RFM-LR1 manual

LORAWAN module for GSD8-RFM water meter

This manual offers a simple guide for getting started with the meter, as well as configuration and information for advanced users. The RFM-LR1 Water meter module is designed with focus on ease-of-use and reliable operation in LoRaWAN networks.
The unit is shipped in sleep mode, i.e. with all functions, including radio, deactivated. The device activates when the red button is pressed for more than 8 seconds. This happens automatically when the unit is mounted on to a GSD8-RFM mechanical water meter.

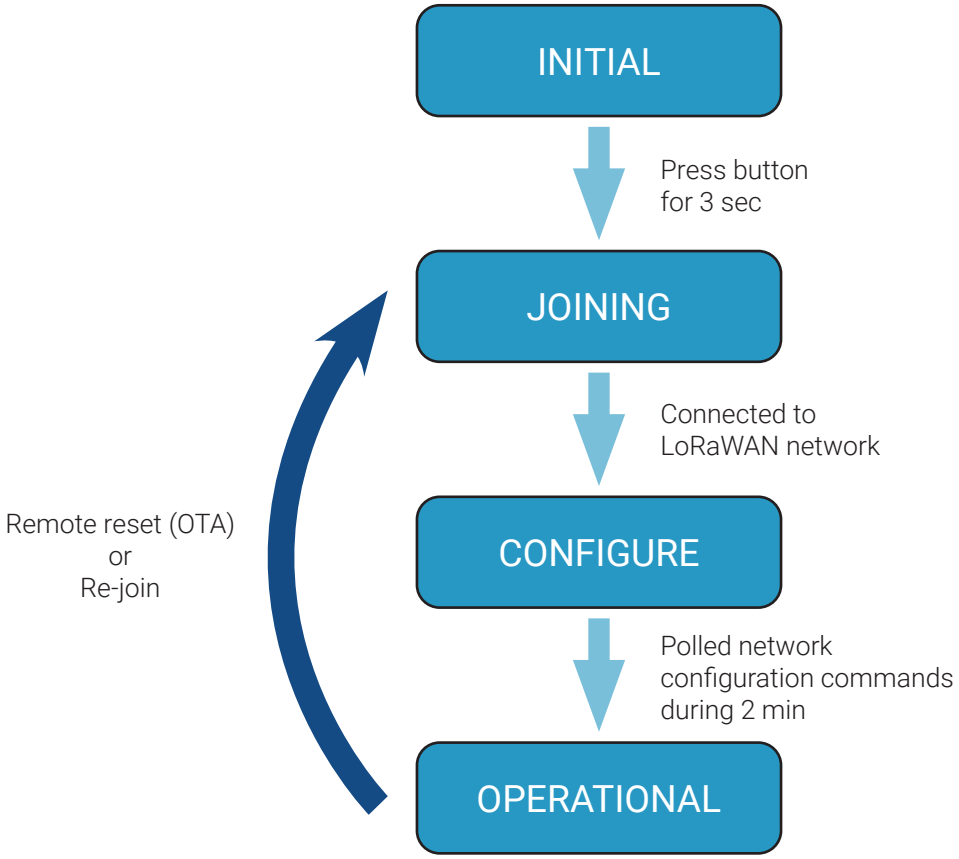
The following safety precautions must be observed during all phases of the operation, usage, service or repair of this product.

- **Read the product manual.**
- **Do not modify the product.**
- **The product should not be exposed to extreme heat or open flame.**
- **The device must not be exposed to harsh chemical agents or solvents.**

The labelling of the product may not be changed, removed or made unrecognizable.

Sensor states and state check

The sensor has four states: Initial, Joining, Configure and Operational state.



Re-join functionality

The device supervises its connectivity to the network, by monitoring that periodic downlink messages are received.
The device tries to re-join the network if it has not heard anything from the network for 288 uplinks (~ 36 days).

Startup Sequence

When the device has joined the network, startup transmissions are performed to make it easier to configure the device using downlink commands. When the startup sequence is completed normal operation is started.

There are at least five startup transmissions. The Status command (index 0x20) is sent unless a reply to a downlink is sent. If no replies are sent the Status commands are sent with increasing intervals starting with 15 seconds and ending with two minutes. This startup sequence should be utilized to set the starting value of the water meter (if not equal to 0 m^3). For accurate calibration, the water meter should not be used during the calibration.

Physical installation

When the meter has been digitally configured into your Lora network it is time to physically activate and install it. The installer mounts the RFM-LR1 unit on the GSD8-RFM and mount the locking pin and seal.

Physical installation process

1. **Mount RFM-LR1 unit on the water meter**
2. **Mount the locking pin and seal**

If you require further support, please contact ticket@bmeters.com or your vendor.

Activating on the network

Standard devices are configured to use OTAA (Over The Air Activation). It is possible to order a batch of devices configured for ABP (Activation By Personalization).

Standard devices are configured with the AppEUI (a.k.a. JoinEUI) 70-B3-D5-D7-2F-F8-1301. It is possible to order a batch of devices configured with a customer unique AppEUI for this contact B METERS support.

Upon receiving your RFM-LR1 you can request from B METERS the necessary information to connect it to your network server. This consists of the following:
1. DevEUI
2. AppKey
These codes are unique for each device. The DevEUI can be seen as a unique identification code, the AppKey is a securely generated authentication code.

The first step you should take is to simply provision the network server. This can be any LoRa system that you would like to integrate the sensor with, with the AppEUI.

The second step is to provision the application server with your unique DevEUI and AppKey.

Digital activation process

1. **Provision network server with AppEUI**
2. **Provision application server with unique DevEUI and AppKey**

Alarms

The RFM-LR1 LoRa module have several alarm functions built in.
When an alarm is detected the corresponding alarm flag in the status data is set. When any alarm flag is set the status, data is included in every report. The alarm flag must be reset manually using a Downlink command.

Module removed
If the module is removed from the water meter after activation this alarm flag is set.

Magnetic fraud attempt
The module has a detector that can sense if a magnet is used to manipulate the function of a dry dial water meter. If a magnet is sensed the alarm flag is set.

Flow exceeds Q3
If the flow exceeds Q3 for more than 10 minutes the alarm flag is set. Q3 depends on the water meter (based on pipe) and should be configured using a Downlink command. The default Q3 value is based on the largest Q3 for the specific series.

Leak detection
If a continuous flow has been detected for 24 hours the alarm flag is set. Two configuration parameters are used for this alarm, Leak window size and Leak zero tolerance, and these can be configured using Downlink commands. The leak window size defines how long it should be between the detected water meter movements to consider no flow. Leak zero tolerance defines how many electric pulses that are required to consider a flow. The default values are 2 minutes and 2 pulses (0.25 liter for DN15 and 2.5 liter for DN20).

Alarm reset
The alarm flags are reset by setting the Status data with a Downlink command. Setting it to 0 resets all alarms. Setting it to 0xFE resets alarm flag 0.

Specification

Versions
RFM-LR1 LoRaWAN Water meter

Operations

Operating temperature	from +1°C to +55°C

Connectivity

Network	LoRaWAN
Frequency bands	868 MHz
Provisioning	Over the air & personalization
Class	A

Security

Algorithms	AES-128
Hardware	Cryptographic co-processor
Features	Secure boot

Hardware based ultra-secure key storage

Battery life

Battery life length	Maximum 10 years* (at 4-hour intervals, at SF12)
Primary cell	Lithium-Manganese 3V
Capacity	2.2 Ah

Method

Optical readout	Using infrared diodes

Weight

Weight	85 g

Configuration

Transmission intervals	4 hours, configurable over the air
Starting value	Configurable over the air

Unique App EUI available upon request

Alarm functions
1. Module removal
2. Flow exceeding threshold value continuously (configurable)
3. Magnetic fraud attempt
4. Leak detection (configurable)

Enclosure
IP68

Certifications
RoHS compliant
CE
LoRaWAN

*The battery life strongly depends on the working time window, set during the configuration process, and on the environmental conditions.

Protocol

The protocol consists of different types of data
- LoRaWAN v.1.0.2 standard commands
- Unsolicited uplink status commands during configure state
- Periodic measurement reports
- Downlink commands and queries
- Uplink query response

Note 0x denotion means hexadecimal encoded.

Unsolicited uplink status commands

The sensor polls the server for configuration parameters the during the **Configure** state. This is done by sending unsolicited uplink status report (0x20). This is gives quick feedback to the installer that the installation has been successful and enables downlink configuration commands to be sent. After approximately 2 minutes the device changes to **Operational** state.
Port: **Port 1**
Payload 0x01 20 00
0x01: Data type
0x20: Status command
0x00: bit0 =0 => Normal startup
bit1 =0 => No boot problem
bit2-7 reserved
The expected behavior is 0x01 20 00.

Downlink commands and queries

This describes the payload data that is sent to and from the application server. All downlink application communication is done on LoRaWAN **port 1**.

Uplink command device => network				
Field	Bytes	Value	Description	Note
Type	1	xx	0x01: Data 0x02: Command NACK	
Index	1	xx	Command Index	
Data			As defined for Command Index (only for Type: Data)	

Downlink command network => device				
Field	Bytes	Value	Description	Note
Type	1	xx	0x01: Set 0x02: Query 0x03: Action	
Index	1	xx	Command Index	
Data			As defined for Command Index only applicable for set-commands	

Index	Description	Datatype	Encoding	Valid range	Access	Unsolicited	Description	Note
0x03	FW build hash	6 x Uint8			Query	No	Unique number that identifies the firmware version	
0x05	Device reset				Action	No	Reset of device	
0x06	CPU voltage	Uint8	25mV/ LSB	0 - 3.6V	Query	No	Read CPU voltage. Max/min ranges depend on battery chemistry.	
0x0A	CPU temperature	Uint16 Big endian	0.01C / LSB	-50 - +125 C	Query	No	Temperature from CPU sensor with 50 °C offset. Approximately 5 °C accuracy	
0x20	Status	Uint8	Bitfield		Set Query	Yes	Bit 7: Flow exceeds Q3 at least for 10 min Bit 6: - Bit 5: Magnetic fraud attempt Bit 4: - Bit 3: Module removed Bit 2: - Bit 1: - Bit 0: Leakage during last 24 hours	To clear alarms: 0xFF clears no alarms, 0x00 clears all alarms, 0x80 clears all alarms except 'module removed' etc.
0x21	Volume	Uint32 Big endian	Liter		Query	Yes	Volume as indicated on meter x 0.001 m3	
0x22	Reporting interval	Uint16 Big endian	Minutes	1-10080	Set Query	No	Reporting interval in minutes	
0x25	Starting value	Uint32 Big endian	Liter		Set Query	No	Volume as indicated on meter x 0.001 m3	
0x27	Back flow volume	Uint32 Big endian	Liter		Query	No	Volume as indicated on meter x 0.001 m3	
0x2B	Q3MaxFlow	Uint16 Big endian	Liters per hour	0 - 65535	Set Query	No	Corresponds to mechanical meter Q3 (based on pipe)	
0x2C	Leak Window size	Uint8	Number of 15 seconds samples	1 - 255	Set Query	No	The size, in units of 15 seconds sample windows, in which we expect flow below "zero tolerance" to reset leak detection	
0x2D	Leak Zero tolerance	UInt8	Opto phase changes	0 - 255	Set Query	No	Zero tolerance, max number of shaft phase changes considered "not moving"	

Examples

Uplink: 012100001738
Normal Volume with the meter reading 5944 liter

Uplink: 012100001738012008
Normal Volume with the meter reading 5944 liter combined with Status data indicating Module removed alarm flag

Downlink: 012000 Uplink: 012000
Resets all alarm flags

Downlink: 012205A0 Uplink: 012205A0
Sets the Reporting interval to 1440 minutes = 24 hours.

Downlink: 0227
Uplink: 012700000017
Query the Back flow volume. The reply is 23 liter.

Reset device

The device can be remotely reset and forced into Joining state. All settings are back to factory default.
Example
Remote device reset: Port 1: 0305

LoRa MAC Commands

The RFM-LR1 can be controlled over by sending down link commands.
The following MAC commands per LoRaWAN specification 1.0.2

CID	Command	Transmitted by	Short Description
0x02	***LinkCheckReq***	End device	Used by an end device to validate its connectivity to a network.
0x02	***LinkCheckAns***	Gateway	Answer to LinkCheckReq command. Contains the received signal power estimation indicating to the end device the quality of reception (link margin).
0x03	***LinkADRReq***	Gateway	Requests the end device to change data rate, transmit power, repetition rate or channel.
0x03	***LinkADRAns***	End device	Acknowledges the LinkRateReq.
0x04	***DutyCycleReq***	Gateway	Sets the maximum aggregated transmit duty cycle of a device
0x04	***DutyCycleAns***	End device	Acknowledges a DutyCycleReq command
0x05	***RXParamSetupReq***	Gateway	Sets the reception slots parameters
0x05	***RXParamSetupAns***	End device	Acknowledges a RXSetupReq command
0x06	***DevStatusReq***	Gateway	Requests the status of the end device
0x06	***DevStatusAns***	End device	Returns the status of the end device, namely its battery level and its demodulation margin
0x07	***NewChannelReq***	Gateway	Creates or modifies the definition of a radio channel
0x07	***NewChannelAns***	End device	Acknowledges a NewChannelReq command
0x08	***RXTimingSetupReq***	Gateway	Sets the timing of the of the reception slots
0x08	***RXTimingSetupAns***	End device	Acknowledges RXTimingSetupReq command

Contact Info

B METERS srl
Via Friuli, 3 • Gonars 33050 (UD) • ITALY

Tel: +39 0432 931415
Fax: +39 0432 992661

E-Mail (sales/info): info@bmeters.com
E-mail (support): ticket@bmeters.com
Web: www.bmeters.com