



LPN CM-1

SW Specification / V09

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Revision History

REVNr	Author	Description
REV00	2017-02-20-Ra	Generate file
REV00	2017-02-20-Ra	Functionality of the release REV0. 32 described
REV01	2017-02-23-Ra	Changes and adjustments of REV0.38 added
REV02	2017-02-28-Ra	Photo added, adjustments Chapter 4
REV03	2017-03-03-Ra	Changes of REV0.50 added. New: Chapter 4 LEDs, Chapter 5 bootloader
REV04	2017-03-24-Ra	Changes of REV0.66 added
REV05	2017-07-10-Ra	New payload definition, small changes on whole document (SW Release REV01.16)
REV06	2017-08-03-Ra	New payload definition for official release (REV01.26)
REV07	2017-10-17-Ra	Changes in HWREV01 added, changes in Payload (REV01.45)
REV07	2017-12-18-Zs	Format of the document changed
REV08	2018-05-31-Ra	Payload datatypes added
REV09	2018-08-03-Ra	Changes from new Release added (REV01.66)

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1 Introduction

This document describes the software specifications and functions that have been implemented for the CM1.

2 Functionality LEDs

The CM1 has 2 status LEDs (blue and orange). The blinking of the LEDs varies depending on the device mode or status. The table below shows the different LED blinking modes for the blue LED:

LED	Blink duration	Meaning
Orange	25 ms (very short blink)	A LoRa message was received (downlink)
	2 x 25 ms (2 very short blinks)	Error while trying to join CM1 (OTAA only)
	100 ms (short blink)	A temperature-humidity measurement was not successful
	1 s	CM1 has been initialized
Blue	25 ms (very short blink)	A LoRa message has been sent (uplink)
	2 x 25 ms (2 very short blinks)	CM1 is busy (Duty Cycle conformity)
	100ms (short blink)	A temperature-humidity measurement was successful

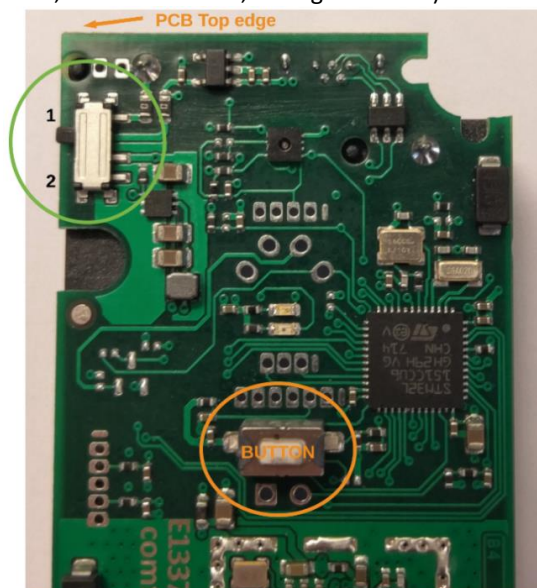
3 Functionality of the button

Button	Function/Meaning	Remarks
Button	During Power Up	When only button 1 is held while switching on, the boot loader is activated
	During operation	An uplink will be send by a push shorter than 3 seconds. Pressing the button for more than 3 seconds will reset the CM1.

3.1 Functionality Side Switch (HWREV01 and higher)

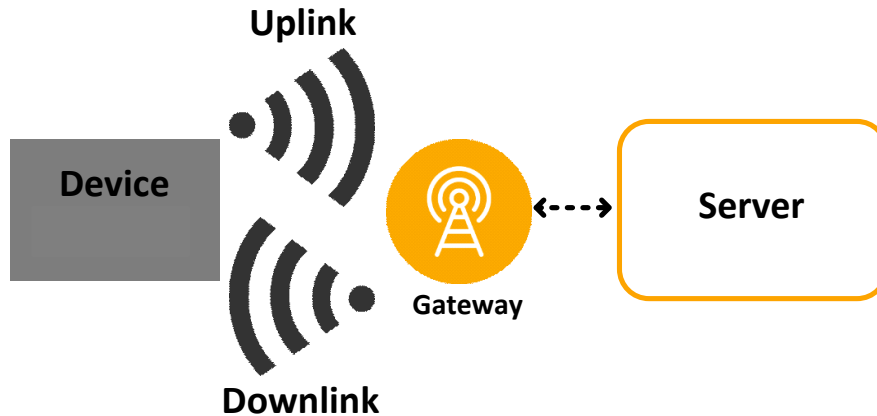
All CM1 starting from the HWREV01 have a side switch, which can be used to choose the device's power source. 2 Options can be selected as power source:

- 1) Battery power (Position 1 UP, closer to PCB top edge, see figure below)
- 2) USB Power (Position 2 DOWN, closer to Button, see figure below)



4 LoRa Up- and Downlink

A message from the device to the server is an **uplink** message. A message from the server to the device is a **downlink** message.



4.1 LoRa Uplink-Payload on port 3

The size of a CM1 uplink message is **13 Bytes**. The payload is always sent with **MSB first**. The table below shows the structure of the CM1 payload.

Byte No. [0...X]	Function/Meaning	Remarks
0	Status Byte	BIT7: MAX TEMP ON (is max. Temp. Control on?) BIT6: MIN TEMP ON (is min. Temp. Control on?) BIT5: 0 BIT4: TX_ON_EVENT (was it an "event" uplink?) BIT3: MAX HUM ON (is max. Hum. Control on?) BIT2: MIN HUM ON (is min. Hum. Control on?) BIT1: 0 BIT0: BOOSTER ON (is Booster on? Usually on when battery level low)
1	Min. temp. Threshold [°C]	Minimum temperature threshold in °C (int8), -15 to 75 °C, where -15 means OFF
2	Max temp. Threshold [°C]	Maximum temperature threshold in °C (int8), -15 to 75 °C, where -15 means OFF
3	Min. Hum. Threshold [%]	Min. Humidity threshold in % (int8), 0 to 99%, where 0 means OFF
4	Max. Hum. Threshold [%]	Max. Humidity threshold in % (int8), 0 to 99%, where 0 means OFF
5-6	Send interval [minutes]	Actual send interval in minutes (uint16)
7-8	Battery voltage [mV]	Battery voltage in mV (uint16)
9-10	Temperature [°C]	Raw temperature (int16) → 1223 is 12.23 °C and so on
11-12	Humidity [%]	Raw humidity (int16) → 2345 is 23.45% and so on

All uplink messages are sent on **port 3**. The send interval, as well as the temperature and humidity thresholds can be adjusted via CFG-File (see chapter 5.1) or with a downlink message (see chapter 4.1.1).

The CM1 supports 3 types of uplink:

- 1) TX_ON_INIT: **first uplink message**, which is sent after a reset / power-up (always confirmed).
- 2) TX_ON_TIMER: uplink message, which is sent on every send interval (usually unconfirmed, except once a day, see chapter 5.1).
- 3) TX_ON_EVENT: uplink message, which is sent on so-called **events**. An event can be either a button action, a threshold detection or a downlink update (see chapter 4.1.1).

4.1.1 Example of LoRa Uplink payload

Below a received and decrypted payload, decoded below
00 f1 f1 00 00 00 0f 0a 5e fe d4 19 ec

Byte No. [0...X]	Function/Meaning	Remarks
0	Status Byte	0x00 = everything off BIT7: MAX TEMP ON (is max. Temp. Control on?) BIT6: MIN TEMP ON (is min. Temp. Control on?) BIT5: 0 BIT4: TX_ON_EVENT (was it an "event" uplink?) BIT3: MAX HUM ON (is max. Hum. Control on?) BIT2: MIN HUM ON (is min. Hum. Control on?) BIT1: 0 BIT0: BOOSTER ON (is Booster on? Usually on when battery level low)
1	Min. temp. Threshold [°C]	0xf1 = -15 Minimum temperature threshold in °C (int8), -15 to 75 °C, where -15 means OFF
2	Max temp. Threshold [°C]	0xf1 = -15 Maximum temperature threshold in °C (int8), -15 to 75 °C, where -15 means OFF
3	Min. Hum. Threshold [%]	0x00 = 0 = OFF Min. Humidity threshold in % (int8), 0 to 99%, where 0 means OFF
4	Max. Hum. Threshold [%]	0x00 = 0 = OFF Max. Humidity threshold in % (int8), 0 to 99%, where 0 means OFF
5-6	Send interval [minutes]	0x00 0f = 15 = 15 Minutes send interval Actual send interval in minutes (uint16)
7-8	Battery voltage [mV]	0x0a 5e = 2654 = 2.654V Battery voltage in mV (uint16)
9-10	Temperature [°C]	0xfe d4 = -300 = -3.0 degree Raw temperature (int16) → 1223 is 12.23 °C and so on
11-12	Humidity [%]	0x19 ec = 6'636 = 66.36% Raw humidity (int16) → 2345 is 23.45% and so on

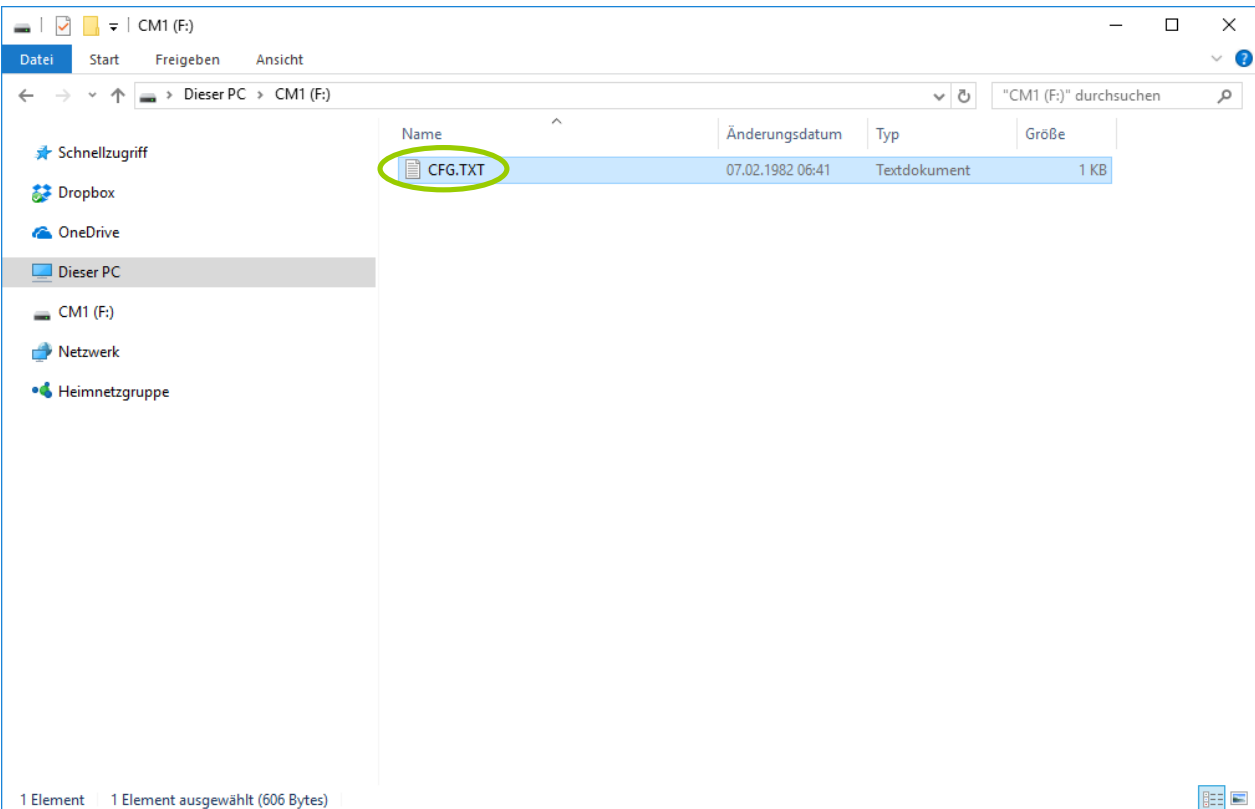
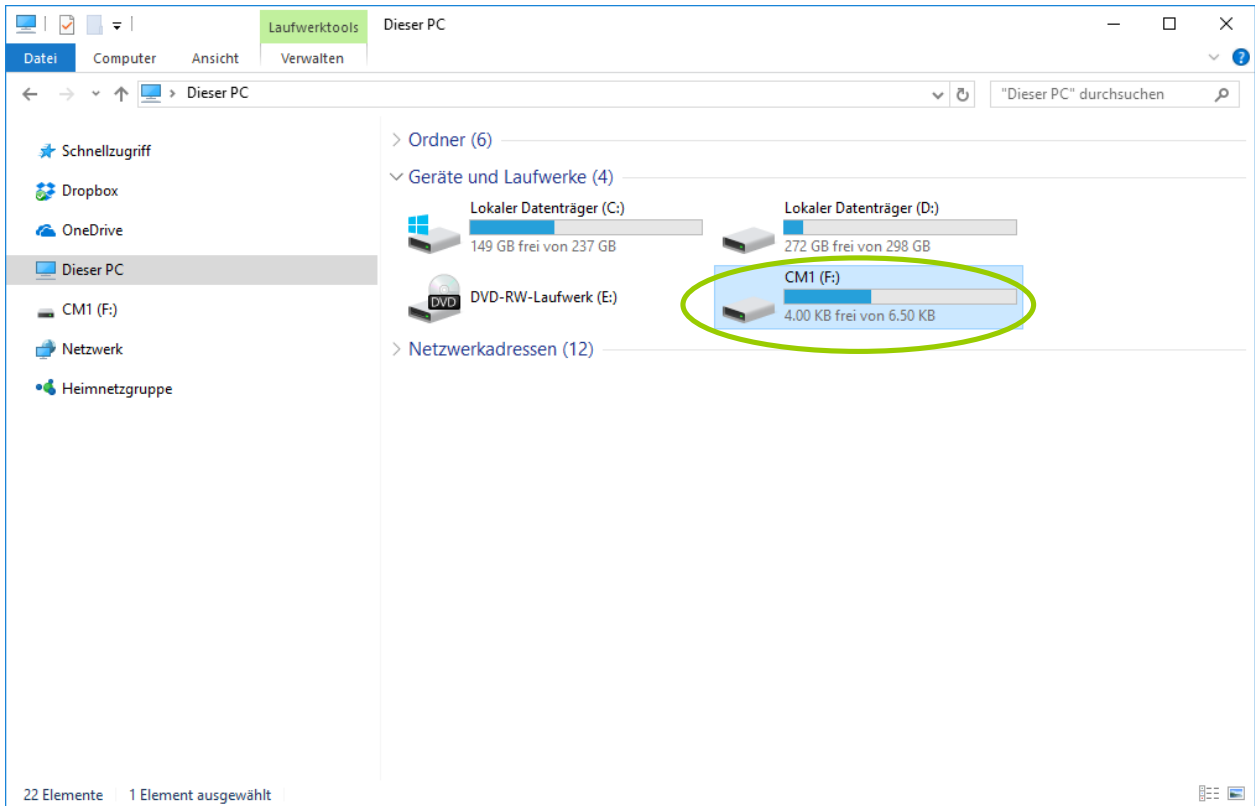
4.2 Downlink-Payload on port 2

The send interval, as well as the temperature and humidity thresholds can be set with a downlink message. A downlink message consists of **5 bytes** and is sent on **port 2**. Once the CM1 successfully received a downlink message, a "confirmed" uplink (TX_ON_EVENT) is sent back to the server to actualize the device status after the downlink changes.

Byte No. [0...X]	Function/Meaning	Remarks
0	Send interval	If multiple bits are set at the same time, then the smallest time is set as send interval. BIT7: 1 day BIT6: 12 hours BIT5: 6 hours BIT4: 3 hours BIT3: 1 hour BIT2: 30 minutes BIT1: 15 minutes BIT0: 10 minutes
1	Min. Temperature threshold	Minimum temperature threshold in °C (int8), from -15 to 75 °C, where -15 means MinTemp OFF
2	Max. Temperature threshold	Maximum temperature threshold in °C (int8), from -15 to 75 °C, where -15 means MaxTemp OFF
3	Min. humidity threshold	Minimum humidity threshold in % (int8), from 0 to 99%, where 0 means MinHum OFF
4	Max. humidity threshold	Maximum humidity threshold in % (int8), from 0 to 99%, where 0 means MaxHum OFF

5 Configuration over USB interface

When plugging in a USB cable to the device, a new drive will show up on the computer (CM1, see pictures below). Inside this drive, a CFG-File can be found. The CM1 can be configured with this file.



5.1 Settings in CFG-File

The figure below shows the settings in the CFG-File.

```
App.vers.:01.66

SendInterval=0015 (0000..9999 minutes, 0000 for no interval)

LoRa Config (LoRaMac version 430):

PrivateNetwork=0 (0: Public Network, 1: Private Network)
ADR=1 (0: ADR OFF, 1: ADR ON)
OTAA=0 (0: ABP, 1: OTAA)

OTAA (OverTheAirActivation):
DevEUI=70B3D5FFFE2971DC
AppEUI=70B3D5FFFE297019
AppKey=C28918CDDF0148A054C616D296FE22AD

ABP (ActivationByPersonalization):
DevAddr=26011343
NetwSesKey=AD899E7D12DC19890313507E2E7E6162
AppSesKey=AFCE2A3ECCB19900722DB91CA7892AD

BroadcastAddr=00000000
BroadcastNetwSesKey=132245678990CDEEEDCBA9704263222
BroadcastAppSesKey=5DACDC1109013211F8FB456789ABCDBB

LoRaMAC Datarate (0..5; DR_0..DR_5; SF12..SF7):
MinDatarate=0
MaxDatarate=5
DefDatarate=
Rx2DefDatarate=3

CM1 Config:

Temperature and Humidity Thresholds:
MinTmp[°C]=-15
MaxTmp[°C]=-15
(Valid temperature threshold between -15 and 75°C, -15°C means threshold OFF)
MinHum[%]=0
MaxHum[%]=0
(Valid humidity threshold between 0 and 99%, 0% means threshold OFF)
```

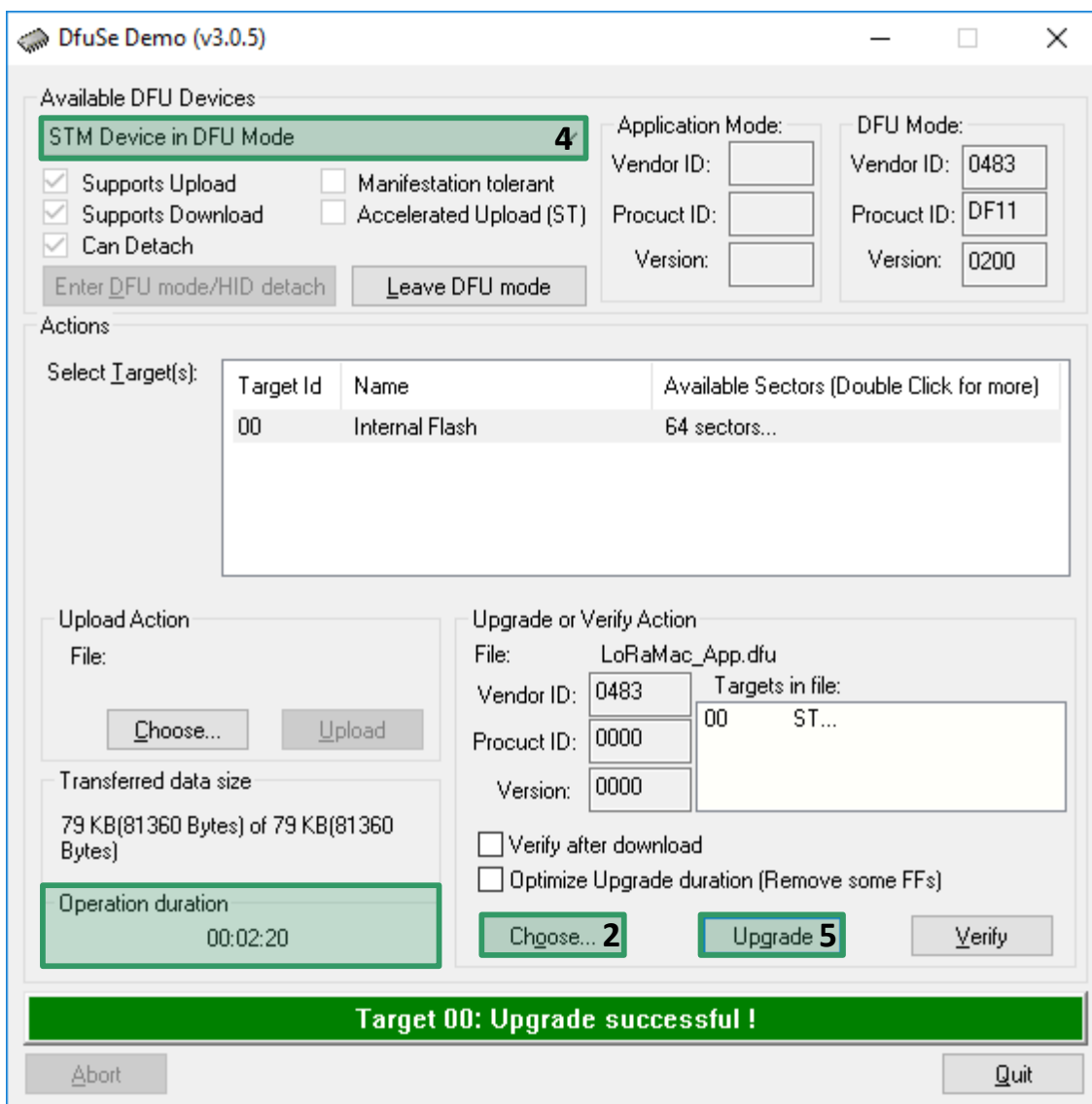
- A send interval of 15 minutes is configured by default. This can be adjusted with the variable **SendInterval**.
- The CM1 is by default set to work in public networks (**PrivateNetwork**). **ADR** is by default on.
- The LoRa activation mode can be configured with the variable **OTAA**. **ABP** is configured by default.
- By default, the CM1 is configured with the lowest data rate (DR_0, SF12, approximately 250bps). The data rate adapts automatically if possible (network server can adjust the data rate to a faster one).
- The CM1 sends a so-called «confirmed» message (message with server confirmation) once a day. If the sent message was not confirmed by the server, then the CM1 will reduce the data rate and try again. All in all, the CM1 will try to get an acknowledgement from the server 8 times.
- The threshold detection mode of the CM1 is off by default. This mode can be activated with the variables **MinTmp** and **MaxTmp** for temperature, and **MinHum** and **MaxHum** for humidity. In this mode, temperature and/or humidity are measured once per minute. If a measured value is above the maximum or below the minimum threshold, a «confirmed» message is sent.
- “confirmed” messages can also be sent by button action.

Important: Changes in the CFG-File are visible only **after a reset!** The CM1 can also be reset with the button. Pressing the button for **more than 3 seconds** will reset the CM1.

6 SW update via USB bootloader

If necessary, the device can be updated using USB DFU:

- 1) DFU tool «DFuSe demo» start (link → <http://www.st.com/en/development-tools/stsw-stm32080.html>).
- 2) Click "Choose..." under **upgrade or verify action** (bottom right) to load the current DFU file.
- 3) **Take out the battery (turn off device), plug in USB cable with the button pushed and then put the batteries back in (turn on device).**
- 4) The device should be now in bootloader mode (device appears under «available DFU devices» and both LEDs blink time-shifted every 500ms).
- 5) Click «Upgrade» and ignore any messages. The update takes about 1 minutes and 30 seconds.
- 6) Once the update is finished, unplug the USB cable and restart the device (take out batteries, and put them back in).



Important: After having installed the DFU tool, look up the UM0412.pdf file. Before starting with the first update, the driver path must be searched manually (C:\Program files (x 86)\STMicroelectronics\Software\DfuSe v3.0.5\Bin\Driver\).