Product Name: wMBUS-LoRaWAN
Related Firmware: ≥ V1.5.1
Document Date: 2018-08-31
1. Overview

The Loba ro wireless M-Bus (wMBUS) to LoRaWAN Bridge is a cost-effective & energy-efficient device that receives, caches and transparently forwards wireless M-Bus metering data from up to 500 consumption meters via any LoRaWAN network onto the Internet.

Many gas, water, electricity and heat meters can be read wirelessly today using the common short range Wireless M-Bus standard. Because such wMBUS enabled meters use the classical energy saving FSK radio modulation, the wireless range is often limited to less than 50m and therefore requires the use of additional longer-range radio technologies to forward the metering data onto the Internet. The advanced LoRa radio modulation used inside the Loba ro wMBUS to LoRaWAN Bridge is such a key technology.

LoRaWAN based LPWANs (Low Power wide area networks) allow connections to the Internet from small battery powered devices with wireless ranges of up to 5 kilometers between the transmitter and receiving gateway antenna - without the usual cellular network costs in classical M2M or smart metering solutions. Also - unlike with cellular networks - it’s possible to setup own gateways if needed. This often results in much lower operational costs with the Loba ro wMBUS bridge compared to conventional remote meter reading via LTE networks.

The metering data will not be decrypted by the LoRaWAN Bridge, instead an unchanged 1:1 forwarding takes place via one or more LoRaWAN packets (depending on the wMBUS telegram byte size). Thus the end-to-end encryption of sensitive wireless MBUS consumption data is preserved.

Initial configuration, firmware updates & status readouts are done user-friendly via USB on the PC with the Loba ro Tool (Windows, Linux, Mac). An additional possibility of configuration

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2. The Device

2.1. Device installation

The device must be fixed on a flat surface using the lateral mounting holes of the case, see chapter 6.1 for a detailed description of all housing dimensions. Alternatively we offer as accessory a mounting clip for a standard 35mm DIN rail. The device can then easily snapped on such rails. It can therefore be added to a variety of racks alongside other devices.

Under any circumstances the device must not be mounted higher than 2 meters above ground to avoid any risks in case of falling down!

For optimal RF performance (e.g. LoRa range) any metal obstacles near the internal antenna should be avoided. In this case ‘near’ is defined as keep-out distance of about 3-5 centimeters around the antenna. The internal helix antenna can be identified by the winding pcb traces near the white printed encircled ‘connectivity’ symbol. In any case a device mounting directly on top of a metal surface is not advisable since it will degrade the possible RF range. Stone walls, wood or plastic standoffs are perfectly ok.

In case of challenging installation locations (e.g. in basements) or unavoidable long distances to the next LoRaWAN gateway, Lobar offers on request custom product variant equipped with a ‘SMA’ connector to support a external antenna connection.

2.2. Power Supply

The wMBUS over LoRaWAN Bridge default power supply consists of two series connected off-the-shelf 1.5V ‘AA’ sized batteries. Be sure to get the polarity right, see the ‘+’-Symbol on the board. In general only AA cells of the types Alkali-Manganese (1.5V, LR6) and Lithium-Iron-Sulphide (1.5V, FR6) are allowed to be inserted in the device. Lobaroi recommends the use of FR6 batteries like the Energizer Ultimate Lithium over LR6 types because of the higher capacity and better discharge properties.

Other Batteries or accumulators with a nominal voltage of more than 1.5V must not inserted into the device under any circumstances. In particular, lithium based cells with a nominal voltage of 3.6V or 3.7V must not be used on the AA battery slots!
On request we can supply custom product variants with special housings powered by even bigger batteries. For example a 3.6V C sized mono cell typically has a capacity of 9Ah with leads to a 3x increased battery life compared to the standard AA-cells. With D sized cells of typically 19Ah capacity this value can be doubled once again (6x). Also available on request are options with permanent external power supply (230V, 9-24V, 5V USB).

2.3. Battery life time

The battery life time of the wireless M-Bus to LoRaWAN Bridge can not be specified trustworthy without knowledge of the detailed installation scenario. At least estimations for the following custom project based parameters have to be known:

- Meter count per single wMBUS bridge, e.g. 10 different meters.
- Needed LoRaWAN transmission interval, e.g. daily uploads.
- Average wireless M-Bus telegram size in bytes, e.g. 35 byte.
- Wireless M-Bus telegram transmission interval of the meter, e.g. every 10 seconds.
- Typically used LoRa Spreading Factor / LoRa link quality, e.g. SF10.

Depending on these parameters battery life times from a few months to over 15 years can be achieved. You may send us your use-case details as described above to info@lobaro.com and we will return to you a custom battery lifetime calculation, a recommendation for the best power supply scheme and the needed minimal battery capacity.

2.3.1. Example calculation

In this battery lifetime calculation scenario the target meters send a 35 byte long (‘L-Field’) wireless M-Bus telegram constantly every 10 seconds. This behavior is for example very similar to a ‘Hydrus’ ultrasonic water meter of Diehl Metering\(^2\). The Diehl meter itself has a specified battery life time of 12 years.

Because of the mentioned 10 second send interval it is sufficient to configure the bridge for a wireless M-Bus listen period of 20 seconds by setting the bridge configuration parameter \(c\text{modeDurSec}\) to a value of 20 (refer to section 4.3.2). This will ensure that all meters of interest sent their consumption telegrams at least ones during the configured listen period of the bridge.

For a worst-case battery-lifetime calculation the weakest possible LoRaWAN connectivity has been selected. That means to reach a LoRaWAN Gateway the Lobaro hardware has to send out its Uplink data very slowly (\(\geq 2\) seconds) and redundant by using a LoRa spreading factor of 12. Beside this the actual usable battery capacity has been set to 80% of the nominal value. The resulting worst-case minimal battery-life times are represented in table 1.

\(^2\)https://www.diehl.com/metering/
2. The Device

<table>
<thead>
<tr>
<th>Collected meters</th>
<th>Battery life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA cell (3Ah)</td>
</tr>
<tr>
<td>1</td>
<td>10.7</td>
</tr>
<tr>
<td>5</td>
<td>7.0</td>
</tr>
<tr>
<td>10</td>
<td>4.9</td>
</tr>
<tr>
<td>20</td>
<td>3.1</td>
</tr>
<tr>
<td>40</td>
<td>1.8</td>
</tr>
<tr>
<td>80</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Table 1: Battery life for daily LoRaWAN uploads with SF12

<table>
<thead>
<tr>
<th>Collected meters</th>
<th>Battery life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA cell (3Ah)</td>
</tr>
<tr>
<td>1</td>
<td>12.1</td>
</tr>
<tr>
<td>5</td>
<td>11.8</td>
</tr>
<tr>
<td>10</td>
<td>11.4</td>
</tr>
<tr>
<td>20</td>
<td>10.6</td>
</tr>
<tr>
<td>40</td>
<td>9.4</td>
</tr>
<tr>
<td>80</td>
<td>7.7</td>
</tr>
</tbody>
</table>

Table 2: Battery life for daily LoRaWAN uploads with SF7

Estimations for the opposite situation with a excellent LoRa link quality and thus the possible usage of SF7 are also presented in table 2.

In real world installations the possible spreading factor may be optimized anytime by setting up additional LoRaWAN Gateways near the meters of interest.

2.3.2. Usage scenario recommendations

As a simple rule of thumb using the Lobaro wireless M-Bus over LoRaWAN bridge is a good fit in applications that require daily (or less often) consumption values of 1 to 40 installed wireless M-Bus meters. For installations with a higher meter count simply more Lobaro bridges may be used.

Another key factor for high battery lifetime is to select or configure your wireless M-Bus meters in a way that they send short telegrams very frequently, proven good values are periods smaller than 30 seconds and telegram sizes smaller 50 bytes. This helps to minimize the needed wMBus listening time period and avoids the need for multiple LoRaWAN packets per single telegram (data splitting).
3. Work Cycle

Beside this the bridge is naturally most economical when multiple meters per single bridge can be collected and forwarded via LoR WAN. Although for some applications a 1:1 setup, e.g. one bridge per meter, may deliver enough benefits to justify the invest.

For hourly or even more frequent meter data uploads, as requested by some of our customers, LoRaW AN isn’t the perfect match from a technology point of view. The same holds for scenarios where hundreds of meters are expected to be transferred by a single bridge, e.g. in ‘sub-metering’ applications with tons of installed heat cost allocators. For such more demanding cases Lobaro can offer better solutions using higher bandwidth transmission techniques like NB-IoT\(^3\) or classical 4G/LTE. Contact us if you need such a alternative solution by sending your request to info@lobaro.com – either English or German is fine.

3. Work Cycle

The Bridge has a simple work cycle that consists of five phases. It is illustrated in figure 2.

3.1. Initial Phase

This is the phase that is executed after the device is started or restarted. The Bridge performs a quick self test which you can easily spot by the green internal LED flashing. After that, the configuration is evaluated. If successful, the LoRaW AN Join phase is executed next.

3.2. LoRaW AN Join Phase

If the Bridge is configured to use over the air activation (OTAA), the OTAA join is performed at this point. The device will repeatedly try to join its LoRaW AN network until the process is successful. It then enters the Data Collection Phase.

If the Bridge is configured to use ABP instead of OTAA, this phase is left immediately and the Data Collection Phase is entered according to the cron configuration.

\(^3\)Narrowband IoT
3. Work Cycle

3.3. Data Collection Phase

During the wMBUS collection phase the device receives any wireless M-Bus data with valid CRC and stores it for the following LoRaWAN upload phase but only if the received telegram passes the user defined white list filters. Similar telegrams of one identical meter may be received multiple times during this phase. In this case the newest telegram with the same id, type and length will replace the previously received one. Only the latest telegram will be uploaded via LoRaWAN.

After the configured amount of time for collecting data the LoRaWAN data transfer phase is entered.

3.4. Data Transfer Phase

During the Data Transfer Phase the Bridge uploads all previously stored wMBUS data using LoRaWAN. Depending on original wMBUS telegram byte size this can require multiple LoRaWAN messages to be sent. Since LoRa requires any device to respect a strict duty cycle, it is possible, that the Bridge will need to wait before sending its messages. If this happens, the device will enter a power saving modus while waiting for the next message. It is possible that transferring all data will take several minutes.

In addition to the wireless M-Bus data, the Bridge sends a status packet once a day during this phase. The status packet will always be transmitted prior to any data packets.

For a detailed description of the data sent refer to chapter 5.2.

3.5. Sleep Phase

After transferring all data packets the Bridge enters the Sleep Phase. During this it is completely inactive to avoid wasting power. It remains sleeping until one of the cron expressions given in the configuration triggers. When that happens, it enters the Data Collection Phase again.
4. Configuration

4.1. The Lobaró Maintenance Tool

The initial device configuration can be done very comfortably from your PC via the serial configuration interface. Beside the needed Lobaró USB to UART adapter the *Lobaró Maintenance Tool*\(^4\) needs to be installed. This tool is freely available for various operating systems including Windows, Linux, Mac and Linux-ARM (e.g. Raspberry-PI) on and works with all Lobaró sensors.

Technically this software opens a webserver on port 8585 that runs in a background console window. The actual user interface can be accessed normally using a standard web browser at address [http://localhost:8585](http://localhost:8585) (see fig. 3). Normally your default browser should be opened with this URL automatically after tool startup. Even remote configuration and log-observation over the Internet is possible, e.g. having a Raspberry PI via USB connected to the Lobaró device and accessing the maintenance tool from a remote machines browser over the Internet.

Additionally to the device setup the tool can also be used for firmware updates (‘Firmware Tab’), watching real-time device diagnostic output (‘Logs Tab’) and initiating device restarts. **Please note that the device is automatically restarted each time the configuration has been changed!**

\(^4\)Lobaró Maintenance Tool free download: [https://www.lobaro.com/lobaro-maintenance-tool/](https://www.lobaro.com/lobaro-maintenance-tool/)
4. Configuration

4.2. Connecting the USB config adapter

For configuration and firmware updates we provide a special serial-USB adapter that can be connected as shown in figure 4. The corresponding connector on the PCB is marked with the word ‘Config’.

The USB-adapter will add a virtual serial ‘COM’ Port to your system. Your operating system needs the CP210x USB to UART Bridge\textsuperscript{5} driver installed. A download link is provided next to the ‘Connect’ button when you start the Maintenance Tool.

While the config adapter is connected, the device will be powered from the USB port with a regulated voltage of 3.3V. It is not necessary – although it would be no problem – having batteries inserted or a different supply connected while using the config adapter. All configuration parameters will be kept non-volatile regardless of the power supply.

![Figure 4: Connected Lobaro USB configuration adapter](image)

4.3. System parameters

After being successfully connected to the hardware using the Lobaro Maintenance Tool you can press ‘Reload Config’ in the ‘Configuration’ tab to read the current configuration from the device. For every parameter a default value is stored non volatile inside the hardware to which you can revert using the ‘Restore default’ button in case anything got miss configured.

All LoRaWAN & other firmware parameters are explained in the following.

\textsuperscript{5}https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers
4. Configuration

4.3.1. LoRaWAN network parameters

A large part of the configuration parameters are used to control the device’s usage of LoRaWAN. Table 3 lists all of them. There are two different ways to use LoRaWAN: over-the-air activation (OTAA) and activation by personalization (ABP). Some configuration parameters are only used with one of those methods, others are used for both.
<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Used</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OTAA</td>
<td>bool</td>
<td>both</td>
<td>\textit{true}: use over-the-air activation (OTAA) \textit{false}: use activation by personalization (ABP)</td>
</tr>
<tr>
<td>DevEUI</td>
<td>bytes[8]</td>
<td>OTAA</td>
<td>the 8 byte long DevEUI is used with OTAA to identify the device on join. The default is predefined in the hardware and guarantees an ID that is unique world wide. Should not be changed unless required by the network provider. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>AppEUI</td>
<td>bytes[8]</td>
<td>OTAA</td>
<td>ID defining the application used in the LoRaWAN network. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>AppKey</td>
<td>bytes[16]</td>
<td>OTAA</td>
<td>Application Key as defined by the LoRaWAN network operator. This is used to encrypt communication, so keep it secret. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>OTAADelay</td>
<td>int</td>
<td>OTAA</td>
<td>Seconds to wait for a new attempt after an unsuccessful OTAA join. The actual waiting time will be randomly increased by up to a third of that amount, in order to avoid devices repeatedly interfering with each other through bad timing. The default value is 300, which means the timeout between attempts is 300-400 seconds.</td>
</tr>
<tr>
<td>AppSKey</td>
<td>bytes[16]</td>
<td>ABP</td>
<td>App Session Key as defined by the LoRaWAN network operator. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>NetSKey</td>
<td>bytes[16]</td>
<td>ABP</td>
<td>Network Session Key as defined by the LoRaWAN network operator. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>DevAddr</td>
<td>bytes[4]</td>
<td>ABP</td>
<td>Device Address as defined by the LoRaWAN network operator. Hex format without 0x prefix.</td>
</tr>
<tr>
<td>SF</td>
<td>int</td>
<td>both</td>
<td>Initial LoRa spreading factor used for transmissions. Valid range is 7-12. The actual spreading factor used might change during operation of the device if Adaptive Data Rate (ADR) is used.</td>
</tr>
<tr>
<td>TxPower</td>
<td>int</td>
<td>both</td>
<td>Initial transmission output power in dBm. The LoRaWAN protocol allows only specific values: 2, 5, 8, 11, 14. The actual power used might change during operation if Adaptive Data Rate (ADR) is used.</td>
</tr>
<tr>
<td>ADR</td>
<td>bool</td>
<td>both</td>
<td>\textit{true}: use adaptive data rate (ADR) \textit{false}: don't use adaptive data rate (ADR)</td>
</tr>
</tbody>
</table>

Table 3: LoRaWAN network parameters
### 4.3.2. wMBUS bridge parameters

Table 4 lists all parameters that are relevant for wireless M-Bus bridge firmware behavior:

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>loraMaxMsgSize</td>
<td>int</td>
<td>Received wireless M-Bus telegrams might have a byte size bigger than a single LoRaWAN message can hold. This parameter defines the bytes per LoRaWAN message before a partition over multiple LoRaWAN Uplink msg appears. (Range 10-50 bytes)</td>
</tr>
<tr>
<td>resetHours</td>
<td>int</td>
<td>Hours after which the firmware will reset and rejoin the network. Can support the change of LoRaWAN network providers with already deployed devices. (0 = never)</td>
</tr>
<tr>
<td>cmodeCron</td>
<td>string</td>
<td>Cron Expression defining when the device starts wMBUS T1/C1 mode receive phases. Please refer to chapter 4.3.3 for an introduction. (blank = no T1/C1 receive)</td>
</tr>
<tr>
<td>cmodeDurSec</td>
<td>int</td>
<td>Duration in seconds for each C1/T1-mode wMBUS receive phase, if cmodeCron != blank. Should be chosen in relation the wMBUS sendout interval of the target meter.</td>
</tr>
<tr>
<td>smodeCron</td>
<td>string</td>
<td>Cron Expression defining when the device starts wMBUS S1 mode receive phases. Please refer to chapter 4.3.3 for an introduction. (blank = no S1 receive)</td>
</tr>
<tr>
<td>smodeDurSec</td>
<td>int</td>
<td>Duration in seconds for each S1-mode wMBUS receive phase, if smodeCron != blank. Should be chosen in relation the wMBUS sendout interval of the target meter.</td>
</tr>
<tr>
<td>devFilter</td>
<td>string</td>
<td>wMBUS device id white-list filter using 8 digits with leading zeros list separated by <code>,</code>. Example <code>88009035,06198833</code>. (blank = filter inactive)</td>
</tr>
<tr>
<td>mFilter</td>
<td>string</td>
<td>wMBUS manufacturer white-list filter separated by <code>,</code>. Example: ‘DME,QDS’ for receiving just telegrams from Diehl Metering GmbH and Qundis GmbH meters. Telegrams with different 3 character wMBUS manufacturer id will not be uploaded via LoRaWAN. (blank = filter inactive)</td>
</tr>
<tr>
<td>typFilter</td>
<td>string</td>
<td>wMBUS device type white-list filter list separated by <code>,</code>. Example: ‘08,07’ for Heat-Cost and Water meters. Please refer to appendix B.1 for a list of possible values. (blank = filter inactive)</td>
</tr>
</tbody>
</table>

Table 4: wMBUS bridge parameters
4.3.3. Cron expressions

Cron expressions are used to define specific points in time and regular repetitions of them. The schedule for data collecting phases is defined using the Cron\(^6\) format which is very powerful format to define repeatedly occurring events\(^7\).

**Standard Lobarro devices typically do not need to know the real time for proper operation. All times are relative to the random time when batteries are inserted.** If needed by the target application Lobarro can deliver on request special hardware support for keeping data acquisition intervals based on a real time clock which stays in sync with the real time. Please contact Lobarro directly if you need such a custom product variant.

A cron expression consists of 6 values separated by spaces:

- Seconds (0-59)
- Minutes (0-59)
- Hours (0-23)
- Days (1-31)
- Month (1-12)
- Day of Week (SUN-SAT = [0,6])

Examples of CRON definitions:

- `0 5 * * * *` Hourly at minute 5, second 0 (at 00:05:00, 01:05:00, ...)
- `0 1/10 * * * *` every 10 minutes from minute 1, second 0 (minutes 1, 11, 21, ...)
- `0 0 6 * * *` Daily at 6:00:00
- `0 0 13 1,15 * *` 1st and 15th day of every month at 13:00:00
- `0 0 9 1-5 * *` Every month daily from day 1 till 5 at 9:00:00

5. LoRaWAN Data Upload Formats

After collecting wireless M-Bus telegrams over the air, the Bridge starts uploading data via LoRaWAN. There exist two data formats that are transmitted over different LoRaWAN ports.

As LoRaWAN can only transmit very short messages, the message formats contain only data bytes. The meaning of a byte is determined by its position within a message. The following describes the package formats used by the wireless M-Bus Bridge.

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\(^6\)For more information about Cron see [https://en.wikipedia.org/wiki/Cron](https://en.wikipedia.org/wiki/Cron)

\(^7\)Online introduction: [https://github.com/lobaro/docs/wiki/CRON-Expressions](https://github.com/lobaro/docs/wiki/CRON-Expressions)
5. LoRaWAN Data Upload Formats

5.1. Status Packet

Port 1 – In order to provide some information about the health & connectivity state of the device itself, the device sends a status update at a daily basis. The status packet is sent on the first upload phase after activation of the device (after reboot) and then repeatedly in every upload phase that takes place a day or longer after the previous status packet. It has a fixed length of 7 bytes. The battery voltages and ambient temperature are encodes as 16 bit integer using little endian encoding.

![Bytes, port 1 – Status Packet](image)

<table>
<thead>
<tr>
<th>name</th>
<th>type</th>
<th>description</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>version</td>
<td>uint8[3]</td>
<td>Version of the firmware running on the device</td>
<td>1, 5, 1 ≡ v1.5.1</td>
</tr>
<tr>
<td>v_bat</td>
<td>uint16</td>
<td>Battery voltage in mV</td>
<td>2947 ≡ 2.947V</td>
</tr>
<tr>
<td>temp</td>
<td>int16</td>
<td>Temperature measured inside the device in $\frac{1}{10}$°C</td>
<td>246 ≡ 24.6°C</td>
</tr>
</tbody>
</table>

Table 5: Fields port 1 – Status Packet

We provide a JavaScript reference implementation of a decoder for this status packet on GitHub\(^8\), which can be used directly for decoding in The Things Network\(^9\).

5.2. Data Packet

After each wMBUS collecting phase, all saved telegrams (up to 500 can be stored) will be uploaded via LoRaWAN uplink messages as fast as possible. The received wMBUS telegrams that did pass the configured white list filters will be uploaded without any modification in one or more LoRaWAN messages.

If a wMBUS telegram is bigger than the bridge configuration parameter `loraMaxMsgSize` the transmission will be done using multiple LoRaWAN messages. This parameter is limited to ≤ 50 bytes due to LoRaWANs maximum payload size restrictions. In case of telegram splitting is needed the receiving backend application server as to reassemble the original wMBUS telegram before decryption & parsing of the meter data. This is done by simply joining the messages together in the order of receive.

The LoRaWAN port encodes identifies a LoRaWAN fragment of the original wireless M-Bus telegram. This way partial messages can be identified using the LoRaWAN Port:

\(^8\)https://github.com/lobaro/ttn-data-formats/blob/master/wmbus-bridge/decoder.js
\(^9\)The Things Network (TTN): An open source LoRaWAN network provider see https://www.thethingsnetwork.org/
5. LoRaWAN Data Upload Formats

\[
10 \leq \text{LoRaWAN Port} \leq 100 \equiv (\text{Part Number} | \text{Total Parts})
\]

Gaps in the LoRaWAN Frame Counter are giving a hint for missing telegram parts which can happen in LoRaWAN since it’s a ALOHA based protocol, e.g. collisions and some packet losses are accepted by principle of operation. In case the backend noticed a missing packet the wMBUS telegram can’t be assembled anymore as described before.

5.2.1. Examples

Examples (with \(\text{loraMaxMsgSize} = 50\)):

- A 48 Byte wMBUS telegram will be send on LoRaWAN port 11. Port 11 says it is the first message of only one message (no splitting).

- A 75 byte wMBUS telegram will be send in two messages on LoRaWAN ports 12 and 22. Port 12 means this part one of a wMBUS telegram that got splitted into two LoRaWAN messages. Port 22 means that this data is the 2nd part of the original wMBUS data. Both parts have to been concatenated in the order of receive by the backend.

- A 101 byte wMBUS telegram will be send in three messages on LoRaWAN ports 13, 23 and 33. Port 13 means this part one of a wMBUS telegram that got splitted into three LoRaWAN messages. Port 23 means that this data is the 2nd part of the original wMBUS data. Port 33 means that this data is the 3rd part of the original wMBUS data. All three parts have to been concatenated in the order of receive by the backend.

5.2.2. Upload Rate

The bridge has to work in compliance with the European SRD 868 1% duty-cycle regulations. This implies as a rule of thumb the device can upload at most wMBUS telegrams for 36 seconds every hour. The actual transmit time (‘ToA: time on air’) for each LoRaWAN message depends on the byte size and the used LoRa spreading factor (SF) which defines how redundant LoRa data is send. This means a device with good connectivity and consequently using LoRa SF7 (ToA \(\leq 0.050s\)) can upload much faster more data than a node using LoRa SF11 (ToA \(\geq 1s\)) due to a hard to reach LoRaWAN gateway. The bridge will upload in conformity with the regulations automatically as fast as possible. When it has to wait it enters a low power sleep mode until the next transmission is possible again.

The next data collection phase will be started only after completion of the previous upload phase in respect to the configured \(\text{cmodeCron}\) or \(\text{smodeCron}\), whichever is earlier. Because of this it is advisable to define the cron parameters with an estimation of the upload duration in mind. This will avoid unexpected ‘skipping’ of data collection phases.
If you find that the data rate LoRaWAN offers is a limitation for your setup, we could also provide you with a wireless M-Bus solution that uses alternate data transmission technologies, for example GSM/LTE or NarrowBand-IoT.

Find our contact information under https://www.lobaro.com/contact/, or simple send us an email to info@lobaro.com – either English or German is fine.

5.2.3. Decoding wireless M-Bus

After receiving the raw wireless M-Bus telegrams from your LoRaWAN network provider the actual metering data has to be decrypted and decoded by a backend service for further processing. The details of this are described in the EN 13757 norm and the newer OMS\textsuperscript{10} specification, which is a clarification of the original underlying norm.

A universal wireless M-Bus decoder is a relatively complicated piece of software if you start implementing it from scratch since the norm covers many different use cases, units, meter types and data formats. If you know in advance the exact telegram format of the deployed meters in your setup a hard coded data decoding may be a feasible approach. This is because wireless M-Bus devices often send the same telegram format in every transmission. Please contact the manufacturer of your meters for the needed telegram format details.

![Figure 6: Lobarro wireless M-Bus decoder REST-API](https://oms-group.org/en/download4all/oms-specification/)

An an alternative to support a quick evaluation of our hardware Lobarro offers a easy to use webservice which is designed to decode all sorts of wMBUS input data including decryption if the correct key has been provided (see figure 6). This REST API returns a JSON object

\textsuperscript{10}https://oms-group.org/en/download4all/oms-specification/
including all encapsulated fields, e.g. the actual metering values. This greatly simplifies the bridge integration into your web based service or application.

A 12 months period of free access to this API is included in our ‘wmbus bridge testpacket’ offer for quick device evaluation. API Integration into production systems is also possible, but in this case a separate agreement about a royalty fee must be achieved up front. For more information on licensing our wireless M-Bus parsing API please send us your request via email to info@lobaro.com – either English or German is fine.
## 6. Technical characteristics

<table>
<thead>
<tr>
<th><strong>Product</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type name</td>
<td>wMBUS-LoRaWAN</td>
</tr>
<tr>
<td>Description</td>
<td>wMBUS over LoRaWAN Bridge</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>RF transceiver</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chipset</td>
<td>Semtech SX1272</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>863 to 870 MHz</td>
</tr>
<tr>
<td>TX Power</td>
<td>$\leq 14$ dBm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LoRa communication</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LoRaWAN Protocol</td>
<td>LoRaWAN 1.0.1, Class A, EU868</td>
</tr>
<tr>
<td>Activation method</td>
<td>Over-the-air activation (OTAA)</td>
</tr>
<tr>
<td></td>
<td>Activation by personalization (ABP)</td>
</tr>
<tr>
<td>Encryption</td>
<td>AES128</td>
</tr>
<tr>
<td>Typically RF range</td>
<td>$\leq 2$ km</td>
</tr>
<tr>
<td>Ideal RF range</td>
<td>$\leq 10$ km (free line of sight)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Wireless M-BUS communication</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supported Modes (EN13757-4)</td>
<td>S1, C1, T1</td>
</tr>
<tr>
<td>Frequencies</td>
<td>868.3 MHz, 868.95 MHz</td>
</tr>
<tr>
<td>RF Range</td>
<td>$\leq 30$ m</td>
</tr>
<tr>
<td>Telegram memory</td>
<td>up to 500 telegrams (on request: 1.500)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Power Supply</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Supply Voltage</td>
<td>3V</td>
</tr>
<tr>
<td>Supply Voltage Range</td>
<td>2.2V - 3.7V</td>
</tr>
<tr>
<td>Power supply</td>
<td>2xAA battery, 1.5V (LR6/FR6)</td>
</tr>
<tr>
<td></td>
<td>5V USB powered over Lobar Adapter</td>
</tr>
<tr>
<td>On Request:</td>
<td>230V mains adapter, 3.6V Battery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Current consumption @3V</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>$\leq 3$ mA</td>
</tr>
<tr>
<td>Wireless M-BUS RX</td>
<td>$\leq 14$ mA</td>
</tr>
<tr>
<td>LoRa RX</td>
<td>$\leq 14$ mA</td>
</tr>
<tr>
<td>LoRa TX</td>
<td>$\leq 80$ mA</td>
</tr>
<tr>
<td>Sleep with RTC running</td>
<td>$\leq 20$ $\mu$A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Mechanical dimensions</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>114.3 mm × 59.3 mm × 26.8 mm</td>
</tr>
<tr>
<td>Housing Material</td>
<td>ABS plastic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Environmental Requirements</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range</td>
<td>-20°C to +55°C</td>
</tr>
<tr>
<td>Max. Installation height</td>
<td>2m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Conformity</strong></th>
<th></th>
</tr>
</thead>
</table>

wMBUS over LoRaWAN Bridge
6. **Technical characteristics**

6.1. **Housing Dimensions**

![Diagram of housing dimensions](image)
A. CE Declaration of Conformity

Declaration of Conformity
RED directive (2014/53/EU)
RoHS directive (2011/65/EU)

We, the manufacturer
Lobaro GmbH
Tempowerkring 21d
21079 Hamburg
Germany

declare on our sole responsibility that the product with following identification:

wMBUS-LoRaWAN

to which this declaration relates is in conformity with the essential requirements and other relevant requirements of the RED directive (2014/53/EU) if used for its intended purpose and in accordance with the manufacturers operating instructions. The mentioned product is also compliant to the RoHS directive (2011/65/EU).

The following norms, standards, or documents have been applied:

Health and safety (RED Art. 3(1)(a)):
IEC 62368-1:2014 (Ed. 2) + Cor.:2015
IEC 62479:2010

EMC (RED Art.3(1)(b)):
ETSI EN 301 489-1 V1.9.2 (V2.2.0)†
ETSI EN 301 489-3 V1.6.1 (V3.2.0)†
IEC 61000-6-2:2005

Radio spectrum (RED Art. 3(2)):
ETSI EN 300 220-1 V3.1.1 (2017-02)
ETSI EN 300 220-2 V3.1.1 (2017-02)

†Referenced newer standard versions in parenthesis will supersede its predecessors. At time of testing the newer standards were not harmonized yet. All tests were carried out successfully in accordance to the already harmonized standards as well as to the superseding ones.

Hamburg, 27.07.2018
Place and date of issue

Dipl.-Ing. Theodor Rohde
Managing Director Lobaro GmbH
B. Wireless M-Bus definitions

B.1. List of device types

Possible values are:

- 00: "Other"
- 01: "Oil"
- 02: "Electricity"
- 03: "Gas"
- 04: "Heat"
- 05: "Steam"
- 06: "Warm Water"
- 07: "Water"
- 08: "Heat Cost"
- 09: "Compressed Air"
- 0A: "Cooling load meter (outlet)"
- 0B: "Cooling load meter (inlet)"
- 0C: "Heat (inlet)"
- 0D: "Heat / Cooling load meter"
- 0E: "Bus / System component"
- 0F: "Unknown"
- 10 - 14: Reserved
- 15: "Hot Water"
- 16: "Cold Water"
- 17: "Dual Water meter"
- 18: "Pressure"
- 19: "A/D Converter"
- 1A - DD: Reserved
- 1B: "Room"
C. Disposal

This chapter informs you on our policy in respect to EU ‘Waste electrical and electronic equipment Directive’ 2002/96/EC, implemented in German law by the ‘Gesetz über das Inverkehrbringen, die Rücknahme und die umweltverträgliche Entsorgung von Elektro- und Elektronikgeräten (Elektro- und Elektronikgerätegesetz – ElektroG)’. The following statements about the disposal of retired Lobaró devices are binding for customers in Germany. Customers in other countries should contact their local authorities in order to acquire equivalent information for their respective country.

It is a major goal of EU directive 2002/96/EC reduce the amount of retired electronic devices disposed in household waste, but have them gathered in special facilities instead for recycling and orderly disposal. Electronic devices often contain hazardous substances which are harmful to the environment as well as to human health. Under no circumstances should they be disposed in household trash.

C.1. WEEE

The WEEE-directive is the EU-directive ‘Waste of Electrical and Electronic Equipment’ (2002/96/EC). It aims to reduce the growing amount of electrical and electronic waste created by disposed electronic devices. The goal is to avoid and reduce disposal, and to make the disposal more friendly for the environment, by including the manufacturer in a broader responsibility.

C.1.1. Proper disposal of Lobaró B2B devices

Lobaró develops and manufactures devices for professional use. Because of this, our products have been recognised by the responsible agency ‘Stiftung EAR’ (Elektro-Altgeräte Register) as B2B (business to business) products. Lobaró GmbH is registered under DE18824018.

Classification as B2B implies that Lobaró is not required to pick up disposed electronic devices from local recycling points, as the law ‘ElektroG’ dictates manufacturers of consumer electronics to do.

Consequently, our products may not be disposed in this way.

Instead, we offer our customers to take back retired Lobaró devices and dispose them properly free of charge. Devices to be disposed must be sent to Lobaró GmbH postpaid and marked with the words ‘ZUR ENTSORGUNG’. 
C. Disposal

C.2. RoHS

As a manufacturer of industrial devices of information and telecommunication technology we are producing conforming to RoHS as specified in the EU-directive 2011/65/EU.

C.3. Batteries

Conforming to the German law about the disposal of used batteries (§ 12 Satz 1 Nr. 1-3 BattV (Verordnung über die Rücknahme und Entsorgung gebrauchter Batterien und Akkumulatoren (BattVO) vom 27. März 1998 (BGBl. I S. 658))), we as the manufacturer advise you, that the customer and end-consumer is required by law to return used batteries for a proper disposal. After usage, batteries can be returned to the vendor or at a place close proximity free of charge. If used batteries are sent to the vendor, parcels must be sent fully postpaid.

The following symbol indicates, that a battery contains heavy metal or other hazardous substances, and that it must not be disposed in common household or industrial waste. The abbreviations under the symbol stand for: ‘Cd’ (Cadmium), ‘Li’ (Lithium) / ‘Li-Ion’ (Lithium-Ion), ‘Ni’ (Nickel), ‘Mh’ (Metal Hydride), ‘Pb’ (Lead), ‘Zi’ (Zinc).
D. Entsorgung (German)


D.1. WEEE


Folglich dürfen unsere Produkte auch nicht auf diesem Wege entsorgt werden.

Stattdessen bieten wir unseren Kunden an, nicht mehr gebrauchte Lobaró Geräte zurückzunehmen und auf unsere Kosten ordnungsgemäß zu entsorgen.
Geräte zur Entsorgung müssen mit bezahltm Porto an die Lobarö GmbH eingesendet werden und mit der Kennzeichnung „ZUR ENTSORGUNG“ versehen sein.

**D.2. RoHS**

Als Hersteller von industriellen Geräten der Informations- und Telekommunikationstechnik produzieren wir RoHS konform, gemäß den Inhalten der EU-Richtlinie 2011/65/EU.

**D.3. Batteriegesetz**


Das nachfolgende Symbol bedeutet, dass es sich um schwermetallhaltige, schadstoffhaltige Batterien handelt, die nicht mit dem einfachen Haus- oder Gewerbeabfall entsorgt werden dürfen. Die unter dem Symbol befindlichen Abkürzungen bedeuten: „Cd“ (Cadmium), „Li“ (Lithium) / „Li-Ion“ (Lithium-Ionen), „Ni“ (Nickel), „Mh“ (Metallhydrid), „Pb“ (Blei), „Zi“ (Zink).

![Symbol für Batterien](image)

**E. Document Versions**

Changes to this document:

- **2018-08-31 – Version 0.0.3** Correction of battery-lifetime calculation table
- **2018-08-22 – Version 0.0.2** Addition of battery life time calculations
- **2018-08-21 – Version 0.0.1** Initial public version of completely reworked manual