Loadsensing LS-G6 Laser Node

Configuring and operating the Loadsensing LS-G6 Laser node

Overview of the Laser node

This user guide explains the basic procedure for configuring and making operational the Loadsensing LS-G6 Laser node by Worldsensing. Further technical description is available in the datasheets.

The Loadsensing Laser node is a low-power long-range wireless datalogger and distance meter in a single compact box. It measures distance with a highly precise Leica Laser module. The Laser node can also be used as a standalone logger for manual monitoring and can be configured easily and connected with a USB cable and an Android phone.

It is designed for different applications including monitoring convergences in tunnels, on civil works, and in underground mining, and also for continuous remote monitoring of landslides and slope movement, in particular open pits.

Equipment provided

The Worldsensing LS-G6-Laser node is shipped with the following accessories:

- Laser node
- Antenna
- Antenna adapter

The package does not include:

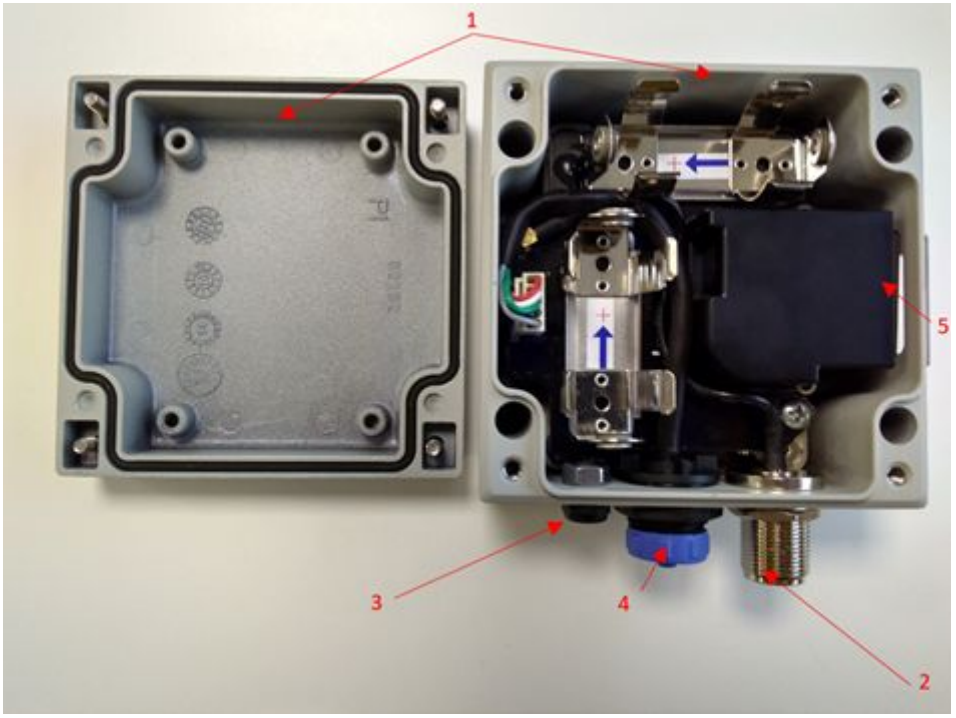
- USB-OTG configuration cable
- Batteries
- Grounding connector
- Mounting support

The Laser node comprises:

1. Casing
2. RP N Female connector
3. Gore valve for protection against condensation
4. External mini USB B Female connection

5. Laser module case
6. Connector male RP N to RP - SMA male and aerial with RP - SMA male

See the labels in the photos below for the position of each component.



Laser node and its labelled component parts

LS-G6-INC15 Antenna with N-connector

Laser node installation

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

Supports

The Laser node needs to be mounted on a support. Depending on the application, the Laser node 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.

Four types of support have been designed in order to cover these applications:

- Fixed mounting for vertical surfaces (LS-ACC-IN15VP-4)
- Fixed mounting for horizontal surfaces (LS-ACC-IN15HP)
- Adjustable mounting plate (LS-ACC-LAS-AP)
- Swivel mounting bracket (LS-ACC-LAS-SB)
- Vertical mounting plate (pole mounting) (LS-ACC-IN15VPP2)

For the first three types of supports (fixed, adjustable, and swivel), supports can be attached to the Laser node using threaded rods and chemical anchors (bonded anchors) or using torque-controlled expansion anchors that go into the surface. Three-point mounting is the best option because it prevents bending and torsion that can lead to unstable readings. Single-anchor mounting is more prone to drift and disturbance. It is not recommended for long-term applications.

For long-term applications, chemical anchors are preferable because their performance is more stable and their vibration resistance is higher. Torque-controlled expansion anchors can also be used, but only if the mounting plate or bracket is drawn tight against the surface and cannot shift laterally.

We recommend sourcing the chemical anchors locally because they are considered dangerous goods for air transportation. If you want to install chemical anchors, Worldsensing can supply the

mounting plates with the M4 lock washers and socket screws required to attach the tiltmeter to the mounting plate. Please contact us with questions or for additional details.

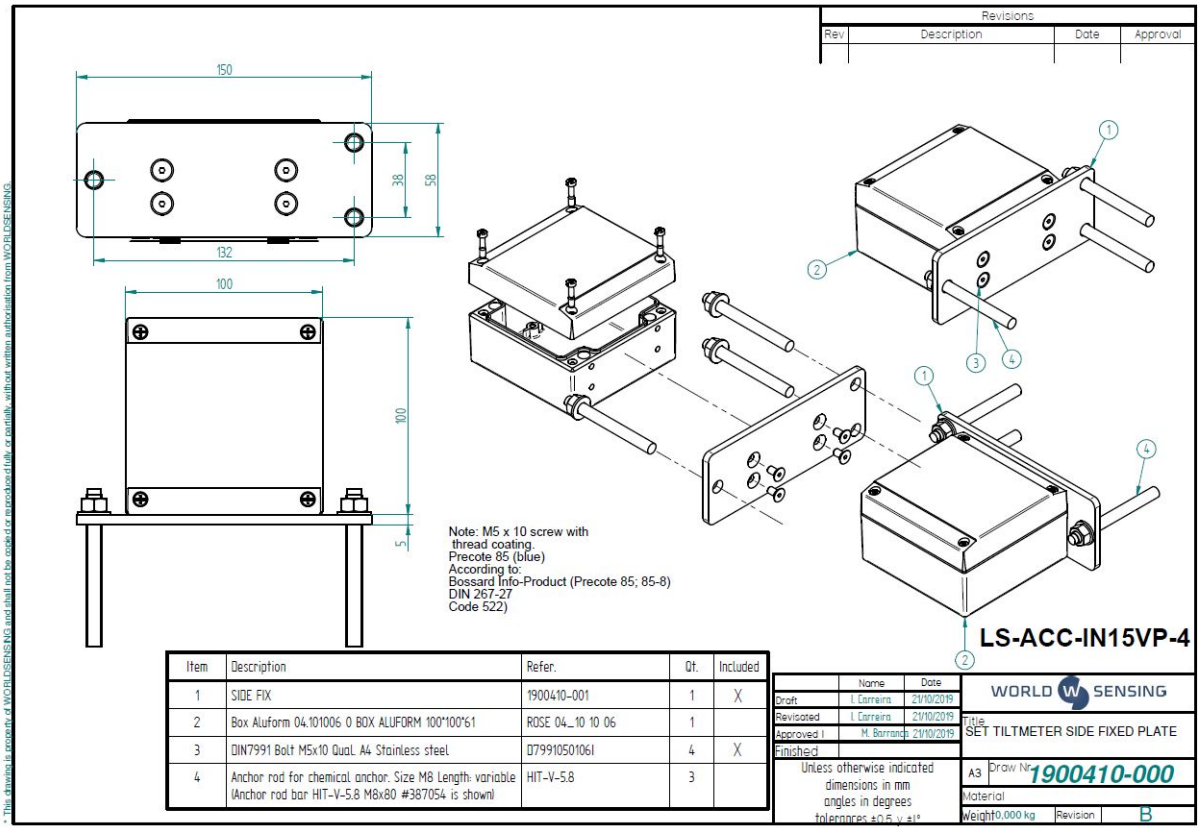
Fixed mounting for vertical surfaces

The fixed mounting does not allow any movement. It is possible to use the same fixed mounting brackets and plates compatible with Loadsensing wireless tiltmeter.

Product code: LS-ACC-IN15VP-4

Vertical mounting plate (aluminium). Wall mounting. (Anchor bolts are not included)

In this case, the laser beam is perpendicular to the vertical surface plane.



Fixed mounting for vertical surfaces, exploded diagram

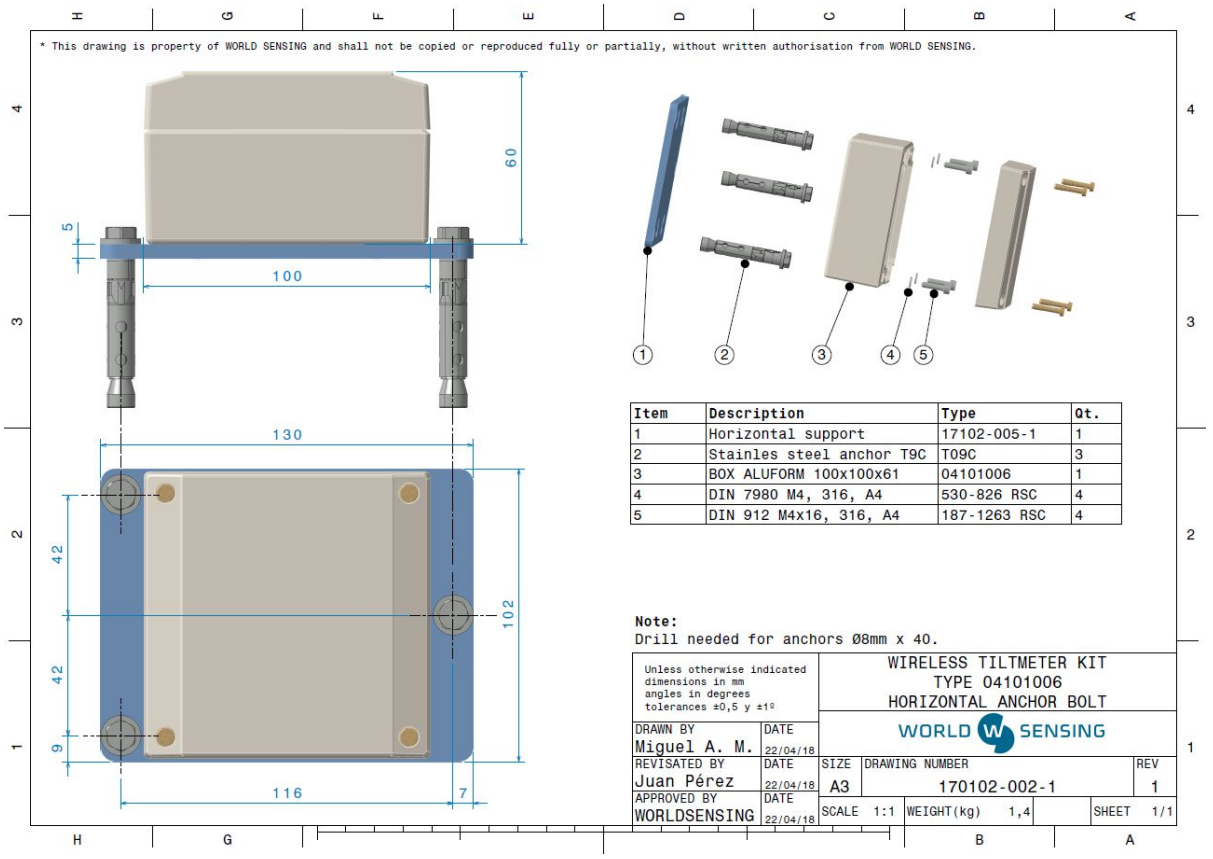
Fixed mounting for horizontal surfaces

The fixed mounting does not allow any movement. It is possible to use the same fixed mounting brackets and plates compatible with Loadsensing wireless tiltmeter.

Product code: LS-ACC-IN15HP

Wireless tiltmeter horizontal mounting plate

In this case, the laser beam is parallel to the surface plane.

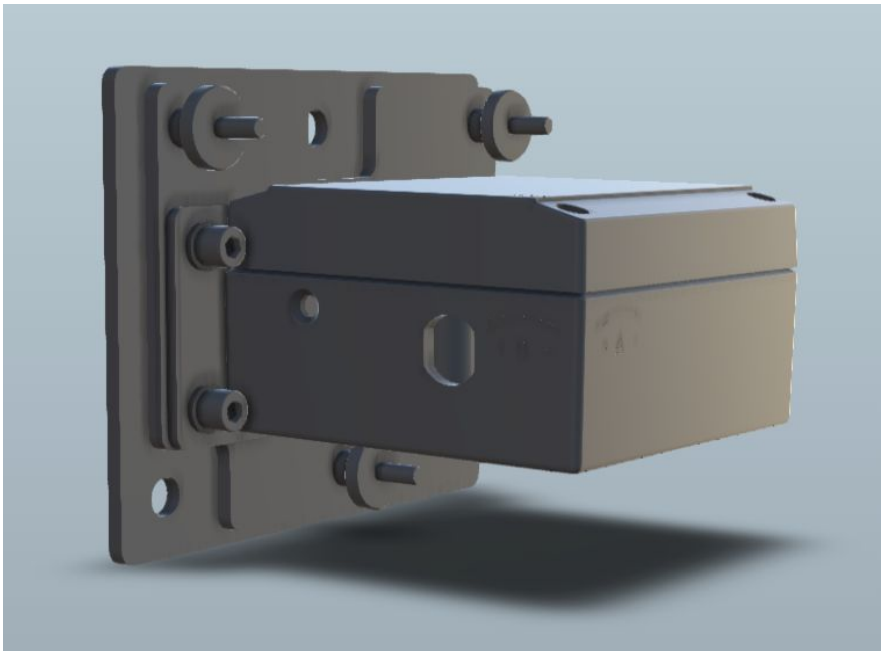


Adjustable mounting plate

For use on vertical surfaces, this support allows limited rotation in two axis with respect to the reference surface. It can be fixed to the surface with the same bolts as the fixed mounting plate. This support is proper for fine aiming of the laser beam.

Product code: LS-ACC-LAS-AP

Adjustable mounting plate for vertical surface. (Anchor bolts are not included)



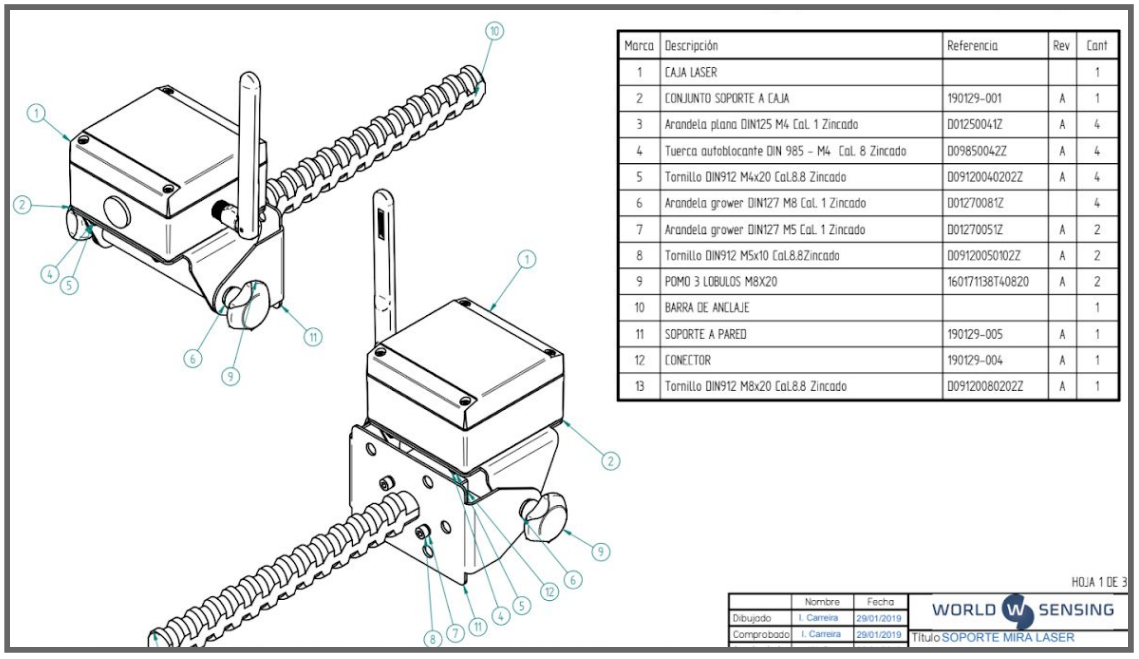
Adjustable mounting plate

Swivel mounting bracket

The swivel mounting bracket allows swivelling around the vertical axis (+/- 90°) and a minor rotation of the enclosure on the plate (+/- 3°). It can be mounted on a wall or on a convergence bolt with ⅜" male thread.

Product code: LS-ACC-LAS-SB

Swivel mounting bracket. For a wall or a convergence bolt with 3/8". (Anchor bolts are not included)



Marca	Descripción	Referencia	Rev	Cant
1	CAJA LASER			1
2	CONJUNTO SOPORTE A CAJA	190129-001	A	1
3	Arandela plana DIN125 M4 Cal. 1 Zincado	D012500417	A	4
4	Tuerca autoblocante DIN 985 - M4 Cal. 8 Zincado	D09850042Z	A	4
5	Tornillo DIN912 M4x20 Cal.8.8 Zincado	D091200402022	A	4
6	Arandela grower DIN127 M8 Cal. 1 Zincado	D012700817		4
7	Arandela grower DIN127 M5 Cal. 1 Zincado	D012700517	A	2
8	Tornillo DIN912 M5x10 Cal.8.8Zincado	D091200501022	A	2
9	POMO 3 LOBULOS M8X20	160171138T40820	A	2
10	BARRA DE ANCLAJE			1
11	SOPORTE A PARED	190129-005	A	1
12	CONECTOR	190129-004	A	1
13	Tornillo DIN912 M8x20 Cal.8.8 Zincado	D091200802022	A	1

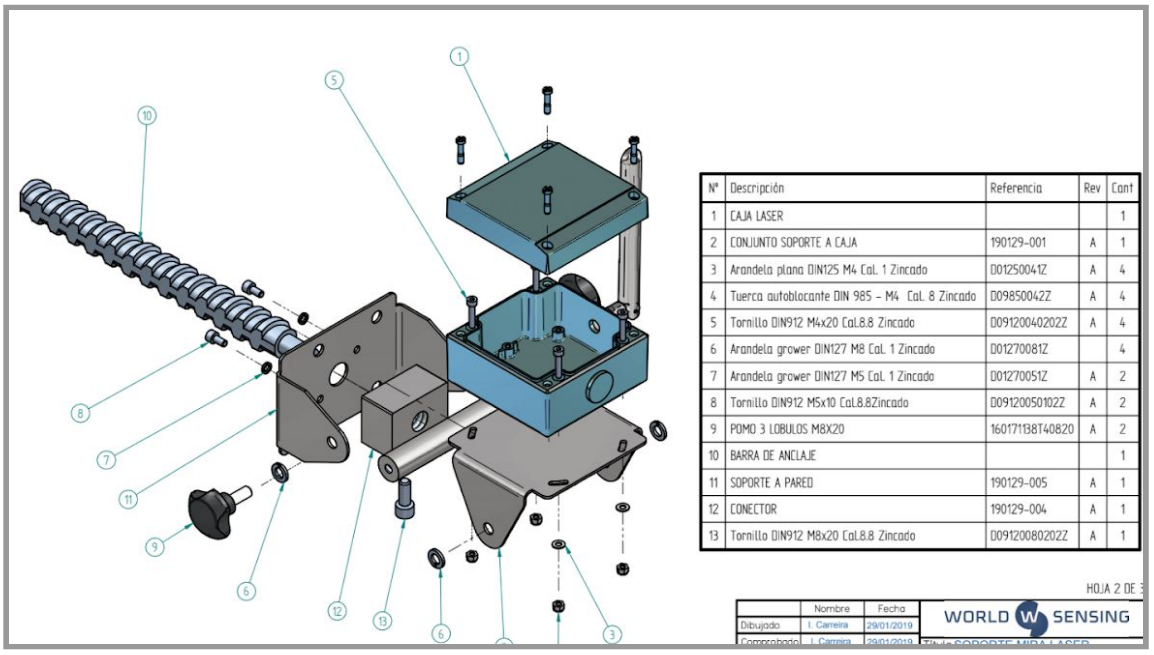
HOJA 1 DE 3

	Nombre	Fecha
Dibujado	I. Carreira	29/01/2019
Comprobado	I. Carreira	29/01/2019

WORLD SENSING

Título SOPORTE MIRA LASER

Swivel mounting bracket



Nº	Descripción	Referencia	Rev	Cant
1	CAJA LASER			1
2	CONJUNTO SOPORTE A CAJA	190129-001	A	1
3	Arandela plana DIN125 M4 Cal. 1 Zincado	D012500417	A	4
4	Tuerca autoblocante DIN 985 - M4 Cal. 8 Zincado	D09850042Z	A	4
5	Tornillo DIN912 M4x20 Cal.8.8 Zincado	D091200402022	A	4
6	Arandela grower DIN127 M8 Cal. 1 Zincado	D012700817		4
7	Arandela grower DIN127 M5 Cal. 1 Zincado	D012700517	A	2
8	Tornillo DIN912 M5x10 Cal.8.8Zincado	D091200501022	A	2
9	POMO 3 LOBULOS M8X20	160171138T40820	A	2
10	BARRA DE ANCLAJE			1
11	SOPORTE A PARED	190129-005	A	1
12	CONECTOR	190129-004	A	1
13	Tornillo DIN912 M8x20 Cal.8.8 Zincado	D091200802022	A	1

HOJA 2 DE 3

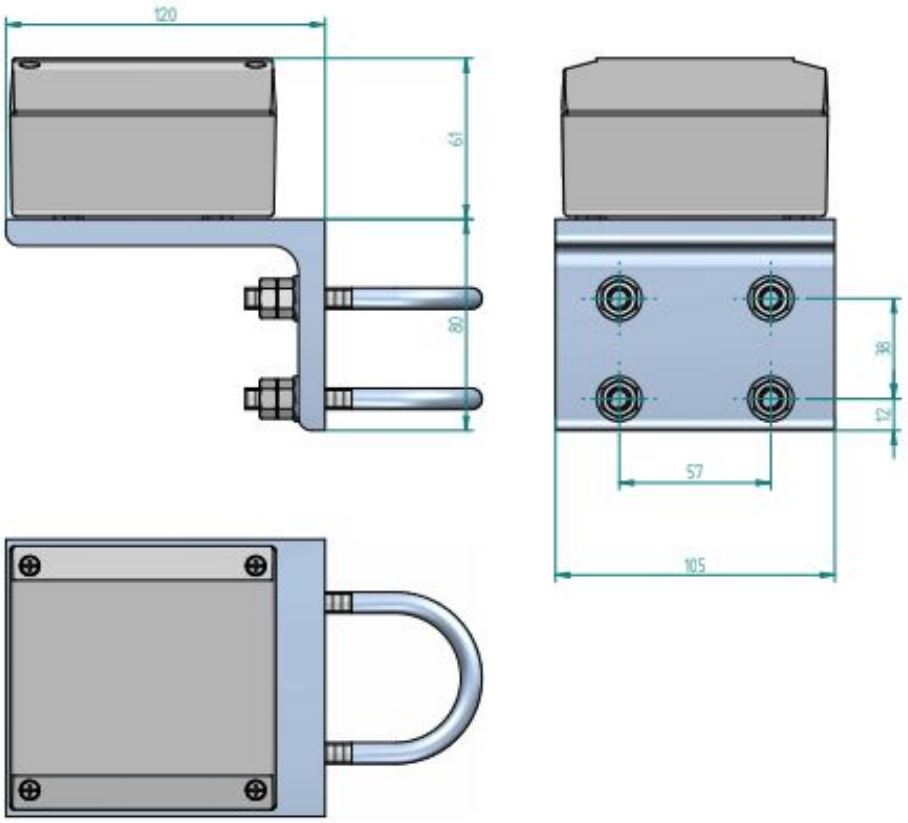
	Nombre	Fecha
Dibujado	I. Carreira	29/01/2019
Comprobado	I. Carreira	29/01/2019

WORLD SENSING

Swivel mounting bracket, exploded diagram

Vertical mounting plate (pole mounting)

In the vertical mounting configuration, the Laser node can be mounted on a pole using metallic supports. The installation of the pole and its stability will be critical for the reliability of the readings. Depending on the installation, a pole can be more sensitive to deformation caused by environmental loads, such as wind, rain, snow, groundwater, or frost, than other structures.

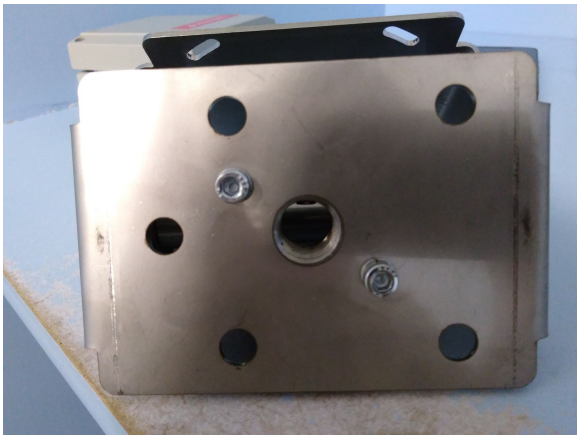
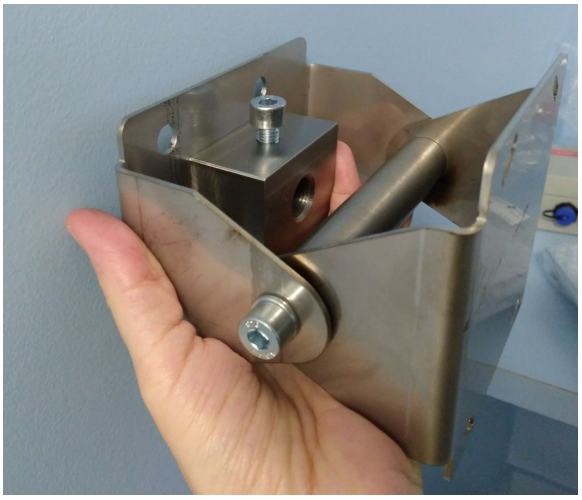
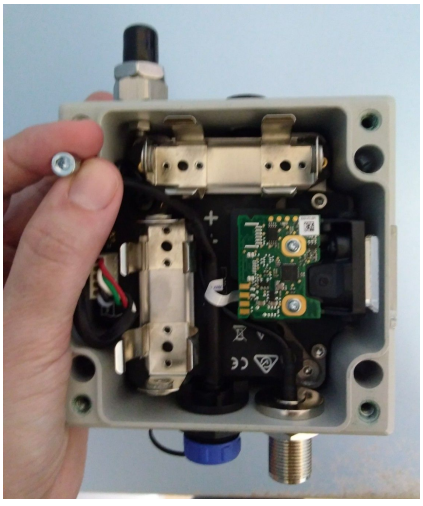


Vertical mounting plate for pole mounting

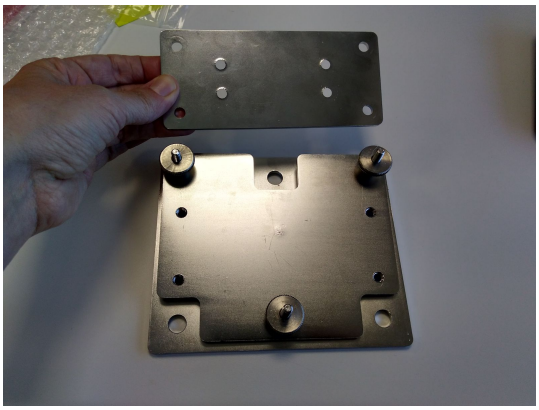
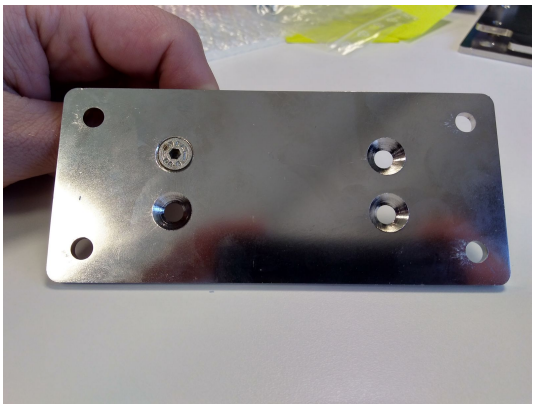
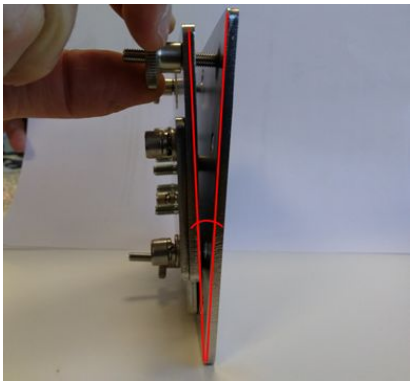
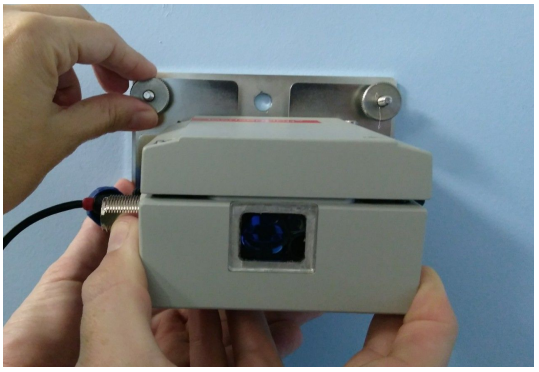
Mounting the Laser node

See the images below for mounting the Laser node on a swivel mounting bracket and an adjustable mounting plate. The process is the same for installing the tiltmeter node on a fixed vertical bracket, so we have omitted images for that process.

Mounting the Laser node on a swivel mounting bracket

	
Drill the surface, place the anchor on the wall and adjust the head of the anchor into the hole on the plate.	Adjust the upper bolt to fix the swivel support to the anchor.
	
Place the bolts inside the Laser node.	Place the aerial in the vertical position and connect the Laser node to the Dlog app and use the Installation tools menu to focus the target on the optimal conditions.

Mounting the Laser node on an adjustable mounting bracket

	
Take off the lateral plate from the adjustable support by unscrewing the bolts.	Insert the bolts provided inside the holes of the plate.
	
Turn the four screws inside the device.	Drill the three holes on the wall following the instruction and screw the four bolts onto the rectangular plate.
	
Adjust the right angle by moving the three circular wheels.	Place the aerial on a vertical position and connect the Laser node to the Dlog app. Use the Installation tools menu to focus the target on the optimal conditions while finally adjusting the angle of the plate.

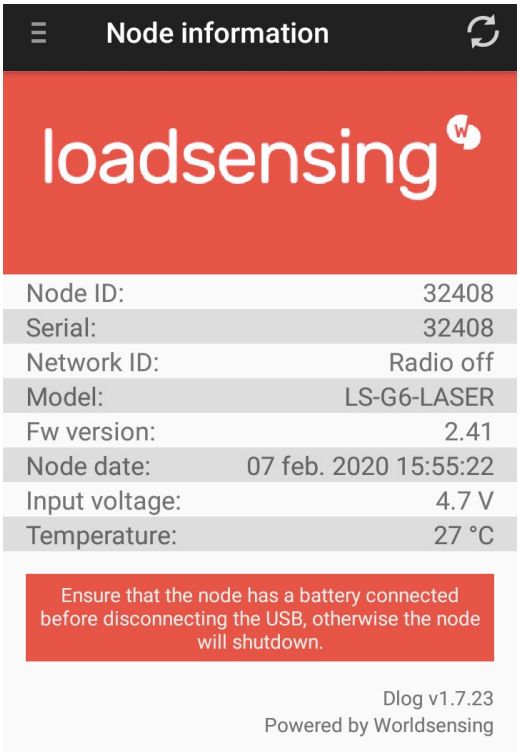
Powering the laser node

The LS-G6 laser node is shipped closed and without batteries installed. In order to initialise it, you should follow these steps:

1. Open the laser node (using a 2.5 mm Allen wrench)
2. Insert **C-type batteries** in the battery holders. One or two batteries can be placed (the more batteries placed, the longer life the logger will have). Polarity is indicated; 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 laser node for a long time.

   Warning: Risk of explosion if incorrect batteries are used. Dispose of batteries according to instructions. This equipment should be installed in restricted access areas.
3. The logger can be powered with batteries and with external power, but there is no switch available to select battery or external power.



Node information

Laser node configuration

Ideally, this step of the process should be carried out in the same location where the node is going to be installed. This way, users can perform an on-site radio coverage test.

The node configuration process is done using the Worldsensing app, known as the DLog, which is compatible with any Android device equipped with OTG technology (OS Android HoneyComb 3.1 or higher required). WorldSensing has tested Motorola Moto G4 and G5 and ensures that they are able to configure and test all nodes.

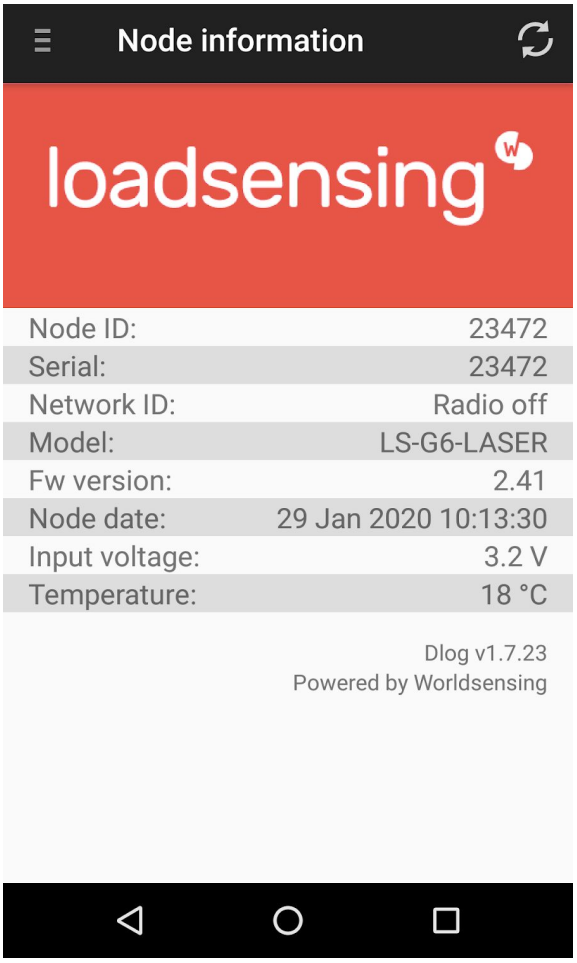
DLog starts up once the device has been connected to the node using the USB-OTG cable. Manual startup is not necessary.

When a new version of the app is available, DLog will automatically display a message.

The whole configuration process does not take more than five minutes and, from that moment, the node will start taking readings and sending data to the Gateway.

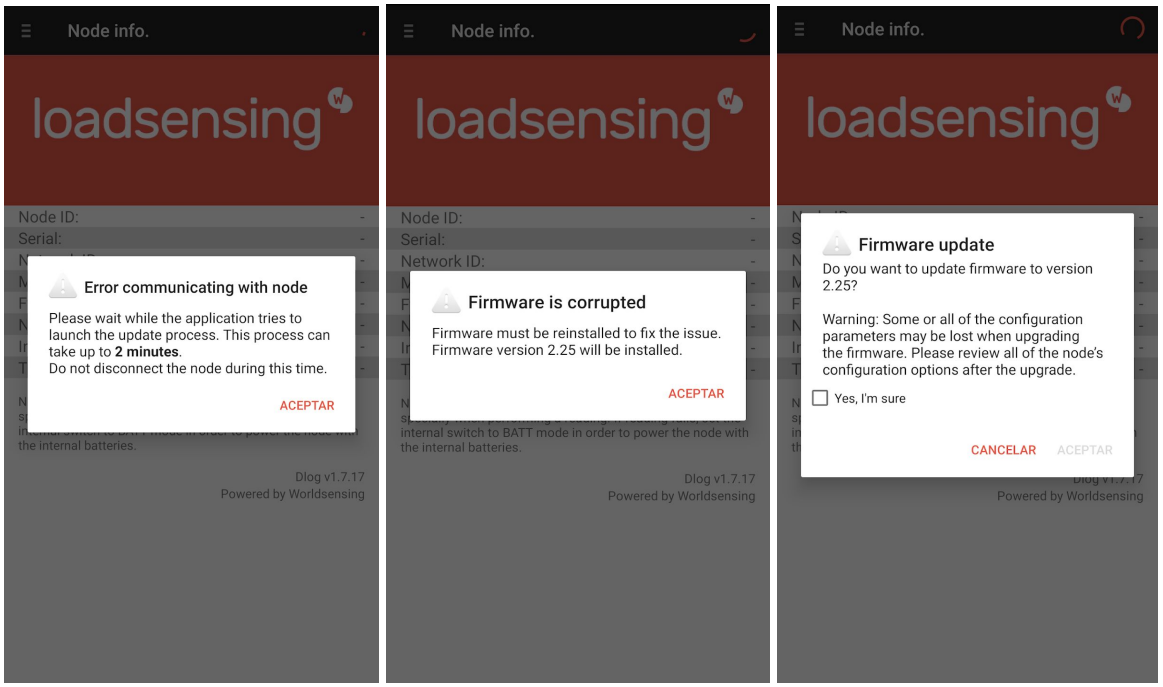
Step 1: Connect DLog Android application

Download the app onto your Android device from the download website: http://wsop.cat/industrial/dlog/Dlog.apk, and install it. Connect your device to the node using the USB-OTG cable (see Accessories list above). Make sure the node has the required batteries. The app will automatically launch and display the node's basic information.



Node information

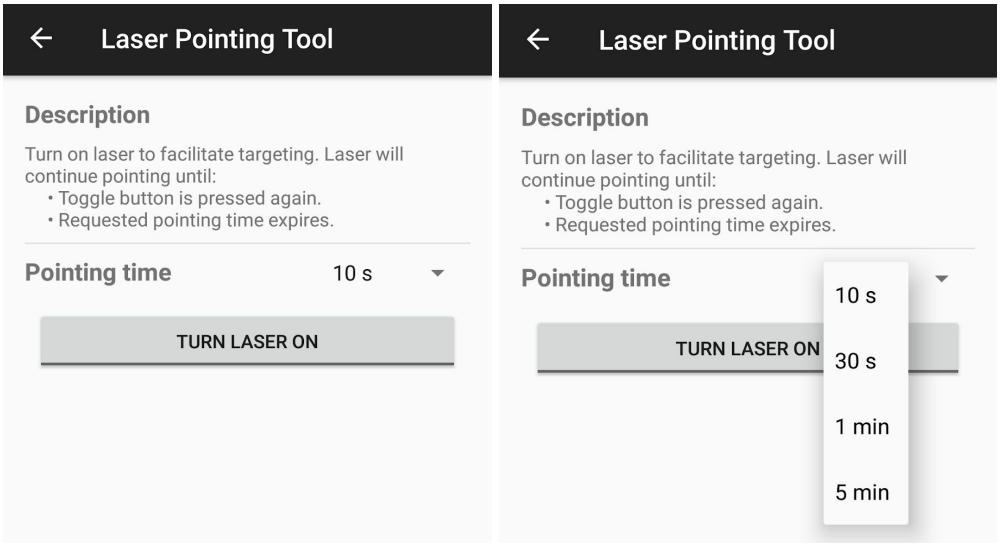
If the node needs to be recovered for some reason, an error prompt will be displayed on the screen. Once the user clicks on OK, a warning message about firmware corruption will also be displayed. After that, a firmware update will be needed to recover the node.



Firmware screens

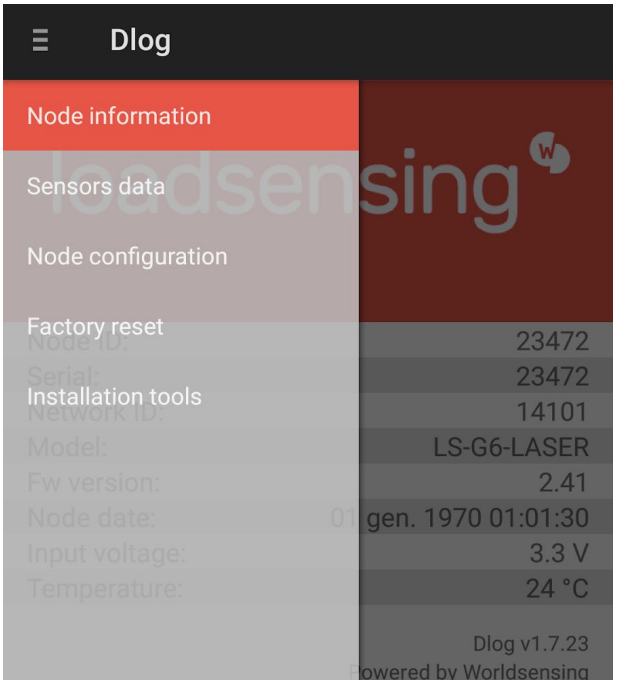
Step 2: DLog main menu

1) **Node info:** Basic information about the node, such as version, ID, and temperature
2) **Sensors data:** Access to real time sensor readings and downloaded data stored in the node
3) **Node configuration:** Access this menu to configure the node
    a) Change node ID: Optional. Change node ID and use a different number
    b) Set date and time
    c) Setup wizard: sensor and radio configuration
4) **Factory reset:** This option resets the configuration parameters and removes all stored data. This feature is designed to allow the node to be used in different sites. We do not recommend using it for other purposes unless suggested by Worldsensing Technical Support
5) **Installation tools:** this option allows for enabling the Laser pointer and to point to an element for a certain lapse of time. This function makes the targeting easier. Pointing time can be 10 s, 30 s, 1 min, or 5 min and the Laser will turn off after the time expires or if the Toggle button is pressed again

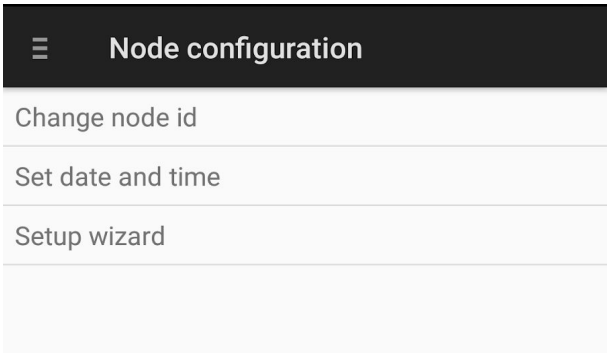


Laser pointing tool screens

To start node configuration, go to **Node configuration** from the main menu and then **Setup Wizard**.



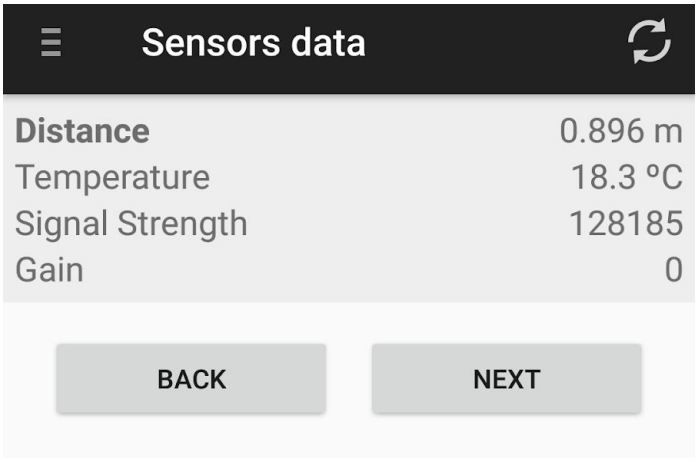
Node configuration



Node configuration - Setup wizard

Step 3: Sensors Data

The **Sensors data** screen displays the current readings of the unit.



Sensors data

- Distance in meters, Temperature in degrees Celsius, Signal Strength, and Gain results are displayed
- The node takes a new reading every time the Refresh button (top right) is clicked
- Note that taking a reading might take some time

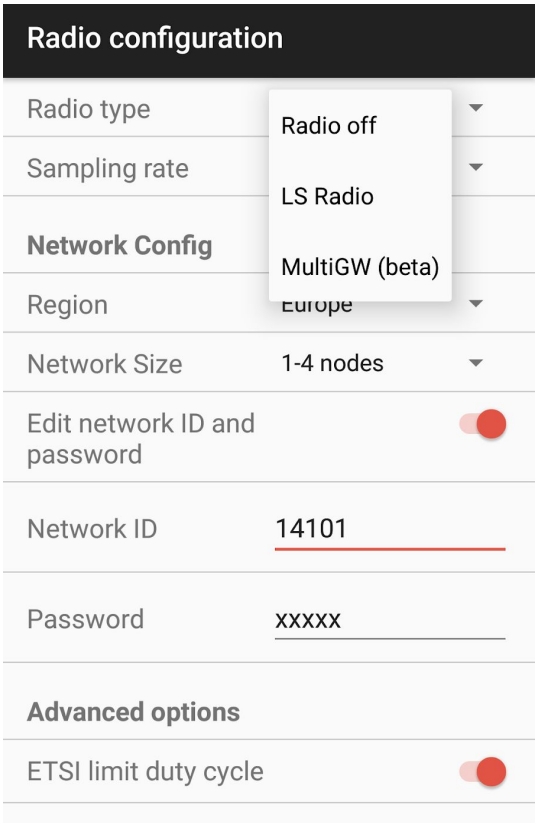
Step 4: Radio configuration

Default configuration parameters should be suitable for the majority of networks. In this first step, radio settings must be selected.

Radio type will need to be selected:

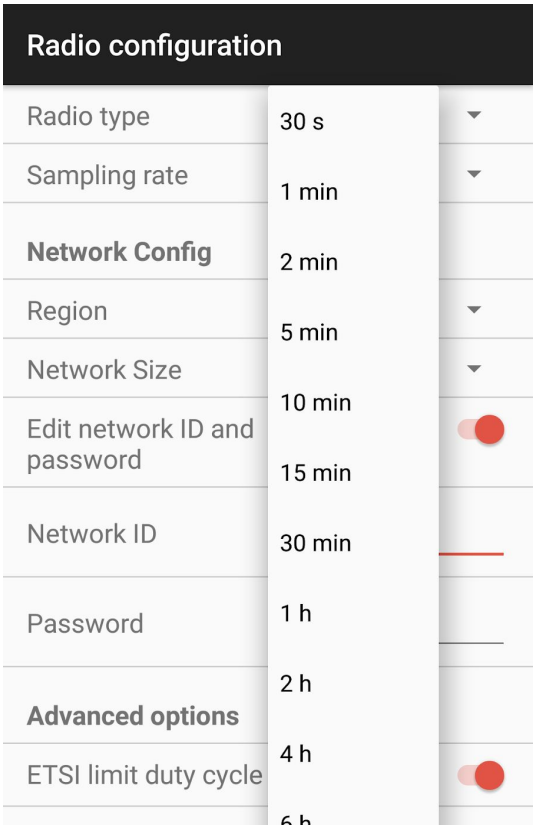
- Radio off if you want to work on the standalone mode
- LS Radio for embedded configuration

- MultiGW for Connectivity Suite



Radio type

Sampling rate also needs to be set. Several sampling rates are displayed on the screen, and their availability will depend on the Network Size. Choose the desired reading frequency from the drop-down menu. The highest possible sampling rate is limited by the network size and vice versa. Smaller networks can read up to every 30 seconds and frequency is progressively reduced on bigger networks. DLog will show the available sampling rates according to the network size chosen in the previous step.



Sampling rate

Select the correct **Region** of radio frequency that matches with the LoRa region regulations. For successful communication, the same region must be applied in the Gateway radio configuration.

The **Network size** is the number of nodes. We strongly recommend initially setting it to the final number of nodes that the wireless network will have since this parameter determines the available sampling rates. Larger networks do not allow selection of small sampling rates.

Enter the **Network ID** and password provided in the *Gateway Information Sheet*. All messages are encrypted with the network password.

Radio configuration advanced options

1. For more information regarding network size limitations, see the Tables, Number of nodes, Sampling rate and Slot time chapters in the Gateway User Guide
2. It is highly recommended that to set up the sampling rate from the Gateway, once the node has been configured, as the Gateway will be able to optimise slot time radio communication. For further information, please refer to the Gateway manual
3. See the Radio specification chapter of the Gateway User Guide or **Annex 01: LS G6 Gateway Radio Specifications v1.8** for more details on radio models and settings

4. Remember that the DLog saves and maintains radio settings to simplify configuration of all the nodes in a network. To modify these settings, Radio must be enabled again
5. Correct configuration of these two parameters (network size and sensor sampling rate) is crucial to prevent data transmission collisions, which translates to data loss on the Gateway. For more information, please check the Radio specification chapter in the Gateway User Guide

Step 5: Radio signal coverage test

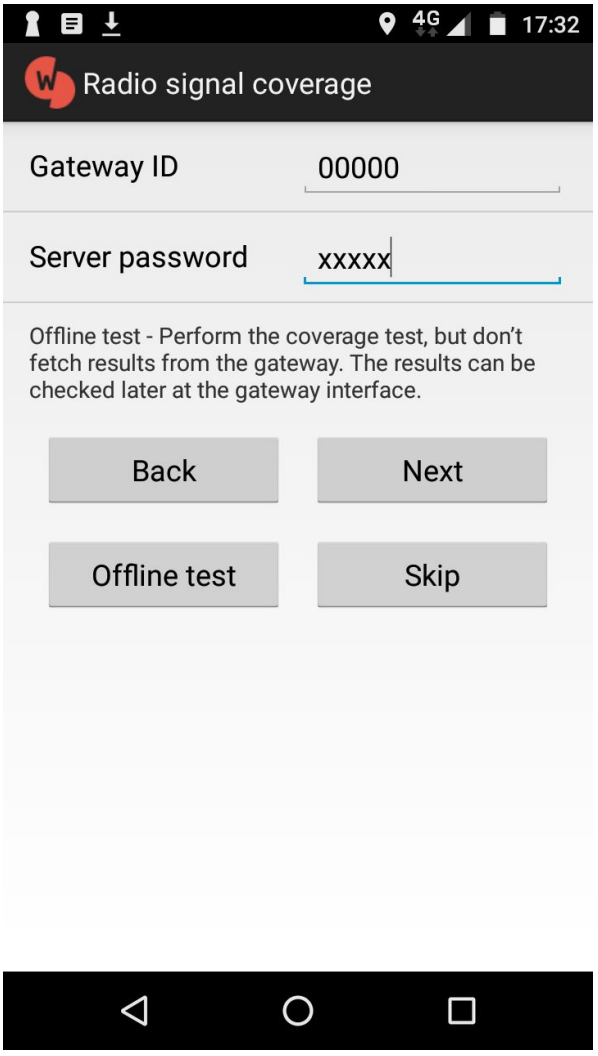
This is the final step in configuring the Laser node. DLog performs a signal coverage test to check the quality of communication with the Gateway. The Gateway must have been previously connected and configured.

This radio signal coverage test will check for correct connectivity between the laser node and the Gateway. The laser node will send some test packages. The Android app will then check on the Gateway (using the Internet connection) for the reception of these packets. Hence, the test will check for:

- Correct Gateway operation and communication
- Correct radio configuration of both the Gateway and laser node (including matching region and ID/password configurations)
- Quality of the signal received by the Gateway from the laser node

By clicking the **Next** button, DLog will run an **Online test**. For the results of this test to be immediately displayed on the Android device, the Gateway and the Android device must also be connected to the Internet.

In order to perform an **Online test**, the Gateway serial number and remote access password must be provided to the DLog app. The remote access password is used to protect the Gateway from access via the local network or the Internet. It is different from the radio network password even though it's set to the same value by default (credentials at *Gateway Information Sheet*).



Radio signal coverage

When doing the Radio signal coverage test, the position of the Android device is saved (if you gave the app permission to access the GPS data) and a security token number identifies each test.

If the Gateway and/or the Android device are not connected to the Internet during the test, the online test will fail and you will need to perform an **Offline test**. In this mode, however, the results of the test cannot be displayed on the Android device. The security token number identifies each test. Write down the token number along with a description of where and under what conditions the test was taken. Check the results of the coverage test on the Gateway web interface by going to **Network**, then **Signal coverage test map**, and then **Download all tests of this network**.

Radio signal coverage test, Setup wizard

If the Android does not have an active Internet connection, then the test must be run offline. Click **Offline test**. A CSV file with the test results can be downloaded from the Gateway web interface.

Step 6: Test results interpretation

The results displayed are listed for each Spreading Factor (SF). The SF represents a way of modulating data. The lower the SF number, the shorter the message; thus, more messages can be sent on the network.

The SF is proportional to the distance between the laser node and Gateway: higher SFs are capable of transmitting data over greater distances, while lower SFs reach smaller distances.

During the radio signal coverage test, the laser node sends five or ten data packages at SF7 to SF12. The number of data packages that reach the Gateway can be viewed in the results in order to ensure correct communication.

A coverage test is considered correct if any of the SFs available on the network are able to deliver at least half the packages sent. A coverage test is considered to be successful if the SF allowed in the radio region receives an average of at least one third of the messages sent, and one of them should receive at least half of the messages sent. For more information, please refer to the 01. LS G6 Gateway User Guide v1.8.pdf and the Annex 01_ LS G6 Gateway Radio Specifications v1.8.pdf

Note that performing the Radio signal coverage test takes approximately two minutes.

Note also that Radio Australia 500MHz works differently. See the wireless radio section in the Gateway User Guide.

Safely closing the laser node

This is a very important step to ensure water tightness and durability of the laser node. Close the cover by cross-screwing the indicated 2 Nm torque.
The LS-G6-Laser node has undergone watertightness testing by an external laboratory and is rated IPX7 (One meter for 30 minutes) and IPX8 for extended immersion (One meter for seven days).

To guarantee watertightness, you must ensure that:

- The box is closed in a cross-shaped order after sensor connection. All the screws must first be inserted and screwed in until they are connected to the box and then adjusted using the torque wrench. If these steps are not followed, 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 toric joint (seal) may not be properly sealed and the degree of protection against water intrusion (IP) could not be guaranteed
- The box is screwed at 2 Nm using a torque screwdriver (e.g. Ref. 1227107 from WERA)
- The antenna is mounted. If it is not, the antenna connector should be covered with a cap
- The sealing ring has not been manipulated either physically or chemically
- The sealing cap USB connector is coiled

If any of these conditions are not met, or if one or several components (e.g. Gore valve) are damaged, IPX7 and IPX8 ratings cannot be guaranteed.
Should the laser node need further sealing due to placement in an extreme environment or in a floodable manhole, additional sealants will be required to close the box (e.g. Sikaflex products).

Note that box screws shouldn't be torqued more than 2 Nm, even though they can support a maximum torque of 3.5 N.m. If the torque is exceeded, the Helicoil insert may be damaged. We do not recommend using electric drills or electric screwdrivers.

Understanding data

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 colours 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.

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.

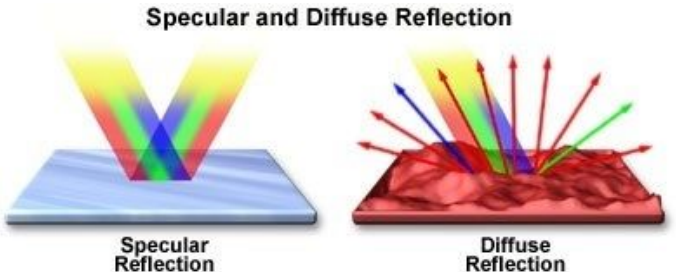
Target

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 type of targets. In the following table we describe when to use any kind of target.

Target colour/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

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

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

Maintenance and troubleshooting

Unlike other nodes, the Laser node may need some maintenance, 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.

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 favourable 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 colour 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 applying white and matt tape above the reflective surface.

Currently, Loadsensing does not provide pointer accessories, but some recommendations according to the conditions can be seen below.

In some applications, we have successfully used target foils from the following supplier:

Company: Avery Dennison (http://graphics.averydennison.eu/)

Series: Avery 500 Event Film

Type: Avery 501 EM - (white, matt)

The foil can be easily stuck to the surface of the relevant fixture designed according to your monitoring need.

Below are listed different types of LEICA Disto target plates models. These are some examples suitable for the Laser node, but they have been designed for manual readings (to be added at the support and take some measurements). For Loadsensing Laser node, they should be fixed permanently.

Other manufacturer's models can also be suitable for this purpose.

GZM3 is suitable for measurements up to 200 m	
GZM27 for fixing to edges and corners	

GZM26 for measurements on poorly reflective surfaces. Two sided: grey side for shorter distances and brown side for longer	
GZM30 stick-on target plates for placing on ground markers	

An additional suitable target will be the one, considering the conditions exposed on the previous paragraphs, with a combination of a white target with black edges. This way, in case laser points to the black contorn the Signal Strength will fall immediately.

Battery lifespan and data storage

The following table provides the battery lifespan indicated for two SAFT LSH14 batteries lifetime estimates are based on distance measurements in the range 10 to 20 m and a model following a Barcelona temperature profile. Bear in mind that consumption varies depending on the sampling rate and environmental conditions.

Sampling rate	SF9@14dBm	SF8@20dBm
30 sec	9 weeks	12 weeks
1 min	18 weeks	23 weeks
5 min	18 months	22 months
30 min	5 years	5.5 years
1 h	6.5 years	7 years
6 h	8.5 years	8.6 years
12 h	8.8 years	8.9 years
24 h	9 years	9 years

Note that extreme temperatures could cut down the capacity. In this case, check battery specifications. USB not used.

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

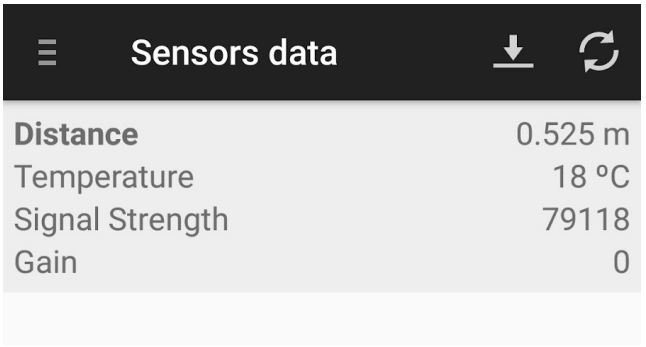
Sampling rate		
60 minutes	30 minutes	10 minutes
More than 10 years	More than 20 years	3.5 years

Indicative storage capacity of the Laser node.

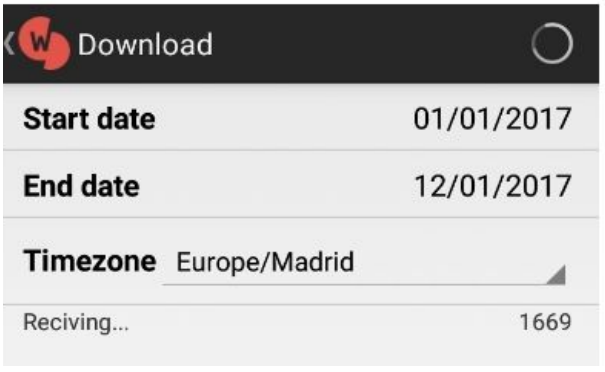
Data acquisition

Data is stored in the laser node in comma-separated variable (CSV) files. These files are available to download using the Android DLog application. Both readings and Health files can be downloaded.

For this purpose, an Android device must be connected to the node Mini USB port with a USB-OTG cable. When the DLog application loads, data can be downloaded by clicking on the Download icon in the Sensors Data tab. A Start and End date must be set, and data from that period will be downloaded. The Android device allows these CSV files to be opened with applications such as e-mail or cloud apps. Files are also stored on the device memory, on the SD Card, or in the DLog folder.



Sensors data



Readings dump to the Android device

Troubleshooting

If the Signal Strength of the Laser beam is in the range 512-350000 uV, the Laser will return an error. When an error is returned a new timestamp is registered on the reading error CSV file on the Gateway (for Gateways with firmware version 2.3 and later). Please refer to the Gateway Manual for further information.

The following errors can be returned on the CSV file:

- Laser module is either too hot or too cold
- Not enough reflection from target or distance out of range
- Too much reflection from the target
- Too much sunlight on the laser

The reliability of the wireless Laser node reading can be affected by:

- **Impacts** - dents on the Laser node enclosure are signs of impacts
- **High vibration levels -** the laser node is not proper when the application requests high vibration intensities
- **Water ingress** - the LS-G6-Laser node ingress protection is IP67 (1 m of water column for 30 minutes). The tiltmeters should never be submerged in water. Water damage to the internal components voids the warranty

In case of doubt regarding the reliability of the readings, the best way to detect and identify the defect is to compare the collected readings with additional topographic measures or any other alternative method for measuring the distance.

First, inspect the structure where the node is attached and the mounting hardware, such as mounting plates and anchors, and also the structure that is being monitored. Any compromise to or mechanical deformation of the mounting hardware can cause unstable readings.

If the results comparing both readings determine that the Laser node is taking erratic readings, it can be concluded that the unit has been damaged in the field or has an issue.

Upon detecting an affected Laser node, the user must open a ticket in our Help Center to request a Return Material Authorization (RMA).

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

For further information regarding the warranty conditions and the RMA process please refer to the Sales and Condition terms.

Technical specifications

Description	**Value**	
Measuring range at favorable conditions	0.05 - 150 m	
Typical measuring accuracy	+/- 1 mm	
Resolution	0.1 mm	
Repeatability (1 sigma)	0.15 mm	
Laser type (light source)	Visible Laser Class II, Laser with 655 nm	
Laser power	0.75-0.95 mW	
Accuracy	**In favourable conditions***	**In unfavourable conditions****
@1 m	+/- 1 mm	+/- 2 mm
@10 m	+/- 1 mm	+/- 2 mm
@20 m	+/- 1.5 mm	+/- 3 mm
@50 m	+/- 4 mm	+/- 7 mm
@100 m	+/- 9 mm	+/- 15 mm
@150 m	+/- 16 mm	not applicable
Size of the Laser spot		
@5 m	5mm x 2.5mm (smallest value)	
@10 m	7mm x 3mm	
@20 m	14mm x 6mm	
@50 m	35mm x 15mm	
Mechanical		

Box dimensions (WxLxH)	100 x 100 x 61 mm
Overall dimensions	150 x 100 x 61 mm (excluding antenna)
Operating Temperature (º)	-10 to +50
Storage temperature (º)	-25 to +70
Weather protection	IP67
External antenna	100 mm length (including connector)
External port	MiniUSB port for configuration and data access. Can also be used to power the node
Box material	Aluminium alloy
Vibration resistance	Laser modules comply with standard ISO 9022-3, Method 36, Severity 05 (0.15mm, 10Hz..55Hz)

* on natural objects (white wall, low target illumination <3K lx, moderate temperatures)
**on natural objects (white wall, high target illumination with 30K lx, full specified operating temperature range)

For completeness, find below a list of favourable/unfavourable conditions for measuring:

Favourable average measuring conditions	Materials with good reflecting characteristics, meaning they reflect the Laser beam in a divergent (not mirrored!) manner
	Laser dot is brighter than the ambient light
	Operating within the allowable temperature range 14° to 122°F (-10° + 50° C)
Unfavorable measuring conditions	Highly reflective surfaces
	Highly absorbing surfaces, such as wet or dark surfaces
	Operating at the limits of the allowable temperature range
	Not waiting for temperature calibration
	Very intensive ambient light
	Shimmering
	For optical and safety reasons, do not measure against colorless liquids (water) or glass

FAQ

What is the temperature influence on the measurement?

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

For further information and real scenario data signal analysis regarding temperature and weather conditions please refer to “Laser node data analysis under different scenarios” document.

What are the effects of the weather conditions on the measurement?

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-life scenario data signal analysis regarding temperature and weather conditions please refer to “Laser node data analysis under different scenarios” document.

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

Please refer to the Maintenance and troubleshooting section.

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).

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.

 CAUTION

Looking into the Laser beam may be hazardous to the eyes.

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

October, 4th, 2017

Dr. Thomas Piok
Head of the Laser Classification Laboratory

Wolfram Mathis
Project Manager
Quality Management

Leica Geosystems AG
Heinrich-Wild-Strasse
CH-9435 Heerbrugg
Switzerland
Phone +41 71 727 31 31
www.leica-geosystems.com