LPWAN Networks & Sensors Solutions

NetOP Technology

LPWAN Devices

User Manual and Data Protocol Definition

v1.9

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Document History

Version	Date	Description	Issued By
v1.0	02/01/2018	Initial release of document	BB
v1.1	02/03/2018	Information types are added including PSM Active Timer Value, PSM Periodic Timer Value, Connection Number. Furthermore, unit of signal power was converted into dBm.	GA
v1.2	04/03/2018	Added new sensors and their data formats. Added data type values to titles. Document versions were corrected.	BB
v1.3	07/05/2018	Visual modifications	BB
v1.4	29/05/2018	Data payload section revised. Step 1 has been added.	BB
v1.5	07/08/2018	Protocol is completely revised. Data header is changed. Sensor board type and sensor function splitted. Payload formats re-defined. Battery level has been added. Protocol header has been added.	GA+BB
v1.6	13/08/2018	Checksum explained. Protocol version defined as "1". Error bit added to data header.	BB
v1.7	11/09/2018	Soil Moisture and Manhole Sensors have been added.	BB
v1.8	15/02/2018	Timestamp is changed to time before transmit. Some new sensor functions have been added.	BB
v1.9	03/09/2019	Added new sensor functions	BB

1. Frame

Format of the frame is shown below.

Table 1: Frame Format

1 byte	4 bytes	N bytes	N bytes	...	N bytes	1 byte
Protocol Header	Serial Number	Data Block 1	Data Block 2	...	Data Block n	Checksum

First byte of each frame starts with a 1-byte protocol header. Device serial number having length of 4-bytes follows it. Then, a number of data blocks that contain different information come. Finally, frame is terminated by checksum byte.

Data blocks include 3-bytes “Data Header” to identify sensor board type, sensor function and slot number and n-bytes “Data Payload”. Information types and content lengths are pre-defined concepts and given in next sections. User must parse them due to specific rules.

Maximum length of a frame is 256-bytes.

2. Protocol Header

It shows version of the protocol. Server side should know it to understand how to parse the frame.

Table 2: Protocol Header Format

7	6	5	4	3	2	1	0
Reserved					Protocol Version		

Example: XXXXX001 means that protocol version is 1. Most significant 5-bits are reserved bits.

This document implies protocol version 1.

3. Serial Number

Serial number consist of 4-bytes and it shows unique device ID.

4. Data Block

Format of a data block is shown below.

Table 3: Data Block Format

3 bytes	N bytes
Data Header	Data Payload

Each data block starts with 3-bytes “Data header”. It gives some information including “Slot Number”, “Sensor Function/Device Information” and “Sensor Board Type”. Table 4 shows details of 3-bytes data header.

4.1. Data Header

Data header contains information about the following data payload. User can get information about the message contains read timestamp or not, slot number, sensor function or device information, sensor board type. Table 4 shows the data header format. Detailed information is given at Table 5.

Table 4: Data Header Format

Byte 1								Byte 2								Byte 3							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Message Contains Read Timestamp	Reserved	Slot Number			Data Payload Might Have Error	Sensor Function / Device Information									Reserved	Sensor Board Type							

Table 5: Description of Data Header

Bit	Name	Description
23	Message Contains Read Time Information	This bit controls whether data payload will contain read time information. If it is '1', time information will be added before sensor data, otherwise there won't be time information before sensor data
22	Reserved	Reserved for future use
21-19	Slot Number	Represents the slot number which data came from 0: Device's itself Other: Slot number of related sensor
18	Data Payload Might Have Error	Indicates there might be an error while reading sensor data. User can choose to discard this data.
17-9	Sensor Function / Device Information	Represents the function of sensor. Data parsing must be made according to this information. If bits 7-0 of this header is 0x00, then this field represents device information. Please refer the tables below for meaning of this field.
8	Reserved	Reserved for future use
7-0	Sensor Board Type	Represents which sensor hardware is plugged on related slot.

4.1.1. Message Contains Read Timestamp

This field shows if there is a timestamp information which is belong to sensor reading is present or not. This timestamp is located before data payload and it is 4 bytes long.

4.1.2. Slot Number

Sensors can be located on different slots. This field shows the slot number of the sensor board. If this field is 0, that means, following information Is related to the complete device.

4.1.3. Data Payload Might Have Error

This field indicates that there might be some error at payload in that data block. User can choose discarding this data, showing some error, or using it even it is faulty.

4.1.4. Sensor Function / Device Information

This field shows the purpose of plugged sensor board. Sensor functions and their data payloads are given in Table 6. If sensor board type field is 0x0000, this means, this field shows some information about related slot number. These informational parameters are given in Table 7.

Table 6: Sensor Functions

Value	Description	Payload Length
0x000	N/A	N/A
0x001	Shaking Sensor	6 bytes
0x002	2 Plane Tilt Detection Sensor	4 bytes
0x003	Vibration Sensor	2 bytes
0x004	1 Phase Current Sensor	2 bytes
0x005	3 Phase Current Sensor	6 bytes
0x006	Dry Contact Sensor	1 byte
0x007	Asset Tracking Sensor	To be defined
0x008	Geofence Sensor	To be defined
0x009	Temperature Sensor	2 bytes
0x00A	Humidity Sensor	2 bytes
0x00B	Temperature & Humidity Sensor	3 bytes
0x00C	Door Opening - Closing Counter Sensor	4 bytes
0x00D	3 Plane Tilt Detection Sensor	6 bytes
0x00E	1 Button Sensor	1 byte
0x00F	3 Button Sensor	1 byte
0x010	Door Sensor	1 byte
0x011	RTD Temperature Sensor	2 bytes
0x012	PIR Sensor	1 byte
0x013	Distance Sensor	2 bytes
0x014	Ambient Light Sensor	4 bytes
0x015	Sound Level Sensor	1 byte
0x016	Glass Break Sensor	1 byte
0x017	1 Phase Mains Voltage Sensor	2 bytes
0x018	3 Phase Mains Voltage Sensor	6 bytes
0x019	Metal Detection Sensor	To be defined
0x01A	Compass Sensor	To be defined
0x01B	RS485 Sensor	To be defined
0x01C	1 Phase Mains Voltage Sensor with Power Cut Detection	2 bytes

0x01D	3 Phase Mains Voltage Sensor with Power Cut Detection	6 bytes
0x01E	BLE Signal Strength	To be defined
0x01F	Soil Moisture Sensor	1 byte
0x020	Manhole Sensor	1 byte
0x021	Magnetic Field Sensor	9 bytes
0x022	Power Line Analyzer Sensor	172 bytes
0x023	Barometric Pressure Sensor	3 bytes
0x024	Tilt Switch Sensor	1 byte
0x025	Parking Lot Sensor	1 byte
0x026	3 Axis Accelerometer Sensor	6 bytes
0x027	6 Axis Accelerometer Sensor	12 bytes
0x028	Power Line Analyzer Sensor (Model – 2)	224 bytes
0x029	Water Flooding Sensor	1 byte
0x02A	Water Level Threshold Sensor	1 byte
0x02B	Park Calibration Sensor	Not for customer use
0x02C	Waste Bin Sensor	2 bytes
0x02D	UV Light Sensor	To be defined
0x02E	Barometric Pressure & Temperature & Humidity Sensor	To be defined
0x02F	Modbus Sensor	Customer specific length

Table 7: Device Information Parameters

Value	Description	Payload Length
0x000	Number of Transmits	4 bytes
0x001	Number of Slots	1 byte
0x002	Plugged Slots	1 byte
0x003	Serial Number	4 bytes
0x004	Connectivity FW Version	2 bytes
0x005	SW Version	2 bytes
0x006	HW Version	2 bytes
0x007	Cell ID	4 bytes
0x008	Signal Power	1 byte
0x009	IMEI	7 bytes
0x00A	IMSI	7 bytes
0x00B	Frequency	2 bytes
0x00C	EDRX Mode Support	1 byte
0x00D	Number of Connection Trials	1 byte
0x00E	PSM Periodic Timer Value	1 byte
0x00F	PSM Active Timer Value	1 byte
0x010	Battery Level	1 byte
0x011	Alive Message Period	4 bytes

4.1.5. Sensor Board Type

This field shows the type of sensor board hardware of related slot. If this field is 0x00, that means, following information is device information parameter. User should use the information on Table 7 for “Sensor Function / Device Information” section. For other sensor board type values, types are given in Table 8.

Table 8: Sensor Board Types

Value	Description
0x00	Used to indicate “Device Information Parameter”
0x01	3 Axis Accelerometer Sensor Board
0x02	Current Transformer Sensor Board
0x03	Dry Contact Sensor Board
0x04	GPS Sensor Board
0x05	Temperature & Humidity Sensor Board
0x06	6 Axis Accelerometer Sensor Board
0x07	Button Sensor Board
0x08	RTD Sensor Board
0x09	PIR Sensor Board
0x0A	Laser Distance Sensor Board
0x0B	Ambient Light Sensor Board
0x0C	Piezo Sensor Board
0x0D	Sound Sensor Board
0x0E	Voltage Sensor Board
0x0F	Magnetometer Sensor Board
0x10	RS485 Sensor Board
0x11	Voltage & Power Cut Sensor Board
0x12	BLE Signal Strength Sensor Board
0x13	Reed Switch Sensor Board
0x14	Soil Moisture Sensor Board
0x15	Tilt Switch Sensor Board
0x16	Energy Meter Sensor Board
0x17	Barometric Pressure Sensor Board
0x18	Ultrasonic Sensor Board
0x19	UV Light Sensor Board
0x1A	Prototyping Board
0x1B	Relay Board

5. Sensor Data Payloads

Tip: If "Message Contains Read Timestamp" bit is "1", then 4 bytes long time information will be added before these payloads. This time information gives an information about when the sensor measured from the physical environment. This contains how many seconds were passed between that specific reading and the actual time of transmission. We can assume that transmission time is equal to server time at receive.

5.1. Shaking Sensor (0x001)

In this type of data, payload contains 6-bytes acceleration data. Each 2 bytes represents one axis. Message is delivered when device shaked.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Acceleration X		Acceleration Y		Acceleration Z	

Acceleration data is in +/- 2g range. These sections are in signed short format. User must divide the value to 1000 to reach actual acceleration value.

Example Data Payload: 0xFE 0x0C 0xFF 0x38 0x04 0xB0
Acceleration X: 0xFE0C -> -500 -> -0.5g
Acceleration Y: 0xFF38 -> -200 -> -0.2g
Acceleration Z: 0x04B0 -> 1200 -> +1.2g

5.2. 2 Plane Tilt Detection Sensor (0x002)

In this type of data, payload contains 4-bytes tilt data. Each 2 bytes represents one plane.

Byte 1	Byte 2	Byte 3	Byte 4
Tilt X		Tilt Y	

Tilt data is +/- 90 degrees range. User must subtract 9000 and divide this value to 100 to get actual tilt value.

Example Data Payload: 0x27 0x10 0x1D 0x4C
Tilt X: 0x2710 -> 10000 -> 10000 - 9000 -> 1000 / 100 -> +10,0 degree
Tilt Y: 0x1D4C -> 7500 -> 7500 - 9000 -> -1500 / 100 -> -15,0 degree

5.3. Vibration Sensor (0x003)

In this type of data, payload contains 2 bytes vibration data. This data is in 0.01mm/s scale.

Byte 1	Byte 2
Vibration Data	

Example Data Payload: 0x00 0xE2
Vibration: 0x00E2 = 226 -> 2.26mm/s

5.4. 1 Phase Current Sensor (0x004)

In this type of data, payload contains 2 bytes. One phase is represented by 2 bytes unsigned integer. Current value is in 100mA scale.

Byte 1	Byte 2
Current Value of Phase 1	

Example Data Payload: 0x02 0xEF
Phase 1: 0x02EF= 751 -> 75.1A

5.5. 3 Phase Current Sensor (0x005)

In this type of data, payload contains 6 bytes. One phase is represented by 2 bytes unsigned integer. Current value is in 100mA scale.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Current Value of Phase 1		Current Value of Phase 2		Current Value of Phase 3	

Example Data Payload: 0x02 0xEF 0x01 0xF8 0x02 0x14
Phase 1: 0x02EF = 751 -> 75.1A
Phase 2: 0x01F8 = 504 -> 50.4A
Phase 3: 0x0214 = 532 -> 53.2A

5.6. Dry Contact Sensor (0x006)

In this type of data, payload contains 1-byte input status data. Each input shown with one bit. If the bit is 1, then input is not asserted. If the bit is 0, then input is asserted. Input bits are located as the least significant side of the byte.

Byte 1							
7	6	5	4	3	2	1	0
0000				IN4	IN3	IN2	IN1

Example Data Payload: 0x0E
Inputs: 1110 -> IN1: asserted, IN2: not-asserted, IN3: not-asserted, IN4: not-asserted

5.7. Asset Tracking Sensor (0x007)

To be defined.

5.8. Geofence Sensor (0x008)

To be defined.

5.9. Temperature Sensor (0x009)

In this type of data, payload contains 2-bytes temperature data.

Byte 1	Byte 2
Temperature	

Temperature information is at 0.01 degrees celcius scale. Temperature range is between -40.00 degrees and 120.00 degrees celcius. User must subtract 4000, then divide the value by 100 to reach actual temperature value.

Example Data Payload: 0x18 0x7E
Temperature: 0x187E -> (6270 – 4000)/100 = 22.70 degrees celcius

5.10. Humidity Sensor (0x00A)

In this type of data, payload contains 2-bytes humidity data.

Byte 1	Byte 2
Relative Humidity (%)	

Relative humidity information is at %0.1 scale. It is between %0.0 and %100.0 range. User must divide the value by 10 to reach actual relative humidity value.

Example Data Payload: 0x02 0x5E
Relative Humidity: 0x25E -> 606 / 10 = %60.6

5.11. Temperature & Humidity Sensor (0x00B)

In this type of data, payload contains 3-bytes temperature and humidity data. Most significant 14 bits of the 3 bytes long data represents temperature information. Least significant 10 bits represents humidity information.

Byte 1								Byte 2								Byte 3							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
13	12	11	10	9	8	7	6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1	0
Temperature														Humidity									

Temperature information is at 0.01 degrees celcius scale. Temperature range is between -40.00 degrees and 120.00 degrees celcius. User must subtract 4000, then divide the value by 100 to reach actual temperature value.

Relative humidity information is at %0.1 scale. It is between %0.0 and %100.0 range. User must divide the value by 10 to reach actual relative humidity value.

Example Data Payload: 0x61 0xfa 0x5e
Temperature + Humidity: 0x61fa5e
Temperature: 0x187e -> (6270 – 4000)/100 = 22.70 degrees celcius
Relative Humidity: 0x25e -> 606 / 10 = %60.6

5.12. Door Counter Sensor (0x00C)

In this type of data, payload contains 4 bytes data. 2 bytes for opening counter and 2 bytes for closing counter. These counters are unsigned integers.

Byte 1	Byte 2	Byte 3	Byte 4
Opening Counter		Closing Counter	

Example Data Payload: 0x00 0x21 0x00 0x20
Opening counter: 0x0021 -> 33 times opened
Closing counter: 0x0020 -> 32 times closed

5.13. 3 Plane Tilt Detection Sensor (0x00D)

In this type of data, payload contains 6-bytes tilt data. Each 2 bytes represents one plane.

Byte 1-2	Byte 3-4	Byte 5-6
Tilt X	Tilt Y	Tilt Z

Tilt data is +/- 90 degrees range. User must subtract 9000 and divide this value to 100 to get actual tilt value.

Example Data Payload: 0x27 0x10 0x1D 0x4C
Tilt X: 0x2710 -> 10000 -> 10000 - 9000 -> 1000 / 100 -> +10,0 degree
Tilt Y: 0x1D4C -> 7500 -> 7500 - 9000 -> -1500 / 100 -> -15,0 degree

5.14. 1 Button Sensor (0x00E)

In this type of data, payload contains 1 byte button status data. Each button shown with one bit. If the bit is 0, then the button is not pressed. If the bit is 1, then button is pressed. Input bits are located as the least significant side of the byte.

Byte 1							
7	6	5	4	3	2	1	0
0000000							BUTTON1

Example Data Payload: 0x01
Inputs: 1 -> BUTTON1: pressed

5.15. 3 Button Sensor (0x00F)

In this type of data, payload contains 1 byte button status data. Each button shown with one bit. If the bit is 0, then the button is not pressed. If the bit is 1, then button is pressed. Input bits are located as the least significant side of the byte.

Byte 1							
7	6	5	4	3	2	1	0
00000					BUTTON3	BUTTON2	BUTTON1

Example Data Payload: 0x01
Inputs: 001 ->BUTTON3: not-pressed, BUTTON2: not-pressed, BUTTON1: pressed

5.16. Door Sensor (0x010)

In this type of data, payload contains 1 byte door status data. Door status shown with one bit. If the bit is 1, then the door is closed. If the bit is 0, then the door is opened.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Door Status

Example Data Payload: 0x01
Door: 1 -> Door Status: closed

5.17. RTD Temperature Sensor (0x011)

In this type of data, payload contains 2 bytes temperature data.

Byte 1	Byte 2
Temperature data	

Temperature information is at 0.1 degrees celcius scale. Temperature range is between -200.0 degrees and 850.0 degrees celcius. User must subtract 2000, then divide the value by 10 to reach actual temperature value.

Example Data Payload: 0x11 0xfa
Temperature: 0x11fa -> (4602 – 2000) / 10 = 260.2 celcius.

5.18. PIR Sensor (0x012)

In this type of data, payload contains 1-byte detection status data. Detection represented with one bit. This bit is 1 when a movement is detected.

Byte 1							
7	6	5	4	3	2	1	1
0000000							Movement Detected

Example Data Payload: 0x01
PIR: Movement Detected

5.19. Distance Sensor (0x013)

In this type of data, payload contains 2 bytes distance data. This information is at millimeter scale.

Byte 1	Byte 2
Distance data	

Example Data Payload: 0x01 0x28
Distance: 0x0128 -> 296mm

5.20. Ambient Light Sensor (0x014)

In this type of data, payload contains 4 bytes ambient light level data.

Byte 1	Byte 2	Byte 3	Byte 4
Ambient Light Level			

Light information is at 0.01 lux scale. Measurement range is 0.01 – 83000 lux.

Example Data Payload: 0x00 0x00 0x2E 0xD9
Ambient Light: 0x00002ED9 = 11993 -> 119.93 lux.

5.21. Sound Level Sensor (0x015)

To be defined

5.22. Glass Break Sensor (0x016)

In this type of data, payload contains 1-byte glass break detection status data. Detection represented with one bit. This bit is 1 when a glass break event is detected.

Byte 1							
7	6	5	4	3	2	1	1
0000000							Glass Break Event Detected

Example Data Payload: 0x01
Glass Break Event: Break Detected

5.23. 1 Phase Mains Voltage Sensor (0x017)

In this type of data, payload contains 2 bytes. One phase is represented by 2 bytes unsigned integer. Voltage value is in 10mV scale.

Byte 1	Byte 2
Voltage Value of Phase 1	

Example Data Payload: 0x57 0x56
Phase 1: 0x5756 = 22358 -> 223.58V

5.24. 3 Phase Mains Voltage Sensor (0x018)

In this type of data, payload contains 6 bytes. One phase is represented by 2 bytes unsigned integer. Voltage value is in 10mV scale.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Voltage Value of Phase 1		Voltage Value of Phase 2		Voltage Value of Phase 3	

Example Data Payload: 0x94 0x70 0x94 0x82 0x94 0x04
Phase 1: 0x9470 = 38000 -> 380.00V
Phase 2: 0x9482 = 38018 -> 380.18V
Phase 3: 0x9404 = 37892 -> 378.92V

5.25. Metal Detection Sensor (0x019)

To be defined.

5.26. Compass Sensor (0x01A)

To be defined.

5.27. RS485 Sensor (0x01B)

To be defined.

5.28. 1 Phase Mains Voltage Sensor with Power Cut Detection (0x01C)

In this type of data, payload contains 2 bytes. One phase is represented by 2 bytes unsigned integer. Voltage value is in 10mV scale. Message is sent periodically, also in a power cut event.

Byte 1	Byte 2
Voltage Value of Phase 1	

Example Data Payload: 0x57 0x56
Phase 1: 0x5756 = 22358 -> 223.58V

5.29. 3 Phase Mains Voltage Sensor with Power Cut Detection (0x01D)

In this type of data, payload contains 6 bytes. One phase is represented by 2 bytes unsigned integer. Voltage value is in 10mV scale. Message is sent periodically, also in a power cut event.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Voltage Value of Phase 1		Voltage Value of Phase 2		Voltage Value of Phase 3	

Example Data Payload: 0x94 0x70 0x94 0x82 0x94 0x04
Phase 1: 0x9470 = 38000 -> 380.00V
Phase 2: 0x9482 = 38018 -> 380.18V
Phase 3: 0x9404 = 37892 -> 378.92V

5.30. BLE Signal Strength (0x01E)

To be defined.

5.31. Soil Moisture Sensor (0x01F)

In this type of data, payload contains 1 byte that represents moisture as a percentage value.

Byte 1
Soil Moisture Percentage

Example Data Payload: 0x44
Soil Moisture: 0x44 = 68 -> %68

5.32. Manhole Sensor (0x020)

In this type of data, payload contains 1 byte lid status data. Manhole lid status shown with one bit. If the bit is 0, then the lid is closed. If the bit is 1, then the lid is opened.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Lid Status

Example Data Payload: 0x01
Lid: 1 -> Manhole Lid Status: opened

5.33. Magnetic Field Sensor(0x021)

In this type of data, payload contains 9 bytes magnetic field data. This 9 bytes contains 3 axis (X, Y, Z) data and each one costs 3 bytes. User should substract 50000 from all of 3 axis data. Then user get the magnetic field value in milligauss scale.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 8	Byte 8	Byte 9
Magnetic Field of X Axis			Magnetic Field of Y Axis			Magnetic Field of Z Axis		

Example Data Payload: 0x00, 0xE4, 0x68, 0x00, 0xA2, 0x87, 0x01, 0x09, 0xC4

X Axis: 0x00E468 = 58472 – 50000 = -8478 mgauss
Y Axis: 0x00A287 = 41607 – 50000 = -8393 mgauss
Z Axis: 0x0109C4 = 68036 – 50000 = 18036 mgauss

5.34. Power Line Analyzer Sensor(0x022)

In this type of data, payload contains some useful statistics about a three phase power line. This information is packed to 172 bytes. Each value is in IEEE754 floating point format. Following parameters will be packed in block.

1-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	40-44	44-48	48-52	52-56
P1 Voltage (RMS)	P1 Current (RMS)	P1 Effective Current	P1 Frequency	P1 Power Factor	P1 Active Power	P1 Reactive Power	P1 THD on Current	P1 THD on Voltage	P1 3rd Harmonic of Current	P1 5th Harmonic of Current	P1 7th Harmonic of Current	P1 9th Harmonic of Current	P1 11th Harmonic of Current
56-60	60-64	64-68	68-72	72-76	76-80	80-84	84-88	88-92	92-96	96-100	100-104	104-108	108-112
P2 Voltage (RMS)	P2 Current (RMS)	P2 Effective Current	P2 Frequency	P2 Power Factor	P2 Active Power	P2 Reactive Power	P2 THD on Current	P2 THD on Voltage	P2 3rd Harmonic of Current	P2 5th Harmonic of Current	P2 7th Harmonic of Current	P2 9th Harmonic of Current	P2 11th Harmonic of Current
112-116	116-120	120-124	124-128	128-132	132-136	136-140	140-144	144-148	148-152	152-156	156-160	160-164	164-168
P3 Voltage (RMS)	P3 Current (RMS)	P3 Effective Current	P3 Frequency	P3 Power Factor	P3 Active Power	P3 Reactive Power	P3 THD on Current	P3 THD on Voltage	P3 3rd Harmonic of Current	P3 5th Harmonic of Current	P3 7th Harmonic of Current	P3 9th Harmonic of Current	P3 11th Harmonic of Current
168-172													
Neutral Current													

5.35. Barometric Pressure Sensor(0x023)

In this type of data, payload contains 3 bytes barometric pressure data. User get the barometric pressure value in pascal scale. Then user can divide the value to 100 to reach more traditional hPa value.

Byte 1	Byte 2	Byte 3
Barometric Pressure		

Example Data Payload: 0x00, 0xE4, 0x68

X Axis: 0x00E468 = 58472 = 584,72 hPa

5.36. Tilt Switch Sensor(0x024)

In this type of data, payload contains 1 byte tilt switch status data. Tilt switch status shown with one bit. If the bit is 0, then switch isn't activated. If the bit is 1, then the switch is activated.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Tilt Switch Status

Example Data Payload: 0x01
Switch: 1 -> Activated

5.37. Parking Lot Sensor(0x025)

In this type of data, payload contains 1 byte vehicle presence data. Vehicle detection status shown with one bit. If the bit is 0, then there is no vehicle. If the bit is 1, then there is a vehicle.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Vehicle Detection Status

Example Data Payload: 0x01
Parking lot status: 1 -> Occupied

5.38. 3 Axis Accelerometer Sensor(0x026)

In this type of data, payload contains acceleration value for three axes (X, Y, Z). Each axis represented with two bytes. Acceleration range is +/-2g. User should refer to datasheet of STMicroelectronics LIS3DH accelerometer for learning how to evaluate this values.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
Acceleration at X		Acceleration at Y		Acceleration at Z	

5.39. 6 Axis Accelerometer Sensor(0x027)

In this type of data, payload contains acceleration value for three axes (X, Y, Z) and angular rate value for three plane (Yaw, Pitch, Roll). Each axis/plane represented with two bytes. Acceleration range is +/-2g and angular rate range is 250dps. User should refer to datasheet of STMicroelectronics LSM6DSL accelerometer & gyroscope for learning how to evaluate this values.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12
Acceleration at X		Acceleration at Y		Acceleration at Z		Angular Rate at Yaw		Angular Rate at Pitch		Angular Rate at Roll	

5.40. Power Line Analyzer Sensor – Model 2 (0x028)

In this type of data, payload contains some useful statistics about a three phase power line. This information is packed to 224 bytes. Each value is in IEEE754 floating point format. Following parameters will be packed in block.

1-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	40-44	44-48	48-52	52-56	56-60	60-64	64-68	68-72
P1 Voltage (RMS)	P1 Current (RMS)	P1 Frequency	P1 Power Factor	P1 Active Power	P1 Reactive Power	P1 THD on Current	P1 THD on Voltage	P1 3rd Harmonic of Current	P1 5th Harmonic of Current	P1 7th Harmonic of Current	P1 9th Harmonic of Current	P1 11th Harmonic of Current	P1 3rd Harmonic of Current (Abs)	P1 5th Harmonic of Current (Abs)	P1 7th Harmonic of Current (Abs)	P1 9th Harmonic of Current (Abs)	P1 11th Harmonic of Current (Abs)
72-76	76-80	80-84	84-88	88-92	92-96	96-100	100-104	104-108	108-112	112-116	116-120	120-124	124-128	128-132	132-136	136-140	140-144
P2 Voltage (RMS)	P2 Current (RMS)	P2 Frequency	P2 Power Factor	P2 Active Power	P2 Reactive Power	P2 THD on Current	P2 THD on Voltage	P2 3rd Harmonic of Current	P2 5th Harmonic of Current	P2 7th Harmonic of Current	P2 9th Harmonic of Current	P2 11th Harmonic of Current	P2 3rd Harmonic of Current (Abs)	P2 5th Harmonic of Current (Abs)	P2 7th Harmonic of Current (Abs)	P2 9th Harmonic of Current (Abs)	P2 11th Harmonic of Current (Abs)

144-148	148-152	152-156	156-160	160-164	164-168	168-172	172-176	176-180	180-184	184-188	188-192	192-196	196-200	200-204	204-208	208-212	212-216
P3 Voltage (RMS)	P3 Current (RMS)	P3 Frequency	P3 Power Factor	P3 Active Power	P3 Reactive Power	P3 THD on Current	P3 THD on Voltage	P3 3rd Harmonic of Current	P3 5th Harmonic of Current	P3 7th Harmonic of Current	P3 9th Harmonic of Current	P3 11th Harmonic of Current	P3 3rd Harmonic of Current (Abs)	P3 5th Harmonic of Current (Abs)	P3 7th Harmonic of Current (Abs)	P3 9th Harmonic of Current (Abs)	P3 11th Harmonic of Current (Abs)
216-220																	
Neutral Current																	

5.41. Water Flooding Sensor (0x029)

In this type of data, payload contains 1 byte water flooding data. Flooding status shown with one bit. If the bit is 0, then there is no water between the two pins of sensor. If the bit is 1, then there is water between the two pins of the sensor. Since the sensor should be placed near the floor, user can decide there is a water flooding if this sensor sends the status as 1.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Flooding Status

Example Data Payload: 0x01
Water flooding status: 1 -> There is flooding water.

5.42. Water Level Threshold Sensor (0x02A)

In this type of data, payload contains 1 byte water level data. Level status shown with one bit. If the bit is 0, then there is no water above the threshold. If the bit is 1, then there is water above the threshold. Since the sensor should be placed a specific level at the water tank, user can decide this specific water level threshold is passed or not.

Byte 1							
7	6	5	4	3	2	1	0
0000000							Water Level Status

Example Data Payload: 0x01
Level threshold status: 1 -> Threshold passed.

5.43. Park Calibration Sensor (0x02B)

Not for customer usage. There will be no payload parsing information.

5.44. Waste Bin Sensor (0x02C)

In this type of data, payload contains 2 bytes distance data which is between sensor and waste surface. User can calculate level of waste bin according to total height of waste bin. This information is at millimeter scale.

Byte 1	Byte 2
Distance to waste data	

Example Data Payload: 0x02 0x28
Distance to waste surface: 0x0228 -> 552mm

If total height of waste bin is 1.2 meters, then waste level is 552 / 1200 = 46%.

5.45. UV Light Sensor (0x02D)

To be defined.

5.46. Barometric Pressure & Temperature & Humidity Sensor (0x02E)

To be defined.

5.47. MODBUS Sensor (0x02F)

Payload will be prepared by customer's needs. Payload contains the data which will be read from target device over RS485 MODBUS RTU protocol. Amount and order of these data will be acknowledged with customer.

6. Device Information Payloads

6.1. Number of Transmits (0x000)

Contains 4 bytes unsigned integer that corresponds the number of transmits since a battery is plugged.

6.2. Number of Slots (0x001)

Contains 1-byte value that corresponds number of total slots on this device.

6.3. Plugged Slots (0x002)

Contains 1-byte value. Each bit corresponds one slot. Least significant bit is Slot 1, most significant bit is Slot 8 The bit value "1" means; a sensor is connected on the slot, the value "0" means; no sensor connected on this slot.

6.4. Serial Number (0x003)

Contains a 4 bytes unsigned integer that corresponds serial number of device's itself or plugged sensors.

6.5. Connectivity FW Version (0x004)

Contains a 2 bytes unsigned integer that corresponds software version of connectivity stack.

6.6. SW Version (0x005)

Contains a 2 bytes unsigned integer that corresponds software version of device's itself or related sensor in the scale of one minor version number.

Example Payload: 0x0B
0x0B: 11 -> v1.1

6.7. HW Version (0x006)

Contains a 2 bytes unsigned integer that corresponds hardware version of device's itself or related sensor in the scale of one minor version number.

Example Payload: 0x0E
0x0D: 14 -> v1.4

6.8. Cell ID (0x007)

Contains a 5 bytes unsigned integer that corresponds connected cell tower ID. This information is not used by LoRa® sensors.

6.9. Signal Power (0x008)

Contains a 1-byte unsigned integer that corresponds NB-IoT signal power in terms of dBm. This information is not used by LoRa® sensors.

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6.10. IMEI (0x009)

Contains a 7 bytes unsigned integer that corresponds IMEI number. This information is not used by LoRa® sensors.

6.11. IMSI (0x00A)

Contains a 7 bytes unsigned integer that corresponds IMSI number. This information is not used by LoRa® sensors.

6.12. Frequency (0x00B)

Contains 2 bytes unsigned integer that corresponds carrier frequency value in 0.1MHz scale.

6.13. EDRX Mode Support (0x00C)

Contains 1-byte unsigned integer that indicates whether network settings of base station supports eDRX mode. Following values are supported:

0 -> Access technology is not using eDRX mode
5 -> Access technology supports eDRX mode

6.14. Number of Connection Trials (0x00D)

Contains 1-byte unsigned integer that corresponds the number of connections since a battery is plugged. This information is not used by LoRa® sensors.

6.15. PSM Periodic Timer Value (0x00E)

Contains 1-byte unsigned integer that indicates the duration of PSM period. User need to convert it to binary number system and calculate periodic timer. This information type is supported for only NB-IoT sensors. Bits 5 to 1 represent the binary coded timer value, Bits 6 to 8 define the timer value unit as follows:

Bit 8	Bit 7	Bit 6	Timer Value	Bit 5 - 0
0	0	0	10 minutes	Multiplier of Timer values
0	0	1	1 hour	
0	1	0	10 hours	
0	1	1	2 seconds	
1	0	0	30 seconds	
1	0	1	1 minute	
1	1	0	320 hours	
1	1	1	Deactivate	

<u>Example Payload:</u> 0x04
0x04: 00000100 -> 4 times 10 minutes = 40 minutes

6.16. PSM Active Timer Value (0x00F)

Contains 1-byte unsigned integer that indicates the active duration to receive data before power save mode. User need to convert it to binary number system and calculate active time. Bits 5 to 1 represents the binary coded timer value, Bits 6 to 8 define the timer value unit as follows:

Bit 8	Bit 7	Bit 6	Timer Value	Bit 5 - 0
0	0	0	2 seconds	Multiplier of Timer values
0	0	1	1 minute	
0	1	0	6 minutes	
1	1	1	Deactivate	

Example Payload: 0x24
0x24: 00100100 -> 4 times 1 minute = 4 minutes

6.17. Battery Level (0x010)

Contains 1-byte unsigned integer that indicates the battery level. Value is battery level as percentage.

Value (Decimal)	Description
0 – 100	Battery status (%), Not charging
100 – 200	Battery status (%); Charging
255	Battery measurement not supported

6.18. Alive Message Period (0x011)

Contains a 4 bytes unsigned integer that corresponds alive message period of the device. Unit of the value is seconds.

7. Checksum

A checksum mechanism implemented to control the data Is correctly received. This is at last byte of the frame. Checksum is calculated by summing all bytes except last byte, ANDing the sum with 0xFF to fit the result to one byte, and get one's complement (reversing all bits) of this value. User need to compare the result of this calculation with the last byte of frame. Both are need to be same to decide that the frame is received. If they are not same, user should discard entire frame.

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If you have any questions, please don't hesitate to contact us.

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