atim cloud wireless™
PRODUCT LINE

Atim Cloud Wireless®

Temperature, humidity and air quality (CO2, VOC)

User Guide

Concerned models:

ACW/LW8-THAQ
ACW/SF8-THAQ

LoRaWAN™

sigfox ready

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Table of contents

This user guide deals with the following references:

	Product references	Product Version (on the product label)
LoRaWAN	ACW/LW8-THAQ	A.5
Sigfox	ACW/SF8-THAQ	A.5

Document version history

Version	Date	Description	Author	Concerned software version
0.1	23/11/2020	Document creation	AC	V0.0.1
0.2	10/12/2020	Correction of the datalogging downlink frame description	AC	V0.0.1
1.0	15/02/2021	Air Quality addition (sensor, config, frames) + description of downlink frames for temperature compensation	AC	V0.0.2
1.1	29/03/2021	CO2 addition	AC	V0.0.2
1.2	12/05/2021	Add Downlink frame for the configuration of CO2 sensor + update configuration chapter + guidance for air quality indicator	AC	V0.0.3
1.3	22/06/2021	Compatibility mode regarding repeaters LoRa/LoRaWAN and FSK/Sigfox description Modification of the operation mode description: LED behavior when searching for a network. Add guidance notes for samples sorting in periodic frame	AC	V0.0.4
1.4	28/09/2021	Add information about new product features Detail configuration of new settings	AC	V1.0.0

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Declaration of compliance

All ACW Atim Cloud Wireless® products comply with the regulatory requirements of the R&TTE Directive (1999/5/EC), article 3:

CE

1 SAFETY (Article 3.1a of the 1999/5/EC Directive)

NF EN60950-1 Ed. 2006/A1:2010/A11:2009/A12:2011 (health)

EN62479: 2010 (power <20mW) or EN62311:2008 (power > 20mW)

2 Electromagnetic compatibility (Article 3.1b of the 1999/5/EC Directive)

EN 301489-3 v1.4.1, EN 301489-1 V1.9.2

3 Efficient use of the radio frequency spectrum (Art.3.2 of the 1999/5/EC Directive)

ETSI EN300 220-2 v2.4.1 and EN300 220-1 v2.4.1

Environmental recommendations

a. Explosive atmosphere

Except for the ACW-ATEX line specifically intended for this purpose, do not use ACW radio modems in the presence of flammable gases or fumes. Using the equipment in such an environment constitutes a safety hazard.

b. Environment

Respect the temperature ranges for storage and operation of all products. Failing to respect these guidelines could disrupt device operation or damage the equipment. ACW products in IP65 water- and dust-resistant housings may be placed outdoors but must not be submerged under any circumstances.

Follow the instructions and warnings provided below to ensure your own safety and that of the environment and to protect your device from any potential damage.

General hazard – Failure to follow the instructions presents a risk of equipment damage.

Electrical hazard – Failure to follow the instructions presents a risk of electrocution and physical injury.

Direct-current symbol

WARNING: do not install this equipment near any source of heat or any source of humidity.

WARNING: for your safety, it is essential that this equipment be switched off and disconnected from mains power before carrying out any technical operation on it.

WARNING: the safe operation of this product is ensured only when it is operated in accordance with its intended use. Maintenance may only be performed by qualified personnel.

Waste disposal by users in private households within the European Union. This symbol appears on a product or its packaging to indicate that the product may not be discarded with another household waste. Rather, it is your responsibility to dispose of this product by bringing it to a designated collection point for the recycling of electrical and electronic devices. Collection and recycling waste separately at the time you dispose of it helps to conserve natural resources and ensure a recycling process that respects human health and the environment. For more information on the recycling centre closest to your home, contact your closest local government office, your local waste management service, or the business from which you purchased the product.

c. Radio

Modems in the ACW line are radio-communication modems that use the ISM (industrial, scientific, and medical) bands, which may be used freely (at no cost and with no authorization required) for industrial, scientific, and medical applications.

Technical features

a. Product

Dimensions	80 x 80 x 35 mm
Antenna	Integrated (¼ d'of wave)
Temperature	-40°C to +125°C (operation) -40°C to+150°C (storage)
Mounts to	Wall
Casing	Indoor
Power supply	1 battery-pack [7,2 Ah]
Weight	200 g
Frequency	863 – 870 MHz
Power	25 mW (14 dBm)
Rate	Sigfox : 100 bits/s LoRaWAN : 300 bit/s to 10 Kbit/s

Consumption	Sigfox	LoRaWAN
Tx mode	60 mA	55 mA
Standby mode	60 µA	60 µA
Rx mode	50 mA	25 mA

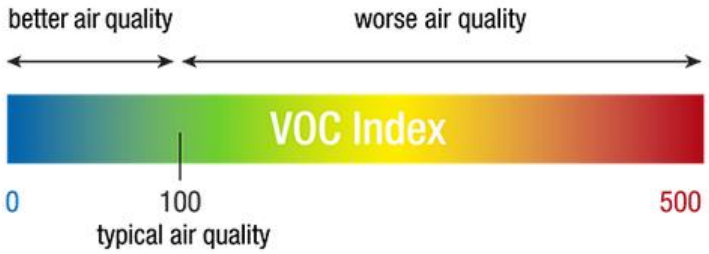
b. Sensors functions

Temperature	Range	-40°C to +125 °C
	Resolution	0,01°C
	Precision between -40°C to +80°C	+/- 0.2°C

Humidity	Range	0 to 100 %RH
	Resolution	0,01 %RH
	Preicsion between 0 %RHC and 100 %RH (operating range)	+/- 2 %RH

VOC index	Range	0 – 500
	Resolution	1

The VOC index represents the overall concentration of all VOCs (volatile organic compounds) and not a specific concentration of a given compound. The index is defined on a scale from 0 to 500 (0 for almost zero VOC concentration and 500 for very high VOC concentration). The scale below provides an approximate representation based on colors:



This scale does is unitless.

CO2	Range	0 to 40 000 ppm (particules/millions)
	Resolution	1 ppm
	Precision between 400 ppm to 2000 ppm	± 40 ppm (+ 5 % of the measurement)

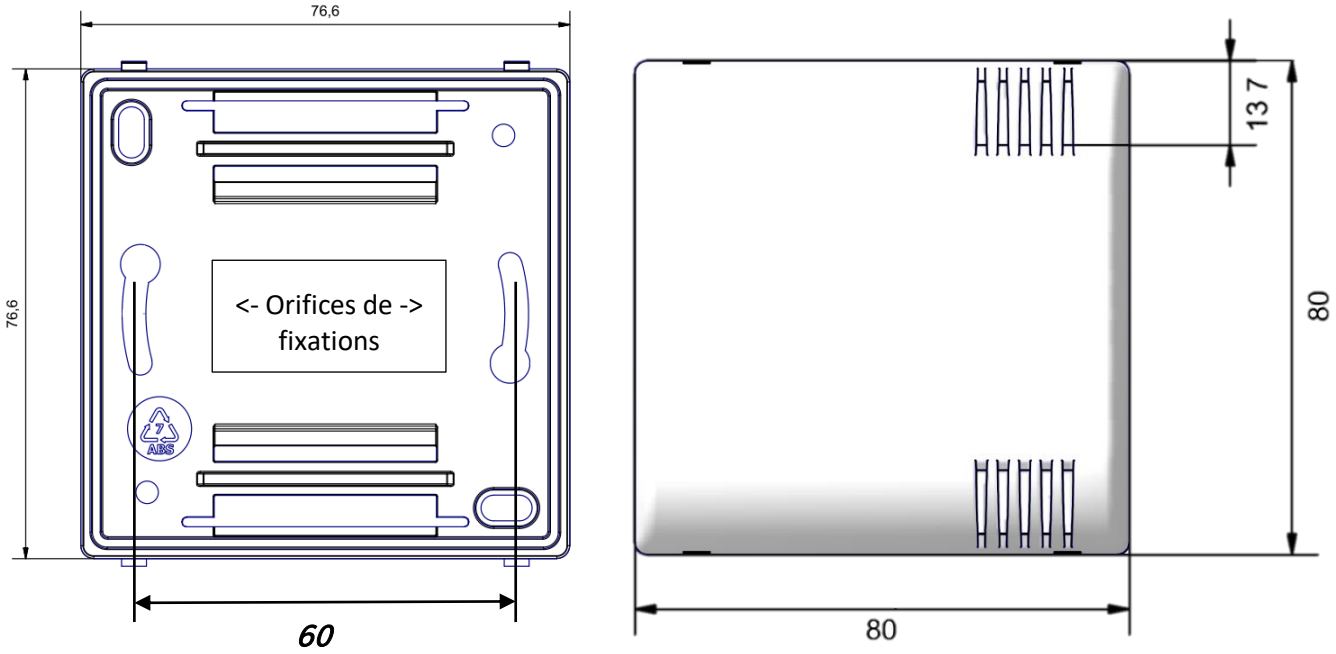
The CO2 measurement represents the concentration of carbon dioxide in the ambient air. In general, the measurement will rarely drop below 400 ppm, this value being the minimum detection threshold in the outside air.

Here is an informative table providing air quality zones according to CO2 concentration:

NBN EN 13 779 European standards	
Air quality zone	**CO2 concentration**
Excellent	< 400 [ppm]
Good	400 à 600 [ppm]
Moderate	600 à 1000 [ppm]
Bad	> 1000 [ppm]

Casing

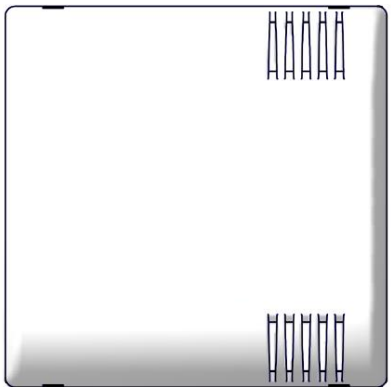
a. Space requirements



b. Mounts to

ACW-THI modems are attached to a wall with two screws that fit into the two mounting holes on the back of the box.

The vents on the cover must be on the right, in the same direction as the photo opposite.



Match the pivots at the top of the case base with their respective locations on the back face.

To remove the two faces, place a screwdriver in one of the two fixing areas at the bottom * of the front face and press inwards until the cover is released from the base.

* It is imperative to open the case from below; opening from the top can damage the circuit.

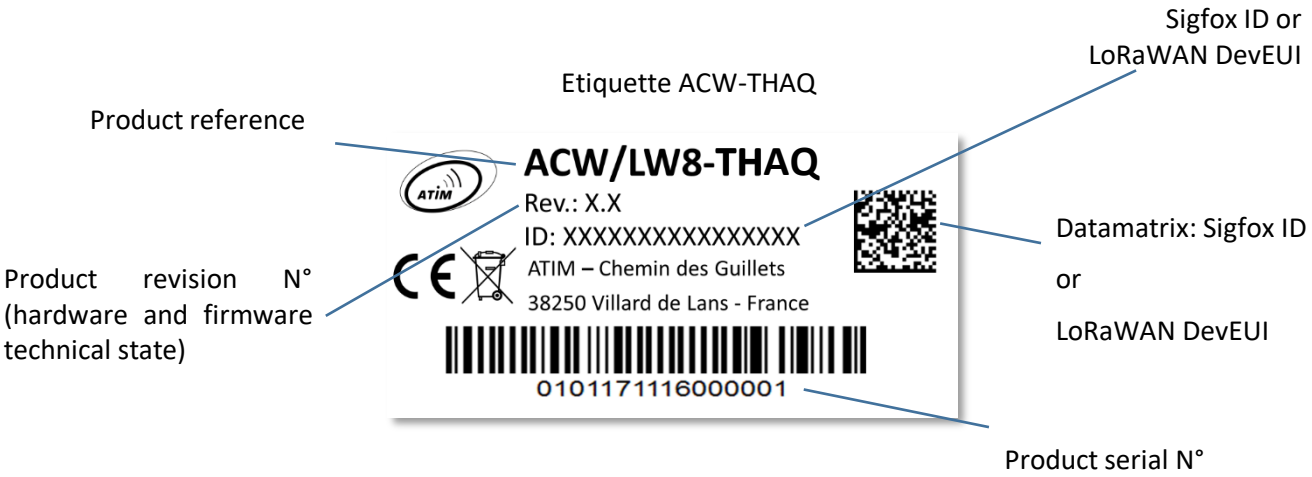
c. Installation

For best results, it is recommended to install the box without environmental obstruction and to place it at a minimum height of 2m. For information, the antenna is integrated into the box. It must be mounted on a vertical support, or fixed to a wall.

d. Identification

The product identifier is visible on the outside label on the back of the product, inside on the electronic card and in the status bar of the configuration software.

For LoRaWAN modems, the communication keys are automatically given by the network (pairing by “Over The Air Activation”, or OTAA).



Operation

a. Operating mode

The operating of the ACW-THAQ is divided between different modes:

- **Operating mode**: this is the default mode when starting the product. In this mode, the module periodically sends measurements according to the configuration applied (if the product has never been configured, the factory configuration applies, see Factory settings).
- **Deep sleeping mode**: this standby mode mainly allows you to put the product to sleep from the time it is put into service until it is installed on site. In this mode no measurement or radio communication functions are possible.
- **Configuration mode:** This mode is active FIVE minutes after exiting deep sleep mode and allows configuration of the product in **Bluetooth** using the PC configurator. In addition, radio frames are sent every minute (therefore five frames) to ensure that the product is properly commissioned. After these five minutes, the product returns to operating mode and **Bluetooth** is deactivated (possibility of reactivating it via **Downlink**).
- **Network pairing mode:** This mode is active when the product exits deep standby mode and allows pairing to a network.
- **Fault mode**: This mode allows the normal operation of the module to be interrupted when a critical event occurs. The nature of the event can be multiple:
    - Empty Battery (less than x% of the maximum battery level)
    - Radio module error
    - Automated tests errors
    - Application error

The entry in the Fault mode is shown by a **RED** LED blinking of the product.

If the error does not come from the radio module, the product will send 3 radio frames every 24 hours containing the error code (s) (see Frames format for error codes). In addition, the product will emit a luminous warning depending on the nature of the event.

Once in this mode, the module must be restarted (by disconnecting and reconnecting the battery or by command in Downlink) to return to its normal operation.

At any time, it is possible to identify which mode the product is in by bringing a magnet close **at least for 2 seconds** to the diamond mark on the case. The product led will light up in one of these colors depending on the mode:

- for operating mode
- for configuration mode
- for deep sleep mode
- for fault mode
- for network pairing mode

b. Product start-up

In most cases, the ACW-THAQ is started up before delivery (battery packs already connected) and then placed in deep standby to limit consumption.

To place the product in its operating mode, bring a magnet close to the diamond-shaped marking on the box for 6 seconds. During these six seconds, the product led must flash in WHITE then in GREEN at the end of the six seconds to indicate that the product is on the way.

The ACW then enters the network pairing phase. During this phase, a FUSCHIA light signal with a fading effect indicates that the search phase is in progress.

If the connection is successful, the product will emit a light signal depending on the quality of the network:

- **GREEN** led signal: good network quality
- **YELLOW** led signal: medium network quality
- **ORANGE** led signal: bad network quality
- **WHITE** led signal: no information on the network quality

The module will then enter its operating mode and start feeding information back to the network according to the configuration.

Particular Case

- For a Sigfox device
    - For information on the quality of the Sigfox, it is necessary to provision a Downlink. It is this one which will make it possible to decide on the quality of the network. The product emits at startup a test Uplink described in the chapter Classic frame (frame type 0x02). If a Downlink is provisioned, the information on network quality will then be relayed by the ACW (light signal). If no Downlink is provisioned, the ACW will always display a WHITE light signal.
    - If a WHITE light signal at the end of 5 minutes of the pairing phase is emitted by the product AND a Downlink has been provisioned, this therefore means that the Network is not accessible.
    - If a WHITE light signal at the end of the 5min pairing phase is emitted by the product WITHOUT a Downlink having been provisioned, this has no meaning for the quality of the network. The quality of the network can be good as well as bad (or nonexistent).

- For a LoRaWAN device
    - In the default LoRaWan Class A operating mode, (see chapter Radio Parameters), if at the end of the 5 minutes of the pairing phase, no network has been reached, then the product goes into standby and will restart a pairing phase of 5 minutes 24 hours later. So, if the product is placed in an area not yet covered by a network, the product will join it when connectivity is possible. There is no need to intervene on the product for it to join the network.
    - In the LoRa / LoRaWan Repeater Compatibility operating mode, (see chapter Radio Parameters), if at the end of the 5 minutes of the pairing phase, no network has been reached, then the product emits a WHITE light signal and enters its nominal operating mode. Even if no network has been reached, it is assumed with this mode that an ATIM LoRa / LoRaWan repeater located nearby will be able to repeat the Local frames sent by the product in LoRaWan frame on the network that the repeater will have joined.

c. Emission of a test frame

When the product is in its operating mode (and only in this mode), it is possible to send a test frame including a measurement sample (which avoids waiting for the next measurement frame).

To do this, simply bring the magnet closer until the **GREEN** light signal goes out. The successful sending of the test frame will be indicated by a **CYAN** light signal.

d. Deep sleep

When transporting or storing the ACW-THAQ, it is best to place it in its deep standby mode to limit unnecessary energy consumption.

From any operating mode (except fault mode), bring a magnet near the diamond marking on the box for **6 seconds.**

During these six seconds, the product led will flash in the color corresponding to the operating mode, then the end of the sequence will be indicated by a **WHITE** fade acknowledging that the product has been put on standby. The magnet can therefore be removed.

e. Radio module activity

Any sending of a radio frame is indicated by three brief **GREEN** flashes of the LED.

f. Threshold exceeded

When thresholds have been configured using the configurator and the measurement values exceed these thresholds, the product LED emits a periodic **ORANGE** flash to notify it.

g. Substitution to the magnet

You can use the push button on the ACW-THAQ card to perform the same actions as the magnet (activate or deactivate the product, activate / deactivate Bluetooth).

To do this, open the case and exert two simultaneous presses on the push button. A white flashing indicates that the button now acts as the magnet (**button pressed = magnet approached**, refer to Product commissioning, Test frame, Deep sleep above to find out how to use the button).

WARNING: Once the manipulations have been completed, press the button again two times to restore it to its main function. A white flashing indicate that the manipulation has been successful.

h. Battery passivation

The ACW-THAQ incorporates a battery depassivation feature, to limit the phenomenon of battery passivation during prolonged phases of deep standby. This feature is automatically activated as soon as the product goes into its deep sleep mode. The product will then be awakened once a day to start the battery depassivation sequence, then the product will return to deep standby by itself.

i. Air quality indication

When the product comes into operation, a brief and periodic flashing (every 5 seconds) is emitted to give an indication of the CO2 concentration in the room.

If the CO2 level is below **400** ppm the flashing is **GREEN**, between **400** ppm and **600** ppm, the flashing is **YELLOW**, between **600** and **1000** ppm the flashing is **ORANGE** and above 1000 ppm the flashing is **RED**.

(The values taken here reflect the indications of standard NBN EN 13 779 concerning the ventilation of non-residential buildings).

However, these values can be customized using the ACW Configurator app.

j. Night mode

The ACW-THAQ allows to stop measurement and radio emission during a given time slot (this time slot is customizable). The primary purpose of this feature is to reduce the power consumption of the sensor throughout the day to increase its autonomy

In operation, the sensor will therefore automatically stop the radio emission from the start time configured for this mode and will restart, again automatically, at the configured end time.

In addition, this mode can be activated or deactivated at any time during the operation of the sensor.

Activation/deactivation as well as the configuration of the start and end times can be done via the **ACW Configurator** application or by downlink.

ACW configurator

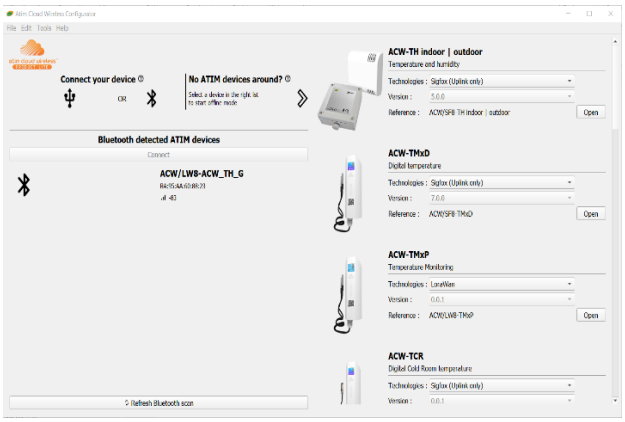
a. Compatible configurator version

For a THAQ with the following application software version:	Use the version of ACW Configurator:
Sigfox: V0.0.1 LoRaWAN: V0.0.1	V5.2.2

Download and install the configuration software setup 'setupACW.exe' at:

https://www.atim.com/en/support-2/downloading/

***Notes**: The product must be in its **Configuration** mode to be able to be detected by the configurator. To do this, you must first put the product into deep standby mode (magnet close to 6 seconds), wait about twenty seconds for the entry into deep standby to take effect, then wake up the product (magnet 6 seconds to new). The product can then be configured.*



When the ACW Configurator is launched, the waiting window appears on the screen.

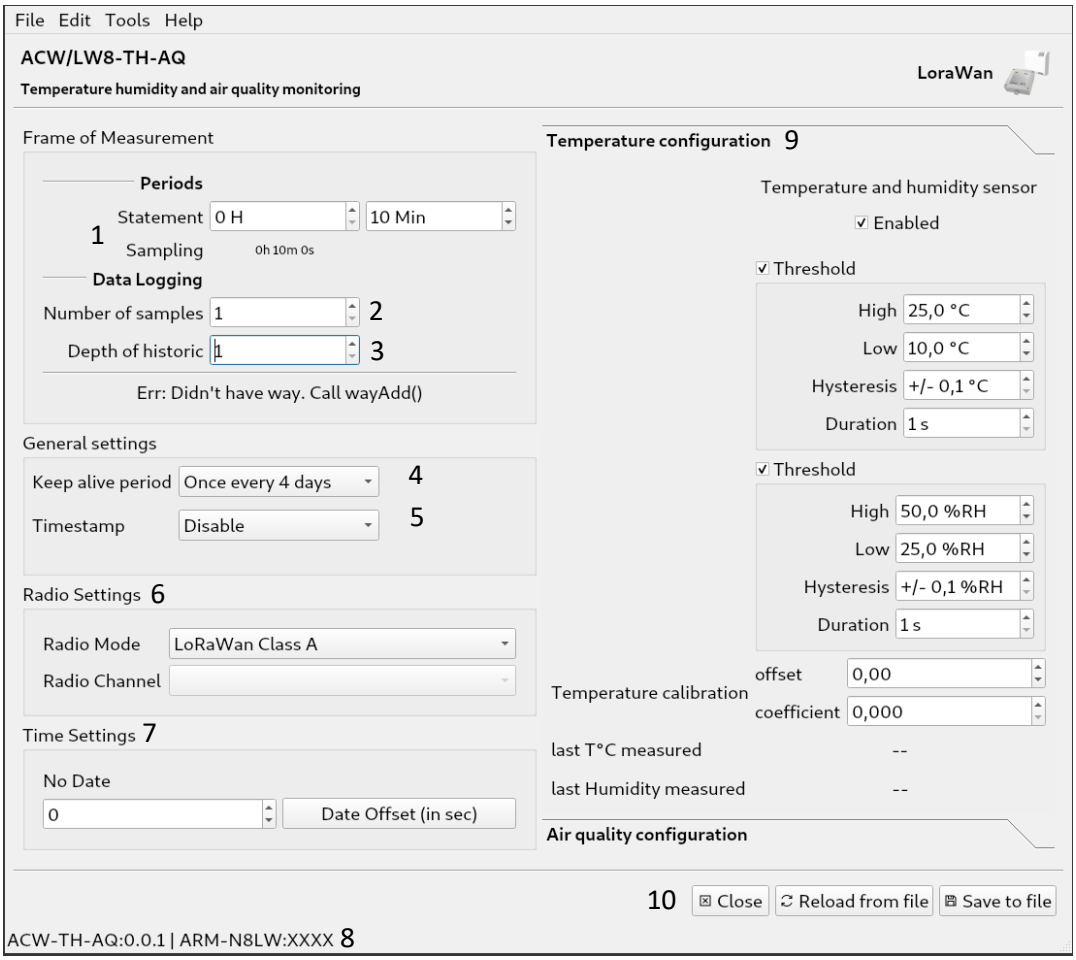
Click on "Help" at the top left of the window then on "About" to display the version number of the ACW configurator.

Pairing the ACW-THAQ with the configurator can be done in two ways:

- **By USB**: open the case of the ACW-THAQ and connect it to a computer with a micro-USB cable.
- **By Bluetooth**: make sure that Bluetooth is activated

Do not leave the product connected to the configurator (via USB or Bluetooth) unnecessarily, otherwise the autonomy of the product will be seriously degraded.

b. ACW-THAQ setup



Emission and sampling period of the frame

The transmission period (1) corresponds to the time interval between each sending of a measurement frame. This period can be configured from 10 min to 255 h and its default value is 1 hour.

In addition, it is possible to configure the number of samples in a frame (2). Thus, several measurements will be carried out before the sending of the frame which will contain all these measurements.

For example, with a period of 60 minutes and several samples of 4, one measurement will be taken every 15 minutes and the 4 samples will be sent in 4 frames every hour. (4 frames because Sigfox product. It would take 2 frames in LoRaWAN).

Finally, it is possible to apply a redundancy of the data (3), which means that samples having been sent in the frame n-1, n-2 or n-3 could be sent again in the frame n to the continuation of the new measurement samples (the most recent sample first in the frame and the least recent last).

For example, for a history depth of 3, the data of the last 2 frames will be sent, in addition to the new data, in the next frame.

Keep alive frame period

A life frame can be sent periodically (4). This frame will raise the supply voltage of the product.

The value of this period can be configured from 1 hour to 1 month. By default, the value is set to 4 days.

Frame timestamp

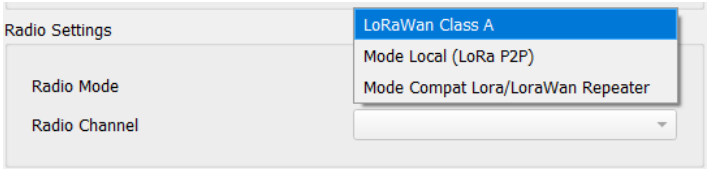
It is possible to deactivate / activate the time stamping of all radio frames (5).

WARNING: This option when activated monopolizes 4 bytes in the frame which cannot be used for useful data.

Configuration of the Radio module

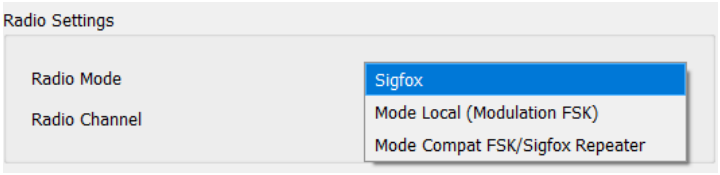
The device can work in 3 different operating modes (6):

- For a LoRaWAN device:



  - **LoRAWAN Class A** (default): The product is modulated in LoRa and uses the LoRAWAN Class A protocol. This is the product's default mode. This mode requires a private LoRAWAN network (private gateway), or an operated network to view the data sent by the product.
  - **Local mode** : Product modulation remains LoRa modulation. However, there is no LoRAWAN overlay. In this mode, you must choose the radio channel on which the product will transmit. To be able to receive the product frames, a radio modem with the same parameters is then required. This mode has no real concrete use case for the moment, but future developments of this mode will provide interesting point-to-point features.
  - **Compatibility mode with the ATIM LoRa / LoRAWAN Repeater:** This mode should be selected when you want to operate in classic LoRAWAN, but no network (private or operated) is accessible. This mode, associated with the ATIM LoRa / LoRAWAN Repeater, then makes it possible to join the LoRAWAN network through this repeater. In this mode, if the network is not joined (no JOIN_ACCEPT), then the product will send its frames locally. The LoRa / LoRAWAN repeater then relays these frames on the network that it has joined (the repeater must be placed at a location with connectivity to the desired network).
    Important note: If the product has access to the LoRAWAN network, the default operating mode (LoRaWAN Class A) must be used. If this mode is chosen, while the network is accessible, the product will still send a frame over the LoRAWAN network and this same frame in Local mode to the Repeater, which will consume battery unnecessarily.

- For a Sigfox device:



  - **Sigfox** (default): Modulation and Sigfox Protocol used. This is the product's default mode. This mode requires access to the Sigfox network to operate.
  - **Local mode**: The modulation of the frames switches to FSK. In this mode, you must choose the radio channel on which the product will transmit. To be able to receive the product frames, a radio modem with the same parameters is then required. This mode has no real concrete use case for the moment, but future developments of this mode will provide interesting point-to-point features.
  - **Compatibility mode with the ATIM FSK / Sigfox Repeater**: This mode should be selected when you want to operate in Sigfox, but the network is not accessible. This mode, associated with the ATIM FSK

/ Sigfox Repeater, then makes it possible to join the Sigfox network through this repeater. In this mode, the product transmits these frames both on the Sigfox network and in Local (FSK modulation). The FSK / Sigfox repeater then relays these frames on the Sigfox network (The repeater must be placed in a location where the Sigfox network is accessible).

Important note: If the product has access to the Sigfox network, the default operating mode (Sigfox) must be used. If this mode is chosen, the product will always send a frame on the Sigfox network and this same frame in Local mode to the Repeater, which will consume battery unnecessarily.

Product clock

If the time stamping function is activated, it is essential to configure the internal clock of the product from the configurator, which will retrieve the system clock from the computer to apply it to the product (7).

Product versions

When connecting to the product, the configurator retrieves all the software versions of the product (product software and radio module software) as well as the network identifier (8).

Configuration of sensors

Temperature

On the ACW-THAQ, there is an embedded temperature & humidity sensor.

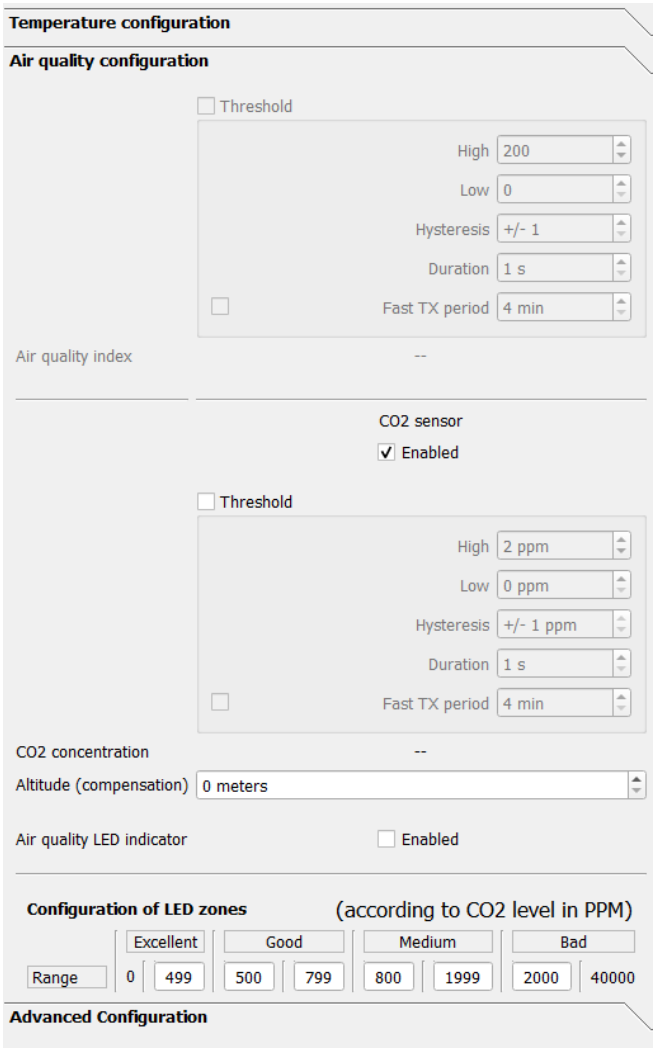
Here are the configuration parameters available for this sensor (9):

- Enabling/disabling of the sensor.
- Temperature & humidity thresholds
- Temperature compensation on two points

The thresholds can be configured by a high and low threshold according to a configurable hysteresis and duration of overrun. When a measurement reaches a threshold, a radio frame will be sent (see the Alert Frame chapter for details on the frame format).

In addition, the temperature and humidity values of the sensor are visible in real time when the product is connected to the configurator (these values are refreshed every two seconds).

Air quality



Two sensors are present for the quality measurement: a first for the measurement of the CO2 concentration, the second for the measurement of VOCs (Volatile Organic Compounds).

For each one, you will find the following configuration elements:

- Enabling/disabling of the sensor.
- High and Low thresholds configuration.

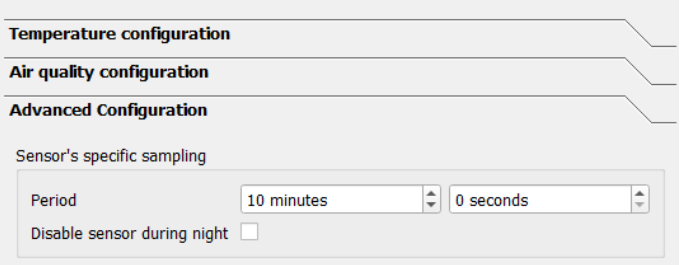
Also, it is also possible to see in real time the value measured by each of the sensors.

In addition, for the CO2 sensor, it is possible to configure the altitude at which the sensor will be installed to improve the CO2 measurement, as well as to activate / deactivate the air quality indication via the LED (A note that this light indication has a small impact on the autonomy of the product).

Finally, it will be possible to configure the thresholds of the LED indicator for air quality ("Excellent" = > green color, "Good" = > yellow color, "Medium" = > orange color and "Bad" = > red color).

Notes: It is advisable to fill in the threshold starting with the one on the right side and continue from right to left.

c. Advanced configuration



A final tab provides access to the advanced configuration setting of the product.

For the "Period" field, it is advisable to leave the default value.

Otherwise, there is a checkbox to activate or not the night mode (box is checked = night mode activated).

Currently, the activation time slot of this mode is only configurable by Downlink, the configuration from the application will be possible very soon.

However, the default time slot is as follows:

- Mode On: 20 H 00 UTC
- Mode Off: 4:00 UTC

Configuration validation

After having filled in all the configuration parameters, it is imperative to click on the “Apply to ACW” button to send the configuration to the product (10).

It is also possible at any time to read the current configuration of the product which will update the parameters on the configurator or restore the default configuration of the product.

d. Factory settings

Radio frames settings:

- Radio frame emission period: 10 minutes
- Number of samplings: 1
- History depth: 1

General settings:

- Keep alive frame emission period: 4 days
- Timestamp: disabled
- Radio parameters: LoRaWAN Class A (for a LoRAWAN product) / Sigfox (For a Sigfox product)

Sensors' settings:

Temperature & humidity

- State: enabled
- Temperature threshold: disabled
- Humidity threshold: disabled

Air quality sensor

- State: enabled
- Threshold: disabled

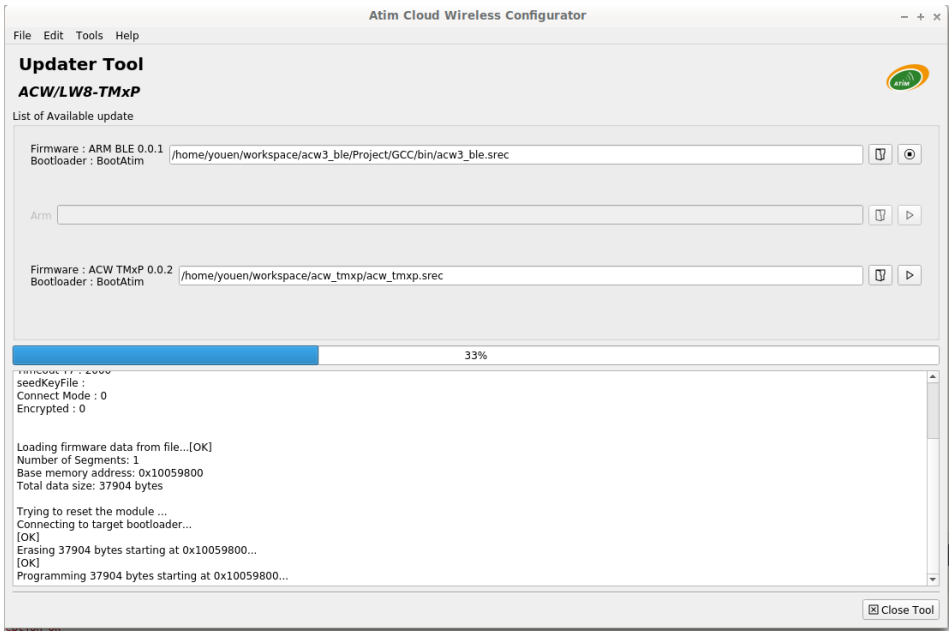
CO2 sensor

- State: enabled
- Threshold: disabled

e. Update of ACW

When you are connected via Bluetooth Low Energy to the product, it is possible to update the various software that makes it up.

To do this, go to the menu *Tools->Updater (CTRL+U*)



Frames format

a. Sigfox and LoRaWAN

Uplink frame			
Byte 1	Byte 2	. . .	Byte n
Frame-header	Frame-specific data		

We can differentiate three types of frames:

- **Classic frame; New generation**: Very close to the old frames, the difference is that you can activate the timestamp. These are for example the life frame, the error frame, the response to configuration frames, ... These last frames are common to all ACWs but, it is also possible to have other independent frames for each ACWs.
- **Measurement frame; New generation**: These frames consist of samples of the different values of each of the channels that an ACW can read. Beforehand, the number of samples and the depth of the history will be inserted in the header.

> ***Note**: The number of samples and the depth of the history are in common for all the channels of the frame.*

- **Alert frame (threshold crossing); New generation**: These frames combine a conventional frame and a measurement frame. They consist of a header warning that a threshold has been exceeded, followed by samples of each of the channels for which a threshold has been exceeded.

Classic frame

Byte 1 - header							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
New generation= 1	Timestamp = 1 - enabled 0 - disabled	Measurement frame = 0	Reserved= 0	Type of frame			

If Timestamp is enabled, 4 bytes with the value of the Timestamp will precede the header (byte 1).

Different frames' type

Frame type	Size of data	Descriptions
0x00	--	Reserved
0x01	5 bytes	Keep alive frame
0x02	0 byte	Downlink request for network testing (Only Sigfox)
0x03	8 bytes	Reserved
0x04	--	Reserved
0x05	1 byte	Test frame with counter
0x06	Variable	(Cfg box) Response to a setup frame.
0x07	Variable	(Cfg box) Response to a command frame.
0x08	Variable	(Cfg box) Response to an incorrect frame.
0x09	--	Reserved
0x0a	--	Reserved
0x0b	--	Reserved
0x0c	--	Reserved
0x0d	Variable	Alert measurement frame (threshold crossing or back to normality), sampling follow up of each channel in alert
0x0e	Variable	General error - (see page 23)
0x0f	Variable ...	Subframe for ACW. Depending on the ACW

Measurement

Byte 1 - Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation = 1	Timestamp	Measurement frame = 1	History depth (-1) Max: 4		Number of samplings (-1) Max: 8		

If the Timestamp is enabled, 4 bytes with the Timestamp value will be preceded by the header (byte 1).

WARNING: if Depth of history or Number of samplings is greater than 1, the frame emission period (in minutes) will be added after header (byte 1) on two bytes (Little Endian encoding, LSB first).

For each channel, a header is inserted afterwards and is constituted as follows:

Channel header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved = 0		Numbers of channel		Type of measurement			

Type of possible measure:

Measure type	Unit	Data size	Data type	Descriptions
0x08	c°C	2 bytes (**Big Endian - MSB**)	Entier signé	Temperature in **hundredth** of Celsius Degree ➢ Resolution: 0.01°C ➢ Max value: 125°C ➢ Min value: -40°C
0x09	%RH	2 bytes (**Big Endian - MSB**)	Entier signé	Humidity in **hundredth** of relative humidity pourcentage (%RH) ➢ Resolution: 0.01 %RH ➢ Max value: 100 %RH ➢ Min value: 0 %RH
0x0C	-	2 bytes (**Big Endian - MSB**	Entier non signé	VOC index : ➢ Resolution: 1 ➢ Max value: 500 ➢ Min value: 0
0x0D	ppm	2 bytes (**Big Endian – MSB first**)	Entier non signé	CO2 concentration : ➢ Resolution: 1 ppm ➢ Max value: 40 000 ppm ➢ Min value: 0 ppm

Then follows the data of the measurement sample (s) (depending on the product configuration).

Notes: *When the frame contains several samples (number of samplings > 1 or depth history > 1), the samples are sorted from the latest to the oldest.*

The number of bytes sent can be determined as follows:

(Size in bytes of the measurement) * (number of samples) * (depth of history)

Example: For example, for the measurement type 0x08 (the size of a value is two bytes) with a history depth of 2 and several samples of 3, the size of the data to be read would be 12 bytes (2x2x3).

WARNING: a received temperature of 0x8000 corresponds to a measurement error. This is often due to an improperly connected cable.

Alert measurement frame

Byte 1 - Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation = 1	Timestamp	Measurement frame = 0	Reserved = 0	Alert frame = 0x0d			

Notes: *For the ACW-THAQ, alerts only apply when a counter is exceeded.*

If the Timestamp is activated, 4 bytes with the Timestamp value will be preceded by the header (byte 1).

For each of the channels in alert a header is inserted and is constituted as follows:

Channel Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Alert type		Number of the channel		Measurement type			

The **type of alert** field is used to identify whether it is a breach of the high threshold, the low threshold, or a return between the thresholds.

These values are defined as follows:

Value	Description
0x00	In between thresholds
0x01	Exceeding the high threshold
0x02	Exceeding the low threshold
0x03	Reserved

These values are defined as follows:

The measurement type field is here identical to that of the measurement frame (ie 0x08, 0x09, 0x0C or 0x0D in hexadecimal for the ACW-THAQ).

The sample that triggered the alert is then inserted afterwards (with **Big Endian encoding** - MSB first)

Keep alive frame

The life frame is sent at regular intervals according to the configuration applied (by default 4 days) and contains the battery levels of the product when empty (the product does nothing) and when charging (the product is transmitting a frame radio).

Byte 1 - Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation = 1	Timestamp = 0	Measurement frame = 0	Reserved = 0	Keep alive frame = 0x01			

Following this header are 4 bytes, 2 for the empty battery level and 2 for the charging battery level.

The frame is therefore split as follows: 0xAABBBBCCCC

0xAA being the frame header (always equal to 0x81), 0xBBBB the empty battery level (value in millivolts, MSB coding) and 0xCCCC the charging battery level (value in millivolts, MSB coding)

Example: 0x81 0d24 0c68
0d24: empty battery level = 3364 mV therefore 3.364 V
0c68: battery charging level = 3176 mV therefore 3.176 V

Error and alarm generic frame

Byte 1 - Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation = 1	Timestamp	Measurement frame = 0	Reserved = 0	Error frame = 0x0e			

If the Timestamp is activated, 4 bytes with the Timestamp value will be preceded by the header (byte 1).

For each error message, a header is inserted and is formed as follows:

Error frame header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Index of message			Error message length				

The **message index** field is used to prioritize messages when several errors occur.

The **length of the error message** field indicates the size in bytes of the error message.

The following byte identifies the nature of the error that occurred:

Error code	Type of error	Description
0x81	ERR_UNKNOWN	
0x82	ERR_BUF_SMALLER	The data table is full, impossible to write any additional data
0x83	ERR_DEPTH_HISTORIC_OUT_OF_RANGE	The history depth is too large or too small for the frame
0x84	ERR_NB_SAMPLE_OUT_OF_RANGE	The number of sampling is too large or too small for the frame
0x85	ERR_NWAY_OUT_OF_RANGE	The number of the channel in the header of the frame is too large or too small
0x86	ERR_TYPEWAY_OUT_OF_RANGE	The type of measurement in the frame header is too large or too small
0x87	ERR_SAMPLING_PERIOD	Bad structure of sampling period
0x88	ERR_SUBTASK_END	End of a sub-task after leaving an infinite loop

0x89	ERR_NULL_POINTER	Pointer with value “NULL”
0x8A	ERR_BATTERY_LEVEL_DEAD	Critical battery level
0x8B	ERR_EEPROM	EEPROM is corrupted
0x8C	ERR_ROM	ROM is corrupted
0x8D	ERR_RAM	RAM is corrupted
0x8E	ERR_ARM_INIT_FAIL	Radio module initialization has failed
0x8F	ERR_ARM_BUSY	The module is already busy (possibly not initialized)
0x90	ERR_ARM_BRIDGE_ENABLE	The module is in bridge mode, cannot send data by radio
0x91	ERR_RADIO_QUEUE_FULL	Radio queue is full
0x92	ERR_CFG_BOX_INIT_FAIL	Error during black box initialization
0x93	ERR_KEEP_ALIVE_PERIOD	Wrong keep alive frame structure
0x94	ERR_ENTER_DEEP_SLEEP	The device entered deep sleep mode
0x95	ERR_BATTERY_LEVEL_LOW	Low battery
0x96	ERR_ARM_TRANSMISSION	A transmission has been initiated but an error has occurred
0x97	ERR_ARM_PAYLOAD_BIGGER	Message size is too large for the capacity of the network
0x98	ERR_RADIO_PAIRING_TIMEOUT	Impossibility to pair to a network within the fixed period
0x99	ERR_SENSORS_TIMEOUT	A timeout has been reached out on the sensor
0x9A	ERR_SENSOR_STOP	The sensor did not report a value after reading
0x9B	ERR_SENSORS_FAIL	The sensor has stopped to operate
0x9C	ERR_BOX_OPENED	Casing opening
0x9D	ERR_BOX_CLOSED	Casing closing

Only codes 0x8A and 0x95 are followed by additional data corresponding to the battery level in millivolts. This value is coded in two bytes, the most significant byte first (MSB).

Warning: for codes ranging from 0x81 to 0x92, the product will enter its FAULT mode and will no longer perform its measurement function. For codes ranging from 0x93 to 0x9D, these correspond only to alarms, the product therefore continues to operate normally.

b. Examples of frames

Measurement frame

With disabled timestamp, there is no historic and the sampling number is 1 (Temperature and humidity exclusively):

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
0xA0 (new generation measurement frame, no history, 1 sampling)	0x08 (channel 0, measurement type: temperature)	0x08	0x85	0x09 (channel 0, measurement type: humidity)	0x17	0xDE

The device sends values of 0x0885 (21.81°C) for temperature and 0x17DE (61.10 %RH) for humidity.

With disabled timestamp, no history and the sampling number of 1((Temperature, humidity and VOC):

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10
0xA0 (new generation measurement frame, no history, 1 sampling)	0x08 (channel 0, measurement type: temperature)	0x08	0x85	0x09 (channel 0, measurement type: humidity)	0x17	0xDE	0x0C (channel 0, measurement type: VOC)	0x00	0xA0

The device sends values of 0x0885 (21.81°C) for temperature, 0x17DE (61.10 %RH) for humidity and 0x00A0 (160) for VOC.

Now with a sampling number of 2:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11	Byte 12
0xA1 (new generation measurement frame, no history, 2 samplings)	0x003C (emission period)	0x08 (channel 0, measurement type: temperature	0x01	0x2C	0x08	0xA4	0x09 (channel 0, measurement type: humidity)	0x22	0x13	0x17	0xDE

Bytes 2 and 3 indicate the transmission period, here 60 minutes (so a sample is measured every 30 minutes).

- First sampling is 0x012C (3°C) / 0x2213 (8723 %RH)
- Second is 0x08A4 (22.12°C) / 0x17DE (61.10 %RH)

Note: This example is valid for the product with a LoRaWAN module. In the case of Sigfox, the size of an uplink is 12Bytes and therefore this frame is divided in two.

Alert measurement frame

a high threshold being exceeded on channel 1 (virtual probe), the frame will be:

Byte 1	Byte 2	Byte 3	Byte 4
0x8D (new generation alert frame)	0x58 (exceeding high threshold channel 1, temperature measurement)	0x02	0xC9

The sampling that triggered the higher threshold deals with 0x02C9 (7.13 °C)

Downlink

This functionality is available on ACW-THAQ fulfilling the following conditions:

	Application software:	Radio firmware:
Sigfox version	V0.0.1	V5.9.3.2
LoRaWAN version	V0.0.1	V5.1.1

The operation of the Downlink is explained in the document ATIM_ACW-DLConfig_UG_FR_v1.4, relating to version V1.2.0 of the ATIM Downlink Protocol (see this document for all parameters and commands common to all products).

The parameters specific to ACW-THAQ are as follows:

a. Configuration of the frame parameters (sending period, number of samples, etc.)

Parameter code (Byte 1)	Parameter code (Byte 2)	Parameter code (Byte 3)	Parameter code (Byte 4)	Parameter code (Byte 5)	Parameter code (Byte 6)
0xD4	0x04	0x00	0b00YY0ZZZ	0xYY	0xZZ

For byte 4, both bytes **YY** deal with the depth of history value – 1 (max = 3) and three bits **ZZZ** deal with the number of samples per frame – 1 (max = 7).

Bytes 5 and 6 deal with the period of a frame emission (= 0xZZYY) from 1 minute to 255 hours (15300 minutes).

Example: Byte 4 = 0x13

4 samples per frame + addition of the four samples sent in the previous frame.

Byte 5 = 0x3C and byte 6 = 0x00

Emission period = 0x003C = 60 minutes

b. Sensors activation

Parameter code (Byte 1)	Parameter value (Byte 2)
0x15	0b00000XYZ

For byte 2, the value of the x, y and z bits indicates whether a sensor is activated or not.

When one of these bits is 1, the sensor is activated; when it is zero, the sensor is disabled.

The **Z** field enables / disables the temperature-humidity sensor.

The **Y** field enables / disables the air quality sensor.

The **X** field allows you to activate / deactivate the CO2 sensor.

c. Threshold configuration

Parameter code (Byte 1)	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8	Byte 9	Byte 10	Byte 11
0xD6 (temperature threshold) **0xD7** (humidity threshold) **0xDA** (VOC threshold) **0XDE** (CO2 threshold)	0x09	0x00	High threshold value		Low threshold value		Hysteresis		Durée	Thresh old Tx

High threshold value field: value (in hundredths ° C or% RH) triggering the high threshold (**Little Endian** encoding)

Low threshold value field: value (in hundredths ° C or% RH) triggering the low threshold (**Little Endian** encoding)

Hysteresis field: threshold uncertainty margin (in hundredths ° C or% RH - **Little Endian** encoding)

Duration field: minimum waiting time before triggering the alert following the threshold crossing. Possible values range from **1 to 10 seconds** (whole numbers only). To deactivate the threshold, this field must be at **0**.

Threshold tx field: period of transmission of periodic frames during a threshold crossing. This value allows periodic frames to be sent more regularly when a threshold is exceeded. However, the frame sent will only contain one sample per active channel. This value must be **between 4 minutes and the basic emission period** of the product (set during product configuration). To deactivate this feature, this field must be at **0**.

d. Configuration of the temperature compensation

The temperature compensation can be done on two points:

- The offset: addition or subtraction of a given value from the temperature measured by the sensor.
- Coefficient: multiplication of a given value by the temperature measured by the sensor.

These two points of compensation can obviously be combined.

Offset

Parameter code (Byte 1)	Byte 2	Byte 3
0x58 (temperature offset)	Value	

The temperature offset is represented by the "Value" field in the table above. The offset value must be sent in **Little Endian** encoding and can be between 10,000 and -10000 (hundredths of a ° C).

Example: For a 2°C temperature offset, the value will be 200 = 0xC800.

For an offset of -1°C, the value will be -100 = 0x9CFF.

Coefficient

Parameter code (Byte 1)	Byte 2	Byte 3
0x59 (temperature coefficient)	Value	

The multiplication coefficient is represented by the "Value" field in the table above. The coefficient value must be sent in **Little Endian** encoding and can be between 0 and 10,000 (this value is divided by 1000 by the product).

Example: For a coefficient of 0,1, the sent value will be 100 = 0x6400.

For a coefficient of 1, the value will be 1000 = 0xE803.

e. Altitude configuration (compensation of the CO2 sensor)

Parameter code (Byte 1)	Parameter value (Byte 2)	Parameter value (Byte 3)
0x5D	0xZZ	0xYY

The altitude value (in meters) is encoded as follows: 0xYYZZ.

Exemple : pour configurer le paramètre à une altitude de 1000m (0x03E8 en hexadécimal), la trame sera 0x5D E8 03.

f. Air quality index configuration

Parameter code (Byte 1)	Parameter value (Byte 2)
0x1C	value

The field **value** can exclusively be « 1 » (indicator enabled) or « 0 » (indicator disabled).

a. Led Indicator threshold configuration

Parameter code (Byte 1)	Parameter value (Byte 2)	Parameter value (Byte 3)	Parameter value (Byte 4)	Parameter value (Byte 5)
0x9F	0xaa	0xbb	0xcc	0x00

The value of byte 2 represents the limit value between green and yellow flashing.

The value of byte 3 represents the limit value between yellow and orange flashing.

The value of byte 4 represents the limit value between orange and red flashing.

Notes: All values are in tens of PPM, to configure a threshold of 500 it will be necessary to send 50 (or 0x32 in hexadecimal).

Example: For 0x9F3250C800 frame,

We have for the first threshold 0x32 or 50 in decimal or 500 ppm, 0x50 for the second is 80 in decimal or 800ppm and for the last 0xC8 is 200 in decimal or 2000ppm.

The flashes according to the CO2 level will be as follow:

0 -> 499: green flashing

500 -> 799: yellow flashing

800 -> 1999: orange flashing

2000 +: red flashing

b. Night mode configuration

Parameter code (Byte 1)	Parameter value (Byte 2)	Parameter value (Byte 3)	Parameter value (Byte 4)	Parameter value (Byte 5)	Parameter value (Byte 6)	Parameter value (Byte 7)	Parameter value (Byte 8)
0xE0	0x06	0x00	0xaa	0xbb	0xcc	0xdd	0xee

Bytes 1 to 3 have a fixed value for the night mode configuration.

Byte 4 is the minutes while byte 5 is the hours for the start time.

Byte 6 is the minutes and byte 7 is the hours for the end time of the night mode.

The minutes and hours must be encoded in BCD (first 4 bits for the tens and the last 4 bits for the unit).

Example: if the start time of the mode is 20:45 summer end time 6:15, the corresponding values for the bytes from 4 to 7 will be:

Byte 4 = > 0x20 / Byte 5 = > 0x45 for the start time

Byte 6 => 0x06 / Byte 7 => 0x15 for end time

Finally, byte 8 can take two values: 0x00 to disable night mode or 0xFF to activate night mode.

c. Reserved codes for futures software evolutions

Parameter code (Byte 1)	Parameter value (Byte 2)
0x10	0x08
0x11	0x00

WARNING : DO NOT MODIFY THESE VALUES

Technical support

For any information or technical problems, you can contact our technical support:

https://www.atim.com/en/technical-support/