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Zone User Guide

LoRaWAN Wireless Environmental Sensor

LoRa long range wireless
Battery powered
Built in sensors for:

- Temperature (°C) • Humidity (%RH) • Carbon Dioxide (CO_2) • Motion (PIR)*
- Barometric Pressure (Pa)
- Light level

RF-LW-THVB-S

RF-LW-THLVBPM-S

RF-LW-THLVBC-S

Temperature | Humidity | Light level | VOC's | CO_2 | Pressure | Motion

Zone accurately measures multiple environmental parameters including room temperature, humidity, light level, VOC's, CO_2, barometric pressure and human presence (motion)*. Volatile Organic Compounds (VOC's) from paints (such as formaldehyde), lacquers, paint strippers, cleaning supplies, furnishings, office equipment, glues, adhesives and alcohol can be detected.

Readings are transmitted to the cloud using long range LoRa wireless, where the data can be displayed and analysed. The unit is battery powered with long life of 3+ #years. A built in USB port allows all parameters including sensor, air quality data, wireless signal strength and wireless network configuration to be viewed and set using simple menus via any USB enabled host such as a PC or Mac.

Features

- Multiple sensor options*
- LoRa long range wireless
- Frequency Range 863-870MHz*
- Frequency Range 902-928MHz*
- Up to +16dBm Tx Power
- Built in USB port for configuration
- Battery powered
- CE /FCC compliant
- RoHS compliant
- Made in the UK

*Option / model dependent, see Selection Guide
#Dependent on factors such as transmission interval

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(lux)*

RF-LW-THLVBCM-S

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- Volatile Organic Compounds (VOC's)

Introduction

Zone accurately measures up to seven key indoor air quality parameters with class leading accuracy.

Available with temperature, relative humidity, CO_2, VOC's, barometric pressure, light level and presence (motion detection).

Data is transmitted via long range LoRaWAN wireless for remote analysis.

The units are battery powered for ease of installation.

2. Configuration

LoRaWAN devices are configured using OTAA (Over-the-Air-Activation).

OTAA is the most secure way to connect a device to the LoRaWAN network. In OTAA, the device performs a Joinprocedure with the network, during which a dynamic DevAddr (device address) is assigned and security keys are negotiated with the device.

The OTAA configuration requires the following parameters to be correctly set:

- DevEUI: End-device Identifier. It is unique for every device and is set at device manufacture.
- AppEUI / JoinEUI*: Application Identifier. Used to identify the end application.
- AppKey: Application key. Used to create the session keys.

*Note: In LoRaWAN 1.1, AppEUI was renamed to JoinEUI.

Providing the LoRa gateway has the matching values, the join process will happen automatically once the Zone unit is in wireless range and switched on.

The DevEUI is always set at device manufacture and is unique. The device AppEUI and AppKey can easily be set via the USB connection if required and the process is detailed later in this document.

3. Join devices to the LoRaWAN network

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Devices in wireless range and with the correct AppEUI and AppKey settings set will automatically join the LoRaWAN network when they are first powered up.

Zone Unit and Label

The unique **DevEUI** is printed on all devices and is also present in the QR code. The **DevEUI** can be used to identify the device once joined to the network.

4. Powering the Zone unit

To power the device ON, remove the rear cover of the Zone by inserting a small screwdriver blade into the slots on the bottom of the unit as shown below.

Cover Removal

To power the device ON, slide the power switch to the OFF position and insert the 2 x AA sized Lithium 3.6V batteries taking great care to insert them the correct way around. Locate the plus (+) and minus (-) signs on the battery and use the plus (+) and minus (-) guides on AA battery holders to insert the batteries in the proper direction. Both batteries face in the same direction.

Be sure to insert the minus (-) end first and remove the plus (+) end first when replacing the batteries.

Lithium batteries have very high energy capacity and a great degree of care should be exercised to ensure that all batteries are new, from the same manufacturer, installed the correct way around and are not in any way damaged. Refer to Section 12 **Error! Reference source not found.** for more details.

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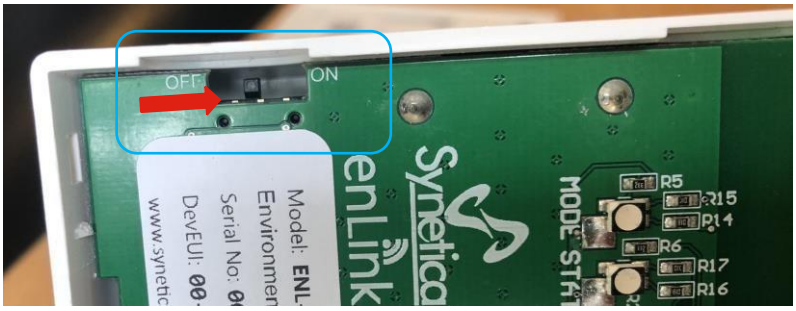
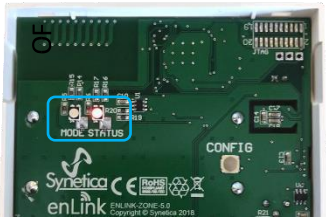
Check that the batteries are correctly inserted and then use a small screwdriver to gently slide the power switch towards the ON position marked on the unit as shown.



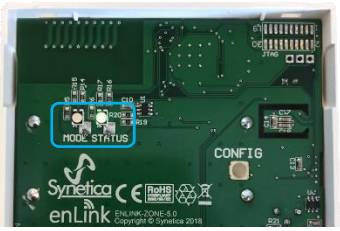
Switch to the ON position

Once powered ON, the device will send a Join request message to the Conduit. The Status LED will blink RED as shown below whilst the Join process is taking place. Depending on factors such as signal strength, RF interference etc. the join process may take several seconds to complete.



Blinking Red LED – Attempting Join

When the device has successfully joined the network the Status LED will blink GREEN five times to show that the join has been completed. The LED's will then switch off to conserve the batteries.



Blinking Green LED – Device Successfully Joined

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Devices which have Joined the network appear in the Conduit **LoRaWAN** - > **Devices** menu as shown previously.

5. Setting / changing the LoRaWAN keys

If the LoRa gateway has matching keys the join process will happen automatically once the Zone unit is in wireless range and switched on.

The DevEUI is always set at device manufacture and is unique. The device **AppEUI** and **AppKey** can easily be set via the USB connection as detailed below.

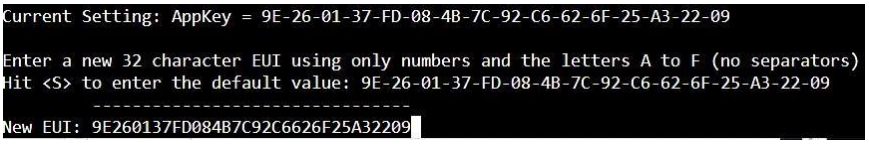
Remove the Zone board from its enclosure as shown previously. Take care when removing the board from the front part of the enclosure and only use the slots provided at the bottom of the board to gently lift the board up and out of the enclosure.

Connect a micro USB cable to the unit. The device will attach to a COM port on your PC.

Using a terminal program (e.g. Tera Term https://ttssh2.osdn.jp/) connect to the COM port used by the device.

To verify which COM port is being used, check the Windows™ Device Manager (In Windows - Click the **Start** button, type **device manager** into the search box and tap **Device Manager** on the menu.) Expand the **Ports (Com & LPT)** menu as shown below.

From the **Quick Start Settings Menu** access the **AppKey** setting by entering **k**. Enter the 32 character **Appkey** using numbers and letters a to f. Do not include spaces or any other characters. Pressing **S** will enter the default **AppKey** which you can then edit. Press **Enter** when the key is correctly entered to return to the **Quick Start Settings Menu**.



AppKey setting

Press **X** from the **Quick Start Settings Menu** to return to the Main menu.

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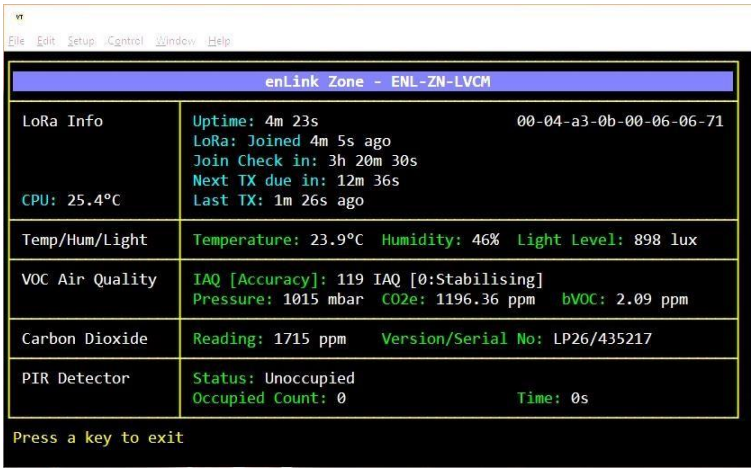
The header will show ** **Reboot Required** ** as shown below. The new key settings will not take effect until the device is restarted. Enter **R** to reboot followed by **OK**. The device will restart with the entered **AppEUI** and **AppKey** and attempt to join the LoRa network.

Reboot Required notification

Check the Conduit **LoRaWAN** -> **Devices** menu detailed previously to verify that the device has joined successfully.

6. Live Menu

Zone incorporates a live data screen which shows all readings and device status for easy data validation. To enter the Live status screen, from the **Main Menu** enter **c** for Configure Device followed by **d** for Live readings display. A screen similar to the one below will show. The sensors will vary according to the Zone model and the installed sensors.



Live Display

7. Configuration Menu

The Zone configuration menu allows you to view current sensor readings and also to change various functions of their behaviour such as calibration data. To enter the Configure Device menu press **c**

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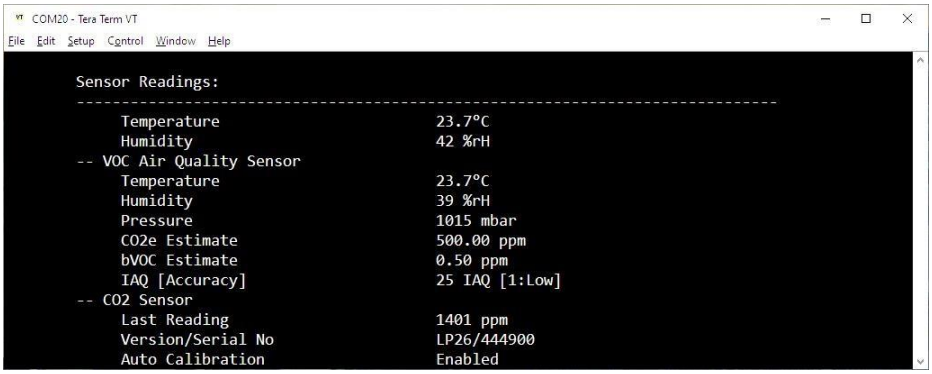
from the main menu. A screen similar to the one below will show. The exact parameters shown will vary according to the Zone model and sensors fitted.



continuously occupied for a long period and the minimum CO_2 reading does not fall below, say 450ppm, then it is undesirable to run the autocalibration routine based on a target of 400ppm. In this case, if the "Set Target CO2 Level" is set to 400ppm and the "Out-of-bounds check" value is set to +/- 50 ppm then the autocalibration routine will not run unless the minimum read value falls below 451ppm in the interval.

CO_2 Monitoring

Measuring CO_2 levels can serve as a good indicator of the indoor air quality. CO_2 concentrations within a building often are used to indicate whether adequate fresh air is being supplied to the space. Indoor CO_2 concentration is directly proportional to the number of people in a building and the ability of the ventilation system to dilute the CO_2 generated by occupants.

Moderate to high levels of carbon dioxide can cause headaches and fatigue, and higher concentrations can produce nausea, dizziness, and vomiting. Elevated levels of CO_2 can also affect performance and productivity. In one study[3] of 24 employees, cognitive scores were 50% lower when the participants were exposed to 1,400ppm of CO_2 compared with 550ppm during a working day.

CO_2 concentration	Remarks / Effect
400ppm	Normal CO_2 concentration in outdoor ambient air

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400-1,000ppm	Concentrations typical of occupied indoor spaces with good ventilation
1,000-2,000ppm	Complaints of drowsiness and poor air.
2,000-5,000 ppm	Headaches, sleepiness and stagnant, stale, stuffy air. Lack of concentration, loss of attention, increased heart rate and slight nausea may also be present.
5,000ppm +	Workplace exposure limit (as 8-hour TWA)

VOC Monitoring

In both indoor and outdoor environments, poor air quality can greatly impact our health and wellbeing. Volatile Organic Compounds (VOC) concentration in an indoor space is a key indicator for air pollution measurement

Official air quality monitoring stations provide only consolidated or averaged data for the outdoor environment without the corresponding indoor air data. They do not generate personalised information.

The Zone unit incorporates a highly sensitive VOC sensor for air pollution measurement. Gases that can be detected by the VOC sensor include: Volatile Organic Compounds (VOC) from paints (such as formaldehyde), lacquers, paint strippers, cleaning supplies, furnishings, office equipment, glues, adhesives and alcohol.

The table below illustrates the IAQ Index parameter with a description of the air quality, its impact and suggested action for that level / banding. The unit also outputs a bVOC parameter which is the total VOC's expressed as a parts per million (PPM) value instead of an index (see section 13 below for more details).

IAQ Index	Air Quality	Impact (long-term exposure)	Suggested action

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0 – 50	Excellent	Pure air; best for wellbeing	No measures needed
51 – 100	Good	No irritation or impact on wellbeing	No measures needed
101 – 150	Lightly polluted	Reduction of wellbeing possible	Ventilation suggested
151 – 200	Moderately polluted	More significant irritation possible	Increase ventilation with clean air
201 – 250[1]	Heavily polluted	Exposition might lead to effects like headache depending on type of VOC	Optimise ventilation
251 – 350	Severely polluted	More severe health issue possible if harmful VOC present	Contamination should be identified if level is reached even without the presence of people; maximise ventilation and reduce attendance
> 351	Extremely polluted	Headaches, additional neurotoxic effects possible	Contamination needs to be identified; avoid presence in room and maximise ventilation

Indoor air quality (IAQ) classification and colour coding [1]

[1] According to the guidelines issued by the German Federal Environmental Agency, exceeding 25 mg/m^3 of total VOC leads to headaches and further neurotoxic impact on health.

Compliant to the ISO16000-29 standard "Test methods for VOC detectors".

PIR Sensor Operation

The PIR Sensor incorporated within some variants of the Zone can be used to indicate occupancy status within an area.

The implementation incorporates two incrementing counters PIR_COUNT and PIR_OCC_TIME to represent the occupied/unoccupied historical profile.

The PIR has a concept of an 'inactivity timeout'. This is set to 30 seconds.

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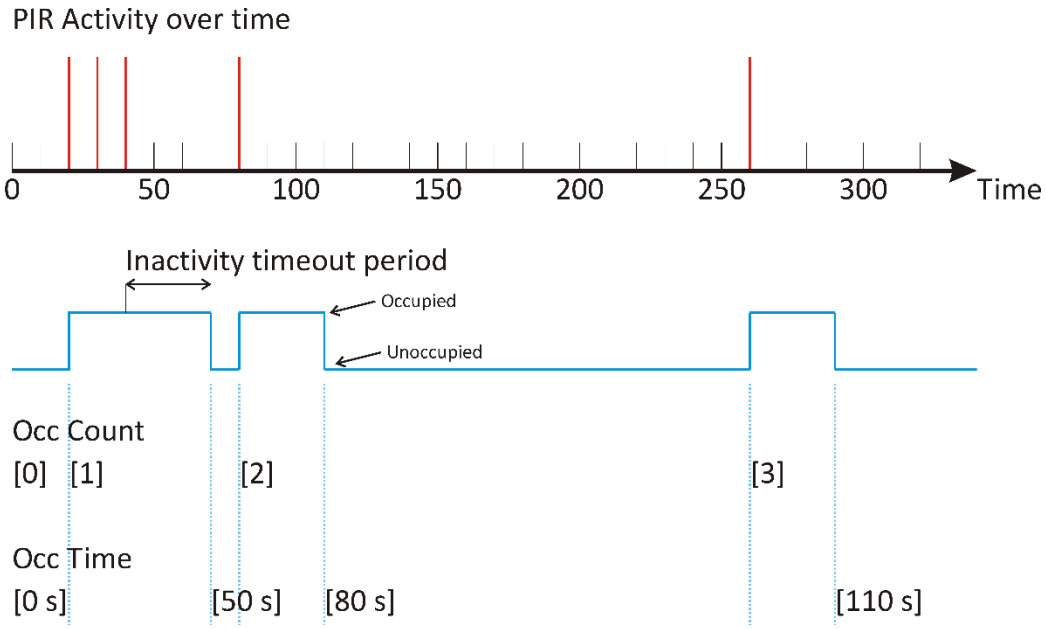
When the PIR detects movement (possibly multiple times) the internal occupancy state changes to the 'occupied' state. If the PIR does not detect any movement for a period of 30 seconds the internal state changes to 'unoccupied' (see diagram below).

The sensor has two LoRa wireless data parameters associated with the PIR operation:

- PIR_COUNT – the number of changes from the 'unoccupied' state to the 'occupied' state. This is reported in the data packet as Type 0x13 (Detection Count)
- PIR_OCC_TIME – the total time period spent in the 'occupied' state in seconds. This is reported in the data packet as Type 0x14 (Total Occupied Time).
- Each counter is implemented as a 32 bit number so the maximum PIR_COUNT is 4,294,967,295 and the PIR_OCC_TIME is over 49 thousand days. The counters are stored in non-volatile memory but can be reset via the configuration menu.



PIR data transmission interval

Depending on the Zone settings the PIR_COUNT and PIR_OCC_TIME messages will be sent at a fixed time interval or when the status changes (within constraints of the regulatory wireless duty cycle).

In some applications it is useful to receive a wireless notification when the PIR state changes without waiting for the transmit interval. This is known as "Adaptive Transmission Interval".

When set to a fixed time interval the unit will send a wireless message containing the PIR status at the set Transmit Interval.

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When set to “Adaptive” transmit interval the unit will send a wireless message containing the PIR status when the status changes with the following constraints:

- The message will be transmitted immediately providing at least the time in the **Adaptive Min Interval** has passed. So, for example if the **Adaptive Min Interval** is set to 5 mins then if the last message was sent 4 minutes ago transmission will be delayed until the 5 minutes have passed. This prevents messages being sent more frequently than the **Adaptive Min interval** setting.

- If the occupancy state does not change then a wireless message will be sent at the **Adaptive Max Interval.** This in effect acts as a heartbeat message.

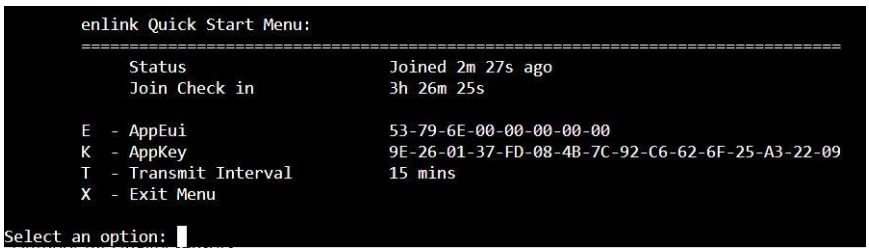
Please note that LoRa operates in unlicensed radio spectrum and therefore each device must obey regulatory duty cycle regulations. If messages are sent too frequently then the device will delay transmission to comply with the duty cycle limits.

The transmission interval is configured from within the **Quick Start** menu of the Zone unit (note that this setting is only present in models incorporating the PIR). To configure the transmit interval, follow the steps below:

Remove the Zone board from its enclosure. Take care when removing the board from the front part of the enclosure and only use the slots provided at the bottom of the board to gently lift the board up and out of the enclosure.

Connect a micro-USB cable to the unit. The device will attach to a COM port on your PC. Refer to section 5 for details on connecting to the USB menu.

From the **Main Menu**, enter **Q** to enter the **Quick Start Menu**.



Quick Start Settings Menu

Access the **Transmit Interval** setting by entering **t**.

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Transmit Interval settings

To select a fixed transmit interval select the required interval from the menu options.

To select **Adaptive Transmit Interval** select the **A** option and then change the settings for the **Adaptive Min interval** and **Adaptive Max interval** as required.

With adaptive transmit interval set, when a change of PIR status occurs a wireless message is sent immediately, however messages will not be sent more frequently than the **Adaptive Min interval.**

The **Adaptive Max interval** acts like a heartbeat, so if no change of PIR state occurs then a message is sent at the **Adaptive Max interval.**

Press **Enter** when the key is correctly entered to return to the **Quick Start Settings Menu**.

12. Battery Installation / Replacement

Zone devices use 2 x SAFT LS14500 or EVE ER14505 AA size 3.6 Volt Lithium Thionyl Chloride (LiSOCl2) batteries (non-rechargeable) or direct equivalent.

No other batteries are approved for use in the device.

Lithium Thionyl Chloride batteries have very high energy capacity and must be used and handled with care observing the guidance below.

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WARNING

Risk of death or serious injury from explosion or fire.

- Keep out of sight and reach of children.
- Fire, explosion and burn hazard - do not recharge, short circuit, crush, disassemble, incinerate.
- Due to the high terminal voltage (3.6V), they are not suitable as direct replacements for other battery technologies in the same can sizes.
- When not in use the Batteries must be stored in a non-Hazardous Area.
- Do not change batteries in an explosive gas atmosphere.
- When installing batteries, do not snag the battery terminal on the clip or the battery may be damaged. Do not apply excessive force.
- Do not drop. Dropping the battery may cause damage. If a battery is dropped, do not install the dropped battery into the unit. Dispose of dropped battery promptly per local regulations or per the battery manufacturer's recommendations.

Guidance

- Always install the batteries correctly as per instructions taking great care to observe the battery polarity.
- Ensure that the contact points are clean and conductive.
- All batteries must be the same model from the same manufacturer.
- Do not mix old and new batteries or batteries from different manufacturers.
- Do not heat or attempt to recharge the battery.
- Do not dispose of in a fire.
- Only install approved batteries: SAFT LS14500 or EVE ER14505 Lithium Thionyl Chloride AA Battery 3.6 Volt, or direct equivalent.