



atim cloud wireless™
PRODUCT LINE

ATIM Cloud Wireless

Metering and Dry contacts inputs

MR4

User Guide



Concerned models:

ACW/SF8-MR4

ACW/LW8-MR4



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This user guide is applicable to the following references

	Product references	Product version (Visible on the label of the product)
LoRaWAN	ACW/LW8-MR4	A.2
Sigfox	ACW/SF8-MR4	A.2

Document version history

Version	Date	Description	Author	Software version
0.1	23/01/2020	Document creation	AC	V0.0.1
0.2	28/02/2020	Current consumption addition	AC	V0.0.1
0.3	05/03/2020	Correction	AC	V0.0.1
0.4	10/03/2020	Add connector mapping	AC	V0.0.1
0.5	25/03/2020	Correction on measurement frame	AC	V0.0.1
0.6	15/04/2020 28/04/2020	Endianness modification of the fields of the frames. Modification of LED/Buzzer sequencies and magnet usage	YLB/AC	V0.0.1
0.7	06/05/2020	Terminal block wiring update Document title modification + operation mode Error code correction	AC/YLB	V0.0.1
0.8	07/09/2020	Keep alive frame description + product error codes addition	AC	V0.0.2
0.9	23/10/2020	Batteries passivation description	AC	V0.0.3
0.10	10/12/2020	Datalogging downlink frame description correction	AC	V0.0.4
0.11	21/01/2021	Compatibility mode regarding repeaters LoRa/LoRaWAN and FSK/Sigfox description Modification of the operation mode description: LED behavior when searching for a network	YLB	V0.0.6
1.0	29/01/2021	Minor corrections	FR	V0.06
1.1	16/06/2021	Datalogging downlink corrections	AC	V1.0.0
1.2	22/06/2021	Text formatting	AC	V1.0.0
1.3	09/07/2021	Add input's characteristics	AC	V1.0.0

1.5	02/06/2022	Change measurement frame Add downlink command to change counter index	YLB	V1.0.4
1.6	03/04/2023	Removal anti-fraud system	JML	V1.0.9

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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:



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

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

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, under any circumstances, be submerged.

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.



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.

ACW-MR Product line

ACW-MR product line regroups different types of radio equipment which allow pulse metering, dry contacts and fraud detection.

Each device of this product line is available in LoRaWAN and Sigfox version and are delivered with removable batteries. They can be parametrized through intern switches or via downlink frames on the network (exclusively on LoRaWAN version).



ACW-MR4

The ACW-MR4 is a sensor used for remote metering monitoring (gas, water, electricity, pluviometer meters...) or for remote bang-bang equipment control (eg: starting up/shutting down, opening/closing...).

This sensor can be connected to 4 independent equipment when they are close enough, allowing devices and network plans savings.

The ACW-MR4 is delivered with two Lithium 3.6V removable batteries packs with a total capacity of 14400 mAh.

CAPT-OPT2 & CAPT-MECA

In addition to the ACW-MR4, there are 2 metering sensors options: an integrated optical sensor, this plug and play device monitors remotely the consumption of an LED optical electrical meter (eg: Linky meters, PME-PMI meters) or an integrated mechanical sensor which traduces the rotation of the meter index into pulses and then to energy consumption. It is delivered and pre-set to memorize the consumption index every 10 minutes and send the last 6 every hour.



CAPT-DOCK

In addition to the ACW-MR4, there is an industrial detector opening/closing door/window/trap. Coupled with an ACW-MR4, it comes wired and preconfigured for immediate installation. This sensor is generally used for intrusion detection. It is also suitable for monitoring Skydome openings or for checking the presence of objects in their parking area. Data is sent through LPWAN technologies (Sigfox / LoRaWAN).

Technical specifications

a. Product

Dimensions	154 x 54 x 54 mm	
Antenna	Integrated (1/4 of wave)	
Temperature	-25°C to +70°C (Operating mode)	
	-40°C to +70°C (Storage)	
Mounts to	Wall, tube or mast, DIN-Rail	
Casing	IP 65	
Power Supply	1 pack of 2 batteries as standard, 1 second in option	
Weight	300 g	
Frequency	865 – 870 MHz	
Power	25 mW (14 dBm)	
Rate	Sigfox: 100 bits/s	
	LoRAWAN: 300 bits/s to 10 Kbits/s	
Consumption	Sigfox	LoRaWAN
Mode Tx	60 mA	55 mA
Mode veille	< 90 µA	< 90 µA
Mode Rx	50 mA	25 mA

Sensors' function

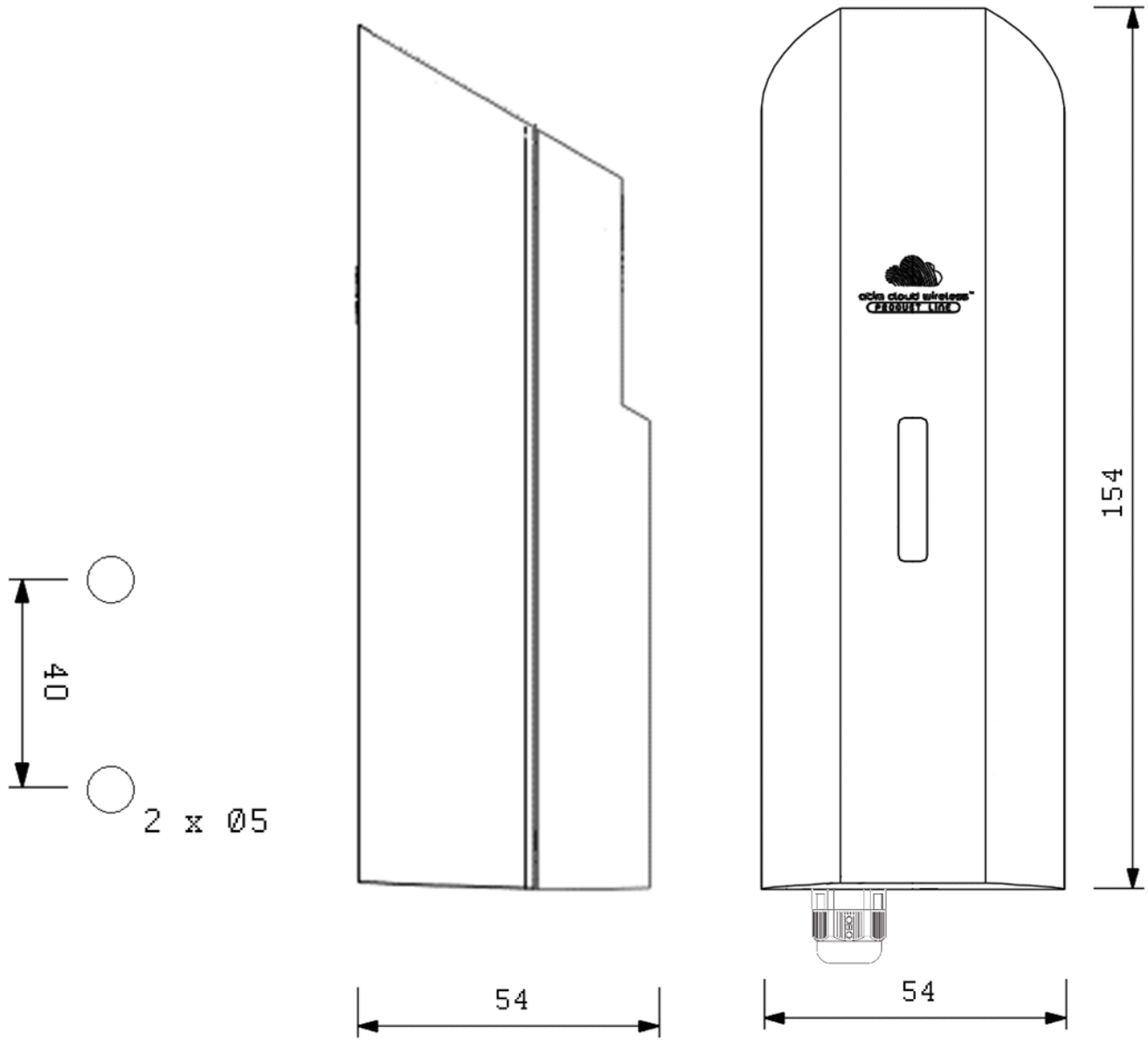
4 digital inputs with edge detection or pulse metering.

Input's characteristics

	MIN.	TYP.	MAX.
Working voltage (Volts)	0	3.3	30
Input high level voltage (Volts)	2.3	-	-
Input low level voltage (Volts)	-	-	0.4
Frequency (Hz)			40
Bounce filtering time (ms)	5		255

Casing

a. Footprint



Maximum diameter of the cable in the stuffing box: 7 mm.

b. Fasteners

ACW modems are fixed on a flat wall, a mast or on a DIN rail depending on the type of installation desired. These three types of fasteners are plugged into the back of the case.

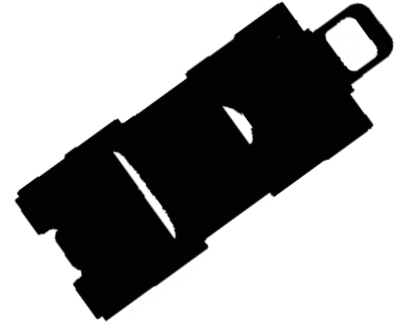
Fixing on a flat wall (supplied):



On tube or mast:



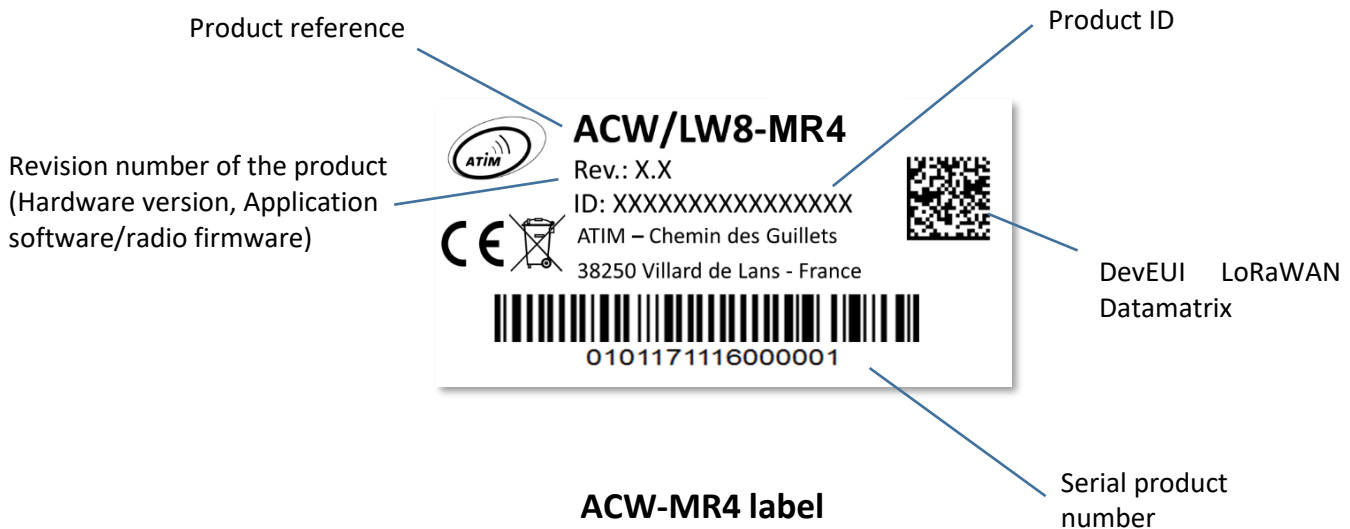
DIN rail mounting:



c. Product Identification

The Sigfox or LoRaWAN IDs of the product are visible on the outside label on the back of the product, inside on the electronic card, and in the status section of the ACW configurator.

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



d. Installation and dismantling



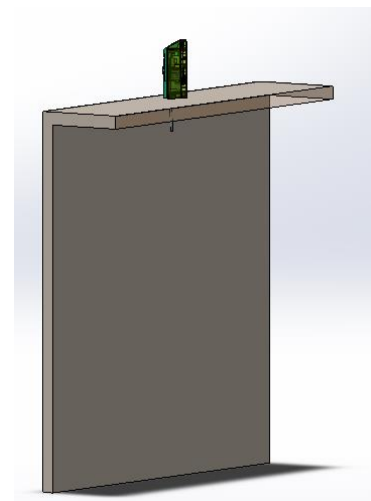
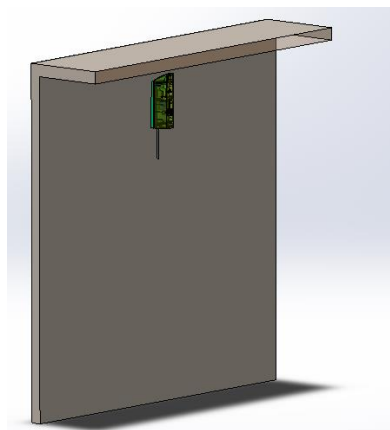
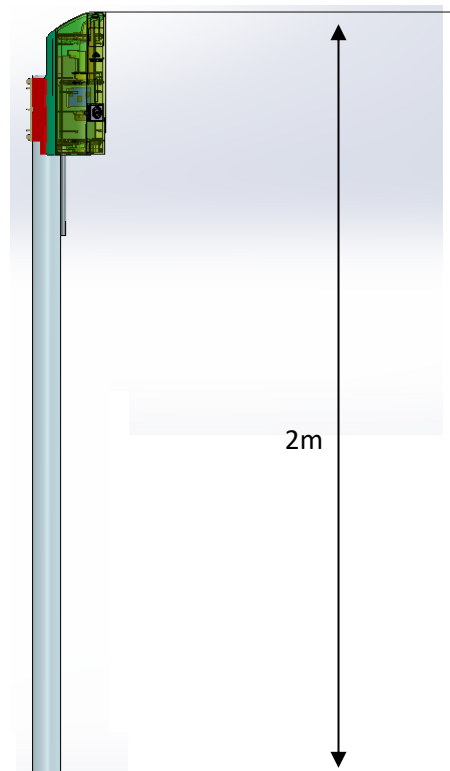
It is necessary to open the box to access on the one hand the micro-USB port allowing the configuration of the module and on the other hand to the connection terminal block.

To do this, you must insert the screwdriver into the slot and tilt it downwards to lift the internal tab (see photo opposite). Then pull on the back side to separate the two parts of the case.

e. Installation

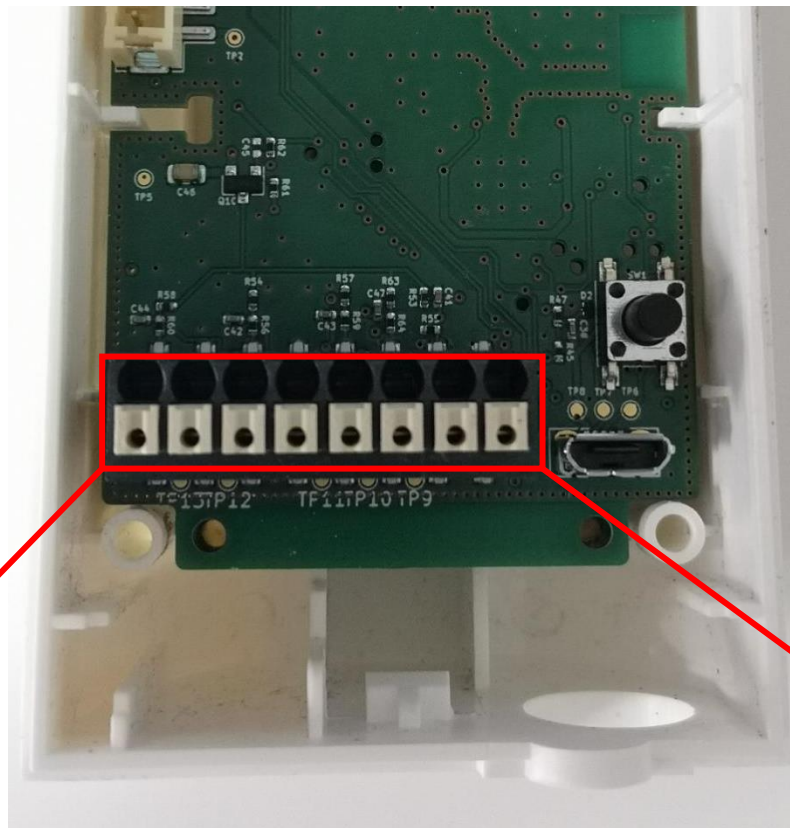
Install the modem at a minimum height of 2m and not glued to the wall, ideally offset at least 20cm. Cables must not exceed 10m in length and must be shielded.

For optimal results, it is advised to place it high and clear of any metallic obstacle within a radius of 1 meter if possible (see figures below). For information, the antenna is integrated in the box.



f. Connector Mapping

The connector mapping is as follows:




VCC	GND	IN4	IN3	IN2	WIRECUT	IN1	GND
-----	-----	-----	-----	-----	---------	-----	-----


Operating


a. Mode of operation


The new generation 2020 ACW (Atim Cloud Wireless®) products are all based on the same internal software (Firmware) and bring interesting new features such as the selection and visualization of their operating mode. To know the status of the product, you just must pass a magnet briefly (<2 sec) against the QR CODE label or on the Pepper boxes against the small diamond, which causes the LED indicator of the corresponding color to light up:




 **Deep sleep mode:** When you take the product out of its packaging, it is by default in this deep sleep mode, which optimizes the life of the batteries by avoiding their oxidation. The product does not transmit and waits patiently for you to wake it up.

 **Network pairing mode:** This mode is active as soon as the product leaves the deep sleep mode and allows the pairing to a network (automatic in case of battery change).

 **Configuration mode:** this mode is active 5 minutes after the exit of the deep sleep mode and authorizes the configuration of the product in Bluetooth thanks to the PC configurator or to the mobile application ATIM. During these 5 minutes messages are sent by radio every minute (5 "radio frames"), that allows you to check that the product works well, for example after having placed it under a cast iron manhole. After this period, the product goes into operation mode and the Bluetooth is deactivated (possibility to reactivate it via Downlink).

 **Operating mode:** this is the default mode after the product start-up phase. 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 Configuration).

 **Internal 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:

- Battery empty (Battery voltage < 2.2V)
- Internal error of the radio module
- System error

The entry in this mode "Internal fault" is signaled by a **RED** flashing of the LED 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 chapter Frame Format for error codes). In addition, the product will emit a warning light depending on the nature of the event.

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

b. Putting the product into service

- Unless otherwise requested, ACW products are delivered with batteries connected and set to "deep sleep" mode.

To place the product in its operating mode, hold a magnet against the QR CODE label for 6 seconds. During these six seconds, the product's LED should blink **WHITE** and then **GREEN** at the end of the six seconds to indicate that the product has been successfully switched on.

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

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

GREEN light signal: good network quality

- **YELLOW** light: average network quality
- **ORANGE** light: low network quality
- **WHITE** light: no information on network quality

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

NOTE

The LoRaWAN version, if it fails to connect, will go into simple sleep mode and make the next pairing attempt the next day and every day until it successfully joins the network.

Special case

For a Sigfox product

- To have the information on the quality of the Sigfox network (**GREEN**, **YELLOW** or **ORANGE** light signal), it is necessary to provide a Sigfox Downlink. It is this one which will allow to rule 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 Sigfox Downlink is provided, the information on the network quality will be sent back by the ACW (light signal). If no Downlink is provided, the ACW will always display the **WHITE** light signal at the end.
- If a **WHITE** light signal is emitted by the product at the end of the 5min pairing phase and a Downlink has been provisioned, it means that the Network is not accessible.
- If a **WHITE** light at the end of the 5min pairing phase is emitted by the product without a downlink having been provisioned, this has no meaning as to the quality of the network. The network quality can be good or bad (or non-existent).

For a LoRaWAN product

- In the default LoRaWAN Class A operating mode, (see Radio settings chapter), if at the end of the 5 minutes pairing phase, no network has been reached, then the product goes into standby and will restart a 5-minute pairing phase 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 emitted by the product in LoRaWAN frames on the network that the repeater has reached.

c. Sending a test frame

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

To do this, simply move the magnet against the QR CODE label, which turns the LED **GREEN** and wait for it to go out before removing the magnet. The successful sending of the test frame will be indicated by a **CYAN** light signal.

Just before sending, a leak detection is performed, and a value of this measurement is integrated in the frame. This ensures that the cable or the electrodes are correctly installed. The test frames are identical to the alert frames. See their structure in the "Alert frames" section.

In the case of a cable without the "Distance measurement" option (yellow and black cable). The measured value should be close to zero.

d. Deep sleep

When transporting or storing the ACW-WL, it is best to place it in its deep sleep mode to limit unnecessary power consumption.

From any operating mode (**except fault mode**), move a magnet against the QR CODE on the case for 6 seconds.

- During these six seconds, the product's LED will flash the color corresponding to the operating mode and then the end of the sequence will be indicated by a **WHITE** fade acknowledging that the product has been put to sleep. The magnet can then be removed.

e. Radio module activity

Any radio frame transmission is normally indicated by three short flashes of **GREEN** color of the LED. This function is disabled by default on all products with a front panel LED, such as the ACW-THAQ and ACW-WL.

f. Threshold exceeded

When thresholds have been configured using the configurator and the measurement values exceed these thresholds, the product's LED emits a periodic **ORANGE** flash to notify this. This function is disabled by default on all products with a front panel LED, such as the ACW-THAQ and ACW-WL.

g. Anti-fraud system

WARNING

Since the product version 1.0.9, the anti-fraud system has been removed; the push button always works as substitution to the magnet.

A mechanism (push button) is present on the product to notify any opening of the case during normal operation.

In normal times, the box presses the button. As soon as the back cover is removed, the button is released, triggering the fault mode of the ACW-MR4. A light signal indicates that the opening of the case has been considered.

In addition, if the module is connected to a network, an error frame will be sent every 24 hours until its next restart.

h. Substitution to the magnet

You can use the push button on the ACW-MR4 card to perform the same actions as the magnet (activate or deactivate the product, activate / deactivate Bluetooth). Since the product version 1.0.9, this is the permanent behavior.

To activate this functionality on the previous versions, 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.

i. Battery passivation

The ACW-MR4 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.

ACW configurator

a. Compatible configurator version

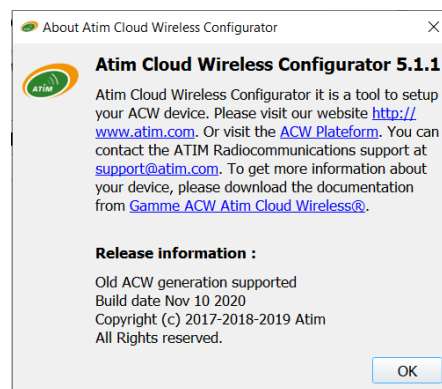
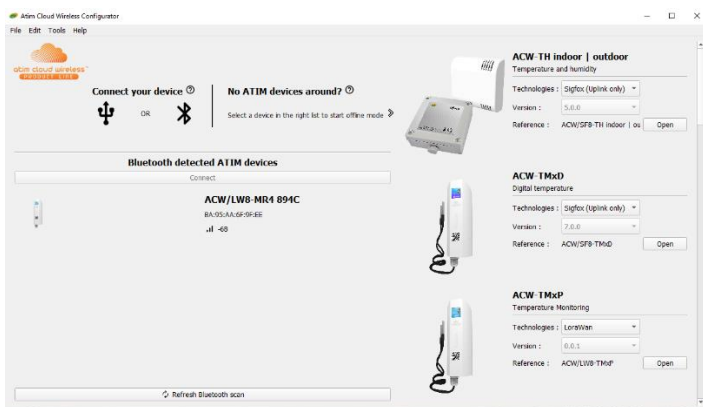
For an MR4 with the following application software version:	Use the version of ACW Configurator:
Sigfox: V0.0.1 LoRaWAN: V0.0.1	V5.1.0

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

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

NOTE

The product must be in its configuration mode to be detected by the configurator. For safety reasons, configuration is only possible for 5 minutes after the product has been started. First, the product must be put into deep sleep mode (magnet close for 6 seconds), wait about 20 seconds for the entry into deep sleep to be effective, then wake up the product (magnet 6 seconds again). 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-MR4 with the configurator can be done in two ways:

- **By USB:** open the case of the ACW-MR4 and connect it to a computer with a micro-USB cable.
- **By Bluetooth:** make sure that Bluetooth is activated.

WARNING

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-MR4 setup

The screenshot shows the 'Atim Cloud Wireless Configurator' window for 'ACW/LW8-MR4' (Equipments monitoring, 4 inputs, 4 counters) in 'LoraWan' mode. The interface includes the following sections and highlighted elements:

- Datalogging:**
 - Periods:** Statement is set to '0 H' and '10 Min' (highlighted with a red circle 1).
 - Samples and Redundancy:** Number of samples is '1' (highlighted with a red circle 2) and Depth of historic is '1' (highlighted with a red circle 3).
 - A note states: '2 way of 1 sample(s), sampling at 0h, 10m and 0s with a historic depth 1 will be send every at 0h and 10m in 1 frame(s)'.
- General settings:**
 - Keep alive period: 'Once every 4 days' (highlighted with a red circle 4).
 - Timestamp: 'Disable' (highlighted with a red circle 5).
- Radio Settings:** Radio Mode is 'LoRaWan' (highlighted with a red circle 6).
- Time Settings:** No Date is '0' and Date Offset (in sec) is empty (highlighted with a red circle 7).
- Input configuration:** Bounce Time is '50 ms' (highlighted with a red circle 9). Inputs 1-4 are configured with Event Mode, Pull, Trigger Mode, and Active level.
- Counters Threshold:** Counter 1 and Counter 2 have 'High 0' thresholds (highlighted with a red circle 10).
- Counter view:** A table showing counter values and triggers (highlighted with a red circle 11).
- Footer:** 'ACW-MR4:1.0.0 | ARM-N8LW:XXXX' (highlighted with a red circle 8) and buttons for 'Close', 'Reload from file', and 'Save to file' (highlighted with a red circle 12).

Emission period and samples in 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 12 minutes and a number of samples of 4, a measurement will be made every 3 minutes and the 4 samples will be sent in a single frame every 12 minutes.

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.

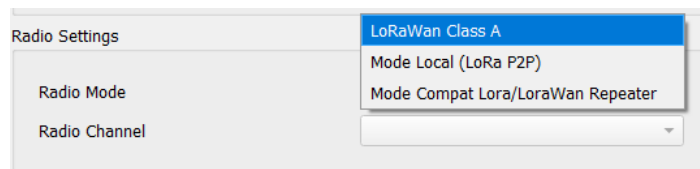
WARNING

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

Radio parameter

The device can work in 3 different operating modes ⁶:

- For a **LoRaWAN** device

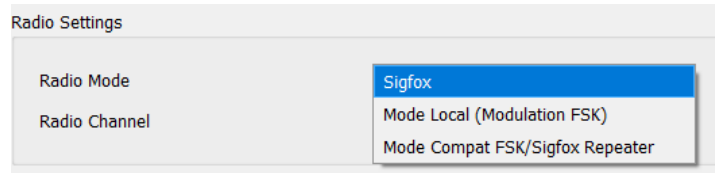


1. **LoRAWAN Class A** (default): The product is modulated in LoRa and uses the LoRAWAN Class A protocol. This is the product's default mode. This mode requires a private LoRAWAN network (private gateway), or an operated network to view the data sent by the product.
2. **Local mode** : Product modulation 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.
3. **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



1. **Sigfox** (default): Modulation and Sigfox Protocol used. This is the product's default mode. This mode requires access to the Sigfox network to operate.
2. **Local mode**: The modulation of the frame's 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.
3. **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.

Inputs configuration

On the ACW-MR4, the 4 inputs can be configured individually ⁹. So, for each entry you can configure:

- **Input function**: front detection, metering or disabling
- **Type of line draw**: to ground or towards power supply
- **Trigger front**: rising, falling edge or both.

In addition, it is possible to configure an anti-bounce time which corresponds to the wait following a level change before taking it into account ("**Bounce time**" on the configurator).

Finally, when the input is configured for edge detection, and only in this mode, its current state is indicated on the right (under "**Active level**").

Metering thresholds setup

In the case where an input is configured as a counter, it is possible to activate a threshold detection function allowing to alert by a radio frame that the counter has exceeded a certain value ¹⁰.

Meters overview

When an input is configured as a counter, it is then possible to have a real-time display of the value of the counter and of the triggering input ¹¹.

Setup validation

After having filled in all the configuration parameters, it is essential to click on the "Apply to ACW" button to send the configuration to the product ¹².

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

c. 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)

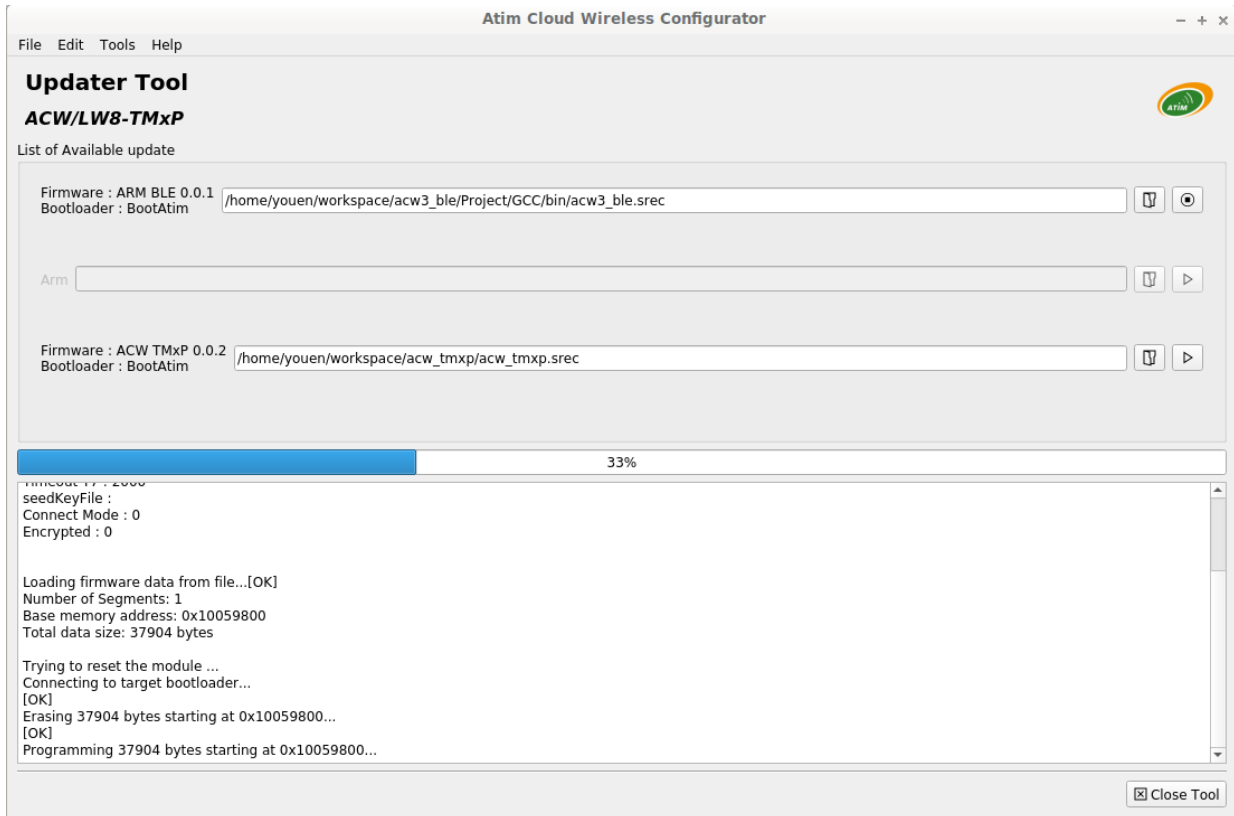
Sensors' parameters

- Inputs 1 and 2 deal with meter 1 and meter 2 respectively
- Pull up "+"
- Rising edge detection

d. Updates of ACW

When connected with Bluetooth Low Energy to the product, it is possible to update the different software that composes it.

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 type of frames:

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 frame

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			

In the case of ACW-MR4, **the measurement type** can be worth **0x01** for the state of the inputs or **0x04** for the value of a counter. The state of the four inputs of the MR4 is on 1 byte, the value of a counter on 4 bytes (**Little Endian** encoding, LSB first).

In the case of input status measurement, the channel number will always be 0. In the case of a counter value, the channel number + 1 will correspond to the counter number (see the table below).

Type of measurement	Units	Data size	Data type	Descriptions
0x01	Bit	1 byte	Bit field	Status of 4 inputs (on the first 4 bits of the byte: Bit 0 -> IN1 / bit 1 -> IN2 / bit 2 -> IN3 / bit 3 -> IN4)
0x04	Pulse	4 bytes (Big Endian)	Unsigned integer	Counter value

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

NOTE

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 measure) * (number of samplings) * (depth history)

EXAMPLE

For a frame containing the state of 8 inputs (measure 0x01 on 1 byte) with a history depth of 1 and number of samples of 3, we are left with 3 bytes of data (1x1x3).

Specific case: In and out configured in Edge mode

When at least one of the inputs is configured in change of state detection, the ACW-MR4 emits a measurement frame immediately after each change of state on this input (based on the type of detection selected during configuration). This measurement frame only contains the measurement type 0x01, even if some inputs have been configured as counting.

The data contained in the frame will then include the value of the four inputs as well as a flag indicating which input has been triggered (note that bits 4 - 7 will always be at "0" in a periodic measurement frame).

Byte1	Byte2	Byte3
Frame header (0xA0 without timestamp) (0xE0 with timestamp)	Channel header (0x01)	Data

Byte3 (Data)							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
IN4 state change Flag	IN3 state change Flag	IN2 state change Flag	IN1 state change Flag	IN4 state	IN3 state	IN2 state	IN1 state

EXAMPLE

0xA0 01 12 => Input 1 change from high to low state (0x12 = 0b00010010).
 0xA0 01 21 => Input 2 change from high to low state (0x21 = 0b00100001).
 0xA0 01 03 => Every input flag is set to 0 (0x03 = 0b00000011). It means this frame is a periodical measurement frame and has not been sent after an input state change.

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			

NOTE

The ACW-MR4, 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:

Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0

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

The **measurement type field** is here identical to that of the measurement frame (ie 0x04 in hexadecimal for the ACW-MR4).

The sample that caused 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), 0BBBB the empty battery level (value in millivolts, MSB coding) and 0CCCC 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 samplings 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.

MR4 specific frame

This ACW-MR4-specific frame is used to notify changes of state on the WIRECUT input

Byte 1 - Header							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
New generation	Timestamp	Measured frame	Reserved = 0	Alert frame = 0x0F			

= 1		= 0		
-----	--	-----	--	--

Following the frame header is a byte indicating the change of state on the WIRECUT input. Its value is fixed and equals 0x1C. This byte is followed by a last byte indicating the current state of the WIRECUT entry:

- 0x01 => WIRECUT not cut
- 0x20 => WIRECUT cut

b. Examples of frames

Measurement frame

1 counter input (counter 1) and 1 edge detection input (input 2), without time stamp, no history and a sample number of 1.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0xA0	0x01	0xFD	0x04	0x00	0x00	0x00	0x52
(new generation measurement frame, no history, 1 sampling)	(channel 0, measurement type: state of inputs)		(channel 0, measurement type: metering value)				

Byte 3 corresponds to the state of the inputs, so input 2 is low. The value of the counter on channel 0 (counter 1) is 0x00000052 (82 in decimal).

Here is a frame following a change of state on input 2 (sent immediately).

Byte 1	Byte 2	Byte 3
0xA0	0x01	0xFF
(new generation measurement frame, no history, 1 sampling)	(channel 0, measurement type: state of inputs)	

The state of the inputs is only found in the frame.

Alert measurement frame

For exceeding the threshold value defined for the counter:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6
0x8D	0x54	0x00	0x00	0x38	0x29
(new generation alert frame)	(exceeding high threshold channel 0, distance measurement)				

The sample that triggered the threshold on channel 0 (counter 1) is 0x00003829 (14 377).

Downlink

This functionality is available on ACW-MR4 fulfilling the following conditions:

	Application software:	Radio firmware:
Sigfox version	V1.0.4	V5.9.3.2
LoRaWAN version	V1.0.4	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-MR4 are as follows:

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

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

For byte 4, the two bits YY correspond to the history depth (max = 3) and the three bits ZZZ correspond to the number of samples per frame (max = 7).

Bytes 5 and 6 correspond to the period for sending a frame (= 0xYYZZ) ranging from 1 minute to 255 hours (15,300 minutes).

EXAMPLE

Byte 4 = 0x13

4 samples per frame + addition of the 4 samples sent to the previous frame.

Byte 5 = 0x3C and byte 6 = 0x00

Emission period = 0x003C = 60 minutes

b. Inputs setup

Parameter code (Byte 1)	Parameter value (Byte 2)
0xXX (depends on the input to configure)	0bAABBOCCC

Each input being independently configurable, there is a different parameter code for each of them:

Input 1 => parameter code = 0x16

Input 2 => parameter code = 0x17

Input 3 => parameter code = 0x18

Input 4 => parameter code = 0x19

For the value of the parameter (byte 2), the byte is divided into three parts:

Bits 7,6 (AA) => choice of trigger edge: Rising edge - AA = 1; falling edge - AA = 2; Rising and falling edges – AA = 3

Bits 5,4 (BB) => choice of draw resistance: pull up - BB = 1; pull down – BB = 2.

Bits 2-0 (CCC) => choice of input mode: Front detection - CCC = 1; counter 1 - CCC = 2;

counter 2 - CCC = 3; counter 3 - CCC = 4; counter 4 - CCC = 5

c. Threshold counters setup

Parameter code (Byte 1)	Frame size (Byte 2)	Index (Byte 3)	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
0xD5	0x06	0xAA	0xWW	0xXX	0xYY	0xZZ	0 = disabled threshold 1+ = enabled threshold

This parameter is used to configure the threshold value for the 4 counters.

The configuration for a counter extends over 5 bytes: the first 4 for the threshold value (0xZZYYXXWW) and the last byte to activate or deactivate the threshold.

This downlink frame allows to configure the threshold for 1 counter at a time. The **Index** byte value allows to choose between the 4 below counters as follows:

- For the counter 1; the Index byte value is 0xAA = 0x00
- For the counter 2; the Index byte value is 0xAA = 0x05
- For the counter 3; the Index byte value is 0xAA = 0x0a
- For the counter 4; the Index byte value is 0xAA = 0x0f

d. Input bounce time configuration

Parameter code (Byte 1)	Parameter value (Byte 2)
0x1A	0xXX

This parameter is used to configure the debounce value of the inputs in milliseconds

The value of the parameter 0xXX can therefore be between 0x0A and 0xFF

e. Counter value change.

Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
0xC1	0x06	0x11	0xXX	0xYY	0xYY	0xYY	0xYY

With:

- **XX** the index of the counter
 - **XX** = 01 to select counter 1
 - **XX** = 02 to select counter 2
 - **XX** = 03 to select counter 3
 - **XX** = 04 to select counter 4
 - **XX** = FF to select all counter
- **YYYYYYY** the new value to apply to the selected counter. This value shall be Little Endian encoded

EXAMPLE

*If you want to change the value of counter index 1 with new value 39852, you should send this downlink 0xC10611**01AC9B0000***

Technical support

For any further information or technical question, you can open a ticket on our [technical support dedicated webpage](#).

