enLink
IAQ-Plus / IAQ-Vape
USER GUIDE

LoRaWAN Wireless Indoor Air Quality Monitor

synetica

Contents

enLink IAQ Plus / Vape User Guide

1. Introduction 4
2. Configuration 4
3. Join enLink Devices to the LoRa Network 5
4. Powering the Unit 6
5. Setting / Changing the enLink LoRa Keys 8
6. Setting / Changing the transmit Interval 11
7. Adaptive Transmit Interval 12
8. Live Menu 13
9. Configuration Menu 14
10. CO_2 Sensor Auto Calibration Configuration 15
11. CO_2 Monitoring 17
12. VOC Sensor Configuration 18
13. VOC Monitoring 19
14. Particulate Matter Sensor Configuration 20
15. Smoke / Vape Detection 20
16. Enclosure Mounting Details 22
17. LoRaWAN Payload Decoder 23
18. Technical Support 23

enLink IAQ-Plus / IAQ-Vape

LoRaWAN Wireless Indoor Air Quality Monitor

Synetica's enLink IAQ-Plus / IAQ-Vape indoor air quality monitor measures key environmental parameters continuously and in real time with the exacting accuracy required for projects wishing to adhere to WELL® and RESET ® building standards. This advanced system monitors ultra-fine particulate matter (PM0.1) which are responsible for up to 90% of indoor airborne particles.

Designed and manufactured in the UK, the enLink IAQ-Plus / IAQ-Vape allows for easy visualization and analysis of air quality data including temperature, relative humidity, particulate matter, CO_2, Ozone, CH_2O, CO, NO_2, H_2S, SO_2, O_2, volatile organic compounds, barometric pressure and sound levels.

The enLink IAQ-Plus / IAQ-Vape can be externally powered from 12-24V DC or via a PoE splitter ensuring flexible installation options. Data is transmitted up to 16km using LoRaWAN long-range wireless with building, interior penetration of 1-2km without repeaters.

enLink IAQ-Plus / IAQ-Vape:

- Satisfies the accuracy and range requirements for IWBI WELL v2 standard
- Vaping / cigarette detection function
- Built in sensors and options for:
  - Temperature (°C)
  - Humidity (%RH)
  - Barometric Pressure (Pa)
  - Volatile Organic Compounds (VOC's)
  - Carbon Dioxide (CO_2)
  - Particles PM0.1, 0.3, 0.5 1, 2.5, 5, 10
  - Ozone (O_3)*
  - Sound (dB)*
  - One additional gas from CO, NO_2, H_2S, SO_2, O_2, HCHO (Formaldehyde)

Features

- Multiple sensor options*
- LoRa long range wireless
- Frequency range 863-870MHz*
- Frequency range 902-928MHz*
- Up to +18dBm Tx power
- Built in USB port for configuration
- Externally powered 12-24V DC
- UKCA, CE, FCC, RoHS compliant
- Made in the UK
- Works with WELL Licensed

**Option / model dependent*

1. Introduction

enLink IAQ-Plus / IAQ-Vape accurately measures up to nine key indoor air quality parameters with class leading accuracy.

Available with temperature, relative humidity, CO_2, Ozone, CH_2O, CO, NO_2, H_2S, SO_2 , O_2, VOC's, barometric pressure and sound level sensors, the IAQ Plus / Vape+ has an advanced particle sensor which measures and categorises all particles across the range of PM0.1 to PM10+.

In addition, the unit identifies the presence of vaping and cigarette smoke and distinguishes between them by classifying the particles. Alerts can be sent immediately upon detection of vaping or cigarette smoke. The smoke / vape function requires continuous operation of the sensors and therefore the unit must be externally powered from 12- 24V DC. A Power over Ethernet adapter is available for installations which have this facility.

These sensors meet all of the requirements for WELL® and RESET® air quality monitoring. Data is transmitted via long range LoRaWAN wireless for remote analysis.

---

2. Configuration

LoRa devices can be configured using OTAA (Over-the-Air-Activation) or ABP (Activation-by-Personalisation).

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

ABP allows you to set the DevAddr as well as the security keys in the module. This is simpler than OTAA as there is no join procedure, however, it is less secure than OTAA.

This guide will illustrate using OTAA as it is the most secure and flexible method.

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.*

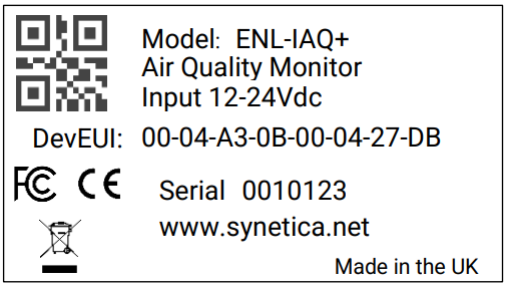
The LoRaWAN keys will be supplied in a seperate file for bulk upload to your LoRa Newtwork Server such as Chirpstack, Loriot TTN etc.

For many applications Synetica can supply enLink IAQ-Plus / IA-Vape units with the above parameters pre-configured, so providing the LoRa gateway has the matching keys the join process will happen automatically once the 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 enLink Devices to the LoRa Network

enLink devices in wireless range and with the correct AppEUI and AppKey settings will automatically join the LoRa network when they are first powered up.



enLink IAQ-Plus / IAQ-Vape Unit Label

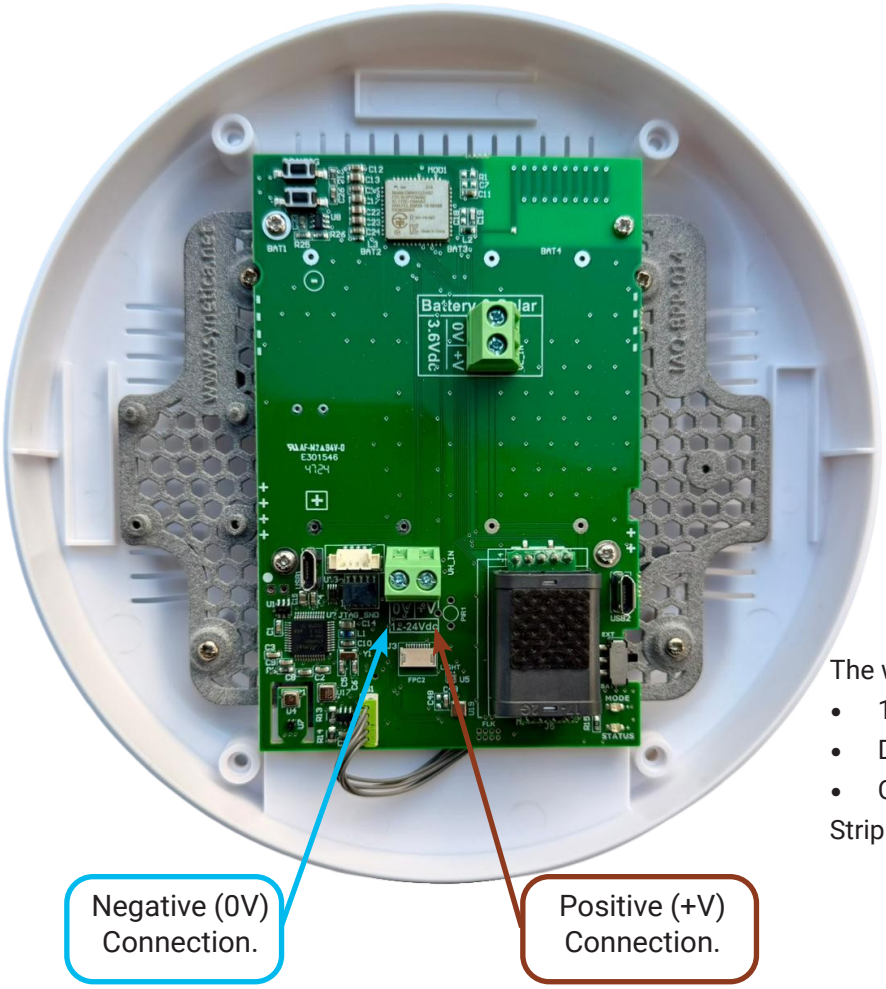
The unique DevEUI is printed on all enLink devices and is also present in the QR code. The DevEUI can be used to identify the device once joined to the network.

4. Powering the Unit

The unit is externally powered from a PSU with 12V to 24V DC (rated 200mA or greater). Insert the power cable through the cable entry point as shown below.

enLink IAQ-Plus / IAQ-Vape Cable Entry Point

The enclosure moulding will guide the cable through the enclosure. Route the cable through to the screw connector as shown below. Move the power switch to the BATT position, then connect the power cable to the unit, carefully observing the polarity shown. Power is supplied to the unit via a 2-pole screw connector.



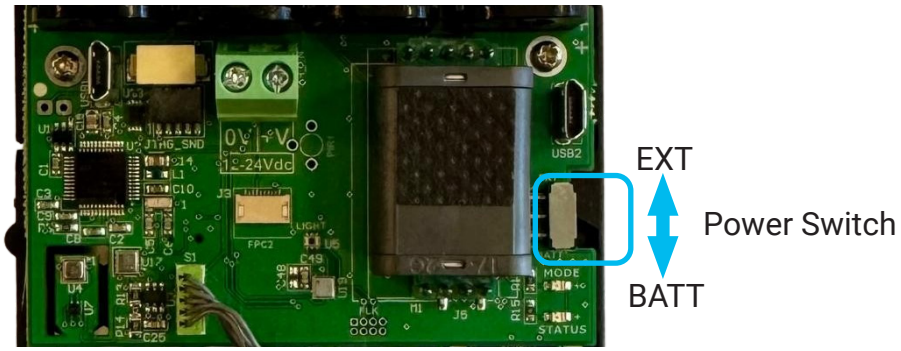
enLink IAQ-Plus / IAQ-Vape External Power Connection

The wire size should be:

- 12 – 22 AWG
- Diameter: 2mm – 0.6mm
- CSA: 3.3mm^2 – 0.32mm^2

Strip the wire to expose 5mm of conductor.

Once complete, move the power switch to the EXT position for external power as shown below. The unit will power up and attempt to join the LoRaWAN network.



enLink IAQ Plus/Vape Power Switch. Select EXT Position

Once powered ON, the enLink device will send a join request message to the gateway. The Status LED will blink RED 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.

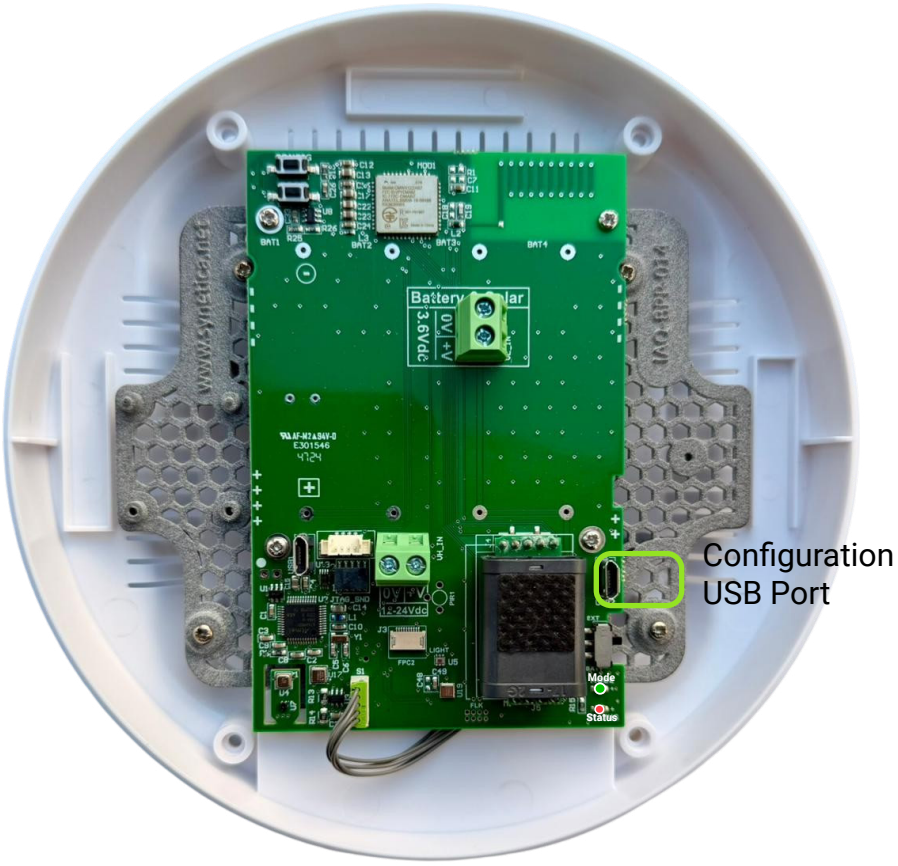
When the device has successfully joined the network the Mode LED will blink GREEN for several seconds to show that the join has been completed. The LED's will then switch off.

5. Setting / Changing the enLink LoRa Keys

For many applications, Synetica can supply enLink IAQ Plus / Vape units with the LoRa AppEUI and AppKey parameters preconfigured to your requirements, whereby if the LoRa gateway has matching keys the join process will happen automatically once the unit is in wireless range and powered 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.

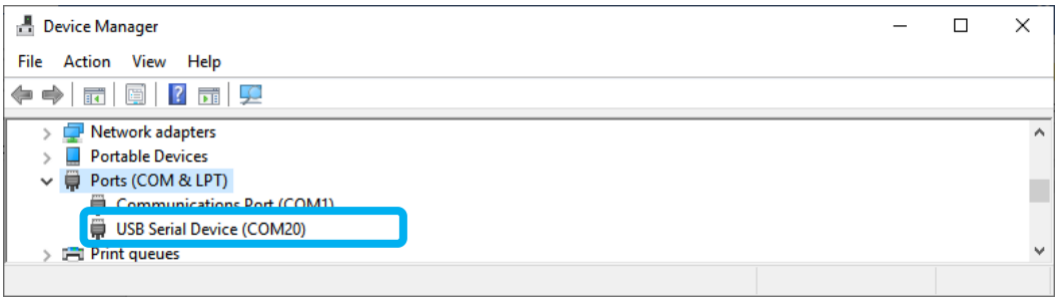
Once the cover is removed, connect a micro USB cable to the enLink unit. There are two USB connectors on the unit, so be sure to connect to the correct USB port as shown in the image below. The device will attach to a COM port on your PC.



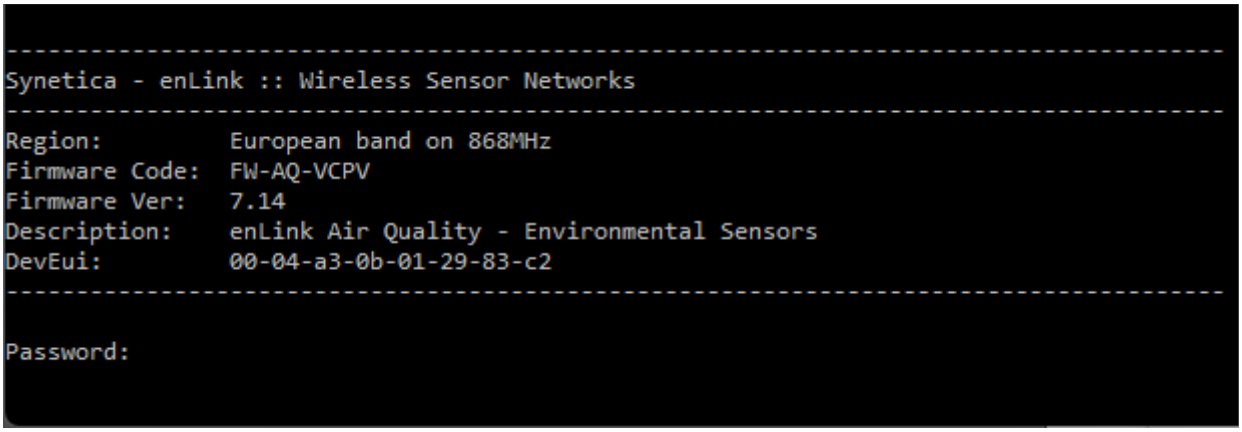
Using a terminal program (e.g. Teraterm https://github.com/TeraTermProject/teraterm/releases) connect to the COM Port used by the enLink device.

See Synetica document “Configuring enLink Devices Using Serial Terminal Applications” for more details including using PuTTY and serial applications that will operate on Apple and Linux computers.

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 click Device Manager on the menu.) Expand the Ports (Com & LPT) menu as shown below.

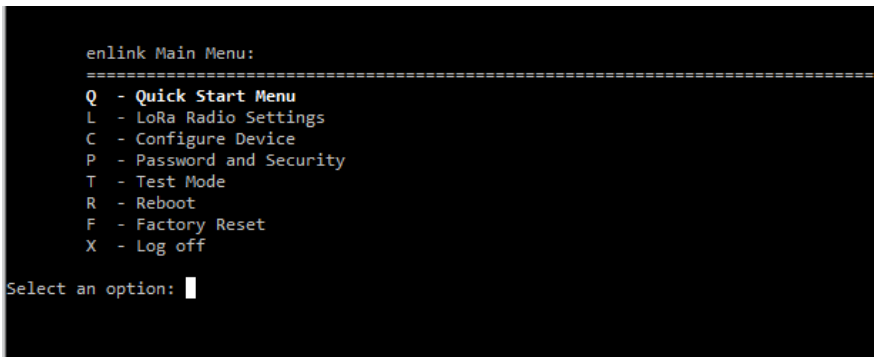


In your terminal program press the **Enter key**. An enLink summary screen will appear as shown below. The default password is the last four digits of the displayed DevEUI, in the screen below this is 83C2.



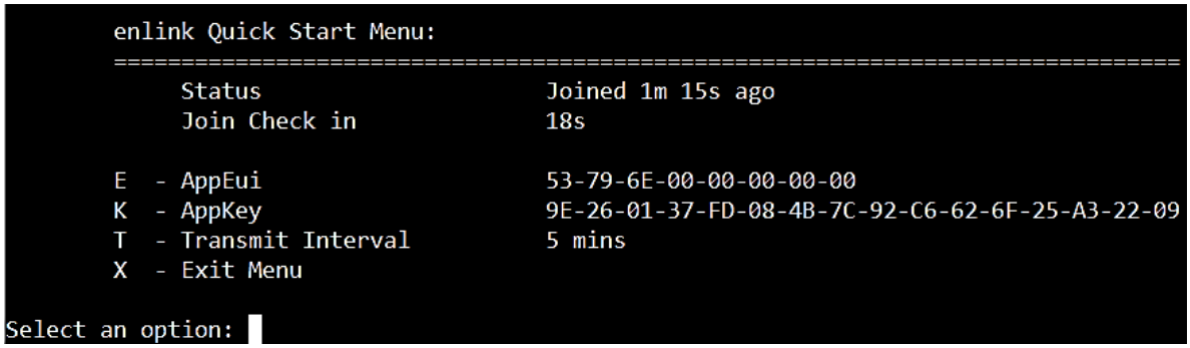
enLink Logon Screen

The screen below will show with the enLink Main Menu options. Enter **Q** to enter the **Quick Start Menu.**



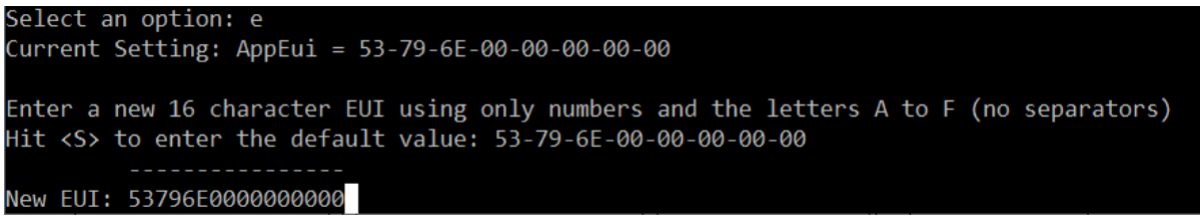
enLink Main Menu

The **Quick Start Menu** contains only the parameters that normally need to be configured to setup the device and join the LoRa network. From the Quick Start Menu you can change the **AppEUI** and **AppKey.**



Quick Start Settings Menu

From the **Quick Start Settings Menu,** access the **AppEUI** setting by entering **E.** Enter the 16 character **AppEUI** using numbers and letters A to F. Do not include spaces or any other characters. Pressing **S** will enter the default **AppEUI** which you can then edit. Press **Enter** when the key is correctly entered to return to the **Quick Start Settings Menu.**



AppEUI Setting

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**.

```
Select an option: k
Current Setting: AppKey = 9E-26-01-37-FD-08-4B-7C-92-C6-62-6F-25-A3-22-09

Enter a new 32 character EUI using only numbers and the letters A to F (no separators)
Hit <S> to enter the default value: 9E-26-01-37-FD-08-4B-7C-92-C6-62-6F-25-A3-22-09
        ------------------------------
New EUI: 9E260137FD084B7C92C6626F25A32209
```

AppKey Setting

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

The header will show **** Reboot Required **** as shown below. The new key settings will not take effect until the enLink 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.

```
enLink Main Menu:   ** Reboot Required **
=========================================================================
Q - Quick Start Menu
L - LoRa Radio Settings
C - Configure Device
P - Password and Security
T - Test Mode
R - Reboot
X - Exit and log off

Enter Selection:
```

Reboot Required Notification

6. Setting / Changing the transmit Interval

Access the Transmit Interval setting by entering T from the quick start menu.

```
Transmit Interval:   ** Reboot Required **
=========================================================================
1  - 30 s
2  - 1 min  <==
3  - 2 mins
4  - 5 mins
5  - 10 mins
6  - 15 mins
7  - 20 mins
8  - 30 mins
9  - 60 mins
10 - 2 hours
11 - 3 hours

Enter Selection:
```

Transmit Interval Settings

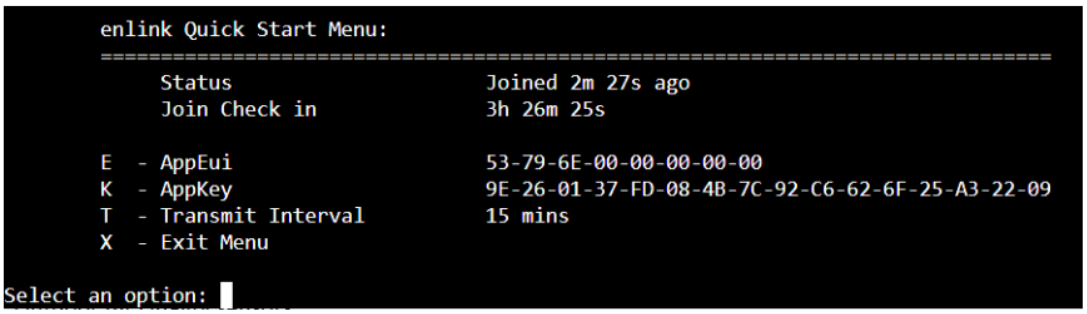
Select a fixed transmit interval from the menu options. The Transmission Interval may also be changed by using a LoRaWAN downlink message. See https://github.com/synetica/enlink-decoder?tab=readme-ov-file#downlink-message-index-tables for more details and example downlink messages. **Press Enter** when the interval is correctly set to return to the **Quick Start Settings Menu**.

7. Adaptive Transmit Interval

Adaptive Transmit Interval (ATI) is a function which dynamically changes the LoRa message transmit frequency based on events. It is useful where notification of events such as the detection of smoke / vaping is requited in as short a time frame as possible.

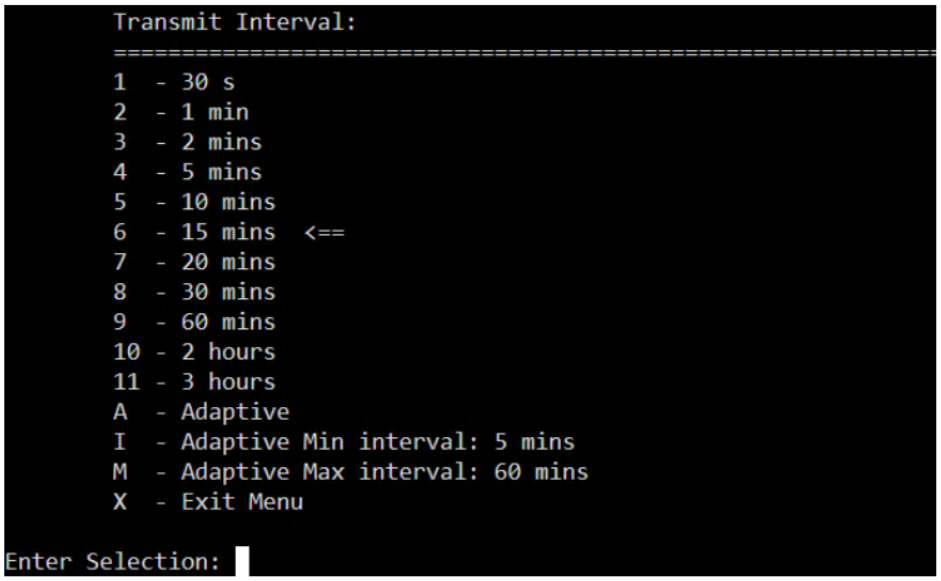
To set adaptive transmit mode, follow the steps below:

Enter **Q** to enter the **Quick Start Menu.**



Quick Start Settings Menu

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



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.

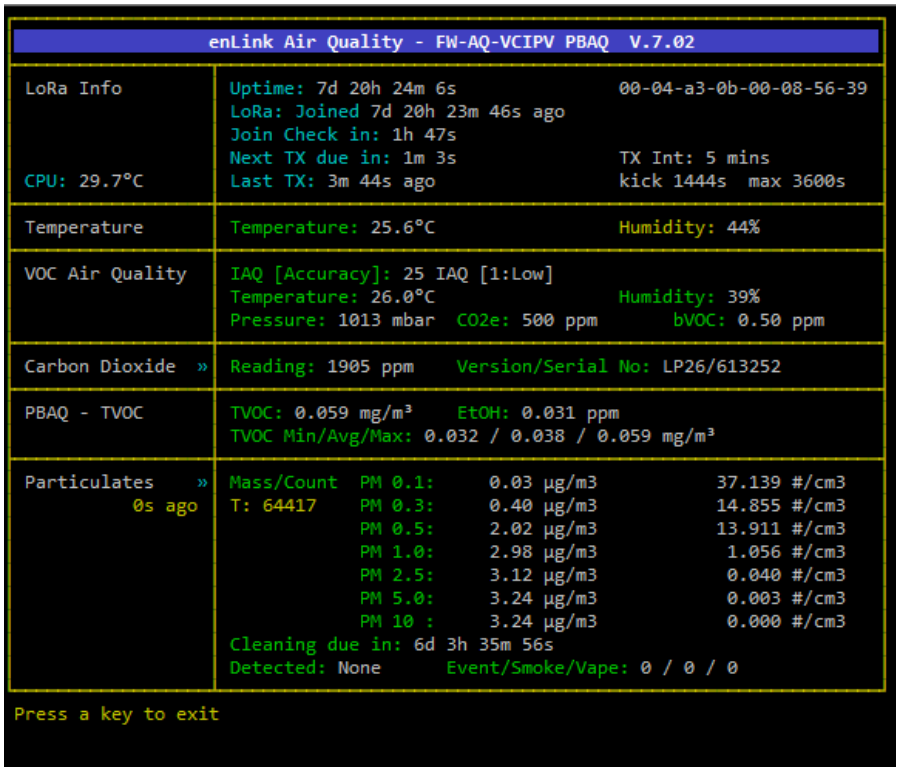
With adaptive transmit interval set, when a vaping event occurs a wireless message is sent immediately (if regulatory duty cycle restrictions allow), however messages will not be sent more frequently than the **Adaptive Min interval**. The **Adaptive Max interval** acts like a heartbeat, so if no event occurs then a message is sent at the **Adaptive Max interval**.

Press **X** to return to the **Quick Start Settings Menu**.

The Transmission Interval may also be changed by using a LoRaWAN downlink message. See "https://github.com/synetica/enlink-decoder?tab=readme-ov-file#downlink-message-index-tables" for more details and example downlink messages.

8. Live Menu

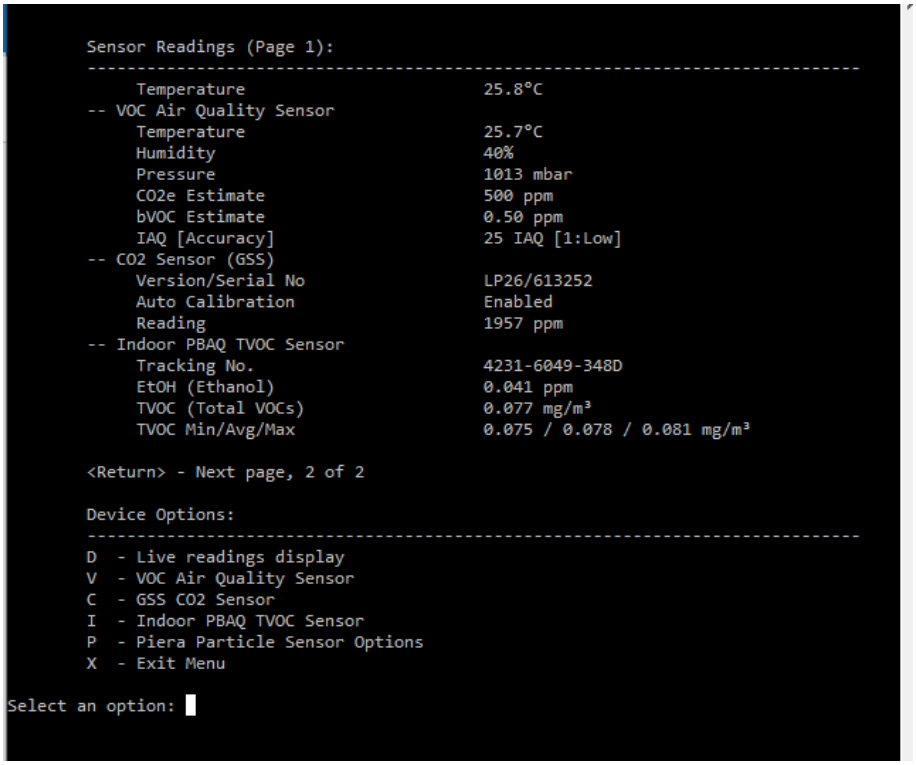
enLink IAQ-Plus / IAQ-Vape incorporates a live data screen which shows all readings and device status for easy data validation. To enter the Live status screen, from the **Main Menu** enter **C** for Configure Device followed by **D** for Live Readings display. A screen similar to the one below will show. The sensors will vary according to the enLink IAQ-Plus / IAQ-Vape model and the installed sensors.



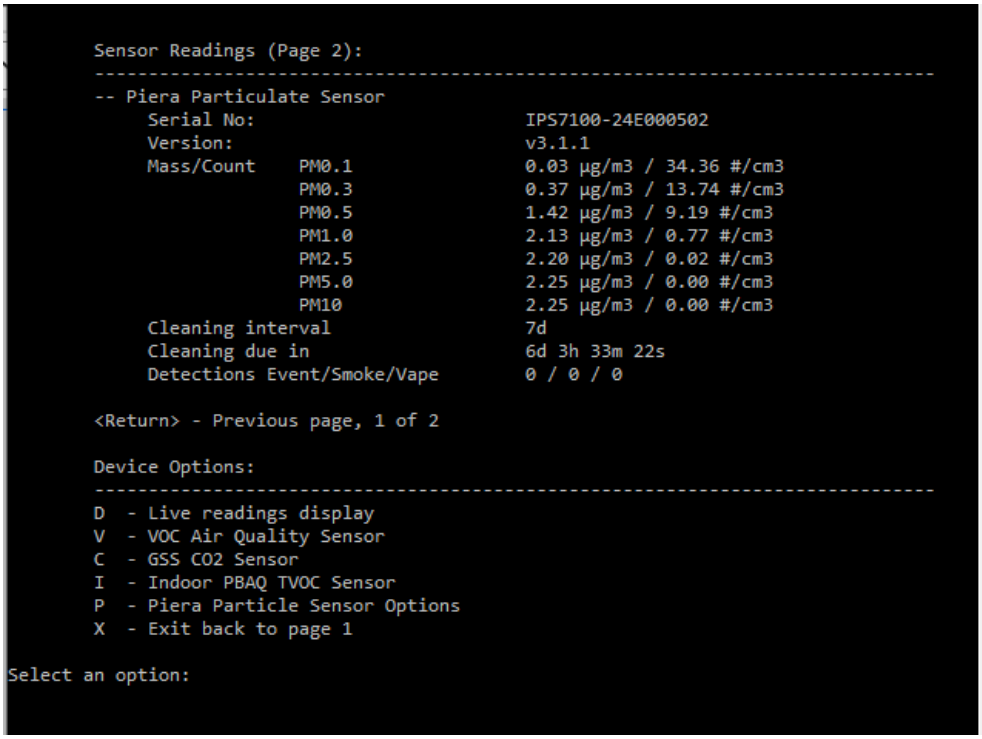
Live Display

9. Configuration Menu

The enLink IAQ-Plus / IAQ-Vape 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** from the main menu. A screen similar to the one below will show. The exact parameters shown will vary according to the model and sensors fitted.

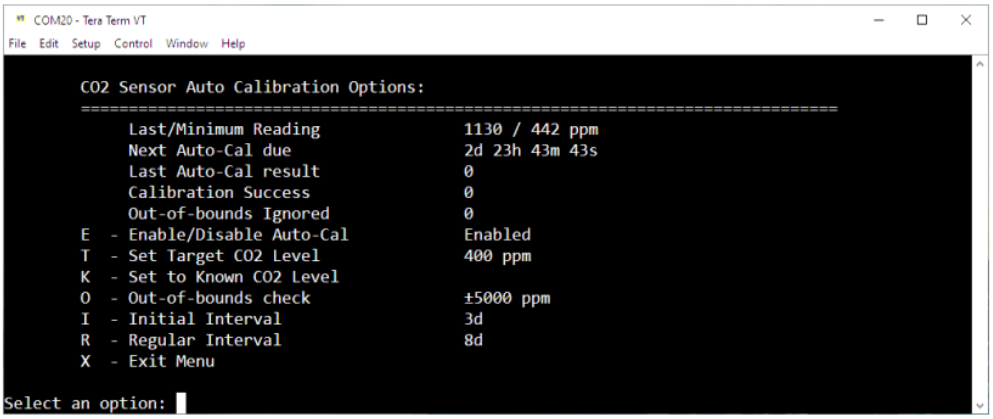


Page 1. Press the Enter (Return) Key to Show Page 2.



10. CO_2 Sensor Auto Calibration Configuration

To view and set CO_2 sensor calibration information, enter **C** and the screen below will show.



Please see the table below for information on each menu item.

Menu Item	Description Details
Last/Minimum Reading	Shows the last CO_2 value read and the minimum CO_2 value read since the last auto calibration.
Next Auto-Cal due	Shows when the next auto-calibration routine will occur
Last Auto-Cal result	Shows the value of the last auto calibration result. Used internally by the sensor.
Calibration Success	This shows the total number of successful auto calibrations since the device was powered up.
Out-of-bounds Ignored	Shows the number of times that auto calibration did not run due to the Out Of Bounds setting.
E - Enable/Disable Auto-Cal	Enables or disables the auto calibration routine.
T - Set Target CO_2 Level	This is the known CO_2 corresponding to the minimum value the sensor has read since power-up or last calibration. It is normally 'fresh air' or the lowest level when the building is unoccupied overnight or at weekends. Typically this is 400 ~ 450 ppm.
K - Set to Known CO_2 Level	This will re-calibrate the zero point of the sensor to a known gas concentration. The sensor should be placed in this gas concentration and allowed to stabilise. This command runs in the background and will take 8 to 10 seconds to complete. As an example, fresh air is typically around 400 ~ 450 ppm.
O - Out-of-bounds check	The Out-of-bounds value is used to ignore the calibration if the minimum value the sensor has read is not within a sensible range of the target concentration level. So, if the target concentration level is 400, the Out-of-bounds value is ±50 and the minimum reading is 451 (or more), the calibration routine is ignored.
I - Initial Interval	It is possible for the first auto-calibration to take place more quickly than the regular auto-calibration events. This can be useful to stabilise the readings quickly after installation.
R - Regular Interval	This is the standard calibration interval, it is set to 8 days by default to accommodate a week long period where the minimum sensed CO_2 level should have fallen to background levels.

Many of the above parameters can also be set via LoRaWAN downlink message.

See https://github.com/synetica/enlink-decoder?tab=readme-ov-file#carbon-dioxide-sensor-downlinks for more details.

The CO_2 sensor needs to be exposed to fresh, clean air periodically for the auto calibration to be successful. Most occupied areas are unoccupied for some time during a week-long period, typically at night, or at the weekend and therefore the auto calibration runs every 8 days by default. Background CO_2 levels are typically around 400-450 ppm, if the background CO_2 level is known to be a different value then this can be set in the “Set Target CO_2 Level” parameter

If a unit is placed in an area where the CO_2 level may not fall below a certain level, e.g. 450ppm, during the calibration interval then the “Out-of-bounds check” parameter can be set so that the auto calibration routine does not run. As an example, if an area is 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 auto-calibration routine based on a target of 400ppm. In this case, if the “Set Target CO_2 Level” is set to 400ppm and the “Out-of-bounds check” value is set to +/-50 ppm then the auto-calibration routine will not run unless the minimum read value falls below 451ppm in the interval.

11. CO_2 Monitoring

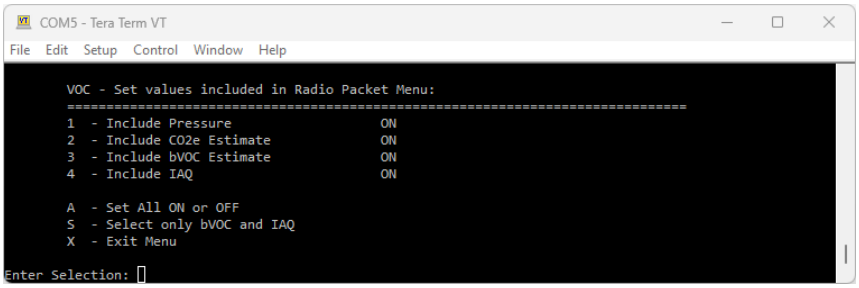
Measuring CO_2 levels can serve as a good indicator of the indoor air quality. CO_2 concentrations within a building are often used to indicate whether adequate fresh air is being supplied to the space. Indoor CO_2 concentration is directly proportional to the number of people in a building and the ability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

CO2 concentration	Remarks / Effect
400ppm	Normal CO_2 concentration in outdoor ambient air
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)

12. VOC Sensor Configuration

To view and set the VOC sensor configuration, enter **V** from the Configuration menu and the screen below will show.



The VOC configuration settings allow you to select which VOC sensor values are included in the LoRa data packet. By default, all parameters are transmitted, these can be turned off to reduce the amount of information transmitted or to avoid sending data which is not required by the application. All parameters can be toggled on or off from the menu.

The above parameters can also be set via LoRaWAN downlink message.

See https://github.com/synetica/enlink-decoder?tab=readme-ov-file#voc-sensor-downlinks for more details.

Menu Item	Description Details
Include Pressure	The VOC sensor includes an accurate barometric pressure sensor. Barometric pressure data can be integrated into HVAC (heating, ventilation, and air conditioning) systems to optimize air flow and pressure, improving energy efficiency and indoor air quality.
Include CO2e Estimate	The VOC sensor can provide a CO2 estimate. By using the IAQ index and other environmental data (like temperature, humidity, and pressure), the sensor estimates the equivalent CO2 (eCO2) levels. The estimation algorithm is designed to approximate the indoor CO2 levels that would be expected given the measured VOCs. Note that CO2e is not a CO2 measurement and should not be used where the unit is fitted with a CO2 sensor.
Include bVOC estimate	bVOC refers to the concentration of VOCs detected by the sensor, providing a baseline measure of indoor air quality. It represents the aggregated level of VOCs present in the environment, which is used to assess overall air quality. The bVOC reading is the same as the IAQ value expressed as parts per million (ppm) instead of as an Index.
Include IAQ	The VOC sensor provides an Indoor Air Quality (IAQ) index, which is a numerical value representing the overall quality of the indoor air. This index is calculated based on the concentrations of volatile organic compounds (VOCs) detected by the sensor, along with other environmental factors such as temperature, humidity, and pressure. The IAQ index ranges from 0 to 500, with lower values indicating better air quality and higher values indicating poorer air quality. Here's a general interpretation of the IAQ index values: 0-50: Excellent air quality 51-100: Good air quality 101-150: Lightly polluted (acceptable) 151-200: Moderately polluted (somewhat unhealthy) 201-300: Heavily polluted (unhealthy) 301-500: Severely polluted (very unhealthy to hazardous)

13. VOC Monitoring

In both indoor and outdoor environments, poor air quality can greatly impact our health and well-being. Volatile Organic Compounds (VOCs) 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 enLink IAQ unit incorporates a highly sensitive VOC sensor for air pollution measurement. Gases that can be detected by the VOC sensor include: Volatile Organic Compounds (VOCs) 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 VOCs expressed as a parts per million (PPM) value instead of an index (see section 12 above for more details).

IAQ Index	Air Quality	Impact (long-term exposure)	Suggested action
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/m3 of total VOC leads to headaches and further neurotoxic impact on health.

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

14. Particulate Matter Sensor Configuration

To view and set particulate sensor information, enter **P** and the screen below will show.

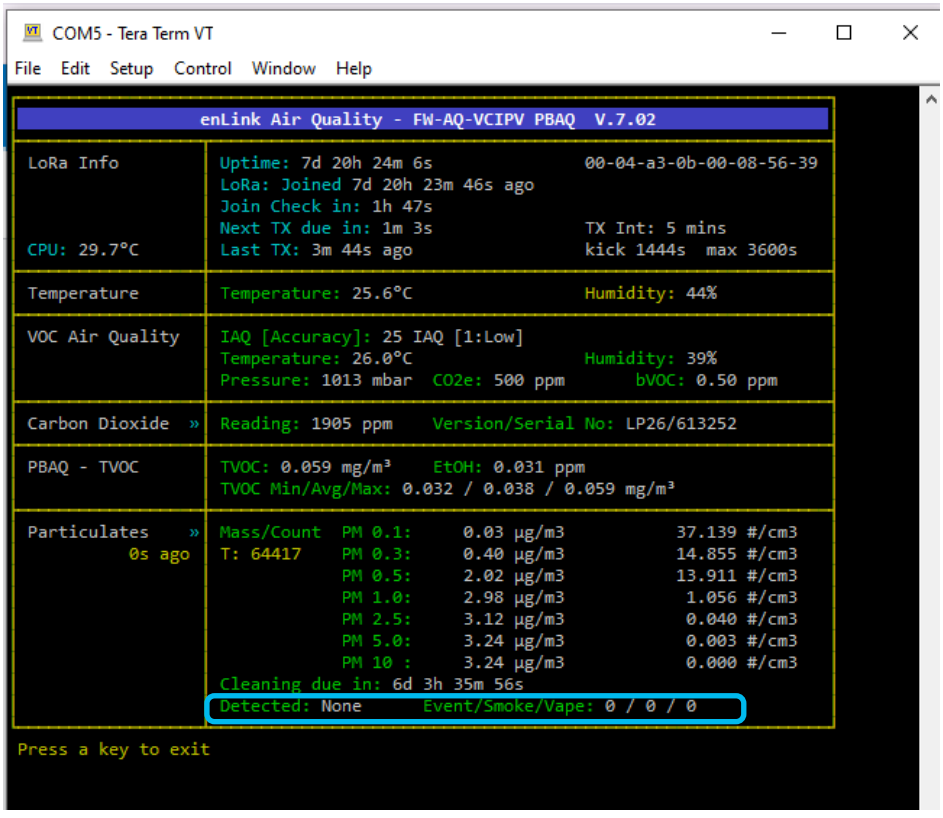
```
Select an option: p

        Piera Particulate Sensor:
        ================================================================================
        C   - Cleaning interval                 7d
        R   - Set values included in Radio Packet
        X   - Exit Menu

Enter Selection:
```

The particulate sensor has a self-cleaning function which runs the fan at high speed to clean away any dust build up in the measurement chamber. By default, this cleaning cycle operates every 7 days but may be changed if required.

---

15. Smoke / Vape Detection

The IAQ-Vape unit has a smoke and vaping detection function which can detect and distinguish between cigarette smoke and vape. When the particle signature for either vape or cigarette smoke is detected an event flag is raised. The particle signature is then processed further to establish if it is cigarette smoke of vape that has caused the event.



Smoke / Vape Detection

The unit transmits three messages to report the smoke / vaping status:

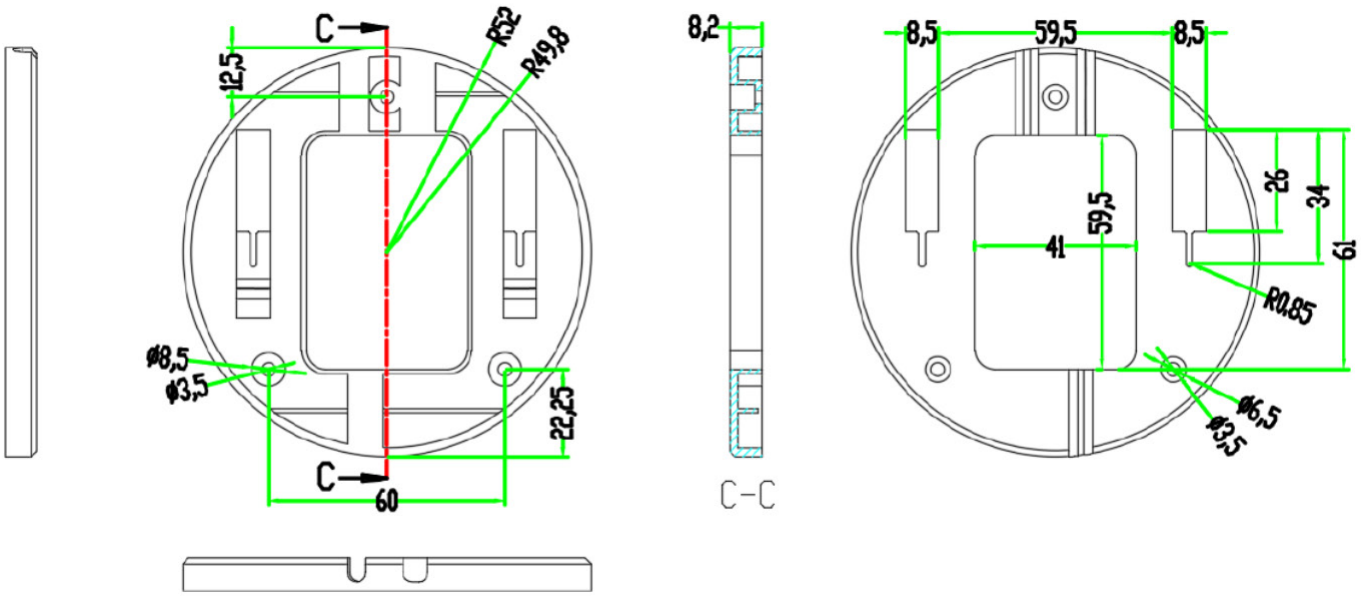
- Event count (type 0x70): the number of smoke / vaping event detected (the event could be vape or smoke).
- Smoke count (type 0x71): the number of smoke events detected.
- Vape count (type 0x72): the number of vaping events detected.

The smoke / vape detection should be used with the Adaptive Transmission function to allow detection events to be transmitted when detected. See section 7 for more details.

Refer to section 17 for details on the LoRa messages and decoding.

16. Enclosure Mounting Details

The IAQ-Plus / IAQ-Vape enclosure has an overall diameter of 168mm and depth of 47mm. The weight is approximately 300g.



Mounting Bracket

The IAQ-Plus / IAQ-Vape can be wall or ceiling mounted. A mounting bracket is provided with three mounting screw locations, the hole diameter is 3.5mm with a 6.5mm recess.

Fix the mounting bracket to the wall or ceiling using suitable fixings and then slide the unit onto the bracket.

When wall mounted, it is important that the unit has the recessed vent pointing down towards the floor to prevent dust build-up in the particle sensor. When the bracket is mounted with the orientation shown above the vent will be positioned correctly facing towards the floor.

17. LoRaWAN Payload Decoder

The latest LoRaWAN payload decoders and guides are available on the Synetica GitHub repository:

https://github.com/synetica/enlink-decoder

A live payload decoder which allows you to paste LoRa payloads in Hexadecimal or Base 64 and see the correctly decoded results can be found at the link below:

https://synetica.github.io/enlink-decoder/

18. Technical Support

For technical assistance, please visit the downloads section of our web site at www.synetica.net or email us at support@synetica.net

About us

Synetica was established in 2008 with the simple idea to revolutionise air quality monitoring, energy usage and remote asset monitoring. Our global customer base relies on our expertise to help them reduce emissions and clean up the air they breathe by allowing them to monitor their energy usage and key environmental parameters via the touch of a button.

www.synetica.net

T: **+44 (0)1785 818919** E: **enlink@synetica.net**

Synetica Limited, Hilton House, 40 High Street, Stone, Staffordshire. ST15 8AU UK

Rev 2.1