Reference guide for

System Integrators

IMBuildings B.V.

2022

v1.1

Preface

Note: This document is shared by IMBUILDINGS B.V. for the purpose of transferring knowledge only to our customers and/or partners.

This document is not to be distributed by any other than IMBUILDINGS B.V.

Revision history

Version, Date, Author(s)	Changes
v0.1 05-09-2019 R. Conen	Preliminary release
v0.2 16-03-2020 R. Conen	Device specific information added (People Counter and Comfort Sensor)
v0.3 05-05-2020 R. Conen	New features LoRaWAN configuration added
v0.4 R. Conen	Updates on payload structure chapter.
v0.5 (latest) 14-01-2021	Device and Sensor status information added for People Counters. Updated list of people counters
v1.0	Change of document structure Added payload type 2 variant 8 Added information for the Office Occupancy Counter Added information about new downlink features and general settings
v1.1	Moodbox payload definition added Some payload examples added

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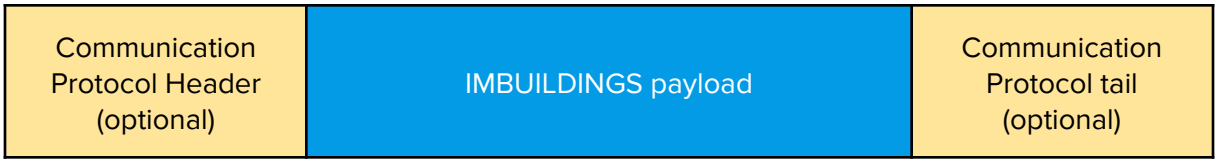
About this reference guide

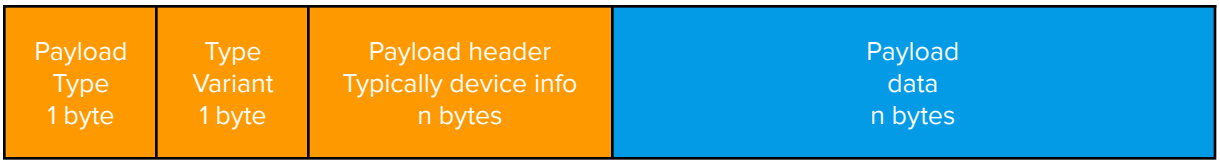
This reference guide helps system integrators implementing IMBUILDINGS products within their solutions.

We are open for discussion on any topic for the improvement of this guide.

Support can only be given on the delivered IMBUILDINGS products. Additionally we are able to help on specific topics which may or may not be a subject within this reference guide.

1. Payload structure





The byte order for the payload structure and the configuration memory structure is big-endian.

Most recent device versions have the capability to disable the meta data. This will result into a payload without the following parts:

- Payload Type
- Type Variant
- Payload header

This saves on air time and battery power.
Within the decoding software there needs to be a way to be sure the payload is decoded in the right way. For this there are several ways, e.g. when using LoRaWAN each payload type/variant can be transmitted on different ports.

Overview

The table below contains a summary of the various payload definitions.

Type	Variant	Used in
Comfort Sensors		
1	1	Comfort Sensor CO2 - NB-IoT
1	2	Comfort Sensor CO2 - NB-IoT (with date and time) Comfort Sensor CO2 - IoT
1	3	All models of Comfort Sensor - LoRaWAN (temperature, rel. humidity, CO2, presence)
1	4	Comfort Sensor Presence - NB-IoT (min. temperature, max. temperature, current temperature)
1	5	Comfort Sensor Presence - NB-IoT (presence event)
1	6	All models of Comfort Sensor - LoRaWAN (temperature, rel. humidity)
1	7	All models of Comfort Sensor - LoRaWAN (temperature, rel. humidity, presence)
1	8	All models of Comfort Sensor - LoRaWAN (temperature, rel. humidity, CO2)
People Counters		
2	1	People Counter - NB-IoT
2	2	People Counter - NB-IoT (1 byte count values)
2	3	People Counter - NB-IoT (2 byte count values)
2	4	People Counter - NB-IoT (with date and time)
2	5	People Counter - LoRaWAN (with payload counter) NOT USED
2	6	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN (with total count values)
2	7	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN (only total count values)

2	8	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN (only status information)
Other		
3	1	Buttons - NB-IoT
3	2	Buttons - NB-IoT (with date and time)
3	3	Buttons - LoRaWAN (e.g. Moodbox)
3	4	Buttons - LoRaWAN (e.g. Moodbox)
4	1	Pulse Counter - NB-IoT (with date and time)
5	1	Tracker - LoRaWAN (with battery and temperature without header)
0xF1	1	Downlink payload for reading and writing settings

1.1 Comfort Sensor

Type 1 / variant 1

Type	1 (0x01)
Variant	1 (0x01)
Products	Comfort Sensor CO2 - NB-IoT
Size	19 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x01	
Type variant	1	1	0x01	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	7	12 14 16 18	Temperature Humidity CO2 Presence	2 bytes 2 bytes 2 bytes 1 byte

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 1 / variant 2

Type	1 (0x01)
Variant	2 (0x02)
Products	Comfort Sensor CO2 NB-IoT , Comfort Sensor CO2 - IoT
Size	26 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x01	
Type variant	1	1	0x02	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	14	12 16 19 21 23 25	Date (UTC) Time (UTC) Temperature Humidity CO2 Presence	4 bytes (YYYYMMDD) (BCD) 3 bytes (HHmmss) (BCD) 2 bytes 2 bytes 2 bytes 1 byte

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 1 / variant 3

Type	1 (0x01)
Variant	3 (0x03)
Products	Comfort Sensor CO2 - LoRaWAN
Size	20 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x01	
Type variant	1	1	0x03	
Payload header	11	2 10 11	Device ID Status Battery voltage	8 bytes 1 byte (unsigned) 2 bytes (unsigned int16)
Payload	7	13 15 17 19	Temperature Humidity CO2 Presence	2 bytes 2 bytes 2 bytes 1 byte

Type 1 / variant 4

Type	1 (0x01)
Variant	4 (0x04)
Products	Comfort Sensor CO2 - NB-IoT
Size	18 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x01	
Type variant	1	1	0x04	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	6	12 14 16	Min. Temperature Max. Temperature Current Temperature	2 bytes 2 bytes 2 bytes

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Temperature is measured every 60 minutes. Min. and Max. temperature since last transmission. Before transmission the current temperature is measured/

Type 1 / variant 5

Type	1 (0x01)
Variant	5 (0x05)
Products	Comfort Sensor CO2 - NB-IoT
Size	13 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x01	
Type variant	1	1	0x05	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	1	12	Event type	1 bytes 0x01 = Presence event

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

A back off time is used before the next event can trigger.

1.2 People Counter

Type 2 / variant 1 - NOT USED

Type	2 (0x02)
Variant	1 (0x01)
Products	People Counter - NB-IoT
Size	To be determined

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x01	
Payload header	10	2 8 9 11	Device ID Device status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload		12 16	Date (UTC) Time (UTC)	4 bytes (YYYYMMDD) (BCD) 3 bytes (HHmmss) (BCD)

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Additional notes:

This variant is to be determined.

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 2 / variant 2

Type	2 (0x02)
Variant	2 (0x02)
Products	People Counter - NB-IoT
Size	15 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x02	
Payload header	10	2 8 9 11	Device ID Device status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	3	12 13 14	Counter A Counter B Sensor status	1 byte (unsigned) 1 byte (unsigned) 1 byte (unsigned)

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 2 / variant 3

Type	2 (0x02)
Variant	3 (0x03)
Products	People Counter - NB-IoT
Size	17 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x03	
Payload header	10	2 8 9 11	Device ID Device status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	5	12 14 16	Counter A Counter B Sensor status	2 bytes (unsigned int16) 2 bytes (unsigned int16) 1 byte (unsigned)

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 2 / variant 4

Type	2 (0x02)
Variant	4 (0x04)
Products	People Counter - NB-IoT, People Counter - IoT
Size	24 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x04	
Payload header	10	2 8 9 11	Device ID Device status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (signed)
Payload	12	12 16 19 21 23	Date (UTC) Time (UTC) Counter A Counter B Sensor status	4 bytes (YYYYMMDD) (BCD) 3 bytes (HHmmss) BCD) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 1 byte (unsigned)

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Type 2 / variant 5 - NOT USED

Type	2 (0x02)
Variant	5 (0x05)
Products	People Counter - LoRaWAN
Size	19 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x05	
Payload header	11	2 10 11	Device ID Device status Battery voltage	8 bytes 1 byte (unsigned) 2 bytes (unsigned int16)
Payload	6	13 15 17 18	Counter A Counter B Sensor status Payload counter	2 bytes (unsigned int16) 2 bytes (unsigned int16) 1 byte (unsigned) 1 byte (unsigned)

Additional notes:

Device ID: This is the LoRaWAN Device EUI address.

The Device EUI is normally also available from the LoRaWAN server. By adding it into the payload it is possible to ignore the LoRaWAN details sent by the server.

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Counter A and Counter B. These are relative values. Once data is sent they will start from 0 again.

Type 2 / variant 6

Type	2 (0x02)
Variant	6 (0x06)
Products	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN
Size	23 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x06	
Payload header	8	2	Device ID	8 bytes
Payload	13	10 11 13 15 17 18 20 22	Device status Battery voltage Counter A Counter B Sensor status Total Counter A Total Counter B Payload counter	1 byte (unsigned) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 1 byte (unsigned) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 1 byte (unsigned)

Additional notes:

Device ID: This is the LoRaWAN Device EUI address.

The Device EUI is normally also available from the LoRaWAN server. By adding it into the payload it is possible to ignore the LoRaWAN details sent by the server.

Device status details can be found in chapter 8.1.5
Sensor status details can be found in chapter 8.1

Counter A and Counter B. These are relative values. Once data is sent they will start from 0 again.

Note 1:

In case the payload is used without header (orange part) use LoRaWAN FPort 26

Example payload:

Hex	02060004A30B00F6B5690800F80003000220060305E661

Parsed*	{
	  received_at: '2021-12-20T13:53:07.952Z',
	  device_type_identifier: 2,
	  device_type: 'People Counter',
	  device_type_variant: 6,
	  device_id: '0004a30b00f6b569',
	  device_status: 8,
	  battery_voltage: 2.48,
	  counter_a: 3,
	  counter_b: 2,
	  sensor_status: 32,
	  total_counter_a: 1539,
	  total_counter_b: 1510,
	  payload_counter: 97
	}

*Parsed with IMBuildings Example parser

Type 2 / variant 7

Type	2 (0x02)
Variant	7 (0x07)
Products	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN
Size	15 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x07	Please read note 1
Payload header	8	2	Device ID	8 bytes
Payload	5	10 11 13	Sensor status Total Counter A Total Counter B	1 byte (unsigned) 2 bytes (unsigned int16) 2 bytes (unsigned int16)

Additional notes:

Device ID: This is the LoRaWAN Device EUI address.

The Device EUI is normally also available from the LoRaWAN server. By adding it into the payload it is possible to ignore the LoRaWAN details sent by the server.

Sensor status details can be found in chapter 8.1

Note 1:

LoRaWAN People Counter EU868 v1.35 and lower containing this payload type/variant transmits 0x06 as variant instead of 0x07
This can be catched by the type 2 variant 6 payload parser by checking the length of the message.

Note 2:

In case the payload is used without header (orange part) use LoRaWAN FPort 27

Example payload:

Hex	02070004A30B00F6B569A0060005E4

Parsed*	{
	  received_at: '2021-12-20T13:47:39.819Z',
	  device_type_identifier: 2,
	  device_type: 'People Counter',
	  device_type_variant: 7,
	  device_id: '0004a30b00f6b569',
	  device_status: 160,
	  total_counter_a: 1536,
	  total_counter_b: 1508
	}

*Parsed with IMBuildings Example parser

Type 2 / variant 8

Type	2 (0x02)
Variant	8 (0x08)
Products	People Counter - LoRaWAN (since v1.37) - Office Occupancy Counter - LoRaWAN
Size	14 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x02	
Type variant	1	1	0x08	Please read note 1
Payload header	8	2	Device ID	8 bytes
Payload	4	10 11 13	Device status Battery voltage Sensor status	1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (unsigned)

Additional notes:

Device ID: This is the LoRaWAN Device EUI address.

The Device EUI is normally also available from the LoRaWAN server. By adding it into the payload it is possible to ignore the LoRaWAN details sent by the server.

Sensor status details can be found in chapter 8.1

Note 1:

In case the payload is used without header (orange part) use LoRaWAN FPort 28

Example payload:

Hex	02080004A30B00F6B5690800F9A0

Parsed*	{
	  received_at: '2022-01-04T11:10:28.031Z',
	  payload_type: 2,
	  payload_variant: 8,
	  device_id: '0004a30b00f6b569',
	  device_status: 8,
	  battery_voltage: 2.49,
	  sensor_status: 160
	}

*Parsed with IMBuildings Example parser

1.3 Buttons

Type 3 / variant 1

Type	3 (0x03)
Variant	1 (0x01)
Products	NB-IoT Buttons
Size	13 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x03	
Type variant	1	1	0x01	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (unsigned)
Payload	1	12	Button pressed	1 byte -- bit 0 is button A pressed -- bit 1 is button B pressed -- bit 2 is button C pressed -- bit 3 is button D pressed -- bit 4 is button E pressed

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Buttons pressed is a bit value. 1 is pressed, 0 is not pressed.

Type 3 / variant 2

Type	3 (0x03)
Variant	2 (0x02)
Products	Buttons - NB-IoT
Size	20 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x03	
Type variant	1	1	0x02	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (unsigned)
Payload	8	12 16 19	Date (UTC) Time (UTC) Button pressed	4 bytes (YYYYMMDD) (BCD) 3 bytes [HHmmss) (BCD) 1 byte -- bit 0 is button A pressed -- bit 1 is button B pressed -- bit 2 is button C pressed -- bit 3 is button D pressed -- bit 4 is button E pressed

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

Buttons pressed are represented as a bit value. 1 is pressed, 0 is not pressed.

Type 3 / variant 3

Type	3 (0x03)
Variant	3 (0x03)
Products	Buttons - LoRaWAN
Size	14 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x03	
Type variant	1	1	0x03	
Payload header	11	2 10 11	Device ID Status Battery voltage	8 bytes 1 byte 2 bytes (unsigned int16)
Payload	1	13	Button pressed	1 byte -- bit 0 is button A pressed -- bit 1 is button B pressed -- bit 2 is button C pressed -- bit 3 is button D pressed -- bit 4 is button E pressed

Additional notes:

Buttons pressed is a bit value. 1 is pressed, 0 is not pressed.

Type 3 / variant 4

Type	3 (0x03)
Variant	4 (0x04)
Products	Buttons - LoRaWAN
Size	23 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x03	
Type variant	1	1	0x04	
Payload header	11	2 10 11	Device ID Status Battery voltage	8 bytes 1 byte 2 bytes (unsigned int16)
Payload	10	13	Button A count Button B count Button C count Button D count Button E count	2 bytes (unsigned int16) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 2 bytes (unsigned int16) 2 bytes (unsigned int16)

Additional notes:

For each button a total count of pushes is transmitted. Values starting from 0 when the device powers on.

1.4 Pulse Counter

Type 4 / variant 1

Type	4 (0x04)
Variant	1 (0x01)
Products	Pulse Counter - NB-IoT
Size	20 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x04	
Type variant	1	1	0x01	
Payload header	10	2 8 9 11	Device ID Status Battery voltage RSSI Level	6 bytes 1 byte (unsigned) 2 bytes (unsigned int16) 1 byte (unsigned)
Payload	8	12 16 19	Date (UTC) Time (UTC) Counter	4 bytes (YYYYMMDD) (BCD) 3 bytes [HHmmss) (BCD) 1 byte (unsigned)

Additional notes:

RSSI Level: In case the level is 0x63 (decimal 99), no reading is available.

1.5 Tracker

Type 5 / variant 1

Type	5 (0x05)
Variant	1 (0x01)
Products	Tracker - LoRaWAN
Size	6 bytes

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0x05	
Type variant	1	1	0x01	
Payload	4	2 4	Battery Temperature	2 bytes 2 bytes

1.6 Downlink

Type 241 / variant 1

Type	241 (0xF1)
Variant	1 (0x01)
Products	People Counter - LoRaWAN, Office Occupancy Counter - LoRaWAN
Size	Dynamic

Section	Size in bytes	index	Structure / values	Info
Payload type	1	0	0xF1	
Type variant	1	1	0x01	
Payload	n	from 2	Device Configuration	For more information about this structure read chapter 7

This payload type allows reading or writing the Device Configuration.
In case a configuration is entered without a value it will act as a read command.

A downlink can be sent on FPort 1 .. 223.

Please note that the response on this downlink will be sent back on the same Port on which the downlink was sent.

Please note that setting identifier 0xC8 is reserved for device commands.

LoRaWAN People Counter commands:

Command code	Command	info / arguments
0x01	Request payload uplink history	Payload counter to be retrieved **Argument:** payload counter
0x02	Reset IoT connection	In case of LoRaWAN perform an OTAA **Argument:** none
0x03	Preset of count values	Preset total count values Argument 4 bytes: 2 bytes Total Value A 2 bytes Total Value B
0x04	Save settings to NFC	Available from LoRaWAN devices of version v1.37
0x05	Preset of Button count values	2 bytes TotalValue button A 2 bytes TotalValue button B 2 bytes TotalValue button C 2 bytes TotalValue button D 2 bytes TotalValue button E

Please note that the call history only stores the last 16 transmitted payload uplinks.

1.6.1 Cascaded configuration settings

Since device version v1.37 it is possible to add multiple configuration settings in a single downlink.
This feature is used when you want to save the settings to the NFC memory.

Example:
Change interval to 5 minutes and change the payload to type 2 variant 7 with header and save it into the NFC memory.

```
0xF1 0x01 0x03 0x1E 0x05 0x05 0x20 0x02 0x07 0x01 0x03 0xC8 0x04
```

Please be aware of the maximum payload size especially for the NA915 region. A limitation of payload size is applied. More information is available about this in the LoRaWAN Regional Parameters documentation.

1.6.2 Example downlink requesting history data:

In case you are missing the uplink with payload counter 0x5D you can retrieve it with the following command.

```
0xF1 0x01 0x04 0xC8 0x01 0x5D
```

`0xF1` Payload type downlink
`0x01` Payload variant 1 of the downlink type
`0x04` Length of the data including this length
`0xC8` Device command
`0x01` Request payload uplink history
`0x5D` Payload counter to be requested

1.6.3 Example downlink change transmit interval:

Changing the transmit interval to 5 minutes.

```
0xF1 0x01 0x03 0x1E 0x05
```

`0xF1` Payload type downlink
`0x01` Payload variant 1 of the downlink type
`0x03` Length of the data including this length
`0x1E` Transmit interval identifier
`0x05` Transmit interval in minutes (when 0, the device is in event mode)

Note: Depending on the wireless technology the answer of a downlink may come at a later moment.

In case of LoRaWAN the downlink is sent immediately when the LoRaWAN server receives an uplink.

The new interval will become active the moment the device receives the new setting.

1.6.4 Common downlinks

General data uplink settings

Change the total counter values back to 0

```
0xF1 0x01 0x07 0xC8 0x03 0x00 0x00 0x00 0x00
```

Setup event settings (example with 2 counts and 5 minute timeout) (for People Counter devices)

```
0xF1 0x01 0x05 0x1F 0x01 0x02 0x05
```

Enable event (for People Counter devices)

```
0xF1 0x01 0x03 0x1E 0x00
```

Set interval to 10 minutes

```
0xF1 0x01 0x03 0x1E 0x0A
```

Set payload to type 2 variant 6 (with metadata enabled)

```
0xF1 0x01 0x05 0x20 0x02 0x06 0x01
```

Set payload to type 2 variant 7 (with metadata disabled)

```
0xF1 0x01 0x05 0x20 0x02 0x07 0x00
```

Change port number for general data uplinks to 27

```
0xF1 0x01 0x03 0x33 0x1B
```

Heartbeat settings

Enable heartbeat interval of 1 hour (60 minutes)

```
0xF1 0x01 0x03 0x21 0x3C
```

Disable heartbeat

```
0xF1 0x01 0x03 0x21 0x00
```

Change port number of heartbeat to 1

```
0xF1 0x01 0x03 0x36 0x01
```

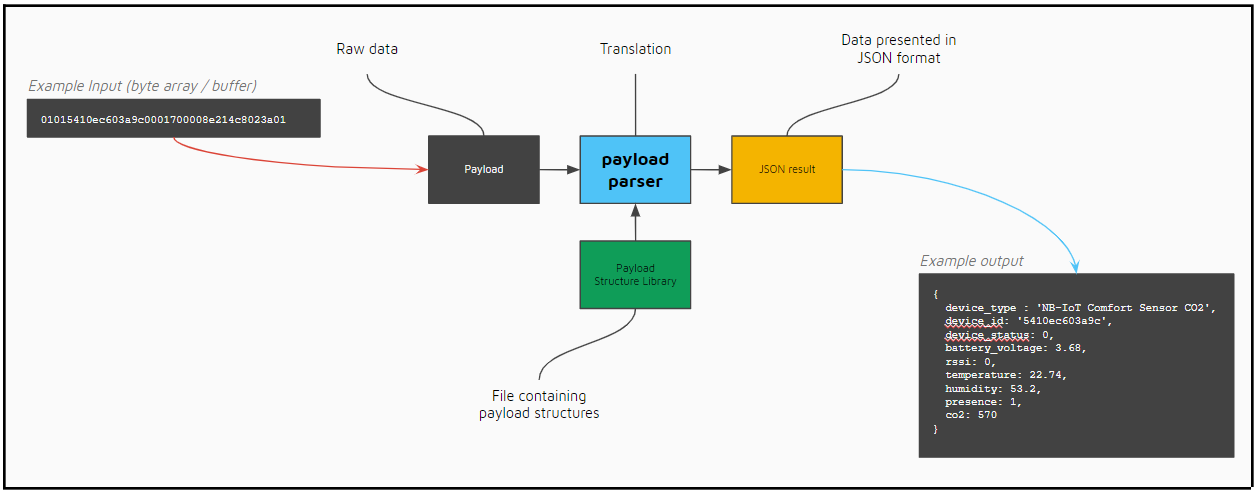
2. Payload parser

2.1 Javascript/Node JS

On most cloud solutions and on some operated networks Javascript can be used to decode received data from the IoT devices.

We supply an example Javascript containing a payload parser which includes decoding functions of all our products.
The raw binary payload is inserted into the parse function and returned as a JSON object containing all the parsed data.

Payload parser on GitHub: https://github.com/IMBUILDINGS/PayloadParser



3. Device configuration

3.1 NFC

NFC short for near field communication is used in the current product range, to configure sensors.
At this moment almost all mobile devices running Android are capable of reading and writing NFC.

3.2 App

For system integrators there is an Android App available.
This App is intended for initial configuration of devices, and not intended for redistribution to third parties.

The app works by using NFC to read and write settings into sensors.
The App in its current state only reads and writes settings, if more features are required we encourage our system integrators to create their own app.

Benefits of creating a custom App that is integrated in your platform would be for example device provisioning and backend integration.

3.3 Configuration structure

The Following is the structure on how to configure Devices.

Each setting is store as the following block of bytes

1 byte Total Length	1 byte Identifier	n bytes Value

End of configuration is defined by the following rule:

- Total Length = 0 and Identifier = 0

List of settings

Identifier	Setting	Info
0x00	Free space	Used for reserving free space
0x01	Device Info	Product ID (2 bytes) & Firmware version (2 bytes)
0x02	Device ID	In case of LoRaWAN this is the Device EUI
0x03	IMEI	IMEI number of the LTE Module
0x04	IMSI	IMSI number of the SIM card
0x05	ICCID	ICCID number of the SIM card
0x06	Module info	Version info from communication module as string.
0x07	Battery type	1 byte identifier
0x0A	Dest. IP Port	IP and port of the destination server (4 bytes ip, 2 bytes port)
0x0B	IP or NONIP	NB-IoT Setting. Values can be in ASCII “IP” or “NONIP”
0x0C	APN	ASCII
0x0D	Operator	NB-IoT Operator value in ASCII
0x0E	NB-IoT Band	(1 byte)
0x0F	UDP Listen Port	UDP Listen port (2 bytes)
0x14	MQTT-SN Client ID	ASCII
0x15	MQTT-SN Topic name	ASCII
0x1E	Transmit interval	Interval in minutes (1 byte) 0: Interval disabled. Transmit on event enabled 1 - 240 minutes Predefined values: 241: 8 hours 242: 12 hours 243: 24 hours 244: 6 hours
0x1F	Event setting	3 Arguments (3 bytes) **First argument (first byte) - Event type**

		1: count value changed 2: button pushed **Second argument (second byte) - Event setting** (1) number of counts (1 to 200 counts) (2) number of pushes (1 to 200 pushes) **Third argument (third byte) - Event time out** Timeout in minutes. See interval for valid values. A value of 0 will disable the time out.
0x20	Payload definitions	3 Arguments (3 bytes) **Argument 1 (1 byte):** Payload Type according to the payload structure **Argument 2 (1 byte):** Payload Variant according to the payload structure **Argument 3 (1 byte):** Payload options: 0x00: Payload without Metadata 0x01: Payload with Metadata Default value: 0x02, 0x06, 0x01
0x21	Heartbeat interval	Interval in minutes (1 byte) 0: Interval disabled 1 - 240 minutes Predefined values: 241: 8 hours 242: 12 hours 243: 24 hours 244: 6 hours
0x22	Heartbeat payload	3 Arguments (3 bytes) **Argument 1 (1 byte):** Payload Type according to the payload structure **Argument 2 (1 byte):** Payload Variant according to the payload structure **Argument 3 (1 byte):** Payload options: 0x00: Payload without Metadata 0x01: Payload with Metadata

		Default value: 0x02, 0x06, 0x01
0x23	Energy level interval * for EnOcean devices	Interval in minutes (1 byte) 0: Interval disabled 1 - 240 minutes Predefined values: 241: 8 hours 242: 12 hours 243: 24 hours 244: 6 hours
0x28	LoRaWAN Activation	1 byte; 0 = ABP 1 = OTAA
0x29	ABP App session key	
0x2A	ABP Nwk session key	
0x2B	Device Address	
0x2C	OTAA App key	16 bytes
0x2D	OTAA App EUI	8 bytes
0x2E	ADR	1 byte
0x2F	Confirmed messages	1 byte; On = 1; Off = 0; 0= Off 1 = On 2 = First 2 uplinks confirmed 10 = No downlinks possible 11 = One downlink after uplink 12 = only on the first two uplinks a downlink possible
0x30	Reset	1 byte; 1 = Resetting communication module to factory defaults 2= Reboot device 11= Reset timers. Will trigger data, heartbeat etc. transmissions. 12= Reload timers. Will make changed timers active. This setting is set back to 0 when action is performed.
0x31	Data rate min max	4 bits min (0..5) -- 4 bits max(0..5) Default: Min:0 Max:5

0x32	Data rate	value between min and max setting
0x33	LoRaWAN Port	1 to 223, default 1
0x34	Region	1 byte; 0 = EU868 (LoRaWAN, EnOcean) 1 = EU433 (LoRaWAN) 2 = NA915 (LoRaWAN) 3 = AU915 (LoRaWAN) 4 = AS923 (LoRaWAN) 5 = US902 (EnOcean)
0x35	RX2 RecWindow	10 bytes: 1st byte is data rate {0..7} 9 bytes frequency e.g. 869525000
0x36	LoRaWAN Port used by heartbeat	1 to 223, default 2
0x49	enOcean Device ID	
0x50	Office Occupancy Counter distance settings. (distance measured from sensor)	2 bytes. 1st byte: ignore distance in cm 2nd byte: detection distance in cm Maximum distance is 200cm Detection distance must be longer than the ignore distance
0x51	Led indication	1 byte; On = 1; Off = 0;
0x52	Button delay time	1 byte; per 100msec 0x05 default (= 500ms) 0-160 (max 16sec)
0xC8	Device commands	Note: this is reserved for downlink commands
0xF0	Connection error	
0xFE	Free memory	
0xFF	Not used	

The highlighted items can be used with a downlink message to the LoRaWAN device.

3.3.1 Product ID's

To determine the type of product each product contains a product ID within the NFC Device information identified within the configuration by identifier 0x01

Product	Product ID
Comfort Sensors	
Comfort Sensor CO2 - NB-IoT Professional	0x0101
Comfort Sensor CO2 - NB-IoT Economic	0x0102
Comfort Sensor CO2 - LoRaWAN EU868 (US915/AU915/AS923)*1 Professional	0x0103
Comfort Sensor Presence - NB-IoT	0x0104
Comfort Sensor CO2 - LoRaWAN EU868/US915/AU915/AS923 Economic	0x0105
People Counters / Office Occupancy Counters	
People Counter - NB-IoT	0x0204
People Counter - LoRaWAN EU868 (US915/AU915/AS923)*1	0x0206
People Counter - LoRaWAN US915/AU915	0x0207
Office Occupancy Counter - LoRaWAN EU868/US915/AU915/AS923	0x0208
People Counter - EnOcean EU868/US902	0x0001
Office Occupancy Counter - EnOcean EU868/US902	0x0002
Moodbox / Button box	
Moodbox - LoRaWAN EU868/US915/AU915/AS923	0x0303

*1 Since version v1.37

3.4 Example Library

At this moment there is a Java library available which can be used for an Android App for reading and writing the NFC memory structure. Handling the NFC communication is not within this library. Please contact us in case you are implementing NFC configuration within your own App.

4. Device specific information

4.1 People Counter

Models of horizontal based battery powered People Counters

Article	Product	Description
LoRaWAN		
IB010-001.00 IB010-001.02	People Counter set - LoRaWAN EU868 (White) People Counter set - LoRaWAN EU868 (Black)	LoRaWAN Communication on the EU868 band **Measuring:** people counting in 2 directions
IB010-002.00 IB010-002.02	People Counter set - LoRaWAN US915 (White) People Counter set - LoRaWAN US915 (Black)	LoRaWAN Communication on the US915 band **Measuring:** people counting in 2 directions
IB010-003.00 IB010-003.02	People Counter set - LoRaWAN AU915 (White) People Counter set - LoRaWAN AU915 (Black)	LoRaWAN Communication on the AU915 band **Measuring:** people counting in 2 directions
IB010-006-00 IB010-006.02	People Counter set - LoRaWAN AS923 (White) People Counter set - LoRaWAN AS923 (Black)	LoRaWAN Communication on the AS923 band **Measuring:** people counting in 2 directions
NB-IoT		
IB011-001.00 IB011-001.02	People Counter set - NB-IoT (White) People Counter set - NB-IoT (Black)	NB-IoT Communication **Measuring:** people counting in 2 directions
IoT		
IB012-001.00 IB012-001.02	People Counter set - IoT EU868 (White) People Counter set - IoT EU868 (Black)	Sub-GHz proprietary communication for EU868 band **Measuring:** people counting in 2 directions

IB012-002.00 IB012-002.02	People Counter set - IoT US915 (White) People Counter set - IoT US915 (Black)	Sub-GHz proprietary communication for US915 band **Measuring:** people counting in 2 directions
IB012-001.01 IB012-001.03	People Counter set - IoT EU868 instant (White) People Counter set - IoT EU868 instant (Black)	Sub-GHz proprietary communication for US915 band **Measuring:** people counting in 2 directions. Each count is transmitted
IB012-002.01 IB012-002.03	People Counter set - IoT US915 instant (White) People Counter set - IoT US915 instant (Black)	Sub-GHz proprietary communication for US915 band **Measuring:** people counting in 2 directions. Each count is transmitted
EnOcean		
IB039-001.00 IB039-001.02	People Counter set - EnOcean EU868 (White) People Counter set - EnOcean EU868 (Black)	Sub-GHz EnOcean communication for EU region **Measuring:** people counting in 2 directions
IB039.002.00 IB039.002.02	People Counter set - EnOcean US902 (White) People Counter set - EnOcean US902 (Black)	Sub-GHz EnOcean communication for US region Measuring: people counting in 2 directions

Sensor Status

The table below contains the various available status bits.

Dec.	Hex.	Description
128	0x80	Infrared blocked (Receiver doesn't see the infrared from the Transmitter)
64	0x40	Receiver detected disturbance on the sensor
32	0x20	Receiver Low Battery
16	0x10	reserved
8	0x08	reserved
4	0x04	Sensor Power Up
2	0x02	IR signal not at full strength.
1	0x01	reserved

This status is bitwise which means multiple status messages can appear at once.

General information about line crossing based People Counting

Line crossing based people counting means as much as counting how many people are crossing a line. Such a particular countline can be defined by software in (passive) camera based solutions or by an active signal beam from a device.

The core question is always about accuracy. However there is no "one-size-fits-all" answer available for any device. The only way to determine whether the accuracy meets the requirements, is to test.
There are multiple factors influencing the accuracy.

- Width of the count line / pathway / entrance
- Amount of people crossing the count line within a period of time
- Sensor technology
- Protocol of determining the count
- Installation / configuration complexity
- External interferences

Within a smart building environment most entrances are less than 4 meters wide. These are mostly doorways in offices, schools, hospitals etc.
Another area of interest is the retail environment, that may have much wider entrances.
Within these environments the focus is not on big crowds or crowd management. This is another topic that uses different techniques and estimations.

All cases can be solved by camera based or active beam solutions like horizontal People Counters.
Several questions can be asked when choosing a solution/technology.

- Costs of installation and maintenance
- Available and possible communication methods
- Ease of installation (installed by a specialist or by anyone)
- Is privacy a topic (is the device placed within the personal space of individuals)

<u>Example case - entrance up to 4 meter.</u>
In this situation it can be assumed that a simultaneous passage of multiple individuals is limited. The use of a camera based solution within this setting may not result into higher accuracy. Furthermore, keeping an as simple and easy solution possible, will gain better overall results.

Example case - wider entrances up to 12 meter.
It is more likely for multiple people crossing the count line simultaneously in this situation, on the other hand these wider entrances are required to handle higher numbers of people entering.
A high accuracy is possible when a camera based solution is applied. However the configuration of such a setup is much more complex, in most cases it requires multiple cameras to be linked together.

In case privacy is a topic a camera based solution will always evoke a discussion. Even when privacy is ensured and it still looks like a camera which is generally known as a recording device.

Nowadays it is generally expected that applying technology requires no technician. A Plug & Play solution is mandatory. For example; to define the count line, a camera based solution requires more configuration whilst placing 2 devices in opposite to each other requires none..

General information about occupancy

To determine how many people are within a given area, multiple solutions are possible. The most effective one is to count how many people are entering and leaving the area. By calculating the difference between the ingoing and outgoing count values you can determine the occupancy.

A good indicator of accuracy is the difference between the total number of ingoing and outgoing people. The closer these numbers are together, the more accurate the occupancy value is during the period of time.

Consider the following situation regarding accuracy in a given moment of time:

- A system displays a live occupancy of 9 when there are actually 10 people in a room
- This system displays 99 visits of the same room while there were actually 100 visits

This deviation of 1 seems to have a significant impact in situation 1. However the accuracy on the total count value over time (situation 2) is 99%.

Because of this difference it is important to know in which case an optimization using a software protocol is required. When there is a possibility to control the physical situation at the entrance, the results will be improved.

In case of a maximum number of allowed people, it is common (and recommended) to apply a margin within the values, in case there is a difference between the actual situation and the digital created situation.

Information about interval vs event based / real time data transmission

Our People Counter - EnOcean, People Counter - LoRaWAN and Office Occupancy Counter - LoRaWAN is able to transmit data at a regular interval or event based.

Interval based
In this mode the device will transmit data at a configured interval.
The minimum interval available is 1 minute where the maximum is 1 day. The default value is set to 15 minutes.

Event based
This option allows real time transmission of the count values.
To use this real time functionality the device will transmit on each count.

Furthermore the event can be configured.
Example: Transmit data when 5 counts are registered or when there is no new count after 1 minute.
In this situation the event is configured for 5 counts and using a timeout of 1 minute.

Please note that the IMBUILDINGS Devices respect the regulations within the ISM frequency band it is working.
In case there are too many data packets sent within a short period of time, the device will wait until it is allowed again to transmit. During this short waiting period, the data is not lost. In case of a People Counter the count values are incremented and not lost.

4.1.1 People Counter - LoRaWAN - Additional information about uplink settings.

The People Counter LoRaWAN can work in 2 modes:

- Interval based
- Event based

Interval based
In case it is interval based the uplink of the payload will take place at a regular configurable interval. The factory default interval is set to 15 minutes.

Event based
Event based uplinks can be configured. This option can be used to transmit count values in real time.
Currently a ‘changed count value’ event can be chosen. The amount of counts to trigger the event can also be set.
The timeout argument of an event ensures that the event is transmitted in case it is not triggered within the selected period of time.

The settings can be found in the list of settings in chapter 7.3

Default event is on count change. Required count value is 1.

4.1.2 People Counter - LoRaWAN - Additional information about downlink setting

Please note that settings changed using a downlink are volatile meaning that when the device resets or powers off and on again the settings are back to the configured settings within NFC memory.

4.1.3 People Counter - LoRaWAN - Additional information about the payload

By default the People Counter - LoRaWAN transmits a payload in the format described as type 2 variant 6.
This payload includes a header containing for example the Device EUI. While this is an additional payload it enables payload parsers to work with the payload directly without getting information from the LoRaWAN meta data.

Using the payload configuration setting it is possible to choose another payload type/variant with the option to leave out the type/variant and payload header.

4.1.4 People Counter - LoRaWAN - Heartbeat

In case the device is configured for event based uplinks a heartbeat can be useful in case no events are triggered. The heartbeat enables an ‘I’m still online’ feature. The payload send by the heartbeat can be chosen.

Note: Using the heartbeat it is possible to receive data from the device on event base and at a regular interval.
To do this you configure the event and set the heartbeat payload to device data.

4.1.5 People Counter - LoRaWAN - Device status

A few status bits give information about the device.
These are as follows.

Dec.	Hex.	Description
0	0x00	No status information
1	0x01	Startup
2	0x02	Reconnect
4	0x04	Settings changed
8	0x08	Placed battery not full during startup
16	0x10	reserved
32	0x20	reserved
64	0x40	reserved
128	0x80	reserved

Please note that when these events occur the status bit will be transmitted once during the next uplink.

4.2 Comfort Sensor

Range of battery powered Comfort Sensors

Article	Product	Description
LoRaWAN		
IB013-001.00	Comfort Sensor CO2 - LoRaWAN EU868 Professional	LoRaWAN Communication on the EU868 band **Measuring:** temperature, humidity, presence and CO_2 (30ppm accuracy)
IB013-001-01	Comfort Sensor CO2 - LoRaWAN US915 Professional	LoRaWAN Communication on the US915 band **Measuring:** temperature, humidity, presence and CO_2 (30ppm accuracy)
IB013-001.02	Comfort Sensor CO2 - LoRaWAN AU915 Professional	LoRaWAN Communication on the AU915 band **Measuring:** temperature, humidity, presence and CO_2 (30ppm accuracy)
IB013-001.03	Comfort Sensor CO2 - LoRaWAN AS923 Professional	LoRaWAN Communication on the AS923 band **Measuring:** temperature, humidity, presence and CO_2 (30ppm accuracy)
IB013-004.00	Comfort Sensor CO2 - LoRaWAN EU868 Economic	LoRaWAN Communication on the US915 band **Measuring:** temperature, humidity, presence and CO_2 (50ppm accuracy)
IB013-004.01	Comfort Sensor CO2 - LoRaWAN US915 Economic	LoRaWAN Communication on the US915 band **Measuring:** temperature, humidity, presence and CO_2 (50ppm accuracy)
IB013-004.02	Comfort Sensor CO2 - LoRaWAN AU915 Economic	LoRaWAN Communication on the AU915 band **Measuring:** temperature, humidity, presence and CO_2 (50ppm accuracy)
IB013-004.03	Comfort Sensor CO2 - LoRaWAN AS923 Economic	LoRaWAN Communication on the AS923 band **Measuring:** temperature, humidity, presence and CO_2 (50ppm accuracy)

IB013-003.00	Comfort Sensor Presence LoRaWAN EU868	LoRaWAN Communication on the EU868 band **Measuring:** temperature, humidity, presence
IB013-003.01	Comfort Sensor Presence LoRaWAN US915	LoRaWAN Communication on the US915 band **Measuring:** temperature, humidity, presence
IB013-003.02	Comfort Sensor Presence LoRaWAN AU915	LoRaWAN Communication on the AU915 band **Measuring:** temperature, humidity, presence
IB013-003.03	Comfort Sensor Presence LoRaWAN AS923	LoRaWAN Communication on the AS923 band **Measuring:** temperature, humidity, presence
IB013-002.00	Comfort Sensor Temperature LoRaWAN EU868	LoRaWAN Communication on the EU868 band **Measuring:** temperature, humidity
IB013-002.01	Comfort Sensor Temperature LoRaWAN US915	LoRaWAN Communication on the US915 band **Measuring:** temperature, humidity
IB013-002.02	Comfort Sensor Temperature LoRaWAN AU915	LoRaWAN Communication on the AU915 band **Measuring:** temperature, humidity
IB013-002.03	Comfort Sensor Temperature LoRaWAN AS923	LoRaWAN Communication on the AS923 band **Measuring:** temperature, humidity

Additional information about the mentioned eCO2:

When measuring CO2 it is not always important to have the highest accuracy which you will have with a CO2 sensor.

The estimated CO2 gives an insight of the CO2 levels without the high accuracy PPM values.

Addition information about the presence detection:

The presence sensor will tell if someone was in the room during the last transmission interval.

4.3 Buttons & Moodbox

4.3.1 Moodbox / Buttons - LoRaWAN - Device status

A few status bits give information about the device.
These are as follows.

Dec.	Hex.	Description
0	0x00	No status information
1	0x01	Startup
2	0x02	Reconnect
4	0x04	Settings changed
8	0x08	Placed battery not full during startup
16	0x10	reserved
32	0x20	reserved
64	0x40	reserved
128	0x80	reserved

Please note that when these events occur the status bit will be transmitted once during the next uplink.

4.4 Office Occupancy Counter

Range of Occupancy Counters

Article	Product	Description
LoRaWAN		
IB036-001.00	Office Occupancy Counter - LoRaWAN EU868	LoRaWAN Communication on the EU868 band **Measuring:** people counting in 2 directions
IB036-002.00	Office Occupancy Counter - LoRaWAN US915	LoRaWAN Communication on the US915 band **Measuring:** people counting in 2 directions
IB036-003.00	Office Occupancy Counter - LoRaWAN AU915	LoRaWAN Communication on the AU915 band **Measuring:** people counting in 2 directions
IB036-004.00	Office Occupancy Counter - LoRaWAN AS923	LoRaWAN Communication on the AS923 band **Measuring:** people counting in 2 directions

4.4.1 Distance settings

The device can be configured with 2 distances. More information about the working of this is described in the manual of the Office Occupancy Counter.

These distances can be changed using NFC and the Android app.
It is also possible to change these distances with a downlink.

The following downlink example sets the ignore distance to 30cm and the detection distance at 150cm.

```
0xF1 0x01 0x04 0x50 0x1E 0x96
```

It is recommended to cascade multiple commands in a single downlink. In this case you could add the save command, This would result in the following downlink:

```
0xF1 0x01 0x04 0x50 0x1E 0x96 0x03 0xC8 0x04
```

5. Related information

For more information please contact your supplier.

Notes

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