



LPN CM-2

SW Specification / V02.00

Comtac AG
CH-8247 Flurlingen

Revision History

REVNr	Author	Description
REV00	2018-02-01-Mc	Generate file
REV01.00	2018-03-23-Mc	New Payloads and Cfg configuration, update HW and LED description, change project number
REV01.01	2018-05-16-Mc	Description ADC values and max value
REV02.00	2018-06-22-Mc	Add DIN state in the payload, change photos to new hardware

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1 Introduction

This document describes the software specifications and functions that has been implemented for the LPN CM-2.

2 Functionality LEDs

The LPN CM-2 has 2 status LEDs (green and orange). The blinking of the LEDs varies depending on the device mode or the state. The table below shows the different LED blinking modes for the both LEDs:

LED	Blink duration	Meaning
Orange	25 ms (very short blink)	A LoRa message was received (downlink)
	2s	SleepMode activated
	1 s	LPN CM-2 has been initialized
Green	25 ms (very short blink)	A LoRa message has been sent (uplink)
	2 s	Reset activated

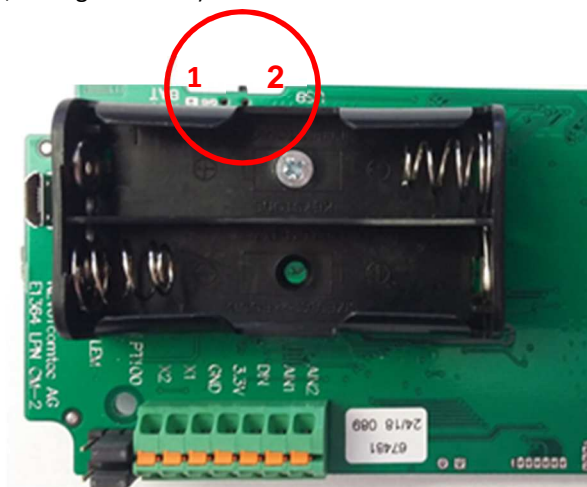
3 Functionality of the button

Button	Function/Meaning	Remarks
Button	During Power Up	When the button is held while switching on, the bootloader is activated If the bootloader is active the green and orange LED blink alternate
Button	During operation	An uplink will be sent when pressing the button no longer than 3 seconds. Pressing the button for more than 3 seconds and less than 10s will reset the LPN CM-2. Pressing the button for more than 15 seconds will set the LPN CM-2 in sleep mode.
Button	Sleep Mode	Pressing the button for more than 15 seconds will set the LPN CM-2 from sleep mode in normal mode.

3.1 Functionality Side Switch

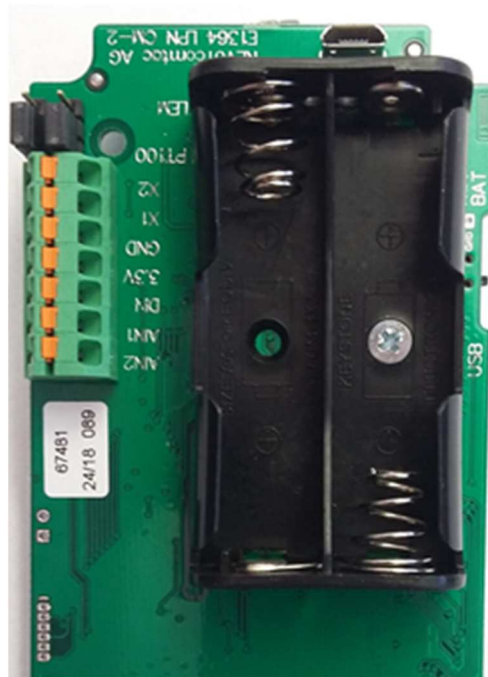
The LPN CM-2 has a side switch, which can be used to choose the device's power source. There are two options for the power source:

- 1) battery power (position 1, see figure below)
- 2) USB power (position 2, see figure below)



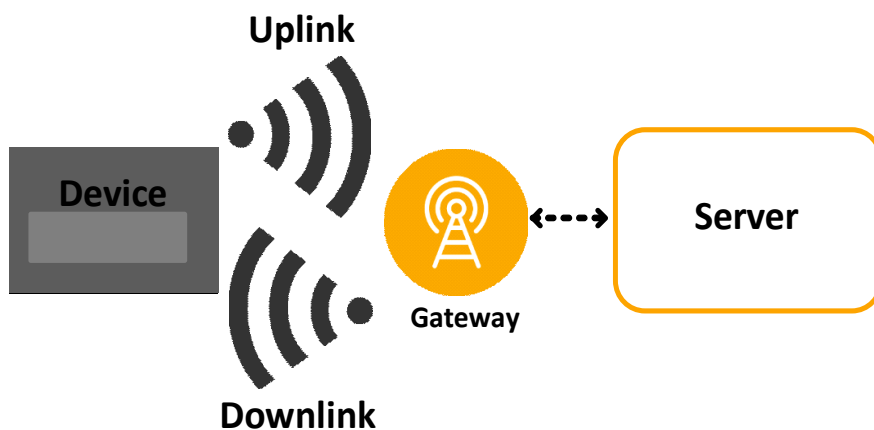
3.2 Pining of the Connector

- 1 X2: PT100 or LEM
- 2 X1: PT100 or LEM
- 3 GND
- 4 VCC (+3.3VDC)
- 5 DIN
- 6 Analog Input 1
- 7 Analog Input 2



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 LPN CM-2 uplink message on port 3 is **22 Bytes**. The payload is always sent with **MSB first**. The table below shows the structure of the LPN CM-2 payload.

Byte No. [0...X]	Function/Meaning	Remarks
0	App Main Version	Application Version major (uint8)
1	Status Byte	BIT7: Digital Input State (actual state of the digital input) BIT6: DeepSleepEvent BIT5: Digital Input Event (digital input detected an interrupt) BIT4: Button Event BIT3: TX_ON_EVENT (was it an "event" uplink?) BIT2: TX_ON_TIMER (was it a "timer" uplink?) BIT1: - BIT0: BOOSTER ON (is Booster on? Usually on when battery level low)
2	Status Event	BIT7: LEM Max Event BIT6: LEM Min Event BIT5: PT100 Max Event BIT4: PT100 Min Event BIT3: Humidity Max Event BIT2: Humidity Min Event BIT1: Temperature Max Event BIT0: Temperature Min Event
3-4	Battery voltage [mV]	Battery voltage in mV (uint16)
5-6	Temperature [° C]	Raw temperature (int16) → 1223 is 12.23 °C and so on
7-8	Humidity [%]	Raw humidity (int16) → 2345 is 23.45% and so on
9-10	PT100 Temperature [°C]	Raw temperature (int16) → 1223 is 12.23 °C and so on
11-12	External analog Input1	ADC value (uint16) -> max Value 4095
13-14	External analog Input2	ADC value (uint16) -> max Value 4095
15-16	LEM TT 50-SD (LEM USA)	Current Value (uint16)
17	Brightness Sensor	Value (uint8) between 0...100 no lux value
18-19	Total Counter DI	Counter (uint16) of digital Input since last reset
20-21	Counter DI	Counter (uint16) of digital Input since last message

The LPN CM-2 supports 4 types of uplink:

- 1) TX_ON_TIMER: uplink message, which is sent on every send interval (usually unconfirmed, except once a day, see chapter 5.1).
- 2) TX_ON_EVENT: uplink message, which is sent on a threshold detection or an interrupt on the digital input.
- 3) Button Event: uplink message, which is sent if the button was pressed.
- 4) DeepSleep Event: uplink message, which is sent if the button is pressed for more than 15 seconds.

4.1.1 Example of LoRa Uplink payload

Below a received and decrypted payload, decoded below

01 10 00 0a 5e fe d4 19 ec 07 d0 01 f4 04 48 09 ca 15 45 78 21 6a

Byte No. [0...X]	Function/Meaning	Remarks
0	App Main Version	0x01 = 01 Application Version major (uint8)
1	Status Byte	0x10 = button was pressed BIT7: Digital Input State BIT6: DeepSleep Event BIT5: Digital Input Event BIT4: Button Event BIT3: TX_ON_EVENT (was it an "event" uplink?) BIT2: TX_ON_TIMER (was it a "timer" uplink?) BIT1: TX_ON_INIT (was it an "init" uplink?) BIT0: BOOSTER ON (is Booster on? Usually on when battery level low)
2	Status Event	0x00 = everything off BIT7: LEM Max Event BIT6: LEM Min Event BIT5: PT100 Max Event BIT4: PT100 Min Event BIT3: Humidity Max Event BIT2: Humidity Min Event BIT1: Temperature Max Event BIT0: Temperature Min Event
3-4	Battery voltage [mV]	0x0a 5e = 2654 = 2.654V Battery voltage in mV (uint16)
5-6	Temperature [°C]	0xfe d4 = -300 = -3.0 degree Raw temperature (int16) → 1223 is 12.23 °C and so on
7-8	Humidity [%]	0x19 ec = 6'636 = 66.36% Raw humidity (int16) → 2345 is 23.45% and so on
9-10	PT100 Temperature [°C]	0x07 d0 = 2000 = 20.0 degree Raw temperature (int16) → 1223 is 12.23 °C and so on
11-12	External analog Input1	0x01 f4 = 500 ADC value (uint16)
13-14	External analog Input2	0x04 48 = 1096 ADC value (uint16)
15-16	LEM [mA]	0x09 ca = 2500 = 2.5A Current Value (uint16)
17	Brightness Sensor	0x15 = 21 Value (uint8) between 0...255 no lux value
18-19	Total Counter DI	0x45 78 = 17784 Counter (uint16) of digital Input since last reset
20-21	Counter DI	0x21 6a = 8554 Counter (uint16) of digital Input since last message

4.2 LoRa Uplink-Payload on port 100

The size of a LPN CM-2 uplink message on port 100 is **3 Bytes**. The payload is always sent with **MSB first**. The table below shows the structure of the LPN CM-2 payload.

Byte No. [0...X]	Function/Meaning	Remarks
0	comtac device Type	Applications Type (uint8)
1	App Main Version	Application Version major (uint8)
2	App Sub Version	Application Version minor (uint8)

The uplink message on port 100 are only sent if a downlink was received on port 100.

4.2.1 Example of LoRa Uplink payload

Below a received and decrypted payload

00 00 05

Byte No. [0...X]	Function/Meaning	Remarks
0	comtac device Type	0x00 = 0 Applications Type (uint8)
1	App Main Version	0x00 = 0 Application Version major (uint8)
2	App Sub Version	0x05 = 5 Application Version minor (uint8)

4.3 LoRa Uplink-Payload on port 101

The size of a LPN CM-2 uplink message on port 101 is **9 Bytes**. The payload is always sent with **MSB first**. The table below shows the structure of the LPN CM-2 payload.

Byte No. [0...X]	Function/Meaning	Remarks
0-1	Send interval	Actual send interval in minutes (uint16)
2	Min. Temperature threshold	Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
3	Max. Temperature threshold	Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
4	Min. humidity threshold	Minimum humidity threshold in % (from 0 to 99%, where 0 means MinHum OFF) (uint8)
5	Max. humidity threshold	Maximum humidity threshold in % (from 0 to 99%, where 0 means MaxHum OFF) (uint8)
6	Min. PT100 Temperature threshold	Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
7	Max. PT100 Temperature threshold	Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
8-9	Min. LEM Current threshold	Minimum current threshold in mA (from 1 to 5000 mA, where 0 means MinLEMCurent OFF) (uint16)
10-11	Max. PT100 Temperature threshold	Maximum current threshold in mA (from 1 to 5000 mA, where 0 means MaxLEMCurent OFF) (uint16)
12	Digital Input on	Set Interrupt of digital input (uint8)

The uplink message on port 101 are only sent if a downlink is sent on port 101 or after a reset / power-up.

4.3.1 Example of LoRa Uplink payload Port 101

Below a received and decrypted payload
00 0a f1 f1 00 00 f1 f1 00 00 00 00 01

Byte No. [0...X]	Function/Meaning	Remarks
0-1	Send interval [min]	0x00 0a = 10 = 10min Actual send interval in minutes (uint16)
2	Min. Temperature threshold [°C]	0xf1 = -15 = OFF Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
3	Max. Temperature threshold [°C]	0xf1 = -15 = OFF Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
4	Min. humidity threshold [%]	0x00 = 0 = OFF Minimum humidity threshold in % (from 0 to 99%, where 0 means MinHum OFF) (uint8)
5	Max. humidity threshold [%]	0x00 = 0 = OFF Maximum humidity threshold in % (from 0 to 99%, where 0 means MaxHum OFF) (uint8)
6	Min. PT100 Temperature threshold [°C]	0xf1 = -15 = OFF Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
7	Max. PT100 Temperature threshold [°C]	0xf1 = -15 = OFF Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
8-9	Min. LEM Current threshold	0x0000 = 0 = OFF Minimum current threshold in mA (from 1 to 5000 mA, where 0 means MinLEMCurent OFF) (uint16)
10-11	Max. PT100 Temperature threshold	0x0000 = 0 = OFF Maximum current threshold in mA (from 1 to 5000 mA, where 0 means MaxLEMCurent OFF) (uint16)
12	Digital Input on	0x01 = 1 = SET Set Interrupt of digital input (uint8)

4.4 Downlink-Payload on port 100

A downlink message consists of **1 bytes** and is sent on **port 100**. Once the LPN CM-2 successfully received a downlink message, an uplink on port 100 is sent back to the server to actualize the device information.

Byte No. [0...X]	Function/Meaning	Remarks
0	Empty	(uint8)

4.4.1 Example of LoRa Downlink payload

Below a received and decrypted payload
00

Byte No. [0...X]	Function/Meaning	Remarks
0	Empty	(uint8)

4.5 Downlink-Payload on port 101

The send interval, the temperature, humidity and current thresholds can be set with a downlink message. A downlink message consists of **13 bytes** and is sent on **port 101**. Once the LPN CM-2 successfully received a downlink message, a "confirmed" uplink on port 101 is sent back to the server to actualize the device status after the downlink changes.

Byte No. [0...X]	Function/Meaning	Remarks
0-1	Send interval	Actual send interval in minutes (uint16)
2	Min. Temperature threshold	Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
3	Max. Temperature threshold	Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
4	Min. humidity threshold	Minimum humidity threshold in % (from 0 to 99%, where 0 means MinHum OFF) (uint8)
5	Max. humidity threshold	Maximum humidity threshold in % (from 0 to 99%, where 0 means MaxHum OFF) (uint8)
6	Min. PT100 Temperature threshold	Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
7	Max. PT100 Temperature threshold	Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
8-9	Min. LEM Current threshold	Minimum current threshold in mA (from 1 to 5000 mA, where 0 means MinLEMCurent OFF) (uint16)
10-11	Max. PT100 Temperature threshold	Maximum current threshold in mA (from 1 to 5000 mA, where 0 means MaxLEMCurent OFF) (uint16)
12	Digital Input on	Set Interrupt of digital input (uint8)

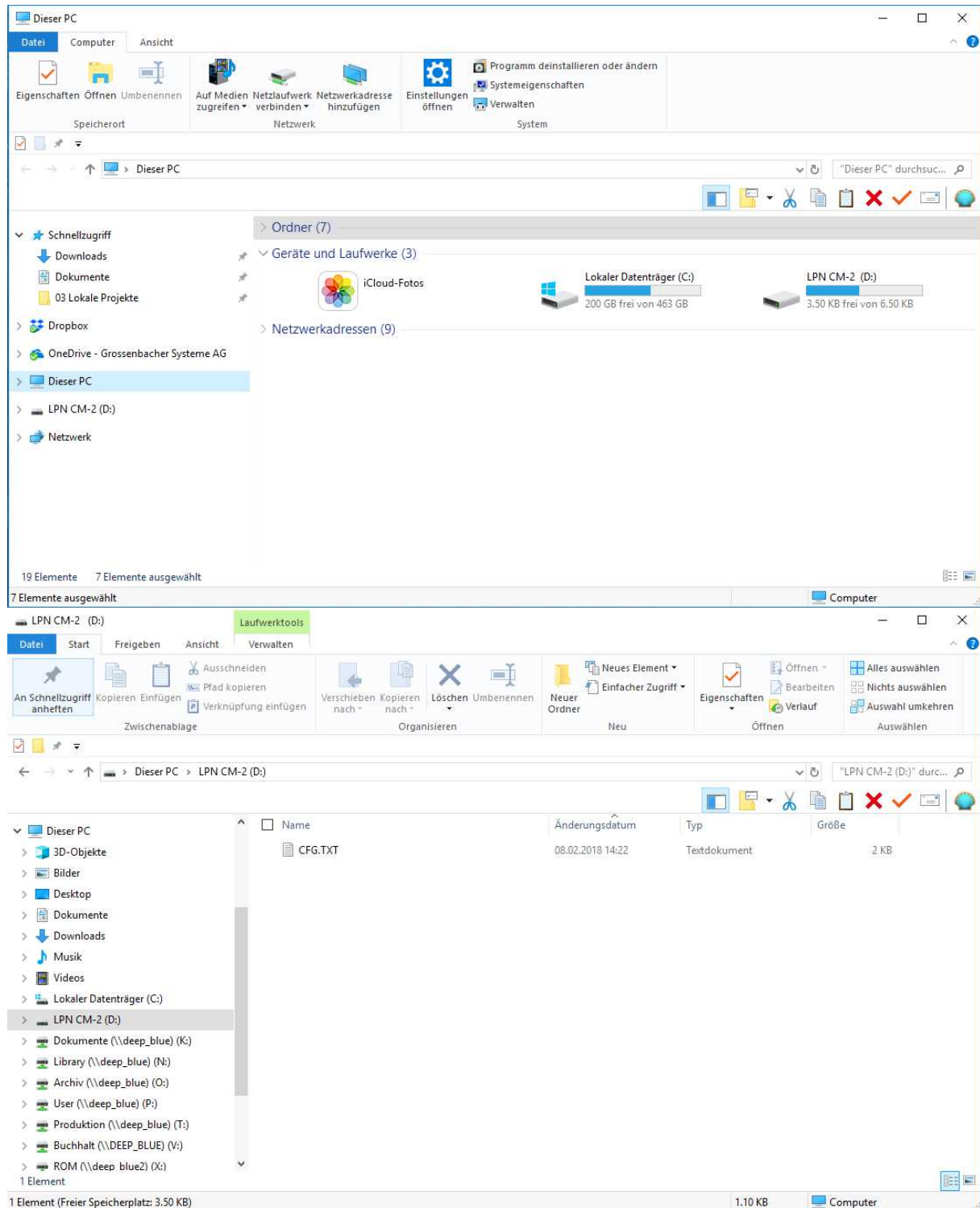
4.5.1 Example of LoRa Downlink payload

Below a received and decrypted payload
00 0a f1 f1 00 00 f1 f1 00 00 00 00 01

Byte No. [0...X]	Function/Meaning	Remarks
0-1	Send interval [min]	0x00 0a = 10 = 10min Actual send interval in minutes (uint16)
2	Min. Temperature threshold [°C]	0xf1 = -15 = OFF Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
3	Max. Temperature threshold [°C]	0xf1 = -15 = OFF Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
4	Min. humidity threshold [%]	0x00 = 0 = OFF Minimum humidity threshold in % (from 0 to 99%, where 0 means MinHum OFF) (uint8)
5	Max. humidity threshold [%]	0x00 = 0 = OFF Maximum humidity threshold in % (from 0 to 99%, where 0 means MaxHum OFF) (uint8)
6	Min. PT100 Temperature threshold [°C]	0xf1 = -15 = OFF Minimum temperature threshold in °C (from -15 to 75 °C, where -15 means MinTemp OFF) (int8)
7	Max. PT100 Temperature threshold [°C]	0xf1 = -15 = OFF Maximum temperature threshold in °C (from -15 to 75 °C, where -15 means MaxTemp OFF) (int8)
8-9	Min. LEM Current threshold	0x0000 = 0 = OFF Minimum current threshold in mA (from 1 to 5000 mA, where 0 means MinLEMCurent OFF) (uint16)
10-11	Max. PT100 Temperature threshold	0x0000 = 0 = OFF Maximum current threshold in mA (from 1 to 5000 mA, where 0 means MaxLEMCurent OFF) (uint16)
12	Digital Input on	0x01 = 1 = SET Set Interrupt of digital input (uint8)

5 Configuration over USB interface

When plugging in a USB cable to the device, a new drive will show up on the computer (LPN CM-2, see pictures below). Inside this drive, a CFG-File can be found. The LPN CM-2 can be configured with this file.



5.1 Settings in CFG-File

```

App.vers.:02.00

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=70B3D5FFFE60E1
AppEUI=70B3D5FFFE297020
AppKey=B6057EC9091AD92DF521516A9CFCA961

ABP (ActivationByPersonalization):
DevAddr=0x014c0131
NetwSesKey=F6783E5F9FBA1E775CCE0136216EBC4C
AppSesKey=16404D77FA6ABF57BD93944601F957A0

BroadcastAddr=0x00000000
BroadcastNetwSesKey=615BB65EB35CF29BD98EAA976A8366B1
BroadcastAppSesKey=E16A128C33AE275F8FCAC56A7DE69C8E

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

App Config:
SendInterval=0010 (0000..9999 minutes, 0000 for no interval)
PT100OffsetValue=0000 (-2000..2000 0.01°C, 0000 for no Offset)
DINInterruptActive=0 (0..1)
(0: no Lora message if DIN has an interrupt, 1: send a Lora message if DIN has an interrupt)

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)
MinPT100[°C]=-15
MaxPT100[°C]=-15
(Valid temperature threshold between -15 and 75°C, -15°C means threshold OFF)
MinLEM[mA]=0
MaxLEM[mA]=0
(Valid current threshold between 0 and 5000mA, 0mA means threshold OFF)

```

- A send interval of 10 minutes is configured by default. This can be adjusted with the variable **SendInterval**.
- The LoRa activation mode can be configured with the variable **OTAA**. ABP is configured by default.
- By default, the LPN CM-2 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 LPN CM-2 sends a «confirmed» message (message with server confirmation) once a day. If the sent message was not confirmed by the server, then the LPN CM-2 will reduce the data rate and try again. All in all, the LPN CM-2 will try to get an acknowledgement from the server 8 times.

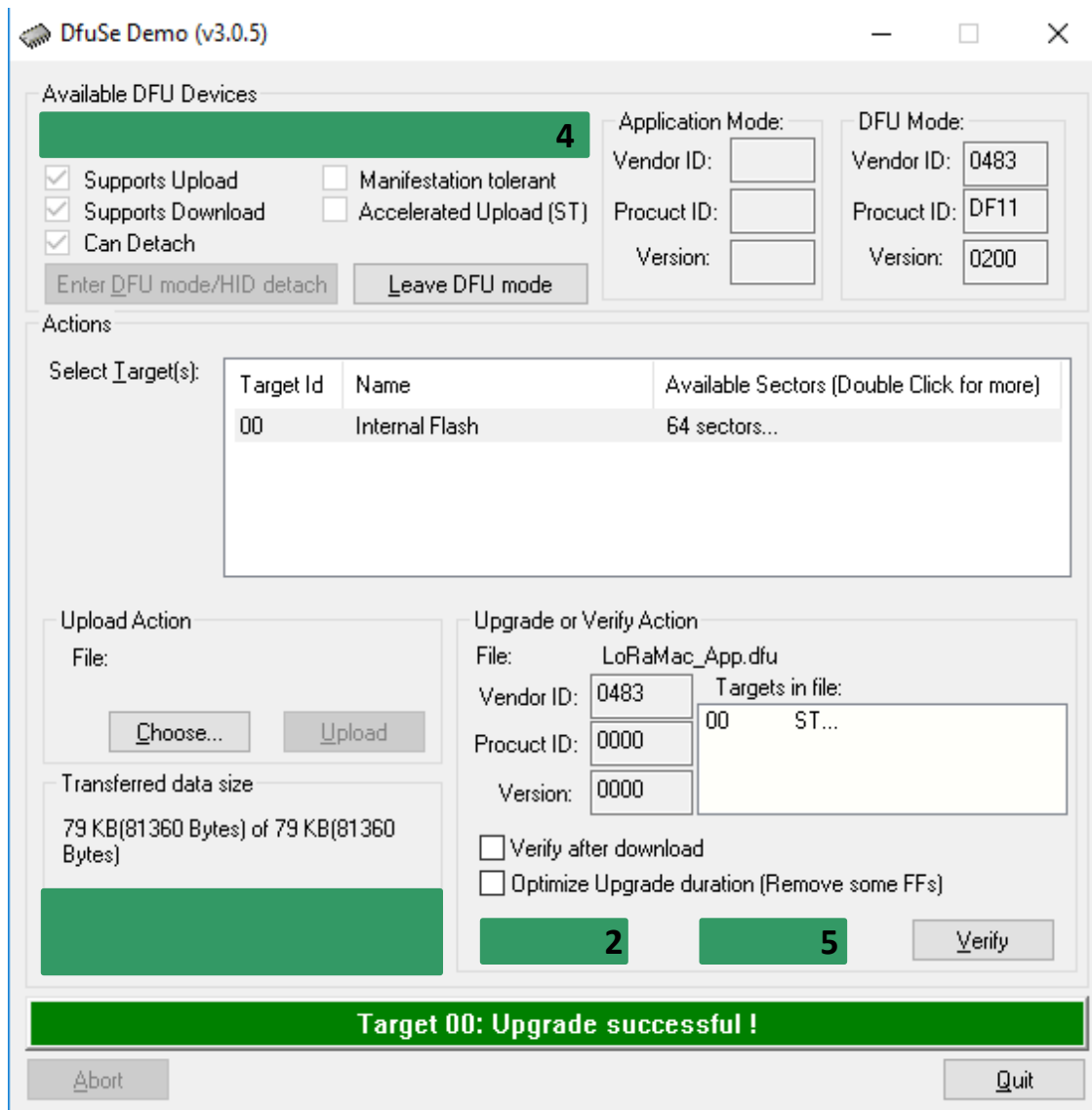
- The threshold detection mode of the LPN CM-2 is by default turned off. This mode can be activated with the variables MinTemp and MaxTemp for temperature, MinHum and MaxHum for humidity, MinPT100 and MaxPT100 for PT100 temperature and MinLEM and MaxLEM for the current of the external LEM. If a threshold is set, temperature, humidity and/or current are measured once per minute. As soon as a measured value is above the maximum or below the minimum threshold, a «confirmed» message is sent. After a message the device doesn't measure for 10 minutes.
- An offset of 00.00 °C is configured by default. This can be adjusted with the variable **PT100OffsetValue**. The PT100OffsetValue is either added or subtracted from the measured temperature. If the measured temperature is too high, the offset value has to be negative.

Important: Changes in the CFG-File are visible only **after a reset!** The LPN CM-2 can also be reset with the button. Pressing the button for **more than 3 seconds and less than 15 seconds** will reset the LPN CM-2.

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 and turn the switch to position 2 (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 2 minutes and 20 seconds.
- 6) Once the update is finished, unplug the USB cable and restart the device (take out the USB cable, put in the batteries and turn the switch to position 1).



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\).