LVM110 LORA VOLTAGE MONITOR

Instructions Manual

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INTRODUCTION

This user manual helps you setup and use the LVM110 LoRaWAN voltage monitor, it contains both installation and protocol description for the product. LVM110 is used to accurately measure its own supply voltage level and well as device temperature and humidity and transmit this data periodically over LoRaWAN.

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TECHNICAL SUPPORT

If you have problem using this product and can't find the information in this manual, please contact us via e-mail at support@dnil.se

PRODUCT DESCRIPTION

OVERVIEW

LVM110 is a low power device powered by 8-30VDC that measures and reports its own supply voltage level over LoRaWAN. With supply current in the range of a 170µA to 240µA (fraction of a mA) the device power consumption is in most cases negligible and allows LVM110 to be permanently connected to DC power sources such as Lead-Acid or Lithium batteries. The supply voltage, surrounding air temperature and humidity is sampled periodically and sent over LoRaWAN creating a monitoring solution for a range of applications where the voltage level in combination with environmental conditions are critical factors. Examples of such applications include

- Recreational vehicles (RVs) in storage during off season
- Rescue vehicles in stand-by
- Solar powered equipment with battery backup (temporary traffic lights for example)
- UPS battery banks

FEATURES

- LoRa EU868 version 1.0.2 device
- LoRa Class A receiver
- LED status indication for Power and LoRa connection
- Built-in high accuracy temperature and humidity sensor
- High resolution supply voltage measurement
- Programmable measurement interval via LoRa downlink

TECHNICAL DATA

SUPPLY VOLTAGE

- Voltage range: 8-30VDC

- Current consumption: ~170µA at 12VDC, ~240µA at 24VDC (average)

- Resolution: 12-bit ADC, report resolution 1mV

- Accuracy: ~10mV (typical)

- Physical Interface: Würth Electronic WR-TBL Series 3455 2-pin plug (included)

- Protection: Reverse polarity and overvoltage protection

TEMPERATURE SENSOR

- Resolution: Report resolution 0.1°C

- Accuracy: ±0.2°C (typical)

HUMIDITY SENSOR

- Resolution: Report resolution 0.1%RH

- Accuracy: ±2% (typical)

LORAWAN

- Frequency: 868MHz (EU868 region)

- Output power: 14dBm

- Antenna: Built-In

- Activation mode: OTAA (Over The Air Activation)

ENVIRONMENTAL

- Operating Temperature: -30C to +55C

- Storage Temperature: -40C to +85C

- Altitude: 0 to 2000m

- Operating humidity: Max 85% RH (non-condensing)

- Usage: Indoor usage, pollution degree 2

INSTALLATION

LVM110 installation is very simple, connect supply voltage in the range of 8-30VDC using the supplied connector while observing correct polarity as marked on the front panel. LVM110 will power on and the LED labeled "Power" should start blinking within a few seconds. Supplied connector is of type Würth Electronic WR-TBL Series 3455 2-pin (part number 691345510002), this connector is readily available from many sources in case a replacement is needed.

LVM110 can be mounted either using screws or tiewraps (not supplied) to a nearby panel or wall. It is also possible to use double sided tape and attach LVM110 to a smooth surface.

LVM110 needs to be provisioned on the LoRaWAN network as a class A LoRaWAN device using the DevEUI and over the air activation (OTAA) key supplied with your purchase of LVM110. As soon as LVM110 is powered the LoRaWAN join procedure till start. Successful LoRaWAN OTAA join is indicated when the LED labeled "LoRaWAN" starts blinking.

LEDs will always blink to indicate active state in order to conserve power. No further activation or field configuration of LVM110 is required.

OPERATION

During normal operation LVM110 periodically samples its own DC supply voltage level as well as air temperature and humidity, after sampling this data is transmitted over LoRaWAN to the application server. The time period between sampling is called the measurement interval, this is by default every 15 minutes but can be altered between 5 minutes and 1440 minutes (24 hours) via LoRaWAN downlink commands. LVM110 average current consumption is strongly related to measurement interval, values in the technical data section of this manual are based on the default measurement interval of 15 minutes, decreasing this interval will increase the average current consumption and vice versa.

The air temperature and humidity sensor is located inside the LVM110 enclosure, resulting in a sensor protected from dirt and debris. Surrounding air humidity will over time be equal to the air humidity inside the LVM110 enclosure, but in cases where the surrounding air humidity changes rapidly it will take some time for this to be reflected inside the LVM110 enclosure. Relative air humidity reported by LVM110 should be considered an average value and not an accurate representation of fast changing air humidity levels.

LORAWAN PROTOCOL

OVERVIEW

In this section, uplink refers to all communication from the LVM110 device to the network server and downlink to all communication from network server to the device.

The LVM110 has a LoRa class A receiver which means that the downlink channel is available in a short window after each uplink message transmitted from LVM110. Sending commands to LVM110 is therefore only possible once every 15 minutes (default measurement interval).

Downlink communication can be used to perform either a "set command", "query command" or an "action" on the LVM110. A "set command" is used to change a parameter setting inside the LVM110, for example the measurement interval. Using "queries" it is possible to retrieve parameter settings or additional status information from the LVM110 which will be sent on the uplink channel as protocol data. "Actions" are used to perform operations such as a device reset. Only one command or action is allowed per downlink, all downlink communication is performed on LoRaWAN port 1.

Uplink communication is divided into two different groups, "protocol data" and "periodic data". Protocol data is sent from the LVM110 in response to queries performed using the downlink channel and is always sent on LoRaWAN port 1. Periodic data is sent at the measurement interval and contains supply voltage level and air temperature and humidity data, periodic data is always sent on LoRaWAN port 2.

All data is sent in binary form using network byte order ("big endian" or "most significant byte first").

UPLINK PERIODICAL DATA

Periodic data is what the device normally sends every measurement interval, this data is sent on LoRaWAN port 2 with size and contents according to Table 1below.

Index	Data Bytes	LoRa Port	Data encoding
Periodic data, index byte not present	5	2	Byte [2:0]: Air temperature and humidity encoded as 12 bit each as follows: Byte 0: Air temperature bits 11:4 Byte 1: Air humidity bits 11:4 Byte 2 bits [7:4]: Air temperature bits 3:0 Byte 2 bits [3:0]: Air humidity bits 3:0 Air temperature is sent in units of 0.1°C with an offset of 80.0°C Air humidity is sent in units of 0.1% RH with an offset of 25.0% RH. Bytes [4:3]: Supply voltage in mV encoded as unsigned 16-bit, sent in big endian. See example decoder logic below.

Table 1: Downlink periodical data

Table 2 contains example uplink periodical frame data and decoding

Example Packet data	Packet Action
0x32 0x45 0x42 0x31 0x45 on port 2	Periodical data, air temperature, humidity and supply voltage Humidity: 85.6% RH Supply voltage: 12613mV Temperature: 0.4°C

Table 2: Example uplink packets

Sample code below shows decoding of periodical data sent on port 2 for air temperature, humidity and supply voltage.

```
if (fPort === 2) {
    // Temperature and humidity
    obj.temperature = (((bytes[0] << 4 | bytes[2] >> 4 ) -800 ) / 10);
    obj.humidity = (((bytes[1] << 4 | bytes[2] & 0x0F ) -250 ) / 10);

    // Supply voltage data
    obj.supply_mV = (((bytes[3] << 8) | bytes[4])) >>> 0;
}
```

DOWNLINK PROTOCOL DATA

Table 3 shows the structure of a downlink packet sent to LVM110, a packet consists of at least 2 bytes of data (packet type and index). Only "set packets" have data bytes after the index byte, data bytes are not present for action and query packets.

Byte 0 Packet Type	Byte 1 Index	Byte 2-5 Data
0x01 : Set Packet 0x02 : Query Packet 0x03 : Action Packet	See Table 4 for valid indexes	See Table 4, only present for some indexes

Table 3: Downlink packet

Table 4 shows valid combinations of packet types and index bytes, and also the data encoding for the defined set packets. When valid query packets are received by the LVM110 a response will be sent on the uplink channel after roughly 10 seconds.

Packet type	Index	Data Bytes	Data encoding
Set Packet	0x22: Measurement Interval	2	16-bit unsigned data big endian 5 to 1440 minutes
Query Packet	0x03: FW git SHA	None	
Query Packet	0x06: CPU Voltage	None	
Query Packet	0x0A: CPU Temperature	None	
Query Packet	0x20: Status	None	
Query Packet	0x22: Measurement Interval	None	
Action Packet	0x05: Device Reset	None	

Table 4: Downlink index and data encoding

Table 5 contains example frames showing valid downlink packets.

Example Packet data	Packet Action
0x01 0x22 0x00 0xB4	Packet type 0x01 (set), index 0x22, data 0x001E Set measurement interval to 0x001E (30) minutes
0x02 0x0A	Packet type 0x02 (query), index 0x0A Query CPU temperature
0x03 0x05	Packet type 0x03 (action), index 0x05 Request LVM110 device reset

Table 5: Example downlink packets

UPLINK PROTOCOL DATA

Table 6 shows the structure of a protocol uplink packet sent by to LVM110 on LoRa port 1, packet structure is similar to downlink packets with packet type and index bytes followed by data.

Byte 0 Packet Type	Byte 1 Index	Byte 2-3 Data
0x01 : Data Packet 0x02 : NACK Packet	See Table 7	See Table 7

Table 6: Uplink packet

Normally uplink packets are sent with packet type set to 0x01 (data packet), in case a downlink query was sent with an invalid index the uplink packet type will be set to 0x02 (NACK) and the index byte will be the same invalid index.

Table 7 contains valid index bytes and data encoding for uplink data packets.

Index	Data Bytes	LoRa Port	Data encoding
0x03: FW git SHA	6	1	6 ASCII characters showing FW revision
0x06: CPU Voltage	2	1	16-bit unsigned data big endian Supply voltage encoded in mV.
0x0A: CPU Temperature	2	1	16-bit unsigned data big endian Temperature (celsius) encoded: (data / 100) – 50.0
0x20: Status	1	1	Bit 0: Watchdog reset occurred Bit 1: LVM110 startup error occurred
0x22: Measurement Interval	2	1	16-bit unsigned data big endian Measurement interval encoded in minutes

Table 7: Uplink index and data encoding

Table 8 contains example uplink protocol frames and data decoding.

Example Packet data	Packet Action
0x01 0x20 0x00 on port 1	Packet type 0x01 (Data), index 0x20 (Status) Status = 0x0, "no errors"
0x02 0xAA on port 1	Packet type 0x02 (NACK), index 0xAA LVM110 was unable to respond to a query on index 0xAA

Table 8: Example uplink protocol packets