Leica TS01

User Manual
Version 1.1.9
English

- when it has to be **right**

Leica Geosystems

PART OF HEXAGON

Introduction

Purchase

Congratulations on the purchase of the Leica TS01.

This manual contains important safety directions as well as instructions for setting up the product and operating it. Refer to 1 Safety Directions for further information.

Read carefully through the User Manual before you switch on the product.

The content of this document is subject to change without prior notice. Ensure that the product is used in accordance with the latest version of this document.

☞

The content of this document is subject to change without prior notice. Ensure that the product is used in accordance with the latest version of this document.

Updated versions are available for download at the following Internet address:

myWorld@Leica Geosystems > myProducts.

Product identification

The model and serial number of your product are indicated on the type plate.

Always refer to this information when you need to contact your agency or Leica Geosystems authorised service centre.

Validity of this manual

This manual applies to the TS01 manual total station.

Leica Geosystems address book

On the last page of this manual, you can find the address of Leica Geosystems headquarters. For a list of regional contacts, please visit http://leica-geosystems.com/contact-us/sales_support.

myWorld@Leica Geosystems offers a wide range of services, information and training material.

With direct access to myWorld, you are able to access all relevant services whenever it is convenient for you.

The availability of services depends on the instrument model.

Service	Description
myProducts	Add all products that you and your company own and explore your world of Leica Geosystems: View detailed information on your products and update your products with the latest software and keep up-to-date with the latest documentation.
myService	View the current service status and full service history of your products in Leica Geosystems service centres. Access detailed information on the services performed and download your latest calibration certificates and service reports.

Service	Description
mySupport	Create new support requests for your products that will be answered by your local Leica Geosystems Support Team. View the complete history of your support requests and view detailed information on each request in case you want to refer to previous support requests.
myLearning	Welcome to the home of Leica Geosystems online learning! There are numerous online courses – available to all customers with products that have valid CCPs (Customer Care Packages).
myTrustedServices	Add your subscriptions and manage users for Leica Geosystems Trusted Services, the secure software services, that assist you to optimise your workflow and increase your efficiency.
mySmartNet	HxGN SmartNet is the GNSS correction service built on the world's largest reference station network, enabling GNSS-capable devices to quickly determine precise positions in the range of one to two centimetre accuracy. The service is provided 24/7 by a highly-available infrastructure and professional support team with more than 10 years of experience reliably delivering the service.
myDownloads	Downloads of software, manuals, tools, training material and news for Leica Geosystems products.

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1 Safety Directions

1.1 General

Description

The following directions 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.

About warning messages

Warning messages are an essential part of the safety concept of the instrument. They appear wherever hazards or hazardous situations can occur.

Warning messages...

- make the user alert about direct and indirect hazards concerning the use of the product.
- contain general rules of behaviour.

For the users' safety, all safety instructions and safety messages shall be strictly observed and followed! Therefore, the manual must always be available to all persons performing any tasks described here.

DANGER, **WARNING**, **CAUTION** and **NOTICE** are standardised signal words for identifying levels of hazards and risks related to personal injury and property damage. For your safety, it is important to read and fully understand the following table with the different signal words and their definitions! Supplementary safety information symbols may be placed within a warning message as well as supplementary text.

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.
NOTICE	Indicates a potentially hazardous situation or an unintended use which, if not avoided, may result in 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.

1.2 Definition of Use

Intended use

- Measuring horizontal and vertical angles
- Measuring distances
- Recording measurements
- Visualising the aiming direction and vertical axis
- Data communication with external appliances
- Computing with software

Reasonably forseeable misuse

- Use of the product without instruction
- Use outside of the intended use and limits
- Disabling of safety systems
- Removal of hazard notices
- Opening the product using tools, for example a screwdriver, unless this is permitted for certain functions
- Modification or conversion of the product
- Use after misappropriation
- Use of products with recognisable damage or defects
- Use with accessories from other manufacturers without the prior explicit approval of Leica Geosystems
- Deliberate dazzling of third parties
- Controlling of machines, moving objects or similar monitoring applications without additional control and safety installations
- Aiming directly into the sun
- Inadequate safeguards at the working site

1.3 Limits of Use

Environment

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

⚠WARNING

Working in hazardous areas, or close to electrical installations or similar situations

Life Risk.

Precautions:

- ▶ Local safety authorities and safety experts must be contacted by the person responsible for the product before working in such conditions.

1.4 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 safe condition.

Person responsible for the product

The person responsible for the product has the following duties:

- To understand the safety instructions on the product and the instructions in the User Manual
- To ensure that it is used in accordance with the instructions
- To be familiar with local regulations relating to safety and accident prevention
- To stop operating the system and inform Leica Geosystems immediately if the product and the application become unsafe
- To ensure that the national laws, regulations and conditions for the operation of the product are respected

1.5 Hazards of Use

NOTICE

Dropping, misusing, modifying, storing the product for long periods or transporting the product

Watch out for erroneous measurement results.

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 as well as before and after important measurements.

⚠DANGER

Risk of electrocution

Because of the risk of electrocution, it is dangerous to use poles, levelling staffs 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.

⚠WARNING

Lightning strike

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.

⚠WARNING

Distraction/loss of attention

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 working site

This can lead to dangerous situations, for example in traffic, on building sites and at industrial installations.

Precautions:

- Always ensure that the working site is adequately secured.
- Adhere to the regulations governing safety, accident prevention and road traffic.

⚠CAUTION

Pointing product toward the sun

Be careful when pointing the product toward 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.

⚠CAUTION

Not properly secured accessories

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 can 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.

⚠WARNING

Inappropriate mechanical influences to batteries

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 it, discharge the batteries by 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

Exposure of batteries to high mechanical stress, high ambient temperatures or immersion into fluids

This can cause leakage, fire or explosion of the batteries.

Precautions:

- Protect the batteries from mechanical influences and high ambient temperatures. Do not drop or immerse batteries into fluids.

⚠WARNING

Short circuit of battery terminals

If battery terminals are short circuited e.g. by coming in contact with jewellery, keys, metallised paper or other metals, the battery can overheat and cause injury or fire, for example by storing or transporting in pockets.

Precautions:

- Make sure that the battery terminals do not come into contact with metallic objects.

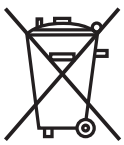
⚠WARNING

Improper disposal

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 unauthorised 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.
- The product does include parts of Beryllium inside. Any modification of some internal parts can release Beryllium dust or fragments, creating a health hazard.

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 unauthorised personnel.

Product-specific treatment and waste management information can be received from your Leica Geosystems distributor.

⚠WARNING

Improperly repaired equipment

Risk of injuries to users and equipment destruction due to lack of repair knowledge.

Precautions:

▸ Only authorised Leica Geosystems Service Centres are entitled to repair these products.

1.6 Laser Classification

1.6.1 General

General

The following chapters provide instructions and training information about laser safety according to international standard IEC 60825-1 (2014-05) and technical report IEC TR 60825-14 (2004-02). The information enables the person responsible for the product and the person who actually uses the equipment, to anticipate and avoid operational hazards.

☞ According to IEC TR 60825-14 (2004-02), products classified as laser class 1, class 2 and class 3R do not require:

- laser safety officer involvement,
- protective clothes and eyewear,
- 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.

☞ National laws and local regulations could impose more stringent instructions for the safe use of lasers than IEC 60825-1 (2014-05) and IEC TR 60825-14 (2004-02).

1.6.2 Distancer, Measurements with Reflectors

General

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

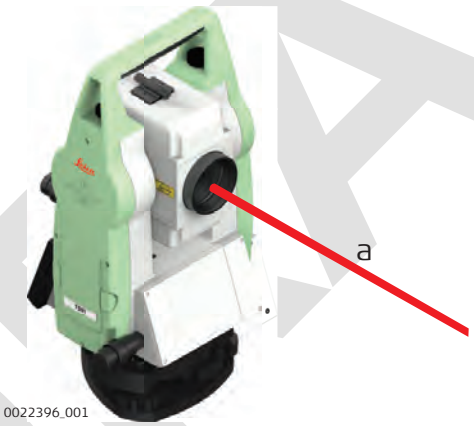
The laser product described in this section is classified as laser class 1 in accordance with:

- IEC 60825-1 (2014-05): "Safety of laser products"

These 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
Wavelength	685 nm
Pulse duration	6673 ps
Pulse repetition frequency	75 MHz
Maximum average radiant power	0.34 mW
Beam divergance	1.5 mrad x 3 mrad

Labelling



a Laser beam

1.6.3 Distancer, Measurements without Reflectors

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 (2014-05): "Safety of laser products"

Direct intrabeam viewing may be hazardous (low eye hazard level), in particular for deliberate ocular exposure. The beam may cause dazzle, flash-blindness and after-images, particularly under low ambient light conditions. 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
Wavelength	685 nm
Maximum average radiant power	4.8 mW
Pulse duration	6673 ps
Pulse repetition frequency	75 MHz
Beam divergence	0.2 mrad x 0.3 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25s	44 m

⚠CAUTION

Class 3R laser products

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.

⚠CAUTION

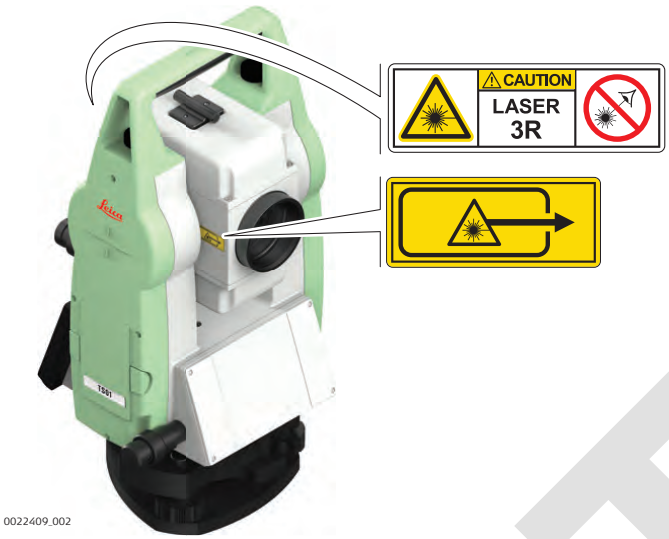
Reflected beams aimed at reflecting surfaces

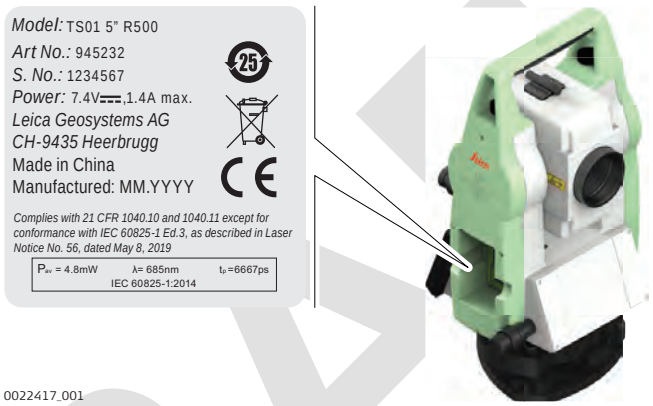
Potential hazards are not only related to direct beams but also to reflected beams aimed at reflecting surfaces such as prisms, windows, mirrors, metallic surfaces, etc.

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





1.6.4 Red Laser Pointer

General

The laser pointer built into the product produces a visible red 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 (2014-05): "Safety of laser products"

Direct intrabeam viewing may be hazardous (low eye hazard level), in particular for deliberate ocular exposure. The beam may cause dazzle, flash-blindness and after-images, particularly under low ambient light conditions. 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
Wavelength Measurements to prisms and reflectorless	685 nm
Maximum average radiant power	4.8 mW

Description	Value
Pulse duration	6673 ps
Pulse repetition frequency (PRF)	75 MHz
Beam divergence	0.2 mrad x 0.3 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25 s	44 m / 144 ft

⚠CAUTION

Class 3R laser products

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.

⚠CAUTION

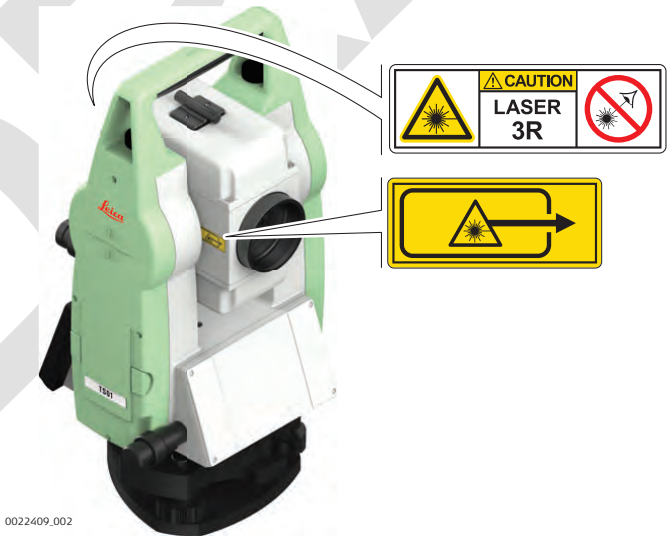
Reflected beams aimed at reflecting surfaces

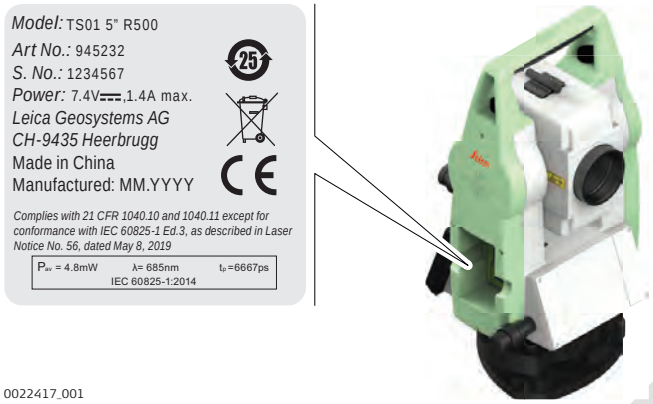
Potential hazards are not only related to direct beams but also to reflected beams aimed at reflecting surfaces such as prisms, windows, mirrors, metallic surfaces, etc.

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





1.6.5 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 (2014-05): "Safety of laser products"

These products are safe for momentary exposures but can be hazardous for deliberate staring into the beam. The beam may cause dazzle, flash-blindness and after-images, particularly under low ambient light conditions.

Description	Value
Wavelength	640 nm
Maximum average radiant power	0.95 mW
Pulse duration	0.1 ms - cw
Pulse repetition frequency (PRF)	1 kHz
Beam divergance	<1.5 mrad

⚠CAUTION

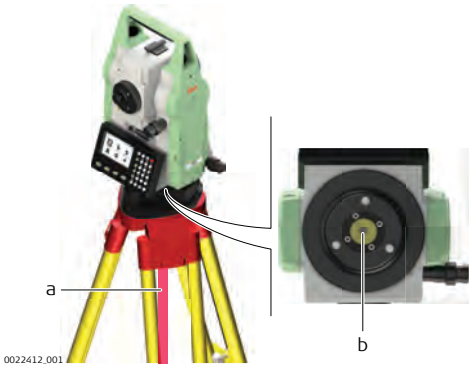
Class 2 laser product

From a safety perspective, class 2 laser products are not inherently safe for the eyes.

Precautions:

- ▸ Avoid staring into the beam or viewing it through optical instruments.
- ▸ Avoid pointing the beam at other people or at animals.

Labelling



a Laser beam
b Exit for laser beam

1.7 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

Electromagnetic radiation can cause disturbances in other equipment.

Precautions:

- 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

Use of the product with accessories from other manufacturers. For example, field computers, personal computers or other electronic equipment, non-standard cables or external batteries

This may cause disturbances in other equipment.

Precautions:

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

⚠CAUTION

Intense electromagnetic radiation. For example, near radio transmitters, transponders, two-way radios or diesel generators

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 function of the product may be disturbed in such an electromagnetic environment.

Precautions:

- Check the plausibility of results obtained under these conditions.

⚠CAUTION

Electromagnetic radiation due to improper connection of cables

If the product is operated with connecting cables, attached at only one of their two ends, the permitted level of electromagnetic radiation may be exceeded and the correct functioning of other products may be impaired. For example, external supply cables or interface cables.

Precautions:

- While the product is in use, connecting cables, for example product to external battery or product to computer, must be connected at both ends.

Radios or digital cellular phones

⚠WARNING

Use of product with radio or digital cellular phone devices

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

Precautions:

- 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 can be disturbed or that humans or animals can 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 medical equipment.
- Do not operate the product with radio or digital cellular phone devices in aircrafts.
- Do not operate the product with radio or digital cellular phone devices for long periods with the product immediately next to your body.

⚠CAUTION

Exceeding the RF radiation exposure limits for general population

Health risk

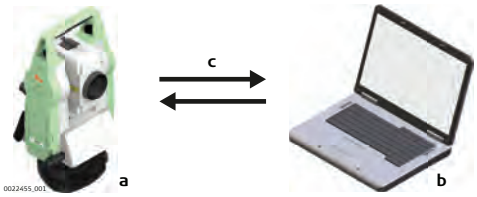
Precautions:

- The antennas used for this transmitter must be installed such that a minimum separation distance of at least 23 cm is always maintained between the radiator (antenna) and all persons.
- The antennas used for this transmitter must not be co-located or operated with any other antenna or transmitter.

2 Description of the System

2.1 System Components

Main components



a TS01 instrument with basic field software
b Computer with office software
c Data transfer

Component	Description
TS01	An instrument for measuring, calculating and capturing data. Ideally suited for tasks from simple surveys to complex applications. Equipped with a Basic field software to complete these tasks.
Basic field software	The firmware package installed on the instrument. Consists of a standard base operating system with additional applications.
Office software	An office software consisting of a suite of standard and extended programs for the viewing, exchanging, managing and post processing of data.
Data transfer	Data can be transferred between a TS01 and a computer via USB-stick.

2.2 Container Contents

Container contents

a Instrument
b GEB264 battery
c Tool pouch
d GKL264 charger
e GEV289 adapter for charger
f Manuals
g Protective cover

2.3 Instrument Components

Instrument components part 1 of 2

a Battery cover
b Optical sight
c Detachable carrying handle with mounting screw
d Objective with integrated Electronic Distance Measurement (EDM). Exit for EDM laser beam
e Horizontal drive

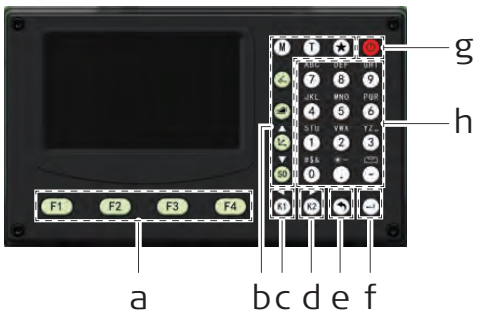
Instrument components part 2 of 2

f Focusing telescope image
g Eyepiece; focusing graticule
h Vertical drive
i Foot screw
j Compartment for USB memory stick
k Keyboard with display

3 User Interface

3.1 Keyboard

Keyboard



a Function keys F1 - F4
b Fixed keys
c Short cut key K1, navigation
d Short cut key K2, navigation
e ESC key
f ENTER key
g ON/OFF key
h Number/letter keys

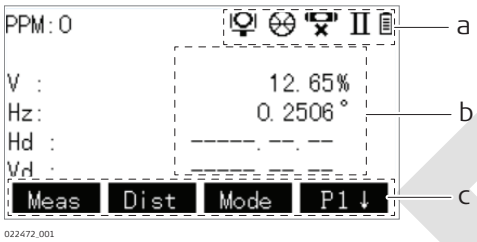
Keys

Key	Description
	If the instrument is already off: Turns on the instrument when held for 2 s. If the instrument is already on: Turns to Power Options menu when held for 2 s.
	Enter the **Main Menu**
	Switch between prism and non-prism mode
	Favourites key Quick-access to measurement supporting functions.
	Enter the angle survey interface during standard survey
	Enter the distance measurement panel during standard survey Double click to switch between slope distance and height difference.
	Enter the coordinate measurement panel during standard survey Navigation key, up
	Enter the set out panel during standard survey Navigation key, down
	User key 1 Programmable with a function from the **K1 Setting** menu. Navigation key, left
	User key 2 Programmable with a function from the **K2 Setting** menu. Navigation key, right
	Pressing **ESC** short: Returns to next higher level. Quits a screen or edit mode without saving changes. Pressing **ESC** long: Returns to the standard survey screen.

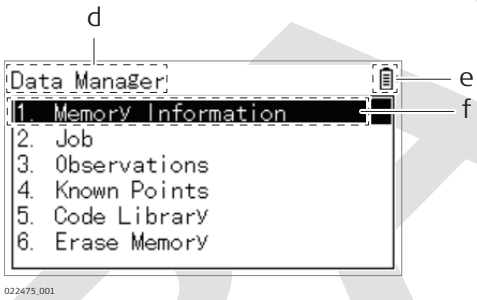
Key	Description
	**ENTER** key Confirms an entry and continues to the next field.
	Turn the red laser on/off.
	Access the centering/leveling interface.
	Function keys that are assigned the variable functions displayed at the bottom of the screen.

3.2 Screen

Screen



a Status icons
b Fields
c Softkeys



d Title of screen
e Status icons
f Focus in screen. Active field

☞ Press the ↵ key or the number key to run a function.

3.3 Status Icons

Description

The icons provide status information related to basic instrument functions. Depending on the configuration, different icons are displayed.

Icons

Icon	Description
	Prism mode
	EDM type for measuring to Round prism.
	EDM type for measuring to Mini prism.
	EDM type for measuring to 360° prism.

Icon	Description
	EDM type for measuring to 360° Mini prism.
	EDM type for measuring to Custom prism.
	Non prism EDM mode for measuring to all targets.
	EDM mode for measuring to reflective foils.
	EDM mode for measuring to reflective foils. Custom defined.
	Compensator is on.
	Compensator is off.
	Indicates that telescope position is face I.
	Indicates telescope position in face II.
	The battery symbol indicates the level of the remaining battery capacity in 25% steps.

3.4 Softkeys

Description

Softkeys are selected using the relevant **F1** to **F4** function key. This chapter describes the functionality of the common softkeys used by the system. The more specialised softkeys are described with the apps where they appear.

Common softkey functions

Key	Description
OK	If entry screen: Confirms measured or entered values and continues the process. If message screen: Confirms message and continues with selected action or returns to the previous screen to reselect an option.
Back	To return to the last active screen.
EDM	To view and change EDM settings. Refer to 5.6 EDM Settings.
Coord	To open the manual coordinate entry screen.
Search	To search for an entered point.
Value	To display the list of available points.
Meas	To start distance and angle measurements and save the measured values.
Store	To save the displayed values without executing a distance measurement.

Key	Description
Dist	To execute a distance measurement.
View	To view details about the selected item.
Letter	To change the keypad operation to alphanumerical.
Number	To change the keypad operation to numerical.
P↓	To display the next softkey level.

3.5 Operating Principles

Turn instrument on/off

Button	Description
	To turn the instrument on or off, use the On/Off key on the keyboard of the instrument.

Alphanumeric keypad

The alphanumerical keypad is used to enter characters directly into editable fields.

- **Numeric fields**: Can only contain numerical values. By pressing a key of the keypad the number will be displayed.
- **Alphanumeric fields**: Can contain numbers and letters. By pressing a key of the keypad the first character written above that key will be displayed. By pressing several times you can toggle through the characters. For example: 1->S->T->U->1->S....
  When the alphanumeric mode is active, numbers are not selectable. For example: T=>U=> V=>T....

Edit fields

Button	Description
☞	**ESC** deletes any change and returns to previous panel.
	Moves the cursor to the left
	Moves the cursor to the right.

3.6 Point Search

Description

Pointsearch is a function to find measured points or fixpoints in the memory storage.

It is possible to limit the point search to a particular job. The search procedure always finds fixpoints before measured points that fulfil the same search criteria.

Direct search

By entering an actual point number, for example 402, and pressing **Search**, all points within the selected job and with the corresponding point number are found.

Key	Description
Search	To search for matching points within the selected job.

4 Operation

4.1 Instrument Setup

Description

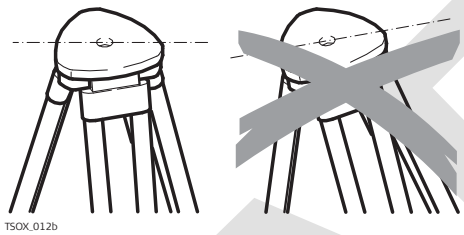
This topic describes an instrument setup over a marked ground point using the laser plummet. It is always possible to set up the instrument without the need for a marked ground point.

☞

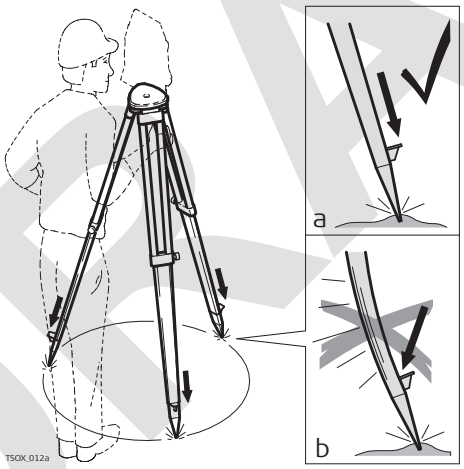
Important features

- 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 with a tribrach equipped with an optical plummet.

Tripod



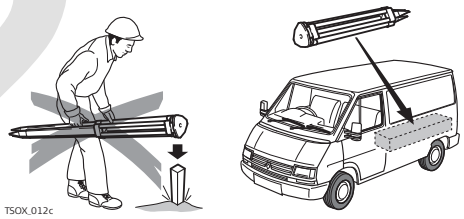
When setting up the tripod pay attention to ensuring a horizontal position of the tripod plate. Slight corrections of inclination can be made with the foot screws of the tribrach. Larger corrections must be done with the tripod legs.



Loosen the clamping screws on the tripod legs, pull out to the required length and tighten the clamps.

a In order to guarantee a firm foothold sufficiently press the tripod legs into the ground.

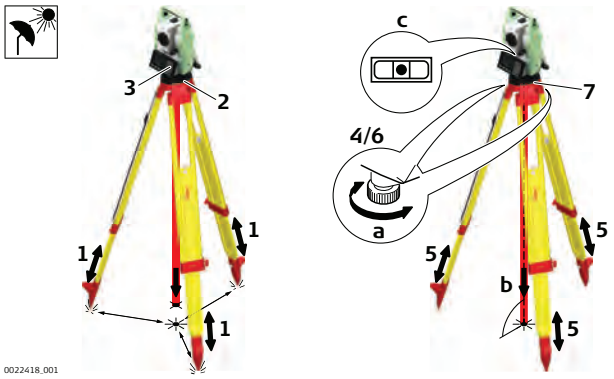
b When pressing the legs into the ground note that the force must be applied along the legs.



Careful handling of tripod.

- Check all screws and bolts for correct fit.
- During transport, always use the cover supplied.
- Use the tripod only for surveying tasks.

Setup step-by-step



1.	Extend the tripod legs to allow for a comfortable working posture. Position the tripod over the marked ground point, centring it as best as possible.
2.	Fasten the tribrach and instrument onto the tripod.
3.	Turn on the instrument, and, if tilt correction is set to **ON**, the laser plummet will be activated automatically, and the **Auto-Compensator** screen appears. Otherwise, press the ★ key from within any app and select **Level**.
4.	Move the tripod legs and use the tribrach footscrews (a) to centre the plummet over the ground point (c).
5.	Adjust the tripod legs to level the axis level (c).
6.	By using the electronic level, turn the tribrach footscrews to precisely level the instrument. Refer to Level up with the electronic level step-by-step.
7.	Centre the instrument precisely over the ground point by shifting the tribrach on the tripod plate.
8.	Repeat steps 6. and **7.** until the required accuracy is achieved.

Level up with the electronic level step-by-step

The electronic level can be used to precisely level up the instrument using the footscrews of the tribrach.

1.	Turn the instrument until it is parallel to two footscrews.
2.	Centre the circular level approximately by turning the footscrews of the tribrach.
3.	Turn on the instrument, and, if tilt correction is set to on, the laser plummet will be activated automatically, and the **Auto-Compensator** screen appears. Otherwise, press the ★ key from within any app and select **Level**. ☞ The bubble of the electronic level and the arrows for the rotating direction of the footscrews only appear if the instrument tilt is inside a certain levelling range.
4.	Centre the electronic level of the first axis by turning the two footscrews. The first axis is levelled, when the bubble is exactly in the centre of the first axis.
5.	Turn the instrument by 90° so that it is perpendicular to the previous position.

6. Centre the electronic level for the second axis by turning the last footscrew.
The second axis is levelled when the bubble is also in the centre of the second axis. This bubble should now be exactly in the centre of the electronic level.

7. Repeat step **5.** and step **6.**.

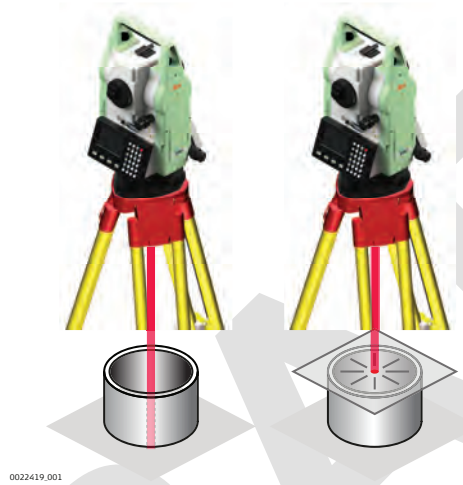
Change the intensity of the laser plummet

External influences and the surface conditions may require the adjustment of the intensity of the laser plummet.

In the **Auto-Compensator** screen, adjust the intensity of the laser plummet using the and key.

The laser can be adjusted in 20% steps as required.

Position over pipes or holes



Under some circumstances the laser dot is not visible, for example over pipes. In this case, using a transparent plate enables the laser dot to be seen and then easily aligned to the centre of the pipe.

4.2 Batteries

4.2.1 Operating Principles

First-time use/ charging batteries

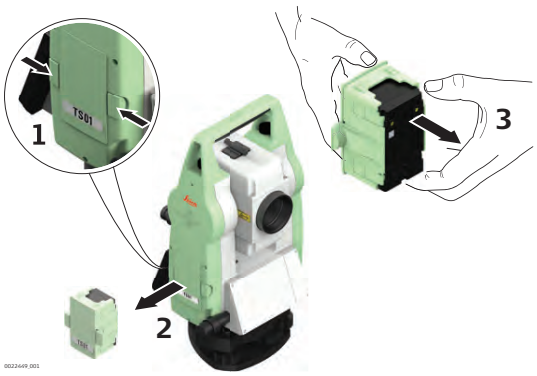
- The battery must be charged before using it for the first time because it is delivered with an energy content as low as possible
- The permissible temperature range for charging is from 0 °C to +40 °C/ +32 °F to +104 °F. For optimal charging, we recommend charging the batteries at a low ambient temperature 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 once the temperature is too high
- 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 from the actual battery capacity available.

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; high operating temperatures reduce the service life of the battery.

4.2.2 Battery for the TS Instrument

Change the battery step-by-step



1.	Face the instrument so that the horizontal drive is at the right side, where also the battery compartment is located. Press both knobs on the side of the battery compartment to open it.
2.	Pull out the battery housing.
3.	Pull the battery out of the battery housing.
4.	At the top of the battery is a notch which corresponds to the inner surface of the battery housing. This notch helps you to place the battery correctly. Place the battery into the battery housing, ensuring that the contacts are facing outward. Click the battery into position.
5.	Place the battery housing into the battery compartment. Push the battery housing in until it fits completely into the battery compartment.
6.	Push the battery compartment back into the instrument. ☞ A sound appears when the compartment snaps in its final position.

4.3 Data Storage

Description

An internal memory is included in the instrument. The basic field software stores all data in projects and jobs in a database in the internal memory.

Data can be transferred from the internal memory to a computer or other device via an USB stick inserted into the USB host port.

☞ Removing the USB stick during operation can cause loss of data. Only remove the USB stick when the TS instrument is switched off.

4.4 Main Menu

Main Menu

Press Ⓜ on the keyboard to enter the **Main Menu**.

Description of the Main Menu functions

Function	Description
Apps	To select and start apps. Refer to 7 Apps.

Function	Description
Survey	App to begin measuring. Refer to 4.5 Standard Measurements.
Manage	Contains all functions for entering, editing, checking and deleting data in the field. Refer to 9 Data Management.
Transfer	To export and import data. Refer to 10 Data Transfer.
Settings	To change EDM configurations and general instrument settings. Refer to 5 Settings.
Tools	• Contains tools to be used for the electronic adjustment of the instrument. Using these tools helps to maintain the measuring accuracy of the instrument. • Displays instrument, system and firmware information, as well as settings for the date and time. • To load all instrument related firmware as well as licences. Refer to 11 Tools.

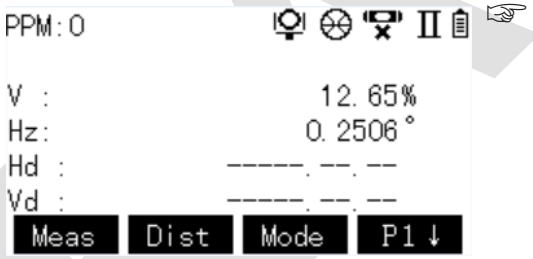
4.5 Standard Measurements

4.5.1 Overview

Access

Select **Survey** in the **Main Menu**.

Standard measurement screen



Depending on the measuring mode, a different screen is displayed.

Standard measurement softkeys

Depending on the selected measuring mode and the **Survey** app used, different softkeys are displayed on the standard measurement screen.

The softkeys available in the app **Survey** vary slightly.

Measuring Mode	Softkey	Description
Angle Measurement	**Hz=0**	Set horizontal angle to 0.
	Lock	Lock the horizontal angle.
	HZ=?	Enter and set a horizontal angle.
	Comp	Enter compensator settings.
	Rmea	Enter angle repeat measurement.
	V%	Toggle between vertical angle unit % and gon/grad/mil depending on the unit settings.
	R/L	Toggle between horizontal angle left and horizontal angle right.

Measuring Mode	Softkey	Description
	VA/ZA	Set vertical angle to Horizon = 0°. Set vertical angle to Zenith = 0°.
Distance Measurement	**Meas**	To execute a distance measurement and store the displayed values.
	Dist	To execute a distance measurement.
	Store	To save the displayed values without executing a distance measurment.
	EDM	Enter EDM settings.
	OffSet	Enter offset function.
	SetOut	Enter Set Out app.
Coordinate Measurement	**Meas**	To execute a distance measurement and store the displayed values.
	Dist	To execute a distance measurement.
	Store	To save the displayed values without executing a distance measurment.
	EDM	Enter EDM settings.
	hr	Enter target height.
	hi	Enter station height.
	STN	Enter station coordinates.
	Backsight	Enter the back-sight orientation program
	OffSet	Enter offset function.

4.5.2 Angle Measurement

Access

1. Power on to enter the standard survey interface.
2. Press button on the keyboard.

Measure horizontal and vertical angles between two points

1. Align to the first target A.
2. Press **Hz=0** to set the horizontal angle to **0°0'0''**.
3. Press **YES**.
4. Align to the second target B to read the horizontal and vertical angles between B and A.

Set an angle

By locking the angle

1. Rotate the angle by the horizontal drive.
2. Press **Lock** to fix the horinzontal angle.
3. Align to the target.

4. Press **YES** to set the horizontal angle.

☞ Screen will return to normal measurement mode.

By keyboard input

1. Align to the target.
2. Press **HZ=?**.
3. Type in the value for the angle, for example 90.
4. Press **OK**.

Repeat an angle measurement

1. Press **Rmea**.
2. Press **YES**.
3. Align to the target A.
4. Press **Hz=0** and **YES**.
5. Align to the target B.
6. Press **Lock** to complete the first observation.
7. Align to the target A.
8. Press **Releas**.
9. Align to the target B.
10. Press **Lock** to complete the second observation.
11. Repeat steps **7.** + **8.** and **9.** + **10.** as needed.

☞ **Ht:**: The cumultative angle

☞ The horizontal angle can increase up to 3600°00'00' (3599°59'55'' ±5'').

Hm:: The average angle

☞ If the difference between the angle and **Hm:** is bigger than 10'', an error message is displayed.

12. Press ⟲ to quit the remeasuring and to return to the standard measuring mode.

4.5.3 Distance Measurement

Access

1. Power on to enter the standard survey interface.
2. Press ◢ button on the keyboard.
3. Press ◢ button on the keyboard again to switch between display views.

V :: The vertical angle
Hz:: The horizontal angle
Hd :: The horizontal distance
Vd :: The height difference
Sd :: The slope distance

Measure distance

1. Align to the target.
2. Press **Meas**.

3.	To check the slope distance, press button on the keyboard to switch between display views.
☞	Press **Mode** to switch between measuring modes: **Standard**, **Quick**, **Track**, **Repeat**, **Average**. The **EDM Mode:EDM Mode:** remains unchanged. Press to return to the standard surveing screen.
☞	Press **EDM** to change between prism and non-prism mode.
☞	Press **m/ft** to change between the units meter and feet.
☞	Press **OffSet** to enter the offset function.
☞	Press **SetOut** to enter the **Set Out** app.
☞	Refer to 5 Settings for more information on settings.

4.5.4 Coordinate Measurement

Access

1.	Power on to enter the standard survey interface.
2.	Press button on the keyboard.

Measure coordinates

1.	Align to the target.
2.	Press **Meas**. The coordinates are displayed.
☞	Press **Mode** to switch between measuring modes: **Standard**, **Quick**, **Track**, **Repeat**, **Average**. The **EDM Mode:EDM Mode:** remains unchanged. Press to return to the standard surveing screen.
☞	Press **EDM** to change between prism and non-prism mode.
3.	Press P↓: **hr**: The height of the prism **hi**: The height of the instrument **STN**: The coordinates of the station
4.	Press P↓: **OffSet** to enter offset function. **BS** to enter the back-sight orientation program. **m/ft** to toggle between distance unit meter and feet.

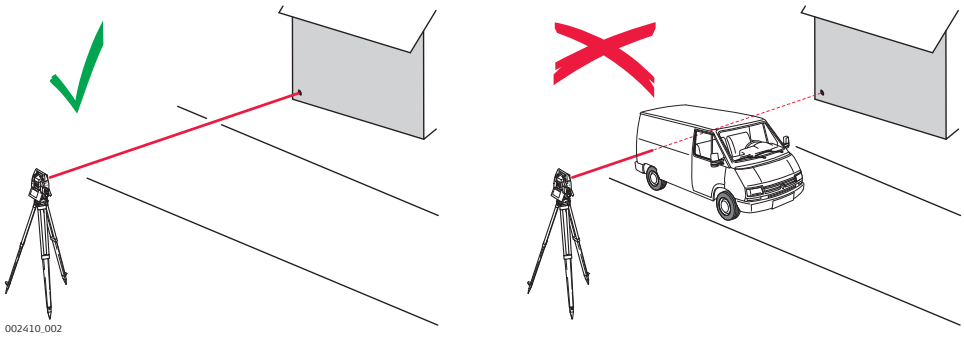
4.6 Distance Measurements - Guidelines for Correct Results

Description

An EDM is incorporated into the instrument. The distance can be determined by using a visible red laser beam which emerges coaxially from the telescope objective. There are two EDM modes:

- Prism measurements
- Reflectorless measurements

Non-prism measurements



- 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.
- Be sure that the laser beam is not reflected by anything close to the line of sight, for example highly reflective objects.
- Avoid interrupting the measuring beam while taking Non-Prism measurements or measurements using reflective foils.
- Do not measure with two instruments to the same target simultaneously.

Prism measurements

- Accurate measurements to prisms should be made in **Standard** mode.
- Measurements to strongly reflecting targets such as traffic lights in Prism mode without a prism should be avoided. The measured distances may be wrong or inaccurate.
- When a distance measurement is triggered, the EDM measures to the object which is in the beam path at that moment. If for example people, cars, animals, or swaying branches cross the laser beam while a measurement is being taken, a fraction of the laser beam is reflected from these objects and may lead to incorrect distance values.
- In practice, because the measuring time is very short, the user can always find a way of avoiding unwanted objects from interfering in the beam path.

5 Settings

5.1 Unit Settings

Access

1.	Select **Setting** from the **Main Menu**.
2.	From the **Setting** menu, select **Unit Setting**.
3.	Press P↓ to scroll through the screens of available settings.

Unit Setting

Key	Description
OK	To confirm the entered values and to continue the process.
P↓	To scroll through the screen of available settings.

Description of fields

Field	Option	Description
AngleUnit:		Sets the units shown for all angular fields. The setting of the angle units can be changed at any time. The current displayed values are converted according to the selected unit.
	°	Degree decimal. Possible angle values: 0° to 359.999°
	° ' "	Degree sexagesimal. Possible angle values: 0° to 359°59'59"
	gon	Gon. Possible angle values: 0 gon to 399.999 gon
	mil	Mil. Possible angle values: 0 to 6399.99mil.
MinRead		Sets the number of decimal places shown for all angular fields. This is for data display and does not apply to data export or storage.
	0.0001 **0.0005** **0.001**	Available for **AngleUnit:: °**.
	1" **5"** **10"**	Available for **AngleUnit:: ° ' "**.
	0.1mgon **0.5mgon** **1 mgon**	Available for **AngleUnit:: gon**.
	0.01 **0.05** **0.1**	Available for **AngleUnit:: mil**.
Temperature:		Sets the units shown for all temperature fields.
	°C	Degree Celsius.
	°F	Degree Fahrenheit.

Field	Option	Description
Pressure:		Sets the units shown for all pressure fields.
	hPa	Hecto Pascal.
	mbar	Millibar.
	mmHg	Millimeter mercury.
	inHg	Inch mercury.
DistanceUnit:		Sets the units shown for all distance and coordinate related fields.
	m	Metres [m].
	US-ft	US feet [ft].
	INT-ft	International feet [fi].
	ft-in1/16	US feet-inch-1/16 inch [ft].
DistanceDec:		Sets the number of decimal places shown for all distance fields. This is for data display and does not apply to data export or storage.
	3	Displays distance with three decimals.
	4	Displays distance with four decimals.

5.2 Parameters Settings

Access

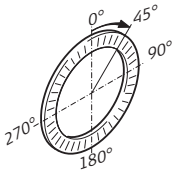
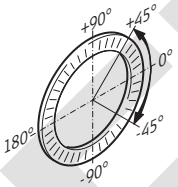
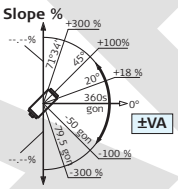
1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **Parameters Setting**.

Meas. Parameters

Key	Description
OK	To confirm the entered values and to continue the process.

Description of fields

Field	Option	Description
Compensator:	**ON**	To turn the compensator on.
	OFF	To turn the compensator off.
Hz-Correction:	**ON**	Horizontal corrections are activated. For normal operation the horizontal correction should remain active. Each measured horizontal angle will be corrected, depending on the vertical angle.
	OFF	Horizontal corrections are deactivated. ☞ Turn the compensator off, if the instrument is mounted on unstable ground, such as on a shaking platform or a ship. Otherwise, the compensation exceeds the limit caused by shaking, which will interrupt the surveying due to warning messages.

Field	Option	Description
Hz <=> :	**Right**	Set horizontal angle to clockwise direction measurement.
	Left	Set horizontal angle to counter-clockwise direction measurement. Counter-clockwise directions are displayed but are saved as clockwise directions.
V Setting:		Sets the vertical angle.
	Zenith	 Zenith=0°; Horizon=90°.
	HZ0	 Zenith=90°; Horizon=0°. Vertical angles are positive above the horizon and negative below it.
	Slope %	 45°=100%; Horizon=0°. Vertical angles are expressed in % with positive above the horizon and negative below it. The % value increases rapidly. --.--% appears on the display above 300%.

5.3 Display Settings

Access

1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **Display Setting**.

Display Setting

Key	Description
OK	To confirm the entered values and to continue the process.

Description of fields

Field	Option	Description
Meas. Mode:		Sets which screen is accessed after the instrument is turned on.
	AGMeas	Startup with angle measuring screen.
	DTMeas	Startup with distance measuring screen.
HD&VD/SD:	**HD&VD**	Horizontal distance to the point. Vertical angle to the point.
	SD	Slope distance to the point.

Field	Option	Description
COForm:		The order in which grid coordinates are shown in screens.
	NEZ	North is shown first, East second.
	ENZ	East is shown first, North second.

5.4 Other Settings

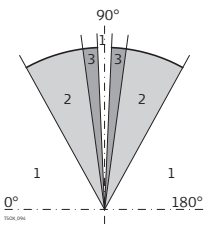
Access

1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **Other Setting**.

Other Setting

Key	Description
OK	To confirm the entered values and to continue the process.
P↓	To scroll through the screen of available settings.

Description of fields

Field	Option	Description
Contrast:	**0%** to **100%**	Sets the display contrast in 10% steps.
Illumination:	**ON** or **OFF**	Sets the screen illumination on or off.
Reticule:	**0%** to **100%**	Sets the reticle illumination in 10% steps.
Beep:	**ON** or **OFF**	The beep is an acoustic signal after each key stroke.
Sector Beep:	**ON**	Sector beep sounds at right angles (0°, 90°, 180°, 270° or 0, 100, 200, 300 gon).  1 No beep 2 Fast beep; from 95.0 to 99.5 gon and 105.0 to 100.5 gon. 3 Permanent beep; from 99.5 to 99.995 gon and from 100.5 to 100.005 gon.
	OFF	Sector Beep is deactivated.

5.5 Shortcut Keys Settings

Access

Configures the K1 and K2 keys with a function.

When a function is assigned to one of the keys, the function can be started by just one button press.

1. Select **Setting** from the **Main Menu**.

2. From the **Setting** menu, select **Shortcut Keys Setting**.
3. Select **K1 Setting** or **K2 Setting**.
4. Select a function from the list.

5.6 EDM Settings

Access

The settings on this screen define the active EDM, Electronic Distance Measurement. Different settings for measurements are available with reflectorless and prism EDM modes.

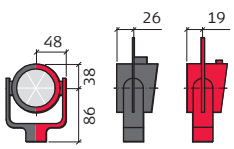
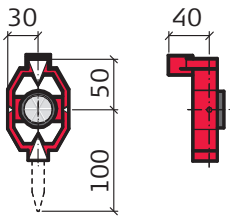
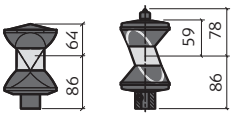
1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **EDM Setting**.

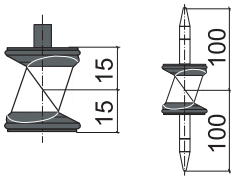
EDM Settings

Select the options to be changed by the up and down navigation keys, then change by the left and right keys. Enter the corresponding settings through the softkeys. Page down through P⇩.

Key	Description
Atmos	To enter atmospheric data ppm.
PPM	To enter an individual ppm value.
OK	To confirm the entered values and to continue the process.
Scale	To enter projection scale details. Coordinate will be corrected by PPM parameters.
Signal	To view EDM Signal reflection value.
Reset	To reset all editable fields to their default values.

Description of fields

Field	Description	Description
EDM Mode:	**Prism**	For distance measurements using prisms.
	Foil	For distance measurements using Retro reflective targets.
	NonPrism	For distance measurements without prisms.
Prism Type:	☞	The Leica prism constant is shown.
	Round	 Leica prism constant: 0 mm
	MINI	 Leica prism constant: 17.5 mm
	360°	 Leica prism constant: 23.1 mm

Field	Description	Description
	360°MINI	 Leica prism constant: 30.0 mm
	Foil	 Leica prism constant: 34.4 mm
	Custom	The user can define their own prism. Constants can be entered in mm in **Leica Const:**. Leica constant = Absolute constant + 34.4 mm
Meas. Mode:	**Standard**	For distance measurements with prisms.
	Quick	Quick measuring mode with prisms, with higher measuring speed but lower accuracy.
	Track	For continuous distance measurements with prisms.
	Average	Repeats three measurements in standard measuring mode. The average distance and the standard deviation for the averaged distance are calculated.
	Repeat	Repetitive measurements with standard accuracy.
Leica Const:	Editable field	This field displays the Leica constant for the selected **Prism Type:**. Where **Prism Type:** is **Custom** this field becomes editable to set a user defined constant. Input can only be made in mm. Limit value: -999.9 mm to +999.9 mm.
Laser:	**OFF**	Visible laser beam is deactivated.
	ON	Visible laser beam for visualising the target point is activated.

EDM Setting - Atmos

This screen enables the entry of atmospheric parameters. Distance measurement is influenced directly by the atmospheric conditions of the air in which the measurements are taken. In order to take these influences into consideration distance measurements are corrected using atmospheric correction parameters.

The refraction correction is taken into account in the calculation of the height differences and the horizontal distance. Refer to 13.6 Scale Correction for the application of the values entered in this screen.

☞ When **PPM0** is selected, the Leica standard atmosphere of 1013mbar and 12°C is applied.

Description of fields

Field	Option	Description
Temp:	Editable field	The temperature value can be entered manually.
Pressure:	Editable field	The atmospheric value can be entered manually. The value for **Elev:** changes accordingly.
Elev:	Editable field	The elevation value can be entered manually. The value for **Pressure:** changes accordingly.
Ref:	Editable field	The refraction value can be entered manually.

EDM Setting - Input PPM

This screen enables the entry of individual scaling factors. Coordinates and distance measurements are corrected with the PPM parameter. Refer to 13.6 Scale Correction for the application of the values entered in this screen.

EDM Setting - Projection Scale

This screen enables entry of the scale of projection. Coordinates are corrected with the PPM parameter. Refer to 13.6 Scale Correction for the application of the values entered in this screen.

EDM Setting - Signal

This screen tests the EDM signal strength (reflection strength) in steps of 1%. Enables optimal aiming at distant, barely visible, targets. A percentage bar and a beeping sound, indicate the reflection strength. The faster the beep the stronger the reflection.

5.7 Date/Time Settings

Access

1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **Time and Date Setting**.

Time and Date Settings

Set the current time and date of the instrument. Use the ↵ key to switch to the next digit.

5.8 Key Function Settings

Access

With the key function settings the assignment of the function to the single soft keys can be changed.

The customised key assignments can be saved in the memory of the instrument and restored.

Configure:

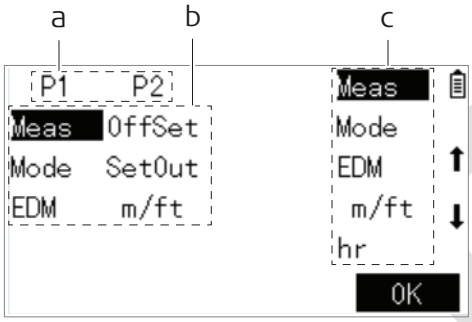
- The assignment of functionality to the softkeys in the standard survey screen
- The assignment of key configuration to a user
- The recovery of a saved user assignment or of factory default assignments

1. Select **Setting** from the **Main Menu**.
2. From the **Setting** menu, select **Key Function**.
3. Select:

Key distribution	To assign the functionality to the softkeys
Key function consignment	To save the customsed key assignments in the memory of the instrument. If the general key assignment is changed, the saved key assignment can be restored.
Key function recovery	To recover a saved user assignment or the factory default assignments

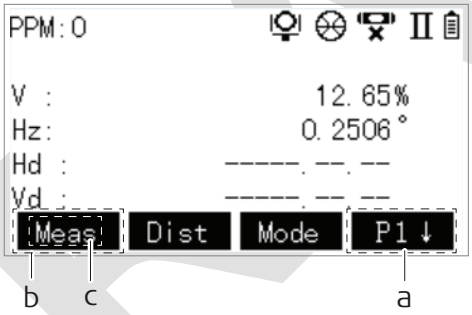
Key Function - Key distribution

In the setting panel:



a **P1 P2** or **P1 P2 P3** on the left represent the two or three pages in a screen.
b The softkeys on a page, in the order, with the currently assigned functionality
c The functions listed on the right can be selected and assigned to the softkeys.

In the standard surveying panel:



a The two or three pages in a screen.
b The softkey on a page
c The assigned functionality

Assign key functions step-by-step

1. In the columns on the left, select the softkey to which you want to assign a functionality.
   Use the K2 to move downwards in the list and also to the column of another page.
   Use the K1 to move upwards in the list.
   ☞ In the example above, the left cursor is located in the column of P1 on the position of F1 [Meas]. indicating that F1 softkey function on page 1 can be set.
2. In the column on the right, select the functionality which you want to assign to a softkey.
   Use the ↵ and the S0 key to move upwards in the list.
3. Press the ↵ key to assign the functionality.

	4.	Press **OK** to complete the settings.

Key Function - Key function consignment

1.	Select **Key function consignment** from the **Key function** menu.
2.	Select **Custom 1** or **Custom 2**. The current assignment of functionality to the softkeys is saved to the selection.
3.	Press **YES** or ↵ to complete.

Key Function - Key function recovery

1.	Select **Key function recovery** from the **Key function** menu.
2.	Select the saved assigments to recover: **Custom 1**, **Custom 2** or **Factory Default**.
3.	Press **YES** or ↵ to complete.

5.9 WiFi Settings

Access

1.	Select **Setting** from the **Main Menu**.
2.	From the **Setting** menu, select **Wifi Setting**.

WiFi Settings

Key	Description
OK	To confirm the entered values and to continue the process.
Select	Available for **WIFI: Enable**. To search and select a Wifi network.
Hotspot:	Available for **WIFI: Enable**. to enter the hotspot and password for a known access point to connect to.

Description of fields

Field	Option	Description
WIFI:	**Disable**	To turn Wifi off.
	Enable	To turn Wifi on.

6 Apps - Getting Started

6.1 Overview

Description

Apps are predefined programs, that cover a wide spectrum of surveying duties and facilitate daily work in the field. The following apps are available:

- Survey
- Set Out
- OffSet
- Miss.Line Measure(MLM)
- Remote Elevation
- Area
- Resection
- Reference Line
- Road

6.2 Starting an App

Access

1. Select **Apps** from the **Main Menu**.
2. Press the or button to scroll through the screen of available apps.
3. Press or press the number of the app to select the specified app in the **Main Menu**.

Pre-settings screens

Description of items in the list

The availability of items depends on the app.

Item	Description
Go	Starts the selected app.
Select Station	To define the current position of the instrument station. Refer to 6.3 Station Setup.
Select Orientation	To define the orientation and horizontal direction of the instrument station. Refer to 6.3 Station Setup.
Select Job	To define the job where data will be saved. Refer to 6.5 Setting the Job.

Next step

Select an item from the list. Press .

OR

On the keyboard, press the number of the item in the list.

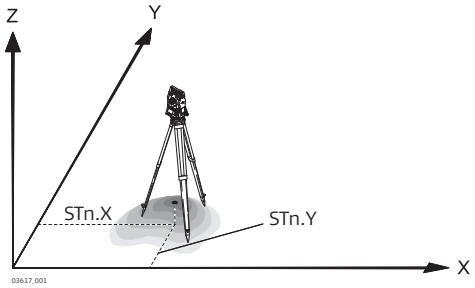
6.3 Station Setup

Description

All measurements and coordinate computations are referenced to the set station coordinates. The coordinates can be entered manually or selected from the memory.

The station coordinates that are set must include:

- at least grid coordinates (E, N), and
- the station height, if required.



Directions

X Easting
Y Northing
Z Height

Station coordinates

Stn.X Easting coordinate of station
Stn.Y Northing coordinate of station

Station input

Key	Description
Value	To search for a point.
Coord	To open the manual coordinate entry screen.
OK	To confirm the entered values and continue in the process.

Description of fields

Field	Option	Description
E :, N :, Z :	Display only	The coordinates of the station.
PointID:	Display only	Station name of a previously saved station position.
hi:	Editable field	Instrument height ☞ The calculation of coordinates is based on plane coordinates (X and Y). Enter the instrument height if necessary.

☞ If no station was set and an app was started, then the last station is set as the current station and the current horizontal direction is set as the orientation.

6.4 Selecting the Orientation

6.4.1 Overview

Description

All measurements and coordinate computations are referenced to the orientation of the set station. The orientation can be entered manually or determined from points that are either measured or selected from the memory.

Access

Select **Select Orientation**in the **Pre-settings** screen and choose:

- **Angle Orientation** to enter a new bearing. Refer to 6.4.2 Orientation with Angle.
- **Coordinates Orientation** to calculate and set the orientation using existing coordinates. Refer to 6.4.3 Orientation with Coordinates.

☞ If no station was set and an app was started, then the last station is set as the current station and the current horizontal direction is set as the orientation.

6.4.2 Orientation with Angle

Access

Select **Angle Orientation** in the **Backsight** screen.

Select Orientation

Key	Description
OK	To confirm the entered values and continue in the process.

Description of fields

Field	Option	Description
PointID:	Editable field	Point ID of the backsight point.
Hz:	Editable field	The azimuth between survey point and backsight point.

6.4.3 Orientation with Coordinates

Access

Select **Coordinates Orientation** in the **Backsight** screen.

BS coordinate

Key	Description
Value	To search for a point.
Coord	To open the manual coordinate entry screen.
OK	To confirm the entered values and continue in the process.

Description of fields

Field	Option	Description
E :, N :, Z :	Display only	The coordinates of the station. ☞ The coordinates must be based on plane coordinates (X and Y). Enter the instrument height if necessary.
PointID:	Editable field	Point ID of the backsight point.
hr	Editable field	Height of the reflector.

Next step

Find an existing backsight point in the pointsearch or enter ENZ coordinates for a new point. Press **OK** to continue to **Backsight Check**.

Backsight Check

Key	Description
Meas	To start distance and angle measurements. To calculate and display azimuth and distance.
Coord	To display calculated coordinates.
NO	To reject the orientation and to return to **BS coordinate**.
YES	To set the orientation.

Description of fields

Field	Option	Description
Hz:	Display only	Horizontal direction to the target point.
CAL. HD:	Display only	Horizontal distance to the target point.

Field	Option	Description
HD:	Display only	Horizontal distance to the survey point.
dHD:	Display only	Horizontal distance difference to the target point.

Next step

- Press **YES** to set the orientation and return to the Pre-Settings screen.
- Press **NO** to return to the **BS coordinate** screen. No changes will be saved.

☞ If no orientation was set and an app was started, then the current horizontal direction is set as the orientation.

6.5 Setting the Job

Description

All data is saved in Jobs, like file directories. Jobs contain measurement data of different types, for example measurements, codes, fixpoints or stations. Jobs are individually manageable and can be exported, edited or deleted separately.

Select Job

Key	Description
Call	To display the list of available jobs.
New	To create a new job.
OK	To continue with the selected job.

Description of fields

Field	Option	Description
Job:	Display only	Name of an existing job to be used.
User:	Display only	Name of operator, if entered.
Date:	Display only	Date the selected job was created.
Time:	Display only	Time the selected job was created.

Job list

Key	Description
Attrib	To display job related information such as creator or date and time of the creation.
Delete	To delete the highlighted job.
Select	To select the highlighted job as working job.

Recorded data

Once a job is set up, all subsequent recorded data will be stored in this job. The last used job is the active job.

If no job was defined and an app was started, then the system automatically creates a new default job.

7 Apps

7.1 Common Fields

Description of fields

The following table describes common fields that are found within the firmware apps. These fields are described here once and not repeated in the app chapters unless the field has a specific meaning within that app.

Field	Description
PointID:	Point ID of the point.
hr	Height of the reflector.
Hz:	Horizontal direction to the point.
V :	Vertical angle to the point.
Hd :	Horizontal distance to the point.
Sd :	Slope distance to the point.
Height	Height to the point.
E :	Easting coordinate of the point.
N :	Northing coordinate of the point.
Z :	Height coordinate of the point.

7.2 Survey

Description

Survey is an app used for the measurement of an unlimited number of points. It includes pre-settings for the job, station and orientation prior to beginning a survey.

Access

1. Select **Survey** from the **Main Menu**.
2. Complete the pre-settings. Refer to 6.2 Starting an App.

Survey

Key	Description
Meas	To execute a distance measurement and store the displayed values.
Store	To save the displayed values without executing a distance measurment.
Dist	To execute a distance measurement.
P↓	To switch between individual and running point numbers.
Code	To add a code to the measured point.
OffSet	To apply an offset to the measurement.

7.3 Set Out

Description

Set Out is an app used to place marks in the field at predetermined points. These predetermined points are the points to be staked. The points to be staked may already exist in a job on the instrument, or be manually entered.

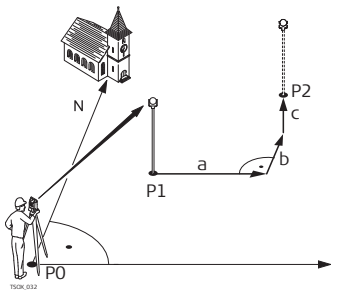
The app can continuously display differences, between current position and desired set out position.

Set out modes

Points can be staked using different modes:

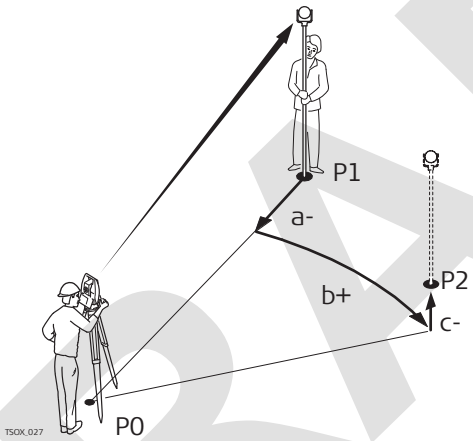
- Cartesian mode: Using coordinates
- Polar mode: Using angle and distance

Cartesian set out mode



P0	Instrument station
P1	Current position
P2	Point to be staked
a	**dE:**: Difference in Easting coordinate
b	**dN:**: Difference in Northing coordinate
c	**dZ:**: Difference in height

Polar set out mode



P0	Instrument station
P1	Current position
P2	Point to be staked
a-	**dHD:**: Difference in horizontal distance
b+	**dHz:**: Difference in direction
c+	Difference in height

Access

1.	Select **Apps** from the **Main Menu**.
2.	Select **Set Out**.
3.	Complete app pre-settings. Refer to 6 Apps - Getting Started.
4.	Select **Coordinates Set Out** or **Angle, Distance Set Out**.

Input

Key	Description
Store	To save the displayed values without executing a distance measurment.
Value	To display the list of available points.
OK	To continue to set out.

Description of fields

Mode	Field	Description
Cartesian	**E :**, **N :**, **Z :**	Easting, Northing and Height coordinate of the set out point.

Mode	Field	Description
	hr	Height of the reflector.
Polar	**Dist:**	Distance to the set out point.
	Hz:	Horizontal angle to the set out point.
	hr	Height of the reflector.

Next step

Press **Value** to find an existing point with the pointsearch or enter ENZ coordinates for a new point. Press **OK** to continue the set out.

Compute

Key	Description
Store	To save the displayed values without executing a distance measurment.
Shift	To enter the polar set out screen. To enter the set out screen for coordinates.
<-->	To switch to the navigation screen or to use horizonal and vertical angle for guidance.
HD	To measure a distance.
Coord	To measure the coordinates.

Description of fields

Mode	Field	Description
Cartesian	**dE:**	Easting offset: Positive if set out point is to the right of the measured point.
	dN:	Northing offset: Positive if set out point is further away than the measured point.
	dZ:	Height offset: Positive if set out point is higher than the measured point.
	Hz:	Computed horizontal angle.
	dHz:	Angle offset: Positive if set out point is to the right of the measured point.
Polar	**Dist:**	Distance to the set out point.
	Hz:	Horizontal angle to the set out point.
	hr	Height of the reflector.

Next step

- Either, press **Store** to store the set out point and to continue with the next set out point.
- Or, press ⟲ to exit the application.

7.4 Target Offset

7.4.1 Overview

Access

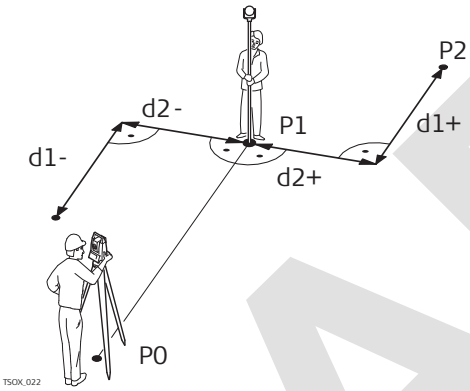
1. Select **Apps** from the **Main Menu**.
2. Select **OffSet**.
3. Complete app pre-settings. Refer to 6 Apps - Getting Started.

4. Select:
   - **Single Distance Offset**.
     Refer to 7.4.2 Distance Offset.
   - **Angle Offset**.
     Refer to 7.4.3 Angle Offset.
   - **Double Distance Offset**.
     Refer to 7.4.4 Double Distance Offset.
   - **Cylinder Offset**.
     Refer to 7.4.5 Cylindrical Offset.

7.4.2 Distance Offset

Description

This app calculates the target point coordinates if it is not possible to set up the reflector, or to aim at the target point directly. The offset values (length, traversal and/or height offset) can be entered. The values for the angles and distances are calculated to determine the target point.



P0	Instrument station
P1	Measured point
P2	Calculated offset point
d1+	Length offset, positive
d1-	Length offset, negative
d2+	Perpendicular offset, positive
d2-	Perpendicular offset, negative

Access

Select **Single Distance Offset** from the **OffSet** menu.

Enter offset values

Key	Description
OK	To confirm the measurement and to calculate the offset point.
Meas	To measure the distance. The corrected angle and distances are displayed as soon as a valid distance measurement has been triggered or exists.
P↓	To scroll down and display further fields on the screen.

Description of fields

Field	Option	Description
Hd :	Display only	Horizontal distance to the measured point.
Hz:	Display only	Horizontal angle to the measured point.
PointID:	Editable field	The name of the calculated offset point.
OffSet	Editable field	☞ The offset values are always reset to 0 when the app is quit.
Deviation:	Editable field	Direction of the offset

Field	Option	Description
	Left	Perpendicular offset to the left of the measured point. ☞ The angle between the line connecting target point and calculated offset point and the line connecting instrument station and target point must be 90°.
	Right	Perpendicular offset to the right of the measured point. ☞ The angle between the line connecting target point and calculated offset point and the line connecting instrument station and target point must be 90°.
	Up	Longitudinal offset. Closer than the measured point. ☞ The surveying point must be on the line between instrument station and measured point
	Down	Longitudinal offset. Further away than the measured point. ☞ The surveying point must be on the line between instrument station and measured point
hr	Editable field	Height of the reflector.

7.4.3 Angle Offset

Description

This function calculates the target point coordinates if it is not possible to set up the reflector, or to aim at the target point directly. The offset point and the measurement point must have the same distance to the instrument.

Access

Select **Angle Offset** from the **OffSet** menu.

Enter offset values and result

☞ Set the measured point to the left or right of the offset point. The distance from the instrument station must be the same.

Key	Description
Meas	To execute a distance measurement and store the displayed values.
Dist	To execute a distance measurement.
Store	To save the displayed values without executing a distance measurment.
Shift	To display Easting, Northing and Height or slope distance, vertical angle and horizontal angle.

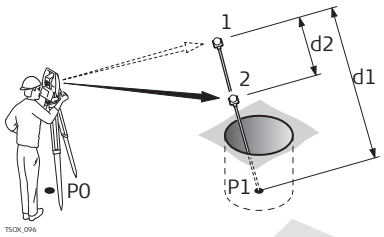
Description of fields

Field	Option	Description
PointID:	Editable field	The name of the target point.
hr	Editable field	Height of the reflector.
Sd :	Display only	Slope distance to the measured point or calculated offset point.
V :	Display only	Vertical angle to the measured point or calculated offset point.
Hz:	Display only	Horizontal angle to the measured point or calculated offset point.

7.4.4 Double Distance Offset

Description

This app is used for measurements to a point that is not directly visible, using a special hidden point rod.



P0 Instrument station
P1 Hidden point
1-2 Prisms 1 and 2
d1 Distance between prism 1 and the hidden point
d2 Distance between prism 1 and 2

Access

Select **Double Distance Offset** from the **OffSet** menu.

Enter offset values and result

Key	Description
Meas	To measure the distance.
Store	To save the displayed values without executing a distance measurment.
Shift	To display Easting, Northing and Height or slope distance, vertical angle and horizontal angle.

Description of fields

Field	Option	Description
PointID:	Editable field	The name of the target point.
hr	Editable field	The length of the special hidden point rod.
Sd :	Display only	Slope distance to the measured point or calculated offset point.
V :	Display only	Vertical angle to the measured point or calculated offset point.
Hz:	Display only	Horizontal angle to the measured point or calculated offset point.
B-C:	Editable field	Spacing between the centres of the prisms 1 and 2.

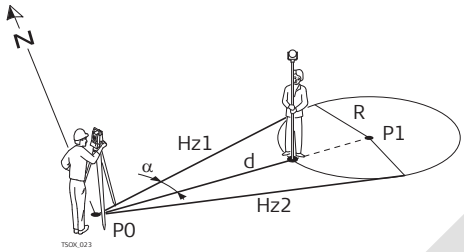
Next step

Measure to the first and second prisms using **Meas**, enter the distance between the two prisms and the result screen **Double DT Offset** screen is displayed.

7.4.5 Cylindrical Offset

Description

Determines the coordinates of the centre point of cylindrical objects and their radius. The horizontal angle to points on both the left and right sides of the object are measured, and the distance to the object as well.



P0	Instrument station
P1	Centre point of cylindrical object
Hz1	Horizontal angle to a point on the left side of the object
Hz2	Horizontal angle to a point on the right side of the object
d	Distance to the object in the middle between Hz1 and Hz2
R	Radius of cylinder
α	Azimuth from Hz1 to Hz2

Access

Select **Cylinder Offset** from the **OffSet** menu.

Enter offset values and result

Key	Description
Meas	To execute a distance measurement and store the displayed values.
OK	To accept the measurement.
Store	To save the displayed values without executing a distance measurment.
END	To exit the app without storing the results.

Description of fields

Field	Option	Description
PointID:	Editable field	The name of the target point.
hr	Editable field	The height of the reflector
Sd :	Display only	Slope distance to the measured point or calculated offset point.
V :	Display only	Vertical angle to the measured point or calculated offset point.

Field	Option	Description
Hz:	Display only	Horizontal angle to the measured point or calculated offset point. Measured horizontal direction to the right side of the object. Measured horizontal direction to the left side of the object.
E :	Display only	Easting coordinate of the centre point.
N :	Display only	Northing coordinate of the centre point.
Z :	Display only	Height of the point measured with the reflector. ☞ This is not the calculated height of the centre point.
Radius:	Display only	Radius of the cylinder.

Cylindrical offset measurements step-by-step

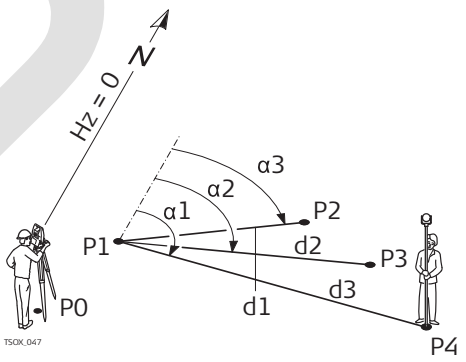
1.	Align to a point on the cylinder. Rotate the instrument to aim in the direction of the centre point of the cylindrical object, such that horizontal angle is zero.
2.	Press **Meas** for survey.
3.	To repeat the measurement, press **Meas** again. Press **OK** to save the point.
4.	Using the vertica lhair, aim at the left side of the object.
5.	Press **OK** for survey.
6.	Using the verticalhair, aim at the right side of the object.
7.	Press **OK** for survey.
8.	Check the results.
9.	Press **Store** to record the results. Press **END** to exit the app without storing the results.

7.5 Missing Line Measurement

Description

Miss.Line Measure(MLM) is an app used to compute slope distance, horizontal distance, height difference and azimuth of two target points which are either measured, selected from the memory, or entered using the keypad.

Radial method



P0 Instrument station
P1-P4 Target points
d1 Distance from P1-P2
d2 Distance from P1-P3
d3 Distance from P1-P4
α1 Azimuth from P1-P4
α2 Azimuth from P1-P3
α3 Azimuth from P1-P2

Access

1.	Select **Apps** from the **Main Menu**.

2. Select **Miss.Line Measure(MLM)**.

Missing line measurements

After completing the measurements required, the Missing Line result screen will appear.

Tie distance measurements step-by-step

Step-by-step

1. Align to point 1.
2. Press **Meas**.
   The distance is displayed.
3. Align to point 2.
4. Press **MLM**.
5. After completing the measurements required, the results screen will appear.

Key	Description
MLM	To calculate the missing line information.
NewSTN	To set point 2 as the starting point of a new line. A new point 2 must be measured.
SD	To change to another display view showing slope distance values.
Meas	To execute a distance measurement and store the displayed values.

Description of fields

For Meas

Field	Option	Description
Hd :	Display only	Horizontal distance between point 1 and point 2.
V :	Display only	Vertical angle to the point.
Hz:	Display only	Azimuth between point 1 and point 2.
hr	Display only	Height of the reflector.

For MLM

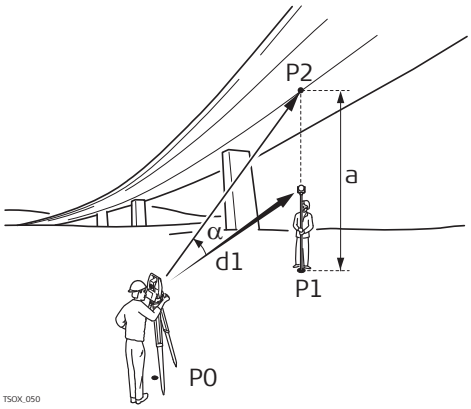
Field	Option	Description
MLM-S	Display only	Slope distance between point 1 and point 2.
H	Display only	Horizontal distance between point 1 and point 2.
V	Display only	Height difference between point 1 and point 2.
Hd :	Display only	Horizontal distance between point 1 and point 2.
Hz:	Display only	Azimuth between point 1 and point 2.
hr	Display only	Height of the reflector.

Next step Press **ESC** to exit the app.

7.6 Remote Elevation

Description

Remote Elevation is an app used to compute points directly above the base prism without a prism at the target point.



P0 Instrument station
P1 Base point
P2 Remote point
d1 Slope distance
a Height difference from P1 to P2
α Vertical angle between base point and remote point

Access

1. Select **Apps** from the **Main Menu**.
2. Select **Remote Elevation**.

Remote height measurement

Measure to the base point.

Next step

After measuring, the results screen appears.

Results

Aim the instrument at the inaccessible remote point.

Description of fields

Field	Option	Description
Ht:	Display only	Calculated difference in height between the base point and the remote point.
Hd :	Display only	Horizontal distance between station point and target point.
V :	Display only	Vertical angle to the measured point or calculated offset point.
Hz:	Display only	Horizontal angle to the measured point.

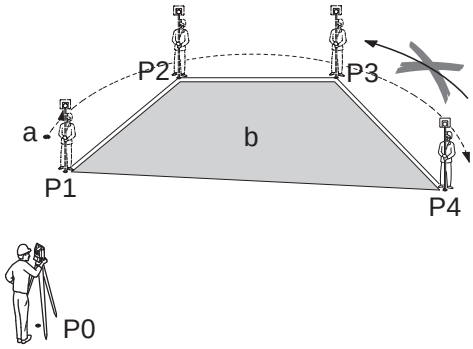
Next step

- Either, press **OK** to save the measurement and record the calculated coordinates of the remote point.
- Or, press **Stop** to measure the base point again.

7.7 Area

Description

Area is an app used to compute online areas to a maximum of 50 points connected by straights. The target points have to be measured, selected from memory, or entered via the keypad in a clockwise direction. The calculated area is projected onto the horizontal plane (2D).



P0 Instrument station
P1 Start point
P2-4 Target points
a Perimeter, polygonal length from start point to the current measured point.
b Calculated area always closed to the start point P1, projected onto the horizontal plane.

Access

1. Select **Apps** from the **Main Menu**.
2. Select **Area**.

Enter values and results

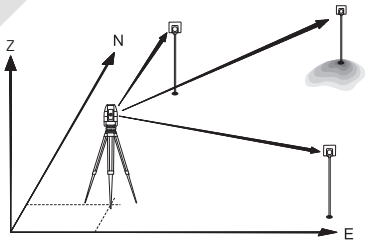
Key	Description
Value	To select a point from the memory.
Meas	To execute a distance measurement and store the displayed values.
Coord	To enter point coordinates manually.
CAL	To display and record results.
Over	To exit the app.
P↓	To display the next softkey level.

1. Measure or select existing points to define the area.
2. The 2D can be calculated and displayed once three points have been measured or selected.
   Press **CAL** to calculate area and volume and proceed to the results screen.
3. The result is displayed in square, hectar, acer and feet.
   View the area in square, hectar, acer and feet.
4. Press **Over** to exit the app.

7.8 Resection

Description

Resection is an application used to determine the instruments position from measurements to known points. A minimum of 2 known points and a maximum of 10, can be used to determine the position.



Access

1. Select **Apps** from the **Main Menu**.

2. Select **Resection**.

Enter values

Key	Description
Value	To select a point from the memory.
Meas.A	To measure only the angle.
Meas	To execute a distance measurement and store the displayed values. To calculate and display the station coordinates, if at least two points and a distance were measured.
Coord	To enter point coordinates manually.
OK	To accept the selection.

1. Press **Value** to select a point from the memory.
   OR
   Press **Coord** to enter point coordinates manually.
2. Press **OK** to accept the selection for the first point.
3. Repeat **1.** and **2.** for the following points.
   At least three points are required.
4. Before starting the measurements:
   Press **OK** to finish the selection and start measuring.
5. ☞ **Meas** is available after the selection of the second point.
   Align to the target and press **Meas**.
   When distance is surveyed, the angle is surveyed as well.
6. Press **YES** to accept the measurement.
   Press **NO** to repeat the measurement.
7. Repeat the measuring steps for all selected points.
8. Press **CAL** to calculate and display the station coordinates.

Results

Key	Description
AddPT	To add more points and to return to the input screen.
STN	To set as the station point which is not saved.
Store	To save and set as the station point.
P↓	To display the next valuesl.

Description of fields

Field	Option	Description
PointID:	Display only	The name of the result point.
hi	Display only	Instrument height
E :	Display only	Easting coordinate of the centre point.
N :	Display only	Northing coordinate of the centre point.
Z :	Display only	Height of the point measured with the reflector.
dE:	Display only	Computed residual for the Easting coordinate.

Field	Option	Description
dN:	Display only	Computed residual for the Northing coordinate.
dZ:	Display only	Computed residual for the Height coordinate.

7.9 Reference Line

7.9.1 Overview

Description

The Reference Line app can be used to stake out or measure points relative to a line defined by two points.

Reference Line is an application that facilitates the easy stake out or checking of lines, for example, for buildings, sections of road, or simple excavations. It allows to define a reference line and then complete the following tasks regarding that line:

- Line & offset
- Set out points

Access

1. Select **Apps** from the **Main Menu**.
2. Select **Reference Line**.
3. Complete app pre-settings. Refer to 6 Apps - Getting Started.

Next step

Define the base line for the reference line.

7.9.2 Defining the Reference Line

Access

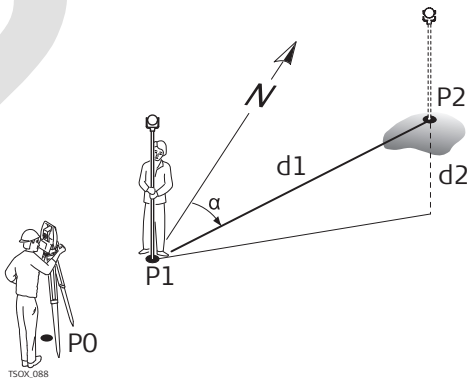
Select **Define Reference Line** from the **Reference Line** menu.

Description

A reference line can be defined by referencing a known base line. The reference line can be offset either longitudinally, in parallel or vertically to the base line, or be rotated around the first base point as required. Furthermore the reference height can be selected as the first point, second point or interpolated along the reference line.

Define the base line

The base line is fixed by two base points. All points can be either measured, manually entered, or selected from the memory.



Base line

P0 Instrument station
P1 Start point
P2 End point
d1 Known distance
d2 Difference in height
α Azimuth

Define the base line by measuring or selecting the start and end points of the line.

Define Ref.(Start Pt)
Define Ref.(End Pt)

Determine the reference line by two basis points. All points can be observed, manually entered, or selected from memory.

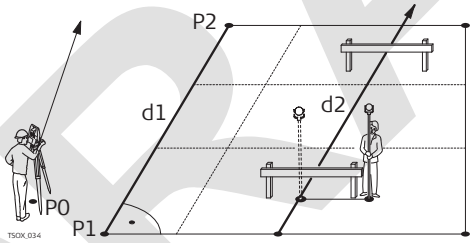
Key	Description
Value	To select a point from the memory.
Coord	To enter point coordinates manually.
Meas	To execute a distance measurement and store the displayed values.
Store	To save the displayed values without executing a distance measurment.

Description of fields

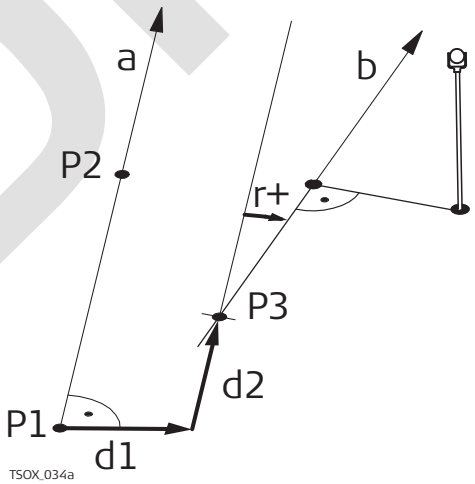
Field	Option	Description
PointID:	Editable field	The name of the result point.
hr	Editable field	Height of the reflector.
Hz:	Display only	Horizontal direction to the point.
Sd :	Display only	Slope distance to the point.

Description

The base line can be offset from, either longitudinally, in parallel or vertically, or be rotated around the first base point. This new line created from the offsets is called the reference line. All measured data refers to the reference line.



P0 Instrument station
P1 Start point
P2 End point
d1 Base line
d2 Reference line



P1 Base point
P2 Base point
a Base line
d1 Parallel offset
d2 Longitudinal offset
P3 Reference point
r+ Rotation parameter
b Reference line

Define Refline(1)
Define Refline(2)

Define offset values.

Key	Description
OK	To confirm the measured or entered values and continue the process.
P↓	To display the next softkey level and fields.

Description of fields

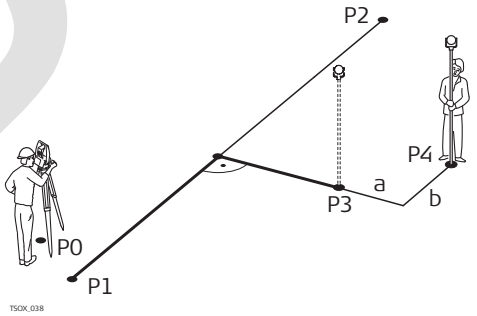
Field	Option	Description
Hz:	Display only	Azimuth of a reference line connecting the start point and the end point.
HD:	Display only	Horizontal distance between the start point and the end point.
VD:	Display only	Vertical distance between the start point and the end point.
Slope:	Display only	Difference in height between the start point and the end point.
L-Offset:	Editable Field	Longitudinal offset of the start point, reference point (P3), of the reference line in the direction of base point 2. Positive values are towards base point 2.
T-Offset:	Editable Field	Parallel offset of the reference line relative to the base line (P1-P2). Positive values are to the right of the base line.
H-Offset:	Editable Field	Height offset of the reference line to the selected reference height. Positive values are higher than the selected reference height.
Rotate:	Editable Field	Rotation of the reference line clockwise around the reference point (P3).

7.9.3 Stakeout

Description

Calculates the difference between a measured point and the calculated point. The orthogonal differences are displayed.

Example orthogonal stakeout



P0 Instrument station
P1 Start point
P2 End point
P3 Stake out point
P4 Measured point
a Δ Parallel offset
b Δ Longitudinal offset

Access

Select **Reference Line Setout** from the **Reference Line** menu.

Refline Setout

Enter the stake out elements for the target points to be staked out relative to the reference line.

Decription of fields

Field	Option	Description
T-Offset:	Display only	Perpendicular offset: Positive if stake out point is to the right of the reference line.
L-Offset:	Display only	Longitudinal offset: Positive if stake out point is further away from the reference line.
H-Offset:	Display only	Height offset: Positive if stake out point is higher than the reference line.

Next step

Press **OK** to calculate the coordinates of the stake out point.

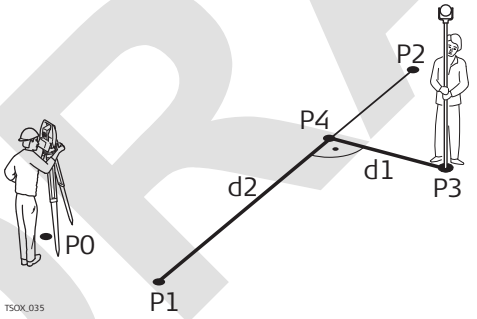
The coordinates for the stake out point are displayed.

Key	Description
SetOut	To start the **Set Out** app. Refer to 7.3 Set Out.
Store	To save the displayed values without executing a distance measurment.

7.9.4 Measuring to a Reference Line

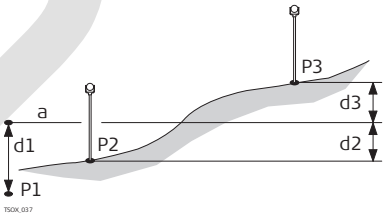
Description

Calculates from measurements or coordinates, longitudinal offsets, parallel offsets and height differences of the target point relative to the reference line.



P0 Instrument station
P1 Start point
P2 End point
P3 Measured point
P4 Reference point
d1 Δ Offset
d2 Δ Line

Example of height difference relative to first reference point



P1 Start point
P2 Target point
P3 Target point
a Reference height
d1 Height difference between start point and the reference height
d2 Height difference between P2 and the reference height
d3 Height difference between P3 and the reference height

Access

1. Align to the target point.
2. Select **Refline Measurement** from the **Reference Line** menu.
3. A measurement is taken.
4. The corrdinates and the offset values are displayed.

Refline Measurement

Key	Description
Meas	To execute a distance measurement and store the displayed values.
Store	To save the displayed values without executing a distance measurment.
P↓	To display the next fields.

Description of fields

Field	Description
T-Offset:	Calculated distance perpendicular from the reference line.
L-Offset:	Calculated distance longitudinal to the reference line.
H-Offset:	Calculated height difference relative to the defined reference height.

7.9.5 Projections

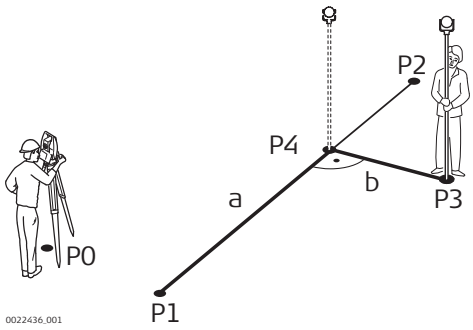
Description

Projects a point perpendicular onto a reference line. The initial coordinates of the point can be either measured, manually entered, or selected from the memory.

Displayed are:

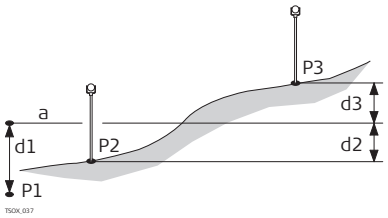
- Coordinates of the projected point on the reference line
- Offsets between the initial point and the calculated point on the reference line

Example



P0 Instrument station
P1 Start point
P2 End point
P3 Initial point
P4 Point projected on the reference line
a Δ Longitudinal offset
b Δ Parallel offset

Example of height difference relative to first reference point



P1 Start point
P2 Target point
P3 Target point
a Reference height
d1 Height difference between start point and the reference height
d2 Height difference between P2 and the reference height
d3 Height difference between P3 and the reference height

Access

Select **Point Projection** from the **Reference Line** menu.

Point Projection Will project PTCoord

Enter the coordinates of the initial pont.

Key	Description
Value	To select a point from the memory.
Meas	To execute a distance measurement and store the displayed values.
Store	To save the displayed values without executing a distance measurment.
OK	To confirm the entered values and continue in the process.

Projection PT data

Key	Description
SetOut	To start the **Set Out** app. Refer to 7.3 Set Out.
Store	To save the displayed values without executing a distance measurment.
P↓	To display the next softkey level and fields.

Description of fields

Field	Description
T-Offset:	Calculated distance perpendicular to the reference line. Positive if the initial point is to the right of the reference line.
L-Offset:	Calculated distance longitudinal to the to the reference line. Positive if the initial point is further away from the reference line.
H-Offset:	Calculated height difference relative to the defined reference height. Positive if the initial point is higher than the reference line.

7.10 Road

7.10.1 Overview

Description

The app is used to stake out points or for as-built checks relative to a road alignment, including slopes. It supports the following features:

- Horizontal alignments with the elements straight, curve, and spiral (entry and exit as well as partial).
- Vertical alignments
- Import of alignments from the folder \ROAD on the USB memory stick
- Export of alignments into the folder \ROAD on the USB memory stick
- Creation, editing and deletion of alignments onboard.

Access

1. Select **Apps** from the **Main Menu**.
2. Select **Road**.
3. Complete app pre-settings. Refer to 6 Apps - Getting Started.

Road menu

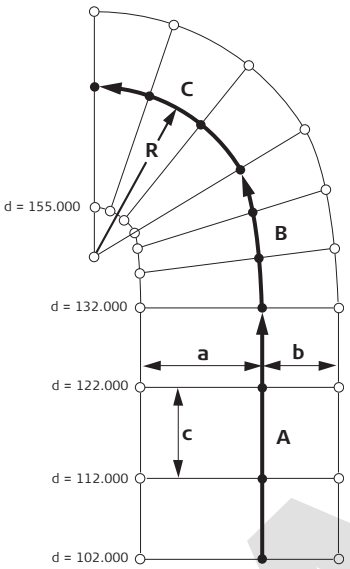
The Road app includes:

Menu selection	Description
Road Define	To view and enter control points which can be used for station setup and orientation. To define the horizontal and vertical alignments.
Road Setout	To stakeout points on the alignment or relative to the alignment. To measure transections. To view results of transection and stakeout.
Delete alignments	To delete the horizontal and vertical alignments. ☞ When deleting a horizontal alignment, the horizontal alignment data and the calculated coordinate data are deleted.
Data Transfer	To upload and download Road data.

- The alignments must be continuous because geometrical gaps and chainage equations are not supported.
- The created road alignments are permanent and stored even if the app is closed.
- Road alignments can be deleted onboard.
- Road alignments can be edited onboard.

7.10.2 Basic Terms

Elements



A Straight
B Spiral
C Curve
R Radius
a Perpendicular offset left
b Perpendicular offset right
c Increment
d Stationing

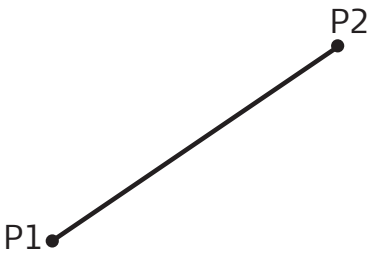
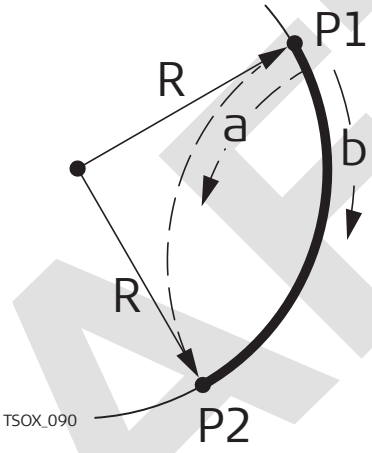
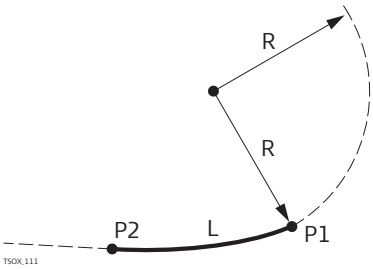
Terminology

Term	Description
Increment direction	The forward direction of the alignment facing the large stake number.
Right and left	Facing to the forward direction of the alignment.
Larger stake number	Refers to the number in front of the principal point along the alignment.
Smaller stake number	Refers to the number behind the principal point along the alignment.

Horizontal geometry elements

For onboard input Road supports the following elements for horizontal alignments.

Element	Description
Straight	A straight has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates.

Element	Description
	 P1 Start point P2 End point
Curve	A circular curve has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates. • Radius (R). • Direction: Clockwise (b) or Anticlockwise (a).  P1 Start point P2 End point R Radius a Anticlockwise direction b Clockwise direction
Spiral	A spiral is a transition curve whose radius changes along its length. A spiral has to be defined by: • Start point (P1) and end point (P2) with known Easting and Northing coordinates. • Radius at the start of the spiral (R). • Spiral parameter (A) or length (L) of the spiral. $A = \sqrt{L \cdot R}$ • Direction: Clockwise or Anticlockwise. • Spiral type: Spiral in or Spiral out.  P1 Start point P2 End point R Radius L Length

Vertical geometry elements

For onboard input Road supports the following elements for vertical alignments:

- Chainage
- Elevation

7.10.3 Creating a New Alignment

Description

An alignment is a set of data that can be used to describe and determine the exact location of a road centerline. It describes the whole road in terms of elements of the road, including starting point, straight line, curve and spiral.

Create horizontal and vertical road alignment files with the basic field software and upload them onto the instrument.

Alternatively, horizontal and vertical road alignments can be created onboard the instrument.

Access

1. Select **Road Define** from the **Road** menu.
2. Select:
   - **Define H Alignment**
     - Select **Element** or **Cross point**
   - **Edit H Alignment**
   - **Define V Alignment**
   - **Edit V Alignment**

☞ Using a horizontal alignment file is mandatory.

☞ Using a vertical alignment file is not mandatory. A height can be defined manually instead.

Start point and Exist Element

Key	Description
Back	To return to the last active screen.
Straight	To insert a straight into a horizontal alignment. Available in Exist Element when the start point has been defined.
Curve	To insert a curve into a horizontal alignment. Available in Exist Element when the start point has been defined.
Spiral	To insert a spiral into a horizontal alignment. Available in Exist Element when the start point has been defined.
OK	To accept the selection.

Description of fields

For **Start point**

Field	Option	Description
Chainage:	Editable field	Stake number of the starting point on road centerline. Characters such as “K”, “k” or “+” are not allowed. Example: K2+224.224 must be 2224.224.
E :	Editable field	Easting of the start point of the horizontal alignment.
N :	Editable field	Northing of the start point of the horizontal alignment.

Field	Option	Description
Bearing:	Editable field	The tangential azimuth of the line at the starting point.

For **Straight**

Field	Option	Description
Length:	Editable field	The length of the straight element.

For **Curve**

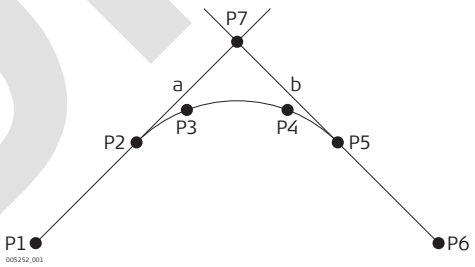
Field	Option	Description
Radius:	Editable field	Radius of the curve. Positive when the curve is turning right along the forward direction of the alignment. Negative when the curve is turning left along the forward direction of the alignment.
Length:	Editable field	Length from the start to the end point of the curve.

For **Spiral**

Field	Option	Description
Length:	Editable field	Length of the clothoid element.
Rs:	Editable field	The entry radius of the spiral. Positive when the spiral is turning right along the forward direction of the alignment. Negative when the spiral is turning left along the forward direction of the alignment.
Re:	Editable field	The exit radius of the spiral. Positive when the spiral is turning right along the forward direction of the alignment. Negative when the spiral is turning left along the forward direction of the alignment.

Create cross points

Cross points are the intersection points of two tangents of a symmetric alignment. Cross points can be used to define a complete road alignment.



P1	Start point straight 1
P2	Start point spiral 1
P3	Start point circle
P4	Start point spiral 2
P5	Start point straight 2
P6	End point
P7	Cross point
a	Tangent 1
b	Tangent 2

☞ Start and end element have to be a straight or rather an end point.

☞ At least two cross points have to be entered. The first cross point is the start point of the straight.

Key	Description
Back	To return to the last active screen.

Key	Description
Store	To save the displayed values without executing a distance measurment.
OK	To accept the selection.

Description of fields

Field	Option	Description
E :	Editable field	Easting of the point of intersection.
N :	Editable field	Northing of the point of intersection.
Radius:	Editable field	Curvature radius of the circular curve corresponding to the point of intersection. The curvature radius at the end must be input as 0. Positive when right along the forward direction of the alignment. Negative when turning left along the forward direction of the alignment.
A1:	Editable field	The parameter A defining the spiral at the beginning. Positive when the spiral is turning right along the forward direction of the alignment. Negative when the spiral is turning left along the forward direction of the alignment.
A2:	Editable field	The parameter A defining the spiral at the end. Positive when the spiral is turning right along the forward direction of the alignment. Negative when the spiral is turning left along the forward direction of the alignment.

Define V Alignment

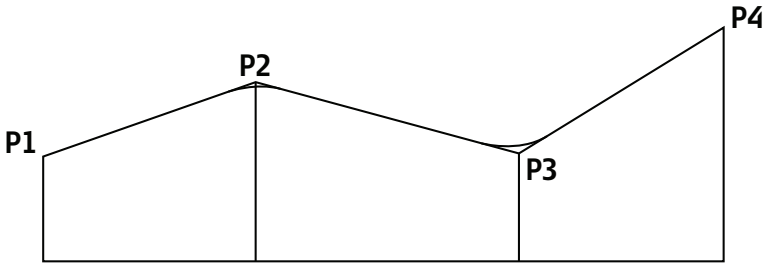
The vertical alignment consists of a set of intersecting points, including chainage, height, and length of an element.

Key	Description
Back	To return to the last active screen.
OK	To save the data entry and proceed to enter the value of the next element.

Description of fields

Field	Option	Description
Chainage:	Editable field	Start chainage of the vertical alignment.
Elevation:	Editable field	The end elevation of the straight.
Length:	Editable field	Using the length of the straight. ☞ The length at the start and end of the vertical alignment must be zero.

Example



	P1	P2	P3	P4
Chainage:	0	200	450	600
Elevation:	200	425	170	285
Length:	0	200	250	150

Edit horizontal and vertical alignment

Key	Description
Edit	The displayed fields change to editable fields.
First	To display the first alignment element.
Last	To display the last alignment element.
Search	To find an alignment element based on the chainage.

Description of fields

Refer to Start pointandExist Element and Define V Alignment.

Calculate Coordinate

After the definition of the alignments, the coordinates for staking can be calculated.

☞ Using a horizontal alignment file is mandatory.

☞ Using a vertical alignment file is not mandatory. A height can be defined manually instead.

Key	Description
OK	To save the data entry and proceed to calculate the coordinates.

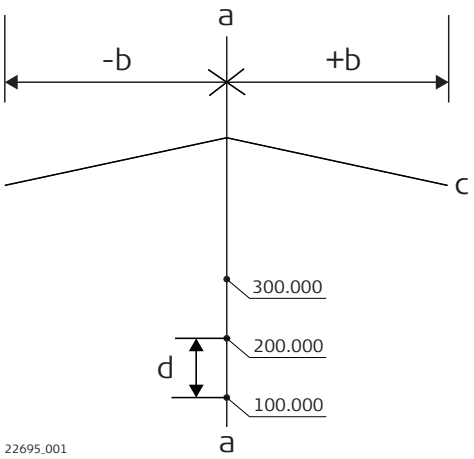
Description of fields

Field	Option	Description
SPACING:	Editable field	Chainage increment.

7.10.4 Stake

Description

Stake out points relative to an existing alignment. The height difference is relative to a vertical alignment or manually entered height.



a Centreline
+b Deviation to the right, positive
-b Deviation to the left, negative
c Height difference
d Stake interval

Access

1. Select **Road Setout** from the **Road** menu.
2. Select:
   - **Use Coordinate Data**
     To set out the calculated coordinates.
     Refer to Start Setout.
   - **Input Chainage and Offset**
     To set out by stake number and direction.
     Refer to Start Setout.

List

Available for **Use Coordinate Data**.

Select a chainage from the list.

Key	Description
Search	To search for a particular chainage.
View	To display chainage and coordinates.
OK	To accept the selection proceed to set out.

Start Setout

Available for **Input Chainage and Offset**.

Key	Description
Back	To return to the last active screen.
OK	To accept the selection proceed to set out.

Description of fields

Field	Option	Description
Chainage:	Editable field	The chainage to set out.
SPACING:	Editable field	Chainage increment.
L/R:	Editable field	Offset to left or right. Positive to the right. Negative to the left. Set to zero to set out in the middle.

Field	Option	Description
U/D:	Editable field	Offset to up or down. Positive up. Negative down. Set to zero to set out in the middle.

Angle SO 1/3

Key	Description
hr	To enter a prism height.
Meas	To execute a distance measurement and store the displayed values.
Store	To save the displayed values without executing a distance measurment.
P↓	To display the next softkey level and fields.
Back	To return to the last active screen.
List	To display the list of available points.
Coord	To display and check the coordinates for set out.

Description of fields

Field	Option	Description
Chainage:	Selectable list	Selected chainage to stake out.
dHR:	Display only	Perpendicular offset to alignment. The direction is correct when "0" is displayed.
dHD:	Display only	Horizontal offset: Positive if the stake out point is further away than the measured point.
HDc	Display only	Height difference between the measured point and the defined height.

7.10.5 Data Transfer

Description

Road data can be exported to and imported from the USB memory stick.

No additional software is required for the transfer.

Access

Select **Data Transfer** from the **Road** menu.

Road SO-Data transfer

Key	Description
Back	To return to the last active screen.
OK	To select the file format and continue with the export.

Description of fields

Field	Option	Description
Mode:	Selectable list	Select between data import and export.
Data type:		Data type to be transferred.

Field	Option	Description
	Control point	Available for data import. The calculated coordinate data.
	H Element	Available for data import. The horizontal alignment.
	H Cross point	Available for data import. The intersection point
	Control point	Available for data export. The calculated coordinate data.
	Road SO result	Available for data export. The coordinates of the stake out results.
	H alignment	Available for data export. The horizontal alignment.
Device:	**USB**	The memory device to which data are exported.
Overwrite:	**Yes**	Set for **Mode:**: **Import**. Existing data are overwritten. ☞ Download existing data first to the USB stick for a backup.
	No	Set for **Mode:**: **Export**. Existing data of the same type are not overwritten.

☞

Type	Folder on USB stick	Format
Export	\ROAD	• Chainage points: *.FPT • Alignement definition: *.HLN • Road Set out points: *.STR
Import	\ROAD	• Chainage points: *.FPT • Alignement definition: *.HLN

Road data format for import

☞ The data must follow the stated standards.

Example

control point (USB Drive:\Road\Road.FPT)
chainage,coord_n,coord_e,coord_h

line_element (USB Drive:\Road\Road.HLN)

type,startpile,coord_n,coord_e,startAZ	//start point	type:0
type,length	//straight	type:1
type,radius,length	//circular arc	type:2
type,length,radius_start,radius_end	//spiral	type:3

```
line_crosspoint (USB Drive:\Road\Road.HLN)
startpile,coord_n,coord_e                    //start point
coord_n,coord_e,radius,A1,A2                 //cross point
```

8 Coding

Description

Codes contain information about recorded points. With the help of coding, points can be assigned to a particular group simplifying later processing.

Access

Select **Data Manager** from the **Main Menu** and choose **Code Library**.

Code Library

Displayed is list of existing code names.

Key	Description
Last	Available if a code has been previously used in the job. To select from a list of last used codes. The codes are sorted by time with the most recently used code at the top of the list.
Search	To search for a code using the number. After entry, the firmware searches for a matching code name, and displays these.
Delete	To delete the selected code.
New	To enter a new code.

9 Data Management

9.1 Overview

Access

Select **Manage** in the **Main Menu**.

Data Manager

The **Data Manager** menu contains all functions for entering, editing, checking and deleting data in the field.

Menu item	Description
Memory Information	Displays job specific memory information such as the number of stored stations, fix points and measurement records. The memory in use is shown as well.
Job	To select, view, create and delete jobs. Jobs are a summary of data of different types, for example, fixed points, measurements or codes. The job definition consists of the job name and user. The system generates time and date at the time of creation. Refer to 6.5 Setting the Job.
Observations	To view and delete observation data. Observation data available in the internal memory can be searched for via a specific point search, or by viewing all points within a job.
Known Points	To view, create, edit and delete known points. Valid fixed points contain at least the point ID and the coordinates E, N or H.
Code Library	To view, create, edit and delete codes. To each code a description and a maximum of 8 attributes with up to 12 characters each can be assigned. Refer to 8 Coding.
Erase Memory	To delete individual jobs, known points and measurements of a specific job or all jobs in the memory. ☞ Deleting the memory cannot be undone. After confirming the message all data is permanently deleted.

9.2 Memory Information

Access

1. Select **Data Manager** in the **Main Menu**.
2. Select **Memory Information** in the **Data Manager** menu.

Memory information

Key	Description
OK	To return to the previous screen to reselect an option.

Description of fields

Field	Option	Description
Job:	Display only	Name of an existing job for which information from the memory is displayed.
Stations:	Display only	The number of stations saved in the selected job.

Field	Option	Description
Fix:	Display only	The number of known point saved in the selected job.
Meas. REC:	Display only	The number of recorded measurements saved in the selected job.
Used Mem.:	Display only	The percentage of used memory by this job.

9.3 Deleting the Memory

Access

1. Select **Data Manager** in the **Main Menu**.
2. Select **Erase Memory** in the **Data Manager** menu.

Erase Memory

Key	Description
Back	To return to the last active screen.
Delete	To delete the selected records.

Description of fields

Field	Option	Description
Data type:	**Job**	Delete a all data (measurements and known point).
	Observation	Delete only measurements.
	Known Point	Delete only fixed point.
Job:	**Single Job**	Delete only one particular job.
	All jobs	Delete all job at once.
SelJob:	Selectable list	Available for **Job:**: **Single Job** Displays the selected job.

9.4 Working with a USB Memory Stick

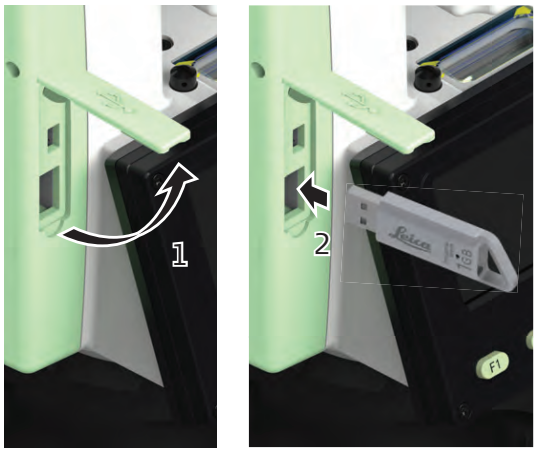
☞ Always return to the **Main Menu** before removing the USB memory stick.

☞
- Keep the USB memory stick dry.
- Use it only within the specified temperature range, -40°C to +85°C (-40°F to +185°F).
- Protect the USB memory stick from direct impacts.

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

☞ Whilst other USB memory sticks may be used, Leica Geosystems recommends Leica industrial grade USB memory sticks and cannot be held responsible for data loss or any other error that may occur when using a non-Leica USB memory stick.

Insert a USB memory stick step-by-step



0022434_001

1. Open the compartment lid.
2. Insert the USB memory stick into the USB host port.

10 Data Transfer

10.1 Exporting Data

Description

Job data can be exported from the internal memory of the instrument. Data are exported to the USB memory stick into the folder \JOBS.

A USB memory stick can be inserted and removed. No additional software is required for the transfer.

Access

1. Select **Transfer** in the **Main Menu**.
2. Select **Data Export** in the **Data Transfer** menu.

Data Export

Key	Description
Back	To return to the last active screen.
List	To list all jobs within the internal memory.
OK	To continue with the export.

Description of fields

Field	Option	Description
to:	**USB-Stick**	The memory device to which data are exported.
DataType:		Data type to be transferred.
	Obs.&Fix	Measured points and fixpoints.
	Observation	Only measured points.
	Known Point	Only fixpoints.
SelJob:	Selectable list	Displays the selected job.

Export data step-by-step

1. Press **OK** in the **Data Export** screen after selecting the export details.
2. Select the data format, enter the file name and press **OK**.

   ASCII: American Standard Code for Information Interchange. Free format. Use and order of variables and delimiter can be defined during import. Continue with step 3..

   IDEX: The Independent Data Exchange format is a Leica proprietary ASCII format used to exchange data between TPS and GPS instruments and software.
3. A message will display confirming the successful export of data.

10.2 Importing Data

Description

Data can be imported to the internal memory of the instrument via USB memory stick. Data are imported from the folder \JOBS of the USB memory stick.

A USB memory stick can be inserted and removed. No additional software is required for the transfer.

Importable data formats

When importing data, the instrument automatically stores the file in a directory folder based on the file extension. The following data formats can be imported:

Data Type	File extension	Recognised as
ASCII	any ASCII file extension e.g. .txt	Fixpoints

Access

1. Select **Transfer** in the **Main Menu**.
2. Select **Data Import** in the **Data Transfer** menu.

Data Import

Key	Description
Back	To return to the last active screen.
OK	To select the file format and continue with the import.

Description of fields

Field	Option	Description
From:	**USB-Stick**	Only option
to:	**Instrument**	Only option
File:	**Single File**	Only option

Import data step-by-step

1. Press **OK** in the **Data Import** screen to proceed to the file directory of the memory device.
2. Select the file to be imported and press **OK**.
   ☞ Files for importing must be placed in the \JOBS folder.
3. Define the job name for the imported file.
4. Press **OK** to proceed
5. Define the delimiter value, the units and the data fields of the file and press **OK** to continue.
6. A message will display once the file has been successfully imported.

11 Tools

11.1 Check & Adjust

11.1.1 Overview

Description

Leica Geosystems 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 check and adjust can be done in the field by running through specific measurement procedures. The procedures are guided and must be followed carefully and precisely as described in the following chapters. Some other instrument errors and mechanical parts can be adjusted mechanically.

Electronic calibration

The following instrument errors can be checked and calibrated electronically:

- Horizontal collimation error, also called line-of-sight error.
- Vertical index error.
- Compensator index error of the electronic level, transversal and longitudinal.

☞ For determining these errors, it is necessary to measure in both faces, but the procedure can be started in any face.

Checking parts

The following instrument parts can be checked:

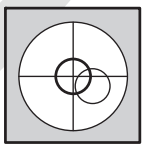
- Circular level on the instrument and tribrach.
- Laser plummet.
- Screws on the tripod.

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

- Before the instrument is used for the first time.
- Before every high precision survey.
- After rough or long periods of transport.
- After long periods of work or storage.
- If the temperature difference between current environment and the temperature at the last calibration is more than 10°C (18°F).

11.1.2 Preparation

☞



Before determining the instrument errors, the instrument has to be levelled using the electronic level.
The tribrach, the tripod and the underground should be stable and secure from vibrations or other disturbances.

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

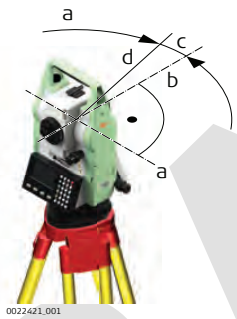
Before starting to work, the instrument has to become acclimatised to the ambient temperature. Take at least 15 minutes into account or approximately 2 minutes per °C of temperature difference from storage to working environment.

11.1.3 Adjusting Line-of-Sight and Vertical Index Error

The procedures and conditions required to correct line-of-sight and vertical index errors are the same, therefore the procedure will only be described once.

Line-of-sight error

The line-of-sight error, or horizontal collimation error is the deviation from the perpendicular between the tilting axis and the line of sight.

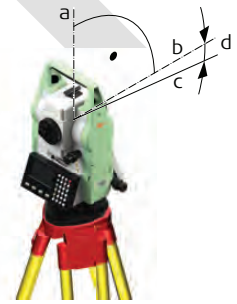


a Tilting axis
b Line perpendicular to tilting axis
c Horizontal collimation, or line-of-sight, error
d Line-of-sight

Vertical index error

A vertical index error exists, if the 0° mark of the vertical circle reading does not coincide with the mechanical vertical axis of the instrument, also called standing axis.

The V index error is a constant error that affects all vertical angle readings.



a Mechanical vertical axis of the instrument, also called standing axis
b Axis perpendicular to the vertical axis. True 90°
c Vertical angle is reading 90°
d Vertical index error

By determining the vertical index error the electronic level is adjusted automatically.

Access

1. Select **Tools** in the **Main Menu**.
2. Select **Check & Adjust** in the **Tools** menu.

3. Select:
   - **Hz Collimation**, or
   - **V-Index**.
   - **Compensator**
   - **View Calibration**.

Calibration options

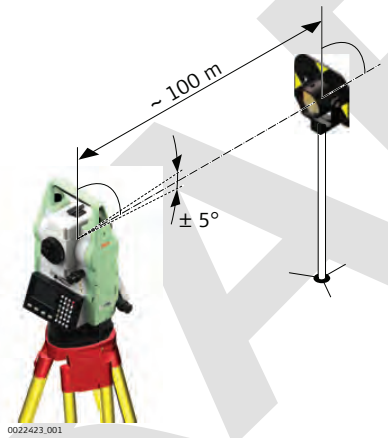
In the **Check & Adjust** screen there are several calibration options.

Menu selection	Description
Hz Collimation	Refer to Check and adjust step-by-step.
V-Index	Refer to Check and adjust step-by-step.
Compensator	Refer to 11.1.4 Adjusting the Compensator.
View Calibration	Displays the current calibration values and compensator indexes that have been set for HA-Collimation and V-index.

Check and adjust step-by-step

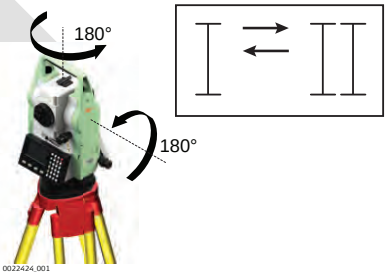
1. Level the instrument with the electronic level. Refer to 4 Operation - Level up with the electronic level step-by-step.

2. Aim at a point approximately 100 m from the instrument which is within 5° of the horizontal.



3. Press **OK** to measure to the target point.

4. Change face and aim at the target point again



☞ For checking the horizontal aim, the difference in Hz and V are displayed.

5. Press **OK** to measure to the target point.

☞ The old and new calculated values are displayed.

6. Either:
   - Press **OK** to save the new adjustment data, or
   - Press ↩ to exit without saving the new adjustment data.

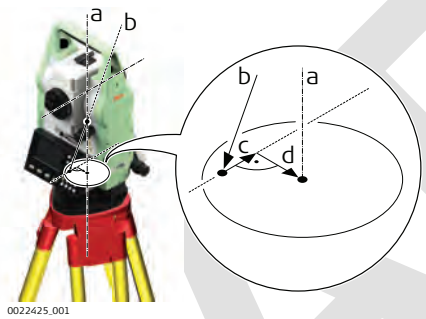
Messages

The following are important messages or warnings that may appear.

Messages	Description
V not suitable\r\nfor Calibration	The vertical angle deviates from the required horizontal / line-of-sight. Aim correctly at the target point. Confirmation of the message required.
Compensator unstable.\r\nPlease remeasure.	Computed values out of tolerance. The previous values are retained and measurements should be repeated. Confirmation of the message required.
Compensator unstable.\r\nPlease remeasure.	Measurement error appears when, for example, there is an unstable set up. Repeat the process. Confirmation of the message required.

11.1.4 Adjusting the Compensator

Compensator index error



a Mechanical vertical axis of the instrument, also called standing axis
b Plumb line
c Longitudinal component (l) of the compensator index error
d Transversal component (t) of the compensator index error

The compensator index errors (l, t) occur, if the vertical axis of the instrument and the plumb line are parallel but the zero points of the compensator and the level do not coincide. The calibration procedure electronically adjusts the zero point of the compensator.

A longitudinal component in direction of the telescope and a transversal component perpendicular to the telescope define the plane of the dual axis compensator of the instrument.

The longitudinal compensator index error (l) has a similar effect as the vertical index error and effects all vertical angle readings.

The transversal compensator index error (t) is similar to the tilting axis error. The effect of this error to the horizontal angle readings is 0 at the horizon and increases with steep sightings.

Access

1.	Select **Tools** in the **Main Menu**.
2.	Select **Check & Adjust** in the **Tools** menu.
3.	Select **Compensator** in the **Calibration** menu.

Check and adjust step-by-step

1.	Level the instrumentl.
2.	Press **OK** to measure the first face. No target has to be aimed at.
3.	**OK** to release the measurement in the other face.

☞ If one or more errors are bigger than the predefined limits, the procedure must be repeated. All measurements of the current run are rejected and are not averaged with the results from previous runs.

4. Measure the target.
The standard deviations of the determined adjustment errors can be calculated from the second run onwards.

11.1.5 Adjusting the Level of the Instrument and Tribrach

Adjust the level step-by-step

1. Place and secure the tribrach onto the tripod, and then secure the instrument onto the tribrach.

2. Using the tribrach footscrews, level the instrument with the electronic level. To activate the electronic level, turn on the instrument, and press the ★ key from within an app. In some panels, access is possible by pressing the - key.

3. The bubbles of the instrument and tribrach levels must be centred. If one or both levels are not centred, adjust as follows.

   Instrument: If the bubble extends beyond the centre marking, use the Allen key supplied to centre it with the adjustment screws.

   Tribrach: If the bubble extends beyond the centre marking, adjust it using the adjustment pin with the adjustment screws. Turn the adjustment screws:

   - To the left: and the bubble approaches the screw.
   - To the right: and the bubble goes away from the screw.

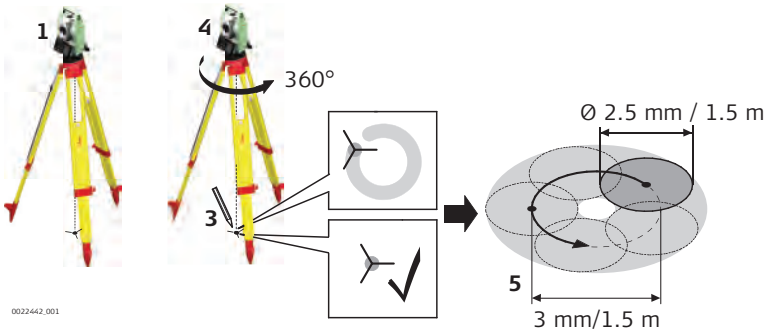
4. Repeat step 3. on the instrument and tribrach until both levels are centred and no further adjustments are necessary.

☞ After the adjustment, no adjustment screw should be loose.

11.1.6 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, return the instrument to any Leica Geosystems authorised service workshop.

Inspect the laser plummet step-by-step



1. Set up the instrument on the tripod approximately 1.5 m above the ground and level up.

2. To activate the laser plummet, turn on the instrument, and press the ⊛ key from within any app and access the level panel.

   ☞ Inspection of the laser plummet should be carried out on a bright, smooth and horizontal surface, such as a sheet of paper.

3. Mark the centre of the red laser dot on the ground.

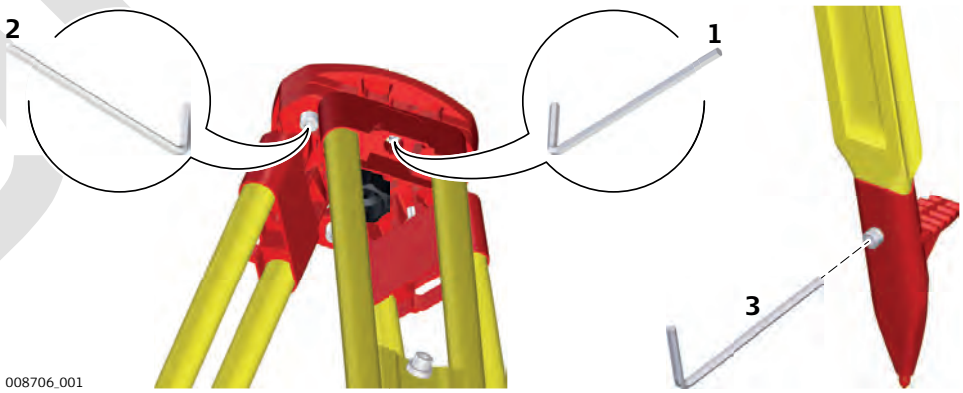
4. Turn the instrument slowly through 360°, carefully observing the movement of the red laser dot.

   ☞ The maximum diameter of the circular movement described by the centre of the laser dot should not exceed 3 mm at a height of 1.5 m.

5. 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 authorised service centre. Depending on brightness and surface, the diameter of the laser dot can vary. At 1.5 m, it is about 2.5 mm.

11.1.7 Servicing the Tripod

Servicing the tripod step-by-step



The following table explains the most common settings.

☞ 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 enough to keep the tripod legs open when lifting the tripod off the ground.

3. Tighten the Allen screws of the tripod legs.

11.2 System Information

Description

The System Information screen displays instrument, system and firmware information, as well as settings for the date and time.

☞ Please provide the instrument-related information, such as instrument type and serial number, as well as the firmware version and build number when contacting support.

Access

1. Select **Tools** in the **Main Menu**.
2. Select **System Information** in the **Tools** menu.

System information

Key	Description
Format	To format the memory. ☞ By activating the format command all data will be lost. Make sure that all important data has been backed up before formatting.
Back	To return to the last active screen.

Description of fields

Field	Option	Description
First line		Displays the current date and time.
Type :	Display only	Displays the instrument type.
SN:	Display only	Displays the serial number of the instrument.
Firmware:	Display only	Displays the firmware version number installed on the instrument.
EDM-FW:	Display only	Displays the version number of the EDM firmware.

11.3 Loading Firmware or License

Description

The software can be loaded via a USB memory stick. This process is described below.

Access

1. Select **Tools** in the **Main Menu**.
2. Select **Upload FW** in the **Tools** menu.

☞ Never disconnect the power supply during the system upload process. The battery must be at least 30% capacity before commencing the upload.

Loading firmware or license step-by-step

1. Store the firmware or license files in the root directory of the USB stick. The upload file has the extension *.key.
2. Insert the USB stick into the instrument.
3. Select **Upload FW** from the **Main Menu**.

4. Select the type to be loaded from the **Upload FW** menu. Press ↵.
   OR
   On the keyboard, press the number of the item in the list.
   - **Mainboard FW**: The firmware installed on the instrument.
   - **EDM FW**: The firmware of the EDM.
   - **BOOTLOADER FW**: The firmware of the bootloader. The bootloader enables loading the operating system within the memory when the instrument is started.
   - **License**: The license key for certain functionality.

5. Press **YES** to confirm the warning message.

6. Once successfully loaded, the system will shut down and restart again automatically.

12 Care and Transport

12.1 Transport

Transport in the field

When transporting the equipment in the field, always make sure that you

- either carry the product in its original 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 container and secure it.

For products for which no container is available use the original packaging or its equivalent.

Shipping

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

Shipping, transport of batteries

When transporting or shipping batteries, the person responsible for 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

Exposing the product to high mechanical forces, for example through frequent transport or rough handling, or storing the product for a long time may cause deviations and a decrease in the measurement accuracy. Periodically carry out test measurements and perform the field adjustments indicated in the User Manual before using the product.

12.2 Storage

Product

Respect the temperature limits when storing the equipment, particularly in summer if the equipment is inside a vehicle. Refer to 13 Technical Data for information about temperature limits.

Li-Ion batteries

- Refer to 13 Technical Data for information about storage temperature range
- 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
- A storage temperature range of 0 °C to +30 °C / +32 °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 40% to 50% charge can be stored for up to one year. After this storage period the batteries must be recharged

12.3 Cleaning and Drying

Product and accessories

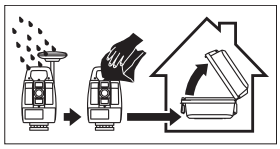
- Blow dust off lenses and prisms.
- Never touch the glass with your fingers.
- Use only a clean, soft, lint-free cloth for cleaning. If necessary, moisten the cloth with water or pure alcohol. Do not use other liquids; these may attack the polymer components.

Fogging of prisms

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. Remove the battery cover and dry the battery compartment. 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.

13 Technical Data

13.1 Angle Measurement

Accuracy

Available angular accuracies	Standard deviation Hz, V, ISO17123-3	Display resolution			
["]	[mgon]	["]	[°]	[mgon]	[mil]
5	1.5	1	0.0001	0.1	0.01

13.2 Distance Measurement with Reflectors

Range

Reflector	[m]*	[ft]*
Standard prism (GPR1)	3000	10000
360° prism (GRZ4, GRZ122)	1500	5000
Reflector tape 60 mm x 60 mm Foil mode,	700	2300
Mini prism (GMP101)	1200	4000

* The distance range can vary depending on the conditions and can be above or below the specified value. The specified range value is referring to non-extreme conditions, visibility about 20 km, moderate sunlight, slight heat shimmer.

Accuracy

Accuracy refers to measurements to standard reflectors.

Distance measuring mode	std. dev. ISO 17123-4, standard prism	Measurement time, typical [s]
Standard	2 mm + 2 ppm	1.5
Quick	-	1.1

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy.

Characteristics

Type	Description
Principle	Phase measurement
Type	Coaxial, visible red laser
Carrier wave	685 nm
Measuring system	Phase surveying about 75 MHz (74.926925 MHz)

13.3 Distance Measurement without Reflectors (Non-Prism mode)

Range

Kodak Gray Card	[m]*	[ft]*
White side 90% reflective	500	1640
Grey side 18% reflective	200	820

* The distance range can vary depending on the conditions and can be above or below the specified value. The specified range value is referring to non-extreme conditions, visibility about 20 km, moderate sunlight, slight heat shimmer.

Accuracy

	ISO17123-4	Measure time, typical [s]
Standard measuring	3 mm + 2 ppm	1.1 in **Quick** mode 1.4 in **Standard** mode
>200m	5 mm + 3 ppm	-

Beam interruptions, severe heat shimmer and moving objects within the beam path can result in deviations of the specified accuracy and measurement time.

Laser dot size

Distance [m]	Laser dot size, approximately [mm]
at 50	12 × 24

Characteristics

Type	Description
Principle	Phase measurement
Type	Coaxial, visible red laser
Carrier wave	685 nm
Measuring system	Phase surveying about 75 MHz (74.926925 MHz)

13.4 General Technical Data of the Product

Telescope

Type	Value
All-around rotation	
Magnification	28 x
Objective diameter	44 mm
Focusing range	1.50 m/4.92 ft to infinity
Field of view	1°30'/1.66 gon
Field width at 100 m	2.8 m

Compensation

Compensator range: ±8'

Level

Type	Value
Longitudinal level sensitivity	2'/2 mm

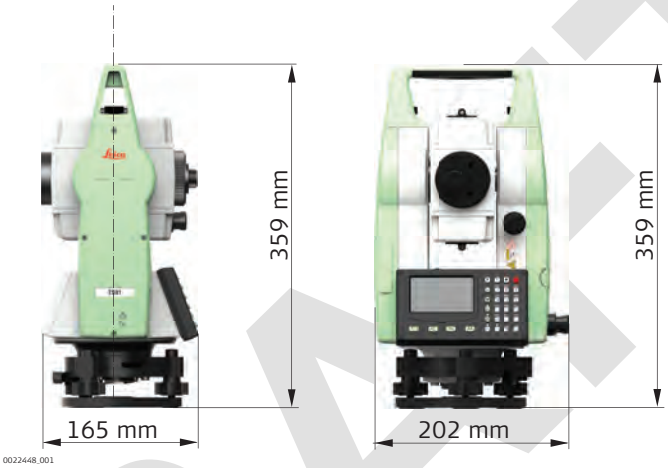
Control unit

Type	Description
Resolution ratio	240 x 128 pixels, greyscale
Display lightning	Background light available
Number of keys	28

Instrument ports

Name	Description
USB device port	Cable connection from USB device to PC for communication
WLAN	WLAN connection for Internet access, communication
USB host port	Port for USB memory stick for data transfer

Instrument dimensions



Weight

Type	Value
Instrument With battery and tribrach	5.9 kg

Tilting axis height

Type	Description
Without tribrach	196 mm
With tribrach (GDF301)	237 mm ± 5 mm

Recording

Memory Type	Number of measurements
Internal memory	50,000

Laser plummet

Type	Description
Type	Visible red laser class 2
Location	In standing axis of instrument
Accuracy	Deviation from plumb line 1.5 mm at 1.5 m instrument height
Diameter of laser point	2.5 mm at 1.5 m instrument height

Internal battery

Type	Battery	Voltage	Capacity	Operating time, typically*
GEB264	Li-Ion	7.2 V	4.4 Ah	≤ 24 h

* Based on single measurements at 25°C. Operating time may be shorter if battery is not new.

Environmental specifications

Temperature

Operating temperature [°C]	Storage temperature [°C]
-20 to +50	-30 to +55

Protection against water, dust and sand

IP55 (IEC 60529)

Humidity

Max 95 % non condensing.

The effects of condensation are to be effectively counteracted by periodically drying out the instrument.

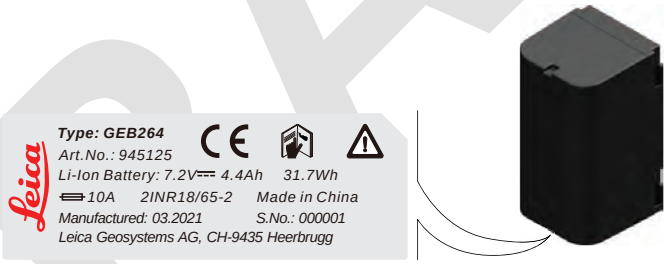
Automatic corrections

The following automatic corrections are made:

- Line of sight error
- Vertical index error
- Compensator error

13.5 Conformity to National Regulations

Labelling GEB264



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13.5.1 TS01

13.5.1.1 EU Declaration of Conformity

EU

Hereby, Leica Geosystems AG declares that the radio equipment type TS01 is in compliance with Directive 2014/53/EU and other applicable European Directives.

Europe

Class 1 equipment according to European Directive 2014/53/EU (RED) can be placed on the market and be put into service without restrictions in any EEA member state.

- The conformity for countries with other national regulations not covered by the European Directive 2014/53/EU has to be approved prior to use and operation.

Frequency band (for EU)

Type	Frequency band [MHz]
WLAN	2412 - 2472
Bluetooth LE	2402 - 2480

Output power (for EU)

Type	Output power [mW]
WLAN	8.63 (cond.)
Bluetooth LE	2.63 (cond.)

Antenna (for EU)

Type	Antenna	Gain [dBi]	Connector
WLAN Bluetooth LE	Internal Patch antenna	3 max.	-

13.5.1.2 FCC Declaration of Conformity

☞ This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

USA

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. If not installed and used in accordance with the instructions, it may cause harmful interference to radio communications.

However, there is no guarantee that interference does 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.

⚠CAUTION

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

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body. This trans-

mitter must not be co-located or operating in conjunction with any other antenna or transmitter.

13.5.2 Dangerous Goods Regulations

Dangerous Goods Regulations

Many products of Leica Geosystems are powered by Lithium batteries.

Lithium batteries can be dangerous under certain conditions and can pose a safety hazard. In certain conditions, Lithium batteries can overheat and ignite.

☞ When carrying or shipping your Leica product with Lithium batteries onboard a commercial aircraft, you must do so in accordance with the **IATA Dangerous Goods Regulations**.

☞ Leica Geosystems has developed **Guidelines** on "How to carry Leica products" and "How to ship Leica products" with Lithium batteries. Before any transportation of a Leica product, we ask you to consult these guidelines on our web page (http://www.leica-geosystems.com/dgr) to ensure that you are in accordance with the IATA Dangerous Goods Regulations and that the Leica products can be transported correctly.

☞ Damaged or defective batteries are prohibited from being carried or transported onboard any aircraft. Therefore, ensure that the condition of any battery is safe for transportation.

13.6 Scale Correction

Use of scale correction

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

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

For highest precision distance measurements, the atmospheric correction should be determined with:

- An accuracy of 1 ppm
- Air temperature to 1 °C
- Air pressure to 3 mbar

Formulas

Formula for visible red laser

$$\Delta D_1 = 286.338 - \left[\frac{0.29535 \cdot p}{(1 + \alpha \cdot t)} - \frac{4.126 \cdot 10^{-4} \cdot h}{(1 + \alpha \cdot t)} \cdot 10^{x} \right]$$

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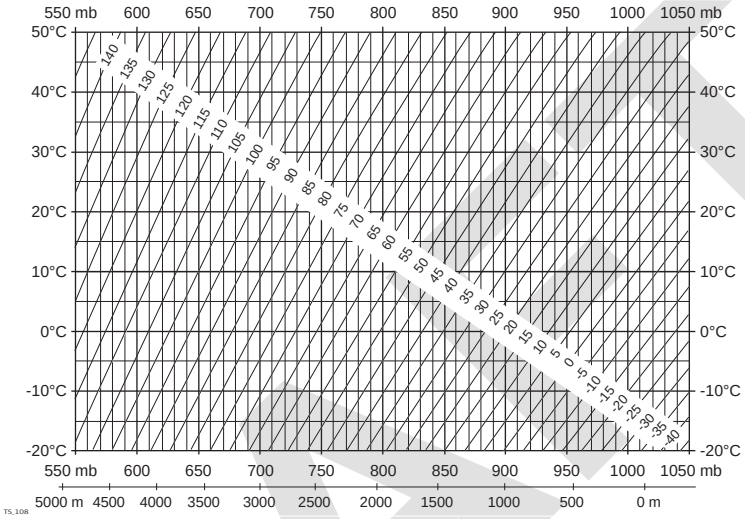
ΔD_1	Atmospheric correction [ppm]
p	Air pressure [mbar]
t	Air temperature [°C]
h	Relative humidity [%]
α	$\frac{1}{273.15}$
x	(7.5 * t/(237.3 + t)) + 0.7857

The formula with a relative humidity value of 0% is applied.

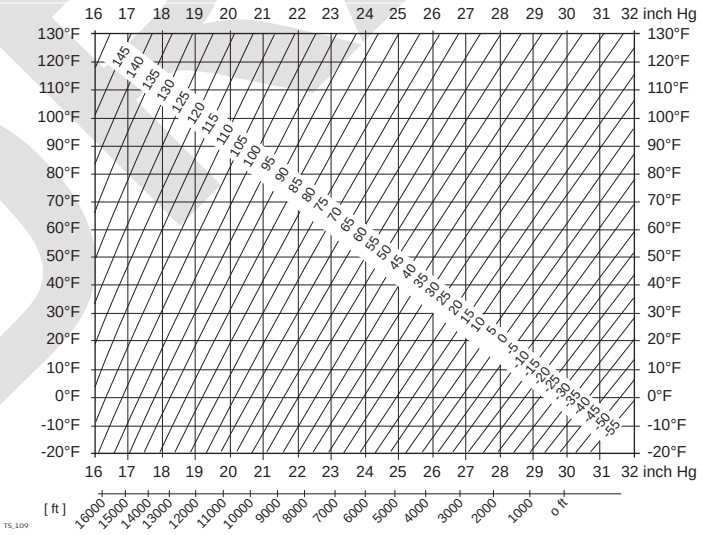
Atmospheric corrections °C

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



Atmospheric corrections °F

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



13.7 Reduction Formulas

Reflector types

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

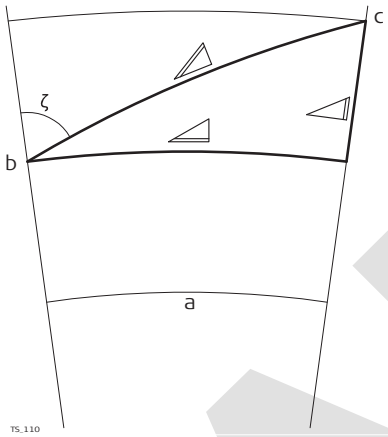
- To prisms
- To reflector tape
- Reflectorless measurements

Slope distance - corrections

Available formats depend on the instrument.

Format	Description
• Instrument display • ASCII	• Corrections for the atmospheric ppm are applied to the slope distances according to the formulas.

Formulas



a Mean Sea Level
b Instrument
c Reflector

◿ Slope distance
◿ Horizontal distance
◿ Height difference

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

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

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

$$◿ = Y - A \cdot X \cdot Y$$

TS_112

$$◿ = X + B \cdot Y^2$$

TS_113

◿ 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) / (2 * R) = 6.83 * 10^{-8} [m^{-1}]
k 0.13 (mean refraction coefficient)
R 6.378 * 10^6 m (radius of the earth)

Earth curvature (1/R) and mean refraction coefficient (k) 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.

14 Software Licence Agreement/Warranty

Software Licence Agreement

This product contains software that is preinstalled on the product, or that is supplied to you on a data carrier medium, or that can be downloaded by you online according to prior authorisation from Leica Geosystems. Such software is protected by copyright and other laws and its use is defined and regulated by the Leica Geosystems Software Licence Agreement, which covers aspects such as, but not limited to, Scope of the Licence, Warranty, Intellectual Property Rights, Limitation of Liability, Exclusion of other Assurances, Governing Law and Place of Jurisdiction. Please make sure, that at any time you fully comply with the terms and conditions of the Leica Geosystems Software Licence Agreement.

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Appendix A Menu Tree

Menu tree

|-- Apps
| |-- Survey
| |-- Set Out
| |-- OffSet
| |-- Miss.Line Measure(MLM)
| |-- Remote Elevation
| |-- Area
| |-- Resection
| |-- Reference Line
| |-- Road
|-- Survey
|-- Manage
| |-- Memory Information
| |-- Job
| |-- Observations
| |-- Known Points
| |-- Code Library
| |-- Erase Memory
|-- Transfer
| |-- Data Export
| |-- Data Import
|-- Settings
| |-- Unit Setting
| |-- Parameters Setting
| |-- Display Setting
| |-- Other Setting
| |-- Shortcut Keys Setting
| |-- K1 Setting
| |-- K2 Setting
| |-- EDM Setting
| |-- Time and Date Setting
| |-- Key Function
| |-- Key distribution
| |-- Key function consignment
| |-- Key function recovery
| |-- Wifi Setting
|-- Tools
| |-- Calibration
| |-- Hz Collimation
| |-- V-Index
| |-- Compensator
| |-- View Calibration
| |-- System Information
| |-- Upload FW
| |-- Mainboard FW
| |-- EDM FW
| |-- BOOTLOADER FW
| |-- License

Appendix B Directory Structure

Description

On the internal memory, files are stored in certain directories. The following diagram is the default directory structure.

Directory structure

|-- JOBS |	Files for import/export to/from job
|-- SYSTEM	Firmware files
|-- ROADS	Files for import/export to/from the Roads app: • Chainage points: *.FPT • Alignement definition: *.HLN • Road Set out points: *.STR

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PART OF HEXAGON

- when it has to be right

Leica Geosystems