aquastream®

System modules
for mechanicals water meters

Protocol aquastream® M-Bus
& aquastream® Radio W8 (Wireless M-Bus/OMS)
& aquastream® M-Bus/Pulses
& aquastream® Radio L8 (LoRaWAN)

Manufacturer:	INTEGRA Metering AG
Device:	aquastream®
Firmware version:	AQS-MB: V108/111 (M-Bus version) AQS-MBOC: V67 (M-Bus/Pulses version) AQS-W8: V63 (Wireless M-Bus/OMS) AQS-L8: V3.0 (LoRaWAN)
Manufacturer Code:	0xB425
Device Version:	0x05
Media:	0x07 (Water)

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1. Overview

1.1 Firmware Version

This document is valid for the following Firmware:

Module	Version	Communication Protocol
aquastream® M-Bus (AQS-MB)	V108/111	M-Bus
aquastream® Radio W8 - Wireless M-Bus/OMS (AQS-W8)	V63.1	Wireless M-Bus / OMS Support of OMS Encryption mode 5
	V63.2 & Higher	Wireless M-Bus / OMS Support of OMS Encryption mode 5 & 7
aquastream® M-Bus/Pulses (AQS-MBOC)	V67	M-Bus
Aquastream® Radio L8 – LoRaWAN (AQS-L8)	V3.0	LoRaWAN

2. M-Bus Protocol

The device communicates according to EN 13757-2 and EN 13757-3. In this document, these two standards are referred to as EN 13757.
The device supports only some of the telegrams defined in this standard.
The following parameters can be configured via SND_UD:

- Date and time, primary address, secondary address, customer text field, baud rate.

The following telegrams can be selected for the response REQ_UD2 (response telegram):

- The data dependent on the selected telegram can be read with a REQ_UD2 command.
  - Standard.

The following commands are used for addressing:

- Slave-Select, SND_NKE.

2.1 Explanation of abbreviations

Various abbreviations are used in this document and are described in the following table.

Abbreviations	Explanation
REQ_UD2	Request a data telegram (RSP_UD) from the master
RSP_UD	Data telegram in response to the master
SND_UD	Data / parameterisation telegram from the master to the aquastream®.
SND_NKE	Initialization telegram according to EN 13757
ACK	Confirmation telegram according to EN 13757 to a SND_UD
PADR	Data for primary address (1 byte)
LEN	Data for the length byte (1 byte), calculation according to EN 13757
IDENT	Data for secondary address (4 bytes)
MAN	Data for manufacturer code (2 bytes)
DEV	Data for device version (1 byte)
MED	Data for the media (1 byte)
ACC	Data for the access counter (1 byte)
STAT	Status data (1 byte)
CS	Checksum data (1 byte), calculation according to EN 13757

*Table 1: A*bbreviations

2.2 Baud rate

aquastream® module can communicate at 300, 2400 and 9600 bauds. The baud rate is set to 2400 on delivery (default value).

2.3 M-Bus Addresses

The device supports primary and secondary addressing according to EN 13757. The primary address is set to zero on delivery of the devices (default value).

Addresses	PADR	For detail see chapter
Primary Address	0 ... 250	2.4.1 Primary Address
Point-to-point addressing	254	2.4.2 Point-to-point addressing
Broadcast Addressing	255	2.4.3 Broadcast Addressing
Secondary Address	253	2.4.4 Secondary Address

2.4 Addresses management

2.4.1 Primary Address

Each aquastream® module can be addressed in an M-Bus network via the primary address. The permitted range of the primary address is 0...250. Each telegram contains the primary address in the A field.

2.4.2 Point-to-point addressing

If the M-Bus network consists of a single M-Bus slave (in this case aquastream®) and a master, point-to-point addressing can be used. For this purpose, field A of the master telegram is set to 254 (0xfe). The aquastream® responds to point-to-point telegrams regardless of the setting of its primary address.

2.4.3 Broadcast Addressing

Broadcast addressing can be used if all meters in a network are to receive a telegram at the same time (e.g. change the baud rate) and process it. Field A of the master telegram is set to 255 (0xff). The aquastream® does not respond to telegrams but executes the commands.

2.4.4 Secondary Address

If an M-Bus network contains more than 250 devices, secondary addressing is used. The secondary addressing is done via field A: 253 (0xfd) with the 8-byte header selection. The device must be selected before the actual communication by means of a slave select telegram. After the actual communication, the secondary addressing can be cancelled again. Deselection is carried out by means of a SND_NKE command or by selecting another device.

2.4.4.1 Selection frame (Slave-Select)

The aquastream® is selected for secondary addressing with the following telegram:

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-field	1	0x0b	
L-field	1	0x0b	
Start	1	0x68	
C-field	1	0x53 / 0x73	SND_UD
Adr.-Field	1	0xfd	Secondary Address
CI field	1	0x52	Slave Select
Sec. address field	4	IDENT	Secondary Address of aquastream®
Manufacturer code	2	MAN	0xB425 INTEGRA Metering AG
Device version	1	DEV	0x05 = aquastream®
Medium	1	MED	0x07 = Water
Checksum	1	CS	
Stop	1	0x16	

C-Field: no distinction between 0x53 and 0x73.

IDENT: Instead of the exact secondary address, the 8-bit character 0c0xff can also be used. Example 0xfffffffff344: All aquastream® with a secondary address ending in 0x344 are selected.

MAN: Instead of 0xb425, the 16-bit 0xffff can also be used.

DEV: Instead of 0x05, the 8-bit value 0xffffff can also be used.

MED: Instead of 0x06 or 0x07, the 8-bit value 0xffffff can also be used.

- If all 4 data correspond to the aquastream® settings, the device is selected and responds with an ACK telegram.
- If one of the values does not correspond to the parameterisation, it is deselected and does not respond.

2.4.4.2 Frame SND_NKE

Secondary addressing can be cancelled by means of the following telegram:

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x10	
C field	1	0x40	SND_NKE
Addr. field	1	PADR	Primary Address
Checksum	1	CS	
Stop	1	0x16	

- Answers with an ACK telegram.

2.5 Readout commands

2.5.1 REQ_UD2 telegram

Reading is always requested by the master via the REQ_UD2 telegram:

Name	Length (bytes)	Value	Explanation (examples)
Start-Field	1	0x10	
C-Field	1	0x5b / 0x7b	REQ_UD2
Addr.-Field	1	PADR	Primary Address
Checksum	1	CS	
Stop	1	0x16	

- No distinction between 0x5B and 0x7B in field C.
- Answers with a RSP_UD telegram

2.5.2 RSP_UD telegram

The following explanation details the construction of the aquastream® response telegram (REQ_UD2).

Header						
	Name	**Value**	**Length (bytes)**	**Note**		
	Start byte	0x68	1			
	L-Field	LEN-4	1	LEN = all bytes		
	L-Field	LEN-4	1	LEN = all bytes		
	Start byte	0x68	1			
	C-Field	0x08	1			
	Primary Address	variable	1			
	CI-Field	0x72	1			
	Identification number[1]	variable	4			
	Manufacturer code	0xB425	2			
	Device[2]	variable	1	0x05 = aquastream		
	Medium typ	variable	1	0x07 = water		
	Access counter	variable	1	counter		
	Status-Field	variable	1			
	Signature	0x0000	2			
Application layer						
	Record	**DIF**	**DIFE1**	**VIF (depends on unit)**	**VIFE1**	**Data type**
	volume (net)	0x04	-	0x13	-	Int 32 bit
	reverse volume	0x84	0x10	0x13	-	Int 32 bit
	flow	0x04	-	0x3B	-	Int 32 bit
	flow (max)	0x14	-	0x3B	-	Int 32 bit
	date and time	0x04	-	0x6D	-	Int 32 bit
	fabrication number of module	0x0C	-	0x78	-	BCD 8 digits
	fabrication number of water meter	0x8C	0x40	0x78	-	BCD 8 digits
	customer textfield (O)[3]	0x0D	-	0xFD	0x11	variable length
	firmware version	0x01	-	0xFD	0x0E	Int 8 bit
	hardware version	0x01	-	0xFD	0x0D	Int 8 bit
	info status	0x02	-	0xFD	0x17	Int 16 bit
	battery life	0x02	-	0xFD	0x74	Int 16 bit

END					
	Fields	**Data**	**length**		
	Check sum[5]	variable	1 byte		
	last byte	0x16	1 byte		

Status-field[4]		
Bit	**Meaning when bit set**	**Meaning when bit cleared**
7	man. Specific	man. Specific
6	man. Specific	man. Specific
5	man. Specific	man. Specific
4	temporary error (alarm)	no temporary error
3	permanent error (error)	no permanent error
2	power supply low	power supply ok
1,0	0 0	no error
	0 1	application busy
	1 0	arbitrary application error
	1 1	unusual condition
Check sum[5]		

The identification number depends on the configuration of the parameters in the following order (higher priority first)

a) Secondary address, if address is defined (not 0)

b) The production number of the PMK, if defined (not 0)

c) The manufacturing number of the aquastream module

[2] The Type field in M-Bus depends on the configuration of the parameters in the following order (higher priority first)

a) Set to 0x07 (Water) if the PMK production number is set (not 0)

b) Set to 0x0E (Bus/System Component)

[3] (O): Optional, added to the telegram only when the text field is not empty

[4] Status-field: see table

[5] Check-Sum: calculated = from field C to the end without checksum and end byte (bytes are added)

2.6 Description of "ErrorFlag" values

The following table details the different values for Alarm management.

Alarm name	**Decimal value**	**Hexadecimal value**	**Bit position**	**Description**
AlarmTamper	1	00000001	1	Tampering alarm - No PMK detection (cannot read wheel position)
AlarmBurst	4	00000004	3	Flow rate higher than the set limit
AlarmLeak	8	00000008	4	Detection of a leak
AlarmNoConsumption	128	00000080	8	No flow during the set time
BatteryLow	256	00000100	9	Low battery
AlarmReverseFlow	512	00000200	10	Negative flow rate beyond detection threshold (flow rate/time)
AlarmOverFlow	1024	00000400	11	Flow rate higher than the set limit

2.7 Configuration

All parameters are stored in an internal memory and are not lost in the event of a power failure due to the main battery.

All configurations are initiated by the master by means of a SND_UD telegram. The aquastream® responds with an ACK telegram.

2.7.1 SND_UD telegrams (set commands)

There is a separate telegram for all configurable values. Only one parameter can be changed per telegram. It is not possible to combine several values in one telegram.

2.7.2 Date and Time Configuration

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	0x09	
L-Field	1	0x09	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0x51	Configuration
DIF	1	0x04	
VIF	1	0x6d	
Value	4	Type F	New Date/Time
Checksum	1	CS	
Stop	1	0x16	

- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

2.7.3 Primary Address Configuration

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	0x06	
L-Field	1	0x06	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	(old) Primary Address
CI-Field	1	0x51	Configuration
DIF	1	0x01	
VIF	1	0x7a	
Value	1	0x00…0xfa	New Primary Address 0..250
Checksum	1	CS	
Stop	1	0x16	

- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

2.7.4 Secondary Address Configuration

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	0x09	
L-Field	1	0x09	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0x51	Configuration
DIF	1	0x0c	
VIF	1	0x79	
Value	4	BCD8	New Secondary Address
Checksum	1	CS	
Stop	1	0x16	

- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

2.7.5 Customer Field Text Configuration

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	LEN	
L-Field	1	LEN	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0x51	Configuration
DIF,	1	0x0d	
VIF, VIFE	2	0xfd, 11	
	1	0x01…0x28	Number of bytes of the Customer Text
Value	1…40		Value Customer Text (table ASCII)
Checksum	1	CS	
Stop	1	0x16	

- The length of the customer text field is variable. The number of possible bytes is from 1 to 40 bytes. The length is between VIFE and the text field.
- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

2.7.6 Baudrate Configuration

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	0x03	
L-Field	1	0x03	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0xb8 / 0xbb / 0xbd	0xb8 = 300 Baud 0xbb = 2400 Baud 0xbd = 9600 Baud
Checksum	1	CS	
Stop	1	0x16	

- No distinction between 0x53 and 0x73 in field C.
- Responds with an ACK telegram in the old baud rate and then switches to the new baud rate.

2.7.7 Telegram Set Answer

The response telegram can be selected using the following command. The telegram always has the same structure. Depending on the desired response telegram, the corresponding DIF, DIFE and VIF must be used. These are available below.

The standard telegram is active on delivery.

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	L	
L-Field	1	L	
Start	1	0x68	
C-Field	1	0x53 / 0x73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0x51	Configuration
DIF, DIFE	variable		See column "DIF, DIFE" in the following table
VIF	1		See column "VIF" in the following table
Checksum	1	CS	
Stop	1	0x16	

- Memory numbering according to EN 1434 or EN 13757.
- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

Response Type	DIF, DIFE	VIF
Standard	0x08	0x7e

2.7.8 Telegram Set Answer via Application-Reset

The software supports an application reset with application code (Sub-Code).

Application reset commands are initiated by the master via a SND_UD telegram.

Name	Length (bytes)	Value	Explanation (examples)
Start	1	0x68	
L-Field	1	0x03	
L-Field	1	0x03	
Start	1	0x68	
C-Field	1	0x53 / 73	SND_UD
A-Field	1	PADR	Primary Address
CI-Field	1	0x50	Application-Reset
Checksum	1	CS	
Stop	1	0x16	

- Resetting the application activates the standard telegram and has the same effect as the corresponding parameter command.
- No distinction between 0x53 and 0x73 in field C.
- Answers with ACK telegram

2.7.9 ACK telegram

Name	Length (bytes)	Value	Explanation (examples)
ACK	1	0xe5	

3. Wireless M-Bus / OMS Protocol

The device communicates according to EN 13757-3 and EN 13757-4. In this document, these standards are referred to as EN 13757.

The device supports only some of the telegrams defined in this standard.

3.1 Reduced Telegram

The reduced telegram is sent when the module is not installed on a PMK water meter. Only available with FW63.1 and not with FW higher.

Name	Value	Length (bytes)	Explanation (examples)
L-Field	variable	1	data length: LEN-1
C-Field	0x44	1	Send, no reply
M-Field	0xB425	2	manufacturer code
A-Field	variable	4	BCD Serial number Module
A-Field	0x05	1	version number module
A-Field	0x0E	1	device type = system component
CI-Field[1]	0x7A	1	Short telegram
TC 2 (access counter)	variable	1	transmission counter
status-field	variable	1	status counter
Configuration-field	0x0000	2	

Record	DIF	DIFE1	VIF (depends on unit)	VIFE	Datatype
info status	0x02	-	0xFD	0x17	Int 16 bit
battery life	0x02	-	0xFD	0x74	Int 16 bit

*The long header CI 0x72 is only used if the production number of the PMK counter is set (>0). If it is not defined, the reduced telegram is transmitted CI 0x7A (only available with FW 63.1).

With FW63.2 or Higher, no frame is sent if PMK meter counter is not set.

3.2 Standard Telegram

Long telegram when the module is installed on the meter.

Names	Data	length (bytes)	Note
L-Field	variable	1	data length: LEN-1
C-Field	0x44	1	Send, no reply
M-Field	0xB425	2	manufacturer code
A-Field	variable	4	BCD Serial number Module
A-Field	0x05	1	version number module
A-Field	0x0E	1	device type = system component

CI-Field[2]	0x72		1		Long Telegram
Ident. No.	variable		4		BCD Serial number Meter
M-Field	0xB425		2		manufacturer code
Meter-Version	0x01		1		version number meter
meter-device type	variable		1		water or warm water
TC 2 (access counter)	variable		1		transmission counter
status-field	variable		1		status
Configuration-field	0x0000		2		
Record	**DIF**	**DIFE1**	**VIF (depends on unit)**	**VIFE**	**Datatype**
(1) Main Volume	0x04	-	0x13 (liter), 0x16 (m^3) [3]	-	Int 32 bit
(2) Reverse volume	0x84	0x10	0x13 (liter)	-	Int 32 bit
(3) Date and time[4]	0x04	-	0x6D	-	Int 32 bit
(4) Main Volume Historic	0x44 /0x7C[5]	-	0x13, 0x16[6]	-	Int 32 bit
(5) Date historic	0x42	-	0x6C	-	Int 16 bit
(6) Info status	0x02	-	0xFD	0x17	Int 16 bit
(7) Battery life	0x02	-	0xFD	0x74	Int 16 bit

[2] The CI header 0x72 is only used if the production number of the PMK counter is initialized (>0), which implies that the module is installed. Otherwise, the reduced telegram is transmitted (only with FW63.1).

With FW63.2 or Higher, no frame is sent if PMK meter counter is not initialized.

[3] The VIF value depends on the configuration of the module (litres or m3).

[4] As long as the date/time of the module is not configured, the date/time is then set invalid IV-Bit

[5] If a historical volume is not yet acquired, the value is DIF=0x7C (wrong value status).

[6] The VIF value depends on the configuration of the module (litres or m3).

3.3 Description of « ErrorFlag » values

The following table details the different values for Alarm management.

Alarm name	Decimal value	Hexadecimal value	Bit position	Description
AlarmTamper	1	00000001	1	Tampering alarm - No PMK detection (cannot read wheel position)
AlarmBurst	4	00000004	3	Flow rate higher than the set limit
AlarmLeak	8	00000008	4	Detection of a leak
AlarmNoConsumption	128	00000080	8	No flow during the set time
BatteryLow	256	00000100	9	Low battery
AlarmReverseFlow	512	00000200	10	Negative flow rate beyond detection threshold (flow rate/time)
AlarmOverFlow	1024	00000400	11	Flow rate higher than the set limit

4. LoRaWAN Protocol

The following LoRa functionality which are part of the LoRa Alliance specification is stated to emphasize the requirement for LoRa compatibility in typical environments.

The device built-in radio is compliant with LoRa Alliance.

4.1 LoRa parameters

By default the meter operates in OTAA with the following parameters :

RECEIVE_DELAY1	1s
RECEIVE_DELAY2	2s (must be RECEIVE_DELAY1 + 1s)
JOIN_ACCEPT_DELAY1	5s
JOIN_ACCEPT_DELAY1	6s
MAX_FCNT_GAP	16384
ADR_ACK_LIMIT	64
ADR_ACK_DELAY	32
ACK_TIMEOUT 2	+- 1s (random delay between 1 and 3 seconds)

OTAA AppKey and NwkKey are unique for each device

4.2 Frame emission interval

Messages are emitted twice a day at 06.00 and 18.00 UTC. A randomization of emission time of 0 to 4 minute is done to avoid collisions.

4.3 Communication Key Management

Data required to register device on the network (in OTAA : dev_eui, app_key, in ABP : dev_eui, dev_addr, app_skey, nwk_skey) can be provided through Integra Metering Key Management System.

It allows secure transfer from manufacturer to customer and potential end user: keys can be claimed (and seen) only once by the final user or authority that will register the device.

4.4 Connection strategy

Communication mode is OTAA.

At each emission date, if the meter is not connected to network it will make a join attempt instead of transmitting a payload. Once connected the meter will send uplink frames.

No downlink is supported by meter.

Join can be triggered manually via IM Connect+®.

4.5 OMS over LoraWAN

Telegram definition is the same as described in section §3.2 with the following deviations:

- Encryption mode is 0 (no encryption of telegram in the LoraWAN Payload)
- CRCs removed from telegram
- Payload :

Field name in OMS over LoRaWAN	Equivalent field in OMS
RECORD 1 (main volume)	RECORD 1
RECORD 2 (reverse volume)	RECORD 2
RECORD 3 (error indicator)	RECORD 6
RECORD 4 (remaining battery lifetime)	RECORD 7

4.6 Alarms definition

All alarms are defined in the following table:

Alarm name	Decimal value	Hexadecimal value	Bit position	Description
AlarmTamper	1	00000001	1	Tampering alarm - No PMK detection (cannot read wheel position)
AlarmBurst	4	00000004	3	Flow rate higher than the set limit
AlarmLeak	8	00000008	4	Detection of a leak
AlarmNoConsumption	128	00000080	8	No flow during the set time
BatteryLow	256	00000100	9	Low battery
AlarmReverseFlow	512	00000200	10	Negative flow rate beyond detection threshold (flow rate/time)
AlarmOverFlow	1024	00000400	11	Flow rate higher than the set limit

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