

Leica iCON aps 200



User Manual
Version 3.1
English

- when it has to be **right**

Leica
Geosystems

PART OF
HEXAGON

Introduction

Purchase

Congratulations on the purchase of the Leica iCON aps 200.



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.

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

- *Bluetooth®* is a registered trademark of Bluetooth SIG, Inc.
- All other trademarks are the property of their respective owners.

Validity of this manual

This manual applies to the Leica iCON aps 200 instrument and the Leica CGA100 antenna.

Available documentation

Name	Description/Format		
Leica iCON aps 200 Quick Guide	Provides an overview of the product together with technical data and safety directions. Intended as a quick reference field guide.	✓	✓
Leica iCON aps 200 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.	-	✓

Refer to the following resources for all Leica iCON aps 200 documentation/software:

- the Leica USB documentation card.
- <https://myworld.leica-geosystems.com>



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

Table of Contents

1	Safety Directions	6
1.1	General Introduction	6
1.2	Definition of Use	7
1.3	Limits of Use	7
1.4	Responsibilities	8
1.5	Hazards of Use	8
1.6	Electromagnetic Compatibility (EMC)	13
2	Description of the System	15
2.1	System Components	15
2.1.1	General Information	15
2.1.2	Power Concept	16
2.2	Unpacking the Container	17
2.2.1	iCON aps 200 Dual GNSS Container	17
2.3	Instrument Components	18
3	Using iCON aps 200	21
3.1	Power Supply	21
3.2	Installing a SIM Card	21
3.3	Using USB Memory Devices	22
3.4	Installation on a Machine	22
3.5	Antenna Heights	26
3.5.1	Understanding Antenna Heights	26
3.5.2	The Antenna Reference Plane, ARP	26
3.5.3	Measuring the Antenna Height for a Mast Setup	27
3.6	Dual GNSS Positioning and Heading	27
4	Setups with Accessories	29
4.1	Dual GNSS Setup, with Internal Radio/Modem	29
5	Using the Web Interface	30
6	Care and Transport	42
6.1	Transport	42
6.2	Storage	42
6.3	Cleaning and Drying	42
7	Technical Data	43
7.1	Technical Data iCON aps 200	43
7.1.1	Tracking Characteristics	43
7.1.2	Accuracy	43
7.1.3	General Technical Data of the Product	44
7.2	Antennas Technical Data	46
7.3	Pin Assignments and Sockets	48
7.4	Conformity Declarations	50
7.4.1	iCON aps 200	50
7.4.2	CGA100	55
8	Software Licence Agreement/Warranty	57
Appendix A	NMEA Message Formats	58
A.1	Overview	58
A.2	Symbols Used for Describing the NMEA Formats	58
A.3	GGA - Global Positioning System Fix Data	61
A.4	GGK - Real-Time Position with DOP	62
A.5	GGQ - Real-Time Position with CQ	63
A.6	GLL - Geographic Position Latitude/Longitude	64
A.7	GNS - GNSS Fix Data	65

A.8	GSA - GNSS DOP and Active Satellites	66
A.9	GSV - GNSS Satellites in View	68
A.10	GST - Position Error Statistics	70
A.11	HDT - Heading, True	71
A.12	LLK - Leica Local Position and GDOP	71
A.13	LLQ - Leica Local Position and Quality	72
A.14	RMC - Recommended Minimum Specific GNSS Data	73
A.15	VTG - Course Over Ground and Ground Speed	74
A.16	XDR - Transducer Measurements	75
A.17	ZDA - Time and Date	75
A.18	PJK - Local Coordinate Position Output	76
Appendix B	ORP - Orientation and Position	78
Appendix C	Glossary	81
C.1	NTRIP	81
C.2	WGS84	82

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.

1.2

Definition of Use

Intended use

- Computing with software.
- Carrying out measurement tasks using various GNSS measuring techniques.
- Recording GNSS and point related data.
- Remote control of product.
- Data communication with external appliances.
- Computing coordinates using carrier phase and code signal from GNSS satellites.

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 recognisable damage 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

WARNING

Altered function and safety of the machine

Unauthorised modification of building and constructions machines by mounting or installing the product may alter the function and safety of the machine.

Precautions:

- ▶ Follow the instructions of the machine manufacturer. If no appropriate instruction is available, ask machine manufacturer for instructions before mounting or installing the product.

1.3

Limits of Use

Environment

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

WARNING

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

Life Risk.

Precautions:

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

1.4

Responsibilities

Manufacturer of the product

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

Person responsible for the product

The person responsible for the product has the following duties:

- To understand the safety instructions on the product and the instructions in the User Manual
- To ensure that it is used in accordance with the instructions
- To be familiar with local regulations relating to safety and accident prevention
- To stop operating the system and inform Leica Geosystems immediately if the product and the application become unsafe
- To ensure that the national laws, regulations and conditions for the operation of the product are respected
- To ensure that the radio modem is not operated without the permission of the local authorities on frequencies and/or output power levels other than those specifically reserved and intended for use without a specific permit. The internal and external radio modems have been designed to operate on frequency ranges and output power ranges, the exact use of which differs from one region and/or country to another.

WARNING

Unqualified installation on building or construction machinery

This may result in personal and material damage.

Precautions:

- ▶ Only an appropriately trained and qualified specialist may install this product on building or construction machinery.

1.5

Hazards of Use

CAUTION

Unsuitable installation location

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.

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

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.

 **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.

 **DANGER****Risk of being struck by lightning**

If the product is used with accessories, for example on masts, staffs, poles, you may increase the risk of being struck by lightning. Danger from high voltages also exists near power lines. Lightning, voltage peaks, or the touching of power lines can cause damage, injury and death.

Precautions:

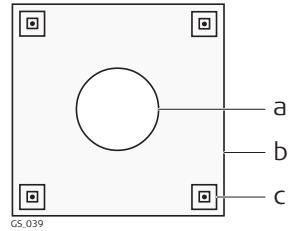
- ▶ Do not use the product in a thunderstorm as you can increase the risk of being struck by lightning.
- ▶ Be sure to remain at a safe distance from electrical installations. Do not use the product directly under or close to power lines. If it is essential to work in such an environment contact the safety authorities responsible for electrical installations and follow their instructions.
- ▶ If the product has to be permanently mounted in an exposed location, it is advisable to provide a lightning conductor system. A suggestion on how to design a lightning conductor for the product is given below. Always follow the regulations in force in your country regarding grounding antennas and masts. These installations must be carried out by an authorised specialist.
- ▶ To prevent damages due to indirect lightning strikes (voltage spikes) cables, for example for antenna, power source or modem should be protected with appropriate protection elements, like a lightning arrester. These installations must be carried out by an authorised specialist.
- ▶ If there is a risk of a thunderstorm, or if the equipment is to remain unused and unattended for a long period, protect your product additionally by unplugging all systems components and disconnecting all connecting cables and supply cables, for example, instrument - antenna.

Lightning conductors

Suggestion for design of a lightning conductor for a GNSS system:

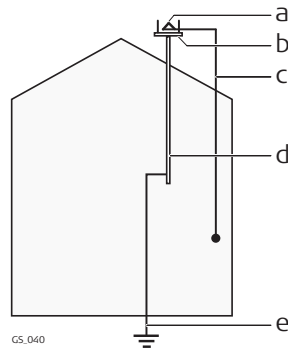
1. On non-metallic structures
Protection by air terminals is recommended. An air terminal is a pointed solid or tubular rod of conducting material with proper mounting and connection to a conductor. The position of four air terminals can be uniformly distributed around the antenna at a distance equal to the height of the air terminal.
The air terminal diameter should be 12 mm for copper or 15 mm for aluminium. The height of the air terminals should be 25 cm to 50 cm. All air terminals should be connected to the down conductors. The diameter of the air terminal should be kept to a minimum to reduce GNSS signal shading.
2. On metallic structures
Protection is as described for non-metallic structures, but the air terminals can be connected directly to the conducting structure without the need for down conductors.

Air terminal arrangement, plan view



- a Antenna
- b Support structure
- c Air terminal

Grounding the instrument/antenna



- a Antenna
- b Lightning conductor array
- c Antenna/instrument connection
- d Metallic mast
- e Connection to earth

WARNING

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

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

Precautions:

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

WARNING

Incorrect fastening of the external antenna

Incorrect fastening of the external antenna to vehicles or transporters poses the risk of the equipment being broken by mechanical influence, vibration or airstream. This may result in accident and physical injury.

Precautions:

- Attach the external antenna professionally. The external antenna must be secured additionally, for example by use of a safety cord. Ensure that the mounting device is correctly mounted and able to carry the weight of the external antenna (>1 kg) safely.

CAUTION

Inadequate steering if machine is defective

Beware of inadequate steering if machine is defective like after a crash or other damaging events or alterations to the machine.

Precautions:

- ▶ Periodically perform control measurements and field adjustments on the machine as specified in the User Manual. While working, construction and grading should be checked by appropriate means, for example spirit level, tachymeter, before and after important measuring tasks.

WARNING

Missing attention of operators or malfunctions

While steering or navigating the machine accidents may occur due to:

- The operator not paying attention to the surroundings (persons, ditches, traffic, etc.), or
- Malfunctions (...of a system component, interference, etc).

Precautions:

- ▶ The operator assures that the machine is operated, guided and monitored by a qualified user (e.g. driver).
- ▶ The user has to be able to take emergency measures, for example an emergency stop.

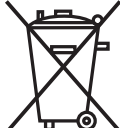
WARNING

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.

1.6

Description

Electromagnetic Compatibility (EMC)

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

WARNING

Electromagnetic radiation

Electromagnetic radiation can cause disturbances in other equipment.

Precautions:

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

CAUTION

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

This may cause disturbances in other equipment.

Precautions:

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

CAUTION

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

Although the product meets the strict regulations and standards which are in force in this respect, Leica Geosystems cannot completely exclude the possibility that the function of the product may be disturbed in such an electromagnetic environment.

Precautions:

- ▶ Check the plausibility of results obtained under these conditions.

CAUTION

Electromagnetic radiation due to improper connection of cables

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

Precautions:

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

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.
-

2 Description of the System

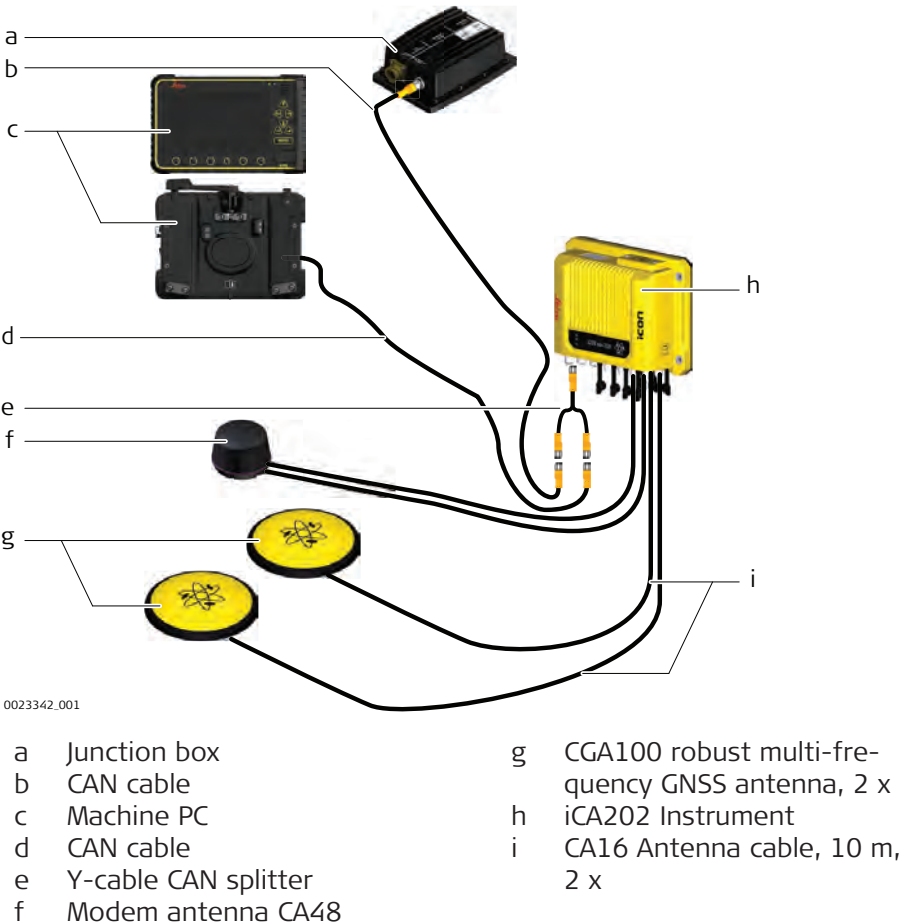
2.1 System Components

2.1.1 General Information

Description The Leica iCON aps 200 instrument and the Leica CGA100 GNSS antenna together with dedicated accessories offers you highest productivity and flexibility.

An example configuration is shown below.

**Main components,
iCA202 configuration
with internal cell
modem**



Component	Description
iCA202 Instrument	To calculate two positions from the computed ranges to all visible GNSS (G lobal N avigation S atellite S ystem) satellites. For correction data transfer radios/modems are used.
CGA100 GNSS Antenna	To receive the signals from the GNSS satellites. This Antenna is specified to the high environmental requirements on mining and construction machines.

Component	Description
Machine PC	To determine the position of the machine using measurement information from the instrument and GNSS antenna and for an automatic adjustment of the machine's hydraulic system.
Junction box	The components are connected directly to the standard machine junction box and communication cables are connected via the machine's own CAN bus.

Satellite channels

Depending on the satellite systems and signals configured, a maximum number of 555 channels is allocated.

Instrument	Description
iCA202	GPS, GLONASS, BeiDou and Galileo GNSS receiver, multi-frequency, code and phase, real-time capable

Special features iCA202

iCA202 instruments are equipped with several special features:

- Wide supply voltage range of 9 V to 32 V
- Voltage peak protection and reverse polarity protection
- Can be mounted on a machine in both the vertical and horizontal orientations
- Can be used near the sea
- Protection caps on connectors
- LEDs for status information
- Versatile connectivity including CAN, Serial RS232, Ethernet, Bluetooth and WiFi
- USB host port for data transfer and firmware upgrade
- Integrated high speed LTE (4G) / WCDMA (3G)
- Integrated radio
- Support of external devices via serial port
- Robust, compact aluminium housing

Special features CGA100

CGA100 antennas are equipped with several special features:

- Can be used near the sea
- Standard robust 5/8" Whitworth thread
- Robust TNC connector
- Future proof four constellation, multi-frequency antenna element
- Robust, compact plastic housing

2.1.2

Power Concept

General

Use the accessories recommended by Leica Geosystems to ensure the correct functionality of the instrument.

Power options

Power for the instrument is to be supplied externally.

External power can be supplied by:

- 9 V to 32 V DC power supply (machine or vehicle) via a converter cable supplied by Leica Geosystems AG.



iCON aps 200 can only be powered using the CAN1 port.

2.2

Unpacking the Container

Description

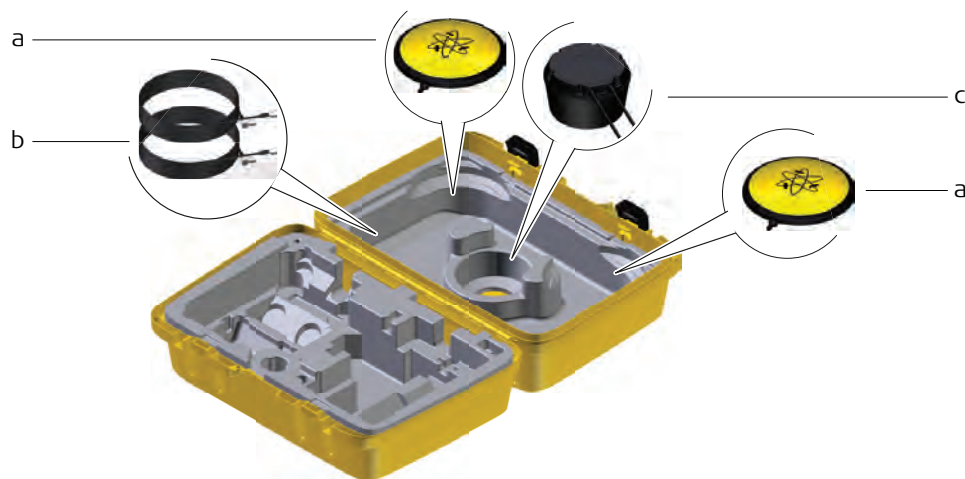
Available delivery packages:

- Delivery box: when a single iCON aps 200 instrument was ordered. Includes the instrument, the printed iCON aps 200 Quick Guide and the USB documentation card.
- A hard-top container comprising all items for a Dual GNSS configuration.

2.2.1

iCON aps 200 Dual GNSS Container

iCON aps 200 container upper shell

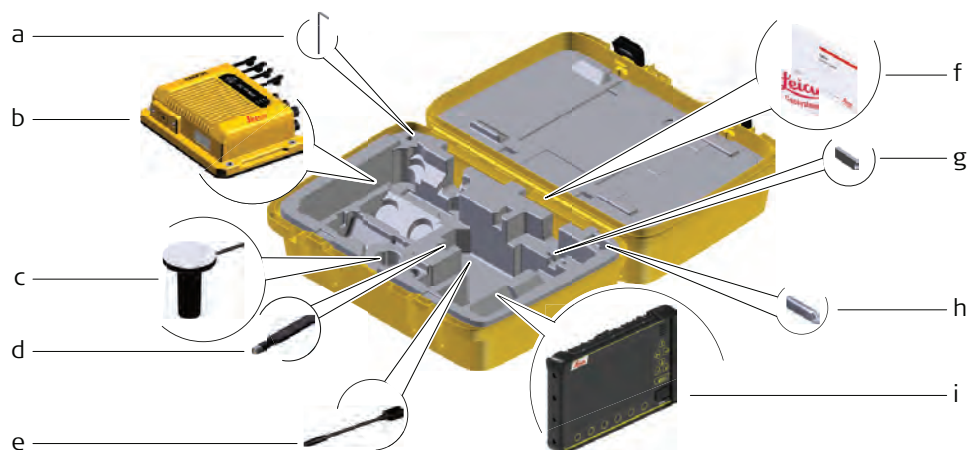


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- a CGA100 Robust multi-frequency GNSS antenna, 2 x
- b CA16 Antenna cable, 10 m, 2 x

- c Modem antenna CA48

iCON aps 200 container lower shell



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- | | | | |
|---|---|---|----------------------------------|
| a | Hex key 2.5 mm | e | USB adapter |
| b | iCON aps 200 instrument | f | Manuals & USB documentation card |
| c | Radio antenna CA12/CA13/CA43 with CA22 magnetic radio antenna mount | g | USB flash drive for MCP80 |
| d | GAT32 Bluetooth antenna | h | USB flash drive |
| | | i | MCP80 |

2.3

Instrument Components

iCA202 components

Top view:



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- | | |
|---|---------------------|
| a | Position LED |
| b | Internet status LED |
| c | Power LED |
| d | Mounting holes |

Front view:



- a CAN1/Power in
- b CAN2/Power out
- c CAN3/Power out
- d External Bluetooth antenna port
- e External WiFi antenna port
- f External modem antenna port 1
- g External modem antenna port 2
- h Secondary external GNSS antenna port
- i Primary external GNSS antenna port
- j External radio antenna port, only iCA202 with radio
- k Serial port
- l USB port
- m Ethernet port 2
- n Ethernet port 1
- o Grounding screw

Port	Description
CAN1/PWRIN	CAN port + Power Input (9-32 V DC, 1A). M12, A-code, Male, 5 pin connector
CAN2/PWROUT	CAN port + Power Output (Power Input Voltage, Maximum 2A limit shared with CAN3). M12, A-code, Female, 5 pin connector
CAN3/PWROUT	CAN port + Power Output (Power Input Voltage, Maximum 2A limit shared with CAN2). M12, A-code, Female, 5 pin connector
ETH1	Independent 10/100 Ethernet Port. M12, D-code, Female, 4 pin connector
ETH2	Independent 10/100 Ethernet Port. M12, D-code, Female, 4 pin connector
Serial Port (2x)	Serial Port with RS232 level on an M12, A-coded, 8 pin connector
USB0	USB 2.0, 480 Mbit port. M8, 4 pin connector
Radio	For connection of an external radio antenna
Modem 1, 2	For connection of an external antenna for the internal 4G/3G modem
WiFi	For connection of an external antenna for the internal WiFi module
Bluetooth	For connection of an external antenna for the internal Bluetooth module
GNSS1, GNSS2	GNSS antenna input. ANT1 is the primary GNSS antenna and ANT2 is the secondary (heading) GNSS antenna

CGA100 components



- a Whitworth thread, 5/8"
 - b Antenna reference plane
 - c TNC female connector
-

3 Using iCON aps 200

3.1 Power Supply

External power supply only

- 9 V to 36 V DC power supply (machine or vehicle) via a converter cable supplied by Leica Geosystems.
- The iCON aps 200 instrument is powered via the **CAN1** port.



For permanent operations use **Uninterruptible Power Supply** units as a back-up in a main power failure.



In general, all installation works - including the setting up of a permanent power supply - must be done by a dedicated installation specialist. Please contact the local selling unit or dealer for further information.

3.2 Installing a SIM Card

Insert and remove the SIM card step-by-step



0020459_002



Ensure the instrument is placed in its fixed position or place it onto a stable surface.

1. Loosen the screws of the SIM card cover with the supplied hex key.
2. Remove the SIM card cover and press the clip next to the SIM card tray to eject it.
Pull out the SIM card tray.
3. Orientate the SIM card as illustrated and place it onto the SIM card tray.
4. Insert the SIM card tray into the card slot and push it in until it locks into place.
5. Place the SIM card cover back into position.
6. Tighten the screws of the SIM card cover, with maximum 100 Ncm.

3.3

Using USB Memory Devices

Insert and remove
a USB data storage
device step-by-step



0020460_002



Ensure the instrument is placed in its fixed position or place it onto a stable surface.

1. Unscrew the cap from the USB port.
2. Plug in the USB adapter cable.
3. Slide the USB data storage device firmly into the USB host port until it clicks into position.



Take care not to damage the USB data storage device when moving the iCON aps 200 or when handling around the device.



Remove the adaptor cable and close the USB port cover when no USB data storage device is used.

Preconditions for using USB Memory devices



USB Memory devices must be formatted in the FAT or FAT32 format.

To import data from a USB Memory device to the iCON aps 200 appropriate folders must be created on the USB device and the files placed in the correct folder.

Folder	Files to be placed
[CoordinateSystems]	Coordinate system files
[User]	User files
[System]	Antenna and/or System Configuration files

3.4

Installation on a Machine



In general, all installation works must be done by a dedicated installation specialist. Please contact the local selling unit or dealer for further information.

The installation information within this User Manual is indicated to increase the operators understanding of the system and its maintaining.



Before installation:

- Please observe the maximum vibration and ambient temperature values indicated in chapter [7 Technical Data](#).
- Check that all parts needed are delivered.
- It is strongly recommended that you bench test all components before commencing installation on the actual machine to make sure that all components are fully operational.

Installation location

The iCON aps 200 instrument should preferably be installed either inside a compartment just behind the cabin or in the machine cabin itself. If the machine has no space inside a weather proof compartment or cabin, the instrument is to be installed only on components that have no direct connection to the machine tool and/or are positioned separately from the tool or at locations that lie in the safe area of the mechanically moving components. Further, the instrument is to be installed so that it is protected from mechanical influences, for example stoning.

Examples of a **correctly placed** instrument.



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The product must not be installed on the tool of the machine and/or on mechanical components that move the tool. Tools include for example bucket of excavator, blade of dozer, screed of paver. Mechanical parts include for example boom and stick of an excavator, hydraulic cylinder of a dozer or tow arm of an asphalt paver. Further, the instrument must not be installed near chassis, chain gear, wheels or on engine components connected to the engine itself. The cases stated are intended simply as examples.

Installation direction

- For inside assembly, the iCON aps 200 instrument must be installed either vertically with the connectors pointing upwards/downwards or horizontally on a flat plane. A clear view onto the LEDs should be guaranteed.
- For outside assembly, it is strongly recommended to install the instrument vertically with the connectors pointing downwards, in case this is not possible horizontally on a flat plane, but never with the connectors pointing upwards.

Fastening

The iCON aps 200 instrument must have supports beneath all mounting holes and should be fastened with four M6 bolts (or equivalent).

Electrical grounding

The electrical grounds of a Machine may be at different potentials either due to other large current electronic devices on the machine or when different grounds of the machine are isolated in service or welding operations.

Different DC and RF noise may exist at different points in the machine which is out of the control of Leica Geosystems. Such noise may have a negative effect on the satellite tracking performance of the iCON aps 200.

For this reason, it is best that all external antennas connected to the iCON aps 200, including the GNSS antenna(s), radio antenna and modem antenna, are isolated from the machine. This avoids additional ground paths being introduced.



In an ideal installation, with isolated antennas, the connection of the grounding pin on the rear panel of the iCON aps 200 to the machine should not be required.



It is extremely important to disconnect all cables from the iCON aps 200 before starting any welding operations on the machine. Otherwise the instrument may be damaged beyond repair.

Installation of GNSS antennas

For best results, it is recommended to mount the two GNSS antennas according to following guidelines:

- separated as far as possible,
- at approximately the same height,
- with the TNC connectors orientated in approximately the same direction, and
- ensuring an unobstructed view of the sky.

Installation on an excavator:

- Install the two GNSS antennas on the masts in the back of the machine.
- One mast should be placed on each side of the machine. Be aware of heat from the exhaust.



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Installation of external radio

Installation of antennas for Bluetooth, WiFi, UHF and cellular

A special bracket for proper mounting can be used.

- External antennas with a magnetic mount can be used and installed on the roof of the cabin.
- This will increase the radio signal and therefore the reception of correction signals from a base station or when using an Ntrip solution.
- External antenna needs to be placed with a distance of at least 20 cm to another antenna.



005942_001

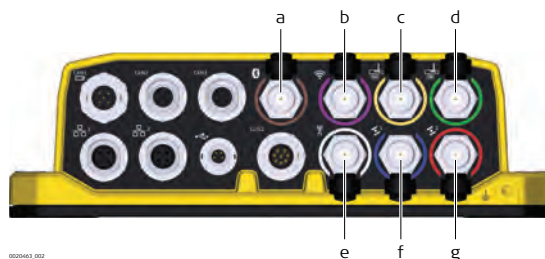
Cable installation

- Ensure that the cables between iCON aps 200 and CGA100 antenna in particular are installed to prevent them from becoming bent and stretched.
- It is recommended to use strain relief brackets.
- Route the cable as directly as possible and avoid crossing cables.
- Be sure not to tie the cables into "hot" hydraulic hoses.



Connecting the wrong antenna to the wrong connector may damage the antennas. In order to minimise the chance of connecting the incorrect external antenna, the four TNC connectors are colour coded. Cables with corresponding colours are available.

The colour coding is as follows:



- a Brown: Bluetooth
- b Purple: WiFi
- c Yellow: Modem 1
- d Green: Modem 2
- e White: Radio
- f Blue: GNSS Antenna 1
- g Red: GNSS Antenna 2

3.5

Antenna Heights

3.5.1

Understanding Antenna Heights

Description

The height of the GNSS antenna above a point consists of three components:

- the vertical or slope height reading,
- the vertical offset,
- the vertical phase centre offset.

For most operations, pre-configured standard settings in the instrument can be used. They automatically take the vertical phase centre offsets into account.

ARP

The antenna accepts vertical height readings to the **Antenna Reference Plane, ARP**.

Vertical phase centre variations

These are handled automatically in the standard antenna records. The antenna calibrations to determine the phase centre variations were executed by Geo++ GmbH.



Mast setup. The dimensions of the mast must be determined.

3.5.2

The Antenna Reference Plane, ARP

Description

The Antenna Reference Plane:

- Is where the instrument heights are measured to.
- Is where the phase centre variations refer to.
- Varies for different instruments.

ARP of the antenna

The ARP for the CGA100 antenna is shown in the diagram.



- a The Antenna Reference Plane is the underside of the threaded metal insert.

3.5.3

Measuring the Antenna Height for a Mast Setup

Measuring the antenna height - pole setup

Setup Type	Antenna type	The required measurement
Mast	CGA100	vertical distance from the GNSS antenna ARP to a fixed point on the top of the blade (when the blade has both zero long fall and cross fall).

3.6

Dual GNSS Positioning and Heading

General information

When two GNSS antennas are connected to the iCA202 instrument and have a clear view of the sky, the instrument automatically provides a precise GNSS heading relative to True North.

- ✎ ORP outputs heading relative to grid north instead of true north when a local grid coordinate system is used. The HDT, VTG, XDR messages will always be relative to true north as defined in NMEA-0183 standard.

The iCA202 uses a **Advanced SmartHeading** method of calculating the precise position of the secondary GNSS antenna. This means that precise heading output is available even when the instrument is not receiving corrections from a base station.

The antenna connected to port ANT1 is the primary GNSS antenna while the one on port ANT2 is the secondary (heading) GNSS antenna.

Mounting of GNSS antennas

For best results, it is recommended to mount the two GNSS antennas according to following guidelines:

- separated as far as possible,
- at approximately the same height,
- with the TNC connectors orientated in approximately the same direction, and
- ensuring an unobstructed view of the sky.

Heading Adjustment

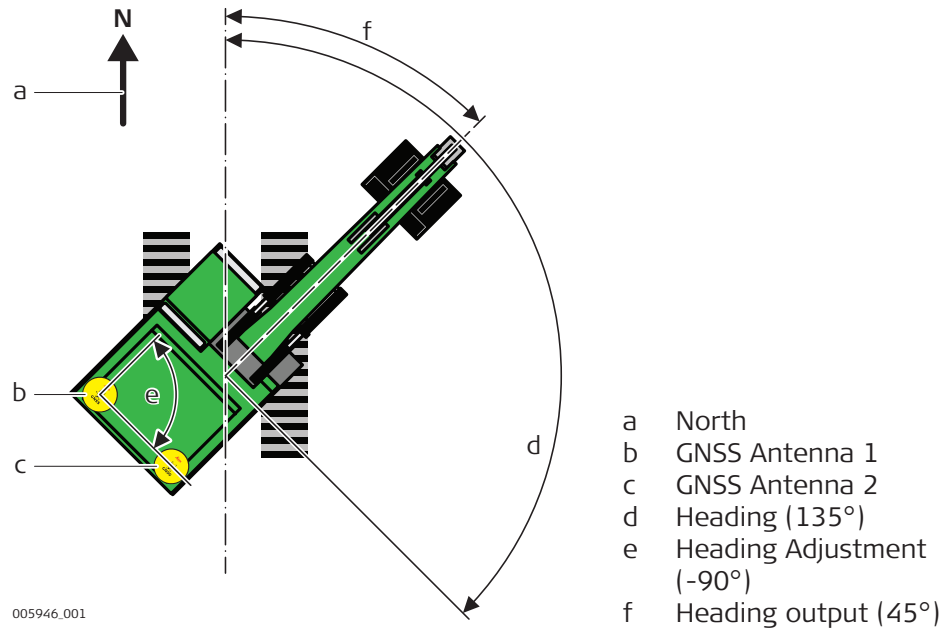
Heading output is the azimuth from GNSS Antenna 1 to GNSS Antenna 2. If it is not possible to mount the antennas parallel to the centreline of the vehicle, then the **known orientation to the centreline** can be entered as a **Heading Adjustment**.

The Heading Adjustment field offers the opportunity to enter an angle correction in order for the heading to be calculated in the exact direction of the machine.

It is important to note that:

- The Heading is the vector from Antenna 1 to Antenna 2 in degrees clockwise from north rather than clockwise from the vehicle reference frame.
- The Heading Adjustment is always applied from a bird's eye view perspective.
- A positive Heading Adjustment is applied clockwise from North while a negative Heading Adjustment is applied anticlockwise from North.

The following picture illustrates that interrelationship.



Heading output

Heading information is available on the web interface.

Heading output is available in following message formats:

- Leica ORP
- NMEA HDT
- NMEA VTG
- NMEA XDR

Refer to the Web Interface User Guide for further information.

Configuration

For information about Sensor configuration, please, refer to the following documents on myWorld:

- MC1 User Manual
- iCA202 Web interface User Guide



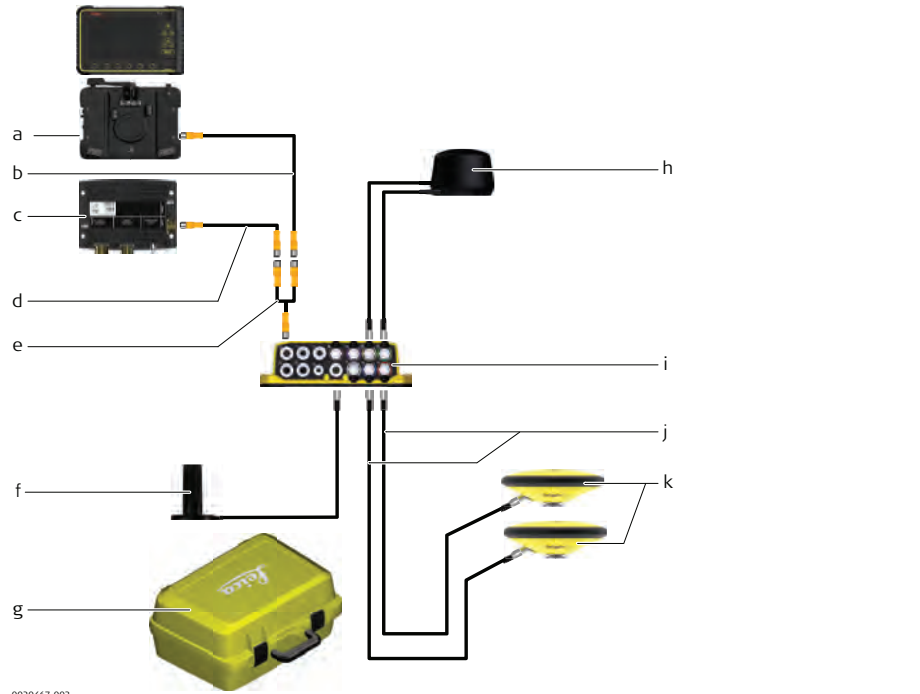
In the following chapter an example configuration is shown, covering a common use case.

Further configurations are possible. Please contact the local selling unit or dealer for information regarding special use cases.

4.1

Dual GNSS Setup, with Internal Radio/Modem

Dual GNSS setup with internal radio/modem



- | | | | |
|---|---|---|--|
| a | Machine PC | g | MTC1408 Carry Case |
| b | CAN cable | h | Modem antenna CA48 |
| c | Junction box | i | iCA202 Instrument |
| d | CAN cable | j | CA16 Antenna cable, 10 m, 2 x |
| e | Y-cable CAN splitter | k | CGA100 Robust triple frequency GNSS antenna, 2 x |
| f | Radio antenna CA12/CA13/CA43 with CA22 magnetic radio antenna mount | | |



All necessary installation works must be carried out by a dedicated installation specialist. Please contact the local selling unit or dealer for further information.

Getting connected to the Web Interface

Connection between the sensor and your device is established via Bluetooth.



The following instructions are based on using Windows 10.

1. Power on the iCA202.



If you intend to use the Web Interface with iCA202 make sure the external Bluetooth antenna is attached.

2. On your computer go to **Start Menu > Settings > Devices**.



Activate Bluetooth if not yet switched on.

3. Click "Add Bluetooth or other devices".



Make sure that computer and sensor are in reach for a Bluetooth connection.

4. Click Bluetooth and select the sensor from the list. Wait for the connection to be established.



The sensor can be identified by its serial number.

5. Go to **Start Menu > Settings > Network & Internet**. Under **Advanced Network Settings** click "Change Adapter Options". In the **Network Connections** page double-click on "Bluetooth Network Connection". Finally, right-click on the sensor that you have just added and select **Connect using > Access Point** from the context menu.

6. Open a browser on your computer and enter the URL: <http://www.icasetup.leica-geosystems.com>. User name is "leica", as password enter the serial number of the sensor.

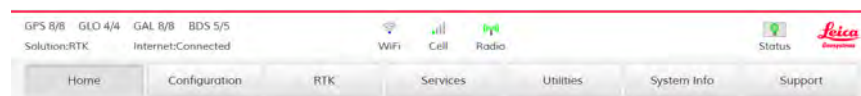
7. Start configuring the iCA202 using the Web Interface.



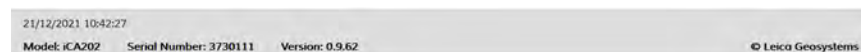
For mobile devices it is only required to pair the sensor via Bluetooth.

Web Interface - Frame

The header section contains a status information bar.




The footer includes information on the connected receiver, its serial number and firmware version.



The frame will always be visible independent of which tab you open for further configuration.

Status information bar

The status bar shows the satellite status, internet connection, antenna configuration and receiver status information.

Item	Description
Satellites	Number of satellites currently used/tracked by the receiver. Shows the solution type.
Internet	Indicates whether a connection is established on the sensor or not.
WiFi/Cell/Radio	Indicates the signal strength for each configured link.
	Indicates receiver operational status. Green: normal operation Yellow: warning Red: error When pressed, the icon will re-direct you to the status information page. See also: System Info

Home

The **Home** page is a pure status information page. You will find detailed information on:

- Position/Tracking Status of the connected antennas
- Status of the RTK link
- Status of the communication devices
- ConX and Analytics services


Category	Description
Position/Tracking Status ▲	<ul style="list-style-type: none"> • Sensor position • Position quality and solution type • Antenna heading information • Tracked satellites for each constellation
Coordinates:	47.40943025°N 9.61990829°E 468.731 m
Position Quality	0.004
Height Quality	0.004
GDOP	1.600
Date (GMT)	1/10/2021
Time (GMT)	09:46:14
Position 1 Solution	RTK
Position 2 Solution	RTK
Heading	0.000°
Slope Distance	2.187 m
Tilt	0.23°
Antenna 1 Satellites	
GPS	8
GLONASS	6
Galileo	5
Beidou	8
Antenna 2 Satellites	
GPS	8
GLONASS	6
Galileo	5
Beidou	8

Category	Description																						
<div>RTK Status</div> <table> <tr><td>Interface</td><td>Internal Radio</td></tr> <tr><td>Correction Format</td><td>MSM5</td></tr> <tr><td>Correction Age</td><td>1.00s</td></tr> <tr><td>Percentage Received</td><td>95%</td></tr> <tr><td>Detected Reference Antenna</td><td>CGA60</td></tr> <tr><td>Detected Reference Receiver</td><td>ICG60</td></tr> <tr><td>Base ID</td><td>16</td></tr> <tr><td>Base Latitude</td><td>47.40943095°N</td></tr> <tr><td>Base Longitude</td><td>9.61988861°E</td></tr> <tr><td>Base Height</td><td>468.800 m</td></tr> <tr><td>Baseline</td><td>0.001 km</td></tr> </table>	Interface	Internal Radio	Correction Format	MSM5	Correction Age	1.00s	Percentage Received	95%	Detected Reference Antenna	CGA60	Detected Reference Receiver	ICG60	Base ID	16	Base Latitude	47.40943095°N	Base Longitude	9.61988861°E	Base Height	468.800 m	Baseline	0.001 km	<ul style="list-style-type: none"> Currently configured interface for real-time kinematic correction data status Data corrections Automatically detected reference antenna/receiver Base details
Interface	Internal Radio																						
Correction Format	MSM5																						
Correction Age	1.00s																						
Percentage Received	95%																						
Detected Reference Antenna	CGA60																						
Detected Reference Receiver	ICG60																						
Base ID	16																						
Base Latitude	47.40943095°N																						
Base Longitude	9.61988861°E																						
Base Height	468.800 m																						
Baseline	0.001 km																						
<div>Communications</div> <table> <tr><td>Bluetooth</td><td>Enabled</td></tr> <tr><td>WiFi</td><td>Connected, lgs-guest</td></tr> <tr><td>Serial</td><td>Satel TR489</td></tr> <tr><td>Ethernet</td><td>Connected, 10.60.142.51</td></tr> <tr><td>Cell Network</td><td>Disconnected, None</td></tr> </table>	Bluetooth	Enabled	WiFi	Connected, lgs-guest	Serial	Satel TR489	Ethernet	Connected, 10.60.142.51	Cell Network	Disconnected, None	Status of communication devices												
Bluetooth	Enabled																						
WiFi	Connected, lgs-guest																						
Serial	Satel TR489																						
Ethernet	Connected, 10.60.142.51																						
Cell Network	Disconnected, None																						
<div>Services</div> <table> <tr><td>ConX</td><td>Connected</td></tr> <tr><td>Analytics</td><td>Off</td></tr> </table>	ConX	Connected	Analytics	Off	Status of ConX and Analytics services																		
ConX	Connected																						
Analytics	Off																						

Sensor Configuration

The **Configuration** page allows for configuring device settings such as:

- Tracking settings
- Activation of a coordinate system
- Rover antennae settings
- Bluetooth, CAN and PPS
- Network settings for the Internet connection via WiFi, Ethernet or Cellular modem
- NMEA
- System language

Category	Description
<div>GNSS</div> <div> <div>GPS</div> <div>Enabled</div> </div> <div> <div>GLONASS</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Galileo</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Beidou</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>L2C</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>L5</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>SmartLink Fill</div> <div><input type="checkbox"/></div> </div> <div> <div>Active Primary Antenna Switch</div> <div><input type="checkbox"/></div> </div> <div> <div>Elevation Cutoff</div> <div>10</div> </div> <div> <div>Height Offset</div> <div>0.000</div> <div>m</div> </div>	<p>GPS is always enabled. Additional satellite systems and frequencies can be selected depending on the loaded licenses.</p> <p>Activate or de-activate SmartLink Fill. SmartLink Fill is a correction service delivered via Satellite to bridge outages of RTK corrections up to 10 minutes. Use SmartLink Fill to increase uptime when facing short outages on the RTK infrastructure.</p> <p> SmartLink Fill is available for all RTK formats.</p>

Enable or disable **Active Primary Antenna Switch**. This feature allows for the receiver to switch automatically between Antenna 1 and Antenna 2 as primary antenna when obstructions prevent Antenna 1 from normal operation.

Enter the **Cutoff Angle** to be applied for satellites near the horizon and a **Height Offset**, if required.

<div>Coordinate System</div> <div> <div>Status</div> <div>Normal</div> </div> <div> <div>Current</div> <div>None</div> </div> <div> <div>Select</div> <div></div> </div>	Select the required coordinate system from the drop-down list.
<div>Antennas</div> <div> <div>Antenna 1</div> <div> <div>Antenna Type</div> <div>CGA60</div> </div> </div> <div> <div>Antenna 2</div> <div> <div>Antenna Type</div> <div>CGA60</div> </div> </div>	Select the antennas that are currently connected to the sensor from the drop-down lists.
<div>Ports</div> <div> <div>Bluetooth</div> <div> <div>Active</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Network Active</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Bluetooth Name</div> <div>ICA202 3730093</div> </div> <div> <div>Connected Serial Remote</div> <div></div> </div> </div> <div> <div>CAN</div> <div> <div>Bit Rate</div> <div>250 kbps</div> </div> </div> <div> <div>PPS (Serial Port)</div> <div> <div>Rate</div> <div>1s</div> </div> <div> <div>Polarity</div> <div>Negative Edge</div> </div> </div>	<p>Bluetooth is always active. This ensures seamless communication with the web interface.</p> <p>The Bit Rate of the CAN protocol can be modified if required.</p>


Set the PPS (**P**ulse **P**er **S**econd) output parameters: **Rate** and **Polarity**. If configured, iCON aps 200 sends out an electric pulse at a specified interval time. For example, in order to activate another device.

Rate defines the interval at which the pulses are output, **Polarity** defines if the pulses are output at the negative or positive edge of the pulse. PPS output is possible using the serial port on the iCON aps 200. The PPS output source is a 0 V to +5.0 V signal referenced to Vin negative.

Internet connection can be established via *Cell Modem*, *Ethernet* or *WiFi* depending on the chosen device.

Each of the devices can be configured. Make sure that a connection is possible and the respective antenna is connected to the receiver.

It is possible to configure **WiFi** as Hotspot where the internet connection is shared with external devices (provided an internet connection is established on the sensor).

 **Cell Modem**
requires a SIM
card. PIN, PUK and
APN have to be
entred and set.

Click **Apply** to take over any changes.

Category

Description

NMEA

Heading Adjustment

0.000

NMEA Output 1

☐

NMEA Output 2

☒

Port

Serial 2

Baud Rate

115200

Parity

None

Flow Control

Off

Talker ID

Auto

CQ Control

Off

CQ Limit

0.1

Antenna Transpose

☒

ORP Rate

Off

ORP Output

Position 1

GGA Rate

1s

GGK Rate

Off

GGQ Rate

Off

GLL Rate

Off

GNS Rate

Off

GSA Rate

Off

GST Rate

Off

GSV Rate

Off

HDT Rate

Off

To transmit data using the **NMEA** standard protocol, the instrument must be configured accordingly.

Install the appropriate position rate licences to access all output rates.

Two NMEA interfaces can be active in parallel corresponding to **Output 1** and **Output 2**. The NMEA interfaces can be assigned to the serial port, Bluetooth port or TCP Server via Ethernet or cell modem.

When using a TCP server, configure the **Port** settings (see above) prior to the NMEA setup.

If a static IP is desired, the DHCP service must be turned off. This allows you to set the IP manually.

A different **Talker ID** can be manually entered once it is set to **User**.

For **CQ Control** choose between *Position only*, *Position & height* or *Height only*. When CQ Control is active the **CQ Limit** must be defined.

Antenna Transpose allows for streaming Antenna 1 and Antenna 2 positions on separate outputs (NMEA Output 1 and NMEA Output 2). Once an NMEA link is configured, each NMEA message can be set to stream at the desired **Rate**.

Refer to [NMEA Message Formats](#) for more details on NMEA messages.

For **ORP**, besides the desired rate, the following output formats are available: *Position 1*, *Position 1 & 2* or *Position 1, 2 & Heading*. The Height is set automatically according to the coordinate system used: *Ellipsoidal* for WGS84 and *Orthometric* for Local Grid.

Refer to [ORP – Orientation and Position](#) for further information on ORP.

RTK Configuration

The **RTK** page allows for configuring the real-time kinematic data link.

Category	Description
<div>Data Link</div> <div> <div>Interface</div> <div>Internal Radio</div> </div> <div> <div>Reference Receiver</div> <div>Auto Detect</div> </div> <div> <div>Reference Antenna</div> <div>Auto Detect</div> </div> <div> <div>Reference Acceptance Mode</div> <div>Any</div> </div> <div> <div>Reference Station ID</div> <div>0</div> </div> <div> <div>Network</div> <div>None</div> </div>	<p>From the drop-down list select the Interface for the RTK data link. Available options are: <i>Internal Radio</i>, <i>External Radio</i>, <i>NTRIP</i> or <i>TCP</i>.</p> <p>Reference Receiver and Reference Antenna allow for manual selection from a drop-down list, if required.</p>



If you select NTRIP as data link, the **Network** must be set accordingly.

<div>Radio</div> <div>Internal Radio</div> <div> <div>Model</div> <div>Satel TR489</div> </div> <div> <div>Frequency Band</div> <div>400Mhz</div> </div> <div> <div>Frequency Mode</div> <div><input checked="" type="checkbox"/></div> </div> <div> <div>Frequency</div> <div>433.575</div> <div>MHz</div> </div> <div> <div>Bandwidth</div> <div>25 KHz</div> </div> <div> <div>Protocol</div> <div>Satel 3AS</div> </div> <div> <div>FEC</div> <div><input type="checkbox"/></div> </div> <div> <div>Status</div> <div>Running</div> </div>	<p>When internal radio is set as Data Link (see above), then Radio configuration becomes enabled.</p> <p>Depending on the loaded licenses, the Frequency Band is set by default or can be selected from a drop-down list (USA and Canada only).</p> <p>Select a channel from the channel table or enter a Frequency manually.</p>
--	---



To manually set the frequency, **Frequency Mode** must be active.

The required **Bandwidth** can be selected from the drop-down list. Bandwidth is dependent on the currently selected frequency.

FEC (Forward Error Correction) allows for safeguarding data integrity in detriment of data throughput. This feature requires a match on both, Base and Rover, and availability is dependent on the selected transmission **Protocol**.

The screenshot shows an NTRIP configuration:

<div>Network</div> <div> <div>Address</div> <div>hmcbase.dyndns.org</div> </div> <div> <div>Port</div> <div>2101</div> </div> <div> <div>Username</div> <div>lgs-guest</div> </div> <div> <div>Password</div> <div>*****</div> </div> <div> <div>Mountpoint</div> <div></div> <div>Edit</div> </div> <div> <div>Server</div> <div>Connected</div> </div> <div> <div>Authenticated</div> <div>No</div> </div> <div> <div>Mount Points Valid</div> <div>No</div> </div> <div> <div>Receiving Data</div> <div>No</div> </div>	<p>When NTRIP or TCP is set as Data Link (see above), then Network settings become enabled.</p> <p>Once a valid Address and Port are entered and the correct credentials (Username and Password) are set, you can select a Mountpoint from the drop-down list.</p>
--	---



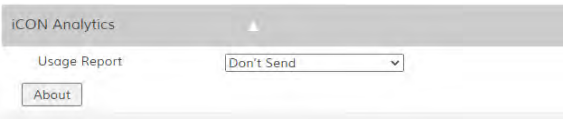
In order to use NTRIP/TCP as data link, an Internet connection is required.

Services

The **Services** page allows for active services to be configured.

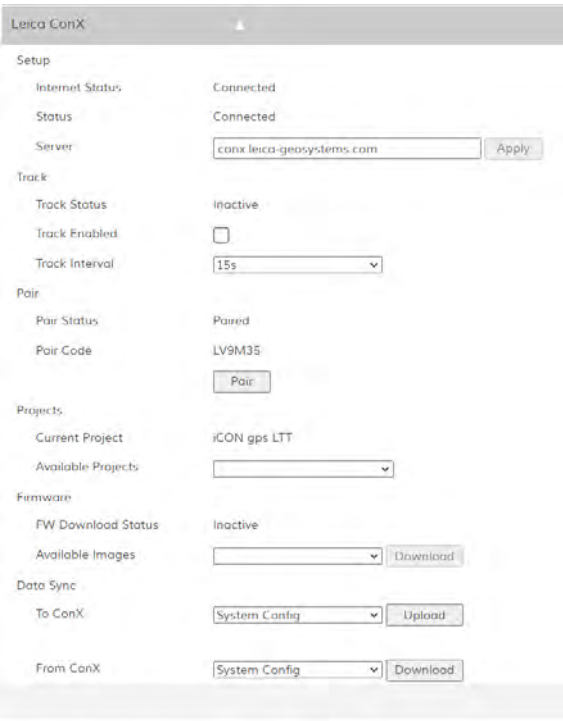


In order to make use of the available services, an internet connection must be established on the sensor. See also: [Sensor Configuration](#)

Category	Description
 <p>The iCON Analytics interface shows a 'Usage Report' section with a 'Don't Send' dropdown menu and an 'About' button.</p>	<p>The iCON Analytics Analytics service is enabled by default and active once an internet connection is established on the sensor.</p> <p>If you wish to disable this service or send data anonymously, you can select the respective options from the drop-down list.</p>



Click the **About** button to get detailed information on the scope and implications of using iCON Analytics.

 <p>The Leica ConX interface shows various setup options including Internet Status (Connected), Server (conx.leica-geosystems.com), Track Status (inactive), Pair Status (Paired), and Firmware Download Status (inactive).</p>	<p>You can set up and configure a connection to Leica ConX here.</p> <p>Click Pair to establish the connection and use the given Pair Code to proceed with the setup on the ConX server.</p> <ul style="list-style-type: none"> Select Track Enabled if you want the sensor position to be sent to ConX at regular intervals. The Track Interval can be selected from the drop-down list. Available Projects can be selected from the drop-down list. Select a project from the list if you wish to use a different project.
--	---

- Select which data shall be synchronised to or from ConX: You can upload System Configuration files, Coordinate Systems, Log Files for Support or User Files. Select and click the **Upload** button. You can download System Configuration files, Coordinate Systems, Antenna Lists, Licenses or User Files. Select and click the **Download** button.
- You can also download **Firmware** from ConX. If Firmware files are available for download, the **Status** turns to "Active" and you can select files from the list of **Available Images**. Select and click the **Download** button.

The **Utilities** page allows for firmware updates, adding license keys and uploading antenna lists from the connected device or from a USB flash drive on the sensor.

 No internet connection required on the sensor.

Category

Firmware Update

System

Current:0.9.52

Upload:

Choose File

No file chosen

Available:

Upgrade

The **current** firmware version is shown.

Click on **Choose File** to select an upgrade file stored locally on the connected device. Then click the **Upload** button to upload the file to the sensor (via Bluetooth).

From the drop-down list select the uploaded file and click **Upgrade** to start the firmware upgrade process.

If a USB flash drive containing firmware files is connected to the sensor, you can directly select the upgrade file from the drop-down list.

Licenses

License Key

ME1 Auth Key

ME2 Auth Key

Production

Maintenance

Invalid

Exp: 2023-7-26

Add

Add

Add

Individual licenses can be added to the sensor as well as authorisation codes for the **ME1** and **ME2** (Measurement Engines 1 and 2).

The current status of all licenses is displayed below.

Antennas

Upload Antenna List

Choose File

No file chosen

Upload

Click on **Choose File** to select an antenna list stored locally on the connected device.

Then click the **Upload** button to upload the file to the sensor (via Bluetooth).

Category	Description
<div> <div>Import/Export/Delete</div> <div> <div>Import From USB</div> <div> <div>Antennas List</div> <div>System Configuration</div> <div>All Coordinate Systems</div> <div>Selected Coordinate System</div> <div>User Files</div> <div>License File</div> <div>SSH Public Key</div> </div> <div> <div>Import</div> <div>Import</div> <div>Import</div> <div>Import</div> <div>Import</div> <div>Import</div> </div> </div> <div> <div>Export To USB</div> <div> <div>System Configuration</div> <div>All Coordinate Systems</div> <div>Selected Coordinate System</div> <div>User Files</div> </div> <div> <div>Export</div> <div>Export</div> <div>Export</div> <div>Export</div> </div> </div> <div> <div>Delete</div> <div> <div>User Files</div> <div>SSH Public Keys</div> <div>Coordinate Systems</div> </div> <div> <div>Delete All</div> <div>Delete All</div> <div>Delete All</div> </div> </div> </div>	<p>You can as well import or export files via USB flash drive.</p> <p>Attach the USB flash drive to the sensor. See also: Using USB Memory Devices</p> <p>From the drop-down lists select the files you want to upload to or download from the sensor and click Import/Export.</p> <p>On the USB flash drive coordinate systems must be stored in the folder "CoordinateSystems", all other files in the "System" folder.</p>
<p>To delete files from the sensor, select a file from the drop-down list and click Delete.</p> <p>Or Click Delete All to delete all User Files, all SSH Public Keys or all Coordinate Systems stored in the internal memory on the sensor.</p>	

System Info

The **System Info** page shows read-only information on the sensor hardware and system status.

Category

Description

Hardware

Instrument

Type:ICA202

Serial Number:3730111

Firmware Version:0.9.62

Measurement Engine 1

Model:FFNLNNTVN

Serial Number:DMGY21070649T

Hardware Version:11.1.4

Firmware Version:7.506.1

Measurement Engine 2

Model:FFNLNNTVN

Serial Number:DMGY21070605J

Hardware Version:11.1.4

Firmware Version:7.506.1

Internal Radio

Model:Satel TR489

Firmware Version:V07.45.2.5.0.28

Internal Modem

Model:EM7565

Firmware Version:SWI9X50C_01.07.02.00 6c91bc jenkins 2018/06/13 23:08:16

IMEI:359260080550566

Region:Unavailable

Status

Error

No errors.

Warning

No warnings.

Power Supply

Voltage11.89V

Memory

System Flash

Free:25954.2 MB (98%)

Used:627.0 MB (2%)

Total:26581.2 MB

USB Flash

Free:0.0 MB

Used:0.0 MB

Total:0.0 MB

Logging Data:Disabled

Temperature

Status:Temperature OK

Internal Temperature:42°C





Under **Hardware** you can visualise additional information about the hardware components inside the sensor.

Under **Status** you can find detailed information on errors and warnings.

In case there is an issue the light bulb icon in the Status information bar turns yellow or red. See also: [Web Interface - Frame](#)

Support

The **Support** page allows for log files handling service ports and resetting single components.

Category	Description
<div>Support Logging</div> <div> Setup LB2 Logging <div> Status: Disabled <div>Logging Rate: Off</div> <div>Logging Enabled: <input type="checkbox"/></div> <div>Export Logs To USB</div> </div> </div>	<p>Click the Export Logs To USB button to export log files including information on all modules running on the sensor.</p> <p> A USB flash drive must be connected. See also: Using USB Memory Devices</p>
<p>In order to include LB2 data in the log files, enable LB2 Logging.</p> <p> LB2 logs contain raw data information from the visible satellite signals and are required for troubleshooting position or tracking performance issues. Roughly 10 min of LB2 logging are usually sufficient.</p> <p> Log file size grows rapidly over time when LB2 is enabled.</p>	
<div>Service Port Config</div> <div> MC Mode Override: <input type="checkbox"/> SSH Server: <input checked="" type="checkbox"/> Beta Mode: <input type="checkbox"/> Console: <input checked="" type="checkbox"/> SSH Password Authentication: <input checked="" type="checkbox"/> Old Password: <input type="text"/> New Password: <input type="text"/> <div>Reset</div> </div>	<p>Allows for configuring the Service Ports and resetting the Secure Shell (SSH) password.</p> <p>Select MC Mode Override to pause CAN communication with the machine temporarily for troubleshooting.</p> <p> MC Mode Override is always disabled while booting the instrument.</p>
<div>Reset Options</div> <div> <div>Reset Memory</div> <div>Reset Ext Port Config</div> <div>Reset Instrument</div> <div>Reset Almanac</div> <div>Reset Antenna List</div> <div>Reset Login Password</div> <div>Reset SSH Password</div> </div>	<p>Allows for resetting single system components.</p>
<div>Uptime</div> <div> Since Last Boot: 411h 07m Total: 1635h 07m <div>Restart Instrument</div> </div>	<p>Shows the elapsed time since the last system boot as well as the total uptime of the sensor.</p> <p>Tap Restart Instrument to reboot the system.</p>
<div>Open Source SW Licenses</div> <div> This software contains copyright-protected software that is licensed under various open source licenses. The according copyright statements and license texts are part of the documentation delivered with this product. If foreseen in the corresponding open source license, you may obtain the source code, license texts and other related data on the open source center website of Leica Geosystems. </div>	<p>Software Licence agreement for copyright-protected Open Source Software.</p>

6	Care and Transport
6.1	Transport
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	<p>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.</p> <p>For products for which no container is available use the original packaging or its equivalent.</p>
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.
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.
6.3	Cleaning and Drying
Product and accessories	<ul style="list-style-type: none"> 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	<div data-bbox="464 1255 737 1388"> <p>0034481_001</p> </div> <p>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 dry. Always close the transport container when using in the field.</p>
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.

7

Technical Data

7.1

Technical Data iCON aps 200

7.1.1

Tracking Characteristics

Instrument technology

SmartTrack

Satellite reception

Triple frequency

Instrument channels



Depending on the satellite systems and signals configured, a maximum number of 555 channels is allocated.

Supported signals

GPS

L1	L2	L5
Carrier phase, C/A-code	Carrier phase, C code (L2C) and P2-code	Carrier phase, code

GLONASS

L1	L2
Carrier phase, C/A-code	Carrier phase, P2-code

Galileo

E1	E5a	E5b	AltBOC
Carrier phase, code	Carrier phase, code	Carrier phase, code	Carrier phase, code

BeiDou

B1	B2
Carrier phase, code	Carrier phase, code



Carrier phase and code measurements on L1, L2 and L5 (GPS) are fully independent with AS on or off.

Satellites tracked

Up to 60 satellites simultaneously on two frequencies

7.1.2

Accuracy



Accuracy is dependent upon various factors including the number of satellites tracked, constellation geometry, observation time, ephemeris accuracy, ionospheric disturbance, multipath and resolved ambiguities.

The following accuracies, given as **root mean square**, are based on measurements processed using Leica Infinity and on real-time measurements.

The use of multiple GNSS systems can increase accuracy by up to 30% relative to GPS only.

Differential code

The baseline precision of a differential code solution for static and kinematic surveys is 25 cm.

Differential phase in real-time

Type	Horizontal	Vertical
Single Baseline (<30 km)	8 mm + 1 ppm	15 mm + 1 ppm
Network RTK	8 mm +0.5 ppm	15 mm +0.5 ppm

Precise Heading

Heading accuracy with

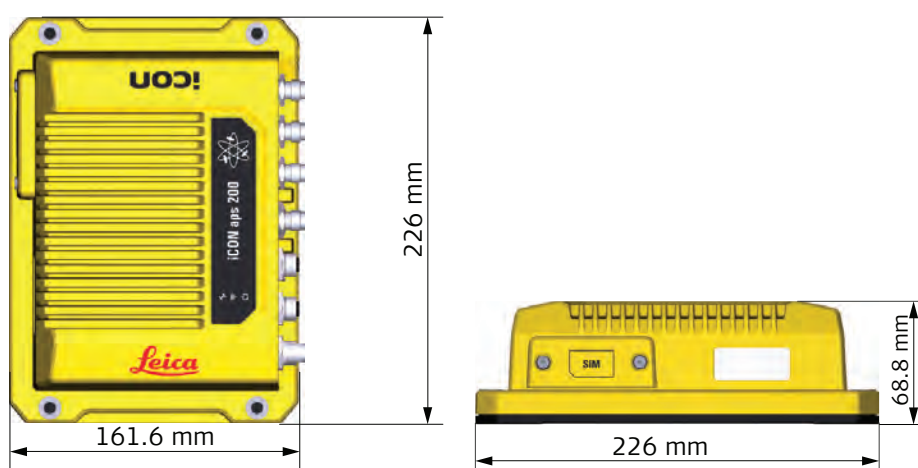
- 1 m antenna separation: 0.18°
- 2 m antenna separation: 0.09°
- 5 m antenna separation: 0.05°

7.1.3

General Technical Data of the Product

Dimensions

The overall dimensions are given for the housing including the sockets.



0020471_001

Length [mm]	Width [mm]	Thickness [mm]
226	161.6	68.8

Weight

Type	Weight [kg]/[lbs]
iCA202	2.2/4.85 (including internal LTE modem)

 The modem is integrated.

Power

Power consumption:

iCA202, Dual GNSS, NTRIP Rover, radio excluded: 11.0 W typically, 24 V @ 475 mA

External supply voltage:


Nominal 24 V DC (---), voltage range 9 V to 32 V DC, supplied by:

- 9 V to 32 V DC power supply (machine or vehicle) via a converter cable supplied by Leica Geosystems

Electrical data

Type	iCON aps 200
Voltage	Nominal 24 V

Type	iCON aps 200
Current	iCA202: 11.0 W typically, 24 V @ 475 mA
Frequency	GPS L1 1575.42 MHz GPS L2 1227.60 MHz GPS L5 1176.45 MHz GLONASS L1 1602.5625 MHz - 1611.5 MHz GLONASS L2 1246.4375 MHz - 1254.3 MHz Galileo E1 1575.42 MHz Galileo E5a 1176.45 MHz Galileo E5b 1207.14 MHz Galileo AltBOC 1191.795 MHz BeiDou B1 1561.098 MHz BeiDou B2 1207.14 MHz Bluetooth 2400 MHz - 2483.5 MHz
Gain (internal antenna)	Typically -12 dBi
Noise Figure	Typically < 2 dBi

 For corresponding information for optional, internal radios refer to their specifications.



Galileo AltBOC covers bandwidth of Galileo E5a and E5b.

Pulse Per Second (PPS)

Type	iCON aps 200
Peak	5.0 V
Pulse length	1 ms
Positive/Negative Edge	Selectable on web interface
Connector	Serial Port M12
Typical PPS pulse accuracy	50 ns (120 ns 3σ)

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
Instrument	-40 to +65	-40 to +85

Protection against water, dust and sand

Type	Protection
Instrument	IP66/IP68, ISO 20653 IEC 60068-2-27 60 g / 6 ms

Humidity

Type	Protection
Instrument	IEC 60068-2-30 +25 °C to +55 °C > 95 % RH, 6 x 24 hours

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

Vibration/Shock

Type	iCON aps 200	CGA100
Vibration	IEC 60068-2-6: 5-500 Hz, 5 g, ± 15 mm, 10 cycles MIL-STD-810G: Fig.514.7E-1 7.7 grms	IEC 60068-2-6: 5-500 Hz, 15 g, ± 15 mm MIL-STD-810G: Fig.514.6E-1: Category 24 (20-2000 Hz, 7.7 grms)
Shock	ISO9022: 60 g, 6 ms, IEC 60068-2-27: 60 g, 6 ms	IEC 60068-2-27 (special): 60 g, 6 ms IEC 60068-2-27: 100 g, 2 ms

7.2

Antennas Technical Data

Description and use with iCA202

The GNSS antenna is selected for use based upon the application. The table gives a description and the intended use of the antenna.

Type	Description	Use
CGA100	GPS, GLONASS, Galileo, BeiDou SmartRack+ antenna with built-in ground plane	Machine Control, RTK Rover and Network RTK applica- tions

Dimensions

Type	CGA100
Height	60 mm
Diameter	165 mm

Connector

TNC female

Mounting

5/8" Whitworth

Weight

0.4 kg

Electrical data

Type	CGA100
Voltage	3.8 V to 18 V DC
Current	35 mA typical
Frequency	
GPS L1	1575.42 MHz
GPS L2	1227.60 MHz
GPS L5	1176.45 MHz
GLONASS L1	1602.5625 - 1611.5 MHz
GLONASS L2	1246.4375 - 1254.3 MHz
GLONASS L3	1207.14 MHz
Galileo E1	1575.42 MHz

Type	CGA100
Galileo E5a	1176.45 MHz
Galileo E5b	1207.14 MHz
Galileo E6	1278.75 MHz
Galileo AltBOC	1191.795 MHz
BeiDou B1	1561.098 MHz
BeiDou B2	1207.14 MHz
BeiDou B3	1268.52 MHz
Gain (typically)	29 dB
Noise Figure (typically)	2 dB



Galileo AltBOC covers bandwidth of Galileo E5a and E5b.

Environmental specifications

Temperature

Type	Operating temperature [°C]	Storage temperature [°C]
CGA100	-40 to +85	-55 to +85

Protection against water, dust and sand

Type	Protection
CGA100	IP68, IP69K Dust tight Protected against water jets Waterproof to 1 m temporary immersion

Humidity

Type	Protection
CGA100	IEC60068-2-30 98% r.H. / 25 °C 93% r.H. / 55 °C The effects of condensation are to be effectively counteracted by periodically drying out the antenna.

Vibration/shock

Type	CGA100
Vibration	IEC 60068-2-6: 5–500 Hz, 15 g, ±15 mm MIL-STD-810G: Fig.514.6E-1: Category 24 (20–2000 Hz, 7.7 grms)
Shock	IEC 60068-2-27 (special): 60 g, 6 ms IEC 60068-2-27: 100 g, 2 ms

Cable length

Separation distance from instrument ...	to antenna	Optional cable lengths [m]
iCON aps 200	CGA100	2.8, 5, 10

7.3

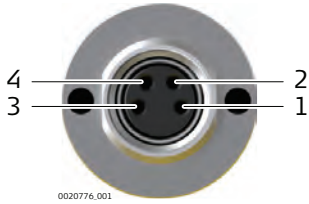
Pin Assignments and Sockets

Expert knowledge required

Modification or adaption on base of the pin assignments and socket descriptions need expert knowledge.

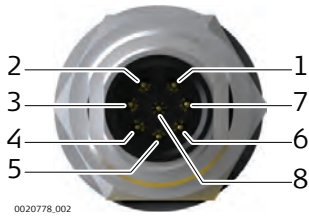
Changes or modifications not expressly approved by Leica Geosystems for compliance could void the user's authority to operate the equipment.

USB M8 connector



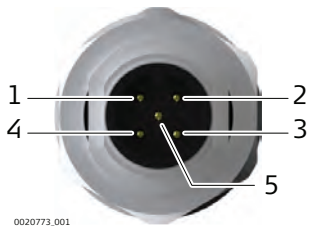
Pin	Function	Direction
1	5 V	USB power Out
2	USB Data +	Bus
3	GND	USB power return
4	USB Data -	Bus

Serial port M12



Pin	Function	Direction
1	13.8 V	Power out
2	TX1-RS232-TxD-	Out
3	PV	Out
4	RX1-RS232-RxD+	In
5	TX2-RS232-TxD+	Out
6	PPS	Out
7	RX2-RS232-RxD-	In
8	GND (ground)	Power out

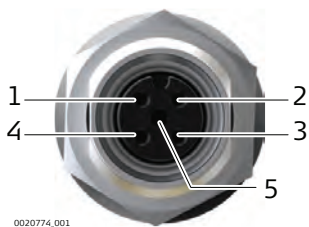
CAN1



Type: CAN M12 5-pin

Pin	Name	Function	Direction
1	Vcan+	Input power/ bus supply	Supply power in
2	CANH	CAN high	Bus
3	Vcan-	Ground	Supply power return
4	CANL	CAN low	Bus
5	CAN ON	CAN ON	Bidirectional

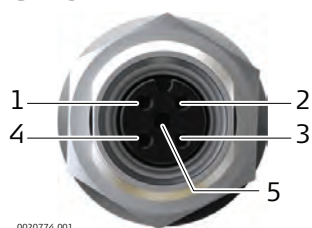
CAN2



Type: CAN M12 5-pin

Pin	Function/Signal	Direction
1	POWEROUT, Batt+	AUX power out
2	CANH	Bus
3	POWEROUT_GND (ground), Batt-	AUX power return
4	CANL	Bus
5	CAN ON	Bidirectional

CAN3



Type: CAN M12 5-pin

Pin	Function/Signal	Direction
1	POWEROUT	AUX power out
2	CANH	Bus
3	POWEROUT_GND (ground)	AUX power return
4	CANL	Bus
5	N/C	N/A

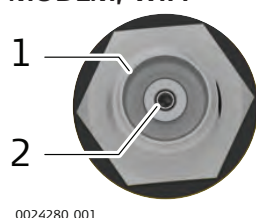
Ethernet 1/Ethernet 2



Type: M12 4 Pin

Pin	Name	Function	Direction
1	Tx+	Transmit data +	Out +
2	Rx+	Receive data +	In +
3	Tx-	Transmit data -	Out -
4	Rx-	Receive data -	In -

ANT1, ANT2, RADIO, MODEM, WiFi



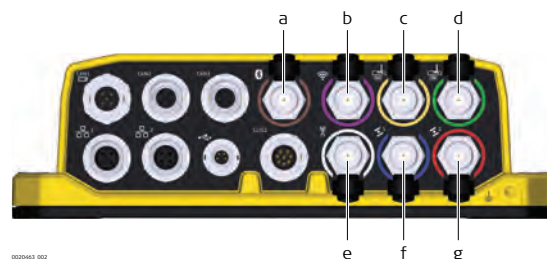
Type: TNC Female

Pin	Description
1	Shield/Ground
2	Antenna signal and antenna power



Connecting the wrong antenna to the wrong connector may cause damage to the antennas. In order to minimise the chance of connecting the incorrect external antenna, the four TNC connectors are colour coded. Cables with corresponding colours are available.

The colour coding is as follows:



- a Brown: Bluetooth
- b Purple: WiFi
- c Yellow: Modem 1
- d Green: Modem 2
- e White: Radio
- f Blue: GNSS Antenna 1
- g Red: GNSS Antenna 2

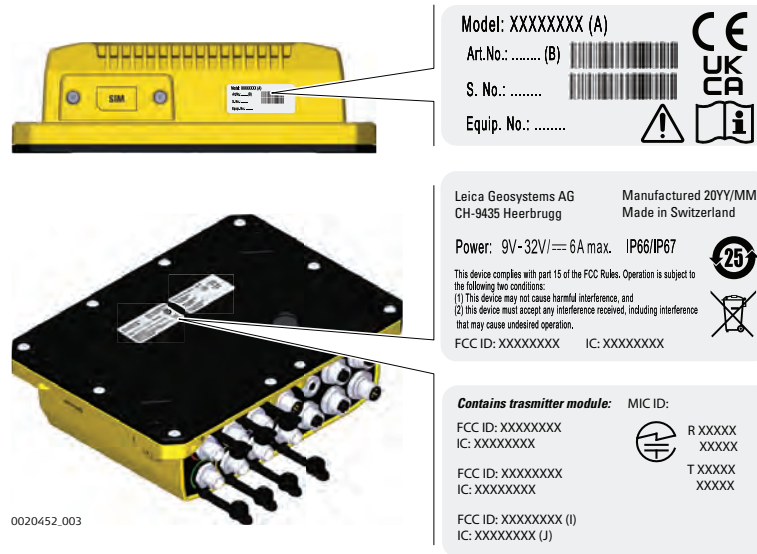
7.4

Conformity Declarations

7.4.1

iCON aps 200

Labelling iCON aps 200



Antenna

Type	Application	Connector	Frequency band [MHz]
CA12	Radio TR489	TNC (CA22, Magnetic antenna mount)	406 - 440
CA13	Radio TR489	TNC (CA22, Magnetic antenna mount)	430 - 480
CA43	Radio TR489	TNC (CA22, Magnetic antenna mount)	690 - 960 1710 - 2700
CA46	LTE diversity modem antenna	TNC	698 - 960 1710 - 2170 2300 - 2700

Frequency band

Type	Frequency band [MHz]
Bluetooth	2402 - 2480
Radio	403 - 473 (TR489) 902 - 928 (TR489)
WiFi	2400

EM7565

Type	Frequency band [MHz]
WCDMA	Band 1 Tx: 1920 - 1980 Rx: 2110 - 2170
	Band 2 Tx: 1850 - 1910 Rx: 1930 - 1990

Type	Frequency band [MHz]
	Band 4 Tx: 1710 - 1755 Rx: 2110 - 2155
	Band 5 Tx: 824 - 849 Rx: 869 - 894
	Band 6 Tx: 830 - 840 Rx: 875 - 885
	Band 8 Tx: 880 - 915 Rx: 925 - 960
	Band 9 Tx: 1749.9 - 1784.9 Rx: 1844.9 - 1879.9
	Band 19 Tx: 830 - 845 Rx: 875 - 890
LTE	Band 1 Tx: 1920 - 1980 Rx: 2110 - 2170
	Band 2 Tx: 1850 - 1910 Rx: 1930 - 1990
	Band 3 Tx: 1710 - 1785 Rx: 1805 - 1880
	Band 4 Tx: 1710 - 1755 Rx: 2110 - 2155
	Band 5 Tx: 824 - 849 Rx: 869 - 894
	Band 7 Tx: 2500 - 2570 Rx: 2620 - 2690
	Band 8 Tx: 880 - 915 Rx: 925 - 960
	Band 9 Tx: 1749.9 - 1784.9 Rx: 1844.9 - 1879.9
	Band 12 Tx: 699 - 716 Rx: 729 - 746
	Band 13 Tx: 777 - 787 Rx: 746 - 756

Type	Frequency band [MHz]
	Band 18 Tx: 815 - 830 Rx: 860 - 875
	Band 19 Tx: 830 - 845 Rx: 875 - 890
	Band 20 Tx: 832 - 862 Rx: 791 - 821
	Band 26 Tx: 814 - 849 Rx: 859 - 894
	Band 28 Tx: 703 - 748 Rx: 758 - 803
	Band 29 Tx: n/a Rx: 717 - 728
	Band 30 Tx: 2305 - 2315 Rx: 2350 - 2360
	Band 32 Tx: n/a Rx: 1452 - 1496
	Band 41 2496 - 2690 (TDD)
	Band 42 3400 - 3600 (TDD)
	Band 43 3600 - 3800 (TDD)
	Band 46 Tx: n/a Rx: 5150 - 5925 (TDD)
	Band 48 3550 - 3700 (TDD)
	Band 66 Tx: 1710 - 1780 Rx: 2110 - 2200

Output power

Type	Output power [mW]
Bluetooth	3.0
UMTS	Band 1, 2, 4, 5, 6, 8, 9, 19: 200
LTE	Band 1, 2, 3, 4, 5, 8, 9, 12, 13, 18, 19, 20, 26, 28, 66: 200 Band 7, 41, 42, 43, 48: 160
WiFi	according to country-specific regulations

Radiation Exposure Statement

The radiated output power of the instrument is below the radio frequency exposure limits. Nevertheless, the instrument should be used in such a manner that the potential for human contact during normal operation is minimised. To avoid the possibility of exceeding the radio frequency exposure limits, keep a distance of at least 30 cm between you (or any other person in the vicinity) and the instrument.

Specific Absorption Rate (SAR)

The product meets the limits for the maximum permissible exposure of the guide-lines and standards which are force in this respect. The product must be used with the recommended antenna. A separation distance of at least 20 centimetres should be kept between the antenna and the body of the user or nearby person within the intended application.

SAR limits

Country	Head	Body	Limb
EU	0.5 W/Kg, 10-gram	0.5 W/Kg, 10-gram	n/a
France	0.5 W/Kg, 10-gram	0.5 W/Kg, 10-gram	0.5 W/Kg, 10-gram
USA & Canada	1.492 W/Kg, 1-gram	1.6 W/Kg, 1-gram	n/a

EU



Hereby, Leica Geosystems AG declares that the radio equipment type iCON aps 200 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

FCC ID: RFD-ICA20X
FCC Part 15, 22, 24, 27 and 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.

Exposure to radio frequency (RF) signals

The wireless device is a radio transmitter and receiver. It is designed and manufactured not to exceed the emission limit for exposure to radio frequency (RF) energy set by the OET Bulletin 65 Supplement C / Ministry of Health (Canada), Safety Code 6. These limits are part of comprehensive guidelines and established permitted levels of RF energy for the general population. These guidelines are based on the safety standards previously set by international standard bodies. These standards include a substantial safety margin designed to assure the safety of all persons, regardless of age and health. This device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter. This device has been shown to be capable of compliance for localised specific absorption rate (SAR) for uncontrolled environment / general public exposure limits specific in ANSI/IEEE C95.1-1992 and had been tested in accordance with the measurement procedures specified in IEEE Std. 1528-2003.

Canada

CAN ICES-003 Class B/NMB-003 Class B
IC ID: 3177A-ICA20X

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

Japan

- This device is granted pursuant to the Japanese Radio Law (電波法) and the Japanese Telecommunications Business Law (電気通信事業法).
 - This device should not be modified (otherwise the granted designation number will become invalid).
-

South Korea



Applicant name: Leica Geosystems AG
Product name: Specific small output wireless device
Model name: 2020-07-09
KC number: R-R-rks-iCA200/202
Manufacture date: Marked separately
Manufacturer: LEICA GEOSYSTEMS AG/SWITZERLAND

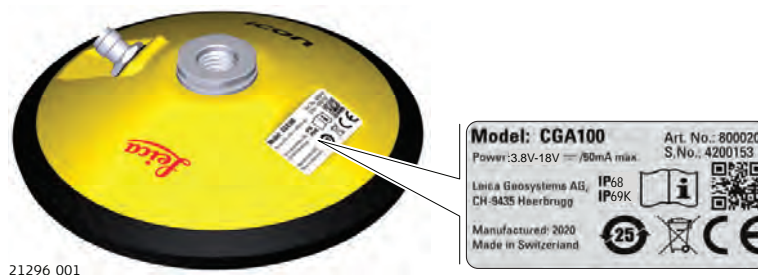
Others

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

7.4.2

CGA100

Labelling CGA100



21296_001

Frequency band

Type	CGA100
GPS L1	1575.42 MHz
GPS L2	1227.60 MHz
GPS L5	1176.45 MHz
GLONASS L1	1602.5625 - 1611.5 MHz
GLONASS L2	1246.4375 - 1254.3 MHz
GLONASS L3	1207.14 MHz
Galileo E1	1575.42 MHz
Galileo E5a	1176.45 MHz
Galileo E5b	1207.14 MHz
Galileo E6	1278.75 MHz
Galileo AltBOC	1191.795 MHz
BeiDou B1	1561.098 MHz
BeiDou B2	1207.14 MHz
BeiDou B3	1268.52 MHz

Output power

Receive only

EU



Hereby, Leica Geosystems AG declares that the product/s is/are in compliance with the essential requirements and other relevant provisions of the 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>.

⚠ CAUTION

This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

USA

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

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

This equipment generates, uses, and can radiate radio frequency energy 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.

Canada

CAN ICES-003 Class B/NMB-003 Class B

Others

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

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 licensed 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/icon>

If foreseen in the corresponding open source licence, you may obtain the corresponding source code and other related data on <http://opensource.leica-geosystems.com/icon>.

Contact opensource@leica-geosystems.com in case you need additional information.

Appendix A NMEA Message Formats

A.1 Overview

Description

National Marine Electronics Association is a standard for interfacing marine electronic devices. This chapter describes all NMEA-0183 messages which can be output by the instrument.

Access



NMEA can be configured via the web interface. For further information refer to the Web Interface User Guide.



A Talker ID appears at the beginning of the header of each NMEA message. The Talker ID can be user defined or standard (based on the NMEA 4.0).



For information on how to manually define the Talker ID, refer to the Web Interface User Guide.



When enabling CQ Control, the coordinate quality is being checked. If the coordinate quality of the position and/or the height component exceeds the defined limit, no NMEA messages are output.

A.2 Symbols Used for Describing the NMEA Formats

Description

NMEA messages consist of various fields. The fields are:

- Header
- Special format fields
- Numeric value fields
- Information fields
- Null fields

Certain symbols are used as identifier for the field types.

These symbols are described in this section.

Header

Symbol	Field	Description	Example
\$	-	Start of sentence	\$
--ccc	Address	<ul style="list-style-type: none">• -- = alphanumeric characters identifying the talker Options: GN = Global Navigation Satellite System GP = GPS only GL = GLONASS GA = Galileo GB = BeiDou	GNGGA GPGGA GLGGA GAGGA GBGGA

Symbol	Field	Description	Example
		<ul style="list-style-type: none"> ccc = alphanumeric characters identifying the data type and string format of the successive fields. Usually the name of the message. 	

Special format fields

Symbol	Field	Description	Example
A	Status	<ul style="list-style-type: none"> A = Yes, Data Valid, Warning Flag Clear V = No, Data Invalid, Warning Flag Set 	V
III.II	Latitude	<ul style="list-style-type: none"> Degreesminutes.decimal Two fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length. 	4724.538950
yyyyy.yy	Longitude	<ul style="list-style-type: none"> Degreesminutes.decimal Three fixed digits of degrees, two fixed digits of minutes and a variable number of digits for decimal fraction of minutes. Leading zeros are always included for degrees and minutes to maintain fixed length. 	00937.046785
eeeeee.eee	Grid Easting	At the most six fixed digits for metres and three fixed digits for decimal fractions of metres.	195233.507
nnnnnn.nnn	Grid Northing	At the most six fixed digits for metres and three fixed digits for decimal fractions of metres.	127223.793
hhmmss.ss	Time	<ul style="list-style-type: none"> hoursminutesseconds.decimal Two fixed digits of hours, two fixed digits of minutes, two fixed digits of seconds and a variable number of digits for decimal fraction of seconds. 	115744.00

Symbol	Field	Description	Example
		<ul style="list-style-type: none"> Leading zeros are always included for hours, minutes and seconds to maintain fixed length. 	
mmddyy	Date	<ul style="list-style-type: none"> Monthdayyear - two fixed digits of month, two fixed digits of day, two fixed digits of year. Leading zeros always included for month, day and year to maintain fixed length. 	093003
No specific symbol	Defined field	<ul style="list-style-type: none"> Some fields are specified to contain predefined constants, most often alpha characters. Such a field is indicated by the presence of one or more valid characters. Excluded from the list of valid characters are the following that are used to indicate other field types: A, a, c, x, hh, hhmmss.ss, llll.ll, yyyyyy.yy. 	M

Numeric value fields

Symbol	Field	Description	Example
x.x	Variable numbers	<ul style="list-style-type: none"> Integer or floating numeric field Optional leading and trailing zeros. Decimal point and associated decimal-fraction are optional if full resolution is not required. 	73.10 = 73.1 = 073.1 = 73
hh_	Fixed HEX field	Fixed length HEX numbers	3F

Information fields

Symbol	Field	Description	Example
c--c	Variable text	Variable length valid character field	A
aa_	Fixed alpha field	Fixed length field of upper case or lower case alpha characters	N
xx_	Fixed number field	Fixed length field of numeric characters	1

Null fields

Symbol	Field	Description	Example
No symbol	Information unavailable for output	Null fields do not contain any information.	,,



Fields are always separated by a comma. Before the Checksum field there is never a comma.



When information for a field is not available, the position in the data string is empty.

A.3

GGA - Global Positioning System Fix Data

Syntax

\$--GGA,hhmmss.ss,lll.ll,a,yyyy.yy,a,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

Description of fields

Field	Description
\$--GGA	Header including Talker ID
hhmmss.ss	UTC time of position
lll.ll	Latitude (WGS 1984)
a	Hemisphere, N orth or S outh
yyyy.yy	Longitude (WGS 1984)
a	E ast or W est
x	Position quality indicator 0 = Fix not available or invalid 1 = No real-time position, navigation fix 2 = Real-time position, ambiguities not fixed 3 = Valid fix for GNSS P recise P ositioning S ervice mode, for example WAAS 4 = Real-time position, ambiguities fixed
xx	Number of satellites in use. For \$GNSS messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	HDOP
x.x	Altitude of position marker above/below mean sea level in metres. If no orthometric height is available the local ellipsoidal height will be exported. If the local ellipsoidal height is not available either, the WGS 1984 ellipsoidal height will be exported.
M	Units of altitude as fixed text M
x.x	Geoidal separation in metres. The Geoidal separation is the difference between the WGS 1984 earth ellipsoid surface and mean sea level.
M	Units of geoidal separation as fixed text M
x.x	Age of differential GNSS data, empty when DGPS not used
xxxx	Differential base station ID, 0000 to 1023

Field	Description
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

For NMEA v4.0 and v4.1:

Standard Talker ID = GPS only

\$GPGGA,141909.00,4724.5294609,N,00937.0836236,E,1,09,1.0,366.745,M,100.144,M,,*52

Standard Talker ID = GNSS

\$GNGBGA,142309.00,4724.5296834,N,00937.0832766,E,1,16,0.7,366.740,M,100.144,M,,*4E

A.4

GGK - Real-Time Position with DOP

Syntax

\$--GGK,hhmmss.ss,mmddyy,llll.ll,a,yyyyy.yy,a,x,xx,x.x,EHTx.x,M*hh<CR><LF>

Description of fields

Field	Description
\$--GGK	Header including Talker ID
hhmmss.ss	UTC time of position
mmddyy	UTC date
llll.ll	Latitude (WGS 1984)
a	Hemisphere, N orth or S outh
yyyyy.yy	Longitude (WGS 1984)
a	E ast or W est
x	Position quality indicator 0 = Fix not available or invalid 1 = No real-time position, navigation fix 2 = Real-time position, ambiguities not fixed 3 = Real-time position, ambiguities fixed 5 = Real-time position, float
xx	Number of satellites in use. For \$GNGBGK messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	GDOP
EHT	Ellipsoidal height
x.x	Altitude of position marker as local ellipsoidal height. If the local ellipsoidal height is not available, the WGS 1984 ellipsoidal height will be exported.
M	Units of altitude as fixed text M
*hh	Checksum
<CR>	Carriage Return

Field	Description
<LF>	Line Feed

Examples

For NMEA v4.0 and v4.1:

Standard Talker ID = GPS only

\$GPGGK,142804.00,111414,4724.5292267,N,00937.0832394,E,1,09,2.3,EHT466.919,M*46

Standard Talker ID = GNSS

\$GNGGK,142629.00,111414,4724.5295910,N,00937.0831490,E,1,16,1.6,EHT467.089,M*5C

A.5

GGQ - Real-Time Position with CQ

Syntax

\$--GGQ,hhmmss.ss,mmddyy,llll.ll,a,yyyyy.yy,a,x,xx,x.x,x.x,M*hh<CR><LF>

Description of fields

Field	Description
\$--GGQ	Header including talker ID
hhmmss.ss	UTC time of position
mmddyy	UTC date
llll.ll	Latitude (WGS 1984)
a	Hemisphere, N orth or S outh
yyyyy.yy	Longitude (WGS 1984)
a	E ast or W est
x	Position quality indicator 0 = Fix not available or invalid 1 = No real-time position, navigation fix 2 = Real-time position, ambiguities not fixed 3 = Real-time position, ambiguities fixed 5 = Real-time position, float
xx	Number of satellites in use. For \$GNGGQ messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	Coordinate quality in metres
x.x	Altitude of position marker above/below mean sea level in metres. If no orthometric height is available the local ellipsoidal height will be exported. If the local ellipsoidal height is not available either, the WGS 1984 ellipsoidal height will be exported.
M	Units of altitude as fixed text M
*hh	Checksum
<CR>	C arriage R eturn
<LF>	L ine F eed

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

```
$GPGGQ,144419.00,111414,4724.5290370,N,00937.0833037,E,1,10,3.894,366.261,M*01
```

Standard Talker ID = GNSS

```
$GNGGQ,144054.00,111414,4724.5294512,N,00937.0834677,E,1,21,3.679,366.584,M*12
```

```
$GPGGQ,144054.00,111414,,,,,10,,,*45
```

```
$GLGGQ,144054.00,111414,,,,,07,,,*5F
```

```
$GBGGQ,144054.00,111414,,,,,04,,,*51
```

For NMEA v4.1:

Standard Talker ID = GPS only

```
$GPGGQ,144339.00,111414,4724.5290715,N,00937.0833826,E,1,10,4.060,366.339,M*03
```

Standard Talker ID = GNSS

```
$GNGGQ,144224.00,111414,4724.5293821,N,00937.0835717,E,1,22,3.673,366.944,M*12
```



When more than one GNSS is active only \$GNGGQ is output.

A.6

GLL - Geographic Position Latitude/Longitude

Syntax

```
$--GLL,IIII.II,a,yyyyy.yy,a,hhmmss.ss,A,a*hh<CR><LF>
```

Description of fields

Field	Description
\$--GLL	Header including talker ID
IIII.II	Latitude (WGS 1984)
a	Hemisphere, N orth or S outh
yyyyy.yy	Longitude (WGS 1984)
a	E ast or W est
hhmmss.ss	UTC time of position
A	Status A = Data valid V = Data not valid
a	Mode indicator A = Autonomous mode D = Differential mode N = Data not valid
*hh	Checksum
<CR>	C arriage R eturn
<LF>	L ine F eed



The Mode indicator field supplements the Status field. The Status field is set to A for the Mode indicators A and D. The Status field is set to V for the Mode indicator N.

Examples

For NMEA v4.0 and v4.1:

Standard Talker ID = GPS only

```
$GPGLL,4724.5289712,N,00937.0834834,E,144659.00,A,A*68
```

Standard Talker ID = GNSS

```
$GNGLL,4724.5294325,N,00937.0836915,E,144839.00,A,A*72
```

A.7

GNS - GNSS Fix Data

Syntax

```
$--GNS,hhmmss.ss,llll.ll,a,yyyy.yy,a,c--c,xx,x.x,x.x,x.x,x.x,xxxx,h*hh<CR><LF>
```

Description of fields

Field	Description
\$--GNS	Header including talker ID
hhmmss.ss	UTC time of position
llll.ll	Latitude (WGS 1984)
a	Hemisphere, N orth or S outh
yyyy.yy	Longitude (WGS 1984)
a	E ast or W est
c--c	Four character mode indicator for each GNSS constellation used in the position where the <ul style="list-style-type: none">First character is for GPSSecond character is for GLONASSThird character is for GalileoFourth character is for BeiDou N = Satellite system not used in position fix or fix not valid P = Precise, for example no deliberate degradation such as SA A = Autonomous; navigation fix, no real-time fix D = Differential; real-time position, ambiguities not fixed R = Real-time kinematic; ambiguities fixed F = Float real-time kinematic
xx	Number of satellites in use. For \$GNGGA messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	HDOP
x.x	Altitude of position marker above/below mean sea level in metres. If no orthometric height is available the local ellipsoidal height is exported. If the local ellipsoidal height is not available either, the WGS 1984 ellipsoidal height is exported.
x.x	Geoidal separation in metres
x.x	Age of differential data

Field	Description
xxxx	Differential base station ID, 0000 to 1023
h	For NMEA v4.1. Navigation Status Indicator S = Safe C = Caution U = Unstable V = Navigation status not valid
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

\$GPGNS,150254.00,4724.5290110,N,00937.0837286,E,A,10,0.8,366.282,100.143,,*33GNSS

Standard Talker ID = GNSS

\$GNGNS,145309.00,4724.5293077,N,00937.0838953,E,AANA,22,0.5,367.326,100.144,,*64



When more than one GNSS is active only \$GNGNS is output.

For NMEA v4.1:

Standard Talker ID = GPS only

\$GPGNS,150219.00,4724.5290237,N,00937.0837225,E,A,10,0.8,366.329,100.143,,,V*4FGNSS

Standard Talker ID = GNSS

\$GNGNS,145339.00,4724.5292786,N,00937.0838968,E,AANA,22,0.5,367.334,100.143,,,V*19



When more than one GNSS is active only \$GNGNS is output.

A.8


GSA - GNSS DOP and Active Satellites

Syntax

\$--GSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x,h*hh<CR><LF>

Description of fields

Field	Description
\$--GSA	Header including talker ID
a	Mode M = Manual, forced to operate in 2D or 3D mode A = Automatic, allowed to change automatically between 2D and 3D
x	Mode 1 = Fix not available 2 = 2D

Field	Description																																				
	3 = 3D																																				
xx	<p>PRN numbers of the satellites used in the solution.</p> <p>For NMEA v4.0: This field is repeated 12 times.</p> <p>For NMEA v4.1: This field is repeated 16 times.</p> <p> A new GSA message is sent for each GNSS constellation tracked.</p> <p>For NMEA v4.0 and v4.1:</p> <table><tr><td>GPS</td><td>1 to 32</td><td>GPS satellites</td></tr><tr><td></td><td>33 to 64</td><td>SBAS satellites</td></tr><tr><td></td><td>65 to 99</td><td>Undefined</td></tr><tr><td>GLONASS</td><td>1 to 32</td><td>Undefined</td></tr><tr><td></td><td>33 to 64</td><td>SBAS satellites</td></tr><tr><td></td><td>65 to 99</td><td>GLONASS satellites</td></tr></table> <p>For NMEA v4.1 also:</p> <table><tr><td>Galileo</td><td>1 to 36</td><td>Galileo satellites</td></tr><tr><td></td><td>37 to 64</td><td>Galileo SBAS</td></tr><tr><td></td><td>65 to 99</td><td>Undefined</td></tr><tr><td>BeiDou</td><td>1 to 37</td><td>BeiDou satellites</td></tr><tr><td></td><td>38 to 64</td><td>BeiDou SBAS</td></tr><tr><td></td><td>65 to 99</td><td>Undefined</td></tr></table>	GPS	1 to 32	GPS satellites		33 to 64	SBAS satellites		65 to 99	Undefined	GLONASS	1 to 32	Undefined		33 to 64	SBAS satellites		65 to 99	GLONASS satellites	Galileo	1 to 36	Galileo satellites		37 to 64	Galileo SBAS		65 to 99	Undefined	BeiDou	1 to 37	BeiDou satellites		38 to 64	BeiDou SBAS		65 to 99	Undefined
GPS	1 to 32	GPS satellites																																			
	33 to 64	SBAS satellites																																			
	65 to 99	Undefined																																			
GLONASS	1 to 32	Undefined																																			
	33 to 64	SBAS satellites																																			
	65 to 99	GLONASS satellites																																			
Galileo	1 to 36	Galileo satellites																																			
	37 to 64	Galileo SBAS																																			
	65 to 99	Undefined																																			
BeiDou	1 to 37	BeiDou satellites																																			
	38 to 64	BeiDou SBAS																																			
	65 to 99	Undefined																																			
x.x	PDOP																																				
x.x	HDOP																																				
x.x	VDOP																																				
h	<p>For NMEA v4.1. GNSS System ID</p> <p>1 = GPS</p> <p>2 = GLONASS</p> <p>3 = Galileo</p> <p>4 = BeiDou</p>																																				
*hh	Checksum																																				
<CR>	Carriage Return																																				
<LF>	Line Feed																																				

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

\$GPGSA,A,3,01,04,06,09,11,17,20,23,31,,,,,1.5,0.8,1.3*31

Standard Talker ID = GNSS

\$GNGSA,A,3,01,04,06,09,11,17,20,23,31,,,,,1.1,0.5,1.0*25

\$GNGSA,A,3,65,71,72,73,74,80,86,87,88,,,,,1.1,0.5,1.0*26

For NMEA v4.1:

Standard Talker ID = GPS only

\$GPGSA,A,3,01,04,06,09,11,17,20,23,31,,,,,,,,,1.5,0.8,1.3,1*2C

Standard Talker ID = GNSS

\$GNGSA,A,3,01,04,06,09,11,17,20,23,31,,,,,,,,,1.1,0.5,1.0,1*38

\$GNGSA,A,3,65,71,72,73,74,80,86,87,88,,,,,,,,,1.1,0.5,1.0,2*38

\$GNGSA,A,3,05,07,10,11,,,,,,,,,,,,,1.1,0.5,1.0,4*33

A.9

GSV - GNSS Satellites in View

Syntax

\$--GSV,x,x,xx,xx,xx,xxx,xx,.....,h*hh<CR><LF>

Description of fields

Field	Description
\$--GSV	Header including talker ID
x	Total number of messages, 1 to 9
x	Message number, 1 to 9
xx	Number of theoretically visible satellites according to the current almanac.
xx	PRN numbers of the satellites used in the solution.
	GPS
	1 to 32
	GPS satellites
	33 to 64
	SBAS satellites
	65 to 99
	Undefined
	GLONASS
	1 to 32
	Undefined
	33 to 64
	SBAS satellites
	65 to 99
	GLONASS satellites
	Galileo
	1 to 36
	Galileo satellites
	37 to 64
	Galileo SBAS
	65 to 99
	Undefined
	BeiDou
	1 to 37
	BeiDou satellites
	38 to 64
	BeiDou SBAS
	65 to 99
	Undefined
xx	Elevation in degrees, 90 maximum, empty when not tracking
xxx	Azimuth in degrees true north, 000 to 359, empty when not tracking
xx	Signal to Noise Ration C/No in dB, 00 to 99 of L1 signal, null field when not tracking.
...	Repeat set PRN / Slot number, elevation, azimuth and SNR up to four times
h	For NMEA v4.1. Signal ID
	GPS
	0
	All signals
	1
	L1 C/A
	2
	L1 P(Y)

Field	Description
	3 L1M
	4 L2 P(Y)
	5 L2C-M
	6 L2C-L
	7 L5-I
	8 L5-Q
	9-F Reserved
GLONASS	0 All signals
	1 G1 C/A
	2 G1 P
	3 G2 C/A
	4 GLONASS (M) G2 P
	5-F Reserved
Galileo	0 All signals
	1 E5a
	2 E5b
	3 E5a+b
	4 E6-A
	5 E6-BC
	6 L1-A
	7 L1-BC
	8-F Reserved
BeiDou	0 All signals
	1-F Reserved
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed



Satellite information can require the transmission of multiple messages, specified by the total number of messages and the message number.



The fields for the PRN / Slot number, Elevation, Azimuth and SNR form one set. A variable number of these sets are allowed up to a maximum of four sets per message.

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

```
$GPGSV,3,1,09,01,31,151,45,06,37,307,47,09,47,222,49,10,14,279,44*7D
```

```
$GPGSV,3,2,09,17,29,246,47,20,69,081,49,23,79,188,51,31,18,040,41*76
```

```
$GPGSV,3,3,09,32,23,087,42,,,,,,,,,,,,,*49
```

Standard Talker ID = GNSS

\$GPGSV,3,1,09,01,34,150,47,06,34,308,47,09,44,220,48,10,11,277,43*7B
\$GPGSV,3,2,09,17,31,248,49,20,71,076,48,23,76,192,50,31,19,042,42*7A
\$GPGSV,3,3,09,32,25,085,40,,,,,,,,,,,,*4F
\$GLGSV,3,1,09,65,24,271,45,71,37,059,47,72,67,329,49,73,31,074,45*66
\$GLGSV,3,2,09,74,17,127,44,80,15,022,41,86,12,190,44,87,49,239,48*66
\$GLGSV,3,3,09,88,38,314,46,,,,,,,,,,,,*53
\$GBGSV,1,1,04,05,18,123,38,07,23,044,39,10,35,068,45,11,29,224,45*61

For NMEA v4.1:

Standard Talker ID = GPS only

\$GPGSV,3,1,09,01,31,151,46,06,36,307,47,09,46,222,49,10,13,278,44,0*64
\$GPGSV,3,2,09,17,29,246,48,20,69,080,49,23,79,189,51,31,18,040,42,0*66
\$GPGSV,3,3,09,32,23,087,42,,,,,,,,,,,,0*55

Standard Talker ID = GNSS

\$GPGSV,3,1,09,01,32,151,46,06,35,308,47,09,45,221,49,10,12,278,42,0*6C
\$GPGSV,3,2,09,17,30,247,47,20,70,078,49,23,77,191,51,31,19,041,41,0*6B
\$GPGSV,3,3,09,32,24,086,41,,,,,,,,,,,,0*50
\$GLGSV,3,1,09,65,25,272,46,71,36,060,47,72,68,333,49,73,31,073,45,0*73
\$GLGSV,3,2,09,74,18,126,47,80,15,021,38,86,11,190,45,87,48,238,50,0*71
\$GLGSV,3,3,09,88,38,312,46,,,,,,,,,,,,0*49
\$GBGSV,1,1,04,05,18,123,38,07,23,044,40,10,35,067,45,11,28,224,46,0*7E

A.10

GST - Position Error Statistics

Syntax

\$--GST,hhmmss.ss,x.xxx,x.xxx,x.xxx,xxx.x,x.xxx,x.xxx,x.xxx*hh

Description of fields

Field	Description
\$--GST	Message ID; varies depending on the satellite system used for the position solution: <ul style="list-style-type: none">• \$GPGST: GPS only• \$GLGST: GLONASS only• \$GN: Combined
hhmmss.ss	UTC of position fix
x.xxx	RMS value of the pseudo-range residuals; includes carrier phase residuals during periods of RTK (float) and RTK (fixed) processing
x.xxx	Error ellipse semi-major axis 1 sigma error, in meters
x.xxx	Error ellipse semi-minor axis 1 sigma error, in meters
xxx.x	Error ellipse orientation, degrees from true north
x.xxx	Latitude 1 sigma error, in meters
x.xxx	Longitude 1 sigma error, in meters
x.xxx	Height 1 sigma error, in meters

Field	Description
*hh	Checksum; data always begins with *

Example

\$GPGST,172814.0,0.006,0.023,0.020,273.6,0.023,0.020,0.031*6A

A.11

HDT - Heading, True

Syntax

\$--HDT,x.x,T*hh<CR><LF>

Description of fields

Field	Description
\$--HDT	Header including talker ID
x.x	Heading, degrees True
T	Fixed text T for true north
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

Standard Talker ID

\$GNHDT,11.4,T, 00*4B

A.12

LLK - Leica Local Position and GDOP

Syntax

\$--LLK,hhmmss.ss,mmddyy,eeeeee.eee,M,nnnnnn.nnn,M,x,xx,x.x,x.x,M*hh<CR><LF>

Description of fields

Field	Description
\$--LLK	Header including talker ID
hhmmss.ss	UTC time of position
mmddyy	UTC date
eeeeee.eee	Grid Easting in metres
M	Units of grid Easting as fixed text M
nnnnnn.nnn	Grid Northing in metres
M	Units of grid Northing as fixed text M
x	Position quality 0 = Fix not available or invalid 1 = No real-time position, navigation fix 2 = Real-time position, ambiguities not fixed 3 = Real-time position, ambiguities fixed 5 = Real-time position, float
xx	Number of satellites in use. For \$GNLLK messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	GDOP

Field	Description
x.x	Altitude of position marker above/below mean sea level in metres. If no orthometric height is available the local ellipsoidal height will be exported.
M	Units of altitude as fixed text M
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

\$GPRLL,153254.00,111414,546628.909,M,5250781.888,M,1.09,1.8,366.582,M*15

Standard Talker ID = GNSS

\$GNLLK,153819.00,111414,546629.154,M,5250782.866,M,1.20,1.3,367.427,M*05

\$GPRLL,153819.00,111414,,,,,09,,,*50

\$GLLLK,153819.00,111414,,,,,07,,,*42

\$GBLLK,153819.00,111414,,,,,04,,,*4C

For NMEA v4.1:

Standard Talker ID = GPS only

\$GPRLL,153254.00,111414,546628.909,M,5250781.888,M,1.09,1.8,366.582,M*15

Standard Talker ID = GNSS

\$GNLLK,153504.00,111414,546629.055,M,5250782.977,M,1.20,1.3,367.607,M*05



When more than one GNSS is active only \$GNLLK is output.

A.13

LLQ - Leica Local Position and Quality

Syntax

\$--LLQ,hhmmss.ss,mmddyy,eeeeee.eee,M,nnnnnn.nnn,M,x,xx,x.x,x.x,M*hh<CR><LF>

Description of fields

Field	Description
\$--LLQ	Header including talker ID
hhmmss.ss	UTC time of position
mmddyy	UTC date
eeeeee.eee	Grid Easting in metres
M	Units of grid Easting as fixed text M
nnnnnn.nnn	Grid Northing in metres
M	Units of grid Northing as fixed text M

Field	Description
x	Position quality 0 = Fix not available or invalid 1 = No real-time position, navigation fix 2 = Real-time position, ambiguities not fixed 3 = Real-time position, ambiguities fixed 5 = Real-time position, float
xx	Number of satellites in use. For \$GNLLQ messages: The combined GPS, GLONASS, Galileo and BeiDou satellites used in the position.
x.x	Coordinate quality in metres
x.x	Altitude of position marker above/below mean sea level in metres. If no orthometric height is available the local ellipsoidal height will be exported.
M	Units of altitude as fixed text M
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

For NMEA v4.0:

Standard Talker ID = GPS only

```
$GPLLQ,154324.00,111414,546629.232,M,5250781.577,M,1,09,3.876,366.54
9,M*05
```

Standard Talker ID = GNSS

```
$GNLLQ,154119.00,111414,546629.181,M,5250782.747,M,1,20,3.890,367.39
3,M*1D
```

```
$GPLLQ,154119.00,111414,,,,,09,,, *44
```

```
$GLLLQ,154119.00,111414,,,,,07,,, *56
```

```
$GBLLQ,154119.00,111414,,,,,04,,, *58
```

For NMEA v4.1:

Standard Talker ID = GPS only

```
$GPLLQ,154324.00,111414,546629.232,M,5250781.577,M,1,09,3.876,366.54
9,M*05
```

Standard Talker ID = GNSS

```
$GNLLQ,154149.00,111414,546629.191,M,5250782.727,M,1,20,3.880,367.38
7,M*1B
```



When more than one GNSS is active only \$GNLLQ is output.

A.14

RMC - Recommended Minimum Specific GNSS Data

Syntax

```
$--RMC,hhmmss.ss,A,llll.ll,a,yyyy.yy,a,x.x,x.x,xxxxx,x.x,a,a*hh<CR><LF>
```

Description of fields

Field	Description
\$--RMC	Header including talker ID
hhmmss.ss	UTC time of position fix
A	Status
	A = Data valid V = Navigation instrument warning
llll.ll	Latitude (WGS 1984)
a	Hemisphere, North or South
yyyyy.yy	Longitude (WGS 1984)
a	East or West
x.x	Speed over ground in knots
x.x	Course over ground in degrees
xxxxxx	Date: ddmmyy
x.x	Magnetic variation in degrees
a	East or West
*hh	Mode Indicator
	A = Autonomous mode D = Differential mode N = Data not valid
<CR>	Carriage Return
<LF>	Line Feed

Examples**For NMEA v4.0 and v4.1:****Standard Talker ID = GPS only and GNSS**

\$GNRMC,154706.00,A,4724.5288205,N,00937.0842621,E,0.01,144.09,141114,0.00,E,A*10

A.15**VTG - Course Over Ground and Ground Speed****Syntax**

\$--VTG,x.x,T,x.x,M,x.x,N,x.x,K,a*hh<CR><LF>

Description of fields

Field	Description
\$--VTG	Header including talker ID
x.x	Course over ground in degrees true north, 0.0 to 359.9
T	Fixed text T for true north
x.x	Course over ground in degrees magnetic North, 0.0 to 359.9
M	Fixed text M for magnetic North
x.x	Speed over ground in knots
N	Fixed text N for knots
x.x	Speed over ground in km/h
K	Fixed text K for km/h
a	Mode Indicator

Field	Description
	A = Autonomous mode D = Differential mode N = Data not valid
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

For NMEA v4.0 and v4.1:

Standard Talker ID = GPS only

\$GPVTG,152.3924,T,152.3924,M,0.018,N,0.034,K,A*2D

Standard Talker ID = GNSS

\$GNVTG,188.6002,T,188.6002,M,0.009,N,0.016,K,A*33

A.16

XDR – Transducer Measurements

Syntax

\$--XDR,A,x.x,D,PITCH,A,x.x,A,YAW*hh<CR><LF>

Description of fields

Field	Description
\$--XDR	Header including talker ID
A	Transducer type: angular displacement
x.x	Pitch Measurement data
D	Units of measure is Degrees
PITCH	Transducer #1 ID: PITCH
A	Transducer type: angular displacement
x.x	Yaw Measurement data
D	Units of measure is Degrees
YAW	Transducer #2 ID: YAW
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed

Examples

Standard Talker ID

\$GPXDR,A,0.071,D,PITCH,A,228.132,D,YAW*5E

A.17

ZDA - Time and Date

Syntax

\$--ZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>

Description of fields

Field	Description
\$--ZDA	Header including talker ID
hhmmss.ss	UTC time

Field	Description
xx	UTC day, 01 to 31
xx	UTC month, 01 to 12
xxxx	UTC year
xx	Local zone description in hours, 00 to ±13
xx	Local zone description in minutes, 00 to +59
*hh	Checksum
<CR>	Carriage Return
<LF>	Line Feed



This message is given high priority and is output as soon as it is created. Latency is therefore reduced to a minimum.

Examples

For NMEA v4.0 and v4.1:

Standard Talker ID = GPS only and GNSS

\$GPZDA,155404.05,14,11,2014,01,00*61

A.18

PJK - Local Coordinate Position Output

Syntax

\$PTNL,PJK,hhmmss.ss,mmddyy,nnnnnn.nnn,N,eeeeee.ee,E,xx,xx,x.x,-HTxx.xxx,M*hh



The PTNL,PJK message is longer than the NMEA-0183 standard of 80 characters.

Description of fields

Field	Description
\$PTNL,PJK	Message ID \$PTNL,PJK
hhmmss.ss	UTC of position fix
mmddyy	Date
nnnnnn.nnn	Northing, in metres
N	Direction of Northing is always N (North)
eeeeee.ee	Easting, in metres
E	Direction of Easting is always E (East)

Field	Description
xx	GPS quality indicator 0 = Fix not available or invalid 1 = Autonomous GPS fix 2 = RTK float solution 3 = RTK fix solution 4 = Differential, code phase only solution (DGPS) 5 = SBAS solution 6 = RTK Float 3D network solution 7 = RTK Fixed 3D network solution 8 = RTK Float 2D network solution 9 = RTK Fixed 2D network solution 10 = OmniSTAR HP/XP solution 11 = OminSTAR VBS solution 12 = Location RTK 13 = Beacon DGPS
xx	Number of satellites in fix
x.x	DOP of fix
-HTxx.xxx	Height of Antenna Phase Center GHT : If a user-defined geoid model or an inclined plane is loaded into the receiver, the NMEA PJK string always reports the orthometric height EHT : If the latitude/longitude of the receiver is outside the user-defined geoid model bounds, the height is shown as ellipsoidal height
M	M = height is measured in metres
*hh	Checksum; data always begins with *



If the receiver does not have a coordinate system loaded, this string returns nothing in fields **nnnnnn.nn,N,eeeeee.ee,E** and **-HTxx.xxx**.

Examples

- \$PTNL,PJK,202831.50,011112,+805083.350,N,+388997.346,E,10,09,1.5,GHT+25.478,M*77
- \$PTNL,PJK,010717.00,081796,+732646.511,N,+1731051.091,E,1,05,2.7,EHT+28.345,M*7C

Appendix B

ORP – Orientation and Position

Description

This proprietary Leica message provides the current Position and Quality in either Geodetic or Grid coordinates for one or two antennas plus the resulting orientation.

Access



NMEA can be configured via the web interface. For further information refer to the Web Interface User Guide.

Description of fields

Message type	Format	Description
RESPONSE:	\$PLEIR,	Header, message sent from instrument
Position and Quality	ORP,	Message Identifier
	xxxx,	ControlType ¹
	x,	Coordinate System ²
	The following block is available if Control Type = 1 or = 2 (Single or Dual GNSS)	
	x,	Position Status Flag - 1st Antenna ³
	If Position Status Flag - 1st Antenna != "0" (not computed yet) and != 4 (not used)	
	hhmmss.ss,	UTC time
	ddmmyy,	UTC date
	xx,	Latency ⁴ [milliseconds]
	xx.xx,	Quality Latitude/Northing [metres]
	xx.xx,	Quality Longitude/Easting [metres]
	xx.xx,	Quality Height [metres]
	xx.xx,	GDOP – Value for first Antenna
	x,	Number of Satellites used in Computation (GPS)
	x,	Number of Satellites used in Computation (GG)
	If Coordinate System = 0 (Geodetic) the following block is present:	
	llll.ll,	Latitude (+: North -: South)
	yyyy.yy,	Longitude (+: East -: West)
	xxxx.xxxx,	Altitude of position marker ⁵ [metres]
	If Coordinate System = 1 (Grid) the following block is present:	
	xxxx.xxxx,	Grid Northing [metres]
	xxxx.xxxx,	Grid Easting [metres]
	xxxx.xxxx,	Altitude of position marker [metres]
	x,	Height type ⁶
	The following block is only available if Control Type = 2 (Dual GNSS)	

Message type	Format	Description
	x,	Position Status Flag - 2nd antenna ³
		If Position Status Flag - 2nd Antenna != "0" (not computed yet) and != 4 (not used)
	hhmmss.ss,	UTC time
	ddmmyy,	UTC date
	xx,	Latency ⁴ [milliseconds]
	xx.xx,	Quality Latitude/Northing [metres]
	xx.xx,	Quality Longitude/Easting [metres]
	xx.xx,	Quality Height [metres]
		If Coordinate System = 0 (Geodetic) the following block is present:
	lll.ll,	Latitude (+: North -: South)
	yyyyy.yy,	Longitude (+: East -: West)
	xxxx.xxxx,	Altitude of position marker ⁵ [metres]
		If Coordinate System = 1 (Grid) the following block is present:
	xxxx.xxxx,	Grid Northing [metres]
	xxxx.xxxx,	Grid Easting [metres]
	xxxx.xxxx,	Altitude of position marker [metres]
	x,	Height type ⁶
		The following block is only available if Control Type = 3
	hhmmss.ss,	UTC time
	ddmmyy,	UTC date
	xx,	Latency ⁴ [milliseconds]
	xxxx.xxxx,	Orientation Angle ⁷ [degrees], 0.0° to 359.9°
	xx.xx,	Quality of calculated Orientation [degrees]
	*hh	Checksum
	<CR>	Carriage Return
	<LF>	Line Feed

1 Control Type

- 1: Antenna1 Position Information
- 2: Antenna1 and Antenna2 Information
- 3: Antenna1 and Antenna2 Information + Orientation

2 Coordinate System

- 0: WGS Geodetic
- 1: Local Grid

3 Position Status

0: Computed Position not yet available
1: Differential code Position
2: Differential phase Position
3: Non-differential Position
4: xRTK

4 Latency given is defined as the difference in time between the UTC of the measurements used in the computation and the UTC of the first Message byte sent out the instrument port.

5 Ellipsoidal height is forced for Geodetic coordinates.
Orthometric height is forced for Grid coordinates.

6 Height

0: Ellipsoidal height
1: Orthometric height

7 Orientation is available for Local Grid and WGS84.

Example

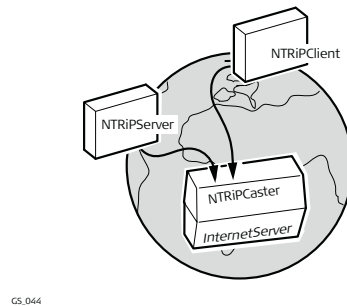
\$PLEIR,ORP,3,1,2,084709.25,310713,50,0.006,0.005,0.016,1.847,5,7,525078
1.241,546672.161,371.528,1,254,084709.25,310713,100,0.005,0.004,0.012,
5250781.277,546671.390,371.497,1,084709.25,310713,100,272.683,0.592*
23

Ntrip

Networked Transport of RTCM via Internet Protocol

- is a protocol streaming real-time corrections over the Internet.
- is a generic protocol based on the Hypertext Transfer Protocol HTTP/1.1.
- is used to send differential correction data or other kinds of streaming data to stationary or mobile users over the Internet. This process allows simultaneous computer, laptop, PDA, or instrument connections to a broadcasting host.
- supports wireless Internet access through mobile IP networks like digital cellular phones or modems.

The Ntrip Server could be the GPS instrument itself. This setup means the GPS instrument is both the Ntrip Source generating the real-time data and also the NTRIP Server transferring this data to the Ntrip Caster.



Ntrip and its role in the Internet

Ntrip Caster

The Ntrip Caster

- is an Internet server handling various data streams to and from the Ntrip Servers and Ntrip Clients.
- checks the requests from Ntrip Clients and Ntrip Servers to see if they are registered to receive or provide real-time corrections.
- decides whether there is streaming data to be sent or to be received.

Ntrip Client

The Ntrip Client receives data streams. This setup could be, for example a real-time rover receiving real-time corrections.

In order to receive real-time corrections, the Ntrip Client must first send

- a user ID
- a password
- an identification name, the so-called Mountpoint, from which real-time corrections are to be received

to the Ntrip Caster.

Ntrip Server

The Ntrip Server transfers data streams.

In order to send real-time corrections, the Ntrip Server must first send

- a password
- an identification name, the so-called Mountpoint, where the real-time corrections come from

to the Ntrip Caster.

Before sending real-time corrections to the Ntrip Caster for the first time, a registration form must be completed. This form is available from the Ntrip Caster administration centre. Refer to the website of the Ntrip Caster administration centre.

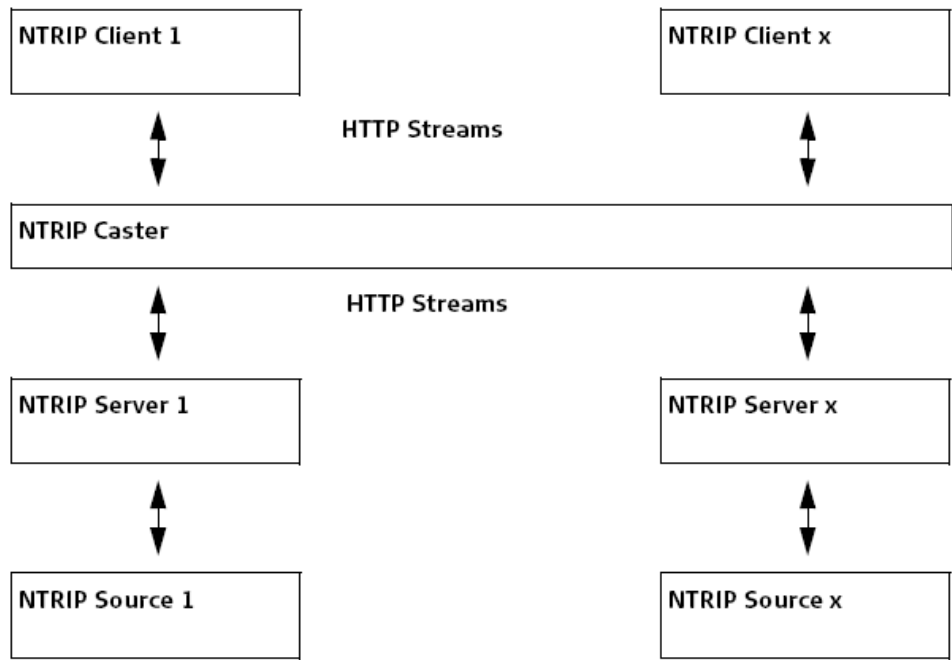
Ntrip Source

The Ntrip Source generates data streams. This setup could be base sending out real-time corrections.

Ntrip system components

Ntrip consists of three system components:

- Ntrip Clients
- Ntrip Servers
- Ntrip Caster



C.2

WGS84

WGS 84

WGS 84 is the global geocentric datum to which all GNSS positioning information is referred to.

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- when it has to be **right**

Leica
Geosystems