User Guide

Loadsensing Wireless Laser Tiltmeter
LS-G6-LAS-TIL90

WORLD SENSING

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1.Important instructions prior to use

Please read these instructions carefully and ensure that the required conditions specified in this document are met before using the product. Each of our edge devices includes this information inside the packaging

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.

Symbol	Description
	Caution. Do not proceed until the instructions are clearly understood and all required conditions are met.
	Read the instructions for use carefully before using.
	Caution, hot surface.
	According to the European Union WEEE Directive 2012/19/EU, this product and its batteries should not be discarded as unsorted waste. Please send them to separate collection facilities for recovery and recycling. It is your responsibility to dispose of your waste equipment and batteries properly. The correct disposal of your old equipment and batteries will help prevent potential negative consequences for the environment and human health.

2.Device Overview

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

The Loadsensing Wireless Laser Tiltmeter is a long-range, low-power wireless data logger with a laser distantiometer sensor and a 3 axes tiltmeter in the same enclosure. It measures 3-axis inclination with respect to gravity's direction and reports the two axes of rotation from the horizontal plane in any orientation.

This device contains the same distantiometer sensor that the laser node has and the accelerometer sensor than the TIL90-X node.

The wireless laser 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.

Measurement of tunnel convergence is one of the applications for LaserTilt 90, as it may be easily relocated along the convergence cross sections up to the excavation front or until the measured relative displacements are stabilized when the required frequency of measurements is reduced. It can also be used for measuring deformations in underground excavations and mining without causing work disruptions and delays.

3.Device Specifications

You can check the Laser tiltmeter datalogger specifications here

4. System requirements

The LASTIL90 is:

- available from version 2.56 onwards
- Needs to be configured by using the Worldsensing App (instead of the Dlog)
- CMT Edge version: from firmware version 2.5/2.5.1 onwards
- CMT Cloud version: from firmware version 1.6.0 onwards

5. Equipment Provided

The wireless laser tiltmeter **(LS-G6-LAS-TIL90)** has the following elements:

1. Metallic casing
2. USB connector
3. RP N Female connector, which complies with Federal Communications Commission (FCC) regulations, for the sensor network radio antenna
4. Pressure stabilizer for protection against condensation (protective vent)
5. Connector male RP N to RP - SMA male and aerial with RP - SMA male
6. Antenna

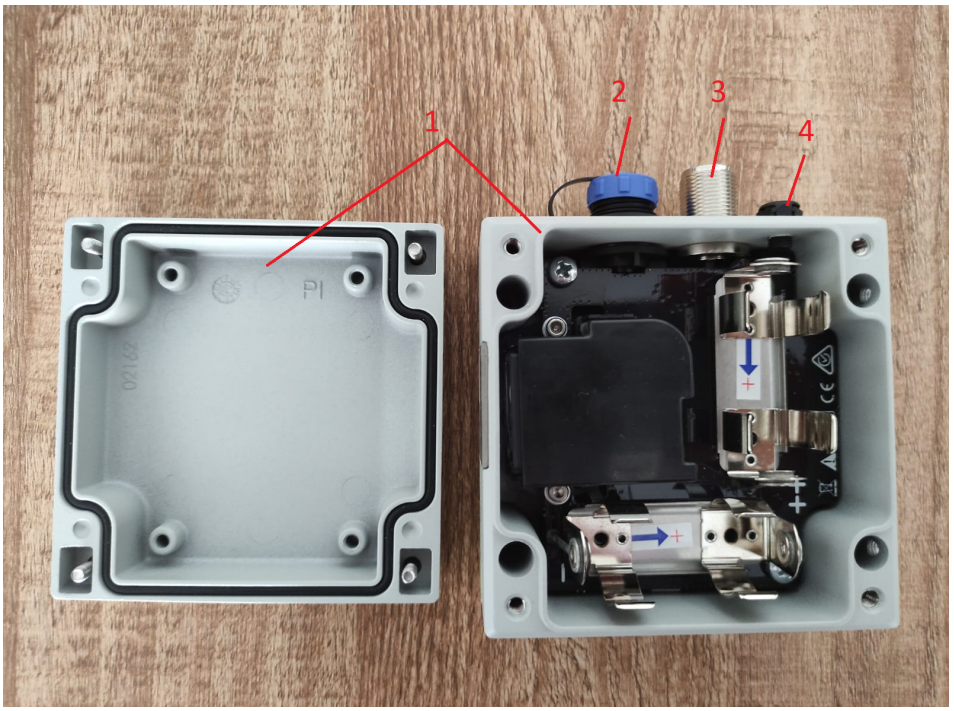


Figure 1: LS-G6-LAS-TIL90 elements

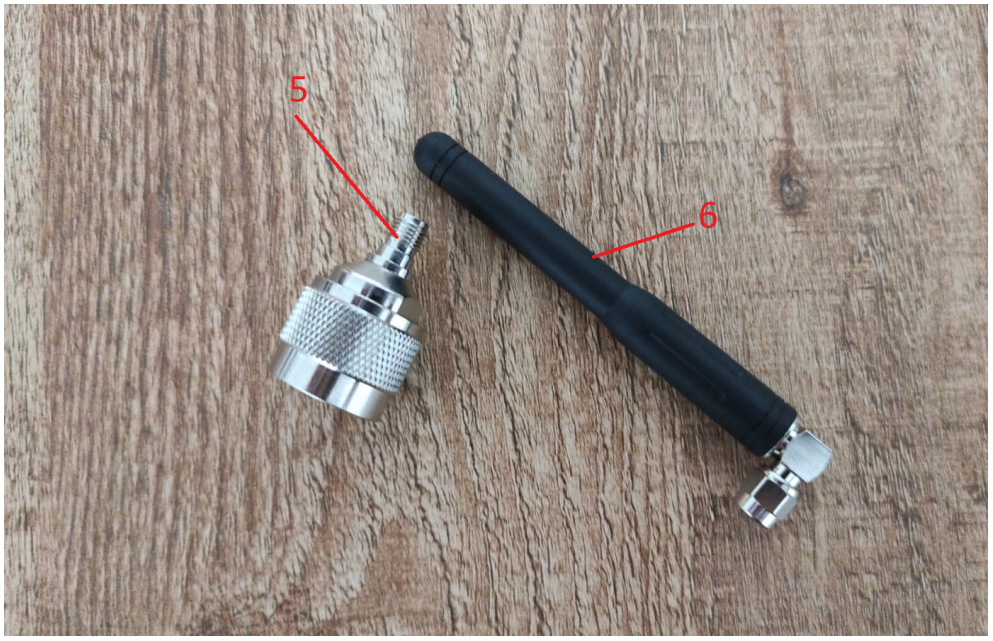


Figure 2: LS-G6-LAS-TIL90 antenna with N-connector

The LS-G6-LASTIL90 can also be equipped with a more robust antenna, placed horizontally, instead of the standard L-antenna that is installed vertically. Please contact us for more details.

The following elements are sold separately:

- Mounting supports. See the mounting instructions for each support
- USB-OTG configuration cable
- Batteries

6. Wireless LS-G6-LASTIL90 installation

The first task of getting your Loadsensing Laser Tiltmeter node up and running on your site is to install it. There are three major factors to consider when installing the node: the various supports you might use according to the application, the mounting of the Laser Tiltmeter node, and powering the node once it is installed. We discuss each of these three here.

6.1 Supports

The Laser Tiltmeter node needs to be mounted on a support. Depending on the application, it needs to be installed with a certain inclination to achieve curved surfaces and on others applications it can be just installed aligned to the surface.

Wireless Laser tiltmeters can be mounted horizontally or vertically, depending on the monitoring objective. Please note that the accessories designed for the TIL90 are also included on the list below and are compatible with the LAS-TIL90.

Adjustable and swivel mounting bracket have been designed specifically for the LAS-TIL90 node in order to achieve inclination:

Description	Code
Mounting plate for vertical mounting	LS-ACC-IN15-VP
Horizontal surface mounting plate	LS-ACC-IN15-HP
Adjustable mounting plate for vertical surface	LS-ACC-LAS-AP
Swivel mounting bracket	LS-ACC-LAS-SB
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 leveling)	LS-ACC-IN15DP
Vertical mounting plate (pole mounting) [1]	LS-ACC-IN15VPP2

[1] *This mounting plate can be useful for some applications, but it will be important to take into account that using it will affect the quality of the data.*

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

7. 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.

   IMPORTANT: **Taking into account the limitations of available space between the two battery holders, Worldsensing only recommends the use of Saft**

LSH14 batteries in the LaserTilt90. Other batteries compatible with different models, such as LM26500, are longer than the LSH14 and cannot be used in the LaserTilt90 equipment, as they could cause unwanted contact between the battery poles, potentially leading to a short circuit. It is important to consider the dimensional aspects when selecting batteries for this device.

Note: The Loadsensing Wireless Laser tiltmeter does not have a 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 with batteries or external power. It does not have a switch to set to battery or external power mode, thus when placing batteries the node will be powered in battery mode and while using an external power mode, the node will be powered by external power mode.

8. Loadsensing Device Configuration

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

Device configuration has to be carried out using Worldsensing Android app, WorldsensingApp, which is compatible with USB On-The-Go (OTG) Android devices. Please refer to the Worldsensing App for more details. To make sure the app works properly, we recommend purchasing one of the mobile phone models in stock from Worldsensing. Please contact the technical support team for more information.

WorldsensingApp starts up once the Android device is connected to the Loadsensing node using an USB-OTG cable. It does not need to be started up manually.

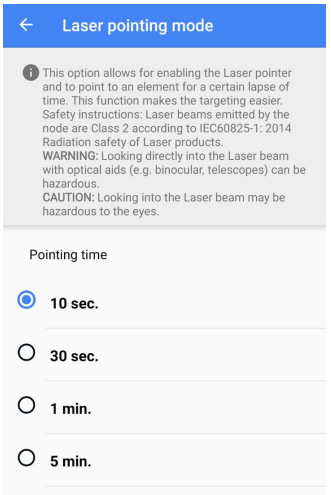
The whole configuration process takes no more than five minutes. From then on, the Loadsensing node will start taking readings and sending data to the gateway.

Please take note of the following credentials in the Gateway Information Sheet. These will be necessary to perform the radio coverage test:

Gateway Information Sheet	Mobile app field
Default network ID	Network ID
Default network key	Password
Default network access password	Server password

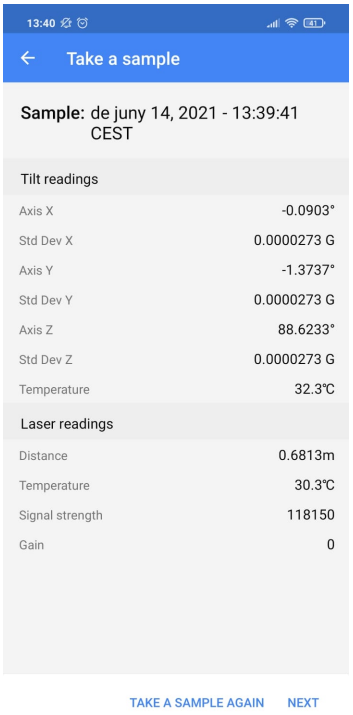
The process for configuring the LASTIL90 node is the same as the other nodes and it is detailed on the WorldsensingApp user guide. There are some functionalities that are particular for the LASTIL90 node as the **Laser pointing mode**.

When displaying the WorldsensingApp main menu, the laser pointing mode will be available. This feature allows enabling the Laser pointer and to point to an element for a certain lapse of time. By default is set to 10 sec, but it can be configured to other lapses of time.



This node integrates two sensors, so it is not necessary to configure the sensor's settings on the WorldsensingApp. Once the radio configuration is finished the app will show the

option of taking a sample. Taking a sample will show the parameters measured and allow you to check the consistency of the readings.



The app will show information from the two sensors. On the top, tiltmeter readings: the 3-axis inclination measurement with respect to gravity's direction, its standard deviation (expressed in Gravity) and also the internal temperature of the node.

3-axis Inclination measured by the tiltmeter is calculated as the average of a certain amount of acceleration samples in a period. At the same time the standard deviation of the sample is obtained, and it could be useful to filter anomalous readings collected by the Til90 affected by some movements.

For the laser readings, distance in meters, temperature and signal parameters (Signal Strength and Gain) will be shown. Please refer to the Laser user guide for more information about these parameters.

The Loadsensing node will display an error prompt on the screen if it needs to be recovered. Click on 'Accept' and the firmware will be updated to recover the device.

9. Safely Closing the Device

The wireless Laser tiltmeter has undergone watertightness testing by an external laboratory and has been rating 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 IP68.

Note: We can't guarantee the 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.

10. Understanding data

As mentioned before, this node has two sensors: the accelerometer, which is the same used for the wireless TIL90-X and the laser disto. For understanding data from the wireless

tiltmeter, please refer to the user guide where several aspects are discussed such as parameters measured and their meaning and information about calibration (for TIL90).

In this chapter we will review the laser part, which can be also found at the discontinued LASER node user guide.

The Laser node reads and transmits four values:

- Distance in meters
- Temperature in Celsius degrees
- Gain - the magnitude which expresses the relation between the output signal amplification respect to the input signal
- Signal Strength - the amount of signal that receives the photoelectric sensor; the range is 0-3,300,000 uV

The table below presents the range of values for both parameters where the Laser can operate. The colors of a traffic light have been used to classify the signal strength according to the following thresholds.

Signal Strength	Gain
< 512 : Error code @255:: Too Low	Gain = 0 (High Gain; Enough signal strength)
~ 2000	
~ 10000	
10000 < x < 200000	
40000 < x < 260000	Gain = 1 (Low Gain; too much signal strength; Reduction by 5 factor)
~ 260000	
~ 320000	
> 350000 : Error code @256:: Too High	

Any Signal Strength value in the green or orange areas of the table above is guaranteed to be in specifications with a Signal Strength value located in the green or orange area.

However, in the orange area, due to the nature of the Laser, the Signal Strength has more variability and is susceptible to fall into red zones, where they will display a **Not enough Signal Strength** error.

If the signal strength of the Laser beam falls into the red area an error will be displayed. For more information, please refer to the Troubleshooting section.

10. 1 Deployment recommendations

The signal can be influenced by several factors, such as type or nature of the target and weather conditions of the environment.
The following is a list of common conditions and the recommendation to follow for Target and Environment when deploying the Laser node.

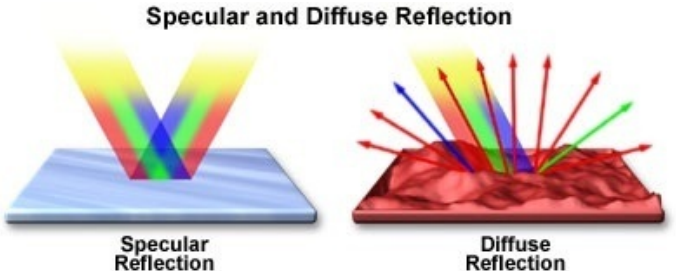
10.1.1 Target

Target color, type of surface, and material affects the quality of the signal (Signal Strength). There are use cases where it is better to avoid some types of targets. In the following table we describe when to use any kind of target.

Target color/surface	Use this target when Laser reports
White (Increases Reflectance)	Poor Signal Strength (near lower limit)
Black (Decreases Reflectance)	Excess of Signal Strength (near upper limit)

If a target is not available then the Laser can be aimed at the natural surface. An important advantage of using a target is to avoid irregular surfaces and to identify the two points between which the relative distance is measured. Check that the strength is within the limits presented in the previous section.

Lambertian reflectance of the Target	Use case
Metallic (Specular, in a single direction)	Optimal for long distances (>20 m)
Matte (Diffuse, in all directions)	Optimal for short distances (<20 m)



Example of Lambertian Reflectance

10.1.2 Environment

Environment, luminity, dust, wind and in general any weather condition also affects the quality of the signal (Signal Strength). The following is a table with a list of typical conditions and how they affect it.

Luminity	Implication
Cave	Signal Strength not affected. Optimal scenario.
Artificial light or natural light exposure	Signal Strength is affected depending on the direction of the external light; however, not enough to affect the quality of the signal. Standard scenario.
Direct Sunlight into the Laser receiver	Signal Strength is severely affected, Laser receiver will saturate. Avoid this scenario.

Temperature	Implication
Cold (<10°C)	Signal Strength is not affected.
Ambient (~20 °C)	Signal Strength is not affected. Optimal scenario.
Hot (>45 °C)	Signal Strength is not affected if sunlight is not hitting directly into the Laser receiver.

10.1.3 Other

There are other factors that can affect also the Signal Strength, here is a list of other parameters that are present in the deployment and should be taken into consideration to determine if the deployment is good enough for the Signal Strength to be within recommended values:

- Inclination of target surface: decreases signal strength
- Irregularity of target surface: the distance measurement is subject to where the Laser is pointing. Any movement within the irregularity target surface could report undesired distance changes
- Dust of the environment: decreases the signal strength, however it will only be a problem in severe dust conditions

10.2 Pointer accessories

As explained earlier, for some installation conditions it may be required to use some target foils. Targets may help the Laser node to work well and execute the measurement, even in less favorable conditions, at the maximum specified accuracy. The use of targets for Laser distance measurements helps improve the measuring conditions to reach the specified accuracy based on the device when there is a need for long distances, or the environment light is not ideal.

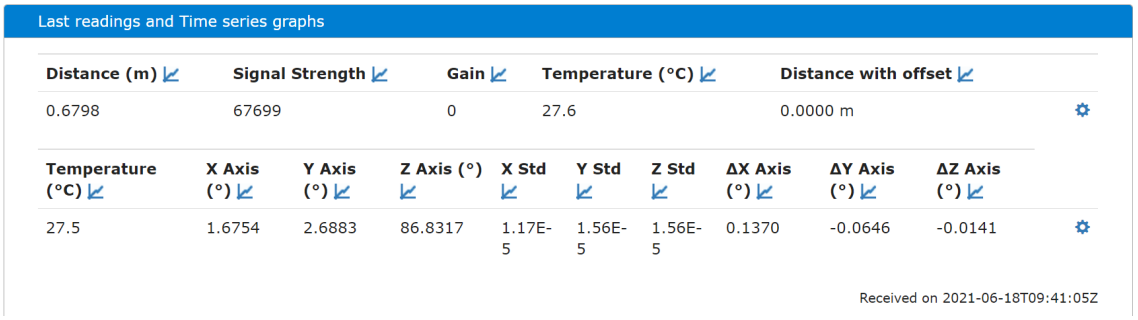
Special plates with color marks can help aiming at specific points or specific form factors, as well as when measuring corners.

Reflectant targets and prisms used in surveying are not recommended for this purpose; opaque surfaces must be used. The prisms are designed to improve the quality of the measurements using a total station. In the case of a laser distance node, the result is opposite because round prisms and their circular housing can compromise the accuracy of the laser distance meter to up to 3 mm. Regarding the reflective target marks, depending on the application, the laser measurement can be affected by an excess of reflectance. In addition, bireflex targets used for tunnel convergence monitoring using total stations can be too transparent. It is possible to use these bireflex targets by applying white and matt tape above the reflective surface.

Worldsensing has designed a special target for easily improving the quality of the signal and measuring conditions that can be ordered with the code WS-ACC-LAS-TG. You will find more information about material provided, ways of fixing it to the surface and also possible orientation on the mounting instructions.

11. Dataserver visualization

When connecting the LASTIL90 to the Dataserver, last readings referred to each of the sensors will be shown.


Last readings and Time series graphs

Distance (m)	Signal Strength	Gain	Temperature (°C)	Distance with offset
0.6798	67699	0	27.6	0.0000 m

Temperature (°C)	X Axis (°)	Y Axis (°)	Z Axis (°)	X Std	Y Std	Z Std	ΔX Axis (°)	ΔY Axis (°)	ΔZ Axis (°)
27.5	1.6754	2.6883	86.8317	1.17E-5	1.56E-5	1.56E-5	0.1370	-0.0646	-0.0141

Received on 2021-06-18T09:41:05Z

Note that with the LASTILT90 it is possible to calculate the **vertical settlement** by selecting the formula "vertical settlement". This formula allows calculating the settlement by doing certain assumptions (such as the target is only affected by settlement and

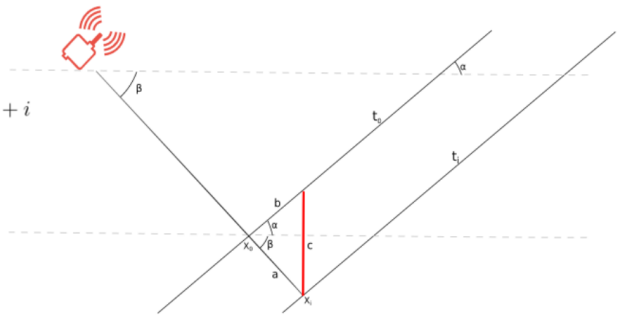
maintains the inclination) and using the inclination measured by the node with respect to the horizontal plane.

Additional parameters must be typed to do the conversion, such as the Initial distance reading from the node to the target surface and the target angle (angle of the target with respect the horizontal plane). A drawing for better understanding is attached.

Formula:

Vertical Settlement

$$c = h[\sqrt{a^2 + b^2 - 2ab\cos(\alpha + \beta)}] + i$$
$$a = X_0 - X_i$$
$$b = \frac{a \cdot \cos(\beta)}{\cos(\alpha)}$$



X_0: Initial distance reading from the node to the target surface.
X_i: Current distance reading from the node to the target surface.
α: Target angle.
ß: Current Y axis angle measurement on the horizontal plane.

Besides the vertical settlement formula, there are other conversions that can be done, such applying the distance formulae that allows to convert from meters to other units and also apply an offset, and all the formula for the tiltmeter such as:

- Angle variation

$$\Delta X = X_i - X_0$$
$$\Delta Y = Y_i - Y_0$$
$$\Delta Z = Z_i - Z_0$$

ΔX: Angle variation in degrees
ΔY: Angle variation in degrees
ΔZ: Angle variation in degrees
X_i: Current angle reading in degrees
Y_i: Current angle reading in degrees
Z_i: Current angle reading in degrees

Where:

AX: angle variation in degrees
AY: angle variation in degrees
AZ: angle variation in degrees
X_i: Current angle reading in degrees
Y_i: Current angle reading in degrees
Z_i: Current angle reading in degrees

- *Tangent generic equation (necessary to adjust it for the two axis)*

$$E_A = C_A tan(A_i - A_0) + D_A$$
$$E_B = C_B tan(B_i - B_0) + D_B$$

E: Converted data in units
A_i: Current angle reading in degrees
B_i: Current angle reading in degrees

Where:

A_0: Offset in degrees
C_A: Multiplicative factor
D_A: Offset in units
B_A: Offset in degrees
C_B: Multiplicative factor
D_B: Offset in units

- *Sine generic equation (It is necessary to adjust it for the two axis)*

$$E_A = C_A sin(A_i - A_0) + D_A$$
$$E_B = C_B sin(B_i - B_0) + D_B$$

E: Converted data in units
A_i: Current angle reading in degrees
B_i: Current angle reading in degrees

Where:

A_0: Offset in degrees
C_A: Multiplicative factor
D_A: Offset in units
B_A: Offset in degrees
C_B: Multiplicative factor
D_B: Offset in units

Note: these formulae have been implemented since Gateway firmware version 2.6

12. Errors implemented

When an error is returned a new timestamp is registered on the reading error CSV file on the Gateway, the reading file will show blank readings corresponding to that timestamp.

There are several errors that can be returned on the CSV file, related to the tiltmeter sensor or the laser distance meter. On the table below there is a relation between the codes and the error description for each sensor:

Sensor	Type	Code	Description
accelerometer	General	1	Sensor does not respond
	Specific	2	Sensor self test error.
		3	Sensor temperature bad reading.
Laser	General	1	Laser module is either too hot or too cold.
		2	Not enough reflection from target or distance out of range.
		3	Too much reflection from the target.
		4	Too much sunlight on the laser.

13. Maintenance and troubleshooting

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

The LS-G6-LASTIL90 node may need some maintenance in regards to the laser module part, especially on tunnel or civil applications where the activities generate dusty environments.

Gain and signal strength can allow the user to schedule cleaning tasks. Note that it is not necessary to clean the surface if the Laser node continues transmitting the measured

distance (signal strength of the Laser beam is between 512 and 350000 uV). Outside these values, the Laser will return an error.
Worldsensing recommends that for deployment in severely dusty environments the Laser node be cleaned if the Signal Strength is lower than 2000 uV.

Besides the regular maintenance that may be required and acknowledged by signal strength parameters, the laser tiltmeter would require no maintenance other than normal cleaning, battery replacement and inspection of the seals. It is important to take into account that this device is not field serviceable.

It is important to take into account that the LS-G6-LAS-TIL90 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.

It is important to avoid any impact to protect the internal sensors and to avoid distorting the mechanics of the device, as the reliability of the readings can be affected by impacts, high vibration levels or Water ingress or water ingress. The wireless node should never be submerged in water. **WATER DAMAGE TO INTERNAL COMPONENTS VOIDS THE WARRANTY.**

In case of doubt regarding the reliability of the readings, first inspect the wireless node mounting and the structure where it is attached. Any compromise to or mechanical deformation of the mounting hardware can cause unstable readings.
After ruling out issues related to the structure or the mounting hardware, we recommend installing the device on a known stable place and compare data. If the results of the wireless tiltmeter lead to think that the unit is not working as expected, please open a ticket to support@worldsensing.com in our Help Center to request a Return Material Authorization (RMA).

After receiving the device, Worldsensing will inspect the mechanical parts, reassemble and recalibrate the device. If this occurs after expiration of the warranty, Worldsensing will repair the equipment at its factory and may require additional charges for parts and labor charges. Worldsensing will provide a quote for repairs, if feasible, for products returned after warranty expiration.

Worldsensing is not liable for damages or erroneous decisions caused by defective units, since it is only responsible for the warranty of the equipment.

14. Battery Life Estimates

Battery consumption varies depending on several factors such as the sampling rate, environmental and wireless network conditions, temperature profile of the installation site and also for the LASTIL90 from the length of the distance that is being measured .

The following tables provide the battery lifespan in years based on the SAFT mathematical model for specific radio transmission conditions (SF9@14dBm and SF8@20dBm), considering different temperature profiles and also the length of the distance measured.

Sampling rate	Lifetime estimate in years (SF9@14dBm)					
	Distance =20 m			Distance =65 m		
	Singapore	Barcelona	Moscow	Singapore	Barcelona	Moscow
30 s	-	0,17*	-	-	0,05*	-
5 min	1.5	1.6	1.8	0.5	0.5	0.5
1 h	7.9	9.1	10.9	4.6	4.2	5.3
6 h	10.5	12.9	16.2	10.8	9.1	13.1

Table 3: Lifetime estimations in years based on the mathematical model from Saft, for typical Europe radio configuration (Spreading factor 9 and radio transmit power 14 dBm), obtained for 20 m and 65 m considering three different temperature profiles. Consumption varies depending on sampling rate and environmental and wireless network conditions. * These values have been extrapolated using Worldsensing model, which considers wireless network conditions and also SAFT LSH14 battery parameters and they can be used as an approach.

Sampling rate	Lifetime estimate in years (SF8@20dBm)					
	Distance =20 m			Distance =65 m		
	Singapore	Barcelona	Moscow	Singapore	Barcelona	Moscow
30 s	-	0,17*	-	-	0,05*	-
5 min	1.6	1.7	1.7	0,5	0,5	0,5
1 h	8	9,3	9,9	4,2	4,7	4,8
6 h	10,5	13	14,6	9,1	10,9	11,9

Table 3: Lifetime estimations in years based on the mathematical model from Saft, for typical Europe radio configuration (Spreading factor 8 and radio transmit power 20 dBm), obtained for 20 m and 65 m considering three different temperature profiles. Consumption varies depending on sampling rate and environmental and wireless network conditions. * These values have been extrapolated using Worldsensing model, which considers wireless network conditions and also SAFT LSH14 battery parameters and they can be used as an approach.

15. Data storage

The internal data logger memory size is 4 MB. The wireless tiltmeter can store more than 100,000 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.

Sampling rate		
60 minutes	30 minutes	5 minutes
~12 years	~6 years	1 year

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

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

To do this, connect an Android device to the data logger Mini USB port with a USB-OTG cable. When WorldsensingApp loads, press “Download data” , You need to set a start and end date for the data you want to download or alternatively you can enable “All data”. The Android device allows these CSV files to be opened with applications such as e-mail or cloud apps. Files are also stored in the device memory, on the SD card in the Dlog folder.

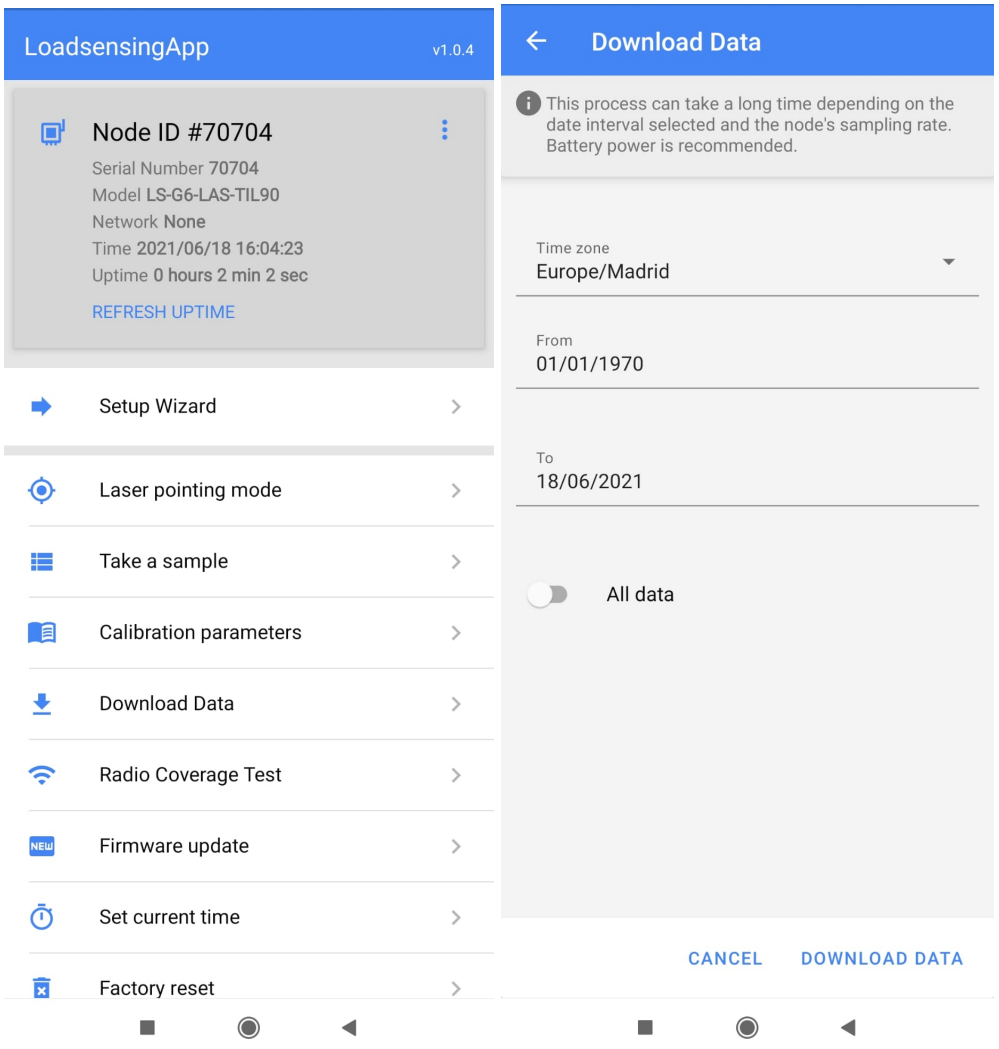


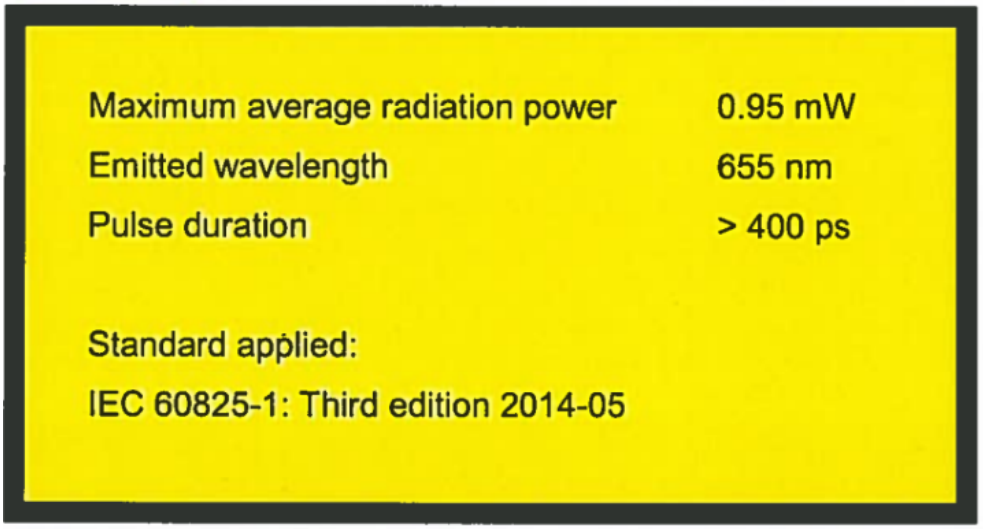
Figure 14: Downloading data manually from the wireless LASTIL90

16. Safety instructions

Laser beams emitted by the node are Class 2 according to IEC60825-1: 2014 Radiation safety of Laser products.

WARNING

Looking directly into the Laser beam with optical aids (e.g. binocular, telescopes) can be hazardous.
Looking into the Laser beam may be hazardous to the eyes.



17. Laser classification Certificate

- when it has to be right

Leica Geosystems

Leica Geosystems
Laser Classification Certificate

Supplier	Leica Geosystems AG, CH-9435 Heerbrugg
Consignee	to whom it my concern
Product Identification	Leica EDM Sigma 1 Module
Standard applied	IEC 60825-1:2014
Author	Dr. Thomas Piok

Certificate

We hereby certify that the Leica product **EDM Sigma1 Module** complies with

Class 2 Laser Product

According to the applied standard and the laser classification document Nr.
LSC_Sigma1 EDM Module v3.pdf

Leica Geosystems AG

Dr. Thomas Piok
Head of the Laser Classification Laboratory

October, 4th, 2017

Wolfram Mathis
Project Manager
Quality Management

Leica Geosystems AG
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18. FAQs

In this section, particular FAQs from TIL90 sensor are not covered.

Why using the combination of a laser and tiltmeter sensor? Which advantages present the LASTIL90 in front of the LASER node?

The main advantage of the laser tiltmeter node is that it measures distance and at the same time 3 axes inclination. This combination allows us to use it for specific applications, for example for vertical settlement calculations on tunnel crown.

Is the LASTIL90 node suitable for high vibration environments?

The LASTIL90 has two sensors with different vibration resistance specified by the sensor manufacturer, published in the technical datasheet.

From the accelerometer side, the sensor can't be subjected to acceleration levels up to +8g.

From the laser distantiometer sensor we refer to standard ISO 9022-3, Method 36, Severity 05 (0.15mm, 10Hz..55Hz). The laser sensor has a much more restrictive resistance and this is a point that would need to be assessed according to the vibration levels expected on the project, in particular for tunnel project excavation where blasting activities will be carried out.

In case that the LASTIL90 does not comply with the vibration requirements from the project, as Loadsensing devices are easy to install, one possibility would be uninstalling devices during the blasting period and reinstalling them once the activities have finished.

What is the temperature influence on the laser measurement? and the weather conditions?

The change of temperature and weather conditions of the deployment can affect the measurements of the laser. However, temperature influence is included on the accuracy of the sensor according to reading conditions. See the technical specifications from the sensor.

The weather conditions of the deployment can affect the measurements of the Laser Node. However, the resulting measurements comply with the accuracy of the sensor according to reading conditions. See the technical specifications from the sensor. In addition, Signal Strength can vary due to the luminosity descension.

For further information and real scenario data signal analysis regarding temperature and weather conditions please refer to this document.

How can I know that some maintenance on the node is needed?

Please refer to the Maintenance and troubleshooting section from this document.

What happens if the laser gets out of the target? How can I detect it?

When the laser gets out of the target the Signal Strength will fall immediately and it will be also a variation of the distance measured. The combination of both parameters will be key to determine it.

What happens when pointing to an irregular surface? What are we measuring?

When pointing to an irregular surface, the edges will hold different signal strength and distance measure will be the one that holds more power (the biggest irregularity).
Please note that inclination of the target surface is relevant as it can decrease signal strength. The optimal situation is when the laser is pointing perpendicular to the target surface.

Do I need to use a target by default where the laser can aim?

The use of a target is not strictly mandatory, although that it can help to improve the measuring conditions to reach the specified accuracy based on the device for certain cases.

It is recommended for its use when measuring distances on irregular surfaces or when the environmental light is not ideal, or even when the laser cannot point perpendicular to the surface.
This might be the case for NTAM tunnel applications where shotcrete covers the tunnel surface to be measured and other types of applications that have similar characteristics.

Environmental best practices

Installation and operation

Please install Worldsensing products in an energy-efficient manner by minimizing power usage for computers, mobile phones or other devices needed for setup and configuration. Minimize the use of small components needed for installation, like mounting brackets and other connection materials. Avoid using toxic materials and/or hazardous substances.
- Set the sampling rate only in the nodes you need.
- When configuring the nodes, use "Set last configuration" whenever possible.
- Remove the batteries if you are not using the node.
- For nodes with switch, use the usb mode when not in operation.

Return Material Authorization (RMA)

In the event of requesting a Return Material Authorization (RMA) please make sure to use the most environmentally friendly mode of transportation possible.

Product End of Life and disposal

Please take the necessary measures to extend the life of the product and reuse it when possible.
Once the product reaches its end of life (EoL) recycling is crucial to divert material from waste streams into new applications.
Electrical and electronic devices, and batteries must be recycled according to the European Union WEEE Directive 2012/19/EU.
Please separate batteries from equipment.
This product and the batteries it may contain should not be discarded as unsorted waste. Please send them to separate collection facilities for recovery and recycling.

Product packaging

Worldsensing's product packaging is recyclable. Separate the different materials for a correct waste management.

Safety and emergency procedures

Please read the safety sheet that comes with our products before installing them. For safety information on batteries and other materials, as well as instructions in case of emergency please read the safety information available at: https://info.worldsensing.com/safety-information/
In the case of an emergency and after it has been managed, please evaluate the waste generated in order to dispose of it in accordance with current legislation and local regulation.
It is your responsibility to dispose of your waste equipment, batteries and packaging properly to help prevent potential negative consequences for the environment and human health.

The cost of environmental waste management is included in the battery's selling price.
By following these best practices you can help protect the environment. Thank you for your cooperation.

CONTACT WORLDSENSING

Need more support? Get in touch with our Customer Success team:
Email: support@worldsensing.com

Phone: +34 93 418 05 85 (08.30h - 16.30h UTC)

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