Payload for LoRaWAN Gas Sensor WSLRW-G4 or WSLRWEX-G

- Payload WSLRW-G4 or WSLRWEX-G | Firmware 1

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1. Payload document is applied for the following products

Item code	HW Version	Firmware Version	Remarks
WSLRW-G4-...	1	1	
WSLRWEX-G-...	1	1	

2. Changes information in this version v.s previous version

Item	Changes	Changed by	Changed Date	Approved by	Approved Date
1	Initial version	P.N.Diep	22-06-2022	N.V.Loc	24-08-2022

The approved date is also the release date of this document.

3. Payload for Uplink messages

START_UP message

When?	Purpose	Wait for Downlink?	LED color
This message will be sent once after 60 seconds from power-up the device	To understand when the device was powered up	YES	Blink WHITE

Payload	EVENT_ID	HW_VERSION	FW_VERSION	CURRENT_CONFIGURATION
bits	4	4	8	64
value	*0b0000 = 0*	*yes*	*yes*	*yes*

PARAMETER_UPDATE message

When?	Purpose	Wait for Downlink?	LED color
When the reed switch is activated by the magnet key. **How?** Move Magnet Key to the contact point of REED SWITCH. Buzzer beeps 1 time; hold Magnet Key 5s. Then the buzzer beeps 2 times; remove the Magnet key.	To send the new configuration to the device via downlink	YES	Blink PURPLE

Payload	EVENT_ID	HW_VERSION	FW_VERSION	CURRENT_CONFIGURATION
bits	4	4	8	64
value	*0b0001 = 1*	*yes*	*yes*	*yes*

FORCE_DATA message

When?	Purpose	Wait for Downlink?	LED color

When the reed switch is activated by the magnet key. **How?** Move Magnet Key to the contact point of REED SWITCH. Buzzer beeps 1 time; move Magnet Key away.	To get the instant measured value from the device for calibration and validation.	YES	Blink SKY BLUE

Payload	EVENT_ID	SENSOR_ERRO	reserved	SCALED_VAL	BATTERY_L	reserved	RAW_VAL
bits	4	1	3	16	2	6	32
value	*0b0010 = 2*	*yes*	*zeros*	*yes*	*yes*	*zeros*	*yes*

CYCLIC_DATA message

When?	Purpose	Wait for Downlink?	LED color
This message will be sent in the pre-defined cycle.	To get the measured value from the device in the pre-defined cycle.	YES	Blink SKY BLUE

Payload	EVENT_ID	SENSOR_I	reserved	SCALED_V	MIN_SCAL	AVG_SCA	MAX_SC	BATTERY	reserved
bits	4	1	3	16	16	16	16	2	6
value	*0b0011 = 3*	*yes*	*zeros*	*yes*	*yes*	yes	*yes*	*yes*	*zeros*

ALARM message

When?	Purpose	Wait for Downlink?	LED color
This message will be sent upon the alarm's occurrence. Sensor_sampling_rate will determine the processing delay of the alarm.	To get the instant measured value upon the measured value was passing a threshold.	YES	Blink **YELLOW**

Payload	EVENT_ID	SENSOR_ER	reserved	ALARM_T	SCALED_V	ALARM_D	TENTAT	BATTERY	reserved
bits	4	1	1	2	16	8	8	2	6
value	*0b0100 = 4*	*yes*	*zeros*	*yes*	*yes*	*yes*	*yes*	*yes*	*zeros*

4. Payload Fields of Uplink

Below is an explanation of the payload fields in the uplink messages.

Data name	Description	Encoding or Possible values	Length (in bits)
EVENT_ID	Unique ID identifying the device event	4-bit unsigned integer 0 = START_UP 1 = PARAMETERS_UPDATE 2 = FORCE_DATA 3 = CYCLIC_DATA 4 = ALARM	**4**

HW_VERSION	HW_VERSION = HW_VERSION value in EEPROM set in production if the Value is unknown, the default value will be 0	4-bit unsigned integer 1..15	**4**
FW_VERSION	Indicate the FW version. Refer to the FW release note	8-bit unsigned integer 1..255	**8**
CURRENT_CONFIGURATION	The current configuration code of the device	64-bit encoded field Refer to the Downlink section	**64**
SENSOR_ERROR	Indicate the sensor error or not	0b0 = no sensor's error 0b1 = sensor's error	**1**
ALARM_TYPE	Alarm type	0b00 = no alarm 0b01 = Hi Alarm 1 (Hi alarm) 0b10 = Hi Alarm 2 (HiHi alarm) 0b11 = not used	**2**
BATTERY_LEVEL	Battery level	2-bit unsigned integer 0 to 3 0: 10% 1: 30% 2: 60% 3: 99%	**2**
RAW_VALUE	Raw value from the sensor	Float The raw value from the sensor; is not scaled or calibrated	32
SCALED_VALUE	The measured value is calculated (scaled/calibrated) from the raw value	16-bit signed integer Formula: (16-bit_SCALED_VALUE/100)= real_SCALED_VALUE in its unit** Example: 0x16B7 = 5815 => (5815 / 100) = 58.15ppm	16
MIN_SCALED_VALUE	The minimum value of the measured values in the duration of sending cycle*	16-bit signed integer Formula: (16-bit_MIN_SCALED_VALUE/100)= real_MIN_SCALE_VALUE in its unit** Example: 0x16B7 = 5815 => (5815 / 100) = 58.15ppm	16
AVG_SCALED_VALUE	The average value of the measured values in the duration of sending cycle*	16-bit signed integer Formula: (16-bit_AVG_SCALED_VALUE/100)= real_AVG_SCALE_VALUE in its unit** Example: 0x16B7 = 5815 => (5815 / 100) = 58.15ppm	16
MAX_SCALED_VALUE	The max value of the measured values in the duration of sending cycle*	16-bit signed integer Formula: (16-bit_MAX_SCALED_VALUE/100)= real_MAX_SCALE_VALUE in its unit** Example: 0x16B7 = 5815 => (5815 / 100) = 58.15ppm	16

ALARM_DURATION	Alarm duration in hours	8-bit unsigned integer Formula: 8-bit_Alarm_duration = real_Alarm_duration_in_hours Range: 0 to **255 hours** Resolution: **1 hour** Example: 0b00100000 = 0x20 = 32 => 32 hours	8
TENTATIVE	Tentative number ** This number counts how many uplink messages were sent since the alarm happened.*	8-bit unsigned integer Formula: (8-bit_Tentative +1)= real_tentative # Range: 1 to 256 Accuracy: 1 Example: 0b00000111 = 0x7=7=> 7+1 =>tentative # 8	8

Notes:

* If the sending cycle = sensor sampling rate, all those values are at the same value: SCALED_VALUE = MIN_SCALE_VALUE = AVG_SCALED_VALUE = MAX_SCALED_VALUE

** Please refer to the unit of each gas sensor as below:

NH3: ppm
CO: ppm
Cl2: ppm
SO2: ppm
NO: ppm
NO2: ppm
O3: ppb

5. Payload for Downlink messages

Users can use a downlink message to change the configuration of the device. There are 02 types of downlink messages:

- **Downlink type = 0:** Write the configuration for the specific type of LoRaWAN sensor. The format is fixed for each type of sensor.
- **Downlink type = 5:** Write a value to any address of the configuration parameter of the LoRaWAN sensor. This method is generic and can be applied to any type of LoRaWAN sensor, the user just needs to know the memory map of the sensor.

5.1 Downlink type = 0

Configurable parameters	LED_BUZZER_ENABLE	Reserved	SENSOR_ENABLE	SEND_ENABLE	ALARM_ENABLE	Reserved	MEASURE_PERIOD	Reserved	CYCLIC_DATA_PERIOD	HI_ALARM1_THRESHOLD	HI_ALARM2_THRESHOLD	Reserved	DEVICE_RESET	DOWNLINK_TYPE
bits	*1*	*3*	*1*	*1*	*1*	*1*	*4*	*1*	*3*	*8*	*8*	*24*	*4*	*4*

Below is the table to explain in detail the meaning of each configuration parameter and its default value.

Parameters	Description	Possible values	Default values	Length (in bits)
LED_BUZZER_ENABL	*Flag to enable/disable LED and Buzzer interactions for action not triggered by the button.*	*0b0 = false, LEDs are OFF* *0b1 = true, LEDs are ON*	0b1 = true	1
SENSOR_ENABLE	*Enable Gas Sensing Module to measure*	*0b0 = false, gas sensing module is disabled* *0b1 = true, gas sensing module is enabled*	0b1 = true	1
SEND_ENABLE	*Enable sending data in a cyclic period*	*0b0 = false, disabled* *0b1 = true, enabled*	0b1 = true	1
ALARM_ENABLE	*Enable alarm processing and sending data*	*0b0 = false, disabled Alarm* *0b1 = true, enabled Alarm*	0b0 = false, disabled Alarm	1

MEASURE_PERIOD	Period for sensing module to wake up and take measurement	*0b0000 = every 1s* *0b0001 = every 2s* *0b0010 = every 5s* *0b0011 = every 10s* *0b0100 = every 20s* *0b0101 = every 30s* *0b0110 = every 1min* *0b0111 = every 2min* *0b1000 = every 5min* *0b1001 = every 10min* *0b1010 = every 20min* *0b1011 = every 30min* *0b1100 = every 1h* *0b1101 = every 2h* *0b1110 = every 3h* *0b1111 = every 6h*	0b1001 = every 10min	4
CYCLIC_DATA_PERIO	Period to send CYCLIC_DATA	*0b000 = every 10min* *0b001 = every 30min* *0b010 = every 1h* *0b011 = every 2h* *0b100 = every 3h* *0b101 = every 6h* *0b110 = every 12h* *0b111 = every 24h*	0b000 = every 10min	3
HI_ALARM1_THRESH	*Hi alarm threshold #1 (it must be < HI_ALARM2_THRESHOLD)*	*8-bit unsigned integer* *Formula: (8-bit_VALUE/2)= real_VALUE_in_its unit*** *Example: **0b01110100 = 0x74 = 116 => (116 / 2) = 58ppm***	0b00001010 = 5ppm	8
HI_ALARM2_THRESH	*Hi alarm threshold #2*	*8-bit unsigned integer* *Formula: (8-bit_VALUE/2)= real_VALUE_in_its unit*** *Example: **0b01110100 = 0x74 = 116 => (116 / 2) = 58ppm***	0b00010100 = 10ppm	8
DEVICE_RESET	*Once this parameter is set, the device shall restart after receiving the Downlink. After restarting, the value turns to 0b0000 automatically.*	*0b1010 = 0xA = Force device reset* *others = do nothing*	others = do nothing	4
DOWNLINK_TYPE	Downlink type	4-bit unsigned integer	0b0000	**4**

EXAMPLE FOR DOWNLINK TYPE = 0

If you plan to change the ***MEASURE_PERIOD = 30 minutes*** and ***CYCLIC_DATA_PERIOD = 30 minutes*** then please enter your desired values, guided by the table below:

Parameter	Desired setting value	Setting Value (in binary)	Length (in bits)
LED_BUZZER_ENABLE	0b1 = enable LED and Buzzer	1	1
Reserved	0	000	3
SENSOR_ENABLE	0b1 = enable sensor module running	1	1
SEND_ENABLE	0b1 = enable to send cyclic data	1	1
ALARM_ENABLE	0b0 = false, disabled Alarm	0	1
Reserved	0	0	1
MEASURE_PERIOD	0b1011 = every 30min	1011	4
Reserved	0	0	1
CYCLIC_DATA_PERIOD	0b001 = every 30min	001	3
HI_ALARM1_THRESHOLD	0b00001010 = 5ppm	00001010	*8*
HI_ALARM2_THRESHOLD	0b00010100 = 10ppm	00010100	8
Reserved	0	000000000000000000000000	24
DEVICE_RESET	0b0000 = do nothing	0000	*4*
DOWNLINK_TYPE	0b0000	0000	*4*

Then you will get the final configuration code as below:

1000 1100 1011 0001 0000 1010 0001 0100 0000 0000 0000 0000 0000 0000 0000 0000 = **8CB10A1400000000**

5.2 Downlink type = 5

With this downlink, the user can write the configuration to any address on the memory map of the device. Please refer to the memory map of the device to understand what parameters can be written.

The length of the configuration parameter can be 1, 2 bytes, or 4 bytes, but the total length of the Downlink payload must equal 64 bits (8 bytes). Please see below the downlink format for both types.

Downlink type 5 for the parameter of 2 bytes length:

Payload	PRM_ADDRESS	PRM_LENGTH	PRM_VALUE	reserved	DOWNLINK_TYPE
bits	**8**	**8**	**16**	**28**	**4**
Value	*yes*	*0x02 = 2*	*yes*	*zeros*	*0b0101 = 5*

Downlink type 5 for the parameter of 4 bytes length:

Payload	PRM_ADDRESS	PRM_LENGTH	PRM_VALUE	reserved	DOWNLINK_TYPE
bits	**8**	**8**	**32**	**12**	**4**
Value	*yes*	*0x04 = 4*	*yes*	*zeros*	*0b0101 = 5*

Where:

- PRM_ADDRESS: address of the configuration parameter in the memory map of the device;
- PRM_LENGTH: is the length of that parameter, in bytes;
- PRM_VALUE: is the value the user wants to write to that parameter;
- reserved: a series of bits of zero to fulfill the downlink so that it has the total length = 64 bits (8 bytes)

> ***EXAMPLE FOR DOWNLINK TYPE = 5***
>
> Here is the list of parameters of WSLRW-G4 or WSLRWEX-G that can be configured via Downlink type = 5 and the examples of the downlink payload on the right-most side column. It is the example value, not the default value of the device. Please check the memory map of the device for more detail about the parameters.

> **Note: the total length of the downlink must be equal to 8 bytes**

PARAMETER	DATA TYPE OF PARAMETER	PRM_AD	PRM_LENG	PRM_VALUE	DOWNLINK_T	PAYLOAD OF DOWNLINK (IN HEXA)
(bytes)		*1*	*1*	*4*	*2*	*8*
CONSTANT_A	Float	0x4E	0x04 = 4	0x3F8CCCCD = 1.1	0x0005	4E043F8CCCCD0005
CONSTANT_B	Float	0x50	0x04 = 4	0x3E4CCCCD = 0.2	0x0005	50043E4CCCCD0005
HIGH_CUT	Float	0x52	0x04 = 4	0x447A0000 = 1000	0x0005	5204447A00000005
LOW_CUT	Float	0x54	0x04 = 4	0x00000000 = 0	0x0005	5404000000000005
SENSOR+AMPLIF	Uint32	0x58	0x04 = 4	0x41300000 = 11	0x0005	5804413000000005

5.3 Free online data conversion tools

- To convert from Float to Hex and vice versa, users may use this free online tool: https://gregstoll.com/~gregstoll/floattohex/
- To convert a decimal number to Hex, the user may use this free online tool: https://www.binaryhexconverter.com/decimal-to-hex-converter

6. Reed switches

The LoRaWAN sensor typically comes with at least one reed switch for user manipulation during commissioning or maintenance.

Some other versions come with 02 reed switches.

The WSLRW-G4 or WSLRWEX-G comes with one reed switch; please find below the functions of this switch.

EVENT	PRE-CONDITION	ACTION	LED STATUS	ACTIVITIES	POST-CONDITION

FORCE_DATA	Any state	Move Magnet Key to the contact point of REED SWITCH. Led blink SKY BLUE, move Magnet Key away.	Blink SKY BLUE	the device will send the uplink message FORCE_DATA	Back to the previous state
PARAMETERS	Any state	Move Magnet Key to the contact point of REED SWITCH. Led blink SKY BLUE, hold Magnet Key 5s. Led blink PURPLE, move Magnet Key away.	Blink PURPLE	the device will send the uplink message PARAMETER_UPD	Back to the previous state