LORA TECHNICAL DOCUMENTATION

Technical Support Material for LoRa Expansion Module

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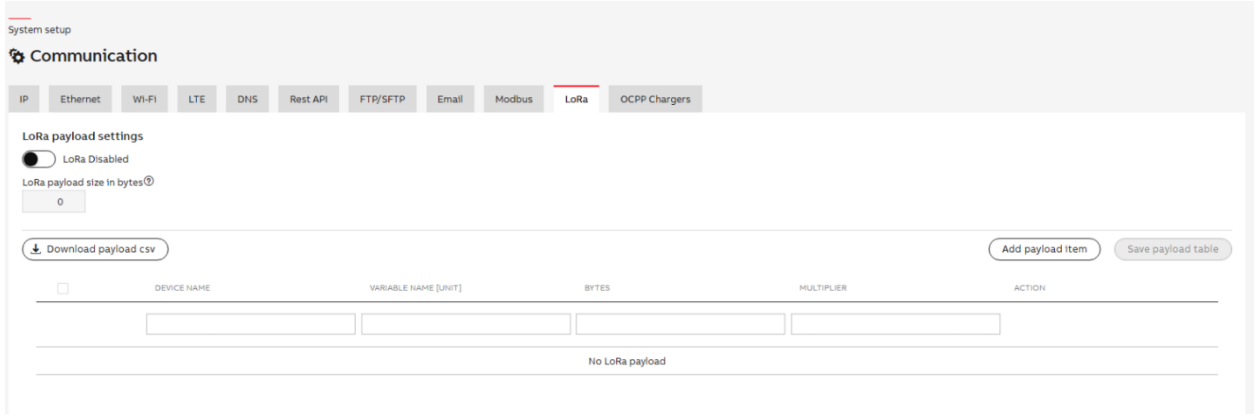
1. Purpose and Basic Description

This document provides a comprehensive step-by-step guide to commissioning the LoRa expansion module for the SCU200 gateway, detailing the entire process from initial setup to full operational readiness. It begins by explaining key technical terms such as Modbus-to-LoRa conversion, device addressing, and uplink/downlink communication. The guide then outlines how to physically connect the module, configure Modbus registers, assign device IDs, and set LoRa parameters including DevEUI, AppKey, and JoinEUI. It walks through integration into a LoRa network server, verifying data transmission, and troubleshooting tips to ensure seamless operation. By the end of the process, the user will have a fully functional LoRa-enabled system transmitting Modbus data wirelessly, ready for scalable and remote energy monitoring.

2. LoRa Configuration

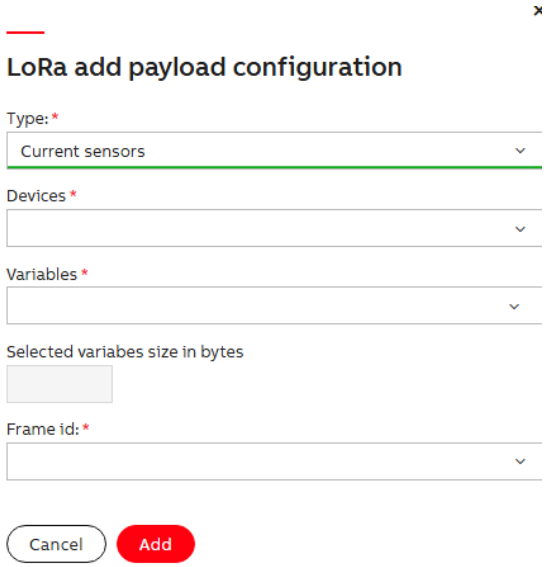
When LoRa module is connected to SCU200, it is automatically detected by the system and LoRa protocol is available for communication under the system setup, communication page.

Here - it is possible to configure LoRa export for SCU200 data.
Currently, it is possible to export data from all connected devices—such as meters, sensors, and I/O modules—with support limited to integer and Boolean data types



The Payload is divided into frames/messages and the maximum of each frame can be 49bytes, where the first two bytes are reserved for the recognition of frame for network integrations.

Within a single frame, we can freely add or remove variables and change their order by selecting them. . After rearranging the order, it is important to save the table changes by clicking the **"Save payload table"** button.



The **LoRa payload size in bytes** field indicates the total size of all frames, expressed in bytes.
To add a new payload item, click the **"Add payload item"** button. In the form, select the device type, the specific device, the variable, and the frame number. It is possible to choose more than one variable. The only restrictions are:

- The frame size cannot exceed 49 bytes.

Users also have the option to download the payload map as a CSV file. To do this, click the **"Download payload CSV"** button. Two files will be downloaded:

1. A file containing the payload.
2. A file with the list of variables, which includes information about the variable, device type, and the object id of the device stored in the database.

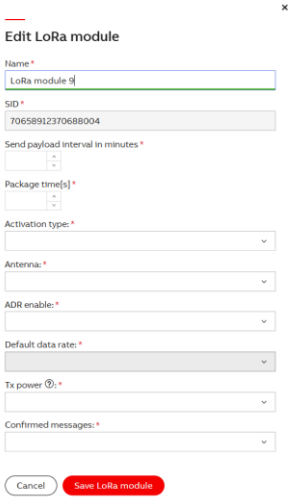
These files can then be used in network integrations of LoRa.

3. Commissioning

Only one LoRa device can be connected to the control unit. When LoRa module is connected to SCU200, it is automatically detected by the system and is available in the main Dashboard under devices section.

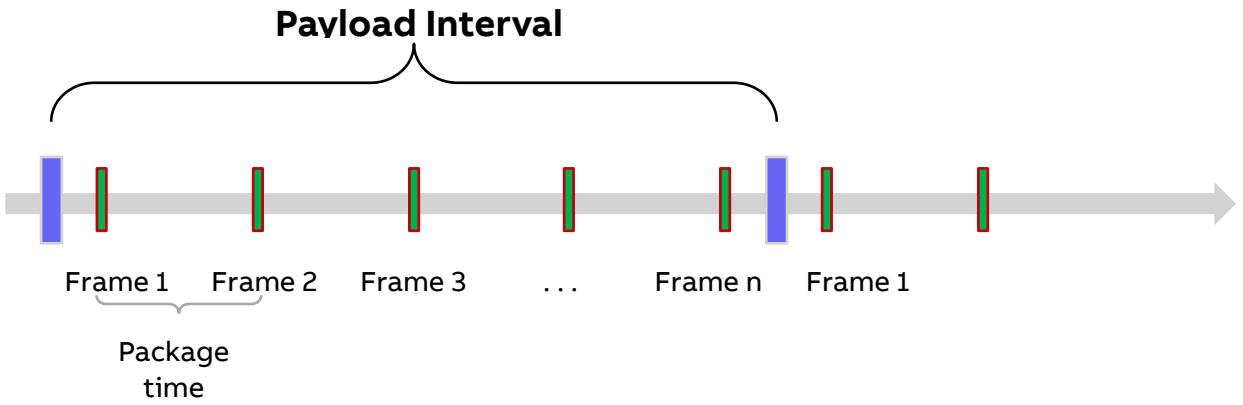
- Main Dashboard > My Plant > Devices > LoRa.

Once the device is detected, it needs to be configured by filling in the required fields:



1. **Name** – The module identification name for reference by the user.
2. **SID** – automatically recognised – cannot be edited by the user.
3. **Payload Interval**: This refers to the time gap between consecutive data transmissions from a LoRa device. It is essentially the interval at which SCU200 sends data to the gateway or network server. This can also be called a transmission interval or reporting interval. This is defined by the application and can be configured based on energy consumption and data needs. A shorter interval means more frequent transmissions, leading to higher power consumption (it might be not impacting since SCU200 and LoRa modules are powered with a supply). A longer interval saves energy but may reduce data update frequency. It should be ensured that the payload interval time is always more than the (Package time * Number of frames).

4. Package time: Package time is the interval between two frames.



5. **Activation type**: In the LoRa protocol, Activation Type refers to the method used to register a LoRa device (node) with the network. SCU200 can work in both OTAA and ABP modes are available
6. **Internal or External Antenna** can be selected.
7. **ADR** (Adaptive Data Rate) allows for adjusting data rate of the device: during commissioning it can be set to ON or OFF. Prior to confirm through “Save Lora module”, it is still possible to change the selection. Once saved, *recommissioning* is needed (removing the device from “My plant” and restart the SCU200)
   Below is an exemplification on what can be possible to configure while ADR is set to ON or OFF
   ADR ON:
   During commissioning:
   a. Data rate: modifiable
   b. TX power: blocked. Initially fixed to max (16 dBm). After successful joining to the network, the device's power is then managed by network infrastructure using ADR mechanism.

   During normal operation:
   c. Data rate: blocked
   d. TX power: blocked
   e. ADR modification (on -> off): blocked. (to unblock, recommissioning is needed)

ADR OFF:

During commissioning:

a. Data rate: modifiable
b. TX power: modifiable

During normal operation:

c. Data rate: modifiable
d. TX power: blocked (to unblock, recommissioning is needed, see above)
e. ADR modification (off -> on): blocked. (to unblock, recommissioning is needed, see above)

8. **Data rate**: The data rate can be adjusted depending on the payload size and transmission power.
9. **TX Power**: The transmitting power of device. It can be changed regarding customer needs.
10. **Confirmed messages**: if required confirmation can be allowed on the receiver devices for all the messages sent from SCU200, however it is advisable to turn it off as it may load the communication channel.

After completing the configuration, LoRa must be activated before it can be used. To do this, go to the **Communication tab** in the System Setup section and click the button under LoRa payload settings to set its status to **Enabled**.

To reset a LORA module, it is necessary to remove the device from “my plant section” and add it again as a new device.
In theFW version 1.6, there will be implemented a new feature to reset the LoRa without this additional function.

3.1. CONCEPT OF PAYLOAD & PACKAGE TIME

- On SCU200, it is possible to customize both payload and package time. For the correct configuration, it is mandatory to ensure total package time is less than the payload interval set
- To define the estimated total payload time – the user must consider three main variables:
  Number of frames, data rate, airtime calculator.

3.1.1. Number of frames :

The number of frames imply the number of total variables selected for exporting via LoRa, there is technically no limit on the number of frames that can be selected in total, however there is a limit on the size of each frame which is 49.

For each frame – **there is a fixed payload of 3 Bytes to be added to calculate the total payload size**, from SCU200, these three bytes are reserved to transfer the details of the frame.

3.1.2. Data rate

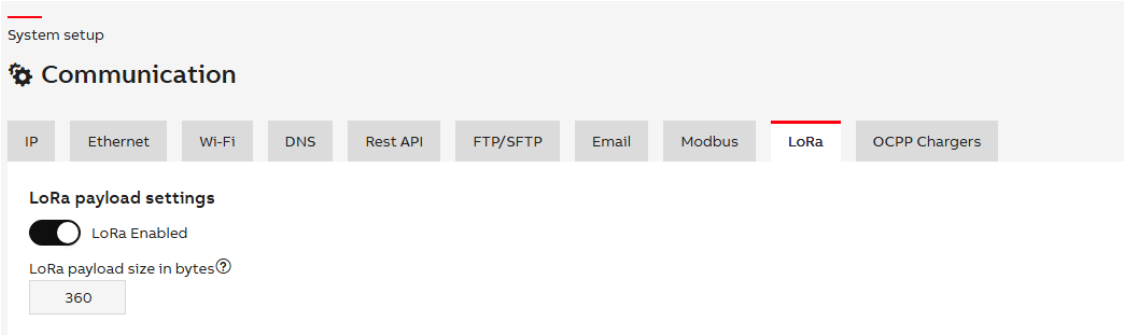
This implies the rate at which data can be transferred. Currently with 1.4.1 FW on SCU200 webserver it is only possible to choose bits/sec, but each of it is associated with a typical data rate, that can be referred from the following table.

DataRate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF8 / 500 kHz	12500
7	RFU	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500
13	LoRa: SF7 / 500 kHz	21900
14	RFU	
15	Defined in LoRaWAN[1]	

3.1.3. Airtime calculator

Once the data rate and payload are fixed, the integrator can use the airtime calculator, to estimate the time for the whole payload.
Variables to be filled in the calculator:

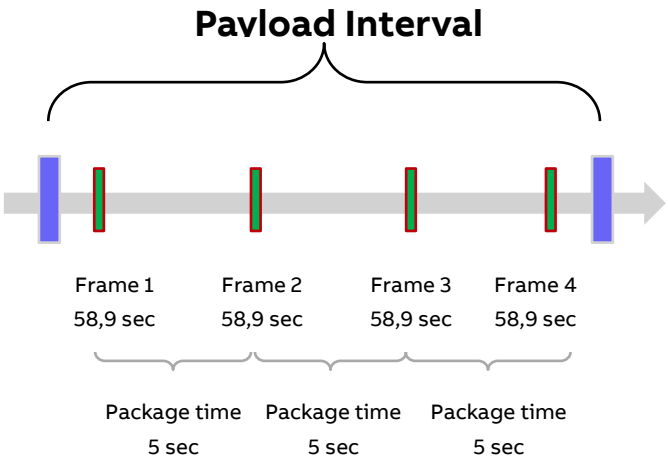
Overhead size is always fixed to be 13.
Payload size can be verified from the configuration page in SCU200 ; however **3 bytes must be added for each frame to** finalize the payload size to be used in the calculator.



So, if the payload size in the configuration page of SCU200 reads 360bytes – and the number of frames is 4, the correct payload size that can be used in the calculator is **(3*4) + 360 = 408 bytes**.

For example, the total payload size is 408 bytes, and the chosen data rate reference is DR5, according to 1% duty cycle rule – each message (Frame in SCU200) takes about – **58.9sec in air.**
Since package time is fixed by the user, and for assumption the package time is fixed to be around 5sec – the total estimated Payload interval can be :

Total Frame : 4 Frames;
Time for each frame : 58.9Sec;
Package interval: 5sec;
So total estimated payload interval : 4*58.9 + (3)*5 SEC = 4.17 MIN.
According to the above example the Payload interval that can be set can be around 5MIN.
So SCU200 can send the data via LoRa every 5MIN for all the selected variables.



4. Theoretical example

Here it can be explained how the variables of INS-E3, can be exported to LoRa based networks using SCU200 and INS-LoRa.
Consider a configuration:
3 energy meter modules to measure three main incomers.
1 scu200
1 Ins – Lora

It is necessary to export the following data from the metering modules:

Active import L1, L2, L3 (for all the 3 modules) – 12 Bytes for each module
Current L1, L2, L3 (for all the 3 modules) – 6 bytes for each module
Voltage L1, L2, L3 (for all the 3 modules) – 6 bytes for each module

By design each module data can be accommodated in 1 frame (MAX 49 BYTES).

Total Frames = 3
Total Payload = 81bytes – (72 total + 3*4)
Data rate = DR3 → 1760 bits/sec
From the airtime calculator – time for each frame = 53.4 Seconds
Assuming package interval = 5sec

The Payload interval can be = 3*(53.4sec) + 5*3 = 2,92 minutes = 3 minutes.
So theoretically SCU200 can update the data of the three modules every 3minutes to network server.

5. Important Notes

Transmission Interval Design
Although the theoretical transmission time may appear shorter, LoRa systems are typically designed to transmit data at longer intervals to optimize battery life and network efficiency.

Factors Affecting Payload Delivery
Multiple factors influence payload performance and must be considered during system design. These include:

- ADR (Adaptive Data Rate) status
- Distance from the LoRa gateway
- Network load on the gateway
- Volume of data being transmitted
- Antenna strength and positioning
- Transmission power settings

Configuration Retention
Even if the LoRa module is temporarily removed (e.g., for maintenance), all configuration settings are retained within the system.

Lost Payloads Cannot Be Re-Sent
If a payload is missed or fails to reach the server, it cannot be retransmitted. However, the system continues storing measurement data locally, which remains accessible via Modbus

Impact of Incorrect Payload Interval Settings
Incorrectly estimating the payload interval may result in the device entering sleep mode, potentially causing subsequent payloads to be lost.

Short Payload Intervals
If the configured payload interval is shorter than the required transmission time, the system may resend the previous payload, causing data refresh issues and outdated readings.

Snapshot Nature of Payloads

Payloads represent a snapshot of the device status now of transmission. If a parameter changes during the payload interval, the transmitted data may not reflect the most recent change until the next payload cycle.