atim cloud wireless™
PRODUCT LINE

Atim Cloud Wireless®

Current temperature sensor

User guide

Models concerned :
ACW/LW8-CTS

LoRaWAN™

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This user guide applies to the following references

	Product references	Product version (Visible on product label)
LoRaWAN	ACW/LW8-CTS	A1

Version history of this document

Version	Date	Description	Author	Software version concerned /Revision
1.2	07/12/2023	Correction of exemple frame errors	YL	V1.0.7 / A1
1.1	25/09/2023	Patches	FR	V1.0.5 / A0
1.0	27/09/2022	Document creation	YL	V1.0.5 / A0

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Declaration of conformity

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

CE

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

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 Directive 1999/5/EC)

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

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

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

Environmental recommendations

a. Environment

Observe the product's storage and operating temperature ranges. Failure to do so could disrupt operation and even damage the equipment.

This equipment is not designed for outdoor use!

Follow the precautions and instructions below to ensure your safety and that of your environment, and to prevent damage to your equipment.

General danger - *If the instructions are not followed, there is a risk of damage to equipment.*

WARNING : *do not install near heat or moisture.*

This symbol on the product or its packaging indicates that this product must not be disposed of with your other household waste. Instead, it is your responsibility to dispose of your waste by taking it to a designated collection point for the recycling of electrical and electronic appliances. Separate collection and recycling of your waste at the point of disposal will help conserve natural resources and ensure recycling that respects the environment and human health. For more information on your nearest recycling center, contact your local town hall, your household waste disposal service or the store where you bought the product.

b. Radio

The modems in the ACW range are part of the radiocommunication modems using the ISM (Industrial Scientific Medical) bands, which can be used freely (free of charge and without authorization) for industrial, scientific and medical applications.

Technical specifications

a. Product

Antennas	Integrated (¼ wave)	
Temperature	-20°C to +55°C (operating)	
	-40°C to +70°C (storage)	
Power	None (energy recovery)	
Weight	130g	
Frequency	863 – 870 MHz	
Power	25 mW (14 dBm)	
Radio version	Sigfox : NA	
	LoRaWan : v1.0.4	
Flow	Sigfox : NA	
	LoRaWAN : 250 bit/s à 5.5 Kbit/s	
Consumption	Sigfox	LoRaWAN
Tx mode	NA	30 mA
Watch	NA	19 µA (sans BLE) 52µA (avec BLE)
Rx mode	NA	5 mA

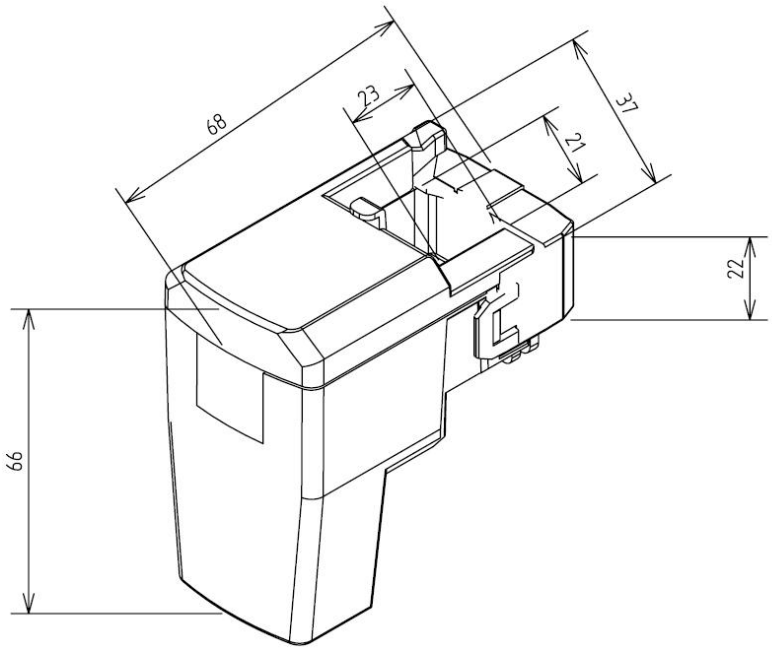
b. Integrated sensor functions

Current sensor	
Range	0A to 200A_{RMS}
Resolution	0,01A
Precision	Class 1

Thermocouple (optional remote sensor)	
Range	-200°C to 1200°C
Resolution	0,1°C
Precision	3%

Box

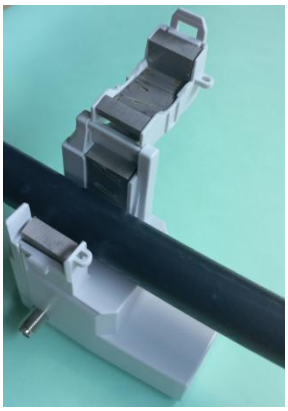
a. Dimensions



Dimensions in mm

b. Installation

1. Open the sensor's movable jaw by lifting the tab on the side of the sensor.



2. Position the sensor so that the conductor passes between the two legs of the magnetic circuit.

3. Close the movable jaw again until the tongue snaps into place on its catch.

c. Identification

The product's LoRaWAN identifier is printed on the sensor and in the status bar of the ACW configurator.

It can also be read by scanning the QR-Code.

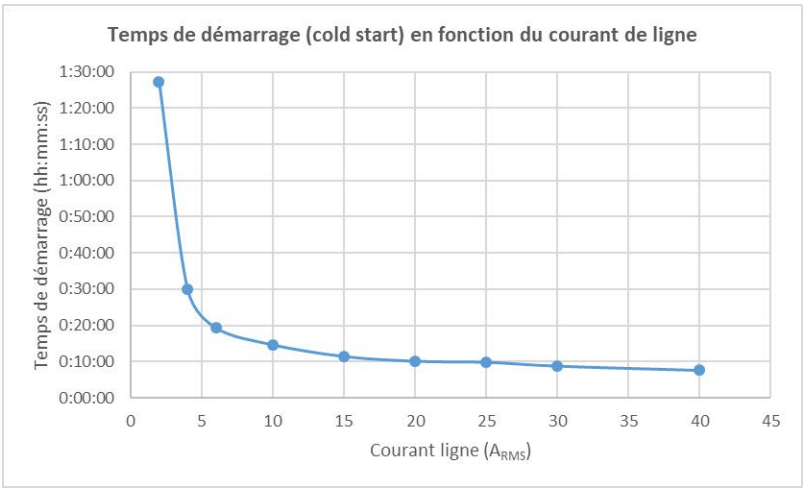
For LoRaWAN modems, the communication keys are automatically given by the network (pairing by "Over The Air Activation", or OTAA).

Operating principle

a. Energy recovery

As this is a stand-alone product, it needs a certain amount of time to store enough energy to be able to start up, particularly on first use when the storage element is empty.

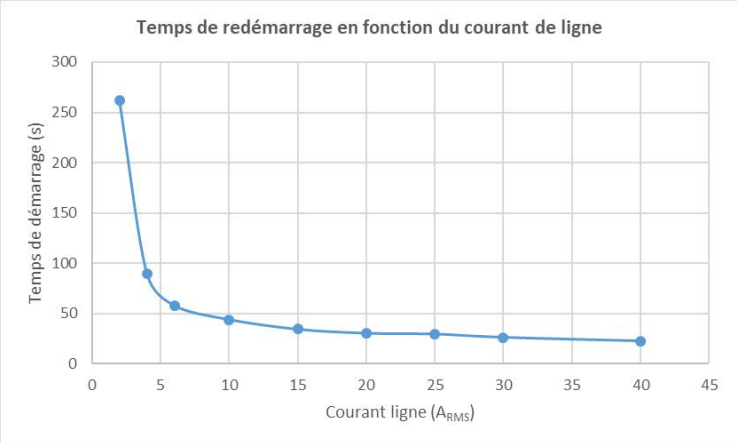
The minimum current required to start drawing energy is 2ARMS. The graph and table below give the charging times for different currents in the phase conductor for cold start.



For currents above 40ARMS, charging time does not drop below 10mn.

In normal operation, if the line current drops below 1ARMS, the energy recovery stage is deactivated. The sensor will continue to operate on stored energy for approximately 30 minutes.

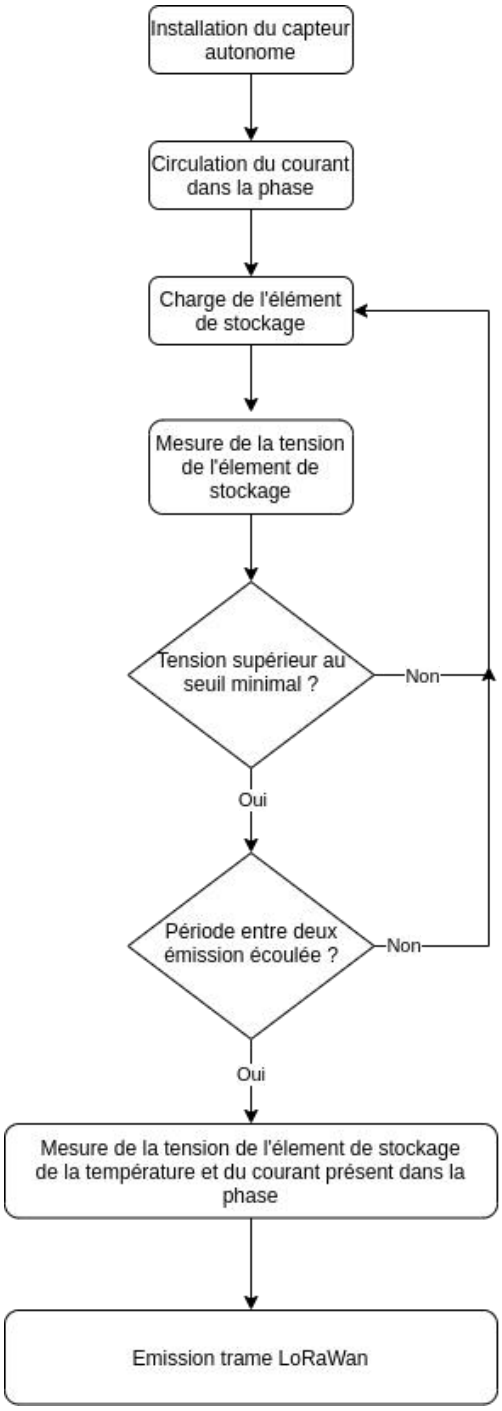
When the current in the phase is restored, the time required to restart is given by the graph below :



In continuous operation, a line current of amplitude 1.2ARMS is sufficient to supply the transducer with the energy required by the system without using the energy stored in the storage element.

b. Operating diagram

Simplified block diagram :


Installation du capteur autonome
Circulation du courant dans la phase
Charge de l'élément de stockage
Mesure de la tension de l'élement de stockage
Tension supérieur au seuil minimal ?
Non
Oui
Période entre deux émission écoulée ?
Non
Oui
Mesure de la tension de l'élement de stockage de la température et du courant présent dans la phase
Emission trame LoRaWan

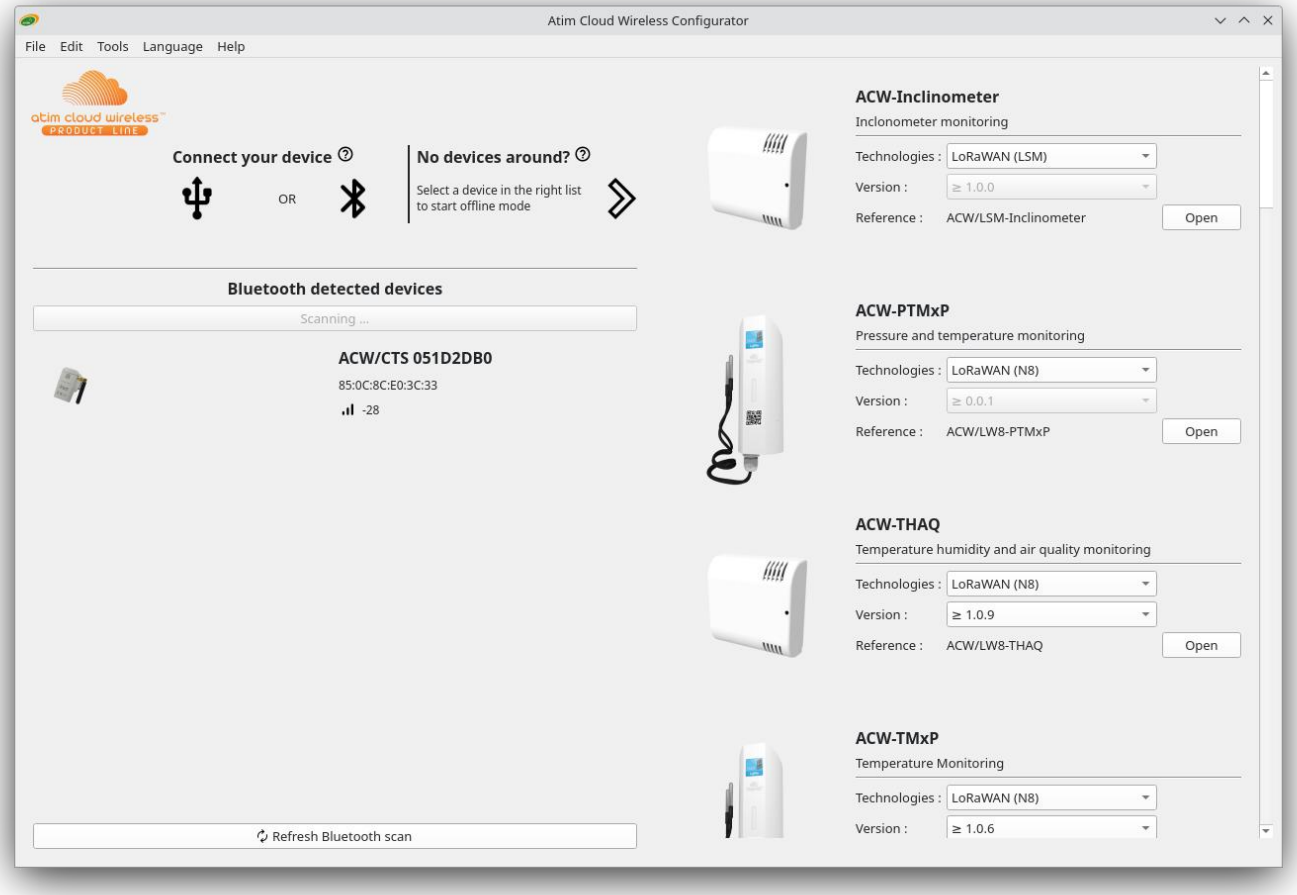
ACW Configurator

a. Compatible configurator versions

For a sensor with the following application software version	Use the ACW Configurator version
LoRaWan: V1.0.5 (revision A0)	V1.0.4 or higher

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

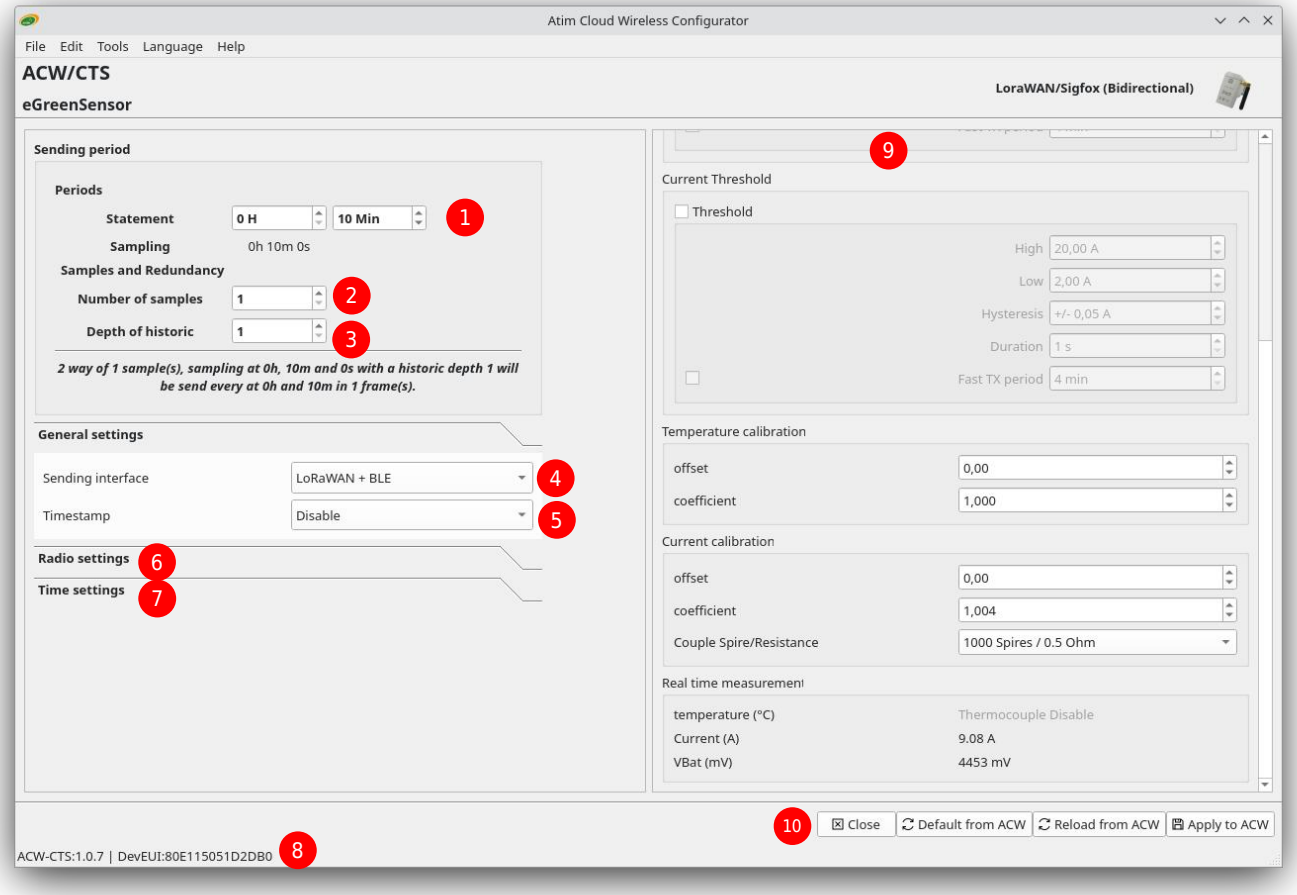
https://www.atim.com/wp-content/uploads/documentation/CONFIGURATEUR/ACW/configurateur-acw.exe



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

WARNING
Connection to the configurator is only possible in local mode (BLE).

b. eGreenSensor configuration



Transmission period and frame samples

- The transmission period 1 corresponds to the time interval between each transmission of a measurement frame. This period can be configured from :
- 1 min to 255h for a LoRaWan product

The default transmission period is 10min.

WARNING
If the transmission period is less than 4 min, a warning message will be displayed to inform the user that ADR (Adaptive Data Rate) will be deactivated, and that the product will freeze its Data Rate at SF9.

The number of samples in a 2 frame can be configured. In this way, several measurements are taken before the frame containing all these measurements is sent.

For example, with a period of 60 minutes and a number of samples of 4, a measurement will be taken every 15 minutes and the 4 samples will be sent in a frame every hour.

Finally, it is possible to apply data 3 redundancy , which means that samples that were sent in

frame n-1, n-2 or n-3 can be sent again in frame n following the new measurement samples (the most recent sample first in the frame and the oldest last).

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

By default, there is only one sample per frame, and no redundancy is enabled.

Communication interface

The product has two communication interfaces :

- LoRaWAN
- BLE

The BLE interface can be activated or deactivated using the 4 parameter . The LoRaWAN interface cannot be disabled.

WARNING
If the BLE interface is deactivated, it will no longer be possible to connect to the configurator. The configurator can only be accessed via BLE. The product can still be reconfigured, but using LoRaWAN downlinks.

By default, the BLE interface is activated.

Frame timestamp

It is possible to disable/enable time stamping of all radio 5 frames.

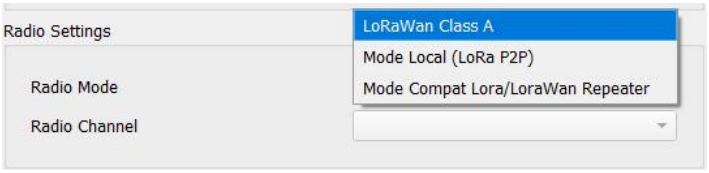
WARNING
When enabled, this option monopolizes 4 bytes in the frame, which cannot be used for useful data. These 4 bytes represent the timestamp of the sensor data acquisition.

By default, time stamping is disabled.

Radio module configuration

The product can operate in three different 6 ways

For a **LoRaWAN** product



1. **LoRaWAN Class A :** The product is modulated in LoRa using 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.

2. **Local mode :** Product modulation remains LoRa modulation. However, there is no LoRaWAN overlay. In this mode, you need to choose the radio channel on which the product will transmit.

   To receive the product's frames, you need a radio modem with the same parameters. For the moment, this mode has no real concrete use case, but future developments of this mode will enable interesting point-to-point functionalities.

WARNING
This radio mode is NOT AVAILABLE on ACW-CTS revision A0 (version detailed in this User Guide).

2. **Compatibility mode with the ATIM LoRa/LoRAWAN Repeater :** This mode is selected when you want to operate in classic LoRaWAN, but no network (private or operated) is accessible. This mode, combined with the ATIM LoRa/LoRaWAN Repeater, enables you to join the LoRaWAN network via this repeater. In this mode, if the network is not joined (no JOIN_ACCEPT), the product will transmit its frames locally. The LoRa/LoRaWAN repeater then relays these frames to the network 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) should be selected. If this mode is chosen, even though the network is accessible, the product will still send a frame on the LoRAWAN network, and the same frame in Local mode to the Repeater, thus unnecessarily consuming battery power.

WARNING
This radio mode is NOT AVAILABLE on ACW-CTS revision A0 (version detailed in this user guide).

Product clock

Each time you connect to the configurator, the product clock is updated (based on the computer clock) 7 and displayed. In addition, an offset in seconds can be applied if required.

Product versions

When connected to the product, the configurator retrieves all product software versions (product software and radio module software) and the 8 network identifier.

Sensor configuration

Here are the configuration parameters available for this sensor 9 :

Thermocouple activation

The ACW-CTS has a connector for type K thermocouples.

If such a thermocouple is used, the thermocouple must be activated in the configurator, so that the measurement is carried out, and the temperature is also transmitted via the LoRaWAN interface.

By default, the thermocouple is not activated.

Threshold Temperature, current and voltage

The ACW-CTS periodically measures the current used to recharge the storage element, as well as the voltage at its terminals.

If the thermocouple is activated, the product also measures temperature.
Sur l'ensemble de ces trois valeurs (courant, tension, et température), il est possible de définir des seuils.

Thresholds can be set with a high and a low threshold, according to a configurable hysteresis and overshoot time. When a measurement reaches a threshold, a radio frame is sent (see chapter Alert frame for details of the frame format).

Current and temperature measurement calibration

Current and temperature measurements can be calibrated by means of an offset and a coefficient.

For current measurement, it is also possible to select a different gauge.

Real-time measurement display

The various measurements are updated every 10 seconds and displayed on the configurator.

Configuration validation

Once all the configuration parameters have been entered, 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 product's current configuration, which will update the settings on the configurator, or to reset the product to its default configuration.

c. Factory settings

Radio frame parameters

- Radio frame transmission period : 10 minutes
- Number of samples : 1
- History depth : 1

General parameters

- Communication interface: LoRaWAN and BLE
- Timestamp : disabled
- Radio parameters: LoRaWAN Class A (for a LoRa product)

Sensor parameters

Thermocouple

- Status: Off

Current measurement

- Threshold disabled
- Rating: 1000 turns / 0.5 Ohms

d. ACW update

➔ Feature not available in version A0 of the product !

UPLINK frame format

a. Description

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

Three types of frame can be distinguished :

- **Classic frame ; New generation :** Very similar 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, etc. These last frames are common to all ACWs, but it is also possible to have other independent frames for each ACW.

- **Measurement frame ; New generation :** These frames are made up of samples of the different values of each channel that an ACW can read. The number of samples and the depth of the history are inserted in the header.

NOTE
The number of samples and the depth of the history are the same for all channels in the frame.

- **Alert frame (threshold exceeded) ; New generation :** These frames combine a classic frame and a measurement frame. They consist of a header warning that a threshold has been exceeded, followed by the samples of each channel 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	Time stamp = 1 – enabled d0 - disabled	Measurement frame= 0	Reserved = 0	Frame type (see below)			

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

The different types of frame

Frame type	Data size	Frame description
0x00	--	Reserved
0x01	4 bytes	Life frame.
0x02	0 bytes	Downlink request for network test.
0x03	--	Reserved
0x04	--	Reserved
0x05	1 byte	Test frame with counter.
0x06	Variable	(Cfg box) Response to configuration frame.
0x07	Variable	(Cfg box) Response to a command frame.
0x08	Variable	(Cfg box) Response to an erroneous frame.
0x09	--	Reserved
0x0a	--	Reserved
0x0b	--	Reserved
0x0c	--	Reserved
0x0d	Variable	Alert frames monitoring of measurement samples from alert channels
0x0e	TBD	General error - TBD (memory, ...)
0x0f	Variable ...	Subframe for ACW. Depending on ACW

Measurement frame

Byte 1 - Leading							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation = 1	Timestamp (Off = 0, On = 1)	Measurement frame= 1	Depth of history (-1) Max : 4		Nombre d'échantillons (-1) Max : 8		

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

WARNING
If the History depth or Number of samples field is greater than 1, the frame transmission period (in minutes) will be added after the header and will occupy 2 bytes (Big Endian encoding, MSB first).

For each channel, a header is inserted as follows :

Byte 2 Channel header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reserved = 0		Lane number		Measurement type			

Possible type of measurement

Measurement type	Units	Data size	Data type	Descriptions
0x08	T°C	2 bytes **(Big Endian - MSB)**	Integer signed	Temperature in hundredths of degrees Celsius • Resolution: 0.01°C • Max. value: 327.67°C • Min. value: -327.68°C
0x0A	mV	2 bytes (**Big Endian - MSB**)	Unsigned integer	Supercap terminal voltage (in mV) • Resolution: 1mV • Max. value: 65535mV • Min. value: 0mV
0x0B	A	2 bytes (**Big Endian - MSB**	Unsigned integer	Current measured in cable (in hundredths of an Ampere) • Resolution: 0.01A • Max. value: 655.35A • Min. value: 0A

This is followed by data from the measurement sample(s) (depending on product configuration).

NOTE
When a frame contains more than one sample per channel (number of samples > 1 or history depth > 1), samples are organized from newest to oldest.

The number of bytes sent can be determined as follows:

(measurement size in bytes) * (number of samples) * (history depth)

EXAMPLE
For measurement type 0x0A (the size of a value is two bytes) with a history depth of 2 and a number of samples of 3, the size of the data to be read would be 12 bytes (2x2x3).

Measurement alert frame

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

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

For each alert channel, a header is inserted as follows :

The **alert type** field identifies whether the alert has exceeded the high threshold, the low threshold or a return between thresholds.

Byte 2 Channel header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Alert type		Lane number		Measurement type			

These values are defined as follows :

Value	Description
0x00	Back between thresholds
0x01	High threshold exceeded
0x02	Low threshold exceeded
0x03	Reserved

The measurement type field is identical to that of the measurement frame (either 0x08, 0x0A or 0x0B in hexadecimal for the ACW-CTS).

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

Error and general alarm frame

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

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

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

Byte 2 - Header Error message							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Message index			Error message length				

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

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

The next byte identifies the nature of the error or alarm:

Byte 3 - Header Error message		
Error code	Nature of error	Description
0x81	ERR_UNKNOWN	
0x82	ERR_BUF_SMALLER	Data table is full, impossible to write additional data to
0x83	ERR_DEPTH_HISTORIC_OUT_OF_RANGE	History depth is too large or too small for the frame
0x84	ERR_NB_SAMPLE_OUT_OF_RANGE	Number of samples too large or too small for the frame
0x85	ERR_NWAY_OUT_OF_RANGE	Number of channels in frame header too large or too small
0x86	ERR_TYPEWAY_OUT_OF_RANGE	Measurement type in frame header too large or too small
0x87	ERR_SAMPLING_PERIOD	Wrong sampling period structure
0x88	ERR_SUBTASK_END	End of a subtask after exiting an infinite loop
0x89	ERR_NULL_POINTER	Pointer with "NULL" value
0x8A	-	-
0x8B	ERR_EEPROM	EEPROM corrupted
0x8C	ERR_ROM	ROM corrupted
0x8D	ERR_RAM	RAM corrupted
0x8E	ERR_ARM_INIT_FAIL	Radio module initialization failed
0x8F	ERR_ARM_BUSY	Module already busy (possibly not initialized)
0x90	ERR_ARM_BRIDGE_ENABLE	Module in bridge mode, unable to send data via radio
0x91	ERR_RADIO_QUEUE_FULL	Radio buffer full
0x92	ERR_CFG_BOX_INIT_FAIL	Black box initialization error
0x93	-	-
0x94	-	-
0x95	-	-
0x96	ERR_ARM_TRANSMISSION	A transmission has been initiated but an error has occurred
0x97	ERR_ARM_PAYLOAD_BIGGER	Message size too large for network capacity
0x98	ERR_RADIO_PAIRING_TIMEOUT	Unable to pair up to a network before the allotted time has elapsed

b. Example frames

Measurement frame

With timestamp disabled, no history and a sample count of 1 (Current and Voltage only) :

Byte						
1	2	3	4	5	6	7
0xA0 (new-generation measurement frame, no history, 1 sample)	0x0B (channel 0, measurement type: current)	0x03	0xA8	0x0A (channel 0, measurement type: voltage)	0x10	0x38

In this example, the sensor returns values of 0x03A8 (9.36A) for current and 0x1038 (4.152V) for voltage.

Now with a number of samples of 2 :

Byte											
1	2 et 3	4	5	6	7	8	9	10	11	12	13
0xA1 (new-generation measurement frame, no history, 2 samples)	0x00A (issue period)	0x0B (channel 0, measurement type: current)	0x07	0xF0	0x07	0x8C	0x0A (channel 0, measurement type: voltage)	0x0F	0x13	0x10	0xA7

2 and 3 indicate the transmission period, in this case 10 minutes (so a sample is measured every 5 minutes).

- The first sample is 0x07F0 (20.32A) / 0x0F13 (3.859V)
- The second is 0x078C (19.32A) / 0x10A7 (4.263V)

With timestamp disabled, no history and a sample count of 1 with thermocouple activated :

Byte									
1	2	3	4	5	6	7	8	9	10
0xA0 (new-generation measurement frame, no history, 1 sample)	0x08 (channel 0, measurement type: temperature)	0x09	0xE8	0x0B (channel 0, measurement type: current)	0x03	0xA8	0x0A (channel 0, measurement type: voltage)	0x10	0x38

In this example, the sensor returns values of 0x09E8 (25.36°C) for temperature, 0x03A8 (9.36A) for current and 0x1038 (4.152V) for voltage.

Byte																
1	2 et 3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
0xA1 (new-generation measurement frame, no history, 2 samples)	0x00A (issue period)	0x08 (channel 0, measurement type: temperature)	0x09	0x34	0x09	0x79	0x0B (channel 0, measurement type: current)	0x07	0xF0	0x07	0x8C	0x0A (channel 0, measurement type: voltage)	0x0F	0x13	0x10	0xA7

Now with a number of samples of 2 :

2 and 3 indicate the transmission period, in this case 10 minutes (so a sample is measured every 5 minutes).

- The first sample is 0x0934 (23.56°C) / 0x07F0 (20.32A) / 0x0F13 (3.859V)
- The second is 0x0979 (24.25°C) / 0x078C (19.32A) / 0x10A7 (4.263V)

Measurement alert frame

If the low threshold (voltage) is exceeded on channel 0, the frame will be :

Byte			
1	2	3	4
0x8D (New generation alert frame)	0x8A (Channel 0 low threshold exceeded, voltage measurement)	0x0E	0x89

The sample that triggered the threshold is 0x0E89 (3.721V)

Downlink

This feature is available on ACW-CTSs meeting the following conditions:

	Application software
LoRaWAN version	V1.0.5

Downlinks provide two product functions :

- Changing parameters
- Sending commands

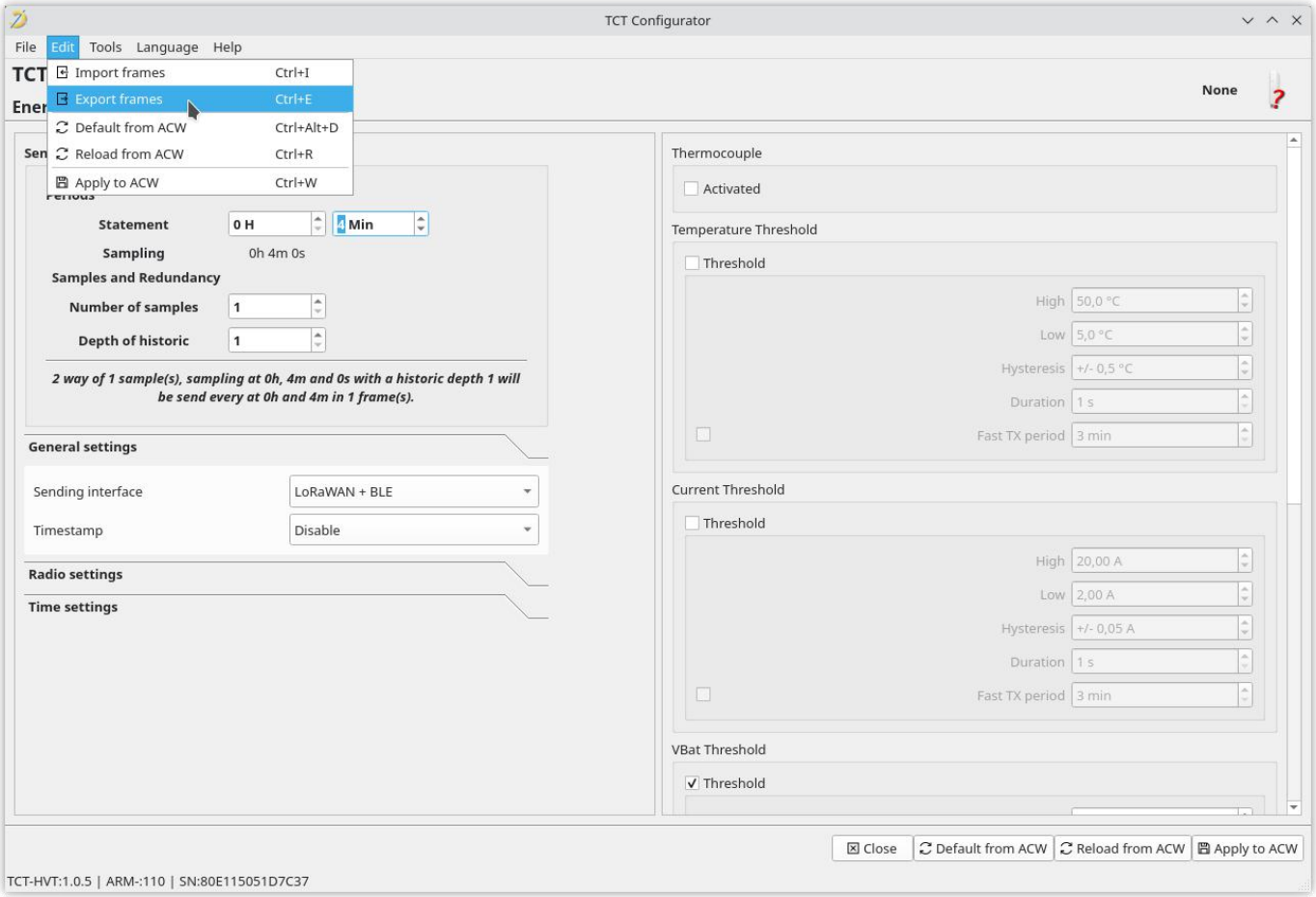
Downlink operation is explained in document ATIM_ACW-DLConfig_UG_EN_v1.4, relating to version V1.2.0 of the ATIM Downlink Protocol (see this document for all parameters and commands common to all ACW products).

a. Parameter modification

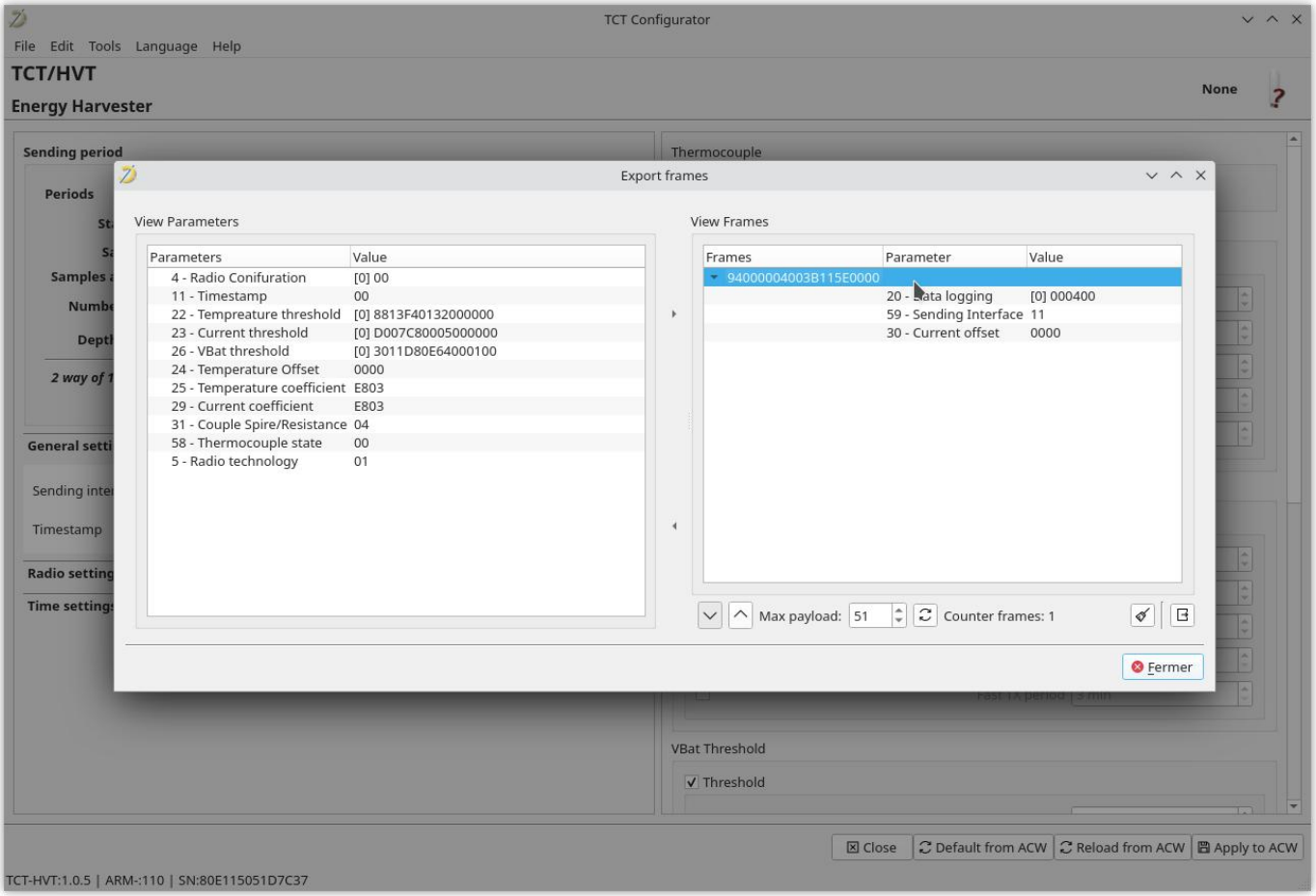
The configurator can be used to generate downlinks for remote parameterization of a product. These downlinks can then be sent via the Sigfox or LoRaWan network.

To do this :

- Open the product configuration page (a virtual page can be opened if the product is not physically in range)
- Build your desired configuration
- Parameters can then be exported using the menu (Edit->Export frames) :



- Simply select the parameter(s) you wish to apply via downlink and build the associated downlink. Here, for example, we wish to modify the data logging, communication interface and current measurement offset parameters. The downlink to be sent will then be 94000004003B115E0000



b. Send downlink command.

Downlink commands are explained in document ATIM_ACW-DLConfig_UG_EN_v1.4, relating to version V1.2.0 of the ATIM Downlink Protocol

Technical support

Pour tout renseignement ou question technique, nous vous invitons à ouvrir un ticket sur notre For any information or technical question, please open a ticket on our dedicated support web page: [Support technique | ATIM]