Present document includes both user guides for the following products:

SOLAR STRING MONITORING SYSTEM

4000002958 Solar SMS Master

4000002959 Solar SMS Slave 8IN25A

4000003982 Solar SMS Slave 8IN50A

4000002961 Solar SMS Slave 12IN25A

4000003983 Solar SMS Slave 12IN50A

SOLAR STRING MONITORING SERVER LoRaWAN® CONFIGURATION MANAGEMENT TOOL

4000003329 Solar SMS Master LoRaWAN®

4000003489 Solar SMS RF LoRaWAN®

27/09/2023 – v0.1

SOLAR STRING MONITORING SYSTEM

en User guide

4000002958 Solar SMS Master

4000002959 Solar SMS Slave 8IN25A

4000003982 Solar SMS Slave 8IN50A

4000002961 Solar SMS Slave 12IN25A

4000003983 Solar SMS Slave 12IN50A

05/09/2023 – v0.2

Content

1. Introduction

Solar String Monitoring System (Solar SMS) is a string monitoring device used to monitor the status of the DC side in a PV system. This product allows to measure current of different number of strings: 8, 12, 16, 20, 24, 28 or 32 as well as the output voltage of the DC string.

The Solar SMS is a high-end solution, reliable and proved.

It is highly recommended that you read thoroughly read this user guide as it contains important safety and performance-related information.

Since Solar String Monitoring System necessitates many technical considerations, a highly reliable and robust solution has been provided in Weidmueller. Some features are highlighted as follows:

- Our Solar SMS solution is a rugged, industrial measurement equipment which meets all the circumstances of such a harsh-environment application including withstanding the same temperature range under full load, the surges due to indirect lightning strikes, the dusty and/or humid atmospheres.
- The Solar SMS is totally modular allowing to install only the necessary Hall effect sensors inside the PV DC Combiner Box to optimize the final design in terms of cost and space.
- The Solar SMS is meant to measure, among other variables, string current and system voltage under the tough electromagnetic interferences typically found in PV plants. That is why it has successfully passed EMC tests under industrial-grade immunity requirements.
- The Solar SMS measures current by means of Hall effect sensors. These sensors allow to do a non-intrusive measurement of the current going through the cable. Furthermore, they do not produce heat inside the PV DC Combiner Box.
- The Solar SMS is certified for safety and EMC in an independent accredited laboratory in the European Union, using the latest available IEC/EN standards.
- The Solar SMS fulfills the latest RS-485 and Modbus industry standards and can be easily integrated into a SCADA or a PLC/datalogger because Weidmüller discloses all the register map information to you in this user guide.
- The Solar SMS can be upgraded with an accessory to extend it capabilities allowing radiofrequency communications based on LoRaWAN® protocol, keeping it robust and compact because this accessory is plugged on top of the Solar SMS Master module main PCB.

2. Safety, application, disclaimers, support

2.1. Precautionary statements

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

	DANGER Indicates that death or severe personal injury will result if the relevant information is not considered.

	WARNING Indicates that death or severe personal injury may result if the relevant information is not considered.

	CAUTION Indicates that minor personal injury or property damage may result if the relevant information is not considered.

	NOTICE Indicates that an unintended result or situation can occur if the relevant information is not considered.

2.2. Safety information

	**DANGER** It is mandatory to completely read this user guide before attempting to install, operate, maintain, or troubleshoot the equipment. Failure to do so creates a life hazard to the persons involved; that is why the equipment is marked with the ISO 7000–0434B caution icon (). This user guide must be available for future reference to any person that will deal with the equipment.

	**DANGER** Any use of this equipment different to the “intended use” declared in this user guide can lead to severe injuries, death and/or property damage. Moreover, doing so will automatically void the warranty and any claims from the customer against Weidmüller.

	**DANGER** This is an industrial equipment meant to be installed, operated, maintained, and troubleshot by skilled persons able to understand the electric shock hazards involved. Always isolate the wires connected to supply the device.

	**DANGER** The skilled persons installing, maintaining, or troubleshooting this equipment must have the right tools available and be trained in how to use them. They must also be familiar and follow all the locally applicable occupational safety and health regulations.

	**CAUTION** Take the necessary precautions regarding electrostatic discharge when manipulating this device.

2.3. Intended use

This equipment is meant to be permanently installed inside a PV DC Combiner Box with the purpose of monitoring DC voltage and current plus some additional field variables (internal temperature and two digital inputs). The measured values can be accessed from a Modbus RTU client (typically a SCADA or a PLC) via a RS-485 cable.

The accurate measurements performed by this device have multiple uses. The list below is not meant to be exhaustive:

- Detecting blown fuse-links: if the current of one input drops to zero permanently during daylight, this is a clear indication of a blown fuse (or a more severe DC issue such as a broken wire, a damaged PV module, etc.).
- Detecting reverse current: if the current of one input drops to zero only during certain periods of daylight but it recovers after a while, this could be due to the fact that in reality the current is momentarily becoming negative. Negative current is reverse current.
- Detecting underperforming strings (due to module mismatching, shading, defects, etc.): some very obvious cases can be detected by just inspecting instant current measurements, but it is recommended to use DC performance ratio (R_P, see IEC 61724) calculations to find “hidden” underperforming strings.
- Detecting worn out surge protective devices: if the remote alert of a Weidmüller SPD is wired to a digital input of the Solar SMS, the Modbus client can detect SPD cartridges that reached the end of their life.
- Detecting DC switch-disconnectors status: accidentally left open after a maintenance session (a switch-disconnector with a dry contact must be used).
- Detecting PV DC Combiner Boxes with internal hot spots: thanks to the temperature measurement function of the Solar SMS, an accidental hot spot (i.e. a loose connection) inside a PV DC Combiner Box can be remedied before it becomes a fire accident.
- Prioritizing maintenance actions: by combining all the measurements above, the maintenance staff can better decide what tasks in the DC side have higher priority due to the lost energy production or the risk level.

	**DANGER** If the Solar SMS is used in a manner not specified by Weidmüller, the protection provided by the equipment may be impaired.

	**WARNING** This equipment shall not be used for measurements on mains circuits. For detailed ratings of the PV-side terminals check the corresponding section in this user guide. Failure to observe this requirement will create an electric shock hazard.

	**NOTICE** Even though DC-side power and energy measurements can be derived from the measurements taken with this equipment, the Solar SMS is not intended to be a power meter or an energy meter.

2.4. 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's 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.

2.5. Manufacturer contact details

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

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

3. Installation

	**WARNING** Installation of this equipment must be performed in a non-dusty environment with the following characteristics: • temperature: 5 °C to 40 °C • maximum relative humidity: 80 % for temperatures up to 31 °C decreasing linearly to 50 % at 40 °C

	**DANGER** During mounting, wiring, configuration, maintenance and troubleshooting of this equipment there shall be no live voltage present in the PV DC Combiner Box. Failure to skip this step creates a life hazard to the persons involved due to the up to 1.5 kV voltages typically found in PV systems.

	**NOTICE** According to EN 61326-1:2013 and IEC 61000-4-2:2008 this product is classified under ESD protection class B (4kV). This need to be considered when handling the product. The criteria for handling products with ESD protection class B are shown in IEC 61340-5-1:2007.

3.1. Mounting requirements

The product is intended to be fixed equipment according to IEC 61010-1:2010 ed3.0. This product is meant to be mounted to an EN 50022 top hat rail (such as Weidmüller's TS 35 range) inside a PV DC Combiner Box fulfilling IEC 61439-2 (or equivalent local standard) and only accessible to authorized people. The enclosure of the PV DC Combiner Box shall fulfill IEC 62208 (or equivalent local standard) to ensure protection against direct contact, indirect contact and spread of fire. The IEC 60529 ingress protection code of the PV DC Combiner Box shall be at least IP65, ideally IP66. The IEC 62262 degree of protection against external mechanical impacts of the PV DC Combiner Box shall be at least IK09, ideally IK10.

If the enclosure of the PV DC Combiner Box is made of steel, it must be connected to the protection earth and must include a rated DC switch-disconnector in order to disconnect the supply of the Solar SMS.

The device has a pollution degree 2 and an overvoltage protection category CAT II. The maximum altitude of installation is 2000 meters.

Thermal considerations

- This product does not need forced convection (i.e. a fan) to operate reliably.
- There is nonspecific mounting orientation besides to be installed onto the terminal rail.
- Leave enough space around the product to allow natural-convection air flow.
- This product shall not be installed in the close vicinity of powerful heat sources.
- Wires passing though the modules containing Hall effect sensors must be installed and wired with the current flowing in the direction of the arrow printed on the PCB.
- It is important to review the connections and to put back in place the plastic top cover to guarantee the electrical safety of the equipment.
- The PV DC Combiner Box design shall guarantee that the air temperature around the PCB of this equipment is between –20 °C and +70 °C.
- Weidmüller's range of PV DC Combiner Boxes is engineered with these considerations in mind and the designs are validated with IEC/TR 60890 thermal models and/or multipoint temperature rise tests. Contact your Weidmüller' sales representative for additional information.

3.2. Wiring of PV inputs

The “PV side” consists of CN1/CN4. CN1 is the PV positive input voltage and CN4 is the PV negative input voltage. Electric schema is shown in figure 1.

⚠	**DANGER** There must be a way to isolate this equipment from the dangerous voltages of the PV modules and the DC input of the inverter. Failure to observe this requirement creates an electrical shock hazard. The recommended solution is to install the following devices easily accessible and near this equipment (typically inside the PV DC Combiner Box): • fuse-disconnectors (placed electrically between the PV modules and this equipment). • an IEC 60947-3 certified DC-21B switch-disconnector (placed electrically between this equipment and the inverter). The fuse-disconnectors and the switch-disconnector should be marked in the PV DC Combiner Box as devices for the disconnection of this equipment.

⚠	**WARNING** The PV-side wires (power supply) shall have the right length so that they do not apply a mechanical strain to this equipment. Failure to observe this requirement creates fire and electrical shock hazards and may also damage this equipment.

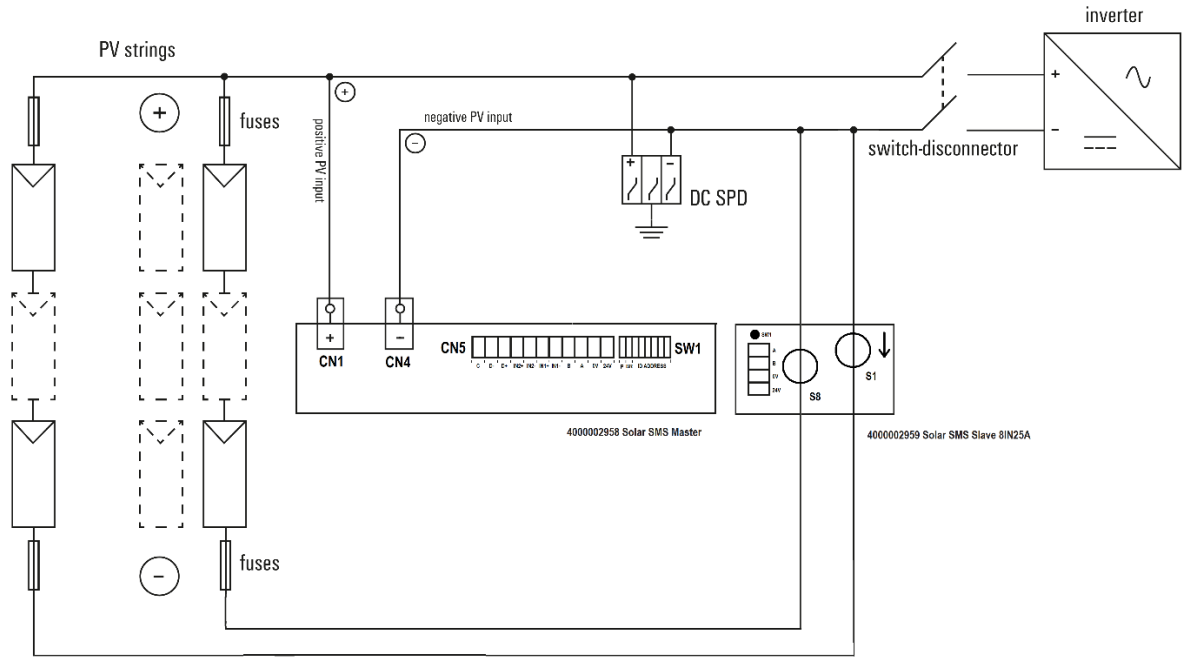

Figure 1

The power supply input of this equipment is floating with regards to the rest of the circuit. This is accomplished by means of a dedicated DC/DC converter which provides a double insulation barrier between the power supply input and the PV-side terminals.

From the user perspective, this means full safety even under severe surges. This equipment is self-powered directly from the string voltage, powered from 200 VDC up to 1500 VDC as shown in figure 2.

⚠	**CAUTION**
	This equipment is marked with “1500VDC MAX.” label; “-“ and “+” symbols because it is fed with DC power up to 1500 VDC.

Connector CN4/CN1	
Stranded wire cross section (with plastic collar ferrule)	0.25 - 6 mm^2
Stranded wire cross section (with wire end ferrule)	
Stranded wire end ferrule stripping length 0.5 mm^2	14 mm ±1 mm
Stranded wire end ferrule stripping length 0.75 mm^2	
Stranded wire end ferrule stripping length 1 mm^2	15 mm ±1 mm
Stranded wire end ferrule stripping length 1.5 mm^2	12 mm ±1 mm
Stranded wire end ferrule stripping length 2.5 mm^2	
Stranded wire end ferrule stripping length 4 mm^2	
Stranded wire end ferrule stripping length 6 mm^2	

⚠	**WARNING**
	The power supply cable shall have the right length, so that it does not apply a mechanical strain to this equipment. Failure to observe this requirement creates an electrical shock hazard and may also damage this equipment.

Figure 2

3.3. Wiring of digital inputs

⚠	**DANGER**
	Digital inputs must be manipulated with the Solar SMS Master powered off. Digital inputs have a basic insulation.

This product includes two digital inputs (pins IN1/IN2 from connector CN5 as shown in figure 3), designed to detect an ‘open’ dry contact as logical “1” and ‘closed’ dry contact as logical “0”. These inputs are galvanically isolated from the internal circuitry.

⚠	**WARNING**
	The digital input cables shall have the right length so that they do not apply a mechanical strain to this equipment. Failure to observe this requirement creates an electrical shock hazard and may also damage this equipment.

⚠	**CAUTION**
	The cables connected to the digital inputs shall each be less than 3 meters long in order to maintain EMC compliance.

Figure 3

Connector CN5 (IN1-/IN1+ and IN2-/IN2+)	
Stranded wire cross section (with plastic collar ferrule)	0.25 - 0.75 mm^2
Stranded wire cross section (with wire end ferrule)	0.25 - 1.5 mm^2
Stranded wire end ferrule stripping length 0.25 mm^2	10 mm ±1 mm
Stranded wire end ferrule stripping length 0.34 mm^2	
Stranded wire end ferrule stripping length 0.5 mm^2	
Stranded wire end ferrule stripping length 0.75 mm^2	

3.4. Wiring of RS-485 ports

⚠	**DANGER**
	RS-485 ports must be manipulated with the Solar SMS Master powered off.

This product includes internal RS-485 port (pins 24V/0V/A/B from connector CN5 as shown in figure 4) designed to communicate with any Slave SMS product to be connected to any variant of Solar SMS Slave 8IN25A, Solar SMS Slave 8IN50A, Solar SMS Slave 12IN25A, and Solar SMS Slave 12IN50A.

⚠	**CAUTION**
	Pay attention when wiring RS-485 cables. A wrong installation can create a lack of communications, but also, it can damage the equipment. All the units shipped out from Weidmüller have their RS-485 ports thoroughly tested right at the end of the production line. Weidmüller will not cover under warranty Solar SMS units that have their RS-485 transceiver IC damaged due to wrong wiring and/or due to surges.

⚠	**CAUTION**
	RS-485 wiring requires technical skills and tools different to those of available to regular electricians. Ensure that this step of the equipment installation is performed by staff with the right skills and tools. This user guide cannot be a replacement for field bus wiring experience and Weidmüller cannot be made liable for any damages resulting from improper wiring.

⚠	**CAUTION**
	This equipment complies with the latest RS-485 and Modbus standards, which are the official sources of information. The installation staff must refer to the following documents, which always have priority over any wiring recommendations given in this user guide: • TIA/EIA–485–A: “Electrical characteristics of generators and receivers for use in balanced multipoint systems” • TIA TSB–89–A: “Application guidelines for TIA/EIA–485–A” • “Modbus application protocol specification” v1.1b • “Modbus over serial line specification and implementation guide” v1.02

Figure 4

Connector CN5 (24V/0V/A/B)	
Stranded wire cross section (with plastic collar ferrule)	0.25 - 0.75 mm^2
Stranded wire cross section (with wire end ferrule)	0.25 - 1.5 mm^2
Stranded wire end ferrule stripping length 0.25 mm^2	10 mm ±1 mm
Stranded wire end ferrule stripping length 0.34 mm^2	
Stranded wire end ferrule stripping length 0.5 mm^2	
Stranded wire end ferrule stripping length 0.75 mm^2	

This product also includes external RS-485 port (pins D+/D-/C from connector CN5 as shown in figure 5), designed to communicate with third-party products.

The RS-485 port of this equipment is floating with regards to the rest of the circuit. This is accomplished by means of dedicated DC/DC converters. From the user perspective, this means reliable communications, no ground loops and full safety, even under severe surges.

In the table below you'll find a correspondence between alternate names for RS-485 pins. The reason for choosing D+/D- over B/A or D1/D0 in this equipment is to avoid confusion with certain third-party products on the market with erroneously swapped B/A and D1/D0 pins. The names D+/D- cannot lead to confusion.

Function	Non-inverting pin	Inverting pin	Reference pin
RS-485 standard	B	A	C
Modbus standard	D1	D0	Common
Weidmüller	D+	D-	C

The RS-485 cable used to wire this equipment must fulfill the following specifications:

- Shielded twisted pair with 1.5 or 2 pairs (preferably 1.5 pairs)
- Braid shield, not foil shield
- 120 Ω characteristic impedance
- Cross section of individual wires 0.2 mm2 (AWG24) or larger

The following are two examples of proper RS-485 cable:

- Belden: 3106 A
- Lapp Cable Unitronic Bus LD 2×2×0.22 (part number 2170204)

Modbus terminology:

- The Solar SMS is a slave and a server from the viewpoint of the Modbus standard.
- A SCADA or the program running in a PLC/datalogger is a client from the viewpoint of the Modbus standard.
- A RS-485 to Ethernet converter or the hardware of a PLC/datalogger is a master from the viewpoint of the RS-485 standard.

Guidelines for RS-485 field wiring of this equipment when installed inside PV DC Combiner Box:

- The RS-485 bus topology must be a daisy chain.
- Short stubs (< 2 meters) are allowed inside the PV DC Combiner Box.
- Even though the RS-485 standard allows up to 1200 meters bus length at low bit rates (i.e. 9600 bps and 19200 bps), we recommend staying below 500 meters.
- Each end of the bus requires a 120 Ω 10% ½ W termination resistor between D+ and D- (see the RS-485 wiring diagram from figure 6). One end of the bus will be the RS-485 master (which may or may not include an internal termination option) and the other end will be inside the PV DC Combiner Box farthest away from the master (in terms of RS-485 cable distance).
- This equipment loads the RS-485 bus with 1/8 UL (Unit Load).
- It is recommended not to mix Solar SMS and other RS-485 slaves in the same bus.
- When daisy-chaining PV DC Combiner Boxes, the D+ and D- of each Solar SMS should use one twisted pair of the cable, leaving the remaining wire (in cables with 1.5 pairs) or the remaining twisted pair (in cables with 2 pairs) for the C connection. Always make sure that D+, D- and C use the right color-coded wire of the cable. It is a must to connect the C pin of all the Solar SMS and the RS-485 master together (see the RS-485 wiring diagram from figure 6).

	CAUTION
⚠	• IMPORTANT: in each PV DC Combiner Box always wire the C pin first and afterwards the D+ and D- pins. • It is very important NOT to connect the shield to the C pin in any PV DC Combiner Box (see the RS-485 wiring diagram from figure 6). Daisy-chained shield running non-stop from end to end of the RS-485 bus. Leave the shield floating (i.e. unconnected) at the far end of the RS-485 bus (i.e. the PV DC Combiner Box farthest from the RS-485 master in terms of cable length). Tie the shield directly to protective earth at the RS-485 master end. • Tie the C pin to protective earth at the RS-485 master end (see RS-485 wiring diagram from figure 6). Before doing this, ensure that the C pin is not connected to protective earth anywhere else in the whole RS-485 bus (keep in mind that some RS-485 masters may already tie internally the C pin to protective earth or to their power supply ground!). This connection makes sure that the RS-485 common-mode voltage stays close to earth potential instead of rising to dangerous voltages due to stray capacitances and conductance in the network. • Check communication schema on next page.

	CAUTION
⚠	Damages to the RS-485 transceiver IC of this equipment due to the following wiring errors will not be covered under warranty: • Connecting the C pin of this equipment to protective earth anywhere except in one point (at the master end). This connection may already be done internally inside the RS-485 master. • Connecting the C pin of this equipment to the cable shield inside a PV DC Combiner Box. • Using non-twisted pair or non-shielded cables. • Not connecting RS-485 cables as it appears on the figure 6.

	WARNING
⚠	The RS-485 cables shall have the right length so that they do not apply a mechanical strain to this equipment. Failure to observe this requirement creates an electrical shock hazard and may also damage this equipment.

Figure 5

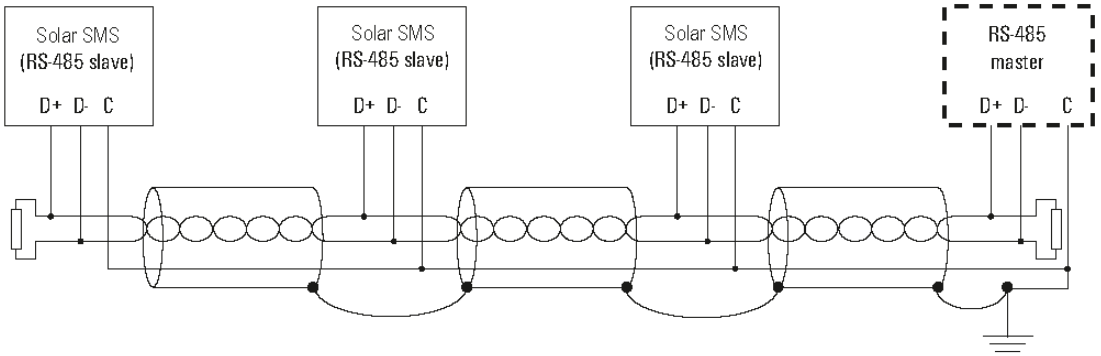

Figure 6

3.5. DIP switch configuration

Use the DIP switch (SW1) to configure the Modbus device address and the RS-485 serial settings. The first eight positions marked as “ID ADDRESS” are used to configure the ID of the Solar SMS device. The last two positions marked as “BR” and “P” are used to configure the RS-485 serial settings.

The following table specifies the binary coding of the Modbus device address via DIP switch. The factory default slave address is 1 (i.e SW1.1 in the ‘ON’ position and SW1.2 to SW1.8 in the ‘OFF’ position). As an example, the DIP switch coding for Modbus address 175 is shown (10101111 in binary).

	SW1.1	SW1.2	SW1.3	SW1.4	SW1.5	SW1.6	SW1.7	SW1.8
Weight	2^0 (LSB)	2^1	2^2	2^3	2^4	2^5	2^6	2^7 (MSB)
Address increment	1	2	4	8	16	32	64	128
Example Modbus address 175	ON	ON	ON	ON	OFF	ON	OFF	ON

RS-485 serial settings (SW1.9 and SW1.10):

- SW1.9 – data signaling rate
  - OFF: 9600 bps (factory default)
  - ON: 19200 bps
- SW1.10 – parity bit
  - OFF: NONE (factory default)
  - ON: EVEN

In order to modify ID number (or Modbus device address), data signaling rate (or baudrate) or parity parameters, a power cycle is needed. In order for any change be effective, the process must be as follows:

- Configure the desired ID (SW1.1 and SW1.8), baud rate or parity (SW1.9 and SW1.10).
- Switch-off the device and wait 5 seconds (any LED might be ON).
- Switch-on again the device.

NOTICE

All the devices belonging to one RS-485 bus must have the same serial settings and the Modbus device address of each Solar SMS cannot be used more than once.

	NOTICE After modifying any DIP switch setting, the changes need to be applied by powering off and then back on the equipment.

	NOTICE Regardless of the SW 1.10 parity bit setting there is always ONE stop bit.

3.6. Solar SMS Slaves configuration

All variants of Solar SMS Slave use Modbus RTU protocol in “slave” mode, returning reading data (current measurements) to the “master” (the Solar SMS Master unit) when asked. The baudrate is fixed at 19200 bps (factory default).

All and each Solar SMS Slave (regardless the variant we do have) are internally connected as daisy-chain configuration to the Solar SMS Master unit and are equipped with a push-button (SW1) as can be seen in figure 7.

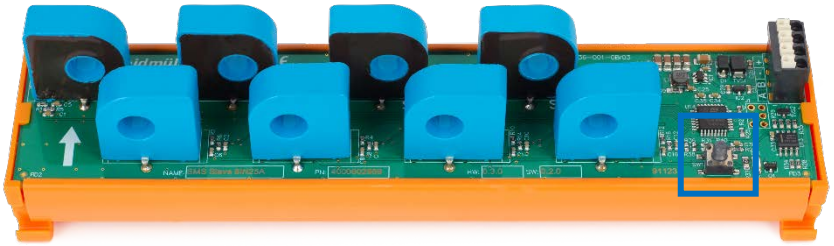

Figure 7

The push-button is meant to set the device address of each and all Solar SMS Slave daisy-chained to the Solar SMS Master unit. The push-button must be pressed in the desired order we do want to assign the current channels order (8 up to 32). In order to do so, a Modbus address must be given to each module and shown explained below:

- Ensure that all Solar SMS Slave units are powered on.
- Shortly press the push-button of the first Solar SMS Slave unit to be configured to enter in “waiting address state” (green LED will blink slowly).
- Solar SMS Master will send a broadcast message with the assigned address number.
- Solar SMS Slave will save the address in the flash memory.
- Solar SMS Slave Modbus address is configured and assigned to the unit.

Repeat the process for all and each Solar SMS Slave daisy-chained to the Solar SMS Master unit.

Note:

- Address assignment is concluded when the process is done within the first 60 seconds after powering on all devices. So there are 60 seconds after power is on to assign the address to all and each connected Solar SMS Slave devices.
- Push-button must be pressed for 5 seconds to reset Modbus address of a Solar SMS Slave unit. Then, the process for assigning a Modbus address must be followed again.

4. Integration with a Modbus RTU client

This equipment has been designed with commercial and utility-sized PV plants in mind. In this type of sites, the Modbus RTU client(s) sending requests to the Solar SMS Master is/are normally …

- … a set of PLCs (typically one PLC per inverter shelter) acting as local dataloggers. In this case a SCADA software will send Modbus requests to the PLCs instead of the Solar SMS Masters.

or …

- … a SCADA software located in the control room sending requests directly to the Solar SMS Masters.

In the case (2), where the SCADA sends Modbus requests directly to the Solar SMS Masters, the appropriate RS-485 masters for the field buses are the following Weidmüller Serial/Ethernet converters, installed in the inverter shelters. Contact your Weidmüller sales representative for further information.

	CAUTION
	Some Serial/Ethernet converters internally tie the RS-485 pin C to their power supply GND. Failure to observe this particularity could permanently destroy the RS-485 transceiver ICs and this damage would not be covered by Weidmüller's warranty. Ensure there are no ground loops (i.e. different paths to protective earth) in the RS-485 bus' pin C.

In terms of configuration of the SCADA or PLC acting as Modbus client, follow these recommendations:

- Set the Modbus client timeout to 1 second.
- The recommended practical polling interval per slave is 20 seconds. This is a good tradeoff between unnecessary network traffic (and database size) and time resolution. Keep in mind that the sun, the clouds and the MPP of the inverter do not change significantly in 20 seconds!
- For the most efficient use of the PV site network bandwidth, we recommend that all the Modbus registers of each Solar SMS Master are read in one single, function code 0x04 "read input registers".
- The averaging window length is 2.5 seconds.

The system is providing several measurements and alarm information via Modbus. This information is listed below. More details can be found at the end of the document under Annex B section.

- Averaged PV system voltage.
- Averaged PV current for each input.
- Averaged PCB temperature.
- Status of the digital inputs.
- Alarm flag: PV system undervoltage (user-configurable threshold).
- Alarm flag: Individual input undercurrent (user-configurable threshold).
- Alarm flag: Blown fuse.
- Alarm flag: PCB over temperature (fixed threshold 70 °C).

5. 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.
- 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 device. Using a current clamp check that there is no current flowing into the Solar SMS. 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.

5.1. LED signals

Solar SMS Master LED signals

The Solar SMS Master is equipped with two signal LEDs which indicate the system's status without use of further equipment.

Green LEDs are present at Solar SMS Master module, providing information about the supply voltage of the unit (the LED marked as "M") and the communications activity with connected Solar SMS Slaves daisy-chained and with the SCADA or a PLC/datalogger (the LED marked as "S") as shown in figure 8.

Figure 8

When the Solar SMS Master is connected for the first time to the voltage supply, both green LEDs (marked as "M" and "S") turns on, indicating that the device is powered on. If communication between Solar SMS Master and any Solar SMS Slaves is stablished, LED marked as "S" starts to blink meaning Solar SMS Master is transmitting. The same way, when the communication between Solar SMS Master and the SCADA or a PLC/datalogger is established, the LED marked as "S" starts to blink, meaning the Solar SMS Master is transmitting data.

Solar SMS Slave LED signals

The Solar SMS Slave is equipped with one signal LED which indicates the system's status without use of further equipment.

The green LED on the Solar SMS Slave module (on each and all variants possible), provides information about the supply voltage and the internal RS-485 communications activity with Solar SMS Master connected (LED marked as "DL1") as shown in figure 9.

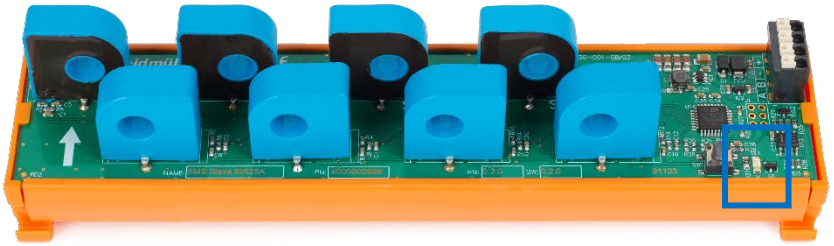

Figure 9

When the Solar SMS Slave is for the first time connected to the voltage supply (note that the supply voltage will come from Solar SMS Master wiring), the green LED (marked as “DL1”) turns on indicating that the device is powered on. Immediately after, “DL1” will start to blink slow meaning Solar SMS Slave has no ID address assigned yet and awaiting to be configured (see section 3.6 Solar SMS Slaves configuration). If the communication between Solar SMS Slave and Solar SMS Master is established, “DL1” starts to blink fast, meaning that the Solar SMS Slave is transmitting data and communicating with the Solar SMS Master unit.

LED signals table

Unit	LED	Color	Status	Description
Solar SMS Master	M	Green	ON	The product is supplied with voltage and can operate
			Blinking	There is RS-485 activity (transmitting/receiving from/to SCADA or a PLC/datalogger)
			OFF	The product is not supplied (with 24 VDC)
	S	Green	ON	The product is supplied with voltage and can operate
			Blinking	There is RS-485 activity (transmitting/receiving from/to Solar SMS Slave)
			OFF	The product is not supplied (with 24 V)

Unit	LED	Color	Status	Description
Solar SMS Slave	DL1	Green	ON	The product is supplied with voltage and can operate
			Slow Blinking	No ID address assigned yet (default ID address is 0)
			Fast Blinking	There is RS-485 activity (transmitting/receiving from/to Solar SMS Master)
			OFF	The product is not supplied (with 24 VDC)

5.2. Solar SMS Slave module replacement

A non-working Solar SMS Slave module can be detected because all current values measurements are 0 ADC event though current is coming from the PV modules and PV DC Combiner Box operation is correct.

In order to replace the faulty Solar SMS Slave module, it is needed to power off the device, disconnect the module and replace it for a brand-new module. Finally, it is necessary to enroll the new Solar SMS Slave following the configuration steps described in section *3.6 Solar SMS Slaves configuration*.

	**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 device. By using a current clamp check that there is no current flowing into the Solar SMS.

6. 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: List of acronyms

DC:	Direct Current
DIP:	Dual In-line Package
EMC:	ElectroMagnetic Compatibility
ESD:	ElectroStatic Discharge
IC:	Integrated Circuit
LSB:	Least Significant Bit
MPP:	Maximum Power Point
MSB:	Most Significant Bit
PCB:	Printed Circuit Board
PDU:	Protocol Data Unit (Modbus frame)
PLC:	Programmable Logic Controller
PV:	PhotoVoltaic
RS-485:	TIA/EIA-485-A “Electrical characteristics of generators and receivers for use in balanced multipoint systems”
SPD:	Surge Protective Device

Annex B: Modbus register table

(located at the very end of the user guide)

Notes:

- As defined in the Modbus standard, the register addresses shown in the table are transmitted in the Modbus PDU as one unit less. For example, register address 23 in the table above is sent through the RS–485 line as 22. This is standard Modbus behavior.
- 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.

Modbus register table

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

IR/HR	@	Size	Units	Data Type	Register Name	Description	Default Value	Min. Value	Max. Value	Notes
IR	1	1	uint	UINT	MODEL_ID	Number identifying the HW variant	---	---	---	
IR	2	1	(see Notes)	UINT	HW_VERS	Hardware version	---	10000	65535	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
IR	3	1	(see Notes)	UINT	FW_VERS	Firmware version	---	10000	65535	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
IR	4	1	ºC x 10	INT	TEMP	PCB temperature	---	-200	800	
IR	5	1	Volts	UINT	PV_VOLT	PV system voltage	---	0	1800	
IR	6	1	mA	UINT	PV_CURRENT_01	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	7	1	mA	UINT	PV_CURRENT_02	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	8	1	mA	UINT	PV_CURRENT_03	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	9	1	mA	UINT	PV_CURRENT_04	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	10	1	mA	UINT	PV_CURRENT_05	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	11	1	mA	UINT	PV_CURRENT_06	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	12	1	mA	UINT	PV_CURRENT_07	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	13	1	mA	UINT	PV_CURRENT_08	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	14	1	mA	UINT	PV_CURRENT_09	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)

IR	15	1	mA	UINT	PV_CURRENT_10	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	16	1	mA	UINT	PV_CURRENT_11	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	17	1	mA	UINT	PV_CURRENT_12	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	18	1	mA	UINT	PV_CURRENT_13	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	19	1	mA	UINT	PV_CURRENT_14	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	20	1	mA	UINT	PV_CURRENT_15	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	21	1	mA	UINT	PV_CURRENT_16	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	22	1	mA	UINT	PV_CURRENT_17	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	23	1	mA	UINT	PV_CURRENT_18	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	24	1	mA	UINT	PV_CURRENT_19	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	25	1	mA	UINT	PV_CURRENT_20	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	26	1	mA	UINT	PV_CURRENT_21	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	27	1	mA	UINT	PV_CURRENT_22	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	28	1	mA	UINT	PV_CURRENT_23	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	29	1	mA	UINT	PV_CURRENT_24	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	30	1	mA	UINT	PV_CURRENT_25	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	31	1	mA	UINT	PV_CURRENT_26	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	32	1	mA	UINT	PV_CURRENT_27	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	33	1	mA	UINT	PV_CURRENT_28	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	34	1	mA	UINT	PV_CURRENT_29	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	35	1	mA	UINT	PV_CURRENT_30	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)

IR	36	1	mA	UINT	PV_CURRENT_31	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	37	1	mA	UINT	PV_CURRENT_32	Individual input current	---	0	25000/50000	Depends on configuration (Hall effect sensors current: 25A or 50A)
IR	38	1	Bitfield	UINT	FLG_EV	Various event flags	---	0x0000	0x000F	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
IR	39-40	2	Bitfield	UNIT	FLG_BF	Binary flag to identify blown fuses	0x0000 0000	0x0000 0000	0xFFFF FFFF	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. Reg 39 LSB Reg 40 MSB
HR	41	1	Volt	UINT	THR_UV	User-defined undervoltage threshold	200	200	1500	-
HR	42	1	mA	UINT	THR_UC	User-defined undercurrent threshold	0	0	25000/50000	-
HR	43-44	2	Bitfield	UINT	MSK_INPUT_EN	Mask to enable individual current inputs	0xFFFF FFFF	0x0000 0000	0xFFFF FFFF	To avoid false events about blown fuse and undercurrent. Reg 43 LSB Reg 44 MSB

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SOLAR STRING MONITORING SERVER LoRaWAN® CONFIGURATION MANAGEMENT TOOL

en User guide

4000003329 Solar SMS Master LoRaWAN®

4000003489 Solar SMS RF LoRaWAN®

26/09/2023 – v0.1

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.

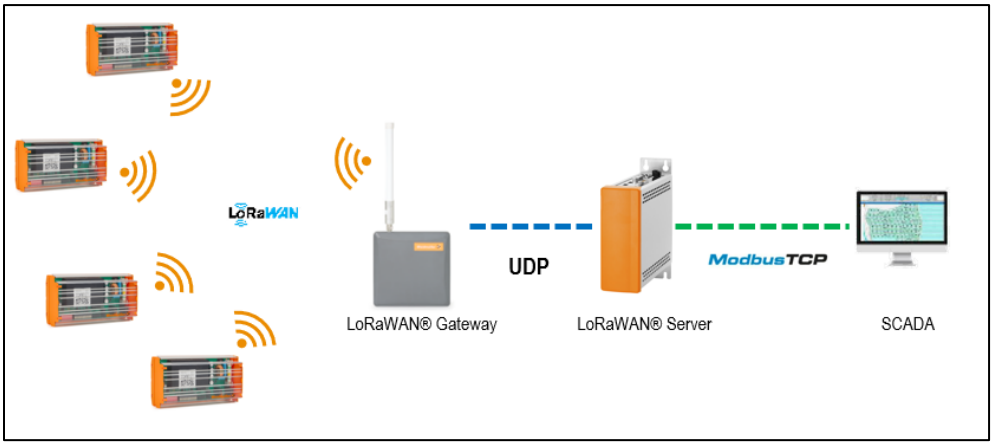

Figure 1. General overview of the system described

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® 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® and its communication with the network grouped by tags as below figure is showing.

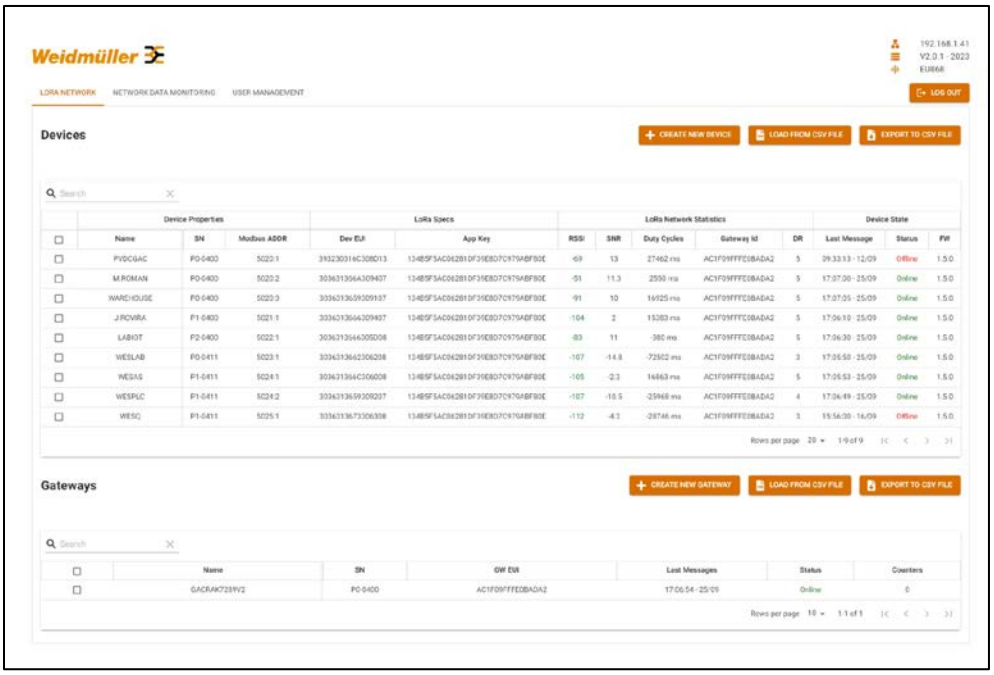

Figure 4. "LORA NETWORK" graphical interface

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.

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.

Explanation and meaning of each field from “Gateways” section:

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

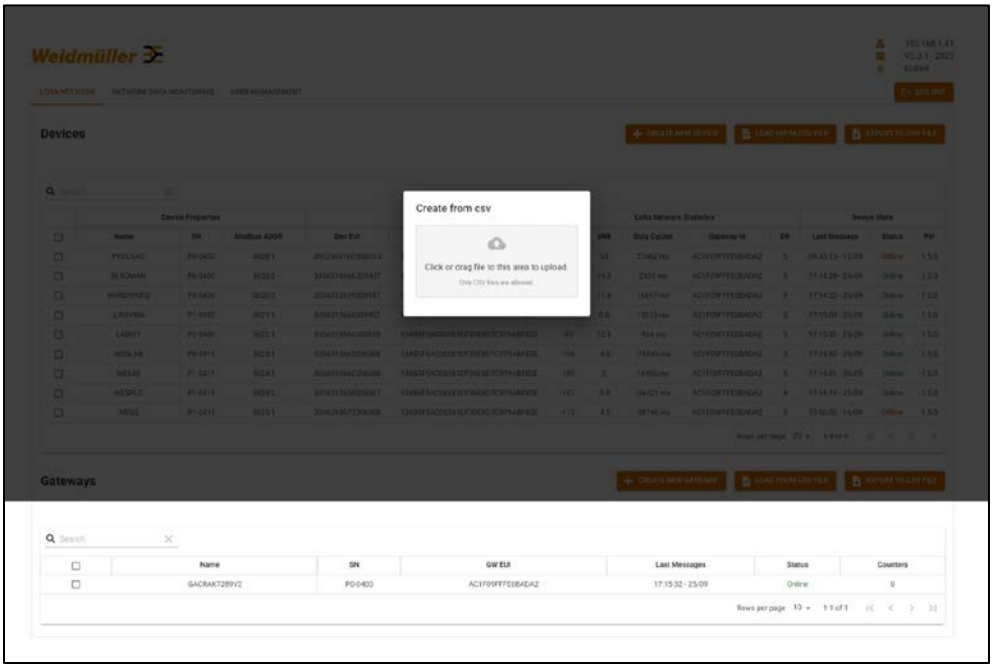

Figure 5. Example of "Devices" upload dialog graphical interface

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

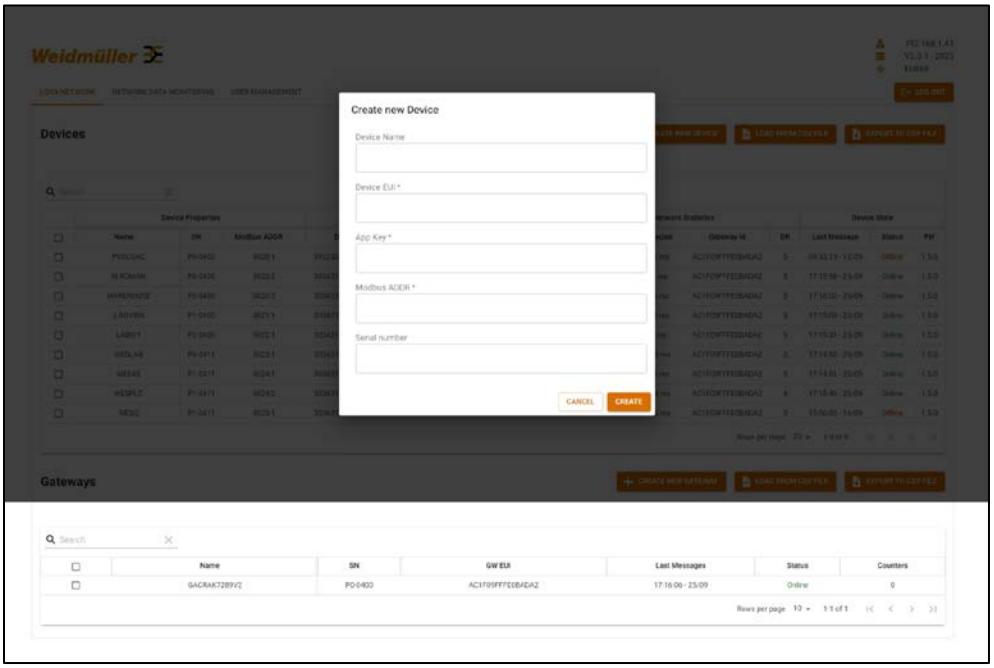

Figure 6. New Solar SMS Master LoRaWAN® (device) tab graphical interface

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	134B5F5AC06821DF39E8D7C979ABF80E

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:

Value	Description
Online	Server has records from the devices less than 3 minutes ago
Linked	Server has records from the devices during 3 to 5 minutes ago
Offline	Server 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.

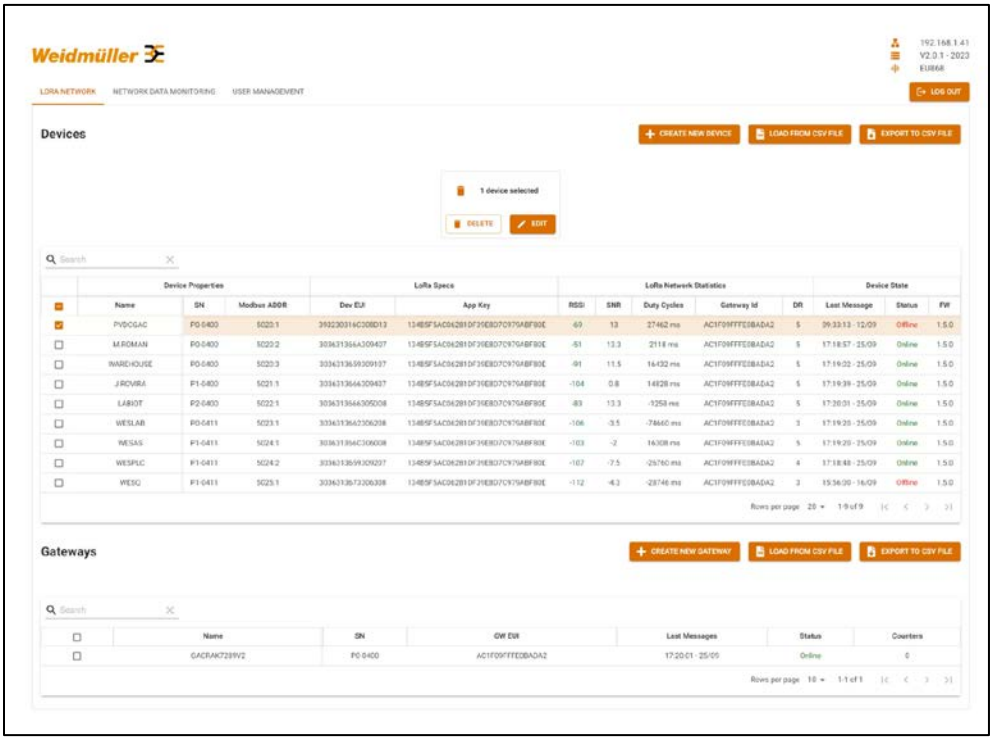

Figure 7. Delete or edit dialog tab

If the edit button is hit, the user can edit the device configuration. It gives the user access to the following dialogue box.

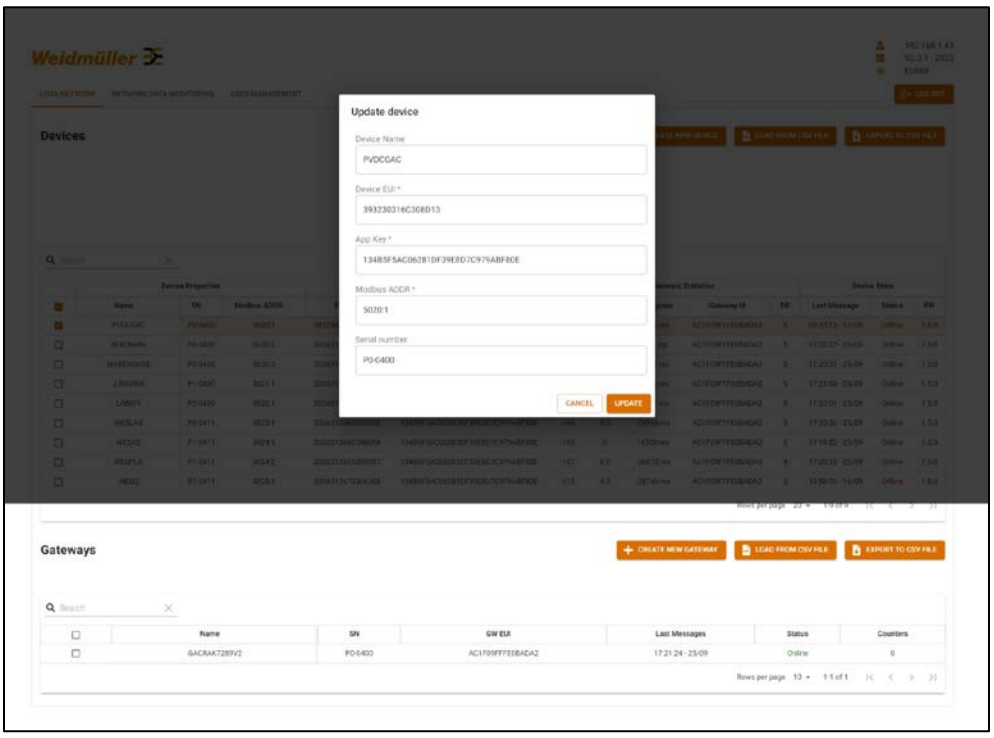

Figure 8. Update Solar SMS Master LoRaWAN® (device) options

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.

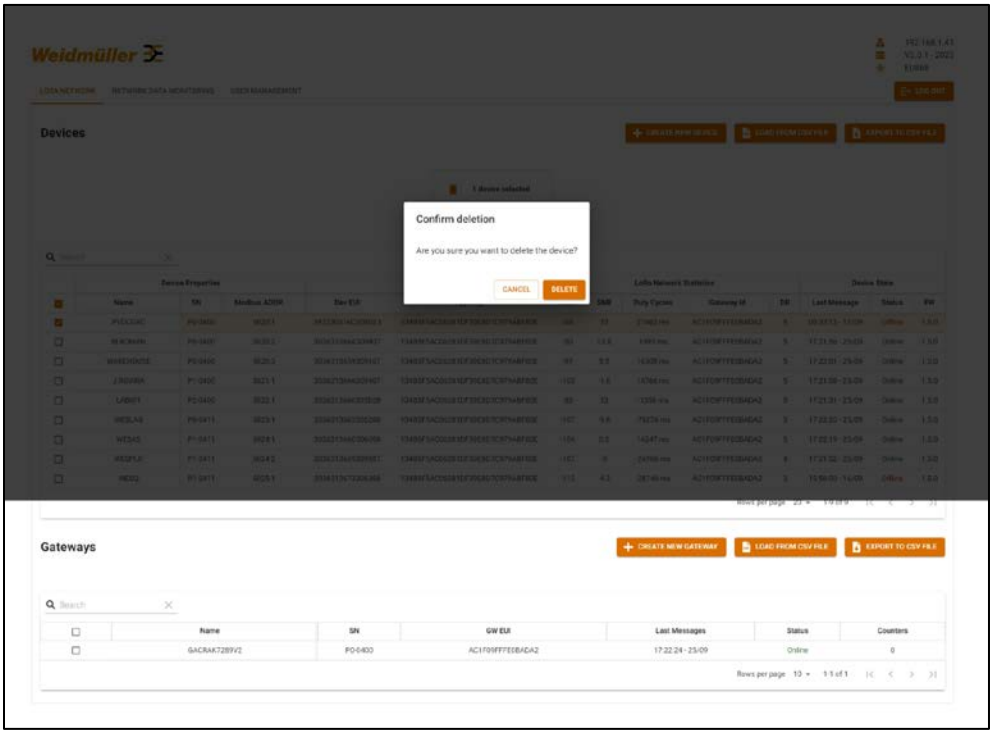

Figure 9. Deleting Solar SMS Master LoRaWAN® (device)

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).

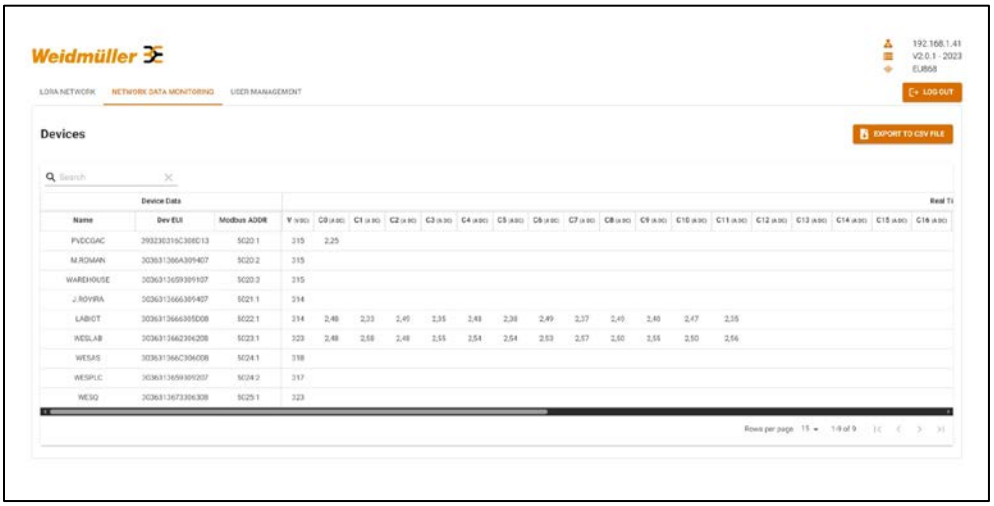

Figure 10. Example of Solar SMS Master LoRaWAN® (device) monitoring data

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
Admin	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
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 can be added, edited, and deleted if desired. There is no limit to create new users. Yet, the "Admin" user is prevailing (cannot be deleted).

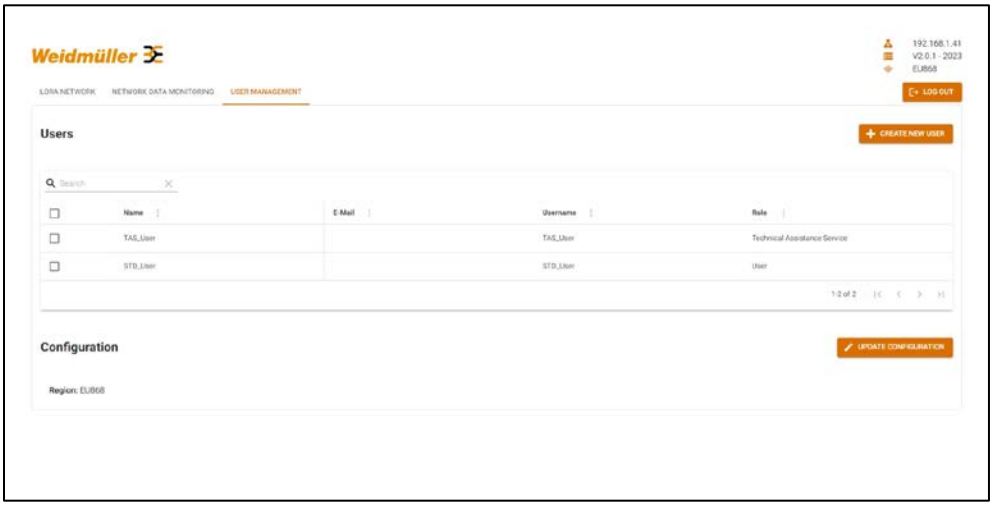

Figure 11. Example of user(s) created by default

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:

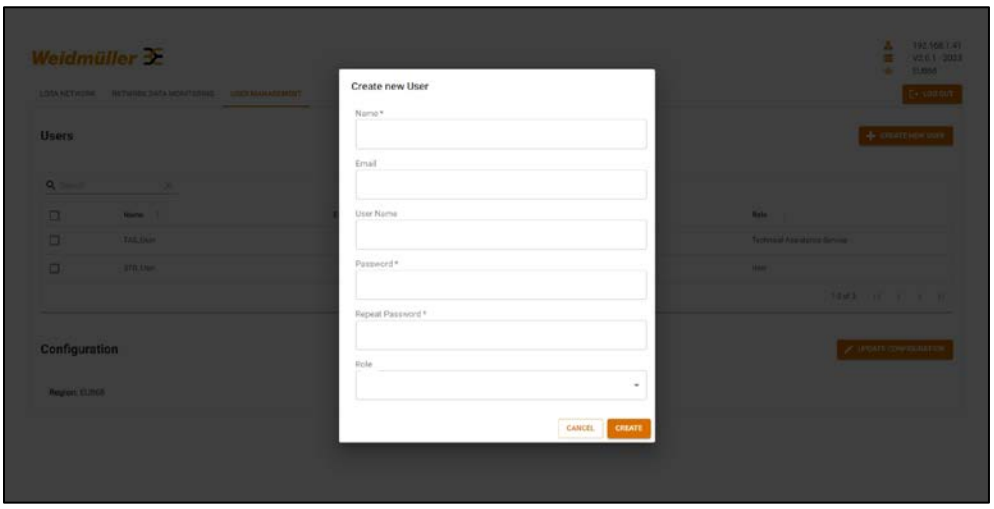

Figure 12. New user creation graphical interface

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:

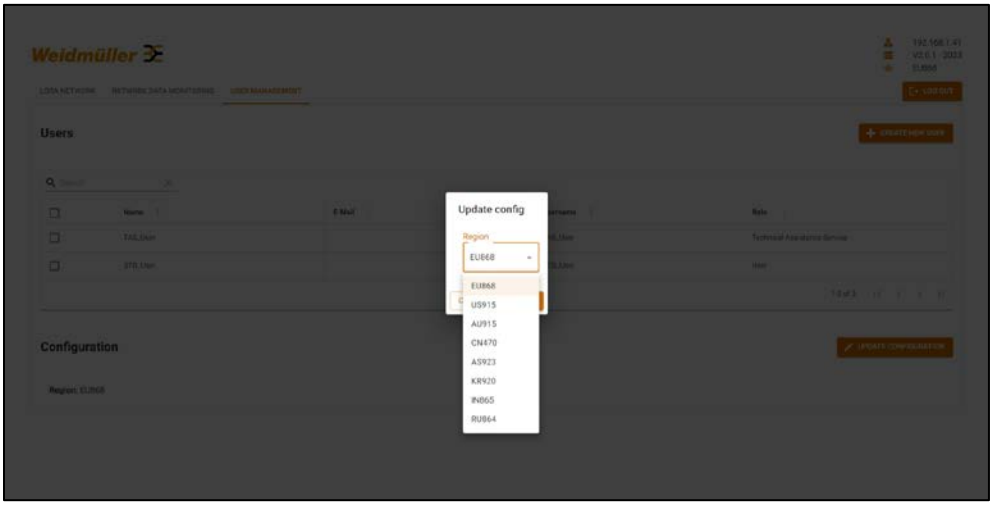

Figure 13. List menu with available frequencies to choose

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.

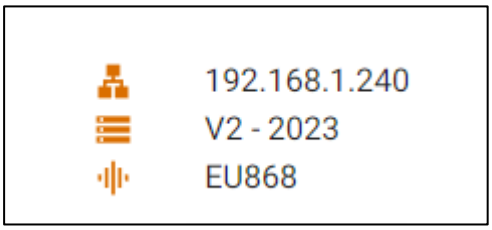

Figure 14. General Server LoRaWAN® *information displayed*

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 device 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. Modbus TCP Solar SMS Master LoRaWAN® 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 255 that each Solar SMS Master LoRaWAN® device is going to be used in Modbus TCP.

If the limit of 256 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 256 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 port 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® system 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:

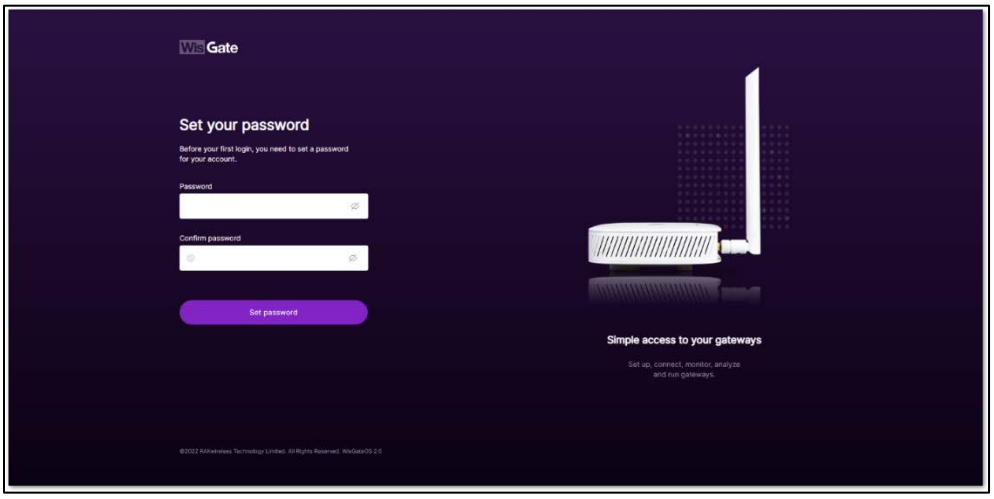

Figure 16. Gateway LoRaWAN® RAK7289V2 logging

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.

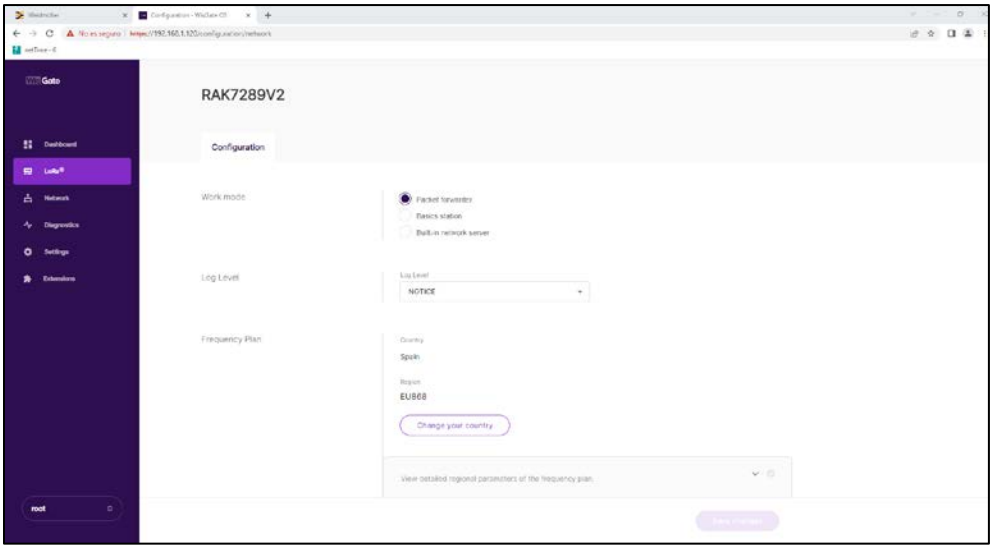

Figure 17. Gateway LoRaWAN® RAK7289V2 LoRa mode selection

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 following parameters must be chosen. Please refer to the values from the table below to be selected/chosen.

Field	Description
Server Address	IP address given to the Server (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

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

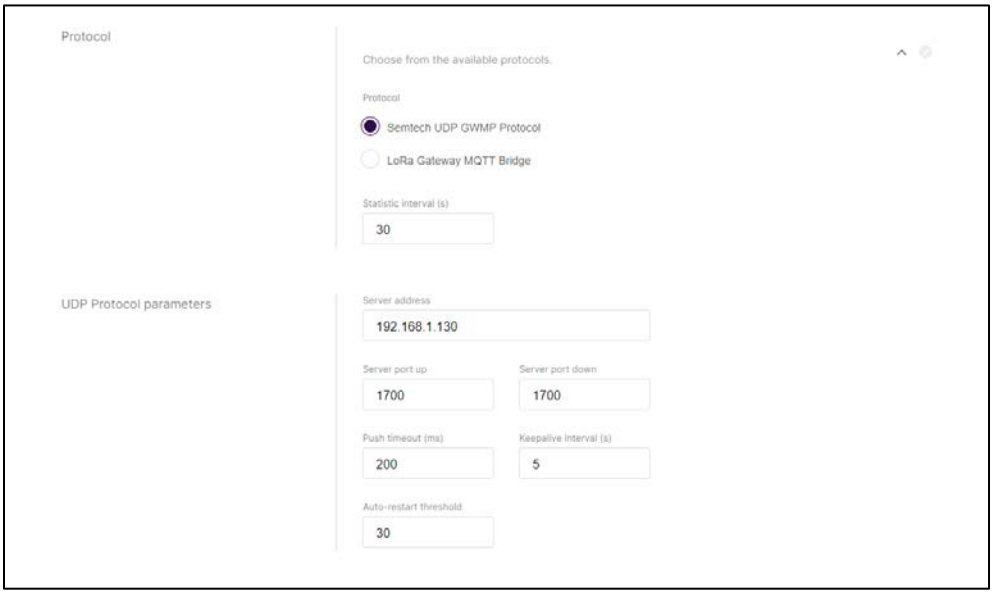

Figure 18. Gateway LoRaWAN® RAK7289V2 UDP Protocol configuration

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.

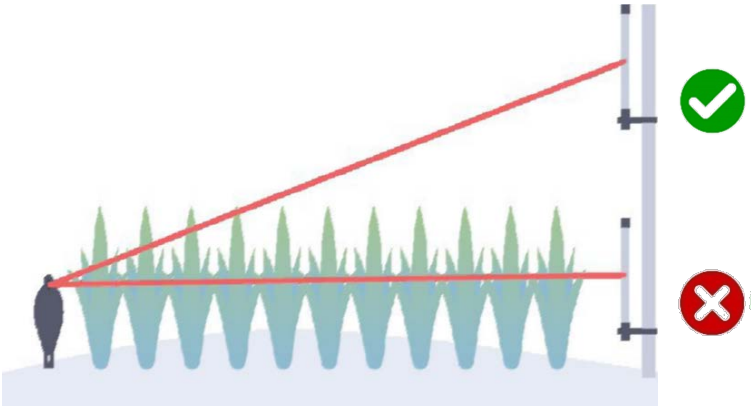

Figure 19. Gateway LoRaWAN® antenna placement on a mast/pole

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 20. Gateway LoRaWAN® antenna placement on a tower (example)

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 21. Gateway LoRaWAN® antenna placement on a building roof (example)

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 22. Gateway LoRaWAN® antenna placement on a building side (example)

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® lighting 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.

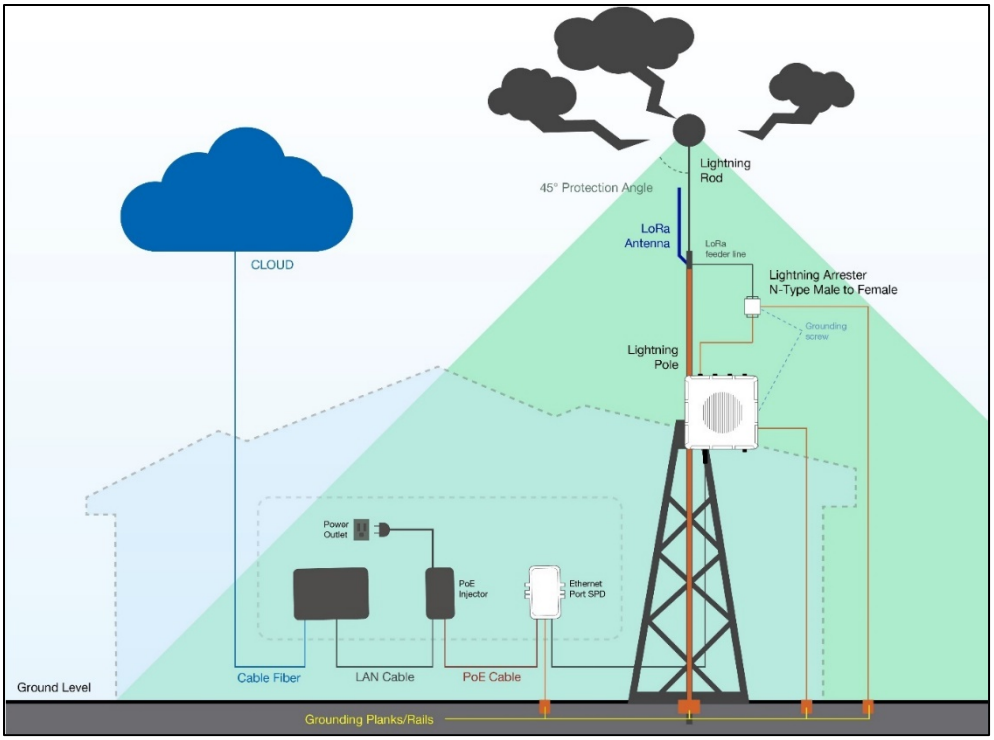

Figure 23. Gateway LoRaWAN® full lighting protection set-up (example)

Recommendation for outdoor surge protection system:

- LoRa® Gateway 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 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 24. PCB with built-in LoRa® module

Figure 25. 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.

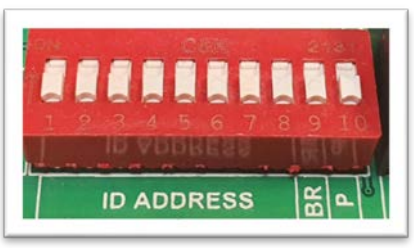

Figure 26. Solar SMS Master LoRaWAN® configuration DIP switch

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

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

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	OFF	1 to 10	30 seconds
OFF	OFF	ON	11 to 100	5 minutes
OFF	ON	OFF	101 to 200	10 minutes
OFF	ON	ON	201 to 300	15 minutes
ON	OFF	OFF	301 to 400	20 minutes
ON	OFF	ON	401 to 500	25 minutes
ON	ON	OFF	501 to 600	30 minutes
ON	ON	ON	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 *5.1.4 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.

5.1.3. 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	Total amount of devices
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	ON	10 minutes

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

5.1.4. 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
	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.
- 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 device. Using a current clamp check that there is no current flowing into the Solar SMS. 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 27. 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
Ask data from Solar SMS Master LoRaWAN®	Read Input Registers	4
Ask configuration from Solar SMS Master LoRaWAN®	Read Multiple Holding Registers	3
Send configuration to Solar SMS Master LoRaWAN®	Write Multiple Holding Registers	16

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 Registers
  - Function code: 4
  - 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: 3
  - 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

Please refer to the annex “Modbus register memory map” 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
	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.

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. Solar String Monitoring Server LoRaWAN® Configuration Management Tool 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

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 request, if records are out of date (by default more than 5 minutes).
5	ACKNOWLEDGE	Pending further information on the device.
7	NEGATIVE_ACKNOWLEDGE	Communication error. If status is present, it means that reception by the device has been acknowledged but no new valid configuration has been returned.
11	GATEWAY_TARGET_FAILED_TO_RESPOND	No response from the device.

Annex B: Modbus Register Table

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

IR/HR	@	Size	Units	Data Type	Register Name	Description	Default Value	Min. Value	Max. Value	Notes
IR	1	1	uint	UINT	MODEL_ID	Number identifying the HW variant	---	---	---	
IR	2	1	(see Notes)	UINT	HW_VERS	Hardware version	---	10000	65535	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
IR	3	1	(see Notes)	UINT	FW_VERS	Firmware version	---	10000	65535	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
IR	4	1	ºC x 10	INT	TEMP	PCB temperature	---	-200	800	
IR	5	1	Volts	UINT	PV_VOLT	PV system voltage	---	0	1800	
IR	6	1	mA	UINT	PV_CURRENT_01	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	7	1	mA	UINT	PV_CURRENT_02	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	8	1	mA	UINT	PV_CURRENT_03	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	9	1	mA	UINT	PV_CURRENT_04	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	10	1	mA	UINT	PV_CURRENT_05	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	11	1	mA	UINT	PV_CURRENT_06	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	12	1	mA	UINT	PV_CURRENT_07	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	13	1	mA	UINT	PV_CURRENT_08	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)

IR	14	1	mA	UINT	PV_CURRENT_09	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	15	1	mA	UINT	PV_CURRENT_10	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	16	1	mA	UINT	PV_CURRENT_11	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	17	1	mA	UINT	PV_CURRENT_12	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	18	1	mA	UINT	PV_CURRENT_13	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	19	1	mA	UINT	PV_CURRENT_14	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	20	1	mA	UINT	PV_CURRENT_15	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	21	1	mA	UINT	PV_CURRENT_16	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	22	1	mA	UINT	PV_CURRENT_17	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	23	1	mA	UINT	PV_CURRENT_18	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	24	1	mA	UINT	PV_CURRENT_19	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	25	1	mA	UINT	PV_CURRENT_20	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	26	1	mA	UINT	PV_CURRENT_21	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	27	1	mA	UINT	PV_CURRENT_22	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	28	1	mA	UINT	PV_CURRENT_23	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	29	1	mA	UINT	PV_CURRENT_24	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	30	1	mA	UINT	PV_CURRENT_25	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	31	1	mA	UINT	PV_CURRENT_26	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)

IR	32	1	mA	UINT	PV_CURRENT_27	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	33	1	mA	UINT	PV_CURRENT_28	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	34	1	mA	UINT	PV_CURRENT_29	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	35	1	mA	UINT	PV_CURRENT_30	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	36	1	mA	UINT	PV_CURRENT_31	Individual input current	---	0	25000/50000	Depends on Hall-effect sensor configuration (Hall effect sensors current: 25A or 50A)
IR	37	1	mA	UINT	PV_CURRENT_32	Individual input current	---	0	25000/50000	Depends on configuration (Hall effect sensors current: 25A or 50A)
IR	38	1	Bitfield	UINT	FLG_EV	Various event flags	---	0x0000	0x000F	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
IR	39-40	2	Bitfield	UNIT	FLG_BF	Binary flag to identify blown fuses	0x0000 0000	0x0000 0000	0xFFFF FFFF	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. Reg 39 LSB Reg 40 MSB
HR	41	1	Volt	UINT	THR_UV	User-defined undervoltage threshold	200	200	1500	-
HR	42	1	mA	UINT	THR_UC	User-defined undercurrent threshold	0	0	25000/50000	-
HR	43-44	2	Bitfield	UINT	MSK_INPUT_EN	Mask to enable individual current inputs	0xFFFF FFFF	0x0000 0000	0xFFFF FFFF	To avoid false events about blown fuse and undercurrent. Reg 43 LSB Reg 44 MSB

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