Leica
GEOSYSTEMS

Leica TS20

User Manual

English
Version 1.0
Model: TPS1

HEXAGON

Introduction

Purchase

Congratulations on the purchase of the Leica TS20.

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.

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

https://myworld-portal.leica-geosystems.com/ > myDownloads

Product identification

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

Always refer to this information when contacting your agency or Leica Geosystems authorised service centre.

Trademarks

- Linux® is a registered trademark of Linus Torvalds in the U.S. and other countries.
- *Bluetooth*® is a registered trademark of Bluetooth SIG, Inc.
- USB-C® is a registered trademark of USB Implementers Forum
- LEMO® is a registered trademark of Lemo SA

All other trademarks are the property of their respective owners.

Validity of this manual

This manual applies to the TS20.

Available documentation

Name	Description/Format		
TS20 Quick Guide	Provides an overview of the product together with technical data and safety directions. Intended as a quick reference guide.	✓	✓
TS20 User Manual	All instructions required in order to operate the product to a basic level are contained in the User Manual. Provides an overview of the product together with technical data and safety directions.	-	✓
Name	**Description/Format**		
Captivate Technical Reference Manual	Overall comprehensive guide to the product and apps. Included are detailed descriptions of special software/hardware settings and software/hardware functions intended for technical specialists.	-	✓

Refer to the following resources for documentation/software:

https://myworld-portal.leica-geosystems.com/

Video tutorials are available on:
http://www.leica-geosystems.com/captivate-howto

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.

https://myworld-portal.leica-geosystems.com/ 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
My Products	Register 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.
My Service	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.
My Support	Create new support requests for your products that will be answered by your local Leica Geosystems support team. View your complete support history and view detailed information on all your support requests.
Knowledge	Enter key words and start searching in our knowledge base. You can find FAQs (Frequently asked questions) as well as Knowledge articles for Leica Geosystems products.
Downloads	Downloads of software, manuals, tools, training material and news for Leica Geosystems products. Download the latest documentation and software to keep yourself and your products up-to-date. You can access downloads of software, manuals, tools, and training material.

Service	Description
Online Learning	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).
My SmartNet	Add and view your HxGN SmartNet subscriptions and user information. HxGN SmartNet delivers high-precision and high-availability GNSS network correction services in real-time and around the globe. The HxGN SmartNet Global family offers Network RTK with RTK bridging and Precise Point Positioning (PPP) services. These services work exclusively with Leica Geosystems GS smart antennas and receivers, providing the highest accuracy. Combined, they ensure HxGN SmartNet coverage everywhere.
My Trusted Services	Leica Geosystems Trusted Services offer you increased productivity while at the same time providing maximum security. New software services and state-of-the-art IT infrastructure offer a vast potential to optimise your workflow and increase your efficiency and productivity, both now and in the future.
My Security	Leica Geosystems Security delivers you total peace-of-mind in knowing that if your instrument is ever stolen, a locking mechanism is available to ensure that the instrument is disabled and can no longer be used.

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PART 1
TS20

1 Safety Directions

1.1 General Introduction

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.

Additional symbols

Warning against flammable substances.

Warning against explosive material.

Product must not be opened or modified or tampered with.

Indicates the temperature limits at which the product may be stored, transported or used.

1.2 Definition of Use

Intended use

- Automatic target search, recognition and tracking
- Capturing and recording images
- Computing with software
- Data communication with external appliances
- Measuring distances
- Measuring horizontal and vertical angles
- Recording measurements
- Remote control of product
- Visualising the aiming direction

Foreseeable misuse

- Aiming directly into the sun
- Deliberate laser exposure to third parties
- Disabling of safety systems
- Inadequate safeguards at the working site
- Modification or conversion of the product
- Opening the product using tools, for example a screwdriver, unless this is permitted for certain functions
- Removal of hazard notices
- Use after misappropriation
- Use of products with recognisable damage or defects
- Use of the product without instructions
- Use outside of the intended use and limits
- Use with accessories from other manufacturers without the prior explicit approval of Leica Geosystems

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.

☞ The following advice is only valid for battery charger, power adapter and car adapter.

Environment

Suitable for use in dry environments only and not under adverse 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 the product 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
- Only certified operators who attended the training and read the User Manual should operate the TS20

1.5 Hazards of Use

⚠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.

⚠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.

⚠CAUTION

Dropping the product

When being dropped, the product can cause personal injury and/or mechanical damage.

Precautions:

- Secure the product when operating it.

⚠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.

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.

NOTICE

Remote control of product

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

Precautions:

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

⚠ 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.

NOTICE

Improper shut down of the system

This could lead to a loss of essential system information.

Precautions:

- Always ensure proper shut down of the system. Do not force shut down of the system.
- Release the power switch as soon as the shut-down splash screen appears.
- Usage of external battery or uninterrupted power supply (UPS) is recommended in an environment with frequent power outages or instable power grid.

NOTICE

Removal of battery during operation or shutdown

This can result in a file system error and data loss!

Precautions:

- Do **NOT** remove the battery during operation of the instrument, or during the shutdown procedure.
- Always switch off the instrument by pressing the On/Off key, and wait until the instrument has shutdown completely before removing the battery.

⚠CAUTION

Damage to instrument

Cleaning the instrument while the device is switched on can damage the instrument or the battery.

Precautions:

- ▸ Before cleaning, switch off the instrument and remove the battery.

⚠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.

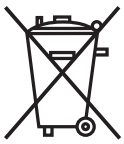
⚠WARNING

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.

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.

⚠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.

All hazards associated with batteries also apply to products with non-removable batteries.

⚠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.
- Consider the products IP class restrictions in chapter 7 Technical Data.
- Do not drop or immerse the product with damaged housing into fluids.

⚠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

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/conductive objects.

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 60825-14:2022. 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 60825-14:2022, 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 60825-14:2022.

1.6.2 Distancer, Measurements with Reflectors

General

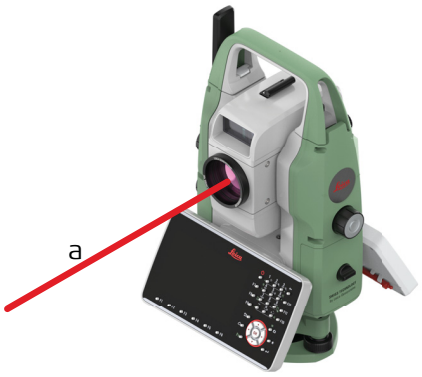
The EDM module built into the product produces a visible laser beam which emerges from the telescope objective.

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	658 nm
Maximum radiant power	0.34 mW
Pulse duration	<1 ns
Pulse repetition frequency (PRF)	1 MHz
Beam divergence	1.6 mrad



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 R800 laser products described in this section are classified as laser class 2 and the R1600 laser products described in this section are classified as laser class 3R in accordance with:

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

Description	Value R800	Value R1600
Wavelength	658 nm	658 nm
Maximum radiant power	0.95 mW	1.8 mW
Pulse duration	<1 ns	<1 ns

Description	Value R800	Value R1600
Pulse repetition frequency (PRF)	2 MHz	2 MHz
Beam divergence	0.15 mrad × 0.24 mrad	0.15 mrad × 0.24 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25 s	-	33 m / 108 ft

R800 laser class 2 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.

⚠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.

R1600 laser class 3R 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.

⚠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 R800 laser products described in this section are classified as laser class 2 and the R1600 laser products described in this section are classified as laser class 3R in accordance with:

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

Description	Value R800	Value R1600
Wavelength	658 nm	658 nm
Maximum radiant power	0.95 mW	3.7 mW
Pulse duration	<1 ns	<1 ns

Description	Value R800	Value R1600
Pulse repetition frequency (PRF)	2 MHz	8 MHz
Beam divergence	0.15 mrad × 0.24 mrad	0.15 mrad × 0.24 mrad
NOHD (Nominal Ocular Hazard Distance) @ 0.25 s	-	62 m / 203 ft

R800 laser class 2 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.

⚠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.

R1600 laser class 3R 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.

⚠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 Automatic Target Aiming (ATR)

General

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

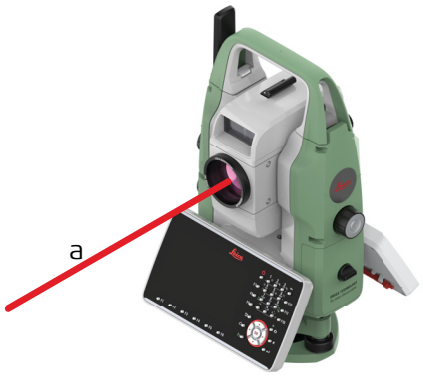
The laser product described in this section is classified as laser class 1 in accordance with:

- IEC 60825-1 (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	785 nm
Maximum radiant peak power per pulse	20 mW

Description	Value
Pulse duration	30 µs–8 ms
Pulse repetition frequency	529 Hz–58 Hz
Beam divergence	26 mrad × 26 mrad
Source type	Extended



29898_001

a Laser beam

1.6.6 PowerSearch (PS)

General

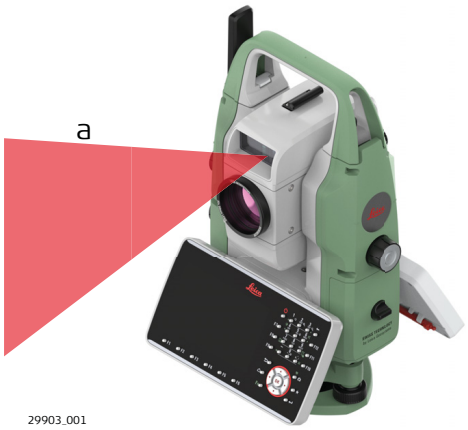
The PowerSearch built into the product produces an invisible laser beam which emerges from the front side of the telescope.

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	850 nm
Maximum average radiant power	15 mW
Pulse duration	17 ns (weak pulse) 27 ns (strong pulse)
Pulse repetition frequency (PRF)	46.8 kHz
Beam divergence	0.4 mrad × 680 mrad
Source type	Extended



a Laser beam

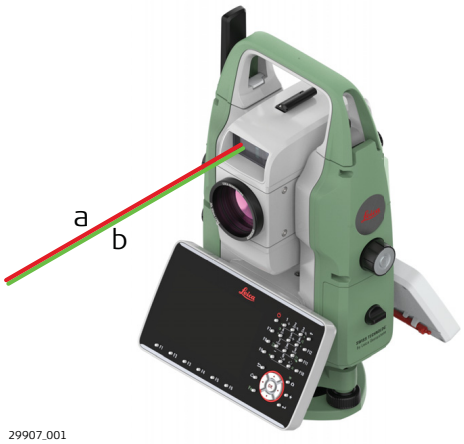
1.6.7 Electronic Guide Light (EGL)

General

The Electronic Guide Light built into the product produces a visible LED beam which emerges from the front side of the telescope.

The product described in this section, is excluded from the scope of IEC 60825-1 (2014-05): “Safety of laser products”.

The product described in this section, is classified as exempt group in accordance with IEC 62471 (2006-07) and does not pose any hazard provided that the product is used and maintained in accordance with this user manual.



a LED beam red
b LED beam green

1.6.8 AutoHeight 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	635 nm

Description	Value
Maximum average radiant power	0.95 mW
Pulse duration	<1 ns
Pulse repetition frequency (PRF)	320 MHz
Beam divergence	<1.5 mrad

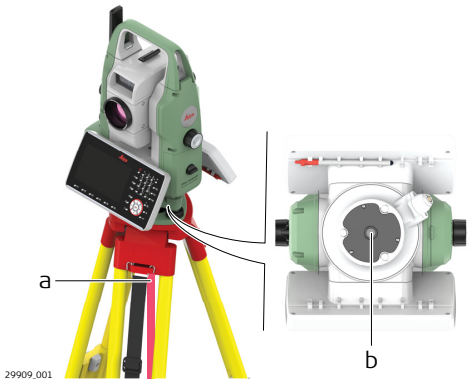
⚠CAUTION

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.



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.

⚠CAUTION

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, digital cellular phones or products with Bluetooth

⚠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.

☞ This warning also applies when using products with Bluetooth.

2 Description of the System

2.1 System Components

Main components

Component	Description
TS20 instrument	• a total station for measuring and calculating data. • consisting of various variants with a range of accuracy classes. • combined with the multi-purpose CS20 field controller, the CS30 tablet, the CC180 tablet or the CC200 tablet to conduct remote control surveys. • connected with Infinity to view, exchange and manage data.
CS20 field controller	A multipurpose 5" screen field controller allowing the remote control of the TS20 instrument.
CS30 tablet	A 7" tablet allowing the remote control of the TS20 instrument.
CC180 tablet	A 8" tablet allowing the remote control of the TS20 instrument.
CC200 tablet	A 10.1" tablet allowing the remote control of the TS20 instrument.
AutoPole (AP)	A product group with active sensor components which can be attached to AP Reflector Poles. The AP can communicate with total station, field controller or tablet.
AP Reflector Pole	A dedicated group of reflector poles with passive sensing elements inside, capable to carry an AutoPole. Without AutoPole, an AP Reflector Pole can also be used as conventional pole.
Infinity	The office software including a series of help programmes which support working with Leica instruments.

Terms and abbreviations

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

Term	Description
Remote Mode	The instrument is remote controlled by the field controller or tablet using radio.
EDM	Electronic Distance Measurement EDM refers to the laser distancer incorporated into the instrument which enables distance measurement. Two measuring modes are available: • **Prism** mode. This mode refers to the ability to measure distances to prisms and reflective tapes. • **Any surface** mode. This mode refers to the ability to measure distances without prisms.
PinPoint	PinPoint refers to the Reflectorless EDM technology which enables an increased measuring range with a smaller laser spot size. Two options are available: R800 and R1600.
EGL	Electronic Guide Light An EGL fitted to an instrument assists with prism targeting. It consists of two differently coloured flashing lights located in the instrument telescope housing. The person holding the prism can align themselves into the line-of-sight of the instrument.
Motorised	Instruments fitted with internal motors, enabling automatic horizontal and vertical turning are referred to as Motorised.
ATR	Automatic Target Aiming ATR refers to the instrument sensor which enables the automatic target aiming and locking to a prism.
Autofocus	Instruments equipped with autofocus offer an automatic focussing of the telescope optics.
Automated	Instruments fitted with ATR are referred to as Automated. Three automation modes are available with Aim at target: • Manual: No automation and no lock. • Automatic: Automatic target aiming to a prism. • LOCK: An already targeted prism is followed automatically.
OVC	Overview camera is located in the upper part of the telescope housing and has a fixed focus.
PS	PowerSearch refers to the instrument sensor which enables the automatic rapid finding of a prism or tape.
Communication compartment	Communication compartment with integrated Bluetooth, USB-C port and WLAN is standard for a TS20 instrument and a component for remote mode.
Mobile connectivity	Integrated dual eSIM module for theft deterrence service (HxGN GeoCloud Protect), fleet management and data exchange as an option.

Available variants

Variant	TS20 A	TS20 P	TS20 I
Angle measurement	✓	✓	✓
Distance measurement to prism	✓	✓	✓

Variant	TS20 A	TS20 P	TS20 I
Distance measurement to any surface (reflectorless)	✓	✓	✓
Motorised	✓	✓	✓
Automatic Target Aiming	✓	✓	✓
PowerSearch (PS)	–	✓	✓
Overview camera (OVC)	–	–	✓
Ethernet, Power and USB-C interface	✓	✓	✓
Bluetooth	✓	✓	✓
Internal Flash Memory (32 GB)	✓	✓	✓
Guide Light (EGL)	✓	✓	✓
WLAN	✓	✓	✓
Mobile connectivity (GMI01)	o	o	o

✓Standard – Not available o Option

2.2 System Concept

2.2.1 Software Concept

Description

All instruments use the same software concept.

Software

Software type	Description
TS firmware and apps	The total station operates with the Leica Captivate software, which provides all essential instrument functions. The firmware includes the main apps and all supported languages. These components are embedded in the system and cannot be removed. Some integrated features and applications are license-protected. To use these, the corresponding software article must be purchased.
Optional apps	A variety of optional, survey-specific apps is available for the total station. These need to be installed separately. While some of these apps can be used without a license, others require a subscription that grants access to the full range of optional apps. A detailed description is available in the Captivate Technical Reference Manual, in the Regional configurator description.
Trial use	All licence-protected features and apps can be trailed. A 14-day trial licence can be activated directly within Leica Captivate and is available once per calendar year.

Software upload

☞ Uploading software can take some time. Ensure that the battery is at least 80% full before you start the upload. Do not remove the battery during the upload process.

Software update instructions for all TS models:

1.	Download the most recent firmware file from https://myworld-portal.leica-geosystems.com/. Refer to .
2.	Copy the firmware file into the **System** folder on the memory device.
3.	Start the instrument. Select **Settings\Tools\Update software**. Select the firmware file and start the update.
4.	When the update is complete, a message appears.

2.2.2 Power Concept

General

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

Power options

Variant	Power supply
all TS variants	Internally by GEB461 battery, OR Externally by GEV306 or GEV303 cable and GEB373 battery. Externally by GEV306 or GEV303 cable and GEV270 power supply. If an external power supply is connected and the internal battery is inserted, then the external power is used.

2.2.3 Data Storage Concept

Description

Data is stored on a memory device. The memory device can be an USB stick or internal memory. For data transfer the USB stick can also be used.

Memory device

Device	Description
USB stick	All instruments have an USB-C port fitted as standard.
Internal memory	All instruments have an internal memory fitted as standard. Available capacity: 32 GB.

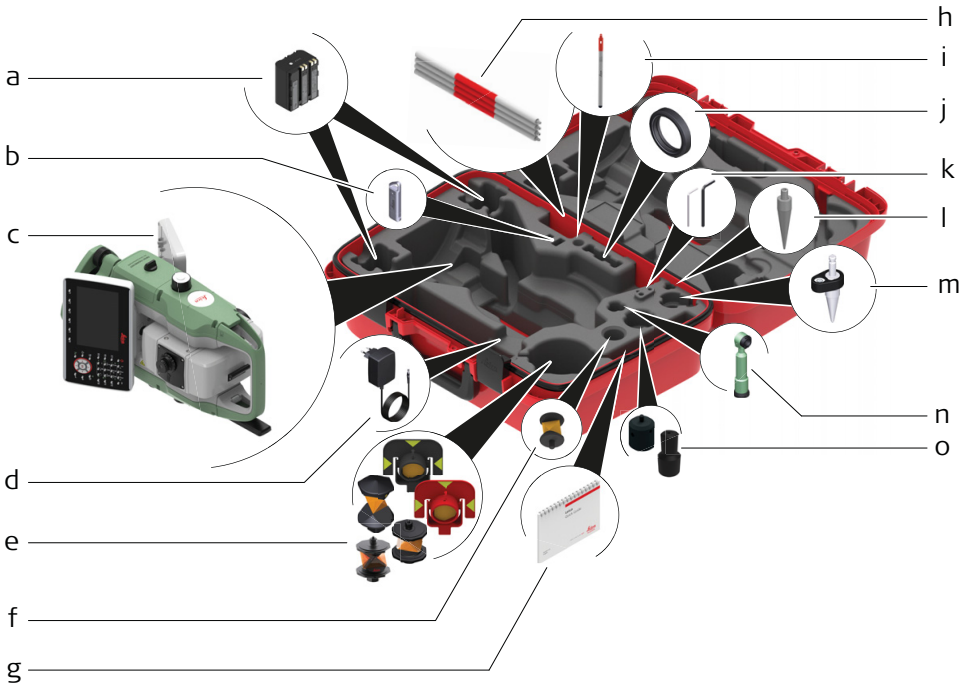
☞ While other USB sticks can be used, Leica Geosystems recommends to only use Leica USB sticks and is not responsible for data loss or any other error that can occur while using a non-Leica USB stick.

☞

- To ensure safe removal of the USB stick, the instrument must either be powered off, or the USB stick must be ejected from within the Leica Captivate field software.
- Removing the USB stick unsafely may result in data loss or damage to the file system.

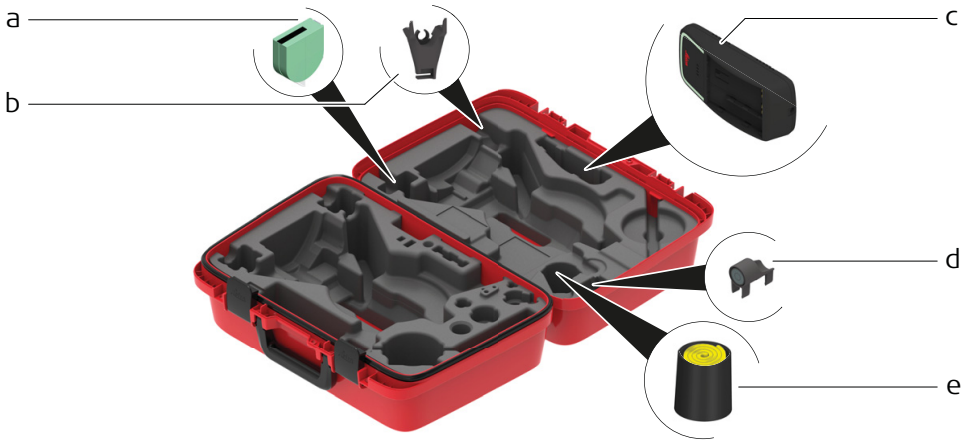
Refer to 4.8 Working with the Memory Device.

Container for instrument and accessories - part 1 of 2



a GEB461 batteries
b MS16, 16GB USB-C memory stick
c Instrument with tribrach
d GEV192 AC power supply for battery charger and cables
e GRZ4/GRZ122/MPR122 or GPR121/GPR111 prism
f GRZ101 mini prism
g Quick Guide and reflective tapes
h GLS115 four section pole for GRZ101
i Stylus (GDZ72)
j Counterweight for diagonal eyepiece
k Allen key and adjustment tool
l Tip for GLS115 and GRZ101
m GLS14 mini pole
n GFZ3 diagonal eyepiece
o GAD103 or GAD105 mini prism adapter

Container for instrument and accessories - part 2 of 2



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a GHM007 Instrument height metre
b Holder for height metre (GHT196)
c GKL311 battery charger
d GLI115 clip on bubble for GLS115 mini pole
e Protective cover for instrument, sunshade for objective lens, cleaning cloth and spare part tips for GDZ72 stylus

Container for TS robotic pole setup, small-size

30513_001

a Manuals
b GAT25 radio antenna
c Tip for GLS115 and GRZ101
d GRZ4/GRZ122 and MPR122 prism
e SD card and cover
f Allen key and adjustment tool
g GRZ101 mini prism and GAD103 adapter
h GEB334, GEB260 or CBA5 battery
i GHT63 pole holder clamp
j Stylus
k GLS115 four section pole for GRZ101
l GLI115 clip on bubble for GLS115 mini pole
m CC180 with GHT90 holder, CS20 with GHT62 holder or CS30 or CSX8 tablet
n GHT87 holder for CSX8

2.4 Instrument Components

Instrument components part 1 of 2

a Carry handle
b Optical sight
c Telescope, integrating EDM, ATR, EGL, PS, overview camera
d EGL flashing diode - green and red
e Overview camera
f PowerSearch, transmitter
g PowerSearch, receiver
h Coaxial optics for angle and distance measurement, exit port of visible laser beam for distance measurements
i Loudspeaker
j USB stick compartment
k 6 pin LEMO for power, communication and data transfer
l Tribrach securing screw
m Horizontal drive with user defineable key
n Focus drive with Autofocus button
o Second keyboard (optional)

Instrument components part 2 of 2

a Vertical drive with user defineable key
b Interchangeable eyepiece
c Circular level
d Battery compartment
e Tribrach footscrew
f Touch screen
g Stylus for touch screen
h Keyboard

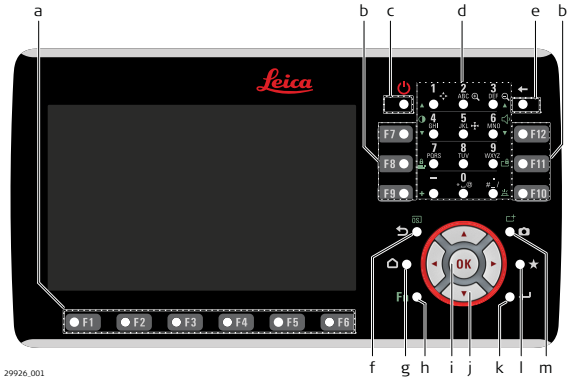
Communication side cover

a BT antenna
b Compartment lid
c USB-C port for USB stick

3 User Interface

3.1 Keyboard

Keyboard



a Function keys F1-F6
b Function keys F7-F12
c ON/OFF
d Alphanumeric keys
e Backspace
f Esc
g Home
h Fn
i OK
j Arrow keys
k Enter
l Favourites
m Camera

Keys

Key		Function
Function keys **F1 to F6**		Correspond to six softkeys that appear on the bottom of the screen when the screen is activated.
Function keys **F7 to F12**		User definable keys to execute chosen commands or access chosen screens.
Alphanumeric keys		To type letters and numbers.
Camera		To capture an image with the camera.
Esc		Leaves the current screen without storing any changes.
Fn		Switches between first and second level of any key on the keyboard.
Enter		Selects the highlighted line and leads to the next logical menu / dialogue. Starts the edit mode for editable fields. Opens a selectable list.
ON/OFF		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.
Favourites		Goes to a favourites menu.
Home		Switches to the Home Menu.

Key	Function
Arrow keys 	Move the focus on the screen.
OK 	Selects the highlighted line and leads to the next logical menu / dialogue. Starts the edit mode for editable fields. Opens a selectable list.
Backspace 	Deletes the job in the centre of the job carousel.

Key combinations

Key	Function
Fn + 	Hold **Fn** while pressing  . Switch to desktop.
Fn + 	Hold **Fn** while pressing  . Take a screenshot of the current screen.
Fn + 	Hold **Fn** while pressing **1**. Increase the screen brightness.
Fn + 	Hold **Fn** while pressing **4**. Decrease the screen brightness.
Fn + 	Hold **Fn** while pressing **3**. Increase the volume for acoustic warning signals, beeps and key presses on the instrument.
Fn + 	Hold **Fn** while pressing **6**. Decrease the volume for acoustic warning signals, beeps and key presses on the instrument.
Fn + 	Hold **Fn** while pressing **7**. Lock/unlock the keyboard.
Fn + 	Hold **Fn** while pressing **9**. Lock/unlock the touch screen.
Fn + 	Hold **Fn** while pressing  . Enter a plus sign instead of a minus sign.
Fn + 	Hold **Fn** while pressing  . Turn the keyboard illumination on/off.

Keyboard and touch screen

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

Operation by keyboard

Information is selected and entered using the keys.

Operation by touch screen

Information is selected and entered on the screen using the supplied stylus or finger.

Operation	Description
To select an item	Tap on the item.
To start the edit mode in editable fields	Tap on the editable field.
To select multiple items in the 3D viewer	Drag the supplied stylus from the left to the right.
To accept data entered into an editable field and exit the edit mode	Tap on the screen outside of the editable field.
To select an item in the 3D viewer and open the context menu	Tap on the item and hold for 2 s.
To zoom in	Tap in the 3D viewer area using two fingers and move them apart. 
To zoom out	Tap in the 3D viewer area using two fingers and bring them closer together. 

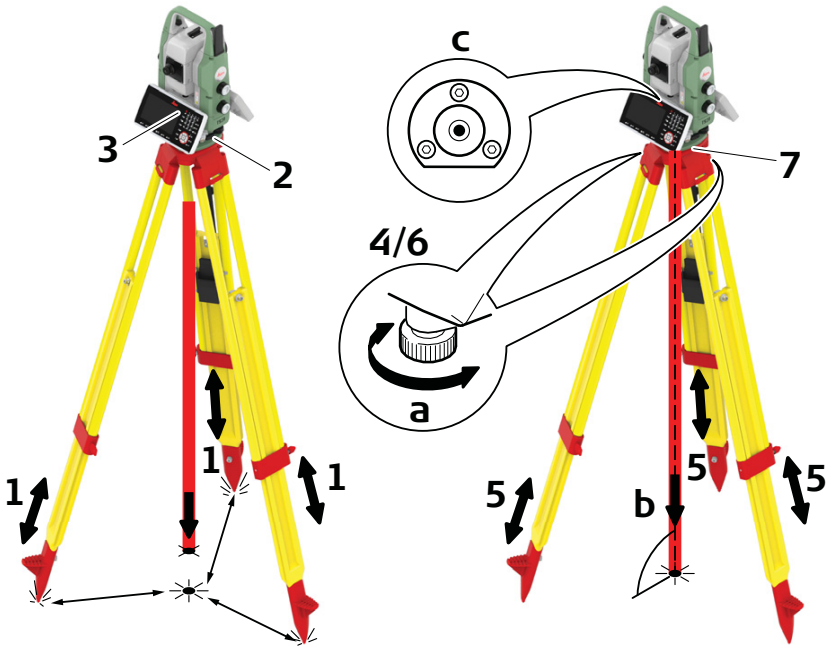
Operation on CC180/CC200/CS30 and other Windows tablets for quick text deletion

Operation	Description
To highlight a whole text for editing	Two options are available: • Double-click the text. • Long-press (press-and-hold) on the text.
To delete a whole text	Highlight a whole text for editing. Press the ⇦ key on the virtual keyboard.
To delete a whole text and enter new text at the same time	Highlight a whole text for editing. Type the characters for the new text on the virtual board.
To set the cursor at the beginning of a text	Highlight a whole text for editing. Press the ◀ key on the virtual keyboard.

Operation	Description
To set the cursor at the end of a text	Highlight a whole text for editing. Press the ▶ key on the virtual keyboard.
To delete the text in the code editable field	Highlight a whole text for editing. Press **Ctrl** plus ⌫ on the virtual keyboard at the same time.

4.1 Setting Up the TS Instrument

Instrument setup step-by-step



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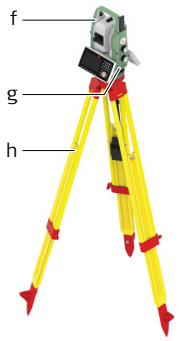
☞	Shield the instrument from direct sunlight and avoid uneven temperatures around the instrument.
1.	Extend the tripod legs to allow for a comfortable working posture. Position the tripod above the marked ground point, centring it as good as possible. Ensure that the tripod plate is roughly horizontal.
2.	Fasten the tribrach and instrument onto the tripod.
3.	Turn on the instrument by pressing ⏻ ◎. Select **Settings**/**TS instrument**/**Level & compensator** to activate the laser plummet and electronic level.
4.	Use the tribrach footscrews (a) to centre the plummet (b) above the ground point.
5.	Adjust the tripod legs to level the circular level ©).
6.	By using the electronic level, turn the tribrach footscrews (a) to level the instrument precisely.
7.	Centre the instrument precisely over the ground point (b) by shifting the tribrach on the tripod plate.
8.	Repeat steps 6. and 7. until the required accuracy is achieved.

☞ Use the AutoHeight laser plummet for vertically setting up the instrument over a ground point and for measuring the instrument height when setting up the station.

4.2 Setting Up SmartPole

SmartPole setup using GS05

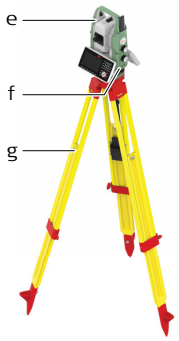


a GS05 antenna
b 360° prism
c Field controller on GHT66 holder (Alternative, not illustrated: tablets on GHT90/GHT91 holder)
d GHT63 clamp
e GLS31 pole with snap-lock positions
f Instrument
g Communication side cover, Bluetooth for Remote Control integrated
h Tripod

4.3 Setting up for Remote Control

4.3.1 Setting up for Remote Control (with Internal Bluetooth)

Setup for remote control with internal Bluetooth

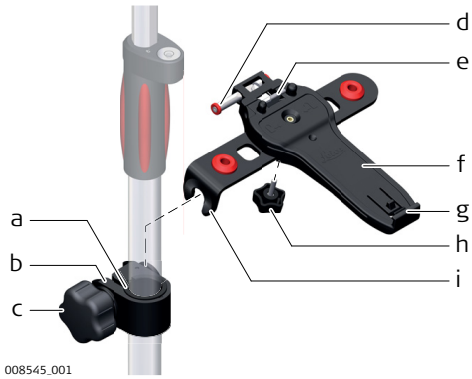


a 360° prism
b Prism pole
c Field controller on GHT66 holder (Alternative, not illustrated: tablets on GHT90/GHT91 holder)
d GHT63 clamp
e Instrument
f Communication side cover, Bluetooth for Remote Control integrated
g Tripod

4.3.2 Fixing the Field Controller to a Holder and Pole

Components of the GHT66 holder

The GHT66 holder consists of the following components:



GHT63 clamp
a Plastic sleeve
b Pole clamp
c Clamp bolt

GHT66 holder
d Locking pin
e Top clip
f Mounting plate
g Bottom clip
h Tightening screw
i Mounting arm

Fixing the field controller and GHT66 to a pole step-by-step

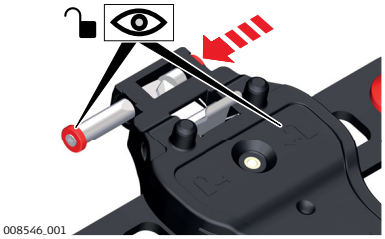
☞	For an aluminium pole, fit the plastic sleeve to the pole clamp.
1.	Insert the pole into the clamp hole.

2. Attach the holder to the clamp using the clamp bolt.

3. Adjust the angle and the height of the holder on the pole to a comfortable position.

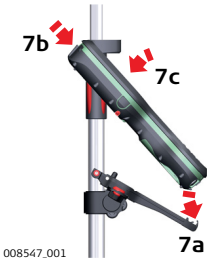
4. Tighten the clamp with the clamp bolt.

5. Before placing the CS field controller onto the mounting plate, ensure that the locking pin is put into the unlocked position. To unlock the locking pin, push the locking pin to the left.

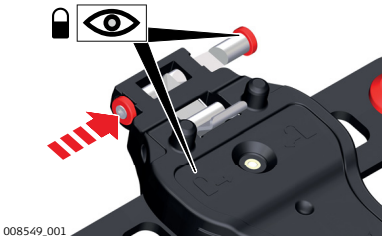


6. Hold the CS field controller above the holder and lower the end of the CS field controller into the mounting plate.

7. Apply slight pressure in a downward direction and then lower the top part of the CS field controller until the unit is clicked into the holder. The guides of the mounting plate aid in this action.



8. After the CS field controller is placed onto the mounting plate, ensure that the locking pin is put into the locked position. To lock the locking pin, push the locking pin to the right.

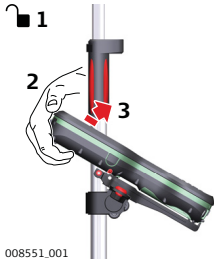


Detaching the field controller from a pole step-by-step

1. Unlock the locking pin by pushing the locking pin to the left of the mounting plate.

2. Place your palm over the top of the field controller.

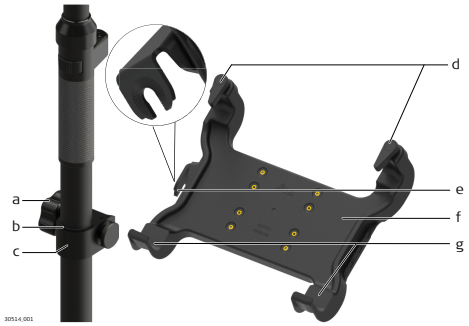
3. While in this position, lift the top of the field controller from the holder.



4.3.3 Fixing the Tablet to a Holder and Pole

Components of GHT63 clamp and GHT90/ GHT91 holder

For fixing the CC180/CC200 tablet to a pole you need the following components:



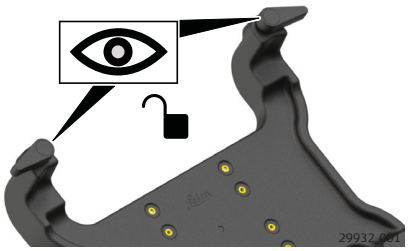
Clamp
GHT63

- a Clamp bolt
- b Plastic sleeve
- c Pole clamp

Holder
GHT90 (for CC180)
GHT91 (for CC200)

- d Locking lever
- e Mounting arm
- f Mounting plate
- g Mounting brackets

Fixing the CC180/CC200 tablet and GHT90/ GHT91 holder to a pole step-by-step

☞	For an aluminium pole, fit the plastic sleeve to the pole clamp.
1.	Insert the pole into the clamp hole.
2.	Attach the holder to the clamp using the clamp bolt.
3.	Adjust the angle and the height of the holder on the pole to a comfortable position.
4.	Tighten the clamp with the clamp bolt.
5.	 Before placing the CC180/CC200 tablet onto the mounting plate, ensure that the locking lever is set to the unlocked position (see illustration).

6.

Lower the left side of the tablet and slide it from right to left into the mounting brackets of the holder.

7.

After placing the tablet onto the mounting plate, set the locking lever to the locked position (see illustration).

Detaching the tablet from the holder/pole step-by-step

1.

Set the locking lever of the GHT90/GHT91 holder to the unlocked position.

2.

Lift the right side of the tablet and slide the tablet to the right and out of the holder.

4.4 Connecting to a Personal Computer

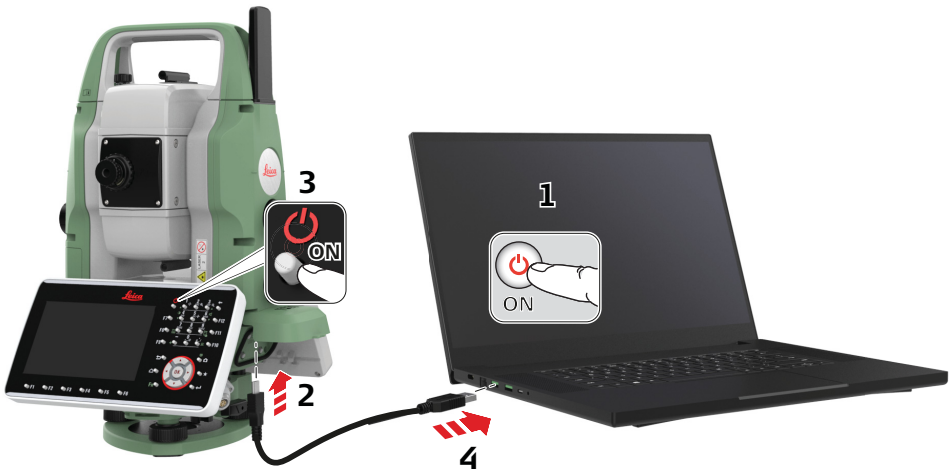
Description

Leica USB drivers are not needed for TS20. Standard Windows drivers support all USB cables used for TS20.

Cables

Name	Description
GEV278	USB type C to USB type C cable, 1 m, connects instrument to PC for file transfer
GEV284	USB type C to USB type A cable, 1.5 m, connects instrument to PC for file transfer

Connect to PC via USB cable step-by-step



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1. Start the PC.
2. Plug the cable into the USB-C port inside the Communication side cover of the instrument.
3. Turn on the instrument.
4. Plug the cable into the USB port of the PC.
5. Open File Explorer on your PC.
6. Select **This PC** and select the Leica TS20 in section **Devices and drives**.
7. Transfer your data between the internal memory of the Leica TS20 and your Windows PC.

4.5 Configuring eSIM of GMI01

Description

The optional available GMI01 contains an eSIM on which a Mobile Internet Operator (MNO) profile can be activated for data services.

Following functions are available to manage eSIM profiles and their respective states:

- Enable and disable eSIM
- View existing eSIM profiles
- Create, edit, deactivate, delete and navigate eSIM profiles

Terms and abbreviations

Term	Description
eSIM	embedded Subscriber Identity Module An eSIM is a SIM card embedded within the phone that can be updated over the air. The user must download the eSIM profile over the air and activate via a remote SIM provisioning process.
ICCID	Integrated Circuit Card Identifier This is a unique numerical code that identifies a SIM card or an eSIM in a mobile device. Every eSIM has its own ICCID, enabling mobile networks to accurately associate the eSIM card with a specific user or account.
SM-DP+	Subscription Manager Data Preparation Protocol+ The SM-DP+ address+ is a unique identifier that specifies the address of the subscription management server used to activate the eSIM. The activation code is an one-time code provided by the service provider that enables the eSIM to be activated on the device.

4.6 Power Functions

Turning the instrument on

Press and hold power key (⏻ ◎) for 2s.

☞ The instrument must have a power supply.

Turning the instrument off

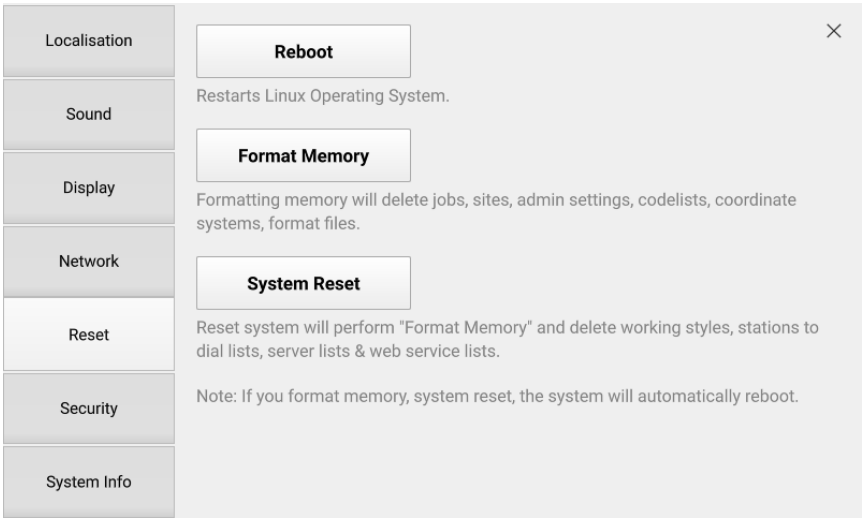
Press and hold power key (⏻ ◎) for 2 s.

☞ The instrument must be on.

☞ For instruments setup in permanent installations with external power sources, for example monitoring, ensure external power remains available until the instrument has successfully completed the power down process.

Reset menu

1. Go to the operating system desktop (**Fn** + **OS**).
2. Open the **Settings** Menu.

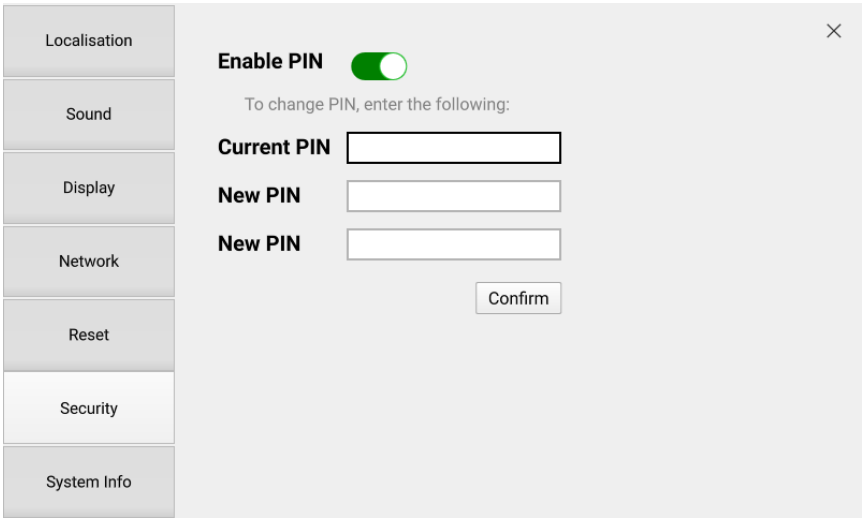


3. **Reset** Menu
Following format and reset options are available:
- **Reboot**
  Restarts Linux Operating System
- **Format Memory**
  Formatting internal memory will delete jobs, sites, admin settings, codelists, coordinate systems and format files.
- **System Reset**
  Resetting the system will perform **Format Memory** and delete working styles, stations to dial lists, server lists and web service lists.
- **Logout**
  Logout is only visible after PIN is enabled. After logout, the device is locked and a PIN must be entered to login again.

Security menu

1. Go to the operating system desktop (**Fn** + **OS**).

2. Open the **Settings** Menu.



3. **Security** Menu
Enable or disable PIN here.
- **Initial PIN**
  If no PIN has been activated before, the new PIN must be entered correctly twice.
- **Change PIN**
  To enter a new PIN, the old PIN must be entered. The new PIN must then be entered correctly twice.
- **Disable PIN**
  To disable the PIN, the current PIN needs to be entered.
- **PUK**
  If the PIN is entered incorrectly three times, the device will be blocked for one minute. The device can be unlocked again using the PUK. If the PUK is entered incorrectly three times, the device will be blocked for 10 minutes.

4.7 Batteries

4.7.1 Operating Principles

First-time use/ charging batteries

- The battery must be charged before using it the first time, because it is delivered with an energy content as low as possible or might be in sleep mode.
- 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 a discharge/charge cycle
- For Li-Ion batteries, a single discharge/charge 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 –30 °C to +60 °C/–22 °F to +140 °F.
- Low operating temperatures reduce the capacity that can be drawn; high operating temperatures reduce the service life of the battery.

4.7.2 Battery for the TS Instrument

Change battery step-by-step

1.	Face the instrument so that the vertical drive screw is on the left. The battery compartment is below the vertical drive. Turn the knob to the vertical position, opening the lid of the battery compartment.
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.
5.	Place the battery into the battery housing, ensuring that the contacts are facing outward. Click the battery into position.

6. Place the battery housing into the battery compartment. Push the battery housing in until it fits completely into the battery compartment.

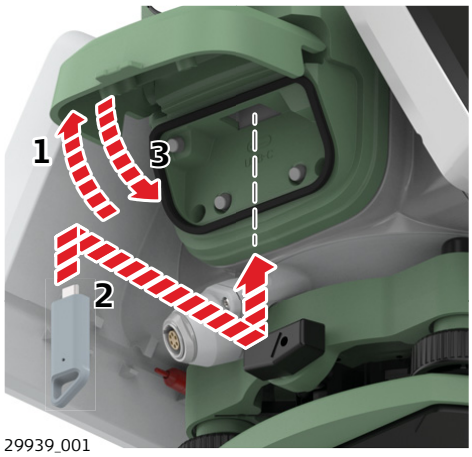
7. Turn the knob to lock the battery compartment. Ensure that the knob is returned to its original horizontal position.

4.8 Working with the Memory Device

☞
- Only use an official Leica USB stick that is designed for the TS20.
- Keep the USB stick dry.
- Use it only within the specified temperature range.
- Protect the USB stick from direct impacts.

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

Insert a USB stick step-by-step



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☞ The USB stick is inserted into the USB-C port inside the communication compartment of the instrument.

1. Open the lid of the communication compartment to access the communication ports.

2. Slide the USB stick into the USB-C port until it clicks into position.

   ☞ Do not force the USB stick into the port.

   If desired, store the lid of the USB stick in the instrument container.

3. Close the lid to lock the compartment.

Remove a USB stick step-by-step

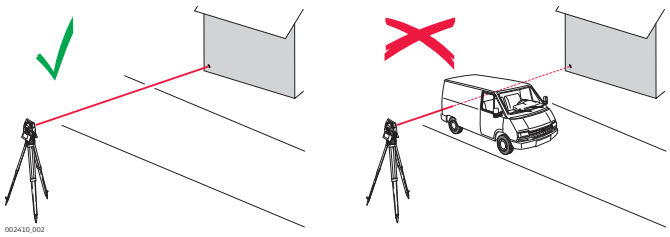
☞ To ensure safe removal of the USB stick, the instrument must either be powered off, or the USB stick must be ejected from within the Leica Captivate field software.

☞ Removing the USB stick unsafely may result in data loss or damage to the file system.

1. If Leica Captivate is running, from within the **Home screen** press **Eject USB** (Fn F2).

2. Open the lid of the compartment and pull the USB stick out from the port.

Distance measurement



When measurements are being made using the red laser EDM, the results can be influenced by objects passing between the EDM and the intended target surface. This occurs because reflectorless measurements are made to the first surface returning sufficient energy to allow the measurement to take place. For example, if the intended target surface is the surface of a building, but a vehicle passes between the EDM and the target surface as the measurement is triggered, the measurement may be made to the side of the vehicle. The result is the distance to the vehicle, not to the surface of the building.

☞ Very short distances can also be measured reflectorless in **Prism** mode to well reflecting natural targets. The distances are corrected with the additive constant defined for the active reflector.

☞ Accurate measurements to prisms should be made in **Prism** mode.

☞ With the TS20, measurements to reflectors are generally not performed in **Any surface** mode to prevent incorrect distance results. However, at longer ranges, such measurements are possible. In these cases, users must be aware that the corresponding prism constant is not being applied.

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

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

ATR/Lock

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

☞ As with all other instrument errors, the collimation error of the automatic aiming must be redetermined periodically. Refer to 5 Check & Adjust about checking and adjusting instruments.

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

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

5 Check & Adjust

5.1 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 adjustment

The following instrument errors can be checked and adjusted electronically:

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

If the compensator and the horizontal corrections are activated in the instrument configuration, every angle measured in the daily work is corrected automatically. Check whether the tilt correction and the horizontal correction are turned on.

The results are displayed as errors but used with the opposite sign as corrections when applied to measurements.

Mechanical adjustment

The following instrument parts can be adjusted mechanically:

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

Precise measurements

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

- To check and adjust the instrument from time to time.
- To take high precision measurements during the check and adjust procedures.
- To measure targets in two faces. Some of the instrument errors are eliminated by averaging the angles from both faces.
- Before beginning work, ensure that the switched-on instrument mounted on the tribrach has acclimatized to the surrounding ambient temperature. Allow at least 20 minutes for this process, or approximately 2 minutes per °C of temperature difference between the storage environment and the working environment.

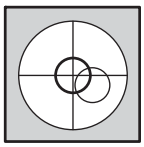
☞ During the manufacturing process, the instrument errors are carefully determined and set to zero. As mentioned above, these errors can change and it is highly recommended to redetermine them in the following situations:

- Before the first use
- Before every high precision survey
- After rough or long transportation
- After long working periods
- After long storage periods
- If the temperature difference between current environment and the temperature at the last calibration is more than 20 °C

Summary of errors to be adjusted electronically

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

5.2 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 beginning work, ensure that the switched-on instrument mounted on the tribrach has acclimatized to the surrounding ambient temperature. Allow at least 20 minutes for this process, or approximately 2 minutes per °C of temperature difference between the storage environment and the working environment.

☞ Precise manual aiming procedures are the base for a fitting determination of the instrument error corrections. Take the time to aim accurately and measure with highest precision. For consistent Check & Adjust results on job sites with

several instruments, the procedures should be performed by the same operator on all instruments.

☞ Even after adjustment of the ATR, the crosshairs may not be positioned exactly on the centre of the prism after an ATR measurement has been completed. This outcome is a normal effect. To speed up the ATR measurement, the telescope is normally not positioned exactly on the centre of the prism. These small deviations ATR offsets, are calculated individually for each measurement and corrected electronically. This means that the horizontal and vertical angles are corrected twice: first by the determined ATR errors for Hz and V, and then by the individual small deviations of the current aiming.

Next step

IF the task is to	THEN
adjust a combination of instrument errors	Refer to 5.3 Combined Adjustment (l, t, i, c and ATR).
adjust the tilting axis	Refer to 5.4 Tilting Axis Adjustment (a).
adjust the circular level	Refer to 5.5 Adjusting the Circular Level of the Instrument and Tribrach.
adjust the laser/optical plummet	Refer to 5.7 Inspecting the Laser Plummet of the Instrument.
adjust the tripod	Refer to 5.8 Servicing the Tripod.

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

Description

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

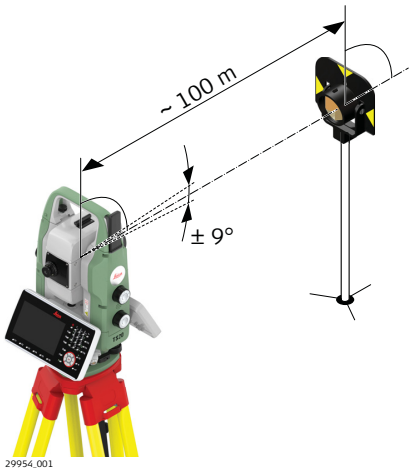
Instrument error	Description
l, t	Compensator longitudinal and transversal index errors
i	Vertical index error, related to the standing axis
c	Horizontal collimation error, also called line of sight error
ATR Hz	ATR zero point error for horizontal angle option
ATR V	ATR zero point error for vertical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

Combined adjustment procedure step-by-step

The following table explains the most common settings.

1.	**Leica Captivate - Home: Settings\TS instrument\Check & adjust**
2.	**Check & Adjust** Select the option: **Check & adjust the compensator, index error, line of sight error & automatic target aiming**
3.	**Next**
4.	**Face I measurement**

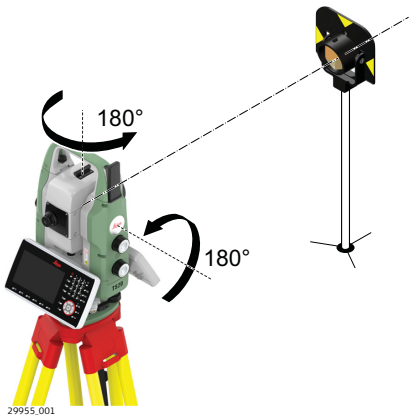
If **Calibrate the automatic target aiming** is checked and an ATR is available, the adjustment will include the determination of the ATR Hz and V adjustment errors.



☞ Use a clean Leica standard round prism as the target. Do not use a 360° prism.

☞ Calibration distances of the automatic target aiming require a precise manual aiming and should be aligned with typical measurement distances on the job site.

5.	Aim precisely at the centre of the prism and press **Measure** to continue to the next screen. Non-motorised instruments guide to the other face. ☞ The fine pointing has to be performed manually in both faces.



6.	**Face II measurement** **Measure** to measure the same target in the other face and to calculate the instrument errors.
☞	If one or more errors are bigger than the predefined limits, the procedure must be repeated. All measurements of the current run are rejected and none of them is averaged with the results from previous runs.
7.	Adjustment Status **Number of measurements**: Shows the number of runs completed. One run consists of a measurement in face I and face II. **l Component quality (1 σ)** and similar lines show the standard deviations of the determined adjustment errors. The standard deviations can be calculated from the second run onwards.
☞	Achieved adjustment qualities should be aligned with the expected measurement accuracies. In order to leverage aiming errors it is advisable to measure at least three runs.
8.	**Next** to continue with the check & adjust procedure.
9.	Follow the proposal **Add another calibration loop** until three runs have been measured. **Next** and continue with step 4. OR

	Select **Finish the calibration & store the results** to finish the calibration process. **Next** to view the adjustment results.
10.	Select **Finish** to accept the results. No more runs can be added later. OR Select **Redo** to decline all measurements and to repeat all calibration runs. OR **Back** returns to the previous screen.

Next step

IF the results are	THEN
to be stored	If the Use status is set to Yes, **Next** overwrites the old adjustment errors with the new ones.
to be determined again	**Redo** rejects all new determined adjustment errors and repeats the whole procedure. Refer to paragraph Combined adjustment procedure step-by-step.

5.4 Tilting Axis Adjustment (a)

Description

This adjustment procedure determines the following instrument error:

Instrument error	Description
a	Tilting-axis error

Determination of tilting axis error step-by-step

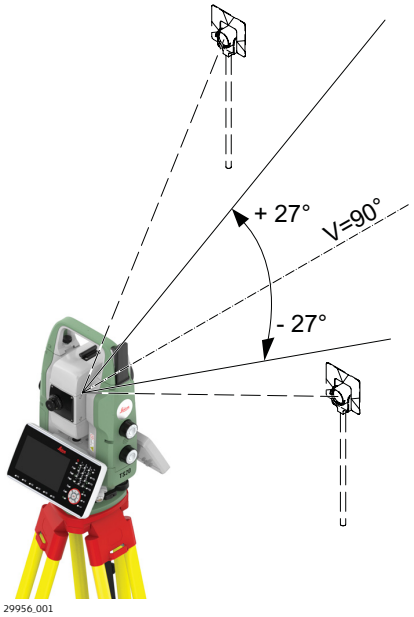
The following table explains the most common settings.

☞ Determine the horizontal collimation error ©) before starting this procedure.

1.	**Leica Captivate - Home: Settings\TS instrument\Check & adjust**
2.	**Check & Adjust** Select the option: **Check & adjust the tilting axis**

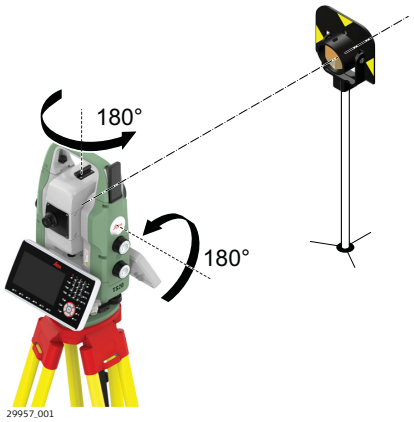
3. **Face I measurement**
Aim the telescope accurately at a target at about 100 m distance (or at least 20 m). The target must be positioned at least 27°/30 gon above or beneath the horizontal plane.

☞ Calibration distances of the automatic target aiming require a precise manual aiming and should be aligned with typical measurement distances on the job site.



4. Aim precisely at the centre of the prism and press **Measure** to continue to the next screen. Motorised instruments change automatically to the other face.
Non-motorised instruments guide to the other face.

☞ The fine pointing must be performed manually in both faces.



5. **Face II measurement**
Measure to measure the same target in the other face and to calculate the tilting axis error.

☞ If the error is bigger than the predefined limit, the procedure must be repeated. The tilting axis measurements of the current run are then rejected and not averaged with the results from previous runs.

6. Adjustment Status
Number of measurements: Shows the number of runs completed. One run consists of a measurement in face I and face II.
a T-axis quality (1 σ): Shows the standard deviation of the determined tilting axis error. The standard deviation can be calculated from the second run onwards.

☞ Achieved adjustment qualities should be aligned with the expected measurement accuracies. In order to leverage aiming errors it is advisable to measure at least three runs.

7. **Next** to continue with the check & adjust procedure.

8. Follow the proposal **Add another calibration loop** until three runs have been measured. **Next** and continue with step 3.

OR

Select **Finish the calibration & store the results** to finish the calibration process. No more runs can be added later. **Next** to view the adjustment results.

9. Select **Finish** to accept the results. No more runs can be added later.

   OR

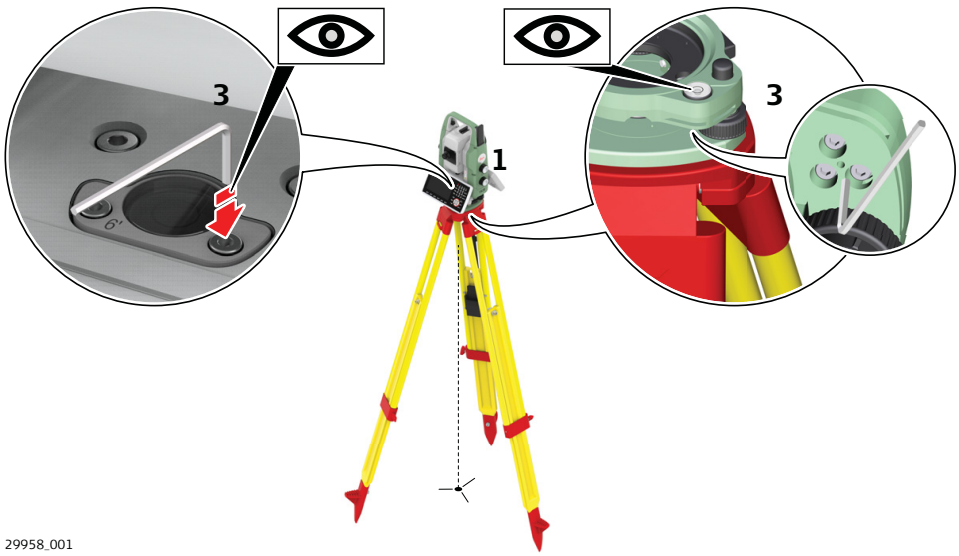
   Select **Redo** to decline all measurements and to repeat all calibration runs.

Next step

IF the results are	THEN
to be stored	**Next** overwrites the old tilting axis error with the new one.
to be determined again	**Redo** rejects the new determined tilting axis error and repeats the whole procedure. Refer to paragraph Determination of tilting axis error step-by-step.

5.5 Adjusting the Circular Level of the Instrument and Tribrach

Adjusting the circular level step-by-step



1. Place and secure the instrument into the tribrach and onto a tripod.
2. Using the tribrach footscrews, level the instrument with the electronic level.
3. Select **Settings\TS instrument\Level & compensator** to access the **Level & Compensator** panel.
4. Check the position of the circular level on the instrument and tribrach.
5. a If both circular levels are centred, no adjustments are necessary.

   b If one or both circular levels are not centred, adjust as follows:

Instrument: If it extends beyond the circle, use the supplied allen key to centre it with the adjustment screws. Turn the instrument by 200 gon (180°). Repeat the adjustment procedure if the circular level does not stay centred.

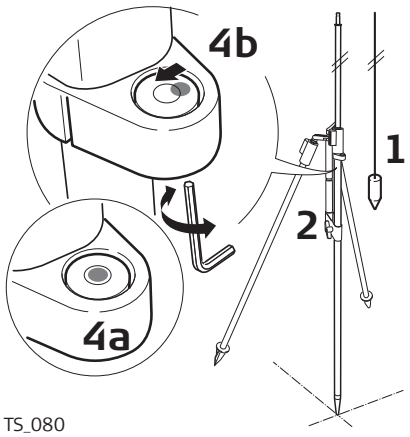
Tribrach: If it extends beyond the circle, use the supplied allen key to centre it with the adjustment screws.

☞ After the adjustments, all adjusting screws must have the same tightening tension and no adjusting screw should be loose.

5.6 Adjusting the Circular Level of the Prism Pole

Adjusting the circular level step-by-step

1. Suspend a plumb line.
2. Use a pole bipod, to align the prism pole parallel to the plumb line.
3. Check the position of the circular level on the prism pole.
4. a If the circular level is centred, no adjustment is necessary.
   b If the circular level is not centred, use an allen key to centre it with the adjustment screws.



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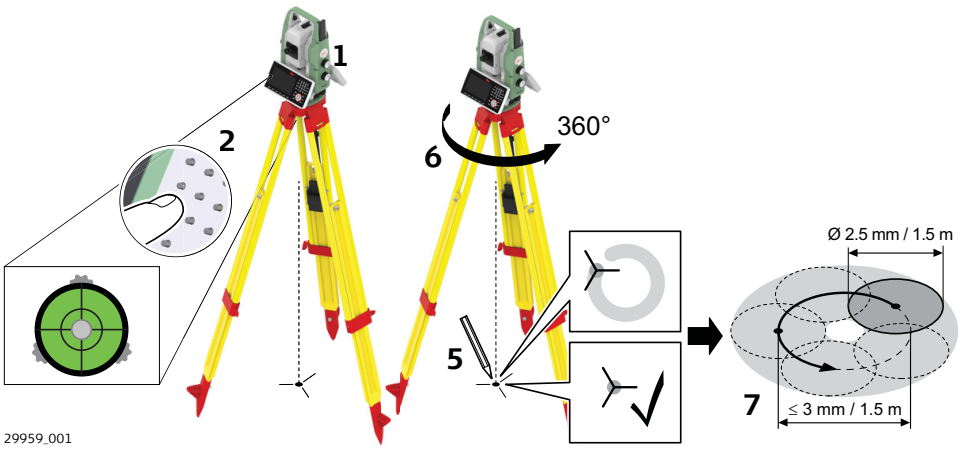
☞ After the adjustments, all adjusting screws must have the same tightening tension and no adjusting screw should be loose.

5.7 Inspecting the Laser Plummet of the Instrument

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

Inspecting the laser plummet step-by-step



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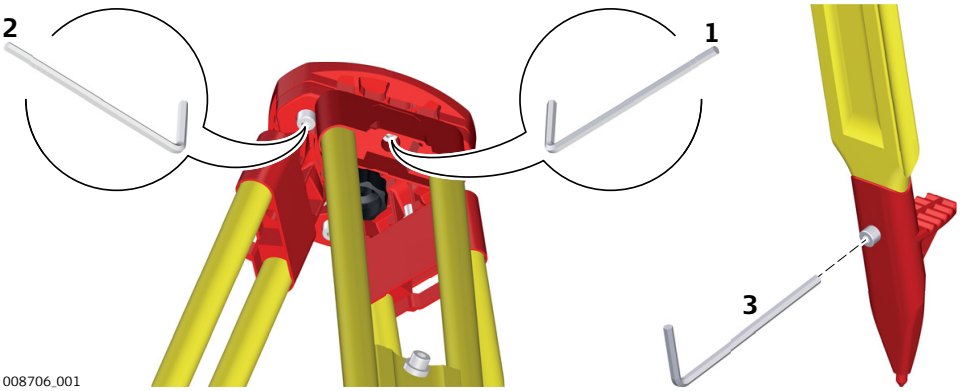
The following table explains the most common settings.

1.	Set up the instrument on the tripod approximately 1.5 m above the ground and level up.
2.	Select **Settings\TS instrument\Level & compensator** to access the **Level & Compensator** panel. The laser plummet is switched on when the **Level & Compensator** panel is entered. Adjust the laser plummet intensity. ☞ 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 3mm at a height of 1.5m.
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.

5.8 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.

6 Care and Transport

6.1 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 the field

When transporting the equipment in the field, always make sure that you carry the product in its original container.

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.

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.

6.2 Storage

Product

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

Li-Ion batteries

- Refer to 7 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

GMI01 battery

A battery containing a 30% charge can be stored for up to three months. After this storage period the battery must be recharged.

Charger and AC/DC power supply

- Keep chargers and AC/DC power supply away from excessive dirt, dust and contaminants
- After unpacking the product, visually inspect the charger for possible damages
- Unplug the product from the outlet before attempting any maintenance or cleaning

6.3 Cleaning and Drying

NOTICE

Wet cleaning cloth

Causes damage to electrical components of the equipment.

Precautions:

- ▶ Use only a dry cloth.

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 not at ambient temperature can fog. Before use, let them adjust to the ambient temperature of the work environment and clean as required.

Battery charger

Use only a clean, soft, lint-free cloth for cleaning.

Cables and plugs

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

Connectors with dust caps

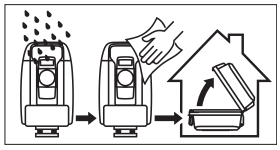
Wet connectors must be dry before attaching the dust cap.

Cleaning

- Keep the product away from excessive dirt, dust and contaminants
- After unpacking the product visually inspect it for possible damage
- Unplug the product from the outlet before cleaning

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 re-pack until everything is completely dry. Always close the transport container when using in the field.



6.4 Maintenance

☞ For units that are exposed to high mechanical forces, for example through frequent transport or rough handling, it is recommended to carry out test measurements periodically.

☞ An inspection of the motorisation in motorised instruments must be done in a Leica Geosystems authorised service centre. Leica Geosystems recommends an inspection of the product every 12 months.

For instruments which are in intensive or permanent use, for example tunnelling or monitoring, the recommended inspection cycle may be reduced.

7 Technical Data

7.1 Angle Measurement

Accuracy

Available angular accuracies	Standard deviation Hz, V ISO 17123-3	Display resolution			
["]	[mgon]	["]	[°]	[mgon]	[mil]
1	0.3	0.1	0.0001	0.1	0.01
2	0.6	0.1	0.0001	0.1	0.01
3	1.0	0.1	0.0001	0.1	0.01
5	1.5	0.1	0.0001	0.1	0.01

Characteristics

Absolute, continuous, diametric.

7.2 Distance Measurement with Reflectors

Range

Reflector	Range A		Range B		Range C	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	2200	7200	7500	24600	>10000	>32800
360° prism (GRZ4, GRZ122)	1500	4900	2600	8500	3500	11500
360° Mini prism (GRZ101)	1000	3300	1600	5200	2500	8200
Mini prism (GMP101)	1500	4900	2600	8500	3500	11500
High reflective tape 60 mm x 60 mm (GZM37)	250	800	450	1500	700	2300
Machine Automation power prism (MPR122)	1500	4900	2600	8500	3500	11500
Shortest measuring distance:			0.8 m			

Atmospheric conditions

Range	Description
A	Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
B	Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
C	Overcast, no haze, visibility about 40 km; no heat shimmer

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

Accuracy

Accuracy refers to measurements to standard prisms.

Distance measuring mode	Standard deviation ISO 17123-4, standard prism	Standard deviation ISO 17123-4, tape	Measurement time, typical [s]
Once	1 mm + 1x10^{-6}D	1.5 mm + 2x10^{-6}D	1.3
Once & fast	2 mm + 1x10^{-6}D	3 mm + 2x10^{-6}D	<1.0
Continuously	3 mm + 1x10^{-6}D	3 mm + 2x10^{-6}D	0.04 (25 Hz)
Repeatedly & average	1 mm + 1x10^{-6}D	1.5 mm + 2x10^{-6}D	-

D is the measured distance in millimetres.

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

The display resolution is 0.1 mm.

Characteristics

Type	Description
Type	Coaxial, visible red laser
Carrier wave	658 nm
Measuring system	Wave Form Digitizer

7.3 Distance Measurement without Reflectors

Range

R800

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	500	1600	700	2300	>800	>2600
Grey side, 18 % reflective	400	1300	600	2000	>600	>2000

Range of Measurement:	0.8 m – 800 m
Display unambiguous:	up to 800 m

R1600

Kodak Gray Card	Range D		Range E		Range F	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
White side, 90 % reflective	1100	3600	1400	4600	>1600	>5200
Grey side, 18 % reflective	1000	3300	1300	4300	>1400	>4600

Range of Measurement:	0.8 m – 1600 m
Display unambiguous:	up to 1600 m

Atmospheric conditions

Range	Description
D	Object in strong sunlight, severe heat shimmer

Range	Description
E	Object in shade, or overcast
F	Underground, night and twilight

Accuracy

	Standard deviation ISO17123-4	Measure time, typical [s]	Measure time, maximum [s]
0-500	2 mm + $2x10^{-6}D$	1.7	15
>500m	4 mm + $2x10^{-6}D$	4	15

D is the measured distance in millimeters.

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

The display resolution is 0.1 mm.

Characteristics

Type	Description
Type	Coaxial, visible red laser
Carrier wave	658 nm
Measuring system	Wave Form Digitizer

Laser dot size

Distance [m]	Laser dot size, approximately [mm]
at 30	7 × 11
at 50	12 × 18
at 100	24 × 36

7.4 Automatic Target Aiming (ATR)

Range of target aiming/ target locking

Reflector	Range (Target Aiming)		Range (Target Locking)	
	[m]	[ft]	[m]	[ft]
Standard prism (GPR1)	2000	6600	1000	3300
360° prism (GRZ4, GRZ122)	1000	3300	1000	3300
360° Mini prism (GRZ101)	450	1500	250	800
Mini prism (GMP101)	900	3000	600	2000
High reflective tape 60 mm x 60 mm (GZM37)	55	180	not qualified	
Machine Automation power prism (MPR122)	750	2500	650	2200

☞ The maximum range depends on the atmospheric condition. Rain, strong sunlight or severe heat shimmer can decrease the maximum range.

Shortest measuring distance, 360° prism (Target aiming): 1.5 m

Shortest measuring distance, 360° prism (Target locking): 5 m

ATR accuracy with the GPR1 prism

Type	Accuracy
ATR angle accuracy Hz, V (std. dev. ISO 17123-3)	1 " (0.3 mgon)
Base Positioning accuracy (std.dev.)	± 1 mm

Maximum speed in lock mode

	Direction of prism movement	
	Tangential	**Radial**
Prism Lock only	14 m/s at 20 m	25 m/s
Prism Lock with **Measure distance: Continuously**	6 m/s at 20 m	6 m/s

☞ A tangential movement means the prism is passing by the instrument at the specified distance.
A radial movement means the prism is moving away from or towards the instrument in the line of sight direction.

Searching

Type	Value
Typical search time in field of view	1.5 s
Field of view	1°25'/1.55 gon
Definable search windows	Yes

Characteristics

Type	Description
Principle	Digital image processing
Type	Infrared laser

7.5 PowerSearch (PS)

Range

Reflector	Range	
	[m]	[ft]
Standard prism (GPR1)	300	1000
360° prism (GRZ4, GRZ122)	300*	1000*
360° mini prism (GRZ101)	200	660
Mini prism (GMP101)	200	660
High reflective tape 60 mm x 60 mm (GZM37)	50	160

Reflector	Range	
	[m]	[ft]
Machine Automation power prism (MPR122)	200	660

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

Shortest measuring distance: 1.5 m

Searching

Type	Value
Typical search time	4 s
Default search area	Hz: 400 gon, V: 40 gon
Definable search windows	Yes

Characteristics

Type	Description
Principle	Digital signal processing
Type	Infrared laser

7.6 GMI01 Mobile Internet Module for Sensor and Data Services (Optional)

Description

The GMI01 enables mobile internet for:

- Sensor services, by purchasing a HxGN GeoCloud Protect subscription
- Data services, if an eSIM profile of a Mobile Network Operator gets installed. Refer to 4.5 Configuring eSIM of GMI01.
  Data Services can be used by purchasing a HxGN GeoCloud Drive subscription. The TS20 mobile internet can be used for any other data service requiring internet connectivity.

Internal battery

Battery	Capacity
Li-Ion	2450 mAh Recharged by the total station battery when GEB461 is inserted or external power supply applied
	Up to 5 days Depending on mode of operation and cellular network conditions

Tracking interval

Depending on the configuration in HxGN GeoCloud. Update rate up to 1 minute.

Environmental specifications

Temperature

Operating temperature [°C]	Storage temperature [°C]
–20 to +50	–40 to +70

Charging temperature: Internal battery –20 to +45°C

7.7 Overview Camera

Overview camera

Type	Value
Sensor	20 M pixel CMOS sensor
Focal length	18.8 mm
Field of view	21.8° x 16.4° (27° diagonal)
Frame rate	≤20 frames per second
Focus	2 m (6.6 ft) to infinity at zoom level 1 x 5 m (16.4 ft) to infinity at zoom level 4 x
Image storage	JPEG up to 7.1 M pixel (3073 x 2304)
Zoom	4-step (1x, 2x, 4x, 8x)
Whitebalance	Automatic and user configurable
Brightness	Automatic and user configurable

7.8 General Technical Data of the Product

System accuracy

Several factors can influence the accuracy of the system for determining the location of a prism:

- Internal ATR accuracy
- Angular accuracy of the instrument
- Type and centring accuracy of the prism
- Selected EDM measuring programs
- External measuring conditions

Therefore, the overall pointing accuracy of the determined point location can be lower than the given angular accuracy and the ATR accuracy.

The following paragraphs provide a short overview of these influencing factors and their possible intensities.

Angular accuracy

The accuracy of angular measurements depends on the instrument type. The angular accuracy for total stations is typically in the range from 0.5″ to 5″. The resulting error depends on the measurement distance.

The table shows possible deviations for typical angular accuracies. 1″ and 3″ are examples.

Angular accuracy	Possible deviation* at 100 m distance
1″	~0.5 mm
3″	~1.5 mm

* Orthogonal to the line of sight.

☞ Refer to the data sheet of the respective instrument variant for information about the angular accuracy.

EDM accuracy

The distance measurement accuracy consists of two parts: a fixed value and a distance-dependent value.

Example: "Single measurements: 1 mm + 1 ppm (1 mm + 1x10^{-6}D)"

The EDM accuracies for prism and reflectorless measurements can differ. Additionally, the accuracies can differ depending on the used technologies.

☞ Refer to the appropriate data sheet for information about the EDM accuracy.

ATR accuracy

Automatic target aiming accuracies, like those of the ATR, are in general the same as the stated angular accuracy. Therefore these accuracies are also distance-dependent parameters.

External impacts, like heat shimmer, rain (prism surface or telescope lens covered by rain drops), fog, dust, strong background lights, dirty targets, alignment of the targets etc. can have a significant influence on the automated target aiming. In addition, the selected EDM mode affects the ATR performance. Under good environmental conditions and with a clean, properly aligned target the accuracy of the automated target aiming is equivalent to the manual target aiming (presumed valid calibration values).

Type and centring accuracy of the prism

The prism centring accuracy depends mainly on the used prism type, for example:

Prism type		Centring accuracy
Leica GPR1	Circular prism	1.0 mm
Leica GPH1P	Precision circular prism	0.3 mm
Leica GRZ122	360° prism	2.0 mm
Leica GRZ4	360° prism	5.0 mm
Leica MPR122	360° prism	2.0 mm

☞ Refer to the white paper "Leica Surveying Reflectors" for information about the different centring accuracies.

More influencing factors

When determining absolute coordinates, the following parameters can also affect the resulting accuracy:

- Environmental conditions: temperature, air pressure and humidity
- Typical instrument errors, such as horizontal collimation error or index error.
- Proper functioning of laser plummet or optical plummet
- Correct horizontal levelling
- Setup of the target
- Quality of extra equipment, such as tribrach or tripod.

Telescope

Type	Value
Magnification	30 ×
Free Objective aperture	50 mm
Focusing	1.45 m/4.75 ft to infinity

Type	Value
Field of view	1°30’/1.66 gon 2.7 m at 100 m

Compensator

Angular accuracy instrument ["]	Setting accuracy		Setting range	
	["]	[mgon]	[’]	[gon]
1	0.5	0.2	4	0.07
2	0.5	0.2	4	0.07
3	1.0	0.3	4	0.07
5	1.5	0.5	4	0.07

Level

Type	Value
Circular level sensitivity	6’/2 mm
Electronic level resolution	2"
Compensation	Centralised quadruple axis compensation

Keyboard display unit

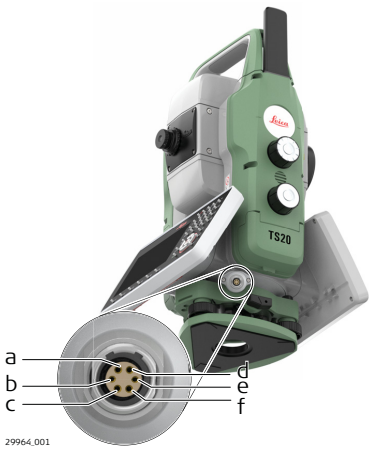
Type	Description
Display	5" WVGA (800 × 480 pixels), colour, graphics Capable LCD, illumination
Touch screen	Capacitive Touch Screen
Multi-touch point	2
Viewing angle	80°
Keyboard	37 keys Including 12 function keys and 12 alphanumeric keys, illumination
Angle display	360°’", 360° decimal, 400 gon, 6400 mil, V %
Distance display	m, ft int, ft us, ft int inch, ft us inch
Position	Face I: Standard Face II: Optional

Instrument ports

Name	Description
LEMO port	• 6 pin LEMO for power, communication, data transfer • This port is located at the base of the instrument.
Bluetooth	• Bluetooth module for communication and Remote Control • This port is housed within Communication side cover.
USB-C port	• USB-C memory stick port for data transfer • This port is housed within Communication side cover.

Name	Description
WLAN	• WLAN module for communication • This port is housed within the Communication side cover.

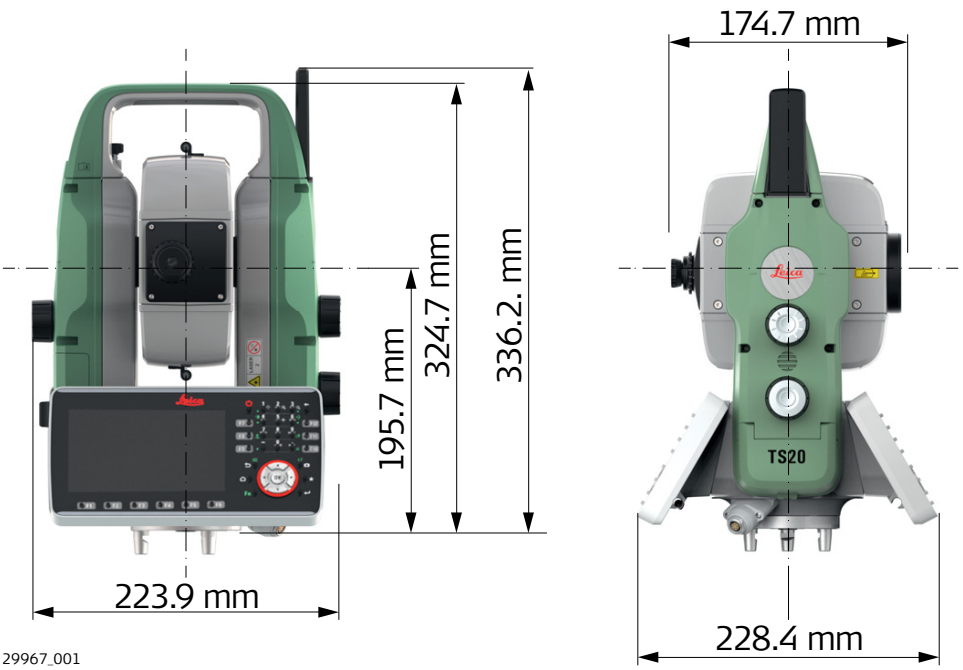
Pin assignments of the 6 pin LEMO port



a Pin 1: Ethernet transmit +
b Pin 2: Ethernet transmit -
c Pin 3: Ethernet receive +
d Pin 4: Ethernet receive -
e Pin 5: Power input
f Pin 6: Single ground

Support Ethernet 100BASE-TX

Instrument dimensions



Weight

Type	Value
Instrument	4.9–5.6 kg
Tribrach	0.8 kg
Internal battery	0.3 kg

Recording

Data can be recorded onto an USB-C stick or into internal memory.

Type	Capacity [GB]	Number of measurements per MB
USB-C stick	16	1750
Internal memory	32	1750

AutoHeight plummet

Type	Description
Type	Visible red laser class 2
Location	In standing axis of instrument
Centering 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
Height accuracy[1,2]	1.0 mm
Measurement range[3]	0.7 m to 2.7 m
Measurement time, typically	< 3 s

1 Standard deviation (1 sigma) over measurement range

2 Object in shade, sky overcast, Kodak Grey Card (18% reflective), balanced tribrach foot screws

3 Instrument height from tilting axis

☞ Avoid dirt on cover glass.

☞ Avoid line-of-sight obstructions. The full spot needs to be on target.

☞ For best performance use the new Leica tripods. For older tripods, an upgrade of the screw is recommended.

Drives

Description
Endless horizontal and vertical drives

Motorisation

Type	Description
Maximum acceleration	400 gon/s^2
Maximum rotating speed	200 gon/s
Time for change face	Typically 1.9 s

Power

Type	Description
External supply voltage	Nominal voltage 13.2 V DC Range 12 V-18 V

Internal battery

Type	Battery	Nominal Voltage	Capacity
GEB461	Li-Ion	10.8 V ⎓	6.7 Ah
GMI01 internal battery	Li-Ion	3.7 V	2.45 Ah

External battery

Type	Battery	Voltage	Capacity
GEB373	Li-Ion	14.4 V ⎓	20.1 Ah

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
All instruments*	–20 to +50	–40 to +70
Leica USB-C stick	–40 to +85	–40 to +85
Battery internal	–20 to +60	–40 to +70
All chargers	0 to +50	-40 to +55

* For Arctic variant: Operation of instrument tested at –35°C

Protection against water, dust and sand

Type	Protection
All instruments	IP66 (IEC 60529) Designed for outdoor use. Allowed to use the instrument temporarily in damp or wet locations.
All chargers	Only operate in dry environments, for example in buildings and vehicles.

Pollution degree

Type	Pollution
All instruments	4 Electrical equipment for outdoor use
All chargers	2 Electrical equipment for office environment

Humidity

Type	Protection
All instruments	100% condensing (ISO 9022-13-01-2, MIL-STD-810H Method 507.6) The effects of condensation are to be effectively counteracted by periodically drying out the instrument.
All chargers	Only operate in dry environments, for example in buildings and vehicles.

Altitude

Type	Protection
All instruments	Unrestricted
All chargers	≤ 2000 m above sea level

Reflectors

Type	Additive Constant [mm]	ATR	PS
Standard prism, GPR1	0.0	yes	yes
Mini prism, GMP101	+17.5	yes	yes
360° prism, GRZ4 / GRZ122	+23.1	yes	yes
Machine Automation power prism, MPR122	+28.1	yes	yes
360° Mini prism, GRZ101	+30.0	yes	yes
Reflector tape GZM29/30/31	+34.4	not recommended	no
High reflective tape GZM37	+34.4	yes	yes
Reflectorless	+34.4	no	no

There are no special prisms required for ATR or for PS.

Electronic Guide Light EGL

Working range:	5m to 150m (15ft to 500ft)
Position accuracy:	5cm at 100m (1.97" at 330ft)

Automatic corrections

The following automatic corrections are made:

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

7.9 Scale Correction

Use 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 ΔD1

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

The atmospheric correction includes:

- Adjustments for air pressure
- Air temperature
- Relative humidity

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

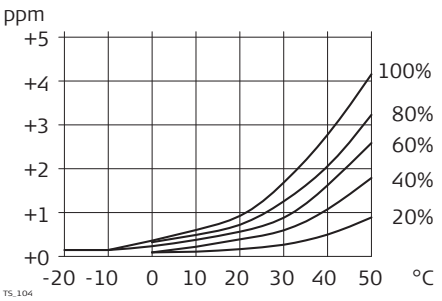
- Air temperature to 1 °C
- Air pressure to 3 mbar
- Relative humidity to 20%

Air humidity

The air humidity influences the distance measurement if the climate is extremely hot and damp.

For high precision measurements, the relative humidity must be measured and entered along with the air pressure and the temperature.

Air humidity correction



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

Index n

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

The index n is calculated from the formula of the IAG Resolutions (1999), and is valid for:

Air pressure p:	1013.25 mbar
Air temperature t:	12 °C
Relative air humidity h:	60%

Formulas

Formula for visible red laser

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

002419_002

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

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

Reduction to mean sea level ΔD_2

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

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

TS_106

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

Projection distortion ΔD_3

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

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

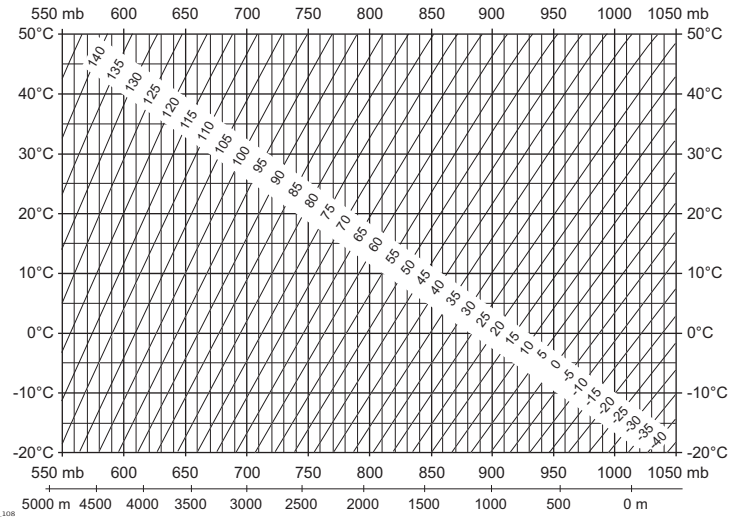
TS_107

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

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

Atmospheric corrections °C

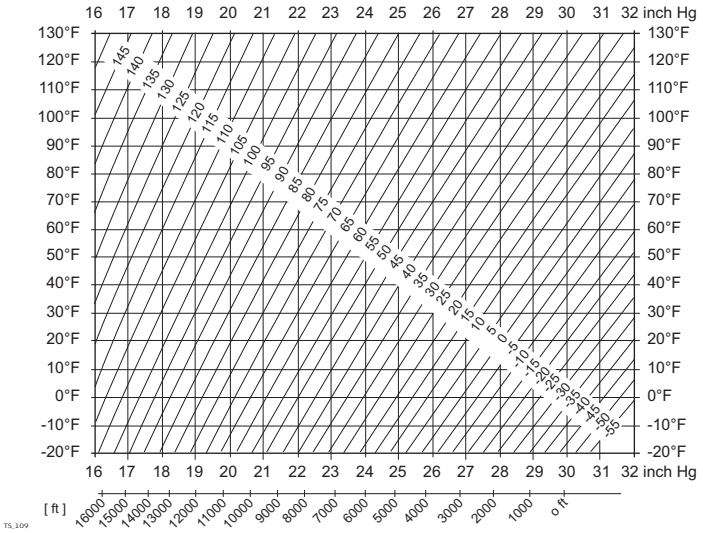
Atmospheric corrections in ppm with temperature [°C], air pressure [mb] and height [m] at 60% relative humidity.



TS_108

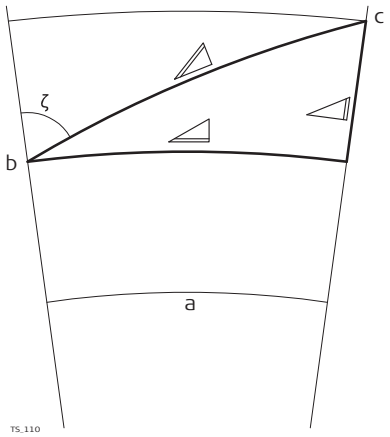
Atmospheric corrections °F

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



7.10 Reduction 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:

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

002425_002

◿ 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)

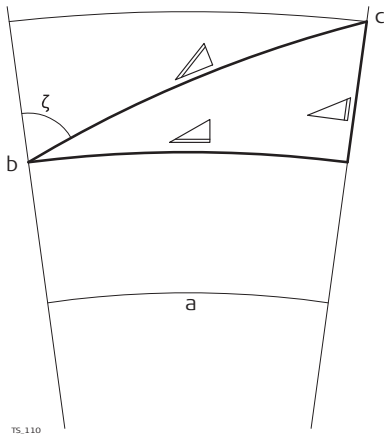
Earth curvature (1/R) and mean refraction coefficient (k) are automatically taken into account when calculating the horizontal distance and height difference. The calculated horizontal distance relates to the station height and not to the reflector height.

Reflector types

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

- To prisms
- To reflector tape
- Reflectorless measurements

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:

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

002425_002

◿	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.

Distance measuring program Averaging

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

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

These values are calculated as follows:

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

TS_114

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

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

TS_115

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

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

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

TS_116

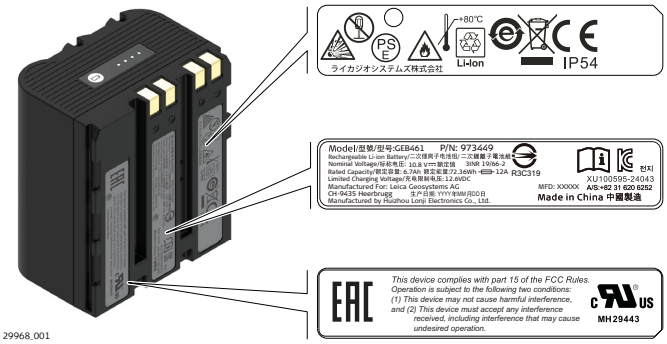
$S_{\bar{D}}$	Standard deviation of the arithmetic mean of the distance
s	Standard deviation of a single measurement
n	Number of measurements

7.11 Conformity to National Regulations

Labelling

29969_001

Labelling internal battery GEB461



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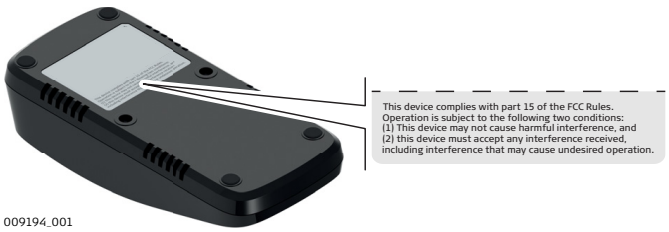
Labelling GKL311



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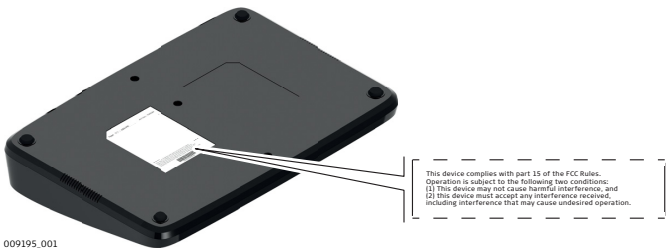
Labelling GKL341



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TS20
Frequency bands, output power

Depending on regional regulatory requirements, the output power may be lower or some frequency bands may not be available.

Type	Frequency band [MHz]	Maximum output power [dBm EIRP]	Comments
Bluetooth	2400–2483.5	20	
Bluetooth LE	2400–2483.5	10	
WLAN	2400–2483.5	20	Client Access Point
	5150–5250	23	Client
	5250–5350	23	Client
	5470–5725	23	Client
	5725–5850	23	Client
	5850–5895	23	Client

GMI01
Frequency bands, output power

Depending on regional regulatory requirements, the output power may be lower or some frequency bands may be not available.

Type	Frequency band [MHz]	Maximum output power [dBm EIRP]	Comments
GNSS receiver		-	
Bluetooth LE	2400 – 2483.5	10	
WLAN	2400 – 2483.5	20	Client
GSM 850	824 – 850	35	
GSM 900	880 – 915	35	
GSM 1800	1710 – 1785	36	
GSM 1900	1850 – 1910	36	
WCDMA Band I	1920 – 1980	29	
WCDMA Band II	1850 – 1910	29	
WCDMA Band V	824 – 849	25	
WCDMA Band VI	830 – 840	25	
WCDMA Band VIII	880 – 915	25	
WCDMA Band IXX	830 – 845	25	
LTE Band 1	1920 – 1980	29	
LTE Band 2	1850 – 1910	29	
LTE Band 3	1710 – 1785	29	
LTE Band 4	1710 – 1755	29	
LTE Band 5	824 – 849	25	
LTE Band 7	2500 – 2570	29	
LTE Band 8	880 – 915	25	
LTE Band 12	699 – 716	25	
LTE Band 13	777 – 787	25	

Type	Frequency band [MHz]	Maximum output power [dBm EIRP]	Comments
LTE Band 18	815 – 830	25	
LTE Band 19	830 – 845	25	
LTE Band 20	832 – 862	25	
LTE Band 25	1850 – 1915	29	
LTE Band 26	814 – 849	25	
LTE Band 28	703 – 748	25	
LTE Band 38	2570 – 2620	29	
LTE Band 39	1880 – 1920	29	
LTE Band 40	2300 – 2400	29	
LTE Band 41	2496 – 2690	29	

SAR values

Country	Head	Torso	Limb
EU	0.24 W/Kg, 10-gram	-	-
USA	0.31 W/Kg, 1-gram	0.31 W/Kg, 1-gram	0.15 W/Kg, 10-gram
Canada	1.06 W/Kg, 1-gram	1.06 W/Kg, 1-gram	1.22 W/Kg, 10-gram

EU

Hereby, Leica Geosystems AG declares that the radio equipment type TPS1 is in compliance with Directive 2014/53/EU and other applicable European Directives.
The full text of the EU declaration of conformity is available at the following Internet address: http://www.leica-geosystems.com/ce.

The band 5250 – 5350 GHz is for indoor use only.

AT, BE, BG, CH, CY, CZ, DE, DK, EE, EL, ES, FI, FR, HR, HU, IE, IS, IT, LI, LT, LU, LV, MT, NL, PL, PT, RO, SE, SI, SK, TR, UK

UK

Hereby, Leica Geosystems AG declares that the radio equipment type TPS1 is following the provisions of the applicable relevant statutory requirement S.I. 2017 No. 1206 Radio Equipment Regulations 2017.

USA

FCC ID: RFD-BELUGA
Part 2, 15 B/C/E, 22, 24, 27, 90

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

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

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, 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.

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

Responsible Party – U.S. Contact Information
Michael Harvey
Leica Geosystems, Inc.
10035 Via Colomba Cir #205
Fort Myers, FL 33966, USA
Tel.: (615) 585-0689
Email: michael.harvey@leicaus.com

Canada

CAN ICES-003(B)/NMB-003(B)
IC: 3177A-BELUGA

Canada Compliance Statement
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference
2. This device must accept any interference, including interference that may cause undesired operation of the device

Canada Déclaration de Conformité
L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence.
L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement du dispositif

---

Taiwan

Hexagon Geosystems (Taiwan) Co., Limited

10F-2, No.150, Fuxing N. Rd., Zhongshan Dist., 10487 Taipei, Taiwan

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Others

The conformity for countries with other national regulations has to be approved prior to use and operation.

7.11.1 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**.

☞ There are guidelines on **How to carry** and **How to ship** products with Lithium batteries. Before any transportation of a Leica product, we ask you to consult the guidelines on the web page (IATA Lithium Batteries) 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.

8 Software Licence Agreement/Warranty

International Limited Warranty

This product is subject to the terms and conditions set out in the International Limited Warranty which you can download from the Leica Geosystems home page at Leica Warranty or collect from your Leica Geosystems distributor.

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.

Such agreement is provided together with all products and can also be referred to and downloaded at the Leica Geosystems home page at Hexagon – Legal Documents or collected from your Leica Geosystems distributor.

You must not install or use the software unless you have read and accepted the terms and conditions of the Leica Geosystems Software Licence Agreement. Installation or use of the software or any part thereof, is deemed to be an acceptance of all the terms and conditions of such Licence Agreement. If you do not agree to all or some of the terms of such Licence Agreement, you must not download, install or use the software and you must return the unused software together with its accompanying documentation and the purchase receipt to the distributor from whom you purchased the product within ten (10) days of purchase to obtain a full refund of the purchase price.

Open Source information

The software on the product may contain copyright-protected software that is licenced under various open source licences.

Copies of the corresponding licences

- are provided together with the product (for example in the About panel of the software)
- can be downloaded on http://opensource.leica-geosystems.com

The Customer is permitted to modify our software components for the customer's own use and to perform reverse engineering of our software components for debugging of such modifications if these software components are linked with libraries licensed under the GNU Lesser General Public License (LGPL). However, forwarding the knowledge acquired during reverse engineering or forwarding modified software to third parties is prohibited.

The safety of this product is of great importance to us.

Therefore, as a rule, modified versions of the deployed Open-Source software can only be installed if the security features in use are removed by us. Please note that the installation of modified software can entail that possible safety requirements on the product are no longer fulfilled and that consequently, it can no longer be used in the originally intended way.

If you still wish to install modified versions of the software components licensed under the GNU General Public License (GPL) and the GNU Lesser General Public License (LGPL), please contact opensource@leica-geosystems.com noting that you would like to install own versions of the software on your device.

You will then receive all necessary information to return the device to us.

In order to comply with our license obligations towards the GPL and/or LGPL licensors, we will remove the security features in use, thereby enabling you to install GPL and/or LGPL software, remove our trademarks from the product, and return the product to you. However, redistribution of the product with modified software is not permitted as exhaustion of the distribution right cannot occur for the specific copy. Also, the use of the product may be prohibited if it violates any legal provisions. It is your responsibility to check whether the use is permissible in the specific case or to obtain the required permits. The warranty is void for any defects related to the use of modified software.

You may also obtain the complete corresponding source code from us on a physical medium (CD-ROM, DVD or USB memory stick) for a period of 3 (three) years after our last shipment of the corresponding product by sending an email to opensource@leica-geosystems.com. Please specify the address to which you wish us to send the source code. Additional product information (e.g. explicit product name, serial number etc.) will help us to identify the corresponding source code for you. The source code will be sent to the given address after reimbursement of the expenses actually incurred for providing the data carrier and shipping.

PART 2
AutoPole

9 Safety Directions

9.1 General Introduction

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.

Additional symbols

Warning against flammable substances.

Warning against explosive material.

Product must not be opened or modified or tampered with.

Indicates the temperature limits at which the product may be stored, transported or used.

9.2 Definition of Use

Intended use

- Measuring pole length
- Measuring pole tilt and computing coordinates
- Verifying target ID
- Data transfer with Bluetooth®
- Data communication with external appliances
- Remote control of product
- Computing with software
- Laying out points and designs, for example from blueprint
- Automatic target search, recognition and tracking
- Measuring coordinates

Reasonably Foreseeable 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
- Inadequate safeguards at the working site

9.3 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.

9.4 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 the product 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 products are respected

9.5 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

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.

For the AC/DC power supply:

⚠WARNING

Electric shock due to use under wet and severe conditions

If unit becomes wet it may cause you to receive an electric shock.

Precautions:

- If the product becomes humid, it must not be used!
- Use the product only in dry environments, for example in buildings or vehicles.

- Protect the product against humidity.

For the AC/DC power supply:

⚠WARNING

Unauthorised opening of the product

Either of the following actions may cause you to receive an electric shock:

- Touching live components
- Using the product after incorrect attempts were made to carry out repairs.

Precautions:

- ▸ Do not open the product!
- ▸ Only Leica Geosystems authorised service centres are entitled to repair these products.

⚠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.
- ▸ Consider the product's IP class restrictions in chapter 17 Technical Data.
- ▸ Do not drop or immerse the product into fluids.

⚠WARNING

Wet or moisture conditions

The housing around the battery has wiring which may produce a short-circuit.

Precautions:

- ▸ Do not place the battery system in water or expose it to moisture, lubricants, solvents or any other liquid.

⚠WARNING

Improper battery handling

Risk of fire, explosion or burn.

Precautions:

- ▸ Only replace battery with supported type.
- ▸ Prevent heating the battery above 70 °C.
- ▸ Never throw battery into fire.
- ▸ Do not disassemble, crush, or modify the battery.

⚠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/conductive objects.

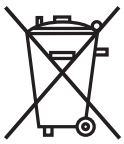
⚠WARNING

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.

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.

9.6 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.

⚠CAUTION

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.

⚠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:

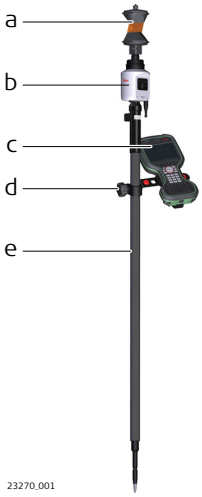
- Although the product meets the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that other equipment can be disturbed or that humans or animals can be affected.
- Do not operate the product with radio or digital cellular 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.

Support of AutoPole functionality

Term	Description
PoleHeight	Automatically measure height or length from the pole tip to the reflector and apply it to field software.
Tilt Compensation	Seamlessly measure and layout points with an arbitrary tilted reflector pole. Constantly show the quality of tilt compensated points in the field and store it with the point.
TargetID	Search and lock onto the target by verifying a specific ID on the fly.

	TS20 A	TS20 P	TS20 I
PoleHeight	✓	✓	✓
Tilt Compensation	✓	✓	✓
TargetID	-	✓	✓

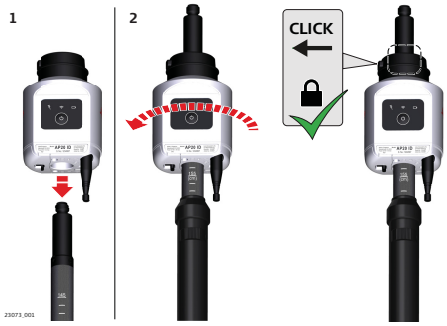
AutoPole setup



a Reflector
b AP20 AutoPole
c Field controller on GHT66 holder, optional
d GHT63 clamp
e AP Reflector Pole

Attaching AP20 onto AP Reflector Pole

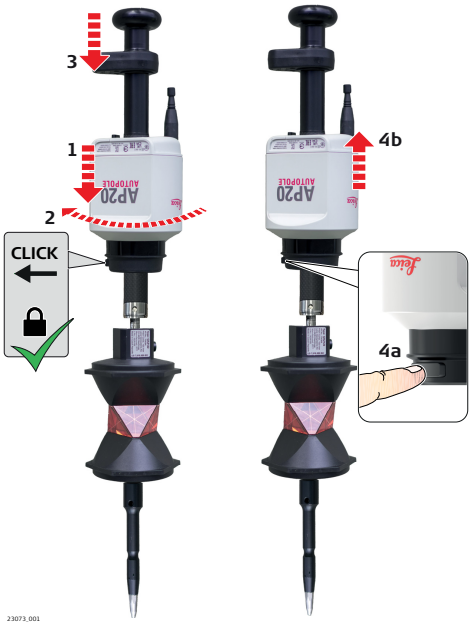
AP20 is compatible with AP Reflector Poles CRP4, CRP5, GLS51 and GLS51F.



1. Place the AP20 over the top of the AP Reflector Pole and slide it down as far as it will go.
2. Rotate the AP20 until it snaps into one of the lock positions.
3. To remove the AP20, press in the lock button to release it, then slide it up and off the top of the AP reflector pole.

Attaching AP20 onto AP Mini Pole

AP20 is compatible with AP Mini Pole GLS53 and GLS54.



1.	Place the AP20 over the top of the AP Mini Pole and slide it down as far as it will go.
2.	Rotate the AP20 until it snaps into one of the lock positions.
3.	Attach the handle with the bubble (CRP14).
4.	To remove the AP20, press in the lock button to release it, then slide it up and off the top of the AP reflector pole.

Pole handling with AP Reflector Pole

	Standard use	Reversed use CRP10 attached on reflector
		
PoleHeight**	✓	–
Tilt Compensation**	✓	✓ Refer to the manual of the field software for information about the setting.
TargetID**	✓	✓

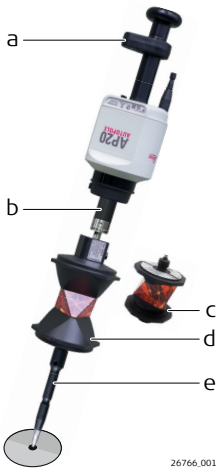
a GLS51
b MPR122
c GRZ122
d CRP10 with optional CRP13*

* Feet adapter for the CRP10 tip

** Features depending on AP20 variant

☞	For reversed use, the target height must be entered manually.			
Reflector	**Target height with exchangeable pole tip**			
	CRP10		**CRP10 + CRP13**	
Unit	[m]	[ft]	[m]	[ft]
MPR122	0.200	0.656	0.305	1.000
GRZ122	0.228	0.748	0.333	1.093

Pole handling with AP Mini Pole

	Standard use **CRP10 attached on reflector**
	 a CRP14 b GLS54 c MPR122 d GRZ122 e CRP10 with optional CRP13*
PoleHeight	–
Tilt Compensation**	✓ Refer to the manual of the field software for information about the setting.
TargetID**	✓

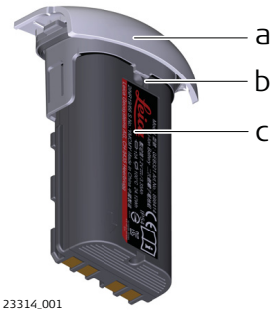
* Feet adapter for the CRP10 tip

** Features depending on AP20 variant

☞	For reversed use, the target height must be entered manually.			
Reflector	**Target height with exchangeable pole tip**			
	CRP10		**CRP10 + CRP13**	
Unit	[m]	[ft]	[m]	[ft]
MPR122	0.200	0.656	0.305	1.000
GRZ122	0.228	0.748	0.333	1.093

Change battery step-by-step

GEB321 batteries must be used in the AP20. GEB211/GEB212 do NOT work with AP20.



a Battery holder
b Notch of battery holder
c Battery GEB321

1.	Push the slide fastener of the battery holder in the direction of the arrow with the open-lock symbol.
2.	Remove the battery holder from the compartment. Remove the battery from the holder.
3.	To insert the battery, attach the battery to the batter holder. Align the battery to fit notch of battery holder.
4.	Insert the battery holder into the compartment.
5.	Push the slide fastener in the direction of the arrow with the close-lock symbol.

13 Software Update

Software upload

In case a software upload for AP20 is indicated, the correct firmware file has to be selected. The firmware file depends on the AP20 model.

Model	Software type
AP20 H AP20 ID	AP20H_ID_Firmware.swu Covers all functions required.
AP20 T AP20	AP20_T_Firmware.swu Covers all functions required.

☞ Uploading software can take some time. Ensure that the battery is at least 20% full before you start the upload. Do not remove the battery during the upload process.

Software update instructions for all AP20 models:

1.	Download the most recent firmware file from https://myworld-portal.leica-geosystems.com/ to your local PC.
2.	Connect AP20 to PC using GEV284 cable.
3.	Copy the firmware file onto the AP20 memory device.
4.	Disconnect GEV284 cable.
5.	Switch AP20 off.
6.	Switch AP20 on.
7.	The upload starts automatically. During the upload, all three LEDs are flashing consecutively.
8.	The update is complete when the Power LED on AP20 is constantly lit.

14 Working with the AutoPole

14.1 Overview

AutoPole functionality

Functionalities are listed according to the individual sales variants.

Functionality	AP20 H	AP20 ID	AP20 T	AP20
PoleHeight	✓	–	✓	✓
Tilt Compensation	–	–	✓	✓
TargetID	–	✓	–	✓

☞ AP20 can only be used in combination with an AP Reflector Pole (CRP4, CRP5, GLS51 and GLS51F) or an AP Mini Pole (GLS53 or GLS54).

☞ Establish a Bluetooth connection between the AP20 and the field controller or the total station in order to be operative. Use the connection wizard.

Supported connection types

AutoPole functionalities are supported in 2-person operation and 1-person operation. Use the field software on the total station or field controller to establish a Bluetooth connection.

In case of 1-person operation, first establish a connection between field controller and total station. Then use the field software on the field controller to establish a connection to the AutoPole.

14.2 PoleHeight

Description

The AP Reflector Pole can be extended to any of the given snap-lock positions in order to overcome obstacles.

As soon as a snap-lock position is reached, the attached AP20 receives the detected height from the AP Reflector Pole and transmits it to the field software of the connected total station or field controller.

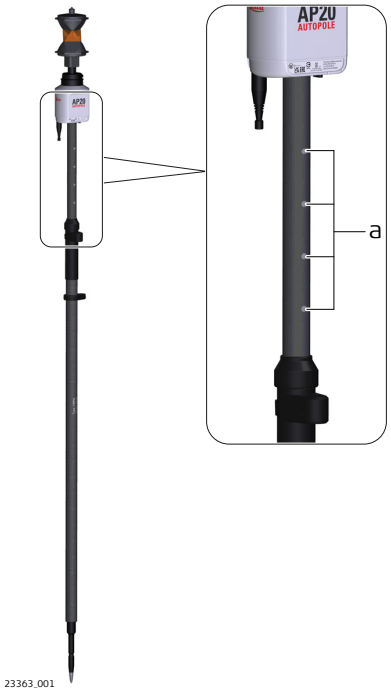
The transmitted height corresponds to the current length between prism centre and pole tip, which is equivalent to the printed scale on the pole and the height input field within the field software.

☞ Valid height detection is limited to the snap-lock positions. Intermediate positions are indicated as invalid. Enter the height manually.

☞ Optional pole extensions are not taken into account.

☞ Transmitted heights can be overwritten manually.

Diagram



a Snap-lock positions

PoleHeight step-by-step

Action	
☞	PoleHeight is only supported with sales variants AP20 H, AP20 T and AP20.
☞	PoleHeight can be used with: • Total station only (2-person operation) • Total station and field controller (1-person operation)
1.	Enter a survey app, for example **Measure** or **Stake points**.
2.	Physically extend or compress the pole to overcome obstacles.
☞	The height input field within Captivate will automatically update to current snap-lock height.
☞	3D viewer is updated with the current height of the pole.
3.	Measure or stake a point. The current height is applied to the coordinate calculation.

14.3 Tilt Compensation

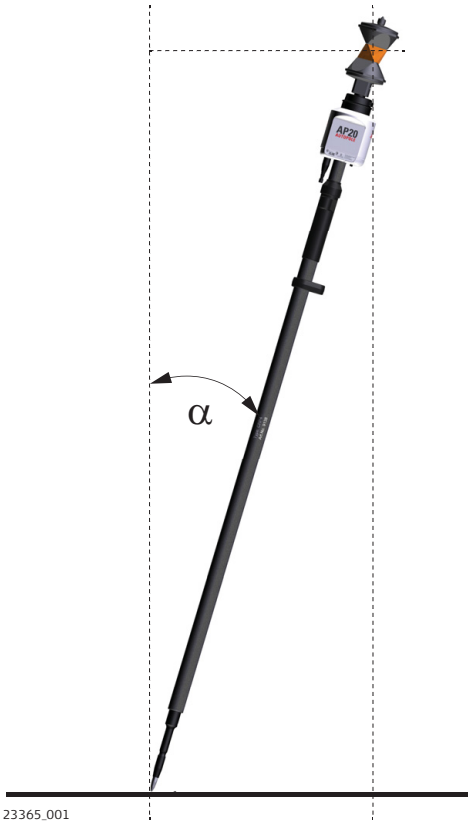
Description

The AP Reflector Pole can be held in a slanting position over the point to be measured without checking the circular bubble on the pole.

When measuring a point, the pole tip must be stable on the point while the pole should be in slight movement. Tilt compensation is indicated by an icon and the Tilt LED and is maintained by natural pole movement, for example while moving to the next point to be measured.

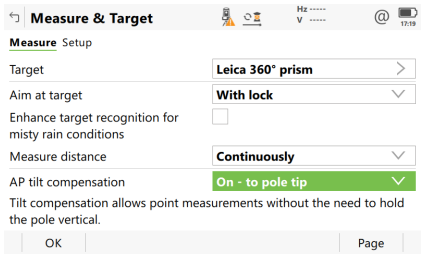
Measurements are reliable and accurate even if the pole is not levelled as the tilt values are calculated by an Inertial Measurement Unit. Tilt values contain information about the 3D position of the pole.

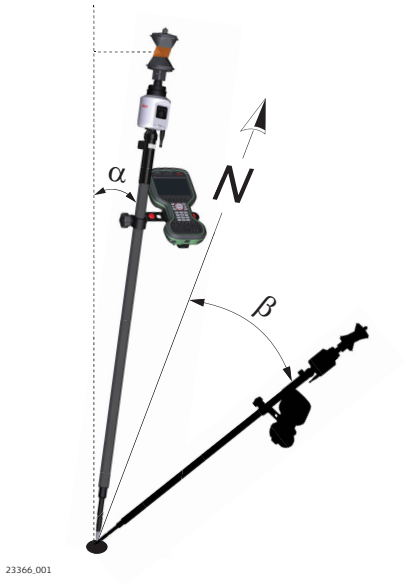
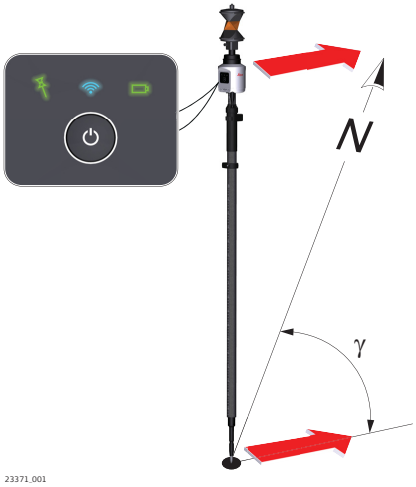
Diagram

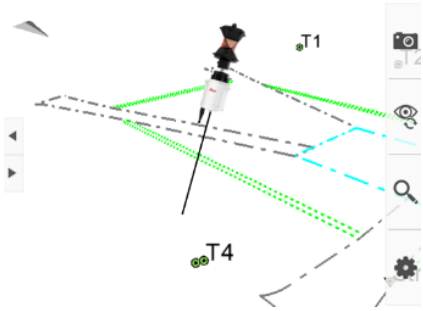
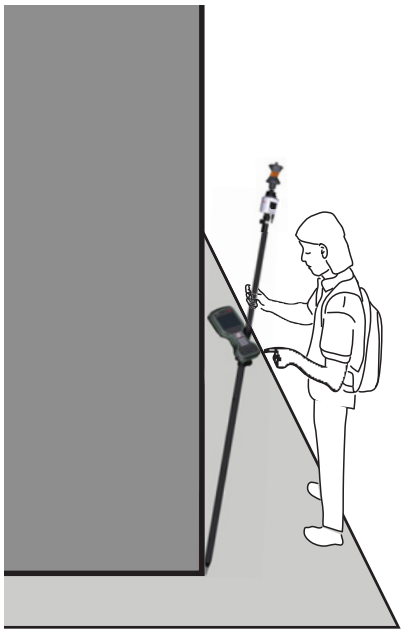
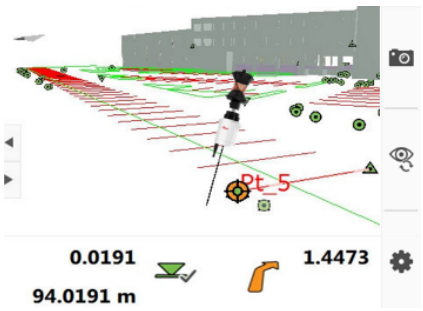


α Tilt

Tilt Compensation step-by-step

Action	Result
☞	Tilt Compensation is only supported with sales variants AP20 T and AP20 connected to a TS20 total station supporting Target Lock.
☞	Tilt Compensation can be used with total station only (2-person operation) or with an additional field controller connected to a total station (1-person operation).
1.	**Leica Captivate - Home: Settings\TS instrument\Measure & target**
2.	**AP tilt compensation** 
3.	**OK**
4.	Enter a survey app, for example **Measure** or **Stake points**.
☞	Tilt Compensation is not supported within the **Setup** app.
5.	Press **Start tilt**.

Action		Result
☞	Move the pole for initialisation. Walking to the survey mark is sufficient. A message and a voice promt indicate that the tilt compensation is being applied.	
☞	The Tilt LED on the AP20 and the green background of the Target Lock icon within Captivate indicate when a tilt compensated measurement is possible. Refer to 15 LED Indicators.	
6.	3D viewer is updated with the current pole alignment. The heading direction is the opposite side to the LED screen and ON/OFF button.	 23366_001 α Tilt toward vertical line β Direction of tilt toward North  23371_001 γ AP heading

Action		Result
7.	**Measure points** **Leica Captivate - Home: Measure** The position of the tilted AP20 is shown in the 3D viewer. Store points by pressing **Store**.	
	Application example:	 23383_001
8.	**Stake points** **Leica Captivate - Home: Stake points** The position of the tilted AP20 is shown in the 3D viewer. Stake out the point. The values are valid for the tip of the pole.	

14.4 TargetID

Description

TargetID provides an automatic target search and identification on-the-fly.

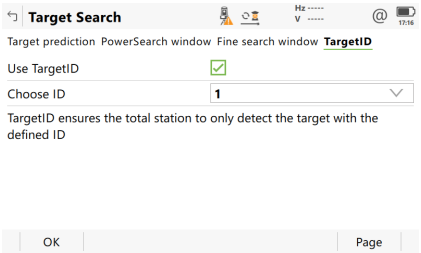
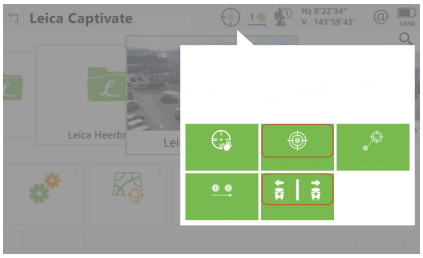
The common search methods, such as PowerSearch, are extended with an additional verification of an ID which is transmitted from the AP20.

While the total station is performing a search, it ignores any other target or foreign reflections and only stops and locks onto the target above the AP20.

Diagram

a TargetID window, 360° coverage

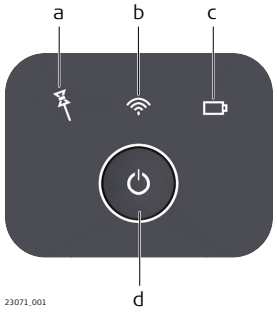
TargetID step-by-step

Action	Result
☞	TargetID is only supported with sales variants AP20 ID and AP20.
☞	TargetID functionality requires a total station with PowerSearch capability.
1. **Leica Captivate - Home: Settings\TS instrument\Target search, TargetID** page.	
2. **Use TargetID**: Check the check box.	
3. **OK**	
4. Start a target search. For example, use the icon **Search & lock** or **PowerSearch**.	
☞ The search includes identification on-the-fly and only stops at and locks onto the target above the AP20.	

15 LED Indicators

Description of the AP20 ON/OFF button and status LEDs

Diagram



a Tilt Compensation LED
b Connectivity LED
c Power LED
d ON/OFF button

Description of the LED Indicators

LED	LED Status	Status of the Instrument
Tilt Compensation LED	off	Tilt compensation is unavailable or switched off.
	green	Tilt compensation is activated, compensation values are stored. Tilt compensation is being applied to the point measurement.
	red	Tilt compensation is activated, but currently not being applied to the point measurement.
Connectivity LED	off	AP20 is not powered or module is not ready.
	green	Bluetooth is visible for other instruments and ready for connecting.
	blue	Bluetooth has connected.
Power LED	off	Battery is not connected, flat or AP20 is switched off.
	green	Power is 21% - 100%.
	red	Power is 11% - 20%. The remaining time for which enough power is available depends on the type of survey, the temperature and the age of the battery.
	flashing red	Power is low (<10%).

16 Care and Transport

16.1 Transport

Transport in the field

When transporting the equipment in the field, always make sure to carry the product in its original container.

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.

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.

16.2 Storage

Product

Respect the temperature limits when storing the equipment, particularly in summer if the equipment is inside a vehicle. Refer to 17 Technical Data for information about temperature limits.

Li-Ion batteries

- Refer to 17 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

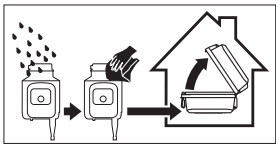
16.3 Cleaning and Drying

Product and accessories

- 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.

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.



AP reflector pole	In case of water ingress in the AP reflector pole, remove the tip of the pole to release water.
Cables and plugs	Keep plugs clean and dry. Blow away any dirt lodged in the plugs of the connecting cables.

17 Technical Data

17.1 PoleHeight

Range

AP Reflector Pole	PoleHeight Minimum		PoleHeight Maximum		Snap-lock spacing	
	[m]	[ft]	[m]	[ft]	[m]	[ft]
CRP4	1.55	-	2.20	-	0.05	-
CRP5	-	6.0	-	7.0	-	1.0
GLS51	1.55	-	2.20	-	0.05	-
GLS51F	-	4.7	-	7.0	-	0.2

Accuracy in reading of PoleHeight

± 1.0 mm

☞ Valid for engaged snap-lock positions of the AP Reflector Pole.

☞ The centring accuracy of the attached prism is not included.

17.2 Tilt Compensation

Range

Tilt range

Tilt Compensation works in arbitrary alignments of the pole as long as the target has free line-of-sight to the total station and positions can be measured continuously.

Range from total station

The maximum measuring range between the tilted pole and the total station depends on the achievable target lock and the remote connection range, typically 300 m.

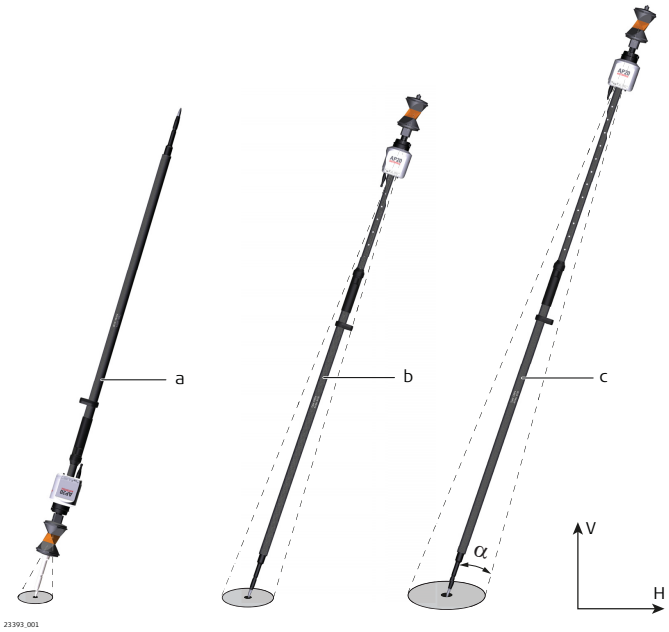
☞ A total station with target locking and continuous distance measurement is required.

Accuracy

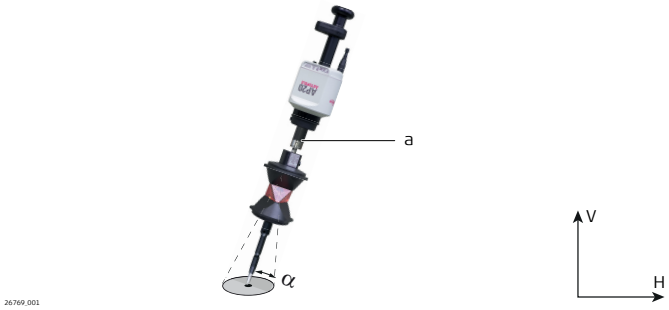
Since the Tilt Compensation uses continuous total station observations for the determination of the pole tilt, the tilt accuracy depends on various factors.

- Angular accuracy of the total station
- Distance accuracy of the total station
- Target type
- EDM measurement frequency of the total station
- Environmental and atmospheric conditions
- Target height
- Level of pole tilt

The derived additional pole tip accuracy in 2D and 1D, given as root mean square, depends on the level of tilt and the used target height. The lower the target height, the higher the pole tip accuracy.



a Target height 0.228 m
b Target height 1.600 m
c Target height 2.000 m
α Tilt accuracy
H Horizontal
V Vertical

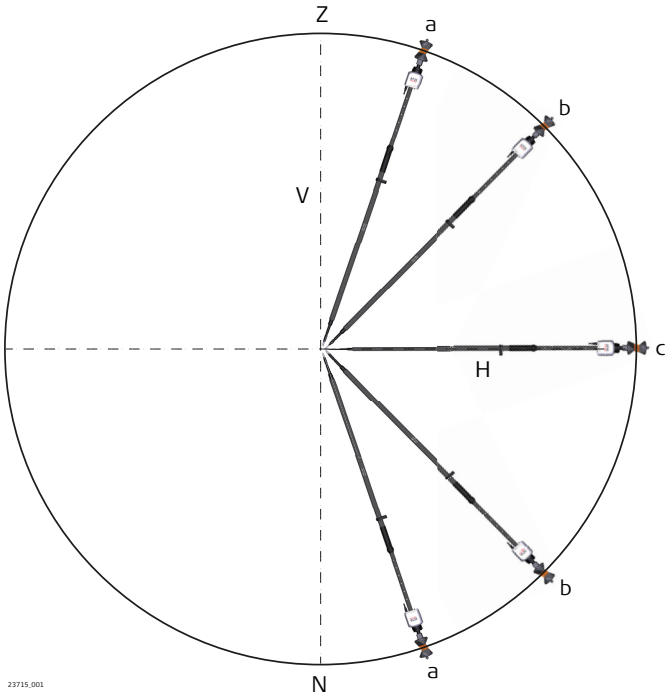


a Target height 0.228 m
α Tilt accuracy
H Horizontal
V Vertical

The less the pole is tilted from zenith/nadir to a horizontal pole alignment, the higher the pole tip accuracy.

	Target height	Additional pole tip uncertainty for tilt down to 90°, typically
Horizontal (2D)	0.228 m	1 mm + 0.1 mm/° tilt
	1.600 m	3 mm + 0.6 mm/° tilt
	2.000 m	4 mm + 0.7 mm/° tilt
	3.000 m	10 mm + 0.9 mm/° tilt
	4.000 m	16 mm + 1.2 mm/° tilt
Vertical (1D)	0.228 m	1 mm + 0.05 mm/° tilt
	1.600 m	1 mm + 0.05 mm/° tilt
	2.000 m	1 mm + 0.1 mm/° tilt
	3.000 m	1.5 mm + 0.6 mm/° tilt
	4.000 m	2.0 mm + 1.6 mm/° tilt

☞ When using the AP20 as a hidden point pole with 3 m or 4 m pole length, avoid a deflection of the pole during point storage to minimise additional errors.



a 15° tilt from zenith/nadir
b 45° tilt from zenith/nadir
c 90° tilt from zenith/nadir
Z Zenith
N Nadir
V Vertical alignment
H Horizontal alignment

When carrying the AP20 on the pole:

- Avoid dropping it and toppling over.
- In case of mechanic shock, test measurements are recommended to check the accuracy.

Measurement principle

Combining the reflector position with attitude information from an Inertial Measurement Unit (IMU) results in a tilt compensated pole tip position.

17.3 TargetID

Range

Pole alignment	Range	
	[m]	[ft]
Vertical	150	500
Tilted ±30°	100	325

TargetID uses PowerSearch technology. Measurements at the vertical limits of the PowerSearch fan or under unfavourable atmospheric conditions may reduce the maximum range.

Shortest measuring distance: 5 m

Separability

Number of different IDs: 16

Principle of TargetID

Type	Description
Principle	Digital image processing
Type	Infrared laser

☞ A total station with PowerSearch is required.

AP20 dimensions

Weight

Type	Value
All AP20	0.4 kg
Internal battery	0.1 kg

Power consumption

Type	Power consumption	
	Typically	Maximum
AP20 H	1.2 W	1.5 W
AP20 ID	1.5 W	13.1 W
AP20 T	3.2 W	4.0 W
AP20	3.6 W	15.6 W

Instrument port

Name	Description
USB type C port	Cable connection from USB devices for firmware update

Internal battery

Type	Battery	Nominal Voltage	Capacity
GEB321	Li-Ion	7.2 V ⎓	3.35 Ah

Operating times

Model	Operating time, typical
AP20 H AP20 ID	> 16 h

Model	Operating time, typical
AP20 T AP20	6 h

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
All AP20	–30 to +60	–40 to +80
Battery internal	–20 to +55	–40 to +70
All chargers	0 to +50	-40 to +70

Protection against water, dust and sand

	Protection
All AP20	IP67 (IEC 60529)
All chargers	Only operate in dry environments, for example in buildings and vehicles.

Pollution degree

Type	Pollution
All AP20	4 Electrical equipment for outdoor use
All chargers	2 Electrical equipment for office environment

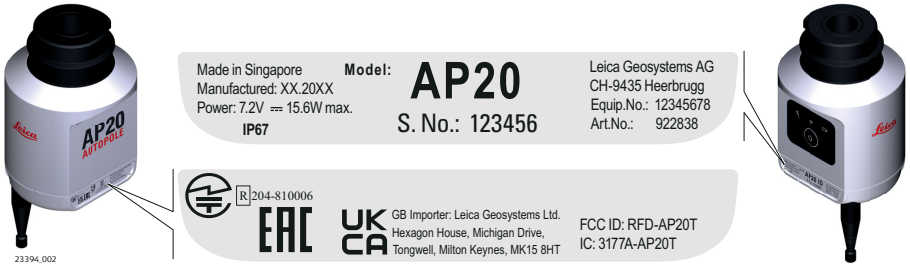
Humidity

Type	Protection
All AP20	Max 95% non condensing The effects of condensation are to be effectively counteracted by periodically drying out the AP20.
All chargers	Only operate in dry environments, for example in buildings and vehicles.

Altitude

Type	Protection
All AP20	Unrestricted
All chargers	≤ 2000 m above sea level

Labelling AP20



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.

24805_001

Labelling GEB321

24804_001

Frequency band

Type	Value
Bluetooth	2402 - 2480 MHz
NFC	13.56 MHz

Output power

Type	Value
Bluetooth LE	9.5 dBm (Average EIRP)

Antenna

Type	Antenna	Gain	Impendance
Bluetooth Classic	Planar Inverted-F Antenna (PIFA)	Internal antenna	50 Ω
Bluetooth LE	1/4 wavelength whip antenna	3.5 dBi (Peak)	50 Ω

Type	Antenna	Gain	Impendance
Near-Field Communication (NFC)	Coil flex	-	-

EU

Hereby, Leica Geosystems AG declares that the radio equipment type AP20 is in compliance with Directive 2014/53/EU and other applicable European Directives.
The full text of the EU declaration of conformity is available at the following Internet address: http://www.leica-geosystems.com/ce.

USA

Contains FCC ID: XPYNINAB22 (AP20 H), XPYNINAB22 (AP20 ID), RFD-AP20T (AP20 T), RFD-AP20T (AP20)
Part 15 B

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

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

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, 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.

Canada

CAN ICES-003(B)/NMB-003(B)
IC: 8595A-NINAB22 (AP20 H), 8595A-NINAB22 (AP20 ID), 3177A-AP20T (AP20 T), 3177A-AP20T (AP20)

Canada Compliance Statement
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference
2. This device must accept any interference, including interference that may cause undesired operation of the device

Canada Déclaration de Conformité
L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. L'appareil ne doit pas produire de brouillage
2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement du dispositif

Japan

- This device is granted pursuant to the Japanese Radio Law (電波法).
- This device should not be modified (otherwise the granted designation number will become invalid).

Others

The conformity for countries with other national regulations has to be approved prior to use and operation.

18 Software Licence Agreement/Warranty

International Limited Warranty

This product is subject to the terms and conditions set out in the International Limited Warranty which you can download from the Leica Geosystems home page at Leica Warranty or collect from your Leica Geosystems distributor.

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.

Such agreement is provided together with all products and can also be referred to and downloaded at the Leica Geosystems home page at Hexagon – Legal Documents or collected from your Leica Geosystems distributor.

You must not install or use the software unless you have read and accepted the terms and conditions of the Leica Geosystems Software Licence Agreement. Installation or use of the software or any part thereof, is deemed to be an acceptance of all the terms and conditions of such Licence Agreement. If you do not agree to all or some of the terms of such Licence Agreement, you must not download, install or use the software and you must return the unused software together with its accompanying documentation and the purchase receipt to the distributor from whom you purchased the product within ten (10) days of purchase to obtain a full refund of the purchase price.

Open Source information

The software on the product may contain copyright-protected software that is licenced under various open source licences.

Copies of the corresponding licences

- are provided together with the product (for example in the About panel of the software)
- can be downloaded on http://opensource.leica-geosystems.com

The Customer is permitted to modify our software components for the customer's own use and to perform reverse engineering of our software components for debugging of such modifications if these software components are linked with libraries licensed under the GNU Lesser General Public License (LGPL). However, forwarding the knowledge acquired during reverse engineering or forwarding modified software to third parties is prohibited.

You may also obtain the complete corresponding source code from us on a physical medium (CD-ROM, DVD or USB memory stick) for a period of 3 (three) years after our last shipment of the corresponding product by sending an email to opensource@leica-geosystems.com. Please specify the address to which you wish us to send the source code. Additional product information (e.g. explicit product name, serial number etc.) will help us to identify the corresponding source code for you. The source code will be sent to the given address after

reimbursement of the expenses actually incurred for providing the data carrier and shipping.

Leica
GEOSYSTEMS

1005019-1.0.0en
Original text (1005019-1.0.0en)

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HEXAGON