

E1446 CM-4 SW Specs

V02



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REV-History

REVNr	Author	Description
V00	2019-12-10-Bt	Create file.
V01	2020-06-05-Bt	Payload examples added.
V02	2020-07-17-Bt	Fixed Error in Payload Example

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1 Functionality LED

The CM4 has 1 status LED (orange). The blinking of the LED varies depending on the device mode or status. The table below shows the different LED blinking modes for the orange LED:

LED	Blink duration	Meaning
Orange	1 x 100 ms	LoRa TxRx successful
	2 x 25 ms	LoRa busy or device not joined
	1 x 1 s	CM4 has been initialized

2 Uplinks (Payload Version V01)

The CM4 supports 3 different types of uplinks:

- 1) Uplink Port 3: Application Data [**DATA**, unconfirmed]
- 2) Uplink Port 100: Configuration Data [**CONFIG**, unconfirmed]
- 3) Uplink Port 101: Info Data [**INFO**, unconfirmed]

2.1 Uplink Port 3 (DATA)

The device's DATA payload is dynamic. Depending on the Payload ID, the size of the payload changes. The first 4 Bytes are always sent (so called header). All DATA Uplinks are sent unconfirmed.

Byte No. [0...X]	Function	Comment
0	Payload Version	Payload Version used by device
1	Status Byte	0 0 BAT LOW Last TEMP valid EXT MEM ACC TEMP I2C TEMP PT100 TEMP PT100: 1 TEMP PT100 placed 0 TEMP PT100 not placed TEMP I2C: 1 TEMP I2C placed 0 TEMP I2C not placed ACC: 1 ACC placed 0 ACC not placed EXT MEM: 1 EXT MEM placed 0 EXT MEM not placed Last TEMP Valid: 1 Last TEMP measurement valid 0 Last TEMP measurement invalid BAT LOW: 1 Low Battery flag set 0 Low Battery flag reset
2	Status Byte	0 0 INFO REQ CONFIG RX BUTTON ALARMING HISTORY ASYNC ASYNC: 1 ASYNCHRONOUS Event set 0 SYNCHRONOUS Event set HISTORY 1 HISTORY Event flag set (SYNC) 0 HISTORY Event flag reset ALARMING: 1 ALARMING Event flag set (SYNC) 0 ALARMING Event flag reset BUTTON: 1 BUTTON Event flag set (ASYNC) 0 BUTTON Event flag reset CONFIG RX: 1 CONFIG RX Event flag set (ASYNC) 0 CONFIG RX Event flag reset INFO REQ: 1 INFO REQ Event flag set (ASYNC) 0 INFO REQ Event flag reset
3	Battery voltage	Battery voltage in 0.5% steps (from 0 to 200 [uint8])
4	Payload ID	Application Payload ID as defined in chapter 2.1.1
5-X	Payload Data	Application Payload Data corresponding to Payload ID

2.1.1 Application Payload IDs and Data structure

The following payload IDs and Data types are defined:

Payload ID	Function	Structure	Size in Bytes w/o ID	Size in Bytes w/ ID
03	TEMP/HUM EVENT	<p>- 2 Bytes: Temperature NOW (MSB first, signed [INT16]) - 1 Byte: Humidity NOW (unsigned [UINT8])</p> <p>EXAMPLES: TEMP +1000 (RAW) -> +10.00 °C -500(RAW) -> -5.00 °C HUM +50 (RAW) -> 50% RH</p> <p>INVALID VALUE (sent if Meas invalid): TEMP > +25000 (RAW) -> +250.00°C HUM -> 250 (RAW) -> 250%</p>	3	4
04	TEMP/HUM HISTORY	<p>- 2 Bytes: Temperature NOW - 1 Byte: Humidity NOW - 2 Bytes: Temperature (NOW – 1*MeasRate) - 1 Byte: Humidity (NOW – 1*MeasRate) - 2 Bytes: Temperature (NOW – 2*MeasRate) - 1 Byte: Humidity (NOW – 2*MeasRate) - 2 Bytes: Temperature (NOW – 3*MeasRate) - 1 Byte: Humidity (NOW – 3*MeasRate) - 2 Bytes: Temperature (NOW – 4*MeasRate) - 1 Byte: Humidity (NOW – 4*MeasRate) - 2 Bytes: Temperature (NOW – 5*MeasRate) - 1 Byte: Humidity (NOW – 5*MeasRate) - 2 Bytes: Temperature (NOW – 6*MeasRate) - 1 Byte: Humidity (NOW – 6*MeasRate) - 2 Bytes: Temperature (NOW – 7*MeasRate) - 1 Byte: Humidity (NOW – 7*MeasRate)</p> <p>*All Temperature values are MSB first and signed (INT16). *All Humidity values are unsigned (UINT8). *MeasRate -> see chapter 4.2</p> <p>EXAMPLE: +1000 (RAW) -> +10.00 °C -500(RAW) -> -5.00 °C HUM +50 (RAW) -> 50% RH</p> <p>INVALID VALUE (sent if Meas invalid / or yet to be done [INIT VALUE]): TEMP > +25000 (RAW) -> +250.00°C HUM -> 250 (RAW) -> 250%</p>	24	25

2.1.2 Examples

UPLINK ID 01 (RAW): 011204C603090B40

01: Payload Version

12: Last TEMP valid, I2C-Sensor placed

04: SYNC event, ALARM event

C6: Battery Voltage in %: 198 -> 198 * 0.5% -> 99%

03090B40: Payload ID 03

Temperature NOW: 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity NOW: 64 -> 64 * 1%RH -> **64%RH**

UPLINK ID 02 (RAW): 011202C604090B40090B40090B40090B40090B40090B40090B40090B40090B40

01: Payload Version

12: Last TEMP valid, I2C-Sensor placed

02: SYNC event, HISTORY event

C6: Battery Voltage in %: 198 -> 198 * 0.5% -> 99%

04090B40090B40090B40090B40090B40090B40090B40090B40090B40090B40: Payload ID 04

Temperature NOW: 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity NOW: 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 1 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 1 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 2 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 2 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 3 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 3 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 4 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 4 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 5 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 5 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 6 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 6 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

Temperature (NOW - 7 * MeasRate): 2315 -> 2315 * 0.01 °C -> **23.15 °C**

Humidity (NOW - 7 * MeasRate): 64 -> 64 * 1%RH -> **64%RH**

2.2 Uplink Port 100 (CONFIG)

The CONFIG payload is defined as follows:

Byte No. [0...X]	Function	Comment
0	Payload Version	Payload Version used by device
1	Status Byte	0 0 BAT LOW Last TEMP valid EXT MEM ACC TEMP I2C TEMP PT100 TEMP PT100: 1 TEMP PT100 placed 0 TEMP PT100 not placed TEMP I2C: 1 TEMP I2C placed 0 TEMP I2C not placed ACC: 1 ACC placed 0 ACC not placed EXT MEM: 1 EXT MEM placed 0 EXT MEM not placed Last TEMP Valid: 1 Last TEMP measurement valid 0 Last TEMP measurement invalid BAT LOW: 1 Low Battery flag set 0 Low Battery flag reset
2	Status Byte	0 0 INFO REQ CONFIG RX BUTTON ALARMING HISTORY ASYNC ASYNC: 1 ASYNCHRONOUS Event set 0 SYNCHRONOUS Event set HISTORY 1 HISTORY Event flag set (SYNC) 0 HISTORY Event flag reset ALARMING: 1 ALARMING Event flag set (SYNC) 0 ALARMING Event flag reset BUTTON: 1 BUTTON Event flag set (ASYNC) 0 BUTTON Event flag reset CONFIG RX: 1 CONFIG RX Event flag set (ASYNC) 0 CONFIG RX Event flag reset INFO REQ: 1 INFO REQ Event flag set (ASYNC) 0 INFO REQ Event flag reset
3	Battery voltage	Battery voltage in 0.5% steps (from 0 to 200 [uint8])
4-5	Meas Rate	Measurement rate in minutes (from 0 to 50000 [uint16], MSB first)
6	History Trigger	Trigger for HISTORY Event (History uplink sent every History trigger * Temp Meas Rate, from 0 to 8 [uint8])
7-8	Temp Offset	Temperature offset used when calculating actual temperature with the I2C sensor (from -5000 to 5000 [int16], where +100[RAW] means +1.00°C and -100[RAW] means -1.00°C)
9	Temp Max	Lower Boundary for Temperature to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if temp > Temp Max, from -25 to 80 [int8], where 1[RAW] means 1°C and -1[RAW] means -1.00°C), +127 if Off
10	Temp Min	Lower Boundary for Temperature to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if temp < Temp Min, from -25 to 80 [int8], where 1[RAW] means 1°C and -1[RAW] means -1.00°C), +127 if Off
11	Hum Offset	Humidity offset used when calculating actual humidity with the I2C sensor (from -99 to 99 [int8], where +1[RAW] means +1%RH and -1[RAW] means -1%RH)
12	Hum Max	Upper Boundary for Humidity to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if hum > Hum Max, from 1 to 99 [uint8], where 1[RAW] means 1%RH, Max. Value 100%RH, 255 if Off
13	Hum Min	Lower Boundary for Humidity to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if hum < Hum Min, from 1 to 99 [uint8], where 1[RAW] means 1%RH, Max. Value 100%RH, 255 if Off

2.2.1 Example

UPLINK CFG (RAW): 011211C6000F0400004600004614

01: Payload Version

12: Last TEMP valid, I2C-Sensor placed

11: ASYNC event, CONFIG RX event

C6: Battery Voltage in %: 198 -> 198 * 0.5% -> **99%**

000F: Meas Rate -> **15 minutes**

04: History Trigger -> 4

0000: Temp Offset -> 0 °C

46: Temp Max -> 70 °C

00: Temp Min -> 0 °C

00: Hum Offset -> 0 %RH

46: Hum Max -> 70% RH

14: Hum Min -> 20% RH

2.3 Uplink Port 101 (INFO)

The INFO payload is defined as follows:

Byte No. [0...X]	Function	Comment
0	Payload Version	Payload Version used by device
1	Status Byte	0 0 BAT LOW Last TEMP valid EXT MEM ACC TEMP I2C TEMP PT100 TEMP PT100: 1 TEMP PT100 placed 0 TEMP PT100 not placed TEMP I2C: 1 TEMP I2C placed 0 TEMP I2C not placed ACC: 1 ACC placed 0 ACC not placed EXT MEM: 1 EXT MEM placed 0 EXT MEM not placed Last TEMP Valid: 1 Last TEMP measurement valid 0 Last TEMP measurement invalid BAT LOW: 1 Low Battery flag set 0 Low Battery flag reset
2	Status Byte	0 0 INFO REQ CONFIG RX BUTTON ALARMING HISTORY ASYNC ASYNC: 1 ASYNCHRONOUS Event set 0 SYNCHRONOUS Event set HISTORY 1 HISTORY Event flag set (SYNC) 0 HISTORY Event flag reset ALARMING: 1 ALARMING Event flag set (SYNC) 0 ALARMING Event flag reset BUTTON: 1 BUTTON Event flag set (ASYNC) 0 BUTTON Event flag reset CONFIG RX: 1 CONFIG RX Event flag set (ASYNC) 0 CONFIG RX Event flag reset INFO REQ: 1 INFO REQ Event flag set (ASYNC) 0 INFO REQ Event flag reset
3	Battery voltage	Battery voltage in 0.5% steps (from 0 to 200)
4	APP MAIN VERSION	From 00 to 99 (uint8)
5	APP MINOR VERSION	From 00 to 99 (uint8)

2.3.1 Example

UPLINK INFO (RAW): 011221C60102

01: Payload Version

12: Last TEMP valid, I2C-Sensor placed

21: ASYNC event, INFO REQ event

C6: Battery Voltage in %: 198 -> 198 * 0.5% -> 99%

01: APP Main Version 01

02: APP Minor Version 02

3 Downlinks (Payload Version V01)

Downlinks can be received on either port 100 (CONFIG) or 101 (INFO). With a downlink message on port 100, the user has the possibility to change the device and sensor configurations. With a downlink message on port 101, the user has the possibility to request an INFO Uplink (see chapter 0).

3.1 Downlink Port 101 (INFO)

The payload structure of an INFO downlink is defined as follows:

Byte No. [0...X]	Function	Comment
0	INFO Request	Send any value != 0

3.1.1 Example

DOWNLINK INFO (RAW): 01

01: INFO Request **TRUE**

3.2 Downlink Port 100 (CONFIG)

The payload structure of a CONFIG in the CM4 is defined as follows:

Byte No. [0...X]	Function	Comment
0-1	Meas Rate	Measurement rate in minutes (from 0 to 50000 [uint16], MSB first)
2	History trigger	Trigger for HISTORY Event (History uplink sent every History trigger * Meas Rate, from 0 to 8 [uint8])
3-4	Temp Offset	Temperature offset used when calculating actual temperature with the I2C sensor (from -5000 to 5000 [int16], where +100[RAW] means +1.00°C and -100[RAW] means -1.00°C), limiting if out of range
5	Temp Max	Upper bound for Temp to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if temp > Temp Max, from -25 to 80 [int8], where 1[RAW] means 1°C and -1[RAW] means -1°C), if +127 then off, limiting if out of range. In case of improbable values (Max < Min) the values will be set to Off.
6	Temp Min	Lower bound for Temp to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if temp < Temp Min, from -25 to 80 [int8], where 1[RAW] means 1°C and -1[RAW] means -1°C), if +127 then off, limiting if out of range. In case of improbable values (Max < Min) the values will be set to Off.
7	Hum Offset	Humidity offset used when calculating actual Humidity value with the I2C sensor (from -99 to 99 [int8], where +1[RAW] means +1%RH and -1[RAW] means -1%RH), limiting if out of range.
8	Hum Max	Upper bound for Humidity to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if hum > Hum Max, from 1 to 99 [uint8], where 1[RAW] means 1%RH, Min. Value 1%RH, Max. Value 99%RH, if 255 then off, limiting if out of range. In case of improbable values (Max < Min) the values will be set to Off.
9	Hum Min	Lower bound for Humidity to Trigger ALARMING Event (Alarming uplink sent every Meas Rate if hum < Hum Min, from 1 to 99 [uint8], where 1[RAW] means 1%RH, Min. Value 1%RH, Max. Value 99%RH, if 255 then off, limiting if out of range. In case of improbable values (Max < Min) the values will be set to Off.

Note that changes in the settings will not take effect until the next uplink (due to Class A, RX only after TX).

3.2.1 Example

DOWNLINK CFG (RAW): 000F0400000000004614

000F: Meas Rate -> **15 minutes**

04: History Trigger -> 4

0000: Temp Offset -> 0 °C

46: Temp Max -> 70 °C

00: Temp Min -> 0 °C

00: Hum Offset -> 0 %RH

46: Hum Max -> 70% RH

14: Hum Min -> 20% RH

4 CFG.TXT File

When plugging in a USB cable to the CM-4, a new drive (CM4) can be seen on the computer. Inside this drive, a CFG.TXT file can be found. The LoRa and the device settings can be configured with this file.

Important: Changes in the CFG-File are applied **only after a reset!** Keeping the button (or reed switch) pressed (active) for **more than 3 seconds** will reset the device (only usable in application mode, please reset with power-up in bootloader mode). **Disconnecting the USB cable while powered up will also reset device.**

```
App.vers.:01.00

Lora Config (LoRaMac version 441):
PrivateNetwork=0 (0: Public Network, 1: Private Network)
ADR=1 (0: ADR OFF, 1: ADR ON)

OTAA (OverTheAirActivation):
DevEUI=3934353767377B15 (READ ONLY)

Datarate (0..5; SF12..SF7):
DefDatarate=0
Rx2DefDatarate=0

Device Parameters:
MeasRate=15 (minutes, max. 50000)
HistoryTrigger=4 (counts, max. 8)

Sensor Thresholds:
TempMax=50 (+1 -> +1.00°C / -25 to 80, +127 when OFF, must be larger than TempMin)
TempMin=0 (+1 -> +1.00°C / -25 to 80, +127 when OFF, must be smaller than TempMax)
HumMax=70 (+1 -> +1%RH / 1 to 99, 255 when OFF, must be larger than HumMin)
HumMin=20 (+1 -> +1%RH / 1 to 99, 255 when OFF, must be smaller than HumMax)

Measurement Offset:
TempOffset=0 (+100 -> +1.00°C / -5000 to 5000)
HumOffset=0 (+1 -> +1%RH / -99 to 99)
```

4.1 LoRa settings

With the LoRa settings it is possible to select a network type (**PrivateNetwork** variable). By default, the device is configured for usage in public networks.

The **DevEUI** parameter needed for OTAA is READ ONLY, which means the user can't change it (**Unique ID given by comtac**).

The AppEUI (required for OTAA) is a hardcoded value and valid for all CM4 devices. The AppKEY (required for OTAA) is generated by the devices themselves and is **UNIQUE** for every device. Both values can only be retrieved by request.

The LoRaMac's native ADR (Adaptive Data Rate) is turned on by default. The **DefDatarate** is the default data rate used for all Uplinks (if ADR off & for Join requests), whereas the **Rx2DefDatarate** is the data rate used for the RX2-Window (At the moment, two values are supported by most providers → 0 [SF12] or 3 [SF9]).

WARNING: When adding a device to a network, the selected RX2-Window value must match the settings of the network for it to work properly!

4.2 Device and sensor settings

With the device and sensor settings, different parameters can be configured. According to these parameters, the device might change its functionality.

The measurement rate of the CM4 is set to 15 minutes by default (**MeasRate**).

With the **HistoryTrigger** variable, an interval for history uplinks can be set (see chapter 2.1). The history interval is calculated by multiplying the trigger with the measurement rate. A history uplink has a limit of 8 temperature values (maximum **HistoryTrigger** = 8). By default, this variable is set to 4 (one history uplink every 4 measurements).

With the variables **TempMax** and **TempMin**, alarming uplinks (see chapter 2.1) can be configured. By default, these variables are set to 50 for **TempMax** and 0 for **TempMin** (alarming sent if temperature is over 50°C or below 0°C). Usage example -> By setting **TempMax** to 70 (70°C) and **TempMin** to -20(-20°C), the device only sends an alarming uplink when the actual measurement is higher than **TempMax** or lower than **TempMin**. If the Temperature is below -20°C or above 70°C an Alarm will be sent, otherwise no alarming uplink is sent. In case of improbable values (Max <Min) the values will be set to Off.

If **TempMax** is set to Off (+127), the Device will only check if the measured value is smaller than **TempMin** to trigger an Alarm event.

If **TempMin** is set to Off (+127), the Device will only check if the measured value is bigger than **TempMax** to trigger an Alarm event.

With the variables **HumMax** and **HumMin**, alarming uplinks (see chapter 2.1) can be configured. By default, these variables are set to 70 for **HumMax** and 20 for **HumMin** (alarming sent if humidity is over 70%RH or below 20%RH). Usage example -> By setting **HumMax** to 50 (50%RH) and **HumMin** to 30(30%RH), the device only sends an alarming uplink when the actual measurement is higher than **HumMax** or lower than **HumMin**. If the Humidity is below 30%RH or above 50%RH an Alarm will be sent, otherwise no alarming uplink is sent. In case of improbable values (Max <Min) the values will be set to Off.

If **HumMax** is set to Off (255), the Device will only check if the measured value is smaller than **HumMin** to trigger an Alarm event.

If **HumMin** is set to Off (255), the Device will only check if the measured value is bigger than **HumMax** to trigger an Alarm event.

The **TempOffset** variable can be used to compensate the static error of the temperature measurement. By default, this variable is set to 0 (no static error compensation).

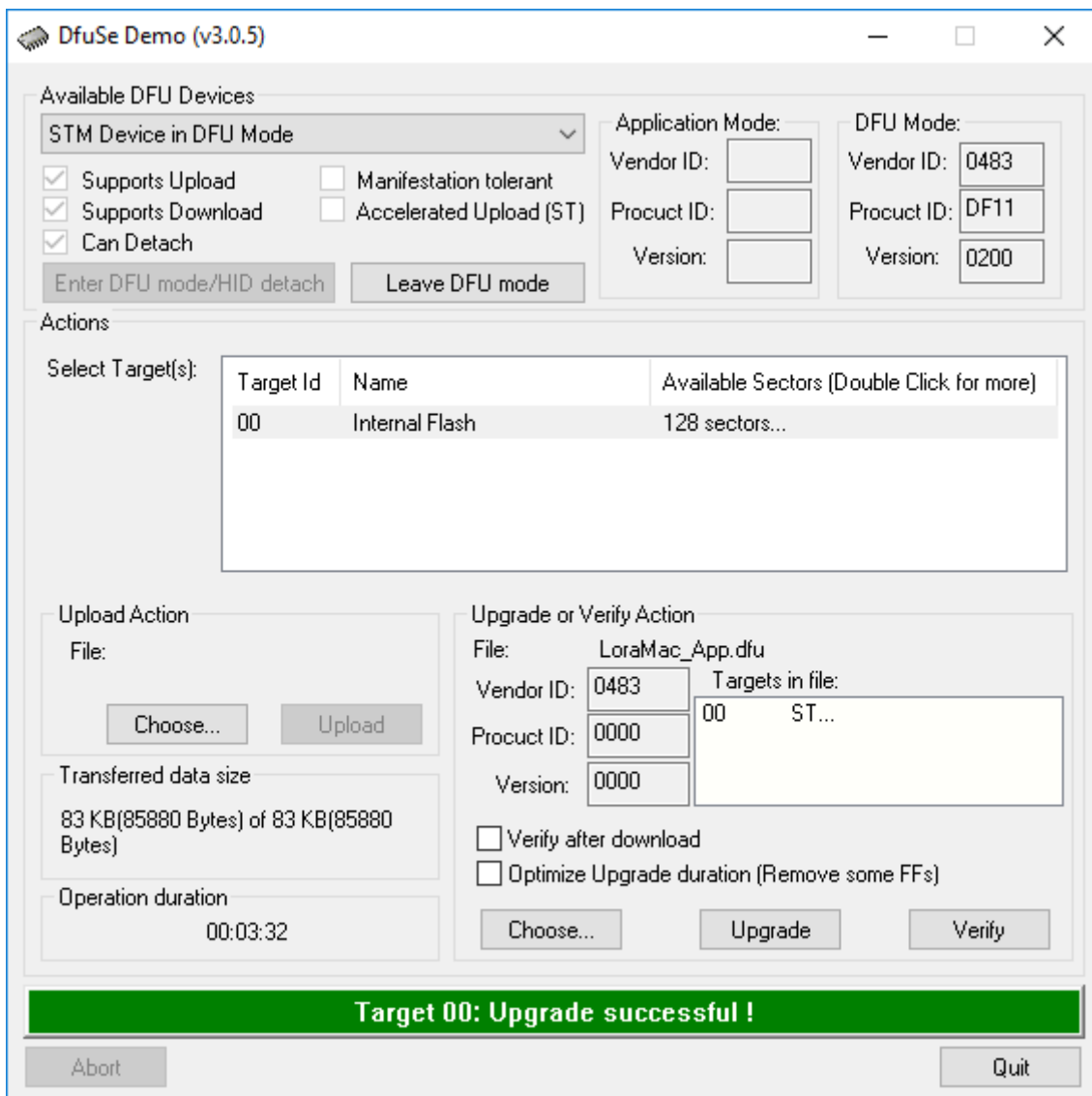
The **HumOffset** variable can be used to compensate the static error of the humidity measurement. By default, this variable is set to 0 (no static error compensation).

After Power-up the device starts by sending an INFO uplink followed by a CONFIG uplink (see chapters 0 and 2.2).

5 SW Update over the USB Bootloader

The CM4 can be updated via USB DFU Bootloader.

1. DFU tool «DFuSe demo» start (link → <http://www.st.com/en/development-tools/stsw-stm32080.html>).
2. Select the current DFU file by clicking on "Choose..." under **upgrade or verify action** (bottom right).
3. Press button at restart (power-up) with USB Cable connected to go to the bootloader mode.
4. The LED should now toggle every 500 ms.
5. The Device should appear under "available DFU devices".
6. Press "Upgrade" **upgrade or verify action** (bottom right), ignore any messages, and continue. The Update should last around 2 minutes.
7. Once Update is finished press "Leave DFU mode", disconnect the USB cable, and restart the device.



Important: After installing the DFU tool, check the UM0412.pdf file. The driver path must be searched manually for the first update (C:\Program files (x 86) \STMicroelectronics\Software\DfuSe v3.0.5\Bin\Driver\).