Weidmüller ⋺⋲

SOLAR STRING MONITORING SERVER LoRaWAN® CONFIGURATION MANAGEMENT TOOL

(en) User guide

4000003329 Solar SMS Master LoRaWAN®

4000003489 Solar SMS RF LoRaWAN®

Content

1. Introduction

This document aims to establish a user guide for the usage and maintenance of the Solar String Monitoring Server LoRaWAN® Configuration Management Tool with the purpose of establishing a communication bridge between Modbus TCP and LoRaWAN® in a transparent way. In addition, it guides to managing the indispensable configurations for the correct functioning of the system.

Below figure is showing all elements involved with the system described in this document, focusing on Solar SMS Master LoRaWAN® devices, LoRaWAN® Gateway, and Server LoRaWAN®. The item described as SCADA is out of the scope of the present document.
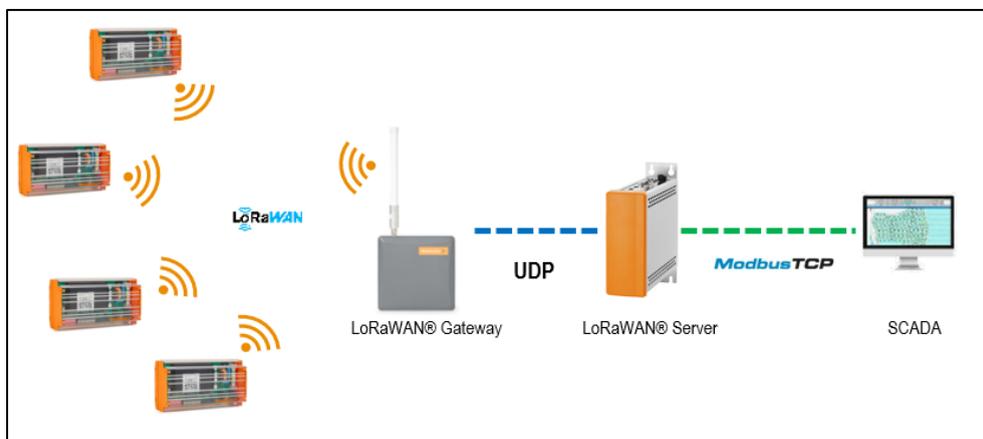
Figure 1. General overview of the system described

Present document requires to be read along (after) with the already existing user guide for the "SOLAR STRING MONITORING SYSTEM" available for downloading under Weidmüller' official Website (*PV monitoring systems*); please read it carefully and pay attention to all advice and warnings stated on it.

2. Safety, application, disclaimers, support

2.1. Precautionary statements

This user guide contains statements that you need to observe to ensure your personal safety, as well as to prevent damage to the property. These precautionary statements are graded according to the degree of the hazard.

2.2. Disclaimers

This user guide has been written with due care and attention. However, unless otherwise required by law, we do not guarantee that the data, images, and drawings are accurate or complete nor do we accept any liability for it. Weidmüller' general terms and conditions of sale apply in their respective valid form. The equipment specifications and the contents of this user guide are subject to change without notice.

2.3. Manufacturer contact details

Contact your local Weidmüller sales representative for support and service information about this equipment. Alternatively, you can contact Weidmüller' headquarters:

Weidmüller Interface GmbH & Co. KG
Klingenbergstraße 26
32758 Detmold
T +49–5231 14-0
F +49–5231 14–292083
www.weidmueller.com

3. Server LoRaWAN® functional specifications

The Server LoRaWAN® is the one in charge of the management of Gateway LoRaWAN®, the authorization of the Solar SMS Master LoRaWAN® devices and the exchange of data (uplink, downlink) between the Solar SMS Master LoRaWAN® and the application running on it.

To run the system, it is necessary to feed the Server LoRaWAN® with +24 VDC power supply and connect the LAN connectivity to a Router or Managed Switch by means of a RJ45 port available.

Figure 2. Industrial PC (or IPC)

The Router or Managed Switch shall offer DHCP functionality. Once the Ethernet port is connected to the Router or Managed Switch, the Server can be powered so will be turned on and the user can login with the provided credentials.

Commonly the Server LoRaWAN® will be assembled within Weidmüller PV Communication Box Server, Lite o Premium design as per Customer requirements. Contact your local Weidmüller sales representative for support and service information about these solutions.

3.1. Server LoRaWAN® system configuration

A graphical interface is available at the Server LoRaWAN® URL by assigning a static IP for it. System configuration changes requires to login to view data and perform changes.

Depending on the user permissions we will be able to carry out different operations, such as enrolling devices, reading online monitoring data, as well as creating new users.

Figure 3. Login graphical interface

Once logged in, three tabs can be seen from the top part under Weidmüller logo.

First tab that appears is the "LORA NETWORK" graphical interface (see figure 4), which is intended to create (enroll) all Solar SMS Master LoRaWAN® devices and Gateway LoRaWAN® from the system to be connected to the Server LoRaWAN®.

Second tab is the "NETWORK DATA MONITORING" graphical interface (see figure 10), which is intended to read all real-time parameters according to data from all Solar SMS Master LoRaWAN® devices connected to the Server LoRaWAN®.

Third tab is the "USER MANAGEMENT" graphical interface (see figure 11), which is intended to manage all desired users and its permissions.

3.1.1. LORA NETWORK – graphical interface

From this view, we can manage the Solar SMS Master LoRaWAN® and Gateways LoRaWAN® to be configured in the system.

It is possible to view all the data from the Solar SMS Master LoRaWAN® (Devices) and all the data from the Gateways LoRaWAN® (Gateways) and its communication with the network grouped by tags as below figure is showing.
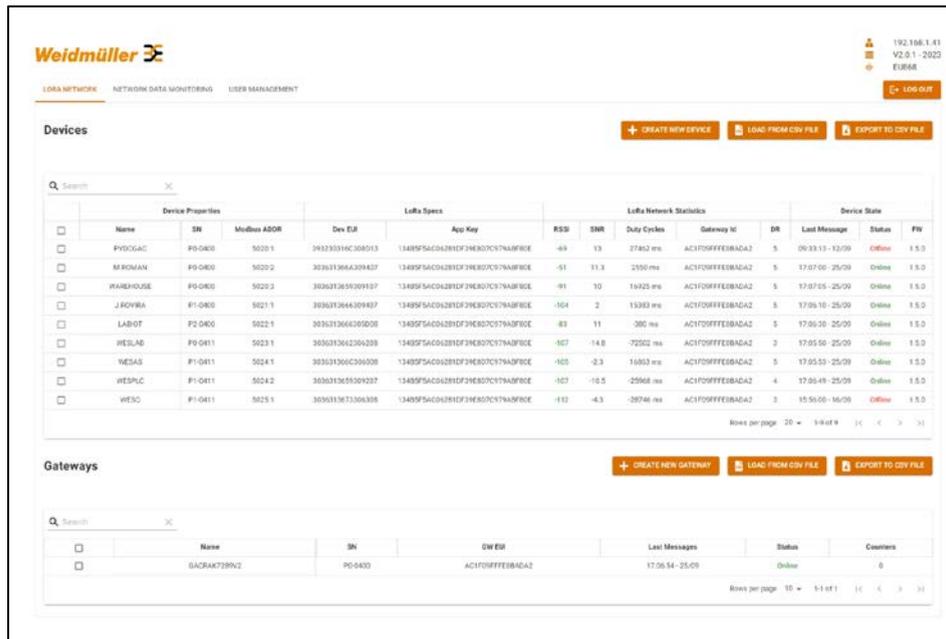
Figure 4. "LORA NETWORK" graphical interface

Data entered can be saved and uploaded as configuration files ("CSV" format). The "device.csv" and "gateway.csv" files are not required at startup. Those files will be necessary to add bulk gateways or devices to the system if desired. Please refer to section *3.2 CSV file format* for more information.

Explanation and meaning of each field from "Devices" section:

Field	Description
Name	Device Solar SMS Master LoRaWAN® name in the system
SN	Device Solar SMS Master LoRaWAN® serial number (if any)
Modbus ADDR	Configuration of the device Solar SMS Master LoRaWAN® in Modbus. It is composed by the port of the LoRaWAN® to which it is connected and the Modbus address. The format to follow is as: *PORT: ADDRESSMODBUS*
Dev EUI	Device Solar SMS Master LoRaWAN® EUI; it must be written in

	upper case (*)
App Key	LoRaWAN® application key (**); will always be the same
RSSI	*Received Signal Strength Indicator* representing the link power from last message received (***)
SNR	*Signal-to-Noise Ratio* from last message received (****)
Duty Cycles	Indicative remaining network usage time
Gateway ID	EUI of the Gateway LoRaWAN® that received the message
DR	Data rate from last message
Last Message	Last message time reception (date and hour/minute/second)
Status	Device Solar SMS Master LoRaWAN® communication status
FW	Device Solar SMS Master LoRaWAN® firmware version

Table 1. Solar SMS Master LoRaWAN® (devices) information

(*) *Dev EUI* is a unique identifier assigned by factory using a combination of the Unique ID of LoRa® microcontroller so, this number is totally unique.

(**) *App Key* is a root key hardcoded on the LoRa® module, and devices configured in the Server must have the same key. This key is used to generate another session keys locally in the Server and in the Solar SMS Master LoRaWAN® device to encrypt the data. This root key must be saved and not printed, so only the Server must know this value. If someone out of the installation knows this key, the security of LoRaWAN® will be compromised. Please contact your local Weidmüller sales representative for support and service information about this key.

(***) *RSSI* is measured in dBm and is a negative value; the closer to zero the better the signal is. For instance, a RSSI signal of -30 dBm will mean a strong signal reception while -120 dBm will mean a weak signal reception.

(****) *SNR* is measured in dB and typical LoRa values are between -20 dB and +10 dB; a value closer to +10 dB will mean that the received signal is less corrupted.

Explanation and meaning of each field from "Gateways" section:

Field	Description
Name	Gateway LoRaWAN® name in the system
SN	Gateway LoRaWAN® serial number (if any)
GW EUI	Gateway LoRaWAN® EUI; it must be written in upper case
Last Message	Last message time reception (date and hour/minute/second)

Status	Gateway LoRaWAN® communication status
Counters	Gateway LoRaWAN® amount of received messages

Table 2. Gateway LoRaWAN® (gateways) information

For both, "Devices" and "Gateways", there are three buttons available:
- *Create new device or Gateway*: to add just one device/Gateway manually
- *Load from CSV file*: to add new devices from a csv file (following a specific format)
- *Export to CSV file*: to download the existing configuration into a CSV file
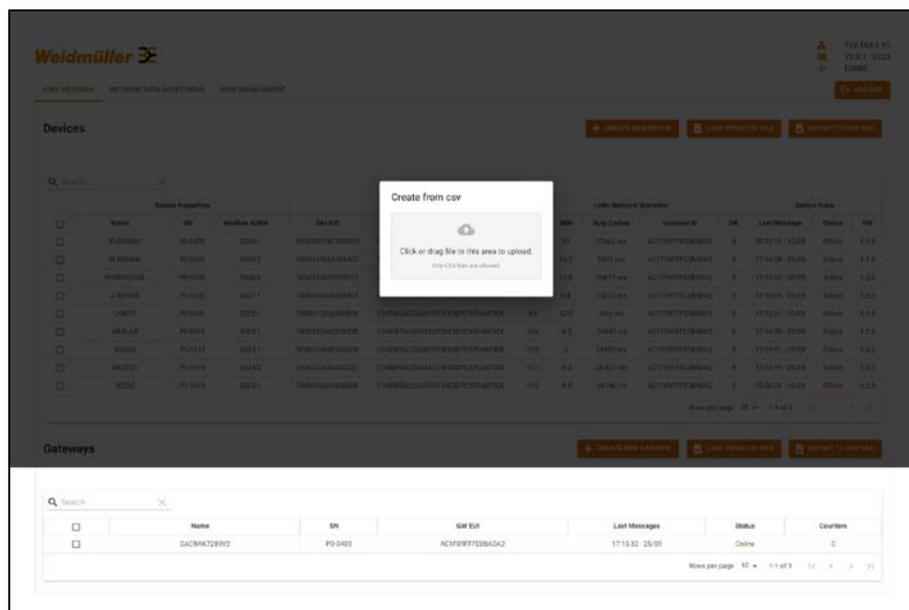

Figure 5. Example of "Devices" upload dialog graphical interface

Data can be entered manually by filling the following empty fields for each device while clicking on the "*Create device*" option:
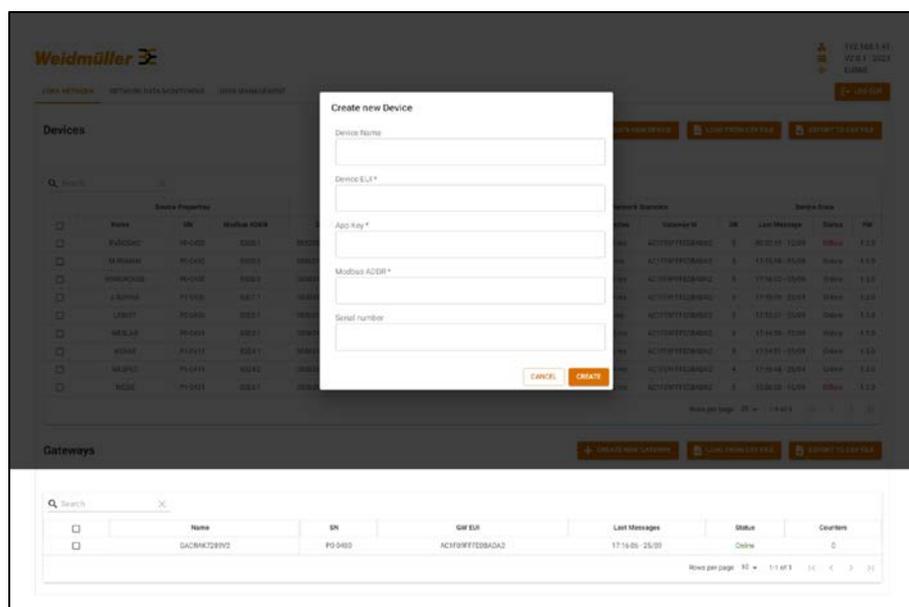

Figure 6. New Solar SMS Master LoRaWAN® (device) tab graphical interface

Below, an example of the data to be entered into the dialog box (see previous figure) for creating a new device in the system:

Field	Description
Device EUI	323833365C378A17
App key	134B5F5AC06281DF39E8D7C979ABF80E
Unit id	5020:2
Serial number	SOLAR_SMS_2

Table 3. Example of Solar SMS Master LoRaWAN® (device) data to enroll

There is also a search box at the top-left side with the possibility of sorting all enrolled devices by clicking on any column.

Each Solar SMS Master LoRaWAN® device shows its communication status information with different color depending on the connection status of the device. By hovering the mouse over, it is possible to see the date and time of the last connection. The four different statuses are described below:

Status	Description
Online	Server LoRaWAN® has records from the devices less than 3 minutes ago
Linked	Server LoRaWAN® has records from the devices during 3 to 5 minutes ago
Offline	Server LoRaWAN® has records from the devices more than 5 minutes ago
Never seen	Device with no connection

Table 4. Description of each Solar SMS Master LoRaWAN® (device) status

It is possible to delete or update any "Device" or "Gateway" created by clicking on the "pencil symbol" from the right side of each "Device" or "Gateway" created as shown below.
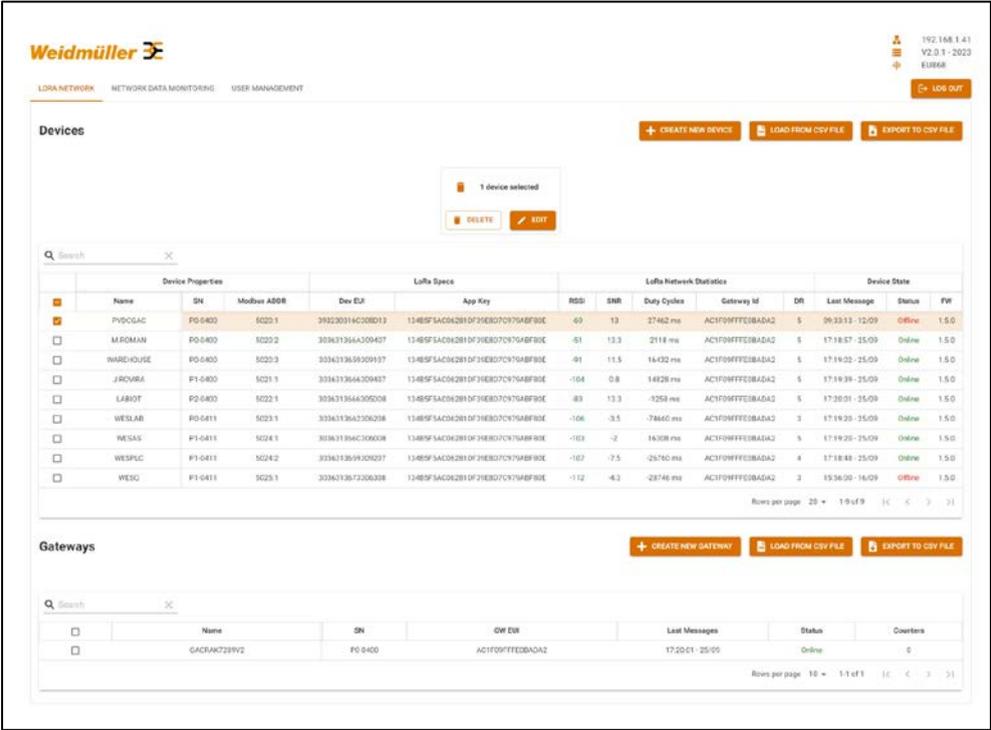
Figure 7. Delete or edit dialog tab

If the edit button is hit, the user can edit the device configuration. It gives the user access to the following dialogue box.
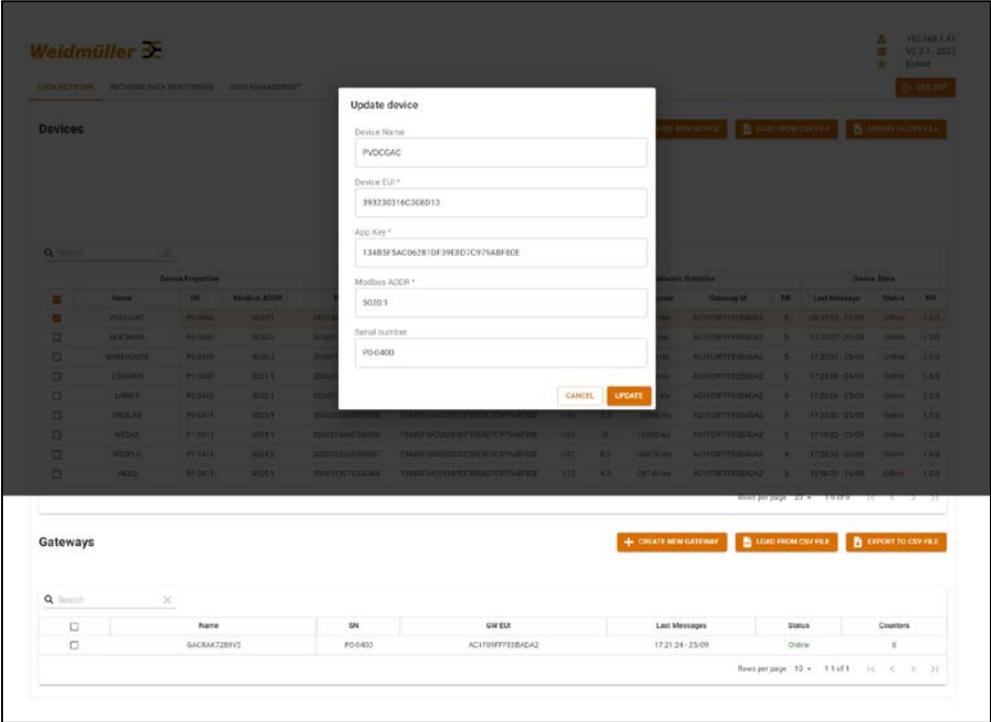
Figure 8. Update Solar SMS Master LoRaWAN® (device) options

It is possible for the user to delete any "Device" or "Gateway" from the system by selecting on the left-hand side of the table. Then, the option to delete them will appear. The user will always be informed (prompted) of the number of devices are selected for deletion.
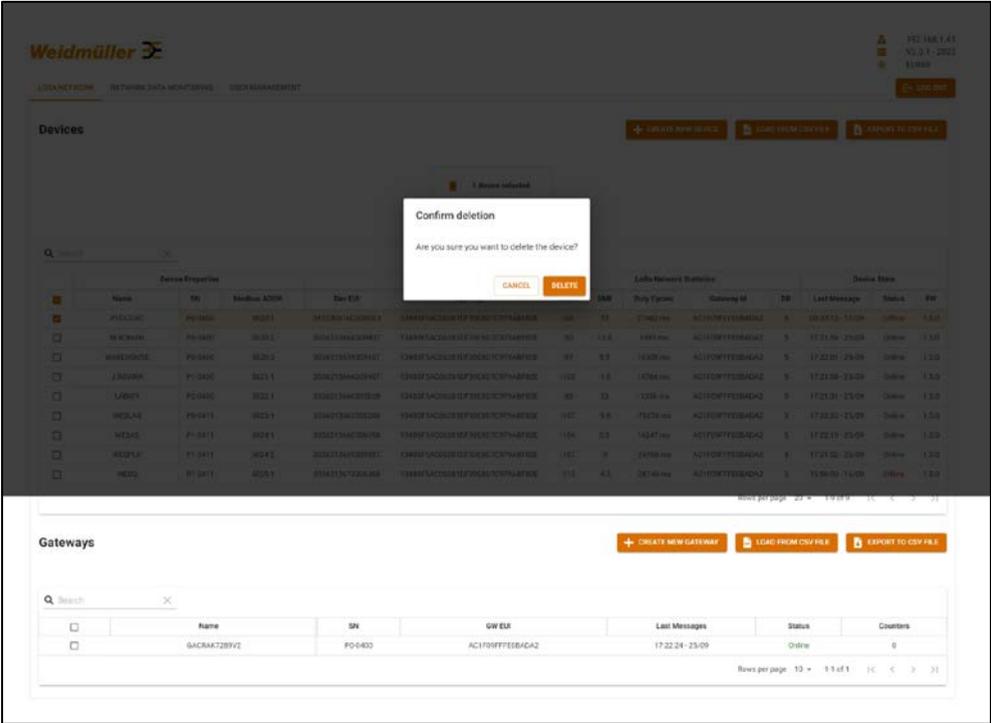
Figure 9. Deleting Solar SMS Master LoRaWAN® (device)

3.1.2. NETWORK DATA MONITORING – graphical interface

From this view it is possible to overview all online (real time) data from all Solar SMS Master LoRaWAN® devices enrolled into the system, such as measured DC voltage, DC current from individual strings, device PCB temperature, digital inputs, and configuration flags' status. All parameters are extracted from the Modbus register memory map (for more information, please refer to the annex at the end of this document).

Figure 10. Example of Solar SMS Master LoRaWAN® (device) monitoring data

Explanation and meaning of each field from figure 10 are:

Field	Description
Name	Solar SMS Master LoRaWAN® (device) name given
Dev EUI	Solar SMS Master LoRaWAN® (device) EUI
Modbus ADDR	Solar SMS Master LoRaWAN® (device) Modbus address given
V	DC voltage measured
Cx	DC current measured (where X is the string number)
DIx	Digital input status (where X is the digital input number)
Temp	PCB temperature
Flags	Different registers flags (in Hexadecimal format)

Table 5. Input parameters from Modbus register map

3.1.3. USER MANAGEMENT – graphical interface

This view is only available for the administrator user. Standard users with predefined permissions are created at the startup of the system; those can be edited or deleted. Once logged in, the user can see the user management menu that allows them to create new users with different permissions and roles.

Predefined users and their credentials are shown from table below.

Role	User	Password	Description
Administrator	Admin	B4rc3l0n4.	It can access to all available tabs (super-user)
Technical Assistance Service	TAS_User	1234	It can access to NETWORK DATA MONITORING and LORA NETWORK tabs only
Standard User	STD_User	1234	It can access to NETWORK DATA MONITORING tab only

Table 7. Default users' information

All users are created by default and new can be added, existing can be edited and deleted if desired. There is no limit to create new users. Yet, the "Admin" user is prevailing (cannot be deleted).
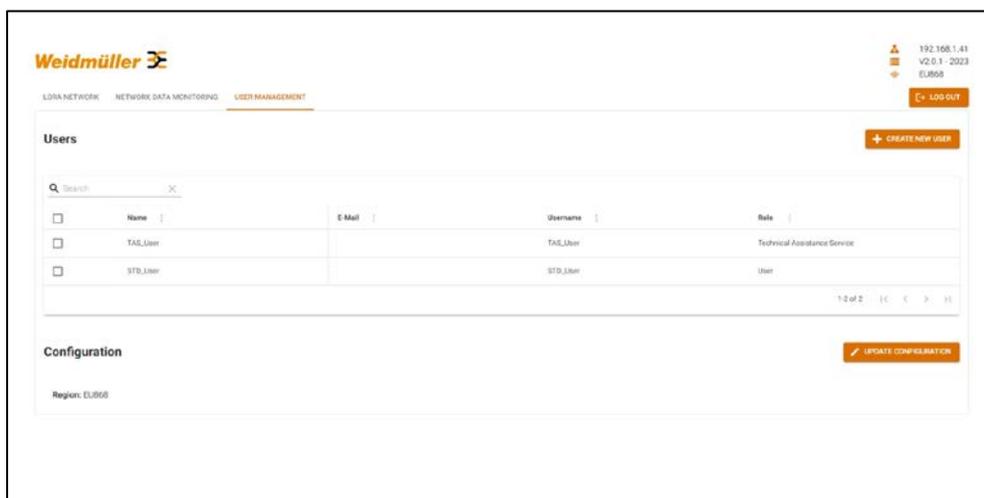
Figure 11. Example of user(s) created by default

New users will be prompted to fill the following fields explained below:

Field	Description
Name	Username (if any)
Email	User email (if any)
Username	Username to login
Role	User's role given

Table 8. Users' information

New users can be created by clicking "new user" button, where the menu to fill the data will be as shown below:
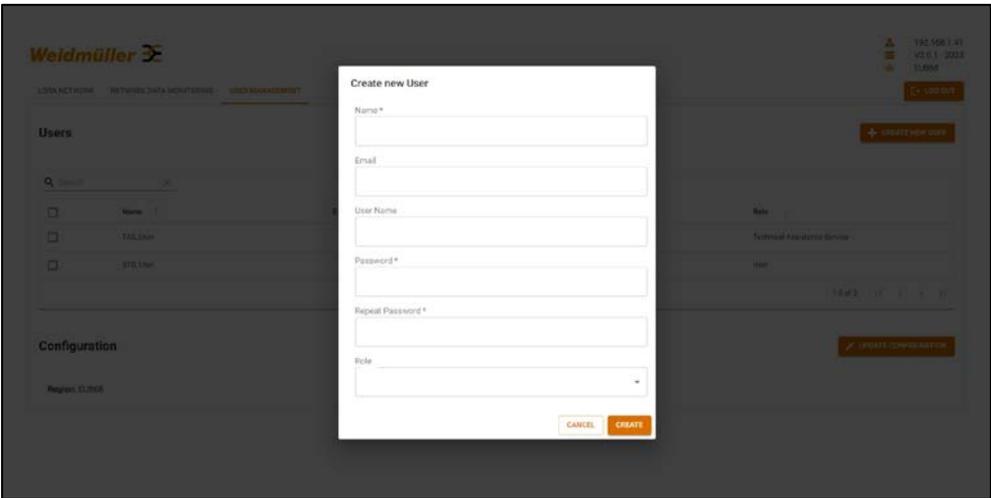
Figure 12. New user creation graphical interface

3.1.4. Server LoRaWAN® frequency configuration menu

This option is only available for the administrator user. The chosen LoRa® frequency must match with the frequency used by Solar SMS Master LoRaWAN® (devices) and Gateways LoRaWAN® (gateways) depending on LoRaWAN® official regional specifications, called Regional Parameters, that can be consulted from the *LoRa® Alliance* Website (follow https://lora-alliance.org/ for more information).

To change Server LoRaWAN® frequency configuration, the "update configuration" button must be hit to see the available LoRa® frequencies, as shown below:
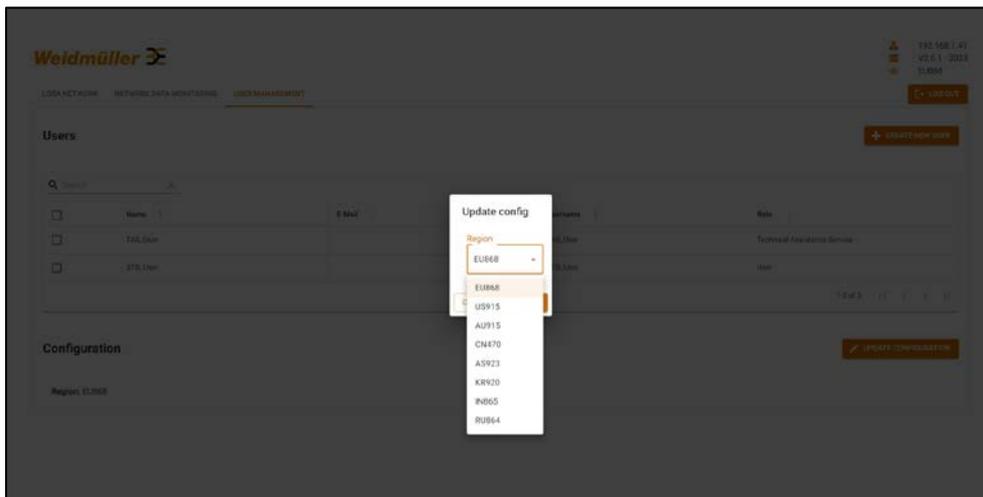
Figure 13. List menu with available frequencies to choose

3.1.5. Server LoRaWAN® general information

From the upper-right corner of the screen, some general Server LoRaWAN® information is displayed, such as the IP on which the Server LoRaWAN® can be accessed, current Server LoRaWAN® version, and current frequency configuration of the Server LoRaWAN® chosen.

Figure 14. General Server LoRaWAN® *information displayed*

3.2. CSV file format

To import several Solar SMS Master LoRaWAN® (devices) at once from a CSV file, a specific file format must be followed so that the correct creation can be guaranteed. An example of the format to be followed is shown below:

```
"name","sn","modbusAddr","devEui","appKey","rssi","snr","dutyCycles","gatewayId","dr","lastMsg","fw"
"PVDCGAC","P0-0400","5020:1","393230316C308D13","134B5F5AC06281DF39E8D7C979ABF80E",-51,13.3,22394.36800000017,"AC1F09FFFE0BADA2",5,"2023-08-30T08:32:07.150+00:00","1.5.0"
```

It is possible to change the order in which the fields appear, but it is important that the separation of all fields is achieved by comma (,) character and to keep double quotes ("") in all fields. The header must be on the first row of the CSV file and each new device must be created from the second row onwards.

The default file is named *devicesInfo.csv*, but it is possible to import a new file with any other name if the extension "CSV" is kept.

To import several Gateways LoRaWAN® (gateways) at once from a CSV file, a specific file format must be followed for its correct creation. An example of the format to be followed is shown below:

```
"name","eui","sn"
"GACRAK7289V2","AC1F09FFFE0BADA2","P0-0400"
```

The user can change the order in which the fields appear, but it is important that the separation of all fields is separated by comma (,) character and to keep double quotes ("") in all fields. The header must be on the first row of the CSV file and each new gateway must be created from the second row onwards.

The default file is named *gateways.csv*, but it is possible to import a new file with any other name if the extension "CSV" is kept.

3.3. Server LoRaWAN® Modbus TCP management

The Server LoRaWAN® is ready to handle up to 1536 Solar SMS Master LoRaWAN® devices, but the Modbus TCP protocol is limited up to 256 devices. Thus, the *Unit ID* has a special format to follow to reach 1536 devices.

As from the Modbus TCP protocol, the *Unit ID* field is composed by *PORT* and *ADDRESSMODBUS* separated by ":" character; and its meaning is explained below:

- *PORT*: is the port to be used by the Solar SMS Master LoRaWAN® (device) on the Server LoRaWAN® for the Modbus TCP connection. By default, the available ports are 5020, 5021, 5022, 5023, 5024, and 5025.

- *ADDRESSMODBUS*: this is the Modbus address range between 0 and 254 that each Solar SMS Master LoRaWAN® device is going to be used in Modbus TCP.

If the limit of 255 devices exceeds, the next devices are moved to the next *PORT* available. For example, after using all available devices for port 5020, the next device should be at 5021 port and as ADDRESSMODBUS starts again with 0 (5021:0). Please, note that the counting starts with device 0. The same consideration must be considered if moving to the next available port when the limit of 255 devices is exceeded again.

It is not necessary to have all devices numbered consecutively. If desired, the devices can be distributed among the different available ports and available addresses.

4. Gateway LoRaWAN® hardware connections

To run the system, it is necessary to feed the Gateway LoRaWAN® with power supply through the available PoE and connect the LAN connectivity to a Router or Managed Switch by using an available RJ45 port.

Figure 15. Gateway LoRaWAN® RAK7289V2 WisGate Edge Pro

The Router or Managed Switch shall offer DHCP functionality. Once the Ethernet cable is connected to the Router or Managed Switch, the Gateway LoRaWAN® can be powered (feed by the PoE) so it will be turned on and the user can login with the provided credentials.

Commonly, the Gateway LoRaWAN® will be delivered as standalone component(s) along with Weidmüller PV Communication Box Server, as per Customer requirements.

4.1. Gateway LoRaWAN® configuration

A graphical interface is available at the Gateway LoRaWAN® URL by accessing to its specific IP given from factory settings. There are two ways to access the Gateway LoRaWAN®: Wi-Fi AP Mode and WAN Port (Ethernet).

	NOTICE
🛈	Please read the available *RAK7289V2 Quick Start Guide* from original manufacturer (RAK) carefully, which is published on their website (*RAKwireless Documentation Center*). Important installation, mounting, and configuration prerequisites must be followed and applied before operation.

	NOTICE
🛈	Make sure all the antennas are connected before powering up the Gateway LoRaWAN®.

After reading and understanding *RAK7289V2 Quick Start Guide* steps, each, and all available Gateway LoRaWAN® will have to be configured for stablishing a correct communication with the Server LoRaWAN®. To do so, the Server LoRaWAN® IP and connection port must be set as per following indications.

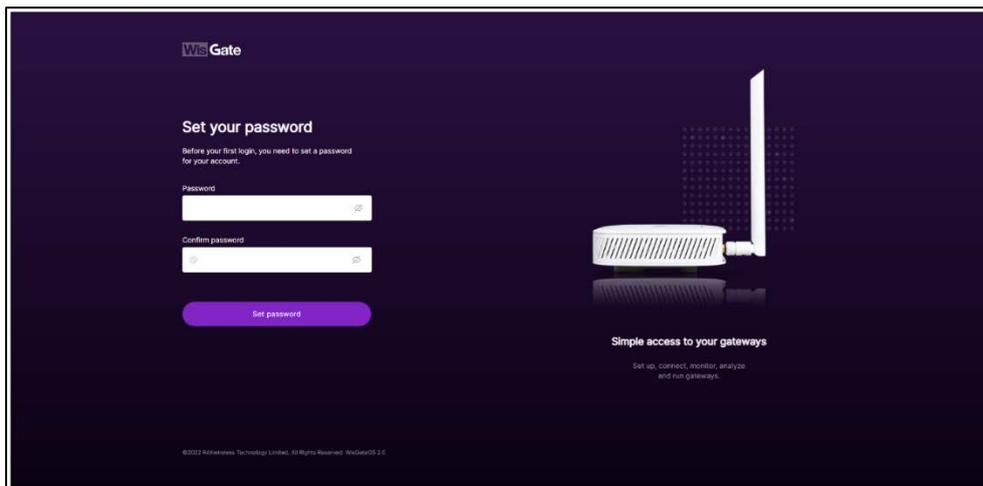To configure it, enter the web interface while accessing the *WisGateOS 2 Web UI* as shown below:

Figure 16. Gateway LoRaWAN® RAK7289V2 logging

The following screenshots are considering EU868 frequency example of configuration; other frequencies can be selected based on Gateway LoRaWAN® version (different hardware) for each frequency range. Please contact your Weidmüller sales

representative for support on choosing the right hardware for your region.

From the Web UI interface, we must go to "*LoRa®*" configuration. As shown in the figure below, "*Packet forwarder*" mode must be selected from "*Work mode*" menu.
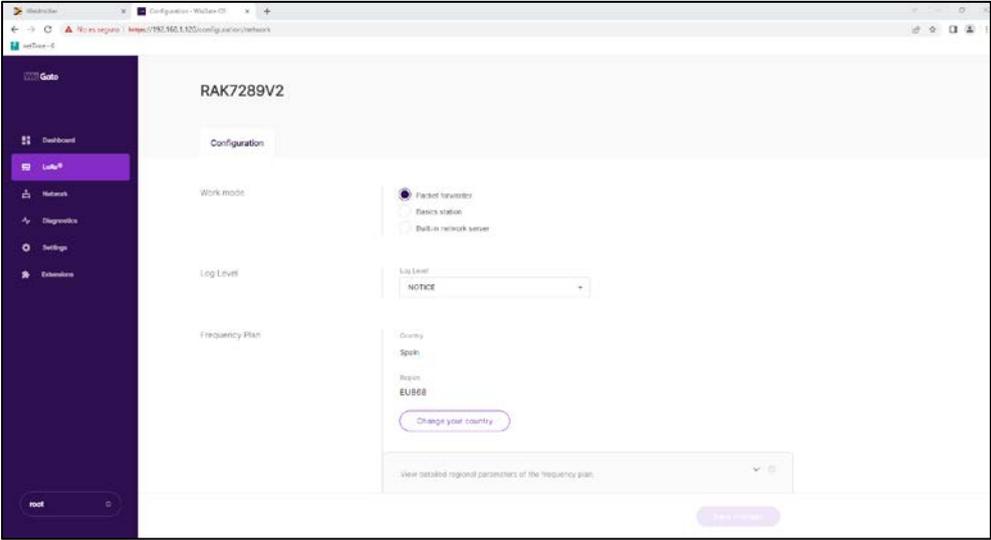
Figure 17. Gateway LoRaWAN® RAK7289V2 LoRa mode selection

After frequency plan chosen, we must go to "*Network*" configuration. As shown in the figure below, "*Protocol*" mode must be selected from menu. Please refer to below table values to be selected/chosen.

Field	Description
Protocol	Semtech UDP GWMP Protocol
Statistic interval (s)	30 (by default value)

Table 9. Protocol parameters selection

After selecting the "*Protocol*" parameters, we must go to "*UDP Protocol*" configuration as shown in figure 18, where the parameters must be chosen. Please refer to the values from the table below to select/chose the right parameters.

Field	Description
Server Address	IP address given to the Server LoRaWAN® (editable value)
Server port up	1700 (editable value, see table 11)
Server port down	1700 (editable value, see table 11)
Push timeout (ms)	200 (by default value)
Keepalive interval (s)	5 (by default value)
Auto-restart threshold	30 (by default value)

Table 10. UDP Protocol parameters selection

Figure 18. Example of gateway LoRaWAN® RAK7289V2 UDP Protocol configuration

The frequency band used will define the parameters to enter for "port up" and "port down" fields, to which the Gateway LoRaWAN® must point to:

Frequency	Value
EU868	1700
US915	1701
AU915	1702
AS923	1703
CN470	1704
IN865	1705
KR920	1706
RU864	1707

Table 11. Bands and frequencies

	NOTICE
ⓘ	Please notice that current Solar SMS Master LoRaWAN® hardware only supports (can operate) under region EU868, US915, AU915, AS923, and KR920. Fail to observe this will result on having a system not running at the allowed frequency band for the region to operate.

4.1.1. Gateway LoRaWAN® configuration: EU868 frequency band

To configure the Gateway LoRaWAN® frequency band to properly operate, country, region, ports up/down, and Server LoRaWAN® address must be selected (as indicated in table 11) and shown from below pictures:

Figure 19. Gateway LoRaWAN® RAK7289V2 region selection

Figure 20. Gateway LoRaWAN® RAK7289V2 region configuration

Also, Server LoRaWAN®.configuration must be updated with the corresponding region as explained in section *3.1.4 Server LoRaWAN® frequency configuration menu* and shown from below picture:

Figure 21. Server LoRaWAN® region configuration

Please ensure that changes took effect while checking the upper-right corner of the screen where the band selection must be shown as explained in section *3.1.5 Server LoRaWAN® general information* and shown from below picture:

Figure 22. General Server LoRaWAN® *information displayed for EU868 region*

4.1.2. Gateway LoRaWAN® configuration: US915 frequency band

To configure the Gateway LoRaWAN® frequency band to properly operate, country, region, first sub-band, channel, ports up/down, and Server LoRaWAN® address must be selected (as indicated in table 11) and shown from below pictures:

Figure 23. Gateway LoRaWAN® RAK7289V2 region selection

Figure 24. Gateway LoRaWAN® RAK7289V2 region configuration

Also, Server LoRaWAN®.configuration must be updated with the corresponding region as explained in section *3.1.4 Server LoRaWAN® frequency configuration menu* and shown from below picture:

Figure 25. Server LoRaWAN® region configuration

Please ensure that changes took effect while checking the upper-right corner of the screen where the band selection must be shown as explained in section *3.1.5 Server LoRaWAN® general information* and shown from below picture:

Figure 26. General Server LoRaWAN® *information displayed for US915 region*

4.1.3. Gateway LoRaWAN® configuration: AU915 frequency band

To configure the Gateway LoRaWAN® frequency band to properly operate, country, region, first sub-band, channel, ports up/down, and Server LoRaWAN® address must be selected (as indicated in table 11) and shown from below pictures:

Figure 27. Gateway LoRaWAN® RAK7289V2 region selection
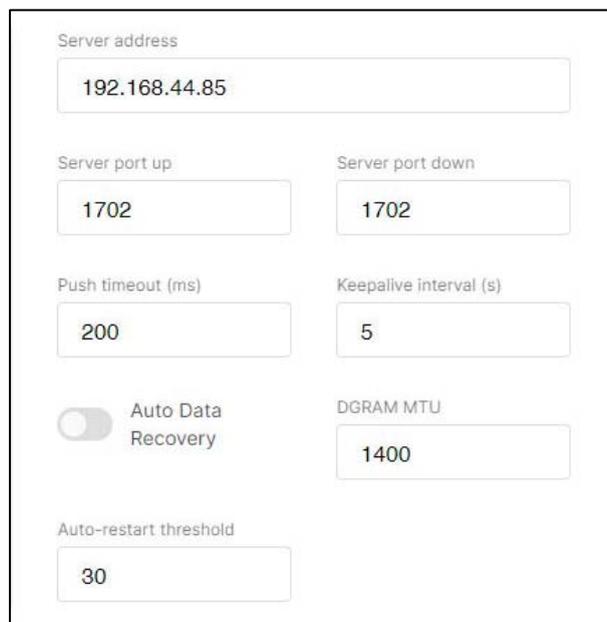
Figure 28. Gateway LoRaWAN® RAK7289V2 region configuration

Also, Server LoRaWAN®.configuration must be updated with the corresponding region as explained in section *3.1.4 Server LoRaWAN® frequency configuration menu* and shown from below picture:

Figure 29. Server LoRaWAN® region configuration

Please ensure that changes took effect while checking the upper-right corner of the screen where the band selection must be shown as explained in section *3.1.5 Server LoRaWAN® general information* and shown from below picture:
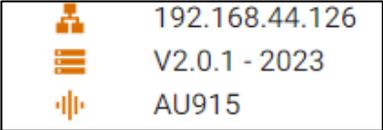
Figure 30. General Server LoRaWAN® information displayed for AU915 region

4.1.4. Gateway LoRaWAN® configuration: AS923 frequency band

To configure the Gateway LoRaWAN® frequency band to properly operate, country, region, variation, ports up/down, and Server LoRaWAN® address must be selected (as indicated in table 11) and shown from below pictures:

Figure 31. Gateway LoRaWAN® RAK7289V2 region selection
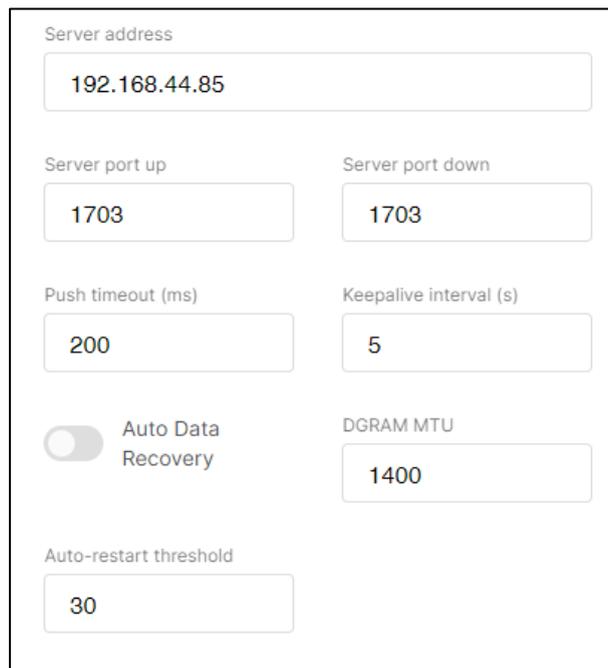
Figure 32. Gateway LoRaWAN® RAK7289V2 region configuration

Also, Server LoRaWAN®.configuration must be updated with the corresponding region as explained in section *3.1.4 Server LoRaWAN® frequency configuration menu* and shown from below picture:
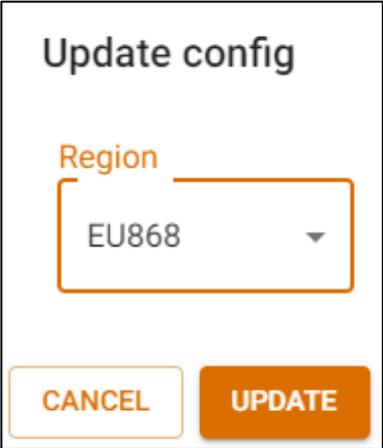

Figure 33. Server LoRaWAN® region configuration

Please ensure that changes took effect while checking the upper-right corner of the screen where the band selection must be shown as explained in section *3.1.5 Server LoRaWAN® general information* and shown from below picture:
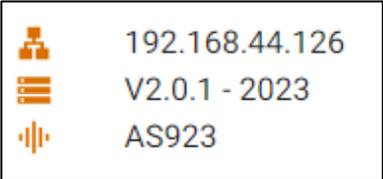
Figure 34. General Server LoRaWAN® *information displayed for AS923 region*

4.1.5. Gateway LoRaWAN® configuration: KR920 frequency band

To configure the Gateway LoRaWAN® frequency band to properly operate, country, region, ports up/down, and Server LoRaWAN® address must be selected (as indicated in table 11) and shown from below pictures:
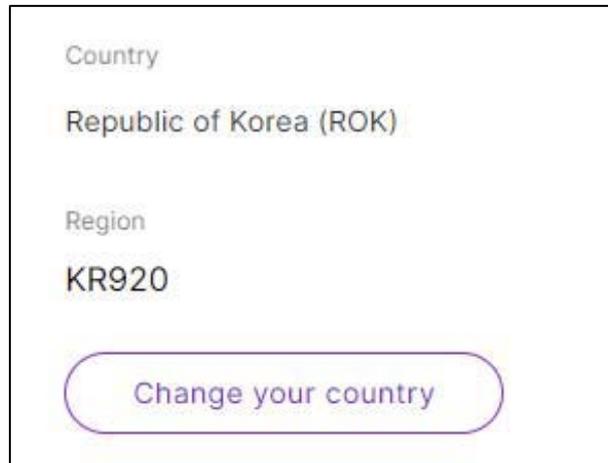
Figure 35. Gateway LoRaWAN® RAK7289V2 region selection
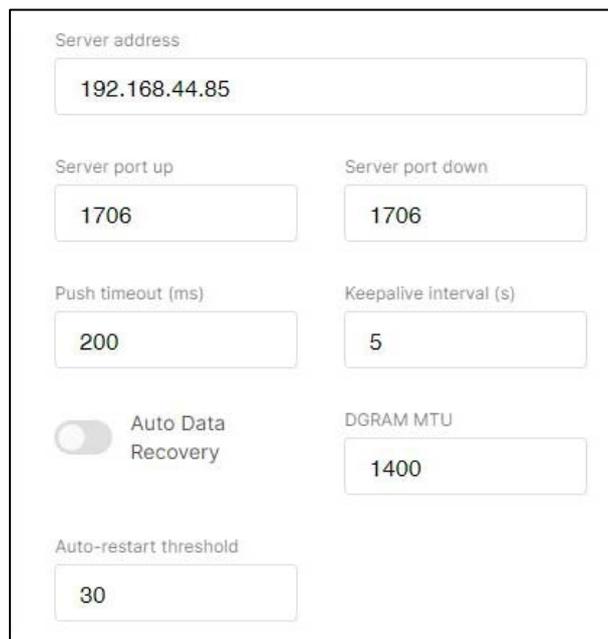
Figure 36. Gateway LoRaWAN® RAK7289V2 region configuration

Also, Server LoRaWAN®.configuration must be updated with the corresponding region as explained in section *3.1.4 Server LoRaWAN® frequency configuration menu* and shown from below picture:
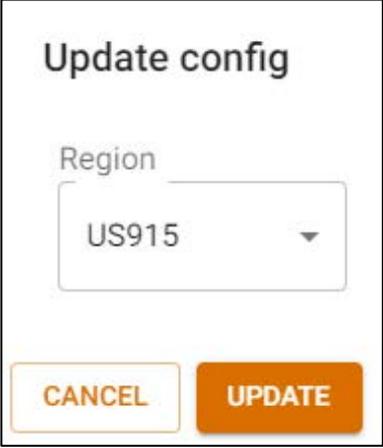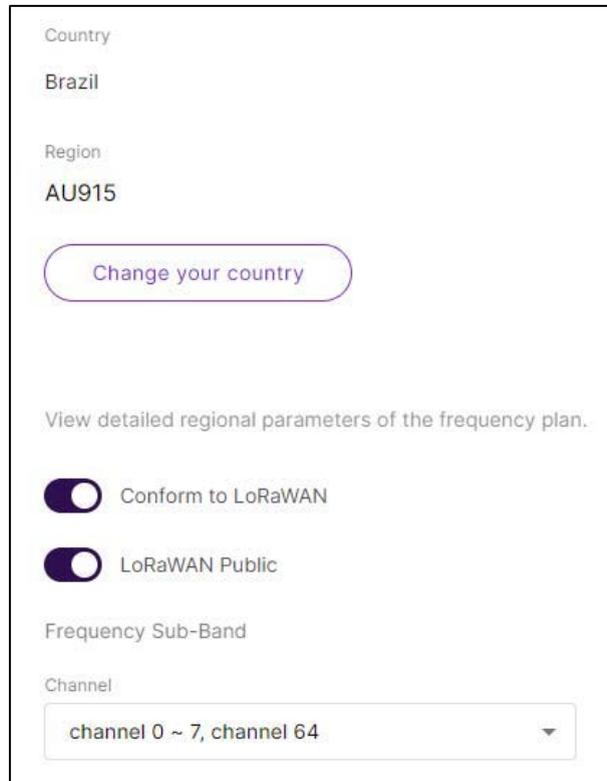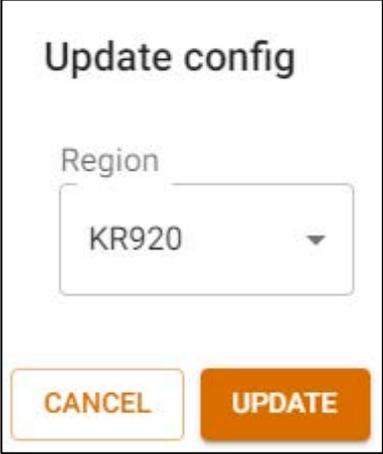

Figure 37. Server LoRaWAN® region configuration

Please ensure that changes took effect while checking the upper-right corner of the screen where the band selection must be shown as explained in section *3.1.5 Server LoRaWAN® general information* and shown from below picture:
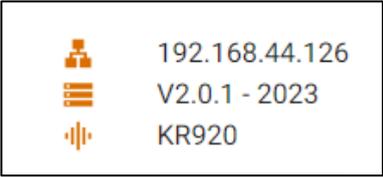
Figure 38. General Server LoRaWAN® *information displayed for KR920 region*

4.2. Gateway LoRaWAN® location of installation requirements

The Gateway LoRaWAN® should be placed as high as possible, with as few obstacles in the way as possible. The ideal fixation is a radio tower (if possible); other options are on top of a roof or a (light) pole. Less ideal, but also possible, is place it on the side of a tall building (if available on-site). In any case, ensure that any Gateway LoRaWAN® is installed at the highest point possible and at least about 5 meters above ground level.

LoRa® communications is a technique that can cover large distances, but the more obstacles between the devices and the walkway, the shorter the range. Obstacles such as hills, trees and buildings reflect and block the signal resulting on less radio coverage (or none radio communication within the LoRaWAN® devices as worst-case scenario).

No matter the location, the main concern is ensuring the best possible line-of-sight of Gateway LoRaWAN® antenna with all Solar SMS Master LoRaWAN® devices deployed on-site. Please refer to below picture as a "good" and "bad" practices.
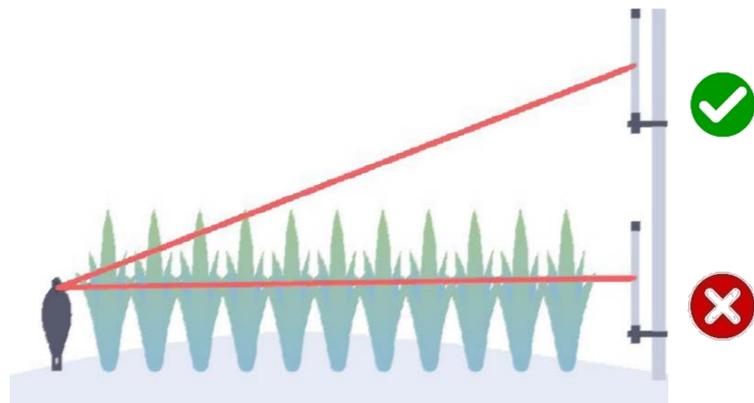
Figure 39. Gateway LoRaWAN® antenna placement on a mast/pole

4.2.1. Gateway LoRaWAN® placement on a tower

Using a tower usually offers the best height and line-of-sight of Gateway LoRaWAN® antenna with all Solar SMS Master LoRaWAN® devices deployed on-site, as they are usually built away from buildings and high up on hills. Because Gateway LoRaWAN® can be placed on top of the tower and somewhat inaccessible, it is recommended to configure and test the Gateway LoRaWAN® first before installing it on top.

Figure 40. Example of a Gateway LoRaWAN® antenna placement on a tower

4.2.2. Gateway LoRaWAN® placement on a rooftop

Whenever the Gateway LoRaWAN® is placed on a rooftop, it is recommended to place it on the roof of the tallest building since all other buildings in the surroundings (if any) could block the signal resulting on less radio coverage (or none radio communication within the LoRaWAN® devices as worst-case scenario). It is recommended to pay attention to use proper mounting bracket supplied with the Gateway LoRaWAN® set so it will not fall during adverse weather conditions.

Figure 41. Example of a Gateway LoRaWAN® antenna placement on a building roof

4.2.3. Gateway LoRaWAN® placement on a building side wall

This location of placement is less ideal, as the building itself is blocking a significant portion of the signal, especially in the scenario when the antenna does not protrude above the roof. This location can be considered when all Solar SMS Master LoRaWAN® devices deployed on-site are all placed on the same side where the Gateway LoRaWAN® is located.

Figure 42. Example of a Gateway LoRaWAN® antenna placement on a building side

4.2.4. Gateway LoRaWAN® placement on a post

Using a post for installing the Gateway LoRaWAN® will work if it can be ensured that it is the tallest free-standing object in the area where the Gateway LoRaWAN® can be fix it. We could find some equal installation benefits using a post like installing the Gateway LoRaWAN® on a tower like described in section *4.2.1 Gateway LoRaWAN® placement on a tower*. Usually using a post is easier to deploy and install on-site because are easily reachable in the market but is important to remark that it must be installed ensuring no surrounding obstacles that could block the signal resulting on less radio coverage (or none radio communication within the LoRaWAN® devices as worst-case scenario).

4.3. Gateway LoRaWAN® lightning protection

It is important to ensure that the system is protected against lightning, whether Gateway LoRaWAN® is situated outdoor or indoor, while using surge protection system. Such a protection system must be taken into consideration to ensure a fully functional Gateway LoRaWAN® without interruption or damage from the lighting.

Below figure shows recommended surge protection system against lightning.

Figure 43. Gateway LoRaWAN® full lighting protection set-up (example)

Recommendation for outdoor surge protection system:

- LoRa® antenna grounding – it is recommended a lightning arrestor to be installed on all the antenna N-type terminals. The arrestors must be N-type Female to Male in order to fit the antenna and enclosure connectors. Make sure you use appropriate wire cross-section to connect the screw terminals of the arrestors to the grounding rail mounted on the building wall (grounding bar in case of field deployment).

- Gateway LoRaWAN® grounding – additionally, it is recommended to use another wire to connect the screw terminal on the bottom left side of the Gateway LoRaWAN® casing to the grounding rail (bar).

Please notice that no additional protection for the Ethernet cabling is required at the Gateway LoRaWAN® side since there is a surge protection system built-in (GDT + Anti-surge resistor).

Recommendation for outdoor surge protection system:

- For protecting the indoor equipment and circuitry connected to the Gateway LoRaWAN®, it is recommended to install an Ethernet port SPD lightning arrestor. It should be positioned along the cabling connecting the Gateway LoRaWAN® to the PoE injector. Make sure you connect its grounding wire terminal to an appropriate building grounding point.

⚠️	WARNING
	Should you fail to adhere to the recommendations in this document Weidmüller carries no responsibility for any damage your equipment incurs due to a lightning strike.

❗	NOTICE
	Do not power the device if the LoRa® antenna port has been left open to avoid potential damage to the Gateway LoRaWAN®.

5. Solar SMS Master LoRaWAN functional description

A LoRa® RF built-in radio module is assembled to connect, after enrolling the device to the LoRaWAN® system described above, the Solar SMS Master LoRaWAN® device to a LoRaWAN® network. The picture below, shows how the LoRa® RF module looks like and where is placed/assembled:

Figure 44. PCB with built-in LoRa® module

Figure 45. Solar SMS Master LoRaWAN® RF LoRa® location

5.1. DIP switch configuration

Due to the similarities with our product Solar SMS Master with RS-485 wired communications, it is important to remark that when the LoRa® RF module is connected, Modbus RTU wired communications are disabled, and the available DIP switch (SW1) acts as the frequency band selector (according to country/region) for wireless LoRa® communications.
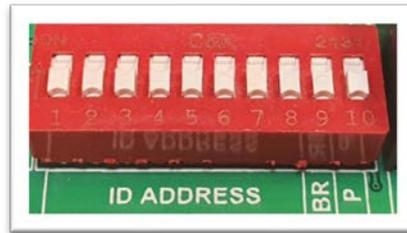
Figure 46. Solar SMS Master LoRaWAN® configuration DIP switch

Use the DIP switch SW1 to configure the LoRa® band, to configure the number of devices of the PV plant, to select the refresh time of all data sent through LoRaWAN®, and to force a 'JOIN' procedure for a specific device.

	NOTICE
ⓘ	LoRaWAN® devices can use many frequency bands but it is mandatory for all devices to work in the same region and therefore, frequency.

	NOTICE
ⓘ	After modifying any DIP switch setting, the changes need to be applied by powering off and then back on the equipment. Changes with the device powered on will not take effect until a reset of the board is done.

5.1.1. LoRa® band selection

The bands accepted by the module are: AS923, AU915, EU868, KR920, US915 which can be selected by modifying the DIP switch position SW1.1, SW1.2, and SW1.3. The following table specifies each functionality via the DIP switch.

SW1.1	SW1.2	SW1.3	Band
OFF	OFF	OFF	AS923
OFF	OFF	ON	AU915
OFF	ON	OFF	EU868
OFF	ON	ON	KR920
ON	OFF	OFF	US915

Table 12. DIP switch explanation to set the accepted bands

For example, to set KR920 band, SW1.1 must be in 'OFF' position and SW1.2 and SW1.3 in 'ON' position.

Every band has it owns restrictions, based on its duty cycle, message time-on-air, permitted data rate and maximum messages in a period of time.

Please check your local restrictions depending on the LoRaWAN® official regional specifications, that can be consulted from the *LoRa® Alliance* Website (follow https://lora-alliance.org/ for more information).

5.1.2. Selection of total number of devices of the PV plant

It is mandatory for any Solar SMS Master LoRaWAN® to follow a procedure (known as 'JOIN' procedure) to be part of a LoRaWAN® network. To do so, each Solar SMS Master LoRaWAN® device must request the Server LoRaWAN® to join the desired network, where it is present. The 'JOIN' procedure is only performed once for each installation, and it is not needed to re-join a network if the Server LoRaWAN® has already acknowledged and accepted the device.

Because several devices can be installed in the PV plant and those might be powered at the same time for the first-time during sunrise, the 'JOIN' procedure must be performed along a defined period of time to avoid "collision join requests" from all devices that could result on the Server LoRaWAN® not accepting the 'JOIN' request. For doing so, a random value is given to all and each Solar SMS Master LoRaWAN® device to avoid those collision with other devices. The random value defines a window of time to be able to 'JOIN' the Server LoRaWAN® and became part of the LoRaWAN® network.

This random value is selected by modifying the DIP switch position SW1.4, SW1.5, and SW1.6 and its value will depend on the total amount of devices installed in the PV plant. Following table specifies each functionality via DIP switch.

SW1.4	SW1.5	SW1.6	Total amount of devices	Random time value
OFF	OFF	ON	1 to 10	30 seconds
OFF	ON	OFF	11 to 100	5 minutes
OFF	ON	ON	101 to 200	10 minutes
ON	OFF	OFF	201 to 300	15 minutes
ON	OFF	ON	301 to 400	20 minutes
ON	ON	OFF	401 to 500	25 minutes
ON	ON	ON	501 to 600	30 minutes
OFF	OFF	OFF	More than 600	40 minutes

Table 13. DIP switch explanation for setting single device random time

The first time this device is powered ON, the Solar SMS Master LoRaWAN® will start sending the 'JOIN' request to the Server LoRaWAN® for exchanging their keys to start a secure session with encrypted data using LoRaWAN® protocol (as explained in section *3.1.1 LORA NETWORK – graphical interface*, the Server LoRaWAN® must have on its internal database all Solar SMS Master LoRaWAN® – with each respective *EUI* and the *AppKey* – listed to correctly follow the join procedure).

Depending on the total amount of Solar SMS Master LoRaWAN® devices, the collision will be higher or lower, resulting on a variable (not fix) total amount of time that all Solar SMS Master LoRaWAN® will successfully perform the 'JOIN' procedure.

Even though total JOIN procedure time is variable, a reference time as for worst case scenario can be given as per the following table values.

Total amount of devices	JOIN procedure total time
1 to 10	30 minutes
11 to 100	1 hour and 45 minutes
101 to 300	2 hour and 30 minutes
301 to 500	3 hour and 30 minutes
501 to 700	5 hours
More than 701	7 hours

Table 14. Approximate total JOIN procedure time

When any Solar SMS Master LoRaWAN® receives a confirmation message as 'JOIN' accept from the Server LoRaWAN®, the LoRaWAN® communication is established properly. If a Solar SMS Master LoRaWAN®, after 3 consecutive times (with its respective timeouts) does not receive a 'JOIN' accept message, the device will restart the 'JOIN' procedure, trying to successfully establish the communications with the Server LoRaWAN®.

The 'JOIN' process will repeat constantly (and forever) until acknowledging the 'JOIN' accept message is received.

Under normal operation, when all Solar SMS Master LoRaWAN® from the network are correctly linked to the Server LoRaWAN®, at every sunrise, the devices will normally power ON and communications will start without any random period of time.

It must be noted that if there are changes in the Server LoRaWAN® (e.g., hardware replacement, new firmware update, extending the network with new Solar SMS Master LoRaWAN®, etc.) all Solar SMS Master LoRaWAN® devices from the network that were already communicating with the Server LoRaWAN® will have to start a 'JOIN' procedure again.

As explained, the 'JOIN' procedure is performed automatically when the Solar SMS Master LoRaWAN® is powered ON (for new devices added) or by intentionally forcing a

manual reset on any Solar SMS Master LoRaWAN® device itself as explained in section *5.1.5 Forcing a Solar SMS Master LoRaWAN® to start the 'JOIN' procedure.*

Must also be noted that any new Solar SMS Master LoRaWAN® device going to be added into an existing network (e.g., network extension) will have to start, as it is the first time, the already explained 'JOIN' procedure.

	NOTICE
❗	Follow the installation prescriptions given to properly communicate with any Solar SMS Master LoRaWAN® device, otherwise any device out of Gateway LoRaWAN® range of coverage will not be detected.

5.1.4. Selection of LoRaWAN® data refresh time

The refresh time of all data sent by any Solar SMS Master LoRaWAN® through the LoRaWAN® network where it belongs to is configurable and can be selected by modifying the DIP switch position SW1.7, SW1.8, and SW1.9. Following table specifies each functionality via DIP switch.

SW1.7	SW1.8	SW1.9	Refresh time
OFF	OFF	ON	1 minute and 30 seconds
OFF	ON	OFF	2 minutes
OFF	ON	ON	3 minutes
ON	OFF	OFF	5 minutes
OFF	OFF	OFF	10 minutes

Table 15. DIP switch explanation for setting single device refresh data time

5.1.5. Forcing a Solar SMS Master LoRaWAN® to start the 'JOIN' procedure

There is an option to force a Solar SMS Master LoRaWAN® to start a 'JOIN' procedure with the Server LoRaWAN®. This could be done while changing the last DIP switch position from OFF to ON while the Solar SMS Master LoRaWAN® is powered ON.

SW1.10	Total amount of devices
OFF to ON transition	Force Solar SMS Master LoRaWAN® to start a 'JOIN' procedure
ON to OFF transition	-
OFF	-
ON	-

Table 16. DIP switch explanation for forced device 'JOIN' procedure

Keeping the SW1.10 in ON position will not affect the Solar SMS Master LoRaWAN® behavior once it joined the network, even after a device power reset. Turning OFF the SW10 will have no effect neither.

	NOTICE
❶	It's important to perform this procedure after at least 4 seconds when the device is powered ON. This will also force to set the random time value to 30 seconds until the board is powered OFF.

Some general considerations about DIP switch:

- Any change of the DIP switch must be done with the Solar SMS Master LoRaWAN® device powered OFF (except to force a 'JOIN' procedure) and powered ON afterwards to take effect.
- If all Solar SMS Master LoRaWAN® devices are configured with less devices than the total amount of devices installed, there may be radio collisions resulting to the LoRaWAN® network system to fail.
- Adding more devices to the existing LoRaWAN® network implies to update all Solar SMS Master LoRaWAN® devices DIP switch configuration for the new total amount of network devices (e.g., updating an installation of 480 devices with current DIP switch as: SW1.4 - OFF, SW1.5 - OFF, and SW1.6 – ON, and adding 30 devices more, new DIP switch must be set to: SW1.4 - ON, SW1.5 - ON, and SW1.6 – OFF, according to table 13).

6. Maintenance and service

⚠	**DANGER**
	The maintenance of this equipment can only be performed when there are no live voltages present in this equipment and after it has cooled down for at least 15 minutes. Failure to observe this requirement creates electrical shock and burn hazards.

⚠	**WARNING**
	The pollution degree of the conductor board is achieved using conformal coating that meets ANSI/UL 746E. Scratches or surface damage can reduce the insulation protection of the device. Thus, the board must be handled with care.

This equipment needs very little maintenance if mounted in a proper PV DC Combiner Box. These are the only maintenance tasks required every two years (increase the frequency of maintenance sessions if the device operates in very polluted/dusty environment and/or is frequently subject to large temperature variations).

- Check the supply voltage with a multimeter.
- Make sure the equipment remains well secured to the PV DC Combiner Box DIN rail.
- Visually inspect the RS-485 wiring with present Slaves current modules.
- Visually inspect the amount of dust/dirt on the equipment cover and on the PCB surface. In case cleaning is needed, it shall be done with just a damp cloth. No other solvent can be used to clean this equipment.
- Visually inspect the metal contacts of the terminal blocks. If there are signs of corrosion, the equipment may need to be serviced by Weidmüller.

⚠	**WARNING**
	This product can only be serviced by Weidmüller. Failure to observe this requirement voids the warranty and can lead to dangerous situations. Contact your Weidmüller sales representative for service information.

⚠	**WARNING**
	Before operating the device, the DC switch disconnector must be open to power off the Solar SMS Master LoRaWAN® device. Using a current clamp check that there is no current flowing into the Solar SMS Master LoRaWAN®. If the onboard PCB fuse-link is blown, it must be replaced by using a gPV type fuse-link of 4 ADC and 1500 VDC nominal rated voltage.

6.1. LED signals

6.1.1. Solar SMS Master LoRaWAN® LED signals

There are two green LEDs (LD1 and LD2) indicating the behaviour of the LoRa® RF module.

Once the Solar SMS Master LoRaWAN® is powered ON, an LED (LD2) on the LoRa® RF module turns ON. When the Solar SMS Master LoRaWAN® device successfully joins a LoRaWAN® network, an LED (LD1) on the LoRa® RF module turns ON.

When Solar SMS Master LoRaWAN® communications is correctly connected to the Server LoRaWAN®, and LED (LD1) will turn ON during one second after the device is powered ON.

When the Solar SMS Master LoRaWAN® is transmitting data bidirectionally (data traffic between Solar SMS Master LoRaWAN® and Server LoRaWAN® is happening), LED (LD1) starts blinking.

Figure 47. PCB with built-in LoRa® module

LED	Color	Status	Description
LD1	Green	ON	The product successfully 'JOIN' a LoRaWAN® network
		Blinking	There is LoRaWAN® activity (transmitting/receiving from/to Server LoRaWAN®)
		OFF	The product is not supplied (powered OFF)
LD2	Green	ON	The product is supplied (powered ON)
		OFF	The product is not supplied (powered OFF)

Table 17. LED signals table

7. Modbus TCP protocol communications

Information from/and to the Server LoRaWAN® is requested and sent through Modbus TCP protocol following standard Modbus functions such as:

Purpose	Function name	Function code	Hexadecimal
Ask data from Solar SMS Master LoRaWAN®	Read Input Register	04	0x04
Ask configuration from Solar SMS Master LoRaWAN®	Read Multiple Holding Registers	03	0x03
Send configuration to Solar SMS Master LoRaWAN®	Write Multiple Holding Registers	16	0x10

Table 18. Modbus standard read/write functions

To successfully connect with the Modbus Master (Server LoRaWAN®) its IP address must be known (same as the one indicated in the Web UI from all each Gateway LoRaWAN® from section 4.1, table 10). To reach any device connected, the port of the Modbus Slave (Solar SMS Master LoRaWAN®) is connected to, and the Modbus address it uses must be known. Following steps have been defined to receive and send information to all Solar SMS Master LoRaWAN® devices. The proposed functionality relies on Modbus TCP standard protocol:

- Ask data from Solar SMS Master LoRaWAN® device:
  - Function name: Read Input Register
  - Function code: 04
  - Number values: Number of values to read (according to Modbus register memory map)

- Ask configuration from Solar SMS Master LoRaWAN® device:
  - Function name: Read Multiple Holding Registers
  - Function code: 03
  - Number values: Number of values to read (according to Modbus register memory map)

- Send configuration to Solar SMS Master LoRaWAN® device:
  - Function name: Write Multiple Holding Registers
  - Function code: 16
  - Hexadecimal frame

The commands are all according to the Modbus RTU/TCP protocols available from the Modbus® organization (www.modbus.org).

The commands can be tested using software tools, such as the program Modbus Poll (from www.modbustools.com).

Please refer to the "*Annex B: Modbus register table*" described at the end of this document.

8. SCADA general configuration

To register all Solar SMS Master LoRaWAN® devices into a SCADA system, same data will be required with some different identifiers:

- Host: Server IP address (always the same)
- Port: 5020, 5021, 5022, 5023, 5024, or 5025 based on amount of Solar SMS Master LoRaWAN® to be connected
- Modbus address: Solar SMS Master LoRaWAN® address (from 0 to 255)

8.1. NTP Server

It is mandatory for the system to properly operate to be connected to a NTP (*Network Time Protocol*) Server, either local or Internet. Main goal of this NTP server is to provide the actual time from a reference clock and distribute this information to all Gateway LoRaWAN® and Server LoRaWAN® connected to the same network.

	NOTICE
❗	Any Server clients opened in a Web browser will also have to be synchronised with the NTP beforehand.

	NOTICE
❗	Fail to not have a NTP Server will result on whole LoRaWAN® network to be non-synchronized and system not running properly.

8.1.1. LoRaWAN® messages validity time

The validity time is used to indicate when the information received by a Solar SMS Master LoRaWAN® device is considered outdated (old) and consider it not valid when Modbus asks for information about the same device. In case of having exceeded the validity time by the error *ILLEGAL_DATA_VALUE* is sent instead of returning a data considered outdated. See *Annex A* for more Modbus error messages.

By default, a message received it is configured to be valid for 5 minutes. Bearing in mind that the Solar SMS Master LoRaWAN® devices might be configured to send a message every minute and a half (lowest refresh time possible), it requires to fail three (3) consecutive times to the Server for considering received data outdated. It is highly possible to lose some packages when working at high concentrated radio broadcast environments like the actual one.

9. Server LoRaWAN® replacement

A non-responding Server LoRaWAN® could result because the hardware (IPC) where the application runs is not working (e.g., damaged, not powering up, etc.) so the applications is not starting and/or running.

To replace the faulty Server LoRaWAN®, it is needed to power off the device, disconnect the IPC and replace it for a brand-new device. Finally, it is necessary to follow all the described steps in this user guide to properly enroll all devices like new Solar SMS Master LoRaWAN® and Gateways LoRaWAN®.

⚠	**WARNING**
	This product can only be serviced by Weidmüller. Failure to observe this requirement voids the warranty and can lead to dangerous situations. Contact your Weidmüller sales representative for service information.

⚠	**WARNING**
	Before operating the device, the AC MCCB must be open to power off the IPC device by observing all LEDs not blinking.

10. Specifications and regulatory information

This equipment device fulfills the essential requirements of the Low Voltage Directive (LVD) 2014/35/EU and the Electromagnetic Compatibility (EMC) Directive 2014/30/EU and therefore, is entitled to be CE marked.

Waste Electrical and Electronic Equipment (WEEE) directive 2012/19/EU

Purchasing this equipment gives you the right to return it to Weidmüller, free of charge, at the end of its service life. Weidmüller will then professionally recycle and dispose of your device in accordance with the applicable laws. Electrical equipment must not be disposed through the "normal waste disposal channels". All devices that fall under the WEEE directive must feature this logo.

Annex A: Modbus error glossary table

Modbus Error	Error message	Description
2	ILLEGAL_DATA_ADDRESS	Error if the device does not exist in the system
3	ILLEGAL_DATA_VALUE	Error if there are no records or data requests or if records are out of date (by default older than 5 minutes)
5	ACKNOWLEDGE	Pending further information from the device
7	NEGATIVE_ACKNOWLEDGE	Communication error if the device has been acknowledged but no new valid configuration has been returned
11	GATEWAY_TARGET_FAILED_TO_RESPOND	No response from the device

Table 19. Modbus error messages

Annex B: Modbus register table

For properly reading the registers from all and each device, a specific order of registers must be known as described below:

- Data requests (FC 04 - 0x04 – Read input register): message sent to any Solar SMS Master LoRaWAN® with a refresh-time configured as described in table 15.

Data					
PV_CURRENT_CH (≤32CH)	TEMP	PV_VOLT	FLG_EV	FLG_BF_H	FLG_BF_L

- Setting request (FC 03 - 0x03 - Read multiple holding registers): message is only sent when the device is powered or when a setting setup is sent.

Data						
THR_UV	THR_UC	MSK_INPUT_EN_H	MSK_INPUT_EN_L	MODEL_ID	HW_VERS	FW_VERS

- Setting setup (FC 16 - 0x10 - Write multiple holding registers): message sent to any Solar SMS Master LoRaWAN® to configure the device with a specified data. It must be written all four (4) registers in a row, in order and within the allowed values, otherwise the values will not be saved and updated incorrectly.

Data			
THR_UV	THR_UC	MSK_INPUT_EN_H	MSK_INPUT_EN_L

Notes:
- As defined in the Modbus standard, the register addresses shown in the table are transmitted in the Modbus PDU as one unit less. Therefore, register address 23 in the table below is sent as 22. This is standard Modbus behavior. Most application software will automatically handle this subtraction, but you need to be aware of this offset by one.
- Some users and even PLC and Scada systems use the obsolete Modicon format for registers' addresses. As an example, input register 23 would be written as 30023 using the old Modicon format.
- The values of the average power registers can be calculated by the Modbus client instead of being transmitted. This saves network bandwidth.
- When using less than 32 channels of current measurement modules the communication result of reading the registers that are not present will be '-1' instead of receiving a '0' value. This won't lead to any misunderstanding between reading a no existing current channel and reading none existing current flow.

	NOTICE
❗	Fail to not follow the register address based on current measurement modules configuration will result on the SCADA system reading wrong data from the Solar SMS Master LoRaWAN® device.

	NOTICE
❗	Before operating this product, please check for latest firmware available or contact your Weidmüller sales representative for service information.

The register map of the Modbus used to perform communication is showed in the table below:

Register name	Register address	Register description	Min	Max	Unit	Read / Write	Data type	Size	Modbus function code	Modbus object	Default value	Notes
TEMP	1	PCB temperature	-200	800	ºC x 10	Read only	INT	1	04	Input register	-	-
PV_VOLT	2	PV system voltage	0	1800	Volts	Read only	UINT	1	04	Input register	-	-
PV_CURRENT_01	3	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_02	4	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_03	5	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_04	6	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_05	7	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_06	8	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_07	9	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_08	10	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_09	11	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_10	12	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_11	13	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_12	14	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_13	15	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_14	16	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_15	17	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_16	18	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_17	19	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_18	20	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_19	21	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_20	22	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)

PV_CURRENT_21	23	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_22	24	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_23	25	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_24	26	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_25	27	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_26	28	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_27	29	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_28	30	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_29	31	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_30	32	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_31	33	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
PV_CURRENT_32	34	Individual input current	0	25000/50000	mA	Read only	UINT	1	04	Input register	-	Depends on configuration (Hall effect sensors current: 25A or 50A)
FLG_EV	35	Various event flags	0x0000	0x000F	Bitfield	Read only	UINT	1	04	Input register	-	b0: set to '1' if TEMP > 70 ºC b1: set to '1' if PV_VOLT < THR_UV b2: set to '1' if digital input 1 is open b3: set to '1' if digital input 2 is open
FLG_BF	36-37	Binary flags for blown fuses	0x0000 0000	0xFFFF FFFF	Bitfield	Read only	UINT	2	04	Input register	0x0000 0000	bX: set to '1' if PV_CURRENT_XX <= THR_UC. If a certain bit is disabled in MSK_INPUT_EN, the corresponding bit in FLG_BF will be 0 (register address 11 --> LSB / register address 12 --> MSB)
THR_UV	1	User-defined undervoltage threshold	200	1500	Volt	Read / Write	UINT	1	03 / 16	Holding register	200	-
THR_UC	2	User-defined undercurrent threshold	0	25000/50000	mA	Read / Write	UINT	1	03 / 16	Holding register	0	-
MSK_INPUT_EN	3-4	Mask to enable individual current inputs	0x0000 0000	0xFFFF FFFF	Bitfield	Read / Write	UINT	2	03 / 16	Holding register	0xFFFF FFFF	To avoid false events about blown fuse and undercurrent (register address 2 --> LSB / register address 3 --> MSB)
MODEL_ID	5	Number identifying the HW variant	-	-	uint	Read only	UINT	1	03 / 16	Holding register	-	-
HW_VERS	6	Hardware version	10000	65535	(see Notes)	Read only	UINT	1	03 / 16	Holding register	-	Tens of thousands: major release number / Thousands and hundreds: minor release number / Tens and units: patch level number (example: 65535 means HW version 6.55.35)
FW_VERS	7	Firmware version	10000	65535	(see Notes)	Read only	UINT	1	03 / 16	Holding register	-	Tens of thousands: major release number / Thousands and hundreds: minor release number / Tens and units: patch level number (example: 65535 means FW version 6.55.35)