

A POLLON Q OPERATING INSTRUCTIONS

Thank you for choosing the Apollon sensor from Sentinum. Please read the following operating instructions carefully to prevent damage to the sensor, yourself and the environment.



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1. GENERAL WARNINGS AND SAFETY INSTRUCTIONS

Warnings and important information about potential hazards or damage

Important information required for smooth operation of the devices

Please note:

- Observe the safety instructions and installation instructions in the manual and the installation list.
- Ensure that the installation environment complies with the prescribed application area guidelines. Observe the temperature and other limit values at all times.
- The device may only be used in the areas specified in the technical specifications.
- The device may only be used for the purposes and in the areas described.
- Safety and functionality can no longer be guaranteed if the device is modified or extended.
- The sensor must not be mounted on ceilings or floors
- Operation of the sensor is only permitted up to a maximum of 2000 meters above sea level.
- Due to human exposure regulations, a minimum distance of 20 cm must be maintained between the device and people.
- Ensure that the installation environment complies with the prescribed guidelines for the area of use. Observe the temperature and other limit values at all times.
- Ensure that the installation environment complies with the prescribed guidelines for the area of use. Comply with the temperature and other limit values at all times.
- Dispose of the device in accordance with national environmental regulations.
- The device may only be repaired by the manufacturer.
- Observe the specific safety instructions for batteries and lithium primary cells.

If the device is installed **incorrectly**:

- It may not function properly.
- It could be permanently damaged.

- Could pose a risk of injury.

Please note:

- Improper handling, such as improper mechanical stress, e.g. dropping the device, may result in damage.
- If battery cells other than those recommended are used, performance and product safety may be adversely affected.

2. FURTHER DOCUMENTATION

Please observe the information and limit values in the [technical data sheet](#).

The sensor-specific factory settings (Sentiface), as well as the keys and permissible values of the sensor can be found in the [NFC and downlink description](#). The Senticom and Sentivisor tables can be found in the [generic NFC and downlink documentation](#). The special functions for [vandalism detection and opening detection](#) are also generic.

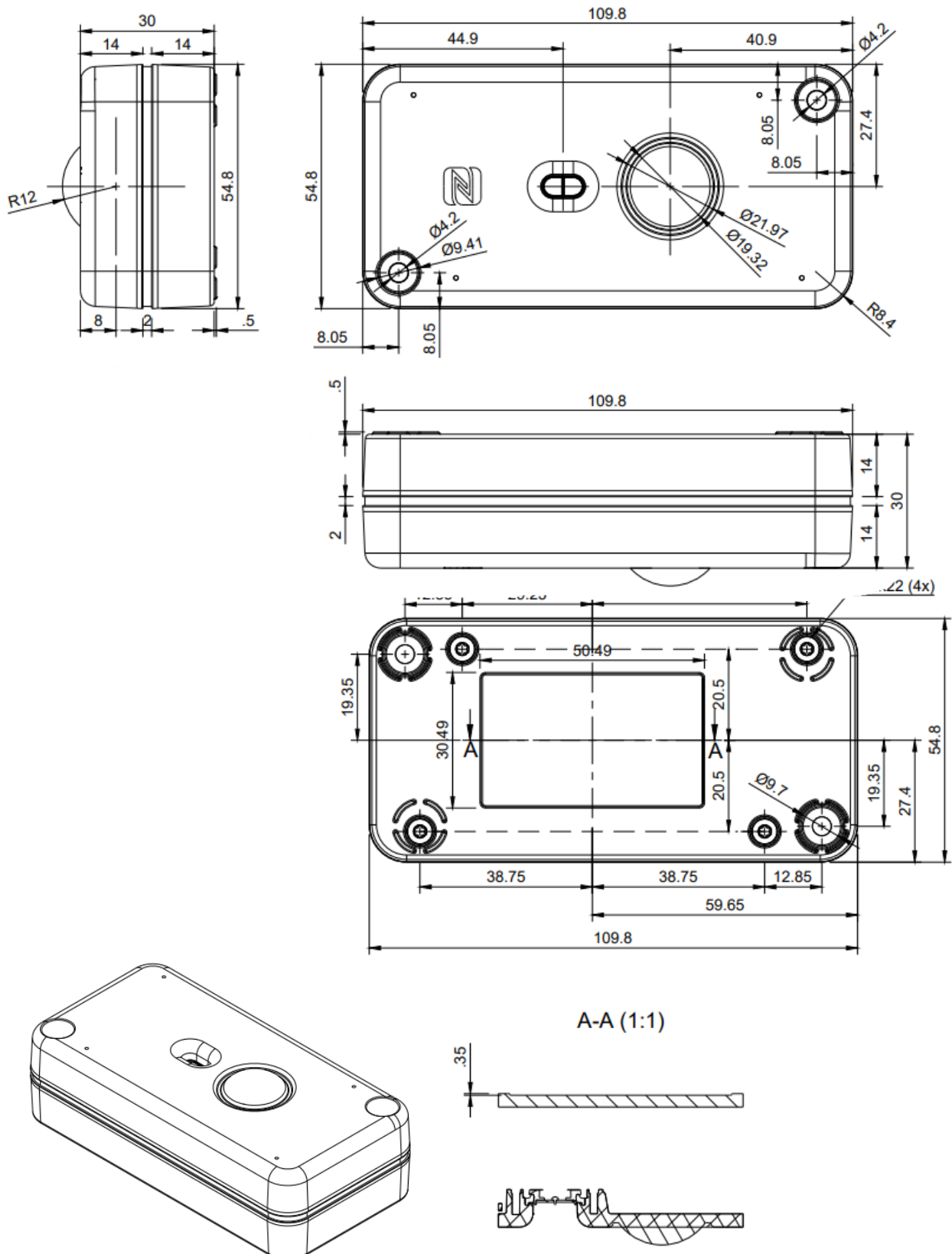
The option to configure sensor communication can be found in the respective generic [LoRaWAN®](#), [Mioty®](#) or [Cellular \(NB-IoT and LTE-M1\)](#) documentation, depending on the version.

All documents for the generic documentation can be found at <https://docs.sentinum.de/wichtig-produktübergreifende-dokumentation-für-sensoren>.

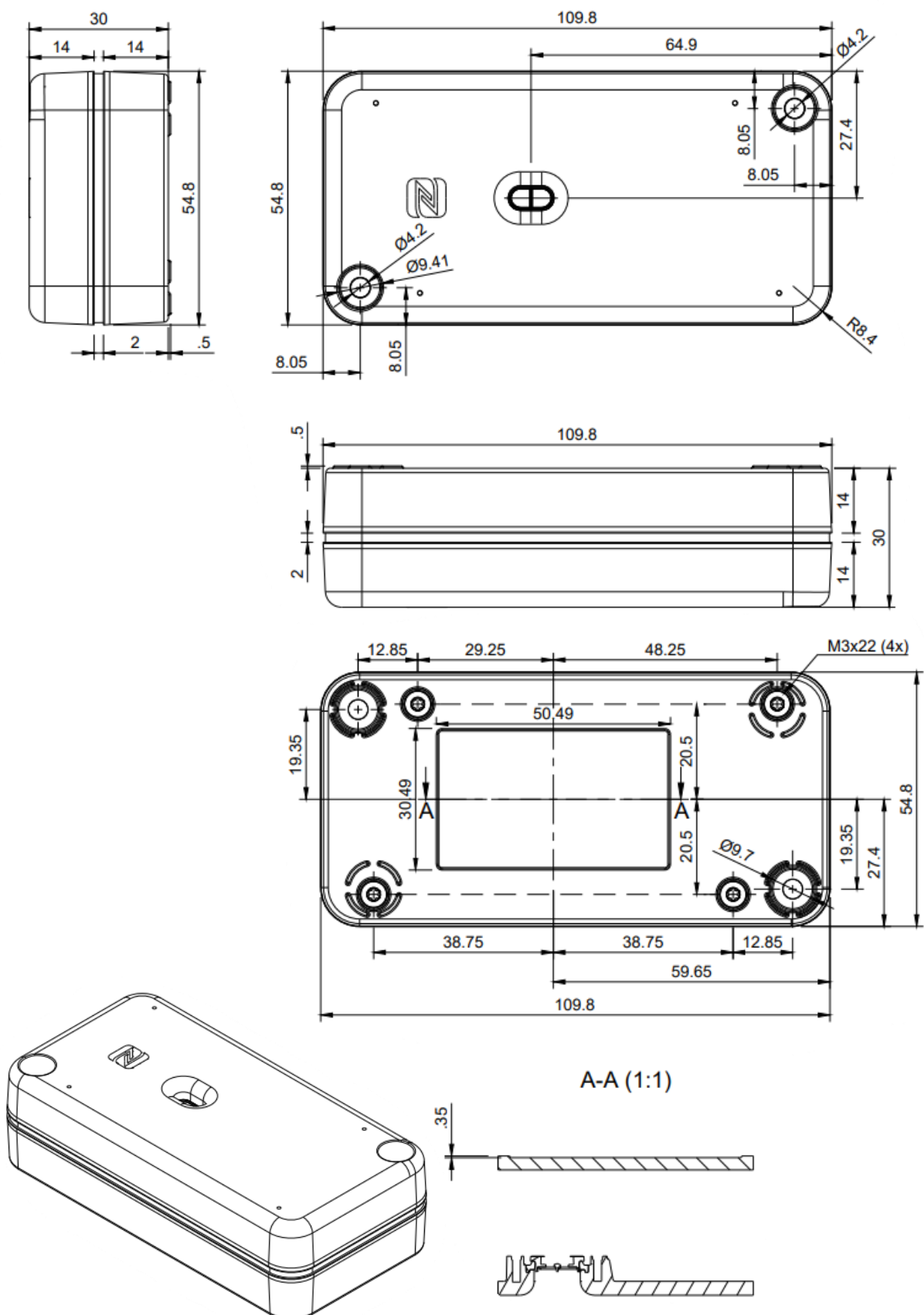
Note: This guide applies only to *-ACC* versions and to Apollon models **without** the *-LIGHT* suffix in the product code.

3. DIMENSIONS AND COMPONENTS OF THE SENSOR

3.1. TECHNICAL DRAWING APOLLON Q R/TR /SW/PP (WITH RADAR)



3.2. TECHNICAL DRAWING APOLLON Q T (WITHOUT RADAR)



4. SCOPE OF DELIVERY AND VERSIONS

4.1. SCOPE OF DELIVERY AND OPTIONAL MOUNTING ACCESSORIES

Art. Item number	Recommended accessories
Z-APOQ-MAG-NEO	Magnet set APOQ ferrite
Z-APOQ-MAG-FER	Magnet set APOQ ferrite
Z-APOQ-RWM-BN	Rear panel mounting set with blind rivets
Z-APOQ-RWM-NM	Rear panel mounting set with M4 rivet nuts
Z-APOQ-VWM-BN	Front wall mounting set with blind rivets
Z-APOQ-VWM-NM	Front panel mounting set with M4 rivet nuts
Z-APOQ-AP	Spacer plate PA
Z-APOQ ADHESIVE	Assembly adhesives
Z-APOQ-SCREWS	Machine screws DIN912 with nuts M4
Z-APOQ-SPX	Wood screws

Drilling templates can be found at the end of the operating instructions

Included in delivery:

- 2x batteries (already inserted)
 - For LoRaWAN® and mioty® sensors
 - Energizer® Ultimate Lithium batteries - AA
 - VARTA ULTRA LITHIUM Mignon AA
 - For cellular sensors (NB-IoT and LTE-CAT-M1)
 - VARTA-CR-AH-R
- Apollon sensor in one of the following versions

4.2. STRUCTURE OF THE PRODUCT VERSIONS

PREFIX-PRODUCT-SERIES-COMMUNICATION-SENSORS-FURTHER-SENSORS

Prefix	Product series	Communication	Sensors	Other sensors
S	APOQ (APOLLON-Q)	mioty	T (ToF)	ACC (Accelometer = acceleration sensor for detecting movements that occur)
	iAPOQ (APOLLON-iQ, on request)	LoEU (LoRaWAN)®	R (radar, fill level)	ACC-HALL (Accelometer = acceleration sensor+ hall = Hall sensor)
		NBM1 (LTE-CAT-M1)	TR (ToF and radar)	
		NB (NB-IoT)	SW (Smart Waste, TR and other software)	
			PP*	

* Not in combination with other sensors!

4.3. EXPLANATION OF THE MEASUREMENT OF THE VARIOUS SENSORS

Designation	Description
LOEU	LoRaWAN EU
MIOTY	mioty EU
NBM1	NB-IoT, LTE-CAT-M1
SW	Optimized radar for smart waste, especially for underfloor containers and heavily polluted areas
T	ToF
R	Radar
TR	Dual measuring principle of ToF and radar
ACC	Acceleration sensor for flap opening and vandalism detection
TR (without SW)	For liquids and good reflectors
SMAV	Small Angle of View 18°

4.4. DIFFERENCES OF THE IQ VERSION

The Apollon iQ versions have extended certifications and security functions for industrial use. These include CRA conformity with integrated secure elements in hardware and software.

The iQ models also offer an extended range of functions and additional configuration options, particularly with regard to measurement and transmission intervals. For example, significantly shorter intervals can be implemented than with the standard series, which enables more precise and dynamic measurement applications. Firmware updates can also be carried out on the iQ versions via FOTA (Firmware Over-the-Air), which makes maintenance in the field considerably easier.

The Apollon iQ series is also visually distinguished by the yellow seals and is particularly suitable for critical and long-term stable industrial applications thanks to comprehensive end-of-line tests and the use of the latest components.

4.5. AVAILABILITY OF THE DIFFERENT VERSIONS

Article code	GNSS	Opening detection	Available	Configuration
S-APOQ-LOEU-T	X	X	✓	NFC
S-APOQ-MIOTY-T	X	X	✓	NFC
S-APOQ-LOEU-T-ACC	✓	✓	✓	NFC/BLE
S-APOQ-LOEU-TR-ACC	✓	✓	✓	NFC/BLE
S-APOQ-LOEU-SW-TR-ACC	✓	✓	✓	NFC/BLE
S-APOQ-MIOTY-T-ACC	X	✓	✓	NFC/BLE
S-APOQ-MIOTY-TR-ACC	X	✓	✓	NFC/BLE
S-APOQ-MIOTY-SW-TR-ACC	X	✓	✓	NFC/BLE
S-APOQ-NBM1-T-ACC	✓	✓	✓	NFC/BLE
S-APOQ- NBM1-TR-ACC	✓	✓	✓	NFC/BLE
S-APOQ- NBM1-SW-TR-ACC	✓	✓	✓	NFC/BLE
S-APOQ-LOEU-R-ACC	✓	✓	✓	NFC/BLE
S-APOQ-MIOTY-R-ACC	X	✓	✓	NFC/BLE
S-APOQ-NBM1-R-ACC	✓	✓	✓	NFC/BLE
S-APOQ-LOEU-T-SMAV	X	X	✓	NFC/BLE
S-APOQ-MIOTY-T-SMAV	X	X	✓	NFC/BLE
S-APOQ-LOEU-T-ACC-SMAV	✓	✓	X	NFC/BLE
S-APOQ-LOEU-TR-ACC-SMAV	✓	✓	X	NFC/BLE
S-APOQ-LOEU-SW-TR-ACC-SMAV	✓	✓	X	NFC/BLE
S-APOQ-MIOTY-T-ACC-SMAV	X	✓	X	NFC/BLE
S-APOQ-MIOTY-TR-ACC-SMAV	X	✓	X	NFC/BLE
S-APOQ-MIOTY-SW-TR-ACC-SMAV	X	✓	X	NFC/BLE
S-APOQ-NBM1-T-ACC-SMAV	✓	✓	X	NFC/BLE
S-APOQ- NBM1-TR-ACC-SMAV	✓	✓	X	NFC/BLE
S-APOQ- NBM1-SW-TR-ACC-SMAV	✓	✓	X	NFC/BLE

* iAPOQ versions on request

Note: This guide applies only to *-ACC* versions and to Apollon models without the *-LIGHT* suffix in the product code.

5. POSITIONING AND LOCALIZATION METHODS OVERVIEW

In general, all LoRaWAN® devices can be located via the LoRaWAN®. This requires gateways with GPS synchronization.

As of Q2 2025, the Apollon-Q and Juno series in the Sentinum product portfolio are equipped with extended tracking functions.

Tracking via BLE function can be activated on request.

Item number	Radio standard	Wi-Fi SSID Scan	GNSS Scan	GNSS	Cell Locate
S-JUNO(-iX)-LOEU-TRACK	LoRaWAN®	✓	✓	X	X
S-JUNO(-iX)-LOEU-TH-TRACK	LoRaWAN®	✓	✓	X	X
S-JUNO(-iX)-NBM1-TRACK-2	Cellular	✓	X	✓	✓
S-JUNO(-iX)-NBM1-TRACK-3	Cellular	✓	X	✓	✓
S-JUNO(-iX)-NBM1-TH-TRACK-2	Cellular	✓	X	✓	✓
S-JUNO(-iX)-NBM1-TH-TRACK-3	Cellular	✓	X	✓	✓
S-JUNO(-iX)-MIOTY-TRACK	mioty®	✓	X	✓	X
S-JUNO(-iX)-MIOTY-TH-TRACK	mioty®	✓	X	✓	X
S-(i)APOQ-LOEU-T-ACC	LoRaWAN®	✓	✓	X	X
S-(i)APOQ-LOEU-TR-ACC	LoRaWAN®	✓	✓	X	X
S-(i)APOQ-NBM1-T-ACC	Cellular	✓	X	✓	✓
S-(i)APOQ-NBM1-TR-ACC	Cellular	✓	X	✓	✓

In the case of cellular sensors, TRACK 2 versions differ from TRACK 3 versions in the number of battery cells to be used; the number 2 or 3 describes these. In addition, SIM cards can be used if only two cells are used.

5.1. COMPARISON OF DIFFERENT TECHNOLOGIES

Technology	Range under good conditions (m)*	Range under poor conditions (m)	Power consumption	Suitability for indoor tracking	Costs
BLE scanning (not implemented, on request)	1 - 3	5 - 10	Low	High	Medium
Wi-Fi SSID scanning	1 - 5	5 - 20	Low	High	Medium
GNSS (GPS, Glonass, BeiDou, Galileo)	3 - 5	5 - 10	High	Not suitable	High
Mobile radio localization via triangulation or radio cells	10 - 150	150 to several kilometers	Low	Low	Low
GNSS scan	1 - 10	10 - 200	Low	Not suitable	Medium
UWB	<0,1 - 0,3	0,3 - 0,5	Low	Very high	Medium
Tracking via the LoRaWAN***	200 - 500	500 - 1500	None	Practically not suitable	Low

*Good conditions: Few shadowing effects, direct connections to satellites or gateways, very good antennas

**Poor conditions: Large shadowing effects such as trees, buildings or walls, poor connection quality

***Dependent on the number of gateways and gateway equipment

5.2. INTELLIGENT USE OF DIFFERENT TRACKING TECHNOLOGIES FOR ENERGY OPTIMIZATION

We combine various tracking technologies for precise and energy-efficient location determination: Wi-Fi SSID Scan, GNSS, GNSS Scan and Cell Locate. Each of these technologies has specific strengths that we use flexibly and depending on the situation.

- Wi-Fi SSID Scan detects Wi-Fi networks available in the vicinity and determines a position based on known SSID locations. This method is extremely energy-efficient and enables fast location updates - ideal in urban areas with dense Wi-Fi coverage.
- GNSS (Global Navigation Satellite System, e.g. GPS) offers very precise positioning, but is very energy-intensive in comparison. GNSS is therefore only activated when other methods do not provide sufficiently accurate data.
- With GNSS Scan, satellite data is only collected and the position calculation is optimized without permanently maintaining an active GNSS session. This also saves considerable energy compared to permanent GNSS use.

- Cell Locate enables positioning based on mobile radio cells. This method is available globally and provides a rough but continuous location determination even if there is no WLAN or GNSS signal.

Intelligent control and prioritization - such as the preferred use of Wi-Fi scans - can significantly reduce the device's energy consumption. Only when Wi-Fi or cell positioning is not sufficient does the device automatically switch to GNSS or other more precise methods.

All tracking strategies and fallback mechanisms are individually configurable so that the best balance between energy efficiency, accuracy and availability can be selected for different applications and regions.

Even if individual technologies vary depending on the environment, this flexible combination enables virtually seamless and detailed route recording worldwide.

We also offer suitable solutions for indoor scenarios where GNSS signals are often unavailable or inaccurate. The Wi-Fi SSID scan and the use of known indoor access points make it possible to reliably determine the position even inside buildings. Optionally, indoor positioning can be supplemented by additional technologies such as Bluetooth Low Energy (BLE) beacons or inertial sensors.

This enables precise location determination even in complex environments such as shopping centers, airports or industrial halls - seamlessly integrated into the existing tracking concept.

5.3. WHICH SENSORS USE WI-FI SSID SCAN?

In the Sentinum product portfolio, parts of the Juno and Apollon-Q series are equipped with a Wi-Fi SSID scan function. The Cellular and mioty® products are equipped with a 2.4 GHz and 5 GHz Wi-Fi SSID scan for the evaluation of up to 20 MAC addresses, the LoRaWAN® products with a 2.4 GHz Wi-Fi SSID scan for up to six addresses:

Article number	Radio standard	2.4 GHz scan	5 GHz scan	Maximum number of MAC addresses
S-JUNO(-iX)-LOEU-TRACK	LoRaWAN®	✓	X	6
S-JUNO(-iX)-LOEU-TH-TRACK	LoRaWAN®	✓	X	6
S-JUNO(-iX)-NBM1-TRACK-2	Cellular	✓	✓	20
S-JUNO(-iX)-NBM1-TRACK-3	Cellular	✓	✓	20
S-JUNO(-iX)-NBM1-TH-TRACK-2	Cellular	✓	✓	20
S-JUNO(-iX)-NBM1-TH-TRACK-3	Cellular	✓	✓	20
S-JUNO(-iX)-MIOTY-TRACK	mioty®	✓	✓	20
S-JUNO(-iX)-MIOTY-TH-TRACK	mioty®	✓	✓	20
S-(i)APOQ-LOEU-T-ACC	LoRaWAN®	✓	X	6
S-(i)APOQ-LOEU-TR-ACC	LoRaWAN®	✓	X	6
S-(i)APOQ-NBM1-T-ACC	Cellular	✓	✓	20
S-(i)APOQ-NBM1-TR-ACC	Cellular	✓	✓	20

5.4. HOW DOES WI-FI SSID SCANNING WORK ?

Wi-Fi SSID Scan-based localization uses the detection of Wi-Fi networks in the environment to determine the location of a device. It uses the signal strength (RSSI) of the Wi-Fi signals to estimate the distance to the various access points (APs). This technique is often used indoors where GPS signals may be unavailable or inaccurate.

Essentially, the localization process works as follows:

1. Activation of the SSID scan: The device begins a passive Wi-Fi scan, listening for any beacon frames being broadcast by access points (APs) in the area. These beacon frames contain the SSID (the name of the network), the BSSID (the MAC address of the AP) and the signal strength of the received signal (RSSI).
2. Measuring the signal strength: The RSSI (Received Signal Strength Indicator) is measured for each signal received. This signal strength indicates how strongly the signal from the access point is received by the device. A higher RSSI usually means that the device is closer to the corresponding access point.
3. Comparison with known positions: To determine the position of the device, the measured RSSI values are used in combination with the known positions of the access points. This is done using methods such as triangulation or trilateration, in which the distances to at least three or more access points are calculated. Using these calculations, the device can determine its position on a map or in a room.
4. Positioning: The data collected from the access points is analyzed to determine the most likely position of the device. This is done taking into account the signal strength and the known positions of the access points. Modern algorithms can also further refine the localization by taking into account additional factors such as environmental conditions or the movements of the device.
5. Displaying the position: Once the device has determined the position, this is displayed to the user on a map or in a corresponding user interface . If required, the accuracy of the position can also be updated in real time, based on further SSID scans and changing signal strengths.

5.5. ADVANTAGES AND APPLICATIONS OF WI-FI-BASED LOCALIZATION:

- High accuracy indoors: As GPS signals are often weak or non-existent indoors, Wi-Fi scanning offers an excellent alternative to indoor positioning.
- Easy to implement: As many buildings are already equipped with Wi-Fi networks, localization via Wi-Fi can be implemented with minimal additional effort.
- Cost-effective: Wi-Fi-based localization requires no additional hardware investment if Wi-Fi access points are already in place.

This localization approach is particularly advantageous in indoor navigation systems, asset tracking or fleet management, as it enables precise positioning even without the use of expensive GPS systems.

Positioning technology based on Wi-Fi SSID scanning is used in a variety of applications where rough to medium positioning accuracy is required and existing Wi-Fi infrastructure can be used. A device records the names (SSIDs) and signal strengths (RSSI) of the surrounding Wi-Fi networks without connecting to them. This information can be used to estimate where the device is located - either by comparing it with an existing Wi-Fi

database (e.g. from Google or Apple), by prior fingerprinting or with the help of a self-built Wi-Fi mapping model.

This technology is used, for example, for indoor localization in buildings, such as shopping malls, airports or large office complexes, where GPS signals are only available to a limited extent or not at all. Wi-Fi scanning is also used in logistics and asset tracking to track the location of devices or goods within warehouses or on company premises - often in combination with other technologies such as BLE or LoRaWAN. In smartphones and wearables, the method is used to enable location-based services such as map navigation, geofencing or location sharing, even when no mobile connection is available.

Another typical use case is assisted positioning for battery-powered IoT devices where GNSS would be too energy-intensive. Here, Wi-Fi Scan can help to determine a sufficiently accurate position without putting a heavy strain on the battery. Due to the wide availability of Wi-Fi networks and the ability to estimate a position even without an active network connection, Wi-Fi SSID scanning is a flexible, cost-effective and energy-saving alternative or supplement to classic GNSS or cellular positioning systems.

5.6. DEPENDENCE ON ACCURACY

The accuracy of Wi-Fi SSID scanning localization depends on several factors and can vary greatly depending on the environment and system architecture. In general, the accuracy of position-based localization using Wi-Fi is typically between 1 and 20 meters. Exact positioning depends on various parameters that are both technical and environmental in nature.

A key influencing factor is the signal strength, also known as RSSI (Received Signal Strength Indicator). This is used to estimate the distance between the device and an access point. However, the relationship between signal strength and distance is not linear and can be significantly distorted by walls, furniture, other devices or structural conditions. In open spaces with few obstacles, the accuracy can be around 1 to 5 meters, while in more complex environments such as residential or office buildings with many obstacles, it tends to fluctuate between 5 and 20 meters.

The number and distribution of available access points also plays a decisive role. The more access points with a known and stable position are available, the more precise the positioning can be. If the device receives signals from at least three well-distributed access points, more precise positioning is possible through triangulation or trilateration. If, on the other hand, only one or two access points are available or if they are unfavorably distributed, the accuracy decreases accordingly.

The environment also has a significant influence on localization accuracy. Wi-Fi signals can be reflected, absorbed or scattered - depending on the material and arrangement of walls, furniture or other objects in the room. Nearby electronic devices can also cause interference. In a densely built-up office building with many steel beams, partition walls and other obstacles, for example, the positioning accuracy can be between 5 and 15 meters, while in an open storage room or corridor it can be between 1 and 3 meters.

In addition to the hardware, the software also plays an important role: the quality of the positioning algorithms used can significantly improve accuracy. Methods based on machine learning or calibration data, for example, can take better account of environmental influences and help to interpret and smooth the measured RSSI values. This increases the reliability of the position information, especially in more complex environments.

Another aspect is the visibility of the networks. Hidden SSIDs, i.e. WLANs that do not broadcast their network name, as well as interference from neighboring networks or other devices, can also reduce positioning accuracy. In such cases, the device has less usable information at its disposal, which can lead to less accurate positioning.

Overall, Wi-Fi scanning is a flexible and, in many cases, sufficiently accurate method for determining position - especially when other positioning technologies such as GPS are not available or are too energy-intensive. However, the accuracy that can be achieved always depends on the interplay of various factors.

5.7. THIS IS WHY POSITIONING VIA WI-FI SSID MAKES SENSE FOR APOLLON

The Juno with Wi-Fi SSID Scanning is particularly suitable for positioning applications where GNSS signals are weak or unavailable, such as indoors or in urban environments. By combining Wi-Fi scanning with GNSS and cell-based positioning technologies, more precise location data can be achieved.

- Wi-Fi Scanning: Supports both active and passive scanning of 2.4 GHz and 5 GHz Wi-Fi networks.
- Energy efficiency: Optimized for low power consumption applications, ideal for battery-powered devices.
- High security with WPA3 support
- Very good indoor detection performance
- Many existing networks
- Can significantly extend service life as it is much more energy efficient than conventional GNSS

Apollon Cellular can evaluate up to 20 different access points and thus provide very precise localization. The accuracy varies depending on the application. Accuracies of 3 to 20 meters are realistic.

5.8. HOW GNSS SCAN WORKS

The GNSS Scan functionality makes it possible to determine position data via various GNSS systems such as GPS, Galileo, GLONASS or BeiDou. The position is determined by an integrated GNSS receiver, which continuously scans for visible satellites and calculates the position of the device based on the signals received. As soon as the position has been determined, the corresponding data is transmitted to a central station or cloud platform. This enables precise localization, even in remote areas, with low energy consumption, as the GNSS receiver is only activated when needed.

The accuracy of the GNSS scan function in LoRa modules depends on various factors. Typical GNSS positioning accuracies are between 2.5 and 10 meters, depending on the system used, when standard GPS is used. When multiple GNSS systems such as GPS, Galileo, GLONASS and BeiDou are combined, accuracy can be improved to 1 to 3 meters. However, in difficult environments, such as in urban mountain canyons or when the signal is heavily shadowed, the accuracy can increase to 10 to 50 meters or more.

- Signal reception: The GNSS receiver (e.g. in the smartphone) receives radio signals from at least four GNSS satellites (e.g. GPS, Galileo, GLONASS).
- Time of flight measurement: Each signal contains a time stamp. The receiver measures how long it took for the signal to travel from the satellite to earth (transit time).
- Distance estimation: The distance to each satellite is calculated from the signal transit time (distance = speed of light × transit time).
- Position calculation (trilateration): Using the distances to at least four satellites, the receiver can calculate its own location (longitude, latitude, altitude) and the exact time by calculating the intersection points of the spheres around the satellites.

- Corrections: Errors due to the atmosphere, satellite orbits or clocks are partially corrected by algorithms or additional systems (such as DGPS or SBAS).

5.9. GNSS SCAN AND LORA® CLOUD

LoRaWAN® devices such as the Juno Tracker or the Apollon-Q are based on the LoRa® Edge LR1110 chipset and send the GNSS scan information to port 192, WIFI SSID SCAN information to Port 197. The data is sent to databases such as the LoRa® Cloud, where the latitude and longitude coordinates are calculated. The coordinates are then returned to the network server via standardized interfaces.

Sentinum offers such a service. You can simply send the data to our servers and we will do the rest for you. Just ask us.

If you want your own integration, the following links will help you:

Connecting TTI to the LoRa Cloud: [LoRa Cloud | The Things Stack for LoRaWAN®](#)

Connecting Chirpstack with the LoRa Cloud: [LoRa Cloud - ChirpStack open-source LoRaWAN® Network Server documentation](#)

LoRa Cloud Homepage: [Semtech LoRa Cloud](#)

Example of the TTI integration:

To connect The Things Stack (TTI) - i.e. the LoRaWAN® platform from The Things Industries - to the Semtech LoRa Cloud, you need to set up an integration so that data, e.g. GNSS scans, are correctly transmitted to the LoRa® Cloud and processed. The LoRa® Cloud takes over tasks such as geolocalization, GNSS conversion, Wi-Fi positioning or modem services.

Requirements:

- An active account with The Things Stack (TTI).
- A registered LoRaWAN device (e.g. a tracker with GNSS).
- API access to Semtech LoRa Cloud Services (via Dev Portal: <https://lora-developers.semtech.com>).
- LoRa Cloud Token (API Key) - you can get this in the LoRa Cloud Portal.

1. activate Semtech LoRa Cloud

- Go to <https://lora-developers.semtech.com>.
- Create an account or log in.
- Under LoRa Cloud→Modem Services you will find your token (API key), which you must enter later in TTI.

2. set up integration in The Things Stack

- Log in to The Things Stack Console (e.g. <https://eu1.cloud.thethingsindustries/>).
- Open your device that you want to connect.
- Go to Integrations→Webhooks.
- Click on Add Webhook and select Semtech LoRa Cloud as the template.

3. configure webhook

- Fill out the form:
 - Base URL: Is automatically suggested by TTI.
 - Token: Enter your API key from the LoRa Cloud here.
 - Activate the desired services, e.g:
 - Modem Services (for GNSS and Wi-Fi scans).
 - Geolocation (for TDOA/RSSI).
 - You can also have GNSS or Wi-Fi data sent, depending on the device type.

4. customize payload formats (if necessary)

- Make sure that your end device uses the expected payload structure for Semtech LoRa Cloud Services (e.g. the format provided by Semtech's LoRa Basics Modem).

5. check data

- As soon as your device sends position data (e.g. GNSS raw data), it is forwarded to the LoRa Cloud via TTI.
- The response from the LoRa Cloud is then sent back to your end device or application via TTI.

Test & monitoring:

- Use the Live Data view in TTI to see if data is being transmitted.
- In the Semtech Cloud, you can see whether requests are arriving and being processed.
- Check the response packets with the geodata (latitude, longitude) and position accuracy.

Note:

This integration works particularly well with devices based on Semtech's LoRa Basics Modem-E architecture (e.g. with LoRa Edge™ chips such as LR1110), but custom formats are also possible as long as the API requests are compatible.

5.10. GPS FUNCTIONALITY

GPS (Global Positioning System) is a satellite-based navigation system that makes it possible to determine the exact position on earth. It consists of at least 24 satellites orbiting the earth at an altitude of around 20,000 kilometers. These satellites continuously send out signals containing information about their current position and the exact time at which the signal was sent. Each satellite is equipped with an atomic clock that is extremely precise.

A GPS receiver, which is installed in devices such as smartphones, navigation systems or other GPS-enabled devices, receives these signals. To determine its own position, the receiver needs signals from at least four satellites. As soon as the signals are received, the receiver measures the time it took for the signal to travel from the satellite to the receiver. As the light travels at a constant speed, the receiver can calculate the distance to each satellite.

With the distances to at least three satellites, the receiver can determine the position on the earth's surface using triangulation. A fourth satellite helps to calculate the altitude (the Z-coordinate) and correct any errors. The accuracy of the GPS position depends on the number of satellites received and the quality of the signal. The accuracy is best in open areas without obstacles such as tall buildings or trees. In urban mountain canyons or in bad weather, signal interference can affect the accuracy.

To further improve accuracy, differential GPS (DGPS) is used in many cases. Stations are installed at fixed, known points on the earth which send correction data to the mobile GPS receivers in order to increase the accuracy to a few centimetres.

In addition to the American GPS system, there are also other global navigation satellite systems (GNSS) such as GLONASS (Russia), Galileo (Europe) and BeiDou (China), which are often used in conjunction with GPS to improve the accuracy and availability of positioning.

5.11. ULTRAWIDEBAND

Ultra-wideband (UWB) is a modern radio technology for high-precision positioning, which is used particularly indoors. Positioning is achieved by transmitting extremely short and broadband radio signals in the frequency range from around 3.1 to 10.6 GHz. These signals have a very high time resolution, which means that the transit time of the signal - i.e. the time it takes to travel from a transmitter to a receiver - can be measured extremely accurately. Based on this time measurement, the distance between two devices can be calculated with an accuracy of typically 10 to 30 centimeters, in some cases even less than 10 centimeters.

UWB positioning works using two main methods: two-way ranging (TWR) and time difference of arrival (TDoA). In two-way ranging, a mobile device (also known as a tag) sends a radio signal to a permanently installed receiver (anchor). This responds and the tag measures the time required for the outward and return journey. The distance can be calculated from this time, taking into account the constant propagation speed of the radio waves. The TDoA method works slightly differently: here the tag only transmits a signal that is received by several anchors simultaneously. The minimum time difference with which the signal arrives at the different receivers is used for triangulated calculation of the position. This method enables particularly energy-efficient applications, as the tag does not have to actively respond and the computing work is carried out on the server side.

A typical UWB positioning system consists of several permanently installed anchors with known positions and mobile tags that are attached to objects, people or vehicles. The position is calculated by a central positioning software that continuously processes the signals. UWB is characterized not only by its high accuracy, but also by its low latency, which makes it ideal for real-time applications - for example in industrial production, in logistics centers or for access control in buildings. Even in complex environments with a lot of metal or other radio sources, UWB remains very reliable due to its high robustness against interference. The typical range indoors is between 30 and 100 meters, depending on the antenna configuration and the structural conditions. This makes UWB an extremely powerful solution for precise, secure and energy-efficient indoor tracking.

5.12. TRACKING IN THE LORAWAN®

Tracking in the LoRaWAN® network works by end devices (so-called nodes) transmitting radio signals that are received by several LoRaWAN® gateways. The exact position of the device is not determined directly by the device itself, but by evaluating the signals received in the network or in a special positioning platform (e.g. the Semtech LoRa® Cloud). There are various methods for determining position, which can be combined depending on the application and infrastructure.

A frequently used approach is the so-called TDOA method (Time Difference of Arrival). Here, the network measures the time difference with which a radio signal from a LoRaWAN® device arrives at various gateways. As radio signals propagate at the speed of light, these minimal time differences can be used to derive distance differences to the gateways. If at least three gateways receive the same signal, the position of the device can be calculated by triangulation. This calculation is performed centrally in the LoRaWAN® network server or in a connected cloud solution. The accuracy of TDOA is usually in the range of around 200 to 1000 meters, depending on gateway density, synchronization and environmental conditions.

The TDOA (Time Difference of Arrival) method in the LoRaWAN® network works on a principle similar to triangulation, or more precisely, it is a variant of multilateration. The position of a device is not calculated directly from the signal strengths (as with the RSSI method), but from the time differences of a radio signal at several gateways.

When a LoRaWAN® end device (node) sends a message, this signal is received simultaneously (or almost simultaneously) by several gateways within range. Each of these gateways notes with extremely high time resolution exactly when the signal arrived. As the radio signal propagates at the speed of light, even differences in the nanosecond range make a measurable difference to the calculated distance.

By calculating the time differences with which the signal arrives at the various gateways, the system can calculate circles (or hyperbolas) with possible positions of the device. The more gateways receive the signal, the more accurately the intersection of these hyperbolas can be determined - i.e. the actual position of the device. This method requires at least three synchronized gateways to calculate a two-dimensional position (latitude/longitude).

Are special gateways required?

A special type of gateway is required for tracking in the LoRaWAN® via TDOA: These must be GPS-synchronized or have another precise time synchronization (e.g. PTP - Precision Time Protocol) so that the time stamps for receiving the signal are exact and comparable.

Standard LoRaWAN® gateways without time synchronization cannot provide reliable TDOA data, as even the smallest deviations in time recording would lead to large errors in position determination.

Accuracy

The accuracy of TDOA depends heavily on the density and distribution of the gateways, the quality of the time synchronization and the environment (e.g. reflections). Typically, it is

in the range of 200 to 1000 meters, in ideal conditions even better. In urban environments, it can be affected by multipath effects (reflections).

TDOA for indoor tracking:

Indoor tracking using the TDOA method in the LoRaWAN® network is theoretically possible, but is severely limited in practice and is usually not recommended when it comes to precise tracking inside buildings. Here are the reasons in detail:

Why TDOA is problematic for indoor applications:

1. Radio wave distortion due to obstacles
Walls, ceilings, furniture and other objects cause strong attenuation, scattering and reflections of radio signals. This changes the effective propagation time of the signal, which leads to massive accuracy errors in a method based on time differences such as TDOA.
2. Multipath propagation
Radio signals not only reach the gateways directly, but often also via reflections. These signals arrive with a minimal delay and distort the time measurement, making the position calculation inaccurate.
3. Difficult gateway placement
For meaningful TDOA tracking, there must be at least three gateways with a clear line of sight to the device - this is difficult to achieve in buildings. Even large buildings are often only covered by one gateway, which does not allow TDOA positioning.
4. Synchronization suffers from poor GPS reception
GPS synchronization of gateways is often not possible or unreliable indoors, which ruins the basis for TDOA. Without accurate time synchronization, the entire method does not work.

When TDOA works to a *limited extent* indoors:

- In very large halls, airport terminals or open logistics areas with good gateway coverage.
- When additional error correction technologies are used (e.g. algorithms that recognize multipath effects).
- In combination with other localization technologies such as Bluetooth, UWB or Wi-Fi to compensate for failures or inaccuracies.

5.13. TRACKING VIA THE "CELL LOCATE" MOBILE NETWORK

Cell locate works by a mobile device communicating with the mobile network via its radio signal, and the network then calculates the approximate location based on various parameters. Here is an overview of the most important methods:

Method	Typical accuracy	Remark
Cell ID	100 m - several km	Very coarse; depends on cell size (city vs. country)
Enhanced Cell-ID	50 - 500 m	Better due to timing information, but depends on the network

TDOA (Time Difference of Arrival)	50 - 150 m	Requires several synchronized stations
AOA (Angle of Arrival)	100 - 200 m	Less common, requires special antennas

The accuracy of positioning via mobile radio depends heavily on the method used, the network coverage and the environment. The power consumption is very low compared to other technologies.

5.14. EDRX: ON THE WAY TO THE INTERROGABLE TRACKER

The eDRX function is only available for mobile devices!

The dream of a tracker that is constantly listening and can be actively interrogated is becoming a reality. The eDRX function helps to make this a reality.

eDRX (Extended Discontinuous Reception) allows a **mobile device** to switch to an energy-saving "sleep mode" after a data transmission, in which it does not constantly communicate with the mobile network. Normally, mobile devices have to check at short intervals whether the network has new messages for them (e.g. incoming commands or updates). These frequent checks cost energy, even if there is no new data.

With eDRX, these check intervals are significantly extended: a sensor can be set to listen for new network messages only every minute or even hour. During idle times, the device's receiver largely switches off, which drastically reduces energy consumption. As soon as the set eDRX phase ends, the sensor "wakes up", listens briefly for new messages and can then go back to sleep if nothing important has been received. The location of the device can be queried by sending a message from the network to the sensor.

The device remains registered with the network - it is not completely offline - but only reduces its active readiness to receive messages. This is ideal for applications where the device mainly sends data itself (e.g. location, sensor readings) and only rarely needs to be accessible.

eDRX cycles can last from seconds to hours (depending on the network operator and the application). The higher the eDRX frequency, the higher the quiescent current consumption of the device. It is therefore crucial to carefully define the required polling frequencies and always set these in relation to the intended service life of the device.

6. MOUNTING AND INSTALLATION

6.1. WARNING AND SAFETY INSTRUCTIONS FOR MOUNTING

If the sensor is easily accessible after installation, install the sensor first and activate it after installation!

If the sensor is no longer accessible after installation, activate the sensor first and install it after activation!

Before using this type of installation, make sure that the surface on which the sensor is to be screwed is flat, otherwise the housing may be damaged.

Please note:

- Do not insert any objects or body parts into the sensor openings.
- Do not mount the sensor on the ceiling or floor.
- Do not install the sensor at heights of more than two meters.
- Only mount the sensor indoors on a wall in a standard room at a height of 1.50 m to 1.80 m.

The standard versions of the Apollon sensor are designed for a wide range of industrial and logistical applications and have robust housings with a high degree of protection. The following points must be observed during installation:

- Select a mounting location that is within the specified ambient temperatures and conditions (see technical data).
- Do not cover the housing: Radio communication (e.g. LoRaWAN, BLE) must not be obstructed by metallic objects, sealed housings or structure-shielding materials.

Ideally, mount the sensor with a clear line of sight to the sky. This will ensure smooth operation of the radio interfaces.

- Mount the sensor securely, ideally using the mounting holes provided. Low-vibration or solid surfaces are recommended.
- Alignment: The standard version does not require any special alignment and can therefore be mounted flat, vertically or horizontally - depending on the application.
- Do not mount in the immediate vicinity of strong electromagnetic sources to avoid signal interference.

Permanent magnets can generate strong magnetic fields, which can be dangerous if handled incorrectly. Therefore, observe the following warnings:

- Protect hands and fingers: Strong magnets can attract abruptly and pinch fingers or skin. This can lead to painful crushing and injuries. Always keep sufficient distance when handling permanent magnets and wear protective gloves if necessary.

- Keep electronic devices away: Magnetic fields can damage electronic devices such as computers, smartphones, credit cards, pacemakers and other sensitive electronics or impair their function. Therefore, always keep a sufficient distance from such devices.
- Be aware of the risk of breakage: Many permanent magnets are made of brittle materials (e.g. neodymium), which can break in the event of sudden impacts or high loads. The splinters can be sharp and cause injuries. Therefore, use the magnets carefully and avoid impacts or excessive loads.
- Health risks: People with pacemakers or other implanted medical devices should avoid contact with strong magnets, as the magnetic fields may interfere with or disable these devices. If necessary, consult a doctor before use.
- Store magnets safely: Keep magnets at a safe distance from each other and from other metallic objects. Sudden attraction can lead to damage, injuries or uncontrollable flying around of the objects.
- Danger for children: Permanent magnets are not toys! Small magnets in particular can be life-threatening if swallowed or inhaled and can cause serious internal injuries. Therefore, always keep magnets out of the reach of children.
- Avoid heating: Permanent magnets permanently lose their magnetic force at temperatures above their maximum operating temperature (between 80 and 200 °C, depending on the material). Therefore, do not expose magnets to direct heat or open flames.

6.2. RECOMMENDED MOUNTING METHODS

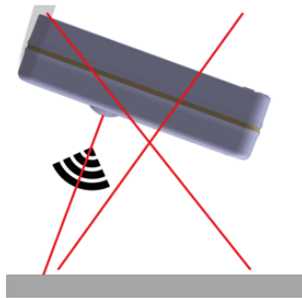
Mounting method	Mounting description	Recommended accessories
Screw connection	2 M4 or M5 screws	2x suitable countersunk head screw, wood screw 4mm - 5mm if necessary
Magnets	2 neodymium pot magnets M4, internal thread	2x neodymium magnets (indoor) together 16-32 kg load capacity
Gluing	Double-sided adhesive tape or mounting adhesive	Double-sided adhesive tape or mounting adhesive

6.3. MOUNTING ACCESSORIES

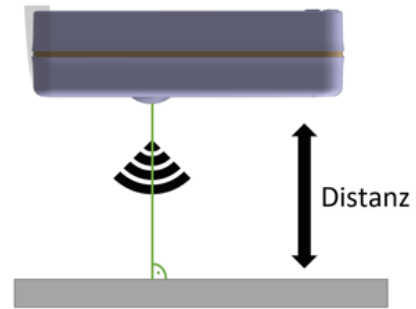
Mounting method	Recommended accessories
Screw connection	DIN912 machine screws with M4 nuts or wood screws
Magnets	2 neodymium pot magnets, adhesive force 16 - 32 kg incl. 2 screws
Gluing	Double-sided adhesive tape
Rivets	For rear wall mounting with M4 rivet nuts or front wall mounting with blind rivets
Spacer plate	Dimensions see technical drawing
Drilling templates	see end of operating instructions

6.4. GENERAL INSTALLATION INSTRUCTIONS

The sensor measures the distance to the object optimally when it is aligned parallel to it. In the case of lumpy or pourable material, the sensor should be mounted parallel to the bottom of the container. Ideally, the sensor beam hits the object to be measured at an angle of 90°.



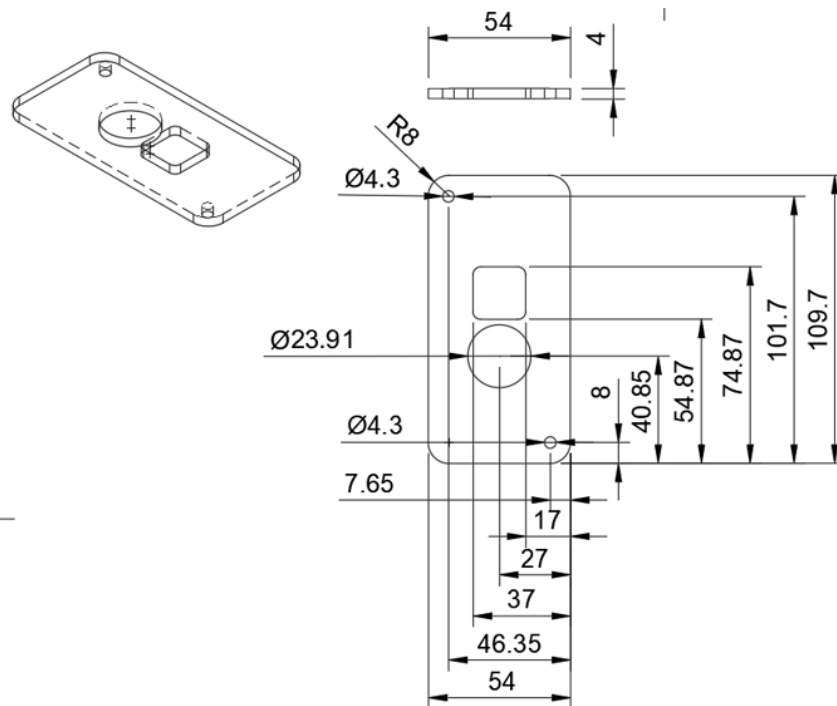
If the sensor is not mounted parallel to the object to be measured, the measuring performance may be impaired. If the sensor is not aligned horizontally, make sure that the percentage calculation of the fill level is adjusted.



6.5. IMPORTANT NOTE FOR DEVICES WITH AN EXTERNAL ANTENNA

If you have ordered a device with an external antenna, which can be recognized by the gold RP-SMA connector, first install the antenna included in the scope of delivery. The sensor should be mounted with the long side on a container. This means that the long side of the sensor and the long side of the container should run parallel. Make sure that the sensor has as free a field of view as possible. The opening angle can be described with a cone of 40°.

Spacer plate: The spacer plate can also be used for front or rear wall mounting. The spacer plate ensures that a flat installation is possible and guarantees the minimum distance between the sensor and the container. In this way, the antenna performance is not impaired. If necessary, the spacer plate can also be used for rear wall mounting.



External antenna: Please note that the antenna should always be mounted vertically and that the tip should point to the sky if the application allows it. The antenna should be at least 2 cm away from metal surfaces. Ensure that the antenna is not shielded by surrounding metal parts, if the application allows this. Internal antenna: If your device has an internal antenna (no external antenna visible), the sensor should always be mounted with the long side vertical, as this allows the maximum signal strength of the device to be achieved. The antenna is located on the top (logo side) of the housing and should be at least 2 cm away from metal surfaces. Ensure that the antenna is not shielded by surrounding metal parts, as far as the application allows.

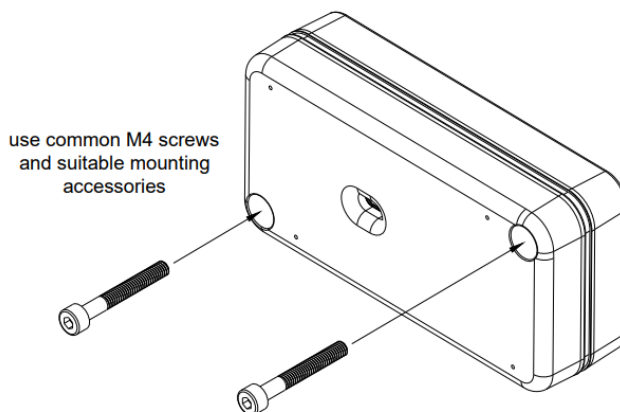
Please note: If you receive a device with an external antenna, never operate the device without an external antenna! This can lead to irreparable damage to the sensor.

6.6. WALL MOUNTING WITH SCREWS

A drilling template can be found at the end of the operating instructions. This type of mounting is generally used to mount the sensor in a container. Insert the appropriate screws into the holes provided on the front. Alternatively, suitable wood or plastic screws can also be used if the sensor is to be attached to the respective materials. Use the two-point bracket supplied for this purpose.

If the sensor is not mounted parallel to the object to be measured, the measuring accuracy may be impaired. If the sensor is not aligned horizontally, the calculation of the level must be adjusted accordingly.

If the sensor is installed on the front wall, a spacer plate should always be used to ensure the necessary distance between the antenna and the wall.



6.7. WALL MOUNTING WITH MAGNETS

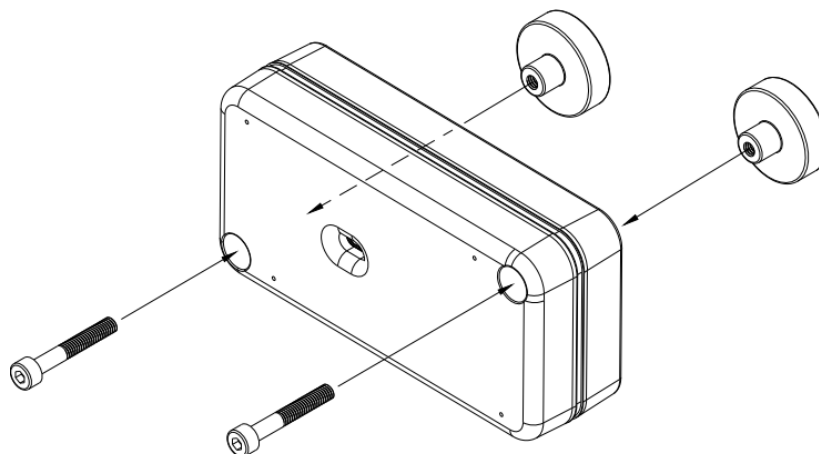
A drilling template can be found at the end of the operating instructions. The magnets shown below are neodymium magnets. Other versions may vary. Although NEODYM magnets offer a higher force per surface area, they are only suitable for outdoor use to a limited extent. Please contact us for advice if required.

Insert the appropriate magnets into the holes provided on the back of the sensor. The magnets shown here are NEODYM magnets. Alternatively, you can carry out this step in the same way for FERRIT magnets.

Insert the screws into the holes on the opposite side and tighten the magnets by screwing them in.

Optional: Pull an anti-slip cover over the magnets. The anti-slip cover prevents the magnet from slipping when the object vibrates or changes position.

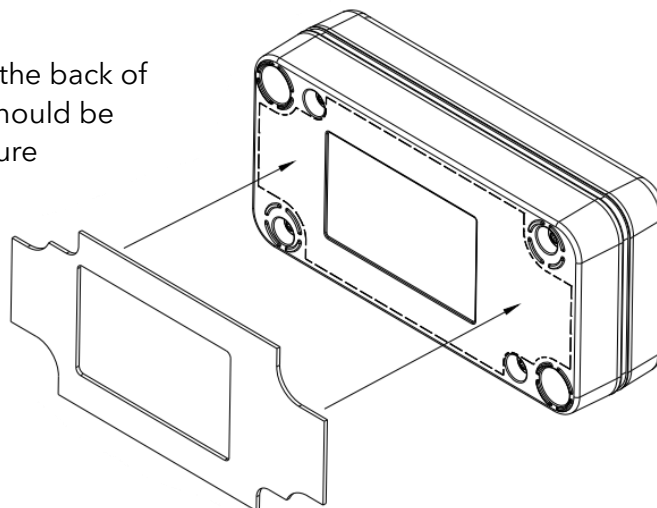
In addition to the rear wall mounting shown, front wall mounting is also possible. To do this, the positions of the magnets are swapped (magnets in the holes on the front, screws in the holes on the back).



6.8. WALL MOUNTING WITH ADHESIVE STRIPS

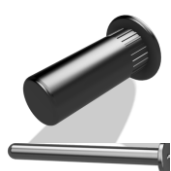
Before using this type of mounting, make sure that the surface is clean, dry, smooth and adhesive, as an uneven or dusty surface can impair the adhesion of the adhesive strips. Avoid mounting on rough, porous or damp surfaces, as this can reduce the adhesive strength and cause the mount to peel off. Press the mount firmly for a few seconds after application to ensure an optimum bond between the adhesive strips and the surface.

Stick the double-sided adhesive tape to the back of the sensor in the area shown. The tape should be sufficiently dimensioned to ensure a secure hold. When mounting with adhesive strips, make sure that the adhesive strips adhere completely and that no corners come loose.

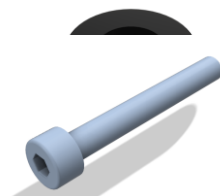


6.9. GENERAL INFORMATION ON MOUNTING WITH BLIND RIVET NUTS

A drilling template can be found at the end of the operating instructions. A blind rivet nut is a type of fastener that is used to insert threads into thin materials such as sheet metal, plastic or wood. It consists of a sleeve with a thread on the inside and a rivet on the outside. The rivet is inserted into the material with a special tool and presses the sleeve together, embedding the thread in the material. The blind rivet nut is often used when it is not possible to fit a nut on the back of the material, as the rivet nut is inserted from one side of the material and the thread on the other side is available for screwing in a screw or bolt. A special tool, known as a blind riveting tool, is required for installation.



Blind rivet nut
(version with
countersunk
head)



Spacer sleeve for blind rivets for
insertion into the back of the
housing for front panel mounting
DIN912 cylinder head screw
M4x40 for front panel mounting
with blind rivet nuts, DIN912
cylinder head screw M4x30 (for
rear panel mounting with blind
rivet nuts)

The following steps are required for **front wall installation with blind rivet nuts** 6.10 :

Step 1: Make sure you have all the necessary materials and tools to hand. You will need a blind rivet nut, riveting pliers, a drill, a drill bit, a measuring device and a wrench or pliers.

Step 2: Drill a hole in the material into which the blind rivet nut is to be inserted. The diameter of the hole should be 0.1 mm larger than the outer diameter of the blind rivet nut.

Step 3: Insert the blind rivet nut into the hole by pushing it through the hole.

Step 4: Place the riveting pliers on the blind rivet nut and tighten the pliers to fix the blind rivet nut in place.

Step 5: Use the riveting pliers to insert the blind rivet nut into the material. Tighten the pliers until the blind rivet nut is fully embedded and forms a firm connection.

Step 6: Check the blind rivet nut to make sure it is installed properly and forms a tight connection. If necessary, tighten it with a wrench or pliers to make sure it is securely fastened.

For **back panel installation with blind rivets** 6.11 the following steps:

Step 1: Make sure you have all the necessary materials and tools to hand. You will need a blind rivet, a rivet gun and, if necessary, a drill and a drill bit.

Step 2: If there is no hole yet, drill one at the desired location. The diameter should be about 0.1 mm larger than that of the blind rivet.

Step 3: Inserting the blind rivet Insert the blind rivet into the rivet gun and push it through the hole in the material.

Step 4: Place the rivet gun on the head of the blind rivet and tighten the gun to tension the rivet.

Step 5: Use the rivet gun to set the blind rivet. Tighten the gun until the rivet is fully embedded and forms a secure joint.

Step 6: Check that the rivet is securely in place. If necessary, you can tighten it with a wrench or pliers to ensure optimal fastening.

6.10. FRONT WALL INSTALLATION WITH BLIND RIVET NUTS

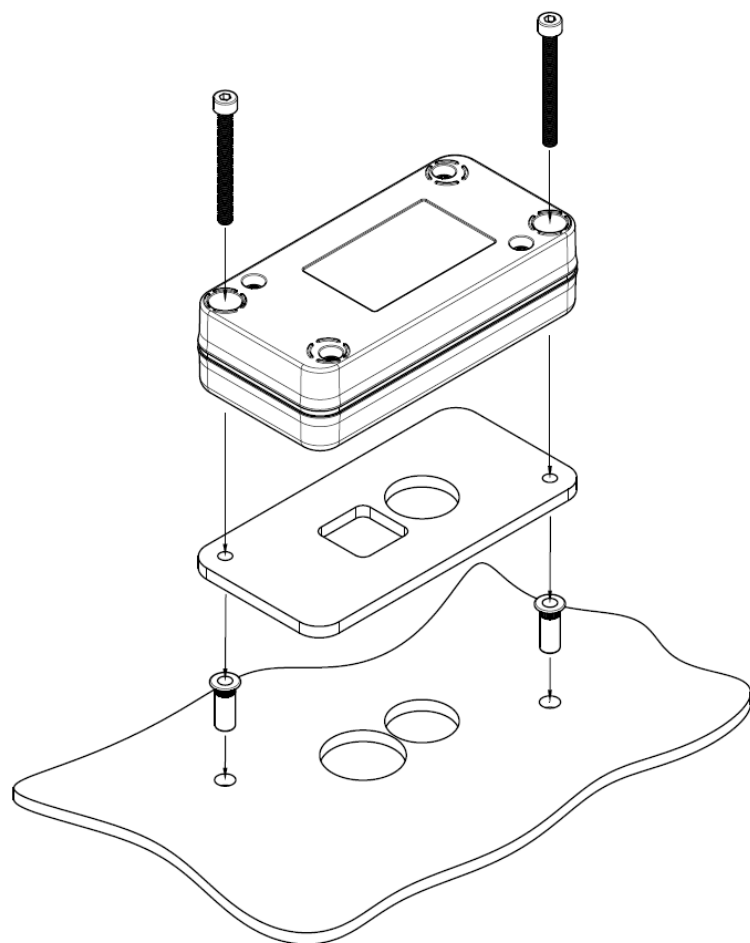
Always use the spacer plate for this type of installation to ensure that the antenna is at the correct distance from the wall.

A drilling template can be found at the end of the operating instructions. **Front wall mounting** is used if you want to attach the front of the Apollon Q sensor to the wall of the object to which the sensor is to be attached. The front side is the side with the opening in the middle, on which the logo is also visible. This mounting method is the **preferred option** as it allows for easy battery or SIM card replacement by simply loosening the screws (as opposed to front wall mounting with blind rivets).

Activate the sensor before starting the installation.

Step 1: Depending on the sensor type (Radar and ToF only), drill the appropriate holes in the wall where you want to mount the sensor. Use the drilling template for this. The holes for the blind rivet nuts should have a diameter of 6.1 mm.

Step 2: Now fasten the blind rivet nuts using a suitable tool. Use the spacer plate and insert the screws into the tabs as described in the illustration. Tighten the screws to a maximum torque of 2 Nm. If constant vibrations are to be expected during operation, we recommend the use of screw locking.



6.11. REAR WALL INSTALLATION WITH BLIND RIVETS EN

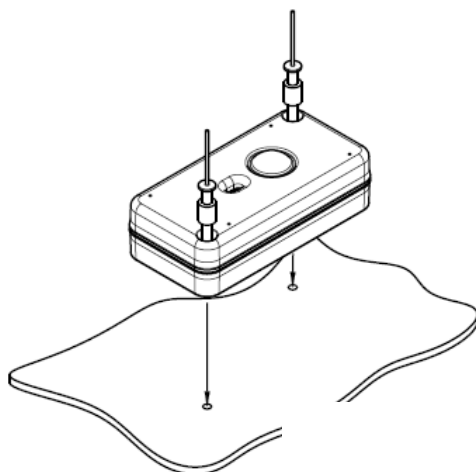
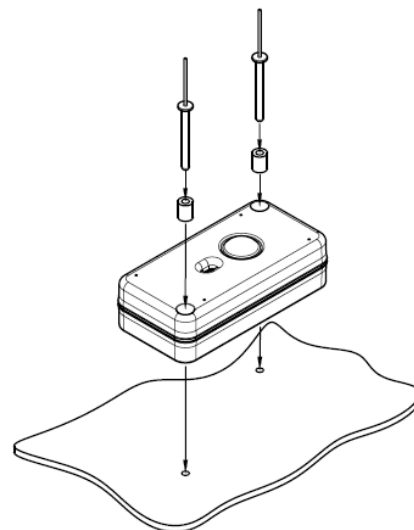
A drilling template can be found at the end of the operating instructions. **Rear** panel mounting works in the same way as front panel mounting with blind rivet nuts.

In this case, the back of the sensor rests against the wall.

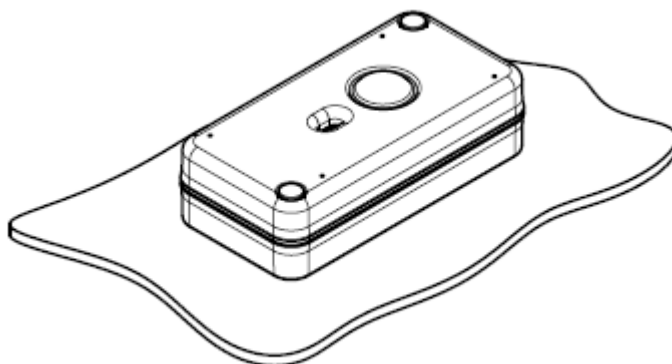
M4x30 screws and 4x40 blind rivets are used for this type of installation. Mounting is carried out **without a spacer plate**. The clamping range is 3 mm to 6 mm.

The holes for the blind rivets have a diameter of 4.1 mm.

Step 1: Depending on the sensor type (radar and ToF only), drill the appropriate holes in the wall on which you want to mount the sensor. Use the drilling template for this. The holes for the blind rivets should have a diameter of 4.1 mm.



Step 2: Insert the rivets through the tabs provided. Use the spacers supplied (the longer version). Insert the blind rivets first through the spacers and then through the tabs on the sensor. Now rivet the blind rivets using a suitable tool.



6.12. FRONT WALL INSTALLATION WITH BLIND RIVETS

Always use the spacer plate for this type of installation to ensure the distance between the antenna and the wall.

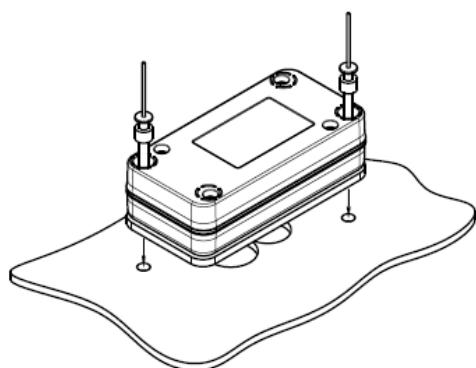
A drilling template can be found at the end of the operating instructions. Front wall mounting is used if you want to mount the front of the Apollon Q sensor on the wall of the object in which the sensor is to be installed. The front or front side is the side with the opening in the middle, on which the logo is also visible.

Activate the sensor before starting the installation.

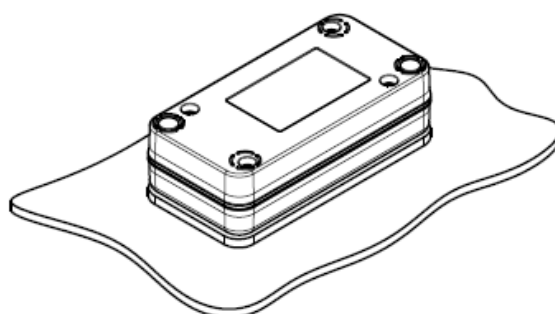
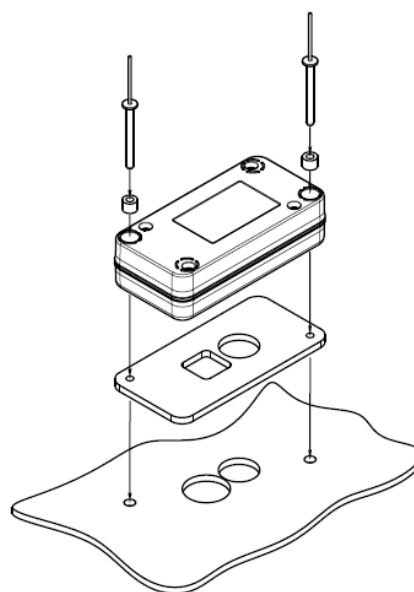
4x40 blind rivets are used for this type of installation. Mounting is done with a spacer plate.

The clamping range is 3 mm to 6 mm. The holes for the blind rivets have a diameter of 4.1 mm.

Step 1: Depending on the sensor type (radar and ToF only), drill the appropriate holes in the wall in which you want to install the sensor. Use the drilling template for this. The holes for the blind rivets should have a diameter of 4.1 mm.



Step 2: Insert the rivets through the tabs provided. Use the spacers provided (the shorter ones). Insert the blind rivets first through the spacers, then through the tabs on the sensor and finally through the spacer plate. Now rivet the blind rivets with a suitable tool.



7. COMMISSIONING AND USE

Please note that the housing or electronics may be damaged if knives or other sharp objects are used.

There are two Hall sensors (magnetic field switches) on the sensor. The following diagram shows the position of the Hall sensors and the recommended placement of the magnets.



The upper, central magnetic field switch (1) can be operated in three different modes:

- container is closed when the magnet is applied
- the container is open when the magnet is applied
- the sensor counts an opening when the magnet passes through twice

For newer sensors, the opening detection function is taken over by the accelerometer.

The activation of all variants of the Apollon Q (except Zeta) can be activated with a standard magnet on magnetic field switch 2. Then follow the steps at 7.4 to configure the sensor.

7.1. COMMISSIONING THE SENSOR VIA BLE

BLE is not available for sensors with ToF and without radar. For these versions, please follow the steps at 7.4 to commission and configure them.

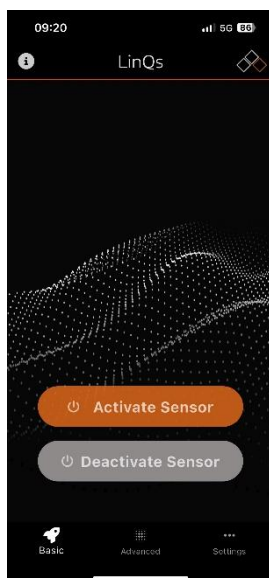
For all other sensors, you can use the convenient variant via BLE as follows:

1. All other variants can be activated via BLE with your cell phone. Simply use our LinQs APP, which you can find in the [APP Store](#) and [Google Play Store](#).
2. Activate the sensor by briefly triggering the lower left Hall sensor (2) with a magnet for at least 2 seconds. The sensor should now emit an acoustic tone sequence. Advertising mode is then started automatically.
3. You can now conveniently control the sensor via BLE from your end device. Make sure that it is switched on on your cell phone and that you are within range of the sensor so that you can reach and control it.

Activate BLE Advertising

Search for BLE device

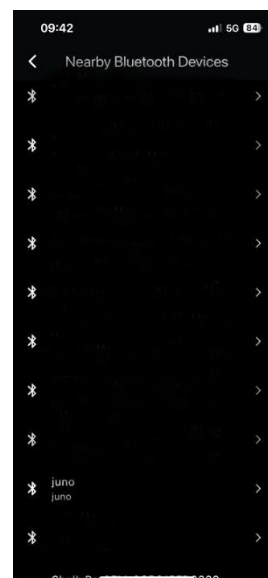
Connect to the sensor via BLE



The BLE Advertising mode can be activated with the magnet or after activating the sensor.

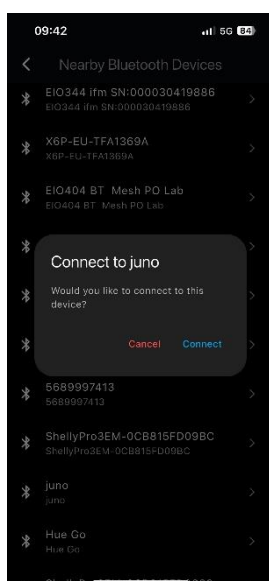


Use the "Search" button to search for the sensor via BLE.



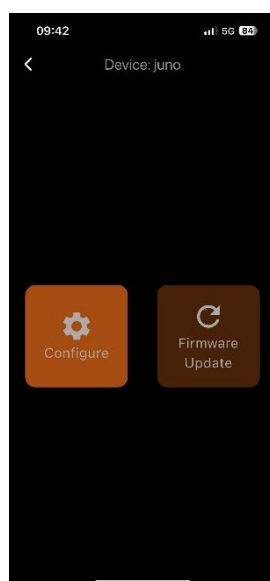
Select the correct sensor and confirm by clicking on "Apollon".

Connect to the sensor via BLE



Click on the "Connect" button

Configure with the sensor via BLE



Now use the "Configure" button to set parameters

Configure with the sensor via BLE



The "Trigger Send" button can be used to trigger a transmission. Tap the desired table entry and change the values. Confirm with the button below "Update & Reboot" or "Update". Update and Reboot forces a reboot in addition to the change, Update is used for the next

measurement or
transmission.

7.2. ACTIVATING THE SENSOR WITH A MAGNET

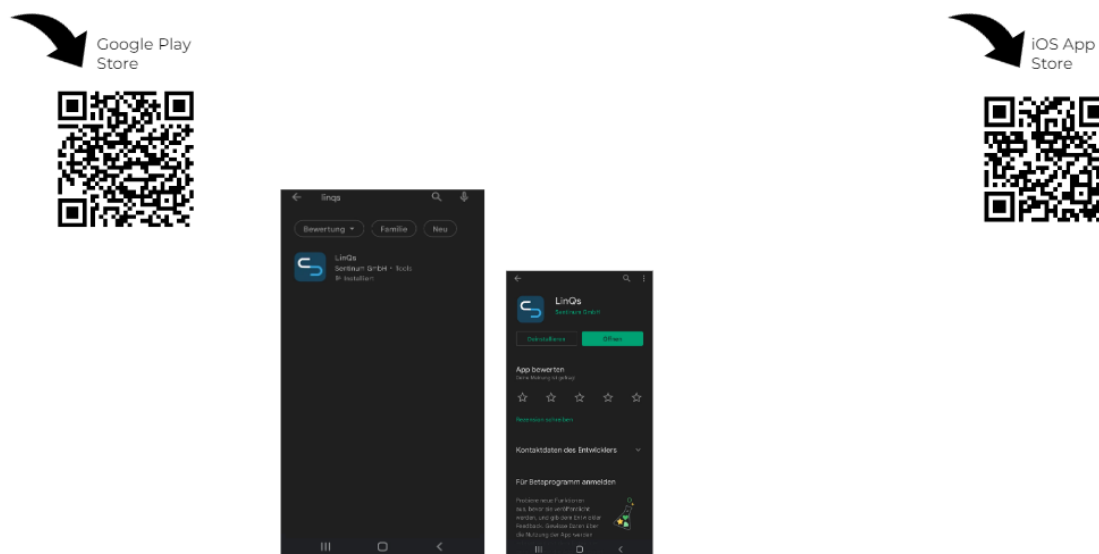
The sensor can be activated easily with a magnet: when a magnet is placed flush against the housing, the built-in reed switch detects its field and powers the sensor on. A strong neodymium magnet is recommended, but any magnet will work; magnets with a broader contact area—such as typical whiteboard magnets—are especially suitable because they transfer the field evenly. After successful activation, the device emits a brief beep, confirming that it is enabled and has automatically entered advertising mode.

7.3. AUDIBLE SIGNAL AND FEEDBACK

- When the device is switched on, an acoustic signal consisting of several ascending tones sounds. This tone sequence signals successful activation of the sensor.
- When the device is switched off, several descending tones are played, which acoustically confirm the shutdown of the device.
- When establishing or disconnecting a Bluetooth connection (BLE), the sensor also emits an acoustic signal to confirm the connection status.

7.4. NFC COMMISSIONING, PARAMETERIZATION AND POSITION OF THE NFC TAG

Activation takes place via an NFC app. A smartphone is required for this. The app can be downloaded from the respective app stores. Simply search for "Sentinum LinQs" and download the LinQs app.



First locate the tag on the sensor and then the reader on your end device. You will find the location of the NFC tag at the position of the orange arrow.



Open the app and activate the sensor. To start the sensor in the basic settings, click on the "Activate sensor" button in the app's start menu. Now place your device on the NFC marker of the sensor.



When the sensor is activated, "Sensor updated!" is displayed. You can then proceed to activate the other sensors.

7.5. POSSIBLE USES OF THE SENSORS

The sensors in the Apollon-Q series are versatile and offer a reliable solution for a wide range of level measurement applications. Thanks to the combination of radar and optical measurement, they enable precise measurements in various areas, regardless of whether liquids, bulk goods or piece goods are involved. Thanks to their robust design and support for common communication standards such as mioty®, NB-IoT, LoRaWAN® and LTE-CAT-M1, they can be used flexibly and ensure reliable data transmission even in demanding environments.

Smart waste management is a key area of application. The sensors reliably detect the fill level in waste bins, glass and used clothing containers and other containers that need to be emptied regularly in cities and municipalities. Thanks to the precise measurement, emptying can be planned more efficiently, unnecessary trips can be avoided and waste disposal logistics can be optimized. Thanks to energy-efficient LoRaWAN® or mioty® communication, the sensors can be operated for many years without the need for frequent battery changes.

The sensors also play an important role in industry and logistics. They enable continuous monitoring of the fill level in IBC containers, industrial waste and stocks of C-parts. Thanks to the support of NB-IoT and LTE-CAT-M1, measurement data can be transmitted directly via mobile networks, enabling seamless integration into existing IoT systems. This helps to make production processes more efficient and ensure timely reorders.

Another relevant area of application is measurement in shafts and ducts. Here, the sensors help to detect fill levels of water, sludge or other materials in order to better plan maintenance intervals and detect critical conditions at an early stage. This helps to prevent flooding or blockages in good time.

With their integrated GPS, the sensors also offer the option of tracking containers and mobile bins. This is particularly advantageous in logistics, as the location and fill level can be monitored at all times in order to control processes efficiently.

The Apollon-PP sensor offers reliable presence detection and is ideal for use in logistics and industry. It enables the monitoring of shelves, C-parts and bins and supports various communication standards such as LoRaWAN®, mioty®, NB-IoT and LTE-CAT-M1, which ensures easy integration into IoT systems.

Additional functions such as opening and vandalism detection as well as simple provisioning via NFC and downlinks ensure a high level of user-friendliness. The sustainable energy-efficient data transmission and wide range of applications.

8. FLAP OPENING DETECTION AND TILT DETECTION

The flap opening detection can be carried out either via the magnetic switch or the acceleration sensor. Tilt detection (tilt feature) is carried out via the acceleration sensor

8.1. FLAP OPENING DETECTION VIA THE MAGNETIC SWITCH



In older versions, the magnetic field switch 2 is used for activation. The opening is controlled by Hall switch 1. The magnetic field switches can be operated in three different modes:

1. The magnetic field switch is active. Either one or both sensors can be used.
2. Large neodymium magnets are recommended. These should be placed as close as possible to the sensor. A recommended distance between the magnet and the sensor cannot be specified universally due to the variable size of the magnet. A maximum distance of 1 cm between the magnet and the housing is recommended.
3. For comparison: With a neodymium disk magnet with $d = 20\text{mm}$ and $h = 5\text{mm}$, reliable values are achieved at distances of less than 1 cm.
4. The magnetic field switches can be operated in three different modes:
 - Container is closed when the magnet is applied.
 - The container is open when the magnet is applied.
 - The sensor counts an opening when the magnet passes through twice.

8.2. FLAP OPENING DETECTION WITH ACCELERATION SENSOR AND INCLINATION DETECTION

In the new versions, only the magnetic switch 2 is triggered to activate the advertising of the BLE.

The Apollon sensor is equipped with an integrated 3-axis acceleration sensor of the type used for reliable detection of changes in movement and position. One of the key functions

of this sensor is to detect the opening of flaps, lids or housings, as typically found in industrial applications.

1. Position detection in idle state:

- When the flap is closed, the sensor is in a defined, stable position.
- The LIS2DTW12 continuously measures the acceleration along the X, Y and Z axes.
- The absolute position of the flap can be clearly identified via the so-called static acceleration (mainly caused by gravity).

2. Change in inclination or movement:

- If the flap is opened or moved, the orientation of the sensor in space changes.
- The sensor recognizes this change by a clear deviation of the measured acceleration values on at least one axis.
- This change is interpreted as a trigger event.

3. Threshold-based detection:

- An inclination angle or a movement threshold can be defined in the Apollon firmware setup (e.g. change by 15, not ultra-low power operation)
- As soon as the measured values exceed this threshold, a damper opening event is registered.

The sensor can of course be operated in a very low-power mode by setting the measurement frequency of the angle to a correspondingly high value, e.g. 5 minutes. The measurement is then insignificant in relation to the remaining power consumption.

4. Optional: Interrupt-controlled operation:

- The sensor supports low-power modes with interrupt triggering.
- This means that the sensor remains in a low-power state and only triggers an interrupt to the microcontroller when movement is detected - ideal for extending battery life.
- **Disadvantage: The angle cannot be adjusted and is fixed at 65°**

5. Event processing and data transmission:

- After a detected opening, the event is logged in the internal memory.
- Depending on the configuration, a data packet can be sent immediately via LoRaWAN, BLE or another network protocol to report the event.

Advantage of this method

- No mechanical components required (compared to reed or magnetic switches)
- Insensitive to magnetic field interference
- Simple retrofitting or adaptation via software

8.3. ORIENTATIONS (USING APOLLON IQ AS AN EXAMPLE)

Front view



Side view



Rear view



9. COMMUNICATION WITH THE INTERFACE

The detailed options for configuring the sensor communication and the join behavior can be found in the respective generic [LoRaWAN®](#), [Mioty®](#) or [Cellular \(NB-IoT and LTE-M1\)](#) documentation, depending on the version.

You can also find all documents relating to the generic documentation at <https://docs.sentinum.de/wichtig-produktübergreifende-dokumentation-für-sensoren>.

9.1. LORAWAN JOIN BEHAVIOR

Before telemetry data can be sent via LoRaWAN, the device must establish a connection with the network. To do this, the device sends join requests until a join accept has been successfully received. As a compromise between energy consumption and a fast join, the transmission intervals of the join requests become longer and longer. In addition, the data rate is also varied (initially large data rate or small spreading factor, then smaller data rate or larger spreading factor). The join behavior strictly adheres to the specifications and recommendations of the LoRa Alliance specification. Sentinum sensors implement the specifications by means of so-called join bursts, the distance between which increases.

A join burst consists of a maximum of 6 join requests with decreasing data rate (DR5-DR0) or increasing spreading factor (SF7-SF12). The intervals between the requests increase quadratically in order not to violate the Lora-Alliance specific duty cycle guidelines. The LoRa Alliance prescribes a decreasing duty cycle for join requests according to the following table Time duty cycle <1h 1% <11h 0.1%

This means that in the first phase (<1h) exactly the same amount of transmission budget is available as in the second (<11h), although only a tenth of the time is available. In order to make maximum use of the budget, the intervals between join bursts (consisting of max. 6 join requests) are initially small and then become larger. Specifically, 2 bursts are carried out in phase 1. In phase 2, 2 further bursts are carried out, and from phase 3 onwards, 1 burst is carried out per day. The length of the bursts increases from approx. 10 minutes in phase 1, to approx. 100 in phase 2, to up to 16 hours in phase 3.

9.2. MIOTY JOIN BEHAVIOR

Before telemetry data can be sent via mioty, the device must establish an initial communication link with the base station. An explicit join process as with LoRaWAN is not required. Instead, the device begins directly with the transmission of so-called telegrams, which consist of 512-bit data packets, which in turn are fragmented into up to 12 sub-packets and distributed over different frequencies and times (telegram splitting). The first successful delivery of a telegram with a valid device ID is interpreted by the backend as network access. The configuration of the device (e.g. device ID, application key) is defined in advance and must match the backend.

If no confirmation is registered in the backend (e.g. due to missing receive timestamps or missing evaluation results), the device begins with new transmission attempts. These repetitions take place in so-called mioty transmission cycles. The cycle duration increases progressively from an initial 5 minutes (after the first attempt), over 30 minutes, to up to 12 hours in order to comply with the duty cycle specifications (<1%) and minimize energy consumption at the same time.

The transmission frequencies (868.0-868.6 MHz in Europe) and channels are changed cyclically to avoid multiple collisions. The device does not actively change the data rate, as this is defined by the protocol (15,625 kbit/s for uplink, optionally 4,882 kbit/s for downlink). The telegrams are robust against interference, as only 3 out of 12 sub-packets have to be received correctly (forward error correction).

A complete transmission attempt consists of one telegram with 12 sub-packets over a period of approx. 1.2 seconds (incl. guard time). If registration is successful, the device switches to a regular operating mode with fixed transmission intervals. If there is no reception after several transmission cycles (typically 10-12), the device pauses for 24 hours before a new initialization attempt is started.

9.3. CELLULAR JOIN BEHAVIOR (NB-IOT AND LTE-M1)

Before telemetry data can be sent via cellular (NB-IoT or LTE-M1), the device must perform the standardized network join according to 3GPP (Release 13 ff.). To do this, the device first scans the LTE frequency range (e.g. band 8 or band 20 for Europe) and searches for available cells. After successful synchronization (PSS/SSS) and decoding of the System Information Block (SIB), the device starts the attach process. This includes RRC connection request, NAS authentication, security setup and establishment of a PDP or PDU context (APN, IP address).

If the first network access fails (e.g. due to no reception, rejected authentication or no PDU context), a retry cycle starts. The retry cycles are subject to an exponential backoff: after the first failure, the next attempt is made after approx. 15 seconds, then 60 seconds, 5 minutes, up to 6 hours. The maximum number of join attempts per day is limited by the carrier, e.g. to 6 or 8 attempts. The cellular modems strictly adhere to the 3GPP and GSMA guidelines for network access control (Access Control Mechanism).

Both NB-IoT and LTE-M1 use Coverage Enhancement Levels (CE Level 0-2) in order to be able to join successfully even with poor reception. In CE Level 2, a message can be transmitted with up to 2048 repetitions. The data rates vary significantly: NB-IoT typically works with up to 250 kbit/s in the uplink and 26 kbps in the downlink, while LTE-M1 achieves uplink rates of up to 1 Mbit/s. The connection time depends on the network status and can take several hours in unfavorable cases (CE Level 2 + backoff).

To reduce energy consumption, cellular devices use power-saving mechanisms after a successful join:

- PSM (Power Saving Mode): The device remains in power-saving sleep mode for several hours or days and does not register again until the next scheduled transmission.
- eDRX (Extended Discontinuous Reception): The device only checks for downlink messages at set intervals (e.g. every 20 minutes to 3 hours).

If no network is found, the device interrupts its search after 60 minutes at the latest and goes into a deep sleep for several hours. Only then does a new network search and join cycle take place. The behaviour is optimized by the manufacturer and is based on the recommendations of network operators and the requirements for high energy efficiency in mass IoT use.

10. CARE AND CLEANING

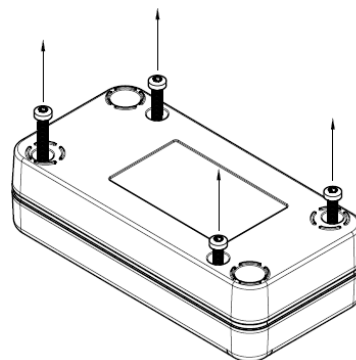
To ensure that the sensor functions reliably and has a long service life, it should be maintained regularly. Please observe the following instructions:

- Clean the housing, especially the ventilation slots of the sensor, with a dry or slightly damp microfiber cloth. Make sure that no moisture penetrates the device.
- Carry out cleaning regularly, especially in dusty or pollen-rich environments, to ensure the long-term functionality of the sensor.
- Do not use cleaning agents containing alcohol or solvents, as these can damage the surface of the sensor.
- Do not use compressed air or other intensive cleaning methods, as these can damage sensitive sensor components.
- Hard deposits (e.g. limescale, oil or grease) can impair the measuring accuracy. If necessary, clean early with a soft, damp cloth and mild detergent.
- In the case of optical or radar-based sensors, the lenses or antenna surfaces should be checked regularly for dirt or scratches.
- Regularly check that the sensor and the bracket are firmly attached.

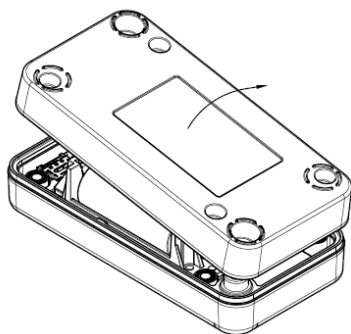
11. CHANGING THE BATTERY

Communication standard	Approved batteries
LoRaWAN® and mioty®	• Energizer® Ultimate lithium batteries - AA • VARTA Ultra Lithium Mignon AA
Cellular sensors (NB-IoT and LTE-CAT-M1)	• VARTA-CR-AH-R A

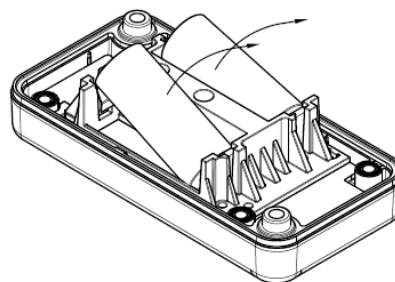
Open the 4 screws on the back of the sensor marked with the orange arrows. You will need a Torx T10 screwdriver for this and make sure that the seal is not damaged.



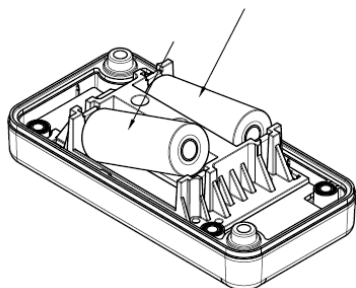
Remove the back of the sensor housing



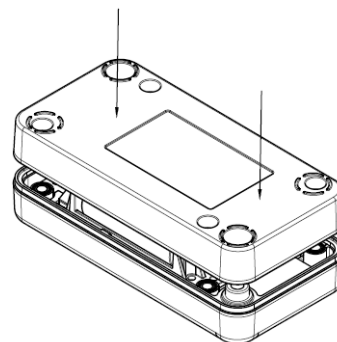
Remove the old batteries from the battery holder



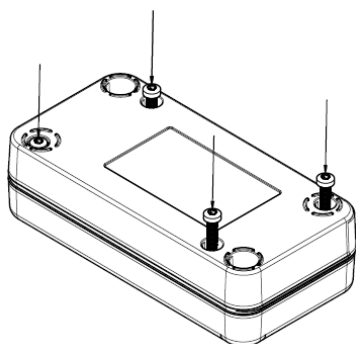
Insert 2 new battery cells. If cells other than those recommended are used, performance and product safety may be impaired and the running times and performance specified in the data sheets may not be achieved.



After inserting the cells, the sensor should start with a short beep. As soon as you hear this signal, replace the back of the housing.



Screw the housing together. Tighten the screws crosswise to ensure even and tension-free fastening. Make sure that the original position of the seal has not been changed. Then reinstall the sensor at its place of use. Dispose of the old batteries in an environmentally friendly manner.



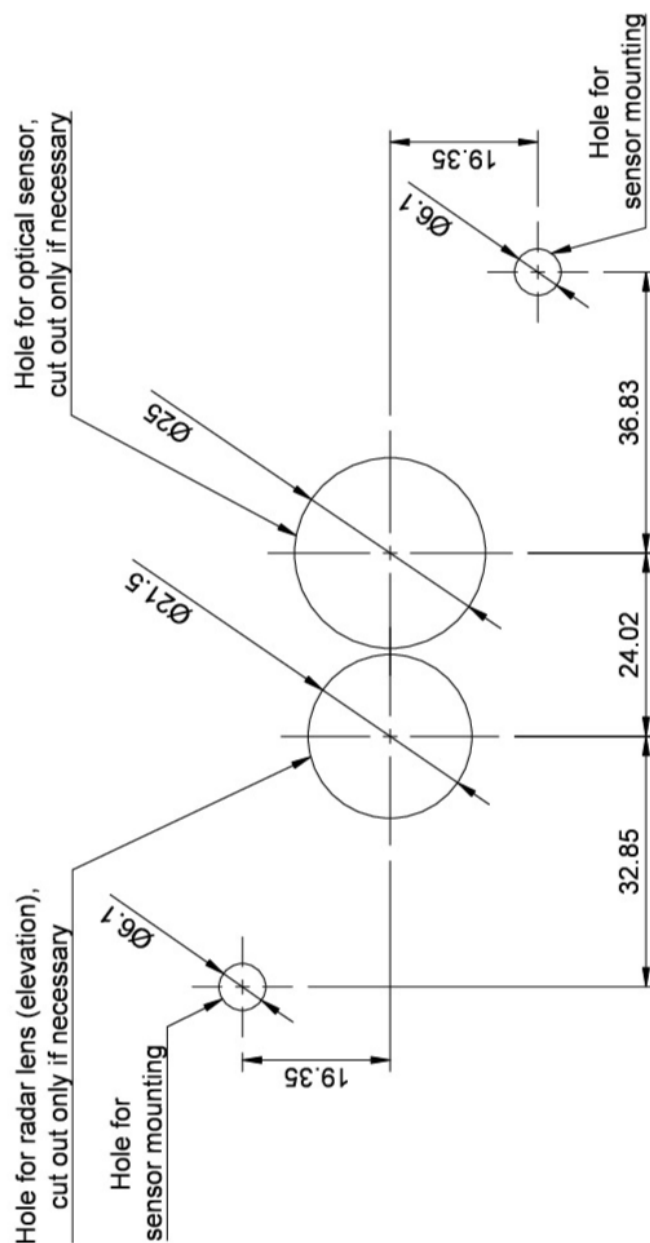
12. MARKING AND CERTIFICATION



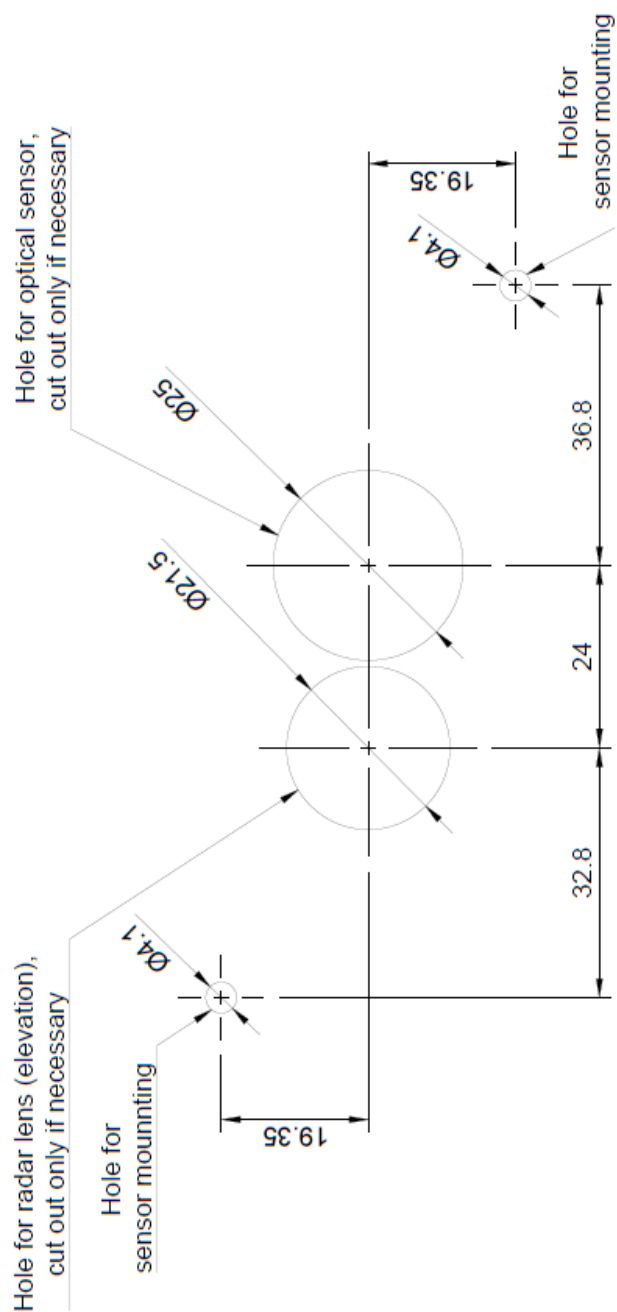
Approval documents and certifications—including the CE EU Declaration of Conformity—are available in English at <https://docs.sentinum.de/sensoren-und-produktreihen>.

13. DRILLING TEMPLATES FOR INSTALLATION

13.1. BLIND RIVET NUT



13.2. BLIND RIVETS



13.3. WALL MOUNTING (SEE NEXT PAGE)

