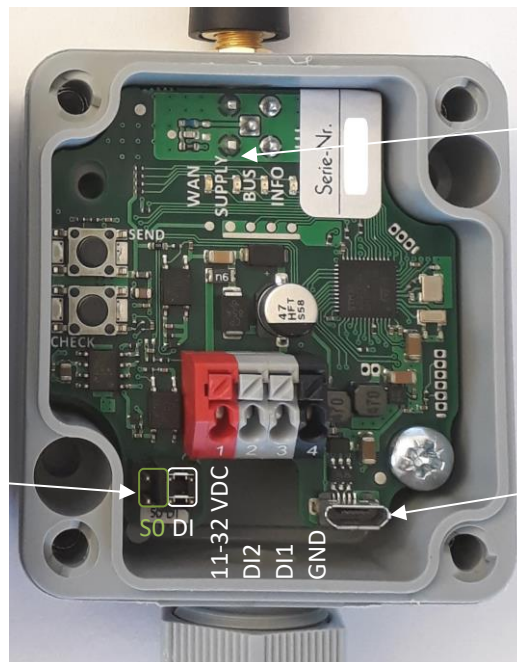




# LPN DI SW Specification / V0.07

**Comtac AG**  
CH-8247 Flurlingen

DI or SO variant selection  
(DI and SO are not mixable)  
(not implemented on REV01)



LED blue  
LED green  
LED yellow  
LED red

USB-Micro-B  
connection for device  
configuration

## History

Date	Description
2017-05-19-Kd	First Release REV01 V00.00
2017-09-12-Kd	Added state Bit[4] Input Variant 0=DI 1=S0 in Uplink Payload REV01 V00.02
2017-10-23-Kd	Added configuration SendOnChange falling and rising edge selection Added state Bit[2] DI1 changed and Bit[3] DI2 changed in Uplink Payload REV01 V00.03
2017-12-18-Zs	V0.04 Design of the document changed
2018-04-12-Kd	V0.06 Implemented FrequencyPlan for ABP, 2018-05-08-Kd V0.06b corr. payload example
2018-11-07-Kd	V0.07 update to REV02 HW

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

---

## Content

1	Features .....	3
1.1	Function Buttons.....	3
1.2	Function of LEDs .....	3
2	LoRa Up- and Downlink.....	4
2.1	Uplink payload structure port 3 'DI' .....	4
2.1.1	LoRa uplink payload example.....	5
2.2	Downlink payload structure port 3 'DI'.....	5
3	Configuration via USB interface.....	6
3.1.1	LoRa configuration in CFG.TXT .....	6
3.1.2	DI configuration in CFG.TXT.....	7
4	SW update via USB bootloader.....	8

## 1 Features

The LPN DI handles 2 digital inputs, by counting them, logging of last inputs change and transmit the results via LoRaWAN V1.0.1 as a Class C device.

The inputs are sampled in a 10ms interval und must be stable 2 time, so the minimum capture time for an impulse is 10..20ms. The counter values (count on active to passive transition) will be saved permanently at power fail.

### 1.1 Function Buttons

Button	Function/Meaning	Remarks
<b>SEND</b>	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).
<b>SEND</b>	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.
<b>SEND</b>	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.
<b>CHECK</b>	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.
<b>CHECK</b>	During operation	Pressing the 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.

**Reset of the device configuration** during startup:

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

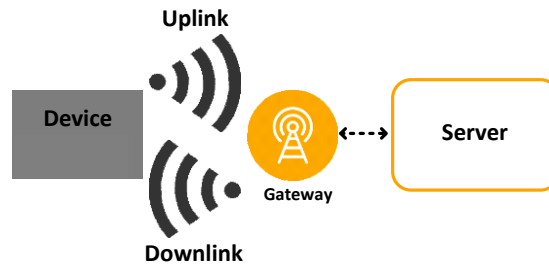
### 1.2 Function of LEDs

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 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

LED	Function/Meaning	Remarks
<b>Red</b>	Status of DI1 Input	Off: DI OFF
<b>Orange</b>	Status of DI2 Input	On: DI ON
<b>Green</b>	Power supply	Lights up when power is available. During startup, a special function selected by the buttons is confirmed by a fast flashing (100ms ON 100ms OFF). During operation: 50%: Power < 10V (DI's are not working) On: Power ok a short extinguishing (100ms) of the LED indicates a LoRa data reception (downlink from the server).
<b>Blue</b>	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 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



Telegrams from the server to the Node (LPN DI) 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 Uplink payload structure port 3 'DI'

An Uplink is send on port 3, when a DI application uplink is triggered or SEND button was pressed or by the live sign interval LivesignConfirmedTx.

The port 3 uplink is also used for each unknown (and Port 3) confirmed port downlink.

Byte No. [0...X]	Function/Meaning	Remarks
0	Comtac device type	Applications Type (21=LPN DI)
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	DI State	Bit[0] DI1 Bit[1] DI2 Bit[2] DI1 changed according to SendOnChange (is automatically set to 0 after sending) Bit[3] DI2 changed according to SendOnChange (is automatically set to 0 after sending) Bit[4] Input Variant 0=DI 1=S0 (only valid when supply was > 10V) Bit[7] 24V Supply Error (supply < 10V), during error DI1+DI2+Input Variant keep last state
6..9	DI1 counter	counter (UINT32 LSB first)
10..13	DI2 Counter	counter (UINT32 LSB first)
14..16	DI1	seconds since last DI1 state change (UINT24 LSB first) (0xFFFFFFFF after startup without change)
17..19	DI2	seconds since last DI2 state change (UINT24 LSB first) (0xFFFFFFFF after startup without change)

Payload size is 20.

### 2.1.1 LoRa uplink payload example

The AI1 of the device is configured with the Sendmethod 0: Value, below the received and decrypted message:

15 00 05 3f 06 80 09C40000 00df0000 010000 090000

Byte No. [0...X]	Function/Meaning	Remarks
0	Comtac device type	<b>0x15</b> = 21 =Applications Type (21=LPN DI)
1	Software version	<b>0x00</b> = Applications Main version
2		<b>0x05</b> = Applications Sub version
3	RSSI value	<b>0x3f</b> = -63dB 0..255 * -1 = RSSI [dB]
4	SNR value	<b>0x06</b> = 6dB -128..+127 = +/- Snr [dB] RSSI [dB]
5	DI State	<b>0x80</b> = 0b1000 0000 <b>Bit[7]</b> 24V Supply Error (supply < 10V), during error DI1+DI2+Input Variant keep last state
6..9	DI1 counter	<b>0x09 C4 00 00</b> = 50'185 counter (UINT32 LSB first)
10..13	DI2 Counter	<b>0x00 df 00 00</b> = 57'088 counter (UINT32 LSB first)
14..16	DI1	<b>0x01 00 00</b> = 1 second DI1 seconds since last state change (UINT24 LSB first) (0xFFFFFFFF after startup without change)
17..19	DI2	<b>0x09 00 00</b> = 9 seconds DI2 seconds since last state change (UINT24 LSB first) ( <b>0xFFFFFFFF after startup without change</b> )

### 2.2 Downlink payload structure port 3 'DI'

Byte No. [0...X]	Function/Meaning	Remarks
0	DI counter	Bit[0] DI1 Counter reset Bit[1] DI2 Counter reset

Payload size is 1. Confirmed downlinks will be answered by an uplink with port 3.

### 3 Configuration via USB interface

Insert the USB cable and open CFG.TXT, where all settings for LoRa and DI 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)
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=DDDCBA98765432111123456789ABCD

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:
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            // 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 by the 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
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	SF <sub>x</sub> (see Rx2DefDR) 125 kHz	3

---

### 3.1.2 DI configuration in CFG.TXT

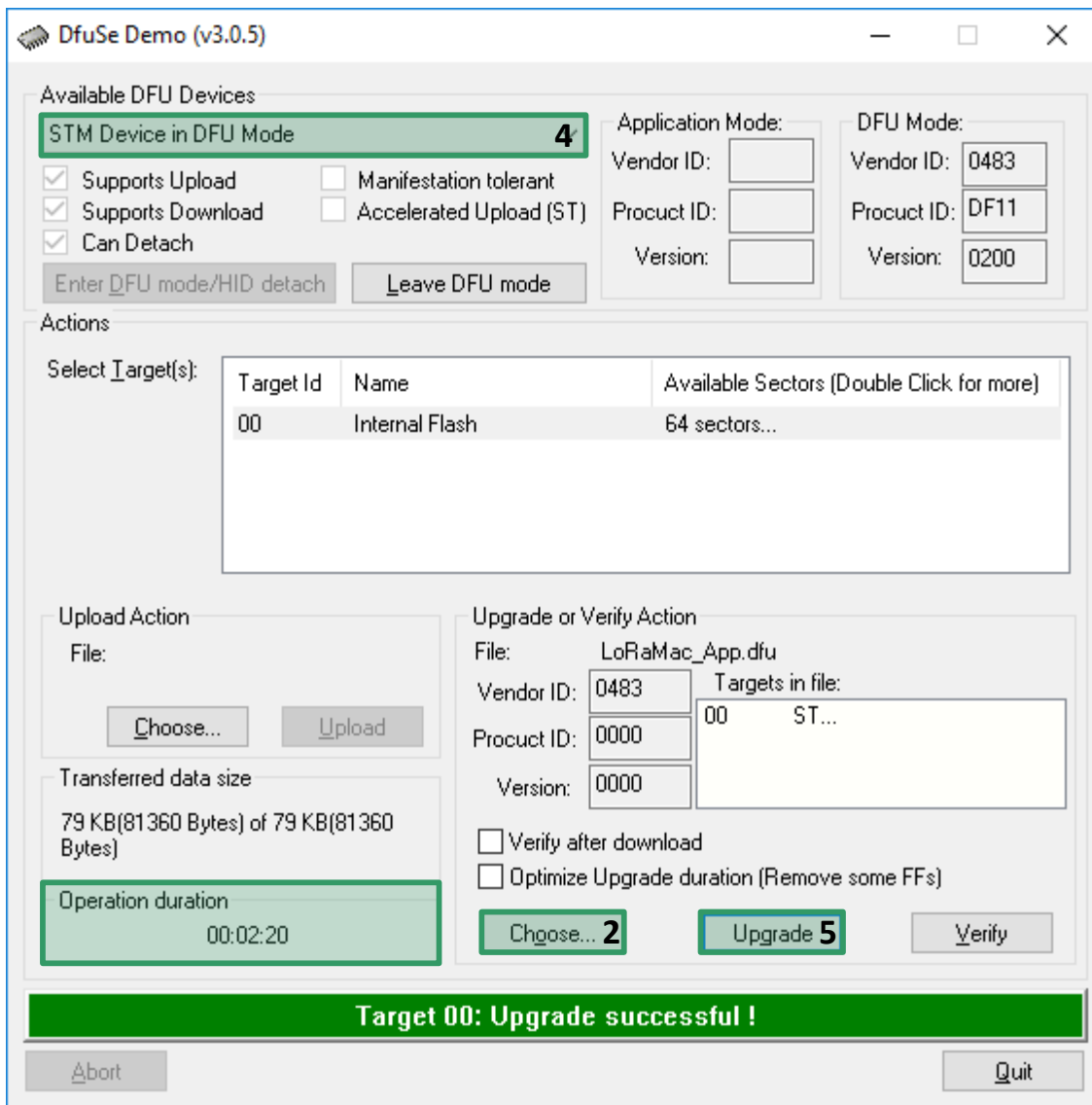
DI:  
SendInterval=**0000** [m] (0000 for none)  
SendOnChange=**1** (send on interval and on 0:none 1:both 2:rising 3:falling edge)  
MinSendOnChangeInterval=**0010** [m] (0000 for none)

A DI uplink is generated each SendInterval or in case of SendOnChange is 1..3 additionally on input state changes according to selected edge(s) and expired MinSendOnChangeInterval. The SendInterval is reloaded after each uplink and 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\).