Leica TDRA6000

User Manual

Version 1.0
English

- when it has to be **right**

Leica Geosystems

Introduction

Purchase

Congratulations on the purchase of a TDRA6000 instrument.

This manual contains important safety directions as well as instructions for setting up the product and operating it. Refer to "6 Safety Directions" for further information.
Read carefully through the User Manual before you switch on the product.

Product identification

The type and the serial number of your product are indicated on the type plate. Enter the type and serial number in your manual and always refer to this information when you need to contact your agency or Leica Geosystems authorized service workshop.

Type: _____

Serial No.: _____

Symbols

The symbols used in this manual have the following meanings:

Type	Description
⚠ **Danger**	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ **Warning**	Indicates a potentially hazardous situation or an unintended use which, if not avoided, could result in death or serious injury.
⚠ **Caution**	Indicates a potentially hazardous situation or an unintended use which, if not avoided, may result in minor or moderate injury and/or appreciable material, financial and environmental damage.
☞	Important paragraphs which must be adhered to in practice as they enable the product to be used in a technically correct and efficient manner.

Trademarks

- CompactFlash and CF are trademarks of SanDisk Corporation
- Bluetooth is a registered trademark of Bluetooth SIG, Inc

All other trademarks are the property of their respective owners.

Validity of this manual

	Description
General	This manual applies to all TDRA6000 instruments.
Telescope	• **Measuring with IR mode**: When measuring distances to a reflector with EDM mode "IR", the telescope uses a **wide** visible red laser beam, which emerges coaxially from the telescope's objective. • **Measuring with RL mode**: When measuring distances with EDM modes "RL", the telescope uses a **narrow** visible red laser beam, which emerges coaxially from the telescope's objective.

Available documentation

Name	Description and Format		
User Manual	All instructions required in order to operate the product to a basic level are contained in the User Manual. Provides an overview of the product together with technical data and safety directions.	✓	✓

Name	Description and Format		
System Field Manual	Describes the general working of the product in standard use and specific onboard application programs. Intended as a quick reference field guide.	✓	✓
Technical Reference Manual	Overall comprehensive guide to the product and program functions. Included are detailed descriptions of special software/hardware settings and software/hardware functions intended for technical specialists.		✓

Refer to the following resources for all TDRA6000 documentation and software

- the TDRA6000 Product CD
- http://metrology.leica-geosystems.com/en/Downloads_6843.htm

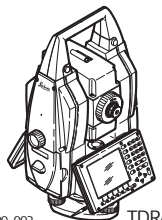
Table of Contents

In this manual

1 Description of the System

1.1 System Components

Main components



Component	Description
TDRA6000	• an instrument of highest accuracy for measuring, calculating and capturing data. • connected with LGO Tools to view, exchange and manage data.
Application Software	Third party metrology software with an interface to the TDRA6000 for acquisition, analysis, management and reporting of data.
LGO Tools	An office software consisting of a suite of standard and extended programs for the viewing, exchange and management of data.

Terminology

The following terms and abbreviations may be found in this manual:

Term	Description
TPS	**T**otal Station **P**ositioning **S**ystem
LGO Tools	**L**EICA **G**eo **O**ffice Tools
EDM	**E**lectronic **D**istance **M**easurement EDM refers to the laser distancer incorporated into the instrument which enables distance measurement. Two measuring modes are available: • **IR** mode. This mode refers to the ability to measure distances to a reflector. • **RL** mode. This mode refers to the ability to measure distances without reflector.
PinPoint	PinPoint refers to the Reflectorless EDM technology which enables an increased measuring range with a smaller laser spot size.
EGL	**E**lectronic **G**uide **L**ight

Term	Description
	The EGL fitted to the instrument serves three different purposes. It consists of two differently coloured flashing lights located in the instrument telescope housing. • **Target Lost Indicator**: The EGL starts flashing when the lock has been lost. This is useful when the instrument is operated remotely. • **Target Illumination**: Reflective tape is dark environment can be illuminated be the EGL to assist manual aiming of the target. • **Reflector alignment**: The person holding the reflector can align him/herself into the instrument's line of sight.
Motorised	TDRA6000 instruments are fitted with internal motors, enabling automatic horizontal and vertical turning are referred to as **M**otorised.
ATR	**A**utomatic **T**arget **R**ecognition ATR refers to the instrument sensor which enables the automatic fine pointing to a reflector.
Automated	Instruments fitted with ATR are referred to as **A**utomated.

Term	Description
	Three automation modes are available with ATR: • None: no ATR - no automation and no tracking. • ATR: automatic fine pointing to a reflector. • LOCK: automatic tracking of an already targeted reflector.
PowerSearch	**P**ower**S**earch refers to the instrument sensor which enables the automatic rapid finding of a prism.
Communication side cover	Communication side cover with integrated Bluetooth is a component with external devices, i.e. laptop with application software.

Instrument models

Model	Description
TDRA6000	Electronic tachymeter with Reflectorless EDM, Automated, Motorised, PowerSearch. 0.5" accuracy.

LEICA Geo Office Tools

- LGO Tools supports TDRA6000 instruments. It also supports all other Leica TPS instruments.
- LGO Tools is based on a graphical user interface with standard Windows® operating procedures.
- LGO Tools provides the following functionality:

Functionality	Description
Standard Functionality	Includes data exchange between computer and instrument, data management including viewing and editing, reporting, creation and management of codelists, creation and use of format files for data conversion, uploading and deleting of system software and application programs.

- Supported operating systems: Windows® XP, Windows® 2000.
- Refer to the online help of LGO Tools for additional information.

1.2 System Concept

1.2.1 Software Concept

Description

TDRA6000 instruments support the following types of software.

Software type

Software type	Description
System software	This software comprises the central functions of the instrument. It is also referred to as firmware. The programs Survey and Setup are integrated into the firmware and cannot be deleted. The English language is integrated into the firmware and cannot be deleted.
Language software	Numerous languages are available for the TDRA6000 instruments. This software is also referred to as system language. The system software enables a maximum of three languages which can be stored at any one time - the English language and two other languages. The English language is the default language and cannot be deleted. One language is chosen as the active language.

Software type	Description
Application programs	A suite of optional specific application programs are available for the instrument. Some of the programs are activated freely and require no license key and others require purchasing and are only activated with a license key.
Third party application programs	There are various third party applications available for the TDRA6000, onboard or computer based software. Please contact your Leica Geosystems representative for details.
Customised application programs	Customised software specific to user requirements can be developed using the GeoC++ development kit. Information on the GeoC++ development environment is available on request from a Leica Geosystems representative.

Software upload

All instrument software is stored in the System RAM of the instrument. The software can be uploaded onto the instrument using the following methods:

- Using LGO Tools the software is transferred via the serial interface to the CompactFlash card in the instrument, which is then stored to the System RAM.
- By connecting the CompactFlash card directly to the computer either via an internal card slot housing or an external OMNI drive, the software is transferred to the card, which is then stored to the System RAM.

1.2.2 Data Storage and Data Conversion Concept

Description

Data is stored within a job in a database on a memory device. This is either a CompactFlash card or an internal memory.

Memory device

CompactFlash card: A CompactFlash card housing is standard. A CompactFlash card can be inserted and removed. Available capacity: 256 MB and 1 GB.

Whilst other CompactFlash cards may be used, Leica recommends Leica CompactFlash cards and cannot be held responsible for data loss or any other error that may occur when using a non-Leica card.

Internal memory: An internal memory is always fitted. It resides inside the instrument. Available capacity: 256 MB.

Unplugging connecting cables or removing the CompactFlash card during the measurement may cause loss of data. Always return to **TDRA6000 Main Menu** before removing the CompactFlash card and switch off the instrument before removing cables.

Data conversion

Export

Data can be exported from a job in a wide range of ASCII formats. A standard set of Export Formats is delivered with the system. Customized export format can defined in Format Manager which is a PC tool in LEICA Geo Office Tools. Refer to the online help of LGO Tools for information on creating format files.
Data can also be exported from a job in DXF or LandXML format.

Import

Data can be imported from ASCII, DXF, GSI8 or GSI16 format.

Transfer raw data to LGO Tools

Raw data can be transferred between the database on the CompactFlash card or the internal memory of the instrument and LGO Tools in two ways:

- From the CompactFlash card or the internal memory directly via a serial interface to a project in LGO Tools on a PC.
- From the CompactFlash card using for example an OMNI drive as supplied by Leica Geosystems to a project in LGO Tools on a PC.

CompactFlash cards can be used directly in an OMNI drive as supported by Leica Geosystems. Other PC card drives may require an adapter.

1.2.3 Power Concept

General

Use the Leica Geosystems batteries, chargers and accessories or accessories recommended by Leica Geosystems to ensure the correct functionality of the instrument.

Power options

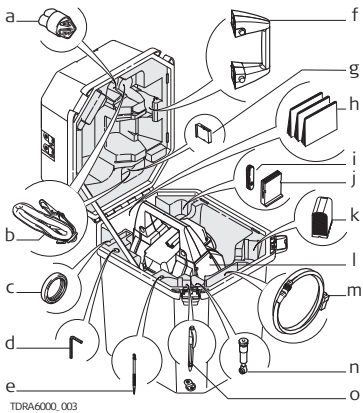
Instrument

Power for the instrument can be supplied either internally or externally. An external battery is connected to the instrument using a LEMO cable.

Internal battery:	One GEB242 battery fitted into the battery compartment.
External battery:	One GEB171 battery connected via cable

1.3 Container Contents

Container for instrument and delivered accessories

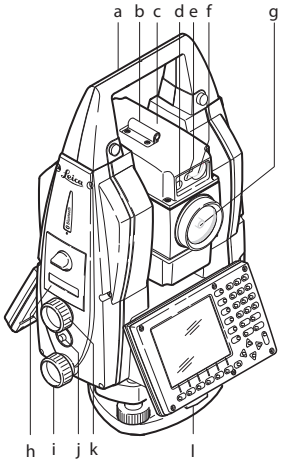


a) Protective cover for instrument and sunshade for objective lens
b) Container straps
c) Counterweight for diagonal eyepiece or zenith eyepiece - optional
d) Allen key
e) Spare stylus
f) Room for normal handle
g) Compact Flash card with cover
h) User manual
i) not applicable
j) CompactFlash card adapter with cover
k) Internal battery GEB242 - optional
l) Instrument with supplied stylus and tribrach (with standard carry handle or RadioHandle attached)
m) Data transfer cable GEV218
n) Diagonal eyepiece GFZ3 or zenith eyepiece GOK6 (eyepiece for steep sighting) - optional
o) Ball pen - optional

1.4 Instrument Components

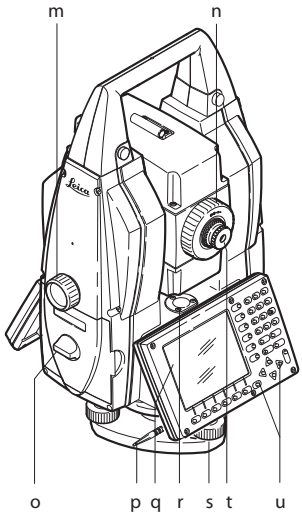
Instrument components part 1 of 2

The instrument components of a TDRA6000 instrument are shown below.



a) Carry handle
b) Optical sight
c) Telescope, integrating EDM, ATR, EGL, PS
d) EGL
e) PowerSearch, transmitter
f) PowerSearch, receiver
g) Coaxial optics for angle and distance measurement, and exit port of visible laser beam for distance measurements
h) CompactFlash card compartment
i) Horizontal drive
j) User defined SmartKey
k) Vertical drive
l) Tribrach securing screw

Instrument components part 2 of 2

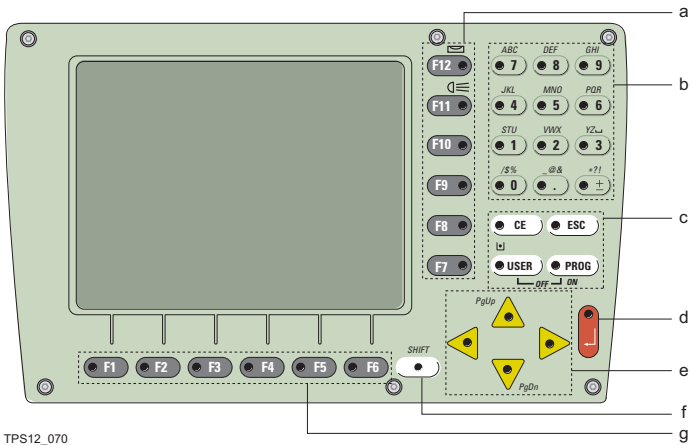


m) Vertical drive
n) Focusing ring
o) Battery compartment
p) Stylus for touch screen
q) Screen
r) Circular level
s) Tribrach footscrew
t) Interchangeable eyepiece
u) Keyboard

2 User Interface

2.1 Keyboard

Keyboard



a) Hot keys **F7**-**F12**
b) Alphanumeric keys
c) **CE**, **ESC**, **USER**, **PROG**
d) **ENTER**
e) Arrow keys
f) **SHIFT**
g) Function keys **F1**-**F6**

Keys

Key	Description
Hot keys **F7**-**F12** 	• User definable keys to execute commands or access chosen screens. • The hot key F13, the user defined SmartKey, is located between the horizontal and vertical drive on the right hand side cover.
Alphanumeric keys	• To type letters and numbers.
CE	• Clears all entry at the beginning of user input. • Clears the last character during user input.
ESC	• Leaves the current menu or dialog without storing changes made.
USER	• Calls the user defined menu.
PROG (ON)	• If the instrument is off: to turn instrument on. • If the sensor is on: press at any time to select an application program.

Key	Description
ENTER	• Selects the highlighted line and leads to the next logical dialog/menu. • Starts the edit mode for edit fields. • Opens a list box.
SHIFT	• Changes between the first and the second level of function keys.
Arrow keys	• Move the focus on the screen.
Function keys **F1**-**F6**	• Correspond to the six softkeys that appear on the bottom of the screen when the screen is activated.

Key combinations

Keys	Description
PROG plus **USER**	Turns instrument off.
SHIFT F12	Calls **STATUS Level & Laser Plummet**.
SHIFT F11	Calls **CONFIGURE Lights, Display, Beeps, Text, Lights** page.
SHIFT USER	Calls **QUICK SET Change Settings to:**.
SHIFT ▲	Pages up.
SHIFT ▼	Pages down.

2.2 Hot Key Assignments

General

TDRA6000 instruments contain two standard configurations at delivery. Two more configurations are available on the Factory CD.

Configuration Set	Description	Length Unit	Angle Unit
TDRA BT Metric	Standard configuration set for Bluetooth connection	Meter	Degree
TDRA Cable Metr	Standard configuration set for Cable connection	Meter	Degree
TDRA BT Inch	Optional configuration set for Blue-tooth connection	Inch	Degree
TDRA Cable Inch	Optional configuration set for Cable connection	Inch	Degree

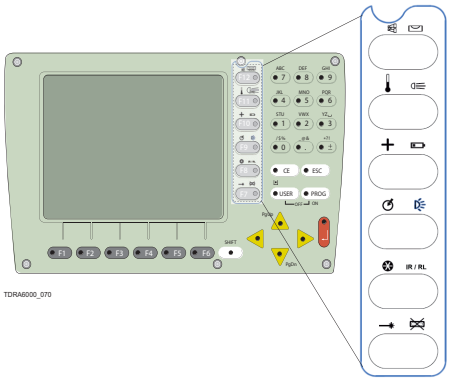
Hot Keys

All default configurations contain the following Hot Key & Shift Hot Key assignments:

Key	Description
F7	Laserpointer On/Off
F8	Reflector Management
F9	ATR On/Off
F10	Lock On/Off
F11	TPS Correction (Environmental Parameters)
F12	Power Search
F13 (Trigger Key)	All (Take a full measurement)
Shift - F7	Compensator functions
Shift - F8	Toggle between measurements to a reflector and reflectorless
Shift - F9	EGL (Target Illumination) On/Off
Shift - F10	Battery & Memory Status
Shift - F11	Lights & Display Settings
Shift - F12	Electronic Level & Plummet

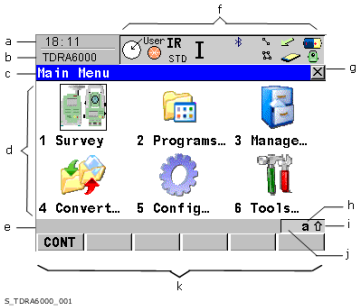
Keyboard Overlay

A self adhesive keyboard overlay is available for the default Hot Key assignments. The keyboard overlay can be affixed to the keyboard as shown below if required.



2.3 Screen

Screen



a) Time
b) Caption
c) Title
d) Screen area
e) Message line
f) Icons
g) ESC ☒
h) CAPS
i) SHIFT icon
j) Quick coding icon
k) Softkeys

Elements of the screen

Element	Description
Time	The current local time is shown.
Caption	Shows location either in **Main Menu**, under **PROG** key or **USER** key.
Title	Name of the screen is shown.
Screen area	The working area of the screen.

Element	Description
Message line	Messages are shown for 10 s.
Icons	Shows current status information of the instrument. Refer to "2.5 Icons". Can be used with touch screen.
ESC ☒	Can be used with touch screen. Same functionality as the fixed key **ESC**. The last operation will be undone.
CAPS	The caps mode for upper case letters is active.The caps mode is activated and deactivated by pressing **UPPER (F5)** or **LOWER (F5)** in some screens.
SHIFT icon	Shows the status of the **SHIFT** key; either first or second level of softkeys is selected. Can be used with touch screen and has the same functionality as the fixed key **SHIFT**.
Quick coding icon	Shows the quick coding configuration. Can be used with touch screen to turn quick coding on and off.
Softkeys	Commands can be executed using **F1**-**F6** keys. The commands assigned to the softkeys are screen dependent. Can be used directly with touch screen.
Scroll bar	Scrolls the screen area up and down.

2.4 Operating Principles

Keyboard and touch screen

The user interface is operated either by the keyboard or by the touch screen with supplied stylus. The workflow is the same for keyboard and touch screen entry, the only difference lies in the way information is selected and entered.

Turn instrument on

Press and hold **PROG** for 2 s.

Turn instrument off step-by-step

Step	Description
☞	The instrument can only be turned off in **TDRA6000 Main Menu**.
1.	Press and hold both **USER** and **PROG** simultaneously. OR Press **ESC** for more then 2 s.
2.	Press **YES (F6)** to continue or **NO (F4)** to cancel.

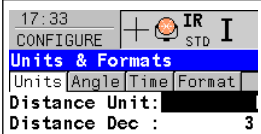
Lock/Unlock keyboard

Option	Description
Lock	To lock the keyboard press and hold **SHIFT** for 3 s. The message 'Keyboard locked' is momentarily displayed on the Message Line.
Unlock	To unlock the keyboard press and hold **SHIFT** for 3 s. The message 'Keyboard unlocked' is momentarily displayed on the Message Line.

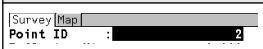
Selecting from a menu

Appearance	Description
	To select an item from a menu, do one of the following: Move the focus to the item. **ENTER** or **CONT (F1)**. OR Type the complete selection number in front of the item. **ENTER** or **CONT (F1)** are not required. OR Tap on the item with the stylus.

Selecting a page

Appearance	Description
	To select a page in a screen, do one of the following: **PAGE (F6)**. OR Tap on the page tab with the stylus.

Edit an entire value in input fields

Appearance	Description
	1. Highlight the field. 2. Type numeric and/or alphanumeric characters to overwrite. 3. **ENTER** or tap outside of the field.

Edit an individual character in input fields

Appearance	Description
	A character can be inserted or overwritten. The procedure is the same for both cases. 1. Highlight the field. 2. For the keyboard: **ENTER**. The edit mode is activated where additional functions like insert and overwrite are available. 3. For the touch screen: Highlight the characters to be changed. 4. Type numeric and/or alphanumeric characters. 5. **ENTER** or tap outside of the field.

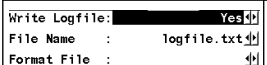
Access special alphanumeric characters for input

Step	Description
1.	Highlight the input field.
2.	For the keyboard: **ENTER**.
3.	Toggle to the desired special character set by using the up/down arrow keys.
4.	Press the function key assigned to the required character group.
5.	Press the function key with the required character.
6.	Repeat step 4. and 5. for entering more special characters of the same character set.
7.	**ENTER**.

Appearance and selection from a choicelist

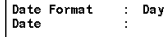
Choicelists have various appearances.

Closed choicelist

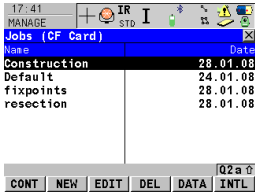
Appearance	Description	Selection
	Triangles on the right indicate further available choices.	Use the arrow keys ◀ ▶ to change through the list or tap the triangles on the screen.

ENTER or tap on the field to access the choicelist. Opening a choicelist reveals either a simple listbox or a comprehensive listbox dialog.

Simple listbox

Appearance	Description	Selection
	• Choicelist shows items to select. • A search field is shown if necessary. • A scroll bar is shown if necessary.	• Highlight the item and **ENTER**. • To exit without changes **ESC**, tap ☒ or outside the simple listbox.

Listbox dialog

Appearance	Description	Selection
	• Choicelist fills the whole screen. • A search field is shown. • A scroll bar is shown if necessary. • The functionality comprise adding, editing and deleting of items. • Listbox dialogs are explained in detail at appropriate places in the manuals.	• Highlight the item and **CONT (F1)**. • To exit without changes press **ESC** or tap ☒.

2.5 Icons

Description

The screen icons display the current status information of the instrument.

Position of the icons on the screen

a) ATR/LOCK/PS
b) Reflector
c) EDM
d) Compensator/face I&II
e) Bluetooth
f) Line/area
g) CompactFlash card/internal memory
h) Battery
i) **SHIFT**
j) Quick coding

Icons

Icon	Description
ATR/LOCK/PS	The currently active ATR/LOCK/PS settings or searches are displayed.
Reflector	The currently active reflector is displayed.

Icon	Description
EDM	The currently active EDM measurement settings are displayed.
Compensator/face I&II	Compensator off, out of range or face I&II icon is displayed.
Bluetooth	The status of each Bluetooth port and any Bluetooth connection is displayed.
Line/area	The number of lines and areas currently open in the active job is displayed.
CompactFlash card/internal memory	The status of the CompactFlash card and internal memory are displayed. • For the CompactFlash card, the capacity of used space is shown in seven levels. • For the internal memory, the capacity of used memory is shown in nine levels.
Battery	The status and source of the battery is displayed. The percentage of remaining power capacity for all batteries are displayed numerically and graphically. For internal and external battery being attached at the same time the internal battery is used until it is empty and then the external battery is used.

Icon	Description
SHIFT	The status of the **SHIFT** key is displayed.
Quick coding	Shows the quick coding configuration. Can be used with touch screen to turn quick coding on and off.

3 Operation

3.1 Instrument Setup

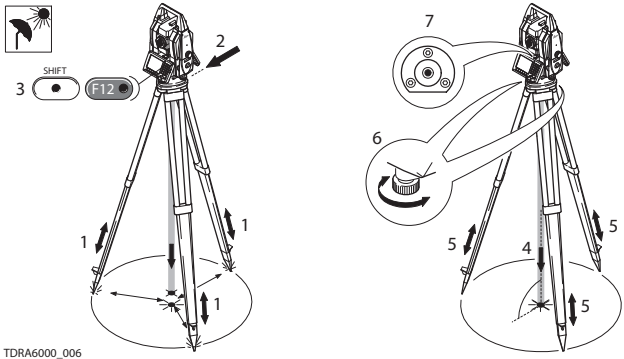
Description

This topic describes an instrument setup over a marked ground point using the laser plummet. It is always possible to set up the instrument without the need for a marked ground point.

Important features:

- It is always recommended to shield the instrument from direct sunlight and avoid uneven temperatures around the instrument.
- The laser plummet described in this topic is built into the vertical axis of the instrument. It projects a red spot onto the ground, making it appreciably easier to centre the instrument.
- The laser plummet cannot be used in conjunction with a tribrach equipped with an optical plummet.
- Refer to "TDRA6000 Technical Reference Manual" for additional information on using the laser plummet.

Setup step-by-step



TDRA6000_006

Step	Description
☞	Shield the instrument from direct sunlight and avoid uneven temperatures around the instrument.
1.	Extend the tripod legs to allow for a comfortable working posture. Position the tripod over the marked ground point, centring it as well as possible.
2.	Fasten the tribrach and instrument onto the tripod.

Step	Description
3.	Turn on the instrument by pressing **PROG** for 2 s. Press **SHIFT (F12)** to access **STATUS Level & Laser Plummet**, activating the laser plummet.
4.	Move the tripod legs (1) and use the tribrach footscrews (6) to centre the plummet (4) over the ground point.
5.	Adjust the tripod legs to level the circular level (7).
6.	By using the electronic level turn the tribrach footscrews (6) to precisely level the instrument.
7.	Centre the instrument precisely over the ground point (4) by shifting the tribrach on the tripod plate (2).
8.	Repeat steps 6. and 7. until the required accuracy is achieved.

3.2 Battery

3.2.1 Operating Principles

Primary use/charging

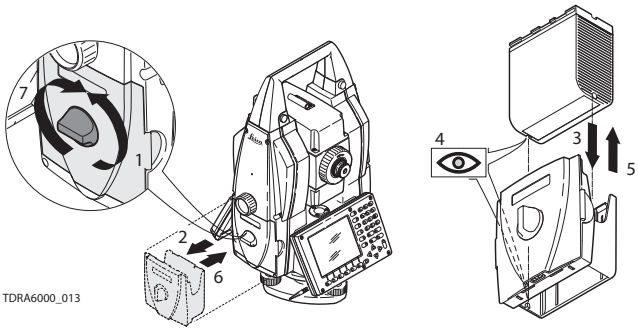
- The battery must be charged prior to using it for the first time because it is delivered with an energy content as low as possible.
- For new batteries or batteries that have been stored for a long time (> three months), it is effectual to make only one charge/discharge cycle.
- For Li-Ion batteries, a single discharging and charging cycle is sufficient. We recommend carrying out the process when the battery capacity indicated on the charger or on a Leica Geosystems product deviates significantly form the actual battery capacity available.
- The permissible temperature range for charging is between 0°C to +40°C/+32°F to +104°F. For optimal charging we recommend charging the batteries at a low ambient temperature of +10°C to +20°C/+50°F to +68°F if possible.
- It is normal for the battery to become warm during charging. Using the chargers recommended by Leica Geosystems, it is not possible to charge the battery if the temperature is too high.

Operation/Discharging

- The batteries can be operated from -20°C to +55°C/-4°F to +131°F.
- Low operating temperatures reduce the capacity that can be drawn; very high operating temperatures reduce the service life of the battery.

3.2.2 Instrument Battery

Change battery step-by-step



Step	Description
1.	Face the instrument on the side with the single finedrive. The battery compartment is located just below. Turn the knob to the vertical position, opening the lid of the battery compartment.
2.	Pull out the battery housing.
3.	Pull the battery from the battery housing.

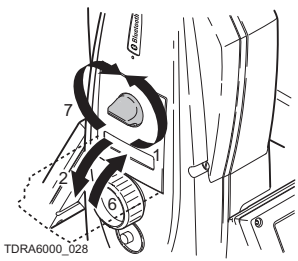
Step	Description
4.	A pictogram of the battery is displayed inside the battery housing. This is a visual aid to assist in placing the battery correctly.
5.	Place the battery into the battery housing, ensuring that the contacts are facing outward. Click the battery into position.
6.	Place the battery housing into the battery compartment. Push the battery housing in until it fits completely into the battery compartment.
7.	Turn the knob to lock the battery compartment. Ensure that the knob is returned to its original horizontal position.

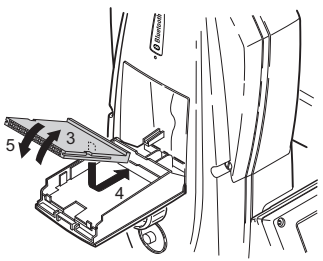
3.3 Working with the CompactFlash Card

- Keep the card dry.
- Use it only within the specified temperature range.
- Do not bend the card.
- Protect the card from direct impacts.

Failure to follow these instructions could result in data loss and/or permanent damage to the card.

Insert and remove a CompactFlash card step-by-step





Step	Description
1.	Face the instrument so that the CompactFlash card compartment is on the right side of the instrument. Turn the knob to the vertical position, opening the lid of the CompactFlash card compartment.
2.	Open the lid of the CompactFlash card compartment.
3.	Pull the front of the CompactFlash card up and take the card out of the lid.
4.	Place the lower end of the CompactFlash card at the lower end of the CompactFlash card compartment. The extended edge of the card has to be on the upper side as shown on the pictogram in the CompactFlash card compartment.
5.	Press the card down on the lid.
6.	Close the lid.
7.	Turn the knob to lock the CompactFlash card compartment. The lid is closed correctly when the knob is turned to a horizontal position.

Format a CompactFlash card step-by-step

Formatting the CompactFlash card before starting to store data is required if a completely new CompactFlash card is used or if all existing data needs to be deleted.

Step	Description
1.	**Main Menu: Tools...\Format Memory Device**.
2.	**TOOLS Format Memory Device** **<Memory Device: CF Card>** **<Format Method: Format Quick>** Select the memory device to be formatted.
☞	By activating the format command all data will be lost. Make sure that all important data on the CompactFlash card has been backed up before formatting the card. Before formatting the internal memory make sure that all important data is first transferred to the PC.
☞	To exit the screen without formatting the memory device, press **ESC**. This returns to the previous screen without execution of any command.
3.	**CONT (F1)**.
4.	**YES (F4)** to complete the formatting of the CompactFlash card.
☞	**NO (F6)** to abort the formatting of the CompactFlash card and return to **TOOLS Format Memory Device**.
5.	Once the formatting of the CompactFlash card is completed the system returns to **TDRA6000 Main Menu**.

3.4 Accessing Survey Application Program

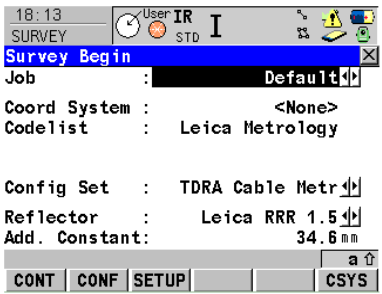
Access

Select **Main Menu: Survey**.

OR

Press **PROG**. Highlight Survey. **CONT (F1)**.

SURVEY
Survey Begin



CONT (F1)
To accept changes and access the subsequent screen. The chosen settings become active.

CONF (F2)
To access **SURVEY Configuration**.

SETUP (F3)
Opens **SETUP Station Setup** to set station and orientation.

CSYS (F6)
To select a different coordinate system. Not available for **<Use Auto CrdSys: Yes>** configured in **CONFIGURE Additional Rover Settings**.

Description of fields

Field	Option	Description
<Job:>	Choicelist	The active job. All jobs from **Main Menu: Manage...\Jobs** can be selected.
<Coord System:>	Output	The coordinate system currently attached to the selected **<Job:>**. Cannot be edited for **<Use AutoCrdSys: Yes>** configured in **CONFIGURE Additional Rover Settings**.
<Codelist:>	Choicelist	No codes are stored in the selected **<Job:>**. All codelists from **Main Menu: Manage...\Codelists** can be selected.
	Output	Codes have already been stored in the selected **<Job:>**. If codes had been copied from a System RAM codelist, then the name of the codelist is displayed. If codes have not been copied from a System RAM codelist but typed in manually, then the name of the active job is displayed.
<Config Set:>	Choicelist	The active configuration set. All configuration sets from **Main Menu: Manage...\Configuration Sets** can be selected.

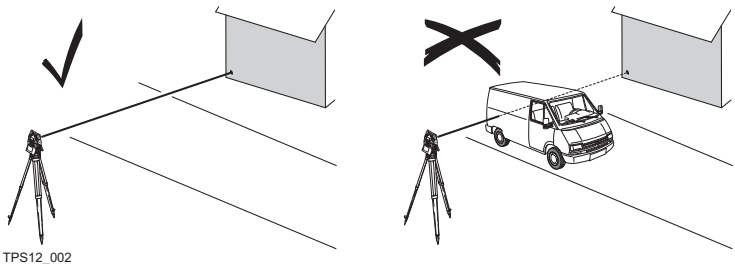
Field	Option	Description
		The instrument has numerous user configuration parameters and functions. This allows a variety of preferences to be addressed. The configuration of the parameters and functions for an individual measuring technique are combined in a configuration set.
<Reflector:>	Choicelist	Displays the active reflector. All reflectors from **Main Menu: Manage...\Reflectors**. All listed reflectors can be selected.
<Add. Constant:>	Output	Displays the additive constant stored with the chosen reflector.

Next step
CONT (F1) to access **SURVEY Survey: Job Name**, where measurements can be performed with **ALL (F1)** or **DIST (F2)** and/or **REC (F3)**.

3.5 Guidelines for Correct Results

Very short distances may be measured reflectorless in IR mode to well reflecting targets. Note that the distances are corrected with the additive constant defined for the active reflector.

Distance measurement



TPS12_002

When measurements are being made using the red laser EDM, the results may be influenced by objects passing between the EDM and the intended target surface. This occurs because reflectorless measurements are made to the first surface returning sufficient energy to allow the measurement to take place. For example, if the intended target surface is the surface of a road, but a vehicle passes between the EDM and the target surface as **DIST (F2)** or **ALL (F1)** is pressed, the measurement

may be made to the side of the vehicle. The result is the distance to the vehicle, not to the road surface.

Accurate measurements to prisms should be made in IR mode using the EDM mode "Precise".

When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. If a temporary obstruction, for example a passing vehicle, heavy rain, fog or snow is between the instrument and the point to be measured, the EDM may measure to the obstruction.

Do not measure with two instruments to the same target simultaneously to avoid getting mixed return signals.

ATR/Lock

TDRA6000 instruments equipped with an ATR sensor permit automatic angle and distance measurements to prisms. The prism is sighted with the optical sight. After initiating a distance measurement, the instrument sights the prism centre automatically. Vertical and horizontal angles and the distance are measured to the centre of the prism. The lock mode, available for TDRA6000, enables the instrument to follow a moving prism.

As with all other instrument errors, the collimation error of the automatic target recognition must be redetermined periodically. Refer to "*4* Check & Adjust" about checking and adjusting instruments.

When a measurement is triggered while the prism is still moving, distance and angle measurements may not be made for the same position and wrong coordinates may be calculated.

If the prism location is changed too quickly, the target may be lost. Make sure that the speed does not exceed the figure given in the technical data.

4 Check & Adjust

4.1 Overview

Description

Leica instruments are manufactured, assembled and adjusted to the best possible quality. Quick temperature changes, shock or stress can cause deviations and decrease the instrument accuracy.
It is therefore recommended to check and adjust the instrument from time to time. This can be done in the field by running through specific measurement procedures. The procedures are guided and have to be followed carefully and precisely as described in the following chapters. Some other instrument errors and mechanical parts can be adjusted mechanically.

Electronic adjustment

The following instrument errors can be checked and adjusted electronically:

l, t	Compensator longitudinal and transversal index errors
i	Vertical index error, related to the standing axis
c	Hz collimation error, also called line of sight error
a	Tilting axis error
ATR	ATR zero point error for Hz and V - option

Every angle measured in the daily work is corrected automatically if the compensator and the Hz-corrections are activated in the instrument configuration. Select **Main Menu: Config...\Instrument Settings...\Compensator** to check the settings.

View current adjustment errors

The currently used adjustment errors can be viewed under **Main Menu: Tools.../Check & Adjust...\Current Values**.

Mechanical adjustment

The following instrument parts can be adjusted mechanically:

- Circular level on instrument and tribrach
- Laser plummet
- Optical plummet - option on tribrach
- Allen screws on tripod

Precise measurements

To get precise measurements in the daily work, it is important:

- To check and adjust the instrument from time to time.
- To take high precision measurements during the check and adjust procedures.
- To measure targets in two faces. Some of the instrument errors are eliminated by averaging the angles from both faces.
- Refer to "4.2 Preparation" to find more important points.

During the manufacturing process, the instrument errors are carefully determined and set to zero. As mentioned above, these errors can change and it is highly recommended to redetermine them in the following situations:

- Before the first use
- Before every high precision survey
- After rough or long transportations
- After long working periods

- After long storage periods
- If the temperature difference between current environment and the temperature at the last calibration is more than 20°C

Summary of errors to be adjusted electronically

Instrument error	Effects Hz	Effects V	Elimination with two face measurement	Automatically corrected with proper adjustment
c - Line of sight error	✓	---	✓	✓
a - Tilting axis error	✓	---	✓	✓
l - Compensator index error	---	✓	✓	✓
t - Compensator index error	✓	---	✓	✓
i - V-Index error	---	✓	✓	✓
ATR Collimation error	✓	✓	---	✓

4.2 Preparation

Before determining the instrument errors, the instrument has to be levelled-up using the electronic level. **SHIFT F12** to access **STATUS Level & Laser Plummet, Level** page.
The tribrach, the tripod and the underground should be very stable and secure from vibrations or other disturbances.

The instrument should be protected from direct sunlight in order to avoid thermal warming.
It is also recommended to avoid strong heat shimmer and air turbulence. The best conditions are usually early in the morning or with overcast sky.

Before starting to work, the instrument has to become acclimatised to the ambient temperature. Approximately two minutes per °C of temperature difference from storage to working environment but at least 15 min should be taken into account.

Note, that even after good adjustment of the ATR, the crosshair might not be positioned exactly on the centre of the reflector after an ATR measurement has been executed. This is a normal effect. To speed up the ATR measurement, the telescope is normally not positioned exactly on the centre of the reflector. The small rest deviations, the ATR offsets are measured individually for each measurement and corrected electronically. This means that the Hz- and V- angles are corrected twice:

first by the determined ATR errors for Hz and V and then by the individual small deviations of the current pointing.

Next step

IF the task is to	THEN
adjust a combination of instrument errors	Refer to "4.3 Combined Adjustment (l, t, i, c and ATR)"
adjust the tilting axis	Refer to "4.4 Tilting Axis Adjustment (a)"
adjust the circular level	Refer to "4.5 Adjusting the Circular Level of the Instrument and Tribrach"
adjust the laser/optical plummet	Refer to "4.7 Inspecting the Laser Plummet of the Instrument"
adjust the tripod	Refer to "4.8 Servicing the Tripod"

4.3 Combined Adjustment (l, t, i, c and ATR)

Description

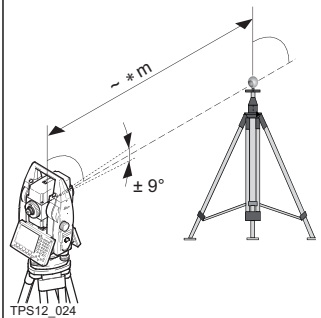
The combined adjustment procedure determines the following instrument errors in one process:

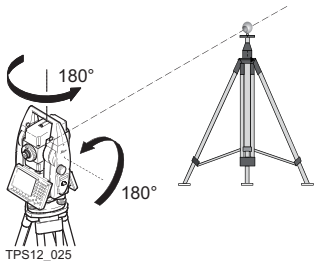
l, t	Compensator longitudinal and transversal index errors
i	Vertical index error, related to the standing axis
c	Hz collimation error, also called line of sight error
ATR Hz	ATR zero point error for Hz angle - option
ATR V	ATR zero point error for V angle - option

Combined adjustment procedure step-by-step

The following table explains the most common settings.

Step	Description
1.	**Main Menu: Tools...\Check & Adjust...**
2.	**TOOLS Check & Adjust Menu**
	Select the option: **Combined (l,t,i,c,ATR)**
3.	**TOOLS Combined I**
	<ATR Adjust: On> Includes the determination of the ATR Hz and V adjustment errors. ☞ It is recommended to use a clean Leica 1.5'' RRR as target. Alternatively a Leica circular prism may be used.

Step	Description
4.	 Aim the telescope accurately at a target at about the usual working distance. The target must be positioned within ± 9°/± 10 gon of the horizontal plane. The procedure can be started in any telescope face. *: Typical working distance

Step	Description
5.	**MEAS (F1)** to measure and to continue to the next screen.  TDRA6000 are motorised instruments and change automatically to the other face. ☞ The fine pointing has to be performed manually in both faces.
6.	**TOOLS Combined II**
	MEAS (F1) to measure the same target in the other face and to calculate the instrument errors.
☞	If one or more errors are bigger than the predefined limits, the procedure has to be repeated. All measurements of the current run are rejected and none of them is averaged with the results from previous runs.
7.	**TOOLS Adjustment Accuracy**

Step	Description
	<No.of Meas:> Shows the number of runs executed. One run consists of a measurement in face I and face II. **<σ I Comp:>** and similar lines show the standard deviations of the determined adjustment errors. The standard deviations can be calculated from the second run onwards.
☞	It is recommended to measure at least two runs.
8.	**MEAS (F5)** if more runs have to be added. Continue with step 3. OR **CONT (F1)** to accept the measurements and to proceed to **TOOLS Adjustment Results**. No more runs can be added later.

Next step

IF the results are	THEN
to be stored	**CONT (F1)** overwrites the old adjustment errors with the new ones, if the **Use** status is set to **Yes**.
to be determined again	**REDO (F2)** rejects all new determined adjustment errors and repeats the whole procedure. Refer to step 3. of paragraph "Combined adjustment procedure step-by-step".

4.4 Tilting Axis Adjustment (a)

Description

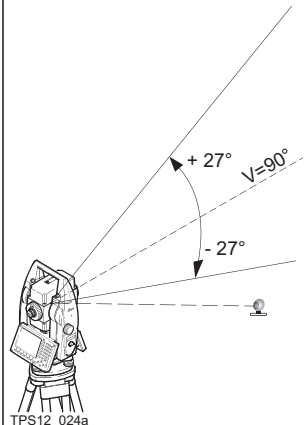
This adjustment procedure determines the following instrument error:

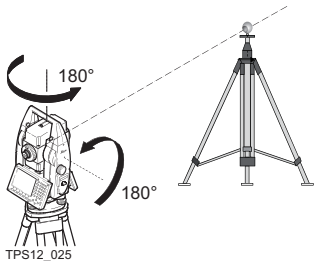
a Tilting axis error

Determination of tilting axis error step-by-step

The following table explains the most common settings.

Step	Description
	The Hz collimation error (c) has to be determined before starting this procedure.
1.	**Main Menu: Tools...\Check & Adjust...**
2.	**TOOLS Check & Adjust Menu** Select the option: **Tilting Axis (a)**

Step	Description
3.	**TOOLS Tilting-Axis Adjustment I**  Aim the telescope accurately at a target at about the usual working distance. The target must be positioned at least 27°/30 gon above or beneath the horizontal plane. The procedure can be started in any telescope face.

Step	Description
4.	**MEAS (F1)** to measure and to continue to the next screen.  TDRA6000 are motorised instruments and change automatically to the other face. ☞ The fine pointing has to be performed manually in both faces.
5.	**TOOLS Tilting-Axis Adjustment II** **MEAS (F1)** to measure the same target in the other face and to calculate the tilting axis error.
☞	If the error is bigger than the predefined limit, the procedure has to be repeated. The tilting axis measurements of the current run are then rejected and not averaged with the results from previous runs.

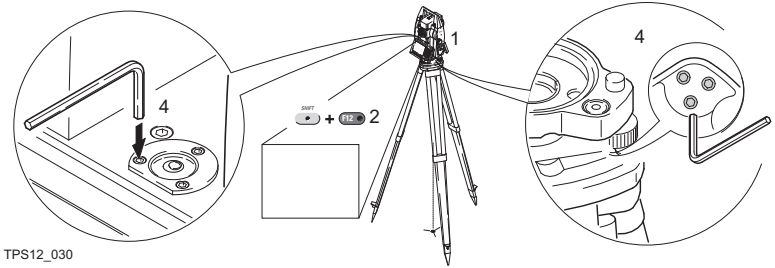
Step	Description
6.	**TOOLS T-Axis Adjustment Accuracy** **<No.of Meas:>** Shows the number of runs executed. One run consists of a measurement in face I and face II. **<σ a T-axis:>** shows the standard deviation of the determined tilting axis error. The standard deviation can be calculated from the second run onwards.
	It is recommended to measure at least two runs.
7.	**MEAS (F5)** if more runs have to be added. Continue with step 3. OR **CONT (F1)** to accept the measurements and to proceed to **TOOLS T-Axis Adjustment Result**. No more runs can be added later.

Next step

IF the results are	THEN
to be stored	**CONT (F1)** overwrites the old tilting axis error with the new one.
to be determined again	**REDO (F2)** rejects the new determined tilting axis error and repeats the whole procedure. Refer to step 3. of paragraph "Determination of tilting axis error step-by-step".

4.5 Adjusting the Circular Level of the Instrument and Tribrach

Adjusting the circular level step-by-step



TPS12_030

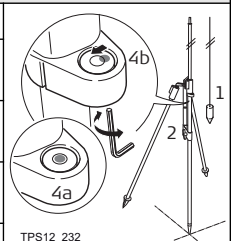
Step	Description
1.	Place and secure the instrument into the tribrach and onto a tripod.
2.	Using the tribrach footscrews, level the instrument with the electronic level. **SHIFT (F12)** to access **STATUS Level & Laser Plummet**.
3.	Check the position of the circular level on the instrument and tribrach.
4.	a) If both circular levels are centered, no adjustments are necessary
	b) If one or both circular levels are not centered, adjust as follows:

Step	Description
	Instrument: If it extends beyond the circle, use the supplied allen key to centre it with the adjustment screws. Turn the instrument by 200 gon (180°). Repeat the adjustment procedure if the circular level does not stay centered.
	Tribrach: If it extends beyond the circle, use the supplied allen key to centre it with the adjustment screws.
☞	After the adjustments, all adjusting screws should have the same tightening tension and no adjusting screw shall be loose.

4.6 Adjusting the Circular Level of the Prism Pole

Adjusting the circular level step-by-step

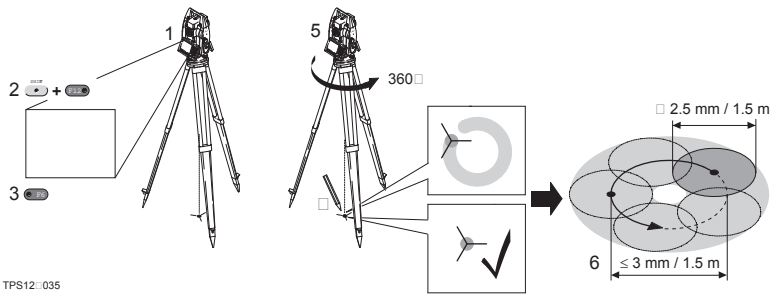
Step	Description
1.	Suspend a plumb line.
2.	Using a pole bipod, align the prism pole parallel to the plumb line.
3.	Check the position of the circular level on the prism pole.
4.	a) If the circular level is centered, no adjustment is necessary.
	b) If the circular level is not centered, use an allen key to centre it with the adjustment screws.
☞	After the adjustments, all adjusting screws should have the same tightening tension and no adjusting screw shall be loose.



4.7 Inspecting the Laser Plummet of the Instrument

The laser plummet is located in the vertical axis of the instrument. Under normal conditions of use, the laser plummet does not need adjusting. If an adjustment is necessary due to external influences, the instrument has to be returned to any Leica Geosystems authorized service workshop.

Inspecting the laser plummet step-by-step

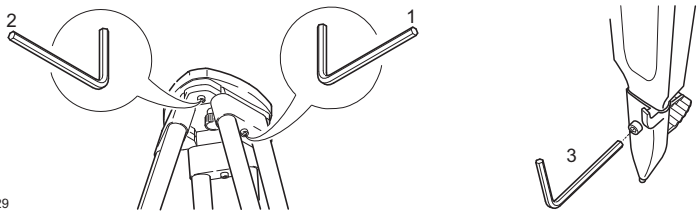


The following table explains the most common settings.

Step	Description
1.	Place and secure the instrument into the tribrach and onto a tripod.
2.	Using the tribrach footscrews, level the instrument with the electronic level. **SHIFT (F12)** to access **STATUS Level & Laser Plummet**.
3.	**PAGE (F6)** to access the **Laser Plummet** page. Switch on the laser plummet. Inspection of the laser plummet should be carried out on a bright, smooth and horizontal surface, like a sheet of paper.
4.	Mark the centre of the red dot on the ground.
5.	Turn the instrument through 360° slowly, carefully observing the movement of the red laser dot.
☞	The maximum diameter of the circular movement described by the centre of the laser point should not exceed 3 mm at a distance of 1.5 m.
6.	If the centre of the laser dot describes a perceptible circular movement or moves more than 3 mm away from the point which was first marked, an adjustment may be required. Inform your nearest Leica Geosystems authorized service workshop. Depending on brightness and surface, the diameter of the laser dot can vary. At 1.5 m it is about 2.5 mm.

4.8 Servicing the Tripod

Servicing the tripod step-by-step



TPS12_029

The following table explains the most common settings.

Step	Description
☞	The connections between metal and timber components must always be firm and tight.
1.	Tighten the leg cap screws moderately, with the supplied allen key.
2.	Tighten the articulated joints on the tripod head just enough to keep the tripod legs open when lifting the tripod off the ground.
3.	Tighten the allen screws of the tripod legs.

5 Care and Transport

5.1 Transport

Transport in the field

When transporting the equipment in the field, always make sure that you
- either carry the product in its original transport container,
- or carry the tripod with its legs splayed across your shoulder, keeping the attached product upright.

Transport in a road vehicle

Never carry the product loose in a road vehicle, as it can be affected by shock and vibration. Always carry the product in its transport container and secure it.

Shipping

When transporting the product by rail, air or sea, always use the complete original Leica Geosystems packaging, transport container and cardboard box, or its equivalent, to protect against shock and vibration.

Shipping, transport of batteries

When transporting or shipping batteries, the person in charge of the product must ensure that the applicable national and international rules and regulations are observed. Before transportation or shipping, contact your local passenger or freight transport company.

Field adjustment

After transport inspect the field adjustment parameters given in this user manual before using the product.

5.2 Storage

Product

Respect the temperature limits when storing the equipment, particularly in summer if the equipment is inside a vehicle. Refer to "7 Technical Data" for information about temperature limits.

Field adjustment

After long periods of storage inspect the field adjustment parameters given in this user manual before using the product.

Li-Ion batteries

- Refer to "7.8 General Technical Data of the Instrument" for information about storage temperature range.
- A storage temperature range of -20°C to +30°C/-4°F to +86°F in a dry environment is recommended to minimize self-discharging of the battery.
- At the recommended storage temperature range, batteries containing a 10% to 50% charge can be stored for up to one year. After this storage period the batteries must be recharged.
- Remove batteries from the product and the charger before storing.
- After storage recharge batteries before using.
- Protect batteries from damp and wetness. Wet or damp batteries must be dried before storing or use.

5.3 Cleaning and Drying

Product and accessories

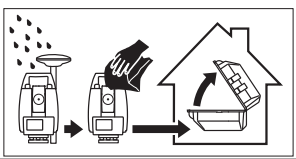
- Blow dust off lenses and prisms.
- Never touch the glass with your fingers.
- Use only a clean, soft, lint-free cloth for cleaning. If necessary, moisten the cloth with water or pure alcohol. Do not use other liquids; these may attack the polymer components.

Fogging of prisms

Reflector prisms that are cooler than the ambient temperature tend to fog. It is not enough simply to wipe them. Keep them for some time inside your jacket or in the vehicle to allow them to adjust to the ambient temperature.

Damp products

Dry the product, the transport container, the foam inserts and the accessories at a temperature not greater than 40°C / 104°F and clean them. Do not repack until everything is completely dry. Always close the transport container when using in the field.



Cables and plugs Keep plugs clean and dry. Blow away any dirt lodged in the plugs of the connecting cables.

5.4 Maintenance

An inspection of the product must be done in a Leica Geosystems authorized service workshop. Leica Geosystems recommends an inspection of the product every 24 months.

As TDRA6000 instruments are equipped with a self-surveillance system designed for maximum motor performance and long maintenance cycles Leica Geosystems recommends inspection of the product whenever indicated in the message line of the user interface.

6 Safety Directions

6.1 General Introduction

Description

The following directions should enable the person responsible for the product, and the person who actually uses the equipment, to anticipate and avoid operational hazards.

The person responsible for the product must ensure that all users understand these directions and adhere to them.

6.2 Intended Use

Permitted use

- Measuring horizontal and vertical angles.
- Measuring distances.
- Recording measurements.
- Automatic target search, recognition and -tracking.
- Visualizing the aiming direction and vertical axis.
- Remote control of product.
- Data communication with external appliances.
- Transmission of measurement data to an external application PC.
- Transmission of coordinates from an external application PC to the product for inspection and build measurements.
- Computing by means of software.

Adverse use

- Use of the product without instruction.
- Use outside of the intended limits.
- Disabling safety systems.
- Removal of hazard notices.
- Opening the product using tools, for example screwdriver, unless this is specifically permitted for certain functions.
- Modification or conversion of the product.
- Use after misappropriation.

- Use of products with obviously recognizable damages or defects.
- Use with accessories from other manufacturers without the prior explicit approval of Leica Geosystems.
- Aiming directly into the sun.
- Inadequate safeguards at the working site, for example when measuring on roads.
- Deliberate dazzling of third parties.
- Controlling of machines, moving objects or similar monitoring application without additional control- and safety installations.

⚠ Warning

Adverse use can lead to injury, malfunction and damage.
It is the task of the person responsible for the equipment to inform the user about hazards and how to counteract them. The product is not to be operated until the user has been instructed on how to work with it.

6.3 Limits of Use

Environment

Suitable for use in an atmosphere appropriate for permanent human habitation: not suitable for use in aggressive or explosive environments.

⚠ Danger

Local safety authorities and safety experts must be contacted before working in hazardous areas, or in close proximity to electrical installations or similar situations by the person in charge of the product.

6.4 Responsibilities

Manufacturer of the product

Leica Geosystems AG, CH-9435 Heerbrugg, hereinafter referred to as Leica Geosystems, is responsible for supplying the product, including the user manual and original accessories, in a completely safe condition.

Manufacturers of non Leica Geosystems accessories

The manufacturers of non Leica Geosystems accessories for the product are responsible for developing, implementing and communicating safety concepts for their products, and are also responsible for the effectiveness of those safety concepts in combination with the Leica Geosystems product.

Person in charge of the product

The person in charge of the product has the following duties:

- To understand the safety instructions on the product and the instructions in the user manual.
- To be familiar with local regulations relating to safety and accident prevention.
- To inform Leica Geosystems immediately if the product and the application becomes unsafe.
- To ensure that the national laws, regulations and conditions for the operation of radio transmitters are respected.

Warning

The person responsible for the product must ensure that it is used in accordance with the instructions. This person is also accountable for the training and the deployment of personnel who use the product and for the safety of the equipment in use.

6.5 Hazards of Use

Warning

The absence of instruction, or the inadequate imparting of instruction, can lead to incorrect or adverse use, and can give rise to accidents with far-reaching human, material, financial and environmental consequences.
Precautions:
All users must follow the safety directions given by the manufacturer and the directions of the person responsible for the product.

Caution

Watch out for erroneous measurement results if the product has been dropped or has been misused, modified, stored for long periods or transported.
Precautions:
Periodically carry out test measurements and perform the field adjustments indicated in the user manual, particularly after the product has been subjected to abnormal use and before and after important measurements.

Caution

Reflectors can cause personal injury and/or mechanical damage, when dropped.
Precautions:
Secure the reflector with a lanyard when moving the reflector.

⚠ Warning

Mounting the sensor on unstable or uneven ground may cause the sensor to tip over or cause unreliable measurement results.

Precautions:

Ensure the ground is stable and even. Do not place the sensor over cracks in the floor.

⚠ Danger

Because of the risk of electrocution, it is very dangerous to use poles and extensions in the vicinity of electrical installations such as power cables or electrical railways.

Precautions:

Keep at a safe distance from electrical installations. If it is essential to work in this environment, first contact the safety authorities responsible for the electrical installations and follow their instructions.

⚠ Caution

With the remote control of products, it is possible that extraneous targets will be picked out and measured.

Precautions:

When measuring in remote control mode, always check your results for plausibility.

⚠ Warning

If the product is used with accessories, for example masts, staffs, poles, you may increase the risk of being struck by lightning.
Precautions:
Do not use the product in a thunderstorm.

⚠ Caution

Be careful when pointing the product towards the sun, because the telescope functions as a magnifying glass and can injure your eyes and/or cause damage inside the product.
Precautions:
Do not point the product directly at the sun.

⚠ Warning

During dynamic applications, for example stakeout procedures there is a danger of accidents occurring if the user does not pay attention to the environmental conditions around, for example obstacles, excavations or traffic.
Precautions:
The person responsible for the product must make all users fully aware of the existing dangers.

⚠ Warning

Inadequate securing of the measurement site can lead to dangerous situations, especially at industrial installations.
Precautions:
Always ensure that the measurement site is adequately secured. Adhere to the regulations governing safety and accident prevention and road traffic.

Warning Only Leica Geosystems authorized service workshops are entitled to repair these products.

Warning If computers intended for use indoors are used in the field there is a danger of electric shock.
Precautions:
Adhere to the instructions given by the computer manufacturer with regard to field use in conjunction with Leica Geosystems products.

Caution If the accessories used with the product are not properly secured and the product is subjected to mechanical shock, for example blows or falling, the product may be damaged or people may sustain injury.
Precautions:
When setting-up the product, make sure that the accessories are correctly adapted, fitted, secured, and locked in position.
Avoid subjecting the product to mechanical stress.

Caution During the transport, shipping or disposal of batteries it is possible for inappropriate mechanical influences to constitute a fire hazard.
Precautions:
Before shipping the product or disposing of it, discharge the batteries by running the product until they are flat.
When transporting or shipping batteries, the person in charge of the product must ensure that the applicable national and international rules and regulations are

observed. Before transportation or shipping contact your local passenger or freight transport company.

Warning

Using a battery charger not recommended by Leica Geosystems can destroy the batteries. This can cause fire or explosions.
Precautions:
Only use chargers recommended by Leica Geosystems to charge the batteries.

Warning

High mechanical stress, high ambient temperatures or immersion into fluids can cause leakage, fire or explosions of the batteries.
Precautions:
Protect the batteries from mechanical influences and high ambient temperatures. Do not drop or immerse batteries into fluids.

Warning

Short circuited battery terminals can overheat and cause injury or fire, for example by storing or transporting in pockets if battery terminals come in contact with jewellery, keys, metallized paper or other metals.
Precautions:
Make sure that the battery terminals do not come into contact with metallic objects.

Warning

If the product is improperly disposed of, the following can happen:
- If polymer parts are burnt, poisonous gases are produced which may impair health.

- If batteries are damaged or are heated strongly, they can explode and cause poisoning, burning, corrosion or environmental contamination.
- By disposing of the product irresponsibly you may enable unauthorized persons to use it in contravention of the regulations, exposing themselves and third parties to the risk of severe injury and rendering the environment liable to contamination.
- Improper disposal of silicone oil may cause environmental contamination.

Precautions:

The product must not be disposed with household waste.
Dispose of the product appropriately in accordance with the national regulations in force in your country.
Always prevent access to the product by unauthorized personnel.

Product specific treatment and waste management information can be downloaded from the Leica Geosystems home page at http://www.leica-geosystems.com/treatment or received from your Leica Geosystems dealer.

6.6 Laser Classification

6.6.1 General

General

The following directions (in accordance with the state of the art - international standard IEC 60825-1 (2007-03) and IEC TR 60825-14 (2004-02)) provide instruction and training information to the person responsible for the product and the person who actually uses the equipment, to anticipate and avoid operational hazards.

The person responsible for the product must ensure that all users understand these directions and adhere to them.

Products classified as laser class 1, class 2 and class 3R do not require:

- laser safety officer involvement,
- protective clothes and eye wear,
- special warning signs in the laser working area

if used and operated as defined in this user manual due to the low eye hazard level.

Products classified as laser class 2 or class 3R may cause dazzle, flash-blindness and afterimages, particularly under low ambient light conditions.

6.6.2 Distancer, Measurements with Reflectors (IR mode)

General

The EDM module built into this product produces a visible laser beam which emerges from the telescope objective.

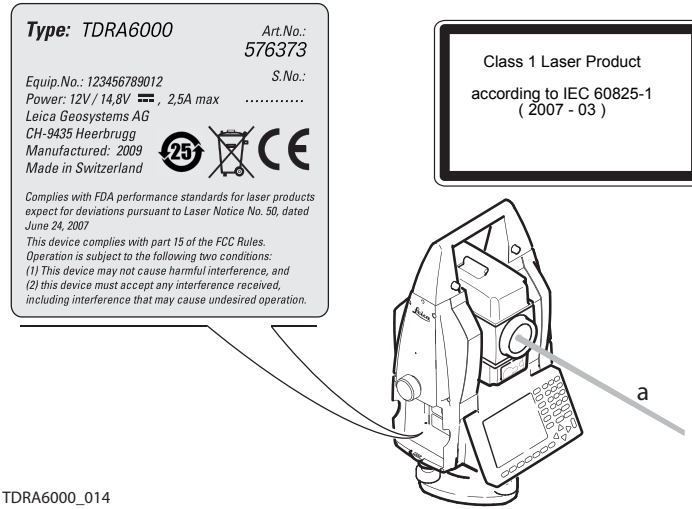
The laser product described in this section is classified as laser class 1 in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products"
- EN 60825-1 (2007-10): "Safety of laser products"

Class 1 laser products are safe under reasonably foreseeable conditions of operation and are not harmful to the eyes provided that the products are used and maintained in accordance with this user manual.

Description	Value
Maximum average radiant power	0.33 mW
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Wavelength	650 nm - 690 nm

Labelling



TDRA6000_014

a) Laser beam

6.6.3 Distancer, Measurements without Reflectors (RL mode)

General

The EDM module built into the product produces a visible laser beam which emerges from the telescope objective.

The laser product described in this section, is classified as laser class 3R in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products"
- EN 60825-1 (2007-10): "Safety of laser products"

Class 3R laser products:
Direct intrabeam viewing may be hazardous (low-level eye hazard), in particular for deliberate ocular exposure. The risk of injury for laser class 3R products is limited because of:

a) unintentional exposure would rarely reflect worst case conditions of (e.g.) beam alignment with the pupil, worst case accommodation,
b) inherent safety margin in the maximum permissible exposure to laser radiation (MPE),
c) natural aversion behaviour for exposure to bright light for the case of visible radiation.

Description	Value
Maximum average radiant power	5.00 mW

Description	Value
Pulse duration	800 ps
Pulse repetition frequency	100 MHz - 150 MHz
Wavelength	650 nm - 690 nm
Beam divergence	0.2 mrad x 0.3 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25s	80 m / 262 ft

Warning

From a safety perspective class 3R laser products should be treated as potentially hazardous.

Precautions:

Prevent direct eye exposure to the beam. Do not direct the beam at other people.

Warning

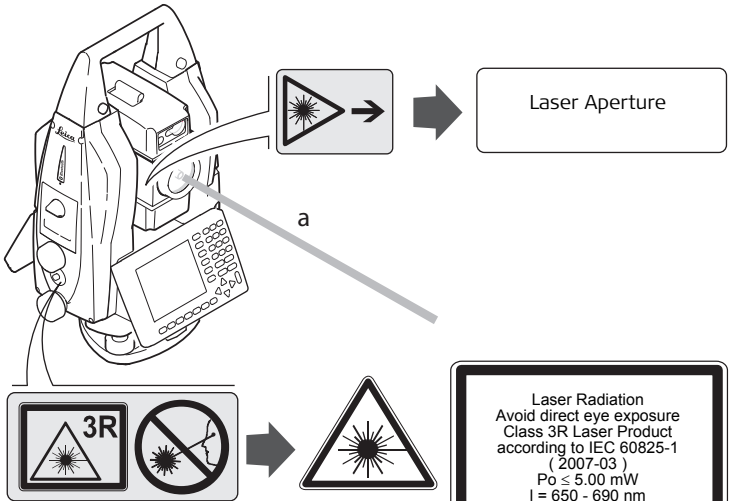
Potential hazards are not only related to direct beams but also to reflected beams aimed at reflecting surfaces such as reflectors, windows, mirrors, metallic surfaces etc.

Precautions:

Do not aim at areas that are essentially reflective, such as a mirror, or which could emit unwanted reflections.

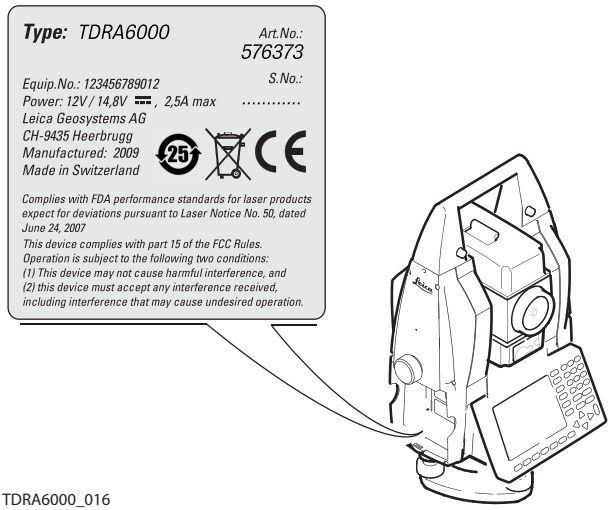
Do not look through or beside the optical sight at prisms or reflecting objects when the laser is switched on, in laser pointer or distance measurement mode. Aiming at prisms is only permitted when looking through the telescope.

Labelling



TDRA6000_015

a) Laser beam



TDRA6000_016

6.6.4 Automatic Target Recognition ATR

General

The Automatic Target Recognition built into this product produces an invisible laser beam which emerges from the telescope objective.

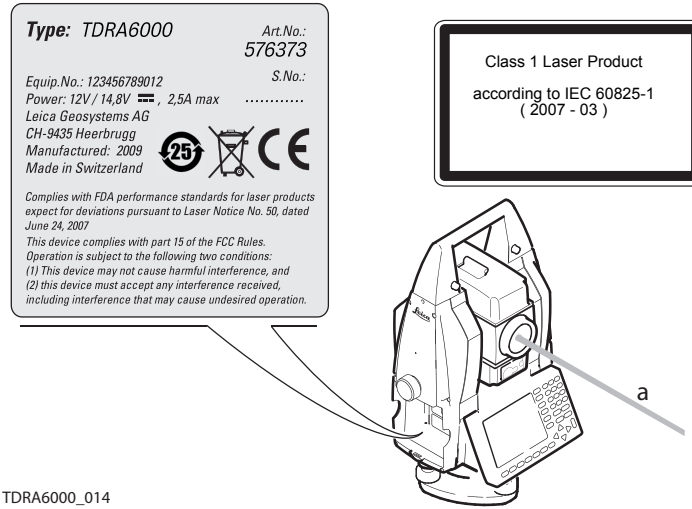
The laser product described in this section is classified as laser class 1 in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products"
- EN 60825-1 (2007-10): "Safety of laser products"

Class 1 laser products are safe under reasonably foreseeable conditions of operation and are not harmful to the eyes provided that the products are used and maintained in accordance with this user manual.

Description	Value
Maximum average radiant power	10 mW
Pulse duration	11 ms
Pulse repetition frequency	37 Hz
Wavelength	785 nm

Labelling



TDRA6000_014

a) Laser beam

6.6.5 PowerSearch PS

General

The PowerSearch built into this product produces an invisible laser beam which emerges from the telescope objective.

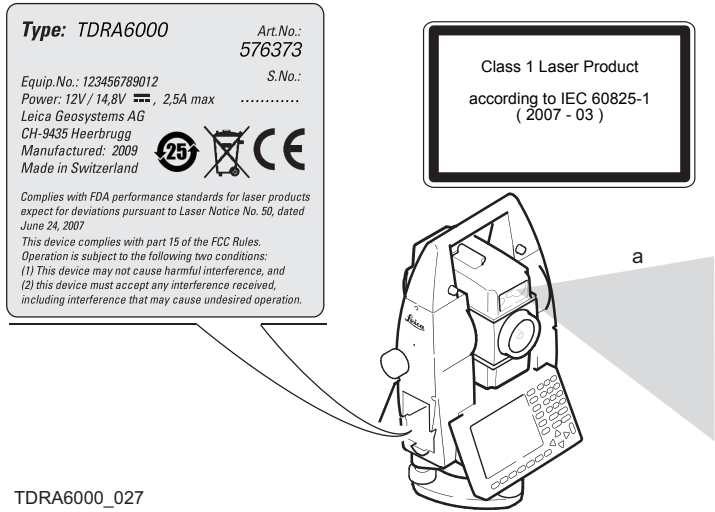
The laser product described in this section is classified as laser class 1 in accordance with:

- IEC 60825-1 (2007-03): "Safety of laser products"
- EN 60825-1 (2007-10): "Safety of laser products"

Class 1 laser products are safe under reasonably foreseeable conditions of operation and are not harmful to the eyes provided that the products are used and maintained in accordance with this user manual.

Description	Value
Maximum average radiant power	11 mW
Pulse duration	20 ns, 40 ns
Pulse repetition frequency	24.4 kHz
Wavelength	850 nm

Labelling



TDRA6000_027

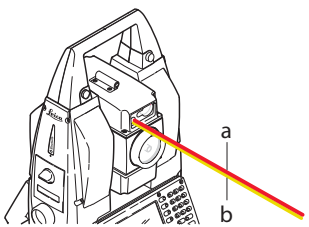
a) Laser beam

6.6.6 Electronic Guide Light EGL

General

The integrated Electronic Guide Light produces a visible LED beam from the front side of the telescope.

The product described in this section, is excluded from the scope of IEC 60825-1 (2007-03): "Safety of laser products".
The product described in this section, is classified as exempt group in accordance with IEC 62471 (2006-07) and does not pose any hazard provided that the product is used and maintained in accordance with this user manual.



TDRA6000_017

a) LED beam red
b) LED beam yellow

6.6.7 Laser Plummet

General

The laser plummet built into the product produces a visible red laser beam which emerges from the bottom of the product.

The laser product described in this section, is classified as laser class 2 in accordance with:

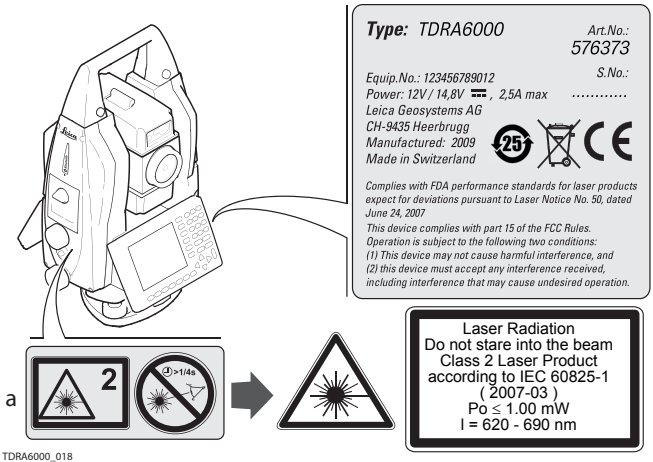
- IEC 60825-1 (2007-03): "Safety of laser products"
- EN 60825-1 (2007-10): "Safety of laser products"

Class 2 laser products:
These products are safe for momentary exposures but can be hazardous for deliberate staring into the beam.

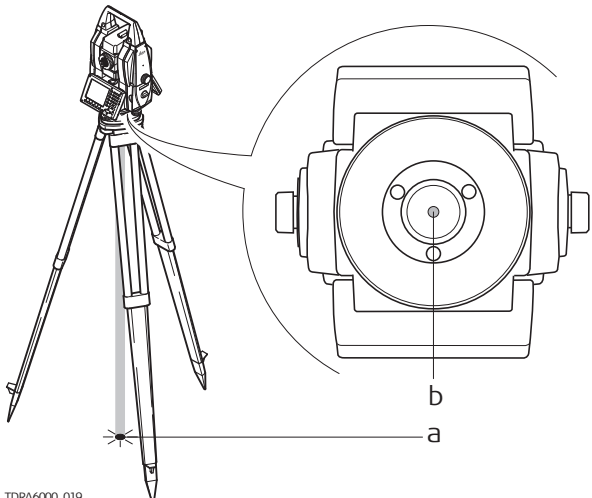
Description	Value
Maximum average radiant power	1.00 mW
Pulse duration	c.w.
Pulse repetition frequency	c.w.
Wavelength	620 nm - 690 nm

Warning From a safety perspective class 2 laser products are not inherently safe for the eyes.
Precautions:
Avoid staring into the beam or pointing the beam at other people.

Labelling



a) Will be replaced by a class 3R warning label if applicable



TDRA6000_019

a) Laser beam
b) Exit for laser beam

6.7 Electromagnetic Compatibility EMC

Description

The term Electromagnetic Compatibility is taken to mean the capability of the product to function smoothly in an environment where electromagnetic radiation and electrostatic discharges are present, and without causing electromagnetic disturbances to other equipment.

Warning

Electromagnetic radiation can cause disturbances in other equipment.

Although the product meets the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that other equipment may be disturbed.

Caution

There is a risk that disturbances may be caused in other equipment if the product is used in conjunction with accessories from other manufacturers, for example field computers, personal computers, two-way radios, non-standard cables or external batteries.

Precautions:

Use only the equipment and accessories recommended by Leica Geosystems. When combined with the product, they meet the strict requirements stipulated by the guidelines and standards. When using computers and two-way radios, pay attention to the information about electromagnetic compatibility provided by the manufacturer.

⚠ Caution

Disturbances caused by electromagnetic radiation can result in erroneous measurements.
Although the product meets the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that the product may be disturbed by very intense electromagnetic radiation, for example, near radio transmitters, two-way radios or diesel generators.
Precautions:
Check the plausibility of results obtained under these conditions.

⚠ Warning

If the product is operated with connecting cables attached at only one of their two ends, for example external supply cables, interface cables, the permitted level of electromagnetic radiation may be exceeded and the correct functioning of other products may be impaired.
Precautions:
While the product is in use, connecting cables, for example product to external battery, product to computer, must be connected at both ends.

Radios, digital cellular phones or SmartAntenna with Bluetooth

Use of product with radio, digital cellular phone devices or SmartAntenna with Bluetooth:

⚠ Warning

Electromagnetic radiation can cause disturbances in other equipment, in installations, in medical devices, for example pacemakers or hearing aids and in aircraft. It can also affect humans and animals.

Precautions:

Although the product meets in combination with radio or digital cellular phone devices recommended by Leica Geosystems the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that other equipment may be disturbed or that humans or animals may be affected.

- Do not operate the product with radio or digital cellular phone devices in the vicinity of filling stations or chemical installations, or in other areas where an explosion hazard exists.
- Do not operate the product with radio or digital cellular phone devices near to medical equipment.
- Do not operate the product with radio or digital cellular phone devices in aircraft.
- Do not operate the product with radio or digital cellular phone devices for long periods immediately next to your body.

6.8 FCC Statement, Applicable in U.S.

Applicability

The greyed paragraph below is only applicable for products of the TDRA6000 System without radio, digital cellular phone devices or Bluetooth.

Warning

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules.
These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

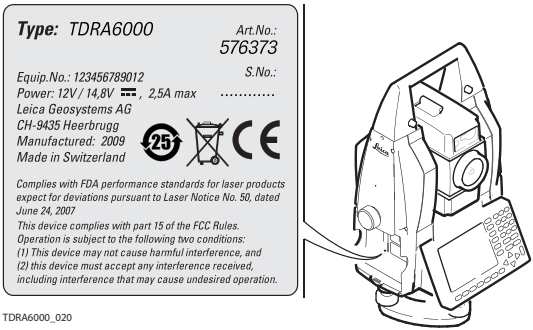
If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Warning

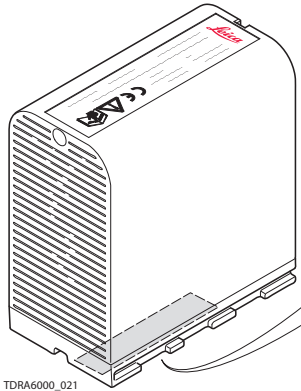
Changes or modifications not expressly approved by Leica Geosystems for compliance could void the user's authority to operate the equipment.

Labelling TDRA6000



TDRA6000_020

Labelling internal battery GEB242



7 Technical Data

7.1 Maximum Permissible Error

General

Accuracy specifications in the technical data of this manual are stated by means of the Maximum Permissible Error (MPE). The Automotive Society of Mechanical Engineers (ASME) defines Maximum Permissible Error (MPE) as the "extreme values of an error permitted by specification, regulations, etc ... for a given instrument".

The ASME B89.4.19-2006 standard further expands this definition by specifiying that if during testing a corresponding measurement fails to meet the MPE requirements, then the failed measurement is allowed to be re-measured 5 times, with the magnitude of the largest error replacing the failed position value. If the new value fails to satisfy the MPE requirement, then the test is allowed to be done a second time (but not more than twice) with a failed result leading to a failed inspection test.

Typical measurement results of the TDRA6000 are half of the relevant MPE values.

7.2 Angle Measurement

Accuracy

Type	Std. Dev. Hz, V, ISO 17123-3		Display least count	
	["]	[mgon]	["]	[mgon]
TDRA6000	0.5	0.15	0.01	0.01

Characteristics Absolute, continuous, quadruple

7.3 Distance Measurement with Reflectors (IR mode)

Range

Reflector	Range *	
	[m]	[ft]
Leica 1.5'' RRR & BRR	300	980
Leica 0.5'' TBR & RFI	300	980
Mini prism (GMP101)	300	980
Reflective tape 60 mm x 60 mm **	300	980

Shortest measuring distance: 1.5 m

Atmospheric conditions

*: Stable indoor conditions, Target squarely aligned

**: The 60 x 60 mm reflective tape is not suitable for distances < 20 m. For short range measurements use 20 x 20 mm reflective tape instead.

Measurements can be made to reflective tapes over the entire range without external ancillary optics.

Metrology Accuracy

Leica 1.5'' RRR *:

EDM measuring mode	Maximum Permissible Error (MPE)	Measurement time, typical [s]
Precise < 120 m	0.5 mm	3
SynchroTrack	9 mm + 1 ppm	< 0.15

*: Stable indoor environmental conditions, target aligned to instrument
Distance measurements are verified against a laser interferometer over a range of 120 m. The MPE values are calculated as average of three single measurements. Typical measurement results are half of the relevant MPE value.

Retro-reflective Tape *:

EDM measuring mode	Maximum Permissible Error (MPE)	Measurement time, typical [s]
Precise 5 m - 60 m	1 mm	3

*: Stable indoor environmental conditions, target aligned to instrument
Distance measurements are verified against a laser interferometer over a range of 60 m. The MPE values are calculated as average of three single measurements. Typical measurement results are half of the relevant MPE value.

General Accuracy

Non-Metrology conditions *:

EDM measuring mode	Std. Dev. ISO 17123-4, Standard Prism (GPH1P)	Std. Dev. ISO 17123-4, Tape **	Measurement time, typical [s]
Precise	0.6 mm + 1 ppm	1 mm + 1 ppm	7

*: Outdoor, overcast, no haze, visibility about 40 km, no heat shimmer
**: Distance › 10 m, target aligned to instrument

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy. The display resolution is 0.1 mm.

Characteristics

Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system:	System analyzer based on phase shift measurement 100 - 150 Mhz

7.4 Distance Measurement without Reflectors (RL mode)

Range

Type	Kodak Gray Card	Range *	
		[m]	[ft]
RL	White side, 90 % reflective	300	980
RL	Grey side, 18 % reflective	300	980

Range of Measurement: 1.5 m - 300 m

Atmospheric conditions

*: Stable indoor environmental conditions

Metrology Accuracy

EDM measuring mode	Maximum Permissible Error (MPE)	Measure time, typical [s]	Measure time, maximum [s]
Standard < 60 m	2 mm	2	6

*: Stable indoor environmental conditions, target aligned to instrument
Distance measurements are verified against a laser interferometer over a range of 60 m. The MPE values are calculated as average of three single measurements. Typical measurement results are half of the relevant MPE value.

General Accuracy

Non-Metrology conditions *:

EDM measuring mode	Std. Dev. ISO 17123-4	Measurement time, typical [s]	Measurement time, max. [s]
Standard ≤ 300 m	2 mm + 2 ppm	3 - 6	12

*: Outdoor, object in shade, sky overcast

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.
The display resolution is 0.1 mm.

Characteristics

Type:	Coaxial, visible red laser
Carrier wave:	658 nm
Measuring system PinPoint:	System analyzer based on phase shift measurement 100 MHz - 150 MHz

Laser dot size

Distance [m]	Laser dot size, approximately [mm]
at 30	7 x 10
at 50	8 x 20

7.5 Automatic Target Recognition ATR

Range ATR/LOCK

Reflector	Range ATR mode *		Range Lock mode *	
	[m]	[ft]	[m]	[ft]
Leica 1.5'' RRR & BRR	300	980	300	980
Leica 0.5'' TBR & RFI	200	650	not qualified	
Mini prism (GMP101)	300	980	300	980
Reflector tape 60 mm x 60 mm	40	130	not qualified	
Reflector tape 40 mm x 40 mm	40	130	not qualified	
Reflector tape 20 mm x 20 mm	25	80	not qualified	
☞	The maximum range can be restricted by poorer conditions.			

Shortest measuring distance: Leica 1.5'' RRR ATR: 2 m
Shortest measuring distance: Leica 1.5'' RRR LOCK: 2 m

*: Stable indoor environmental conditions, target aligned to instrument

ATR accuracy

ATR angle accuracy Hz, V (Maximum permissible error MPE)	3 " (0.014 mm/m)
ATR angle accuracy Hz, V (std. dev. ISO 17123-3):	1 " (0.005 mm/m)
ATR Positioning accuracy (Maximum permissible error MPE):	± 0.5 mm

To achieve the highest possible accuracy for ATR measurement the following conditions should be taken into account:

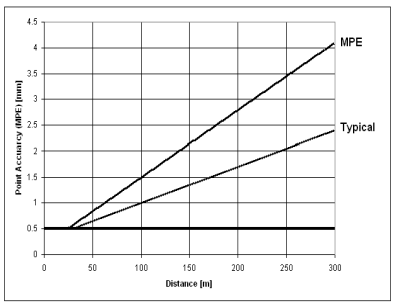
- Usage of Leica 1.5'' RRR reflector
- Reflector should be clean and not fogged
- Reflector should show no damage on reflecting surfaces
- Reflector should be exactly aligned to the instrument
- EDM Mode: Precise
- Indoor light conditions, dark background
- No atmospheric disturbances, including refraction
- Environmental conditions stable during measurement

Unfavourable conditions can result in deviations of the specified ATR accuracy, i.e.:

- Severe heat shimmer
- Air turbulence
- Bright reflections in the field of view
- Uneven light conditions on the measurement object

System accuracy with ATR

- The accuracy with which the position of a reflector can be determined with Automatic Target Recognition (ATR) depends on several factors such as internal ATR accuracy, instrument angle accuracy, reflector type, selected EDM measuring program and the external measuring conditions. The ATR has a basic MPE level of ± 0.5 mm under Metrology conditions. Above a certain distance, the instrument angle accuracy predominates and takes over the accuracy of the ATR.
- The following graph shows the ATR MPE and typical accuracy based on Leica 1.5'' RRR reflector, distances, maximum permissible error and typical accuracy.



Leica 1.5'' RRR reflector

mm	ATR accuracy [mm]
m	Distance measurement [m]
MPE	Maximum Permissible Error
Typical	Typical Accuracy

Maximum speed in lock mode	Maximum tangential speed: Maximum radial speed with **<EDM Mode: Tracking>**:	9 m/s at 20 m; 45 m/s at 100 m 5 m/s
Searching	Typical search time in field of view: Field of view: Definable search windows:	1.5 s 1°25'/1.55 gon Yes
Characteristics	Principle: Type:	Digital image processing Infrared laser

7.6 PowerSearch PS

Range

Reflector	Range PS	
	[m]	[ft]
Leica 1.5'' RRR & BRR	50	160
Mini prism (GMP101)	100	330

Measurements at the vertical limits of the fan or under unfavourable atmospheric conditions may reduce the maximum range. (*aligned to the instrument optimal)

Shortest measuring distance: 1.5 m

Searching

Typical search time:	5 - 10 s
Rotating Speed:	up to 100 gon/s
Default search area:	Hz: 400 gon, V: 40 gon
Definable search windows:	Yes

Characteristics

Principle:	Digital signal processing
Type:	Infrared laser

7.7 Conformity to National Regulations

7.7.1 Communication side cover with Bluetooth

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the Communication side cover with Bluetooth is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EU Member state.

- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.

Frequency band	2402 - 2480 MHz	
Output power	Bluetooth:	5 mW
Antenna	Type	Internal Microstrip antenna
	Gain	1.5 dBi

7.8 General Technical Data of the Instrument

Telescope

Magnification:	30 x
Clear objective diameter:	40 mm
Focusing:	1.7 m/5.6 ft to infinity
Field of view:	1°30′/1.66 gon 2.7 m at 100 m

Compensator

Type	Setting accuracy		Setting range	
	["]	[mgon]	[']	[gon]
TDRA6000	0.5	0.15	*4*	0.07

Level

Compensation:	Centralized quadruple axis compensation
Circular level sensitivity:	6′/2 mm
Electronic level resolution:	2"

Control unit

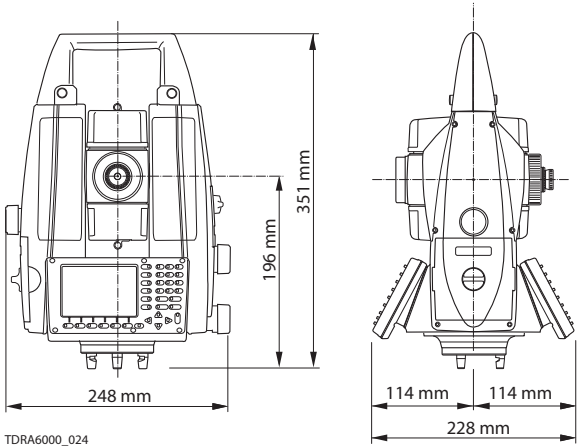
Display:	1/4 VGA (320 x 240 pixels), color, graphics capable LCD, illumination, touch screen
Keyboard:	34 keys including 12 function keys, 12 alphanumeric keys and a user defined SmartKey, illumination

Angle Display:	360°'", 360° decimal, 400 gon, 6400 mil, V %
Distance Display:	m, ft int, ft us, ft int inch, ft us inch
Position:	Both faces
Touch screen:	Toughened film on glass

Instrument Ports

Port	Name	Description
Port 1	Port 1	• 8 pin LEMO-1 for power, communication, data transfer. • This port is located at the base of the instrument.
Port 2	Handle	• Not applicable
Port 3	BT	• Bluetooth module for communication. • This port is housed within Communication side cover.

Instrument Dimensions



TDRA6000_024

Weight

Instrument:	7.25 kg
Tribrach:	0.8 kg
Internal battery GEB242:	0.43 kg

Recording

Data can be recorded onto a CompactFlash card or into internal memory.

Type	Capacity [MB]	Number of measurements per MB
CompactFlash card	• 256, 1024	1750
Internal memory	• 256	1750

Laser plummet

Type:	Visible red laser class 2
Location:	In standing axis of instrument
Accuracy:	Deviation from plumbline: 1 mm at 1.5 m instrument height
Diameter of laser point:	2 mm at 1.5 m instrument height

Operation

Three endless drives:	For one and two hand manual operation
User defined Smartkey:	Fast precision triggerkey for manual high precision measurements

Motorisation

Maximum acceleration:	400 gon/s^2
Maximum rotating speed:	200 gon/s
Time for change face:	Typically 2.9 s

Power

External supply voltage:	Nominal voltage 12.8 V DC, Range 11.5 V-13.5 V
Standby power consumption:	Typically 5.9 W

Internal battery

Type:	Li-Ion
Voltage:	14.8 V
Capacity:	GEB242: 6.0 Ah
Typical operating time:	9 h

External battery

Type:	NiMH
Voltage:	12 V
Capacity:	GEB171: 9.0 Ah
Typical operating time:	12 - 18 h

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
TDRA6000	-20 to +50	-40 to +70
Leica CompactFlash cards, all sizes	-40 to +80	-40 to +80
Battery internal	-20 to +50	-40 to +70
Bluetooth	-20 to +50	-40 to +70

Protection against water, dust and sand

Type	Protection
TDRA6000	IP54 (IEC 60529)

Humidity

Type	Protection
TDRA6000	Max 95 % non condensing The effects of condensation are to be effectively counteracted by periodically drying out the instrument.

Reflectors

Type	Default Additive Constant * [mm]	ATR	PS
Leica 1.5'' RRR & BRR	+34.6	yes	yes
Mini prism, GMP101	+17.5	yes	yes
Reflector tape S, M, L	+34.4	yes	no
Reflectorless	+34.4	no	no

There are no special reflectors required for ATR or for PS.
*: These types of reflectors will be available on the instrument by default. The individual Additional Constants will be applied to the instrument at delivery.

Electronic Guide Light EGL

Working range:	5 - 150 m
Positioning accuracy:	5 cm at 100 m

Automatic corrections

The following automatic corrections are made:

- Line of sight error
- Tilting axis error
- Earth curvature
- Circle eccentricity
- Compensator index error
- Vertical index error
- Standing axis tilt
- Refraction
- ATR zero point error

7.9 Scale Correction

Use

By entering a scale correction, reductions proportional to distance can be taken into account.

- Atmospheric correction
- Reduction to mean sea level
- Projection distortion

Atmospheric correction ΔD_1

The slope distance displayed is correct if the scale correction in ppm, mm/km, which has been entered corresponds to the atmospheric conditions prevailing at the time of the measurement.

The atmospheric correction includes:

- Adjustments for air pressure
- Air temperature
- Relative humidity

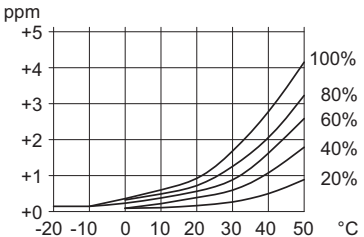
For highest precision distance measurements, the atmospheric correction should be determined with an accuracy of 1 ppm. The following parameters must be redetermined:

- Air temperature to 1°C
- Air pressure to 3 mbar
- Relative humidity to 20 %

Air humidity

The air humidity influences the distance measurement if the climate is extremely hot and damp.
For high precision measurements, the relative humidity must be measured and entered along with the air pressure and the temperature.

Air humidity correction



ppm	Air humidity correction [mm/km]
%	Relative humidity [%]
C°	Air temperature [°C]

Index n

Type	Index n	Carrier wave [nm]
Combined EDM	1.0002863	658

The index n is calculated from the formula of Barrel and Sears, and is valid for:

Air pressure p: 1013.25 mbar

Air temperature t: 12 °C
Relative air humidity h: 60 %

Formulas

Formula for visible red laser

$$\Delta D_1 = 286.34 - \left[\frac{0.29525 \cdot p}{(1 + \alpha \cdot t)} - \frac{4.126 \cdot 10^{-4} \cdot h}{(1 + \alpha \cdot t)} \cdot 10^{x} \right]$$

TPS12_229

ΔD_1 Atmospheric correction [ppm]
p Air pressure [mbar]
t Air temperature [°C]
h Relative humidity [%]

α $\frac{1}{273.15}$

x $(7.5 * t/(237.3 + t)) + 0.7857$

If the basic value of 60 % relative humidity as used by the EDM is retained, the maximum possible error in the calculated atmospheric correction is 2 ppm, 2 mm/km.

Reduction to mean sea level ΔD_2

The values for ΔD_2 are always negative and are derived from the following formula:

$$\Delta D_2 = -\frac{H}{R} \cdot 10^6$$

TPS12_053

ΔD_2 Reduction to mean sea level [ppm]
H Height of EDM above sea level [m]
R $6.378 * 10^6$ m

Projection distortion ΔD_3

The magnitude of the projection distortion is in accordance with the projection system used in a particular country, for which official tables are generally available. The following formula is valid for cylindrical projections such as that of Gauss-Krüger:

$$\Delta D_3 = \frac{X^2}{2R^2} \cdot 10^6$$

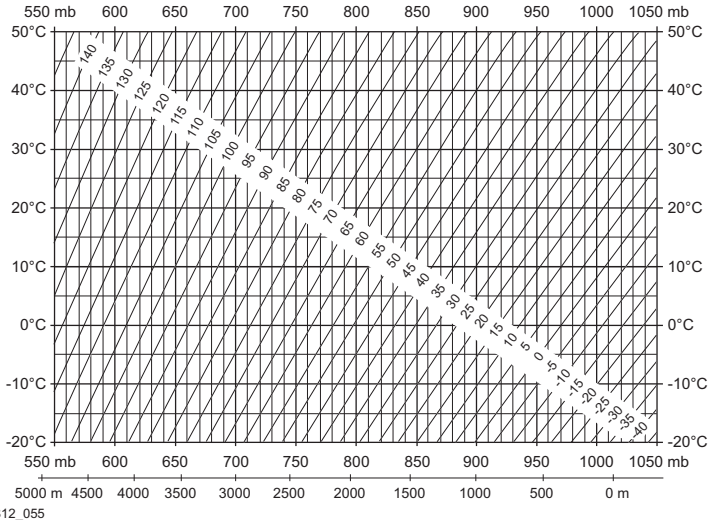
TPS12_054

ΔD_3 Projection distortion [ppm]
X Easting, distance from projection zero line with the scale factor 1 [km]
R $6.378 * 10^6$ m

In countries where the scale factor is not unity, this formula cannot be directly applied.

Atmospheric corrections °C

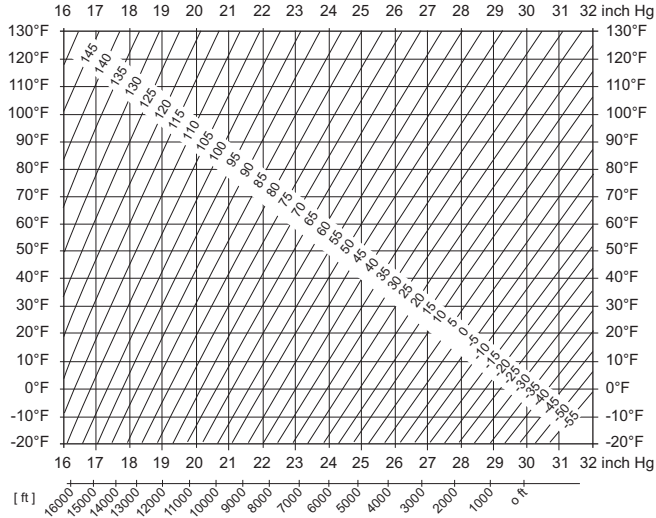
Atmospheric corrections in ppm with temperature [°C], air pressure [mb] and height [m] at 60 % relative humidity.



TPS12_055

Atmospheric correction F

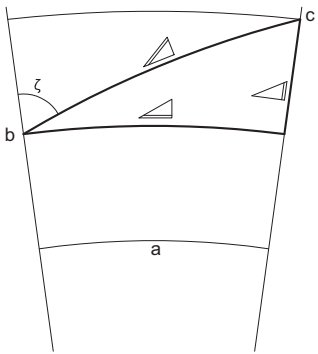
Atmospheric correction in ppm with temperature [F], air pressure [inch Hg] and height [ft] at 60 % relative humidity.



TPS12_056

7.10 Reduction Formulas

Measurements



TPS12_057

a) Mean Sea Level
b) Instrument
c) Reflector
Slope distance
Horizontal distance
Height difference

Reflector types

The reduction formulas are valid for measurements to all reflector types:

- measurements to glass reflectors, prisms, to reflector tape and reflectorless measurements.

Formulas

The instrument calculates the slope distance, horizontal distance, height difference in accordance with the following formulas:

$$\text{◿} = D_0 \cdot (1 + ppm \cdot 10^{-6}) + mm$$

TPS12_058

◿	Displayed slope distance [m]
D_0	Uncorrected distance [m]
ppm	Atmospheric scale correction [mm/km]
mm	Additive constant of the reflector [mm]

$$\text{◺} = Y - A \cdot X \cdot Y$$

TPS12_059

$$\text{◺} = X + B \cdot Y^2$$

TPS12_060

◺	Horizontal distance [m]
◺	Height difference [m]
Y	◿ * |sinζ|
X	◿ * cosζ
ζ	Vertical circle reading
A	$(1 - k/2)/R = 1.47 * 10^{-7}$ [m^{-1}]
B	$(1 - k)/2R = 6.83 * 10^{-8}$ [m^{-1}]
k	0.13 (mean refraction coefficient)
R	6.378 * 106 m (radius of the earth)

Earth curvature (1/R) and mean refraction coefficient (k) (if enabled on the Refraction page in Main Menu: Config...\Instrument Settings...\TPS Corrections) are automatically taken into account when calculating the horizontal distance and height difference. The calculated horizontal distance relates to the station height and not to the reflector height.

Distance measuring program Averaging

In the distance measuring program Averaging, the following values are displayed:

D Slope distance as arithmetic mean of all measurements
s Standard deviation of a single measurement
n Number of measurements

These values are calculated as follows:

$$\bar{D} = \frac{1}{n} \cdot \sum_{i=1}^{n} D_i$$

TPS12_061

$\bar{D}$ Slope distance as arithmetic mean of all measurements
Σ Sum
D_i Single slope distance measurement
n Number of measurements

$$s = \sqrt{\frac{\sum_{i=1}^{n} (D_i - \bar{D})^2}{n-1}} = \sqrt{\frac{\sum_{i=1}^{n} D_i^2 - \frac{1}{n} \left(\sum_{i=1}^{n} D_i \right)^2}{n-1}}$$

TPS12_062

s Standard deviation of a single slope distance measurement
Σ Sum
$\bar{D}$ Slope distance as arithmetic mean of all measurements
D_i Single slope distance measurement
n Number of distance measurements

The standard deviation $S_{\bar{D}}$ of the arithmetic mean of the distance can be calculated as follows:

$$S_{\bar{D}} = \frac{s}{\sqrt{n}}$$

TPS12_063

$S_{\bar{D}}$ Standard deviation of the arithmetic mean of the distance
s Standard deviation of a single measurement
n Number of measurements

8 International Limited Warranty, Software License Agreement

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