



LPN DO

SW Specification / V0.06

Comtac AG
CH-8247 Flurlingen



LED blue
LED green
LED yellow
LED red

USB-Micro-B
connection for device
configuration

History

Date	Description
2017-05-19-Kd	First Release REV00 V00.00
2017-05-29-Kd	REV00 V0.01 added Port 3+4 commands to set the outputs individually
2017-07-20-Kd	V0.02 "LiveSign" auch auf Port 2 versenden (alt Port 1) V0.02 Port 2 downlink new optional Mask-Byte
2017-12-18-Zs	V0.03 Format of the document changed
2018-04-12-Kd	V0.06 Implemented FrequencyPlan for ABP

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

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1 Features

The LPN DO allows to control 2 high side solid state relays outputs over LoRaWAN as a Class C device. After power up the outputs are in off-state.

1.1 Function Buttons

Button	Function/Meaning	Remarks																																			
SEND	On Power Up	When only SEND button is held while switching on, the boot loader is activated (red LED flashes briefly on and all other LED lights).																																			
SEND	During Startup	After 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 SEND button is pressed, the USB will be in USB-CDC Mode (Virtual COM Port), used for special configuration. A special function is acknowledged by a fast flashing of the green LED for 1 second.																																			
SEND	During operation	A Confirm-Uplink is sent by pressing the SEND button. If a connection has not yet been established with OTA, a JoinRequest is sent before.																																			
CHECK	During Startup	After 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 CHECK button 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.																																			
CHECK	During operation	CHECK Button controls the DO's manually: <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th></th> <th>DO2 State</th> <th>LED BUS (yellow)</th> <th>DO 1 State</th> <th>LED INFO (red)</th> </tr> </thead> <tbody> <tr> <td>Before</td> <td>X</td> <td>X</td> <td>X</td> <td>X</td> </tr> <tr> <td>1.Press</td> <td>OFF</td> <td>12% ON</td> <td>OFF</td> <td>12% ON</td> </tr> <tr> <td>2.Press</td> <td>OFF</td> <td>12% ON</td> <td>ON</td> <td>88% ON</td> </tr> <tr> <td>3.Press</td> <td>ON</td> <td>88% ON</td> <td>OFF</td> <td>12% ON</td> </tr> <tr> <td>4.Press</td> <td>ON</td> <td>88% ON</td> <td>ON</td> <td>88% ON</td> </tr> <tr> <td>5.Press</td> <td>X-Before</td> <td>X-Before</td> <td>X-Before</td> <td>X-Before</td> </tr> </tbody> </table> <p>The DO manual state could be overwritten by a LoRa Uplink. Pressing the CHECK button for more than 3s will trigger a software reset. During following startup, the orange and red LEDs will flash simultaneously (100ms ON 100ms OFF) until the CHECK button is released again.</p>		DO2 State	LED BUS (yellow)	DO 1 State	LED INFO (red)	Before	X	X	X	X	1.Press	OFF	12% ON	OFF	12% ON	2.Press	OFF	12% ON	ON	88% ON	3.Press	ON	88% ON	OFF	12% ON	4.Press	ON	88% ON	ON	88% ON	5.Press	X-Before	X-Before	X-Before	X-Before
	DO2 State	LED BUS (yellow)	DO 1 State	LED INFO (red)																																	
Before	X	X	X	X																																	
1.Press	OFF	12% ON	OFF	12% ON																																	
2.Press	OFF	12% ON	ON	88% ON																																	
3.Press	ON	88% ON	OFF	12% ON																																	
4.Press	ON	88% ON	ON	88% ON																																	
5.Press	X-Before	X-Before	X-Before	X-Before																																	

Reset of the device configuration during startup:

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

1.2 Function of LEDs

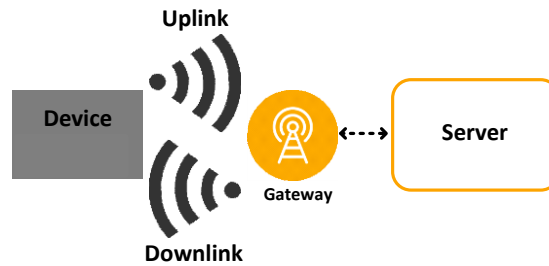
Blink variants of the LEDs:

12% -> 0.7s off + 0.1s on; 50% -> 0.4 s off + 0.4 s on; 88% -> 0.1 s off + 0.7 s on

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.

LED	Function/Meaning	Remarks
Red	Status of DO1	Off: DO OFF (Normal operation)
Orange	Status of DO2	12%: DO OFF (CHECK Button Manual operation) 50%: DO failure (shorten, overtemperature) 88%: DO ON (CHECK Button Manual operation) On: DO ON (Normal operation)
Green	Power 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).
Blue	LoRaWAN Status	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 SEND button). 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



Telegrams from the server to the Node (LPN DO) 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.

2.1 LoRa uplink payload structure

An Uplink is send on port 2, when a DO error or manual state change was triggered or SEND button was pressed or by the live sign interval LivesignConfirmedTx.

The port 2 uplink is also used for each unknown (and Port 2) confirmed port downlink.

Byte No. [0...X]	Function/Meaning	Remarks
0	Comtac device type	Applications Type (20=LPN DO)
1	Software version	Applications Main version
2		Applications Sub version
3	RSSI value	$0..255 * -1 = \text{RSSI [dB]}$ (internal calculated with -139dB Offset)
4	SNr Value	$-128..+127 = +/- \text{Snr [dB]}$ RSSI [dB] (internal calculated with -139dB Offset)
5	DO State	Bit[0] DO1 Bit[1] DO2 Bit[2] DO1 Error (shorten or overheat) Bit[3] DO2 Error (shorten or overheat) Bit[4] DO1 given by LoRa Downlink Bit[5] DO2 given by LoRa Downlink Bit[6] DO's controlled manual by CHECK Button

2.1.1 LoRa uplink payload example

Below a received example which is already decrypted:

14 00 01 6d 05 00

Byte No. [0...X]	Function/Meaning	Remarks
0	Comtac device type	0x14 = 20 Applications Type (20=LPN DO)
1	Software version	0x00 = 0 Applications Main version
2		0x01 = 1 Applications Sub version
3	RSSI value	0x6d = 109 = -109 dB $0..255 * -1 = \text{RSSI [dB]}$
4	SNr value	0x05 = 5dB $-128..+127 = +/- \text{Snr [dB]}$
5	DO State	0x00 = 0 = Bit[0] DO1 Bit[1] DO2 Bit[2] DO1 Error (shorten or overheat) Bit[3] DO2 Error (shorten or overheat)

		Bit[4]	DO1 given by LoRa Downlink
		Bit[5]	DO2 given by LoRa Downlink
		Bit[6]	DO's controlled manual by CHECK Button

2.2 LoRa downlink payload on Port 3 'DO1'

Used to set the individual value for each channel.

An Uplink is send on port 2, when a DO error or manual state change was triggered.

Byte No. [0...X]	Function/Meaning	Remarks
0	DO State	Bit[0] DO1

Payload size is 1. Confirmed downlinks will be answered by an uplink with port 3.
DO-Manual control will be stopped and overwritten.

2.3 LoRa downlink payload on Port 4 'DO2'

Used to set the individual value for each channel.

An Uplink is send on port 2, when a DO error or manual state change was triggered.

Byte No. [0...X]	Function/Meaning	Remarks
0	DO State	Bit[0] DO2

Payload size is 1. Confirmed downlinks will be answered by an uplink with port 4.
DO-Manual control will be stopped and overwritten.

2.4 LoRa downlink payload on Port 2 'DO1 & 2'

Used to set the individual value for each channel.

Byte No. [0...X]	Function/Meaning	Remarks
0	DO State	Bit[0] DO1 Bit[1] DO2
1	DO Mask	(optional) Bit[0] 0=DO1 state not used; 1=overtake DO1 state Bit[1] 0=DO2 state not used; 1=overtake DO2 state

Payload size is 1..2. Confirmed downlinks will be answered by an uplink with port 2.
DO-Manual control will be stopped and overwritten.

3 Configuration via USB interface

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

3.1 LoRa configuration in CFG.TXT

```
LoRa (vers. 0x43010200):
PrivateNetwork=0           // 0 = Public (Preamble = 0x34) 1 = Private (Preamble = 0x12)
LazyDownlinkCnt=0         // Downlink sequence counter is 0=checked 1=not checked (can be lower)

Activation:
OTA=0
OTA(OverTheAir):
DevEUI=3734333665357D04
AppEUI=70B3D5FFFE29701B
AppKey=2B8DEFCD2301674554761032DCFE98BA
ABP(ActivationByPersonalization):
FrequencyPlan=0 (0:EU868_Default_3Ch 1:EU868_Semtech_8Ch 2:EU868_Standard_6Ch)
DevAddr=0x00420136
NetwSesKey=1123456789ABCDEFEDCBA9876543211
AppSesKey=EEDCBA98765432100123456789ABCDEE
Broadcast:
BC_Addr=0x00000000        // 0 for not used
BC_NetwSesKey=2223456789ABCDEEEDCBA9876543222
BC_AppSesKey=DDDCBA98765432111123456789ABCDDD

Datarate (0.7;) DR_0... DR_7. SF12... FSK):
MinDR=0
MaxDR=7
DefDR=0 (Max.5 in OTA)
Rx2DefDR=0                // default receives data rate
ADR_Off=0                  // ADR (AdaptiveDataRate) is 0=on 1=off

Startup:                    // Start-up behavior first sending in a time slot or random:
SlotTime=000 [100ms]      // for Var1 + 3 (min. 10 s at OTA; = 0-> OTA 10s ABP s = 2.3)
TimeSlotNr=0000           // Var1: (0 see Var2) 1.. 9999-> OTA: TimeSlotNr * 10 s ABP: TimeSlotNr * 2.3 s
RndTime=0010 [m]          // Var2: (0 see Var3) 1.. 9999-> randomize 10 s... XXXX * 60s
GrpDevAddr=1024           // Var3: (0 see Var2 with 0060) 1.. 9999-> TimeSlotNr = DevAddr/GrpDevAddr + 1-> Var1

Communication:
ConfirmedTx=0              // 0 = unconfirmed 1 = confirmed send
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 SEND button. 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).

FrequencyPlan	Channel	Frequency	Modulation / BW	Band
EU868_Default_3Ch	0	868.100 MHz	MultiSF 125 kHz	1
	1	868.300 MHz	MultiSF 125 kHz	1
	2	868.500 MHz	MultiSF 125 kHz	1
Additionally on EU868_Semtech_8Ch	3	867.100 MHz	MultiSF 125 kHz	0
	4	867.300 MHz	MultiSF 125 kHz	0
	5	867.500 MHz	MultiSF 125 kHz	0
	6	867.700 MHz	MultiSF 125 kHz	0
	7	867.900 MHz	MultiSF 125 kHz	0
	8 FSK	868.800 MHz	FSK 250 kHz, 50 kbps	2
	9 LoRa	868.300 MHz	SF7 250 kHz	1
	9 LoRa	868.300 MHz	SF7 250 kHz	1
Additionally on EU868_Standard_6Ch	3	868.850 MHz	MultiSF 125 kHz	2
	4	869.050 MHz	MultiSF 125 kHz	2
	5	869.525 MHz	MultiSF 125 kHz	2
	8 FSK	868.300 MHz	FSK 250 kHz, 50 kbps	1
	9 LoRa	868.300 MHz	SF7 250 kHz	1
For all EU868 plans	RX2	869.525 MHz	SFx (see Rx2DefDR) 125 kHz	3

3.2 DO configuration in CFG.TXT

DO:

SendOnChange=**1** (send on DO1 or DO2 error or manual state change)

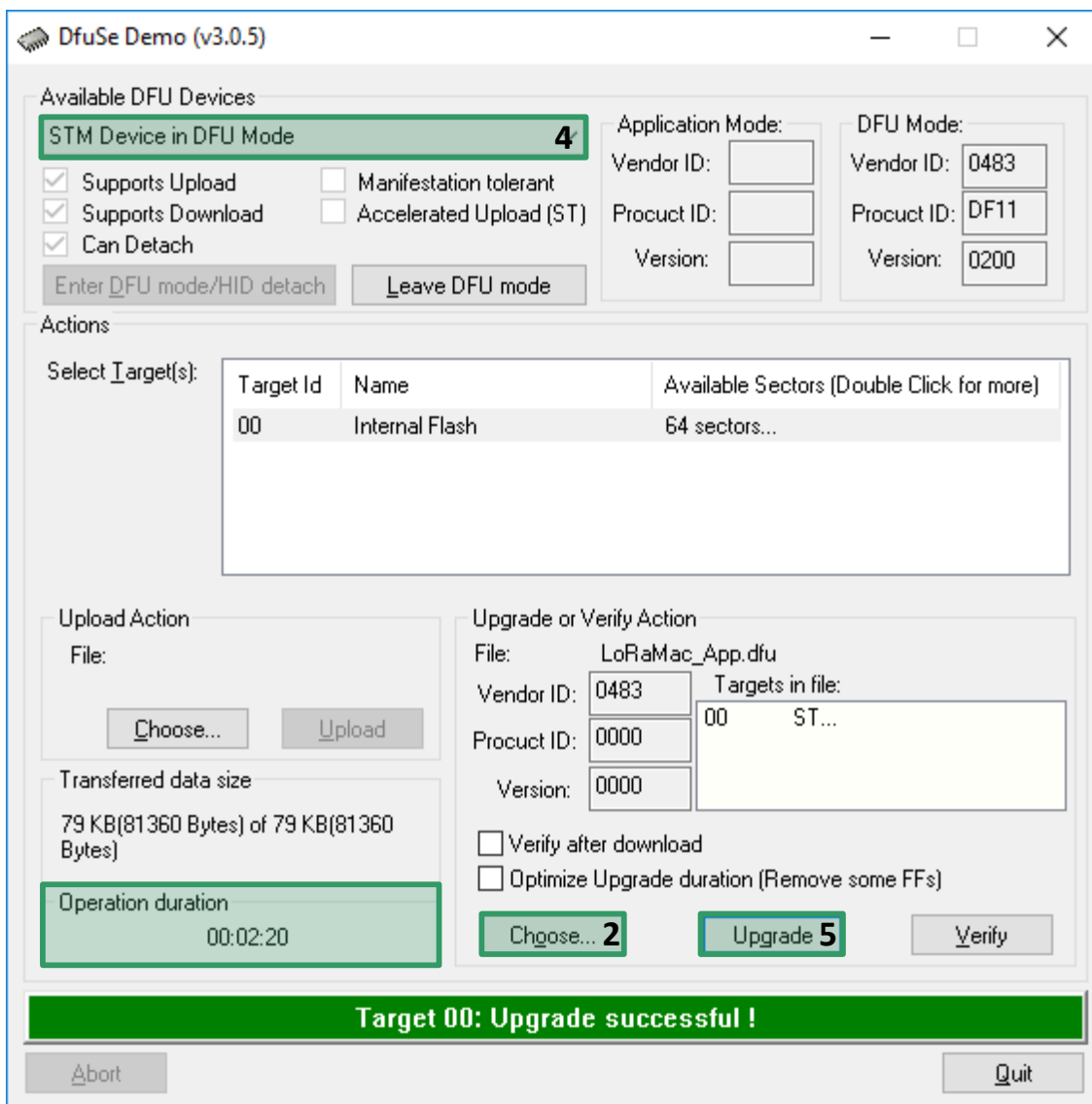
MinSendOnChangeInterval=**0010** [m] (0000 for none)

A DO uplink is generated on active SendOnChange while a DO1 or DO2 error or manual state changed and expired MinSendOnChangeInterval. The MinSendOnChangeInterval is reloaded after a send on change uplink.

4 SW update via USB bootloader

Nodes which have a boot loader can be updated via USB-DFU.

1. Start up DFU Tool «DFuSe Demo»
(Link → <http://www.st.com/en/development-tools/stsw-stm32080.html>).
2. Press "Choose..." button under **upgrade or verify action** (bottom right) to load the current DFU file.
3. Turn off device by removing supply and USB cable
4. Connect the USB micro plug to the PC using a cable, while holding down the "SEND" button.
5. Red Led should be flashing in half-sec-on-time and remaining LEDs should light -> Bootloader active.
6. The device is now in Bootloader mode (device appears under "Available DFU Devices").
7. Press «Upgrade» and ignore any messages. Updating takes about 2 minutes.
8. After the update, unplug the USB cable and restart the device.



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\).