

## User Guide

### Loadsensing Digital Data Logger - RST IPI

Version 1.0



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## Summary

This user guide explains the basic procedure for configuring and operating Worldsensing's Loadsensing LS-G6 digital nodes (LS-G6-DIG-2) with chains of RST IPI sensors with ASCII and Modbus RTU Protocol, the last one only available for CMT Edge firmware versions equal or above [2.5](#) or [2.5.1](#).

The datasheet of the LS-G6-DIG-2 digital logger can be downloaded from our [website](#), where features and main specifications can be found.

## Compatibility with RST

The Loadsensing digital logger provides long-range wireless connectivity and autonomous power supply for several RST IPI generation chains.

According to the serial of the IPI segments, different RST IPI generation models and protocols are used for the communication (see Table 1):

Serial	IPI Generation	Protocol
< 65535	IPI2	ASCII
From 70000 to 79999 (included)	IPI3	ASCII or Modbus
> 80000	IPI4	ASCII or Modbus

Table 1. Serial correspondence to IPI generation model and protocol used.  
Loadsensing digital datalogger is able to read all the IPI generation and also provides compatibility with different IPI generation models on the same chain through the Worldsensing app.

Please consider the following requirements when using the digital node to read RST IPI chains (Table 2).

<b>RST Generation</b>	<b>IPI2</b>	<b>IPI3</b>	<b>IPI4</b>	<b>IPI2 mixed with IPI3/IPI4</b>
<b>Preferred protocol - when configuring digital logger</b>	ASCII protocol	Modbus RTU	Modbus RTU	ASCII protocol
<b>IPI3 Compatibility mode<sup>1</sup></b>	OFF	-	-	ON
<b>Units of measurement transmitted</b>	degrees (°) <sup>2</sup>	Sine (°)	Sine (°)	degrees (°) <sup>2</sup>
<b>Maximum IPI segments on a chain</b>	30	50	50	30
<b>External power needed</b>	No	No	No	No

Table 2. Requirements for using digital data logger to read IPI segments.

<sup>1</sup> Option Selectable on WS App, <sup>2</sup> Digital logger converts the sine of the angle measured by the digital in-place inclinometers to an angle in sexagesimal degrees.

## Before connecting the RST IPI chain to the digital logger

In the previous chapter we have explained digital logger compatibility with the different protocols that RST has implemented for reading IPI segments.

However it is important to take into account that Worldsensing recommends using the Modbus RTU protocol when it is possible, due to its lower consumption.

When configuring IPI Modbus RTU chains with the WS App, it will be necessary to type each Modbus address (see digital logger configuration chapter). We strongly recommend ordering the IPI chains from RST with the Modbus address configured according to their position on the chain to avoid having to assign them manually with the RST 485 interface.

## Equipment provided

The Loadsensing nodes are shipped with the following accessories:

- Digital data logger.
- Antenna.
- Antenna adapter.

The package does not include:

- A USB-OTG configuration cable.
- Batteries.
- A grounding cable or earthing rod.
- Mounting support .

## Digital node installation

The parts of the digital node are the following (related with the number in the figure below):

1. Casing.
2. RP N female connector. (Compatible with Male RP N connector to RP - SMA male and aerial with RP - SMA male.)
3. External mini USB B female connection
4. Gore valve for protection against condensation.
5. A grounding screw for metallic nodes.
6. Cable gland.

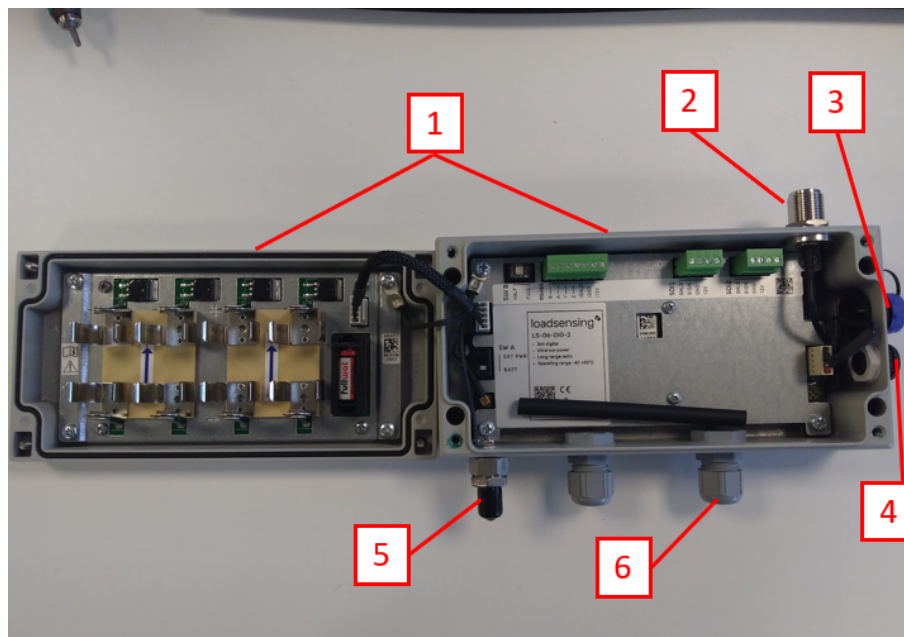


Fig.1 View of an opened LS-G6-DIG node

Please note that on digital nodes with serial 60670 and above, the ½ AA size battery holder and its battery has been removed from the battery board to simplify the product installation and maintenance and in line with Worldsensing thrust to provide more environmentally sustainable products by reducing battery waste. This removable has no impact on the performance of the edge device, as the time synchronization feature has been implemented since CMT Edge firmware version 1.12.1.

## Data Logger Mounting

The digital nodes can be mounted:

- On a wall: mounting brackets are available as additional accessories.
- On a metallic structure: strong magnets are available as additional accessories.
- On a pole: plates for 35 and 50 mm pole diameters are available as additional accessories for this mounting type.
- Inside a manhole (with a plastic or metallic cover): no special accessories are available for this mounting type. The data loggers are IP67 certified when they are closed following the instructions in the [water tightness document](#).

Should the data logger 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). See [Annex 10 LS G6 Dataloggers installation on manholes](#).

## Sensor connection

RST IPI RS485 digital sensors must be connected to the RS485 port of the LS-G6-DIG node with the following wiring:

	ASCII Protocol	Modbus RTU Protocol
RS485 A	Green	Green
RS485 B	Yellow	White
RS485 SHLD	Shield	Shield
RS485 GND	White	Black
RS485 12V	Brown	Red

Table 3. Pinouts for ASCII and Modbus IPI .

Wires and their pinouts must be checked with the sensor data sheet from the manufacturer. As a workaround, pairs can be checked with a multimeter.

After you connect the RST IPI, we recommend taking a sensor reading using the app to make sure the connections have been made correctly.

An alternative can be to compare the sensor reading at installation with a portable readout unit.



## Powering the wireless data logger

The data logger arrives closed and without batteries installed. In order to initialize it, the user should follow these steps:

1. Open the data logger (using a 2.5 mm Allen wrench) following the recommended positions (Figure 2) in order to avoid damaging the lateral gore valve. The batteries are inserted into the cover, so be careful not to snap the cable between the cover and the main board.
2. Insert **C-type batteries** in the battery holders (Figure 3). Between one and four batteries can be connected. Polarity is indicated (see Annex 4 for further information on the batteries).

*Note: The device has reverse battery protection but it is not safe to keep batteries reversed in the data logger for a long time.*

3. Check that the power switch (SW A, Figure 4) is in the correct position. EXT PWR position: the data logger is powered by the USB cable connected to the Android device used to configure the node or to any external power kit. BATT position (default): the data logger is powered by the batteries inserted on the battery holder.

*Note: Some Android devices cannot power the data logger, especially when performing a reading. If reading fails, set the switch to BATT mode in order to power the data logger with batteries during the configuration.*

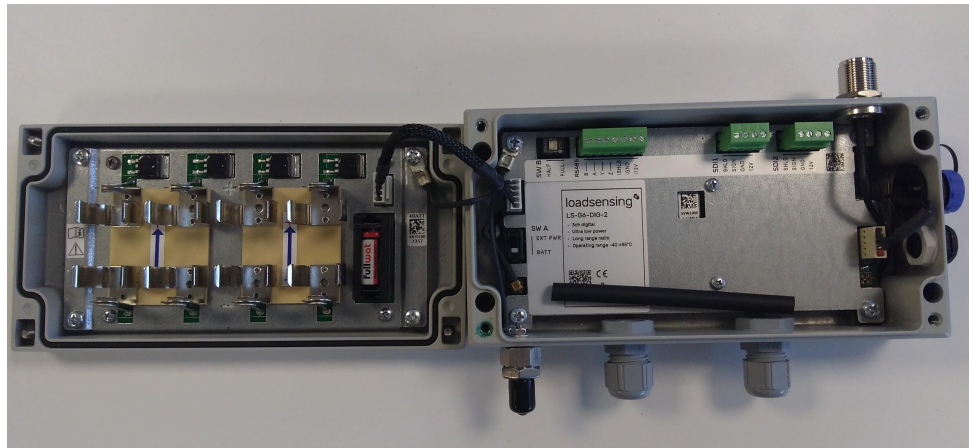


Figure 2: Opened digital node



Figure 3: Insert C-type batteries

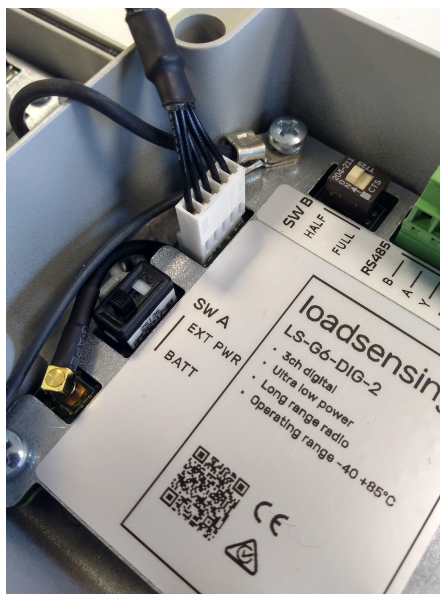


Figure 4: Switch must be in the right position depending on the power source

If the user wants to use different batteries to the ones recommended, it is advisable to check Saft LSH 14 batteries specifications: [Saft LSH-14](#) as a current peak and a high pulse capability are required to power the chain of sensors.

For certain cases in which you may need externally powering the system, please contact our technical team for further information.

## Digital Logger Configuration - RST IPI

Try to carry out this step in the place where you are going to install the node. That way, you can perform an on-site radio coverage test at the same time.

You will need to carry out the node configuration process using Worldsensig App (WS App), which is compatible with USB On-The-Go (OTG) Android devices. To make sure the

mobile app works properly, we recommend you purchase one of the models in stock from Worldsensing. Please contact the technical support team for more information.

Please refer to the [Ws App user guide](#) for general steps to be followed on the configuration process.

## Sensor Configuration

In this step we will review the specific part of the sensor configuration. As mentioned in the second chapter, according to the IPI generation, the protocol selected for the configuration may vary.

### IPI2 Generation segments

In this step you need to select the 'RST ASCII - SN<70000' from the protocols list, set the IPI3 compatibility mode off and type the serial number of the segments according to the order on the chain separated by comma (Figure 5).

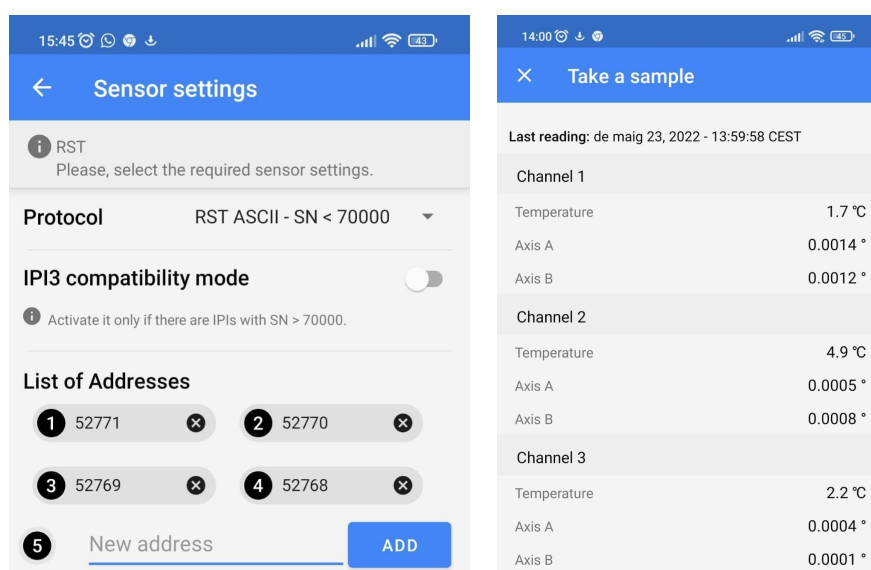


Figure 5.

configuration for RST IPI ASCII protocol.

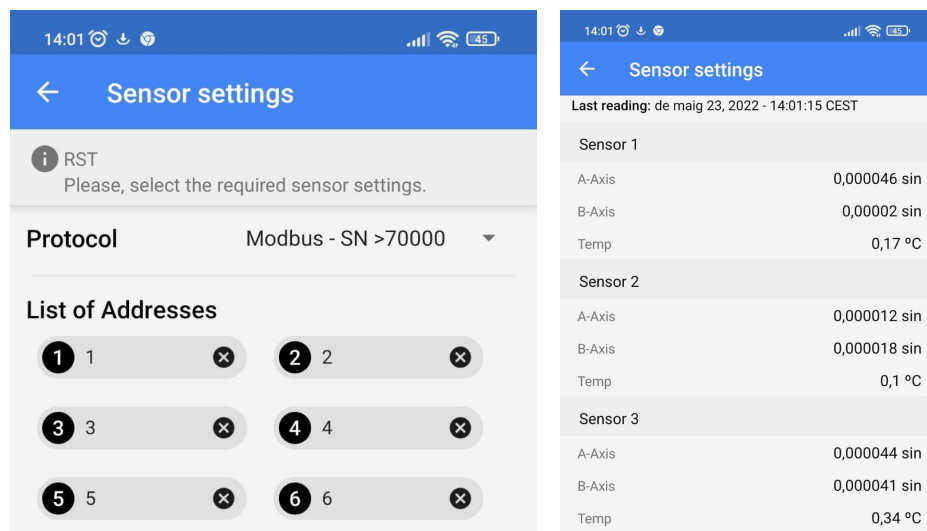
Digital node

The digital logger converts the sine of the angle measured by the digital in-place inclinometers to an angle in sexagesimal degrees.

Note: Loadsensing can read the sensor's range (+/- 30°).

### *IPI3 and IPI 4 Generation segments*

In this step you need to select the 'RST Modbus - SN>70000' from the protocols list and type the Modbus Addresses of the segments according to the order from the segments on the chain separated by comma (Figure 6).



Figure

configuration for RST IPI Modbus protocol.

6. Digital node

**Important Note:** RST In-Place Inclinometers segments Modbus address configuration from factory is 1 by default on every segment. This makes it not possible to read a chain of IPI if they have been configured all with the same address.

We strongly recommend ordering the IPI chains from RST with the Modbus address configured according to their position on the chain to avoid having to assign them manually with the RST 485 interface.

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Note: IPI3 and IPI4 can also be read by using the ASCII protocol, but we strongly recommend to use the Modbus RTU protocol as it adds some advantages, it has less consumption thus brings the possibility of reading more segments on a chain.

In this case the digital logger reads the Sine of the angle measured by the digital in-place inclinometers. The allowed range measurement is +/-0.5 sin for axis and -40°C to +60°C for temperature).

### *IPI2 combined with IPI3 or/and IPI4 Generation segments*

It is only possible to read combined IPI generation segments, by using the ASCII protocol

In this step you need to select the 'RST ASCII - SN<70000' from the protocols list, enable the IPI3 compatible mode and type the serial number of the segments according to the order on the chain separated by comma (Figure 7).

Figure 7. Digital node configuration for RST IPI mixed protocols.

The digital logger converts the sine of the angle measured by the digital in-place inclinometers to an angle in sexagesimal degrees.

## Sensors Data

The **Sensors data** screen displays the current readings of the data logger, according to the protocol used (Figure 8)

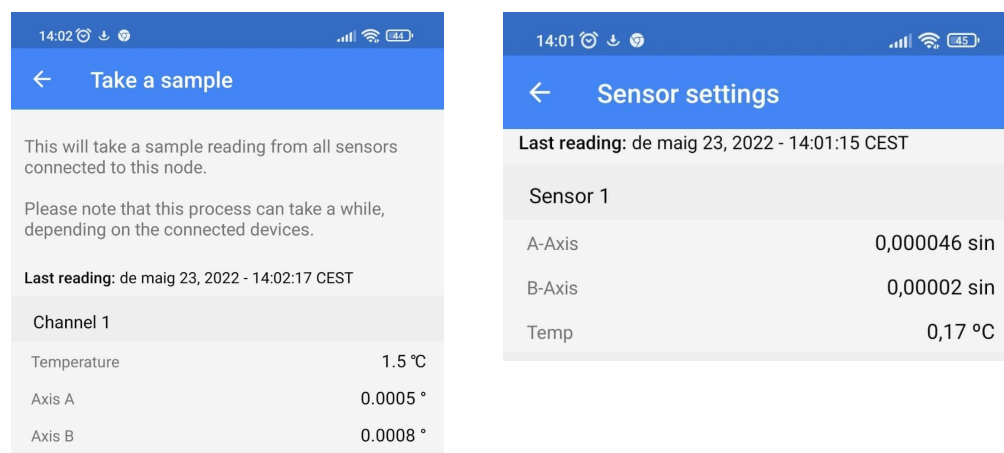


Fig. 8 Sensors data

- The screen shows:
  - A-Axis, B-Axis (units will be reported in degrees or sin angle according to the protocol selected) and Temperature data
  - If any error is reported, check the wiring and the configured protocol as explained in the previous sections.
- The node takes a new reading every time the "Take a sample again" is clicked.
- Note that taking a reading might take some time.



## Safely closing the Digital node

This is a very important step to ensure water tightness and durability of the logger. Please ensure that you follow all the steps detailed on the [water tightness document](#) for closing the device properly.

Digital dataloggers are IP67 rated if they are closed according to the instructions detailed on the document referred on the above.

Please note that any water ingress into the device will void the warranty.

## Battery Lifespan

Battery consumption varies depending on the number of segments, sampling rate and environmental and wireless network conditions. The following table provides the battery lifespan in days/months/years per segment according to different wireless network conditions.

Battery life estimation (SF8@20dBm)				
Number of sensors	Sampling rate 5 min	Sampling rate 30min	Sampling rate 1 h	Sampling rate 6 h
10 sensors	3 months	2.6 years	4.1 years	7.4 years
30 sensors	3 months	1.3 years	2.3 years	6 years
50 sensors	56 days	10 months	1.8 years	5 years

Test settings in terms of radio: US 902-928MHz (FCC) radio configuration. Spreading factor 8. Radio transmit power 20dBm. Considering standard laboratory conditions. Estimations for 4 Saft LSH14 batteries based on the lifetime mathematical model.

Battery life estimation (SF9@14dBm)				
Number of sensors	Sampling rate 5 min	Sampling rate 30min	Sampling rate 1 h	Sampling rate 6 h
10 sensors	6.5 months	2.4 years	3.8 years	7.3 years
30 sensors	78 days	1.1 years	2 years	5.7 years
50 sensors	48 days	9 months	1.4 years	4.6 years

Test settings in terms of radio: EU 868-869MHz radio configuration. Spreading factor 9. Radio transmit power 14dBm. Considering standard laboratory conditions. Estimations for 4 Saft LSH14 batteries based on the lifetime mathematical model.

Note: Battery life may vary considerably from specifications depending on the actual set-up and working conditions; such as sensor version, sampling rate, wireless network status and environmental conditions. The battery life rating is only achieved on the specific sensor models and configurations tested by Worldsensing under the specific test settings at the time of publication and is not an estimate of a system's battery life under any conditions other than the specific test settings.

## Data Acquisition and Storage

The internal node has 4 MB of memory, which corresponds to a capacity up to 90.000 readings from 30 RST In Place Inclinator chain (each reading includes two axis inclinometer reading and Temperature, grouped by 5 sensors).

Data is stored in comma-separated value (DAT for readings and CSV for health) files. You can download readings and health files using the WS App (Figure 15).

To do this, connect an Android device to the node Mini USB port with a USB-OTG cable. When WS App loads, download data by clicking on the Download icon in the Sensors Data tab. You need to set a start and end date for the data you want to download. The Android

device allows these data files to be opened with applications such as e-mail or cloud apps. Files are also stored in the device memory, on the SD card in the WS folder.

Fig. 9 How to download readings to the Android device.

## Node Surge Protection

Following IEC 61000-4-5, digital data loggers have been equipped with class 2 surge immunity protection against damaging spikes and transients. That means the node is protected up to 1kV.

In order to protect the data logger from surges (especially in installations with long cable runs), the data logger must be properly grounded via connection to the grounding screw. Otherwise the surge protection cannot prevent the node from being damaged by direct or indirect lightning. In any case, nothing can protect a system from a direct lightning strike or one so close that it overloads the capacity of the surge protection.

Further information can be found on the [Surge protection document](#).

## Troubleshooting

Before installing Loadsensing digital node, please check basic recommendations from [How to optimize radio performance](#) document.

As digital datalogger is usually used to automate in ground installed instruments that in urban scenarios are covered by manholes, it is important to pay attention on closing properly the device and also to consider some actions to improve communication with the Gateway. Please, take a look at the [Installation on Manhole document](#).

### *Missing readings*

For the RST In-Place-Inclinometer radio transmission messages, the packages are splitted in groups of 5 sensors, thus when downloading reading files from the Gateway and blank readings grouped in multiples of 5 can be seen, this can be attributed to a radio issue.

This can also be checked on the node Status Panel, where lost messages (in red) are detailed for the five last days.

Missing readings on reading files downloaded on the Gateway that can not be grouped in groups of 5 can be attributable to Errors.

### *Reading error file*

For the *RST In-Place-Inclinometer chain read in ASCII protocol*, there are no CSV error files shown on the Gateways, thus when an out of range value or a specific error of the sensor happens, blank readings are shown on the reading file from the Gateway.

When downloading the reading file directly from the node, the user will be able to see an Error stamp registered on the files.

For the *RST In-Place-Inclinometer chain read in Modbus RTU protocol*, when an error occurs it is reported in the Error csv file added with the timestamp when it has been registered and an empty register will appear on the reading file matching with the timestamp when the error has occurred. The following errors with their corresponding codes are listed on the table below:

Code	Description
-1	This error happens when the CMT Edge firmware of the Gateway does not recognize the Modbus configuration. Must be fixed upgrading the Gateway to the correct version
1, 2,3,4	Internal errors. Please contact worldsensing
5	Communication error: no response received from any of the configured sensors
0	Out of range value

## Bad readings

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

- **Impacts:** dents on the node enclosure are a likely sign of impact.
- **High vibration levels:** the node is not proper when the application requests high vibration intensities.
- **Water ingress:** the LS-G6-DIG node has IP67 ingress protection, so it can withstand immersion in up to a meter of water for up to 30 minutes. The node should never be submerged in water, however. Sometimes the node can apparently be working properly after water damage, but giving back weird readings. Water damage to the internal components voids the warranty.

- **Electrical damage:** After an overvoltage in any part of the electronic board, the node can be still working, but integrity of readings can be affected. Electrical damages to the internal components voids the warranty.



## FAQ

### **I have purchased RST In-Place Inclinometers, how can I know which protocol to use?**

Depending on RST In-Place-Inclinometers serial numbers, ASCII or Modbus protocol must be selected through the WS app while configuring the digital node. Please check the compatibility chapter for further information.

Loadsensing digital datalogger is able to read all the RST IPI generation and also provides compatibility with different models installed on the same chain through the WS app.

When dealing with IPI3 and IPI4 segments that could be configured by using both protocols, we strongly recommend to use the Modbus RTU protocol as it will lead to reduce consumption and also will allow to increase the number of segments to read on a chain.

### **How many RST In-Place Inclinometers segments can I read using Loadsensing digital data logger?**

The number of RST In-Place Inclinometers segments that can be read with the digital datalogger depends on the type of protocol used.

Please note that for IPI3 and IPI4 Generation segments, Loadsensing Digital datalogger can power and read up to 50 segments, while for IPI2 or mixed chains with IPI2 and IPI3/IP4 Digital datalogger can power and read up to 30 segments.

**I have purchased Modbus RTU RST In-Place Inclinometers, can I configure them directly with the digital node?**

RST In-Place Inclinometers segments Modbus address configuration from factory is 1 by default on every segment. This makes it not possible to read a chain of IPI if they have been configured all with the same address.

We strongly recommend ordering the IPI chains from RST with the Modbus address configured according to the order of the chain that is going to be installed.

Alternatively, you can use the RST 485 Interface to assign them manually to the IPI segments.



## Environmental best practices

### Installation and operation

Please install Worldsensing products in an energy-efficient manner by minimising power usage for computers, mobile phones or other devices needed for setup and configuration. Minimise the use of small components needed for installation, like mounting brackets and other connection materials. Avoid using toxic materials and/or hazardous substances.

- Set the sampling rate only in the nodes you need.
- When configuring the nodes, use "Set last configuration" whenever possible.
- Remove the batteries if you are not using the node.
- For nodes with switch, use the usb mode when not in operation.

### Return Material Authorization (RMA)

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

### Product End of Life and disposal

Please take the necessary measures to extend the life of the product and reuse it when possible.

Once the product reaches its end of life (EoL) recycling is crucial to divert material from waste streams into new applications.

Electrical and electronic devices, and batteries must be recycled according to the European Union WEEE Directive 2012/19/EU.

Please separate batteries from equipment.

This product and the batteries it may contain should not be discarded as unsorted waste. Please send them to separate collection facilities for recovery and recycling.

### Product packaging

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

### Safety and emergency procedures

Please read the safety sheet that comes with our products before installing them. For safety information on batteries and other materials, as well as instructions in case of emergency please read the safety information available at: <https://info.worldsensing.com/safety-information/>

In the case of an emergency and after it has been managed, please evaluate the waste generated in order to dispose of it in accordance with current legislation and local regulation.

**It is your responsibility to dispose of your waste equipment, batteries and packaging properly to help prevent potential negative consequences for the environment and human health.**

The cost of environmental waste management is included in the battery's selling price.

By following these best practices you can help protect the environment. Thank you for your cooperation.



## CONTACT WORLDSENSING

**Need more support?** Get in touch with our Customer Success team:

Email: [support@worldsensing.com](mailto:support@worldsensing.com) Phone: +34 93 418 05 85 (08.30h - 16.30h UTC)

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