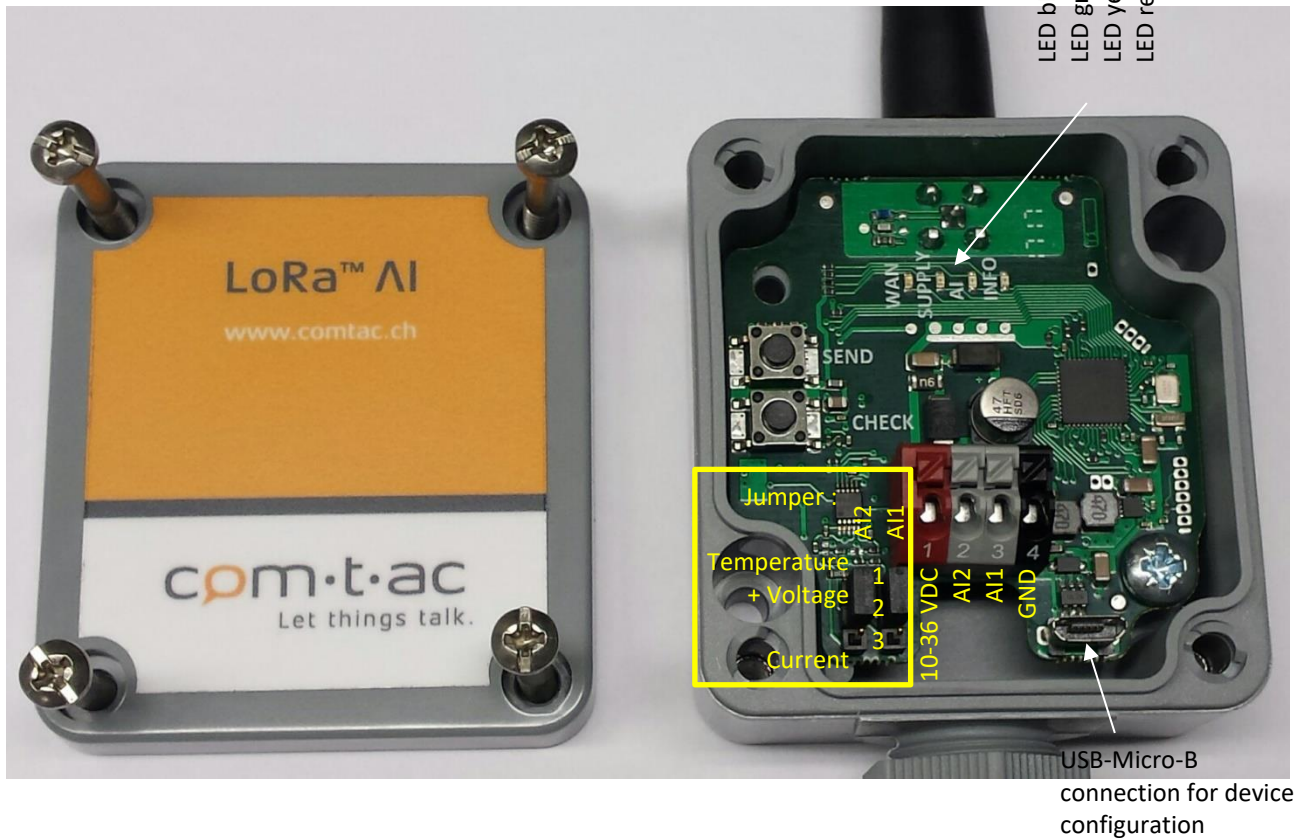




# LPN AI SW Specification / V0.11

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## History

Date	Description
2017-07-20-Kd	First Release REV00 V00.00
2017-10-18-Zs	V0.10 Example value calculation inserted
2017-12-18-Zs	V0.11 Description of the payload actualised

Changes are added in this history, if a new version has been issued.

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## 1 Features

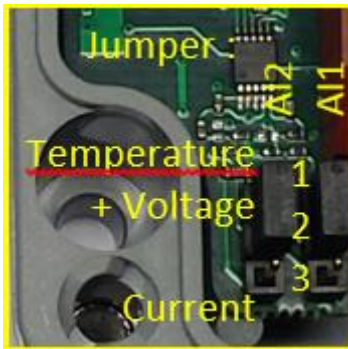
The LPN AI can handle 2 analog inputs, according to user configuration, and transmit the results to a LoRaWAN server.

Measure types (MeasureTyp)	Full-Scale range	measurable range	open input output value
PT1000 (Temperature)	-500..+1'500[°C/10]	-500..+25'000[°C/10]	25'000[°C/10]
U (Voltage)	0..10'000[mV]	0..13'000[mV]	< 10[mV] (for no Jumper)
I (Current)	0..20'000[uA]	0..30'000[uA]	< 100[uA]

Telegrams from the server to the Node (LPN AI) are downlinks and from the node to the server are uplinks. In the LoRaWAN, all uplinks are provided with a CRC by default, but the downlinks are not.

### 1.1 Jumper settings

Before connect the input signal path to the LPN AI, set the jumper correctly:



Jumper Pin 1-2

**PT1000 (Temperature):**

Jumper Pin 1-2 or not inserted

**U (Voltage)**

Jumper Pin 2-3

**I (Current)**

For correct measurement configure the AI1 and AI2 MeasureTyp equivalent.

**Attention: Wrong Jumper settings can damage the device, especially the position 2-3 (0...20mA) with input voltage > 2V can damage the burden!**

## 1.2 Function Buttons

Button	Function/Meaning	Remarks
<b>SEND</b>	During Power Up	When only button 1 is held while switching on, the boot loader is activated (red LED flashes briefly on and all other LED lights).  On power-up, the user got 2 seconds time to perform a special function, which will be indicated by alternately flashing orange and red (100ms clock) LED.  If button 1 is pressed, the USB will be in USB-CDC Mode (Virtual COM Port), used for special configuration.
<b>SEND</b>	During operation	A Confirm-Uplink (port 0 if no other uplinks are pending) is sent by means of button 1. If a connection has not yet been established with OTA, a JoinRequest is sent before.
<b>CHECK</b>	During Power Up	If button 2 is pressed, LoRa TimeOnAir (minimum pause times between the sending) is ignored. A special function is acknowledged by a fast flashing of the green LED for 1 second.
<b>CHECK</b>	During operation	Pressing the button 2 for less than 3s will restart the measurement and send an uplink when joined. Pressing the button 2 for more than 3s will trigger a software reset. When you start up, the orange and red LEDs will flash simultaneously (100ms ON 100ms OFF) until the button 2 is released again.

**Reset** of the device configuration during power up possible:

If both buttons are pressed, the LoRa configuration (CFG.TXT) is reset to the default values.

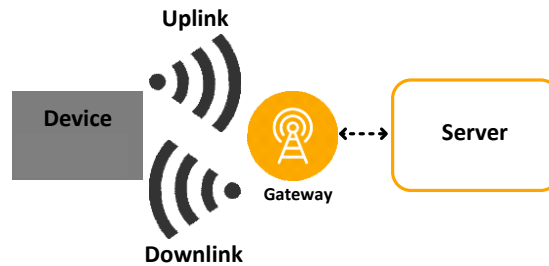
## 1.3 Function of LEDs

After switching on, all LEDs light up for 0.5 seconds, if the LEDs remain lit and the red LED flashes briefly, the bootloader is active.

Blink variants of the blue and green LEDs: 12%--> 0.7s off + 0.1s on; 50%--> 0.4s off + 0.4s on; 88%--> 0.1 s off + 0.7s on

LED	Function/Meaning	Remarks
<b>Red</b>	Status of AI1 Input	0..100% 1s:      0...100% measurement of Blink 100ms:      ADC Communication error
<b>Orange</b>	Status of AI2 Input	
<b>Green</b>	Supply	Lights up when power is available. When switched on, a special function selected by the buttons is confirmed by a fast flashing (100ms ON 100ms OFF). During operation, a short extinguishing (100ms) of the LED indicates a LoRa data reception (downlink from the server).
<b>Blue</b>	WAN, state of the LoRa	Off:      Not initialized. 12%:      Wait for OTA-Joining or wait until the start-up window has expired. 50%:      No server downlink received (only for confirmed uplinks or button 1). 88%:      Uplink in progress or wait for LoRa-TimeOnAir enable (check data rate). On:      In order (currently no uplinks to send).

## 2 LoRa Up- and Downlink



### 2.1 LoRa Port 4 'AI'

An Uplink is send on port 4, when an AI application uplink is triggered or button 1 was pressed or by the live sign interval LivesignConfirmedTx.

The port 4 uplink is also used for each unknown (and Port 4) confirmed port downlink.

#### 2.1.1 Uplink payload structure

The size of the payload is depending on the selected send method chosen in the config.txt file.

Byte No. [0...X]	Function/Meaning	Remarks
0	Comtac device type	Applications Type (22=LPN AI)
1	Software version	Applications Main version
2		Applications Sub version
3	RSSI value	$0..255 * -1 = \text{RSSI [dB]}$ with -139dB Offset calculated
4		$-128..+127 = \pm \text{Snr [dB]}$ RSSI [dB] with -139dB Offset calculated
5	AI1 State	AI1 State: Bit[3..0] Sendmethod (see <i>Sendmethod</i> ) Bit[6..4] MeasureTyp (see <i>MeasureTyp</i> ) Bit[7] ADC Communication error
6 7...	AI1 Value	AI1 Data: Payload vary depending on your setting for the <b>Sendmethod in the config.txt file</b> : <ul style="list-style-type: none"> <li><b>0: Value or (Standard method)</b> <b>3: Mean or</b> <b>5: Delta</b> <b>6: Trigger (x=8):</b> Payload[6+7]: AI1 (INT16 LSB first)</li> <li><b>1: Data list or</b> <b>2: Mean data list (x=7+2*Cnt):</b> Payload[6]: Cnt measurement count (0...10) Payload[7...7+2*Cnt]: AI1 list (INT16 LSB first) (newest measure first)</li> <li><b>4: Mean-Min-Max (x=12):</b> Payload[6+7]: AI1 mean (INT16 LSB first) Payload[8+9]: AI1 min. (INT16 LSB first) Payload[10+11]: AI1 max. (INT16 LSB first)</li> </ul>
..	AI2 State	<b>AI2 State (see Fehler! Verweisquelle konnte nicht gefunden werden.)</b>
..	AI2 Value	<b>AI2 Data (see Fehler! Verweisquelle konnte nicht gefunden werden.)</b>

Payload size (n+1) is 9..49 (Standard size is 11).

The AI1 or AI2 outputs data in the **Fehler! Verweisquelle konnte nicht gefunden werden.** according to the *MeasureTyp*.

### 3 Configuration via USB interface

Insert the USB cable and open CFG.TXT, where all settings for LoRa and AI can be configured (not in USB-CDC Mode).  
**Configuration changes only take effect after a restart.**

#### 3.1.1 LoRa configuration in CFG.TXT

LoRa (vers. 0x43010200):

PrivateNetwork=0                    // 0 = Public (Preamble = 0x34) 1 = Private (Preamble = 0x12)

Activation:

OTA=0

OTA (OverTheAir):

DevEUI=3734333665357D04

AppEUI=70B3D5FFFE29701B

AppKey=2B8DEFCD2301674554761032DCFE98BA

ABP (ActivationByPersonalization):

DevAddr=0x00420136

NetwSesKey=1123456789ABCDEFEDCBA9876543211

AppSesKey=EEDCBA98765432100123456789ABCDEE

Broadcast:

BC\_Addr=0x00000000                // 0 for not used

BC\_NetwSesKey=2223456789ABCDEEEEDCBA9876543222

BC\_AppSesKey=DDDCBA98765432111123456789ABCDDD

Datarate (0.7;) DR\_0... DR\_7. SF12... FSK):

MinDR=0

MaxDR=7

DefDR=0

Rx2DefDR=0                        // default receives data rate

Startup:

SlotTime=000 [100ms]            // Start-up behavior first sending in a time slot or random:

TimeSlotNr=0000                 // for Var1 + 3 (min. 10 s at OTA; = 0-> OTA 10s ABP s = 2.3)

RndTime=0010 [m]                // Var1: (0 see Var2) 1.. 9999-> OTA: TimeSlotNr \* 10 s ABP: TimeSlotNr \* 2.3 s

GrpDevAddr=1024                 // Var2: (0 see Var3) 1.. 9999-> randomize 10 s... XXXX \* 60s

                                    // Var3: (0 see Var2 with 0060) 1.. 9999-> TimeSlotNr = DevAddr/GrpDevAddr + 1-> Var1

Communication:

ConfirmedTx=0                    // send 0 = unconfirmed 1 = confirmed uplinks

LivesignConfirmedTx=1440 [m]    // At the latest after this time + ConfirmedTxTimeout send confirmed Tx uplink

ConfirmedTxTimeout=0000 [s]    // 0 = send immediate. x = no later than x seconds send

RxConfirmTimeout=0000 [s]      // 0 = confirm immediately. x = confirm after x seconds

The first uplink can also be forced with button 1. Uplinks varies randomly in the range of 0...2s.

LivesignConfirmedTx ensures, at a defined interval, that the uplink is maintained by triggering a confirmed Tx. By means of ConfirmedTxTimeout, an application telegram can also be sent as confirmed if an application telegram is sent in this time window.

The Acknowledgment can be terminated by means of the RxConfirmTimeout with the confirmed downlink, so an application response can also contain the acknowledgment during this time (the Ack is sent immediately at 0).

### 3.1.2 AI configuration in CFG.TXT

```
AI:
SendInterval=0060 [m]
MinSendInterval=0010 [m] (for Sendmethod Delta and Trigger)

    MeasureTyp 0:U 0..10000[mV]; 1:I 0..20000[uA]; 2:PT1000 -500..+1500[°C/10] (see Jumper settings)
    | Sendmethod 0:Value 1:Data list 2:Mean data list 3:Mean 4:Mean-Min-Max 5:Delta 6:Trigger
    | | Measureinterval [m] (0:SendInterval for Sendmethod 1+2 and loop (about 8..16ms) for Sendmethod>2)
    | | | Delta
    | | | | Lower Trigger
    | | | | Upper Trigger
AI_1=0;0;0000;0000;00000;00000
AI_2=0;0;0000;0000;00000;00000
```

Max. 10 values can be saved in the data list, so `SendInterval / Measureinterval` should be  $\leq 10$ , otherwise older values will be overwritten by newer ones.

The mean value in the `Mean` data list is measured in a loop (8ms for 1 channel or 16ms for both channels). Other mean values are measured in the `Measureinterval` (0 is loop).

The mean value summarizes up to 65535 measurements (about 18 minutes for 2 channels and 9 minutes for one channel) and after 65535 measurements it calculate like this  $sum = sum - sum / 65535 + measure$ .

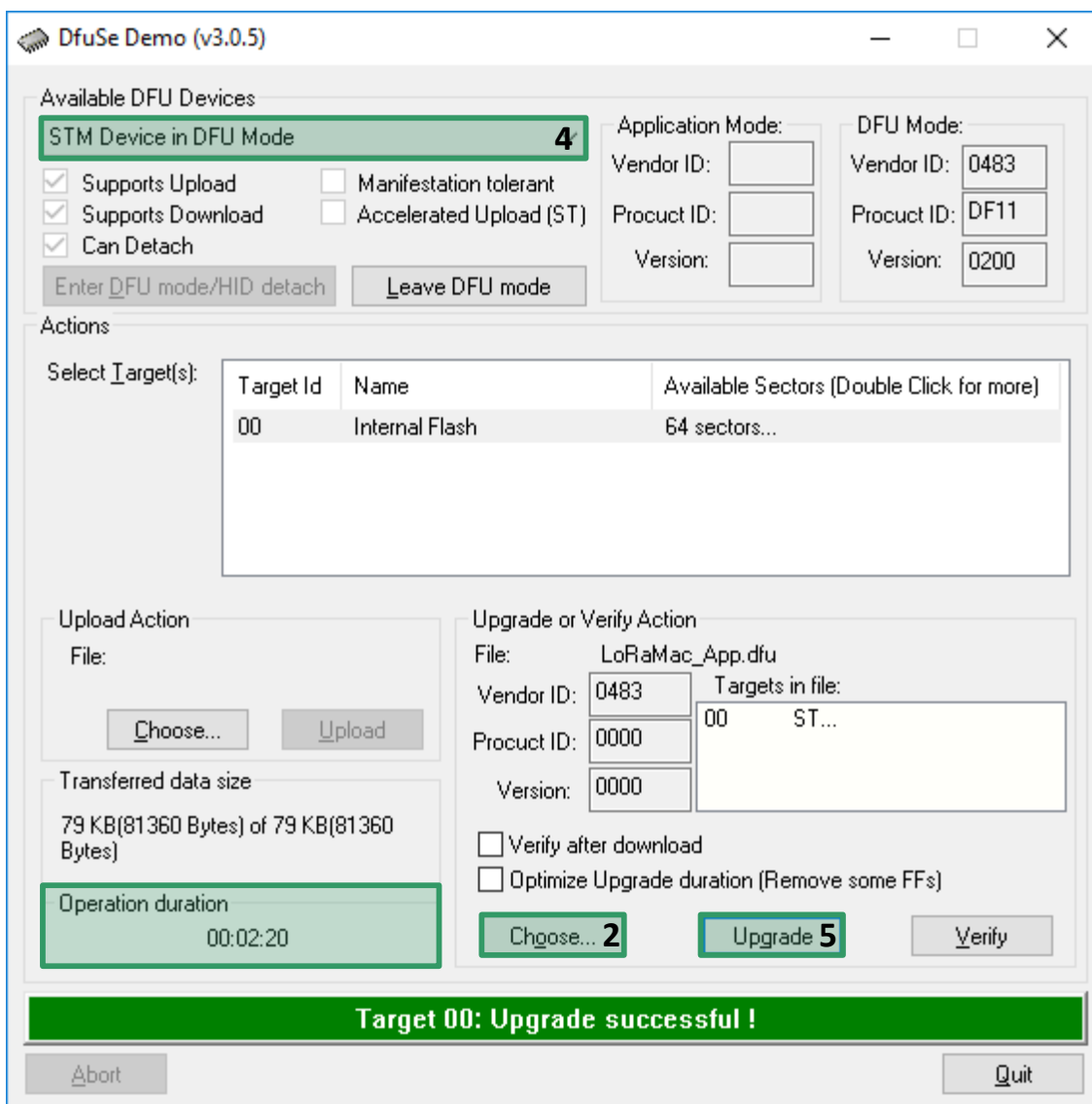
The `Delta`, `Lower Trigger` and `Upper Trigger` value should be in the ***Fehler! Verweisquelle konnte nicht gefunden werden.*** of the corresponding `MeasureTyp`.

An AI uplink is generated each `SendInterval` or in case of `Sendmethod-Delta` or `Sendmethod-Trigger` additionally on event and expired `MinSendInterval`. The `SendInterval` and `MinSendInterval` are reloaded after each uplink.

## 4 SW update via USB bootloader

If necessary, the CM1 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 2 minutes and 20 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\).