VL-100-LRW

User Manual

LoRa®

Overview

The VL-100-LRW is a LoRaWAN™ Class A device that detects approaching thunderstorms within a 40-kilometer radius. It can determine its approximate distance and the energy level of the approaching storm and uses fine-tuned algorithms to reject man-made interference to prevent false positives. It operates entirely on a solar panel and battery for easy maintenance and installation.

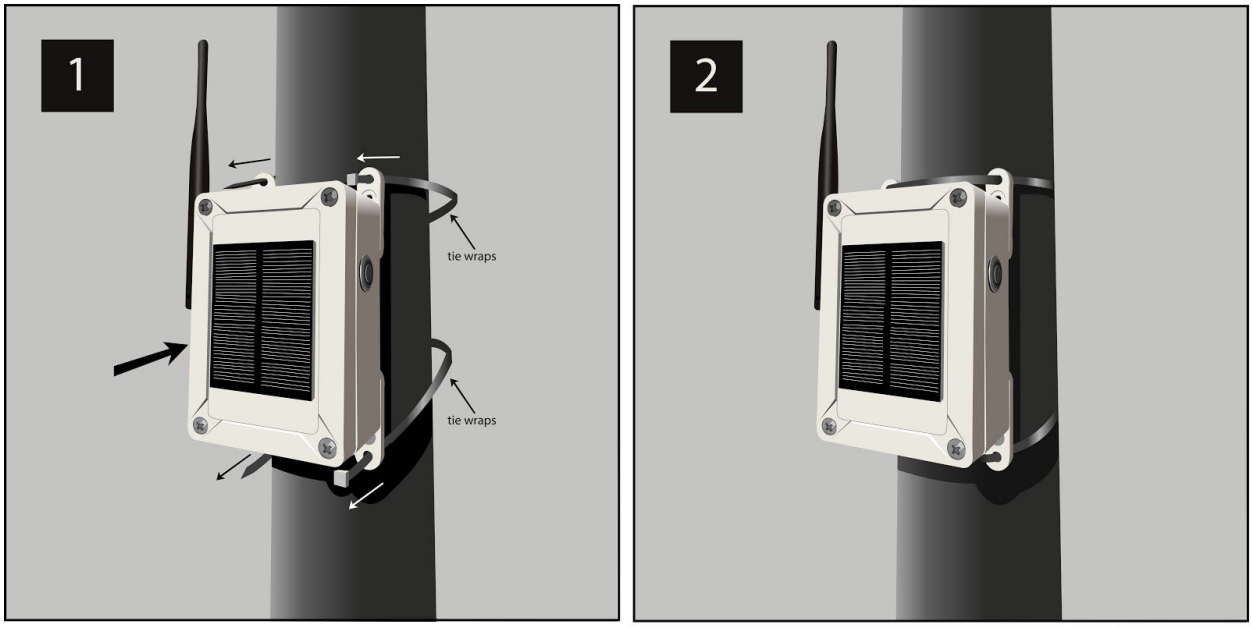
This user manual is meant for system integrators or network operators. The manual will explain how to install the device, connect to an existing LoRaWAN™ network and program their application to communicate with the device.

Getting Started

The VL-100-LRW can be installed anywhere, but is meant to be outdoors. Its enclosure is fully weatherproof (IP67 standard). It should be placed in a sunlit area, with the solar panel oriented towards the sun as much as possible. This will ensure that the battery gets recharged gets optimally recharged.

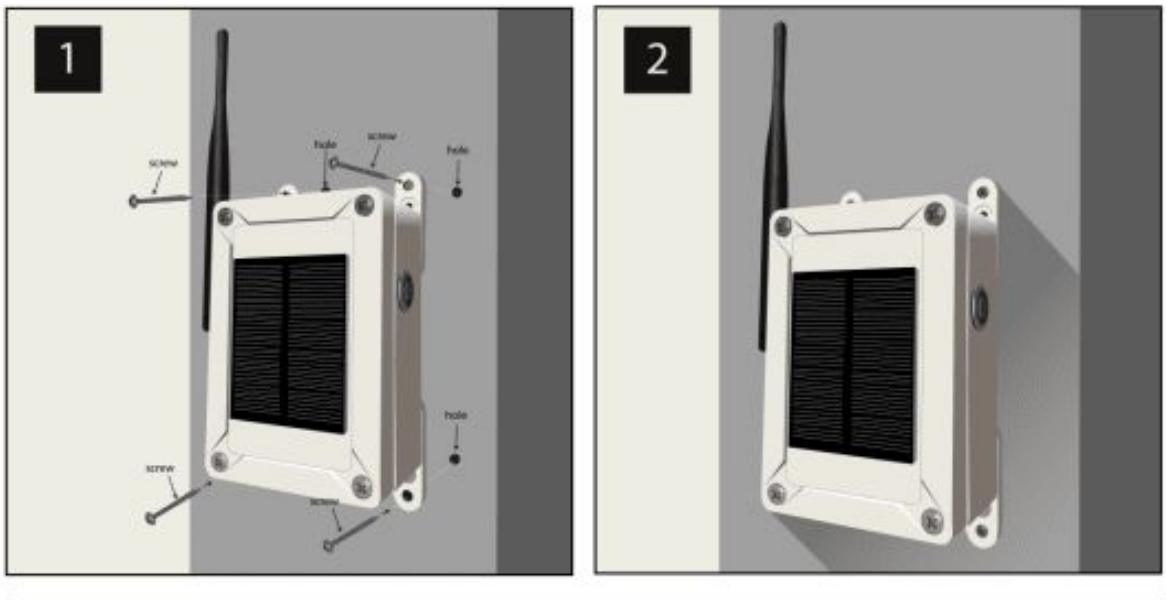
Pole Installation

To install it on a service pole, the user should run the provided tie-wraps through the bracket holes of the device and towards the back of the pole. The user should make sure the tie-wraps are well fastened behind the pole.



Wall Installation

To install it on a wall, the user should drill four holes and drive each provided screw through the bracket towards the back of the wall.



Device Activation

The VL-100-LRW is turned on or off by pressing the button situated on the side of the enclosure. This action automatically turns on the device and triggers the network activation process.

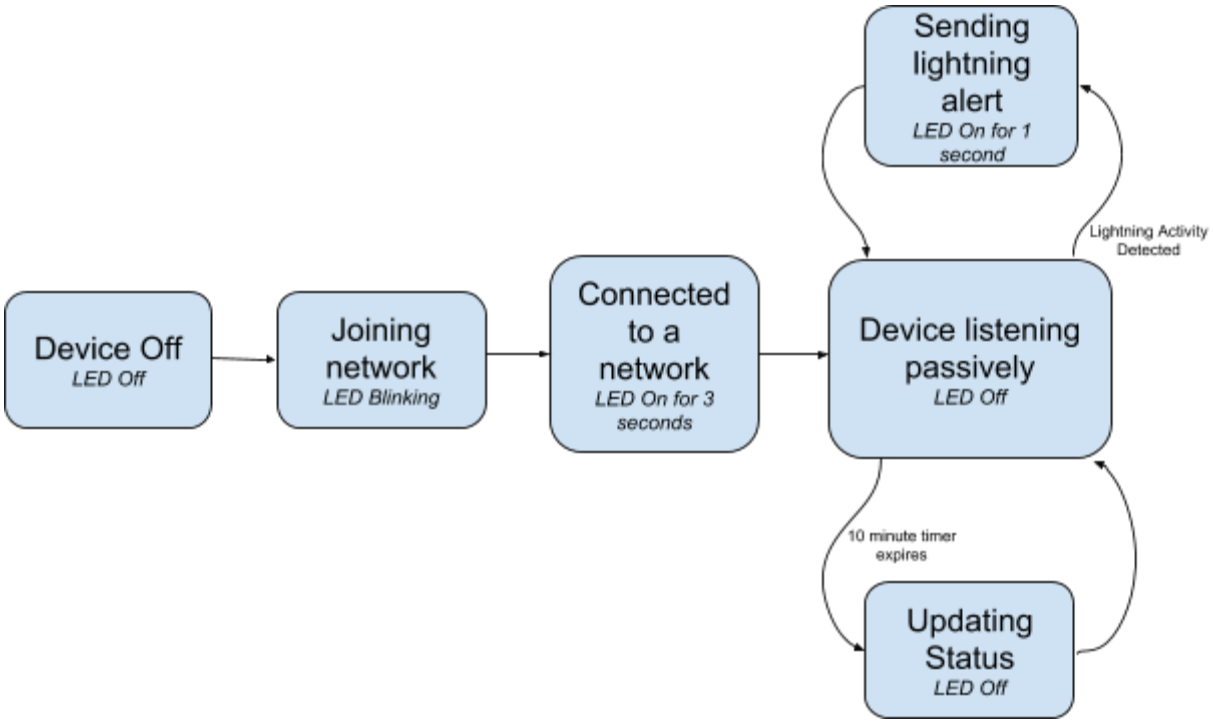
Network Activation

When turned on by pushing on the side button, the VL-100-LRW automatically tries to connect to a LoRaTM network via Over the Air Activation (OTAA). If it doesn't receive a reply from any network, it continues to send join requests until it does. The blue LED ring will keep blinking repeatedly until the device joins a network that was preconfigured to accept the device's Application ID (AppEUI) and Device ID (DevEUI). The AppEUI, application key (AppKey) and DevEui are set by default in each device. This information is indicated on the card shipped with the device.

If the user wishes to activate the device by personalization (ABP), this is done by connecting the Universal Asynchronous Receiver-Transmitter (UART) pins (indicated by BLETX and BLERX on the circuit board) to a FTDI virtual COM port device. To access the menu, close and re-open the device.

Once the VL-100-LRW has joined a network, it will send regular status updates indicating its battery level, and information about any noise and man-made electromagnetic disturbances picked up by the sensor since the last update. The user can also request for additional information to be included in a status update. The VL-100-LRW will also send an alert whenever a lightning strike is detected. The communication protocol for this is detailed in the "Communication Packet Structure" section of this manual.

Device States



Lightning Detection Settings

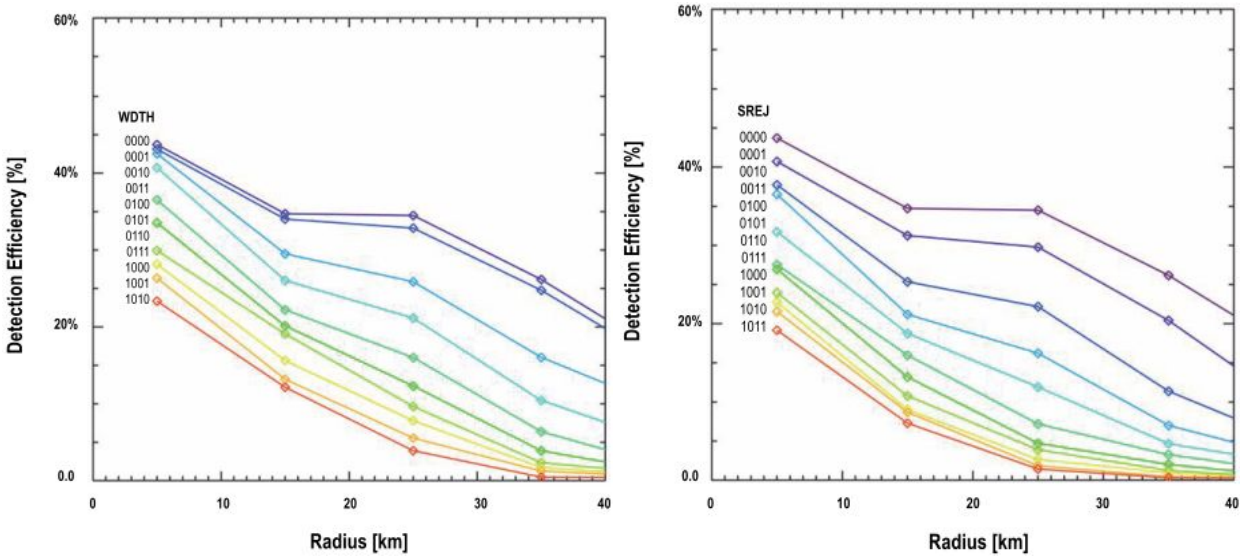
Analog Front-End (AFE) Gain

The gain of the sensor's AFE should be set to different values depending on whether the VL-100-LRW is operating outdoors or indoors. Optimized preset gain values are available for either case. There is a user setting available to select which preset to use. By default, the outdoors setting is selected.

Watchdog Threshold (WDTH) and Spike Rejection (SREJ)

Incoming signals from the sensor are validated to distinguish between lightning strikes and man-made disturbances. The robustness of validation can be customized by changing the value of two settings: the WDTH and SREJ. The watchdog evaluates the overall strength of the signal. Spike rejection checks for the presence of impulses. Increasing either threshold improves the rejection of man-made disturbances, at the cost of losing sensitivity for very far lightning detection.

Figure: Lightning detection efficiency vs. distance for different WDTH settings with SREJ=0 (left), and for different SREJ settings with WDTH=1 (right)



Noise Threshold

The lightning sensor also generates an estimate of its own continuous input noise floor level. Whenever the noise floor level crosses a given noise threshold, the event is recorded by the VL-100-LRW. This recording indicates when the sensor cannot operate properly due to high input noise received by the antenna. The noise threshold can be set by the user to one of 8 levels (from 0 to 7). The noise threshold

voltage corresponding to each level can be optimized differently depending on the AFE gain setting of the VL-100-LRW.

Minimum Number of Lightning Events

The VL-100-LRW sends lightning alerts only if a minimum number of lightning strikes have been detected in the last 15 minutes. The user can set the value for the minimum number of strikes to 1, 5, 9, or 16. Any other value input by the user is rounded down to the nearest valid setting.

Clear Statistics

The lightning sensor keeps statistics to estimate the distance of the head of an approaching storm. There is a user setting available to clear the statistics built up by the distance estimation algorithm block.

Communication Packet Structure

The device sends two types of uplink packets. Every 10 minutes (by default), the device sends status messages indicating the battery level, the current uptime, current electromagnetic interference, etc. There is also a confirmed uplink message that indicates when a lightning strike has occurred.

Uplink Payload Structure

The first byte of payload contains flags that indicate which fields are present in the remainder of the payload. All of the other bytes contain the values associated with these optional fields. Optional fields are ordered within the payload (if present) by their associated flag bits, from LSB to MSB.

Status Uplink Message

The size of this message is variable, to optimize the length of the packet. The first byte indicates the contents of the message. The rest of the message contains the contents described by the first byte.

Flag Bit	Field Description	Field Size (Bytes)
0 (LSB)	Battery level (as a fraction out of 255, where 255 means 100% charge)	1
1	Number of excessive noise events recorded since last update	1
2	Number of disturber events recorded since last update	1
3	Sanity check for the sensor (1 if the sensor responds, 0 otherwise)	1
4	Firmware version	4
5	Uptime (ms)	4
6	Lightning strike information (see Table Y)	4
7 (MSB)	Unassigned	-

Example Packet (in hex):

`17AF030400000002`

`17`: Message Contents indicates there is a battery level, excessive noise events and number of disturber events.

`AF`: 175/255 = 68% Battery

`03`: 3 Excessive Noise Events

`04`: 4 Disturber Events

`00000002`: Firmware version 2

Lightning Front Information Message

Bytes	Description
[0]	Estimated distance from the lightning strike (km)
[1..3]	Measured energy of the lightning strike

Downlink Payload Structure

A downlink payload is composed of one byte of flags (Payload[0]), and one optional byte containing the value associated with one flag, if necessary (Payload[1]). Bits[0..4] of the Flags Byte indicate flags not associated with a value. Bits[5..7] indicate flags associated with a value which necessitates the use of Payload[1]. Therefore only one of these latter flags may be selected in any downlink payload.

Table: Structure of Payload[0]

Bits[7..0]	Field Description	Contents of Payload[1]
xxxxxxx1	Request device reset	-
xxxxxx1x	Clear lightning distance algorithm statistics	-
xxxxx1xx	Request firmware version in the next uplink message	-
xxxx1xxx	Request device uptime in the next uplink message	-
xxx1xxxx	Request sensor sanity check in the next uplink message	-
000xxxxx	Indicates the absence of a second byte (Payload[1])	-
001xxxxx	Set the frequency of status updates from the device	Period in steps of 10s (3 = 30 seconds)
010xxxxx	Set the sensor's noise floor level	0 to 7 (lowest to highest noise floor level threshold)
011xxxxx	Set the sensor's watchdog threshold	0 to 15 (lowest to highest threshold)
100xxxxx	Set the sensor's spike rejection threshold	0 to 15 (lowest to highest threshold)

101xxxxx	Set the sensor's minimum number of lightning strikes	Number of strikes (rounded down to 1, 5, 9 or 16)
110xxxxx	Set the sensor's AFE gain	Outdoors setting if 0, indoors setting otherwise
111xxxxx	Unassigned	-