TLT-STD-LR-2, version 4.0

Tiltmeter

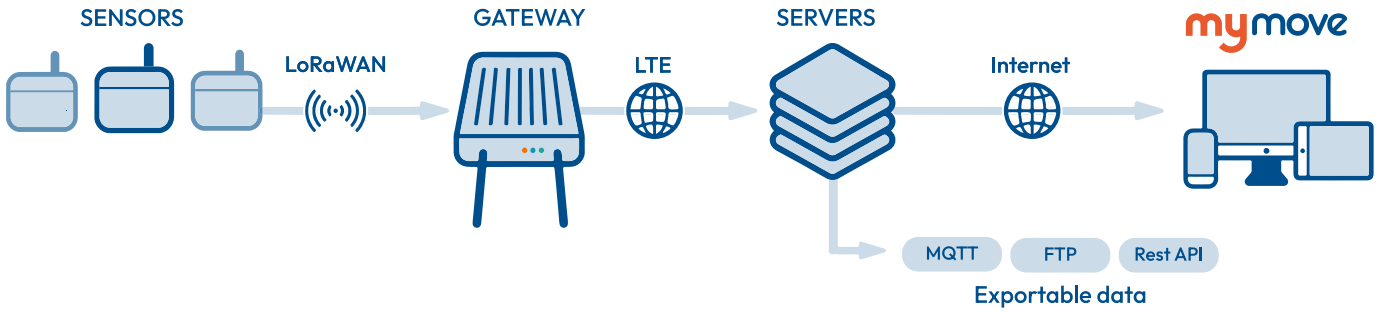
The Tiltmeter measures variations in the static tilt angle relative to the horizontal plane and offers different working modes to suit user needs. In addition to tilt angles, it also measures temperature and vibrations for data correlation and analysis. Part of the Move Solutions sensor family, it integrates seamlessly with the MyMove platform.

KEY FEATURES

- For indoor and outdoor operation
- Long battery life, extendable with Battery Pack
- Wireless LoRaWAN connection
- Fully remote configuration and management
- Quick, flexible, and easy installation
- Measures tilt angles, temperature, and vibrations
- Programmed data acquisition with customizable cadence and synchronization between different sensors
- Trigger-based data acquisition with selectable trigger source
- Data logging in the internal memory
- Data management and processing through the MyMove platform

Its wireless design ensures quick and easy installation, significantly reducing time and costs.

The sensor is optimized for a very long operating life, which can be further extended by adjusting the sensor configuration. To operate the sensor requires a Move Solutions Gateway installed nearby.



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Output data

The sensor provides a comprehensive understanding of the 3D rotation of the structure in which it is installed by measuring two rotational angles of the structure:

- **φ** (Phi) angle: Rotation around longitudinal axis
- **θ** (Theta) angle: Rotation around the transverse axis

The sensor measures the gravity acceleration vector to compute the rotation of the structure relative to it. To enhance accuracy, the input acceleration data is sampled over time and saved into the internal data buffer. The collected data is then averaged and used to compute the tilt angles. At the same time, the collected acceleration data is used to determine the RMS and peak values of the structure's vibration to provide the vibration intensity at the time of acquisition. The sensor also records the temperature at measurement time.

The adjustable accelerometer full scale range and the size of the data buffer make it possible to optimize the instrument for different needs, such as improved accuracy, better battery life, and reliable operation under strong vibrations of the monitored structure.

Working principle

The sensor periodically collects data points at specific times and programmed intervals. This enables multiple sensors to synchronize their data collection with high precision. The time-correlated data points from these acquisitions are useful for several purposes, such as:

- Monitoring trends in tilt angles and their correlation with temperature and vibrations
- Reconstruct the static deflection of structures, such as during static load tests of bridges
- Monitoring cant/twist angles of railways

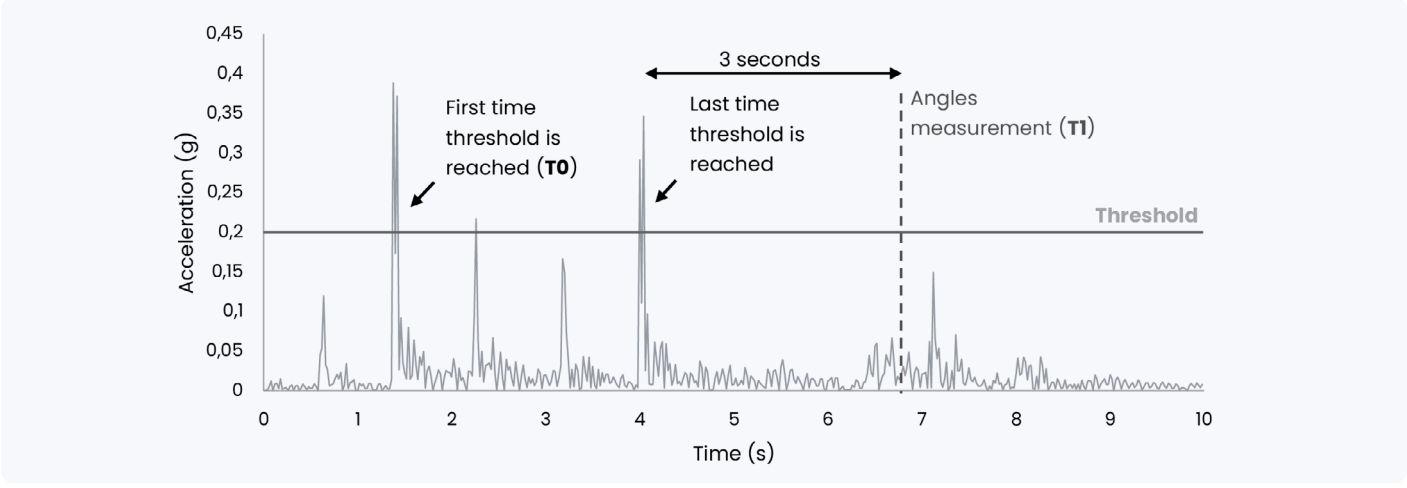
This synchronization and correlation capability, combined with the algorithms provided by the MyMove platform, allows for detailed and accurate analysis of structural behavior over time. Programmed data acquisition is always enabled.

Triggered acquisitions can be enabled alongside the programmed mode to collect additional data points. The transmission of these triggered acquisitions to the MyMove platform is optimized for very low latency, ensuring responsive notification of significant events. Users have the option to enable and configure triggered acquisitions based on their application's specific needs. Note that only one among the following types of triggers can be enabled at any given time. Available trigger sources are now described.

1 TRIGGER ON ACCELERATION

The trigger source is a vibrational event whose amplitude exceeds the programmed acceleration threshold. Vibration amplitude is defined as the magnitude of the three-dimensional acceleration vector. The sensor processes an acceleration-triggered event as follows:

Example of acceleration-triggered acquisition.



- The sensor continuously monitors the three-dimensional acceleration, computing its magnitude and comparing it to the specified threshold
- If the threshold is exceeded (time T0), the sensor processes the subsequent 3 seconds of data to compute the RMS and peak values of the triggering vibrational event
- It then waits until the threshold is not exceeded for at least 3 seconds, then samples the tilt angles (time T1). This delay prevents the sensor from sampling tilt angles during intense vibrations, thereby improving measurement accuracy. A 2-minute timeout from T0 is implemented to prevent excessive waiting times
- The sensor transmits the acquired data, marked with timestamp T1, to the MyMove platform. The peak and RMS values of the vibrational event are measured at time T0, tilt angles and temperature at time T1.

2 TRIGGER ON ANGULAR VELOCITY

The trigger source is the fast variation in one of the structure's tilt angles. The sensor triggers an acquisition when the angular velocity exceeds the programmed threshold. The sensor processes this type of event as follows:

- The sensor acquires the tilt angles every 30 seconds and calculates the angular velocity.
- Angular velocities are computed and compared to the programmed threshold. It is possible to enable the trigger on just a single angle or both.
- If the threshold is exceeded, the sensor acquires and transmits the event.

The sensor sends the data to the MyMove platform, including which angle triggered the acquisition.

3 TRIGGER ON ANGLE VALUE

The trigger source is an out of bounds value for one of the structure's tilt angles, i.e. when a measured angle is not within the low and high thresholds programmed by the user. The sensor processes this type of event as follows:

- The sensor samples the tilt angles with the cadence programmed by the user.
- It compares the measured tilt angles with their respective high and low thresholds.
- If the value of an angle is lower than the low threshold or higher than the high threshold, the sensor triggers the acquisition of an event.

In case the measured angle is constantly out of bounds, the sensor continuously acquires and transmits events with the programmed faster cadence. Acquired events are sent to the MyMove platform, including which angle triggered the acquisition.

Technical specifications

MEASUREMENT PERFORMANCES		
Angle sensing technology	MEMS accelerometer (3 axes)	
Accelerometer sampling frequency	125 Hz (4kHz downsampled)	
Accelerometer full scale range	Customizable, available values:	
	±2g	
	±8g	
Acceleration data buffer size *(Used for both angle and vibrational acceleration measurement)*	Customizable, available values:	
	125 samples / 1 second	
	250 samples/ 2 seconds	
	500 samples / 4 seconds	
	1000 samples / 8 seconds	
	2000 samples / 16 seconds	
Operating modes	Programmed acquisition	
	Programmed acquisition + Acceleration Trigger	
	Programmed acquisition + Angle Trigger	
	Programmed acquisition + Angular Velocity Trigger	
Angle resolution	0.0000001°	
Angle repeatability[1,2,3]	±0.0008°	
Angle accuracy[1,2]	Value	Validity range
	± 0.002°	± 0.5°
	± 0.003°	± 2°
	± 0.01°	± 5°
	± 0.05°	± 20°
	± 0.25°	± 90°
Angle full scale range	± 180°	
Absolute synchronization accuracy[4]	± 1 s	

[1] Referred to absolute, non-compensated angles.

[2] Measurement conditions: ± 2g accelerometer range, buffer depth of 2000 samples, room temperature 20°C, 45%rh.

[3] Applies to consecutive readings within 30 minutes with constant tilt angle. Provided at 95% confidence level.

[4] Evaluated under good quality LoRaWAN network coverage.

MEASUREMENT PERFORMANCES

Vibrational acceleration resolution	0.125 mg	
Vibrational acceleration RMS noise	Range	Value
	± 2g	126 µg
	± 8g	140 µg
Vibrational acceleration full scale	Same as accelerometer range	
Vibrational acceleration bandwidth	0.1 – 31.25 Hz	
Temperature resolution	0.05 °C	
Temperature accuracy	0.2 °C	
Internal storage memory	10000 acquisitions	

GENERAL DATA

Wireless connection technology	Sub-GHz LoRaWAN protocol[1] (Gateway required)
Wireless coverage[2]	1 km line of sight from the nearest Gateway
Cable connection	Move Solutions 8-pole connector. For compatible accessories visit Move Solutions' website or contact us directly.
IP rating[3]	IP67
Power supply	1x 19Ah 3.6V replaceable lithium battery (D-type LiSOCl2 with JST EHR-2 connector).
Operating temperature range	From -40 °C to +85 °C
Dimensions[4]	97.5 x 80.5 x 66 mm
Weight[4]	0.5 kg
Package weight	0.8 kg
Case material	GD-AlSi12 alloy
Installation options	Wall, floor, or ceiling mount. Two-points attachment using screw anchors (Ø6mm max). One set included in the package.

[1] The sensor's LoRaWAN connection operates on a best-effort basis, which means that while most data packets are delivered, there is a slight possibility of occasional packet loss.

[2] Wireless coverage may vary based on the actual deployment scenario.

[3] The declared IP rating is guaranteed only when the product is correctly assembled, with the lid properly screwed in place, the antenna installed, and the Move Link connector protected either by a properly connected external cable or by the supplied protective cap when no cable is present.

[4] Refers to the sensor unit itself. External accessories, such as mounting plate, antenna and protection cover for the antenna are not considered since they are optional and/or can be replaced with alternative parts to fit specific applications.

BATTERY LIFE

Configuration [1,2]	Internal battery	Battery Pack (combined) [3]
Programmed acquisition with 30 minutes period Data buffer depth: any	11 years	15.3 years
Programmed acquisition with 2 minutes period Data buffer depth: 125 samples	8.2 years	13.6 years
Programmed acquisition with 2 minutes period Data buffer depth: 2000 samples	5 years	10.6 years
Programmed acquisitions with 30 minutes period Data buffer depth: any Acceleration trigger[4]	2.7 years	7.2 years
Programmed acquisitions with 30 minutes period Data buffer depth: any Angle trigger[4]	2.3 years	6.4 years
Programmed acquisitions with 30 minutes period Data buffer depth of 2000 samples Angular velocity trigger[4]	2.3 years	6.4 years

ORDERING INFORMATION

SENSOR	PART NUMBER
Tiltmeter sensor, standard *Includes: sensor unit, standard antenna, standard mounting plate*	TLT-STD-LR-2
ACCESSORIES	**PART NUMBER**
Short antenna + protective dome	ANT-DME-MB-0
Short antenna	ANT_SHORT
Battery Pack	SBE-STD-CB-1
Data download cable	SCM-STD-CU-1
L-shaped mounting plate	ATM-INOXL-FP

[1] Configuration parameters that are not specified are to be considered in their default configuration.

[2] The estimation refers to a sensor in a typical working environment with average quality of the radio connection between the sensor and the Gateway. Actual battery life may be worse in case the product is used under extreme conditions, such as prolonged working in high or low temperatures, bad quality of radio connection between the sensor and the Gateway, etc.

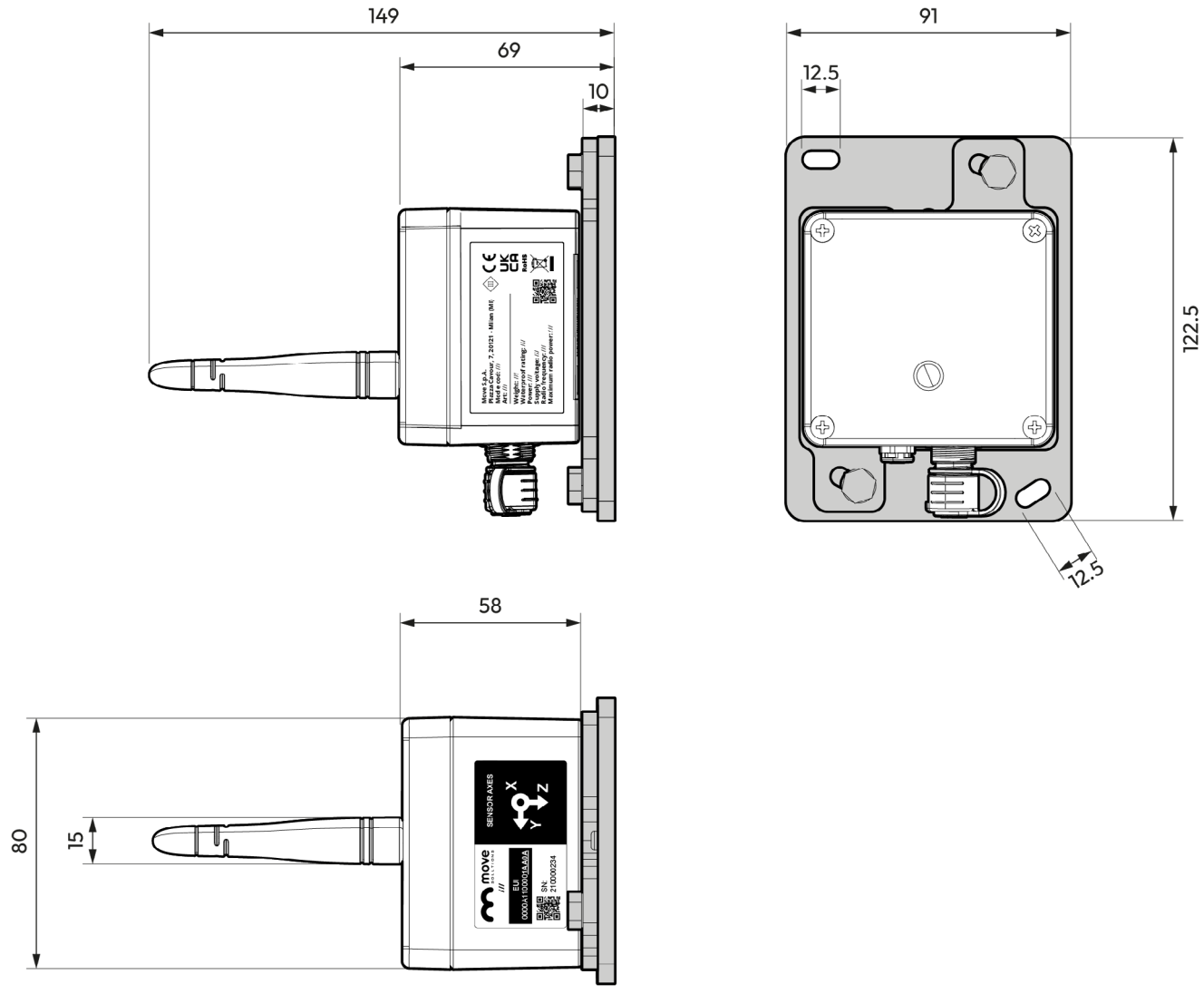
[3] Battery Pack sold separately.

[4] The consumption of trigger acquisitions depends on the actual input signal of the sensor and its configuration, so it may differ from the stated. The estimation refers to an average of 240 trigger events per day.

Mechanical drawings

STANDARD MOUNTING PLATE + STANDARD ANTENNA

All dimensions are in millimeters



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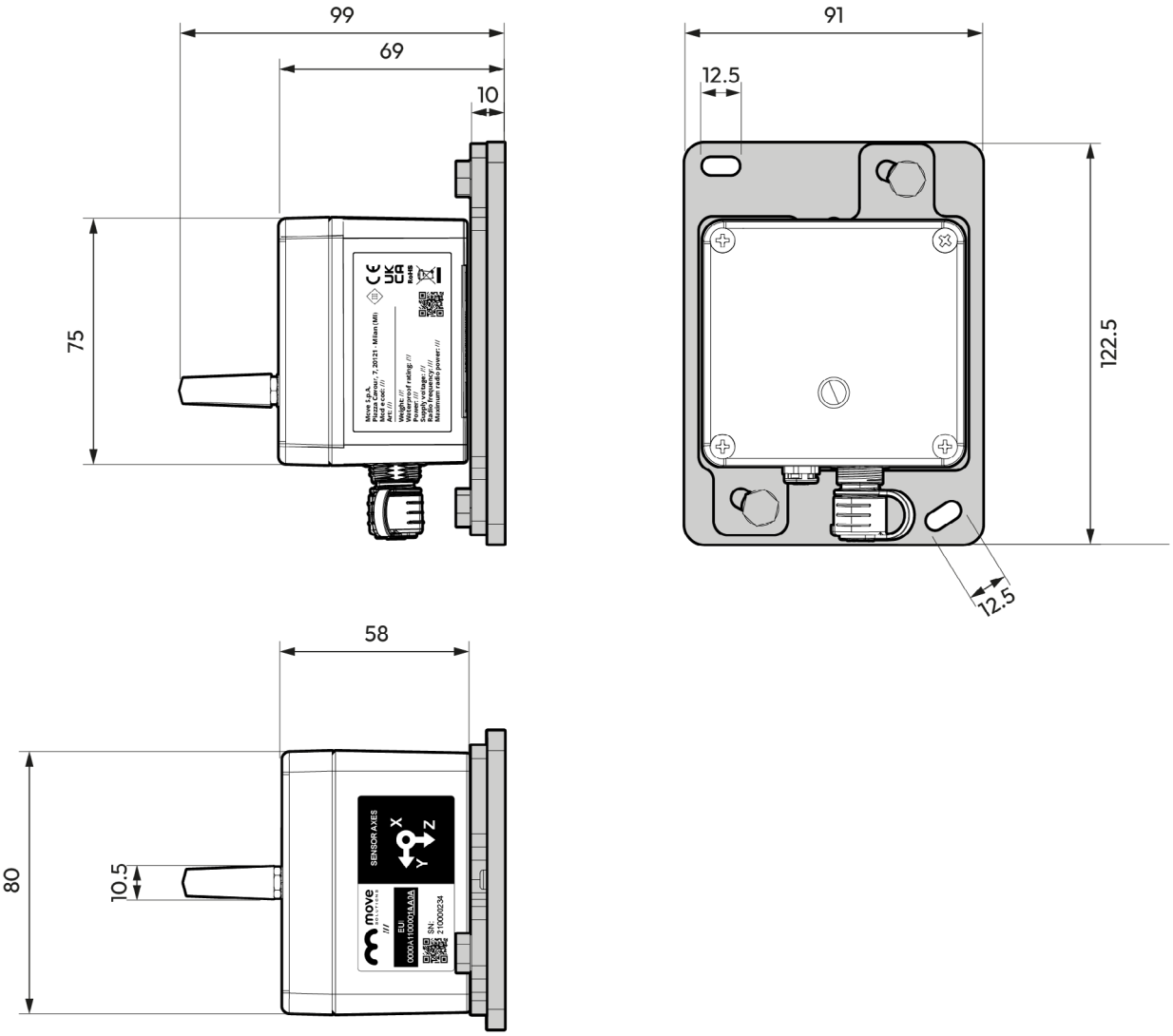
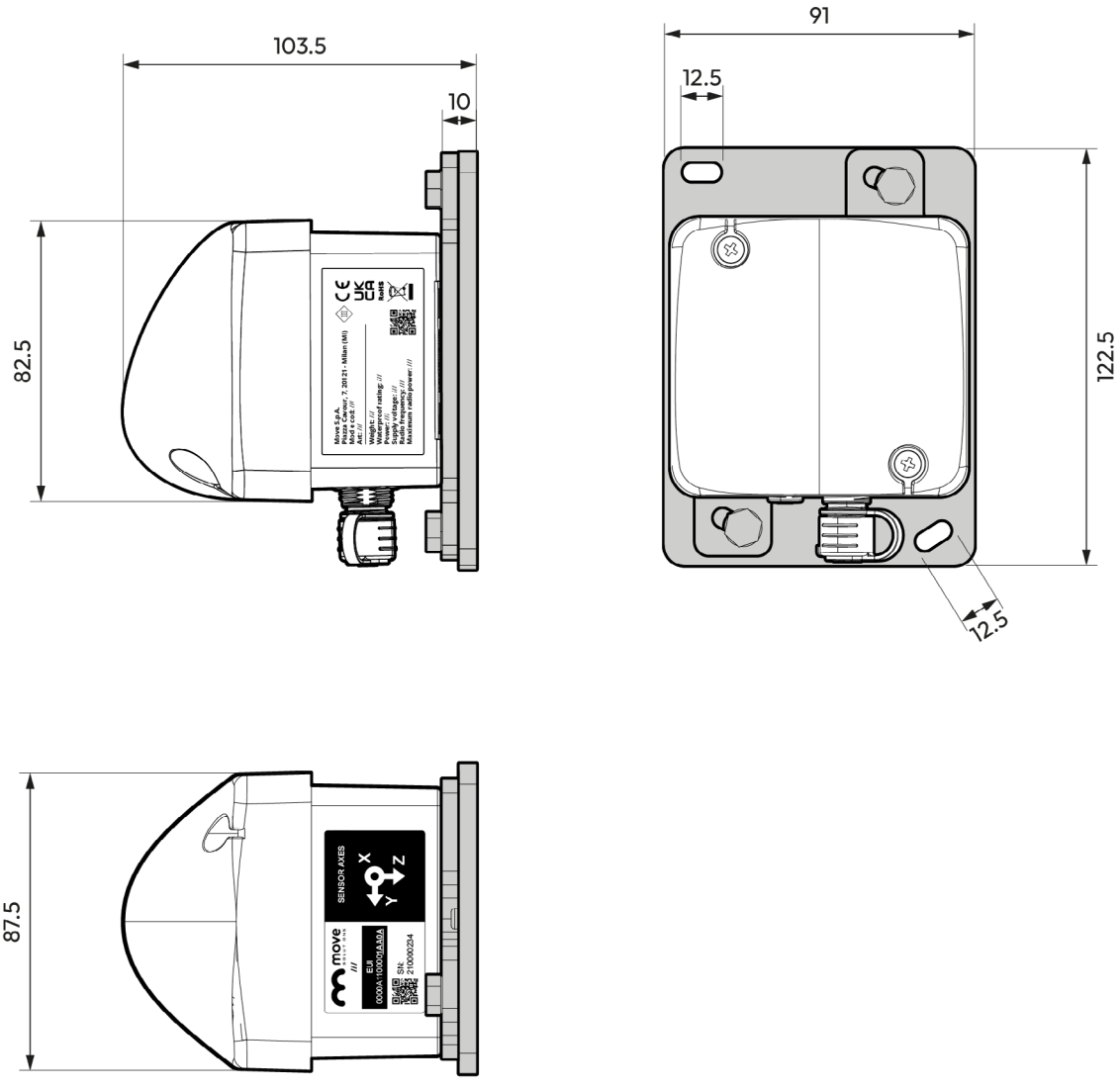
STANDARD MOUNTING PLATE + SHORT ANTENNA

All dimensions are in millimeters



STANDARD MOUNTING PLATE + SHORT ANTENNA + PROTECTIVE DOME

All dimensions are in millimeters



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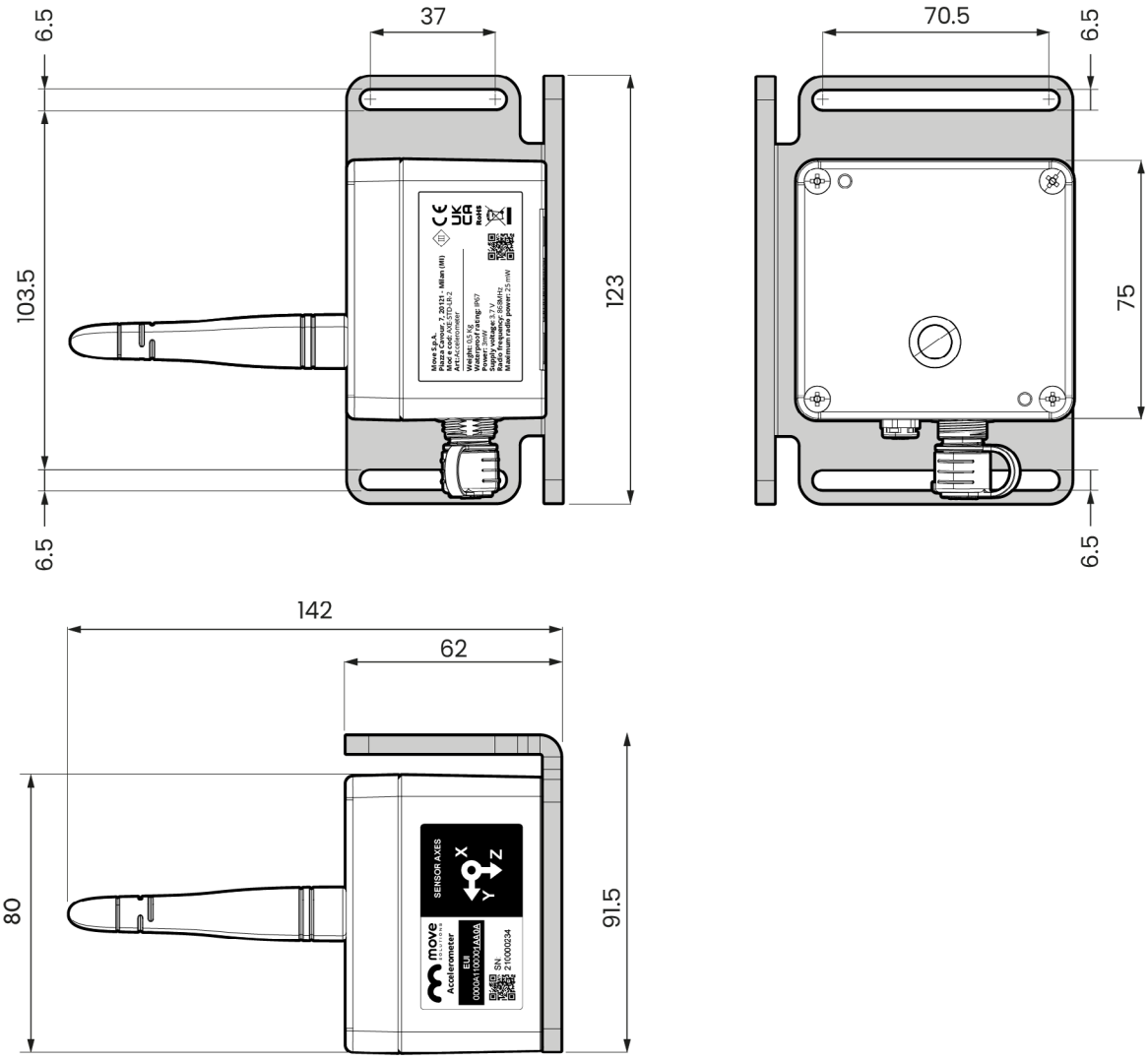
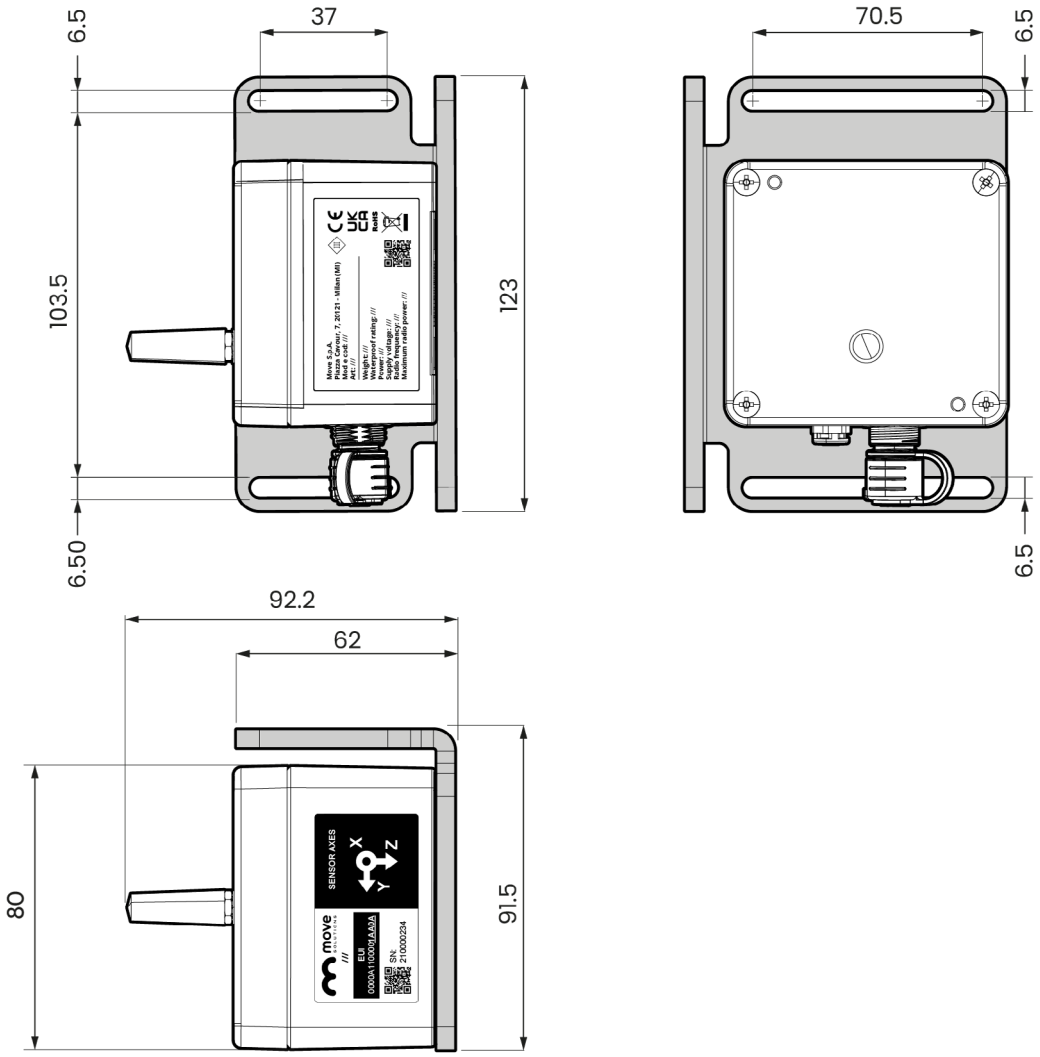
L-SHAPED MOUNTING PLATE + STANDARD ANTENNA

All dimensions are in millimeters



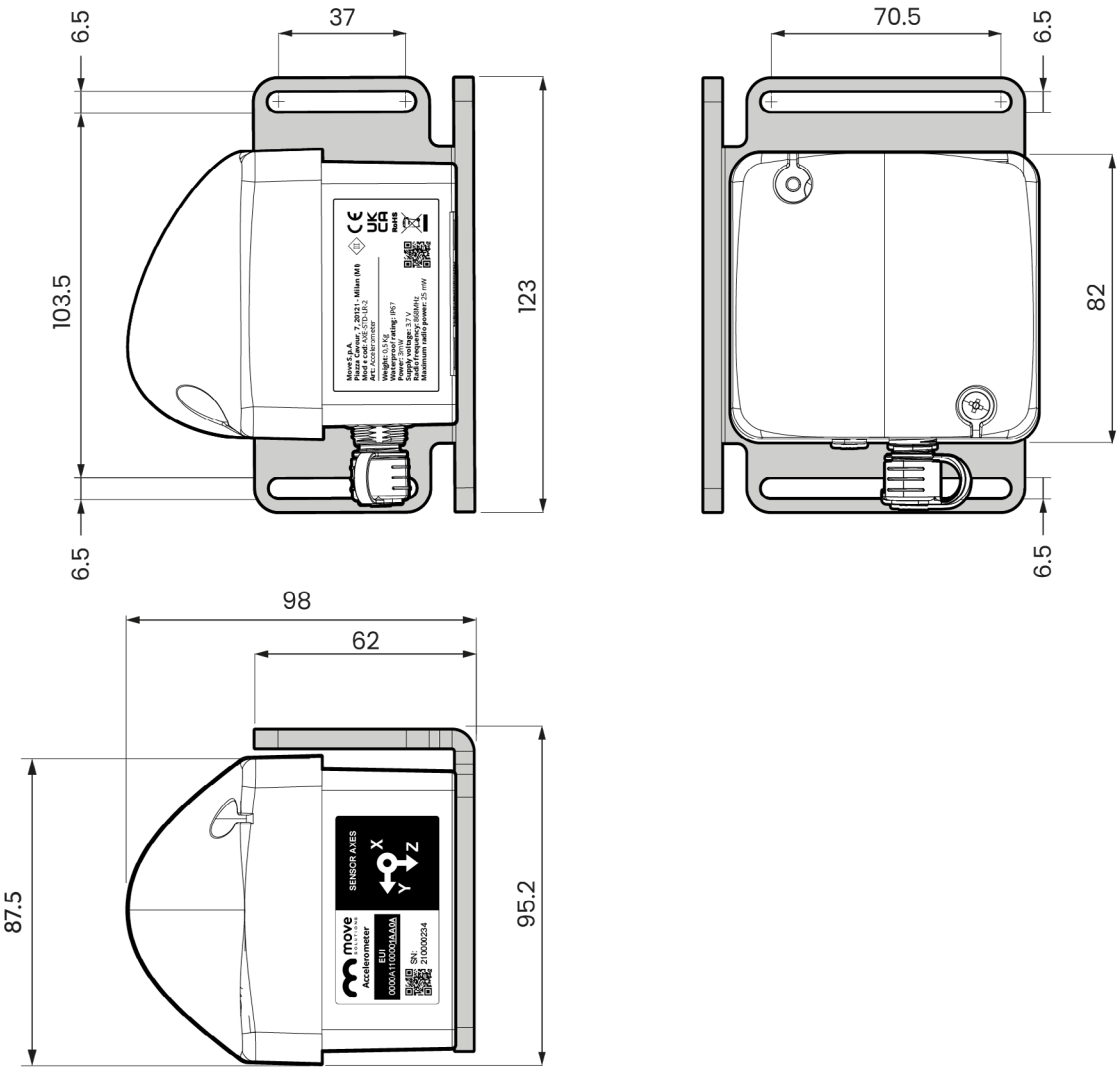
L-SHAPED MOUNTING PLATE + SHORT ANTENNA

All dimensions are in millimeters



L-SHAPED MOUNTING PLATE + SHORT ANTENNA + PROTECTIVE DOME

All dimensions are in millimeters



For complete information regarding proper use of the device, safety precautions, installation, operation, and maintenance requirements, users must refer to the official product manual.

DOCUMENT REVISIONS		
N°	**DATE**	**NOTES**
REV. 1	9 September 2024	Initial release
REV. 2	26 January 2026	Text corrections and formatting updates
REV. 3	14 April 2026	Complete template and style update

Notice of publication

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