NB-Fi MODEM

MODEL BT-100

DATASHEET & USER GUIDE

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1. Introduction

WAVIoT is an innovator in low-power wide-area network (LPWAN) technologies that power the M2M telemetry and Internet of Things. WAVIoT uses the NB-Fi standard that is based on Narrow Band radio technology and operates in the license-free Sub-1 GHz frequency bands.

WAVIoT devices connected to the WAVIoT IoT Platform via the NB-Fi protocol use significantly less power and operate over larger distances compared to other wireless technologies which require more power and work best in short range. Numerous devices send data through bi-directional NB-Fi base stations. The base stations then detect, demodulate and transfer received messages to the WAVIoT Head-End System (HES) which is a part of the WAVIoT IoT Platform. WAVIoT Meter Data Management (MDM) system is a WAVIoT IoT Platform application that requests or collects, validates and processes data (e.g. consumption data or events and alarms) and shares it with suppliers, utility management companies and consumers. The HES and MDM systems have API that allows exchanging data with the customer applications such as billing systems, customer care systems and solutions for data analytics.

Plug-and-play IoT devices, NB-Fi modems with pulse, ADC or RS-232/485 inputs and high-performance bi-directional base stations allow deploying NB-Fi networks for IoT applications rapidly (sometimes within hours) in any part of the world. WAVIoT technology and the NB-Fi standard may be applied for Automated Meter Reading (AMR) systems, Advanced Metering Infrastructure (AMI) solutions, wireless alarm and security systems, industrial monitoring and control, smart agriculture and other wireless sensor network solutions.

The WAVIoT team has extensive practical experience in the rollout of large systems with hundreds of NB-Fi devices within a single project, and as a result, all our R&D activities are focused on the challenges that we meet in numerous use scenarios.
This document describes the WAVIoT Water Meter and also provides a general overview of WAVIoT technology and the NB-Fi standard for IoT communication.

2. Technical characteristics for NB-Fi modem BT-100

General characteristics	
Dimensions (height × width × depth)	200 × 45 × 48 mm
Weight	0.195 kg
Material of the case	ABS
Connectors	By request: – two pairs of pulse inputs, for dry (volt free) contacts – open collector – RS-485 – RS-232
Input voltage data	
Battery	D-size Li-Ion battery, 19000 mAh
Battery voltage	up to 3.6 V
Long Range Communications	
Wireless protocol	NB-Fi
Network topology	Star
Frequency	868.1 MHz (for Europe) adjustable, 860-925 MHz (for other countries)
Maximum RF TX Power	14 dBm (25 mW), duty cycle 1%
Remote readings	custom intervals from 1 minute (once an hour by default)
Distance range	Up to 10 km (urban), up to 30 km (rural)
Data encryption	AES-256
Modulation type	DBPSK
Data rate	50, 400, 3200, 25600 bit/s
Maximum data transfer per 24 h	20 Mbit

Ambient conditions	
IP Rating	IP67
Ambient temperature (operation)	from -40°C to +60°C
Ambient humidity (operation)	≤ 95% (at 25°C, non-condensing)

Certification
Electromagnetic compatibility
Radio Equipment Directive (RED) 2014/53/EU

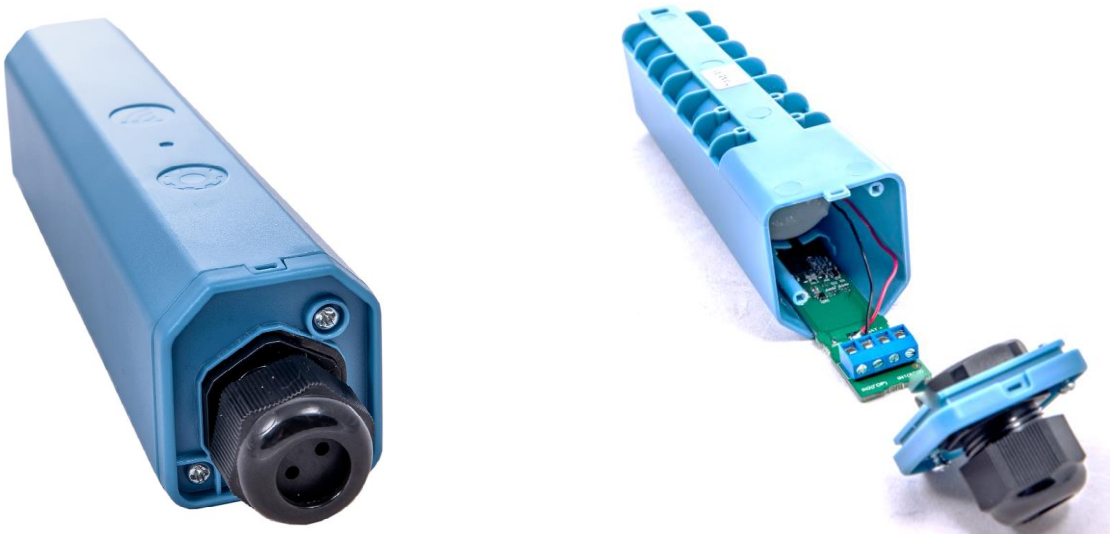


Figure 1 – NB-Fi modem BT-100

We are continuously developing the technology used within our product range delivering outstanding innovative solutions, therefore the specification may change from time to time.

3. Installation

3.1. Safety Warnings

This device must be installed by a trained professional installer only. Please read all safety warnings before commencing an installation.

Electrical Power Warning

Do not locate device near overhead power lines or other electric light or power circuits, or where the device can come into contact with such circuits.

3.2. Installation

NB-Fi modem BT-100 is a radio device capable of transmitting in the unlicensed frequency bands. Because the NB-Fi modem operates in the unlicensed radio frequency bands it is susceptible to interference that can reduce throughput and range.

This section describes the installation of the NB-Fi BT-100 pulse modem on the pulse outputs of water meter and adding it to the WAVIoT MDM system.

One NB-Fi modem BT-100 with pulse interface has two pairs of dry contacts, so you can connect up to two water meters to this modem (for example, water meters for cold and hot water).

3.2.1. Checking the NB-Fi connectivity

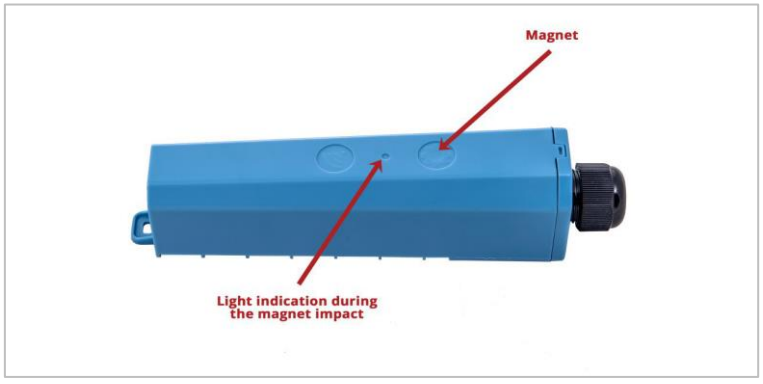
WAVIoT NB-Fi modem BT-100 is a radio device capable of transmitting data in the unlicensed frequency bands.

Because the WAVIoT NB-Fi BT-100 operates in the unlicensed radio frequency bands, it is susceptible to interference that can reduce throughput and range. Follow these simple guidelines to optimize product performance:

- Install the WAVIoT NB-Fi modem BT-100 at a place that with a clear line-of-sight signal path
- Install the WAVIoT NB-Fi base station and antennas in an area where structures, trees, or hills do not obstruct radio signals from the modem

Ensure that installation area is covered by WAVIoT NB-Fi base station. Check the connectivity by manual sending of a test message from the NB-Fi modem and check if the data appears in the WAVIoT MDM system.

3.2.1.1. To send a test message from the NB-Fi modem, bring the modem directly to the point of installation, attach a magnet (preferably a neodymium magnet) to the button with the gear icon on the body. Ensure that the light indicator is flashing – that means that NB-Fi message is sending.



3.2.1.2. Go to https://mdm.waviot.com/flow/ to check for a message from the modem. If the

modem is in the area of NB-Fi coverage, two messages will be received with a payload, starting with numbers 59 and 51.

Alternatively, check for the messages in the WAVIoT Head-End System, at https://hes.waviot.com/reports/bsmessages/. It could be helpful if you use the NB-Fi modems for other applications but utility meters.

This functionality is available only for the owners of the modems or utility management companies who provide the installation service.

3.2.2. Checking the operability of the water meters

3.2.2.1. Switch on hot and cold water in turn, check the operability of water meters (mechanical counter wheels are rotating), and identify which meter is related to hot water and which one to cold water.

3.2.2.2. To check the operability of the water meter pulse outputs, a multimeter must be connected by setting the switch to the resistance measurement mode (buzzer mode) in advance. This mode is usually marked by the "Diode" icon on the multimeter. Next, turn on the water (with a non-installed meter, set the meter wings in motion with air flow – imitation of water supply).

3.2.2.3. The reed contacts should close and the tester should display "0". If the water meter reed switch is inoperable, "0" value will not be displayed on the multimeter.

3.2.2.4. Turn off the water in the taps so that the meters don't change the readings.

3.2.3. Installation procedure for modems

3.2.3.1. Fill in the Installation report with the modem number, name, modification, serial number and resource type (cold water or hot water) of each water meter, current meter readings and current time (time shall be specified down to one minute!), and also pulse value printed on the water meter's face plate, which indicates the output value per pulse (i.e. pulse value = 1 that's 1 pulse = 1 liter). If pulse value is absent or unknown, the only way to know this value is to calibrate the NB-Fi BT-100 modem (see p. 3.2.3.3) and then calculate the Pulse value factor based on the calibration results (see p. 3.2.4.8).

3.2.3.2. Install the modem on the meters. For installation, the pair of pulse outputs of the meters must be connected to the pair of the pulse inputs on the modem.

3.2.3.3. Modem calibration means synchronization of counted pulses with the number of spilled liters transmitted to the WAVIoT MDM system. To start the modem calibration, attach a magnet to the button with the gear icon on the body and wait for EXACTLY 5 flashes of the red light on the body.

Fill in the Installation report with the readings from the connected water meters at the start of calibration. This is necessary for the proper setting of the initial readings for the water meters in the WAVIoT MDM System.

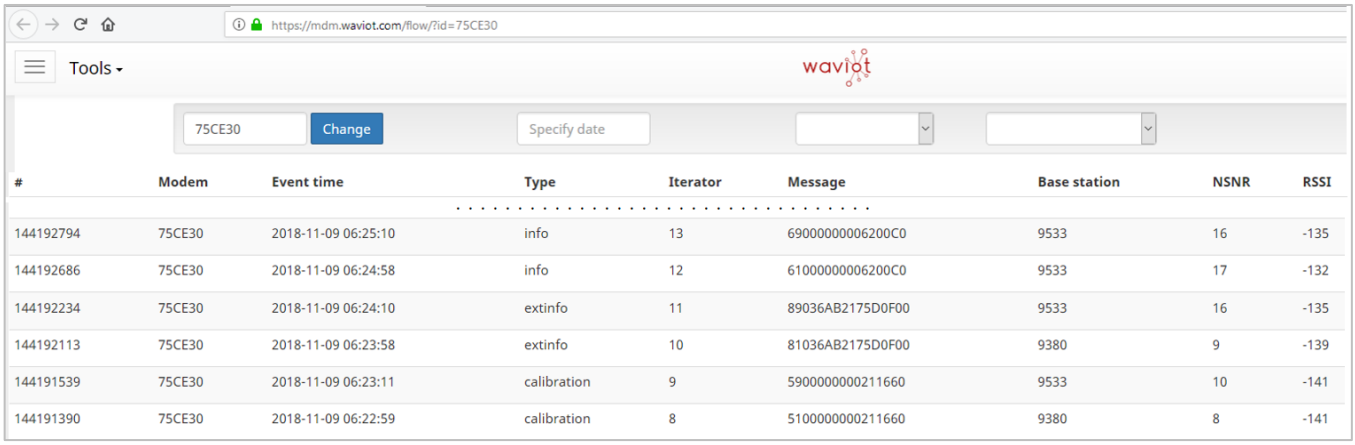
After that the modem calibration starts, and the modem will send one or two "Calibration" messages (depending on the number of data channels) and then up to 10 information messages for each data channel that used for Modem calibration and also for evaluation of the connectivity stability.

3.2.3.4. After step 3.2.3.3, turn on hot and cold water at a good pressure so that at least 10 pulses are generated (for residential water meters with pulse value = 1 this means 10 liters of water which will pour out for 3 minutes). This step is important for the correct calculation of the Pulse value factor.

3.2.3.5. Go to https://mdm.waviot.com/flow/ page 30-60 seconds after the calibration starts, enter the modem number and make sure signals from the modem reach the server. Check the Iterator, NSNR and RSSI values to evaluate the NB-Fi network coverage quality.

3.2.3.5.1. Description of the Flow page

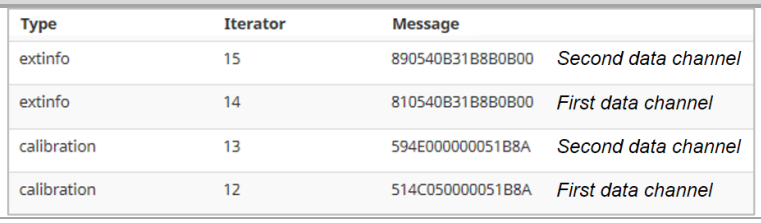
The flow page contains all messages received from the device.



#	Modem	Event time	Type	Iterator	Message	Base station	NSNR	RSSI
144192794	75CE30	2018-11-09 06:25:10	info	13	69000000006200C0	9533	16	-135
144192686	75CE30	2018-11-09 06:24:58	info	12	61000000006200C0	9533	17	-132
144192234	75CE30	2018-11-09 06:24:10	extinfo	11	89036AB2175D0F00	9533	16	-135
144192113	75CE30	2018-11-09 06:23:58	extinfo	10	81036AB2175D0F00	9380	9	-139
144191539	75CE30	2018-11-09 06:23:11	calibration	9	5900000000211660	9533	10	-141
144191390	75CE30	2018-11-09 06:22:59	calibration	8	5100000000211660	9380	8	-141

Below is the description of columns of the flow page.

Column	Description
#	Unique identifier of received message in the WAVIoT MDM system
Modem	Modem ID in Hexadecimal notation
Event time	Date and time of receiving the message in MDM system in user's time zone
Type	Type of message. For the purpose of Modem calibration, there are one or two calibration messages needed first and then up to 10 information messages for each data channel.
Iterator	This number is incrementing from 0 to 31 and then shifting to 0 again. If some messaged are missing due to bad connectivity, there will be a gap between the numbers. When installing, close the riser door to check the connectivity in real conditions. You can use these Iterator values to evaluate the NB-Fi network coverage quality.
Message	The raw data than is contained in the device's message. For the first data channel, the second symbol in Message text value is "1", for the second data channel, the second symbol in Message text value is "9".

Column	Description
	
Base station	ID number of the base station that first received the message. Check if the required base station receives messages.
NSNR	Normalized Signal-to-Noise Ratio, the NB-Fi network quality indicator. A stable signal can be considered with an average SNR of 30 dB or higher.
RSSI	Received signal strength indicator, the NB-Fi network quality indicator. RSSI is the usable strength of radio waves, expressed in decibels between 0 dBm (strongest) and -150 dBm (weakest). Smaller negative numbers represent a cleaner/stronger signal.

3.2.3.6. Assemble the modem into the case, fix the modem in the riser stand with clamps, double-sided adhesive tape, assemble and fix the hanging wires from the meters with clamps, close the riser door. Usually it should take no more than 2 minutes.

3.2.3.7. Turn off the tap water in approx. 3-4 minutes after step 3.2.3.3. If there are no calibration messages, perform step 3.2.3.1 by placing the modem in a different place. Preferred location of the modem: vertically, with the cable glands facing down. The modem in the riser stand can be moved to another corner, try the options of locating close to and away from the metal base.

3.2.3.8. Fill in the Installation report with the readings from the connected water meters at the end of calibration. This step is important for the correct calculation of the Pulse value factor.

Fill the rest of fields in the Installation report. Make sure that the Pulse value factor field is filled in properly.

3.2.3.9. Important notes

Caution: Failure to comply with some of the steps in this User guide may result in unsatisfactory installation of the modem due to:

- Absence of signals from modem
- Failure to set proper initial meter readings at the timestamp
- Wrong Pulse value factor setting

This may result in the need to visit the facility again to properly install the modem.

Step 3.2.3.5 can only be omitted if there is 100% certainty of stable signal reception.

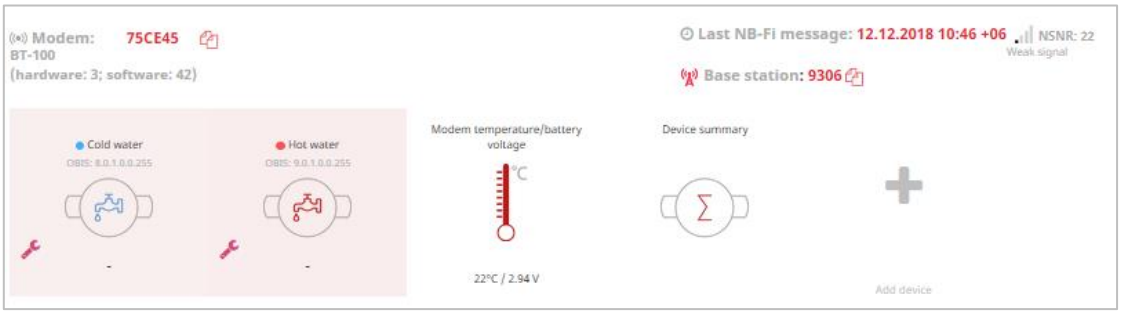
Switching the water on and off (steps 3.2.3.4 and 3.2.3.7) can only be skipped subject to continuous water flow rate at the facility. In other cases, the engineer installing the modems may fail to determine the malfunction of the devices, and may not be able to determine the meter's Pulse value factor after installation based on a mathematical calculation (if the pulse value is not indicated on the device).

Missed "New meter readings" values in the Installation report will lead to a failure to determine the meter's Pulse value factor after installation based on a mathematical calculation (if the pulse value is not indicated on the device).

Refer to p. 3.2.4.8 to calculate the Pulse value factor.

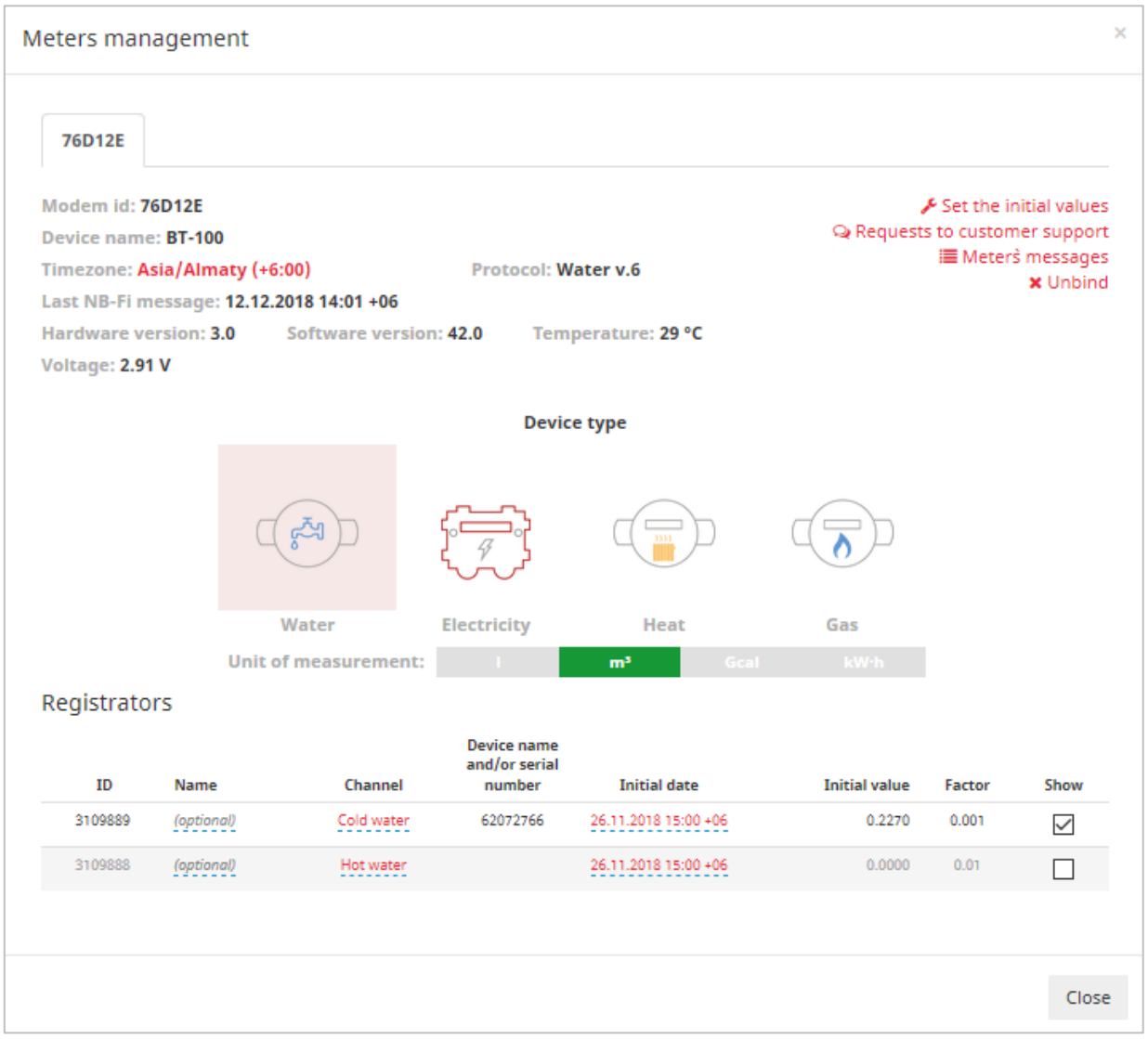
3.2.4. Adding BT-100 modem with connected water meters to the MDM system

3.2.4.1. Add the new node in the Tree View section and add a BT-100 modem to the required node in the WAVIoT MDM system.



The BT-100 modem will appear in the Data View section for the selected node, with two images of Cold water and Hot water meters with the small wrench icons on the bottom left corners. Wrench icon means that initial values have to be set for each device.

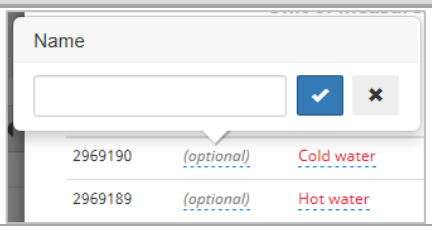
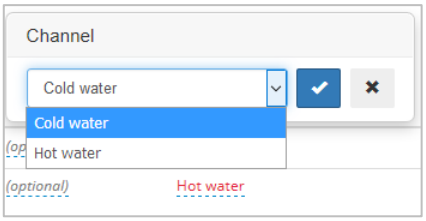
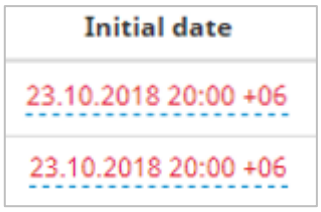
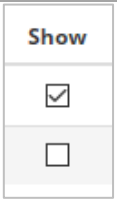
3.2.4.2. Click the “Settings” button at the top right corner of the active tab section and then click on the “Meters management” button. The “Meters management” window will be prompted.



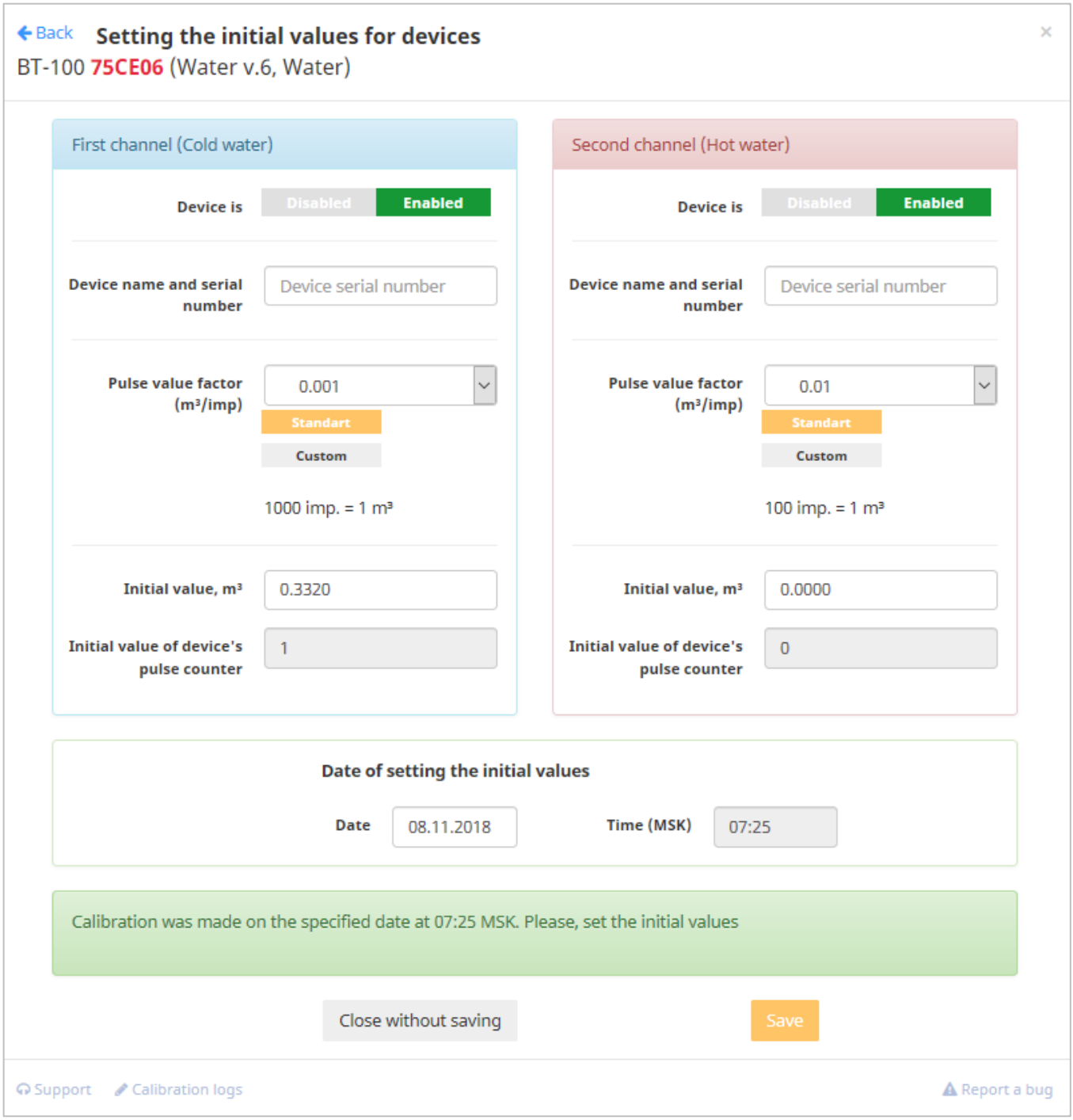
3.2.4.3. The BT-100 modem could be used with any device with pulse outputs. If you connected modem to a device other than water meter, click on the icon with required resource type in “Device type” section. Then choose the unit of measurement under the “Device type” section.

3.2.4.4. Each NB-Fi device has one or several data channels, each of them is registered by “Registrator” in the WAVIoT MDM system. WAVIoT MDM system supports two-channels BT-100 modem only if it is used with “Water” Device type. If other Device type has been chosen, only one data channel is available. However, if two data channels are required for another type of device, choose the “Water” Device type and set the custom name for the Registrator.

3.2.4.5. Define the settings for each Registrator in the “Registrators” section.

Registrator settings		Description
Name		Custom name for the device’s data channel. This name will appear in Data View section.
Channel		Data channel that will be bound to this registration (for devices with two data channels)
Initial date		Initial date and time of the start of data recording from data channel. Click on the row to prompt a window that allows setting the date and time. You can choose only dates when the messages from the device have been registered in the WAVIoT MDM system. If other date has been chosen, the “No messages have been registered on this day” message will be shown.
Show		Check a box if the data channel should be shown on the Data View section.

3.2.4.6. Click on the “Set the initial values” button at the top right corner of the “Meters management” window.

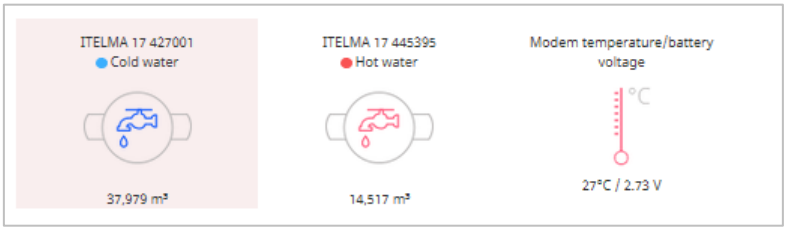


Fill the fields in the “Setting the initial values for devices” window.

Field	Description
Device name and serial number	Enter the name and serial number of the device from the Installation report
Pulse value factor	Enter the pulse value from the Installation report. If this pulse value is unknown, refer to p. 3.2.4.8 to calculate the Pulse value factor.
Initial value	Enter the device’s initial readings from the Installation report
Date	Date of setting of the initial values, by default it is the date of calibration. In case an adjustment of meter readings is needed, select a new date and set the new initial value for this date. The new initial value will be set at the date and time of the message at the selected date.

If the meter readings data in MDM system is unsynchronized with the real values on the meter, check the Pulse value factor, and repeat the installation procedure, if needed.

3.2.4.7. Click Save after filling in all fields. Devices connected to the WAVIoT BT-100 modem will appear in the Data View section.



3.2.4.8. Manual for the calculation of the Pulse value factor based on the calibration data

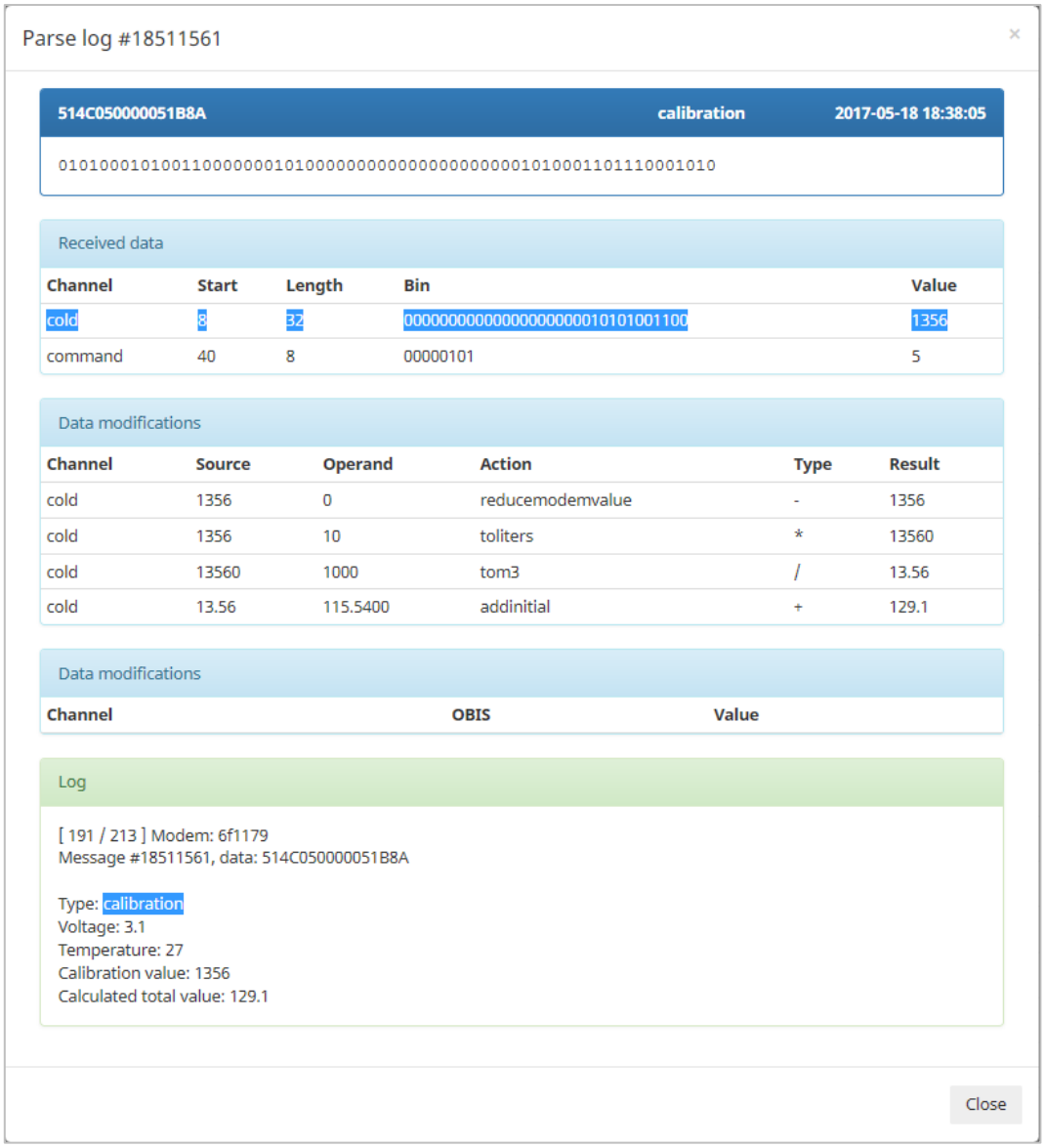
1. Calculate the V volume of water poured out during calibration based on the BT-100 modem Installation report.

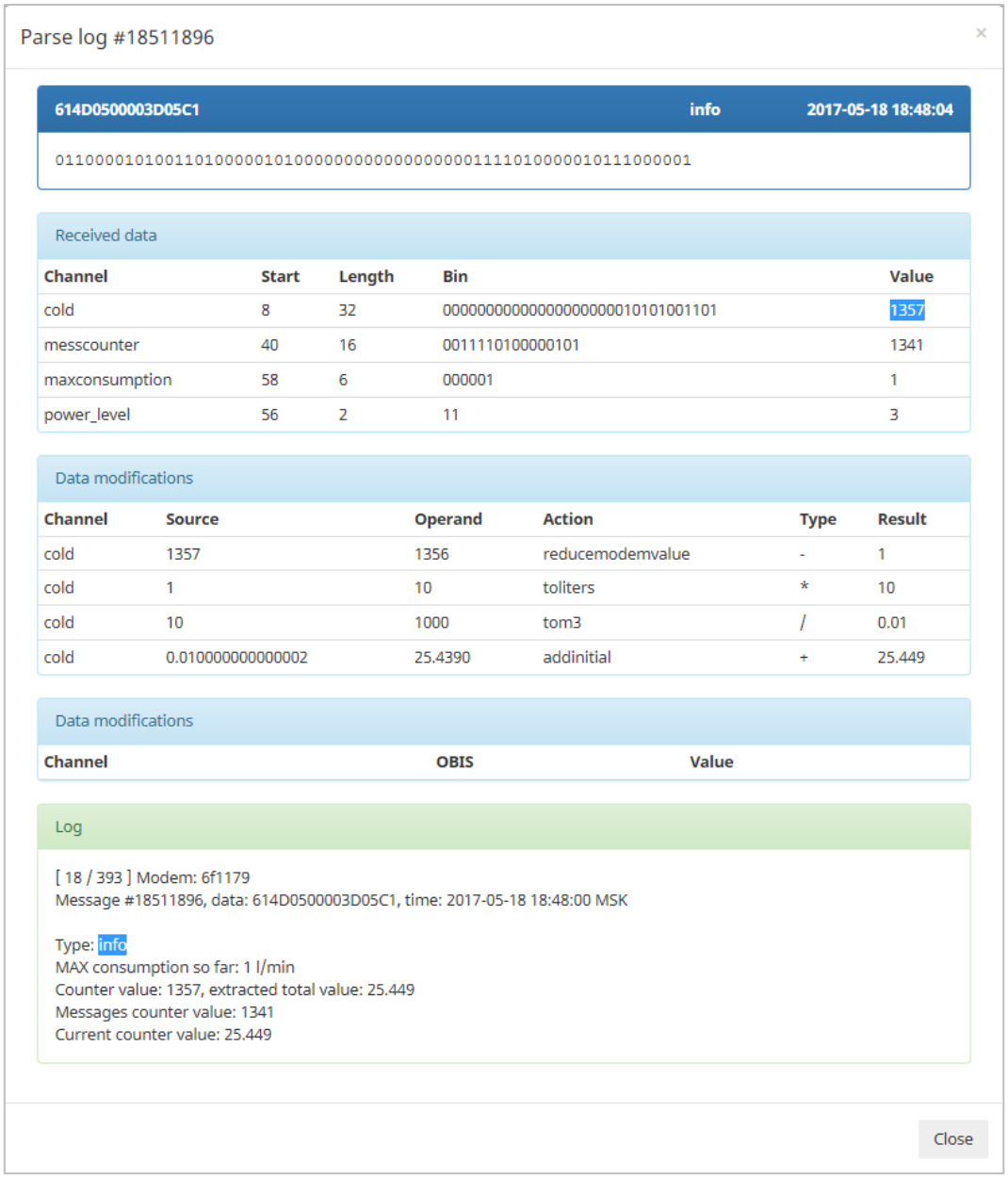
V = New meter readings – Initial meter readings

2. Go to https://mdm.waviot.com/flow/ and find the calibration and information messages on the date of filling of the Installation report.

Click on the “Log” button at the calibration message and at the last information message, and find the initial and the last value of the device's pulse counter.

If there are two data channels, open the logs for the calibration and information messages for each data channel.





Calculate the P number of pulses, counted during the calibration procedure:

N = Last value of device's pulse counter – Initial value of device's pulse counter

Samples of the logs for calibration and information messages for the cold water channel are above. In the sample above, N = 1357 – 1356 = 1 pulse.

3. Calculate the Pulse value factor:

Pulse value factor = V / N

Result of calculation could be inaccurate because of approximate values, taken from the devices and filled into the Installation report. Round the result of calculation to the nearest probably suitable number that most likely should be multiple of 2, 10 or 25 (for example, 0.1, 0.325, 1, 2, 10, 100, 640). Increase the number of pulses passed to increase the accuracy of calculation.

4. Packing list

The following components are included in your package:

#	Item			Quantity	Comment
1	NB-Fi modem BT-100	Interface	D Battery size	1	Required
2	Datasheet			1	Required

Check this packing list before installation to ensure that you have received each item. If you are missing any items, contact your supplier.

The packaging information section is filled by the manufacturer:

Packaging information

NB-Fi modem BT-100

Serial # _____
(factory number)

Packed by Telematics Solutions LLC.

Employee: QA engineer
(position)

_____ _____
(signature) (full name)

Date of packing: _____
(day, month, year)

Software and hardware versions

Hardware version	Software version
HBT100.EU.01	SBT100.EU.01

5. Warranty statement

WAVIoT warrants to the original end user (purchaser) that the NB-Fi modem BT-100 is free from any defects in materials or workmanship under normal use for a period of two (2) years from the date of purchase. During the warranty period, and upon proof of purchase, if the product fails due to faulty workmanship and/or materials, WAVIoT will, at its sole discretion, repair or replace the defective product or components. However, when repair or replacement is not practical, WAVIoT may, at its sole discretion elect to refund the original purchase price of the defective product. Any replacement may consist of a new or re-manufactured functionally equivalent product of equal value, and will be made solely at the discretion of WAVIoT. Repaired or replaced hardware is warranted only for the remainder of the original warranty period or 60 days from the date of replacement, whichever is longer, and is subject to the same exclusions and limitations as the original product. Unless expressly stated otherwise within this document, the purchaser is responsible for all shipping, labor, installation, and other costs associated with the repair and/or replacement. All hardware or part thereof that is replaced by WAVIoT, or for which the purchase price is refunded, shall become the property of WAVIoT upon replacement or refund.

The following are excluded from the warranty:

- Product defects that result from improper operating, mounting, maintenance, or use of the device
- Unauthorized modifications made by parties other than the manufacturer, of if the original security seal have been defaced, altered, or removed
- Damages during transportation or storage
- Catastrophes caused by external influences and force majeure
- Vandalism from persons or animals
- Exposure to environmental conditions outside of the device’s rated specifications

6. Contact Information

Technical support

Once the NB-Fi modem BT-100 is properly installed, you may contact our technical support for any assistance. Please use the following contact details for technical support and troubleshooting: support@waviot.com.

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Installation report No _____ for NB-Fi modem

Filling in this Installation report is necessary to enter information about the WAVIoT device into the WAVIoT MDM system.
If you are filling in this form with the user's personal data, you have to get from the user a written consent to the processing of personal data in accordance with local law. The text of the Personal Data Processing Agreement is on the back of this page.

Information about Customer, WAVIoT modem, utility meters and place of installation:

City / Town / Area _____

Street, Building _____

Apartment / Office _____

First name _____
If an account is created for a Customer to access the WAVIoT MDM system

Last name _____
If an account is created for a Customer to access the WAVIoT MDM system

Email _____
If an account is created for a Customer to access the WAVIoT MDM system

Mobile number _____
If an account is created for a Customer to access the WAVIoT MDM system

Installation place		
Modem serial number		
Resource:	Cold water	Hot water
Device name		
Device serial number		
Pulse value	*i.e. 10 l/imp or 1 l/imp*	*i.e. 10 l/imp or 1 l/imp*
Initial meter readings		
Calibration messages	*Check if calibration messages from the modem exists or not*	
New meter readings		
Installation date and time	Day:_____ Month:_____ Year:_____ Time:_____:_____	

_____, hereinafter referred to as the "Contractor", and the Customer confirm that devices mentioned above have been installed.

Contractor: _____

Customer: _____

I give my consent to the processing of my personal data: _____
(Signature of Customer)

Consent to the processing of personal data

I, _____ (*Full Name*), _____(*ID*)

Series _____ No. _____ issued by _____ *(issuing authority*)

on _____._____._____ (*date of issue*), registered at the place of residence / permanent stay / temporary stay / residing at:

_____,

represented by

_____ (*Full Name*), _____(*ID*)

Series _____ No. _____ issued by _____ *(issuing authority*)

on _____._____._____ (*date of issue*), registered at the place of residence / permanent stay / temporary stay / residing at:

_____,

acting on the basis of _____
(*particulars of the power of attorney or other credentials of the attorney*)[1],

acting freely, in my own volition and in my best interest, do hereby grant to

_____ (Company name),

_____ (Certificate of incorporation),

_____ (Registered address),

hereinafter referred to as the **"Operator"**,

consent to processing my personal data, in particular: full name, residence address, passport details, contact details, and the information concerning utility meters used and their exact locations, details of utility bill accounts, and the amounts of payments for utilities,

by way of their collection, recording, classification, accumulation, storage, validation (updating, changing), extraction, usage, transmission (distribution, submission, access thereto), depersonalization, blocking, deletion, destruction of personal data, with and/or without automation
for the purposes set forth below: collection of utility resource consumption data, preparation and transmission of utility consumption summary reports to utility companies, issuing invoices for consumed utility resources, analysis of utilities consumption to accumulate statistics and develop utility consumption recommendations
for the term of 20 years.
I am aware that this consent may be revoked by me at any time by way of a signed notice of revocation by registered post mail to the Operator. Such notice may contain certain personal data, methods and purposes of processing thereof, the consent to which is revoked by the personal data subject. A notice of revocation of consent for processing of personal data containing none of such parameters shall be considered a revocation of consent for processing of all personal data, by any and all means, and for any and all purposes. Notice of revocation for the purposes of its consideration on the merits shall also specify the number of the personal data subject's or his representative's main ID, the date of issue of the said ID, and the issuing authority.

Date: _____._____._____

Signature of Customer: _____ / _____

[1]To be filled in subject to the consent of the personal data subject's representative.