Mutelcor LoRaWAN Payload Document

Version: 1.5.3

NOTES:

- Currently only **version 2** is in use
- Endianness: **Big-endian**
- The type of payload is indicated by the OpCode
- The version 2 payload might be extended in the future with additional OpCode(s) and potential additional data (e.g. voting or sensor data)
- New payload versions could be introduced in the future, always starting with the version

- We always send the battery-voltage in every message
- Voltage with alkaline batteries is approx. **3.1 Volt for full batteries** and **2.4 Volt for empty**
- After power-up / reset we by default start joining and/or sending after 30 seconds (unless there is an upload before (e.g. on button pressed), then we join and send immediately)

1. LoRa Panic Button with Confirmation MTC-XX-PB01 / 02

The upload fields in the payload in order:

Field	For OpCode	Encoding	Start position	Size	Remark
Version	All	uint8	0	1	Always 2
Voltage	All	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	All	uint8	3	1	0x00: Heartbeat, 0x01: Alarm
Alarm ID	Alarm	uint16	4	2	Only included when alarm confirm is configured

Example panic button payload (length):
- **Heartbeat** (4): 02 01 4A 00
- **Alarm** (4): 02 01 49 01
- **Alarm when alarm confirm is configured** (6): 02 01 48 01 12 34

The alarm can be confirmed by the downlink command to port 1.

Downlink fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
OpCode	uint8	1	1	0x60: Alarm confirm
Alarm ID	uint16	2	2	Should match Alarm ID from Alarm upload

Examples alarm confirm downlink payload (length), send to port 1:
- **Alarm confirm** (4): 02 60 12 34

2. LoRa Alarm Unit MTC-XX-AU01 / 02 / 03 / 04

Upload fields in the payload in order:

Field	For OpCode	Encoding	Start position	Size	Remark
Version	All	uint8	0	1	Always 2
Voltage	All	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	All	uint8	3	1	0x00: Heartbeat, 0x01: Button pressed, 0x50: Alert
Duration	Alert	uint8	4	1	Remaining Alert Duration [1 minute]
Feedbacks	Alert	uint8	5	1	Active Alert Feedbacks, Bit 0 = Feedback 1, Bit 1 = Feedback 2, Bit 2 = Feedback 3, Bit 3 = Feedback 4 Only included when Duration not 0

Examples alarm unit upload payload (length):
- **Heartbeat** (4): 02 01 4A 00
- **Button pressed** (4): 02 01 49 01
- **Alert status**, No Alert (5): 02 01 48 50 00
- **Alert status**, Feedback 4 for 5 more minutes (6): 02 01 47 50 05 08

NOTE: Alert status is returned on every Alert downlink (see below)

The alarm unit can be controlled by downlink commands to port 1.

Downlink fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
OpCode	uint8	1	1	0x50: Alarm feedback
Duration	uint8	2	1	Alert Duration [1 minute] When omitted an Alert status uplink with the current alerts is sent
Feedbacks	uint8	3	1	Alert feedbacks to start, Bit 0 = Feedback 1, Bit 1 = Feedback 2, Bit 2 = Feedback 3, Bit 3 = Feedback 4 Only include when Duration is more than 0

Examples alarm unit downlink payload (length), send to port 1!:
- **Request Alert** status (2): 02 50
- **Stop current Alerts** (3): 02 50 00
- **Alert feedback 2** for 10 minutes (4): 02 50 0A 02
- **Alert feedback 3** for 10 minutes (4): 02 50 0A 04
- **Alert feedback 4** for 10 minutes (4): 02 50 0A 08
- **Extend current Alerts** for 10 minutes (3): 02 50 0A

3. LoRa Customer Feedback MTC-XX-CF01

The **upload** fields in the payload in order:

Field	For OpCode	Encoding	Size	Remark
Version	All	uint8	1	Always 2
Voltage	All	uint16	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	All	uint8	1	0x00: Heartbeat, 0x02: Votes
# Buttons	Heartbeat, Votes	uint8	1	Number of buttons
Button totals	Heartbeat, Votes	3 * uint16	6	Totals per button since start/reset/rollover
Button counts	Votes	3 * uint8	3	Counts per button since last votes uplink

Examples of customer feedback device payload (length):
- **Heartbeat** (11): 02 01 45 00 03 03 E8 07 D0 0B B
  - o   button 1: total 1000,
  - o   button 2: total 2000,
  - o   button 3: total 3000
- **Votes** (14): 02 01 46 02 03 00 0A 00 14 00 1E 01 02 03
  - o   button 1: total 10, count 1
  - o   button 2: total 20, count 2
  - o   button 3: total 30, count 3

4. Smart CO2 LoRa Sensor MTC-XX-CO2-01 / 02 / 03 / 04

The **upload** fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
Voltage	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	3	1	0x01: Alarm 0x03: Measurements 0x05: Thresholds
Measurements	uint8	4	1	Bitmask of included measurements: Bit 0 (LSB) = Temperature Bit 1 = Relative Humidity Bit 4 = CO^2
Temperature	int16	5	2	[°C] in 0.1°C steps, i.e. 378 = 37.8 °C Only included when Temperature bit set in Measurements
Relative Humidity	uint8	7	1	[%] Relative Humidity Only included when Relative Humidity bit set in Measurements
CO2	uint16	8	2	[ppm] CO^2 Only included when CO^2 bit set in Measurements
Threshold Info	uint8	10	1	Threshold info: Bit 0-3: Trigger threshold 1-4 Bit 4-7: Stop threshold 1-4 Only included when OpCode 0x05 (Thresholds)

Examples CO2 unit payload (length):
- **Alarm** (4): 02 01 49 01
- **Measurement** (10): 02 01 30 03 13 00 E5 38 05 1A
  - Temp: 22.9 °C, RH: 56%, CO2: 1306ppm
- **Threshold** (11): 02 01 30 05 13 00 E5 38 05 1A 01
  - Temp: 22.9°C, RH: 56%, CO_2: 1306 ppm, Trigger 1
- **Threshold** (11): 02 01 3B 05 13 00 E5 2A 03 D2 10
  - Temp: 22.9°C, RH: 42%, CO_2: 978 ppm, Stop 1
- **Threshold** (11): 02 01 3B 05 13 00 E5 2A 03 D2 30
  - Temp: 22.9°C, RH: 42%, CO_2: 978 ppm, Stop 1 and Stop 2

5. LoRa Manhole Sensor MTC-XX-MH01

The **upload** fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
Voltage	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	3	1	0x06: Switch 0x07: Reminder
Switch state	uint8	4	1	0x00: Switch Off 0x01: Switch On

Examples Manhole Sensor payload (length):
- Manhole opened (5): 02 01 49 06 01
- Manhole still open (5): 02 01 49 07 01
- Manhole closed (5): 02 01 49 06 00
- Manhole still closed (5): 02 01 49 07 00

NOTES:
- By default the Manhole sensor indicates "On" for manhole open and "Off" for manhole closed
- The Reminder is sent at regular intervals when there has been no switch change, it indicates the current switch state

6. LoRa Multi-Function Device MTC-XX-MF01

The **upload** fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
Voltage	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	3	1	0x03: Measurements 0x05: Thresholds 0x06: Switch (only includes the Main Switch state)
Measurements	uint8	4	1	Bitmask of included measurements: Bit 7 (MSB) = More
Measurements 2	uint8	5	1	Bit 1 (LSB) = Digital Inputs Only included when More bit set in Measurements
Digital Inputs	uint8	6	1	Digital inputs: Bit 0-3: Enabled Digital Inputs 1-4 Bit 4-7: Value Digital Inputs 1-4 Only included when Digital Inputs bit set in Measurements 2
Threshold Info	uint8	7	1	Threshold info: Bit 0-3: Trigger threshold 1-4 Bit 4-7: Stop threshold 1-4 Only included when OpCode 0x05 (Thresholds)
Main Switch state	uint8	8	1	0x00: Switch Off 0x01: Switch On

NOTES:
- The Multi-Function Device indicates "Off" for switch open and "On" for switch closed
- The main switch (MS) sends a message with Opcode (Switch) instantly every time it opens or closes
- The additional switches are connected to the digital inputs and only checked at regular intervals

Examples Multi-Function Device payload (length):
- **Main Switch closed** (5): 02 01 49 `06` `01`
- **Main Switch opened** (5): 02 01 49 `06` `00`
- **Additional Switch 1 closed** (9): 02 01 49 `05` 80 01 `13` `01` `00`
- **Additional Switch 2 opened** (9): 02 01 49 `05` 80 01 03 `20` `00`
- **No change in any Switch** (8): 02 01 49 `03` 80 01 `13` `01`

`Position 4` indicates the type of message: `03` = no switch change, `05` = additional switch change, `06` = main switch change

For `03` and `05` `position 7 bit 4-7` indicates the current state of the additional switches, meaning below in `yellow`.

For `05` **position 8** bit 0-3 indicates the additional switches that just closed

For `05` **position 8** bit 4-7 indicates the additional switches that just opened

The 4 bits of the additional switches indicate (`state between brackets`):
- Value 0 (binary 0000): None (`All switches open`)
- Value 1 (binary 0001): Only Switch 1 (`Switch 1 closed, Switch 2 open`)
- Value 2 (binary 0010): Only Switch 2 (`Switch 1 open, Switch 2 closed`)
- Value 3 (binary 0011): Switch 1 and 2 (`Switch 1 closed, Switch 2 closed`)

The `last position` indicates the state of the main switch: Value 0: Open, Value 1: Closed

NOTE:
- The Measurement (`03`) is sent at regular intervals, it indicates the current state of all switches

7. NFC RFID - LoRa Button MTC-XX-NFC01 / NFC02

The **upload** fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
Voltage	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	3	1	0x00: Heartbeat 0x01: Alarm
Alarm Bitmask	uint8	4	1	0x01: Button 1 pressed 0x02: Button 2 pressed
Alarm ID	uint16	5	2	Unique ID of the Alarm triggered
UID Type	uint8	7	1	Type of RFID / NFC Tag: 0x00, 0x20: ISO/IEC14443-4A 0x01, 0x11: FeliCa 212 kbps 0x02, 0x12: FeliCa 424 kbps 0x03, 0x23: ISO/IEC14443-4B 0x04: Innovision Jewel/Topaz tag 0x10: Mifare (ISO/IEC14443-4A) 0x40: DEP passive 106 kbps 0x41: DEP passive 212 kbps 0x42: DEP passive 424 kbps 0x80: DEP active 106 kbps 0x81: DEP active 212 kbps 0x82: DEP active 424 kbps 0xFF: Error reading the Tag
UID	n * uint8	8	n (1-10)	Included when UID Type NOT 0xFF NFC RFID Tag Identifier. Size can be different dependent on the tag, starts at position 8 and goes until the end of the payload
UID Error	uint8	8	1	Included when UID Type is 0xFF Typical errors reading the tag: 0x20: Reader not found at startup 0x30: No tag/card found 0x40: Reader communication error 0x60: Tag/card read error 0x70: Multiple tags/cards 0x90: Tag/card not supported 0xA0: Reading tag/card interrupted 0xB0: UID too long (max 10) 0xC0: Tag/card with random UID

Example NFC RFID - LoRa Button payload (length):
- **Heartbeat** (4): 02 01 4A 00
- **Alarm with Reader Error, Button 1 pressed** (9) : 02 01 49 01 01 12 34 FF 30
- **Alarm, Button 2 pressed** (13): 02 01 49 01 02 12 34 10 12 34 56 78 90

The alarm can be confirmed by the downlink command to port 1.

Downlink fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
OpCode	uint8	1	1	0x60: Alarm confirm
Alarm ID	uint16	2	2	Should match Alarm ID from Alarm upload

Examples alarm confirm downlink payload (length), send to port 1:
- **Alarm confirm** (4): 02 60 12 34

8. LoRa Service Call Button MTC-SCB01

The **upload** fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
Voltage	uint16	1	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	3	1	0x00: Heartbeat 0x01: Button(s) pressed
Buttons bitmask	uint8	4	1	0x01: Button 1 pressed 0x02: Button 2 pressed 0x04: Button 3 pressed
Alarm ID	uint16	5	2	Unique ID of the Alarm triggered. Only when Alarm Confirmation is enabled in the Device Configuration

Example panic button payload (length):
- **Heartbeat** (4): 02 01 4A 00
- **Alarm, Button 2 pressed** (4): 02 01 49 01 02
- **Alarm, Button 3 pressed, when alarm confirm is configured** (6): 02 01 48 01 04 12 34

The alarm can be confirmed by the downlink command to port 1.

Downlink fields in the payload in order:

Field	Encoding	Start position	Size	Remark
Version	uint8	0	1	Always 2
OpCode	uint8	1	1	0x60: Alarm confirm
Alarm ID	uint16	2	2	Should match Alarm ID from Alarm upload

Examples alarm confirm downlink payload (length), send to port 1:
- **Alarm confirm** (4): 02 60 12 34

Complete payload description

Uplink

The **upload** fields in the payload in order:

Field	Encoding	For OpCode	Size	Remark
Version	uint8	All	1	Always 2
Voltage	uint16	All	2	[V] in 0.01 V steps, i.e. 100 = 1.00 V
OpCode	uint8	All	1	0x00: Heartbeat 0x01: Alarm 0x02: Votes 0x03: Measurements 0x05: Thresholds 0x06: Switch 0x07: Reminder 0x50: Alert 0x70: Info 0x71: Show 0x72: Update 0x80: SCD30
Alarm buttons	uint8	Alarm	1	Bit per button for multi button, bit set if button pressed (LSB = button 1, MSB = button 8) Only included for units with more than 1 button or when the UID reader is enabled for the button
Alarm ID	uint16	Alarm	2	Only included when feedback on (non) confirm is configured or when device with UID reader enabled
UID Type	uint8	Alarm	1	Type of RFID / NFC Tag: 0x00, 0x20: ISO/IEC14443-4A 0x01, 0x11: FeliCa 212 kbps 0x02, 0x12: FeliCa 424 kbps 0x03, 0x23: ISO/IEC14443-4B 0x04: Innovision Jewel/Topaz tag 0x10: Mifare (ISO/IEC14443-4A) 0x40: DEP passive 106 kbps 0x41: DEP passive 212 kbps 0x42: DEP passive 424 kbps 0x80: DEP active 106 kbps 0x81: DEP active 212 kbps 0x82: DEP active 424 kbps

				0xFF: Error reading the Tag Only included when UID reader enabled for button
UID	n * uint8	Alarm	n (1-10)	NFC RFID Tag Identifier. Size can be different dependent on the tag, starts at position 8 and goes until the end of the payload Only included when UID reader enabled for button and UID Type <> 0xFF
UID Error	uint8	Alarm	1	Typical errors reading the tag: 0x20: Reader not found at startup 0x30: No tag/card found 0x40: Reader communication error 0x60: Tag/card read error 0x70: Multiple tags/cards 0x90: Tag/card not supported 0xA0: Reading tag/card interrupted 0xB0: UID too long (max 10) 0xC0: Tag/card with random UID Only included when UID reader enabled for button and UID Type = 0xFF
#Buttons	uint8	Heartbeat & Votes	1	Number of buttons
Button totals	#Buttons * uint16	Heartbeat & Votes	2 * #Buttons	Totals per button since start/reset/rollover
Button counts	#Buttons * uint8	Heartbeat & Votes	#Buttons	Counts per button since last votes uplink
Measurements	uint8	Measurements & Thresholds	1	Bitmask of included measurements: Bit 0 (LSB) = Temperature Bit 1 = Relative Humidity Bit 2 = Pressure Bit 3 = Light Bit 4 = CO_2 Bit 5 = TVOC Bit 6 = Distance Bit 7 (MSB) = More
Temperature	int16	Measurements & Thresholds	2	[°C] in 0.1°C steps, i.e. 378 = 37.8 °C Only included when Temp bit set in Measurements
Relative Humidity	uint8	Measurements & Thresholds	1	[%] Relative Humidity Only included when Relative Humidity bit set in Measurements

Pressure	uint16	Measurements & Thresholds	2	[Pa] in 10 Pa steps, i.e. 10345 = 103450 Pa (1034.5 hPa) Only included when Pressure bit set in Measurements
Light	uint16	Measurements & Thresholds	2	[lx] Illuminance Only included when Light bit set in Measurements
CO_2	uint16	Measurements & Thresholds	2	[ppm] CO_2 Only included when CO_2 bit set in Measurements
Distance	uint16	Measurements & Thresholds	2	[mm] Distance (0-5000) Only included when Distance bit set in Measurements
Measurements 2	uint8	Measurements & Thresholds	1	Bit 1 (LSB) = Digital Inputs Only included when More bit set in Measurements
Digital Inputs	uint8	Measurements & Thresholds	1	Digital inputs: Bit 0-3: Enabled Digital Inputs 1-4 Bit 4-7: Value Digital Inputs 1-4 Only included when Digital Inputs bit set in Measurements 2
Threshold Info	uint8	Thresholds	1	Threshold info: Bit 0-3: Trigger threshold 1-4 Bit 4-7: Stop threshold 1-4
Switch state	uint8	Switch & Reminder	1	Only for units with a 2 state switch (e.g. Manhole sensor) 0x00: Switch Off 0x01: Switch On
Alert Duration	uint8	Alert	1	Remaining Alert duration in steps of 1 minute e.g: 0: No Alert 1: 1 minute 5: 5 minutes 60: 1 hour 240: 4 hours
Alert Feedbacks	uint8	Alert	1	Active Alert Feedbacks Bit 0-3: Feedback 1-4 Only included when Alert Duration > 0
Firmware Info	ASCII	Info	Variable	Until the end of the payload
Config CRC	uint16	Show & Update	2	CRC of the Config
Config Position	uint8	Show	1	
Config Length	uint8	Show	1	
Config Content	length * uint8	Show	Config length	Config content for position with length Load in Mutelcor LoRaButton configurator web page to see the config

Update Result	uint8	Update	1	0x00: Success 0x01: Incomplete (length exceeds payload) 0x02: Failed (not writable or position error) 0x03: No length field 0x04: Failed (max. heartbeat/measurement interval increase more than double)
Update Success Count	uint8	Update	1	Number of successful updates In case of an error this is the number of successful updates preceding the one causing the error Only included since version 1.4.2
SCD30 Result	uint8	SCD30	1	0x00: Success 0x01: Start Timeout 0x02: Address Timeout 0x03: Data Timeout 0x07: Stop Timeout 0x20: Address NACK 0x30: Data NACK 0x38: Arbitration lost Any other value is also an I2C error Success only indicates successful transmission on the I2C bus, not whether the SCD30 accepted the command

Downlink

NOTE: **Downlink** should always be sent to port 1

The fields in the payload in order:

Field	Encoding	For OpCode	Size	Remark
Version	uint8	All	1	Always 2
OpCode	uint8	All	1	0x50: Alert 0x60: Alarm Confirm 0x70: Info 0x71: Show 0x72: Update 0x80: SCD30 0x90: Reset 0x91: Rejoin
Alert Duration	uint8	Alert	1	Alert duration in steps of 1 minute e.g: 0: Stop Alert 1: 1 minute 5: 5 minutes 60: 1 hour 240: 4 hours When omitted an Alert status uplink with the current Alerts is sent
Alert Feedbacks	uint8	Alert	1	Alert feedback to start Bit 0-3: Feedback 1-4 When omitted the Feedback Time stops or extends the current Feedback When omitted the Alert Duration stops or extends the current Alert feedback, either way an Alert status uplink will be sent with the new/updated Alert
Alarm ID	uint16	Alarm Confirm	2	Should match the Alarm ID of the Alarm that is confirmed
Config Position	uint8	Show & Update	1	Since version 1.4.2 update can contain multiple sets of Config Position, Config Length and Config Update fields concatenated
Config Length	uint8	Show & Update	1	Since version 1.4.2 update can contain multiple sets of Config Position, Config Length and Config Update fields concatenated
Config Content	length * uint8	Update	Config length	Config content for position with length Use the Mutelcor LoRaButton configurator web page to create the config update

				Since version 1.4.2 update can contain multiple sets of Config Position, Config Length and Config Update fields concatenated
SCD30 Command	uint16	SCD30	2	SCD30 Command
SCD30 Argument	uint16	SCD30	2	SCD30 Argument Optional, only when SCD30 Command has an argument

Examples of downlinks (length):
- Info (2): 02 70
- Reset (2): 02 90

To show the complete configuration send the following 5 downlinks to port 1:
- Part 1 (4): 02 71 00 13
- Part 2 (4): 02 71 23 28
- Part 3 (4): 02 71 4B 28
- Part 4 (4): 02 71 73 28
- Part 5 (4): 02 71 9B 28

The uplink show responses can be loaded in the Mutelcor LoRaButton configurator web page to see the config

To create configuration update downlinks use the Mutelcor LoRaButton configurator web page

SCD30 commands (length):
- SCD30 Soft Reset (2): 02 80 D3 04

SCD30 change calibration (length):

NOTES:
- You need a very good CO_2 reference to change the calibration, these commands are irreversible!
  - SCD30 Set Forced Recalibration value **400 ppm** (6): 02 80 52 04 01 90
  - SCD30 Set Forced Recalibration value **800 ppm** (6): 02 80 52 04 03 20
  - SCD30 Set Forced Recalibration value **1000 ppm** (6): 02 80 52 04 03 E8
  - SCD30 Set Forced Recalibration value **2000 ppm** (6): 02 80 52 04 07 D0
  - SCD30 Set Forced Recalibration value **x ppm** (6): 02 80 52 04 XX XX (XX XX ppm value in HEX notation, minimum 400, maximum 2000)