

SENSO8 LoRaWAN IAQ Sensor Data Payload Format Document

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The LoRaWAN data payload format document describes the data payload format of downlink and uplink LoRaWAN data for the following IAQ sensor models:

- LRS10701-xxxx-000x
- LRS10701-xxxx-00Bx
- LRS10701-xxxx-00Wx (compatible with Works with WELL)

The gas sensors, GAS1 and GAS2, support 2 resolutions (0.001 ppm and 0.1 ppm). The resolution of the gas sensors is indicated on the EC_RES bit which is included in the General Air Quality Reading payload on Port 10 and Device Settings payload on port 12. If EC_RES is 0, the gas sensors have a resolution of 0.001 ppm. If EC_RES is 1, the gas sensors have a resolution of 0.1 ppm.

LRS10701-xxxx-00Wx is compatible with **Works with WELL**. It can be distinguished by:

- Model number: LRS10701-xxxx-00Wx
- Enquiry through downlink command

1. Uplink Data

1.1. Data Reporting

The IAQ sensor sends a data uplink data report in the following cases:

- Periodic heartbeat
- Button press
- Air condition exceeds preset threshold

1.1.1. Payload Format

General Air Quality Reading (Port: 10)

Byte	0	1	2	3	4	5	6	7	8	9	10
		MSB			LSB		MSB	LSB	MSB	LSB	
Field	EVT	AQI_CO2_T				HUM	GAS1		GAS2		ECR_BAT

Field	Measurement	Calculation
EVT	Alert	<p>Bitmask for the alerts and events. If the corresponding bit is '1', an alert or event is triggered.</p> <p>7 – PMx</p> <p>6 – TVOC</p> <p>5 – EC2</p> <p>4 – EC1</p> <p>3 – CO2</p> <p>2 – Temperature, Humidity</p> <p>1 – Reserved</p> <p>0 – Periodic Data Upload/Button</p>
AQI_CO2_T	Air Quality Index (AQI)	$AQI = AQI_CO2_T \gg 23$
	Carbon dioxide (CO2) reading (ppm)	$CO2 = (AQI_CO2_T \gg 10) \& 0x1FFF$
	Temperature reading (°C)	<p>Temperature</p> <p>$= ((AQI_CO2_T \& 0x03FF) - 300)/10$</p>
HUM	Humidity (%)	$Humidity = HUM * 0.5$
GAS1 ¹	Gas sensor 1 reading (ppm)	<p>If EC_RES = 0, Gas = GAS1/1000</p> <p>If EC_RES = 1, Gas = GAS1/10</p>

Field	Measurement	Calculation
GAS2 ¹	Gas sensor 2 reading (ppm)	If EC_RES = 0, Gas = GAS2/1000 If EC_RES = 1, Gas = GAS2/10
ECR_BAT	Gas sensor resolution (EC_RES)	EC_RES = ECR_BAT >> 7 0 – 0.001 ppm resolution 1 – 0.1 ppm resolution
	Battery reading (%)	Battery = ECR_BAT & 0x7F The reading can be used to determine the battery status, e.g., low battery

Note

1. GAS1 and GAS2 sensor type on standard models.

Model	GAS1 type	GAS2 type	
LRS10701-CPV0	HCHO	-	
LRS10701-AH00	NH3	H2S	
LRS10701-MN00	CO	NO2	

For custom models, the sensor type can be queried by issuing a downlink **Device Setting Request** on port 21 to the device. The device will issue a **Device Settings** uplink data on port 12 containing the GAS1 and GAS2 sensor type.

1.1.2. Example

Payload = 011108AA0F7D21DA00CF5A

EVT = 0x01

Bit 0 = 1 => Periodic Data Upload/Button

AQI_CO2_T = 0x1108AA0F

AQI = (0x1108AA0F >> 23)

= 0x22

= 34 (decimal)

CO2 = (0x1108AA0F >> 10) & 0x01FFF

= 0x4422A & 0x01FFF

= 0x22A

= 554 ppm (decimal)

Temperature = ((0x1108AA0F & 0x03FF) - 300) / 10

= (0x20F - 300) / 10

= (527 - 300) / 10 (convert 0x20F to decimal 527)

= 22.7 °C

HUM = 0x7D

Humidity = 0x7D x 0.5

= 125 x 0.5 (convert 0x7D to decimal 125)

= 62.5 %

ECR_BAT = 0x5A

EC_RES = 0x5A >> 7 = 0

Gas sensor resolution = 0.001 ppm

Battery = 0x5A & 0x7F

= 0x5A

= 90 %

GAS1 = 0x21DA

Gas 1 sensor reading = 0x21DA/1000 (as EC_RES = 0)

= 8666/1000

= 8.666 ppm

GAS2 = 0x00CF

Gas 2 sensor reading = 0x00CF/1000 (as EC_RES = 0)

= 207/1000

= 0.207 ppm

Payload = 206F8C8A1F*58015810B3CB*

EVT = 0x20

Bit 5 = 1 => EC2 high

AQI_CO2_T = 0x6F8C8A1F

AQI = (0x6F8C8A1F >> 23)

= 0xDF

= 223 (decimal)

CO2 = (0x6F8C8A1F >> 10) & 0x01FFF

= 0x1BE3222 & 0x01FFF

= 0x322

= 802 ppm (decimal)

Temperature = ((0x6F8C8A1F & 0x03FF) - 300) / 10

= (0x21F - 300) / 10

= (543 - 300) / 10 (convert 0x21F to decimal 543)

= 24.3 °C

Humidity = 0x58 x 0.5

= 88 x 0.5 (convert 0x58 to decimal 88)

= 44 %

ECR_BAT = 0xCB

EC_RES = 0xCB>>7 = 1

Gas sensor resolution = 0.1 ppm

Battery = 0xCB & 0x7F

= 0x4B

= 75 %

GAS1 = 0x0158

Gas 1 sensor reading = 0x0158/10 (as EC_RES = 1)

= 344/10

= 34.4 ppm

GAS2 = 0x10B3

Gas 2 sensor reading = 0x10B3/10 (as EC_RES = 1)

= 4275/10

= 427.5 ppm

TVOC and PM Reading (Port: 11)

Byte	0	1	2	3	4	5	6	7	8	9	10
	MSB	LSB	MSB		LSB	MSB		LSB	MSB		LSB
Field	TVOC		PM1_0			PM2_5			PM10		

Field	Measurement	Calculation
TVOC	Total volatile compound reading (ppb)	TVOC = TVOC x 200/87 ug/m ³ (LRS10701-xxxx-00Wx) TVOC = TVOC ppb (other models)
PM1_0	PM 1.0 reading (ug/m3)	PM1.0 = PM1_0/1000
PM2_5	PM 2.5 reading (ug/m3)	PM2.5 = PM2_5/1000
PM10	PM 10 reading (ug/m3)	PM10 = PM10/1000

1.1.3. Example

LRS10701-xxxx-00Wx (model compatible with Works with WELL)

Payload = 021A00300C005F640108D8

TVOC = 0x021A x 200/87

= 1236 ug/m³(decimal)

PM1_0 = 0x00300C / 1000

= 12300 / 1000 (convert 0x300C to decimal 12300)

= 12.3

PM2_5 = 0x005F64 / 1000

= 24500 / 1000 (convert 0x5F64 to decimal 24500)

= 24.5

PM10 = 0x0108D8 / 1000

= 67800 / 1000 (convert 0x108D8 to decimal 67800)

= 67.8

Other Models

Payload = 010E00189C001C20001FA4

TVOC = 0x010E

= 270 ppb (decimal)

PM1_0 = 0x00189C / 1000

= 6300 / 1000 (convert 0x189C to decimal 6300)

= 6.3

PM2_5 = 0x001C20 / 1000

= 7200 / 1000 (convert 0x1C20 to decimal 7200)

= 7.2

PM10 = 0x001FA4 / 1000

= 8100 / 1000 (convert 0x1FA4 to decimal 8100)

= 8.1

1.2. Device Configuration Reporting

The IAQ sensor uploads the device information and settings on receiving a downlink request.

1.2.1. Payload Format

Device Version (Port: 8)

Byte	0	1	2	3
	XX	YY	ZZZ	
Field	FWV			

Field	Description	Format
FWV	Firmware Version	XX.YY.ZZZ

Device Settings (Port: 12)

Byte	0	1	2	3	4	5	6	7
	MSB	LSB						
Field	ULT		LED	TYP	STS	G1T	G2T	DACK

Field	Description	Format
ULT	Data upload interval (minute)	Upload interval = ULT
LED	LED on/off status	0 - AQI status led off 1 - AQI status led on
TYP	Sensor installed	1 – Available, 0 – Not Available Bit 0 – Temperature and humidity Bit 1 – TVOC Bit 2 – CO2 Bit 3 – PM1.0/2.5/10 Bit 4 – Gas 1 Bit 5 – Gas 2

Field	Description	Format	
STS	Sensor status	<i>Bit 0 – 6:</i> 1 – Functional, 0 – Not Functional <i>Bit 0</i> – Temperature and humidity <i>Bit 1</i> – TVOC <i>Bit 2</i> – CO2 <i>Bit 3</i> – PM1.0/2.5/10 <i>Bit 4</i> – Gas 1 <i>Bit 5</i> – Gas 2 <i>Bit 6</i> – Reserved <i>Bit 7:</i> Gas sensor resolution (EC_RES) 0 – 0.001 ppm resolution 1 – 0.1 ppm resolution	
G1T	Gas 1 type	0 – None 1 – NH3 2 – H2S	3 – NO2 4 – CO 5 – HCHO
G2T	Gas 2 type	0 – None 1 – NH3 2 – H2S	3 – NO2 4 – CO 5 – HCHO
DACK	RESERVED		

Temperature/Humidity Threshold Settings (Port: 13)

Byte	0	1	2	3	4	5	6
		MSB	LSB	MSB	LSB		
Field	0	HTTH		LTTH		HHTH	LHTH

Field	Description	Default
HTTH	High temperature threshold (°C)	30

Field	Description	Default
LHTH	Low temperature threshold (°C)	18
HHTH	High humidity threshold (%)	80
LHTH	Low humidity threshold (%)	40

Gases Threshold Settings (Port: 13)

Gas Sensor Resolution = 0.001 ppm (EC_RES = 0)

Byte	0	1	2	3	4	5	6	7	8
		MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB
Field	1	CO2TH		TVOC TH		G1TH		G2TH	

Field	Description	Default
CO2TH	CO2 threshold (ppm)	1500
TVOC TH	TVOC threshold	435 ppb
G1TH	Gas 1 threshold (0.001 ppm)	See Default gas thresholds
G2TH	Gas 2 threshold (0.001 ppm)	See Default gas thresholds

Table 1. Default gas thresholds

Gas	Default threshold (0.001 ppm)
NH3	2000
H2S	2000
NO2	360
CO	12400
HCHO	200

Gas Sensor Resolution = 0.1 ppm (EC_RES = 1)

Byte	0	1	2	3	4	5	6	7	8
		MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB
Field	3	CO2TH		TVOC TH		G1TH		G2TH	

Field	Description	Default
CO2TH	CO2 threshold (ppm)	1500

Field	Description	Default
TVOCTH	TVOC threshold	435 ppb
G1TH	Gas 1 threshold (0.1 ppm)	-
G2TH	Gas 2 threshold (0.1 ppm)	-

PM Threshold Settings (Port: 13)

Byte	0	1	2	3	4	5	6	7	8	9
		MSB		LSB	MSB		LSB	MSB		LSB
Field	2	PM1P0TH			PM2P5TH			PM10TH		

Field	Description	Default
PM1P0TH	PM1.0 threshold (ug/m3)	0 (disable)
PM2P5TH	PM2.5 threshold (ug/m3)	56
PM10TH	PM10 threshold (ug/m3)	254

Works with WELL Compatibility Settings (Port: 17)

Byte	0	1
Field	0	WLW

Field	Description	Default
WLW	Works with WELL compatibility	1 – models compatible with Works with WELL 0 – other models

2. Downlink Data

The downlink data is used for updating the IAQ sensor settings online. The format of the downlink commands is described in [Downlink Data Format](#). After issuing a downlink configuration request command, the device will acknowledge with a response/acknowledgment command described in [Device Configuration Reporting](#).

2.1. Downlink Data Format

Device Version Request (Port: 20)

Byte	0
Field	0

Response command: Device Version (Port: 8)

Device Settings Request (Port: 21)

Byte	0
Field	0

Response command: Device Settings (Port: 12)

Threshold Settings Request (Port: 21)

Byte	0
Field	1

Response command:

1. Temperature/Humidity Threshold Settings (Port: 13)
2. Gases Threshold Settings (Port: 13)
3. PM Threshold Settings (Port: 13)

Works with WELL Compatibility Settings Request (Port: 21)

Byte	0
Field	4

Response command: Device Settings (Port: 17)

Device Settings Configuration (Port: 22)

Byte	0	1	2	3
	MSB	LSB		
Field	ULT		LED	DACK

Field	Description	Format
ULT	Data upload interval (minute) (min: 3)	ULT = Upload interval

Field	Description	Format
LED	LED on/off status	0 - AQI status LED off 1 - AQI status LED on
DACK	RESERVED	1

Acknowledgement command: Device Settings (Port: 12)

Temperature/Humidity Threshold Configuration (Port: 23)

Byte	0	1	2	3	4	5	6
		MSB	LSB	MSB	LSB		
Field	0	HTTH		LTTH		HHTH	LHTH

Field	Description	Format
HTTH	High temperature threshold (°C)	HTTH = High temperature threshold
LTTH	Low temperature threshold (°C)	LTTH = Low temperature threshold
HHTH	High humidity threshold (%)	HHTH = High humidity threshold
LHTH	Low humidity threshold (%)	LHTH = Low humidity threshold

Acknowledgement command: Temperature/Humidity Threshold Settings (Port: 13)

Gases Threshold Configuration (Port: 23)

For Gas Sensor Resolution = 0.001 ppm (EC_RES = 0)

Byte	0	1	2	3	4	5	6	7	8
		MSB	LSB	MSB	LSB				
Field	1	CO2TH		TVOCTH		G1TH		G2TH	

Field	Description	Format
CO2TH	CO2 threshold (ppm)	CO2TH = CO2 threshold
TVOCTH	TVOC threshold (ppb)	LRS10701-xxxx-00Wx TVOCTH = TVOC threshold (ug/m3) x 87/200 Other models TVOCTH = TVOC threshold (ppb)

Field	Description	Format
G1TH	Gas 1 threshold (0.001 ppm)	G1TH = Gas 1 threshold (ppm) x 1000
G2TH	Gas 2 threshold (0.001 ppm)	G2TH = Gas 2 threshold (ppm) x 1000

Acknowledgement command: Gases Threshold Settings (Port: 13)

For Gas Sensor Resolution = 0.1 ppm (EC_RES = 1)

Byte	0	1	2	3	4	5	6	7	8
		MSB	LSB	MSB	LSB				
Field	3	CO2TH		TVOCTH		G1TH		G2TH	

Field	Description	Format
CO2TH	CO2 threshold (ppm)	CO2TH = CO2 threshold
TVOCTH	TVOC threshold (ppb)	LRS10701-xxxx-00Wx TVOCTH = TVOC threshold (ug/m3) x 87/200 Other models TVOCTH = TVOC threshold (ppb)
G1TH	Gas 1 threshold (0.1 ppm)	G1TH = Gas 1 threshold (ppm) x 10
G2TH	Gas 2 threshold (0.1 ppm)	G2TH = Gas 2 threshold (ppm) x 10

Acknowledgement command: Gases Threshold Settings (Port: 13)

PM Threshold Configuration (Port: 23)

Byte	0	1	2	3	4	5	6	7	8	9
		MSB		LSB	MSB		LSB	MSB		LSB
Field	2	PM1P0TH			PM2P5TH			PM10TH		

Field	Description	Format
PM1P0TH	PM1.0 threshold (ug/m3)	PM1P0TH = PM1.0 threshold
PM2P5TH	PM2.5 threshold (ug/m3)	PM2P5TH = PM2.5 threshold
PM10TH	PM10 threshold (ug/m3)	PM10TH = PM10 threshold

Acknowledgement command: PM Threshold Settings (Port: 13)

3. Revision History

<i>Revision</i>	<i>Description</i>	<i>Date</i>
1.00	<ul style="list-style-type: none"> Initial Release. 	3 Dec 2020
1.01	<ul style="list-style-type: none"> Corrected a typo on temperature reading calculation. 	18 Dec 2020
1.02	<ul style="list-style-type: none"> Corrected a typo on AQI status LED format. 	19 Feb 2021
1.03	<ul style="list-style-type: none"> Revise firmware version format Add min value in data upload interval (ULT) Revise the EVT field under Port 10 bit 0, event for periodic data upload bit 1, alert for low battery bit 2, alert for both temperature and humidity 	26 Apr 2021
1.04	<ul style="list-style-type: none"> Apply to firmware version 01.00.000 and after Unit of BAT field changed to percentage instead of voltage Add battery low threshold configuration 	30 Jul 2021
1.05	<ul style="list-style-type: none"> Added examples of uplink data. 	24 Aug 2021
1.06	<ul style="list-style-type: none"> Remove battery low bit from EVT field under Port 10 	10 Dec 2021
1.07	<ul style="list-style-type: none"> Updated PM Threshold Configuration payload format 	30 Dec 2021
1.08	<ul style="list-style-type: none"> Added note on GAS1 and GAS2 type 	19 Apr 2021
1.09	<ul style="list-style-type: none"> Added default threshold value 	27 Apr 2023
1.10	<ul style="list-style-type: none"> Corrected AQI LED status format for port 12 Changed Gas 1 and Gas 2 unit to ppm Updated gas sensors resolution support 	12 Mar 2024
1.11	<ul style="list-style-type: none"> Mirror corrections for Battery and EC_RES for Gases Threshold Configuration 	2 Apr 2024
1.20	<ul style="list-style-type: none"> Added supported model, description and updated commands for Works with WELL models. 	23 Jul 2024
1.21	<ul style="list-style-type: none"> Corrected the unit of TVOC reading and threshold for Works with WELL models. 	5 Aug 2025
2.0	First release on docs.senso8.com	Oct 2026