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AXIOMA METERING UAB

ULTRASONIC WATER METER QALCOSONIC W1

Lora Payload (Long) “Extended”



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1. Device activation


Device Lora activation is done using provided keys. Using DevEUI, AppKey and AppEUI for OTAA, NetworkKey, AppSKey and DevAdr for ABP. Lora communication is started, when keys inside the device and server are matching.

2. Decoding the payload

The size of the *Axioma* device's payload can vary depending on the type of measuring device. All VIF data are sending through Port 100.

By default information of the *Flow metering device* will always be shown in the order indicated in the following table.

Order	Number of bytes	Description
1	4	Current date and time
2	1	Status code
3	4	Current volume
4	4	Log date and time
5	4	Volume at log date and time
6	2	Delta volume 1
7	2	Delta volume 2
8	2	Delta volume 3
9	2	Delta volume 4
10	2	Delta volume 5
11	2	Delta volume 6
12	2	Delta volume 7
13	2	Delta volume 8
14	2	Delta volume 9
15	2	Delta volume 10
16	2	Delta volume 11
17	2	Delta volume 12

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18	2	Delta volume 13
19	2	Delta volume 14
20	2	Delta volume 15
21	1	Padding byte 0x2F

By default 15 volume values are transmitted in one telegram. First of all, there is log time and log volume value at the beginning, after these differences only differences are transmitted. Log values are always equal to beginning of an hour or a day. For example: log time is 2019-02-01 23:00, log value is 100 liters, log period is 3600s. Log value + delta volume 1 is the volume value at the time of 2019-02-02 00:00, Log value + delta volume 1 + delta volume 2 is the volume value at the time of 2019-02-02 01:00 and so on until all values are parsed.

3. Explanation of the payload

1. UNIX hexadecimal timestamp, when data was updated from the meter. Example: 0x5AE46015 means Saturday, April 28, 2018 11:50:45 AM (GTM).
2. Status of the metering device indicated in following table.

Bit No.		0	1	2	3	4	5	6	7
↓	Status								
	Low battery			X					
	Permanent				X				
	Dry					X			
	Backflow						X	X	
	Burst						X		X
	Leakage						X		
	Low temperature								X

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Error:	Status:	Error source:
No error	0x00	Normal work. No errors
Power low	0x04	Low battery
Permanent error	0x08	Hardware error; tamper
Temporary error	0x10	Empty spool; negative flow; leakage; burst; freeze
Leak	0x20	Leakage
Burst	0xA0	Burst
Backflow	0x60	Negative flow
Freeze	0x80	Freeze

If more than one temporary error occurs, status shows only one, by priority. Temporary errors are listed by priority: freeze; leakage; burst; negative flow. If status only shows temporary error, it is empty spool. If status shows temporary error + any listed temporary error, it does not mean empty spool + any listed temporary error.

Combinations of errors are possible. Example: Status: 0x38 - leakage + temporary error + permanent error.

All alarm messages are listed in priority order, where priority goes according to the arrow. For instance, if status byte is equal to 0x90, then this would mean that the temperature is low, but if the status byte has only 0x10, then it would mean that the device's pipe is dry.

- Volume is multiplied by 0.001 m³. Example: 0xB0620100 means 90.8 m³. Byte sequence is little-endian.
- The next values in the payload are historical. They are presented in the same dimensions as actual values in previous registers. Historical data is updated whenever relevant values are recorded to the payload. For example actual values of Qalcosonic W1 *Flow metering device* updating every hour so at that moment all registers is rolled to the right by four bytes and the last four bytes are consumed. Historical values are always saved depending on storing period. If storing period is more than one hour it will be equal to the beginning of an hour (01:00:00h; 02:00:00h etc.). If storing period is more than one day, it will be equal to the beginning of a day (00:00:00h).

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4. Configuration parameters

Through Port number 101 configurations of parameters are transmitted in the form of extended payload. Configuration is transmitted every time after ten data telegrams or immediately after any change in device configuration. These telegrams are extended by DIF values and every DIF value is inserted before every VIF value.

1. DIF values means length of data (code of data format) transited in the payload.
 - a. 32 bits integer, i.e. 0x04,
 - b. 16 bits integer, i.e. 0x02,
 - c. 8 bits / 1 byte, i.e. 0x31.
2. VIF values mean type of data (code of data units) in the payload.
 - a. Date and time, unix time, i.e. 0xFF8913,
 - b. Status code, i.e. 0xFD17,
 - c. Volume, liters or 0.001 m³, i.e. 0x13,

Example of payload through port number 101 explained in the following table.

Order	Number of bytes	Description	Example
1	1	DIF – 32 bits integer	0x04
2	3	VIF – Current date and time, unix time	0xFF8913
3	1	DIF – 8 bits / 1 byte	0x31
4	2	VIF – Status code	0xFD17
5	1	DIF – 32 bits integer	0x04
6	1	VIF – Current volume, l	0x13
7	1	DIF – 32 bits integer with storage	0x44
8	3	VIF – Log date and time	0xFF8913
9	1	DIF – 32 bits integer with storage	0x44
10	1	VIF – Volume at the log time, l	0x13
11	1	DIF – variable length with storage	0x4D


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12	1	VIF – Delta volume in liters with extension bit selected.	0x93
13	1	VIFE – compact profile	0x1E
14	1	Length – real data length is (value – 2), so the real data is 30 bytes.	0x20
15	1	Spacing control – Bit7..bit6 – 01 which mean that values are incrementing Bit5 .. bit4 – 10 period between two values are in hours. Bit3 .. bit0 – 0010 which means that delta value is in two bytes.	0x62
16	1	Spacing value – period between two delta values	0x01

5. Device alarms

Device is sending its status through Port number 103 when the critical alarm occurs. The payload in the telegram has timestamp and status / alarm code only (see the table below).

Order	Number of bytes	Description
1	4	Date and time
2	1	Status / alarm code

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Data types are the same as in the default payload (see Chapter above) and shortly explained below:

1. UNIX hexadecimal timestamp, when data was updated from the meter.
2. Alarms of the metering device indicated in following table.


Bit No.	0	1	2	3	4	5	6	7
Status								
Leakage	X							
Burst		X						
Low temperature			X					
Tamper				X				
No consumption (off by default)					X			
Negative flow						X		

Burst – 250l/h more than 60 minutes. Leakage – 25l/h more than 24 hours. Low temperature – less than 5°C. Tamper error occurs when device lid is opened. No consumption – no consumption for seven days (this alarm is not active by default). Negative flow appears when negative flow is detected.

Device is sending status telegram only when new alarm occurs. These telegrams need to be confirmed (are sending with confirmation). If there is no confirmation device repeats alarm message three times immediately.

Device sends its status periodically (even equal to 0x00) through Port 100 with default payload telegram and this period is configurable.

Alarm telegrams have limit which is described in Lora credits management (8.2).

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6. Configurable settings through downlink commands

There are possibilities to modify read and send periods of the module through Port 102. The command to set period when data should be transmitted from the module described below:


Order	Number of bytes	Description and meaning	Example
1	1	DIF value – 32 bit signed integer	0x04
2	4	VIF value – exact command	0xFF898500
3	4	Data send period (LSB), i.e. 3600 sec.	0x100e0000

The reset command of the send period to default is explained below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF898507

The command to set period when data should be collected from the measurement device described below:

Order	Number of bytes	Description	Example
1	1	DIF value – 32 bit signed integer	0x04
2	4	VIF value – exact command	0xFF898C00
3	4	Data read period (LSB), i.e. 3600 sec.	0x100e0000

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The reset command of the read period to default is in the table below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF898C07

Additional commands can be applied to the device through port 102. Number of historical data can be changed according to the command below:


Order	Number of bytes	Description	Example
1	1	DIF value – 8 bit unsigned integer	0x01
2	4	VIF value – exact command	0xFF899200
3	1	Number of historical data, i.e. 1-16.	0x10

Alarm mask which errors send the immediate alarm message can be changed according to the command below:

Order	Number of bytes	Description	Example
1	1	DIF value – 8 bit unsigned integer	0x01
2	4	VIF value – exact command	0xFF899900
3	1	Alarm mask, i.e. 0x07.	0x07

Alarm mask can be configured according to the table below:

0 bit – Leakage
1 bit – Burst
2 bit – Freeze
3 bit – Tamper
4 bit – No consumption
5 bit – Negative flow

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The reset command of the alarm mask to default is in the table below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF899907

It is possible to make the reinitialization of the Lora stack after the selected time. The following command should be applied:


Order	Number of bytes	Description	Example
1	1	DIF value – 32 bit unsigned integer	0x04
2	4	VIF value – exact command	0xFF899A00
3	1	Reinit lora after, i.e. 10s.	0x0A000000

Lora ACK limit, when the ADRAckReq bit is selected can be changed according to the command below:

Order	Number of bytes	Description	Example
1	1	DIF value – 8 bit unsigned integer	0x01
2	4	VIF value – exact command	0xFF899C00
3	1	ADRAckReq bit set period, i.e. 8 telegrams.	0x08

The reset command of the Lora ACK limit to default is in the table below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF899C07

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W-Mbus T1 mode can be enabled or disabled according to the command below:

Order	Number of bytes	Description	Example
1	1	DIF value – 16 bit unsigned integer	0x02
2	4	VIF value – exact command	0xFF899B00
3	1	W-Mbus T1 enable, i.e. 1 means enabled.	0x0100

The reset command to default W-Mbus T1 working mode (disabled) is in the table below:


Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF899B07

Payload structure can be selected between compact and standard according to the command below:

Order	Number of bytes	Description	Example
1	1	DIF value – 16 bit unsigned integer	0x01
2	4	VIF value – exact command	0xFF899D00
3	1	Payload structure, i.e. 1 means basic. 0 means extended.	0x01

The reset command to default (extended) is in the table below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x00
2	4	VIF value – exact command	0xFF899D00

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Additional element to communication telegram can be added according to the example command below:

Order	Number of bytes	Description	Example
1	1	DIF value – 32 bit unsigned integer	0x04
2	1	VIF value – date and time in uplink telegram	0xED
3	1	Command – add to telegram	0x0C

There is an option to choose what parameters to add in uplink telegram.


Additional element from communication telegram can be removed according to the example command below:

Order	Number of bytes	Description	Example
1	1	DIF value – no data to send	0x04
2	1	VIF value – date and time in uplink telegram	0xED
3	1	Command – remove from telegram	0x0D


7. Example of decoding payload

Decoding extended structure packet with 15 historical values. (Port 100)

Payload (Hex) LSB format:		
0ea0355d302935000054c0345de7290000b800b900b800b800b800b900b800b800b800b800b800b900b900b900		
Payload length:		47 (bytes)
Data:		Description:
(5d35a00e) (first 4 bytes of payload)	2019-07-22	Date
	11:37:50	Time
LEAKAGE + TEMPORARY ERROR	30 (payload)	Status code
(00003529) 13,609m3		Volume (current)

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(5d34c054) 2019-07-21 19:00:00	First log date and time
(000029e7) 10,727m3	Volume at log date and time
(00b8) 0,184m3 20:00:00h	Volume and time of the past period 1
(00b9) 0,184m3 21:00:00h	Volume and time of the past period 2
(00b8) 0,184m3 22:00:00h	Volume and time of the past period 3
(00b8) 0,184m3 23:00:00h	Volume and time of the past period 4
(00b8) 0,184m3 00:00:00h	Volume and time of the past period 5
(00b9) 0,185m3 01:00:00h	Volume and time of the past period 6
(00b8) 0,184m3 02:00:00h	Volume and time of the past period 7
(00b8) 0,184m3 03:00:00h	Volume and time of the past period 8
(00b8) 0,184m3 04:00:00h	Volume and time of the past period 9
(00b8) 0,184m3 05:00:00h	Volume and time of the past period 10
(00b8) 0,184m3 06:00:00h	Volume and time of the past period 11
(00b8) 0,184m3 07:00:00h	Volume and time of the past period 12
(00b9) 0,185m3 08:00:00h	Volume and time of the past period 13
(00b9) 0,185m3 09:00:00h	Volume and time of the past period 14
(00b9) 0,185m3 10:00:00h	Volume and time of the past period 15

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Decoding alarm packet (Port 103)

Payload:	43b1315d30
(5d31b143) 2019-07-19 12:02:11	Current date and time
(30) LEAKAGE + TEMPORARY ERROR	Status byte


8. Additional features

8.1. Lora ACKAdrReq management

In order to guarantee the connection with the server ACKAdrReq bit is set every 8th telegram, and if there is no confirmation server asks for ACK 4 more times. After not getting confirmation, SF is reduced by 1. It is possible to change after how many telegrams ACKAdrReq bit is selected using downlink command which is described in chapter 5.

8.2. Lora credits management

In order to save meter from the incorrect data send period change and to save battery power, there is credit management algorithm in the device. It is calculated that Qalcosonic W1 can send up to maximum 8 telegrams per day on SF12. When the spreading factor is higher, for example SF11, device can send 16 telegrams per day and so on. There are separate credits for optical communication, radio communication and alarms. When credits are low, device indicates LOW CREDITS error. Maximum capacity of credits is communication for 7 days constantly. For alarm credits the maximum amount is 30 and after using it device will add one each day until it fills up to 30. Error LOW CREDITS occur when communication time goes below 12 hours. Credits for communication are added every minute. When device indicates LOW CREDITS error, radio sign on device LCD blinks.

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8.3. Lora activation method

It is possible to use both, ABP or OTAA activation methods for the device. It is preconfigured in production for which activation method is required. OTAA connection method uses keys which are provided by server after join procedure.

8.4. Alarm messages processing

Meter sends alarm message when the error occurs which is responsible for alarm message send. Qalcosonic W1 sends alarm message immediately when the error occurs.

8.5. Transportation mode

When device is new and its total volume value is zero, by default it is in transportation mode. In transportation mode radio is disabled. It enables automatically when meter reaches consumption of 10 liters.

8.6. Rejoin

When device does not get acknowledgment after 4 each telegram reduces spreading factor by one, going from SF7 to SF8 and so on. When device reaches SF12 it still asks for ACK, but now it counts how many times it did not get acknowledgment. After 16 telegrams it goes into join state and tries to join to server again.

8.7. Lora communication channels

By default W1 device sends telegrams on 3 different channels. More channels are added only if server requires that and adds it. Usually server adds additional 5 channels so in total communication is happening through 8 channels.