User Guide

K20 Edge Repeater

CONNECTIVITY

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Document Information

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Contents

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Purpose

The purpose of this document is to help you successfully install, power, configure and operate the K20 Edge Repeater within your LoRa Tree deployment. You will find product and network specifications, a step-by-step procedure to install and power your Repeater, and a walkthrough of the Repeater user interface to configure and operate your device.

The K20 Edge Repeater is a key element of Worldsensing's LoRa Tree network topology. It allows you to extend the communication range of your deployments to gain significant network range, especially underground. Especially, when you encounter radio signal obstacles. The Repeater is able to receive a signal from a node and retransmit it to the gateway, in what is called a "data hop". You can install Repeaters strategically to overcome radio signal obstacles such as walls, ramps, and curves. This way, you can transmit data up to 10km underground.

The LoRa Tree network is robust enough to acquire and send data of hundreds of devices under a single network, depending on the sampling rate. Compared to other network topologies, LoRa Tree offers the longest radio range in underground environments. By using two repeaters, for example, you can achieve up to 10 km of coverage. This reduces network density significantly and enables you to cover wide areas underground through one, single network.

The repeater is a robust IP67 certified device. It shares core characteristics with the Worldsensing 4G Rugged Gateway - Edge such as an external antenna and minimum power requirements. The repeater works with Worldsensing's Connectivity Management Tool (CMT), the CMT Edge v2.7.1 onwards[1], to provide a seamless data flow from all Worldsensing Edge device portfolio to your operational systems. It comes with a dedicated user interface that allows you to easily configure your downstream devices and other network parameters.

The Hardware is exactly the same as any other Gateway running CMT Edge or the multiGW Firmware (CMT Cloud)[2] and the Software is a completely new one, whose main purpose is to repeat messages from a node to an end Gateway running CMT Edge.

This opens up the possibility of monitoring a larger area with a network of strategically installed repeaters, to overcome obstacles to the radio signal such as walls, ramps and curves, and on ideal conditions thus be able to transmit data from the nodes up to 10 km underground with 150 m to 3 km coverage per hop, which is especially useful in the underground mining sector.

For this product to work with the rest of the Worldsensing environment, the CMT Edge requires a plugin to be activated (available only from firmware version 2.7.1 onwards). The nodes do not need any changes, so the entire LS node portfolio is compatible with the Edge Repeater, and the communication at spreading factor 7 must be possible.

This document also details installation, powering and configuration procedures for correctly deploying and installing the Edge Repeater.

[1] Available only for LS-G6-KIO-GW-868 and LS-G6-KIO-GW-923

[2] Available only for LS-G6-KIO-GW-868 and LS-G6-KIO-GW-923

Repeater Applications

The Lora Tree Network has been designed for increasing the radio coverage in those areas that due to their geometry conditions radio communications are limited. It has also been designed for projects where internet connection is not possible.

Some applications where this solution could be used for increasing radio comms (without being a restrictive list) are:

- Underground mining applications

- Long Urban underground tunnels without internet connection

- Wide areas, where obstacles need to be overcome, that have points on its route where there is no internet coverage

Please consider that this application is not suitable for projects that require high frequency sampling rates or even for those cases where communications need to be fully granted.

In those cases where internet connection is possible, long areas need to be covered and a big number of sensors need to be monitored with high sampling rate requirements, we strongly recommend using the CMT Cloud solution, which is also prepared for offering redundancy.

Glossary

- **Adaptive Data Rate (ADR)**: It is a mechanism for optimizing data rates, airtime and energy consumption in the network. The ADR mechanism mainly controls the Spreading Factor transmission parameter of a node.
- **Upstream repeater:** Repeater closer to the gateway than the referred one.
- **Downstream repeater:** Repeater closer to the node than the referred one.
- **Downstream devices:** List of Worldsensing Nodes and Edge Repeaters downstream the network.
- **Downlink message:** Message sent from the Main Gateway to the nodes (Ex. a configuration message to modify the sampling rate, time synchronization between the nodes and the main gateway, the adaptive data rate (ADR)).
- **Hops:** Refers to the number of devices that a piece of data travels through. For example, a hop occurs when a packet is passed from one repeater to the next, from the main gateway to a repeater, or from a repeater to a node.
- **Main Gateway:** CMT Edge Gateway where all the messages coming from all the nodes of the network are sent and stored.

- **SF**: Spreading Factor defines the relation between symbol rate and chip rate. A higher spreading factor increases sensitivity and range, but also prolongs the airtime of a packet and will likely raise the risk of a collision.
- **Slot time:** Defined as the period of time spent to send/receive the information. It cannot be configured, it is automatically calculated by the system in each transaction, it can only be reduced or adjusted by setting up the sampling rates from the gateway.
- **$\mu \pm 3\sigma$**: The empirical rule predicts that 99.7% of observations fall within the first three standard deviations ($\mu \pm 3\sigma$).
- **Sampling rate**: Reading frequency.
- **Local devices:** List of Worldsensing Nodes that are at 1-hop distance to the referred repeater.
- **Uplink message:** Message sent from the nodes to the Main Gateway. (Ex. a message containing a reading from sensor connected to the data-logger)

K20 Edge Repeater models

Three different K20 Edge Repeater models are available for different geographical areas. Each country/area defines a specific regulation for the radio to be used, which may vary in the used frequencies and other features.

Each K20 Edge Repeater version is optimized to use a specific range of frequencies. As countries or areas define the frequencies to be used, available radio models may be shared by different gateway versions.

Model	Region	Operating Bandwidth
RPK20E868HW	**Europe**	**863-874.4 MHz**
RPK20E915HW[3]	North America	902-928 MHz
RPK20E923HW	**Asia, Latin America**	**915-928MHz**

[3] This repeater is compatible only with the Gateway LS-G6-KIO-GW-915R.

K20 Edge Repeater Specifications

Equipment

The Worldsensing K20 Edge Repeater is shipped with the following accessories:

- K20 Edge Repeater with internal antenna
- Installation plate with fixing bolt
- Grounding cable
- Ethernet cable gland and other interfaces covers and caps.
- PoE injector + Mains cable
- USB type C to Ethernet adapter (for local connection)

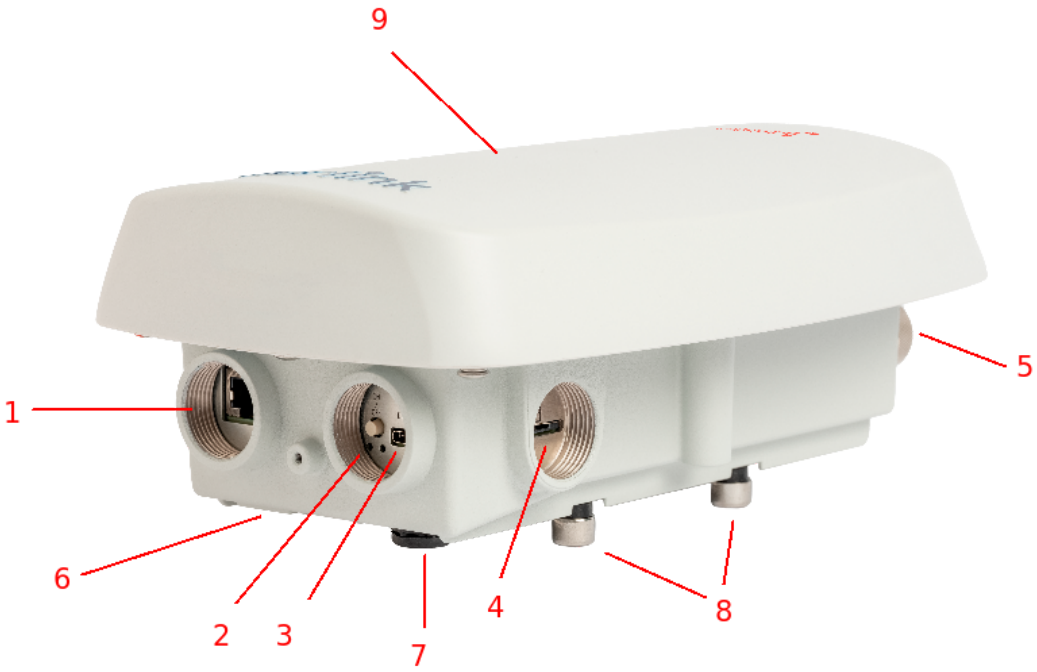
Documentation:

- K20 Edge Repeater gateway information sheet
- K20 Edge Repeater gateway acceptance test document

Not provided material:

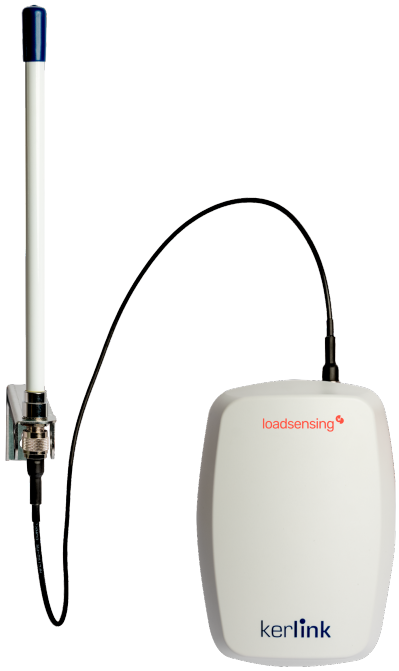
- External antenna adapter and vulcanized tape
- Metallic flanges or bolts for fixing the plate to a wall/pole
- Tools required for mounting the device
- Ethernet cables
- SIM Card
- External omnidirectional antenna kit (available under request)
- PoE and external antenna surge protection (available under request)
- Other peripheral devices

Details



1. RJ-45 Ethernet connector (with specific provided cable-gland)
2. Reset Button & Status leds
3. USB-C connector (local interface)
4. SIM card slot (Mini Sim)
5. External Antenna connector (N) (antenna adapter required in case of using an external antenna)
6. Earthing cable
7. Waterproof air vent valve
8. Template fixing bolts
9. Internal antenna

Specifications and Ratings



The K20 Edge Repeater is made of Aluminium Alloy (case) with a high-impact resistant polycarbonate cover, engineered to withstand harsh industrial and outdoor environments.

Flammability rating (UL94-V0), as well as good UV and chemical resistance

Impact resistance rate:IK07 (for the cover)

Ingress protection rate: IP67

Temperature: It may operate in an industrial temperature range, between -40°C and +60°C.

Altitude max. < 2000m / hygrometry 95% non-condensing

Size : 265 x 165 x 100 mm (without external LoRa antenna)

Weight : 1,4kg (mounting kit included)

Power consumption

The K20 Edge Repeater is powered by the Ethernet port. It requires being powered according to the IEEE 802.3af Power over Ethernet protocol.

This means that the device must be powered using a PoE injector, provided by Worldsensing with the device.

If the PoE must be replaced, a new one can be requested to Worldsensing, or alternatively, acquire a new one locally. This one must comply with IEEE 802.3af protocol.

The power consumption of the device has been tested by Worldsensing in different scenarios to define different profiles depending on the usage.

It has been tested powering the device to 50VDC (PoE injector uses a nominal 48 VDC voltage input, which varies between 42 and 57 VDC), and tested with both Ethernet and mobile communications, with different message load (2msg/min and 50 msg/min)

	Supply Voltage	Current Avg.	Current Max.	Power Avg.	Power Max.
Test 1 (ETH) 2 msgs/min	50V	0.086A	0.117A	4.3W	5.9W
Test 2 (GPRS) 2 msgs/min	50V	0.088A	0.16A	4.4W	8W
Test 3 (GPRS) 50 msgs/min	50V	0.096A	0.124A	4.8W	6.2W

According to the tests, the device consumes a mean power consumption of 4.5 Watt (5 Watt to be on the safe side). This means a 120 Wh daily consumption for an Edge Repeater working 24/7.

This information should be used to define any autonomous power system, such as solar panels, wind turbines or any other external system.

Check the Annex “Solar power system used to power LS 4G gateways” available on the Knowledge base for more information regarding external power sources.

https://worldsensing.zendesk.com/hc/en-us/articles/360017607599-LS-GW-G6-4G-USER-GUIDES

Communications

The repeater is designed to work without an Internet connection, the internet connection is not needed for normal operation, only the main gateway would have Internet access, however if you want to connect the repeater to the Internet you should know that:

Ethernet:

The K20 Edge Repeater has a built-in Ethernet port. A RJ45 cable can be directly connected to it to communicate with a LAN network or the Internet.

This port is also used to power the gateway. This means a 48VDC PoE is required to power the gateway, which can also provide Ethernet connectivity to the device, or use it just for powering the device and use the Mobile connectivity for Internet connection.

The K20 Edge Repeater is compliant with PoE IEEE 802.3af standard. This means the PoE injector (provided with the device) should meet this specification.

The ethernet connection allows connecting the device to other devices such as External Mobile routers and modems, Wi-Fi access points and any other devices with an Ethernet input, extending the range of communications methods to comply with the project requirements.

Mobile connectivity:

Using a SIM card the K20 Edge Repeater can be connected to the Internet all around the world, thanks to a 4G Worldwide module with 3G/2G fallback.

The Edge Repeater uses the SIM card on its MINI-SIM format. A plastic adapter may be used to fit a nano/micro SIM card into the mini SIM card slot.

APN settings, and the PIN number set on the SIM card should be manually set on the Edge Repeater by accessing locally if required.

Some Internet service providers (ISP) require the device being certified by them to make them work with their SIM cards. This is the specific case of Verizon, so Verizon SIM cards may not work with this device. Worldsensing recommends using a different provider to ensure Internet connectivity. For more information please contact our support team at https://worldsensing.com/support

This table shows the frequency bands the Edge Repeater is able to use for each technology (4G, with 3G and 2G fallback)

LTE	Band 1 (2100) Band 2 (1900 PCS) Band 3 (1800+) Band 4 (1700/2100 AWS-1) Band 5 (850) Band 7 (2600) Band 8 (900) Band 12 (700 ac) Band 13 (700 c) Band 18 (800 lower) Band 19 (800 upper) Band 20 (800 DD) Band 25 (1900+) Band 26 (850+) Band 28 (700 APT) Band 38 (TD 2600) Band 39 (TD 1900+) Band 40 (TD 2300) Band 41 (TD 2600+	LTE FDD: - Max 150Mbps (DL) - Max 50Mbps (UL) LTE TDD: - Max 130Mbps (DL) - Max 35Mbps (UL)
WCDMA	Band 1 (2100) Band 2 (1900 PCS) Band 4 (1700/2100 AWS-1) Band 5 (850) Band 6 (850 Japan) Band 8 (900) Band 19 (800 upper)	DC-HSDPA: Max 42Mbps (DL) HSUPA: Max 5.7Mbps (UL) WCDMA: - Max 384Kbps (DL) - Max 384Kbps (UL)
GSM	B2 (1900 PCS) B3 (1800 dcs) B5 (850) B8 (900)	EDGE: - Max 296Kbps (DL) - Max 236.8Kbps (UL) GPRS: - Max 107Kbps (DL) - Max 85.6Kbps (UL)

Radio specifications

The type of available radios varies depending on the K20 Edge Repeater model.

868 K20 EDGE REPEATER

This Edge Repeater is optimized to work in frequencies around 868 MHz (863-874.4MHz) designed for the European region, it supports these radio models:

- 868EU, designed for **Europe** according to ETSI regulations
- 866I to be used at **India**

915 K20 EDGE REPEATER

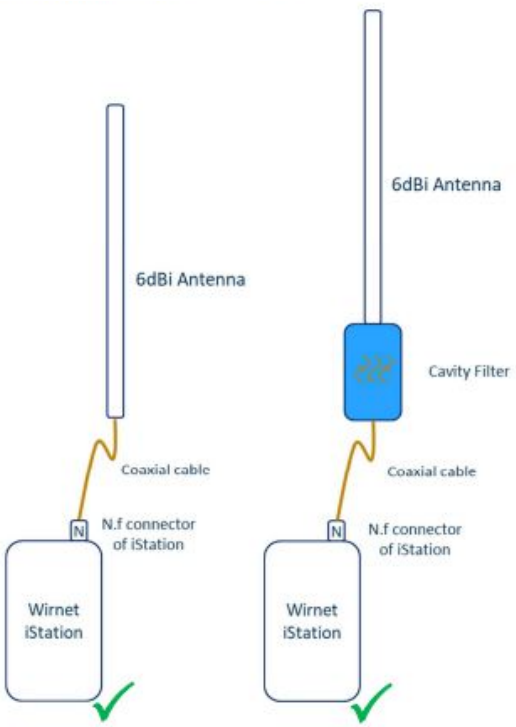
This Edge Repeater is optimized to work in frequencies around 915 MHz (902-928MHz). Initially designed for the American region, it supports these radio models:

FCC to be used at **USA** & **Canada**, according to FCC regulations (8 channel groups available).

The 915 K20 EDGE Repeater is only compatible with the 4G gateway edge 915R model LS-G6-KIO-GW-915R. It can be distinguished from the other models by its label on the front cover (see below).

It is recommended to install a cavity filter on all 915 gateways and repeaters in the following 2 scenarios:

1. If the main gateway is going to use a SIM card to connect to a 4G cellular network to access the internet. Repeater and Gateway will use frequency band 902 MHz, and if cavity filter is not installed then LTE Band 5 will be full of interferences coming from the LoRa radio.
2. If the gateway is going to be installed at a distance of less than 300 meters from a 4G/5G Base station. It will prevent interference and saturation between LoRa and 4G/5G Base stations.



Cavity filter compatible with the 4G gateway 915R and K20 Repeater 915
Worldsensing code: WS-ACC-CFIL-915

When using a 6dBi antenna or a cavity filter, it is mandatory to use a coaxial cable between both as shown in the previous picture.

923 K20 EDGE REPEATER

This Edge Repeater is optimized to work in frequencies around 923 MHz (915-928MHz). Initially designed for the Asian region, it supports these radio models:

- 923A to be used at **Australia**: Channels 8-15
- 922S to be used at **Singapore**
- 922K to be used at **Korea**
- 923M to be used at **Malaysia** (2 channel groups available)
- 923P to be used at **Peru**
- 926C to be used at **Chile**
- 922B to be used at **Brazil** (8 channel groups available)
- 923T to be used at **Taiwan** (2 channel groups available)

Although the Edge Repeater is ready to work without an antenna, as it has an internal one built in, allowing a maximum gain of 2.6 dBi, and coverage close to 75%-90%. The use of the external antenna is highly recommended to provide better radio coverage.

These antennas and antenna kits bypass the internal ones (using the antenna adapter provided with the gateway), and are provided by Worldsensing under request:

- **LS-ACC-ANTGW-01** Vertical omni-directional outdoor antenna, 3 dBi, 868 MHz, 30 cm length.

  This antenna has a **N Male** connector proper for direct connection.

- **LS-ACC-ANTGW-03** Vertical omni-directional outdoor antenna, 3 dBi, 915/923 MHz, 30 cm length.

  This antenna has a **N Male** connector proper for direct connection.

- **LS-ACC-SUPGW-01** Vertical omni-directional outdoor antenna kit, 3 dBi, 868 MHz, 30 cm length. Antenna + 1m cable + support included.

  The kit has a **N Female** connector and requires the cable included for connecting to the Gateway.

- **LS-ACC-SUPGW-03** Vertical omni-directional outdoor antenna kit, 3 dBi, 915/923 MHz, 30 cm length. Antenna + 1m cable + support included.

  The kit has a **N Female** connector and requires the cable included for connecting to the Gateway.

- **LS-ACC-SUPGW-02** Vertical omni-directional outdoor antenna kit, 6dBi, 915/923 MHz, 110 cm length. Antenna + 1m cable + support included

  The kit has a **N Female** connector and requires the cable included for connecting to the Gateway.

Limitations

The K20 Edge Repeater has some limitations to be aware of:

- It is not compatible with CMT Cloud architecture.
- It is not compatible with 3G Gateways.
- It is not possible to convert CMT Edge normal gateways to/from Edge Repeater gateway, or CMT Cloud gateways to/from Edge Repeater.
- The Spreading Factor of the communication between repeaters is limited to SF7, in order to reduce latency and the airtime of a packet, and prevent the risk of message collisions.

Network specifications

Message rate capacity

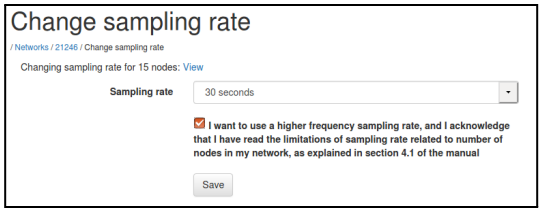
Default Network Capacity	Message rate	3.125 messages/minute
	Successful transmission probability	99.7% μ ± 3σ.[4]
	Sampling rate	**Maximum devices**
	5 min 30 min 1 h	15 93 187

Alternative Network Capacity	Message rate	8 messages/minute
	Successful transmission probability	98.758% μ ± 2.5σ.[5]
	Sampling rate	**Maximum devices**

[4] Tested in a controlled environment. Depending on environmental conditions, it is subject to differ.
[5] Tested in a controlled environment. Depending on environmental conditions, it is subject to differ.

	5 min 30 min 1 h	40 240 480

To use the alternative network capacity of 8 messages/minute, it is necessary to activate dishonored sampling rates. These sampling rates exceed the maximum frequency recommended by the internal algorithm. This may provoke data loss due to messages on air collision.



Devices with the sampling rate modified to a higher frequency than the one recommended by the system will be permanently marked with the dishonored icon .

Successful transmission probability refers only to uplink messages. This percentage is more related to the number of nodes and slot times (network load) than to hops.

The Downlink performance is related to the number of hops in the branch, because the amount of time the message is on the air affects it more. So even on a small network with a few nodes, the more hops there are to a given node, the worse the downlink performance may be. This means that downlink messages may take longer to arrive.

For the digital data loggers, limits can be different as every sample can generate more than one radio message. Consider the number of radio messages to size the network in this case.

Slot times specifications

Slot time is defined as the period of time spent to send/receive the information. It is a normal parameter in every radio communication system and it cannot be configured, it is automatically calculated by the system in each transaction, it can only be reduced or adjusted by setting up the sampling rates from the gateway.

This table shows estimated Slot times (in seconds) for Worldsensing Analog and Vibrating Wire dataloggers and the Wireless Tiltmeter.

Sampling rate	N° devices	Slot times (s)
5 min	0 - 15	288
15 min	16 - 50	960
30 min	51 - 93	1785
1 h	94 - 187	3590

Worldsensing's Digital datalogger LS-DIG does not necessarily comply with the slot times table because readings may take longer to be sent/received. Slot Time may vary depending on the type of sensor connected.

Radio sensitivity specifications

The communication between the node and the repeater is -137 dBm (downstream) and SF11.

The communication between repeaters is fixed to -127 dBm and SF7.

Maximum number of hops in the network

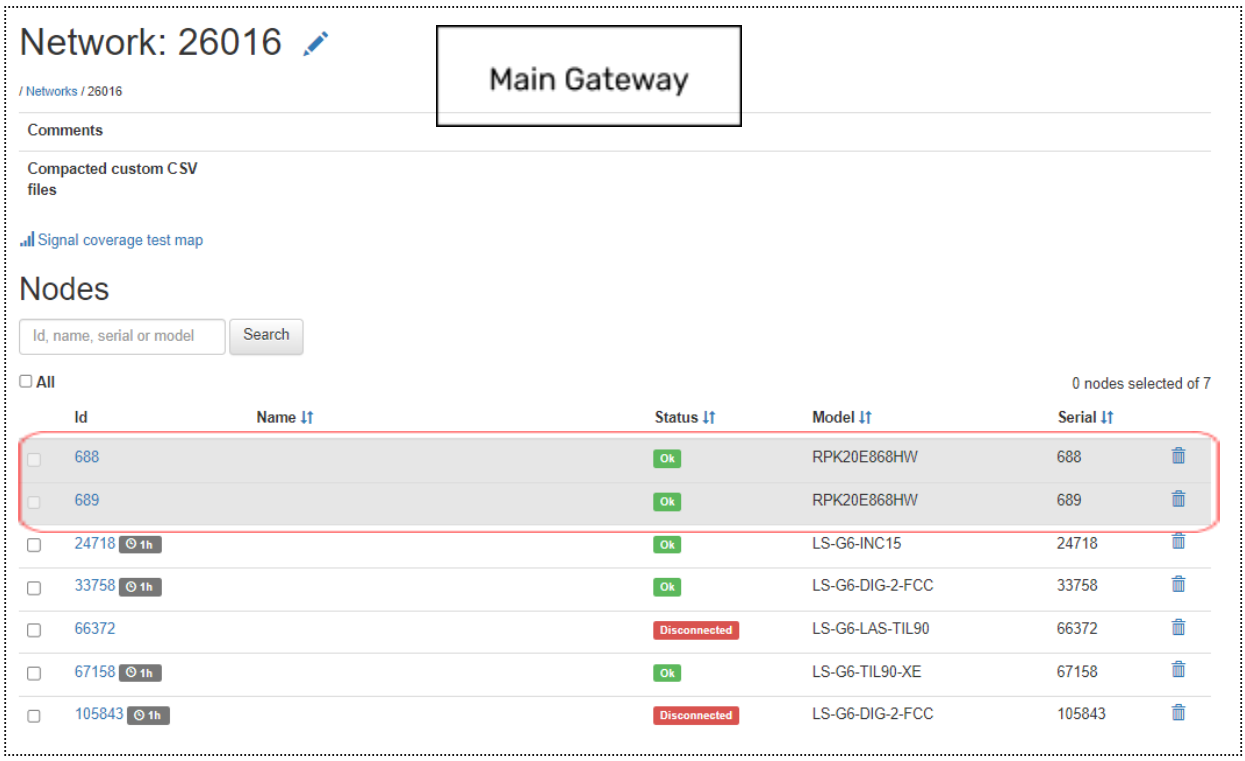
Worldsensing recommends a maximum of 5 hops with which it is possible to have a network range of up to 10 km. In the tests carried out, a network with 5 hops has an efficiency of 90% for downlink messages (meaning that downlink messages will arrive on a first try 9 out of 10 times). Networks with more hops are also possible, with diminishing performance, especially in the downlink messages. For example, for 8 hops, the efficiency will be about 50%.

More than 5 repeaters within a given branch will cause downlink transmission latency and possible message loss, meaning that sampling rate changes may take longer.

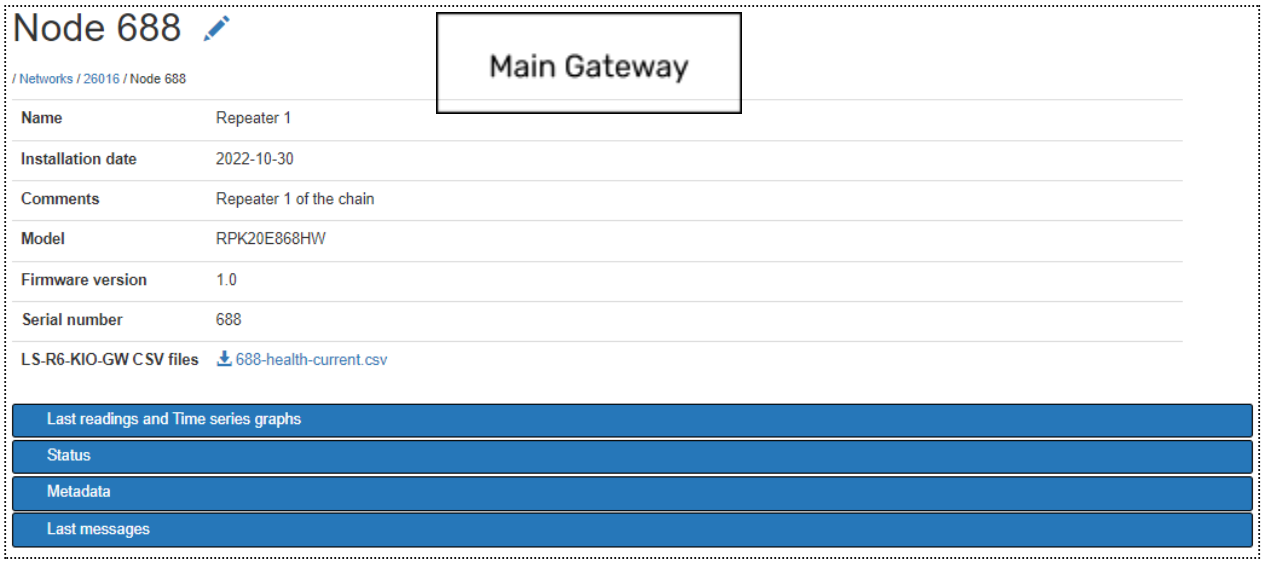
Monitoring specifications

Each Edge Repeater sends to the Main Gateway a health message by radio every 7 hours and 1 minute after power up. These messages are stored in a health CSV file that can be downloaded from the Main CMT Edge Gateway.

Each Edge Repeater will be registered in the Main Gateway as a regular node of the network, then it is possible from the Main Gateway to view monitoring data of each repeater. To differentiate Repeaters from nodes in the nodes list, Repeaters have a gray shadow and its corresponding product code under model.



Also by clicking on the repeater Id it will be possible to view the repeater's own information.

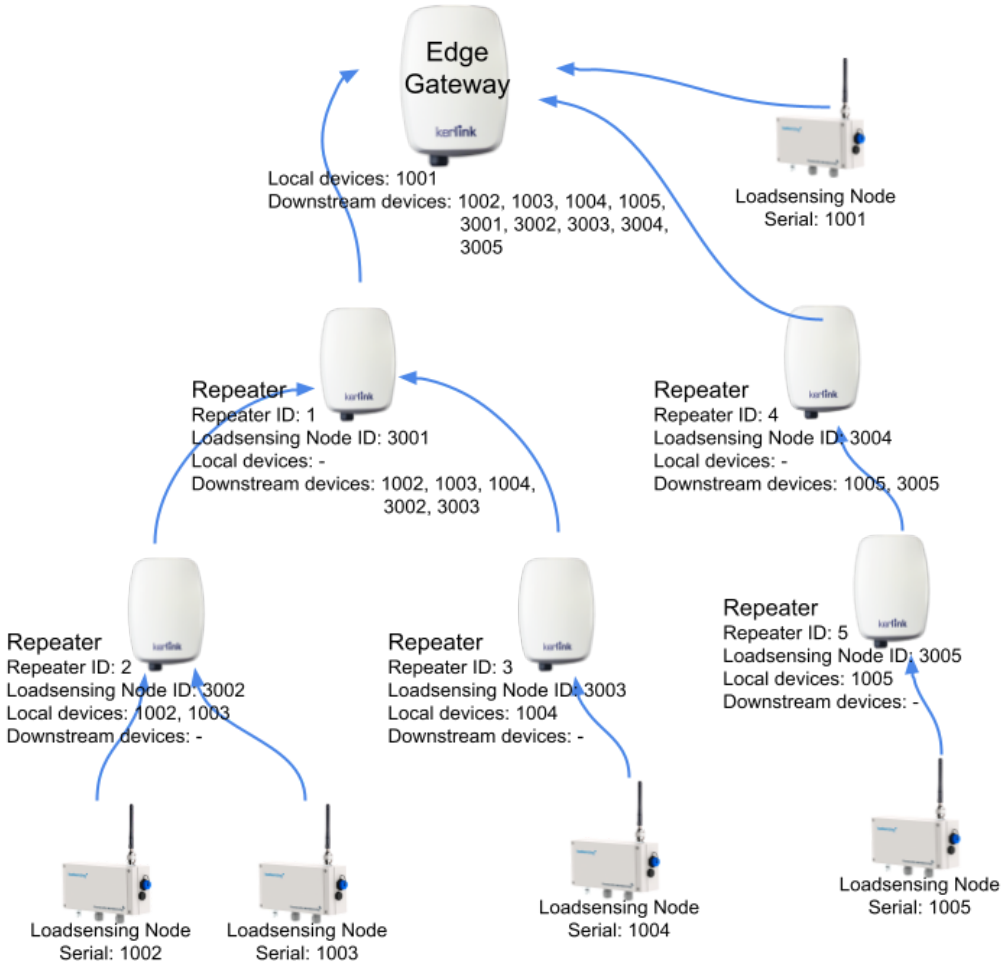


Network Topology

The LoRa Tree network follows a downstream configuration logic in which devices are arranged in a fashion similar to the branches of a tree.

Devices at the lower level are connected to devices at the next higher level, which resembles a tree-like structure. At higher levels of the tree, often point-to-point or point-to-multipoint connections are used.

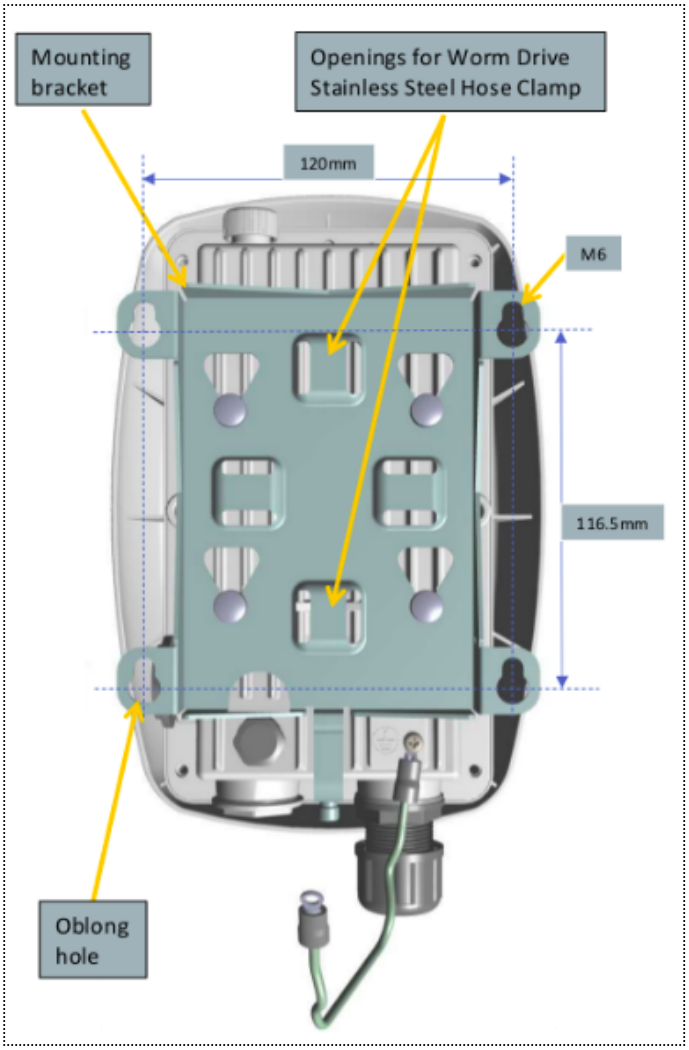
Tree topology based networks have a hierarchical structure as shown in below image. Structure of the network in the image below resembles an inverted tree. The nodes are always end-devices connected to GWs.



K20 Edge Repeater installation

The K20 Edge Repeater has been designed to be easy to install and deploy on the field.

A unique template is provided together with the repeater, which allows a fast mounting and unmounting of the device. This template allows installing it in a wall, by locking it using four 6mm screws to the oblong holes, and also installing it in a pole, by locking it using stainless steel hose clamps in the two central openings. These Hose Clamps width should not exceed 14mm.



Once the template is firmly fixed, the Edge Repeater can be installed on it by using the 4 fixed round bolts of the back, on the template holes, and moving it downwards until they get locked.

Once the Edge Repeater has been presented to the template, it can be locked to it by screwing the security screw in the lowest part of the template.

Note: Check the earthing cable has been fixed to the earthing screw on the back of the Edge Repeater before presenting it.

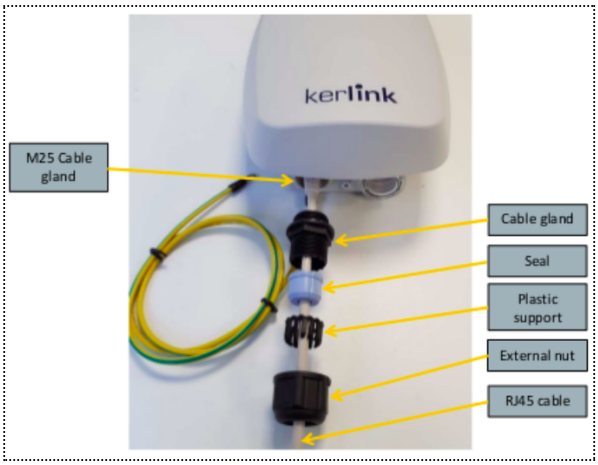
This template is designed to support the Edge Repeater only. In case of using an external antenna instead of the internal antenna, the specific mounting kit shall be used.

The antenna mounting is provided together with the low loss cable and the external antenna itself, when requesting one of the external antenna kits.

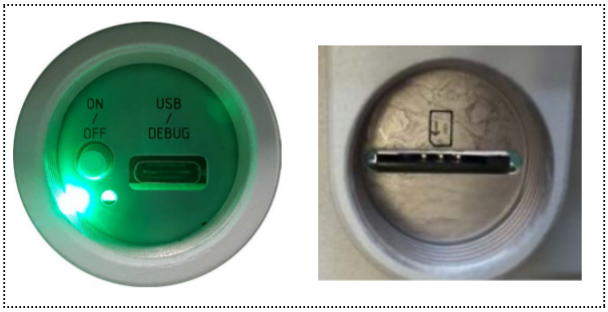
The Edge Repeater comes with a specific cable gland for the Ethernet cable.

This cable gland will ensure a proper closing for the Ethernet interface, so the Edge Repeater can be deployed outdoors. This cable gland is required to ensure the protection level of the device: IP67. This scheme displays how the different parts of the cable gland must be installed:

1) Pass the external nut and plastic support for the seal through the Ethernet cable
2) Put the 2 parts of the seal (blue piece) rounding the cable and fix it with the plastic support
3) Pass the cable gland through the Ethernet cable
4) Firmly connect the cable gland to the gateway, and tighten the external nut to it, covering the seal with it.



Once the Edge Repeater is installed and deployed it is necessary to close and tighten the two round covers for the USB-C and SIM Card interfaces; The transparent one for the USB-C connector and Status leds, and the black one for the SIM Card slot. The SIM Card cover may be tightened with a flat screwdriver while the USB-C one requires using a wrench. Both covers have a 25mm diameter.



Finally, it is strongly recommended wiring the Edge Repeater to earth to ensure lighting immunity and electrical security.

Some installation recommendations:

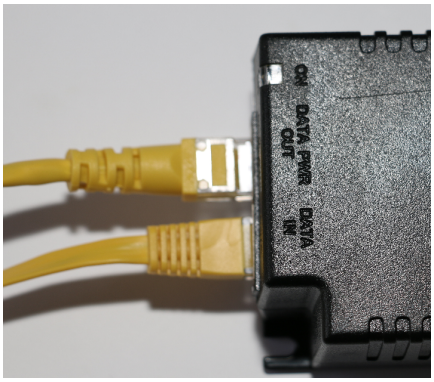
- The Edge Repeater should not be installed on metallic walls to ensure a good radio performance.
- Installing the Edge Repeater in a higher position than the nodes is recommended as a good practice, being at least 2 meter high.
- PoE injector, or any other peripheral device should be protected as required if installed outdoors.
- The internal antenna of the Edge Repeater is not omnidirectional; This means the Edge Repeater should aim to the installed nodes in order to maximize the radio signal.
- The antenna mounting kit should be used to ensure the antenna is separated, at least, 15 cm from any metallic surface, which may provoke a poor radio signal reception.
- The external antenna should be installed in a vertical position, with the provided low loss cable.

Powering options

The K20 Edge Repeater has a unique input port to be powered; the Ethernet port. This port allows powering the device using an Ethernet cable with an RJ-45 connector.

Different alternatives can be used to power the Edge Repeater, depending on the deployment.

AC Source: PoE injector



To power the Edge Repeater using this method, a standard Ethernet cable with RJ45 connectors must be connected to the Edge Repeater on one side, and to the DATA & Power OUT port of the PoE injector.

Using a PoE injector is the most common way to power the device. Is the best option to power the Edge Repeater in those projects where a stable mains source is available near its location, and when a wired Internet connection is required, as this device is able to provide both power and connectivity.

A PoE injector is provided with every Edge Repeater. Alternatively, any PoE injector available on the market can be used, if it complies with IEEE 802.3 af standard.

The PoE injector must provide an output power between 44 and 57 VDC voltage (48 VDC nominal output voltage). PoE switches and other networking devices can also be used. Worldsensing recommends using the provided PoE injector, as it has been tested and complies with all the requirements of the Edge Repeater.

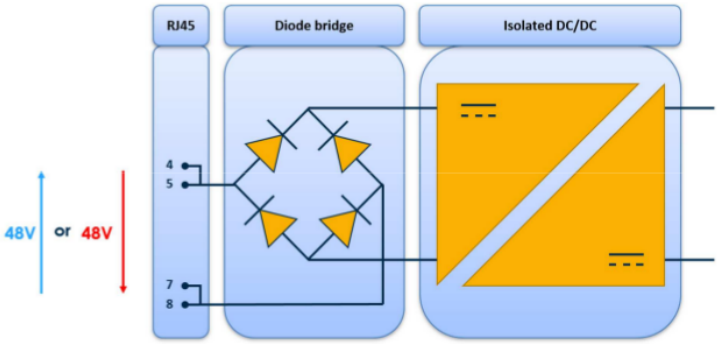
The length of this cable can be up to 100 meters long; this allows installing the Edge Repeater in the top of a tower, pole etc… and installing it in the basement to power it using mains .

The provided PoE injector is not rated to be used outdoors, in case of installing it outdoors, it should be protected as required.

External DC power source

The Edge Repeater can also be powered using a 42 to 57 VDC input, using the same wiring; the Ethernet RJ45 connector. The power supply must be isolated.

This method allows using a customized power supply, using a DIN Rail RJ45 to terminal block adapter for the power output.

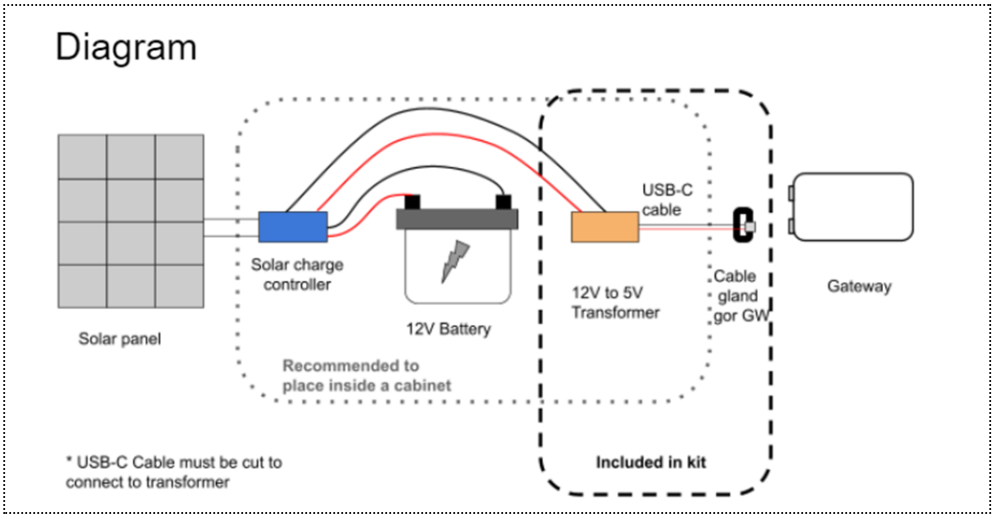


Photovoltaic power source

In case of using a photovoltaic power system, such solar panels, a specific device (charge controller) + battery kit in combination with a converter kit should be used to power the edge repeater.

The converter kit will transform the 12V output coming from the controller/charger to the 5V needed to power the Edge Repeater through the USB-C port (12V IN -> 5V OUT).

More information about powering the Edge Repeater using standalone systems (solar panels, wind turbines and hybrid systems can be found at our knowledge base HERE.

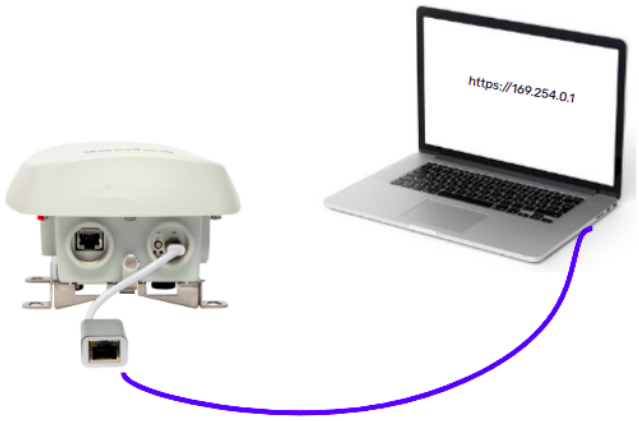


Local access

Currently there are 2 ways to access the menu of the K20 Edge Repeater:

1. Using a USB to USB-C cable. Connecting one USB side of the cable to the computer and the other USB-C side to the USB-C connector on the repeater.
2. Using the USB-C local interface with the Ethernet - USB-C adapter.

This interface allows securely accessing the Edge Repeater if required for the initial deployment, internet connectivity modifications or troubleshooting, when other interfaces are not available.



The steps to access the Edge Repeater using the Ethernet - USB-C adapter are:

1. Connect the USB-C to Ethernet adapter on the USB-C slot
2. Connect an ethernet cable on the adapter side
3. Connect the other side of the cable in the laptop
4. Check the Ethernet interface of the computer is configured to receive an automatic IP address (DHCP mode)
5. In case the Edge Repeater is not powered, power it and wait until it is booted (Green led ON, Red led OFF)
6. Once the connection is available, open a web browser and access to:

   https://169.254.0.1

7. A self-signed security certificate must be accepted to access the gateway
8. Introduce the admin credentials provided by Worldsensing (Available on the Gateway Information Sheet).

System Deployment Using Edge Repeaters

Planification of the Network

A Lora Tree Network requires some previous planification to simplify and optimize the installation.

An estimation of the required repeaters should be done in advance according to the geometry and length that needs to be covered (find attached a use case for an underground mining site), taking into consideration radio coverage range from 150 m to 3 Km between repeaters in the same line of sight between them, and the maximum devices that the solution could manage according to the sampling rate (check limitations on chapter Limitations).

If the sampling rate or the size of the Network is higher than the default network capacity, we recommend splitting the installation into different Main Gateways.

Once a draft distribution tree of the installation has been represented, we recommend drawing a scheme of the installation by assigning local devices and downstream devices ID on the main Gateway and on each repeater (please check Glossary and chapter Network Topology for clarification).

Bringing additional material on site for radio coverage testing and installation purposes could also speed up the installation, such as:

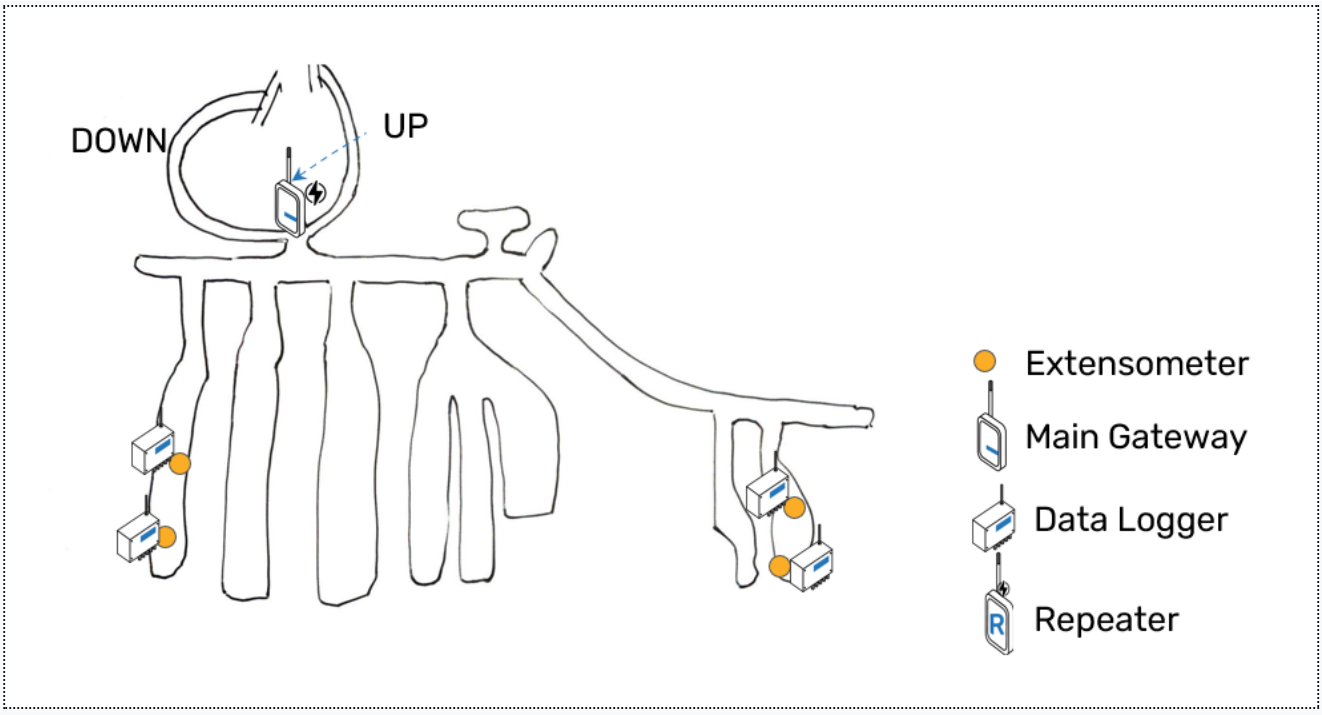
- Power bank with an output of 5VDC and an USB-C connector to externally power the repeater through the USB-C port and easily move and find the best position for it.
- Direct PC connection for local access to the repeater using USB cable.
- If there are expected power outages, it is recommended to install a UPS (Uninterruptible power supply) to guarantee the operation of the repeaters/gateways when the input power source or main power fails.

Installing the LoRa Tree Network:

The first step will be to install the Main Gateway where power and connectivity is available.

We could say that the Lora Tree has two fixed points:

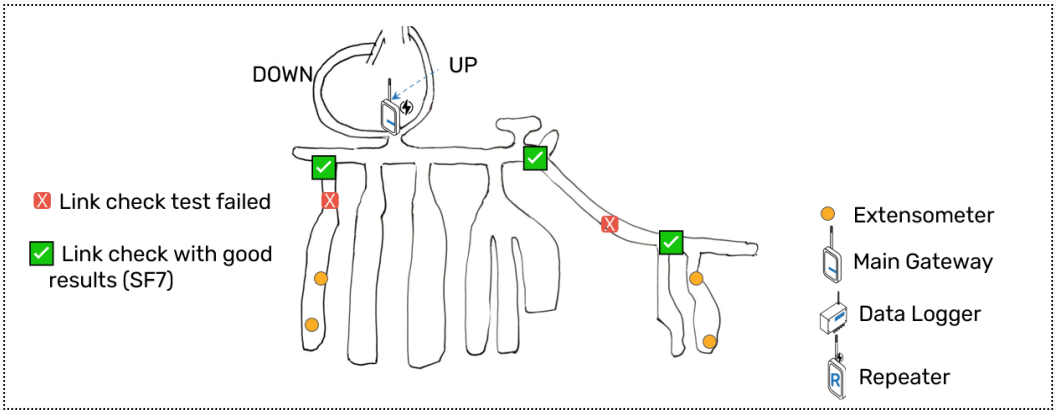
- The position of the data loggers (close to where sensors are installed).
- And the position of the Main Gateway (see picture).



Once the main Gateway is powered up and configured, the first step will be to position the first repeater. The user can have an idea of the position of the first repeater by placing it at the furthest position from the Gateway where communication at SF7 is possible. This can be done by performing a Link Check Test using the Worldsensing app with any node. Communication between consecutive repeaters, and repeaters and Main Gateway is only available with Spreading Factor 7 (SF7). It will not be possible to communicate with higher SF, so good results on this SF must be achieved (3/3 messages received, Link Margin Avg >17).

After having a candidate location for the repeater, it is recommended to carry out a coverage test from the repeater (Repeater Configuration menu) to make sure that radio messages arrive at the gateway. The gateway and repeaters can be powered with a power bank to select candidate locations before doing a definitive installation.

As the final test, perform a “Link Check Test” from the node installation position to verify that the radio messages reach the main gateway through the repeater/s. In this case, the node must be configured in both the Gateway's Downstream Devices list and the Local Devices list to ensure the correct path. In this Link Check Test, the max SF for the region is allowed as this is the case for the hope between Repeater and node.

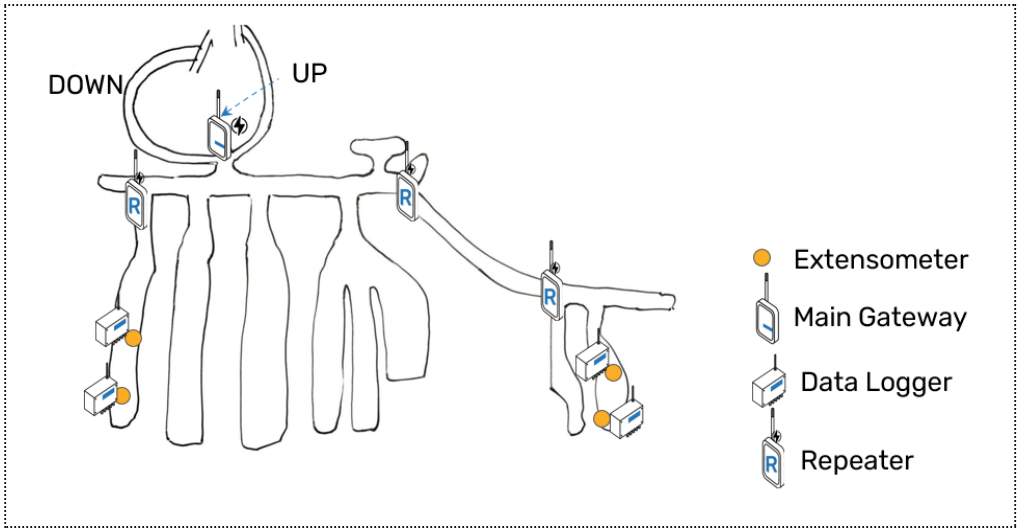


Once this first location has been defined and the Edge Repeater is installed and configured according to the Edge Repeater configuration section, the position for a second repeater can be tested by doing the same process (always within the indicative distances that can be reached).

It is highly recommended the use of an external antenna for the K20 Repeater in underground deployments.

If communication with the Main Gateway is possible, that means that the node can communicate through the Lora Tree Network. As communication between repeaters is fixed to SF7, preinstall the second repeater by testing several positions, it can be powered with the use of a power bank and deploy a link check test with a node to check that the communication is possible through both repeaters.

Repeat the steps if more Edge Repeaters are going to be deployed.



Configuration Process

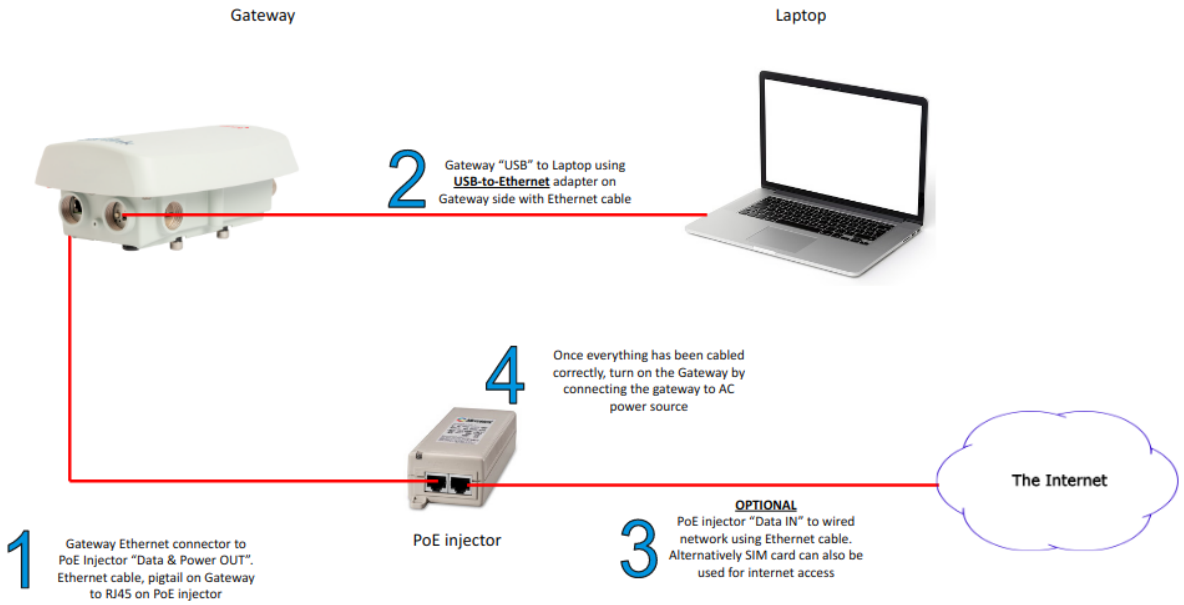
Recommendations:

- Set up and configure the Edge Repeater in a controlled environment rather than doing it in an outdoor or working environment.
- Do some pre-planning beforehand to know where to install the main GW and repeaters.

The deployment of the Worldsensing system using Edge Repeaters consists of the following steps:

Main Gateway Configuration:

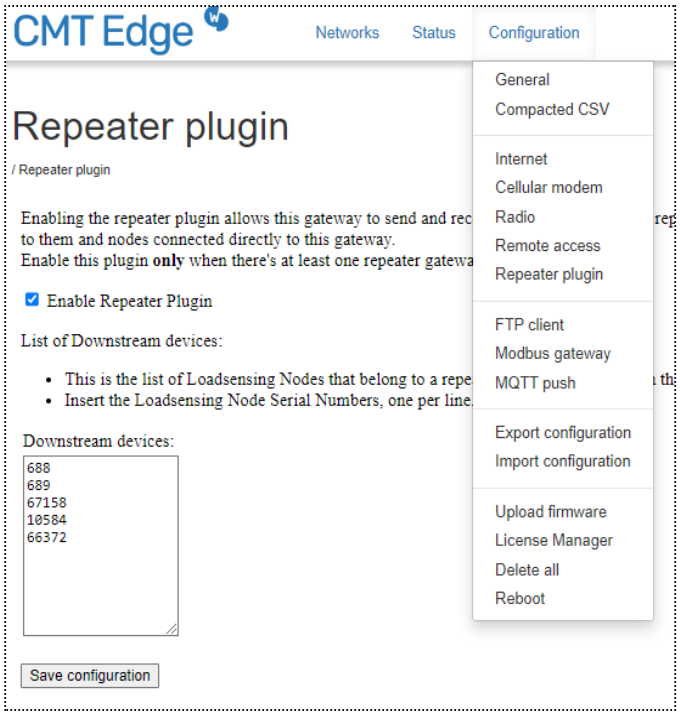
1. Choose a desired location and install the Main Gateway.
    a. Connect the gateway to the PoE injector (Data & Power Out port).
    b. Connect the gateway to a laptop through the USB-C port using the provided USB-C adapter.
    c. Connect the gateway to the Internet. Two options available:
        - Wired mode: Adding an Ethernet cable from the Data IN port of the PoE to the network
        - Wireless mode: Inserting a Mini SIM card on the SIM slot
    d. Connect the PoE injector to the main power to power on the gateway. It will completely boot when the green status led is fixed, once the red blinking led (booting process) stops .



2. Access the gateway GUI and from the menu “Configuration -> Repeater plugin”, enable the “Repeater Plugin” to allow sending and receiving messages from the repeaters.

3. From the “Repeater plugin” tab, insert in the list of “Downstream devices"
   a. The **serial numbers** of all Worldsensing nodes of the chain.
      i. This is the list of Worldsensing Nodes that belong to any Edge Repeater further down the chain away from the main gateway.
   b. The **Loadsensing Node ID** of all Edge Repeaters of the chain.
      i. This **Loadsensing Node ID** can not be modified, and it can be seen from the tab “Gateway Status” of each repeater menu.

Keep in mind the Edge Repeater has assigned a **Gateway ID,** a **Loadsensing Node ID,** and a configurable **Repeater ID** based on its position in the network**. They are not the same thing.**



If a new repeater is added to an existing network, it is mandatory to configure the sampling rates again from the menu Network of the Main Gateway to apply the new slot times.

Slot times in a network with no repeaters are calculated at 30 msg/min, but with repeaters the slot time must be calculated at 3.125 msg/min (default configuration).

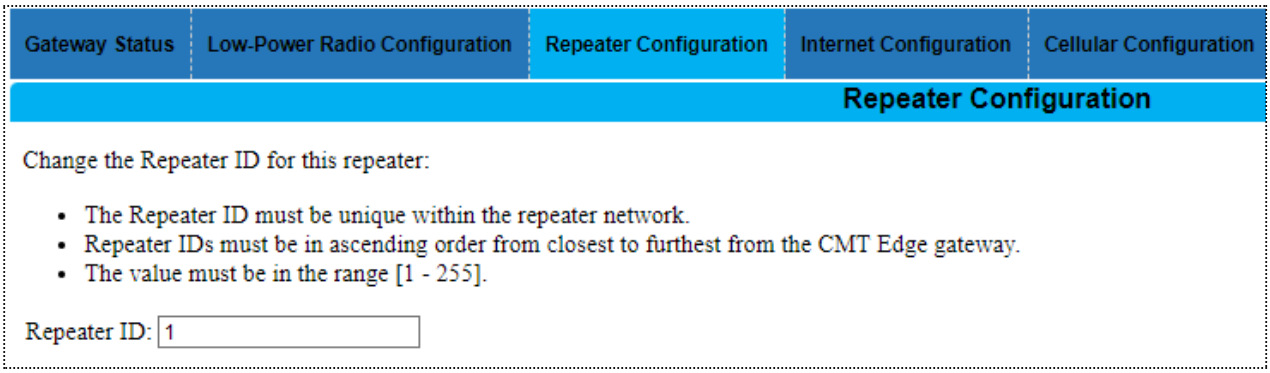
Edge Repeater Configuration:

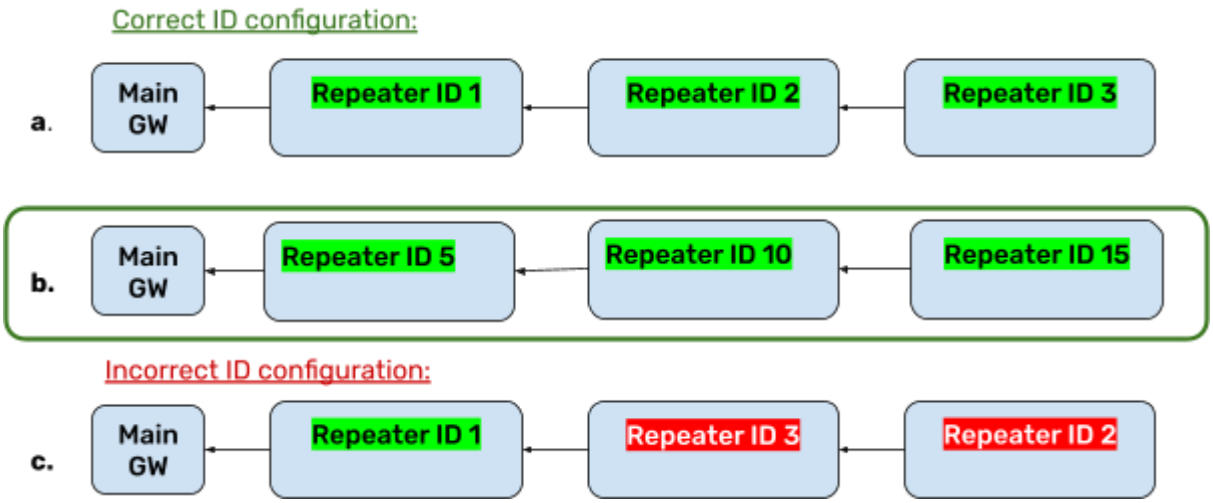
1. Choose a desired location to install the Edge Repeater, and before you install it:
    a. Move with a node to the desired installation location of the Edge Repeater, and using the node plus the Worldsensing app perform a Link Check Test.
    b. The Link Check Test will check the connectivity at that location by forcing the data logger to send 3 radio messages using different sampling rates (from 7 to 11), starting from SF7, and then it will wait for the gateway's result.

    To decide if that location is the right location to install the Edge Repeater, **the messages with sampling rate 7 must be successful**. If not, choose a closer position and repeat the Link Check Test process.

> The Spreading Factor of the communication between repeaters is limited to SF7, in order to reduce latency and the airtime of a packet, and prevent the risk of message collisions.

2. After having a candidate location for the repeater, it is recommended to carry out a coverage test from the repeater (Repeater Configuration menu) to make sure that radio messages arrive at the gateway.
3. Once the installation location is decided, repeat step 1 of the Main Gateway configuration to power the Edge Repeater.
4. Access the Edge Repeater GUI and from the Menu “Low-Power Radio Configuration” configure:
    a. The same radio frequencies configured on the Main Gateway.
    b. The same radio credentials of the Main Gateway. (This can be found in the Gateway Information Sheet received with the Main Gateway).
5. Access the Edge Repeater GUI and from the menu “Repeater Configuration” configure:
    a. **The ID of the repeater:**
        i. The repeater ID must be unique within the repeater network.
        ii. The repeater ID value must be in the range of [1 - 255]
        iii. The repeater ID value must be in ascending order, from the closest to farthest to the main gateway within a repeater branch.



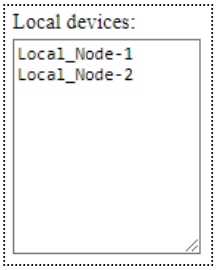


We recommend using the configuration **"b"**, using "**non-consecutive IDs**" since it allows you the possibility to add additional repeaters among the existing ones and make the repeater network bigger, without having to modify all the configuration of the chain.

b. Add the list of Local devices:

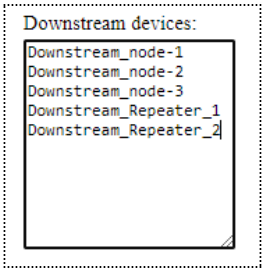
i. This is the list of Worldsensing Nodes that are at 1-hop distance to this repeater.

1. Insert the Worldsensing Node Serial Numbers, one per line.
2. Worldsensing Nodes must appear as local devices of only one repeater in the wireless network.

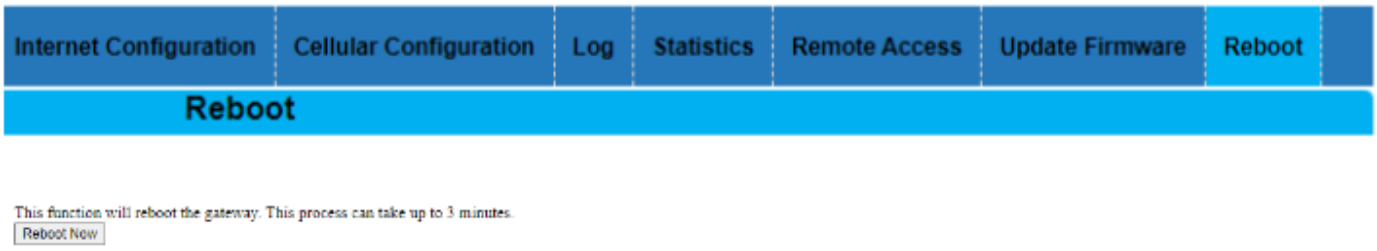


c. **Add the list of Downstream devices:**
   i. This is the list of Worldsensing Nodes that belong to another repeater further down the chain away from the Gateway.
      1. Insert the Worldsensing Node Serial Numbers, one per line.
   ii. Insert the **Worldsensing Node ID** of the Edge Repeaters downstream the network.

Keep in mind the Edge Repeater has a **Gateway ID** and a **Worldsensing Node ID, they are not the same thing.**



6. "Apply Repeater Configuration", using the save changes button.
7. **We recommend rebooting the repeater using the menu after the configuration is finished, that will force the registration of the repeater in the Main Gateway.**



How to add a new Edge Repeater to the network

Depending on the position chosen for the new repeater, the correct ID should be chosen. Keep in mind that the Repeater IDs have to be in ascending order from the closest to the furthest position from the CMT Edge gateway.

If a non-consecutive ID configuration has been implemented from the beginning, it will be easier to choose a repeater ID in the middle of the chain, otherwise all repeater ID configuration must be changed.

If the new repeater is the last one in the chain of repeaters, then it will not be necessary to modify the ID configuration of the rest, it is enough to assign a higher number of all since the new repeater will be the furthest from the main gateway.

If the new repeater is installed in the middle of the chain, follow the instructions of the Edge Repeater Configuration section to add the serial numbers of the nodes at 1-hop distance in list of "Local devices", as well as the serial numbers of the nodes and the Worldsensing Node ID's of the repeaters located downstream the network in list of "Downstream devices".

If the new repeater is installed in the last position of the chain, follow the instructions of the Edge Repeater Configuration section to add the serial numbers of the nodes at 1-hop distance in list of "Local devices", as well as the serial numbers of the nodes and the Worldsensing Node ID of the repeater in the "Downstream Devices" list of all upstream repeaters of the network.

How to add a new node to an Edge Repeater

If a new node is added to the network, follow the instructions of the Edge Repeater Configuration section to add the serial number of the node in the list of "Local devices" of the Edge Repeater at 1-hop distance of it, as well as the serial number of the node in the "Downstream devices" list of all upstream repeaters of the network.

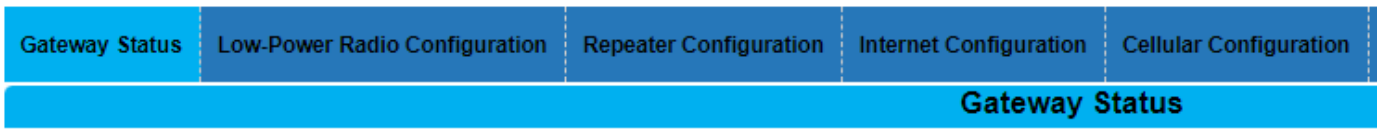
Important note: Keep in mind that the serial numbers of all the nodes connected to a repeater, as well as the Worldsensing Node ID's of all Edge Repeaters added to the network should be added in the list of "Downstream devices" of the Main Gateway.

Follow the instructions of the Main Gateway Configuration section to add the serial numbers and repeater node ID's to the list of "Downstream devices".

Edge Repeater menus

Gateway Status

The Status tab displays all the relevant information related to the Edge Repeater main details, applications and connectivity.



The status is automatically self-updated every 5 minutes.

- **General**

Displays general information about the device and status

- Gateway ID: Set by Worldsensing, different to manufacturer S/N, can not be modified.
- Worldsensing Node ID: Set by Worldsensing, can not be modified.
- Gateway model (Identifies the hardware model, as well as the frequency range).
- Firmware version (Displays the current version).
- Date: Displays the current time and date set on the gateway.
- Uptime in minutes: Amount of minutes since the Edge Repeater was connected or rebooted last time.
- Input voltage: Displays the voltage that powers the gateway. It has a precision of +/- 0.35 V.
- Gateway Health history: List of the generated CSV health files.

- **Application**

  Displays information related to the different applications of the gateway, and how they are performing

  - Network ID: Displays the current radio network ID configured.
  - Internet connection (ping): Indicates whether or not the Edge Repeater is able to connect to the Worldsensing servers. Used for connectivity check.
  - Status reporting: Indicates whether or not the Edge Repeater is able to send status reports to Worldsensing. These reports are sent via HTTP (port 80) to Worldsensing.wocs3.com and provide monitoring information of the Edge Repeater's status to Worldsensing Technical Support.
  - Remote access: Indicates whether or not the Edge Repeater is able to open a remote access connection to the Worldsensing server.

    This Remote access allows the user accessing the Edge Repeater GUI via web, through https://Worldsensing.wocs3.com/[Gateway-ID_Number], as well as Worldsensing technical support department remotely for maintenance purposes.

- **Network**

  Displays the parameters configured on the active network interface.

  - Selected interface: Displays Internet connection selected (Cellular or Ethernet).
  - Ethernet status: Indicates if the Ethernet interface is active (up) or inactive (not connected)
  - Ethernet IP and Netmask: Displays the Ethernet configuration in case of being active when monitored.
  - Cellular modem status: Same as Ethernet status for Cellular connection.
  - Cellular modem IP: IP address assigned to the cellular interface, if enabled.
  - Default gateway and DNS servers: Displays associated addresses.

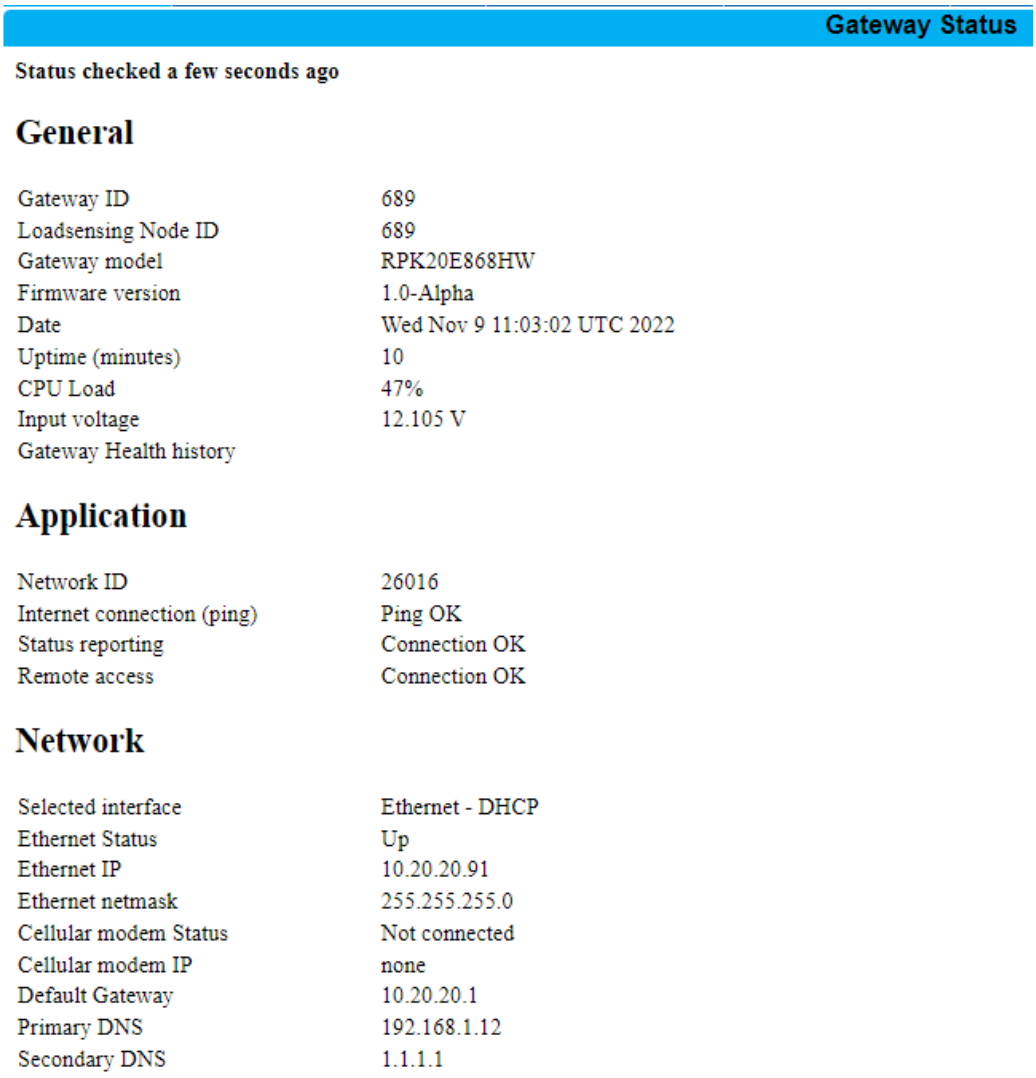
- **Cellular Modem**

This information is provided by the ISP, it may not be shown even if the interface is active.

- Status: Indicates whether or not the current cellular modem status is correct.
- IMSI: Identification number of a given user in a cellular network.
- Operator: Telecommunication operator used for the cellular modem (ISP).
- Roaming: Indicates whether or not roaming mode is activated on the SIM card

  (The roaming function is enabled by default on the gateway, to be controlled by the SIM card provider)

- Mode: Indicates the technology (algorithm) used in telecommunications to define the channels and bandwidth to be used.
- Signal: Indicates the signal coverage of the telecommunications operator in percentages.



Gateway Status

Status checked a few seconds ago

General

Gateway ID	689
Loadsensing Node ID	689
Gateway model	RPK20E868HW
Firmware version	1.0-Alpha
Date	Wed Nov 9 11:03:02 UTC 2022
Uptime (minutes)	10
CPU Load	47%
Input voltage	12.105 V
Gateway Health history	

Application

Network ID	26016
Internet connection (ping)	Ping OK
Status reporting	Connection OK
Remote access	Connection OK

Network

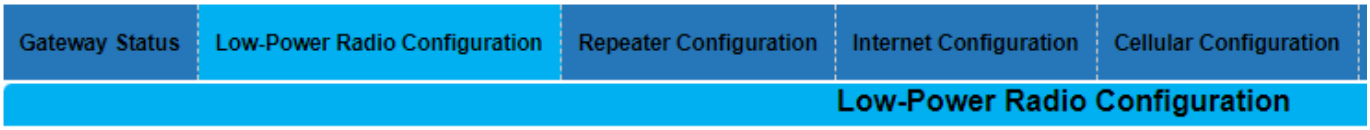
Selected interface	Ethernet - DHCP
Ethernet Status	Up
Ethernet IP	10.20.20.91
Ethernet netmask	255.255.255.0
Cellular modem Status	Not connected
Cellular modem IP	none
Default Gateway	10.20.20.1
Primary DNS	192.168.1.12
Secondary DNS	1.1.1.1

Cellular Modem

Status	Registered
IMSI	214036682390555
Operator	Orange
Roaming	Not roaming
Mode	HSDPA
Signal	100 %

Low-Power Radio Configuration

This page allows configuring Wireless Sensor Radio Network parameters.



There are three different models of K20 Edge Repeaters, with different radio models available, according to the geographical areas where they may be placed. The radio model will be selected based on the local regulations defined by the country where the device will be located.

For some countries, an advanced menu may be displayed. This refers to the possibility of choosing one of the multiple channel groups available for data transmission. A group, usually 0, is set by default, but it can be modified on each gateway. This configuration may avoid or minimize data packet collisions in environments where several gateways are communicating with large amounts of edge devices at high sampling rates, as each group of edge devices will communicate with the gateway in different frequency groups.

The radio configuration of the Edge Repeaters must match the one used in the Main Gateway, and with the edge devices during the setup of the system.

Changing the default configuration, even the channel group at advanced options, requires modifying these parameters at the Main Gateway as well as on the edge devices.

Otherwise, the CMT Edge Main Gateway may not receive the radio messages, and data will not be registered on the system.

The network type, network ID, and password must match on the Main Gateway, the Edge Repeaters, and the edge devices.

The available parameters to configure are:

Country and frequency (Network type)

- Varies depending on the Edge Repeater model. Check the appropriate radio model according to the country regulations.
- Depending on the network model, different channel groups, channels or specific spreading factors may be chosen.

Network ID

- It is a numeric identifier for the wireless network.
- Must be the same used in the Main Gateway.

Network Password

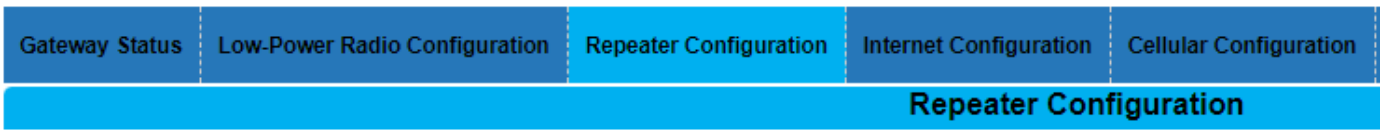
- This password is used to encrypt all data in transit on the Wireless Network.
- The network password must be the same used in the Main Gateway. And it is printed on the Main Gateway Information Sheet.

The process that manages the radio message reception is protected by a watchdog, if at least 1 message has not been received or forwarded in the last 8 hours (no message during 1 Health message period), the repeater will automatically be rebooted.

Rebooting the Edge Repeater minimizes data loss as the process is correctly started again, in case of service failure.

Repeater Configuration

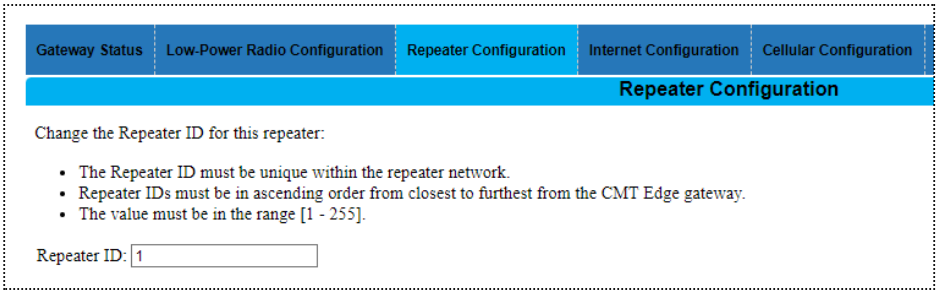
This page allows you to configure the repeater parameters within the wireless network, as well as the list of edge devices and repeaters that will be part of the wireless network.



In the repeater network architecture, they all need to know their relative position, and also which is the next repeater in the wireless network. That will make it possible for a repeater to detect if the next repeater receives a packet, or simply verify that the packet is not for this repeater and continue forwarding the packet. In order to do that, it is necessary to assign an ID to each repeater so that it can be identified within radio communications.

There are some considerations to have into account when configuring the ID of the repeater.

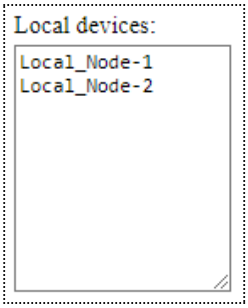
- The Repeater ID must be unique within the repeater network.
- The repeater ID value must be ascending order, from the closest to farthest to the Main Gateway within a repeater branch.
- The value must be in the range [1 - 255].



Edge nodes and edge repeaters that are within 1 hop distance are considered "Local devices" and must be configured accordingly on the repeater.

There are some considerations to have into account when configuring the local devices on the repeater:

- This is the list of Worldsensing Nodes and Edge Repeaters that are closest, with direct view or at 1-hop distance to this repeater.
- Insert the Worldsensing Node Serial Numbers, one per line.
- Worldsensing Nodes must appear as local devices of only one repeater in the wireless network.

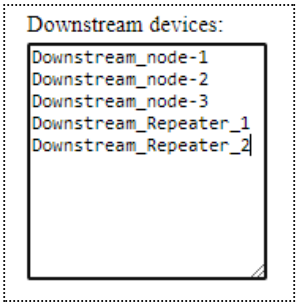


Edge nodes which are configured as “Local devices” in another repeater further down the chain, away from the Main Gateway, and that their messages will be forwarded by this repeater, are considered as “Downstream devices”, and must be configured accordingly on the repeater.

There are some considerations to have into account when configuring the downstream devices on the repeater:

- This is the list of Worldsensing Nodes that belong to another repeater further down the chain away from the Gateway.
- Insert the Worldsensing Node Serial Numbers, one per line.
- Insert the Worldsensing Node ID of the Edge Repeaters downstream the network.

Keep in mind the Edge Repeater has a Gateway ID, and a Worldsensing Node ID, they are not the same thing.

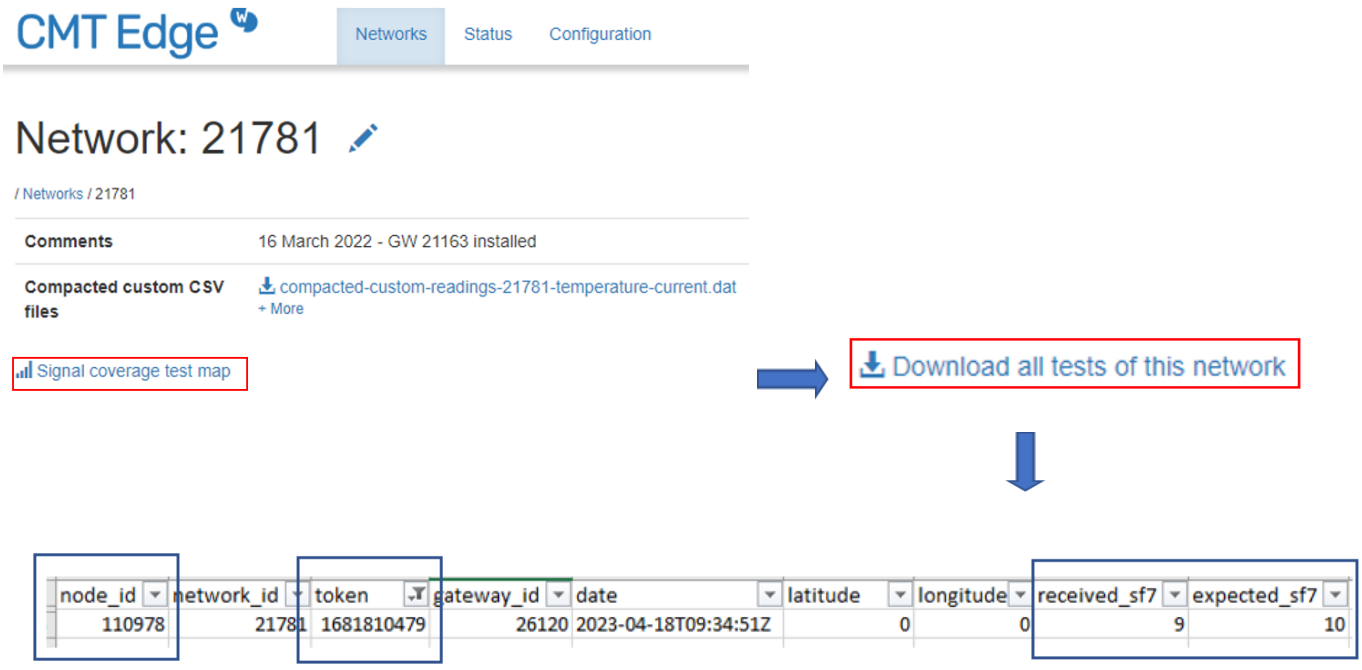


Repeater Coverage Test

For installation purposes, you can perform a Coverage Test and check the results in the Main Gateway.

Once the coverage test is executed a token number will be received.

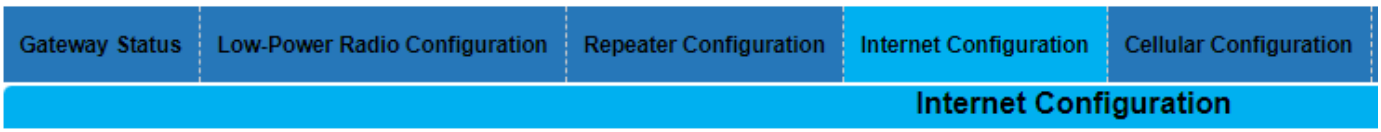
From the Main Gateway it is possible to download the results of the coverage test, once downloaded, filter the results by the returned token number.



Keep in mind that **the messages with sampling rate 7 must be successful**. If not, another location to install the repeater must be chosen and repeat the Coverage Test process.

Internet Configuration

It allows selecting the interface the K20 Edge Repeater will use to connect to the Internet. It can be done via Ethernet physical interface using an ethernet cable with an RJ-45 connector (either LAN or WAN) or Cellular, by inserting a SIM card.

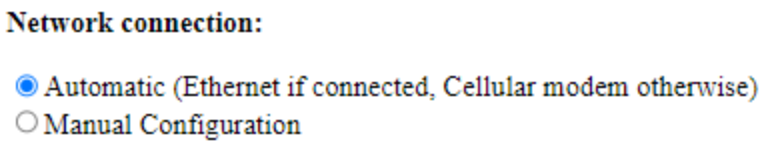


Network Watchdog

Because the repeater has been specially designed for underground applications without internet connectivity, the watchdog mechanism is no longer necessary, although it is possible to see the network watchdog from the menu, it is not available or activated in this firmware version of the repeater due the previous reason.

Network connection

By default, the interface selection is set on automatic mode.



The Edge Repeater when booting will try to connect to the Internet by using the Ethernet configuration using a DHCP configuration. In case the Ethernet connection (link) is not detected, it will switch to Cellular interface, to connect to a mobile network using a SIM card previously inserted in the Edge Repeater with the PIN number disabled.

- Automatic (default)
  - The network connection mode is automatically configured upon Edge Repeater startup.
  - The device will configure the Internet connection as described in the previous paragraph.

- Manual Configuration

  Note: This setting overrides auto-detection and launches the selected connection type.

  - Cellular modem
    - Launches a cellular connection with the settings configured in the "**Cellular Configuration**" tab.
    - The Ethernet interface is disabled but can be used to power the device with a PoE injector.

- In future versions starting with version 1.0.1 onwards, the Edge Repeater will maintain a database of APNs in its internal memory, from where the device will select the most appropriate APN settings and attempt to connect.
- In most cases, the APN must be manually configured from the "Cellular Configuration" menu.

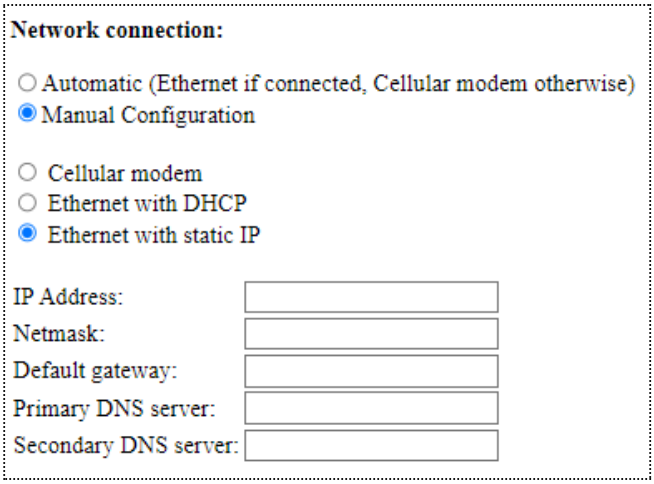
- Ethernet with DHCP
  - Ethernet interface is activated.
  - Receives an IP automatically from an existing DHCP server on the network.
  - The IP address assigned to the device is dynamic.

- Ethernet with Static IP

  This mode requires manually setting of the network parameters:

  - IP address
  - Subnet mask
  - Default gateway
  - DNS servers

Once the network settings have been made, it is required to press the "**Save configuration**" button, and perform a reboot of the device to apply the changes. Otherwise the previous configuration will remain, even if it has been saved.



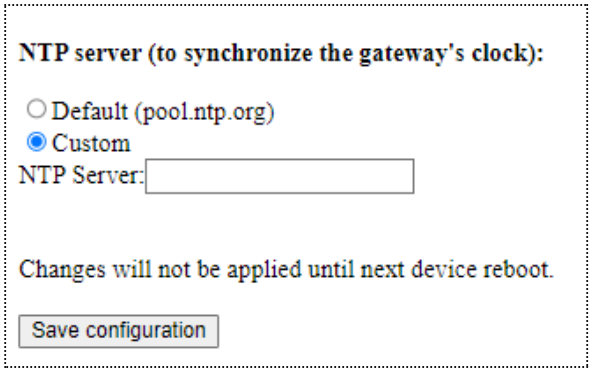
NTP server

Each Edge Repeater periodically synchronizes with a NTP (Network time protocol) server to have the date and time updated. This is mandatory to display and register readings correctly.

The Edge Repeater can be configured to use a custom NTP server.

it is required to press the "**Save configuration**" button, and perform a reboot of the device to apply the changes.

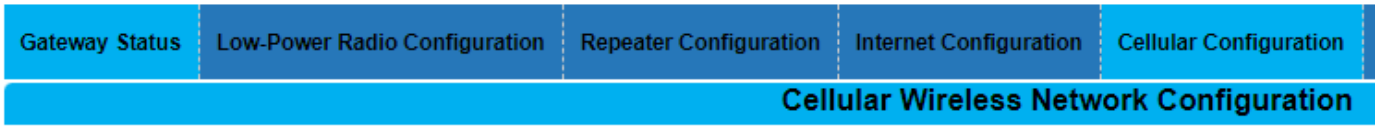
However the date/time of the Edge Repeater is also synchronized with the date/time of the Main Gateway through a "TimeCorrection" downlink message, in response to an out-of-time health message. This synchronization happens 1 minute after the repeater is booted and every 7 hours when it sends the Health message.



Cellular configuration

The cellular modem configuration tab contains some configuration parameters specific to this type of connection.

Note: This tab should be checked when deploying a cellular interface only, if required. This configuration is applied whenever a Cellular connection is used, regardless of whether it was the result of an automatic or manual configuration in the Internet tab.



These are the options available to configure in this tab:

- **PIN** (personal identification number) setting
  - **Off** (selected by default)
    - The Edge Repeater will not attempt to unlock the SIM card.
    - The cellular connection will fail in case the SIM card is PIN protected
  - **On**
    - This setting allows configuring the PIN code for a PIN-locked SIM card.

- **Important**: the Edge Repeater will automatically attempt to unlock the SIM card.

  In case the configured PIN and the real one are different, the SIM card will get blocked once the system exhausts the three possible attempts.

- It is NOT possible to enter the PUK code of the SIM Card using the menu of the Edge Repeater. To enter the PUK code for unlocking the SIM, a mobile phone is needed.

- **APN** (access point name) settings
  - **APN Auto selection** (default)
    - APN stands for Access Point Name, and it is a specific configuration that almost every mobile operator requires to get a connection to the Internet. In future versions starting with version 1.0.1 onwards, the Edge Repeater will maintain a database of APNs in its internal memory, from where the device will select the most appropriate APN settings and attempt to connect.

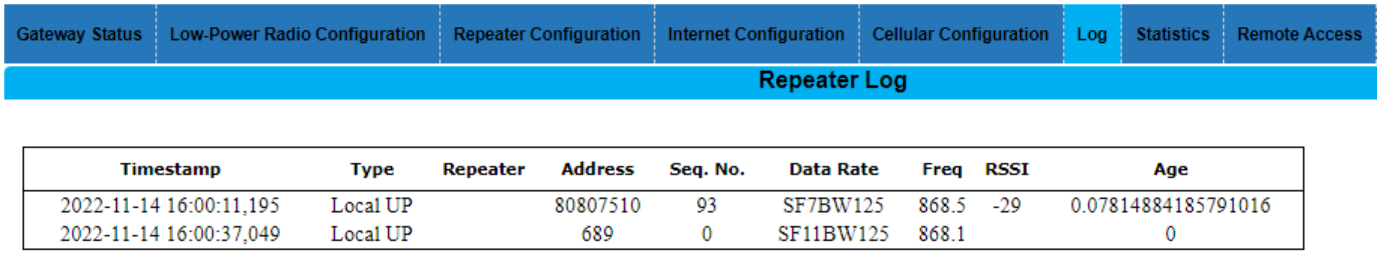
This automatic APN configuration may be wrong for non-standard and some other operators not available on the list. So it is recommended to check that information with the SIM provider and use the manual configuration to configure it.

  - **Manual APN configuration**
    - This setting allows manual input of the mobile operator configuration settings.
    - This feature should be used in case auto-selection does not configure the connection properly.

Important: Roaming is allowed by default in the Edge Repeater. This feature can not be disabled in the device, it should be blocked on the service provider side to avoid using this feature, which may incur on unwanted expenses.

Log

The logs tab shows the last 20 events of the last 1000 lines logged by the packet forwarder message service.



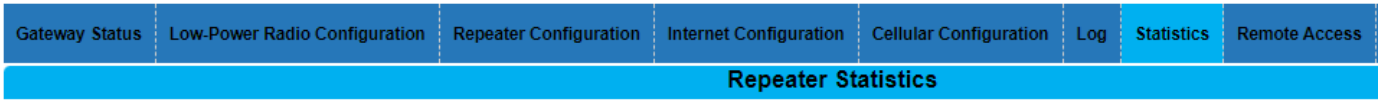
Timestamp	Type	Repeater	Address	Seq. No.	Data Rate	Freq	RSSI	Age
2022-11-14 16:00:11,195	Local UP		80807510	93	SF7BW125	868.5	-29	0.07814884185791016
2022-11-14 16:00:37,049	Local UP		689	0	SF11BW125	868.1		0

Timestamp	Type	Repeater	Address	Seq. No.	Data Rate	Freq	RSSI	Age
2022-11-14 16:00:11,200	Repeated UP		80807510	93	SF7BW125	868.5	-30	0.0836331844329834

- Timestamp: Shows the Date/Time of the logged event.
- Type:
  - Local UP: Message from a device configured locally.
  - Repeated UP: Message repeated from a downstream repeater.
- Repeater: In case the event is a repeated message it will show the repeater ID where it came from.
- Address: The LoRa address where the message originally came from.
- Seq. N°: Sequence number assigned to the message.
- Data Rate: Information of the Spreading factor and Bandwidth.
- Freq: Frequency used to send the message.
- RSSI: "Received Signal Strength Indicator," is a measurement of how well your device can hear a signal from another device. It's a value that is useful for determining if you have enough signal to get a good wireless connection.
- Age: How long has the packet been in process, time in seconds.

Statistics

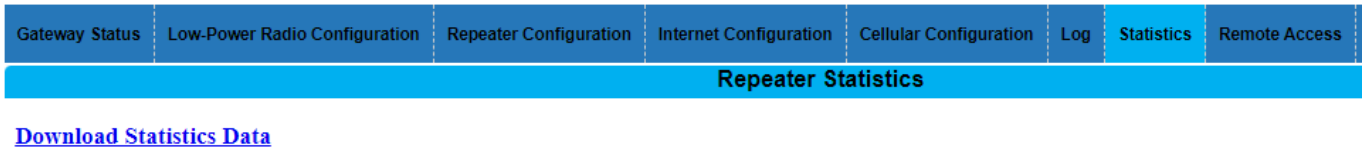
This tab will show monitoring information of each device that sends messages through the Edge Repeater.



Download Statistics Data

All data shown in the tables below can be downloaded in a json file.

- The stats info is persistent between reboots.
- The stats are initialized in the Repeater with the values from this file during the startup (if the file exists).
- The Repeater will update the json file every 30 min.
- Entries in the Devices table that are not Local/downstream nodes expire after 7 days, and are removed from the list.



Identifiers

It shows identification information of the Edge Repeater, such as:

- **Repeater ID:** It is the ID of the repeater within the wireless network, it is the same ID configured from the Repeater Configuration menu.
- **Worldsensing ID:** It is the ID configured by Worldsensing when the device was produced, it can not be modified.

General

It shows information as:

- **Packets Received**: Number of messages received via the packet forwarder message service.

Packets Received 79621

	Duplicated	Overheard	Transmitted	Acked	Forwarded
Up	4693	36937	7444	608	2631
Down	361	484	367	0	256

	Up	Down
Duplicated	Number of upstream packets dropped due to being duplicates of the already forwarded ones.	Number of downstream packets dropped due to being duplicates of already forwarded ones.
Overheard	Number of upstream packets dropped due to being transmitted from an upstream node or repeater that were not part of the chain.	Number of downstream packets dropped due to being transmitted from an downstream node or repeater that were not part of the chain.
Transmitted	Total number of upstream packets transmitted. This value also includes the number of retransmissions for which the ACK was not received.	Total number of downstream packets transmitted. This value also includes the number of retransmissions for which the ACK was not received.
Acked	Number of upstream packets forwarded and acknowledged.	Number of downstream packets forwarded and acknowledged.
Forwarded	Number of UNIQUE upstream packets forwarded.	Number of UNIQUE downstream packets forwarded.

Local

It shows information of the stats of the repeater as a node, such as:

- **Uplinks Sent**: Number of uplink packets generated by the repeater.
- **Downlinks Sent**: Number of downlink packets received by the repeater.

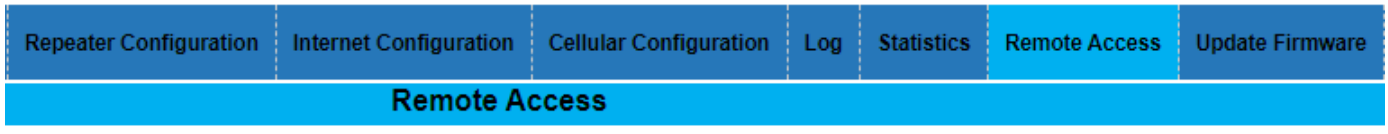
Devices

Statistics for each known node (indexed by node id). All local and downstream devices will always be in this list, initially with zero statistics.

- **ID**: The node ID or repeater ID depending.
- **Type**:
  - Local Node: Node configured as local device in the repeater.
  - Down Node: Node configured as downstream device in the repeater.
  - Other: Node or repeater not part of the repeaters chain.
  - Up Repeater: Repeater that is "upstream". In other words, it is higher in the hierarchy of the branch, or closer to the Main Gateway than this repeater.
  - Down Repeater: Repeater that is “downstream”. In other words, it is below in the hierarchy of the branch, or further from the Main Gateway than this repeater.
- **Received**: Total number of received packets from this node/repeater
- **Acked**: These are the number of messages that have been acknowledged from another repeater.
- **Avg. RSSI**: Avg.RSSI of the last 10 packets.
- **Last Seen**: Date/Time of the last received packet

Remote Access

This tab allows configuring the remote access to the Edge Repeater.



Admin password

The Edge Repeater comes with a preconfigured user with administrator privileges and a predefined password. This credentials can be used to access the Edge Repeater from all the available interfaces, such as:

- Internet access via Public IP address through https://Public_IP_Address/GW_ID
- Remote access through a VPN tunnel https://Worldsensing.wocs3.com/GW_ID

- Local interface using the USB-C to Ethernet adapter.

If required, the factory administrator user password can be changed from this menu.

The previous Admin password will be required when the device is accessed remotely, but no when modifying it through the local access.

Click on the “Change Admin password” button to apply changes.

Keep the new password safely. The Worldsensing support team only keeps a digital copy of the default password, provided at the Gateway information sheet.

Changing the default passwords also affects the local interface (unlike previous firmware versions).

Worldsensing support can reset the passwords to default, in order to do this the Edge Repeater must be accessible remotely. Don’t hesitate to contact us in case you need our support to recover the original access credentials.

Remote Tunnel

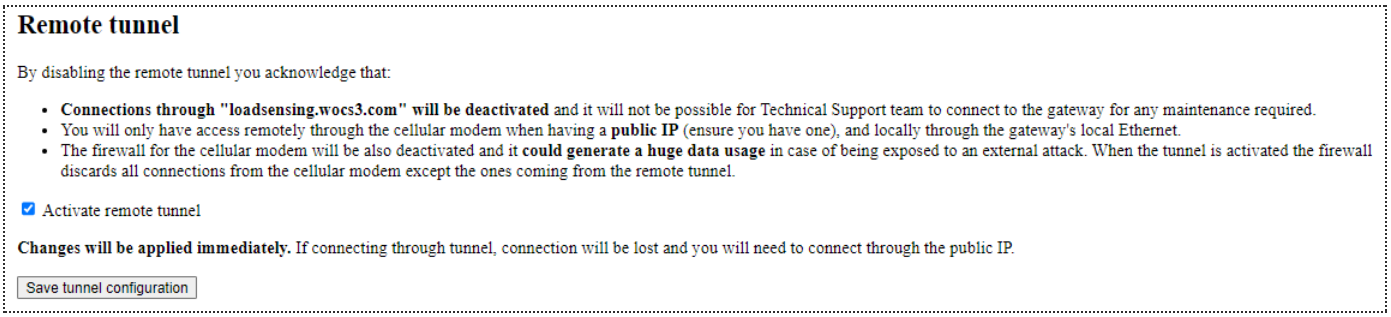
The Edge Repeater can be accessed remotely using Worldsensing's VPN tunnel service.

It allows accessing the Edge Repeater through an URL instead of an IP address that may be dynamic, which is the case when SIM cards or DHCP servers are used to connect the device to the internet.

This known URL is https://Worldsensing.wocs3.com/{GW_ID}, unique for every device produced, and accessible using the credentials provided on the Gateway Information Sheet.

This VPN tunnel also allows remote access for troubleshooting and support purposes.

This feature is enabled by default, but may be disabled if required.



There is one scenario where this tunnel should be disabled only:

- When using a fixed public IP address, then the edge repeater can be accessed using the fixed IP instead of the VPN tunnel.

Tunnel deactivation is done immediately, once the “Save tunnel configuration” button is applied. This may provoke connection loss if the operation is done through the tunnel URL.

Worldsensing recommends disabling this function (if required) from the local interface to avoid any connectivity issue.

Firewall rules

There are some firewall rules to prevent undesired incoming external connections to the Cellular interface (3G/4G/GPRS). When the VPN tunnel is activated, the edge repeater will only accept incoming traffic from the Worldsensing's VPN tunnel.

Deactivating the tunnel when using this interface could generate a huge data usage in case of being exposed to an external attack.

Firewall rules do not apply to wired environments (Ethernet interface). The Ethernet network must be a reliable network, and security must be applied by using firewalls, routers and other networking elements.

VPN Tunnel

Worldsensing’s VPN tunnel uses OpenVPN, a virtual private network system that implements techniques to create secure point-to-point or site-to-site connections in routed or bridged configurations and remote access facilities.

All communication through the VPN tunnel uses AES-256-CBC encryption.

Required network ports

In order to get remote access to the Edge Repeater, some generic ports must be open inbound and outbound.

In private networks, these ports may be closed and therefore the IT department must be requested to open them.

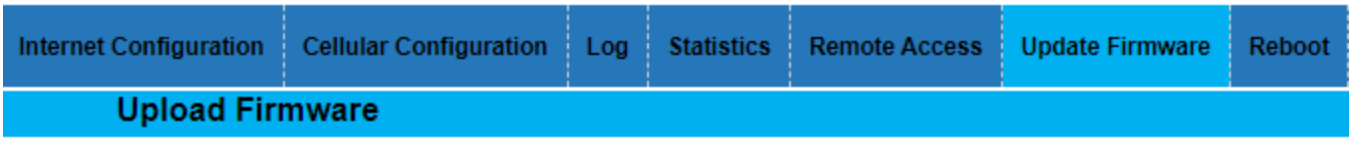
Cellular networks usually allow communication through these ports without any additional configuration.

- TCP 443 (HTTPS port): This port is the one used to access the Edge Repeater via the web.
- UDP 1194 (VPN port): This port is used to enable remote access.
- UDP 123 (NTP port): Required for time synchronization.

Update Firmware

This tab allows upgrading the firmware version of the K20 Edge Repeater using OTA (over-the-air) files released by Worldsensing.

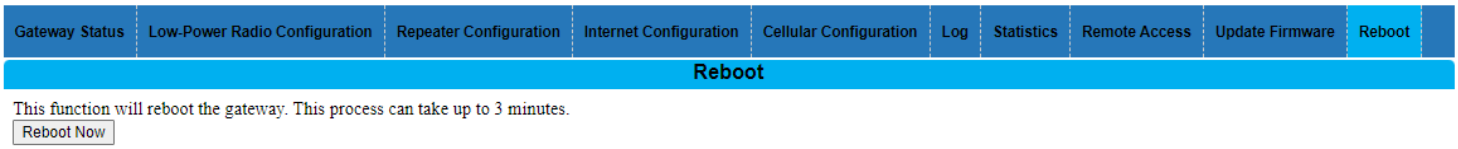
These OTA files are published in our Help Center.



Keeping the gateways updated is considered as a good practice, since in addition to adding new functionalities, we improve how the system works, and we correct the bugs detected.

Reboot

Rebooting the K20 Edge Repeater may be required to apply some configuration changes.
The rebooting process can take up to 3 minutes.
The “Reboot Now” button should be pressed and accept the displayed message.



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.

Certifications

LS-G6-KIO-GW-923 / LS-M6-KIO-GW-923 / RPK20E923 Models

Brazil:

ANATEL
Agência Nacional de Telecomunicações
13787-20-11272

"Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados".

Singapore

Suppliers Declaration of Conformity	COmplies with: IDMA TS SRD IDMA TS CMT

Indonesia

Ministry of communications and information technology	NOMOR : 66489/SDPPI/2020

LS-G6-KIO-GW-868 / LS-M6-KIO-GW-868 / RPK20E868 Models

Europe: CE	Declaration of Conformity
	Certificado de Homologação N°: 25/R/PAD/2020

Mozambique:

INCM
Instituto Nacional das Comunicações de Moçambique
Autoridade Reguladora dos Sectores Postal e de Telecomunicações

LS-G6-KIO-GW-915 / LS-M6-KIO-GW-915 / RPK20E915 Models / LS-G6-KIO-GW-915R

USA:	2AFYS-KLK915LOI
Canada:	
Technical acceptance certificate	IC: 20637-KLK915LOI

Contact Worldsensing Customer Success department for more information about these and other regions.

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)

Want to stay up-to-date about Worldsensing?
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