Leica AT930/AT960
User Manual

Version 1.2
English

- when it has to be **right**

Leica Geosystems

Introduction

Purchase

Congratulations on the purchase of a Leica AT930/AT960.

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.

Product Identification

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

Validity of this manual

This manual applies to all product series instruments. Where there are differences between the various models they are clearly described.

Available Documentation

Name	Description/Format		
User Manual	All instructions required in order to operate the product to a basic level are contained in the User Manual. Provides an overview of the product together with technical data and safety directions.	-	✓
Quick Guide	Provides an overview of the product together with technical data and safety directions. Intended as a quick reference guide.	✓	✓
Tracker Pilot Reference Manual	Describes the specific software for field checks, compensations and system maintenance.	-	✓
LMF Programmers Manual	Describes the usage and commands of the Leica Metrology Foundation (LMF).	-	✓

Refer to the following resources for Absolute Tracker documentation/software:

- http://www.leica-geosystems.com/metrology/

Feedback

Your feedback is important as we strive to improve the quality of our documentation. We request you to make specific comments as to where you envisage scope for improvement.

Please use the following E-mail address to send your suggestions:
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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 herein.

DANGER, **WARNING**, **CAUTION** and **NOTICE** are standardized 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 table below with the different signal words and their definitions! Supplementary safety information symbols may be placed within a warning message as well as supplementary text.

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

1.2 Definition of Use

Intended use

- Measuring coordinates.
- Recording measurements.
- Computing with software.
- Automatic target search, recognition and following.
- Remote control of product.
- Data communication with external appliances.

Reasonably foreseeable misuse

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

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.

DANGER

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

Environment

For AC power supplies:
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 it is used in accordance with the instructions.
- To be familiar with local regulations relating to safety and accident prevention.
- To inform Leica Geosystems immediately if the product and the application becomes unsafe.
- To ensure that the national laws, regulations and conditions for the operation of e.g. radio transmitters or lasers are respected.

1.5 Hazards of Use

CAUTION

Watch out for erroneous measurement results if the product has been dropped or has been misused, modified, stored for long periods or transported.

Precautions:

Periodically carry out test measurements and perform the field adjustments indicated in the user manual, particularly after the product has been subjected to abnormal use as well as before and after important measurements.

WARNING

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

Precautions:

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

WARNING

Inadequate securing of the working site 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

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

Precautions:

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

CAUTION

Risk of damage by overheating

If the product is covered by the protective cover while being switched on, the product may be damaged by overheating.

Precautions:

- Ensure that the product is switched off before covering it with the protective cover.

CAUTION

If the product is hit by a lateral push or moved without taking caution, it can topple over and cause property damage or injury.

Precautions:

- Use caution when working close to the product and when moving the product around the working site.
- Ensure that the working site is level and free of obstruction.
- Detach any accessories from the stand or tripod before moving it.
- Move the stand or tripod slowly and ensure that you do not jam on such things as hoses, cords or open grates.

NOTICE

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

Precautions:

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

WARNING

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

Cables deployed on the ground can be a hazard to pedestrians or vehicular traffic.

Precautions:

Ensure the power cable, LAN cable or any other cables do not lie in the path of pedestrian/vehicular traffic. Use appropriate cable cover and/or warning signs.

WARNING

Do not lift the product with a crane.

Precautions:

The handles of the product are not designed for crane transport.

CAUTION

If the accessories used with the product are not properly secured and the product is subjected to mechanical shock, for example blows or falling, the product may be damaged or people can sustain injury.

Precautions:

When setting-up the product, make sure that the accessories are correctly adapted, fitted, secured, and locked in position.

Avoid subjecting the product to mechanical stress.

WARNING

The instrument may fall off the Quick Release when the locking lever is removed.
Precautions:
Do not remove the locking lever of the Quick Release while the instrument is attached and the Quick Release is locked.
Safeguard the instrument from falling when mounted in an upside-down or tilted position, for example by attaching a suitable lanyard or fall limiter to the handle on the socket of the AT930/AT960 instrument.
Contact your local Leica Geosystems representative for further details on health and safety regulations.

CAUTION

During the operation of the product there is a hazard of squeezing extremities or entanglement of hair and/or clothes by moving parts.
Precautions:
Keep a safe distance of the moving parts.

☞

If the instrument moves unexpectedly during operation, stop the instrument by using the AT Controller or alternatively, disconnect the battery or main power source to prevent further movements.

WARNING

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

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

CAUTION

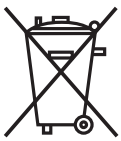
Installing near mechanically moving machine components may damage the product.
Precautions:
Deflect the mechanically moving machine components as far as possible and define a safe installation zone.

WARNING

If the product is improperly disposed of, the following can happen:

- If polymer parts are burnt, poisonous gases are produced which may impair health.
- If batteries are damaged or are heated strongly, they can explode and cause poisoning, burning, corrosion or environmental contamination.
- By disposing of the product irresponsibly you may enable 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.
- The product includes parts of Beryllium inside. Any modification of some internal parts can release dust or fragments, creating health hazard.

Precautions:



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

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

Applies only for California.
The product contains CR Lithium Cell(s) with perchlorate material inside – special handling may apply. See http://www.dtsc.ca.gov/hazardouswaste/perchlorate/

WARNING

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

1.5.1 The AC Power Supply

WARNING

If unit is not connected to ground, death or serious injury can occur.

Precautions:

To avoid electric shock power cable and power outlet must be grounded.

WARNING

The product is not designed for use under wet and severe conditions. If unit becomes wet it may cause you to receive an electric shock.

Precautions:

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

WARNING

If you open 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 workshops are entitled to repair these products.

1.6 Laser Classification

1.6.1 General

General

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

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

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

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

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

The AT930/AT960 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 afterimages, particularly under low ambient light conditions.

⚠ **CAUTION**

From a safety perspective, class 2 laser products are not inherently safe for the eyes.
Precautions:
1) Avoid staring into the beam or viewing it through optical instruments.
2) Avoid pointing the beam at other people or at animals.

Labelling

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☞ The AT930/AT960 is classified as a laser class 2 system although the individual laser sources are classified as laser class 1. The possibility of simultaneous emission of the individual laser sources results in an overall classification as laser class 2.

General

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

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

- IEC 60825-1 (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	795 nm
Maximum average radiant power	0.53 mW cw
Beam diameter	~ 10 mm
Beam divergence	< 1.5 mrad (collimated)
Working principle	Modulation of polarisation
Resolution	0.1 µm
Accuracy (MPE)	± 10 µm

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a) Laser beam

1.6.3 Laser Interferometer

General

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

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

- IEC 60825-1 (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	633 nm
Maximum average radiant power	0.30 mW cw
Emitting aperture	5.5 mm
Beam divergence	< 1.5 mrad
Accuracy (Wavelength Stabilisation)	± 0.2 ppm
Resolution	0.3 µm

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a) Laser beam

General

The PowerLock vision system built into the product produces an invisible 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.

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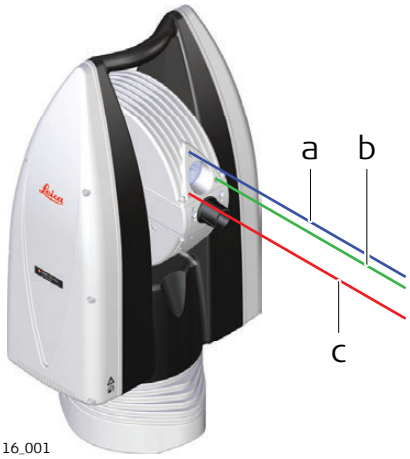
a) LED beam

General

The status LEDs 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.



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a) LED beam blue
b) LED beam green
c) LED beam red

1.7 Electromagnetic Compatibility EMC

Description

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

WARNING

Electromagnetic radiation can cause disturbances in other equipment.

Although the product meets the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that other equipment may be disturbed.
The product is a class A product. In a domestic environment this product can cause radio interference in which case the user can be required to take adequate measures.

CAUTION

There is a risk that disturbances may be caused in other equipment if the product is used with accessories from other manufacturers, for example field computers, personal computers or other electronic equipment, non-standard cables or external batteries.
Precautions:
Use only the equipment and accessories recommended by Leica Geosystems. When combined with the product, they meet the strict requirements stipulated by the guidelines and standards. When using computers or other electronic equipment, pay attention to the information about electromagnetic compatibility provided by the manufacturer.

CAUTION

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

CAUTION

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

Radios or Digital Cellular Phones

WARNING

Use of product with radio or digital cellular phone devices:

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

Precautions:

Although the product meets 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 to medical equipment.
- Do not operate the product with radio or digital cellular phone devices in aircraft.

1.8 FCC Statement, Applicable in U.S.

The greyed paragraph below is only applicable for products without radio.

WARNING

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING

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

Labelling AT930/AT960 Instrument

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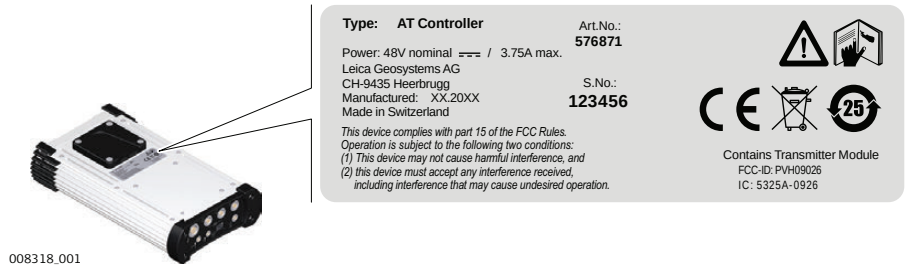
Labelling AT Controller



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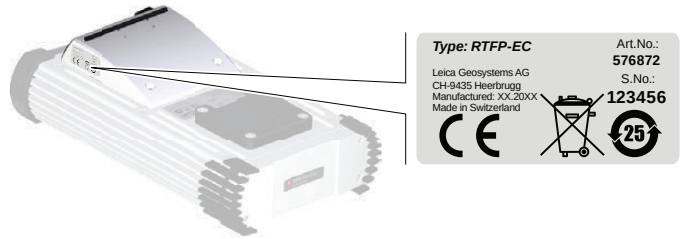
Labelling RTFP



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1.9 ICES-003 Statement, Applicable in Canada

WARNING

This Class (A) digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe (A) est conforme à la norme NMB-003 du Canada.

2 Description of the System

2.1 System Components

Introduction

The Leica Absolute Tracker system consists of:
- AT930/AT960 instrument with built-in MeteoStation
- AT Controller
- Quick Release with 3 1/2" x 8 thread (Brunson compatible)
- Stand Tube (optional)
- Universal Stand Fixture
- AC/DC adapter
- LAN cable

The terms "Absolute Tracker" and "Laser Tracker" are used as synonyms for all types of the Leica Geosystems Absolute Tracker.

System Components

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Component	Description
AT930/AT960 instrument	Absolute Tracker of highest accuracy for measuring, calculating and capturing data. AT930: 3D Measurements AT960: 3D & 6DoF Measurements
AT Controller	Controller running the system software which provides the interface to the Absolute Tracker. The optional **R**eal-**T**ime **F**eature **P**ack for Absolute Tracker AT930/AT960 is designed to provide cyclic measurement data in real-time over an industrial field bus protocol, for example EtherCAT, with minimum jitter and small latency.
Application Software	Third-party metrology software with an interface to the Absolute Tracker for acquisition, analysis, management, automation and reporting of measurement data.
Tracker Pilot	System software to • check the system accuracy and adjust (compensate) instrument parameters. • maintain and update the system software/firmware.

Absolute Tracker Models

The following table shows a list of available Absolute Tracker models. It provides an overview of the measurement ranges and upgrade feasibility to T-Products.

	Absolute Tracker Model			
	AT930	**AT960-LR**	**AT960-MR**	**AT960-XR**
3D Measurement Range	60 m	60 m	20 m	60 m
6DoF Measurement Range	N/A	20 m	10 m	25 m
T-Products Compatibility	No	Yes	Yes	Yes

2.2 Software Concept

General

The Absolute Tracker supports the following types of software applications.

Software Types

Software type	Description
System firmware	This software comprises the central functions of the Absolute Tracker.
Tracker Pilot	The Tracker Pilot software provides functionality to check and adjust the Absolute Tracker system as well as maintaining and updating the system.
Third-party application software	There are various computer-based third-party applications available for the Absolute Tracker. Contact your Leica Geosystems representative for details.
Customised application programs	Customised software specific to user requirements can be developed using the Leica Metrology Foundation (LMF). Contact your Leica Geosystems representative for further information.

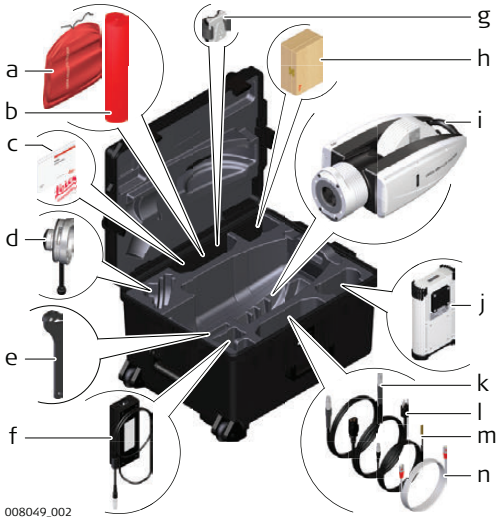
Firmware upload

A firmware update of the Absolute Tracker can be done through the provided Tracker Pilot software.

☞ Refer to Tracker Pilot Reference Manual for details on updating the Absolute Tracker system.

2.3 Container Contents

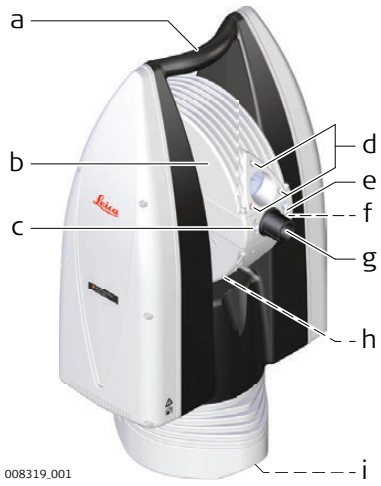
Container for Instrument and Delivered Accessories



a) Optical cleaning kit
b) Protective cover for AT930/AT960 instrument
c) Quick Guide and Product Information USB Stick
d) Quick Release
e) Hinged Hook Wrench
f) AC Power supply
g) Universal Stand Fixture
h) Wooden box containing 1.5″ Red Ring Reflector
i) AT930/AT960 instrument
j) AT Controller
k) Sensor cable
l) Power cable
m) External temperature sensor
n) Ethernet cable

2.4 Instrument Components

AT930/AT960 Instrument Components



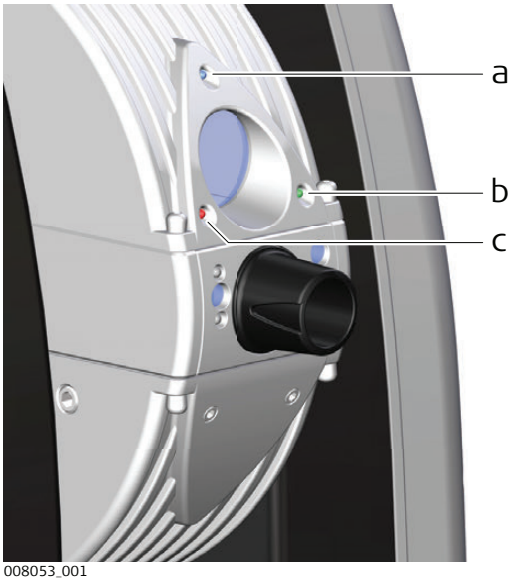
a) Carry handle
b) Telescope integrating AIFM, PowerLock, 6DoF measurement camera and Overview Camera
c) PowerLock
d) Status LEDs
e) PowerLock LED
f) Overview Camera
g) Coaxial optics for angle and distance measurement, and exit port for visible laser beam of the IFM and ADM
h) Circular level
i) Sensor cable connector

Status LEDs

Description

The AT930/AT960 has **L**ight **E**mitting **D**iode indicators at the front side of the telescope. They indicate the following states.

Diagram of the Status LEDs



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a) Blue LED
b) Green LED
c) Red LED

Description of the Status LEDs

LED	Pattern	Status Information
Red, Green and Blue LED	off	The AT Controller or the AT930/AT960 instrument are off.
Red, Green and Blue LED	static	The system is booting up.
Red and Blue LED	static	The system is ready, no reflector is in the field of view. PowerLock is activated.
Red LED	static	The system is ready, no reflector is in the field of view. PowerLock is inactive.
Red LED	flashing slowly	Warm-up in progress. The system is not ready to measure.
Red LED	flashing shortly interrupted by longer breaks	Laser off (stand-by mode)
Red LED	flashing	Target is out of range (too close or too far).
Green LED	static	Target locked and stable. Ready to measure.
Green LED	flashing	Measurement is in progress.
Blue LED	flashing slowly	PowerLock is temporarily suspended while laser is pointing.

2.5 AT930/AT960 Instrument Measurement System

2.5.1 Angular System

Description

The angle measurement system mainly consists of a coded glass circle and four angular encoders using quadruple angle reading. The quadruple angle reading system eliminates systematic and periodical errors of the angle measurement which results in increased measurement accuracy.

2.5.2 Inclination Sensor

Orient-to-Gravity Sensor

The Absolute Tracker AT930/AT960 features a dual-axis Orient-to-Gravity sensor. This inclination sensor is located within the rotating head of the AT930/AT960 instrument. The Orient-to-Gravity sensor can operate in different modes depending on the stability of the ground:

- Orient-to-gravity
- Monitoring
- Inclination sensor off

☞ Refer to Tracker Pilot Reference Manual or the relevant third-party software application manual for details on setting the desired operation mode.

2.5.3 Motorisation

Description

The AT930/AT960 instrument has two orthogonal, rotating axes. The motorisation of the axes uses direct drives that provide highest tracking speed and acceleration for high-dynamic measurements, for example in automation applications.

2.5.4 Absolute Interferometer (AIFM)

Absolute Interferometer (AIFM)

The Absolute Interferometer (AIFM) module combines a heterodyne Interferometer (IFM) for high dynamic measurements with an Absolute Distance Meter (ADM) to set the absolute reference distance. Both modules measure the distance to the reflector simultaneously, which allows a dynamic lock-on to a moving reflector still ensuring the highest accuracy.

Atmospheric influence

The accuracy of the measured distance is primarily dependent on the accuracy of the determination of:

- The ambient air temperature
- The air pressure

A change or a deviation in the atmospheric parameters affects the distance measurement accuracy as follows:

- ± 1°C results in a change in distance of approximately 1 ppm
- ± 4 hPa result in a change in distance of approximately 1 ppm.

Additive constant

For an absolute distance measurement the following values must be known:

- The additive constant (ADM Offset)
- The scale factor

These values are precisely determined in the factory. In the field the additive constant can be verified through a sensor check or compensation process.

☞ Refer to the Tracker Pilot Reference Manual on details of the ADM check and compensation process.

Wavelength Stabilisation

The wavelength of the Interferometer is stabilised by hard- and software to ± 0.2 ppm.

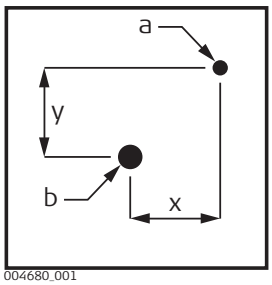
Reflector constant

Glass prism reflectors like the Tooling Ball (TBR) have an internal reflector constant, which causes an apparent increase in the distance measurement. This reflector constant is indicated on the accompanying Producer Certificate.
Please note: Hollow Corner Cube Reflectors (RRR) do not have a reflector constant.

2.5.5 Tracking

Description

The laser beam of the Interferometer represents the collimation axis of the Absolute Tracker. The returning beam from the reflector is read by the receiver and the biaxial Position Sensing Device (PSD). The changes in the PSD values enable the tracking capability of the Absolute Tracker through a control loop to the direct drive motors.



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a) Reflected laser beam
b) Servo control point
x, y) Steering offsets

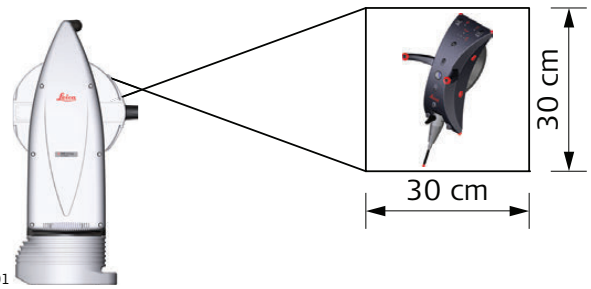
2.5.6 Measurement Camera (AT960 Only)

General

The Measurement Camera of the AT960 is a digital camera system operating with near infrared (IR) radiation, with an optical vario zoom. The Measurement Camera captures the images of the IR LEDs which are used to calculate the rotations of a T-product device in the field of view.

Field of View

The field of view of the Measurement Camera is defined by the target area, which can be replicated on the image sensor. The zoom lens maintains the field of view constantly at 30 x 30 cm in the target range.



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Six Degrees of Freedom (6DoF)

The target device is equipped with a prism and a set of infrared LEDs which represent the measurement targets. In order to completely describe the position of the target device in relation to the Absolute Tracker system, six measurement parameters are needed:

- Three position parameters (Hz, V, D)
- Three orientation parameters (ω, φ, κ)

The Absolute Tracker determines the position parameters, the Measurement Camera determines the orientation parameters.

Measurement Camera Parameter	Absolute Tracker Parameter
Rotation around the X-axis – Omega ω	Horizontal angle - Hz
Rotation around the Y-axis – Phi φ	Vertical angle - V
Rotation around the Z-axis – Kappa κ	Distance - D

2.5.7 PowerLock

Description

To determine the location of a target, the Absolute Tracker uses an additional off-axis vision system, which is built into the sensor. As soon as the target is in the field of view of the sensor, the Absolute Tracker locks on to the target and steers the laser beam back onto the Tracking PSD without operator intervention.
This revolutionary vision system works with all standard reflectors and T-Products.

Field of View

The field of view of the PowerLock vision system is 10°, which corresponds to a covered area of 1.75 m x 1.75 m at a distance of 10 meters.

2.5.8 Overview Camera

Description

The Overview Camera enables the visualisation of reflectors. This camera is located at the front of the telescope above the aperture of the measurement beam, the focus and aperture are fixed. Targets that are recognized by the Power Lock vision system are visualised within the image of the Overview Camera. By this, you can identify and select reflectors to lock on and take measurements.

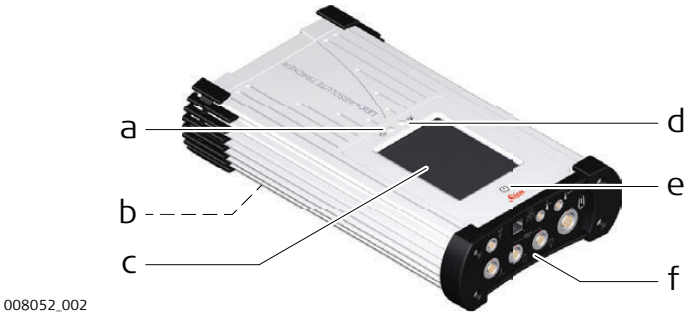
2.5.9 Meteo Station

Description

The air temperature, air pressure and humidity affect the refraction index of the air, which causes a change in velocity of propagation and wavelength of the measurement beam. These changes can influence the values of the distance measurements.
The build-in Meteo Station provides environmental information on air temperature, air pressure and relative humidity, which is used to calculate the current refraction index of the surrounding atmosphere. The internal Meteo Station reads the information from an internal probe, optionally two additional external temperature sensors can be connected, one for the ambient air temperature and one for the object temperature.

☞ To achieve the highest possible measurement accuracy it is strongly recommended to determine the ambient temperature using the provided external temperature sensor.

Controller - Top View



008052_002

a) Power status LED
b) Clip for Universal Stand Fixture (back side of the AT Controller)
c) Touch-sensitive status display with different information pages
d) WLAN status LED
e) Main power switch for AT Controller and AT930/AT960
f) Connectors

Controller - Front View

008321_001

a) Ethernet (LAN) RJ45 (TCP/IP)
b) Probe Cable
c) Trigger cable
d) Socket for AC power supply unit and/or battery unit
e) Connector for external ambient temperature sensor
f) Connector for object temperature sensor
g) Connector for sensor cable

Turn on

To turn on the AT930/AT960 instrument press the power switch on the front panel.

Turn off

To turn off the system press the power switch 2 seconds. This ensures that the system software is shut down properly.

Compatibility

The AT Controller is compatible with the AT930/AT960 instrument. Other types of Leica Laser Trackers are not supported.

2.6.1 AT Controller Display

Description

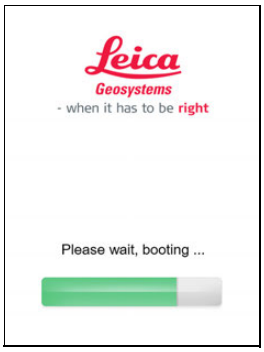
The AT Controller has a touch-sensitive VGA colour display. The display shows essential information about the Absolute Tracker system. The following pages are available:

- Startup splash screen
- Shutdown splash screen
- Software Update splash screen
- Main page
- Network Connection page
- Power Supply page
- Levelling page
- Meteo page
- Information page
- Information Details page

Display brightness

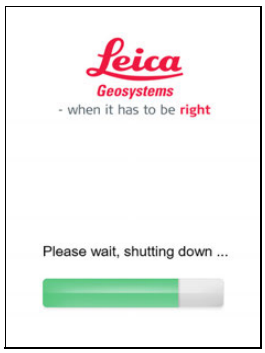
The AT Controller boots with the pre-configured display brightness settings.
5 minutes after your last interaction on the AT Controller, the display dims back to 5% of the brightness range and changes to the main page.
To bring the display brightness back to the pre-configured level, touch the display anywhere.

Splash Screens



Startup splash screen

When turning on the AT Controller, the Startup splash screen with the progress bar "Booting" is displayed. As soon as booting is finished the display switches to the main page.



Shutdown splash screen

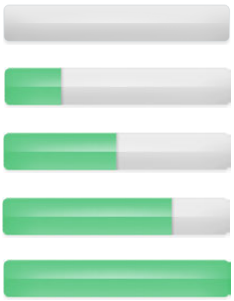
When turning off the AT Controller, the Shutdown splash screen with the progress bar "Shutting down" is displayed. The controller closes all system tasks before shutting down completely.

System Update splash screen

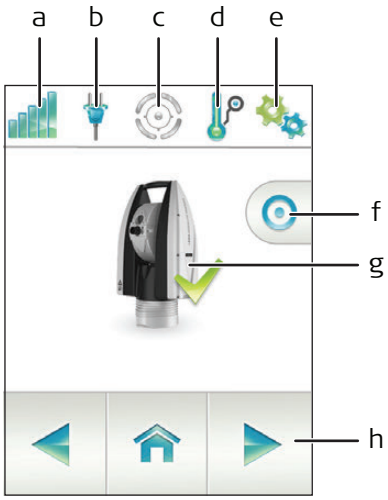
When installing a system update, the System Update splash screen with the progress bar "Installation in Progress" and a warning icon is displayed.

☞ Do not turn off the controller during a system update.

When the update was successful, the display switches back to the main page.

Splash Screen Icons	Description
	While the controller is booting, shutting down or installing a system update, the progress bar indicates the degree of completion:
	0% 25% 50% 75% 100%
	Running progress bar: Installation is ongoing.

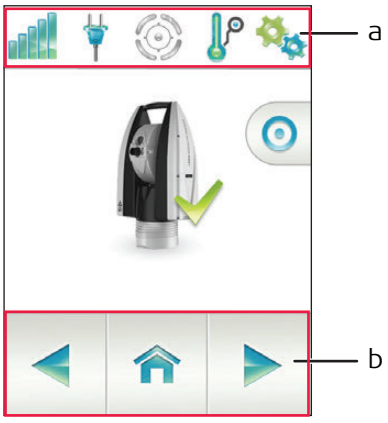
Main page



a) LMF connection status (includes WLAN signal strength if connected by WLAN)
b) Power supply status
c) Levelling sensor status
d) Meteo data source
e) System information
f) Active measurement profile
g) Absolute Tracker status
h) Controller navigation controls

The icons change their appearance depending on the current status of the feature that they represent.

Touch screen sensitive areas:

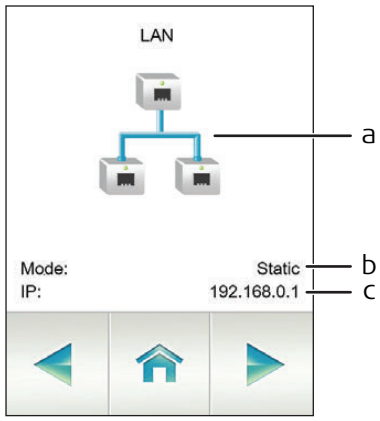


a) Tap on an icon to display the corresponding detail page.
b) Tap on the navigation control areas to toggle between the detail pages and the main page.

Status Icons	Description
Absolute Tracker Status	
	System is ready.
	Sensor is not connected.
	Tracker is not initialised.
	Firmware problem. (Example: Not all device servers are available.)
	Laser is off.
	Laser is not ready.
	Laser is warming up.
	Laser is unable to stabilise.
Measurement Profiles	
	Fast
	Standard
	Precise
	Continuous

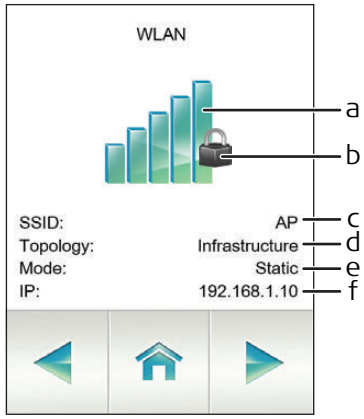
Network Connection Page

LAN:

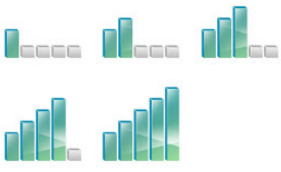


a) Network Connection Status
b) Network Mode
c) IP Address

WLAN:

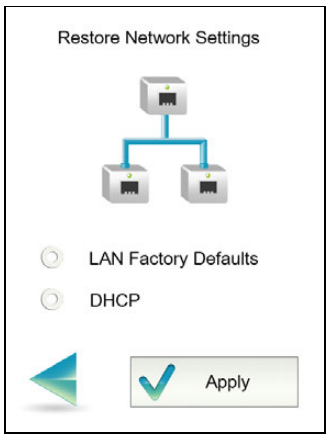


a) WLAN connection status/signal strength
b) WLAN connection encryption status
c) Broadcasted SSID
d) Topology type
e) Network mode
f) IP address

Status Icon	Description
Network Connection Status	
	No LMF connection
	LMF connected via LAN
	LMF connected via WLAN
WLAN Connection Status/Signal Strength	
	No WLAN connection/signal strength: 0-6%
	WLAN established/signal strength: 7-20% 21-40% 41-60% 61-80% 81-100%
WLAN Connection Encryption Status	
	WLAN connection encrypted

Restore Network Settings Page

To restore the network settings, tap on the icon on the Network Connection page

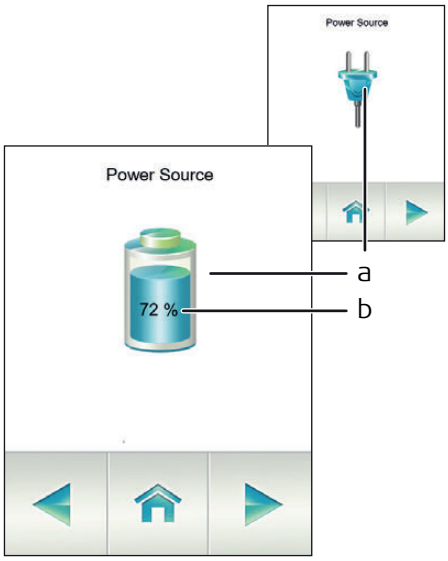


Choose between two different resetting options:

- LAN Factory Defaults
- DHCP

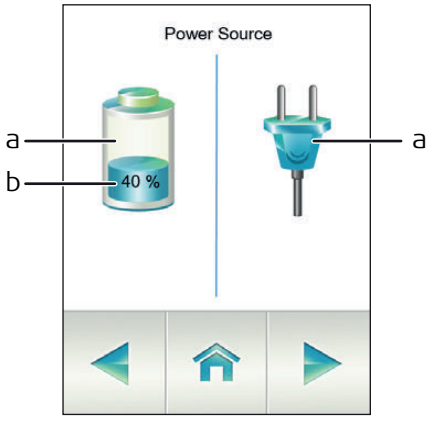
Tap on “Apply” to restore the network settings to the selected option.

Power Supply Page: Single Power Source



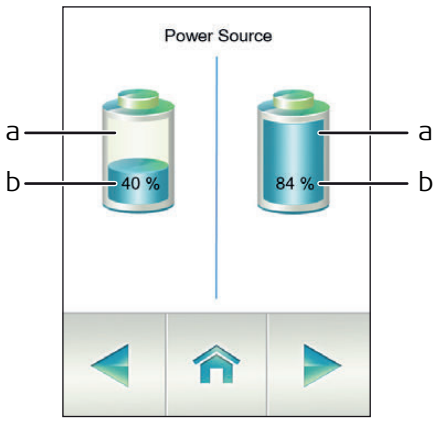
a) Active power source:
Mains connection
OR battery
b) Remaining battery capacity

Power Supply Page: Dual Power Source (Option 1)



a) Active power source (Mains connection **and** battery)
b) Remaining battery capacity

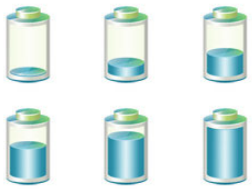
Power Supply Page: Dual Power Source (Option 2)



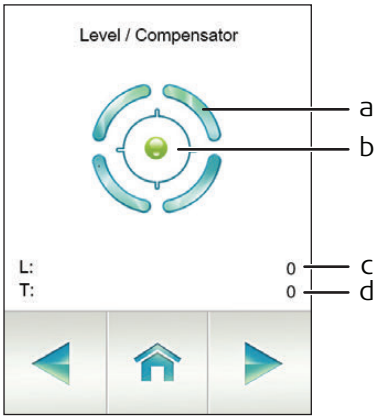
a) Active power source (Battery 1 **and** Battery 2)
b) Remaining battery capacity

☞ If two batteries are connected, the battery icon on the main page shows the sum of the total capacities divided by 2.

Power Supply - Status Icons

Status Icon	Description
Power Source for Absolute Tracker	
	Battery
	Mains connection
Battery Capacity	
	0-6% 7-20% 21-40% 41-60% 61-80% 81-100%
	Low Battery (0-6%)

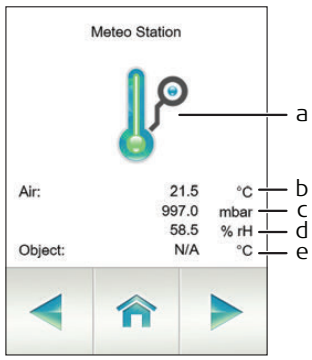
Levelling Page



a) Inclination sensor status
b) Electronic level bubble
c) Longitudinal tilt (unitless)
d) Transversal tilt (unitless)

Status Icon	Description
Inclination Sensor Status	
	Disabled
	Not in working range
	Enabled
	Enabled, levelled enough for a successful OTG

Meteo Page



a) Meteo data source
b) Ambient air temperature
c) Ambient air pressure
d) Ambient relative humidity
e) Object temperature

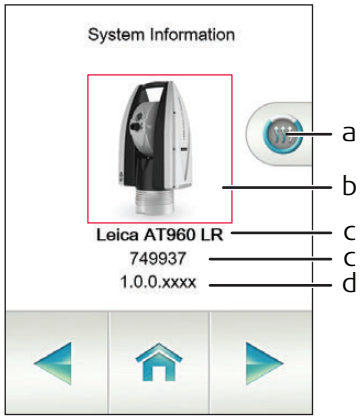
Units:

- Imperial: °F, InHg, %rH
- Metric: °C, mBar, %rH

☞ You can change the unit settings of the Meteo page within the Tracker Pilot software.

Status Icon	Description
Meteo Data Source	
	Automatic reading from internal sensors
	Manually entered environmental data
	Automatic reading from external sensor attached
Meteo Status	
	No Meteo data
	Meteo data out of range

Information Page



a) System Warm-up state
b) Touch sensitive area
c) System type
d) System serial number
e) Installed firmware revision

Status Icon	Description
System Warm-up state	
	Not warmed up
	Warmed up

2.6.2 AT Controller Status LEDs

Status LEDs

Description

The AT Controller has **L**ight **E**mitting **D**iode indicators on the top side. They indicate the following states.

Diagram of the Staus LEDs

008322_001

a) Green LED
b) Yellow LED

Description of the Status LEDs

IF the	is	THEN
LED	off	AT Controller power is off.
Green LED	static	AT Controller is powered up.
Yellow LED	static	WLAN module is activated.

2.7 Application Processor

Description

An application processor which runs the actual application software is required to operate the AT930/AT960. The Leica Metrology Foundation (LMF) provides an open and flexible interface to third-party application programs.
The use of an Application Processor distributes the workload such as:

- The system software runs on the AT Controller Processor, the application software runs on the Application Processor. The resources of the Application processor are fully available for data acquisition, handling, calculation and graphical display to support all user needs. The hardware requirements for the Application Processor depend on the specifications of the supplier of the application software.
- The interface between the system software and the application software is clearly defined, making it easier to maintain both, embedded and application software.

2.8 Accuracy

Description

The accuracy of measurements with the Absolute Tracker depends on the individual accuracy of the following components:

- Angle measurements
- Distance measurements
- Reflectors

2.8.1 Maximum Permissible Error (MPE)

Description

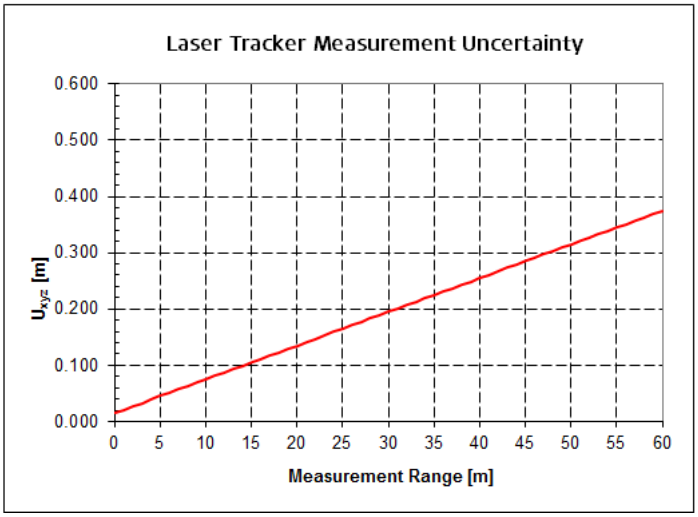
Accuracy specifications in the technical data of this manual are stated by means of the Maximum Permissible Error (MPE). The Automotive Society of Mechanical Engineers (ASME) defines Maximum Permissible Error (MPE) as the "extreme values of an error permitted by specification, regulations, etc. ... for a given instrument". The ASME B89.4.19-2006 standard further expands this definition by specifying that if during testing a corresponding measurement fails to meet the MPE requirements, then the failed measurement is allowed to be re-measured 5 times, with the magnitude of the largest error replacing the failed position value. If the new value fails to satisfy the MPE requirement, then the test is allowed to be done a second time (but not more than twice) with a failed result leading to a failed inspection test. Typical measurement results of the Absolute Tracker are half of the relevant MPE values.

2.8.2 Measurement Uncertainty

Description

The measurement uncertainty of a coordinate "U_{xyz}" is defined as the deviation between a measured coordinate and the nominal coordinate of the measured point. This measurement uncertainty is specified as a function of the distance between the Laser Tracker and the measured point.
All accuracies are specified as Maximum Permissible Error (MPE) and calculated per ASME B.89.4.19-2006 and draft ISO 10360-10 using precision Leica 1.5" Red Ring Reflectors unless otherwise noted.

Range	Uncertainty
U_{xyz} (MPE)	± 15 µm + 6 µm/m



☞ Refer to "7 Technical Data" for detailed specifications of the product.

2.8.3 Reflector

Reflectors

Hollow Corner Cube Reflectors (RRR and BRR) and glass prisms (TBR) are available with the following tolerances:

Roundness (Ball)	Value
Red-Ring Reflector (RRR)	< ± 3 µm
Break Resistant Reflector (BRR)	< ± 3 µm
Tooling Ball Reflector (TBR)	< ± 6 µm

Centring of optics	Value
Red-Ring Reflector (RRR)	< ± 3 µm
Break Resistant Reflector (BRR)	≤ ± 10 µm
Tooling Ball Reflector (TBR)	< ± 10 µm

Reflector constant (ADM)	Value
Red-Ring Reflector (RRR)	0.000 mm ± 0.003 mm
Break Resistant Reflector (BRR)	0.00 mm ± 0.01 mm
Tooling Ball Reflector (TBR)	5.30 mm ± 0.03 mm

☞ If repeatability of measurements is important, the reflector should always be used with the same orientation. The serial number and Leica logo on the reflector housing helps to maintain the orientation.

3 Accessories

Description

This chapter describes the following accessories for the Laser Tracker systems:
- Reflectors
- Measurement Cart

This list of accessories is not exhaustive, various other products are available for different measurement tasks.

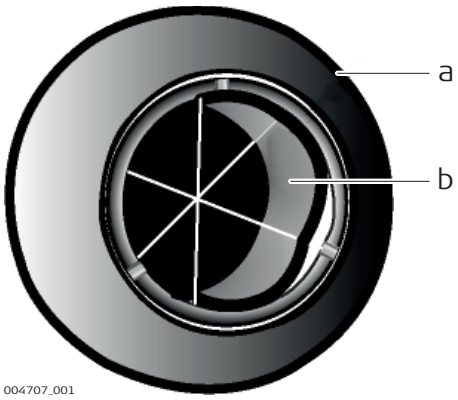
☞ Refer to the brochure “Leica Metrology Product Catalog” for detailed information on additional accessories.

☞ The use of accessories from third-party manufacturers without prior approval of Leica Geosystems is not permitted. Unauthorised modifications to the system make the warranty null and void.

3.1 Reflectors

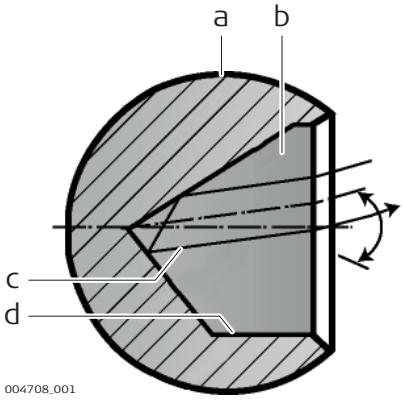
Reflector Types

Leica Geosystems recommends using the following reflector types:
- Hollow corner cube (air path) reflector (Red Ring Reflector (RRR), Break Resistant Reflector (BRR)), consisting of three orthogonal mirrors. The mirrors are centred in a metal sphere and their reflective surfaces have a optimized coating.



a) Housing
b) Reflective surfaces

- Small size glass prism (Tooling Ball Reflector (TBR)). For a small size glass prism, the influence of refraction for small entry angles (± 15°) can be neglected. Glass prism reflectors are recommended for static points, where it can be pointed towards the sensor unit during the actual measurement. To impede measurements with large entry angles of the laser beam, a collar can be mounted on the aperture of the TBR.



a) Reflector housing
b) Solid glass prism
c) Laser beam path
d) Prism surface

Entry Angle of Laser Beam

Reflector Type	Max. Entry Angle
RRR/BRR	± 30°
TBR	± 22°

Housing

Most reflectors are housed in a metal ball (Spherically mounted reflector, SMR), with the advantage of a constant offset when measuring surfaces. A three-point reflector support ensures reliable centering of the sphere.

Reflector support

A reflector support is used, when the reflector needs to be fixed in a particular stable position. A magnet in the reflector support holds the reflector in the same position. Various kinds of reflector supports are available.

☞ Refer to the brochure “Leica Metrology Product Catalog” for detailed information.

Damaged reflectors

A dropped reflector may be damaged, which will affect the measuring accuracy (trueness of the optics and centering). Damages may not be immediately apparent. Dropped reflectors should be sent to your authorised Leica Geosystems representative for inspection.

☞ Secure the reflector with a lanyard when moving the reflector.

3.2 Measurement Cart

Description

A mobile, lockable cart offers flexibility in assembly and portability of the Absolute Tracker system. All components, apart from the Tracker Stand, can be installed or stored inside the cart. The complete system can be lifted onto rails on the side of the cart.
The cart has drawers to store reflectors and smaller accessories, and a provision for a power panel.
A rack enables the installation of an Application Computer, the AT Controller, a UPS-module and the T-Scan Controller.

3.3 Real-Time Feature Pack

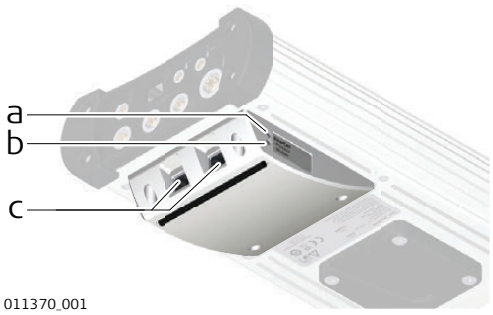
Description

The optional **R**eal-**T**ime **F**eature **P**ack for Absolute Tracker AT930/AT960 is designed to provide cyclic measurement data in real-time over an industrial field bus protocol, for example EtherCAT, with minimum jitter and small latency. The RTFP acts as a slave in the external automation bus system.

The RTFP is an add-on to the AT Controller which needs to be factory - or service fitted.

Contact your Leica Geosystems representative for details.

RTFP Components



a) Protocol Information LED
b) Status Information LED
c) RJ45 Connector

4 Operation

4.1 Setup

General

The first installation of the product should be done by authorised Leica Geosystems personnel. Installation by unauthorised personnel may cause damage and will make the warranty null and void.

Setup Step-by-step

Step	Description
1.	Screw the Quick Release onto the Tracker Stand and tighten it using the hinged hook wrench.
2.	☞ Ensure that the locking lever of the Quick Release is in unlocked position. Set the AT930/AT960 instrument onto the Quick Release.
3.	Close the locking lever to lock the Absolute Tracker on the Quick Release. ☞ Do not remove the locking lever of the Quick Release while the sensor is attached to the Quick Release.
4.	Attach the AT Controller to the Universal Stand Fixture.
☞	This advice refers to the following instructions about connecting cables: When plugging in cables, ensure that the controller is secured against slipping out of the Universal Stand Fixture!
5.	Connect the external temperature sensor to the port of the AT Controller, that is labelled with “Air”. This ensures that you achieve the highest possible measurement accuracy.
6.	Connect one end of the sensor cable to the AT Controller.
7.	Connect the other end of the sensor cable to the AT930/AT960 instrument.
8.	Connect a LAN cable (if applicable).
9.	Connect the AC power supply to the AT Controller and to a grounded mains socket outlet.
10.	To turn on the Absolute Tracker, press the power switch on the frontpanel of the AT Controller.

Step	Description
11.	The system automatically detects when the start-up cycle has finished. The system will initialise automatically once the start-up cycle has finished.
12.	Start the application.

Refer to the relevant application manual for further details on carrying out measurements.

WARNING

Mounting the sensor on unstable or uneven ground may cause the sensor to tip over or cause unreliable measurement results.
Precautions:
Ensure the ground is stable and even. Do not place the sensor over cracks in the floor.

4.2 Connecting to an Application Computer

Connection types

There are two basic connection types for WLAN and LAN:
- Point-to-point configuration (TCP/IP)
- LAN configuration (TCP/IP)

4.2.1 Wired Connection

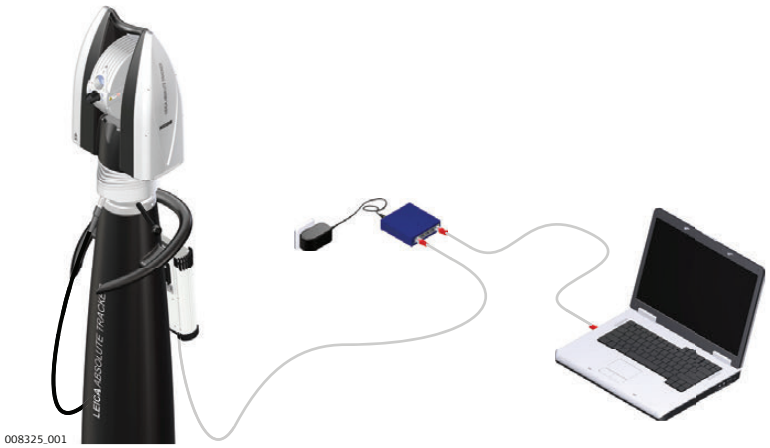
Point-to-point

The standard configuration connects the Application Processor to the AT Controller. Third-party application software is using the Leica Metrology Foundation (LMF) as low-level interface to the AT Controller.
The connection requires the following component:
- Cat5 LAN Cable, RJ45

Network Configuration

The LAN configuration provides a network-based access from the Application Processor to the AT Controller.
The connection requires the following components:

- Crossed-over or straight RJ45 network cable for the connection between the AT Controller and the network hub, depending on the type of hub.
- Crossed-over or straight RJ45 network cable for the connection between the Application Processor and the network hub, depending on the type hub.
- Hub for LAN connection to AT Controller, Application Processor and network.



4.2.2 WLAN Connection

WLAN Configuration

As alternative to the wired connection, you can operate the AT Controller and the Application Processor in a wireless LAN (WLAN) network.
The AT Controller supports the wireless topology “Infrastructure”.
Select the network mode LAN configuration (DHCP).

The setup is similar to the wired configuration. For the Application Processor, install and configure the WLAN module.

☞ Refer to Tracker Pilot Reference Manual for detailed instructions on setting up a WLAN connection.

☞ For certain countries with special regulations for operating wireless networks the WLAN module will be decommissioned by the factory. The user of the product will not be able to activate the WLAN module in this case. Please contact your local Leica Geosystems representative for further details on wireless network regulations.

4.3 Application Processor

Description

The Application Processor runs the application software. The application software must be installed beforehand.

☞ Refer to the manual of the application software for further details.

4.4 Batteries

4.4.1 Operating Principles

First-time Use / Charging Batteries

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

Operation / Discharging

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

Description

Leica Geosystems products are manufactured, assembled and adjusted to the best possible quality. Quick temperature changes, frequent movements of the product, shock or stress can cause deviations and decrease the measurement accuracy.
It is therefore recommended to check and adjust (compensate) the product from time to time. This can be done onsite by running through specific sensor check or compensation measurements. If the sensor checks do not provide satisfying results repeatedly, a full compensation of the product is recommended.
The following product parameters can be checked and adjusted electronically to a product specific parameter file:

- Axis offsets O_x, O_y, e
- Vertical index, related to the standing axis (i)
- Hz collimation correction (c)
- Tilting axis correction (j)
- ADM Offset (AC)

☞ Please refer to "Compensation" or "Sensor Check" in the Tracker Pilot Reference Manual for details on the Sensor Check and Compensation process.

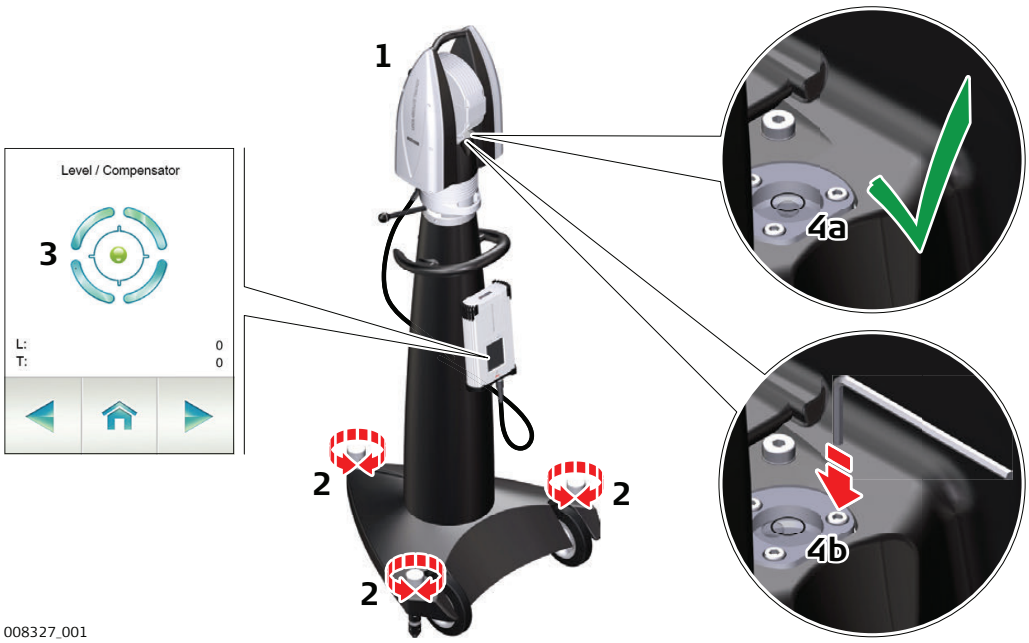
Measurement precision

To achieve precise measurement results in the daily work, it is important to check and adjust (compensate) the product from time to time. During the manufacturing process the product parameters are carefully determined.
As mentioned above, these values can change and it is highly recommended to check or adjust the product in the following situations:

- Before the first use of the product
- Before taking high precision measurements
- After long transportations
- After long working periods
- After long storage periods
- After mechanical shock of the product, for example drop
- In a high or low temperature environment

☞ Before starting to work the product has to become acclimatised the ambient temperature, especially if the product has been stored under different temperature conditions. Ensure sufficient acclimatisation to the environment before taking precision measurements.

Adjusting the Circular Level Step-by-step



Step	Description
1.	Place and secure the instrument into the Quick Release on the Stand Tube.
2.	Level the instrument precisely with the electronic level on the display of the AT Controller using the footscrews.
3.	Check the position of the circular level on the instrument.
4.	a) If the circular level is centred, no adjustments are necessary.
	b) If the circular level is not centred, adjust as follows:
	• If the bubble extends beyond the engraved circle, use a 2-mm allen key to centre it with the adjustment screws. • Turn the sensor unit by 180°. If the bubble of the circular level does not stay centred, repeat the adjustment procedure.
☞	After the adjustments, all adjusting screws must have the same tightening tension and no adjusting screw should be loose.

6 Care and Transport

6.1 Transport

General

The equipment is sensitive to shock, vibration, temperature, humidity and air pressure.

6.1.1 Transport on Site

On-site Transport

When transporting the equipment on site, always make sure that you carry the product

- in its original container,
- or attached to the Tracker Stand.

☞ Ensure that the working site is level and free of obstruction.

☞ Detach any accessories from the stand or tripod and carry them in their original container.

☞ Move the stand or tripod slowly and ensure that you do not jam on such things as hoses, cords or open grates.

☞ Properly set up the stand or tripod at the new position before reattaching the accessories.

⚠ WARNING

Do not lift the product with a crane.

Precautions:

The handles of the product are not designed for crane transport.

Transport in a road vehicle

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

Shipping

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

Shipping, transport of batteries

When transporting or shipping batteries, the person 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

Periodically carry out test measurements and perform the field adjustments indicated in the User Manual, particularly after the product has been dropped, stored for long periods or transported.

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.

Protection Cover

The sensor unit and its external optical parts can be protected from dust with the Protection Cover. Use the Protection Cover whenever the Laser Tracker is not in use.

Field adjustment

After long period of storage inspect the field adjustment parameters given in this user manual and the Tracker Pilot reference manual before using the product.

Li-Ion batteries

- Refer to "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.

6.3 Cleaning and Drying

6.3.1 General

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.

For power supplies and chargers:

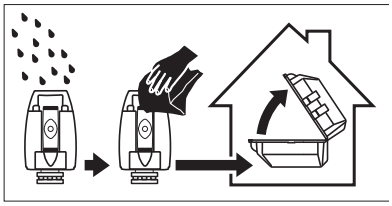
- Use only a clean, soft, lint-free cloth for cleaning.

Cables and plugs

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

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.



6.3.2 Cleaning Optical Parts

General

Optical elements, like the cover glass and reflectors, are sensitive to dirt moisture and mechanical damage, which influence the following factors:

- General functionality (loss of tracking)
- System accuracy (angular and distance accuracy)
- Intensity of laser beam (cover glass)

The cleaning intervals depend on the local conditions of use.
The following optical parts must be cleaned regularly:

- Cover Glass
- Retroreflectors

008328_001

a) Cover glass

NOTICE

Cleaning of all optical parts requires great care. Improper cleaning can destroy optical surfaces which may lead to a malfunction.

Precautions:

Only use appropriate cleaning material and follow the cleaning procedure described in this User Manual.

Cleaning Set

The cleaning set consists of the following articles:

- 1 Hand blower
- 1 Brush
- Cleaning swabs (large)
- Cleaning swabs (small)
- Cleaning cloth

☞ Keep the cleaning set from soiling. Do not reuse swabs or tissues that are contaminated with dust or swarf particles.

☞ If you need to replace cleaning materials, contact your local Leica Geosystems agency as source of supply.

Cleaning liquid

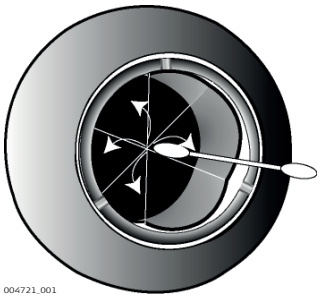
Use Isopropanol as cleaning liquid to soak tissues or cleaning swabs.

☞ Keep the content of the liquid container clean. Do not dip the swabs into the liquid container, pour the liquid onto the swab or tissue.

☞ Do not use common liquid cleaners or cleaning tissues for eyeglasses. They can damage or leave a residue on the optical surfaces.

Cleaning Optical Parts

To clean optical parts like cover glass, reflectors etc., use the following procedure:



1) Use hand blower to clear out dirt.
2) Never touch any glass surfaces with your fingers.
3) Use a hairbrush to loosen and remove remaining dirt.
4) Repeat procedure with the hand blower and brush until the residues of dirt have been removed.
5) Use the cotton swabs soaked in cleaning liquid to remove any remaining dirt.

BRR

A special procedure applies for the cleaning of Break Resistant Reflectors.

CAUTION

For the cleaning of Break Resistant Reflectors (BRR) never use any mechanical force like brushes or cotton swabs to clean the coated surfaces!

Precautions:

For cleaning of Break Resistant Reflectors (BRR) follow the procedure described in the Product Information delivered with the product.

6.4 Maintenance

Service

The product is a high-precision measuring instrument and to be handled with care. Maintenance of the equipment must be carried out by a Leica Geosystems authorised Service Centre.

CAUTION

There are no user-serviceable parts inside the product.

Precautions:

Do not open the product. Breaking the warranty seals will void the warranty.
Refer to "1 Safety Directions" for further details.

Service Intervals

The periodicity of service intervals is dependent on the conditions of use. We recommend a service contract with a yearly maintenance of the equipment. Please contact your local Leica Geosystems representative for details.

Repairs

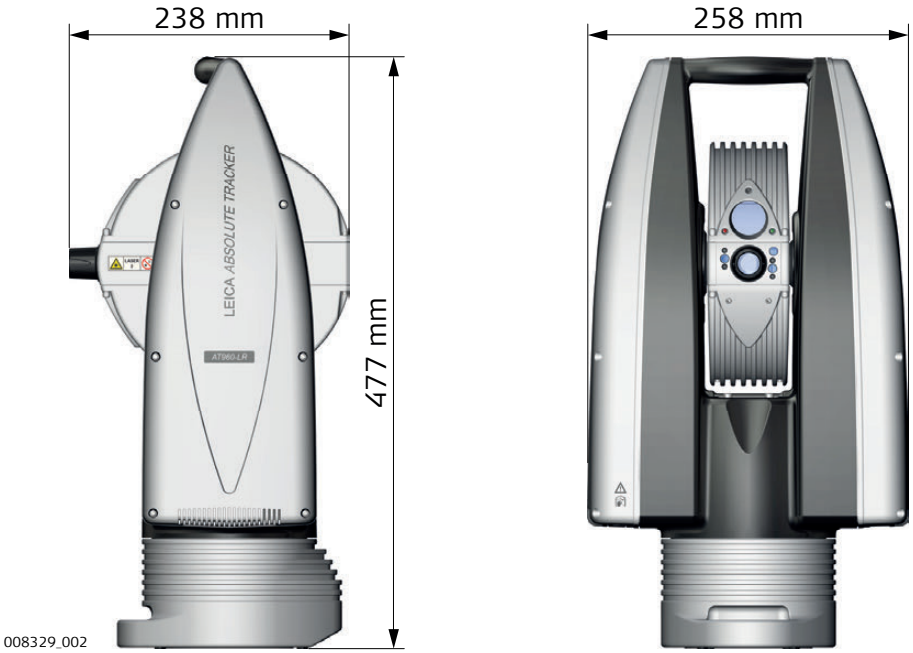
In case of visible damage, system failure or errors, contact your local Leica Geosystems representative.

7 Technical Data

7.1 General Technical Data of the Instrument

Physical Dimensions

AT930/AT960 instrument	Dimensions
Size	258 mm x 238 mm x 477 mm
Transit Axis height	1404 mm
Weight of AT930/AT960 sensor	13.8 kg
Weight of Quick Release	2.75 kg
Sensor Interface	3 ½" - 8 UNC



AT Controller	Dimensions
Size	249 mm x 148 mm x 59 mm
Weight	approximately 1.65 kg

Base Tube	Dimensions
Size (Length)	862 mm effective length (875 mm overall length)
Weight	approximately 9.3 kg

Base Plate	Dimensions
Size (Side Length)	615 mm overall lenght, 602 mm width
Weight	approximately 17.95 kg

Electrical Power

AC/DC Adapter for AT Controller	Value
Input Voltage	100 V to 240 V AC
Output Voltage	48 V DC
Frequency	50/60 Hz
Power	180 W
Max. input AC current	1.7 A (115 AC); 0.9 A (230 V AC)
Max. input AC current (over current protection)	4 A

Environmental Specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
AT930/AT960 instrument	0 to +40	-25 to +70
AT Controller	0 to +40	-25 to +70

Humidity

Type	Protection
AT930/AT960 instrument, AT Controller	Max 95 % non condensing To avoid the effects of condensation, periodically dry out the instrument.

Elevation

Maximum Elevation	Range	
	[m]	[ft]
Operation	3500	11500
Storage	12000	39500

Protection against water, dust and sand

Type	Protection
AT930/AT960 instrument	IP54 (IEC 60529)
AT Controller	IP54 (IEC 60529) (in upright position with the connector plugged in)

MeteoStation

Measurement range	Range
Temperature (internal sensor)	-10°C to +60°C (14°F to 158°F)
Temperature (external sensor)	-20°C to +80°C (14°F to 158°F)
Pressure	500 hPa to 1100 hPa
Humidity	0% to 95%

Device	Measurement uncertainty	Applicable range
External Air/Object temperature	± 0.3°C	0°C to 40°C (32°F to 104°F)
Pressure	± 1.0 hPa	0°C to 40°C (32°F to 104°F) 750 hPa to 1100 hPa
Humidity	± 5% *	-

* Prerequisite: External air temperature sensor is connected.

Measurement Camera (AT960 only)

Measurement Camera	Value
Working principle	Image chip sensitive to infrared radiation
Shutter speed	100 Hz
Image processing accuracy (2σ)	± 0.2 µm
Operating wavelength	880 nm

Overview Camera

Description	Value
Focal length	20.6 mm
Field of view	Approximately 10° (horizontally & vertically)
	At 10 m: Horizontal ~ 1.5 m, Vertical ~ 1.5 m
Focus	~ 17 m (56 ft)
Video Output	VGA (640 x 480)
Update Rate	10 Frames/sec
Target Recognition	Supported by ATR Image Processing

PowerLock

Description	Value
Field of View	Approximately 10° (horizontally & vertically)
Operating Range	2 m - 60 m
Operating Wavelength	850 nm

WLAN Module

Description	Value
Standard	IEEE 802.11g
Channels	1 to 10 (only use channels 1 to 9 outdoors in FR)
Frequencies	2.412 GHz to 2.472 GHz
Data Rate	54 Mbit/s
Operation Modes	Infrastructure
Encryption	• WPA2 PSK • None

Data output

Description	Value
Measurement Data Output Rate	1000 points/s

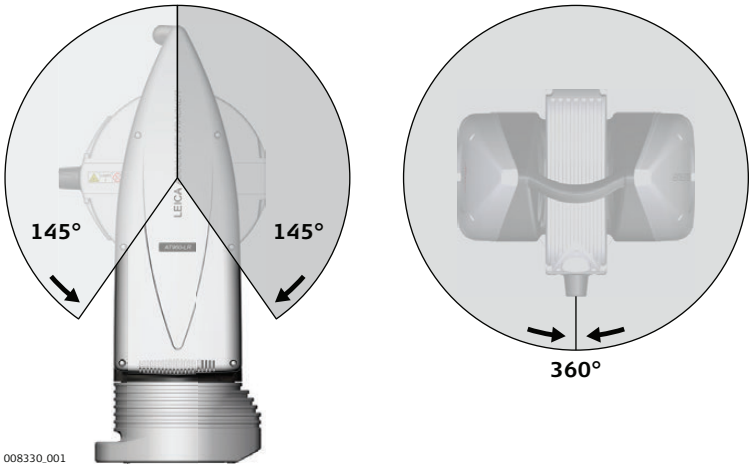
Motorisation

AT930/AT960 instrument	3D	6DoF
Maximum rotation speed	200 gon/s	200 gon/s
Acceleration lateral (› 2.5 m)	1500 gon/s^2	1500 gon/s^2
Acceleration radial	› 180 m/s^2	› 100 m/s^2
Tracking speed lateral (› 2.5 m)	› 160 gon/s	› 120 gon/s
Tracking speed radial	› 6 m/s	› 4 m/s

Measurement Range

Angular measurement range	Value	
Horizontal	endless	
Vertical	Face 1	3D: +75°/-55° 6DoF: +55°/-55°
	Face 2	3D: +90°/-55° 6DoF: +90°/-40°

Distance measurement range	Value			
	AT930	AT960-MR	AT960-LR	AT960-XR
3D	60 m	20 m	60 m	60 m
6DoF	N/A	10 m	20 m	25 m



Angular Measurement

Description	Value
Resolution	0.07 arc sec
Angular repeatability, range depending on Absolute Tracker model	± 7.5 µm + 3 µm/m
Angular accuracy, range depending on Absolute Tracker model	± 15 µm + 6 µm/m

Inclination Sensor

Description	Value
Setting accuracy	± 1.0 arc sec (2σ)
Compensated measuring range for Orient to Gravity (OTG)	± 227 arc sec
Measuring range	± 616 arc sec
Compensation method	Length- and crosswise

Orient to Gravity

Description	Value
Orient to Gravity Uncertainty $U_{Z(OTG)}$	± 15 µm + 8 µm/m

7.2 Conformity to National Regulations

7.2.1 AT930/AT960 Instrument

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product is in compliance with the essential requirements and other relevant provisions of the applicable European Directives. The declaration of conformity may be consulted at http://www.leica-geosystems.com/ce.

7.2.2 AT Controller

Conformity to national regulations

- FCC Part 15 (applicable in US)
- Hereby, Leica Geosystems AG, declares that the product AT Controller with WLAN module is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC and other applicable European Directives. The declaration of conformity can be consulted at http://www.leica-geosystems.com/ce.

  Class 1 equipment according European Directive 1999/5/EC (R&TTE) can be placed on the market and be put into service without restrictions in any EEA Member state.
- The conformity for countries with other national regulations not covered by the FCC part 15 or European directive 1999/5/EC has to be approved prior to use and operation.
- Japanese Radio Law and Japanese Telecommunications Business Law Compliance.
  - This device is granted pursuant to the Japanese Radio Law and the Japanese Telecommunications Business Law.
  - This device should not be modified (otherwise the granted designation number will become invalid).

Frequency band

Type	Frequency band [MHz]
WLAN	2412 - 2472

Output power

Type	Output power [dBm]
WLAN	+ 17 dBm (802.11b mode)

Antenna

Type	Gain [dBi]
AT Controller, WLAN (internal antenna)	1.1

Dangerous Goods Regulations

The products of Leica Geosystems are powered by Lithium batteries.

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

- When carrying or shipping your Leica product with Lithium batteries onboard a commercial aircraft, you must do so in accordance with the **IATA Dangerous Goods Regulations**.
- Leica Geosystems has developed **Guidelines** on "How to carry Leica products" and "How to ship Leica products" with Lithium batteries. Before any transportation of a Leica product, we ask you to consult these guidelines on our web page (http://www.leica-geosystems.com/dgr) to ensure that you are in accordance with the IATA Dangerous Goods Regulations and that the Leica products can be transported correctly.
- Damaged or defective batteries are prohibited from being carried or transported onboard any aircraft. Therefore, ensure that the condition of any battery is safe for transportation.

8 Software Licence Agreement

Software Licence Agreement

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

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Appendix A Abbreviations

Abbreviations

The following abbreviations are used in this manual:

Term	Description
ADM	Absolute Distance Meter
AIFM	Absolute Interferometer
AP	Application Processor
AT	Absolute Tracker
ATR	Automatic Target Recognition
BRR	Break Resistant Reflector
EMC	Electromagnetic Compatibility
EN	Standard of the European Committee for Standardization
IEC	International Electrotechnical Commission
LMF	Leica Metrology Foundation
MPE	Maximum Permissible Error
RJ45	Registered Jack 45, standardised physical interface for connecting telecommunication equipment.
RRR	Red Ring Reflector
SMR	Spherically Mounted Reflector
TBR	Tooling Ball Reflector
TCP/IP	Transmission Control Protocol/Internet Protocol

Appendix B Regional Contact Addresses

Regional Contact Addresses

People's Republic of China Hexagon Metrology (Qingdao) Co., Ltd. 188 Zhuzhou Road 266101 Qingdao China P.R. China Phone +86 532 8870 2188 Fax +86 532 8870 3060	**France** Hexagon Metrology SAS Service Client Leica Immeuble Le Viking 32, Avenue La Baltique 91978 Courtaboeuf Cédex France Phone +33 01 69 29 12 00 Fax +33 01 69 29 00 32
Germany Hexagon Metrology GmbH Siegmund-Hiepe-Straße 2 - 12 35578 Wetzlar Germany Phone +49 6441 207 207 Fax +49 6441 207 122	**Great Britain** Hexagon Metrology Ltd Hexagon House Michigan Drive Tongwell Milton Keynes MK15 8HT Phone +44 (0)870 446 2667 Fax +44 (0)870 446 2668
Italy Hexagon Metrology SpA Via Bizzozzero, 118 20132 Cormano (MI) Phone +39 02 6154 111 Fax +39 02 6150 473	**Spain** Hexagon Metrology S.A. Parc Tecnològic del Vallès C/ Sabaters, 5 ES-08290 Cerdanyola del Vallès (Barcelona) Phone +34 93 594 69 20 Fax +34 93 594 69 21
Switzerland Leica Geosystems AG Metrology Division Moenchmattweg 5 CH-5035 Unterentfelden Phone +41 62 737 67 67 Fax +41 62 737 68 33	**USA** Hexagon Metrology Precision Center 7 Orchard Road, Suite 102 Lake Forest, CA 92630 Toll free +1 800 955 5200 Phone +1 949 916 4490 Fax +1 949 916 449
USA Hexagon Metrology Precision Center 9424 E 37th Street North Suite 220 Wichita, KS 67226 Toll free +1 866 756 6763 Phone +1 316 634 0856 Fax +1 316 634 0878	**USA** Hexagon Metrology Precision Center 2473 Belvo Road Miamisburg, OH 45342 Phone +1 937 353 1206 Fax +1 937 247 0426

Refer to "Sales & Support Contacts" on www.leica-geosystems.com/metrology for a complete list of regional contacts.

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- when it has to be **right**

Leica Geosystems