service)

28.2   Connecting all equipment

Connect all equipment as shown below.

☪

• Make sure that the power of both the SET and the cellular phone is on before connecting.
• The cellular phone must be registered as a companion device in order to make a connection.

☞ "10.1 Necessary settings for Bluetooth communication PROCEDURE Registering Bluetooth companion devices"
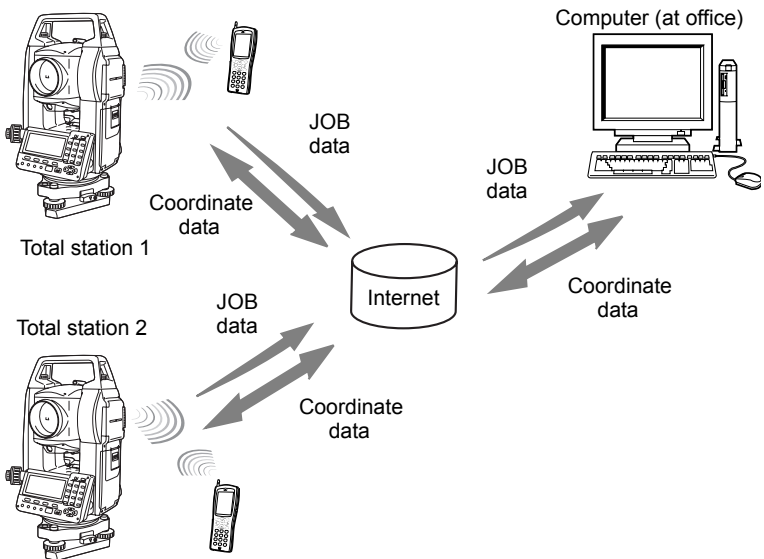
28.3　Booting up and quitting SFX

PROCEDURE Booting up

1. Select "Dial-up" from the Memory
   mode screen.

```
Memory
 JOB
 Known data
 Code
 Dial-up
```

2. Input the previously registered
   password and press **{◀━┛}**.

   As no password was set at the
   factory, leave blank and press
   {◀━┛}.
   Press **{ESC}** to return to Memory
   mode.
   ☞ Setting/changing passwords:
      "28.4 Setting a password"

```
Dial-up
Password              A

                    NEW
```

🐝:
    The power cannot be turned off
    in screens after setting a
    password in the SFX program.

```
Dial-up
Send mail
Receive mail
FTP connect

ADR  FTP   A P  MODEM
```

PROCEDURE Quitting

1. Press **{ESC}** repeatedly to return
   to Memory Mode. The power can
   now be turned off.

28.4   Setting a password

Internet provider details and the operator's e-mail address are recorded in the SFX Dial-up program. Setting a password is recommended to improve the security of this information.

PROCEDURE

1. Press **[NEW]** in <Dial-up>.

```
Dial-up
Password                        A


                            NEW
```

2. Input the current password and press **{◄──}**.

    No password was set at the factory. Leave blank and press **{◄──}**.

```
Dial-up
Old Password                    A
■
```

3. Input the new password and press **{◄──}**. The new password is now set. <Dial-up> will be displayed.

    The maximum password length is 32 alphanumeric characters.

```
Dial-up
New Password                    A
■
```

Note

• When a password is forgotten, clear the memory to return the password to the factory setting. JOB data and communication settings will be lost when the memory is cleared.

  ☞ "30.5 Restoring Default Settings"

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28.5 Registering Internet provider information

Internet provider information must be registered on the SET in order to use the e-mail function.

PROCEDURE

1. After inputting the password, press **[ISP]** to display the Internet provider settings.

```
Dial-up
Send mail
Receive mail
FTP connect

ADR   FTP   A P   MODEM
```

```
Setup ISP
Phone1:0066-22-252
Phone2:03-4360-260
Phone3:0,,,0066-22
PPP login: abc00099
```

```
Setup ISP
PPP password: *****
Mail address: sokki
POP server: pop.sok
POP login: user1_so
```

```
Setup ISP
POP password: *****
Leave on server: Y
SMTP server: smtp.s
POP before SMTP: Y
```

```
Setup ISP
POP before SMTP: Y
SMTP auth: Y
OP25B: Y
IP address: 0.0.0.0
```

```
Setup ISP
IP address: 0.0.0.0
DNS1: 202.203.204.2
DNS2: 202.203.204.2
Timeout(sec): 90
```

2. Use **{ ▲ }/{ ▼ }** to highlight the
    setting to be modified and press
    {◄─■}. When the respective
    screen is displayed input the new
    details and press **{◄─■}**.

3. Press **{ESC}** to finish settings and
    return to <Dial-up>.

Note
• The following settings are made by the operator. The information marked with
  * is supplied by your Internet provider. For any inquiries regarding this
  information, ask your Internet provider.

Phone*
Input the telephone number (including area code) for the access point. Use no
more than 56 characters. Spaces and hyphens may be omitted. Up to 3 telephone
numbers may be registered.

PPP login*
Input the PPP connection login name.

PPP password*
Input the PPP connection password. Use no more than 32 characters.

Mail address*
Input the e-mail address allocated to that instrument. Use no more than 64
characters.

POP server*
Input the POP server name. Use no more than 64 characters.

POP login*
Input the login name for the POP server. Use no more than 56 characters.

POP password*
Input the POP server password. Use no more than 56 characters.

Leave on server
To leave received e-mail on the server, select "Y". To delete received e-mail,
select "N".

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SMTP server*

Input the POP server name. Use no more than 56 characters.

POP before SMTP

If your Internet provider uses "POP-before-SMTP" (a method of user authentication used when sending e-mail) select "Y". Otherwise select "N".

SMTP auth*

Select "Y"/"N" to activate/deactivate user authentication.

OP25B

Configure in accordance with your provider settings.

IP address*

Input the IP address when allocated. When using an address automatically assigned by the server input "0.0.0.0.".

DNS1, DNS2*

Input the primary (DNS1) and secondary (DNS2) addresses for the DNS server. When no DNS server is used input "0.0.0.0.".

Timeout

Set the timeout, in seconds, for the connection to the server.

28.6 Registering FTP server information

FTP server information must be registered on the SET in order to use the FTP server connection function. Up to 3 servers can be registered.

PROCEDURE

1. After inputting the password, press **[FTP]** to display the Internet provider settings.

2. Use **{ ▲ }/{ ▼ }** to highlight the setting to be modified and press **{◄─┘}**.

```
Select FTP server
SOKKIA_HOME
my_private
survey_office


```

When the respective screen is displayed, input the new details and press {◄▬}.

```
Setup FTP server
Name:SOKKIA_HOME
Phone: 0,,,090-4936
PPP login: user01
PPP password: *****
```

```
Setup FTP server
IP address: 192.168
DNS1: 0.0.0.0
DNS2: 0.0.0.0
FTP server: 192.168
```

```
Setup FTP server
FTP login: user1
FTP password: *****
Timeout(sec): 90
FTP server: 192.168
```

3. Press {ESC} to finish settings and return to the screen shown in step 1.

Note

• The following settings are made by the operator. Obtain information marked with * from your system administrator.

Name*
Input the server name. Use no more than 32 characters.

Phone*
Input the telephone number (including area code) for the access point. Use no more than 56 characters. Spaces and hyphens may be omitted. Up to 3 telephone numbers may be registered.

PPP login*
Input the login name for PPP connection.

PPP password*
Input the password for PPP connection. Use no more than 32 characters.

IP address*
Input IP address. When using the DHCP protocol, input "0.0.0.0.".

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DNS1/DNS2 address*
Input the DNS1/DNS2 address. When no DNS server is used input "0.0.0.0."

FTP server address*
Input "aaa@bbb.co.jp" as the FTP server address.

FTP login*
Input the login name for the FTP server. Use no more than 56 characters.

FTP password*
Input the login name for the FTP server. Use no more than 32 characters.

Timeout
Set the timeout, in seconds, for the connection to the server.

28.7   Registering an e-mail address

Register the outgoing e-mail address (no more than 56 characters) beforehand.
Up to 5 e-mail addresses can be registered.

PROCEDURE

1. After inputting the password,
   press **[ADR]** to display the
   currently registered e-mail
   addresses. Use **{ ▲ }**/**{ ▼ }** to
   highlight the desired e-mail
   address.

```
Dial-up
Send mail
Receive mail
FTP connect

ADR   FTP   A P   MODEM
```

```
Setup mail address
user1@sokkia.com
set2030_01@survey.c
smith@sokkia.com
abc001@efghijklmn
--------------------------
```

2. Input the e-mail address and
   press **{◄─┘}**.

```
Setup Mail Address

user1@sokkia.com
```

3. Press **{ESC}** to finish settings and
   return to the screen shown in step
   1.

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[Note] **Saving settings**
• All settings are saved when the operator quits the program. SFX will function according to these new and modified settings once the program has been shut down then rebooted.

28.8　Sending e-mail (JOB data)

JOB data can be sent from the SET as e-mail attachments.
☞ Rules for sending e-mail: "28.11 Sending e-mail to the SET"

PROCEDURE

1. After inputting the password select "Send mail".

2. Select a telephone number. "connecting..." is displayed on the SET.

   When a connection has been established <Send mail (Online)> is displayed on the SET.

```
Select Phone Number
0066-22-2525
03-4360-2600
0...0066-22-2525


```

3. Use {▲}/{▼} to highlight the JOB to be sent and press {◄━}. "OUT" is displayed. Press {◄━} again to remove "OUT". Once all the JOBs to be sent have been selected, press **[OK]**.

```
Send Mail(Online)
JOB1              OUT
JOB2              OUT
JOB3              442
JOB4              576
 OFF              OK

```

4. Select the destination e-mail address and press {◄━}. "OUT" is displayed. Multiple destination addresses can be selected. Once all destination addresses have been selected, press **[OK]**.

```
Send Mail(Online)
user1@sokkia.co   OUT
set2030_01@surv   OUT
smith@sokkia.co
abc001@efghijkl
 OFF              OK

```

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5. Transmission starts.

   The name of the JOB currently
   being transmitted and the number
   of records (JOB data records)
   successfully transmitted are
   displayed on the screen during
   transmission.

```
Send Mail(Online)
 Sending...
63
JOB01
Wait for a moment
 OFF
```

   • JOBs are sent one JOB per e-
     mail.

   When all selected JOBs have
   been successfully transmitted,
   SFX disconnects from the internet
   and returns to <Dial-up>.

   ✿:
   Pressing **[OFF]** during
   transmission will forcibly cut
   the connection and stop
   transmission. The
   transmission of the current
   JOB may not be successfully
   completed as a result.

28.9 Receiving e-mail with the SET (coordinate data)

After reading in a coordinate file sent as an e-mail attachment in SDR format, the
SET records it as coordinate data at the end of the currently selected JOB.
☞ Rules for receiving e-mail: "28.12 Receiving e-mail from the SET"

PROCEDURE

1. After inputting the password,
   select "receive mail".

   "PPP connecting..." is displayed
   on the SET.

```
Dial-up
Send mail
Receive mail
FTP connect
ADR  FTP  AP  MODEM
```

When a connection has been established <Receive Mail (Online)> is displayed.

```
Receive Mail(Online)
Receive mail.st...
     2/3

Wait for moment
 OFF
```

2. SFX will automatically search the server for all e-mail for the SET. A list of all SET-related incoming e-mail and the respective data type will be displayed.

```
Receive Mail(Online)
SDR>test
SDR>P14
SDR>JOB1

 OFF              OK
```

3. Select an e-mail to read and press **[OK]**. While receiving the coordinate data attached to the selected e-mail, the file name and number of coordinate points in the current file are displayed.

```
Receive Mail(Online)
 Receiving...
78
SDR>test
Wait for moment
 OFF
```

When read-in is complete, SFX disconnects from the internet and returns to <Dial-up>.

�:

Pressing **[OFF]** during transmission will forcibly cut the connection and stop transmission. All the data currently being received will be lost.

28.10   FTP server connection (coordinate data/JOB data)

The SET accesses an office or PC FTP server in order to write or read in JOB data or coordinate data.

✖

• The file to be sent is converted to SDR format and written to the server as "*Job No*.sdr".
• When a file with the same name already exists on the server, a letter (from a to z) is appended to the end of the most recent file name (JOB name).

• The SET can only read in files with the file extension ".sdr".
• From the files with the extension ".sdr", only coordinate data is read in. The SET records it as coordinate data at the end of the currently selected JOB.

PROCEDURE Writing (sending) a file

1. After inputting the password, select "FTP connect".

```
Dial-up
Send mail
Receive mail
FTP connect

ADR   FTP    AP   MODEM
```

2. Select the relevant server in <Select FTP server> and press **{◄──}**.

   "PPP connecting..." is displayed on the SET.

   When a connection has been established <FTP server (Online)> is displayed.

```
Select FTP server
SOKKIA_HOME
my_private
survey_office
```

3. Select "Send SDR Job" and press **{◄──}**.

```
FTP server(Online)
Send SDR Job
Receive file

OFF
```

4. Use **{▲}/{▼}** to highlight the JOB to be sent and press **{◄──}**. "OUT" is displayed. Press **{◄──}** again to remove "OUT". Once all the JOBs to be sent have been selected press **[OK]**.

   Transmission starts.

   The name of the JOB currently being transmitted and the number of records (JOB data records, coordinate points) successfully transmitted are displayed on the screen during transmission.

```
FTP Server(Online)
JOB1            OUT
JOB2            OUT
JOB3            442
JOB4            576
OFF             OK
```

When all selected JOBs have been successfully transmitted, SFX disconnects from the internet and returns to <Dial-up>.

🗲:
   Pressing **[OFF]** during transmission will forcibly cut the connection and stop transmission. The transmission of the current JOB may not be successfully completed as a result.

PROCEDURE Reading in (receiving) a file

1. After inputting the password, select "FTP connect".

2. Select the relevant FTP server in <Select FTP server> and press **{◀━━}**.
   "PPP connecting..." is displayed on the SET.

   When a connection has been established <FTP server (Online)> is displayed.

3. Select "Receive file" and press **{◀━━}**.

   SFX will automatically search the server for all data for the SET. A list of all SET-related data and the respective data type will be displayed.

```
FTP server(Online)
Send SDR Job
Receive file

 OFF
```

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4. Select the file containing the
desired coordinate data and press
{◀━━}.

```
FTP server(Online)
. .                  <DIR>
SDR>FACTORY_SYTE
SDR>JOB1
SDR>JOB1a
 OFF
```

While receiving the file, the file
name and number of coordinate
points in the current file are
displayed.

When read-in is complete, SFX
disconnects from the internet and
returns to the <Dial-up>.

✖:
  Pressing **[OFF]** during
  transmission will forcibly cut
  the connection and stop
  transmission. All the data
  currently being received will
  be lost.

28.11   Sending e-mail to the SET

E-mail is sent from the computer to the SET using standard e-mail programs.

The method for sending an e-mail from the computer to the SET is the same as
that for sending a normal e-mail.
Compose an e-mail addressed to the address assigned to the SET.

✖

• So that the SET can distinguish which e-mails to receive, input "SDR>" followed
  by a user-specified title in the subject line.
• SDR-format coordinate data appended as an attachment. The file extension for
  attachment files should be ".sdr".
• Text input in the body of the message will not be displayed on the SET.
• Even if multiple files are attached to a single e-mail, the SET can only receive
  the first attachment.

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Microsoft Outlook Express 6.0 Example
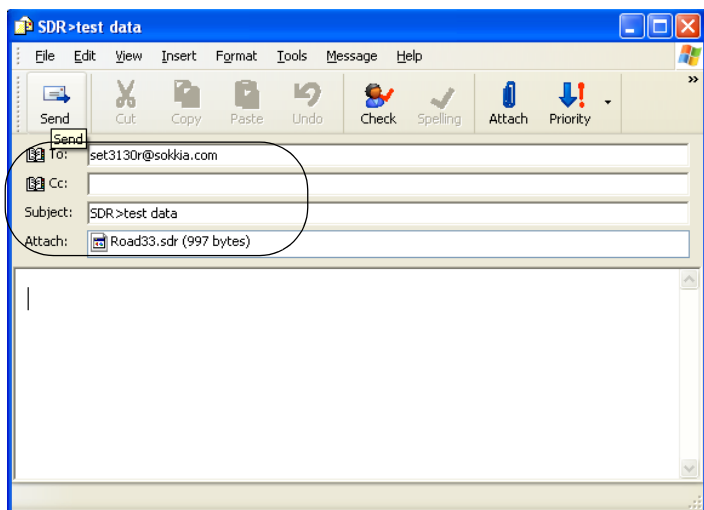
The SET selects incoming e-mail with a subject line starting with "SDR>" and displays them in a list.

☞ For more details on sending and receiving e-mails, see the operator's manual for your e-mail program.

28.12 Receiving e-mail from the SET

The method for receiving an e-mail from the SET on a computer is the same as that for receiving a normal e-mail.

🕊

• The subject line of the e-mail sent from the SET will be in the format, "SDR>*JOBNo.*" and the file name of the attached e-mail in the format, "*JOB name*.sdr".

Microsoft Outlook Express 6 Example
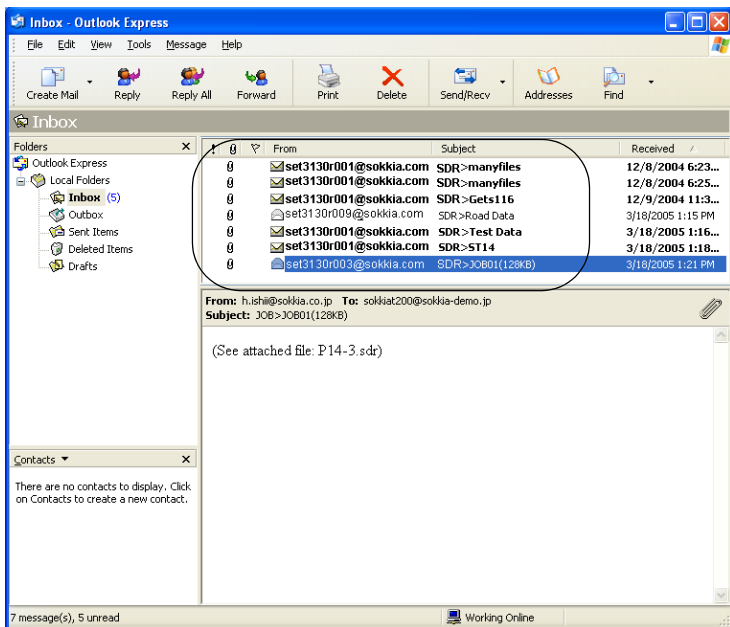
☞ For more details on sending and receiving e-mails, see the operator's manual for your e-mail program.

28.13 Troubleshooting

What follows is a list of foreseeable problems the operator may encounter while using SFX. Under each heading is a description of items to check and possible solutions. When a problem not listed here occurs or the suggested solution is ineffective, contact your local dealer.

Forgotten password

Clear the memory, delete password settings and set a new password.
Clearing the memory will delete all data.
Any important data should be transferred to a computer beforehand.

Loss of power during communication

A depleted battery cannot be replaced during communication. Check the remaining battery power before starting communication.
If the battery power is completely depleted during communication, the instrument will switch off but will still be connected to the internet. Disconnect the Internet connection before replacing the battery.
It is possible that e-mail has not been successfully transferred. If necessary transfer the e-mail again.

Failed connection

Cellular phone reception
Whenever possible, perform communication in areas where there is good cellular phone reception. When performing communication indoors radio field intensity is weak and the connection is unstable. For the service area of your cellular phone, ask your telecoms operator. For other details, see the operator's manual for your cellular phone.

E-mail program settings

Certain e-mail program settings may result in communication failure. Please consult the settings screen shown below. If the "No Attachment" error message is displayed even when a file has been attached, type a message in the body section of the e-mail.

(1) Using Microsoft Outlook Express 6
Select [Tools] - [Options] to open the following window.
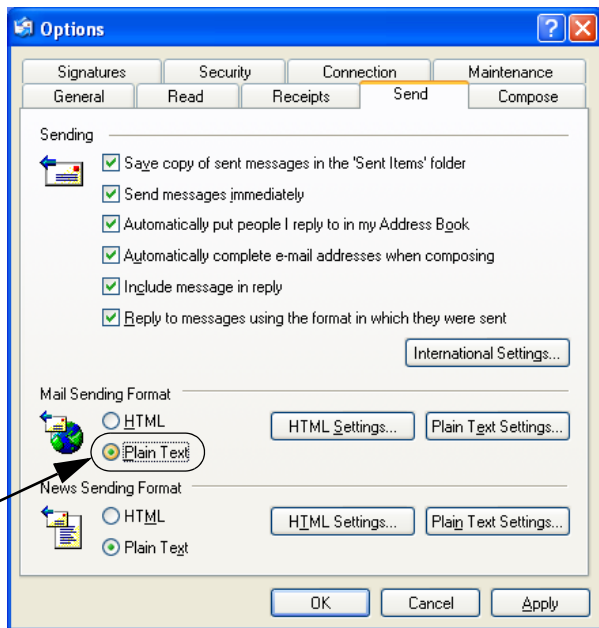
Set "Mail Sending Format" in the [Send] tab to "Plain Text".

Press "Plain Text Settings" to open the next window.
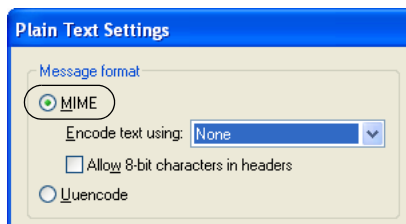
Set "message format" to "MIME".

(2) When using Mozilla Thunderbird 2.0.0
Select [Tools] - [Account Settings...], and select "Composition &
Addressing" of your account in <Account Settings>. Un-check "Compose
messages in HTML format".
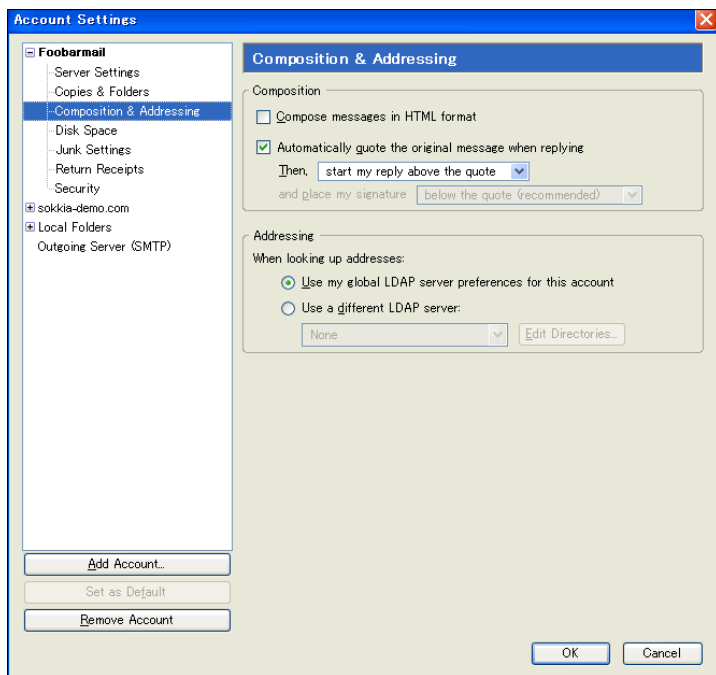
When an error occurs, the following error message appears.

```
E r r o r
P P P  e r r                    ──── error message
0 9 0 - 4 9 3 6 - 9 3 6 3       ──── location of error
( 2 0 1 . 6 . 2 0 : C o m m  e r r )  ──── error details
                    OK
```
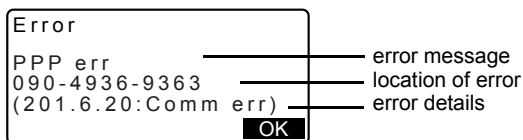
For error messages and troubleshooting solutions, see
"31. WARNING AND ERROR MESSAGES"

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29. USING EXTERNAL MEMORY MEDIA

It is possible to read in/output data from/to a USB memory device or SD card.

29.1 Inserting the USB Memory Device/SD Card

🔧:
• Do not remove the USB memory device or SD card during data read/write. Doing so will cause data stored in the external memory media or the SET to be lost.
• Do not remove the battery or turn off the power during data read/write. Doing so will cause data stored in external memory media or the SET to be lost.

PROCEDURE

1. Slide the catch on the external interface hatch cover down to open.
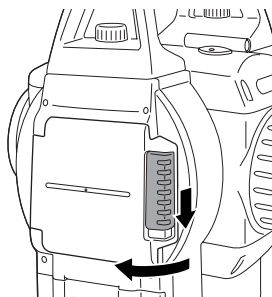
2. Insert the USB memory device/SD card in the respective slot.

   🔧:
   An SD card should be inserted with the contacts facing towards the instrument.

3. Close the cover.

Note
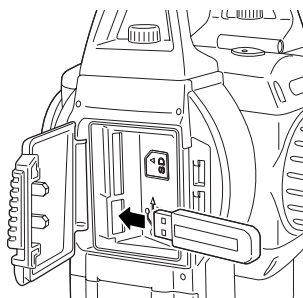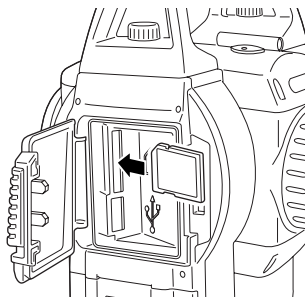
• Push an inserted SD card further into the slot and release to eject.

29.2 Selecting Media Type

PROCEDURE

1. Press **{ON}**.

2. Press **{ESC}** to display the Status screen.

3. Press **[MEDIA]** to display Media mode.

4. Select "Media selection".

```
Media              SD
 Media selection
 Save data
 Load known Pt.
 File status
 Quick format
```

5. Select desired media type from "SD" or "USB".

6. Press **{OK}**.

```
Media selection
 Type:SD


                        OK
```
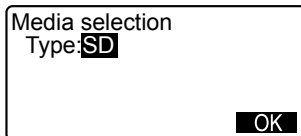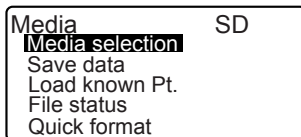
29.3   Storing JOB Data to External Memory Media

The measurement data (distance, angle, coordinate), known point data input on the SET, station point data and note stored in a JOB of the SET can be saved to the SD card/USB memory device. Also, if multiple JOBs are selected, they can be saved to one file.

• Data is saved in the external memory media with extension name .SDR and .CRD.

PROCEDURE

1. Select "Save data" in Media mode.

```
Media            SD
  Media selection
  Save data
  Load known Pt.
  File status
  Quick format
```

2. In the list of JOBs, select the JOB to be recorded and press **{◄──}**. "Out" is displayed to the right of the selected JOB. Multiple JOBs can be selected.

```
* JOB01          Out
  ATUGI          254
  JOB03          Out
  JOB04            0
  JOB05            0▼
                  OK
```

3. After selecting the JOB(s), press **[OK]**.

4. Enter the file name. Press **{◄──}** to set the data.

```
  JOB01. SDR
  Date  : Apr/01/2009
  Time  : 08:00
  Format:SDR33
  123.4MB /  3.8GB
                  OK
```

5. Press **[OK]** to save the JOB to the external memory media. After saving a JOB, the screen returns to the JOB list.

Remaining memory / Total memory size

    If **{ESC}** is pressed while data is being recorded, data recording is canceled.

Note

- Maximum size of file name: 8 characters (alphanumeric) excluding the file extension.
- Characters used to make File name: Alphabet (capital letters only), special characters (-)
- When a file is overwritten, the overwritten file is deleted.

29.4 Reading Known Point Data

By selecting "Load known Pt.", known point data stored in the external memory media can be read in the current JOB on the SET.

- Only coordinate records in files with the .SDR or .CRD extension name can be read on the SET.

PROCEDURE

1. Select "Load known Pt." in Memory mode.

```
Media              SD
   Media selection
   Save data
   Load known Pt.
   File status
   Quick format
```

2. Check the displayed current JOB name, then press **[OK]**

```
Load known Pt.

Job.JOB1

                        OK
```

3. In the list of files, select the file to be read in and press **{◀─┘}**.

```
ABCDE        SDR
FGHI         SDR
JKLMNOPQ SDR
ZZZ          SDR
```

4. Press **[YES]** to read in the file on the SET. <Media> is restored.

   To cancel reading, press **{ESC}**.

```
ABCDE        SDR
5354byte
Jan/01/2009      17:02
Format   :SDR33
          Confirm ?
               NO   YES
```

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29.5   Displaying and Editing Files
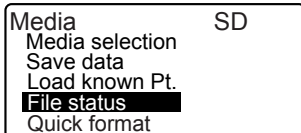
By selecting "File status", file information can be displayed, file names can be
edited and files can be deleted.

• When deleting all files together, format the external memory media.
☞ "29.6 Formatting the Selected External Memory Media"
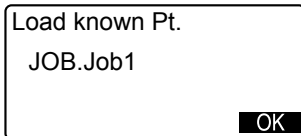
PROCEDURE Displaying File Information

1. Select "File status" in Media
    mode.
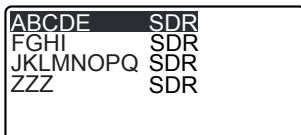
    ```
    Media            SD
     Media selection
     Save data
     Load known Pt.
     File status
     Quick format
    ```

2. Press **[OK]**.
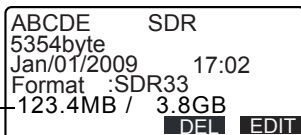
    ```
    Load known Pt.

     JOB.Job1


                        OK
    ```

3. In the list of the files stored in the
    external memory media, select a
    file to be displayed and press
    {◄┘}. Details of the file are
    displayed.

    ```
    ABCDE      SDR
    FGHI       SDR
    JKLMNOPQ SDR
    ZZZ        SDR
    ```

    ```
    ABCDE      SDR
    5354byte
    Jan/01/2009      17:02
    Format  :SDR33
    123.4MB /   3.8GB
                  DEL   EDIT
    ```

    Remaining memory / Total memory size

4. Press **{ESC}** to return to the file
    list.

PROCEDURE Editing the File Name

1. Follow steps 1 to 3 in "PROCEDURE Displaying File Information" until the screen shown at right is displayed.

```
ABCDE        SDR
5354byte
Jan/01/2009      17:02
Format  :SDR33
 123.4MB /   3.8GB
              DEL  EDIT
```

2. Press **[EDIT]** and enter a new file name. Press **{◄━━}** to enter the new file name. The edited file name is displayed on the screen.

```
ABCDE        .SDR
5354byte                 A
Jan/01/2003      17:02
Format  :SDR33
 123.4MB /   3.8GB
              DEL   OK
```

PROCEDURE Deleting a File

1. Follow steps 1 to 3 in "PROCEDURE Editing the File Name" until the screen shown at right is displayed.

```
ABCDE        SDR
5354byte
Jan/01/2009      17:02
Format  :SDR33
 123.4MB /   3.8GB
              DEL  EDIT
```

2. Press **[DEL]**. Press **[YES]**. The file is deleted and the screen returns to the file list.

29.6 Formatting the Selected External Memory Media

By selecting "Quick format", the SD card/USB memory device can be formatted. All files on the SD card/USB memory device are deleted, including files with extension names other than .SDR and .CRD.

PROCEDURE

1. Select "Quick format" in Media mode.

```
Media            SD
 Media selection
 Save data
 Load known Pt.
 File status
 Quick format
```

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2. Press **[YES]** to format. When formatting is completed, <Media> is restored.

```
Format media
    Confirm ?
            NO   YES
```
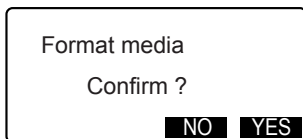
30. CHANGING THE SETTINGS

This section explains the contents of parameter settings, how to change settings and how to perform initialization. Each item can be changed to meet your measurement requirements.

30.1 EDM Settings

The following explains the EDM settings.
• "*": Factory setting

Press **[EDM]** in the second page of Meas mode.

```
EDM
Mode   :Fine"r"
Reflector:Prism
PC     :-30        ▶
Illum.hold: Laser
                   ⬇
```

```
EDM                ⬆
Temp   :  15°C
Press  :1013hPa
ppm    :   0

Oppm
```

• **[0ppm]**: Atmospheric correction factor returns to 0 and temperature and air pressure are set to the default values.
• Atmospheric correction factor is calculated and set using the entered values of the temperature and air pressure. Atmospheric correction factor can also be entered directly.

🚫

• "Illum. hold" is displayed only when the guide light option is mounted.

Items set, options, and input range (*: Factory setting)

Mode (Distance measurement Mode)	Fine "r"*, Fine AVG (Setting: 1 to 9 times), Fine "s", Rapid "r", Rapid "s", Tracking
Reflector	Prism*, Sheet, None (reflectorless)
PC (Prism constant)	-99 to 99 mm ("Prism" is selected: -30*, "Sheet" is selected: 0*)
Illum. hold	Laser (laser sight)*, Guide (Guide light)
Temp. (Temperature)	-30 to 60°C (15*)
Air pressure	500 to 1400hPa (1013*)/ 375 to 1050mmHg (760*)
ppm (Atmospheric correction factor)	-499 to 499 (0*)

Note

• The screen will be displayed only when "Illum. hold " is set to "Guide" and the cursor is on "Guide".

```
EDM
Mode   : Fine"r"
Reflector:Prism
PC     :-30          🕮
Illum.hold: Guide
Guide light: 3        ≈
```
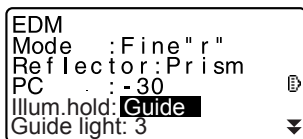
Item set and option (*: Factory setting)

The Guide light (Brightness level of the guide light)	1 to 3 (3*)

Atmospheric correction factor
The SET measures the distance with a beam of light, but the velocity of this light varies according to the index of refraction of light in the atmosphere. This index of refraction varies according to the temperature and air pressure.

• To precisely determine the atmospheric correction factor, the average temperature and air pressure along the measurement beam route must be taken. Take care when calculating the correction factor in mountainous terrain as the difference in height will result in differences in atmospheric conditions between two points.
• The SET is designed so that the correction factor is 0 ppm at an air pressure of 1013 hPa, a temperature of 15°C and a humidity of 0%.
• By inputting the temperature and air pressure values, the atmospheric correction value is calculated using the following formula and set into the memory.

$$ppm = 282.59 - \frac{0.2942 \times \text{air pressure (hPa)}}{1 + 0.003661 \times \text{air temperature (°C)}}$$

• If the weather correction is not required, set the ppm value to 0.
• The atmospheric correction factor can also be calculated in order to take humidity into account.

☞ "38.2 Atmospheric Correction for High Precision Distance Measurement"

📙 **Prism constant correction**
Reflective prisms each have their prism constant.
Set the prism constant correction value of the reflective prism you are using.
When selecting "None (Reflectorless)" in "Reflector", prism constant correction value is set to "0" automatically.

• The following are samples of the prism constant correction values of SOKKIA reflective prisms.

AP01S+AP01AR
(Constant = 30mm)

AP01AR (Constant = 40mm)   CP01 (Constant = 0mm)

Correction Value = −30

Correction Value = -40

Correction Value = 0
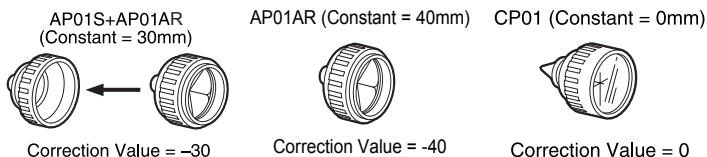
30.2   Configuration -Config Mode-

The following explains the Config Mode.

```
Config
Obs.condition
 Instr.config
 Instr.const
 Comms setup
 Unit
```

```
Key  function      ▲
Change Password
```
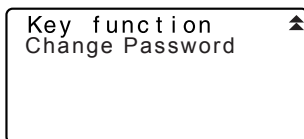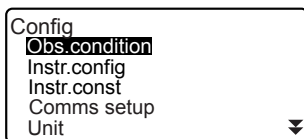
● **Observation Condition**

Select "Obs. condition" in Config mode

```
Dist mode: Sdist
Tilt  crn : Yes(H,V)
coll.crn : Yes
C&R crn. : K=0.20
V  manual: No
V. obs    : Zenith  ▼
```

```
Coord.      : N-E-Z  ▲
Ang.reso.  : 1"
Sea level crn  : No
Stn.ID Incr.   : 100
```
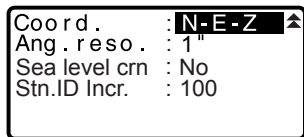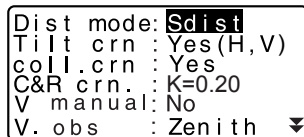
Items set and options (*: Factory setting)

Dist mode	Sdist*, Hdist, Vdist
Tilt crn (Tilt angle compensation)	Yes(H,V)*, Yes(V), No
coll. crn (Collimation correction)	Yes*, No

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C&R crn. (Earth curvature and refraction correction)	No, K=0.142, K=0.20*
V manual	Yes, No*
V.obs (Vertical angle display method)	Zenith*, Horiz, Horiz 90° (Horizontal ±90°)
Coord.	N-E-Z*, E-N-Z
Ang.reso.(Angle resolution)	SET250RX/350RX/550RX:1"*, 5" SET650RX:1", 5"*
Sea level crn (Sea level correction)	Yes, No*
Stn.ID Incr. (station ID increment)	0 to 99999 (100*)

📖 **Automatic tilt angle compensation mechanism**
The vertical and horizontal angles are automatically compensated for small tilt errors using the 2-axis tilt sensor.
• Read the automatically compensated angles when the display has stabilized.
• The horizontal angle error (vertical axis error) fluctuates according to the vertical axis, so when the instrument is not completely leveled, changing the vertical angle by rotating the telescope will cause the displayed horizontal angle value to change.
Compensated horizontal angle = Measured horizontal angle + Tilt in angle /tan (Vertical angle)
• When the telescope is directed close to the zenith or nadir angle, tilt compensation is not applied to the horizontal angle.

📖 **Collimation correction**
The SET has a collimation correction function that automatically corrects horizontal angle errors caused by horizontal axis and leveling axis errors.

📖 **Sea level correction**
The SET calculates horizontal distance using slope distance values. As this horizontal distance does not take height above sea level into consideration, performing spherical correction is recommended when measuring at high altitudes. Spherical distance is calculated as follows.

Spherical distance

$$= \frac{R - Ha}{R} \times d_1$$

Where: R = radius of the spheroid (6372000.000m)
        H_a = averaged elevation of the instrument point and target point
        d_1 = horizontal distance

V obs. (vertical angle display method)

Zenith   Horiz   Horiz 90°
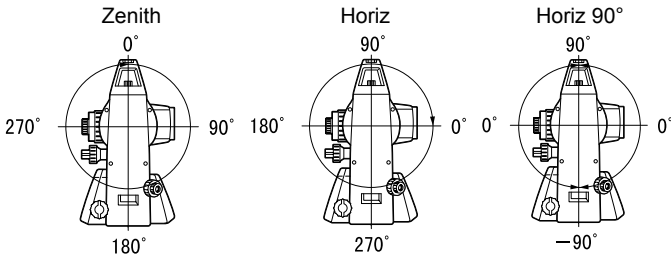
● **Instrument Configuration**

Select "Instr. Config" in Config mode

```
Power off    : 30min
Reticle lev: 3
Contrast     : 10
Resume       : Off
EDM ALC      : Free
Guide pattern : 1
```

• "Guide pattern" is displayed only when the guide light option is selected.

Items set and options (*: Factory setting)

Power off	5min, 10min, 15min, 30min*, No
Reticle lev	0 to 5 level (3*)
Contrast	0 to 15 level (10*)
Resume	On, Off*
EDM ALC	Hold, Free*
Guide pattern	1 (the red and green lights flash simultaneously)*/2 (the red and green lights flash alternately)

📖 **Power-saving automatic cut-off**
To save power, power to the SET is automatically cut off if it is not operated for the selected time.

📖 **Resume function**
When the Resume function is set to "On" and the power is switched off and then on again, the screen appearing before the instrument was switched off, or a prior screen is redisplayed.

📖 **EDM ALC**
Set the light receiving status of the EDM. While carrying out continuous measurement, set this item according to the measurement conditions.
 • When EDM ALC is set to "Free" the instrument's ALC will be automatically adjusted if an error occurs as a result of the amount of light received. Set to "Free" when the target is moved during measurement or different targets are used.
 • When "Hold" is set, the amount of light received will not be adjusted until initial adjustment has been performed and continuous measurement completed.
 • Try setting to "Hold" when the light beam used for measurement is stable but is frequently obstructed by obstacles such as people, cars, or tree branches etc. preventing measurement from being performed.

Note

 • The EDM ALC setting will automatically be switched to "Free" when the distance measurement mode is set to "Tracking" (target is moved during distance measurement).

● **Communication Setup**

Select "Comms setup" in Config mode

```
Wireless  : No          Xon/Xoff : Yes      ≜
Baud  rate: 9600bps
Data  bits: 8bit
Parity    : Not set
Stop  bit : 1bit
Check sum: No          ≛
```

Items set and options (*: Factory setting)

Wireless	Yes, No*
Baud rate	1200bps, 2400bps, 4800bps, 9600bps*, 19200bps, 38400bps
Data bits	8bit*, 7bit
Parity	Not set*, Odd, Even
Stop bit	1bit*, 2bit
Check sum	Yes, No*
Xon/Xoff	Yes*, No

☞ Output format and command operations: "Interfacing with the SOKKIA SDR Electronic Field Book" and "Command Operations" manuals.

Note **SFX Communication using *Bluetooth* technology**
Data can also be transferred using *Bluetooth* technology when a cellular phone equipped with *Bluetooth* wireless technology is registered as a companion device.
(☞ ""10. CONNECTING TO EXTERNAL DEVICES" PROCEDURE Registering Bluetooth companion devices")

Press **[MODEM]** in the screen at right.

```
Dial-up
Send mail
Receive mail
FTP connect

 ADR   FTP   A P  MODEM
```

Use {▶}/{◀} to select the cellular phone registered in the Link device list and press {◀━━}.

```
PORT config
Port      : F900iT
```

✦
• To perform SFX communication using *Bluetooth* technology, "Wireless" in "Comms setup" must be set to "Yes".
• When "Wireless" is set to "No", the **[MODEM]** softkey will not be displayed in <Dial-up>. "Port" will be automatically set to COM PORT and cannnot be changed.

● **Unit**

Select "Unit" in Config mode

```
Temp.      :°C
Press.     :hPa
Angle      :degree
Dist       :meter
```

Items set and options (*: Factory setting)

Temp. (Temperature)	°C*, °F	
Press	hPa*, mmHg, inchHg	
Angle	degree*, gon, mil	
Dist	meter*, feet, inch	
Feet (only displayed when	Int. feet*	(1m = 3.280839895),
"feet" or "inch" selected above)	US feet	(1m = 3.280833333)

📖 **Inch (Fraction of an inch)**

"Fraction of an inch" is the unit used in the United States and expressed like the following example.

10.875 feet → **10-10-1/2** inch
① ② ③
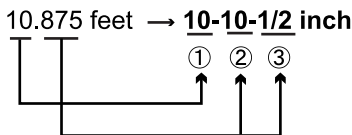
① **10**.000 feet
② 0.875 feet x 12=**10**.5 inch
③ 0.5 inch=**1/2** inch

✍

• Even if "inch" is selected in this setting, all the data including the result of area calculation are output in "feet" and all the distance values must be input in "feet". In addition, when the "inch" display exceeds the range, it is displayed in "feet".

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📖 **International feet and US survey feet**
The SET can display feet values in International feet and US survey feet units.
International feet, the standard feet units, are referred to simply as "feet" elsewhere in this manual.
US survey feet are units used in surveys by the U.S. Coast and Geodetic Survey and are referred to as "US feet" in this manual.
When "feet" or "inch" is selected in "Dist", the "Feet" item will appear on the screen as below. When "meter" is selected, this item will not be displayed.

```
Temp.        : °C
Press.       :hPa
Angle        :degree
Dist         :feet
Feet         :Int. feet
```

Results displayed in feet will differ according to the unit selected in this item.

30.3   Allocating Key Functions

It is possible to allocate the softkeys in Meas mode to suit the measurement conditions. It is possible to operate the SET efficiently because unique softkey allocations can be preset to suit various applications and the ways that different operators handle the instrument.

• The current softkey allocations are retained until they are revised again, even when the power is cut off.
• It is possible to register two sets of key function allocations: user setting 1 and user setting 2.
• It is possible to recall the softkey arrays registered for User 1 and User 2 as necessary.

🗷

• When softkey allocations are recorded and registered, the previously recorded key settings are cleared. When a softkey array is recalled, the key array is changed to the key array that has been recalled, clearing the previous key array. Be sure to remember this.

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● **The following are the softkey allocations when the SET was shipped.**
Page 1 **[DIST] [◢ SHV] [0SET] [COORD]**
Page 2 **[MENU] [TILT] [H.ANG] [EDM]**
Page 3 **[MLM] [OFFSET] [REC] [S-O]**

● **The following functions can be allocated to the softkeys.**

[DIST]	: Distance measurement
[◢ SHV]	: Switch between angle display and distance display
[0SET]	: Set horizontal angle to 0
[COORD]	: Coordinates measurement
[REP]	: Repetition measurement
[MLM]	: Missing line measurement
[S-O]	: Setting-out measurement
[OFFSET]	: Offset measurement
[REC]	: To Record menu
[EDM]	: Setting EDM
[H.ANG]	: Set required horizontal angle
[TILT]	: Display tilt angle
[MENU]	: To Menu mode (Coordinates measurement, setting-out measurement, offset measurement, repetition measurement, missing line measurement, REM measurement, resection measurement, surface area measurement, set-out line, set-out arc, point projection, intersections, traverse)
[REM]	: REM measurement
[RESEC]	: Recection measurement
[R/L]	: Select horizontal angle right/left
[ZA / %]	: Switch between zenith angle/slope in %
[HOLD]	: Hold horizontal angle/release horizontal angle
[RCL]	: Display final measurement data
[D_OUT]	: Output measurement results to an external instrument
[AIM]	: Return signal
[AREA]	: Surface area measurement
[F/M]	: Switch between meters/feet
[HT]	: Set the instrument station height and target height
[S-O LINE]	: Setting-out line measurement
[S-O ARC]	: Setting-out arc measurement
[P-PROJ]	: Point projection measurement
[INTSCT]	: Intersections measurement
[TRAVER]	: Traverse adjustment
[L-PLUM]	: Brightness configuration for laser plummet
[---]	: No functions set

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● **Softkey Allocation Examples**
It is possible to allocate the same key to each page (example 1). The same
function can be allocated to more than one key on the same page (example 2).
And it is also possible to allocate a function to only one key (example 3).
Allocation example 1:
P1 **[DIST] [▲ SHV] [H.ANG] [EDM]**
P2 **[DIST] [▲ SHV] [H.ANG] [EDM]**
Allocation example 2:
P1 **[DIST] [DIST] [▲ SHV] [▲ SHV]**

Allocation example 3:
P1 **[DIST] [▲ SHV] [– – –] [– – –]**

PROCEDURE   Allocating functions

1. Select "Key function" in Config
   Mode.
   Select "Define." Currently
   allocated softkeys are displayed in
   <Key function>.

2. Align the cursor with the softkeys
   whose allocation you want to
   change using {▶}/{◀}.
   The cursor of the selected softkey
   flashes.

```
Key function

DIST  ▲SHV  0SET  COORD
MENU  TILT  H.ANG EDM
MLM   OFFSET REC   S-O
                   OK
```

3. Change the softkey function using
   {▲}/{▼}.
   Set the softkey function and its
   location by pressing {▶}/{◀}. The
   set softkey stops flashing and the
   cursor flashes on the next softkey.

4. Repeat steps 2 to 3 only as many
   times as necessary.

5. Press **[OK]** to record the
   allocations and restore <Key
   function>.
   The functions with their new
   allocations are displayed in Meas
   mode.

PROCEDURE Registering an allocation

1. Allocate functions to the softkeys.
   ☞ "PROCEDURE Allocating
      functions"

2. Select "Key function" in Config
   mode.

3. Select "Registration."
   Select either "User 1" or "User 2"
   as the softkey array to be
   registered.

4. Press **{◄─┃}**. The softkey array is
   registered as user 1 or user 2 and
   <Key function> is restored.

```
Key  function
User's 1
User's 2

Registered to 1
```

PROCEDURE Recalling an allocation

1. Select "Key function" in Config
   Mode.

2. Select "Recall." Select the key
   array for either User 1, User 2, or
   Default (setting when the SET was
   shipped), and press **{◄─┃}**.
   <Key function> is restored. This
   displays the functions in the
   recalled array in Meas mode.

```
Key  function
User's 1
User's 2
Default
```

30.4   Changing Password

Set password can be changed.

• No password was set when the SET was shipped.

PROCEDURE Changing password

1. Select "Change Password" in Config mode.

2. Input old password and press **{◄┘}**.

```
Change password
Old password
:████████
```

3. Input new password twice and press **{◄┘}**. The password is changed and <Config> is restored.

```
Change password
New password
: ********
New password again
:████████
```

   • If no password was input as new password and **{◄┘}** was pressed, no password is set.

Note

• Input range of password: 3 or more characters and 8 or fewer characters

30.5 Restoring Default Settings

The following explains the two methods of restoring default settings:
Restoring set items to initial settings and turning power on. Initializing the data and turning power on.

• Restore the following items to the initial settings when the SET was shipped.
  EDM setting, Config mode settings (including softkey arrays)
☞ About initial settings when the SET was shipped: "30.1 EDM Settings",
  "30.3 Allocating Key Functions"
• Initialize the data. The following data is initialized.
  Data within all jobs
  Known point data within memory
  Code data within memory
  Dial-up menu password

PROCEDURE Restoring set items to initial settings and turning power on

1. Turn the power off.

2. While pressing {F4} and {BS},
   press {ON}.

3. The SET is turned on, "Default
   set" appears on the screen and all
   items are restored to their initial
   settings.

PROCEDURE Initializing the data and turning the power on

1. Turn the power off.

2. While pressing {F1}, {F3} and
   {BS}, press {ON}.

3. The SET is turned on, "Clearing
   memory..." appears on the screen
   and all items are restored to their
   initial settings.

31. WARNING AND ERROR MESSAGES

The following is a list of the error messages displayed by the SET and the meaning of each message. If the same error message is repeated or if any message not shown below appears, the instrument has malfunctioned. Contact your local dealer.

Attached file err

The file extension of the selected file is not ".sdr".

BadCondition

The air is shimmering a lot, etc., measuring conditions are poor.

The center of the target cannot be sighted.
Resight the target.

Unsuitable distance measurement conditions when reflectorless measurement is set. When reflectorless measurement is set, distance cannot be measured because the laser beam is striking at least two surfaces at the same time.
Choose a single surface target for distance measurement.

Bad file name

File name is not entered when saving data on external media.

Calculation error

Coordinates identical to the known point coordinates observed during resection exist. Set another known point so that the known point coordinates do not coincide.

Can't move dir

An error occurred while trying to move a directory on the FTP server.

Cannot format Read-only file exist

External media contains read-only file. External media cannot be formatted.

Checksum error

A sending/repetition error has occured between the SET and external equipment.
Send/receive the data again.

Clock error

Clock error occurs when the voltage of the lithium battery decreases or the battery itself is depleted. For details on replacing lithium batteries contact your local dealer.

Communication error
Comm err

A reception error has occurred in coordinate data from an external instrument.
Check the settings of parameters concerning communication conditions.
☞ "30.2 Configuration -Config Mode-"

Delete mail err

An error occurred while trying to delete received e-mail.

Encode err

Correct encoding (HEXBIN) is not used. Check that HEXBIN is set in the encoding settings for the e-mail software being used.

FileName Full

This file name cannot be used again. File names made up of said file name plus all possible single-letter suffixes "a" to "z" already exist on the server.

File not exist

This file does not exist in the current directory.

Flash write error!
Flash mount error!
FlashMem err

It is impossible to read in data.
Contact your local dealer.

FTPfile open err

An error occurred while trying to open a file on the FTP server.

FTP receive err

An error occurred while reading in a file from the FTP server.

FTP send err

An error occurred while writing a file to the FTP server.

FTPsvr con error

An error occurred while connecting to the FTP server. Check the FTP server settings.

FTPsvr search err

An error occurred while obtaining a file list from the FTP server.

Incorrect Password

    Input password does not match set password. Input correct password.

Insert media

    External media is not inserted.

Invalid media

    Incorrect external media is inserted.

Invalid baseline

    During setting-out line measurement or point projection measurement, baseline has not been defined correctly.

Job data err

    Cannot read/write JOB data. Either the JOB name is invalid or an internal error occurred.

Job record full

    No more records can be recorded in the current JOB. Record in a different JOB.

Line not terminated

    A JOB data format error has occurred.

Mail not exist

    There is no e-mail for the SET. Check that the e-mail sent included a correct subject line.

Mail search err

    The mail list could not be obtained due to an error during reception. Try again.

Media error

    An error has occurred in loading or saving data to external media.

Media full !

    There is no more room to enter data on external media.

Media not found

    External media was removed during Media mode operation.

Memory is full

    There is no more room to enter data.
    Record the data again after deleting unnecessary data from the JOB or coordinate data from the memory.

Need 1st obs

    During missing line measurement, the observation of the starting position was not completed normally.

    Sight the starting position accurately and press **[OBS]** to perform the measurement again.

Need 2nd obs

    During missing line measurement, the observation of the target was not completed normally.

    Sight the target accurately and press **[MLM]** to perform the measurement again.

Need offset pt.

    Observation of the offset point during offset measurement was not completed normally.

    Sight the offset point accurately and press **[OBS]** to perform the measurement again.

Need prism obs

    During REM measurement, the observation of the target was not completed normally.

    Sight the target accurately and press **[OBS]** to perform measurement again.

New password Diff.

    Passwords input when setting a new password do not match.

    Input the same password twice.

No attached file

    There is no file attached to the selected e-mail.

No data

    When searching for or reading in coordinate data or searching for code data, the search stopped either because the item in question does not exist or the data volume is large.

No file

    There is no file for loading known point data or displaying data on the currently selected external media.

No solution

    The calculation of the instrument station coordinates during resection does not converge.

    Assess the results and if necessary, perform the observation again.

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Intersect point could not be calculated. Either necessary data items were not input or the Intersect point does not exist.

North/East is null, Read error
The Northing or Easting field of the given coordinate is null.
Input the coordinate.

Out of range
The tilt of the instrument exceeds the tilt angle compensation range during measurement.
Level the instrument again.
☞ "7.2 Levelling"

Out of value
During gradient % display, the display range (less than ±1000%) has been exceeded.
During REM measurement, either the vertical angle has exceeded horizontal ±89° or the measured distance is greater than 9999.999m.
Install the instrument station far from the target.

The instrument station coordinates calculated during resection are too high.
Perform the observation again.

During setting-out line measurement, scale factor has been less than 0.100000 or exceeded 9.999999.

During area calculation, results exceeded the display range.

Over files
Files cannot be added to the external media because they exceed the file number limit.

POPsvr con error
Connection to the POP server failed. Check the POP server settings.

PPP err
An error occurred during dial-up connection. Check that the phone and cable are connected correctly and that the correct login name and password have been entered.

Print or send first

JOB data output (transmission to the host computer or output to the printer) is not completed before JOB is cleared.

Either transmit the JOB to be cleared to the host computer or output it to the printer.

Pt already on route

Traverse tried to close on a traverse point other than the Start pt. during automatic route search. Press any key to return to the last point found in automatic route search. Either select the next traverse point to continue the current search or specify the Start pt. to close a closed-loop traverse.

RAM cleared

(Displayed when the SET is switched on) The resume function does not work because more than one week (memory back-up period) has passed since the SET was last switched off.

After more than one week, even though "Resume" is still set to "On," the resume function has been canceled.

Rcv mail err

An error occurred while e-mail was being received.

Read-only file

Read-only file on the external media cannot be changed and file contents cannot be edited or deleted.

Same coordinates

The same values are input in Pt.1 and Pt.2 in setting-out line measurement. SET cannot define the baseline.

SDR format err

The file read in is not SDR format. Check the file.

Send mail err

An error occurred while e-mail was being sent.

Signal off

Measuring conditions are poor, and there is not any reflective light for measuring distances.

Resight the target. When using reflective prisms, effectiveness will be improved by increasing the number of prisms used.

SMTPsvr con error

An error occurred while connecting to the SMTP server. Check the SMTP server settings.

Station coord is Null

Cannot calculate. Station point coordinate is set to "Null".
Input the coordinate.

Temp Range OUT

SET is outside useable temperature range and accurate measurement
cannot be performed. Repeat measurement within the appropriate
temperature range. If the SET is used under direct sunlight, use an umbrella
to protect it against the heat of the sun.

Time out (during measurement)

Measuring conditions are poor, and due to the insufficient amount of reflective
light, measuring could not be carried out within the time specified.
Resight the target. When using reflective prisms, effectiveness will be
improved by increasing the number of prisms used.

Time out (during SFX dial-up communication)

Operation was not completed within the time specified so was forcibly
terminated.

Too short

Input password has fewer than 3 characters. Password must have 3 or more
characters and 8 or fewer characters.

✽✽✽✽✽✽✽✽

The calculated result is too large to be displayed on the screen in its totality.
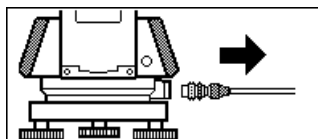
If the printer cable is attached during measurement, measurement cannot be
carried out correctly. SET notifies you by displaying the screen above and
beeping. When the cable is removed, the previous screen is restored.
If connected SDR or host computer is turned Off, the above screen appears.
This is normal, and does not indicate trouble. If connected SDR or host
computer is turned On again or cable is connected again, the previous screen
is restored.

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32. CHECKS AND ADJUSTMENTS

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

- Always perform checking and adjustment in the proper sequence beginning from "32.1 Plate Level" to "32.8 Guide Light".
- In addition, the instrument should be inspected with special care after it has been stored a long time, transported, or when it may have been damaged by a strong shock.
- Make sure the instrument is securely set up and stable before performing checks and adjustments.

32.1 Plate Level

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

PROCEDURE Checking and adjusting

1. Level the instrument and check the position of the bubble of the plate level.
   ☞ "7.2 Levelling" steps 3 to 5

2. Turn the upper part through 180° and check the bubble position.
   If the bubble is still centered, no adjustment is necessary.
   If the bubble is off-center, adjust as follows.

3. Correct half of the bubble displacement using levelling foot screw C.
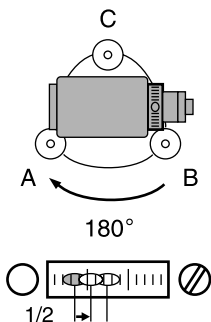
4. Correct the remaining half of the displacement by using the adjustment pin to rotate the plate level adjustment screw. When the plate level adjustment screw is turned in the counterclockwise direction, the bubble moves in the same direction.

Center

5. Rotate the top of the instrument and continue adjustments until the bubble remains centered for any position of the upper part. If the bubble does not move to the center even when the adjustment has been repeated, ask your local dealer to adjust it.
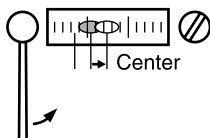
32.2 Circular Level

PROCEDURE Checking and adjusting

1. Perform the plate level inspection and adjustment or carefully use the plate level to level the instrument.
   ☞ "7.2 Levelling" steps 1 to 2

2. Check the position of the bubble of the circular level. If the bubble is not off-center, no adjustment is necessary. If the bubble is off-center, perform the following adjustment.

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

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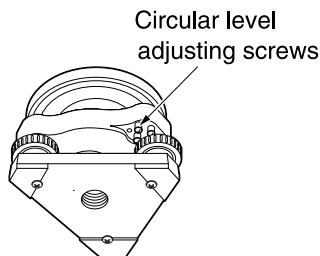
4. Adjust the adjusting screws until
   the tightening tension of the three
   screws is the same to align the
   bubble in the middle of the circle.

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

32.3   Tilt Sensor

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

PROCEDURE Check

1. Carefully level the instrument. If
   necessary, repeat the procedures
   to check and adjust the bubble
   levels.

2. Set the horizontal angle to 0°.
   Press **[0SET]** twice in the first
   page of the Meas mode screen to
   set the horizontal angle to 0°.

3. Select "Instr. const" in the Config. mode screen to display the current correction constant in the X (sighting) direction and Y (horizontal axis) direction.

```
Config
  Obs.condition
  Instr.config
  Instr.const
  Comms setup
  Unit
```

```
Instr.const
 Tilt X-10  Y 7
 Collimation
```

Select "Tilt X Y" and press {◄──} to display the tilt angle in the X (sighting) direction and Y (horizontal axis) direction.

```
Tilt offset
X      -0°01'23"
Y       0°00'04"
HAR    00°00'00"
 Take F1
            OK
```

4. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X1 and Y1.

5. Loosen the horizontal clamp and turn the instrument 180° while referring to the displayed horizontal angle, then retighten the clamp.

6. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X2 and Y2.

```
Tilt offset
X      -0°00'03"
Y       0°00'04"
HAR   180°00'00"
 Take F2
            OK
```

7. In this state, calculate the following offset values (tilt zero point error).
Xoffset = (X1+X2)/2
Yoffset = (Y1+Y2)/2

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If one of the offset values (Xoffset, Yoffset) exceeds ±20", adjust the value using the following procedure.
When the offset value falls within the range ±20", adjustment is not necessary.
Press **{ESC}** to return to <Instr. const>.

PROCEDURE Adjustment

8. Store values X2 and Y2.
    Press **[OK]**. "Take F2" is displayed.

9. Rotate the top of the instrument through 180° until the displayed horizontal angle is 180° ±1' and **[OK]** is displayed.

10. Wait a few seconds for the display to stabilize, then store the automatically compensated angles X1 and Y1.
    Press **[YES]** to store tilt angles X1 and Y1. The new correction constant is displayed.

```
Tilt offset
Current X-10  Y 7
New     X 4   Y-11


              NO   YES
```

11. Confirm that the values are in the adjustment range.
    If both correction constant are within the range ±180, select **[YES]** to renew the correction angle. <Instr. const> is restored. Continue to step 12.
    If the values exceed the adjustment range, select **[NO]** to cancel the adjustment and restore <Instr. const>. Contact your local dealer to perform the adjustment.

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PROCEDURE Recheck

12. Press **{◄▬}** at <Instr. const>.

13. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X3 and Y3.

14. Rotate the top of the instrument through 180°.

15. Wait a few seconds for the display to stabilize, then read the automatically compensated angles X4 and Y4.

16. In this state, the following offset values (tilt zero point error) are calculated.
    Xoffset = (X3+X4)/2
    Yoffset = (Y3+Y4)/2
    When both offset values fall within the range ±20", adjustment is completed.
    Press **{ESC}** to return to <Instr. const>.

    If one of the offset values (Xoffset, Yoffset) exceeds ±20", repeat the check and adjustment procedures from the beginning. If the difference continues to exceed ±20" after repeating the check 2 or 3 times, have your local dealer perform the adjustment.

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32.4   Collimation

With this option you can measure collimation error in your instrument so that the SET can correct subsequent single face observations. To measure the error, make angular observations using both faces.

Procedure

1. Display <Collimation>.
    Select "Instr.const" in the Config. mode screen and select "Collimation".

2. Sight the reference point in Face 1.
    Sight the reference point in Face 1 and press **[OK]**.

3. Sight the reference point in Face 2.
    Rotate the instrument 180°. Sight the same point in Face 2 and press **[OK]**.

```
Collimation
  EL.    -0°00'15"
V Off.    0°00'10"


          NO   YES
```

4. Set the constant.
    Press **[YES]** to set the constant.

    • Press **[NO]** to discard the data and return to <Collimation>.

32.5 Reticle

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

1. Carefully level the instrument.

2. Align a clearly visible target (the edge of a roof for example) on point A of the reticle line.
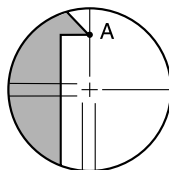
3. Use the telescope fine motion screw to align the target to point B on a vertical line.
   If the target moves parallel to the vertical line, adjustment is unnecessary. If its movement deviates from the vertical line, have our service representative adjust it.
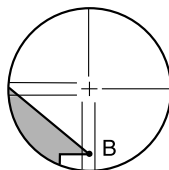
PROCEDURE Check 2: Vertical and horizontal reticle line positions

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

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

2. Level the instrument carefully, turn on the instrument's power.

3. While the Meas mode screen is displayed and the telescope is in face left, sight the center of the target and read out the horizontal angle A1 and the vertical angle B1.
   Example: Horizontal angle A1=18° 34' 00"
   Vertical angle B1=90° 30' 20"

4. While the telescope is in face right, sight the center of the target and read out the horizontal angle A2 and the vertical angle B2.
   Example: Horizontal angle A2=198° 34' 20"
   Vertical angle B2=269° 30' 00"

5. Do the calculations:
   A2-A1 and B2+B1
   If A2-A1 is within 180°±20″and B2(B1 is within 360°±40″, adjust ment is unnecessary.
   Example: A2-A1 (Horizontal angle)
   =198° 34' 20"- 18° 34' 00"
   =180° 00' 20"
   B2-B1 (Vertical angle)
   =269° 30' 00" + 90° 30' 20"
   =360° 00' 20"
   If the difference is large even after repeating the check 2 or 3 times, have our service representative perform the adjustment.

32.6   Optical Plummet

PROCEDURE Check

1. Carefully level the SET and exactly center a survey point in the reticle of the optical plummet.

2. Turn the upper part 180° and check the position of the survey point in the reticle.
    If the surveying point is still centered, no adjustment is necessary.
    If the surveying point is not still centered in the optical plummet, adjust as follows:
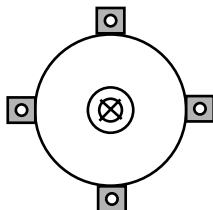
PROCEDURE Adjustment

3. Correct half the deviation with the levelling foot screw.

    1/2
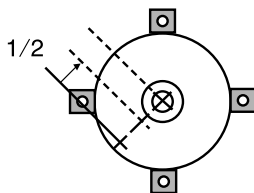
4. Firmly hold down the top portion of the instrument, and remove the optical plummet knob cover, then remove the optical plummet reticle cover on the inside.
    Replace the optical plummet knob cover.
    Use the 4 adjusting screws of the optical plummet to adjust the remaining half of the deviation as show below.

    Optical plummet reticle cover

    Optical plummet knob cover

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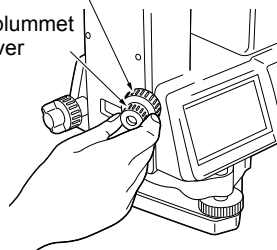
5. When the survey point is on the lower (upper) part of the illustration:
   1 Loosen the upper (lower) screw slightly.
   2 Tighten the lower (upper) screw by the same amount.
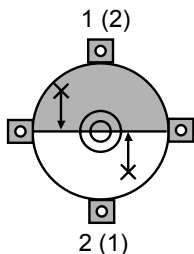
6. If the survey point is on the solid line (dotted line):
   3 Loosen the right (left) screw slightly.
   4 Tighten the left (right) screw by the same amount.
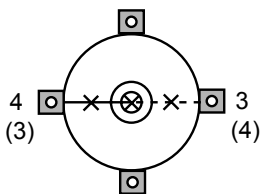
7. Check the adjustment by rotating the upper part of the instrument. The survey point should remain centered in the reticle. If necessary, repeat the adjustment.
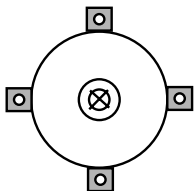
8. Remove the optical plummet knob cover, and install the optical plummet reticle cover on the inside.
   Replace the optical plummet knob cover.

✍

Do not over-tighten the 4 adjusting screws as this may cause the reticle to go out of adjustment.

32.7   Additive Distance Constant

The additive distance constant K of the SET is adjusted to 0 before delivery.
Although it almost never deviates, use a baseline with a known distance precision
to check that the additive distance constant K is close to 0 several times a year
and whenever the values measured by the instrument begin to deviate by a
consistent amount. Perform these checks as follows.

✘

• Errors in setting up the instrument and reflective prism or in sighting the target
  will influence the additive distance constant. Be extremely careful to prevent
  such errors when performing these procedures.
• Set up so that the instrument height and the target height are identical. If a flat
  place is not available, use an automatic level to make sure the heights are
  identical.

PROCEDURE Check

1. Find an area of flat ground where
    two points 100m apart can be
    selected.
    Set up the Instrument at point A
    and the reflective prism at point B.
    Establish a point C half way
    between points A and B.
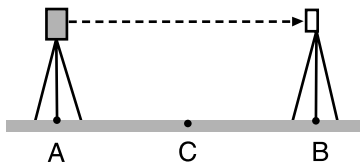
2. Precisely measure the horizontal
    distance between point A and
    point B 10 times and calculate the
    average value.

3. Place the SET at point C directly
    between points A and B and set
    up the reflective prism at point A.
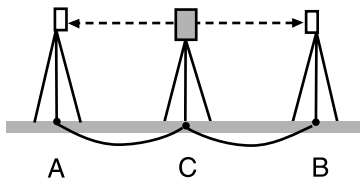
4. Precisely measure the horizontal
    distances CA and CB 10 times
    each and calculate the average
    value for each distance.

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5. Calculate the additive distance constant K as follows.
   K = AB - (CA+CB)

6. Repeat steps 1 to 5 two or three times.
   If the additive distance constant K is within ±3mm even once, adjustment is unnecessary.
   If it always exceeds this range, have our service representative perform an adjustment.

32.8   Guide Light

When the dividing line (the position where it switches back and forth from red to green) for the red and green guide lights is off centered from the reticle lines, use the following procedures to make adjustments.

✗

• The guide light is an optional function. Set "Illum. Hold" to "Guide" in Config. mode, Use the setting page to select, check and adjust the guide light.
   ☞ "30.1 EDM Settings" and "36. OPTIONAL ACCESSORIES"

PROCEDURE Checks

1. Install a prism at a point about 20 meters in the horizontal direction from the SET.

2. Level the instrument.

3. Sight the center of the prism with the telescope (face left).

4. Hold {☼} down to turn the guide lights on.

5. Set the horizontal angle to 0° by pressing **[0SET]** twice on the first page of the Meas mode.

6. Look through the telescope to verify that the guide lights are being reflected in the prism.

   If both colors (red and green) are visible: proceed to procedure 7. If only the red or the green are visible: proceed to procedure 10.
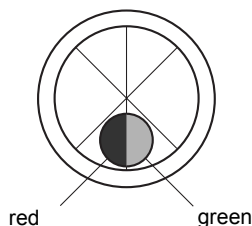
red   green

7. Move the top of the instrument slightly while looking through the telescope, measure the horizontal angle of the position that changes only to green from both colors (red and green) of the guide light colors that are reflected in the prism.

8. Move the top of the instrument slightly while looking through the telescope, measure the horizontal angle of the position that changes only to red from both colors (red and green) of the guide light colors that are reflected in the prism.

9. Calculate the difference of the angle of the horizontal angle to search for the offset direction of the dividing line of the guide lights from the measurement values of procedures 7 and 8.

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Example:
 (Procedure 7) The horizontal angle 0°03' 30" = 04' 30" to the right from the reticle line (=0° set position) of the position that changes to green only from both colors (red and green) of the colors of the guide lights that are reflected in the prism.
(Procedure 8) The horizontal angle 359°57' 00" = 03' 00" to the left from the reticle line (=0° set position) of the position that changes to green only from both colors (red and green) of the colors of the guide lights that are reflected in the prism.

➡ The angle difference for procedures 7 and 8 is 1' 30," with this the dividing line for the green and the red shifts to the right side (the green side).

Range for both colors
Red only range
Green only range
359°57'00"   00°00'00"   00°04'30"
3'00"   4'30"

Note

The illustration depicts how the left and right colors of the guide light are reflected in a prism and seen when viewed through the telescope.

When the angle difference is more than 1', proceed to the adjustments for procedure 10.

When the angle difference is less than 1', adjustments are unnecessary.

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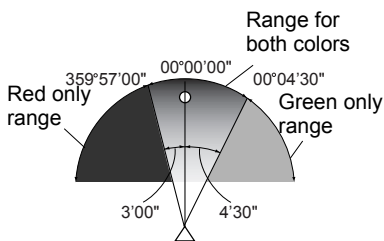
PROCEDURE Adjustments

10. Adjust the dividing line for the red and green lights of the guide lights that are reflected in the prism so that it is centered in the reticle. When only the red is visible, or if the dividing line shifts onto the red side: turn the guide light adjustment screw clockwise. When only the green is visible, or if the dividing line shifts onto the green side: turn the guide light adjustment screw counterclockwise.

Guide light adjustment screw
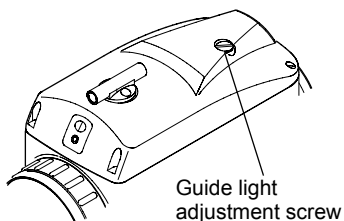
11. Carry out a check of procedures 7 to 9 once again. When the measurement value difference for the horizontal angle is more than 1', then repeat the adjustments for procedure 10. When the measurement value difference for the horizontal angle is less than 1', then adjustments are complete.

32.9   Laser Plummet

Checks and adjustments are performed using an adjustment target (cut out and use targets printed at the back of this manual). As this target is made of paper great care must be taken to prevent it getting wet.

PROCEDURE Check

1. Level the instrument and emit the laser plummet beam.
   🔗 "7.2 Levelling"

2. Rotate the upper part horizontally and place a target so that it is aligned with the center of the circle created by the rotating laser plummet beam.
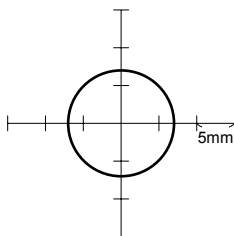
   • Laser beam remains centered on the center of the target – No adjustment necessary
   • Laser beam strays from the center of the target – Adjustment necessary.
   • Laser beam draws a circle outside the target circle – Contact your local dealer.

PROCEDURE Adjustment

1. Turn the laser plummet adjustment cap anticlockwise and remove.
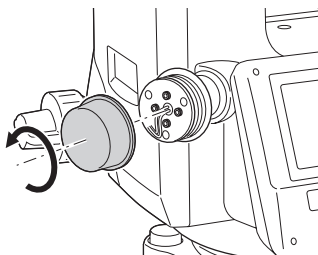
2. Emit the laser plummet beam.

3. Note the current position (x) of the laser beam.

4. Turn the upper part of the instrument horizontally through 180° and note the new position (y) of the laser beam.
    Adjustment will bring the laser beam to a point midway along a line drawn between these two positions.

x   Desired final position   y
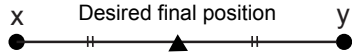
5. Check the position of the desired final position. Place a target so that its center is aligned with the desired final position.
    The remaining deviation will be adjusted using the 4 fine adjustment screws.

Target
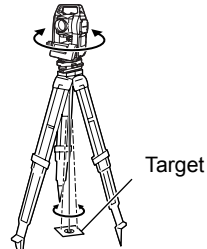
    ✖:
    •   Be extremely careful to adjust all the fine adjustment screws by the same amount so that none will be over-tightened.
    •   Turn screws clockwise to tighten.
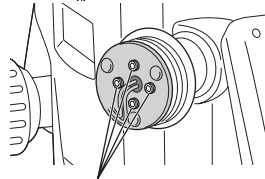
Fine adjustment screws

6. When the laser beam is on the upper (lower) part of Fig. A the up/down adjustment is made as follows:

    ① Insert the provided hexagon key wrench into both the upper and lower screws.

Desired final position

Fig. A

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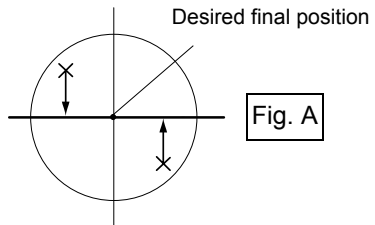
② Slightly loosen the upper (lower) screw and tighten the lower (upper) screw. Make sure that the tightening tension for both screws is identical. Continue to adjust until the laser beam is on the horizontal line of the target.

7. When the laser beam is in the right (left) part of Fig. B the left (right) adjustment is made as follows:

① Insert a hexagon key wrench into both the left and right screws.

② Slightly loosen the right (left) screw and tighten the left (right) screw. Make sure that the tightening tension for both screws is identical. Continue to adjust until the laser beam is aligned with the target center.
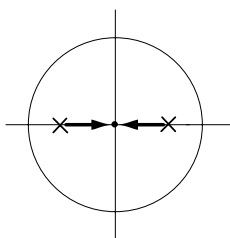
Fig. B

8. Turn the upper part of the instrument horizontally and check that the laser beam is now aligned with the target center.

9. Re-attach the laser plummet adjustment cap.

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Note
• Tightening each of the fine adjustment screws moves the laser plummet beam in the directions shown below.

Fine adjustment screws

Laser plummet adjustment cap pointing towards user
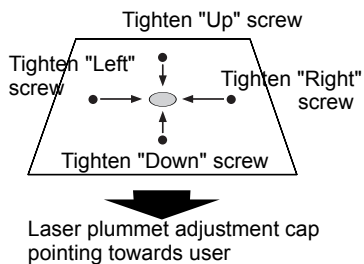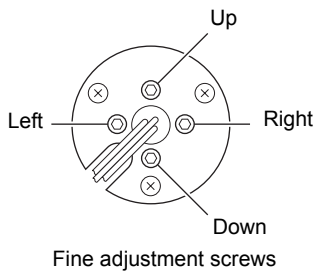
33. POWER SUPPLIES

• Operate your SET with the following combinations of power equipment.

🚫

• Be sure to carefully read the operating manuals for the battery and charger before operating.
• Never use any combination other than those indicated below. If you do, the SET could be damaged.

Battery	Charger	Cable for charger
BDC46B	CDC68	EDC113A/C (110 to 240 VAC) EDC113B (110 to 125 VAC)

AC adapter*	Power cable*
EDC2A Output cable length: 3m	EDC113A/C (110 to 240V AC) EDC113B (110 to 125V AC)
EDC136-compliant EDC2A (w/ label) EDC2A (0.8m) D72168C 防水ケース（EDC136）に収納可能 It is possible to store EDC2A in water-resistant case (EDC136) Output cable length: 0.8m	

Water-resistant case*
EDC136   EDC137A/C (110 to 240V AC) EDC137B (110 to 125V AC)

Cable*	External battery*	Charger*
EDC119	BDC60 (7.2 VDC,6.5Ah)	CDC71 AC adapter EDC117 (100 to 240 VAC) EDC34/35
	BDC61 (7.2 VDC,13Ah)	For car cigarette lighter EDC115 (12 VDC)

*: Optional accessories for SET250RX and Low Temperature Models.

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● **External power supply equipment**
· When using EDC2A mount the BDC46B in place to maintain the balance of the instrument.
· Make sure that the car cigarette lighter is 12 V DC and that its negative terminal is grounded. Use it with the car engine running.

34. TARGET SYSTEM

- Because all SOKKIA reflecting prisms and accessories have standardized screws, it is possible to combine these prisms, accessories, etc. according to your objectives.
- The following are all special accessories (sold separately).
- Because these targets (*2) are coated with fluorescent paint, they reflect when there is little light.

🚫

- When using a reflecting prism equipped with a target for distance and angle measurements, be sure to direct the reflective prism correctly and sight the center of the prism target accurately.
- Each reflective prism (*1) has its own prism constant value. When changing prisms, be sure to change the prism constant correction value.
- To use the triple prism assembly AP31 or AP32 as a single prism for short distance measurements, mount the single reflective prism AP01AR in the center mounting hole of the prism holder.
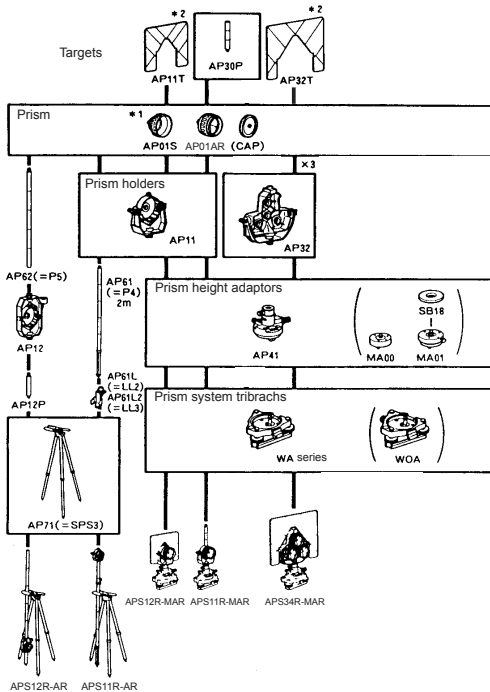
● **2-point target (2RT500-K)**
This target is used for two-distance offset measurement.

Note

• For information about reflective sheet targets and target devices, contact your local dealer.
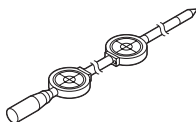
● **Instrument height adaptor (AP41)**
This device is used to adjust the height of the target.

• Adjust the level of the AP41 instrument height adaptor following the checking and adjustment methods of plate level.
ᏒᎡ "32.1 Plate Level"

Height adjustment window

• Adjust the optical plummet of the AP41 instrument height adaptor following the checking and adjustment methods of optical plummet.
ᏒᎡ "32.6 Optical Plummet"

• Make sure that the instrument height "236" (mm) is displayed in the instrument height adjustment window.
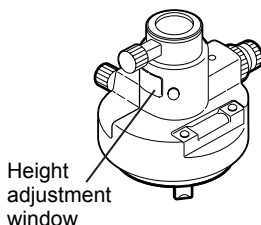
● **Adjusting plate (WASeries)**
Adjust the circular level of the adjusting plate for a prism following the checking and adjustment methods of circular level.
ᏒᎡ "32.2 Circular Level"

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35. STANDARD EQUIPMENT

Please verify that all equipment is included.
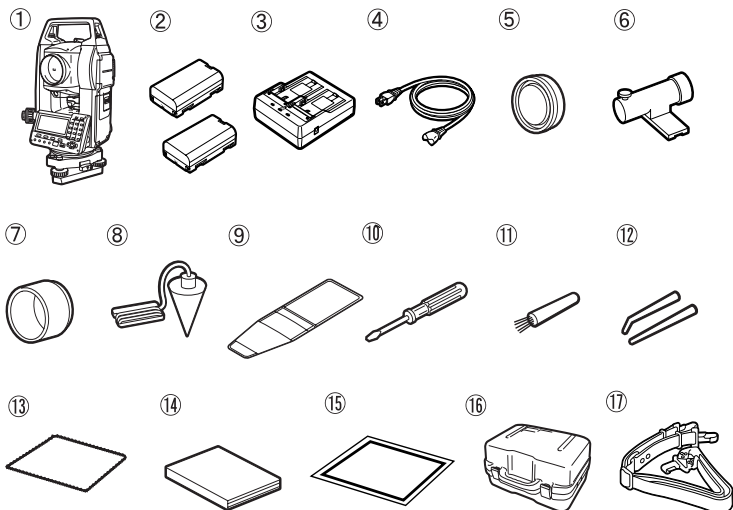
*The power cable shown here is EDC113B.

1	SET main unit. 1	
2	Battery (BDC46B)	
	SET250RX/350RX/550RX . . . 2	
	SET650RX 1	
3	Battery charger	
	(CDC68) 1	
4	Power cable	
	(EDC113A/113B/113C). 1	
5	Lens cap. 1	
6	Tubular compass (CP7) 1	
7	Lens hood 1	
8	Plumb bob 1	

9	Tool pouch 1
10	Screwdriver 1
11	Lens brush 1
12	Adjusting pin 2
13	Wiping cloth 1
14	Operator's manual 1
15	Laser caution sign-board
	(class3R/IIIa) 1
16	Carrying case (SC196) 1
17	Carrying strap 1

N.B. Instruments with laser plummet option also include a 1.5mm hexagonal wrench (x 1).

● **Tubular compass (CP7)**

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

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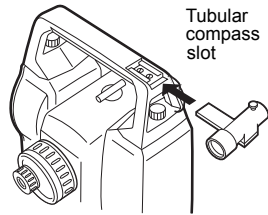
The tubular compass is susceptible to the influence of nearby magnets or metal. Such influence could cause it to fail to accurately indicate magnetic north. Do not use magnetic north as indicated by this compass for base line surveying.

● **Plumb bob**

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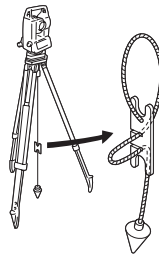
● **Handle**

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

Handle

Handle securing screws

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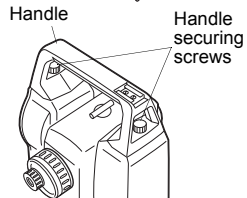
36. OPTIONAL ACCESSORIES

The following are optional accessories which are sold separately from the SET.
☞ Target and power supply optional accessories: "33. POWER SUPPLIES" and "34. TARGET SYSTEM".

● **Wireless keyboard (SF14)**
For SET250RX/350RX/550RX
SF14 makes measuring operation and inputting data easier and speedier. The SET is operated from the Wireless Keyboard by pointing the Wireless Keyboard beam at the Beam Detector on the SET and pressing the required operation keys.
☞ Location of operation keys on the wireless keyboard: "4.1 Parts of the Instrument", operation: "SF14 Manual"

Remote operation
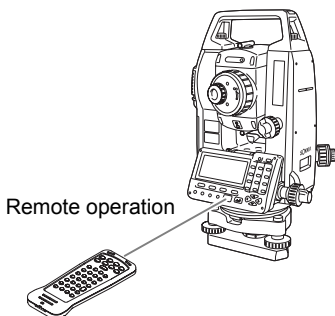
● **Telescope eyepiece lens (EL7)**
Magnification: 40X
Field of view: 1° 20'

● **Diagonal eyepiece (DE25)**
The diagonal eyepiece is convenient for observations near the nadir and in narrow spaces.
Magnification: 30X

After removing the handle from the SET, loosen the attachment screw to remove the telescope eyepiece. Then screw the diagonal lens into place.
☞ Handle removal method: "35. STANDARD EQUIPMENT"

DE25
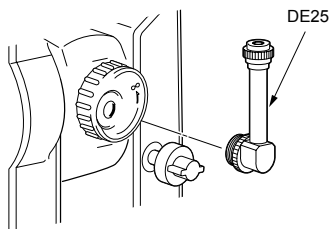
● **Solar filter (OF3A)**
When sighting targets where glare is present, solar observations for example, attach it to the objective lens of the SET to protect its interior and the eyes of the operator. The filter part can be flipped up without being removed.
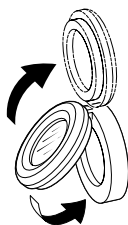
● **Battery Unit (BDC55)**

BDC55 is used as the power source for the ACE5 and LSE1.

● **Auto-collimation eyepiece (ACE5)**

The ACE5 is designed to detect a slight shift in inclination of the reflector. The BDC55 is the power source for the ACE5. The buttons on the BDC55 can also be used to operate the ACE5. For details, see the ACE5 Operator's manual.

● **Laser Sighting Eyepiece (LSE1)**

The LSE1 emits a visible laser beam along the telescope collimation axis. The BDC55 is the power source for the LSE1. For details, see the LSE1 Operator's manual.

● **Printer cable (DOC46)**

The SET can be connected to a Centronics specification printer which supports ESC/PTM by the printer cable DOC46. This allows direct output of data from the SET to a printer.

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● **Interface cable**

Connect between the SET and the host computer for data output.

Computer	Cable	Notes
PC9800 Series	DOC25	Length: 2m Pin Numbers and signal levels: RS-232C compatible D-sub connector: 25 pins (female)
IBM PC/AT or compatible	DOC26	Length: 2m Pin Numbers and signal levels: RS-232C compatible
	DOC 27	D-sub connector: DOC26: 25 pins (female) DOC27: 9 pins (female)
Other computers	DOC1	No connector for attachment to a computer.

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37. SPECIFICATIONS

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

Telescope
Length: 171mm
Aperture: 45mm (EDM:48mm)
Magnification
     SET250RX/350RX/550RX: 30X
     SET650RX: 26X
Image: Erect
Resolving power:
     SET250RX/350RX/550RX: 2.5"
     SET650RX: 3.5"
Field of view   1°30'
Minimum focus: 1.3m
Focussing screw: 1 speed
Reticle illumination: 5 brightness levels

Angle measurement
Horizontal and Vertical circles type:
                  Rotary absolute encoder
IACS (Independent Angle Calibration System)
                  SET250RX only
Angle units: Degree/Gon/Mil (selectable)
Minimum display:
     SET250RX/350RX/550RX:1" (0.0002gon/0.005mil)/5" (0.0010gon/
                  0.02mil) (selectable)
     SET650RX: 5" (0.0010gon/0.02mil)/1" (0.0002gon/0.005mil)
                  (selectable)
Accuracy:
     SET250RX: 2" (0.0006gon/0.010mil)
     SET350RX: 3" (0.0010gon/0.015mil)
     SET550RX: 5" (0.0015gon/0.025mil)
     SET650RX: 6" (0.0019gon/0.030mil)
     (ISO 17123-3 : 2001)
Measuring time: 0.5 sec or less
Collimation compensation: On/Off (selectable)
Measuring mode:
     Horizontal angle: Right/Left (selectable)
     Vertical angle: Zenith/Horizontal/Horizontal ±90° /% (selectable)

Tilt angle compensation
Type: Liquid 2-axis tilt sensor
Minimum display: Agrees with minimum displayed measurement
                  angle

Range of compensation:	±6' (±0.1111 gon)
Automatic compensator:	ON (V & H/V)/OFF (selectable)
Compensation constant:	Can be changed

Distance Measurement

Measuring method:	Coaxial phase-contrast measuring system
Signal source:	Red laser diode 690nm
	Class 3R
	(IEC60825-1 Ed. 2.0: 2007/ FDA CDRH 21CFR Part1040.10 and 1040.11 (Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No.50, dated June 24, 2007.))
	(When the prism or reflective sheet is selected in Config mode as target, the output is equivalent to Class 1).
Measuring range:	(Using SOKKIA reflective prism/reflective sheet target during normal atmospheric conditions[*1]/ [*2] is good atmospheric conditions/[*3] is low temperature conditions)

SET250RX/350RX/550RX:

Reflective sheet RS90N-K[*4]: 1.3 to 500m (1,640ft)
1.3 to 300m (980ft)[*3]

Reflective sheet RS50N-K[*4]: 1.3 to 300m (980ft)
1.3 to 180m (590ft)[*3]

Reflective sheet RS10N-K[*4]: 1.3 to 100m (320ft)
1.3 to 60m (190ft)[*3]

Compact prism CP01: 1.3 to 2,500m (8,200ft)

Standard prism AP01AR X 1: 1.3 to 4,000m (13,120ft)
1.3 to 5,000m (16,400ft)[*2]

Standard prism AP01AR X 3: to 5,000 m (16,400ft)
to 6,000m (19,680ft)[*2]

Mini pole prism OR1PA: 1.3 to 500m (1,640ft)

Reflectorless (White)[*5] : 0.3 to 400m (1,310ft)

Reflectorless (Gray)[*6]: 0.3 to 180m (590ft)

SET650RX:

Reflective sheet RS90N-K[*4]: 1.3 to 500m (1,640ft)

Reflective sheet RS50N-K[*4]: 1.3 to 300m (980ft)

Reflective sheet RS10N-K[*4]: 1.3 to 100m (320ft)

Compact prism CP01: 1.3 to 2,500m (8,200ft)
Standard prism AP01AR X 1: 1.3 to 3,000m
                                        (9,840ft)
                                        1.3 to 4,000m
                                        (13,120ft)[*2]
Standard prism AP01AR X 3: to 4,000m
                                        (13,120ft)
                                        to 5,000m
                                        (16,400ft)[*2]
Mini pole prism OR1PA: 1.3 to 500m (1,640ft)
Reflectorless (White)[*5] : 0.3 to 400m (1,310ft)
Reflectorless (Gray)[*6] : 0.3 to 180m (590ft)

Minimum display:
    Fine/Rapid measurement: 0.001m (0.01ft / 1/8inch)
    Tracking measurement: 0.01m (0.1ft / 1/2inch)
Maximum slope   Prism/ reflective sheet: 9599.999m (31,496.0ft)
    distance display: Reflectorless: 599.999m (1,968.5ft)
Distance unit: m/ft/US ft/inch (selectable)
Accuracy:
    (Using prism)
        Fine measurement: $\pm(2 + 2$ ppm X D) mm
        Rapid measurement: $\pm (5 + 2$ ppm X D) mm
    (Using reflective sheet target)[*4]
        Fine measurement: $\pm(3 + 2$ ppm X D) mm
        Rapid measurement: $\pm(6 + 2$ ppm X D) mm
    (Reflectorless (White))[*5]
        Fine measurement:
        $\pm(3 + 2$ppm X D) mm (0.3 to 200m)
        $\pm(5 + 10$ppm X D) mm (over 200 to 350m)
        $\pm(10 + 10$ppm X D) mm (over 350 to 400m)
        Rapid measurement:
        $\pm(6 + 2$ppm X D) mm (0.3 to 200m)
        $\pm(8 + 10$ppm X D) mm (over 200 to 350m)
        $\pm(15 + 10$ppm X D) mm (over 350 to 400m)
    (Reflectorless (Gray))[*6]
        Fine measurement
        $\pm(3 + 2$ppm X D) mm (0.3 to 100m)
        $\pm(5 + 10$ppm X D) mm (over 100 to 170m)
        $\pm(10 + 10$ppm X D) mm (over 170 to 180m)
        Rapid measurement:
        $\pm(6 + 2$ppm X D) mm (0.3 to 100m)
        $\pm(8 + 10$ppm X D) mm (over 100 to 170m)
        $\pm(15 + 10$ppm X D) mm (over 170 to 180m)

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Measurement mode:	Fine measurement (single/repeat/average)/ Rapid measurement (single/repeat)/Tracking (selectable)

Measuring time:

Fine measurement:	1.7 sec + every 0.9 sec.
Rapid measurement	1.4 sec + every 0.7 sec.
Tracking measurement:	1.4 sec + every 0.3 sec.

Atmospheric correction:

Temperature input range:	- 30 to 60°C (in 0.1°C step)/ - 22 to 140°F (in 1°F step)
Pressure input range:	500 to 1,400 hPa (in 1hPa step)
	375 to 1,050 mmHg (in 1mmHg step)
	14.8 to 41.3 inchHg (in 0.1inchHg step)
ppm input range:	-499 to 499 ppm (in 1 ppm step)
Prism constant correction:	-99 to 99 mm (in 1 mm step)
	0mm fixed for reflectorless measurement

Earth curvature and refraction correction:

	No/Yes K=0.142/Yes K=0.20 (selectable)
Scale factor setting:	0.5 to 2.0
Sea level correction:	No/Yes (selectable)

- ***1**: Slight haze, visibility about 20 km, sunny periods, weak scintillation.
- ***2**: No haze, visibility about 40 km, overcast, no scintillation.
- ***3**: Measurement at -30 to -20°C (-22 to -4°F) (Low Temperature Model only)
- ***4:** Figures when the laser beam strikes within 30° of the reflective sheet target.
- ***5**: Figures when using Kodak Gray Card White side (reflection factor 90%) and brightness level is less than 30000 lx (a little cloudy).
- ***6**: Figures when using Kodak Gray Card Gray side (reflection factor 18%) and brightness level is less than 30000 lx (a little cloudy).
- ***5,*6:** When performing reflectorless measurement, the possible measurement range and precision will change depending on the target reflection factor, weather conditions and location conditions.

Guide Light

(Slight haze, visibility about 20 km, sunny periods, weak scintillation)

Light source:	LED (red 626 nm/green 524 nm)
	Class 1
	(IEC60825-1 Ed. 2.0: 2007/FDA CDRH 21 CFR Part 1040.10 and 1040.11 (Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No.50, dated June 24, 2007.))
Distance:	1.3 to 150m[*1]

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Visible range:	Right and Left/Upward and Downward: ± 4° (7m/100m)
Resolving power at center area (width):	4' (about 0.12m/100m)
Brightness	3 levels (bright/normal/dim)

Internal memory
Capacity   10,000 measurement points

External memory
SD card (up to 4 GB, SDHC-compatible)
USB flash memory (up to 4 GB)

Data transfer
Data input/output   Asynchoronous serial, RS232C compatible
USB   USB Revision 2.0 (FS), Host (Type A)
Card slot   SD card

***Bluetooth* wireless technology (Optional function)**
BT Qualification ID   B02706
Transmission method: FHSS (*Bluetooth* Specification Ver.1.2
                                       compatible, Telec-approved)
Modulation: GFSK (Gaussian-filtered frequency shift keying)
Frequency band: 2,400 to 2,483.5MHz
Bluetooth profile   SPP, DUN
Power class   Class 2
Usable range   about 2m (No obstacles, few vehicles or sources
                                       of radio emissions/interference in the near
                                       vicinity of the instrument, no rain)
Authentication: Yes/No (selectable)

Power Supply
Power source: Rechargeable Li-ion battery BDC46B
Working duration at 20 °C:
      Distance and angle measurement
         (Fine single measurement = every 30 sec.) :
                                       BDC46B: about 8.5 hours
                                       BDC60 (external battery, optional accessory):
                                       about 25 hours
                                       BDC61 (external battery, optional accessory):
                                       about 50 hours
      Angle measurement only:
                                       BDC46B: about 12.5 hours

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	BDC60 (external battery, optional accessory): about 30 hours
	BDC61 (external battery, optional accessory): about 60 hours
Battery state indicator:	4 levels
Auto power-off:	5 levels (5/10/15/30 min/Not set) (selectable)
External power source:	6.7 to 8.0V
Charging time at 25 °C:	about 2.5 hours (using CDC68)**[7]**

Battery (BDC46B)

Nominal voltage	7.2V
Capacity	2.45Ah
Dimensions	38 (W) x 70 (D) x 20 (H) mm
Weight	about 103g

Charger (CDC68)

Input voltage:	AC100 to 240V
Charging time per battery (at 25°C):	
	BDC46B: about 2.5 hours
	(Charging can take longer than the times stated above when temperatures are either especially high or low.)
Charging temperature range:	
	0 to 40°C
Storage temperature range:	
	-20 to 65°C
Size:	94 (W) X 102 (D) X 36 (H) mm
Weight:	about 170g

[7]: Charging can take more than 2.5 hours when temperatures are either especially high or low.

General

Display:	LCD graphic display, 192 dots X 80 dots
SET250RX/350RX/550RX:	1 LCD graphic display on each face with illuminator
SET650RX:	1 LCD graphic display with illuminator
Operation panel (keyboard):	27 keys (soft function, operations, power on, light) with illuminator
Auto power-off:	5 levels (selectable)
Laser sighting function:	Provided On/Off (selectable)
Internal memory:	1MB (about 10,000 points)
Data output:	Asynchronous serial, RS232C compatible Centronics compatible (with DOC46A)

	Printer with ESC/PTM mode (emulation function)
Sensitivity of levels:	
Plate level:	SET250RX/350RX/550RX: 30"/2 mm
	SET650RX: 40"/2 mm
Electronic levels:	
Graphic:	6'
Circular level:	10'/2 mm
Optical plummet:	
Image:	Erect
Magnification:	3X
Minimum focus:	0.3 m
Laser plummet (option):	
Signal source:	Red laser diode 635 ±10nm (Class 2 IEC60825-1 Ed. 2.0:2007/FDA 21 CFR Ch.I Section1040.10 and 1040.11)
Beam accuracy:	1mm or less (when tripod head height is 1.3m).
Spot diameter:	ø3mm or less
Brightness control:	5 levels
Auto power-off	Provided (power cut off after 5 minutes)
Horizontal and vertical motion screw:	
SET250RX:	2 speed
SET350RX/550RX/650RX:1 speed	
Operating temperature:	-20 to 50 °C (-4 to 122 °F) (no condensation)
	-30 to 50 °C (-22 to 122 °F) (no condensation)
	(Low Temperature Model only)
Storage temperature range:	-30 to 70 °C (no condensation)
Dust and water resistance:	IP66 (IEC 60529: 2001)
Instrument height:	192.5 mm from tribrach mounting surface
	236mm +5/-3mm from tribrach bottom
Size (with handle):	SET250RX/350RX/550RX:
	166 (W) X 180 (D) X 341 (H) mm
	SET650RX:
	166 (W) X 173 (D) X 341 (H) mm
Weight (with handle and battery):	
SET250RX:	5.6kg (12.3 lb)
SET350RX/550RX:	5.5kg (12.1 lb)
SET650RX:	5.4kg (11.9 lb)

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38. EXPLANATION

38.1 Manually Indexing the Vertical Circle by Face Left, Face Right Measurement

The 0 index of the vertical circle of your SET is almost 100% accurate, but when it is necessary to perform particularly high precision angle measurements, you can eliminate any inaccuracy of the 0 index as follows.
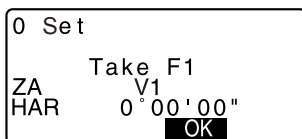
🚫

• If the power is cut off, the vertical circle indexing is ineffective. Do it again every time the power is turned on.

▶PROCEDURE   Manually indexing the vertical circle

1. Select "Obs. condition" in Config mode. Set "V manual" (vertical circle indexing method) to "Yes".

2. Go to the Meas mode screen. The vertical angle V1 is displayed under "Take F1."

```
0 Set

        Take F1
ZA        V1
HAR     0°00'00"
                OK
```

3. Carefully level the instrument.

4. Accurately sight a clear target with a distance of about 30m in the horizontal direction with the telescope in face left.
   Press **[OK]**. The vertical angle V2 is displayed under "Take F2."

```
0 Set

        Take F2
ZA        V2
HAR     0°00'00"
                OK
```
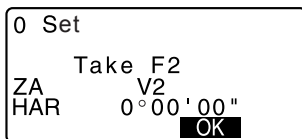
5. Turn the upper part through 180° and clamp it. Then set the telescope in the face right position and accurately sight the same target.
   Press **[OK]**.
   The vertical and horizontal angles are displayed.
   This concludes the vertical circle indexing procedure.

38.2 Atmospheric Correction for High Precision Distance Measurement

• Need for atmospheric correction

The SET measures the distance with a beam of light, but the velocity of this light varies according to the index of refraction of light in the atmosphere. This index of refraction varies according to the temperature and pressure. Near normal temperature and pressure conditions:

With constant pressure, a temperature change of 1°C: an index change of 1 ppm.

With constant temperature, a pressure change of 3.6 hPa: an index change of 1 ppm.

To perform high accuracy measurements, it is necessary to find the atmospheric correction factor from even more accurate temperature and pressure measurements and perform an atmospheric correction.

It is recommended that extremely precise instruments be used to monitor the air temperature and pressure.

• Finding the average temperature and pressure between two points in different atmospheric conditions

To precisely determine the atmospheric correction factor, the average temperature and air pressure along the measurement beam route must be taken.

Determine the temperature and pressure as follows.

Flat terrain   :Use the temperature and pressure at the midpoint of the line.

Mountainous terrain   :Use the temperature and pressure at the intermediate point (C).

If it is not possible to measure the temperature and pressure at the midpoint, take the temperature and pressure at the instrument station (A) and the target station (B), then calculate the average value.

Average air temperature   :(t1 + t2)/2

Average air pressure   :(p1 + p2)/2
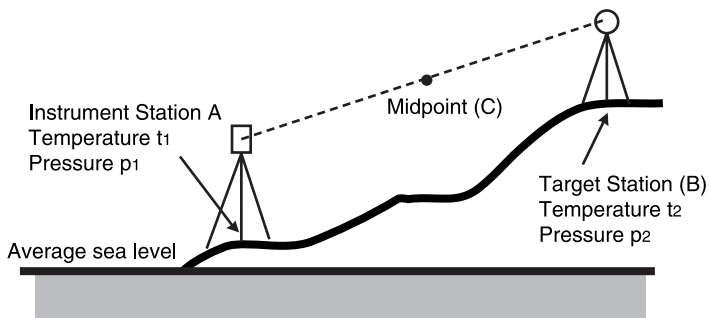
• Calculation of atmospheric correction factor allowing for humidity

The humidity has little influence, particularly on short distance measurements. The effect of humidity should be considered in cases where it is very hot and humid and high precision measurements are to be performed over a particularly long distance.

When taking humidity into consideration, calculate the atmospheric correction factor using the following formula and input the calculated ppm in instrument station data setting or EDM setting.

☞ "24.1 Recording Instrument Station Data" and "30.1 EDM Settings"

Atmospheric Correction Factor (ppm)=

$$282.59 - \frac{0.2942 \times p}{1 + 0.003661 \times t} + \frac{0.0416 \times e}{1 + 0.003661 \times t}$$

e (water vapor pressure) can be calculated using the following formula.

$$e = h \times \frac{E}{100}$$

$$E = 6.11 \times 10^{\frac{(7.5 \times t)}{(t + 237.3)}}$$

- t : Air temperature (°C)
- p : Pressure (hPa)
- e : Water vapor pressure (hPa)
- h : Relative humidity (%)
- E : Saturated water vapor pressure

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39. REGULATIONS

Users must ensure that their instrument is compliant with the relevant regulations and legal restrictions in place in the country of use.

For users in the US

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

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

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

This equipment complies with FCC radiation exposure limits set forth for uncontrolled equipment and meets the FCC radio frequency (RF) Exposure Guidelines in Supplement C to OET65. This equipment has very low levels of RF energy that is deemed to comply without maximum permissive exposure evaluation (MPE). But it is desirable that it should be installed and operated with at least 20cm and more between the radiator and person's body (excluding extremeties: hands, wrists, feet and ankles).

For users in California

WARNING: Handling the cord on this product or cords associated with accessories sold with this product, will expose you to lead, a chemical known to the State of California to cause birth defects or other reproductive harm. *Wash hands after handling.*

For users in Canada

This Class A digital apparatus meets all requirements of Canadian Interference-Causing Equipment Regulations.
Cet appareil numérique de la Class A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

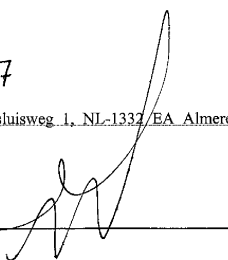This class A digital apparatus complies with Canadian ICES-003.

Cet appareil numerique de la classe A est conforme a la norme NMB-003 du Canada.

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of this device.
This equipment complies with IC radiation exposure limits set forth for uncontrolled equipment and meets RSS-210 of the IC radio frequency (RF) Exposure rules. This equipment has very low levels of RF energy that is deemed to comply without maximum permissive exposure evaluation (MPE). But it is desirable that it should be installed and operated with at least 20cm and more between the radiator and person's body (excluding extremeties: hands, wrists, feet and ankles).

For users in the European Economic Area (EEA)

CE Conformity Declaration

in accordance with EMC Directive 2004/108/EC and R&TTE Directive 1999/5/EC of
the European Community

We herewith declare that the undermentioned instrument, in view of its design and type
of construction, fully complies with the relevant basic radio interference requirements
of the EMC and R&TTE Directive.
Should the instrument be modified without agreement, this declaration becomes invalid.

Instrument Description: Bluetooth module

Model Name :   ZEAL Z1

Relevant EC Directive: EMC Directive(2004/108/EC)
                      R&TTE Directive(99/5/EC)

Applied
Harmonized Standard: Radio   EN 300 328 2004-11
                      EMC   EN 301 489-17 2002-08
                                  EN 301 489-1 2002-08
                      LVD   EN 60950-1 :2001

Date: _September 27, 2007_

Firm: _SOKKIA B.V._

Address: _Industrieterrein De Vaart, Damsluisweg 1, NL-1332 EA Almere_

Representative's Signature: _____

Name of Representative :   Gerben Wolsink

Representative's position :   European Service Manager

Series 50RX Reflectorless Total Station

Česky [Czech]

Sokkia BV potvrzuje, že výše uvedené zařízení je v souladu se základními požadavky a dalšími příslušnými ustanoveními směrnice 1999/5/ES.

Dansk [Danish]

Undertegnede, Sokkia B.V. erklærer herved, at følgende udstyr det ovennaevnte udstyr overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.

Deutsch [German]

Sokkia B.V erklärt,. dass die oben genannten Instrumente in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 1999/5/EG befindet.

Eesti [Estonian]

Käesolevaga kinnitab Sokkia B.V., seadme ülal mainitud varustus direktiivi 1999/5/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele.

English

Hereby, Sokkia B.V., declares that the above-mentioned equipment is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.

Español [Spanish]

Por medio de la presente Sokkia B.V., declara que el equipo arriba mencionado cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.

Ελληνική [Greek]

ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ Sokkia B.V., ΔΗΛΩΝΕΙ ΟΤΙ ο προαναφερόμενος εξοπλισμός ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.

Français [French]

Par la présente Sokkia B.V., déclare que l'équipement mentionné ci-dessus est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.

Italiano [Italian]

Con la presente Sokkia B.V., dichiara che questo Il sopra menzionato equipaggiamento è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.

Latviski [Latvian]

Ar šo Sokkia B.V., deklarē, ka augstāk minētā iekārta atbilst Direktīvas 1999/5/EK būtiskajām prasībām un citiem ar to saistītajiem noteikumiem.

Lietuvių [Lithuanian]

Šiuo Sokkia B.V., deklaruoja, kad šis auksciau mineta iranga atitinka esminius reikalavimus ir kitas 1999/5/EB Direktyvos nuostatas.

Magyar [Hungarian]

Alulírott, Sokkia B.V. nyilatkozom, hogy a a fent említett eszköz megfelel a vonatkozó alapvető követelményeknek és az 1999/5/EC irányelv egyéb előírásainak.

Malti [Maltese]

Hawnhekk, Sokkia B.V., tiddikjara li t-tagħmir imsemmi hawn fuq hu konformi mal-ħtiġijiet essenzjali u provvedimenti rilevanti oħrajn ta' Direttiva 1999/5/KE.

Nederlands [Dutch]

Hierbij verklaart Sokkia B.V., dat bovengenoemd toestel in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.

Polski [Polish]

Niniejszym Sokkia B.V. oświadcza, że sprzet wymieniony powyzej jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 1999/5/EC.

Português [Portuguese]

Sokkia B.V. declara que este o equipamento acima mencionado está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.

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Slovensko [Slovenian]

Sokkia B.V. izjavlja, da je ta zgoraj omenjena oprema v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 1999/5/ES.

Slovensky [Slovak]

Sokkia BV potvrdzuje, že vyššie uvedené zariadenie je v súlade so základnými požiadavkami a všetky príslušné ustanovenia Smernice 1999/5/ES.

Suomi [Finnish]

Sokkia B.V. vakuuttaa täten että ylläoleva laite tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.

Svenska [Swedish]

Härmed intygar Sokkia B.V. att den ovan nämnda utrustningen står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.

Íslenska [Icelandic]

Hér með staðfestir Sokkia B.V. að áðurnefndur búnaður er í samræmi við grundvallarskilyrði og aðrar viðeigandi kröfur í fyrirmæli Evrópusambandsins 1999/5/EC.

Norsk [Norwegian]

Sokkia B.V. erklærer herved at utstyret nevnt ovenfor oppfyller de ubetingede krav og andre relevante bestemmelser i Direktiv 1999/5/EC.

EMC NOTICE
In industrial locations or in proximity to industrial power installations, this instrument might be affected by electromagnetic noise. Under such conditions, please test the instrument performance before use.
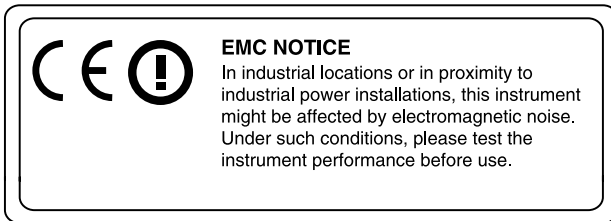
For users in Mexico

Este equipo opera a titulo secundario, consecuentemente, debe aceptar interferencias perjudiciales incluyendo equipos de la misma clase y puede no causar interferencias a sistemas operando a titulo primario.

COFETEL+RCPSOZE06-471

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For users in Taiwan

低功率電波輻射性電機管理辦法 (930322)

第十二條　經型式認證合格之低功率射頻電機，非經許可，公
　　　　　司、商號或使用者均不得擅自變更頻率、加大功率
　　　　　或變更原設計之特性及功能。

第十四條　低功率射頻電機之使用不得影響飛航安全及干擾合
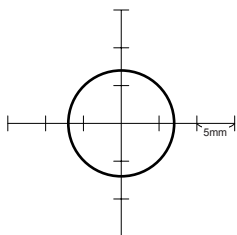　　　　　法通信；經發現有干擾現象時，應立即停用，並改
　　　　　善至無干擾時方得繼續使用。

　　　　　前項合法通信，指依電信法規定作業之無線電通信。

　　　　　低功率射頻電機須忍受合法通信或工業、科學及醫
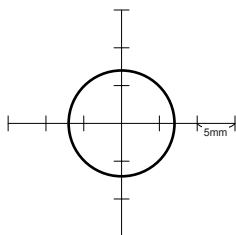　　　　　療用電波輻射性電機設備之干擾。

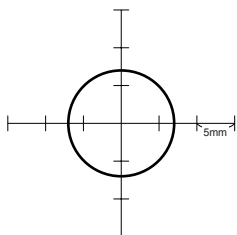**For users in the United Arab Emirates**

Approved by TRA

SOKKIA
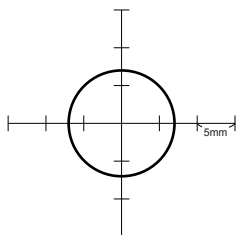
5mm

Series50RX
Target for Laser plummet adjustment

SOKKIA

5mm

Series50RX
Target for Laser plummet adjustment

SOKKIA

5mm

Series50RX
Target for Laser plummet adjustment

SOKKIA

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Target for Laser plummet adjustment

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Series50RX
Target for Laser plummet adjustment