TOPCON

INSTRUCTION MANUAL
DIGITAL LEVEL

DL-501

Li-ion

CONTAINS Li-ion BATTERY.
MUST BE RECYCLED OR DISPOSED OF PROPERLY.

JSIMA

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

TOPCON

DL-501

- Thank you for selecting the DL-501 Advanced/Standard.
- Please read this operator's manual carefully before using this product.
- Verify that all equipment is included.
  ☞ "23. STANDARD EQUIPMENT"
- DL-501 has a function to output data to a connected host computer. Command operations from a host computer can also be performed. For details, refer to "Communication Manual" and ask your local dealer.
- The specifications and general appearance of the instrument are subject to change without prior notice and without obligation by TOPCON CORPORATION 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.

[Softkey] etc. : Indicates softkeys on the display and window dialog buttons.

{Key} etc. : Indicates keys on the operation panel.

<Screen title> etc.: Indicates screen titles.

Notes regarding manual style

• Except where stated, "DL" means DL-501 Advanced and DL-501 Standard in this manual.
• Screens and illustrations appearing in this manual are of DL-501 Advanced.
• Learn basic operations in "3. PRODUCT OUTLINE" and "4. BASIC OPERATION" before you read each measurement procedure. For selecting options and inputting figures, see "4.1 Basic Key Operation".

• *Bluetooth*® is a registered trademark of Bluetooth SIG, Inc.
• All 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 personal 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, or burns could result.

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

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

❗ 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.

Staff

⚠ Caution

🚫 Do not use under thunderous weather conditions. The staff is conductive and if struck by lightning, death or injury could result.

❗ Handle with care when using near high voltage cables or transformers. The staff is conductive and contact could result in electric shock.

Power Supply

⚠ Warning

🚫 Do not short circuit. Heat or ignition could result.

🚫 Do not disassemble, rebuild, mutilate, incinerate, heat or short circuit the battery and charger. Fire, electric shock, burns or an explosion could result.

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

🚫 Do not use batteries other than those designated. An explosion could occur, or abnormal heat generated, leading to fire.

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

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

❗ 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.

🚫 Do not use the battery, charger or AC (power) cable for any other equipment or purpose. Fire or burns caused by ignition could result.

❗ 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.

Remote Trigger (DLC1A)

⚠ **Caution**

🚫 Do not leave batteries within reach of small children. If swallowed, consult a physician immediately.

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 the electromagnetic waves produced may adversely affect operation resulting in an accident.

2. PRECAUTIONS

Precautions concerning water and dust resistance

DL conforms to IP54 specifications for waterproofing and dust resistance when the battery cover, External interface hatch, and Multi Port cap is closed.
• Make sure that moisture or dust particles do not come in contact with the terminal or connectors. Operating the instrument with moisture or dust on the terminal or connectors may cause damage to the instrument.
• Be sure to correctly attach the connector cap to protect the DL from moisture and dust particles when the connector is not in use.
• 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.

The Lithium Battery

The lithium battery is used to maintain the DL Calendar & Clock function. It can back up data for approximately 5 years of normal use and storage (Temperature = 20°, humidity = about 50%), but its lifetime may be shorter depending on circumstances. When the voltage of the lithium battery has decreased, or the battery itself is depleted the date/time may not be displayed correctly and an error message "The battery for the clock function needs to be replaced." will be displayed.
For details on replacing lithium batteries contact your local dealer.

Backing up data

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

Other precautions

• Never place the instrument directly on the ground. Sand or dust may cause damage to the screw holes or the centering screw on the base plate.
• Protect the instrument from heavy shocks or vibration.
• Protect the instrument from rain or drizzle with an umbrella or waterproof cover.
• When the operator leaves the instrument attached to the tripod, the vinyl cover should be placed on the instrument.
• Never carry the instrument on the tripod to another site.
• Turn the power off before removing the battery.
• Remove the battery before placing the DL in its case.
• Make sure that the instrument and the protective lining of the carrying case are dry before closing the case. The case is hermetically sealed and if moisture is trapped inside, the instrument could rust.
• 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

• Wipe off moisture completely if the instrument gets wet during survey work.
• 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.

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• 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 alkaline cleaning solutions, alcohol, or any other organic solvents on the instrument or display.

• Store the instrument 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.

• When removing the instrument from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.

• Check the instrument 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. PRODUCT OUTLINE

3.1　Parts of the Instrument

Parts of the instrument (DL-501 Advanced)

1 Handle
2 Focusing knob
3 Keyboard
4 Measure key
5 Leveling foot screw
6 Base plate
7 Horizontal circle positioning ring
8 Horizontal circle
9　Waterproof Multi Port
10 Beam detector for Remote trigger
11 Eyepiece screw
12 Display
13 View finder

14 View finder eyepiece screw
15 Circular level
16 Bubble mirror
17 Horizontal fine motion knobs (both sides)
18 External interface hatch
SD card slot
" 🗀 SD card slot"
USB port
19　Battery cover
20 Objective lens
21 *Bluetooth* antenna (option)
22　View finder axis alignment screw

Parts of the instrument (DL-501 Standard)

1

1Simple finder

Note
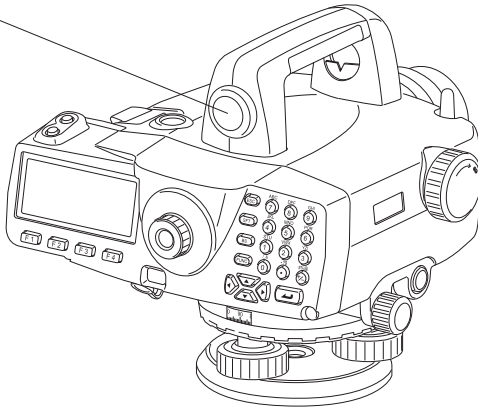
• All other parts are identical to DL-501 Advanced.

Functions of the instrument

SD card slot
The DL supports SD/SDHC cards (hereafter referred to collectively as "SD card" unless otherwise stated) for data write only. The SD card slot is located in the external interface hatch.

Inserting an SD card
An SD card should be inserted with the contacts facing downwards.
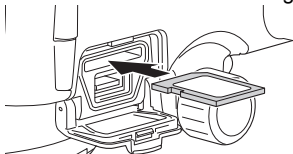
Removing an SD card
Push an inserted SD card further into the slot and release to eject.

3.2 Mode Structure

The diagram below describes the different modes of the DL and key operations for navigating between them.


```
Job: JOB1
R
   DL-501 Adv      ✄ TOPCON
   S/N 999999
   Appli :Ver.XXXX-XX-XX
   Sensor:Ver.XXXX-XX-XX

   Feb/03/2012 14:23:34
```
Status Screen

```
        ( ⊙ )

                        O K
```
Tilt Screen

{ESC}   [TILT]

{ESC}   [O K]

```
Rh
Hd                      S
                        ▨

 TILT  MENU      FOCUS
```
Meas mode

[MENU]   {ESC}

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

{ESC}

1.Meas
```
Meas menu
1.Height dif.
2.Check & adjust.
3.Simple measurement
```

2.Management
```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

3.Config
```
Config menu
Config menu
1.Obs.condition
2.Instr.config
3.Comms setup
4.Tilt offset
5.Unit
```

4.Calculation
```
Calculation menu
1.Dble-run discrePancy
2.Closure error
3.Reobs.route merge
```

.

3.3   *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.
  ☞ "26. REGULATIONS"
• TOPCON CORPORATION 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 DL 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 DL 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.

● When using the DL 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 DL 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 DL in proximity to televisions and radios.
• Televisions and radios use a different frequency band to *Bluetooth* communications.

However, even if the DL is used within proximity to the above equipment with no adverse effects with regard to *Bluetooth* communication, moving a *Bluetooth* compatible device (including the DL) 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 DL 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.

4. BASIC OPERATION

Learn basic key operations here before you read each measurement procedure.

4.1   Basic Key Operation
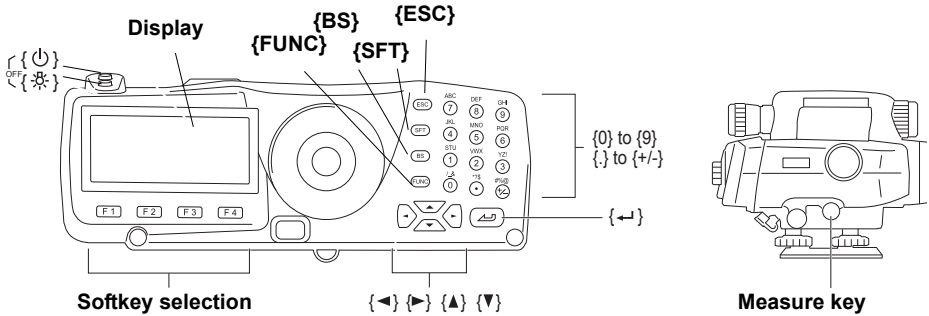
● Power ON/OFF

{ ⏻ } (Press and hold)	Power ON
{☼} while pressing { ⏻ }	Power OFF

● Switching screen/key backlight ON/OFF

{☼}	Switches the screen backlight/key backlight ON/OFF

● Measurement (Auto Focus)

Measure key	Automatically focuses on the staff and starts measurement. (DL-501 Advanced)
	Starts measurement (DL-501 Standard)

● Softkey operation
Softkeys are displayed on the bottom line of the screen.

{F1} to {F4}	Select the function matching the softkeys
{FUNC}	Toggle between softkey pages

● Inputting letters/figures

{SFT}	Switch between numeric and alphabetic (upper/lower case) characters.
{0} to {9}	Input numeral or symbol printed above the key (during numeric input mode)
	Input alphabetic character in the order they are listed (in alphabetic input mode)
{.}	Input a decimal point (during numeric input mode)
{+/-}	Input a plus or minus sign (during numeric input mode)
{◀}/{▶}	Right and left cursor/Select other option.
{ESC}	Cancel the input data.

{BS}	Delete a character on the left.
{⬅}	Select/accept input word/value.

● **Selecting options**

{▲}/{▼}	Move the cursor/selection item up/down
{◀}/{▶}	Move the cursor/selection item left/right or select other option
{⬅}	Select/accept the option

● **Other operation**

{ESC}	Return to previous screen

Example :Entering "Route M" in the Route ID field

1. Press **{6}** three times.
   "R" is displayed.

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

3. Press **{1}** three times.
   "U" is displayed.

4. Press **{▶}** once.

5. Press **{1}** twice.
   "T" is displayed.

6. Press **{8}** twice.
   "E" is displayed.

7. Press **{▶}** twice.
   Input a blank space.

8. Press **{5}** once.
   "M" is displayed. Press **{⬅}** to complete inputting.

.

```
Route id
:  ROUTE M                    A
Memo
:
:                             ▼
                         OK
```

Key operation for Remote trigger (DLC1A)

DLC1A comes as standard with the DL-501 Advanced and is an optional accessory for the DL-501 Standard.

☞ "4.1 Basic Key Operation"

Beam source

Key panel

{MEAS}

{ENT}

{ESC}
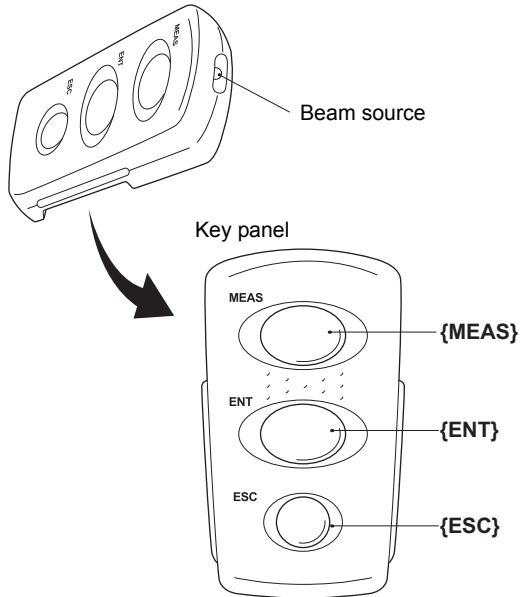
The DL is operated from the Remote trigger by pointing the Remote trigger beam at the DL and pressing the required operation keys.
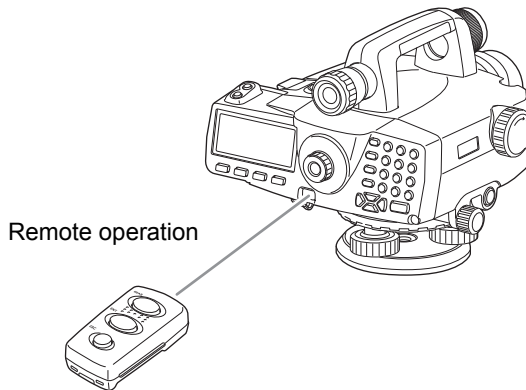
Remote operation

• When sunlight shines directly into the Beam detector on the DL, remote operation with the Remote trigger may not work correctly.

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- If other DLC1A-compatible instruments are turned ON and placed within the operating range of the Remote trigger, they may be unintentionally operated at the same time.
- Do not place the Remote trigger under heavy objects or in a tight space. A key may be continuously depressed and deplete battery power.
- Working duration shortens under low temperatures.

{MEAS}	Performs same operation as Measure key on the DL
{ENT}	Same operation as **{⬅}** on DL
{ESC}	Same operation as **{ESC}** on DL

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4.2   Display Functions

Status screen

Instrument name

```
DL-501 Adv        ✄ TOPCON
S/N 999999
Appli :Ver.XXXX-XX-XX
Sensor:Ver.XXXX-XX-XX


Feb/03/2012 14:23:34   ⍌
```

— Application software version

```
Job:  XXXX            ⍍
Route:XXXX
Rec.remainder
Meas.pt:    XXXX (XXX)
Start info: XXXX (XXX)
Fixed pt:   XXXX (XXX)
```

Available memory (total)

Available memory (current route)

Meas Mode screen

*1 —— Rh
*2 —— Hd

S ← *3
🔋 ← *4
    ← *5

TILT **MENU**   **FOCUS**

Input screen

```
End bench mark id    ⍍
:B2                   A
End bench mark elev.
:  165.00000m


              OK      ⍌
```

— Previous page
— *6
— Next page
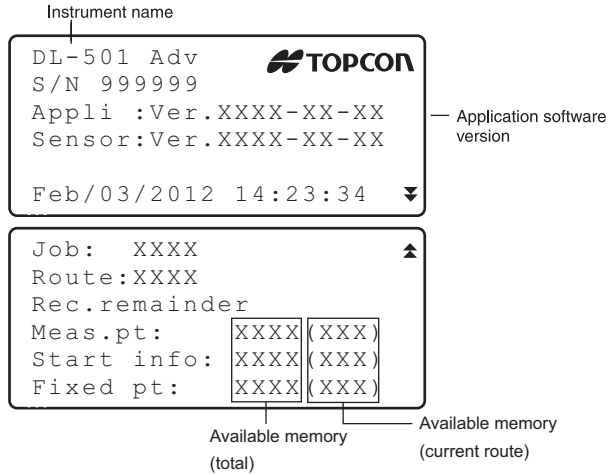
*1 Rh: Staff reading (height)
*2 Hd: Horizontal distance to staff
*3 Measurement mode
    S: Single
    R: Repeat
    A: Average
    T: Rapid
* 4 Remaining battery power (BDC58/70, Temperature=25°C)
    ▧ : level 3 Full power.
    ▨ : level 2 Plenty of power remains.
    ▤ : level 1 Half or less power remains.
    ▱ : level 0 Little power remains. Prepare replacement battery where available.

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"Battery low! Please charge battery." (with audio tone) displayed alternately with current screen
: No power remains.
Stop measurement and save data. Then turn the instrument off and charge the battery.
☞ "5.1 Battery Charging"

*5 *Bluetooth* communication status

⬛:   Connection established

⬛ (flashing):   Waiting

⬛ (flashing):   Disconnecting

⬛:   DL *Bluetooth* device is OFF

*6 Input mode
A :Inputting capital letters
a :Inputting small letters
1 :Inputting numeric characters

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5. USING THE BATTERY

Types of power source: "22. POWER SUPPLY SYSTEM"

5.1 Battery Charging

The battery was not charged at the factory. Charge the battery fully before using the DL.

- The charger will become rather hot during use. This is normal.
- Do not use to charge batteries other than those specified.
- The charger is for indoor use only. Do not use outdoors.
- Batteries cannot be charged, even when the charging lamp is flashing, when the temperature is outside the charging temperature range.
- Remove batteries from the charger before putting into storage.
- When not in use, disconnect the power cable plug from the wall outlet.

PROCEDURE

1. Connect the power cable (EDC113A/113B/ 113C) to the charger (CDC68/68A) and plug the charger into the wall outlet.

2. Mount the battery in the charger by matching the grooves on the battery with the guides on the charger.

Grooves

Guides

Slot 1

Charging lamp

Slot 2
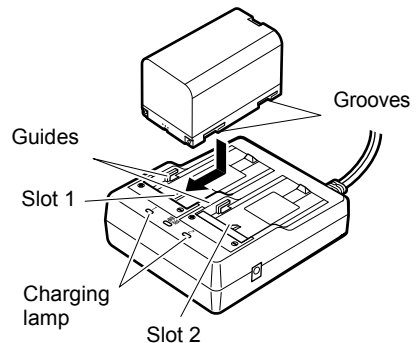
3. When charging starts, the lamp starts blinking.

4. The lamp lights when charging is finished.

5. Remove the battery and unplug the charger.

Note
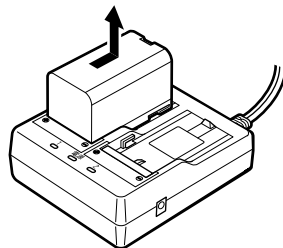
• Slots 1 and 2:
  The charger starts charging the battery mounted first. If you place two batteries in the charger, the battery in slot 1 is charged first, and then the battery in slot 2. (☞ step 2)
• Charging lamp:
  The charging lamp is off when the charger is outside the charging temperature range 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 per battery (at 25°C):
  BDC58: about 4 hours
  BDC70: about 5.5 hours
  (Charging can take longer than the times stated above when temperatures are either especially high or low.)

5.2   Installing/Removing the Battery

Mount the charged battery.
BDC46C and battery adapter SB178 are optional accessories.

• Before removing the battery, turn off the power to the instrument.Settings, and file and folder data may be lost if the battery is removed while the power is switched on.
• When installing/removing the battery, make sure that moisture or dust particles do not come in contact with the inside of the instrument.
• Remove batteries from the instrument or charger before putting into storage.
• Store the battery in a dry room where the temperature is within the following ranges

Storage period	Temperature range
1 week or less	-20 to 50°C
1 week to 1 month	-20 to 45°C
1 month to 6 months	-20 to 40°C
6 months to 1 year	-20 to 35°C

For long-term storage, the battery should be charged at least once every six months.
• The BDC58/70 generates power using a chemical reaction and as a result has a limited lifetime. Even when in storage and not used for long periods, battery capacity deteriorates with the passage of time. This may result in the operating time of the battery shortening despite having been charged correctly. In this event, a new battery is required.

PROCEDURE Mounting the battery

1. Push the catch on the battery cover away from the objective lens.

Catch
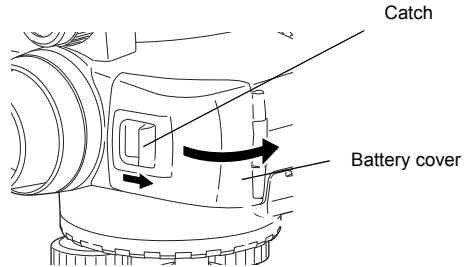
Battery cover

2. Insert the battery in the direction of the arrow on the side of the battery.

3. Close the battery cover. A click is heard when the cover is secure.
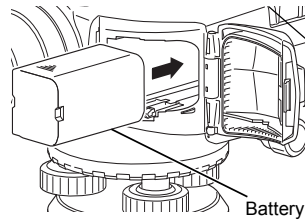
Battery

PROCEDURE Removing the battery

1. Push the catch on the battery cover away from the objective lens.

2. Push the release lever down. Grip the battery and slide out.

Release lever

• If the release lever is not pushed down completely when removing the BDC46C, the battery adapter may jam against the release lever. In this event, push the lever down fully and remove, or re-insert the battery into the instrument and try removing again.

3. Close the battery cover. A click is heard when the cover is secure.
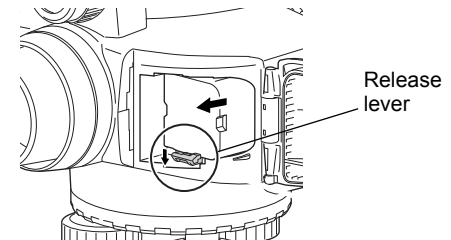
PROCEDURE Using the Battery adapter

Insert the BDC46C into the battery adapter (SB178). The battery can now be mounted in the same way as the BDC58/70.

1. Align the notch in the BDC46C with the SB178 as shown at right. With the terminals-end of the battery inserted, push until the battery adapter is fully extended.

Battery notch
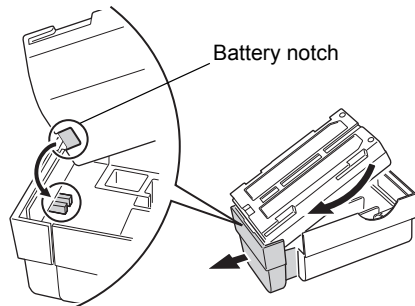
2. Slot the top end of the battery into the battery adapter. The extendable portion of the battery adapter will automatically retract and hold the battery in place.

Note

• To remove, grip both sides of the battery towards the terminals-end and pull out.
• It is possible to charge the BDC46C without removing from the battery adapter.
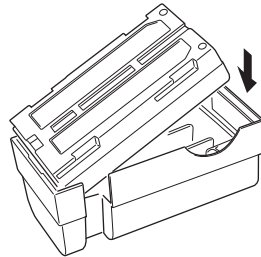
6. SETTING UP THE INSTRUMENT

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

6.1　Setting Up

PROCEDURE

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

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

6.2　Leveling

Instrument can also be levelled using the screen.
☞ " Note Leveling on the screen"

The mirror can be used to check the position of the bubble in the tube when it cannot be viewed from above.

Bubble mirror

PROCEDURE Leveling with the Spherical head tripod

1. Loosen the centering screw.

2. Slide the instrument across the tripod head until the bubble is centered in the circular level.

3. Tighten the centering screw.

4. Level the DL using the leveling foot screws.

Spherical head tripod

Centering screw
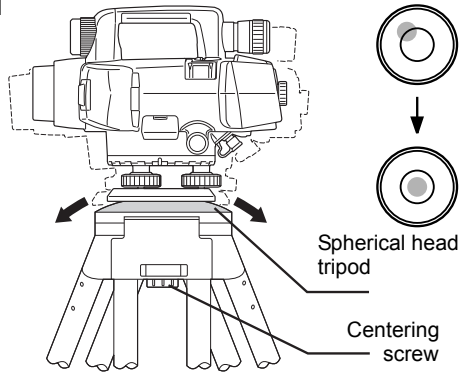
PROCEDURE Leveling with the Flat head tripod

1. 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.

Tripod legs adjustment

2. Adjust one more tripod leg until the bubble is roughly centered.

3. Turn the leveling foot screws while checking the circular level until the bubble is exactly centered in the center circle. When you turn a screw clockwise, raising the instrument, the bubble will move towards the position of that screw.
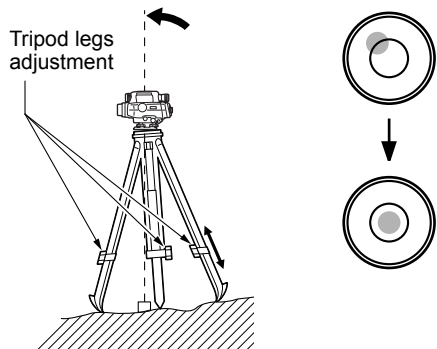
PROCEDURE Leveling on the screen

1. Turn the instrument on.
    ☞ "7. POWER ON/OFF"

2. The screen shown at right is displayed.
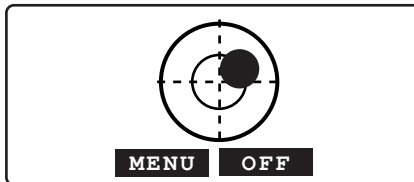
3. Center "●" in the circular level.
    ☞ "6.2 Leveling PROCEDURE Leveling
    with the Spherical head tripod/"6.2 Leveling
    PROCEDURE Leveling with the Flat head
    tripod"
    "●" indicates the bubble in circular level. The
    range of the inside circle is 12' and the range of
    the outside circle is 24'.

    • Press **[OFF]/[BEEP]** to turn the audio tone
    OFF/ON.

Note

   • Measurement cannot be performed when the Tilt screen is displayed.
   • The tilt screen is automatically displayed on startup when "Tilt warn" in "Obs.condition" is set to
     "Yes" and the instrument tilt exceeds the allowable range. Set to "No" to skip levelling on startup.
     ☞ "Tilt warn." setting: "19.2 Instrument Configuration"
   • Pressing **[MENU]** in the screen shown above returns the screen to <Menu> without completing
     leveling. However, measurement cannot be performed until the instrument is levelled.

7. POWER ON/OFF

PROCEDURE Power ON

1. Press **{ ⏻ }**.
    When the power is switched on, a RAM check is run. The Meas mode screen is displayed.

    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 Meas mode screen will be displayed.

```
Rh
Hd                    S
                     ▨
  TILT   MENU      FOCUS
```

Note

• The tilt screen is automatically displayed on startup when "Tilt warn" in "Obs.condition" is set to "Yes" and the instrument tilt exceeds the allowable range. Set to "No" to skip levelling on startup.
• Do not remove the battery while the TOPCON logo is displayed.
• "Tilt warn." in "Obs. condition" should be set to "No" if the display is unsteady due to vibration or strong wind.
☞ "19.1 Observation Conditions"

Resume function
The Resume function redisplays the screen appearing before the instrument was powered OFF when the instrument is powered back ON. All parameter settings are also saved. This function is only activated when the power is turn off while performing height difference measurement or checks and adjustments. When powering back on the screen is returned to the beginning of the procedure being performed on power OFF.

PROCEDURE Power OFF

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

• When there is almost no battery power remaining, "Battery low! Please charge battery." (with audio tone) is displayed alternately with current screen. In this event, stop measurement, switch off the power and charge the battery or replace with a fully charged battery. Data and settings may be lost if the battery is removed while the power is on.
• To save power, power to the DL is automatically cut off if it is not operated for a fixed period of time. This time period can be set to "30 min." or "No" in "Power off" in "Instr.config".
☞ "19.2 Instrument Configuration"

7.1	**Resolving Software Issues**

If you are experiencing problems with the DL and suspect a fault in the software, you should try resetting. If the problem is not resolved the next step is to initialize data.

☞ "19.6 Restoring Default Settings"

✍

• Be sure to back up stored data to an external memory device or computer in advance.

PROCEDURE Initializing data

1. Power OFF the instrument.

2. Press **{ ⏻ }** while holding **{BS}**, **{F1},** and **{F3}** until the TOPCON logo appears. "Clearing memory..." is displayed and data is initialized. The instrument then powers on as normal.

8. FOCUSING AND SIGHTING THE STAFF

8.1   Using the DL-501 Advanced

✖

• If the view finder sighting axis is not aligned with the sighting axis of the objective lens, errors will occur when taking measurements. Always make sure the axes are correctly aligned when using the view finder.

• The View finder can be used to sight staffs at distances of 7m or more.

• Focussing can also be performed manually by turning the focusing knob while looking through the eyepiece. If the staff barcodes are out of focus, they will not be readable and measurements cannot be taken. Make sure they are correctly focused.

• Even when Auto Focus has finished the image in the telescope eyepiece may appear out of focus depending on the eyesight of the operator.

View finder and Auto Focus function
The view finder is used when aligning the DL telescope with the staff. Simply aligning the two center circles in the view finder with the center of the staff and pressing the Measure key automatically focuses the DL on the staff and starts measurement reducing operator workload and increasing operator efficiency in the field.

PROCEDURE Always perform before using the instrument

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

2. Looking through the eyepiece, 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.

3. Looking through the telescope, shift your eyes slightly up and down and to each side. If the staff and reticle show no deviation, the instrument is ready for use.
   If the staff and reticle deviate, return to step 2.

4. Sight a clear vertical line, such as the wall of a building, at a distance usually used for operation.
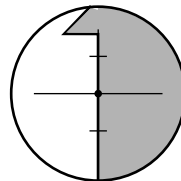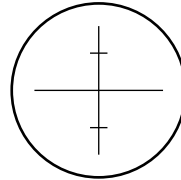
5. Turn the horizontal fine motion knobs until that vertical line is centered in the field of view.

6. Looking through the view finder, turn the view finder eyepiece screw until the 2 circles are focussed.

7. Use the view finder axis alignment screw to align the 2 circles in the view finder with the same vertical line described in step 4.
The sighting axis of the view finder is now aligned with the sighting axis of the telescope as seen through the eyepiece.
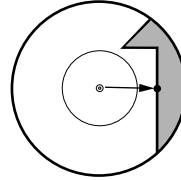
Eliminating parallax
This is the relative displacement of the target image with respect to the reticle when the observer's head is moved slightly before the eyepiece.
Parallax will introduce reading errors and must be removed before observations are taken.
Parallax can be removed by refocussing the reticle.

PROCEDURE Using Auto Focus to focus on the staff

1. Turn the instrument on.
   ☞ "7. POWER ON/OFF"

2. Aim the objective lens roughly in the direction of the staff.

3. Use the horizontal fine motion knobs to align the 2 circles in the view finder until the staff is approximately centered.
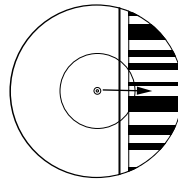
4. Press the Measure key. The instrument automatically focuses on the staff and measurement starts.

8.2   Using the DL-501 Standard

✿

• If the staff barcodes are out of focus, they will not be readable and measurements cannot be taken. Makes sure they are correctly focused.

PROCEDURE

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

2. Looking through the eyepiece, 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.
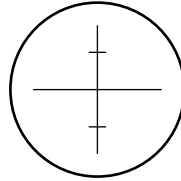
3. Use the Simple Finder to point the objective lens at the staff.
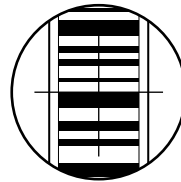
4. Turn the horizontal fine motion knobs until the staff is nearly centered in the field of view, then turn the focusing knob to focus on the staff.

5. Looking through the telescope, shift your eyes slightly up and down and to each side. If the staff and reticle show no deviation, the instrument is ready for use.
If the staff and reticle deviate, return to step 2.
☞ "8.1 Using the DL-501 Advanced 📖 Eliminating parallax"

Note

•Repeat steps 3 and 4 each time measurement is performed.

9. CONNECTING TO EXTERNAL DEVICES

The DL can be connected to a data collector to allow remote operation. Read this manual in conjunction with the operator's manual for the relevant external device and software thereof.

9.1 Wireless Communication using *Bluetooth* Technology

The *Bluetooth* module incorporated in the DL can be used for communication with *Bluetooth* devices such as data collectors.

🦋

• Connection settings are returned to factory settings when defaults are restored. Perform settings again after restoring defaults.

📖 *Bluetooth* connections
Communication between a pair of *Bluetooth* devices requires one device to be set as the "Master" and the other as the "Slave". DL is always the "Slave" device. Connections are initiated from the paired device side

PROCEDURE Necessary settings for *Bluetooth* communication

1. Select "Config" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Comms setup" in <Config menu>.

```
Config menu
1.Obs.condition
2.Instr.config
3.Comms setup
4.Tilt offset
5.Unit          ▼
```

3. Select "*Bluetooth*" in "Mode".

```
Mode       :Bluetooth
Authenticate:No


STX/ETX(CSV):No
 INFO
```

4. Set "Authenticate" to "Yes" or "No".
   If "Authenticate" is set to "Yes" for the DL the passkey will also need to be input on the companion device.

5. When "Authenticate" is set to "Yes", input the same passkey as that for the intended companion device. Even if "Authenticate" is set to "No", a passkey is requested when authentication is set on the companion device being used.
Up to 16 numeral characters can be input. Input characters will be displayed as asterisks (e.g. "*****"). The passkey was set to "0123" at the factory.

```
Mode        :Bluetooth
Authenticate:Yes
Passkey
:****
STX/ETX(CSV):No        ⯆
 INFO
```

6. Set STX/ETX (CSV) settings
☞ "19.3 Communication Setup ⬚ STX/ETX (CSV)"

7. Set average output mode
☞ "19.3 Communication Setup ⬚ AVG out mode"

```
AVG out mode:1         ⯅
```

▶PROCEDURE Displaying *Bluetooth* information for the DL

1. Select "Config" in <Menu>

2. Select "Comms setup" in <Config menu>

3. Select "*Bluetooth*" in "Mode" and press **[INFO]**.

```
Mode        :Bluetooth
Authenticate:No


STX/ETX(CSV):No
 INFO
```

The *Bluetooth* information for the DL is displayed. The "BD_ADDR" for the DL must be registered on your *Bluetooth* device.

```
Bluetooth ID
: Bxxxxxx,Bxxxxxx
Firmware Ver.x.x.x
BD_ADDR
: 00:AA:BB:CC:DD:FF
                   OK
```

📖 *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.

9.2 Establishing a connection between the DL and paired *Bluetooth* device

When "Mode" is set to "*Bluetooth*" in "Comms setup" in <Config menu> [⊤⃝]/[⊤⤬] is displayed in Meas mode.

▶PROCEDURE

1. Complete the necessary settings for *Bluetooth* communication.
    📲 "9.1 Wireless Communication using Bluetooth Technology"

2. Press **[⊤⃝]** in the second page of Meas mode screen.
    The *Bluetooth* module in the DL powers on and connection starts.
    The *Bluetooth* icon indicates communication status.
    📲 "4.2 Display Functions"

```
Rh
Hd                              [ˣS
                                  ▨
                                 P2
                                ⊤⃝
```

[Note]

• Softkeys (in Meas mode)

    [⊤⃝]:Press to enter waiting status
    [⊤⤬]:Press to cancel the connection/exit waiting status

• Audio tones
    (While connecting/disconnecting)
    Start paging/waiting: short beep
    Connection successfully established: long beep
    Connection canceled/being canceled: two short beeps

9.3   Communication between the DL and Companion Device

Setting a data collector as the companion device allows measurement and other operations to be performed from the data collector side.

• *Bluetooth* communication causes DL battery power to be depleted at a rate higher than that for normal operation.
• Check that the companion device (data collector etc.) is turned on and the relevant *Bluetooth* settings are complete.

PROCEDURE

1. Complete the necessary settings for *Bluetooth* communication.
   ☞ "9.1 Wireless Communication using Bluetooth Technology"

2. Check communication status.
   ☞ "9.2 Establishing a connection between the DL and paired Bluetooth device"

3. Initiate measurement using the paired *Bluetooth* device (e.g. a data collector). DL will respond and measurement will start. Measured values are then displayed in the

   Meas mode screen.

9.4   Outputting data using *Bluetooth* communication

It is possible to set a computer as the companion device and output JOB data and route data via wireless communication.

PROCEDURE Outputting JOB data to a host computer

1. Complete the necessary settings for *Bluetooth* communication.
   ☞ "9.1 Wireless Communication using Bluetooth Technology"

2. Check communication status.
   ☞ "9.2 Establishing a connection between the DL and paired Bluetooth device"

32

3. Select "Comms output" in <JOB menu> and
    set "Com.locat."
    ☞ "18.1 Outputting JOB Data PROCEDURE
        Outputting JOB data to host computer"
    DL starts outputting data.

```
Job id
  JOB1
 Format      CSV_1

 Outputting     98/  99
```

*   If a connection has not yet been established,
    the screen at right is displayed. After a
    connection has been established, the data is
    output.

```
Bluetooth


       Waiting for
       connection...
```

9.5   Connecting via Communication Cable

PROCEDURE Basic cable settings

1. Connect the DL to the external device using
    the cable.
    ☞ Cables: "24. OPTIONAL
        ACCESSORIES"

2. Select "Comms setup" in <Config menu>.
    Set communication conditions.
    ☞ "19.3 Communication Setup"

10.BASIC OPERATION

10.1   Reading the Staff

Simply focus on the RAB* code for an automatic reading of the staff. The following explains how to read the RAB code of the staff.
*RAB code (RAndom Bi-directional code) is a coded staff used with certain digital levels.

• Set up the staff in an area free of obstacles.
• Avoid placing the staff next to mirror-like surfaces. The effect of strong light could make measurements impossible.
• Support the staff so that it is perpendicular, checking the circular bubble scope on the staff. If the staff is tilting, height and distance measurements will be incorrect.
• If the surface is catching the light, turn it just enough to stop the reflection.

Turn a few degrees
to the left or right.

RAB code side of
the staff
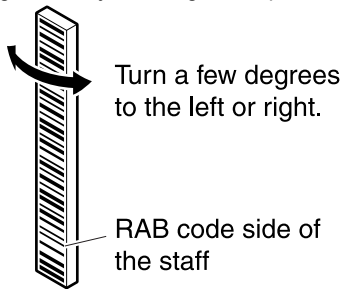
• Make sure shadows are not cast on the staff as this could make measurement impossible.
• When holding the staff during measurement, make sure your hand does not cover the RAB code.
• If dark locations make measurement difficult, shine a flashlight on the staff. Stand at a distance so that the beam shines evenly over the length of the staff.
• If waterdrops or dirt adhere to the barcode, measurement may be impossible. Wipe the staff clean with a soft cloth.
• Clean the staff if grit or dirt gets stuck between the sections. If the staff is dirty, measurements will not be very accurate.
• Avoid scratching or soiling the barcode surface as this could make measurement impossible. Store and carry the staff inside its case.
• If the BIS/BGS series staff is used for leveling, and the height difference and temperature difference are much larger than normal, temperature variations may cause the staff to expand or contract and cause differences in relative height measurements. DL reads in measurements up to 0.01mm and minor deviations in the accuracy of the staff will adversely affect accuracy. To obtain high accuracy measurements, it is important to perform temperature corrections for the staff. See Note below.

Note

• Formula for correcting expansion and contraction of the staff due to temperature changes.

$$\Delta C = \{C0 + (T-T0) \times \alpha\} \times \Delta h$$

ΔC: Staff correction value
C0: Scale factor
T: Measured temperature during observation (average temperature during measurement of known site,

intermediate site, new site)

T0: Reference temperature of 20° C

α : Line expansion coefficient

Δ h: Height difference

PROCEDURE Setting up the staff

1. Set the foot plate on the ground so that the staff will not sink.

2. When using a BGS staff, connect the sections correctly by making sure the numbers on the numeric scale side of the staffs run in unbroken order.

3. Keeping an eye on the circular bubble scope on the staff, set the staff in the foot plate so that it stands up straight.

4. Turn the barcode scale towards the instrument.

PROCEDURE Measuring the height from a ceiling

Rh "negative value"

Inverted staff
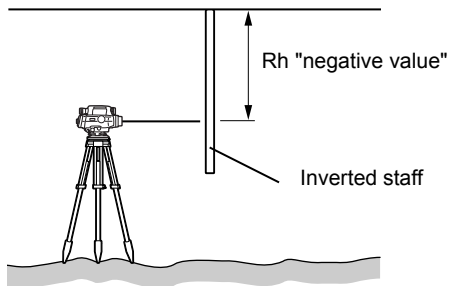
10.2   Measuring in Measure Mode

In Measure mode you can sight point A, take the staff reading Rh, and measure the horizontal distance Hd to the staff.
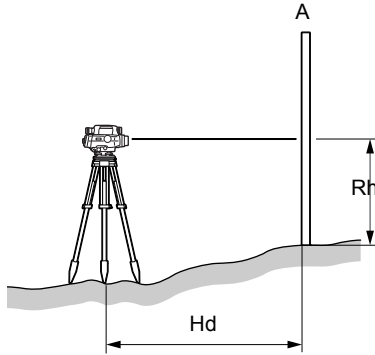
✖
- If direct sunlight or strong light enter the eyepiece during measurement, ambient light is too low, or the staff is set against a background which is too bright, and measurement cannot be performed, an error is displayed (☞ "20. WARNING AND ERROR MESSAGES").
- If the DL or staff is subjected to shocks or vibration during use, measurement may be impossible. Resume measurement during more stable conditions.

PROCEDURE

1. Turn the instrument on.
   ☞ "7. POWER ON/OFF"

2. Aim the instrument at the staff and press the Measure key. Measurement starts. When measurement is complete, the staff readings (Rh) and horizontal distance (Hd) are displayed.

```
Rh      1.2345  m
Hd      4.321   m            S
                           ▐\▌

  TILT   MENU            FOCUS
```
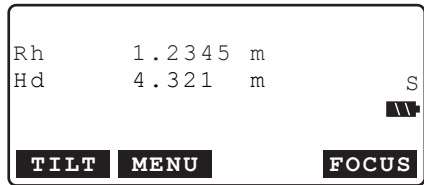
   • In Repeat, Average, or Rapid mode, values are renewed with each measurement. Press **[STOP]** or the Measure key to stop reading. Press **{ESC}** to cancel the reading.

Note
   •Auto focus functionality is not available for the DL-501 Standard. Therefore **[FOCUS]** is not displayed in the screen of step 2.

11.SIMPLE MEASUREMENT

This chapter explains how to measure height difference or elevation without setting a route.

•The maximum number of points per JOB is 2000.

11.1　Measuring Height Difference

This function allows the user to calculate the height difference (dH) between backsight (A) and foresight (B).
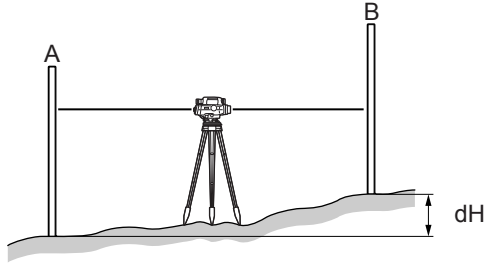
1. Select "Meas" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Simple measurement" in <Meas menu>.

```
Meas menu
1.Height dif.
2.Check & adjust.
3.Simple measurement
```

3. Select "Ht-diff. meas." in <Simple meas. menu>.

```
Simple meas. menu
1.Ht-diff. meas.
2.Elevation meas.
3.View
4.Deletion
```

4. Set up the DL between A and B.

5. Measure backsight.

   • **[FOCUS]**: Press to perform Auto Focus only.

```
BS                    Go
BS0001                ⊞
Rh                     S
Hd                    ＼＼
                      P1
 TILT  CNFG  PT.ID FOCUS
```

• **[PT.ID]**: Press to change the current point ID.
Subsequent point IDs will be assigned
automatically in either ascending or
descending order.
Select **[Decr.]**/**[Incr.]** for descending/
ascending order.

```
Pt.id
:0000A                        A
Meas.pt type:BS               +
Line         :Go

Decr.                         OK
```

|Note|

• 田 (日) will be displayed to the right of the
  point ID when ascending (descending)
  order is selected.
• Point ID settings can be changed mid-route.

• **[CNFG]**: Press to configure measurement
settings.

```
A.F.setting  :Yes
Tilt warn    :Yes
Meas mode    :Single

Ht reso.   : 0.01mm
Dist reso.: 0.001m
```

```
Auto rec     :No            ▲

```

• Press **[INPUT]** on page 2 to manually input
Rh values and Hd values obtained using the
telescope stadia lines.

```
Data input
Rh  :  0.00000m          1
Hd  :  0.000   m

                         OK
```

6. Check point ID, double-run setting, and
   measurement results.
   Press **[OK]**.

```
BS                    Go
BS0001                +
Rh     2.45678m       S
Hd     17.891  m      ▨

                      OK
```

7. Measure foresight.

```
FS                    Go
FS0001                +
Rh                    S
Hd                    ▨
                      P1
TILT   CNFG   PT.ID  FOCUS
```

8. Check point ID, double-run setting, and measurement results.
   Press **[OK]**.
   Results are recorded and the screen in step 7 is restored.

   • When "Auto rec" is set to "Yes", results are displayed for approx. 1 sec. before the screen in step 7 is restored.

```
FS                          Go
FS0001                       ⊞
Rh        2.34567m            S
Hd      12.345   m          ▚▚▸
   h    -1.23456m
              TURN P       OK
```

"Auto rec" set to "No"

```
FS                          Go
FS0001                       ⊞
Rh        2.34567m            S
Hd      12.345   m          ▚▚▸
   h    -1.23456m
```

"Auto rec" set to "Yes"

9. Press **[TURN P]** on page 2 to set the previously measured foresight as a turning point.

```
FS                          Go
FS0001                       ⊞
Rh                           S
Hd                          ▚▚▸
                            P2
 INPUT   TURN P
```

10. Move the DL to the next position.
    Repeat from step 5 using the foresight measured in step 7 as the new backsight.

Note

• When operation has been canceled after moving screens during measurement, the following message will be displayed the next time "Ht-diff. meas." is selected in <Simple meas. menu>. Press **[YES]** to resume measurement from where you left off last time.

```
Operation will continue
from last measurement.
        OK?

                 NO    YES
```

11.2　Measuring Elevation

This function allows the user to calculate the elevation (HA + dH) of a specified point (B) based on the elevation of known point (A).
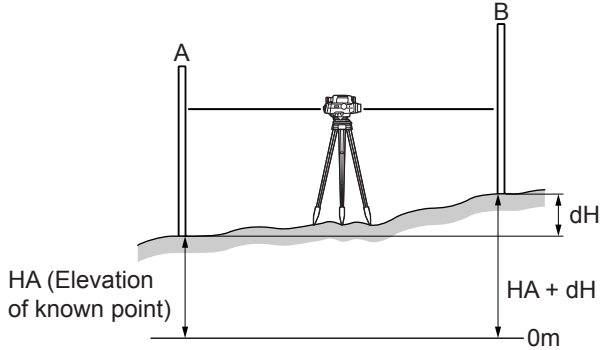
1. Select "Meas" in <Menu>.

2. Select "Simple measurement" in <Meas menu>.

3. Select "Elevation meas." in <Simple meas. menu>.

```
Simple meas. menu
1.Ht-diff. meas.
2.Elevation meas.
3.View
4.Deletion
```
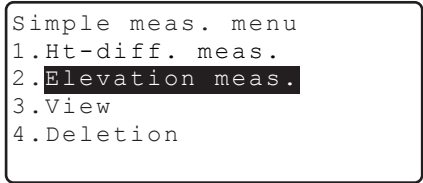
4. Set up the DL between A and B.

5. Input elevation of known point and press **[OK]**.

   •When elevation has been selected, press **[READ]** to read in the elevation of a known point.
   • ☞ "12.3 Setting-Out Measurement PROCEDURE Reading in recorded known point data"

```
BS
                              1
Z      :      1.20000m


       READ           OK
```

6. Measure backsight.

```
BS                      Go
BS0001                  ⊞
Rh                      S
Hd                     ◣◪
                      P1
 TILT  CNFG  PT.ID FOCUS
```

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7. Check point ID, double-run setting, and
   measurement results.
   Press **[OK]**.

```
BS                    Go
BS0001                 ⊞
Rh      2.45678m        S
Hd      17.891  m      ▨▸

                      OK
```

8. Measure foresight.

```
FS                    Go
FS0001                 ⊞
Rh                     S
Hd                    ▨▸
                      P1
 TILT   CNFG   PT.ID  FOCUS
```

9. Check point ID, double-run setting, and
   measurement results.
   Press **[OK]**.
   Results are recorded and the screen in step 8
   is restored.

   • When "Auto rec" is set to "Yes", results are
   displayed for approx. 1 sec. before the
   screen in step 8 is restored.

```
FS                    Go
FS0001                 ⊞
Rh      2.34567m        S
Hd      12.345  m      ▨▸
Z    1001.23456m
       TURN P        OK
```

"Auto rec" set to "No"

```
FS                    Go
FS0001                 ⊞
Rh      2.34567m        S
Hd      12.345  m      ▨▸
Z    1001.23456m

```

"Auto rec" set to "Yes"

10. Press **[TURN P]** on page 2 to set the
    previously measured foresight as a turning
    point.

```
FS                    Go
FS0001                 ⊞
Rh                     S
Hd                    ▨▸
                      P2
 INPUT  TURN P
```

11. Move the DL to the next position.
    Repeat from step 5 using the foresight
    measured in step 8 as the new backsight.

Note

• When operation has been canceled after moving screens during measurement, the following message will be displayed the next time "Elevation meas." is selected in <Simple meas. menu>. Press **[YES]** to resume measurement from where you left off last time.

```
Operation will continue
from last measurement.
        OK?
                    NO    YES
```

11.3   Viewing Simple Measurement Data

It is possible to display measurement data obtained using simple measurement.

PROCEDURE

1. Select "Meas" in <Menu>.

2. Select "Simple measurement" in <Meas menu>.

3. Select "View" in <Simple meas. menu>.

   Note

   •Data can also be displayed via <Management menu>

```
Simple meas. menu
1.Ht-diff. meas.
2.Elevation meas.
3.View
4.Deletion
```

4. Align the cursor with the data to be displayed and press **{◄──}**.

```
BS0000              BS
FS0001              FS
IS0002              IS
IS0003              IS
FIX0004             FIX ▼
↑↓...P   TOP   LAST   SRCH
```

   Detailed information for the selected point is displayed.
   • **[PREV]**: Press to display detailed information for the previous point.
   • **[NEXT]**: Press to display detailed information for the next point.
   • **[EDIT]**: Press to edit point id and measurement point type.

```
BS                  Go
BS0000
Rh     2.45678m
Hd     17.891  m

NEXT   PREV        EDIT
```

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• Press **[SRCH]** to search for point data by point id.

```
Search
Pt.id              A
:IS0003
                OK
```

5. Press **{ESC}** to return to <Simple meas. data menu>

11.4   Deleting Simple Measurement Data

It is possible to delete measurement data obtained using simple measurement.

PROCEDURE Deleting specific simple measurement data

1. Select "Meas" in <Menu>.

2. Select "Simple measurement" in <Meas menu>.

3. Select "Deletion" in <Simple meas. menu>.

Note

• Data can also be deleted via <Management menu>

Align the cursor with the data to be deleted and press **{◄▬}**. "DEL" is displayed to the right of the point id.

```
Simple meas. menu
1.Ht-diff. meas.
2.Elevation meas.
3.View
4.Deletion
```

```
BS0000
FS0001
IS0002
IS0003           DEL ▼
FIX0004          DEL P1
↑↓...P   TOP   LAST   OK
```

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• Press **[DETAIL]** in the second page to display detailed information for the selected simple meas. data.

• Press **{ESC}** to return to the point list.

```
BS0000
FS0001
IS0002
IS0003              DEL  ▼
FIX0004            DEL  P2
DETAIL
```

Note

• Backsight data can be deleted only after all the related foresight data are deleted.

```
BS                    Go
0001
Rh      2.34567m
Hd     12.345  m



```

4. Press **[OK]** in the screen of step 4 to display a confirmation dialog.

Press **[YES]** to delete and return to the point list.

```
Meas. data deletion

Simple meas. data
     deletion
       Confirm?
            N O    Y E S
```

PROCEDURE Deleting all simple measurement data (initialization)

1. Select "Management" in <Menu>.

2. Select "Simple meas. data" in <Management menu>.

3. Select "Initialize".

```
Simple meas. data menu
1.View
2.Deletion
3.Initialize


```

4. Press **[YES]** to delete all simple measurement data in the selected JOB.

```
All simple meas. data
  will be deleted.
       OK?

            N O    Y E S
```

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12.HEIGHT DIFFERENCE MEASUREMENT

Height difference measurement allows the user to calculate the relative height between a known point and a specified point. The instrument is moved from instrument station to instrument station along a route from the known point to the unknown point taking measurements at each section. The total of measurements at all sections gives the height difference between the known point and the specified point. This method is particularly useful when the known and unknown points are far apart, relative height is great, or there are obstacles preventing sighting.
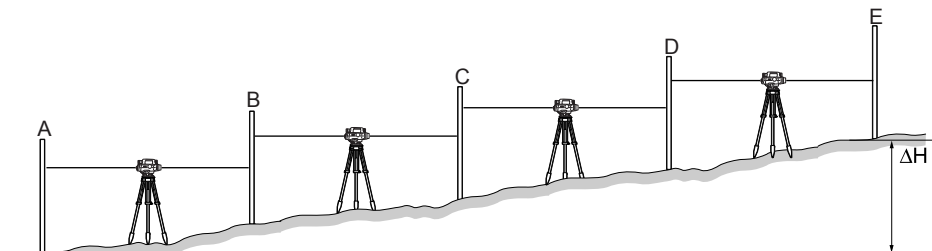
• Except when special circumstances exist, there should be an even number of sections along a route.

12.1　Route Setup

The route between bench mark and bench mark must be set before starting measurement. Select an existing route or create a new route.

• Route setup is performed in <Route menu>.
• It is possible to select a partially completed route and recommence measurement from where you left off.
• When performing double-run leveling, each run is treated as a separate route.
• It is possible to change the route ID and memo of routes containing measurement data.
• Procedures for reobservation are explained elsewhere in this manual.
  ☞ "14.4 Reobserved Route Merge"
• The maximum number of routes per JOB is 100.
• The maximum number of fixed points/end points per route is 100 (2000 total in all routes incl. fixed points/end points)
• The maximum number of start conditions per route is 100 (1000 total in all routes incl. start conditions)

PROCEDURE Selecting a route

1. Select "Meas" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Height dif." in <Meas menu>.

```
Meas menu
1.Height dif.
2.Check & adjust.
3.Simple measurement
```

3. Select "Route" in <Height dif. menu>.

```
Height dif. menu
1.Route
2.Measurement
```

4. The currently selected route is displayed.
   Press **[LIST]**. Align the cursor with the desired
   route name and press **{◄──}**.

   • **[NEW]**: Press to set a new route.
     ☞ "PROCEDURE Recording a new route"

```
Route setting
:R1



 LIST   NEW  DETAIL   OK
```

   • **[DETAIL]**: Press to display route settings.
     Route name can also be changed.
     ☞ "PROCEDURE"
   • **[↑↓...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.

```
 R1                     20
 R2                     20
 LINE01                 15
 LINE02                 10
 LINE03                  0 ▼
↑↓...P   TOP   LAST
```

5. Press **[OK]** to confirm route settings.

```
Route setting
:R2



 LIST   NEW  DETAIL   OK
```

PROCEDURE Recording a new route

1. Select "Meas" in <Menu>.

2. Select "Height dif." in <Meas menu>.

3. Select "Route" in <Height dif. menu>.

4. Press **[NEW]**.

```
Route setting
:R1




 LIST   NEW  DETAIL   OK
```

5. Set the following data items.
   (1) Route ID
   (2) Memo
   (3) Start bench mark ID
   (4) Start bench mark elevation
   (5) End bench mark ID
   (6) End bench mark elevation
   (7) Double-run setting
   (8) Measurement order
   (9) Measurement procedure
   (10) Ht resolution
   (11) Distance resolution
   (12) Rh range
   (13) dH range
   (14) Upper tolerance (distance)
   (15) Lower tolerance (distance)
   (16) Upper tolerance (ht)
   (17) Lower tolerance (ht)
   (18) Distance difference between backsight
        and foresight
   (19) Total distance difference between
        backsight and foresight

   • Press **[READ]** to read in route data when
     setting Start bench mark ID and End bench
     mark ID.
     ☞ "12.3 Setting-Out Measurement
         PROCEDURE Reading in recorded
         known point data"

```
Route id
: Route-001          A
Memo
:
:                    ⩔
                     OK
```

```
Start bench mark id  ⩚
:B1                  1
Start bench mark elev.
:    150.00000m
                     ⩔
 READ                OK
```

```
End bench mark id    ⩚
:B2                  1
End bench mark elev.
:    165.00000m
                     ⩔
 READ                OK
```

```
Line    :Go          ⩚
Order   :1

Meas.Proc:BFFB
                     ⩔
                     OK
```

```
Ht reso.  :0.1mm     ⩚
Dist reso.:0.001m
Rh range  :  0.50mm
dH range  :  1.00mm
                     ⩔
                     OK
```

```
Upper dist  40.000  m ⩚
Lower dist:  3.000  m 1
Upper Rh  :  2.80000m
Lower Rh  :  0.20000m
                     ⩔
                     OK
```

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```
BF dist diff.              ≜
          : 1.000    m  1
Total dist diff.
          : 3.000    m


                        OK
```

6. Press **[OK]** in the screen of step 5 when all data items have been set.

    Press **[YES]** in the subsequent screen to confirm route settings.

```
New route setting
   is registered.
     Confirm?
              NO   YES
```

Note

Conditions such as character input restrictions, input range, and selectable options for the above data items are as follows.
- Route ID/bench mark ID: up to 16 characters
- Memo: 2 rows of up to 16 characters
- Elevation: -20000.00000 to 20000.00000m
- Double-run setting: Go/Return
- Measurement order: 1/2/3/4/5 (each number is allocated to a commonly used measurement procedure making selection of a measurement procedure easier. This allocation is saved in the set route)
- Measurement procedure: BFFB/BBFF/BF/aBFFB/aFBBF/BFBF/aBF("B" means backsight and "F" means foresight, "a" signifies alternation of measurement procedure at subsequent instrument station)
- Ht resolution: 0.01/0.1/1mm
- Distance resolution: 0.001/0.01/0.1m
- Ht/Distance range: 0.00 to 99.99mm ("0.00" setting: no restrictions on this data item)
- Upper/Lower tolerance (distance): 0.000 to 200.000m ("0.000" setting: no restrictions on this data item)
- Upper/Lower tolerance (ht): 0.00000 to 9.99999m ("0.00000" setting: no restrictions on this data item)
- Distance difference between backsight and foresight/Total distance difference between backsight and foresight: 0.000 to 200.000m ("0.000" setting: no restrictions on this data item)
- Format: CSV_1/CSV_2

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PROCEDURE Editing route ID

1. Select "Route" in <Height dif. menu>.

2. Press **[LIST]**. Align the cursor with the desired route and press **{◀━}**.

```
Route setting
:R1



LIST  NEW  DETAIL  OK
```

3. Press **[DETAIL]**.

4. Edit the memo/route ID and press **[OK]** to confirm.

   • Data items other than memo/route ID for routes/reobserved routes containing measurement data cannot be edited.

```
Route id
: R1                      A
Memo
:
:                         ⩡
                        OK
```

12.2 Height Difference Measurement

Each section along the set route is measured using the backsight/foresight sequence selected in the "Meas. Proc." data item in route settings. Fixed points can be established along the route while measuring.

• Power to the instrument can be turned off while moving between sections. The Resume function maintains measurement results obtained prior to shutdown.
• When "Rec cond." is set to "Yes", start conditions must be set when starting measurement of a new route.

📖 **Fixed points**

When checking the accuracy of measurement results, fixed points common to both the go and return runs are set. Fixed points are also set when stopping measurement temporarily.

PROCEDURE Measurement procedure BFFB

1. Select "Meas" in <Menu>.

2. Select "Height dif." in <Meas menu>.

3. Select "Measurement" in <Height dif. menu>.

```
Height dif. menu
1.Route
2.Measurement
```

4. Select "Start cond." in <Meas menu>.
   • Select "Meas start" to skip Start cond. input and proceed to step 7.

```
Height dif. meas menu
1.Start cond.
2.Meas start
3.View
```

5. Set the following data items.
   (1) Temperature
   (2) Weather
   (3) Wind strength
   (4) Wind direction
   (5) Observer name
   (6) Memo

```
Feb/17/2009 10:03:28
Temp      : 15.0 ℃        1
Weather   :Fine
Wind      :Calm
Wind dir  :---          ⬇
                        OK
```

6. Press **[OK]** in the screen of step 5 when all data items have been set.

```
Observer                 ⬆
:                        A
Memo
:
:
                        OK
```

7. Set up the DL in the center of the first section.

8. Press the Measure key to perform pre-measurement and confirm that the distance to the backsight is approximately the same as the distance to the foresight.
   Press **[OK]**.

```
Pre.meas.
Rh      1.2345 m
Hd     34.567  m
                        \\\
  TILT   CNFG   OK   FOCUS
```

9. Measure backsight.

   • **[FOCUS]**: Press to perform Auto Focus only.

```
BFFB                          Go
0000                           ⊞
Rh                             S
Hd                            ⟋⟍
        BS1            FS1     P1
 TILT    CNFG    PT.ID   FOCUS
```

   • **[PT.ID]**: Press to change the current point ID.
Subsequent point IDs will be assigned
automatically in either ascending or
descending order.
Select **[Decr.]**/**[Incr.]** for descending/
ascending order.

```
Pt.id
:Route01-A1-0001            A
                           ⊞

 Incr.                    OK
```

Note

   • ⊞ (⊟) will be displayed to the right of the
point ID when ascending (descending)
order is selected.
   • Point ID settings can be changed mid-route.

   • **[CNFG]**: Press to configure measurement
settings.

```
A.F.setting  :Yes        ⯅
Tilt warn    :Yes
Pre.meas     :Yes
Meas mode    :Single
```

   • Press **[INPUT]** on page 2 to manually input
Rh values and Hd values obtained using the
telescope stadia lines.

```
Data input
Rh  :   0.00000m         1
Hd  :   0.000   m

                         OK
```

10. Check point ID, double-run setting, and
measurement results.
Press **[OK]**.
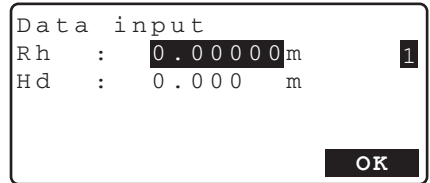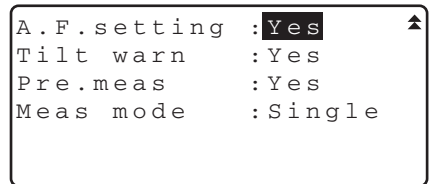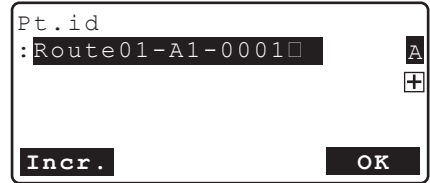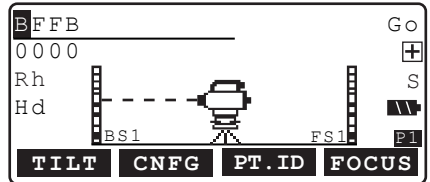
```
BFFB                          Go
Route01-A1-0001                ⊞
Rh      1.5678 m               S
Hd     34.567  m              ⟋⟍
                              OK
```

11. Measure foresight.

```
BFFB                          Go
Route01-A1-0001                ⊞
Rh                             S
Hd                            ⟋⟍
        BS1            FS1     P1
 TILT    CNFG    PT.ID   FOCUS
```

12. Check point ID, double-run setting, and measurement results.
    Press **[OK]**.

```
BF FB                    Go
Route01-A1-0001          ⊞
Rh      1.2345  m          S
Hd      34.456   m        ▚▚
                        OK
```

13. Measure foresight again and check results.

14. Measure backsight again and check results.

15. The following results are displayed for the first section.
    Relative height difference between first and second measurements
    Height difference
    Distance between backsight and foresight
    Distance from previous fixed point
    Distance from first point
    Relative height difference from previous fixed point
    Relative height difference from first point
    Elevation of foresight point

    Press **[OK]** to record results and display the measurement screen for the next measurement point.

```
Route01-A1-0001          Go
 h1      0.3333  m
 h2      0.3331  m
Dif.       0.2  mm        ⯬
  D     69.023  m        P1
  IS    FIXEDP   END    OK
```

```
Σd      69.023  m        ⯬
ΣD      69.023  m
Σh       0.3332  m
ΣH       0.3332  m
 Z      20.3332  m        P1
  IS    FIXEDP   END    OK
```

• Press **[IS]** to measure from the current point to a point not on the route.
  When **[IS]** is pressed, measurement results for the current section are recorded and the screen shown at right is displayed.
  Press the Measure key to measure the IS point.

```
IS                       Go
0002                     ⊞
Rh                        S
Hd                        ▚▚
                        P1
  TILT   CNFG   PT.ID  FOCUS
```

• Press **[PT.ID]** to change the point ID for the IS point.

Note

•Point IDs for IS points will be assigned in ascending order regardless of settings in step 9.

```
Pt.id
:Route01-IS0002          A
                         ⊞
                        OK
```

- Press **[OK]** in the screen shown at right to record results and return to the previous screen.
  Measurements of subsequent IS points can be performed from this screen.
  Press **{ESC}** to exit IS measurement.

```
IS                        Go
Route01-A1-0002
Rh       1.3456  m          S
Hd      30.123   m         ◣◥
Z       20.2222  m
                         OK
```

- When height difference measurement in the first section is complete, press **[S-O]** in the second page to perform setting-out.

```
Σd        69.023  m        ▲
ΣD        69.023  m
Σh         0.3332  m
ΣH         0.3332  m
  Z       20.3332  m       P2
  S - O
```

16. Set up the DL in the center of the next section.

17. Repeat steps 8 to 15 to measure the subsequent sections. The foresight for the previous section becomes the backsight for the current section.

- Press **[FIXEDP]** in the screen of step 15 to set up a fixed point. Input a temperature and memo and press **[OK]** to proceed the next screen.

```
Fixed pt No.0003
Feb/17/2009 10:33:28      1
Temp       :        °C
Memo
:
              END     OK
```

  Press **[END]** then **[YES]** in the screen shown at right to end height difference measurement and return to <Height dif. meas menu>.

```
The measurement
    of the route
       is ended.


              NO     YES
```

18. Check the results for the final section.
    Press **[END]** in the results screen for the final section.

```
Σd     123.456   m        ▲
ΣD     567.890   m
Σh       1.2345  m
ΣH       4.5678  m
  Z     24.5678  m
       FIXEDP   END     OK
```

19. Set temperature and enter a memo.
    Press **[OK]** to record results and end height difference measurement.
    <Height dif. meas menu> is restored.

```
Feb/17/2009 12:23:58
Temp       : 15.0 °C       1
Memo
:
       Meas. is ended.
                         OK
```

Note

• Start cond. input in steps 4 to 5 is optional when restarting measurement of a partially-completed route.
• The pre-measurement of step 8 will be performed in rapid single mode regardless of the "Meas mode" setting in "Obs.condition".
• Auto focus functionality is not available for the DL-501 Standard. Therefore **[FOCUS]** is not displayed in the screen of steps 8, 9 and 11.

Conditions such as character input restrictions, input range, and selectable options for the above data items are as follows.
• Temperature: -30 to 60°C (-22 to 140°F)
• Weather: Fine/Cloudy/Light rain/Rain/Light snow/Snow/Fog
• Wind strength: Calm/Gentle/Light/Strong/Very strong
• Wind direction: ---/N/NE/E/SE/S/SW/W/NW
• Observer name: up to 16 characters
• Memo: 1 or 2 rows of up to 16 characters

12.3 Setting-Out Measurement

This function allows a point to be found at a specified elevation, relative height or distance.

Elevation   Relative height   Distance

Known pt elevation / Elevation (input value) / 0m / Relative height (input value) / Distance (input value)
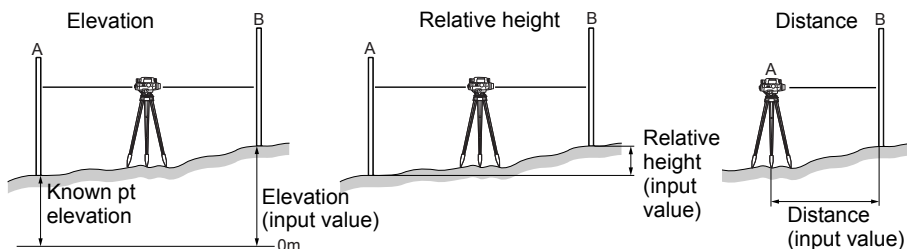
PROCEDURE

1. Perform height difference measurement.
   ☞ "12. HEIGHT DIFFERENCE MEASUREMENT" steps 1 to 15

2. When height difference measurement in the first section is complete, press **[S-O]** in the second page.

```
Σd      69.023  m        ▲
ΣD      69.023  m
Σh       0.33332  m
ΣH       0.33332  m
 Z      41.33332  m      P2
 S - O
```

3. Press **[MODE]** to switch input mode between elevation, height difference, and distance.

```
S-O data
                               1
Z         :        0.00000 m


 MODE   READ            OK
```

4. Input the desired elevation/height difference/ distance and press **[OK]**.

   •When elevation has been selected, press **[READ]** to read in the elevation of a known point.

   ☞ PROCEDURE Reading in recorded

   known point data

```
S-O data
                               1
Z         :       41.00000 m


 MODE   READ            OK
```

5. Measure the foresight.

   The difference between the input value and the actual measured value is displayed. The direction to the input value is displayed along with an arrow. (The screen at right is that for elevation mode)

```
Z         :     41.00000 m
SO-0001
Rh        1.56230 m         S
Hd       10.345   m      ▚▜▖
 ⤓Cut     1.20000 m
           REC           OK
```
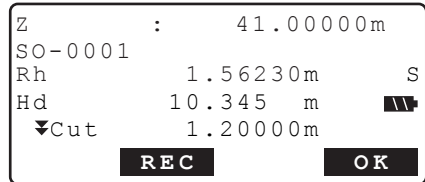
6. Move the staff in accordance with the values on the screen. When directions are no longer displayed and the value on this line is 0, the setting-out point has been reached.
   Press **[OK]** to set a new setting-out point without recording current data.

```
Z         :     41.00000 m
SO-0001
Rh        2.76230 m         S
Hd       10.345   m      ▚▜▖
⬆⬇        0.00 mm
           REC           OK
```
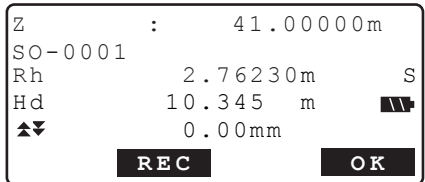
7. Press **[REC]** in the screen illustration of step 6 to display the screen at right. Press **[OK]** to record setting-out data. The screen returns to <S-O data>.
   Press **{ESC}** to return to the screen illustration in step 6.

```
S-O _____
SO-0001
Rh        2.76230 m
Hd       10.345   m      ▚▜▖
Z        41.00000 m
                         OK
```
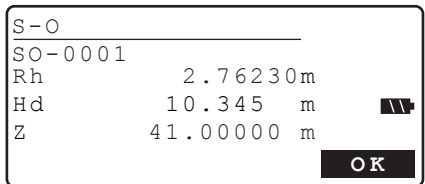
PROCEDURE Reading in recorded known point data

Recorded known point data can be read in and used in setting-out measurement. It is possible to search for data by JOB.

1. Press **[READ]** in the screen at right. (The screen at right is that for elevation mode)

```
S-O data
                                    1
Z              :      41.00000m


 MODE   READ              OK
```

2. Align the cursor with "Search JOB" and press **[LIST]** to display a list of recorded JOBs. Use **{◀}/{▶}** to select "Route data" or "JOB data" in "Data type".

```
Search JOB
:JOB3
Data type
:JOB data

 LIST                     OK
```

3. Press **[OK]** in the screen of step 2 to display a list of known point data in the selected JOB. Align the cursor with the desired data and press **{◀━}**.

   • Press **[DETAIL]** in the second page to display detailed information for the selected known point data.

```
0000                       ▲
0001
0002
0003
0004                      P1
↑↓...P   TOP   LAST   SRCH
```

   <S-O data> is restored. The selected known point name and elevation are displayed.

```
S-O data
0000                       1
Z              :      18.00000m


 MODE   READ              OK
```

   "Done" is displayed next to data already used for setting-out measurement.

```
0000              Done ▲
0001
0002
0003
0004                      P1
↑↓...P   TOP   LAST   SRCH
```

[Note]

Selectable options for the above data items are as follows.
• Data type: JOB data/Route data (the relevant route is displayed in the bottom line when "Route data" is selected)

13.OTHER MEASUREMENT FUNCTIONS

13.1 Measuring Horizontal Angle

You can measure the horizontal angle between point A and point B by using the horizontal circle.
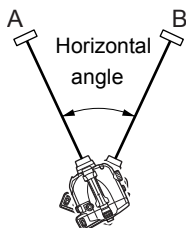
13.2 Using the Instrument as a Standard Level

By using the numeric scale side of the staff, you can use the DL as a standard level. Simply focus on the staff using the eyepiece and read the scale.

In the Height difference measurement mode, manually sighted Rh values and distance values (Hd) measured using the stadia lines can be manually input in the currently selected route by pressing **[INPUT]** in the second softkey page of the backsight/foresight measurement screens.
☞ "12.2 Height Difference Measurement" step 9

Note

• The instrument can be used as a standard level regardless of whether the power is on or off. However, pressing the Measure key when the power is on will result in an error.

14.CALCULATION FUNCTIONS

The functions described in this chapter allow the user to calculate double-run discrepancy, or closure error for closed leveling links/loops using data from measured routes.
.

![icon]

• Route data used in calculation must all come from the same JOB.

14.1 Double-run Discrepancy

This function compares the height difference results recorded for the go and return runs on a specified route observation and calculates any discrepancy between the two sets of results. It is also possible to view discrepancies in height difference for each individual section along the route.

Total discrepancy in height difference between go and return runs

Start point

End point

Discrepancy for individual section
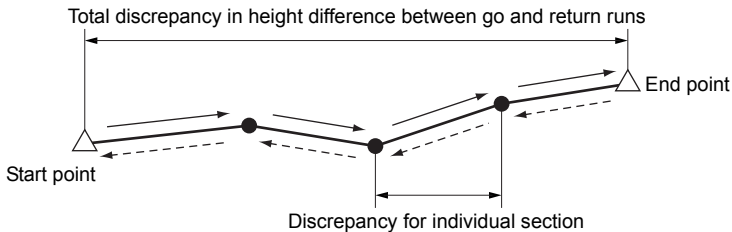
1. Select "Calculation" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Dble-run discrepancy" in <Calculation menu>.

```
Calculation menu
1.Dble-run discrepancy
2.Closure error
3.Reobs.route merge
```

3. Press **[LIST]** to display a list of routes saved in the current JOB.

```
Route selection
Go route id
:R001
Return route id
:R002
 LIST          CALC
```

Align the cursor with the route you wish to use as the go run and press {◄━━}. <Route selection> is restored.
- Press **[TOP]** to move to the first route on the first page.
- Press **[LAST]** to move to the last route on the last page.

Repeat the above to select the route you wish to use as the return run.

```
R001
R002



        TOP    LAST
```

4. Check settings, then press **[CALC]**. Double-run discrepancy and relative height results are displayed.

- Press **[ADJUST]** to distribute discrepancy among points.

- Press **[FIXEDP]** to display results for fixed points. Press **[NEXT]**/**[PREV]** to display results for the next/previous fixed point. Press {ESC} to return to <Dble-run discrepancy>.

```
Dble-run discrepancy
dH           -0.60mm
Relative height
Go         12.43708m
Return    -12.43648m
ADJUST FIXEDP      OK
```

```
Fixed pt. No.0001
dH           -0.30mm
Relative height
Go          4.31280m
Return     -4.31256m
  NEXT
```
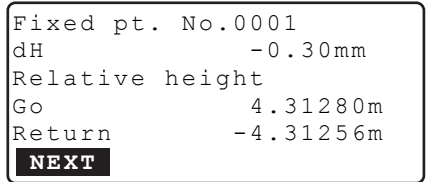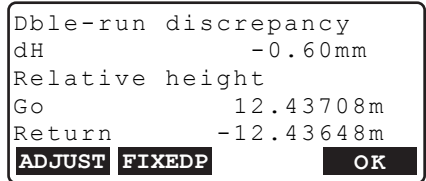
Note
- Both the go run and return run must contain the same number of fixed points.
- The display range for dH results is -99.99 to 99.99 (mm). Results falling below/exceeding this range will be displayed as -99.99 or 99.99 respectively.

5. Press {ESC} to return to <Calculation menu>.

14.2　Closure Error

This function calculates the closure error for closed leveling links and closed leveling loops.
A leveling link ties two different bench marks (with known elevation) together by combining multiple consecutive routes. The start points and end points of a link are different.
A leveling loop, on the other hand, closes on the same bench mark at which it started.
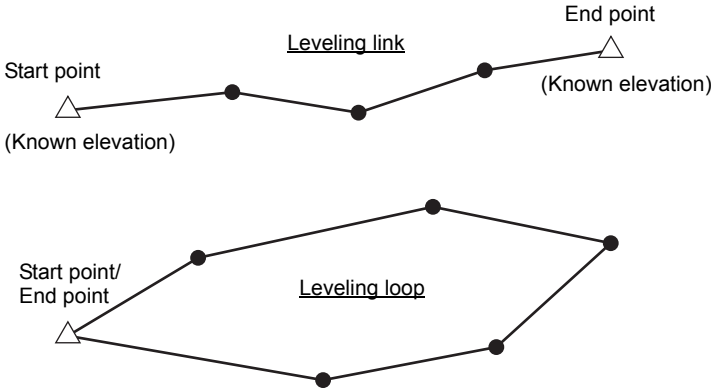
1. Select "Calculation" in <Menu>.

2. Select "Closure error" in <Calculation menu>.
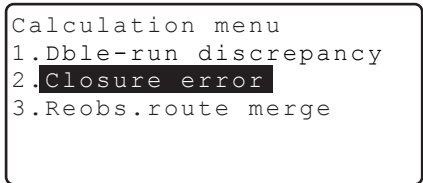
```
Calculation menu
1.Dble-run discrepancy
2.Closure error
3.Reobs.route merge
```

3. Press **[LIST]** to display a list of routes saved in the current JOB.

```
Route001
Route setting
:R001
Start pt
:Route-01-ST0000
 LIST              OK
```
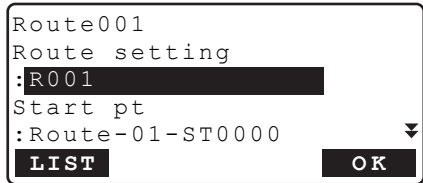
Align the cursor with the route you wish to use and press {◀━┚}.

```
R001
R002



       TOP   LAST
```

• When calculating closure for a leveling link/loop comprising multiple connected routes, set the measurement direction. This direction is set by specifying the start point for each route in the link/loop.

Align the cursor with "Start pt" and press **{◄━━}**.

```
Route001
Route setting
:R001
Start pt
:Route-01-ST0000              ⯯
 LIST                    O K
```

```
End pt                       ⯭
:Route-01-ST0004




                         O K
```

• Align the cursor with the point you wish to use as the start point and press **{◄━━}**. The previous screen is restored.

```
Route-01-ST0000
Route-01-ST0004




```

4. Press **[OK]** to add the selected route to the selected route list.

```
Route001
Route setting
:R001
Start pt
:Route-01-ST0004             ⯯
 LIST                    O K
```

• To add more routes, align the cursor with a blank row and press **{◄━━}**. The route selection screen is re-displayed.

```
001 R001
002

                              P1
          TOP   LAST   O K
```

```
Route002
Route setting
:R002
Start pt
:Route-02-ST0000             ⯯
 LIST                    O K
```

Note

• To delete a route from the selected route list, align the cursor with that route in the selected route list and press **[DEL]** on page 2.

```
001 R001
002

                              P2

 DEL
```

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5. Repeat steps 3 to 4 and add all other routes used in the link/loop.

   Press **[OK]** when all routes have been added.

```
001 R001
002 R002
003 R003
004
                              P1
      TOP    LAST    OK
```

6. Use **{◀}/{▶}** to select closure type.
   "Link": Starts and closes on different bench marks.
   "Loop": Starts and closes on the same bench mark.

```
Closure error
Closure type:Loop



                      OK
```

7. Press **[OK]**

   • When "Link" is selected in step 6 the screen shown at right is displayed. Input the following values.

     "Start bench mark elev.": Elevation of the start point for the first route used in the link.
     "End bench mark elev.": Elevation of the end point for the last route used in the link

     Press **[OK]** to display calculated closure error.

```
Link closure
Start bench mark elev.  1
:    31.24367m
End bench mark elev.
    46.50805m
                      OK
```

   • Press **[ADJUST]** to distribute closure error among points.

   • When "Loop" is selected in step 6 the screen shown at right is displayed.

   Note

   • The display range for dH results is -99.99 to 99.99 (mm). Results falling below/exceeding this range will be displayed as -99.99 or 99.99 respectively.

```
Link closure
:           -0.06mm
Relative height
dZ          15.26438m
Calc dH     15.26432m
ADJUST               OK
```

```
Loop closure
            0.05mm



ADJUST               OK
```

8. Press **[OK]** to return to <Calculation menu>.

14.3　Adjusting for Closure

This function provides two methods for distributing closure error among points on route.

1. Press **[ADJUST]** in the results screen for double-run discrepancy or closure error.

```
Dble-run discrepancy
dH              -0.60mm
Relative height
Go            12.43708m
Return       -12.43648m
ADJUST FIXEDP          OK
```

2. Select distribution method and elevation record settings for each point type.

```
Adj.method  :Weighted

Fixed pt rec:Yes
Meas pt. rec:No
IS pt rec   :No
                       OK
```

When "Weighted" selected

```
Adj.method  :Linear
Add to      :Fixed pt
Fixed pt rec:Yes
Meas pt. rec:No
IS pt rec   :No
                       OK
```

When "Linear" selected

[Note]

•What follows is an explanation of adjustment methods selected in the screen above.

Weighted: Total misclosure is distributed among points in differing amounts. Each adjustment is weighted proportional to the length of that section.

Linear:　Total misclosure is divided equally between all points of the selected point type(s).

•　　　　Fixed pt

Misclosure divided equally between all fixed point sections. MIsclosure alloted to a particular section is then divided equally between the measurement point intervals within that section.

•　　　　Meas pt

Misclosure divided equally between all measurement point sections.

Example:

Total misclosure: 6mm
△ : Start/End point   ● : Fixed point   ○ : Measurement point

"Weighted":

| 0.5 | 0.5 | 1 | 1 | 1.5 | 1.5 |

100 100   200   200   300   300

Section length

"Linear":

"Fixed pt"

| 2 | | 2 | | 2 |

1   1   0.5   0.5   0.5   0.5   1   1

| 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
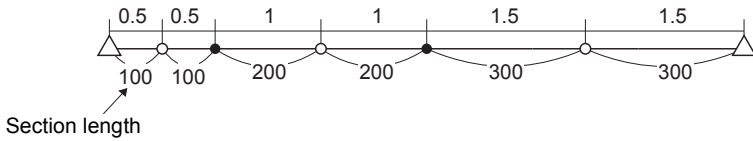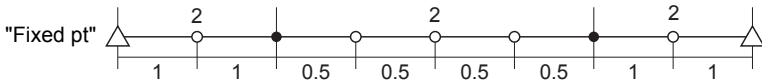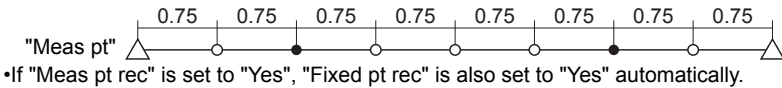
"Meas pt"

•If "Meas pt rec" is set to "Yes", "Fixed pt rec" is also set to "Yes" automatically.

Press **[OK]** to display elevation settings. Input the elevation of the start point (bench mark) of the route being adjusted.

```
Elev. input
Start bench mark elev. 1
:  1227.61832m


                    OK
```

Note

• When adjustment has been initiated from the Link Closure result screen, the start bench mark elevation input for Link closure calculation is automatically displayed here.
☞ "14.2 Closure Error"

Press **[OK]** to display adjustment results.

3. The misclosure applied to each point is displayed in "Adj.value". The adjusted elevation value is displayed in "Z".

Information displayed in the screen at right changes depending on adjustment method and adjustment settings.

```
                         Go

Pt.id  BS0000
Adj.value        0.00mm
Z          1227.61832m P1
 NEXT           IS    REC
```

● **Double-run Discrepancy**
("Fixed pt rec" = "Yes")
Press **[NEXT]**/**[PREV]** to display results for
the next/previous measurement point.

```
                                    Go
Fixed pt  No.0001
Pt.id  FS0001
Adj.value      -0.52mm
Z            1223.44270m P1
 NEXT    PREV     IS     REC
```

[Note]

• Adjustment values displayed and recorded
  are those averaged for the go leg only.
  Applied adjustment value = total
  discrepancy for both the go and return legs
  ÷ 2.

Press **[LIST]** in the second page to display a
list of all measurement points used to
calculate misclosure. Align the cursor with a
point id and press **{◄━━}** to display adjustment
results for that point.
• Press **[TOP]** to move to the first point id on
  the first page.
• Press **[LAST]** to move to the last point id on
  the last page.

```
                                    Go
Fixed pt  No.0001
Pt.id  FS0001
Adj.value      -0.52mm
Z            1223.44270m P2
 LIST
```

```
 BS0000
 FS0001
 FS0002
 FS0003

         TOP    LAST
```

● **Link Closure/Loop Closure**
("Fixed pt rec" = "Yes")
Press **[NEXT]**/**[PREV]** to display results for
the next/previous measurement point.

Note

• Measurement points are displayed in the
same order in which they occur on the link/
loop.
• When two routes in a link/loop have been
connected end bench mark to end bench
mark, points in the latter route will be
displayed from end bench mark to start
bench mark.
• Adjustment values are determined so as to
reduce misclosure to 0. For example,
when misclosure is 6mm, the adjustment
value will be -6mm.

Route 1

```
Route001

Pt.id   RT001BS0000
Adj.value       0.00mm
Z           1227.61832m P1
 NEXT              IS    REC
```

```
Route001

Pt.id   RT001FS0010
Adj.value      -0.52mm
Z           1223.44270m P1
 NEXT   PREV    IS    REC
```

All points in route 1 displayed
in order

Route 2

```
Route002

Pt.id   RT002BS0000
Adj.value      -1.06mm
Z           1221.34754m P1
 NEXT   PREV    IS    REC
```

```
Route002

Pt.id   RT002FS0003
Adj.value      -1.08mm
Z           1220.68226m P1
 NEXT   PREV    IS    REC
```

All points in route 2 displayed
in order
Points in subsequent routes
displayed in the same way.

Press **[LIST]** in the second page to display a
list of all measurement points used to
calculate misclosure. Align the cursor with a
route and press **{◄━}** to display a list of
measurement points in that route.

• Press **[TOP]** to move to the first route on the
first page.
• Press **[LAST]** to move to the last route on the
last page.

```
001 Route-01
002 Route-02
003 Route-03
004 Route-04


      TOP   LAST
```

Note

• Pressing **[LIST]** automatically displays the point list when only one route exists.

Align the cursor with a point id and press **{◄━━}** to display adjustment results for that point.

```
BS0000
FS0001
FS0002
FS0003

        TOP    LAST
```

● **"IS pt rec" = "Yes"**
Press **[IS]** to display adjustment results for IS points.

Note

• This screen is displayed when either "Fixed pt rec" or "Meas pt rec" have been set to "No" in adjustment settings.

```
                          Go

Pt.id  IS0001
Adj.value     -0.35mm
Z           1227.61823m P1
 NEXT                    REC
```

```
                          Go

Pt.id  IS0002
Adj.value     -0.52mm
Z           1223.44270m P1
 NEXT   PREV            REC
```

Press **[LIST]** in the second page to display a list of all IS points in the route being adjusted. Align the cursor with a point id and press **{◄━━}** to display adjustment results for that point.

```
IS0001
IS0002
IS0003
IS0004

        TOP    LAST
```

Note

• **[REC]** is not displayed when either "Fixed pt rec" or "Meas pt rec" have been set to "Yes" in adjustment settings. Press **{ESC}** to return to the previous screen.

```
                          Go

Pt.id  IS0002
Adj.value     -0.52mm
Z           1223.44270m P1
 NEXT   PREV
```
"Fixed pt rec" or "Meas pt rec" = "Yes"

4. Press **[REC]** to record results.

Press **[YES]** in the following screen to record adjustment results as known point data.

```
                          Go

Fixed pt No.0006
Pt.id  FS0020
Adj.value     -3.02mm
Z           1215.18181m P1
        PREV    IS    REC
```

Press **{◄━}** to return to the screen in step 3.

```
Adjusted data
  Route-001
  -> Route-001_01
Recording       3/ 3
Record complete
    Press <Enter>.
```

Note

- A suffix, "_XX (number from 01 to 99)" is added to the original route name when recording an adjusted route.
- Recorded data can viewed in <Known point data menu>.
  ☞ "17.3 Viewing Known Point Data PROCEDURE Displaying adjusted data in a route"

14.4 Reobserved Route Merge

This function merges an existing route (the base route) with a reobserved section of that same route (the reobserved route).
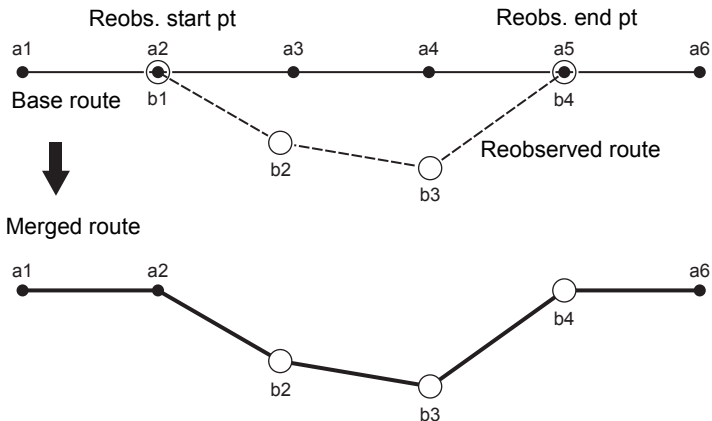
As shown above, the merged route uses the reobs. start point id from the base route and the reobs. end point id from the reobserved route.

Note

• With the exception of route ID and memo data, all route settings for a reobserved route shall be identical to the route settings for the base route being reobserved. However, start bench mark elevation and end bench mark elevation shall be automatically set to 0.0000m, and start bench mark/end bench mark IDs shall be left blank (NULL). These settings cannot be changed.

PROCEDURE Selecting a route to reobserve

1. Select "Management" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Route" in <Management menu>.

```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

3. Select "Reobs.route setting" in <Route menu>.

```
Route menu
6.Reobs.route setting    ⬍
```

4. Align the cursor with "Base route id" and press **[LIST]** Align the cursor with the route you wish to reobserve and press **{◀━}**.

```
Reobs.route setting
Base route id
:Route-01
Reobs.route id
:                        ⬍
 LIST              OK
```

5. Input a memo as necessary and press **[OK]** to confirm.

   Press **[YES]** in the next screen to finish reobservation route settings.

```
Memo                     ⬍
:                        A
:

                   OK
```

�

• Reobserve points in the same order as in the base route.

PROCEDURE Merging reobserved route and base route

1. Select "Calculation" in <Menu>.

2. Select "Reobs.route merge" in <Calculation menu>.

```
Calculation menu
1.Dble-run discrepancy
2.Closure error
3.Reobs.route merge
```

3. Align the cursor with "Route setting" and press **[LIST]**. Align the cursor with the route you wish to set as the base route and press **{◀━}**.

4. Align the cursor with "Reobs.start pt" and press **[LIST]**. Align the cursor with the point you wish to set as the start point and press **{◀━}**.

```
Base route
Route setting
:Route-01
Reobs.start pt
:Route-01-ST0001         ⬍
 LIST              OK
```

5. Align the cursor with "Reobs.end pt" and press **[LIST]**. Align the cursor with the point you wish to set as the end point and press **{◄━━}**.

   Press **[OK]** to confirm settings. The reobs. start point and reobs end point will define the section of the base route being observed.

```
Reobs.end pt              ▲
:Route-01-ED0008

 LIST                   OK
```

6. Align the cursor with "Route setting" and press **[LIST]**. Align the cursor with the reobserved route and press **{◄━━}**.

   • Set points in the reobserved route in the same order as in the base route.

   Press **[OK]** to confirm settings.

```
Reobs.route              ▲
Route setting
:Route-reobs01

 LIST                   OK
```

7. Detailed information for all fixed points in the merged route is displayed.

   • **[PREV]**: Press to display detailed information for the previous fixed point.
   • **[NEXT]**: Press to display detailed information for the next fixed point.

   Check results, then press **[OK]**.

```
Fixed pt No.0005
Pt.id ABC0001
Σh   -15.4567 m
ΣH   -51.4833 m
 Z  1000.0277 m          ▼
 Next                   OK
```

```
Σd        1502.38  m
ΣD        7739.85  m



                         ▼
 Next                   OK
```

8. Enter name for new route. A memo may also be input.

   • Pressing **[OK]** will accept input route name/memo.

9. Press **[OK]** to record route name/memo and end reobserved route merge.
   <Calculation menu> is restored.

```
Route id
:Route-Connect01        A
Memo
:
:
                        OK
```

15.SELECTING/DELETING A JOB

15.1   Selecting a JOB

- A total of 20 JOBs have been prepared, and JOB1 was selected when your DL was shipped from the factory.
- The names of the JOBs have been preset as JOB1 to JOB20; you can change them to any names you wish.
- JOB ID can be edited.

PROCEDURE

1. Select "Management" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "JOB" in <Management menu>.
   <JOB menu> is displayed.

```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

3. Select "JOB selection" in <JOB menu>.

```
Job menu
1.JOB selection
2.JOB deletion
3.Comms output
4.JOB backup
5.JOB restore
```

4. Press **[LIST]**.
   Align the cursor with the desired JOB and
   press **{◄▬}**.
   The JOB is determined and <JOB menu> is
   restored.
   - The numbers to the right represent the
     number of data items in each JOB.
   - Press **[EDIT]** to edit JOB ID.

```
Job setting
 :JOB1



 LIST        EDIT   OK
```

Note

- The list of JOB names is contained on up to 4 pages.
- Maximum length of JOB name: 16 (alphanumeric) characters.

15.2   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 DL was shipped.

✍

• A JOB (containing a route) that has not been output to an external device cannot be deleted.

PROCEDURE

1. Select "Management" in <Menu>.

2. Select "JOB" in <Management menu>.
    <JOB menu> is displayed.

3. Select "JOB deletion".

```
Job menu
1.JOB selection
2.JOB deletion
3.Comms output
4.JOB backup
5.JOB restore
```

4. Align the cursor with the desired JOB and press {◄──}.

```
 JOB1             20
 JOB2             20
 JOB3             15
 JOB4             10
 JOB5             54▼
↑↓...P   TOP   LAST
```

5. Press **[YES]**. The selected JOB is deleted and the JOB list is restored.

```
Job deletion

 JOB1
     deletion
        Confirm ?
              NO   YES
```

.

15.3   Backing Up a JOB

It is possible to back up JOB data to a host computer or external memory device.

PROCEDURE

1. Select "Management" in <Menu>.

2. Select "JOB" in <Management menu>.
   <JOB menu> is displayed.

3. Select "JOB backup".

```
Job menu
1.JOB selection
2.JOB deletion
3.Comms output
4.JOB backup
5.JOB restore
```

4. Align the cursor with "Source JOB id" and press **[LIST]**. Align the cursor with the JOB you wish to back up and press **{◀▬}**.

```
Source JOB id
:Job-base01
Destination :SD
Backup JOB id
:Job-ahead01
 LIST              OK
```

5. Select "SD" or "USB" in "Destination".

6. Enter JOB id for backup file in "Backup JOB id".

7. Press **[OK]** to start backup.

```
Job backup
  Job-base01
  -> Job-ahead01
 Outputting    2/  8
```

8. Press **{◀▬}** when "Output complete" is displayed. The screen in step 4 is restored.

15.4   Restoring a JOB

It is possible to restore backed up JOB data from an external memory device to the internal memory.

PROCEDURE

1. Select "Management" in <Menu>.

2. Select "JOB" in <Management menu>.
    <JOB menu> is displayed.

3. Select "JOB restore".

```
Job menu
1.JOB selection
2.JOB deletion
3.Comms output
4.JOB backup
5.JOB restore
```

4. Select "SD" or "USB" in "Location".

5. Align the cursor with "JOB id in ext. memory"
    and press **[LIST]**. The JOB list screen is
    displayed.
    Align the cursor with the JOB you wish to
    restore and press **{◄──}**.

    • Press **[DETAIL]** to display detailed
      information for the selected JOB.

```
Location     :SD
JOB id in ext. memory
:
JOB id when restored
:Job-ahead01
 LIST              OK
```

```
 RT0001
 RT0002
 RT0003
 RT0004
 RT0005          M
         TOP   LAST  DETAIL
```

```
RT0001
Date/time updated
  2010/09/09 09:38:26
JOB data version
  Ver. 01.02
Press <Enter>
```

6. Align the cursor with "JOB id when restored" and press **[LIST]**. The JOB list screen is displayed.
   Align the cursor with the desired destination JOB id and press **{◄━}**.

   The screen shown at right is displayed.
   Change JOB id as necessary.
   Press **[OK]** to confirm settings.

   ```
   Location    :SD
   JOB id in ext. memory
   :Job-base02
   JOB id when restored
   :Job-ahead01
    LIST              OK
   ```

   ```
   JOB id
   :Job-ahead02           A
   
   
   
                      OK
   ```

   ⚠️

   • Data cannot be restored to a JOB id already containing JOB data.

7. Press **[OK]** to start restore.

   ```
   Location    :SD
   JOB id in ext. memory
   :Job-base02
   JOB id when restored
   :Job-ahead02
    LIST              OK
   ```

8. Press **{◄━}** when "Output complete" is displayed. The screen in step 4 is restored.

15.5   Deleting Backed Up Data

It is possible to delete backed up JOB data, and data created via SD mirroring from an external memory device.

PROCEDURE

1. Select "Management" in <Menu>.

2. Select "JOB" in <Management menu>.
   <JOB menu> is displayed.

3. Select "Backup JOB deletion".

   ```
   Job menu
   6.Backup JOB deletion
   
   
   
   
   ```

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4. Select "SD" or "USB" in "Location".

   Press **[OK]** to display the JOB list.

```
Backup JOB deletion
Destination :SD



                           OK
```

5. Align the cursor with the JOB you wish to
   delete and press **{◀━━▌}** to display a
   confirmation dialog.

   Press **[YES]** to delete.

```
RT0001
RT0002
RT0003
RT0004
RT0005              M
            TOP   LAST  DETAIL
```

Note

• "M" to the right of the JOB id indicates data
  created using SD mirroring.

6. Press **{ESC}** twice to return to the screen in
   step 3.

16.ROUTE SETTINGS

16.1 Deleting a Route

It is possible to delete a route or routes within the current JOB.

[Note]

• A route that has not been output to an external device (displayed with *) cannot be deleted.

PROCEDURE

1. Select "Management" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Route" in <Management menu>.
   <Route menu> is displayed.

```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

3. Select "Route deletion".

```
Route menu
1.Route setting
2.Route deletion
3.Comms output
4.View
5.IS deletion
```

4. Align the cursor with the desired route and press **{◄──}**. "DEL" is displayed next to the route ID.

   • The numbers to the right represent the number of data items in each route.
   • **[↑↓...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.

```
*R1              20
 R2              20
 LINE01          15
 LINE02          10
 LINE03         DEL⤓
↑↓...P  TOP  LAST  OK
```

5. Press **[OK]**.

6. Press **[YES]**. The route is deleted and the route list is restored.

```
Route deletion

Route setting
    deletion
      Confirm?
              NO    YES
```

16.2   Displaying Route Information

It is possible to review data saved within the selected route.

• Route data review is performed in <Route menu>.

PROCEDURE
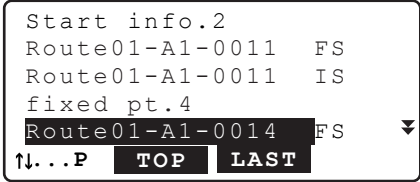
1. Select "Management" in <Menu>.

2. Select "Route" in <Management menu>.
    <Route menu> is displayed.

3. Select "View".

```
Route menu
1.Route setting
2.Route deletion
3.Comms output
4.View
5.IS deletion
```

4. A list of start information and fixed points is displayed in the order in which they were observed. Align the cursor with the desired measurement point and press **{◄──┛}**.

    • "Start info": Start conditions input before height difference measurement. Multiple "Start info" data may exist when a route measurement has been interrupted and restarted.
    • "fixed pt.": Data and details obtained when setting a fixed point during height difference measurement.
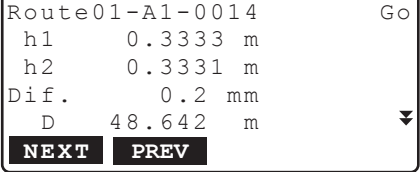
```
 Start info.1
 fixed pt.1
 fixed pt.2
 fixed pt.3
 Start info.2              ▼
↑↓...P   TOP   LAST
```

5. Align the cursor with the desired start info./IS
   point (only when IS results recorded)/fixed pt./
   measurement point and press {◄──}.

```
Start info.2
Route01-A1-0011   FS
Route01-A1-0011   IS
fixed pt.4
Route01-A1-0014   FS    ⯬
↑↓...P    TOP    LAST
```

Detailed information regarding the selected
data item is displayed.
The displayed screen differs depending on the
type of data selected. The screen shown at
right displays data for the measurement point
selected in step 5.
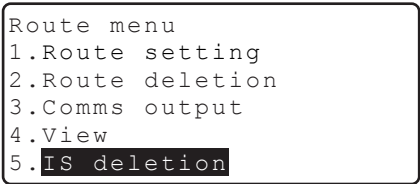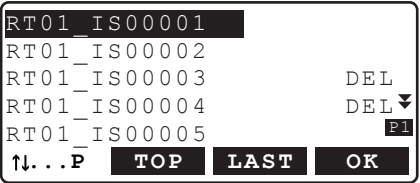
```
Route01-A1-0014        Go
 h1     0.3333  m
 h2     0.3331  m
Dif.       0.2  mm
  D    48.642   m        ⯬
 NEXT    PREV
```

• **[PREV]**: Press to display detailed information
  for the previous data item.
• **[NEXT]**: Press to display detailed information
  for the next data item.

6. Press **{ESC}** to restore previous screens.

16.3   Deleting IS Points

PROCEDURE

1. Select "Management" in <Menu>.

2. Select "Route" in <Management menu>.
   <Route menu> is displayed.

3. .Select "IS deletion".

```
Route menu
1.Route setting
2.Route deletion
3.Comms output
4.View
5.IS deletion
```

4. Align the cursor with the IS point you wish to
   delete and press **{◄──}**. "DEL" is displayed to
   the right of the IS point id.

```
RT01_IS00001
RT01_IS00002
RT01_IS00003          DEL
RT01_IS00004          DEL⯬
RT01_IS00005          P1
↑↓...P    TOP    LAST    OK
```

• Press **[DETAIL]** on page 2 to display detailed information for the selected IS point.

```
RT01_IS00006          DEL▲
RT01_IS00007          DEL
RT01_IS00008

                         P2
DETAIL
```

• Press **{ESC}** to return to the IS point list.

```
IS                      Go
Route01-IS0001
Rh         1.51020  m
Hd         12.519   m
Z         105.44050 m
```

5. Press **[OK]** in the screen of step 4 to display the screen at right.
   Press **[YES]** to delete selected IS point(s).

```
IS deletion

Intermediate sight
     deletion
       Confirm ?
              NO    YES
```

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17.MANAGING KNOWN POINT DATA

In this menu it is possible to register, view, or delete known point data.

- Known point data is recorded in the current JOB. However, data recorded using the misclosure adjustment function is managed in the relevant route.
- Known point data that has been registered can be read in when setting the start and end bench marks in a route, or when performing setting-out (in elevation mode).
- It is possible to register 2000 items of known point data in each JOB.
- There are two registration methods: key entry and entry from external media.

17.1   Using the Key Entry Method

The following screen is displayed when the input point name already exists in the current JOB. The existing file is displayed at the top of the screen.

```
Known point data
Pt.id :PM-FIX-0012
Memo  :

 Overwrite?
 A D D        N O   Y E S
```

[ADD]: Adds current data as a separate file with the same point name.
[NO]: Allows input of a different point name.
[YES]: Overwrites existing data.

PROCEDURE

1. Select "Management" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Known point data" in <Management menu>.

```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

3. Select "Key in coord".

```
Known point data menu
1.Key in coord
2.Comms output
3.View
4.Deletion
5.Initialize
```

4. Input known point name and elevation.

```
Pt.id
:0001
Memo
:
Elev. :         1.0000m
                      OK
```

5. Press **[OK]** to register input data.

Note

Conditions such as character input restrictions, and input range for the above data items are as follows.
• Pt. id: up to 16 characters
• Memo: 1 row of up to 16 characters
• Elevation: -20000.00000 to 20000.00000m

17.2   Reading in from External Media

• It is possible to read in known point data saved on an SD card or USB memory device.
• Output data file including known point data should be moved to the root folder of SD card or USB memory to read in.
• Only files in the CSV 1, CSV 2, or SDR2X format are displayed in the file list.

☞ Output format and command operations: "Communication Manual"
• DL-501 does not check for duplicate file names when reading in data from external media. Read in data with the same file name as existing data will be registered separately.

PROCEDURE Reading in from an SD card

1. Open the external interface hatch cover.

2. Insert an SD card into the SD card slot.
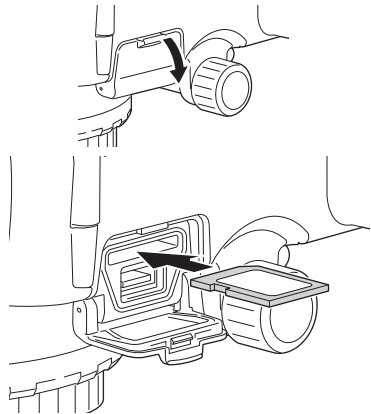
3. Select "Known point data" in <Management menu>.

4. Select "Comms input".

```
Known point data menu
1.Key in coord
2.Comms input
3.View
4.Deletion
5. Initialize
```

5. Set "Location" to "SD".

```
Comms input

Location     :SD


                    O K
```

6. Align the cursor with the file to be read in and
    press **{◄━┘}**.

    *   **[↑↓...P]** = Use **{▲}**/**{▼}** to move from page
        to page.
    *   **[↑↓...P]** = Use **{▲}**/**{▼}** to select individual
        file.
    *   Press **[TOP]** to move to the first file on the
        first page.
    *   Press **[LAST]** to move to the last file on the
        last page.

    Read starts and the number of read in files is
    displayed on the screen. <Management
    menu> is restored when read is complete.

    *   Press **{ESC}** to cancel.

```
JOB01BM1          CS1
JOB01FIX          CS1
JOB01BM2          CS2
JOB02BM           CS1
JOB02FIX          CS2
↑↓...P    TOP    LAST
```

PROCEDURE Reading in from a USB memory device

1. Open the external interface hatch cover.

2. Insert a USB memory device into the USB
    port.

3. Select "Known point data" in <Management
    menu>.

4. Select "Comms input".

5. Set "Location" to "USB".

```
Comms input

Location    :USB


                    O K
```

6. Align the cursor with the file to be read in and
    press **{◄──┛}**.

    Read starts and the number of read in files is
    displayed on the screen. <Management
    menu> is restored when read is complete.

    • Press **{ESC}** to cancel.

Note

Selectable options for the above data item are as follows.
• Location: SD/USB

17.3   Viewing Known Point Data

It is possible to display all known point data in a JOB, as well as data, recorded using the misclosure
adjustment function, managed within each route.

PROCEDURE Displaying data in a JOB

1. Select "Management" in <Menu>.

2. Select "Known point data" in <Management
    menu>.

3. Select "View".

```
Known point data menu
1.Key in coord
2.Comms output
3.View
4.Deletion
5.Initialize
```

4. Select "JOB data".

```
Known point selection
1.JOB data
2.Route data
```

5. Align the cursor with the known point data to be displayed in and press {◄──}.

```
PM-BM-001
 PM-BM-002
 PM-FIX-003
 PM-FIX-004
 PM-FIX-005                  ⯯
↑↓...P    TOP   LAST   SRCH
```

The point id and elevation of the selected known point data is displayed.

```
Pt.id
:PM-BM-001
Memo
:
Elev.:        54.34560m
 NEXT    PREV
```

• **[PREV]**: Press to display detailed information for the previous point.
• **[NEXT]**: Press to display detailed information for the next point.
• Press **[SRCH]** to search for known point data by point id.

```
Search
Pt.id                      A
:PM-FIX-0012


                        O K
```

6. Press **{ESC}** to return to <Known point data menu>.

PROCEDURE Displaying adjusted data in a route

1. Select "Management" in <Menu>.

2. Select "Known point data" in <Management menu>.

3. Select "View".

4. Select "Route data".

```
Known point selection
1.JOB data
2.Route data
```

5. Align the cursor with the relevant route and press **{◄—▌}**. A list of known point data in that route is displayed.

```
*R1                          20
 R2                          20
 LINE01                      15
 LINE02                      10
 LINE03                      15⬇
↑↓...P    TOP     LAST
```

6. Align the cursor with the known point data to be displayed in and press **{◄—▌}**.

   The point id and elevation of the selected known point data is displayed.

```
 PM-BM-001
 PM-BM-002
 PM-FIX-003
 PM-FIX-004
 PM-FIX-005                  ⬇
↑↓...P    TOP     LAST   SRCH
```

7. Press **{ESC}** to return to <Known point data menu>.

17.4   Deleting Known Point Data

It is possible to delete known point data registered in the current JOB.

PROCEDURE Deleting specific known point data

1. Select "Management" in <Menu>.

2. Select "Known point data" in <Management menu>.

3. Select "Deletion".

```
Known point data menu
1.Key in coord
2.Comms output
3.View
4.Deletion
5.Initialize
```

4. Align the cursor with the point you wish to delete and press **{◄—▌}**. "DEL" is displayed to the right of the point id.

```
 PM-BM-001
 PM-BM-002
 PM-FIX-003
 PM-FIX-004              DEL ⬇
 PM-FIX-005              DEL P1
↑↓...P    TOP     LAST    OK
```

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• Press **[DETAIL]** in the second page to display detailed information for the selected known point data.

• Press **{ESC}** to return to the point list.

```
PM-BM-001
PM-BM-002
PM-FIX-003
PM-FIX-004          DEL  ⊻
PM-FIX-005          DEL P2
DETAIL
```

```
Pt.id
:PM-FIX-005
Memo
:
Elev.:       34.34560m
```

5. Press **[OK]** in the screen of step 4 to display a confirmation dialog.

   Press **[YES]** to delete and return to the point list.

```
Known pt. deletion

Known pt. data
    deletion
      Confirm?
              N O    Y E S
```

PROCEDURE Deleting all known point data (initialization)

1. Select "Management" in <Menu>.

2. Select "Known point data" in <Management menu>.

3. Select "Initialize".

```
Known point data menu
1.Key in coord
2.Comms output
3.View
4.Deletion
5.Initialize
```

4. Press **[YES]** to delete all known point data in the selected JOB.

   �

   • .Known point data recorded using the misclosure adjustment function is not deleted. This data is deleted when the route in which it is managed is deleted.

```
All known pt. data
  will be deleted.
      OK?
              N O    Y E S
```

18.OUTPUTTING DATA

It is possible to output JOB and route data to a host computer or external memory device.

☞ *Bluetooth* communication: "9.4 Outputting data using Bluetooth communication"
Communication cables: "24. OPTIONAL ACCESSORIES"
Output format and command operations: "Communication Manual"

• Communication setup can also be performed in <JOB menu> and <Route menu>.

18.1	Outputting JOB Data

• Only 1 JOB can be output at a time.
• JOB information, observation conditions, route information, observation data, start conditions, foresight information and memo data are output.

PROCEDURE Outputting JOB data to host computer

1. Connect the DL and host computer.

2. Select "Management" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

3. Select "JOB" in <Management menu>.

```
Management menu
1.JOB
2.Route
3.Known point data
4.Simple meas. data
```

4. Select "Comms output".

```
JOB menu
1.JOB setting
2.JOB deletion
3.Comms output
4.JOB backup
5.JOB restore            ⯯
```

5. Select format from "CSV 1", "CSV 2" or "SDR2X".

```
Format    :CSV_1
Com.locat.:Com



        C O M M        O K
```

6. Check that "Com. locat." is set to "Com".

7. Press **[OK]**.

 • **[COMM]**: Press to display the communication setup screen.
☞ "19.3 Communication Setup"

8. Align the cursor with the JOB to be output and press **{◄━}**.

   * The numbers to the right represent the number of data items in each JOB.
   * "*" means the JOB has not been output to an external device yet.

```
*JOB1                  99
 JOB2                  20
 JOB3                  15
 JOB4                  10
 JOB5                  54⯬
↑↓...P    TOP    LAST
```

9. Output starts.

   * Press **{ESC}** to cancel output.

10. Press **{ESC}** to return when "Completion" is displayed.

PROCEDURE Outputting JOB data to an SD card

1. Open the external interface hatch cover.

2. Insert an SD card into the SD card slot.
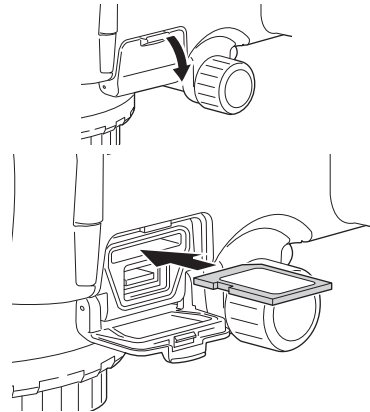
3. Select "JOB" in <Management menu>.

4. Select "Comms output".

5. Select format from "CSV 1", "CSV 2" or "SDR2X".

6. Check that "Com. locat." is set to "SD".

7. Press **[OK]**.

```
Format    :CSV 1
Com.locat.:SD




        COMM         OK
```

8. Align the cursor with the JOB to be output and press **{◄━}**.

9. Enter a file name and press **[OK]**.

10. Output starts.

🚫

  • Do not remove the SD card or turn off the DL
    while files are being copied/transferred.

11. Press **{ESC}** to return when "Completion" is
    displayed.

Note

  •SD cards up to 4GB supported. SDHC supported.

PROCEDURE Outputting JOB data to a USB memory device

1. Open the external interface hatch cover.

2. Insert a USB memory device into the USB
   port.
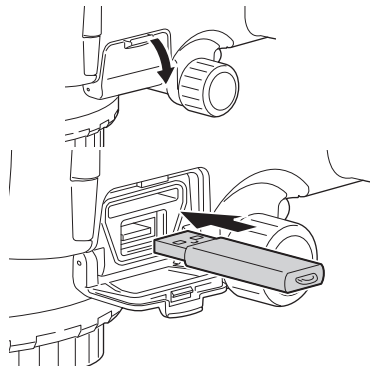
3. Select "JOB" in <Management menu>.

4. Select "Comms output".

5. Select format from "CSV 1", "CSV 2" or
   "SDR2X".

6. Check that "Com. locat." is set to "USB".

7. Press **[OK]**.

8. Align the cursor with the JOB to be output and
   press **{◀──}**.

9. Enter a file name and press **[OK]**.

10. Output starts.

⚠️

- Do not disconnect the USB memory or turn off the DL while files are being copied/transferred.

11. Press **{ESC}** to return when "Completion" is displayed.

Note

- Start cond. input in steps 4 to 5 is optional when restarting measurement of a partially-completed route.
- Conditions such as character input restrictions, input range, and selectable options for the above data items are as follows.
- Output format: CSV_1 (output of measurement results by instrument station for all measurements)/ CSV_2 (measurement results by instrument station split into foresight and backsight before output. Elevation and dH values output in foresight data)/SDR2X
- Com.locat.: Com (output to connected device via RS232C or *Bluetooth* wireless technology depending on "Mode" setting)/SD/USB
- USB memory devices up to 4GB supported.

18.2 Outputting Route Data

PROCEDURE Outputting route data to host computer

1. Connect DL and host computer by attaching the communication cable to the Multi Port.

2. Select "Route" in <Management menu>.

3. Select "Comms output".

```
Route menu
1.Route setting
2.Route deletion
3.Comms output
4.View
5.IS deletion
```

4. Select format from "CSV 1", "CSV 2" or "SDR2X".

5. Check that "Com. locat." is set to "Com".

6. Press **[OK]**.

7. Select the route ID to be output and press
    {◄─┘}.
    "OUT" appears to the right of the route ID
    selected. You can select as many route IDs as
    you want.

    • The numbers to the right represent the
      number of data items in each route.
    • "*" means the route has not been output to an
      external device yet.

```
1                        OUT
2                        OUT
 ROUTE 11                 26
*ROUTE A22                44
                          ⬇
↑↓...P    TOP    LAST    OK
```

8. Press **[OK]**.

9. Output starts.

    • Press **{ESC}** to cancel output.

10. Press **{ESC}** to return when "Completion" is
    displayed.

```
Route id       1/   2
  1
 Format     CSV_1

 Outputting      56/   78
```

PROCEDURE Outputting route data to an SD card

1. Open the external interface hatch cover.

2. Insert an SD card into the SD card slot.

3. Select "Route" in <Management menu>.

4. Select "Comms output".

5. Select format from "CSV 1", "CSV 2" or
    "SDR2X".

6. Check that "Com. locat." is set to "SD".

7. Press **[OK]**.

8. Select the route ID to be output and press
    {◄─┘}.
    "OUT" appears to the right of the route ID
    selected. You can select as many route IDs as
    you want.

    "*" means the route has not been output to an
    external device yet.

9. Press **[OK]**.

10. Enter a filename and press **[OK]**.

11. Output starts.

✿

 • Do not remove the SD card or turn off the DL
   while files are being copied/transferred.

12. Press **{ESC}** to return when "Completion" is
    displayed.

PROCEDURE Outputting route data to a USB memory device

1. Open the external interface hatch cover.

2. Insert a USB memory device into the USB
   port.

3. Select "JOB" in <Management menu>.

4. Select "Comms output".

5. Select format from "CSV 1", "CSV 2" or
   "SDR2X".

6. Check that "Com. locat." is set to "USB.

7. Repeat steps 7 to 12 in "PROCEDURE
   Outputting route data to an SD card"

✿

 •Do not disconnect the USB memory or turn off the DL while files are being copied/transferred.

19.CHANGING THE SETTINGS

This section explains the contents of parameter settings, how to change these settings, and how to restore default settings.
Each item can be changed to meet your measurement requirements.

```
Config menu
1.Obs.condition
2.Instr.config
3.Comms setup
4.Tilt offset
5.Unit
```

```
Config menu                    ⬍
6.Date and time
```

Instrument constants are explained in a different chapter.

☞ "21.2 Tilt Sensor", "21.3 Adjusting the Reticle"

19.1   Observation Conditions

```
Meas mode   :Single

Rec cond.   :Yes
SD mirroring:Off
Ht reso.    :0.01mm
Dist reso.  :0.001m
```

```
C&R          :No       ⬍
A.F.setting  :Yes
Tilt warn    :Yes
```

Items set and options (*: Factory setting)

Measurement mode (Meas mode):	Single*, Repeat, Average, Rapid
AVG times (only displayed when: "Average" selected above)	1 to 20
Rec cond.:	Yes*, No
SD mirroring (only displayed when: "Yes" selected above)	On/Off*
Height resolution (Ht. reso.):	0.01mm/0.0001ft*, 0.1mm/0.001ft, 1mm/0.01ft
Distance resolution (Dist reso.):	0.001m/0.01ft*, 0.01m/0.1ft, 0.1m/1ft
Earth curvature and refraction correction (C&R):	No*, K=0.142, K=0.20
Auto Focus setting. (A.F.setting):	Yes*, No
Tilt warning (Tilt warn):	Yes*, No

�un

• "Rec cond." cannot be changed for a JOB already containing route data.

Note

• There is no "A.F. setting" for the DL-501 Standard.

📓 **SD mirroring**
This function synchronizes the content of the SD card with the internal memory. Data stored to the internal memory will automatically be stored to the SD card. Data deleted from the internal memory will also be deleted from the SD card.

19.2 Instrument Configuration

```
Power off     :30min
Contrast      :10
```

Items set and options (*: Factory setting)
Power off 📓:   No, 30min.*
Contrast: 0 to 15 (10*)

📓 **Power-saving automatic cut-off**
To save power, power to the DL is automatically cut off if it is not operated for 30 minutes.

19.3 Communication Setup

```
Mode        :RS232C        AVG out mode:1          ≨
Baud rate   :1200bps
Parity      :Not set
Xon/Xoff    :No
STX/ETX(CSV):No       ⬇
```

Items set and options (*: Factory setting)
Mode: RS232C*, *Bluetooth*
Baud rate: 1200*, 2400, 4800, 9600, 19200, 38400, 57600bps
Parity: Not set*, Odd, Even
Xon/Xoff: Yes, No*
STX/ETX (CSV):   Yes, No*
AVG out mode: 1*/2
☞ Control commands and communication formats: "Communication Manual"
    Setting "Mode" to "*Bluetooth*": "9.3 Communication between the DL and Companion Device"

📖 **STX/ETX (CSV)**
This setting is relevant only when "Com.locat." is set to "Com".
When this setting is set to "Yes", a "start of text" (STX) code is added to the start, and an "end of text" (ETX) code to the end of output text data.
When "Com.locat." is set to "SD" or "USB", no STX or ETX is added.

📖 **AVG out mode**
This setting determines how data is output when executing measurement in average mode using an output command from an external instrument. When this setting is set to "1", the specified number of measurements are output without averaging. When this setting is set to "2", the averaged value only is output.

19.4　Units

```
Temp.        : °C
Angle unit   :degree
Dist unit    :meter
```

Items set

Temperature:	°C*, °F
Angle unit:	degree*, gon, mil
Distance unit:	meter*, feet
Feet (only displayed when "feet" selected above):	Int. feet*, US feet

✍
• "Temp.", "Dist unit", and "Feet" cannot be changed for a JOB already containing route data.

19.5　Date and Time

```
Date and time

 Date: Mar/04/2009
 Time: 084059

                      O K
```

Items set
　Date:　　　　　　　　　　　　　　Manually input date. (format: MMDDYYYY)
　　　　　　　　　　　　　　　　　e.g. March 20, 2009 is input as "03202009".

Time:	Manually input time. e.g. 2:43:59 pm is input as "144359".

📖 **Date and Time**
The DL includes a clock/calendar function.

19.6 Restoring Default Settings

A reset is necessary in order to restore set items to default settings.

🗲

• The resume function is cancelled when a reset is performed. Finish height difference measurement and reticle adjustment before performing a reset.
• Restoring set items to default settings will not erase stored data. However, if the data in the memory is important, **BE SURE TO BACK UP STORED DATA TO AN EXTERNAL MEMORY DEVICE OR COMPUTER IN ADVANCE.**
• If a JOB contains a route, "Rec cond." in "Obs. condition", "Temp" and "Dist unit" settings will not be reset even when a reset is performed.

PROCEDURE Performing a reset

1. Turn the instrument off.

2. Press **{ ⏻ }** while holding **{BS}**, and **{F4}** until the TOPCON logo appears.
   "Default set" is displayed and the instrument is reset.

3. Power the instrument on as normal.

20.WARNING AND ERROR MESSAGES

The following is a list of the error messages displayed by the DL 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.

Adj. range exceeded

The adjustment range for reticle adjustment (CCD line sensor) has been exceeded, or checks have been performed incorrectly.
Checks and adjustments can be performed but confirm correct procedure beforehand.
Contact your local dealer if this message is displayed again.

Approaching adj. limit

The adjustment range for reticle adjustment (CCD line sensor) is about to be reached, or checks have been performed incorrectly.
Confirm correct procedure.
Stop checks and contact your local dealer if this message is displayed again.

Bad condition

The instrument is subject to excessive vibrations or hot conditions are producing shimmer.

***Bluetooth* device error!**

Either the instrument you are using is not equipped with *Bluetooth* functionality or the *Bluetooth* device in the DL is malfunctioning.
Contact your local dealer if this message is displayed again.

***Bluetooth* setting error!**

Bluetooth connection configuration failed.
Perform configuration again. Contact your local dealer if this message is displayed again.

Brightness error

Something obscured the staff or the brightness level suddenly altered during measurement.

Cannot restore JOB!

Software version for backed up data and DL different.

Dist. over !

The distance you are trying to measure is outside the range (Upper dist - Lower dist) set in route settings.

End pt. closer to route start than start pt.!

Reobs. start point must be located closer to start of base route start than reobs. end point.

File deletion error!

An error occurred while trying to delete a file.
Initialize data after first outputting all necessary data.
☞ "7.1 Resolving Software Issues"

File open error!

An error occurred while trying to open a file.
When trying to write to a USB device, check that the USB is not read-only.
Contact your local dealer.

File read error!
    An error occurred while trying to read in a file.
    Contact your local dealer.

File system error!
File write error!
    It is impossible to read in/write data.
    When trying to write to a USB device, check that the USB is not read-only.
    Otherwise, contact your local dealer.

Fixed pt record full!
    No more fixed points can be recorded.
    Delete unnecessary JOB or route data and try again.

Fixed pt record full in current route!
    No more fixed points can be recorded in the current route.

Focusing error
    Something obscured the staff during Auto Focus, the brightness level suddenly altered. or the DL
    was subjected to large vibrations resulting in a poor focus condition.

Hd diff. over !
    The measured distance is outside the range (BF dist diff.) set in route settings.

Ht-diff. over !
    **The difference in relative height over the 2 measurements is outside the range (dH range)
    set in route settings.**

Lower dist is greater than upper dist!
    The value set in Lower dist is greater than the value set in upper dist value.

Lower Rh is greater than upper Rh!
    The value set in Lower Rh is greater than the value set in upper Rh value.

Max JOB num.
    No more JOBs can be backed up to the external memory device. The maximum (100) has been
    reached.
    Try again after deleting unnecessary JOBs.

Max route num.
    The maximum number of routes (100) has been reached.
    Try again after deleting unnecessary routes.

Meas. error
    An object other than the staff is being sighted.
    The staff is out of focus.
    The staff is partly unreadable because obscured by an obstacle or is damaged.
    The staff is too close or too far away.
    A shadow is falling on part of the staff.
    The staff was incorrectly sighted.

Light is entering the eyepiece.
Use your hand or body to shield the eyepiece from the light source.

Meas.pt record full!
No more meas. points can be recorded.
Delete unnecessary JOB or route data and try again.

Meas. pt record full in current JOB!
No more meas. points can be recorded in the current JOB.

Meas. pt record full in current route!
No more meas. points can be recorded in the current route.

Meas.pt record full!
No more meas. points can be recorded.
Delete unnecessary JOB or route data and try again.

Memory connection err!
External memory device not connected correctly.

Memory full!
The external memory device became full before output finished.
Output the data again after deleting unnecessary data from the memory device, or use a new memory device.

Memory write protect!
External memory device is write protected. Data cannot be written to the external memory device.

No data
No data exists in the current route.

No JOB
No JOB data on external media device

No JOB id
No JOB ID input.

No known point data
No known point data exists in the selected JOB.

No known pt. file
No known pt. files exist in the SD card/USB memory device.

No reobs. route
No routes exist or route merge not possible with existing routes.

No route
No route exists in the current JOB.

No route id
No route ID input. Input a route ID.

No route setting

Route settings have not been made.

No SD card inserted.

No SD card inserted in the SD card slot. Check that the SD card is inserted correctly.

☞ ▯ SD card slot

No staff

No staff detected by the Auto Focus function.
Make sure that the staff is sighted correctly.

No start cond. setting

Start cond. settings for height difference measurement have not been made.

Rec cond. setting < No > Start cond. input unnecessary.

"Rec cond." set to "No". Even if start conditions are input they will not be recorded.
To record start conditions, set "Rec cond." to "Yes".

Remaining meas. pt record insufficient!
Remaining fixed pt record insufficient!
Remaining start info. record insufficient!

No more measurement data can be recorded. Maximum limit exceeded.
Delete unnecessary data and try again.

Rh diff. over !

The difference in staff reading (height) over the 2 measurements is outside the range (Rh range)
set in route settings.

Rh out of range !

The staff reading (height) is outside the range (Upper Rh - Lower Rh) set in route settings.

Same file id

The filename input already exists.
Select a different filename.

Same job id

The job ID input already exists.
Select a different job ID.

Same point selected for start pt and end pt

Reobs. start point and reobs. end point must be different points.

Same route id

The route ID input already exists.
Select a different route ID.

SD card files are read-only

Data on the SD card is read only. Files cannot be deleted, changed, or overwritten.

SD card is write protected.

SD card is write protected. Data cannot be written to the SD card. Cancel write protection or use a different SD card.

SD card record is stopped. Continue?

Data cannot be written to the SD card despite "SD mirroring" being set to "On", perhaps because the SD card is not inserted correctly.

Press **[YES]** to write data to the internal memory only (subsequent recording to the SD card will not be possible for this route).

SD card record is stopped.

Data cannot be written to the SD card despite "SD mirroring" being set to "On", perhaps because the SD card is not inserted correctly. Writing to the SD card has been cancelled.

Selected JOB contains route data.

Cannot restore to selected JOB id. Selected JOB id already contains JOB data. Select an empty JOB.

Sigma Hd diff. over!

The total difference in foresight and backsight distance is outside the range (Total dist diff.) set in route settings.

Staff too far

Move the staff to within the measuring range distance.

☞ "25. SPECIFICATIONS"

Start info.record full!

No more start info. can be recorded.

Delete unnecessary JOB or route data and try again.

Start info.record full in current route!

No more start info. from the current route can be recorded.

The battery for the clock function needs to be replaced.

The voltage of the lithium battery has decreased, the battery itself is depleted, and the date/time display is incorrect.

An error will occur temporarily on the lithium battery when the instrument is powered on using a battery with little remaining power. In this event, re-configure the date/time settings

☞ "19.5 Date and Time"

When a message is constantly displayed upon startup the lithium battery needs to be replaced. For details on replacing lithium batteries contact your local dealer.

The capacity of the SD card is insufficient.

Remaining memory capacity of the SD card is not enough to save data. Insert a new SD card or delete unnecessary data from the current SD card.

The capacity of the USB is insufficient.

Remaining memory capacity of the USB memory device is not enough to save data. Insert a new device or delete unnecessary data from the current device

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The following cannot be used in a file id.
> A file name containing "*", "?", or "/" is invalid. Create a file name which does not use any of these characters.

Time out
> The Auto Focus function could not read the staff, or Auto Focus could not complete within the time specified. Check the staff is set up correctly and try again.

Too bright
> Too bright. The brightness level suddenly altered during measurement.
> Something is shining nearby or behind the staff.
> Light is entering the eyepiece.
>
> Use your hand or body to shield the eyepiece from the light source.

Too dark
> Too dark. The brightness level suddenly altered during measurement.

USB files are read-only.
> Data on the USB memory device is read only. Files cannot be deleted, changed, or overwritten.

USB memory device is write protected.
> USB memory device is write protected. Data cannot be written to the USB memory device.
> Cancel write protection or use a different device.

USB memory device not inserted.
> No USB memory device inserted in the USB port.
> Check that the USB memory device is inserted correctly.

21.CHECKS AND ADJUSTMENTS

DL 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 "21.1 Circular Level" to "21.3 Adjusting the Reticle".
• 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..

21.1 Circular Level

Check and adjust it as outlined below.

�

• 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.

PROCEDURE Checking and adjusting

1. Adjust the leveling foot screws until the bubble is centered in the circle.
   ☞ "6.2 Leveling steps 3 to 5"

2. Turn the instrument 180°. The bubble should not shift from the center. If the bubble does move, adjust as follows.

3. Compensate for one-half of the shift by adjusting the leveling foot screws.

1/2

4. Eliminate the remaining shift by turning the circular level adjusting screws with the hexagonal wrench until the bubble is centered.

Adjust with hexagonal wrench

5. Turn the instrument 180°. If the bubble stays in the center, adjustment is complete. If the bubble moves, repeat steps 3 and 4.

1/2
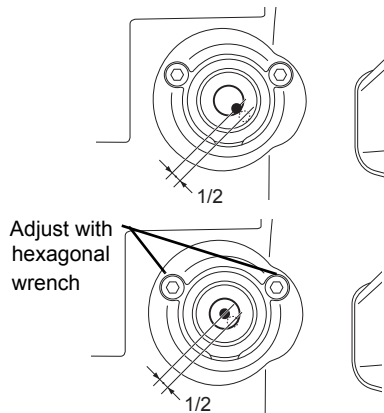
21.2 Tilt Sensor

If the tilt angle shifts from tilt angle 0° (zero point), the instrument is not correctly levelled. The actual circular level and graphic level will not be displayed correctly.
Perform the following procedure to cancel the tilt zero point error.

PROCEDURE Checking and adjusting

1. Carefully level the DL. If necessary, repeat the procedures to check and adjust the circular level.

2. Select "Config" in <Menu>.

3. Select "Tilt offset" in <Config menu> to display the current correction constant in the X (sighting) direction and Y (horizontal axis) direction.

```
Config menu
1.Obs.condition
2.Instr.config
3.Comms setup
4.Tilt offset
5.Unit                    ☰
```

```
Tilt offset

Current X 403 Y 399


                  ADJUST
```

4. Press **[ADJUST]** to display the tilt angle in the X (sighting) direction and Y (horizontal axis) direction.

5. Wait a few seconds for the display to stabilize, then read the automatically compensated F1 angles (X1 and Y1).

```
Tilt adjustment
X      0'40"
Y      1'45"

   Take F1
                    O K
```

6. Press **[OK]** and rotate the top of the instrument and 180° while referring to the horizontal circle.

7. Wait a few seconds for the screen to stabilize, then read the automatically compensated F2 angles (X2 and Y2).

```
Tilt adjustment
X      0'25"
Y     -1'30"

   Take F2
                      O K
```
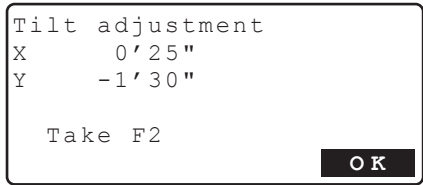
8. In this state the following offset values (tilt zero point error) are calculated.
   Xoffset = (X1 + X2)/2
   Yoffset = (Y1 + Y2)/2

   If one of the values (Xoffset, Yoffset) exceeds ±1', adjust the value using the following procedure.
   When the offset value falls within the range ±1', adjustment is not necessary.
   Press **{ESC}** to return to <Config menu>.

9. Press **[OK]** and rotate the top of the instrument and 180° while referring to the horizontal circle.

10. If the new correction constants are within the range 400 ±50, press **[YES]** or **{◀━}** to renew the correction angle. <Config menu> is restored.
    If the values exceed the adjustment range, select **[NO]** to cancel the adjustment and restore <Tilt offset>. Contact your local dealer to perform the adjustment.

```
Tilt offset
Current X403 Y399
New     X405 Y401


             N O    Y E S
```
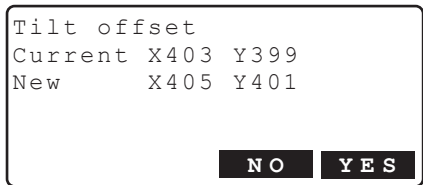
PROCEDURE Recheck

11. Select "Tilt offset" in <Config menu>.

12. Wait a few seconds for the display to stabilize, then read the automatically compensated F3 angles (X3 and Y3).

13. Press **[OK]** and rotate the top of the instrument and 180° while referring to the horizontal circle.

14. Wait a few seconds for the display to stabilize, then read the automatically compensated F4 angles (X4 and Y4).

15. 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 ±1', adjustment is complete.
Press **{ESC}** to return to <Config menu>.

If one of the offset values (Xoffset, Yoffset) exceeds ±1', repeat the check and adjustment procedures from the beginning. If the difference continues to exceed ±1' after repeating the check 2 or 3 times, have your local dealer perform the adjustment.

21.3	Adjusting the Reticle

The reticle cross-lines can be corrected if out of adjustment. While reading the staff RAB-code, adjust the reticle by correcting the reference value of the CCD line sensor and then make mechanical adjustments to the instrument.

�

• As described in the following procedure, high accuracy readings are obtained by taking repeat readings of the staff.

PROCEDURE Correcting the reference value of the CCD line sensor

1. Select "Meas" in <Menu>.

```
Menu
1.Meas
2.Management
3.Config
4.Calculation
```

2. Select "Check & adjust.".

```
Meas menu
1.Height dif.
2.Check & adjust.
3.Simple measurement
```

3. Place staffs a and b approximately 30m apart and set the instrument halfway between the staffs (position A).

4. Perform pre-measurement of staffs a and b to check they are both approximately 15m from the instrument. Press **[OK]** to confirm.

```
Pre.meas.
Rh
Hd        15m         15m
          a       A        b
  TILT  CNFG   OK   FOCUS
```

5. Measure staff a.
   Measurement results are displayed.

```
A abba
Rh     1.00540  m
Hd    15.010    m        S

                    OK
```

6. Press **[OK]** to accept the results.

7. Measure staff b.

```
A ab b a
Rh      1.34560 m
Hd      15.080   m        S
                         ▚▖
                        OK
```

8. Press **[OK]** to accept the results.

9. Measure staff b.

```
A ab b a
Rh       1.34560 m
Hd       15.080   m        S
                          ▚▖
                         OK
```

10. Press **[OK]** to accept the results.

11. Measure staff a.

```
A abb a
Rh      1.00540 m
Hd      15.010   m        S
                         ▚▖
                        OK
```

12. Press **[OK]** to accept the results.

13. Move the instrument to a position approximately 3m from staff a along a straight line joining staffs a and b. The new position is B.

14. Perform pre-measurement of staffs a and b to check that a is approximately 3m from the instrument and b is approximately 33m from from the instrument. Press **[OK]** to confirm.

```
Pre.meas.
Rh
Hd                  33m          S
         3m                     ▚▖
        B  a                 b
  TILT   CNFG    O K    FOCUS
```

15. Repeat steps 5 to 12, sighting the two staffs and taking the readings.

16. Check the difference between the results and decide whether correcting the reference value of the sensor is required.
    If the difference is 0.3mm or less, no adjustment is necessary.
    If the difference is over 0.3mm, adjustment is necessary.

```
 h1   -0.34020m
 h2   -0.34000m
Dif.     0.20mm
                  N O    Y E S
```

17. When adjustment is necessary, press **[YES]**.
    • Press **[NO]** if no adjustment is necessary.

18. Press **[YES]** in the confirmation dialog shown at right.
    • Press **[NO]** to cancel and return to <Meas menu>.

```
Adjust ?



            N O     Y E S
```

19. The instrument calculates and records the required reticle adjustment from the measurement results, and then returns to the menu selection.

20. Repeat steps 3 through 18. Make sure that the difference between the results is 0.3mm or less.
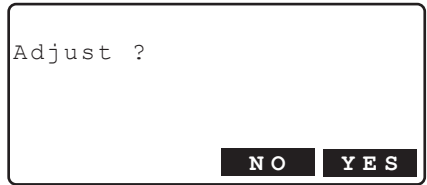
PROCEDURE Mechanical adjustment

1. Sight the barcode face of staff b from position B and measure with the instrument.

2. Sight the scale face of staff b from position B and take a visual reading.

3. Check the difference between the measurements taken at steps 1 and 2. If necessary, adjust the cross-line as described below.

4. Remove the adjusting screw cover and insert a hexagonal wrench in the adjusting screw.

5. Turn the adjusting screw, then repeat steps 1 and 2. Adjust so that the difference between the two measurements is less than 2mm.
    If the measurement at step 2 is larger than the measurement at step 1, lower the cross-line by slightly loosening the adjusting screw.
    If the measurement at step 2 is smaller than the measurement at step 1, raise the cross-line by slightly tightening the adjusting screw.

6. Replace the adjusting screw cover.

Hexagonal wrench

Adjusting screw cover

Note
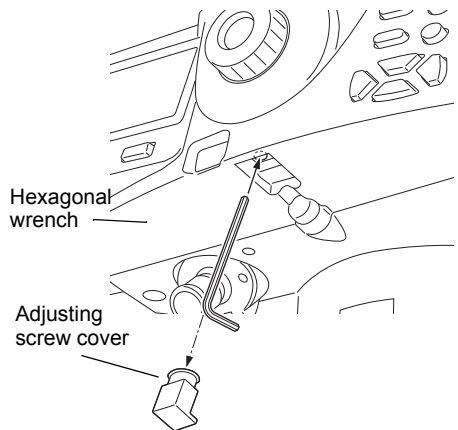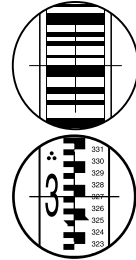
• When the instrument is powered off during reticle adjustment the resume function restores the following screen when the power is turned back on.
> When powered off during measurement of point A: point A/staff a measurement screen
> When powered off during measurement of point B: point B/staff a measurement screen
> When powered off while displaying difference results: difference results screen

• Auto focus functionality is not available for the DL-501 Standard. Therefore **[FOCUS]** is not displayed in the screen of steps 4 and 14.

Difference calculations

The difference value can be calculated as follows.

> Value at position A =   {[(1st reading on staff a) - (1st reading on staff b)] + [(2nd reading on staff a) - (2nd reading on staff b)]} /2
> Value at position B =   {[(1st reading on staff a) - (1st reading on staff b)] + [(2nd reading on staff a) - (2nd reading on staff b)]} /2
> Difference =   absolute value of [(value at position A) - (value at position B)]

22.POWER SUPPLY SYSTEM

Operate your DL with the following combinations of power equipment.

• Never use any combination other than those indicated below. If you do, the DL could be damaged.

Those indicated by * are standard accessories. Others are optional accessories (sold separately).

Battery	Charger	Power cable
BDC58/70* BDC46C SB178	CDC68/68A*	EDC113A/C* (110 to 240 VAC) EDC113B* (110 to 125 VAC) etc.
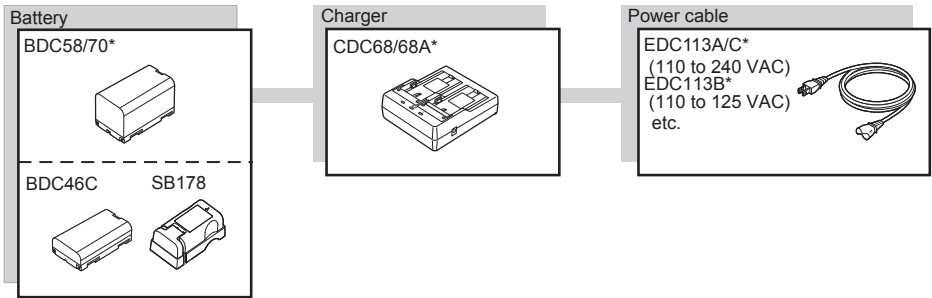
Note

• Dedicated power cables differ according to the country or the area where the instrument is used. Contact your local dealer for the details.

23.STANDARD EQUIPMENT

Please verify that all equipment is included.

23.1	DL-501 Advanced
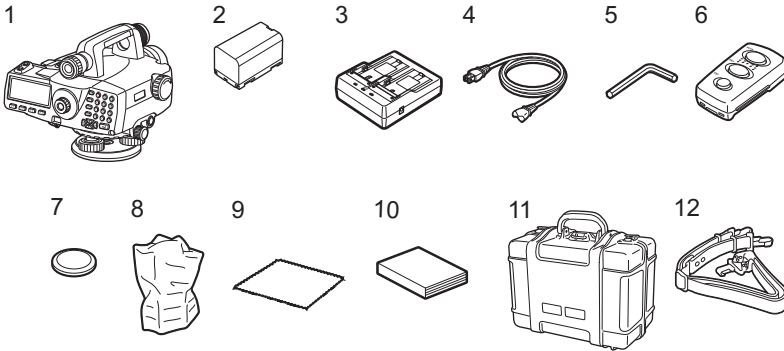
1 DL main unit 1
2 Battery (BDC58/70). 1
3 Battery charger (CDC68/68A). 1
4 Power cable (EDC113A/113B/113C etc.) 1
5 Hexagonal wrench (for both circular level and reticle adjustments) 1
6 Remote trigger (DLC1A) 1
7 Coin-type battery (CR2032) 1
8 Vinyl cover 1
9 Cleaning cloth 1
10 Operator's manual. 1
11 Carrying case (SC230A) 1
12 Carrying strap (SC96B). 1

[Note]

• Optional accessory DE28/29 can also be placed in the carrying case.
• A dedicated power calbe for the country or the area where the instrument is purchased is attached.

● **Remote Trigger (DLC1A)**
Changing battery cells

✠

• Remove the battery cell when the remote trigger is not to be used for a long time.

PROCEDURE

1. Pull the catch on the battery cover down. Remove the
    battery cover.

2. Slide the coin-type battery and press as shown at right
    to remove.

3. Insert a new battery with the + face up.

4. Fit the two prongs on the battery cover into the two
    notches and close the battery cover. A click is heard
    when the cover is in place.
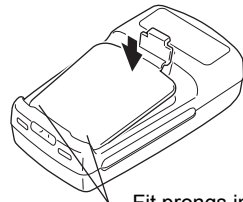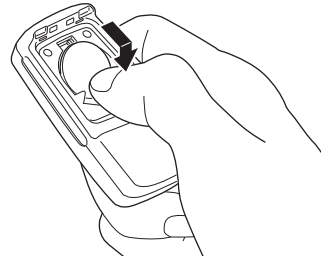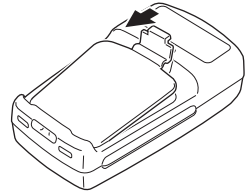
Fit prongs into notches

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23.2 DL-501 Standard
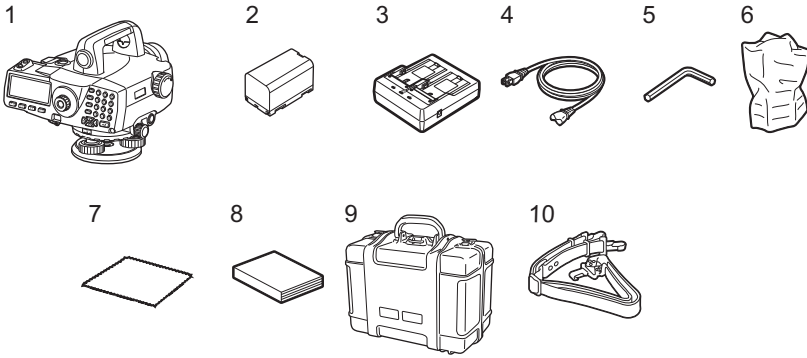
1 DL main unit 1
2 Battery (BDC58/70). 1
3 Battery charger (CDC68/68A). 1
4 Power cable (EDC113A/113B/113C etc.) 1
5 Hexagonal wrench (for both circular level and reticle adjustments) 1
6 Vinyl cover 1
7 Cleaning cloth 1
8 Operator's manual. 1
9 Carrying case (SC230A). 1
10 Carrying strap (SC96B). 1

[Note]

• Optional accessory DE28/29 can also be placed in the carrying case.
• A dedicated power calbe for the country or the area where the instrument is purchased is attached.

24.OPTIONAL ACCESSORIES

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

● **Remote Trigger (DLC1A)**
Optional accessory for the DL-501 Standard.

● **Diagonal eyepiece (DE28/DE29)**
The diagonal eyepiece is convenient for observations in narrow spaces.
Magnification:
DE28:   32X
DE29:   44X

First remove the standard DL eyepiece by turning it counter-clockwise. Then screw the diagonal eyepiece into place.

DE28/29
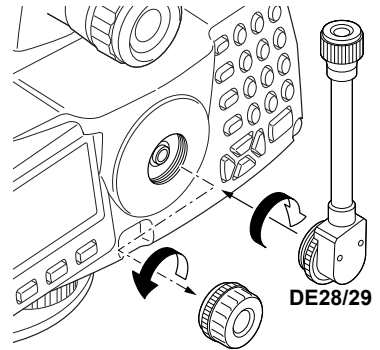
● **Interface cable**
Connect the DL to a data collector using the following cable.

Cable	Notes		
DOC129	Pin number and signal level	:	RS232C compatible
	D-Sub connector	:	9 pins (female)

● **Staffs**

Name	Material	Length/Front/Reverse	Feature
BIS30A	New Super Invar	3.038m (9.8ft) Front: RAB code*	ISO 12858-1: 1999 compatible For high precision leveling
BIS30	Invar	3.038m (9.8ft) Front: RAB code*	ISO 12858-1: 1999 compatible
BIS20	Invar	2.0m (6.6ft) Front: RAB code*	ISO 12858-1: 1999 compatible
BGS40	Glass fiber	4.08m (3 sections) Front : RAB code* Reverse: graduated	With handle
BGS50	Glass fiber	5.09m (4 sections) Front : RAB code* Reverse: graduated	With handle

*RAB code (RAndom Bi-directional code) is a coded staff used with Certain digital levels.

25.SPECIFICATIONS

Except where stated, the following specifications apply to both DL-501 Advanced and DL-501 Standard.

Telescope

Length:	280mm
Aperture:	45mm (1.8 inch)
Magnification:	32X
Image:	Erect
Resolving power:	3"
Field of view:	1°20' (2.3m/100m)
Minimum focus:	1.5m (5.0 ft)
Stadia ratio:	1:100
Stadia additive constant:	0

View Finder (DL-501 Advanced only)

Length:	130mm
Aperture:	22mm (about 0.9 inch)
Magnification:	4.5X
Image:	Erect
Field of view:	3°
Minimum focus:	7m

Auto Focus (DL-501 Advanced only)

Method:	Combination of passive/electronic distance measurement and contrast detection
Range:	1.6m to 100m
Minimum brightness level:	20lx at staff
Auto Focus time:	0.8 to 4 sec. (outdoors, fine to cloudy conditions)
Auto Focus motion:	Yes/No (selectable)
Auto Focus/manual conversion:	No (Manual mode given priority by friction clutch)

Automatic compensator

Automatic compensator:	Magnetic damping and pendulum mechanism
Compensation range:	±12'
Setting accuracy:	±0.3"

Tilt warning

Mechanism:	Liquid 2-axis tilt sensor
Range:	±8.5' (graphic level display and audio tone)

Measurement

Horizontal circle:	Diameter: 103mm
	Graduation: 1°/1 gon
Measuring range[*1]:	
Height	0.0375 to 1.9305m (0.124 to 6.333 ft) (with BIS20 staff)
	0.0375 to 2.9725m (0.124 to 9.752 ft) (with BIS30/30A staff)
	0 to 4m (13.123 ft) (with BGS40 staff)
	0 to 5m (16.404 ft) (with BGS50 staff)
Distance	Electronic measurement: 1.6 to 100m
	Visual measurement: from 1.5m

Minimum display:

Height	0.00001/0.0001/0.001m (0.0001/0.001/0.01ft) (selectable)
Distance	0.001/0.01/0.1m (0.01/0.1/1ft) (selectable)

Accuracy[*1]: (ISO17123-2 compatible)

Height (Standard deviation for 1 km of double-run leveling)

Electronic measurement	0.2mm (with BIS30A, DL-501 Advanced only)[*2]
	0.3mm (with BIS20/30)
	1.0mm (with BGS40/50)
Visual measurement	1.0mm (with BGS40/50)

Distance (Electronic measurement)

±10mm or less (10m or less)

±(0.1% x D) or less (over 10 to less than 50m)

±(0.2% x D) or less (50 to 100m)

(D: measured distance, unit: m)

Measuring modes:	Single/Repeat/Average/Rapid (selectable)

Measuring time[*3]:

Single/Repeat	less than 2.5 sec.
Average	No. of measurements set $\times$ less than 2.5 sec.
Rapid repeat	less than 1 sec.

Earth curvature and refraction correction:

No/Yes K=0.142/Yes K=0.20 (selectable)

*1	When measuring outdoors with minimal atmospheric motion, the staff set up in natural sunlight and luminosity at the surface of the staff equal to 20lx.
*2	When measuring with no atmospheric motion or scintillation, ambient temperature is stable and the instrument and staff are set up out of direct sunlight. Accuracy may be affected by wind conditions and the set up of the instrument and staff.
*3	When measuring to a staff set up outdoors in fine to cloudy conditions.
*1, **3**	These specifications may change depending on the weather conditions and measurement conditions.

Internal memory

Capacity:	10,000 measurement points

External memory

SD card (up to 4GB, SDHC supported)

USB flash memory (up to 4 GB)

Data transfer

Data input/output	Asynchoronous serial, RS232C compatible
USB	USB Ver. 1.1, Host (Type A)
Card slot	SD card

***Bluetooth* wireless communication**

Transmission method:	FHSS
Modulation:	GFSK, π/4DQPSK, 8DPSK
Frequency band:	2.402 to 2.48GHz
Bluetooth profile:	SPP
Power class:	Class 1
Usable range:	to 100m (usable range may vary with different paired devices)

(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 BDC58/70
Working duration at 20 °C (using BDC58/70):
    DL-501 Advanced
    Manual focus and measurement:
                    about 12 hours
    Automatic focus and measurement:
                    about 9 hours
    DL-501 Standard   about 14 hours
Battery state indicator: 4 levels
Auto power-off: 2 levels (30 min/Not set) (selectable)

Battery (BDC70)
    Nominal voltage: 7.2V
    Capacity: 5.2 Ah
    Dimensions: 40 (W) x 70 (D) x 40 (H) mm
    Weight: about 197g
Battery (BDC58)
    Nominal voltage: 7.2V
    Capacity: 4.3 Ah
    Dimensions: 38 (W) x 70 (D) x 40 (H) mm
    Weight: about 195g
Battery (BDC46C)
    Nominal voltage: 7.2V
    Capacity: 2.62Ah
    Dimensions: 38 (W) x 70 (D) x 20 (H) mm
    Weight: about 103g

Charger (CDC68/68A)
    Input voltage: AC100 to 240V
    Charging time per battery (at 25°C):
                BDC58   about 4 hours
                BDC70   about 5.5 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

General
Display: LCD graphic display, 192 dots X 80 dots
    Backlight   LED: ON/OFF (selectable)
Operation panel (Keyboard): 27 keys (soft function, operations, power on, light)
    Key backlight   Yes
Measure key: Yes (right side)
Calendar/clock function: Yes
Circular level sensitivity: 8'/2 mm

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Operating temperature: -20 to 50°C (no condensation)
Storage temperature range: -40 to 70°C (no condensation)
Dust and water resistance: IP54 (IEC 60529:2001)
Instrument size (with handle): 226 (W) X 260 (D) X 200 (H) mm
Instrument weight:
    DL-501 Advanced   3.5 kg (7.7 lb) (with BDC58/70)
    DL-501 Standard   3.4 kg (7.5 lb) (with BDC58/70)

Staffs
New Super Invar (ISO 12858-1:1999 compatible)
BIS30A
    Coefficient of linear expansion: $0\pm0.1 \times 10^{-6}$ /°C
    Scale range: 37.5 to 2972.5mm
    Size: 85 (W) X 40 (D) X 3038 (H) mm
    Weight: 5.5kg (staff only), 23.4kg (case containing 2 staffs)

Invar (ISO 12858-1:1999 compatible)
BIS30
    Coefficient of linear expansion: 1×10^{-6} /°C
    Scale range: 37.5 to 2972.5mm
    Size: 85 (W) X 40 (D) X 3038 (H) mm
    Weight: 5.5kg (staff only), 23.4kg (case containing 2 staffs)

BIS20
    Coefficient of linear expansion: 1×10^{-6} /°C
    Scale range: 37.5 to 1930.5mm
    Size: 85 (W) X 40 (D) X 2000 (H) mm
    Weight: 4.3kg (staff only), 17.1kg (case containing 2 staffs)

Glass fiber
BGS40
    Coefficient of linear expansion: 20×10^{-6} /°C
    Scale range: 0 to 4080mm
    Size: 58 (W) X 28 (D) X 4080 (H) mm
    Weight: 2.4kg (1 staff only), 3.0kg (w/ case)

BGS50
    Coefficient of linear expansion: 20×10^{-6} /°C
    Scale range: 0 to 5090mm
    Size: 58 (W) X 28 (D) X 5090 (H) mm
    Weight: 3.0kg (1 staff only), 3.6kg (w/ case)

Remote trigger (DLC1A) (optional accessory for the DL-501 Standard)
Interface: Modulated infrared LED
Power source: Coin-type battery x 1 (CR2032) (3V DC)
Operating range: within 0.5m (operating range may vary with different operating conditions)
Number of keys: 3
Dust and water resistance: IP66 (IEC60529:2001)
Size: 40(W) x 68(D) x 22(H) mm
Weight: Approx. 35g (with battery cell)

26.REGULATIONS

Region/Country	Directives/Regulations	Labels/Declarations
U.S.A.	FCC-Class A	**FCC Compliance** **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. **Means of conformity** This device complies with part 15 of the FCC Rules, Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. 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 an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment has very low levels of RF energy that it deemed to comply without maximum permissive exposure evaluation (MPE). But it is desirable that it should be installed and operated keeping the radiator at least 20cm or more away from person's body.
California, U.S.A	Proposition 65	**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.*
California, U.S.A	Perchlorate Material (CR Lithium Battery)	This product contains a CR Lithium Battery which contains Perchlorate Material-special handling may apply. See http://www.dtsc.ca.gov/hazardouswaste/perchlorate/ Note ; This is applicable to California, U.S.A. only

Region/ Country	Directives/ Regulations	Labels/Declarations
California and NY, U.S.A.	Recycling Batteries	**DON'T THROW AWAY RECHARGEABLE BATTERIES, RECYCLE THEM.** **Topcon Positioning Systems Inc., United States Return Process for UsedRechargeable Nickel Metal Hydride, Nickel Cadmium, Small Sealed Lead Acid, and Lithium Ion, Batteries** In the United States Topcon Positioning Systems Inc., has established a process by which Topcon customers may return used rechargeable Nickel Metal Hydride(Ni-MH), Nickel Cadmium(Ni-Cd), Small Sealed Lead Acid(Pb), and Lithium Ion(Li-ion) batteries to Topcon for proper recycling and disposal. Only Topcon batteries will be accepted in this process. Proper shipping requires that batteries or battery packs must be intact and show no signs of leaking. The metal terminals on the individual batteries must be covered with tape to prevent short circuiting and heat buildup or batteries can be placed in individual plastic bag. Battery packs should not be dissembled prior to return. Topcon customers are responsible for complying with all federal, state, and local regulations pertaining to packing, labeling, and shipping of batteries. Packages must include a completed return address, be prepaid by the shipper, and travel by surface mode. <u>Under no circumstance should used/recyclable batteries by shipped by air.</u> Failure to comply with the above requirements will result in the rejection of the package at the shipper's expense. Please remit packages to: Topcon Positioning Systems, Inc. C/O Battery Return Dept. 150 7400 National Dr. Livermore, CA 94551 **DON'T THROW AWAY RECHARGEABLE BATTERIES, RECYCLE THEM.**
Canada	ICES-Class A	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 Réglement 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 an uncontrolled environment and meets the RSS-102 of the IC radio frequency (RF) Exposure Guidelines. This equipment has very low levels of RF energy that it deemed to comply without maximum permissive exposure evaluation (MPE). But it is desirable that it should be installed and operated keeping the radiator at least 20cm or more away from person's body.

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Region/ Country	Directives/ Regulations	Labels/Declarations
EU	EMC-Class B R&TTE-Class 1	**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. This product complies with the electromagnetic environmental testing of industrial locations. Model: DIGITAL LEVEL DL-501 **Manufacturer** Name: TOPCON CORPORATION Address: 75-1, Hasunuma-cho, Itabashi-ku, Tokyo, 174-8580 JAPAN **Europe Representative** Name: Topcon Europe Positioning B.V. Representative Director: Jim Paetz Address: Essebaan 11, 2908 LJ Capelle a/d IJssel, The Netherlands $C\!\!\!\in$
EU	WEEE Directive	**WEEE Directive** This symbol is applicable to EU members states only. Following information is only for EU-member states: The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about the take-back and recycling of this product, please contact your supplier where you purchased the product or consult.
EU	EU Battery Directive	**EU Battery Directive** This symbol is applicable to EU members states only. Battery users must not dispose of batteries as unsorted general waste, but treat properly. If a chemical symbol is printed beneath the symbol shown above, this chemical symbol means that the battery or accumulator contains a heavy metal at a certain concentration. This will be indicated as follows: Hg: mercury(0.0005%), Cd: cadmium(0.002%), Pb: lead(0.004%) These ingredients may be seriously hazardous to human and the global environment. This product contains a coin cell. You cannot replace batteries by yourself. When you need to replace and/or dispose batteries, contact your local dealer.

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