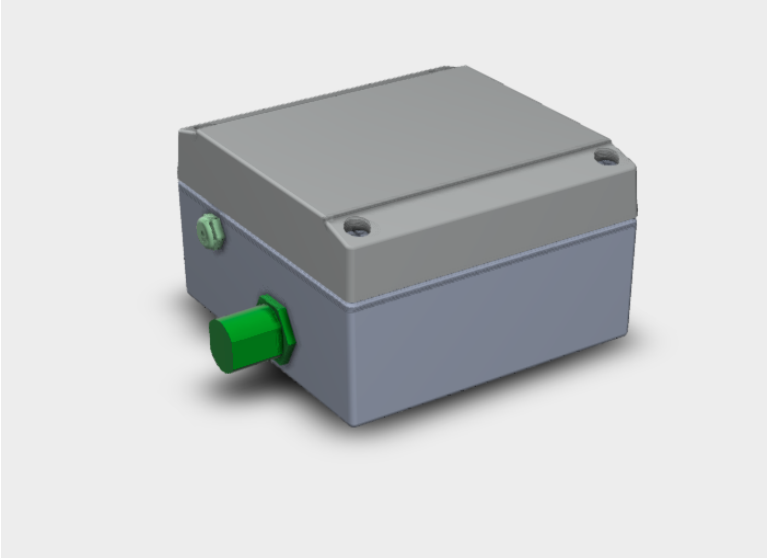
User Guide

Loadsensing Wireless Tiltmeter LS-G6-TIL90 Family

Version 0.1



Wireless Tiltmeter with external antenna
(LS-G6-TIL90-X)

Wireless Tiltmeter with internal antenna
(LS-G6-TIL90-I)

WORLD SENSING

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Important instructions prior to use

Please read these instructions carefully and ensure that the required conditions are met before using the product.

All our Loadsensing edge devices have the following information on the casing.

Symbol	Description
	Caution. Read the instructions carefully and ensure that the required conditions are met before using the product.
	Caution, hot surface.
	Ensure proper waste segregation and follow electronic waste disposal protocols.

Device Overview

This user guide explains how to configure and operate Worldsensing's Loadsensing Wireless Tiltmeter. Further technical descriptions are available in the datasheets.

The Loadsensing Wireless Tiltmeter is a long-range, low-power wireless data logger and inclinometer in a compact box. It can measure tilt on three axes perpendicular to the plane of the base with a precise microelectromechanical systems (MEMS) sensor.

There are two variants: one with an external antenna and metallic box and another with an internal antenna, a metallic box and a polycarbonate lid.

The wireless tiltmeter can be used as a standalone logger for manual monitoring and can be easily configured by connecting it to an Android phone with a USB cable.

Tiltmeters measure changes from vertical on the ground or in structures. This makes them key sensors for monitoring inclinations, movements and differential settlements in slopes or infrastructures.

Tiltmeters can be attached to vertical structures, such as columns, piers, pylons, facades or retaining walls, to track changes in inclination and detect differential settlement; or they can be installed to verify over time the geometry and stability of tunnels or bridges and the cant, twist and vertical alignment of railway tracks.

They have also been extensively used in monitoring slope stability in landslide-prone areas, embankments and mines.

Device Specifications

SENSOR	
Type:	MEMS inclinometer with internal offset compensation
Range:	+/-90°
Axes:	Up to 3
Accuracy within +/-5°	+/- 0.006°
Accuracy within (+/-15°)	+/- 0.013°
Resolution	0.0001°
Repeatability LS-G6-TIL90-X	<0.0003°
Repeatability LS-G6-TIL90-I	<0.001°
Offset temperature dependency LS-G6-TIL90-X (*)	+/-0.002°/°C
Offset temperature dependency LS-G6-TIL90-I (*)	+/-0.005°/°C
Time required for reading	10 secs approximate

(*)Note that temperature dependency can be positive or negative depending on each MEMS sensor manufacturing process. Temperature dependency is given as the maximum value.

MEMORY: CIRCULAR BUFFER STRUCTURE		
Memory records up to 200,000 readings, including time and 1 sensor		
MECHANICAL		
Device	LS-G6-TIL90-X	LS-G6-TIL90-I
Box dimension (WxLxH)	100x100x61 mm	100x100x61 mm
Overall dimensions	150x120x61 mm	103x100x61 mm
Operating temperature	-40°C to 80°C (-40°F to 175°F)	
Water ingress protection	IP67, IP68 (at 2 m for 2 hours)	IP67, IP68 (at 2 m for 2 hours)
Weight (excluding batteries)	841 g	624 g
Antenna	External: 100 mm length (including connector)	Internal
Mounting options	Clearance holes for M4 hexagon socket head cap screws in bottom. Blind holes for M4 screws on the side.	
USB (configuration/EXT power)	Internal mini USB	
Box material	Aluminium alloy	Aluminium alloy
Lid material	Aluminium alloy	Polycarbonate
Batteries	Up to 2	
Vibration resistance	Random vibration test railroad profile according to level C.2 (on sleeper) of standard EN 50125-3:2003	
Impact resistance***	Can be dropped from 1 meter onto a concrete surface (20,000g)	

*** The wireless tiltmeter is impact resistant but should be treated carefully, like any precision instrument.

Equipment Provided

As mentioned above, there are two wireless tiltmeter variants.

Wireless Tiltmeter Mounting Brackets

Wireless tiltmeters can be mounted horizontally or vertically, depending on the monitoring objective. Worldsensing provides several accessories, some specially designed for rail applications.

Description	Code	Note
Mounting plate for vertical mounting	LS-ACC-IN15-VP	Wireless tiltmeters with serial numbers (SN) 24079 onwards have been equipped with blind holes for M4 screws on the lateral side: please request LS-ACC-IN15-VP-4. For older models, contact us for an "L" bracket alternative (LS-ACC-IN15-VP-3)
Horizontal surface mounting plate	LS-ACC-IN15-HP	LS-ACC-IN15-HP-4 LS-ACC-IN15-HP-3
Horizontal surface mounting plate for track monitoring	LS-ACC-IN-HPTM	
Versatile double plate for horizontal surface mounting (includes a threaded hole for a prism or a button head screw, for precise levelling)	LS-ACC-IN15DP	

Further information and drawings can be found in the accessory user guides.

Powering up the Device

Loadsensing devices are shipped closed and without batteries. To power up the device:

1. Open the device using a 2.5 mm Allen wrench.
2. Insert **C-type batteries** in the battery holders, checking they match the polarity indicated. You can connect one or more batteries; the more you use, the longer the device will operate in the field. See our **LS G6 Datalogger recommended batteries guide** for further information on the batteries.
   Please note that the device has reverse battery protection but it is not safe to keep batteries reversed in the device for a long time.

   Note: The Loadsensing Wireless Tiltmeter does not have an real-time clock battery to keep time, so it is very important for the device to be powered with batteries when the time is set during installation. Otherwise the device will default to the year 1970 and data will not appear in the gateway. A warning will appear in the log's tab.

3. The device can be powered only with batteries.

General warnings

- Follow these precautions to avoid a battery explosion or leakage of flammable liquid or gas:
    - Use the correct battery type. Dispose of the batteries according to instructions. Do not dispose of the batteries by throwing them into a fire or a hot oven, or mechanically crush or cut them.
    - Do not leave the batteries in an extremely high-temperature environment.
    - Do not subject the batteries to extremely low air pressure. It may result in an explosion or leakage of flammable liquid or gas.
    - Do not short circuit the batteries. This will blow the protection fuse.
- Batteries and equipment to be connected via the data port must meet IEC 62368-1 ES1 and PS1 requirements.
- Equipment to be installed in restricted access areas.

Figure 3. Wireless tiltmeter information

Loadsensing Device Configuration

We recommend configuring the Loadsensing device on location so you can conduct an on-site radio coverage test at the same time.

Safely Closing the Device

The wireless tiltmeter has undergone watertightness testing by an external laboratory and has been given the following ratings:

Device	LS-G6-TIL90-I	LS-G6-TIL90-X
Water ingress protection	IP67, IP68 (at 2 m for 2 hours)	IP67, IP68 (at 2 m for 2 hours)

To guarantee water tightness:

- Lock the box by tightening screws crosswise on the lid. Adjust the screws using a torque wrench. If this is not done properly, the base faces and cover may not be parallel, screwing may become more difficult and the screw threads or the Helicoil inserts may be damaged. Moreover, the O-ring (seal) may not be properly sealed and the degree of protection against water intrusion could be compromised.
- Screw the box at 2 Nm (the force that needs to be applied is marked on the outside of the device) using a torque screwdriver (e.g. Ref. 1227107 from WERA).
- Mount the antenna or cover the antenna connector with a cap.
- Make sure the sealing ring has not been physically or chemically manipulated.

Note: There is no need to seal the GORE valve to comply with IP67/IP68. If you seal it, the barometer won't be able to measure the atmospheric pressure and you won't be able to apply pressure compensation.

Note: We can't guarantee the IP67/IP68 rating if any of the above conditions are not met or if one or several components (e.g. the GORE valve) are damaged.

Note that box screws shouldn't be torqued more than 2 Nm. If you exceed the torque, the Helicoil insert may be damaged. We do not recommend using electric drills or electric screwdrivers.

Battery Life Estimates

Battery consumption varies depending on the sampling rate and environmental and wireless network conditions. The following tables provide the battery lifespan in years indicated according to different wireless network conditions.

Note: European radios work between SF7 and SF11, and FCC radios work between SF7 and SF9.

Sampling rate	SF9@14dBm	SF8@20dBm
5 min	3.3 years	3.5 years
1 h	> 10 years	> 10 years
6 h	> 10 years	> 10 years

Table 1: Battery lifespan in years assuming intermediate environmental conditions for European and FCC radios

Data storage

The internal data logger memory size is 4 MB. The wireless tiltmeter stores up to 200,000 readings. Data storage periods are indicated in Table 3. Memory mode is a circular buffer. When the memory is full, logging continues by overwriting the earliest readings. Aside from the sensor readings, the device also collects health data hourly, which indicates the battery voltage, the internal temperature of the device and the device uptime.

Number of sensors	Sampling rate		
	60 minutes	30 minutes	10 minutes
1	more than 10 years	more than 20 years	3.5 years

Table 4: Data storage periods (without overwriting) for the wireless tiltmeter

Data is stored in comma-separated value (CSV) files. You can download readings and health

Calibration

All wireless tiltmeters are assembled, calibrated and tested under stringent quality control standards.

In case recalibration is needed, Worldsensing provides a calibration service. Please contact industrialsupport@worldsensing.com for more information.

For the calibration process, Worldsensing will disassemble the wireless tiltmeter to inspect the mechanical parts before recalibrating the device.

Maintenance

The wireless tiltmeter is packaged in a rugged aluminum box and should provide many years of trouble-free operation.

Wireless tiltmeters require no maintenance other than normal cleaning, battery replacement and inspection of the seals. Apart from this maintenance, the devices are not field serviceable.

The wireless tiltmeter is a precision instrument. Minor external actions or changes in the initial conditions of the structure, such as rust in the supports, construction pathology or thermal behavior, can cause changes in the tilt readings. Visual inspections can help to understand the cause of some registered movements.

The wireless tiltmeter is a robust product but it should be handled carefully like any precision instrument. In particular, take care to avoid any impact, to protect the internal MEMS tilt sensor and to avoid distorting the mechanics of the device.

Regulatory notices

FCC - Regulatory Notices

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

This device complies with part 15 of the FCC Rules.

Operation is subject to the following two conditions:

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

Permitted Antenna

This radio transmitter has been approved by the FCC to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Device	**Interface and frequency range**	**Type**	**Max Gain**
	Unlicensed bands		
LS-G6-TIL90-X	LoRA @900 MHz	Stubby dipole	-3.2 dBi
LS-G6-TIL90-I	LoRA @900 MHz	Adhesive FPC antenna	1.9 dBi

RF exposure safety

This device complies with the FCC RF exposure limits and has been evaluated in compliance with **mobile** exposure conditions.

The equipment must be installed and operated with minimum distance of 20 cm of the human body.

Class A device notice

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

ISED - Regulatory Notices

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

This device complies with ISED license-exempt RSS(s).

Operation is subject to the following two conditions:

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

Permitted Antenna

This radio transmitter has been approved by the ISED to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Device	**Interface and frequency range**	**Type**	**Max Gain**
	Unlicensed bands		
LS-G6-TIL90-X	LoRA @900 MHz	Stubby dipole	-3.2 dBi
LS-G6-TIL90-I	LoRA @900 MHz	Adhesive FPC antenna	1.9 dBi

RF exposure safety

This device complies with ISED RF exposure limits and has been evaluated in compliance with **mobile** exposure conditions.

The equipment must be installed and operated with minimum distance of XX cm of the human body.

CAN ICES-00x (A)

This Class A digital apparatus complies with Canadian ICES-00x.

Avis de Conformité Réglementaire - ISED

Les changements ou modifications non expressément approuvés par la partie responsable de la conformité peuvent annuler le droit de l'utilisateur à utiliser l'équipement.

L'équipement est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

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

Antennes autorisées

Cet émetteur radio a été approuvé par l'ISDE pour fonctionner avec les types d'antennes listés ci-dessous avec le gain maximum autorisé indiqué. Les types d'antennes non inclus dans cette liste, ayant un gain supérieur au gain maximum indiqué pour ce type, sont strictement interdits pour une utilisation avec cet appareil.

Device	**Interface and frequency range**	**Type**	**Max Gain**
	Unlicensed bands		
LS-G6-TIL90-X	LoRA @900 MHz	Stubby dipole	-3.2 dBi
LS-G6-TIL90-I	LoRA @900 MHz	Adhesive FPC antenna	1.9 dBi

Sécurité d'exposition aux RF

Cet appareil est conforme aux limites d'exposition RF d'ISDE et a été évalué conformément aux conditions d'exposition mobile.

L'équipement doit être installé et utilisé à une distance minimale de 20 cm du corps humain.

CAN NMB-00x (A)

Cet appareil numérique de classe A est conforme à la norme canadienne NMB-00x.

CONTACT WORLDSENSING

Need more support? Get in touch with our Customer Success team:
Email: industrialsupport@worldsensing.com
Phone: +34 93 418 05 85 (08.30h - 16.30h UTC)

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