NosmoTech Ltd.

BuiltAir© Net

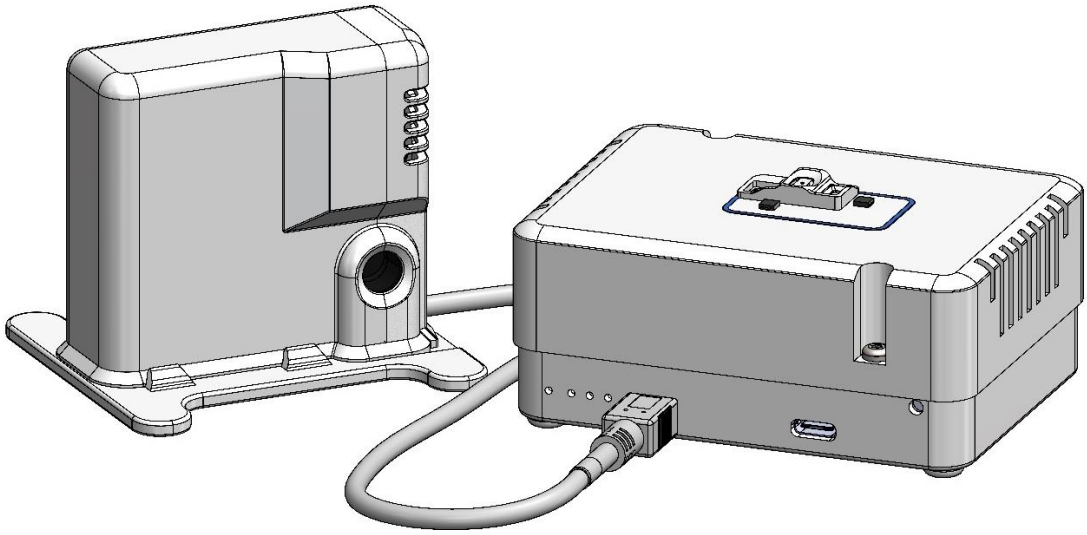
IAQ/IEQ Wireless Network

with

BuiltAir© Loggers

User Manual

May 2025 v2.1.1



SAFETY PREAUTIONS

These safety rules and instructions must be followed for product safety, to avoid personal injury and damage to the Logger and other devices, and to maintain NosmoTech's warranty. Please read carefully and observe these rules and instructions.

SAFETY INSTRUCTIONS

Follow the instructions in this User Manual

- Always use the BuiltAir system correctly. Show respect.
- Do not operate the BuiltAir System outside of the parameters specified in the Specifications (Section 9).
- The devices can be cleaned with a dry cloth. The cases can be wiped with a damp cloth but avoid touching the top sensors on the Logger.

Locating the System

- The BuiltAir System must not be used in ATEX/ IECEx/UL hazardous zones.
- Do not use the System next to explosive gases, vapors, or dust.
- Do not allow water droplets to form on the Logger, Border Router or PM.
- Do not allow water or water vapor to contact the airspeed sensors on top PCB.
- Do not expose the devices to hot or cold temperatures or high humidities outside of the stated ranges specified in the Specifications (Section 9).
- It is recommended to keep the Logger horizontal, although it will function if resting on its side. The Logger is not designed for wall mounting.
- Do not use or store any BuiltAir device near or with any solvents or acids
- Do not block the ventilation slots in the side or the sensors on the top of the Logger

Electrical Safety

- Do not abuse the PM cable or any USB cables Keep cables away from heat, water/ oil and sharp edges
- Use only recommended brands of 21700 Lithium batteries in the Logger. The integral battery does not need any maintenance.
- Only use an appropriate AC Charger with current capability as specified (Section 9).
- Do not use the Logger if it is damaged or operates abnormally.

Good Practice

- Establish a calibration and maintenance schedule that matches your usage.
- If you unscrew the Logger or PM, do not over-tighten when refitting screws.
- This device is an analytical instrument, capable of providing high quality data when used properly by competent users. NosmoTech is not responsible for any possible accidents during its use.

ELECTROMAGNETIC AND ESD COMPATIBLITY

- Complies with EN61326-1
- In extreme cases or abnormal applications, Electrostatic Discharge may cause immediate damage to the BuiltAir System electronics.

BATTERY DISPOSAL & RECYCLING

Take faulty/depleted batteries to proper collection/ recycling centres.

Dispose of batteries, Logger and devices according to statutory regulations. Do not dispose of with regular household items. After the System's useful life, please return to your local authorized distributor or send back to NosmoTech. We will dispose of them properly.

Content

Introduction

Thank you for buying the NetBuiltAir Net system for monitoring indoor air quality and thermal comfort.

This User Manual applies to *BulitAir Loggers* with Serial Numbers IEQ-A2xxxx (The serial number is on the back of the Logger). If the serial number of your Logger is IEQ-A1xxx then contact NosmoTech for the appropriate User Manual.

The quantity of parts depends on your order but for example, if you have a system with two Loggers, then you should have received:

ITEM	QTY	NOTES
IEQ Logger	2	Sensors, memory, battery, wireless comms, microprocessors
Border Router (BR)	1	Connects the Loggers via Thread to the Cloud via WiFi
Particle Monitor (PM)	2	Plugs into the Logger for power and data transfer
Particle Monitor Plate	2	Slide the PM onto this plate to ensure it remains upright
Logger Reset Tool	1	Push the Reset Button for ON/OFF and Shipping Mode
USB cable	1	1 meter USB-A to -C cable for Border Router power

You must provide 5 VDC power to the Border Router and each Logger (>250 mA). Phone AC adaptors or power banks that can charge phones and earpods are adequate.

BuiltAir IEQ Logger

The Logger records data from its sensors and sends the data up to the Cloud for calibration, data processing and storage. The data is transmitted wirelessly using the Border Router to the *BuiltAir Cloud*. You can also datalog offline and use the USB port to download data to a computer and then upload it to the cloud using the *BuiltAir App*.

BuiltAir Particle Monitor (PM)

The Particle monitor measures PM_1, $PM_{2.5}$ and PM_{10}, as well as particle numbers (PNC). It plugs into the Mini-USB socket on the Logger. The PM is remotely connected by cable to avoid generating heat inside the Logger. The Logger can run without the PM and this will extend it's battery life. The PM is powered by the Logger and does not need a separate power supply. A baseplate can be fitted to ensure stability- the PM operates best when used vertically.

BuiltAir Border Router (BR)

The Border Router forms the wireless Open Thread network that is used to transmit data from the Loggers to the Border Router. The Border Router can then forward this data to the BuiltAir Cloud via your local WiFi. As part of setting up your network, you will need to give your WiFi credentials to the Border Router.
See the Section 2 for more information.

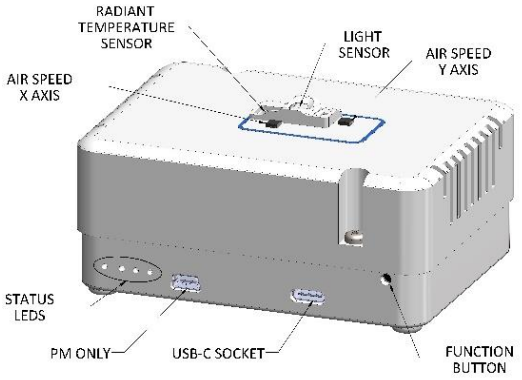
BuiltAir USB Utility App

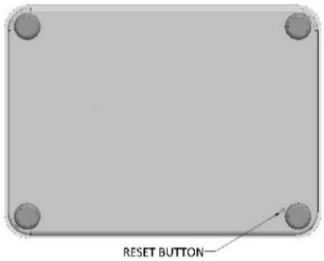
This App will download the data stored in the Logger as a .csv file. Both IOS and Windows versions of the App are available on the *BuiltAir Cloud*. You can either use the uncompensated data directly, or ask the *BuiltAir Cloud* to upload the file from your PC to calibrate, scale, store, and then download as a compensated .csv file. See section

t_rad_c	rh_amb	pressure_hpa	CO2_ppm
24.94	47.4	998.26	694
24.96	47.4	998.27	703
25	47.5	998.28	714
24.92	47.4	998.24	699
24.99	47.5	998.27	733
24.95	47.4	998.25	711

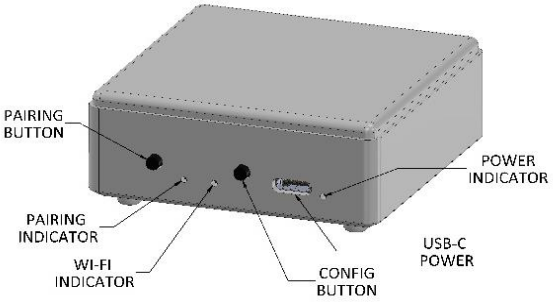
BuiltAir Cloud

The BuiltAir Cloud processes and stores the data sent by the Loggers via the network. Data downloaded through the *BuiltAir App* can also be uploaded direct to the Cloud for processing and storage. The Cloud includes a GUI to view the current status of your loggers, change their settings, download data and analyse results.



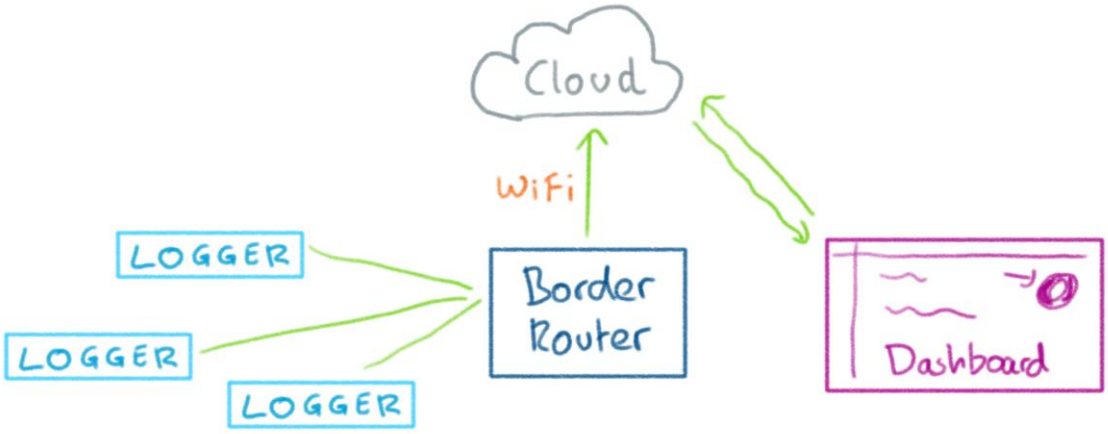


Builtair Logger



Border Router

Interior of BuiltAir logger



BuiltAir IEQ Logger

The *BuiltAir IEQ Logger* can operate in two modes, depending on your application:
Offline Mode: The Logger stores up to 500,000 records with its onboard memory. Wireless communication is switched Off to save power. Power can also be provided through the USB-C socket for long term data logging. Data is downloaded to a PC through the USB socket using the *USB Utility App*. Downloading the complete memory (500,000 records) takes about 6 minutes and data can them be uploaded from your PC to the *BuiltAir Cloud* with the *BuiltAir Cloud* providing compensation and data storage, then downloaded as compensated data to your Windows or IOS PC as a .csv file. You will need to install the *USB Utility App.*

Network Mode: Loggers can operate as a time-synchronised mesh network with up to ten Loggers, using *OpenThread* for wireless communication. A Border Router (Thread-to-WiFi Gateway) connects the Loggers in a mesh topology and transmits data to the *BuiltAir Cloud*. Networked Loggers can be either battery powered or AC powered: *Thread* is a very low power system, used in Alexa and Hey Google for Smart Homes. Readings are transmitted through the Border Router to the Cloud and they are recorded in the Logger; the latest data can be checked at any time with your PC when connected to the *BuiltAir Cloud.*

Unique features include (patented) *FastLog* for capturing transients, synchronised timed logging across the network, user defined flexible logging parameters, continuous system health monitoring, multichannel/ multilogger data analysis, calculated thermal comfort parameters and Min/Max/Avg with all measurements. Best accuracy and data quality from any LCS indoor logger and easy session/ network setup complete the list.

Radiant temperature, light and the two airspeed sensors are located on the top PCB so that they are exposed directly to the ambient air. Be careful to not damage or spill liquids and Do Not Touch. If debris collects on these sensors, then use a vacuum cleaner to remove particles. The ventilation slots on the side of the Logger allow gas access to the other sensors, so keep the vent slots clear.
Do not place the Logger near a heat source for best data quality and beware of theft.

Border Router (BR)

The Border Router is the Gateway between the *BuiltAir Cloud* using WiFi and the wireless Open *Thread* network that connects the Loggers together, creating a mesh network. Loggers are shipped in low power (“Sleepy”) mode which does not affect operation, but they are not able to act as a network extender. You can reassign a Logger to be a Range Extender, effectively being another Router to include loggers located much further from the BR. You can create a single network extending over an entire building, beyond the broadcasting range of the BR, but Loggers in Range Extender/ Router mode should be powered with an AC adaptor. Ensure you can provide at least 250mA at 5VDC to the USB-C socket. You can also power the BR with a Power Bank for a limited time.

Particle Monitor (PM)

The Particle Monitor (PM) Mini-USB cable plugs into the Logger, chosen to avoid misconnections because Mini-USB is an unusual USB connector. DO NOT plug any other device into the PM socket. A flat white mounting plate is included. Although not absolutely required, it is a useful addition to stabilise the PM. Slide the Particle Monitor (PM) onto the plate to improve mechanical stability for the PM: the PM must be in the vertical position to operate to performance specification. Do not exhaust the PM outlet onto the Logger vents: the air will be at a higher temperature and hence affect ambient temperature measurements.

1 Setting up a BuiltAir Network

The Border Router (BR) connects the Loggers to the Cloud. Follow these steps to set it up:

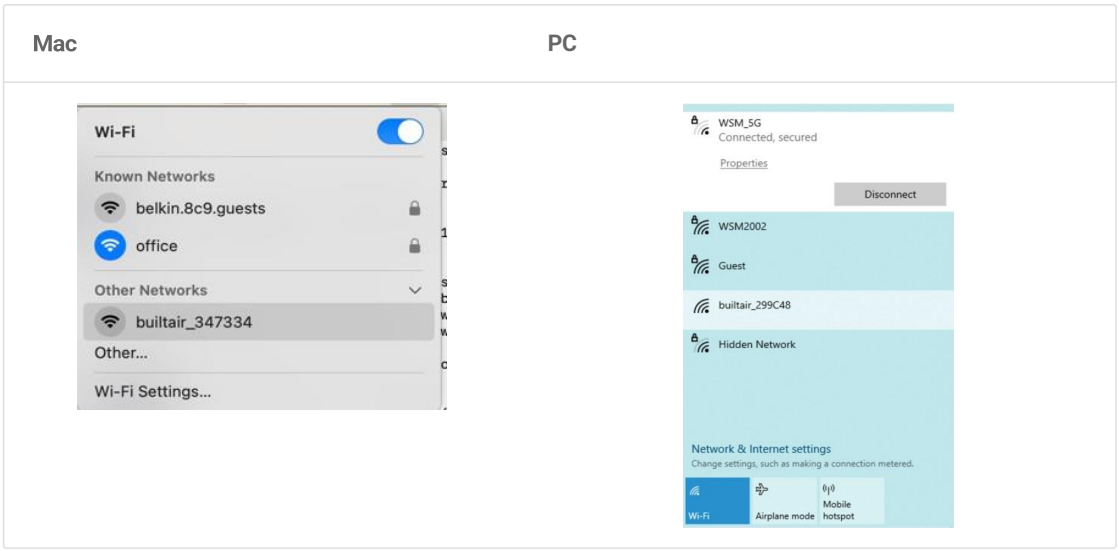
1. Connect the BR to your local WiFi
2. Pair the Loggers with the BR
3. Check the system (optional)
4. Explore and configure your Loggers in the *BuiltAir Cloud*

Even if you are only using the Loggers in *Offline Mode*, you still need to initially connect each Logger to the Cloud to set the logging parameters and select *Offline Mode*.

1.1 Step 1 Connect the BR to your local WiFi

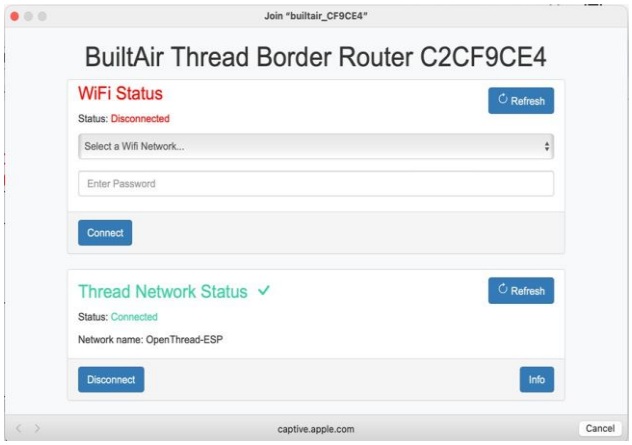
To get started you must first give the Border Router (BR) the name and password of your WiFi network. To do this you will ask the BR to set up it's own temporary WiFi network so it is connected long enough to connect to your WiFi. To do this:

1. Provide power to the BR using a USB-C cable- the Red LED will light, indicating that the BR is powered. Press the BR CONFIG button and the red LED will start to flash, indicating that it is trying to connect to the WiFi.

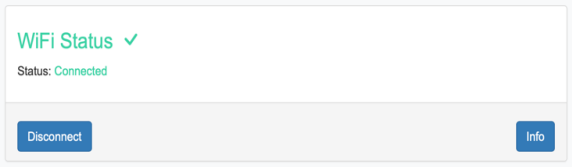


2. Select builtair_XXXXXX from your networks list on mobile or computer - XXXXXX is an alphanumeric code unique to your BR.

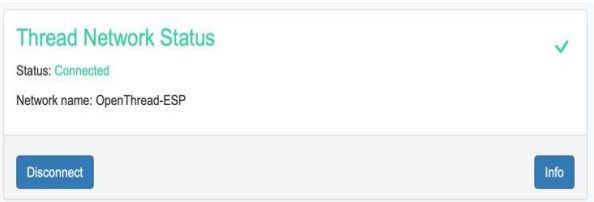
I. A screen is now displayed to show the status of the WiFi and Thread Networks.



2. Select your WiFi network from the list and enter the password for your WiFi network. Click *Connect*. After 5 seconds, the WiFi Status will change to *Connected*. If you do not have access to a password (eg if you are in a public space) then skip this step.



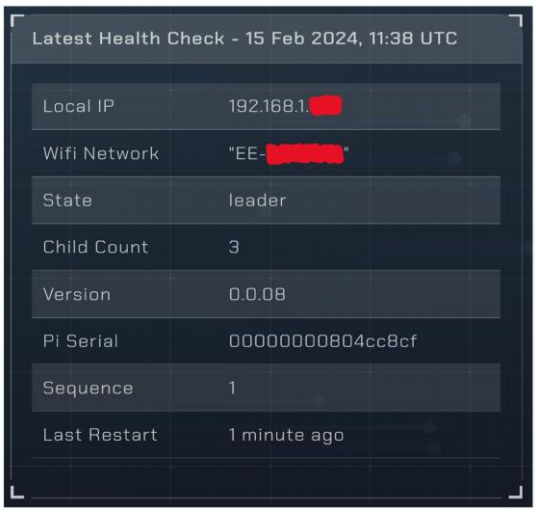
3. By default, a new Thread Network is created and the Thread Network Status is *Connected*. If it does not show *Connected* then click *Refresh*.



4. Your BR now knows how to connect to Wi-Fi so switch back to your normal Wi-Fi network. The BR window will close and the green LED on your BR will light, indicating that you have a WiFi connection.

Your BR should now be online. If connection was not successful, the Access Point will be back up in a few minutes and reloading the page and you can then retry. However, it will try to connect to your default Wifi connection, which may not be your selected WiFi connection. If you continue to not connect then disconnect and then reconnect the USB power cable.

If you want to confirm your BR has internet access, login to the *Builtair Cloud* interface (https://builtair.purit.ie/dashboard/) and navigate to your device. You will need the password you were sent by email. You should now see some data being sent from the BR, as below. Check to ensure the *WiFi Network* is correct.



The BR is now online and the Green LED is On; the next step is to pair Loggers with the BR.
]

1.2 Step 2 Pair the Loggers with the Border Router (BR)

When received, Loggers should be in Shipping Mode with a partially charged battery for safety reasons. We recommend that you connect a power supply to the C-USB socket on the Logger. The power supply should be rated ≥250 mA at 5V. The red LED will flash momentarily, indicating that it is now externally powered. The battery will charge and the Logger is out of Shipping Mode. Charging may take up to 24 hours, although you should be able to start logging after just a few minutes of charging. If you receive the Loggers in OFF Mode (not Shipping Mode) then press the Function Button once with a pen tip to switch ON. The Red LED will flash, showing the Logger is ON.

Plug the PM into the left (Mini-USB) socket on the Logger (PM Only). Ensure the PM plug is firmly plugged in. You do not need to connect the PM to start logging.

To connect the Loggers to the BR:

1 Press either the CONFIG or PAIRING Button on the BR. The Blue LED will flash, showing that the BR is trying to pair with the Loggers.

2 Press the FUNCTION Button once on each Logger, using the tip of a pen or pencil. After a few seconds the blue LED fading in and out on the Loggers will then change to double flashing, showing the Logger is connected with the BR. Allow time for the Thread network to configure itself.

If any Logger does not connect, check that the Logger is within range of the BR.

The Blue LED on the Logger is used to indicate network status:

- No Blue LED — Logger is Off or is in Offline mode
- Fades in and out — Logger is looking for a network to join
- Single flashing — Logger and BR are a network but not connected to the Cloud
- Double flashing — Logger is connected to the Cloud through the BR

To add an extra Logger to the network simply press the BR PAIRING Button. The BR Blue LED blinks, indicating that the BR is in Pairing Mode. Then press once the FUNCTION Button on the Logger you want to add. It will go to double flash when connected.

You can use the QR code on the label on your Logger to go straight to the *BuiltAir Cloud* page for this Logger; alternatively, you can log in at https://builtair.purit.ie

1.3 Step 3 Check the System (Optional)

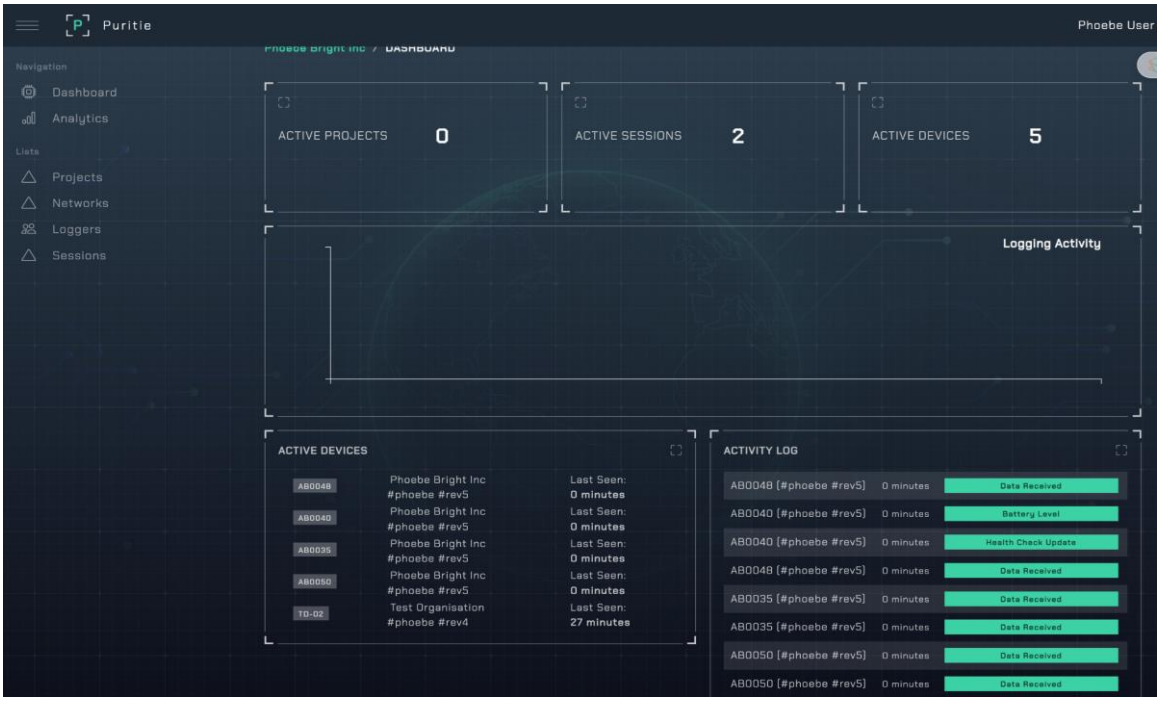
The blue LED on all of your Loggers should now be double flashing with a five second pause between flashes. You should be able to see data being sent from your Loggers on the Cloud online dashboard. Please refer to the *Troubleshooting Guide* section in Section 9 if there are any problems.

Consider your network. The Loggers are programmed in the “Sleepy” Mode: this mode is lowest power, communicating direct with the BR. If you are building an extended network where some of the Loggers will be out of the broadcast range of the BR, then some of the Loggers must be set up as a “Router”, meaning they can act as network extenders. Contact NosmoTech for updating specific Loggers to Router/Extender mode. If you have questions or if you find that your network is not extending the distance you require, then contact us at support.nosmotech.com.

1.4 Step 4 Check out the *BuiltAir Cloud*

Having set up your BuiltAir Logger and Border Router successfully, let's look at the BuiltAir GUI. Login to https://builtair.purit.ie

Home Page gives an overview of your Loggers and current Projects and Sessions.
Sessions are Logging Periods when Loggers collect data at synchronised time intervals.
Projects group the sessions for your convenience, with no limit to the number of projects.



1.5 Know your LEDs!

The Logger Blue, Green and Red LEDs inform you of actions and status, detailed below.

Action/Status	Button Action	LED response	Notes
Switch ON	Press RESET Button (back of Logger) or FUNCTION Button until Red LED shows	**Red LED** lights for 2 seconds **Blue LED** fades in/out	Logger will try to pair and start to log
Switch OFF	Press RESET Button (back of Logger) or press the FUNCTION Button three times	**Red LED** lights for 2 seconds then all LEDs switch off.	Logger will stop logging but not lose previous data- data can be recovered through the USB port on your PC using the USB Utility App
Start pairing with same BR again	Press FUNCTION Button once	**Blue LED** fades in/out	Remember to check battery voltage when connected to the Cloud
Start pairing with new BR	Press FUNCTION Button >3 seconds	**Green LED** flashes momentarily **Blue LED** fades in/out	Green LED indicates that the Logger has cleared the previous BR Open Thread information
Shipping Mode- battery disconnected	Press RESET Button for >10 seconds, Release Button after Yellow LED is extinguished	**Red LED** lights for 5 secs Then no LED for 5 secs Then **Yellow LED** lights for 5 seconds. When Switch is released: **Red LED** flashes for 1 second, then all LEDs Off.	Battery is electrically disconnected Clock will need resetting Logger can only be switched On again by applying power through the USB socket Data is not erased Logger must be disconnected from USB to select Ship Mode
STATUS INDICATORS			
Logger is paired with BR but not the Cloud	-	**Blue LED** single flash	May take a few minutes to connect. Quick press the FUNCTION Button again to retry pair
Logger is paired with BR and Cloud	-	**Blue LED** double flash	May take a few minutes. Quick press the FUNCTION Button again to retry pair
Logger is not connected to BR: in Offline mode	-	**Blue LED** is Off **Green LED** flashes as heartbeat	Logger Comms is switched off - not sending, not receiving. Quick press the FUNCTION Button to wake up Logger and try to pair
Logger is recording	-	**Green LED** flashes as heartbeat	User can switch off the flashing LED using the GUI.
One or more readings are alarm	-	**Yellow LED** slow flashes	See Status in the Cloud
Low Battery		**Red LED** slow flash for 3.6 < V> 3.3V **Red LED** fast flash for V < 3.3V	Start charging via USB-C socket Data may stop being stored if voltage is too low Data is not lost
Logger is Charging		**Red LED** flash every 3 sec	
Clock time is not set		**Yellow LED** is continuous ON	

1.6 Battery Usage

The *BuiltAir IEQ Logger* operates at very low power to ensure that temperature measurements are not affected by internally generated heat. This low power capability also allows battery powered data recording sessions for up to several weeks.

Charging the battery

The Logger uses a single cell large capacity (5Ah) 21700 Li-ion battery. This battery allows you to setup and datalog without the requirement for an AC adaptor and cables. Due to shipping regulations, Li-ion batteries are shipped with q maximum of 1/3 charge. You should charge the battery when you first receive the Logger. The Logger circuitry will control the 160 mA charging current, so about 30 hours may be required to fully charge a discharged battery. The battery will not charge if the ambient temperature is below 0°C or above 60°C. A graph can be displayed in the *BuiltAir Cloud* under the [*Device] Details* screen, showing the recent history of the battery voltage.

AC powering

The USB-C socket in the Logger is used for both power and data downloading. The PM uses 108 mA , so continuous long term or PM use requires AC powering. Ensure your AC adaptor can provide at least 250 mA. If you are AC powering and the AC adaptor is disconnected (eg during office cleaning) - do not fear, the internal battery will take over seamlessly. However, remember to reconnect the power soon to avoid draining the battery and stop operating.

Power Bank powering

If you want to datalog without AC power but are concerned about battery life, then you can connect a Power Bank to the Logger USB-C socket. 10Ah and 20Ah 5V Power Banks (e.g. Anker) are readily available and will significantly increase running time, but you must use a Power Bank with a C-USB output and trickle charging capability (eg earpod compatible) to ensure the Power Bank does not switch off when the Logger requires low power.

Low battery performance

If the battery is nearly discharged and cannot provide the required current, the Logger will first shut down the high power sensors, then eventually the low power sensors will be switched off and logging will stop. But data will not be lost and can be recovered when power is resumed- it can be downloaded through the USB-C port (see Chapter 5). The Logger controls sensor powering, depending on battery voltage:

- When the battery voltage is **below 3.6V** the Red LED flashes every 15 seconds. Plug in either an AC Adaptor or a Power Bank into the C-USB socket or allow the Logger to continue logging- the Logger will operate for several days after the Red LED is flashing.
- When the battery voltage is **below 3.3V** the Red LED flashes every second and high power sensors (CO_2, PM, noise and airspeed) are switched OFF to conserve battery life.
- When the battery voltage is **below 3.0 V** the Red LED no longer flashes. The logger continues to log the low power sensors. The internal RTC will maintain the correct time until the battery gets to 2.5V.
- When the battery voltage is **below 2.5V**. the Logger powers OFF. The RTC will need resetting, but all data is stored.

Extending Session Time when battery powered

The battery will last for up to six weeks if the PM is not attached; however, because the PM uses more than 100mA of battery capacity, the battery life is much shorter if the PM is connected: about two days if the PM is running continuously. You can select the PM logging interval to be longer- if you select 15, 30 or 60 minute *Record Interval* for the PM then the Logger will operate without AC power for weeks. The Logger requires about 110 mA with the PM operating continuously, but only 2-4 mA if the PM is not connected.

You can increase battery life by selecting power reduction options for the four most power-hungry sensors: CO_2, Airspeed, Noise/dB and Particles. For each Logger, go to the Options area (right column) of the GUI and select *Configuration/ Sensor Setup* and the column titled *Update Interval.* Only four sensors are available for this *Update Interval* option: PM, airspeed, noise and CO_2.

The normal update interval for recording sensor readings is about 1 second. *Update Interval* selects the number of updates before that sensor is updated. For example, setting PM to 120 will mean that the PM will be switched On every 120 passes of sensor scans, or about 120 seconds. This means that if the Record Interval is 5 minutes, the average PM readings will be the average of either 2 or 3 readings (120 second PM reading interval during a 300 second recording interval). In this case, setting to 100 or 150 seconds would be advised.

The four sensors that consume battery current (at 3.7 Volts) are listed below:

CO_2	40 µA rms current
Noise/dB	550 µA rms current (30 second update time)
Airspeed	160 µA rms current (15 second update, airspeed dependent)
PM	108 mA rms current for 20 seconds (340 mA when >65%RH)

In *Offline Mode* the default power use of the PM is 300 seconds *(Update Interval* = 300). Reduce power by setting a longer *Record Interval*- eg for 30 minutes set to 1800. The PM monitor is powered for 20 seconds before measuring to ensure a stable reading.

Session time (logging period) when using battery power

The expected session time using only the battery will depend on the Logger configuration:

- *Offline*, "*Sleepy*" Network, or *Extended Network* mode
- PM (and other sensors) record interval (using *Update Interval* "UI")

The table below assumes a fully charged battery, operating at room temperature.

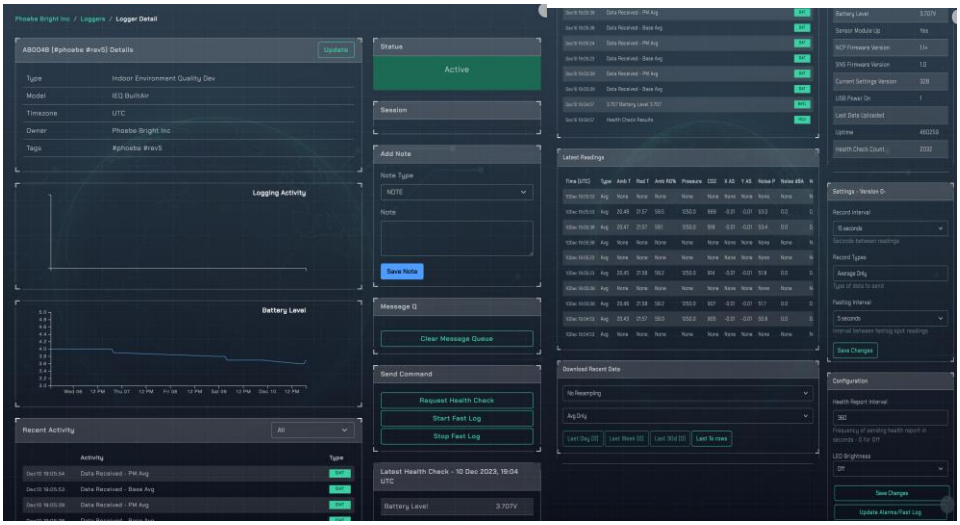
NOTE: battery life is temperature dependent but can be considered constant between 10ºC and 35ºC and battery capacity is at least 5Ah for the first 18 months of use.

The session times below are under review.

Mode	PM interval	CO_2, Airspeed, dB	Session time (days)
Sleepy	No PM	Continuous	42 days
Sleepy	Continuous	Continuous	2.4 days: AC power recommended
Sleepy	2 min	Default UI	13 days
Sleepy	5 min	Default UI	27 days
Sleepy	15 min	Default UI	51 days
Sleepy	60 min	Default UI	77 days
Extended	No PM	Continuous	20 days
Extended	Continuous	Continuous	2.2 days: AC power recommended
Offline	No PM	Continuous	44 days
Offline	Continuous	Continuous	2.4 days: AC power recommended
Offline	15 min	Default UI	52 days: AC power recommended

2 Checking out your Logger

Before getting into programming a Session, let's have a look at your Loggers.
Click on one of the *Active Loggers*



2.1 Panels

Note that recent activity is a log of when events happened for the selected Logger; for example, the date and time when data was received. This is not the time the measurements were taken, there will be a lag due to Internet delays and processing time.

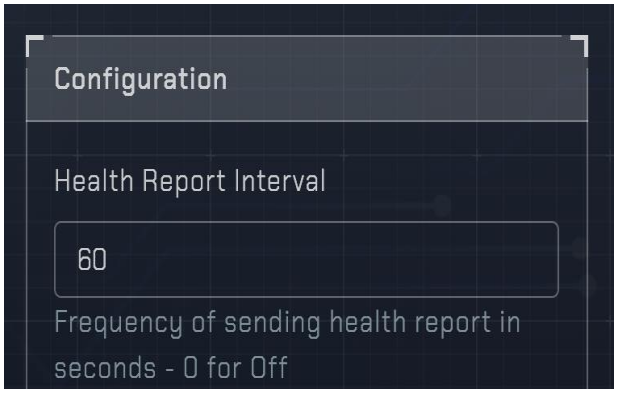
2.2 What is the difference between Settings and Configs?

Settings apply to the group of BuiltAir Loggers that are participating in the **same Session**. Eg. All Loggers are recording averaged values at 1 minute interval, time synchronised.

Configurations apply to a **single BuiltAir Logger**, eg. Calibration, Alarm or Fast Log Trigger levels. Some Configuration Settings are only be changed by NosmoTech Administration.

2.3 Health Checks

The BuiltAir Logger sends a status report at regular intervals on it's health that includes battery voltage, microprocessors' status and Logger settings. The frequency of this Health Check can be changed in *Configurations*, the default time is one minute.



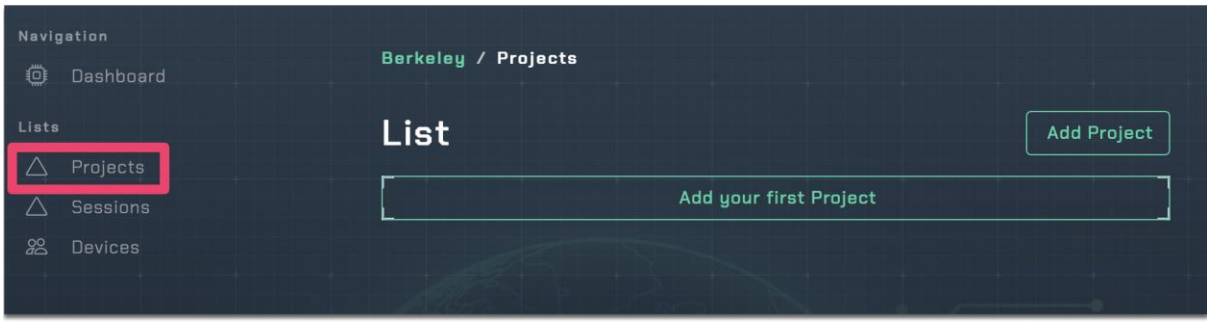
You can also request a Health Check. This request will be sent to the Cloud by the BuiltAir Logger the next time it sends data, so the response is not immediate.

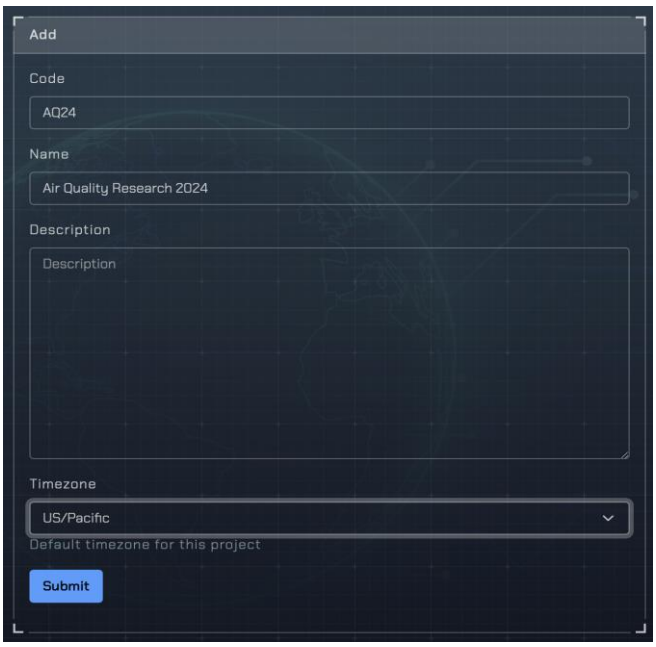
2.4 Reviewing the Data

You can review the processed data from a Session by defining a Dataset. After logging for an extended period, you can then define a Start and Stop date and time and the data interval, which can be the same as the logging interval or longer. You then can then download the **Dataset** (see below) in either *Database* or *Excel* format for analysis on your PC, or you can select **Gallery** to view the Dataset in this Cloud as a suite of preformatted graphs and heatmaps.

3 Create your first Project

When organising multiple sessions, you start by first defining a Project. You assign a Project Code and Description, then you include Logging Sessions within this single Project. The Project code is added to the downloaded file names of your sessions to help you keep your data files organised.





The project code is up to 5 alphanumeric characters.

Lets now learn how to create Logging Sessions and control your downloaded data by defining datasets.

4 Sessions and Datasets

A **Session** is a period of time for which data is collected from selected Loggers using specific Sessions parameters that you have set.

A **Dataset** is the data collected from a Session, sliced and diced in various ways. Session data that is defined as a Dataset can be downloaded in either .csv or Database format and can then be used to generate graphs and analyse the data. Datasets cover the full period or part of a session period.

Datasets can be defined while the Session is running, so in general you can leave the Session running until you move the Logger or want to change the Record Type or Record Interval; you download the Dataset when the dataset Finish Time has passed.

4.1 What if my loggers have been logging but I have not set up a Session?

You can create a Session retrospectively if you have one or more Loggers have been logging data successfully and uploading to the BuiltAir Cloud.

4.2 Raw Data vs. Processed Data

Raw Data is data received from the loggers at intervals determined by the settings you defined in the BuiltAir Cloud. Raw Data is displayed as two packets- the PM data is shown on a separate row.
Note that Calibrations will have been applied to the Raw Data before it is displayed; otherwise, this is the data as received from the sensors

4.3 Processed data

Processed Data is data that has been reformatted, rescaled or calculated. PM and other all other sensor data are merged and sensor data is rescaled/ reformatted for the correct resolution. Calibration offsets are applied. This data is "as received" from the sensor, There are no other modifications to the data, so the data is traceable.

Data can be **rescaled** to non-SI units if you have selected Rescaling:

- White Light as W/m^2
- CO_2 and NO_2 concentration as $\mu g/m^3$
- Temperature as °F
- Airspeed as ft/min
- Pressure as in Hg or mm Hg

Data from multiple sensors is also combined to generate **calculated parameters**, using commonly accepted formulae (references are available):

- Vectored Airspeed
- NO_2 (and other electrochemical gas sensors) concentration (ppb or ppm)
- Equivalent Temperature
- Dew Point Temperature
- Humidity Vapour Pressure
- Heat Index (HI)
- Wet Bulb Globe Temperature (WBGT)

4.4 Resampled data

Resampling is an option to resample the data for a period different to the Record Interval. Resampling is a nice feature, letting you record for example every 1 to 5 minutes but then specify a Sampled Interval of 15, 30 or 60 minutes when you specify a Dataset (see below). The data will be reanalysed at the Sampled Interval, avoiding unnecessarily large data files. If certain regions need closer attention later, then you can revisit the Session and define a new Dataset with a new Sampled Interval and time frame- you have not lost the original higher resolution data. Also, Fast Log will automatically capture unusual events.

Downsampling is the term where you are going from a more frequent to a less frequent sampling period. You can also Upsample, going to a faster Record Interval, but this is only likely to be useful if you want to merge this data with other data at a faster Record Interval.

4.5 What are the options for downloading data?

Currently there are two options for downloading data from a Dataset; both will download in .csv format.

1 **Database Download** Suitable for loading into a database or for data mining data is formatted as one row per logger, along with timestamp and record type (Avg, Min, Max, Spot).

2 **Excel Download** Suitable for graphing in Excel. It lists all data from all Loggers and record types on one row, making it easy to compare and group columns for multi-logger graphing. This csv format should import directly into Excel.

3 Data for a single Logger can be viewed on the **Logger Detail** page

4 There is also the **Gallery** option to view Dataset Data with statistical analysis.

4.6 Nine steps to running a Session (each step is detailed below)

1. Define your Session or describe the purpose of your Session
2. Select the Loggers that are going to participate in this Session
3. Set the parameters: Record Interval, Record Type, Start/ Stop Times, FastLog
4. Check that all Loggers are logging correctly. .Selecting *Synch Loggers* will ensure they all have the same settings and times are exactly the same.

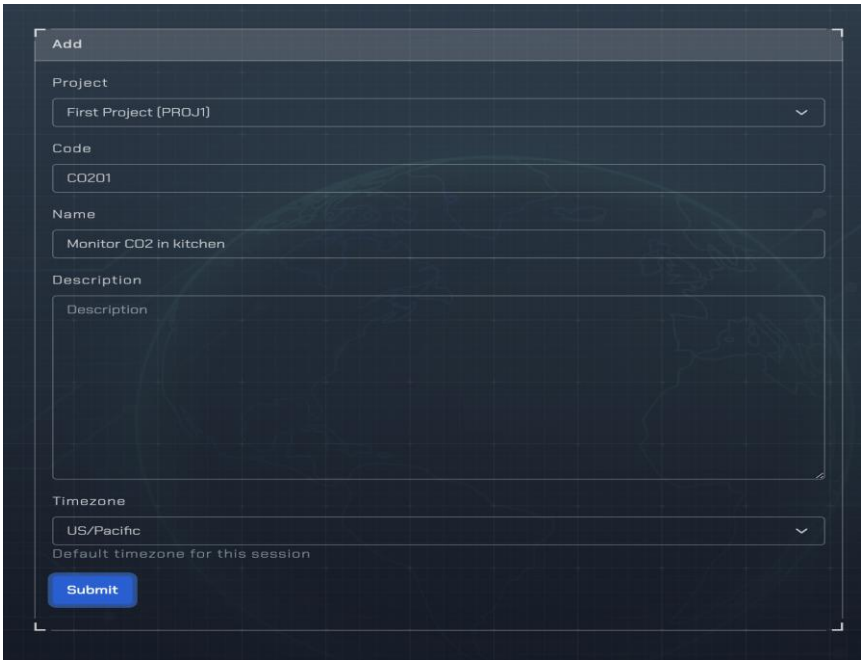
5. Start the Session- manually or at your prespecified time
6. Check that the data is arriving as expected by viewing the Raw Data as soon as the Session begins or by creating a Dataset and viewing the results
7. Stop the Session- manually or at your preset time.

8. Process the data and create Dataset(s)
9. You can also view the data using our *Gallery* visualisation tools

HINT: You can save time by cloning the setup of a Session if you want to carry out a similar Session.

NOTE: Click the *REFRESH* Button to update the GUI

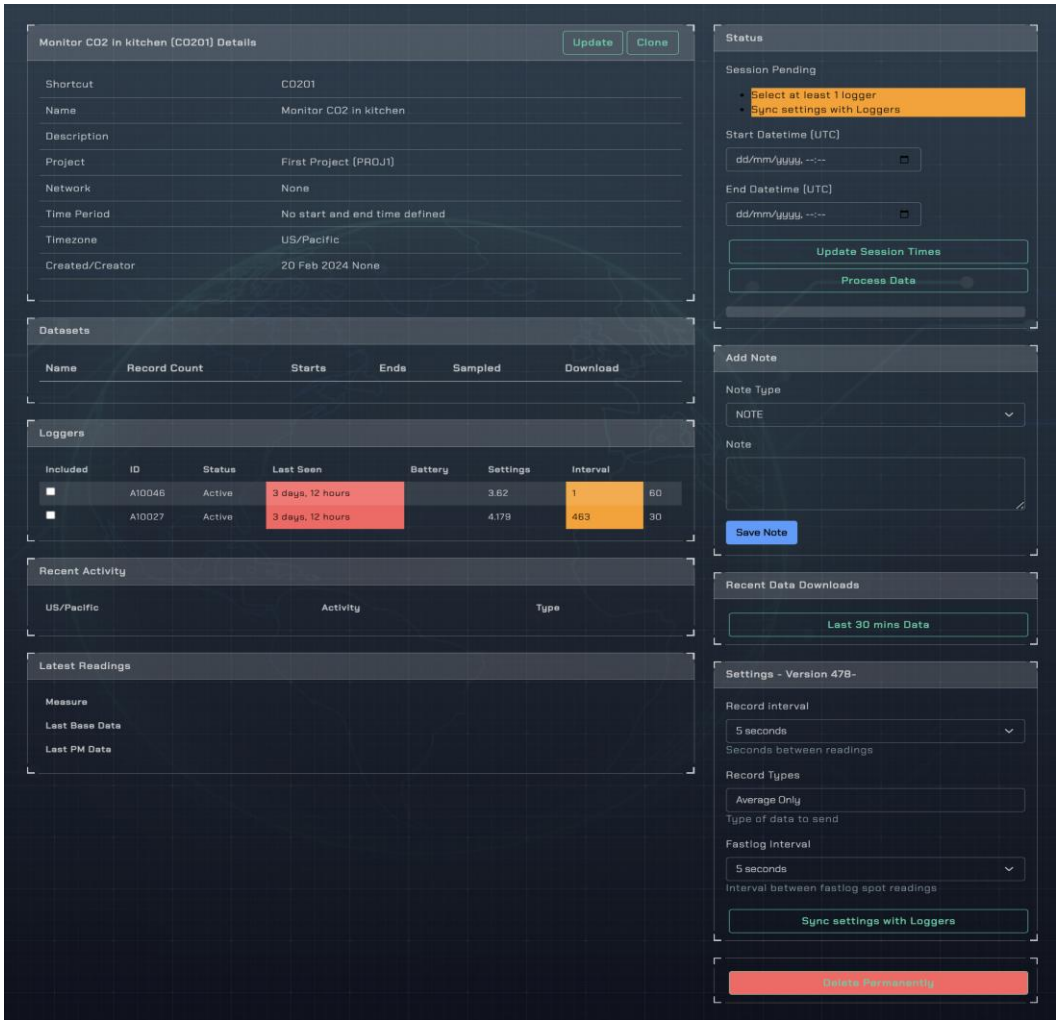
4.6.1 Define the Session



Now you specify the Session details

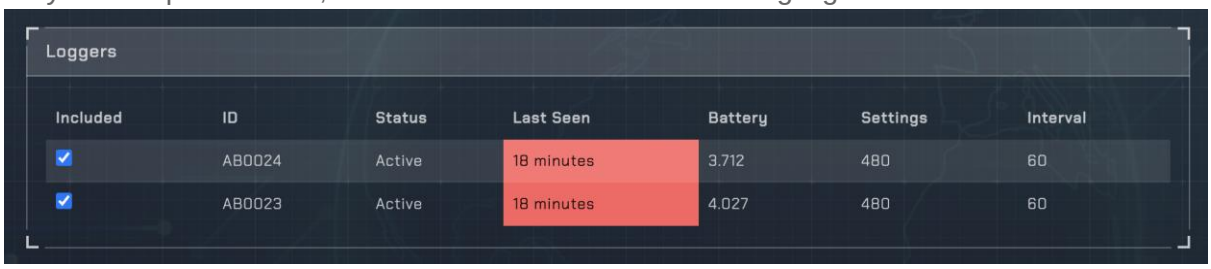
4.6.2 Select the Loggers to participate in the Session

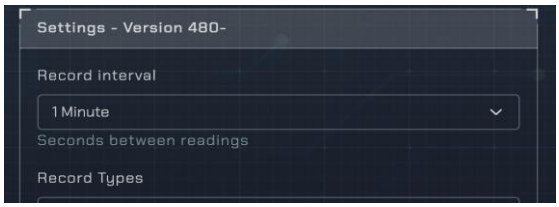
4.6.3 Set the Session Parameters



Look in the top right to see what to do next.

As you set up a Session, items that need attention will be highlighted.





If the *Last Seen* is **red** then the Logger has not sent data for more than twice the current log interval. This may not be a concern if the Logger is on a much longer Record Interval than the settings, or if you are creating a Session based on historic data.

The red LED will light if the battery level is too low, warning you to remotely either recharge the battery or use an AC supply to power the Logger.

Settings will be yellow highlighted if this Logger is not using the same version of settings as setup in the Session. This may be legitimate if your Session is created for historic data; you can also set custom settings for each Logger, but the data will have to be resampled in order to be in sync.

Record Interval

The default Record Interval is 5 minutes but you should set this for all Loggers in a Session to the Record Interval you prefer. The Record interval cannot be changed during a Session- you will need to stop the Session, reset the Record Interval and start a new Session. Select carefully the Record Interval. If you want to synchronise with a reference or equivalent instrument then it is best to choose a Record Interval that matches the reference instrument and you should synchronise the update times as well. If you are monitoring a changing environment then 1 or 2 minute Record Interval is sensible. Very dynamic environments such as kitchens may require 15 or 30 second Record Intervals.

A nice feature is the ability to record every 1 to 5 minutes but specify a sampled interval of 15, 30 or 60 minutes when you specify a Dataset (see below). The data will be reanalysed at the Sampled Interval, avoiding unnecessarily large data files. If certain regions need closer attention then you can revisit the Session and define a new Dataset with a new Sampled Interval and time frame- you have not lost the original higher resolution data. Also, Fast Log will automatically capture unusual events.
HINT: if you select the Dataset to be over the entire time of interest, you can use the *Gallery* option to review the data and select a smaller Dataset period for downloading a smaller datafile.

Record Type

Sensors are sampled at an internally set rate, not user adjustable. You select how regularly the readings are reported by selecting a Record Interval time. The format of the Readings is chosen by selecting one of three options:

AVERAGE ONLY This is the default setting. The Logger averages readings over the Record Interval and records the Mean of the readings. The timing and number of readings taken when calculating the Average are listed below.

Record Interval	Sample interval	No. of samples		Record Interval	Sample interval	No. of samples
1 minute	10 seconds	6		6 hours	15 minutes	24
2 minutes	10 seconds	12		8 hours	15 minutes	32
5 minutes	10 seconds	30		12 hours	15 minutes	48
10 minutes	1 minute	10		24 hours	15 minutes	98
15 minutes	1 minute	15				
30 minutes	1 minute	30				
60 minutes	1 minute	60				

MIN/ MAX/ AVERAGE (MMA) Reports the Mean (average), minimum and maximum readings during the Record Interval. Outliers are included, there is no data filtering, so if the Minimum or Maximum readings are very askew then it is likely there was an outlier reading during that Record Interval. The time stamp is the end of the interval.

5, 15 and 30 second intervals are recorded only as Spot readings.

SPOT If you want a snapshot of the reading at exactly the time of the next Record Interval then select SPOT. There is not averaging so the noise/ variance in the data will increase, but this is most useful when you are calculating response to a change, where averaging will lose time accuracy on the time axis. For this reason SPOT is the only option during Fast Log.

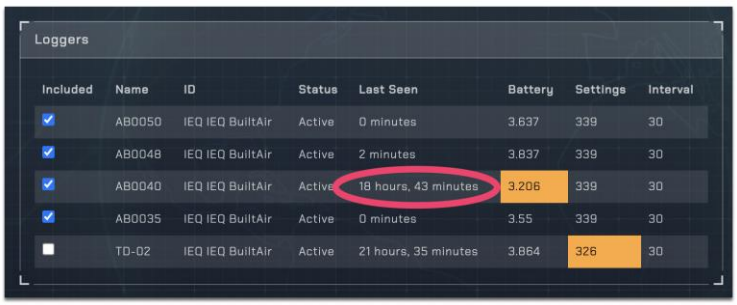
To ensure all loggers are on the same settings, set the Record Interval and Record Type you want to *Record* and click *Sync settings with Loggers*.

This update may take a few minutes and you will need to refresh the screen to see the updated parameters.

You want the settings versions to match. The Example below in Settings is *version 340* and two of the Loggers have yet to sync.

While waiting for the setting to sync…

4.6.4 Check that all Loggers are logging correctly



Looks like AB0040 stopped with a low battery and will need charging before starting the session.
Though in this case it had been on charge, so a press of the reset button was enough to get it ready.

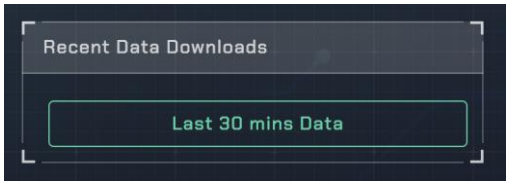
We don't care about TD-02 as it is not included in this session.

4.6.5 Start the Session

The various options for setting the dates and changing them is still in flux (when can you do it and when you can't).
Set the Start Date or click the *Start Session* button in top right.

4.6.6 Check that the data looks OK

You can do a quick check of the raw data by downloading the last 30 mins (regardless of the start/end time of the session) using this button:

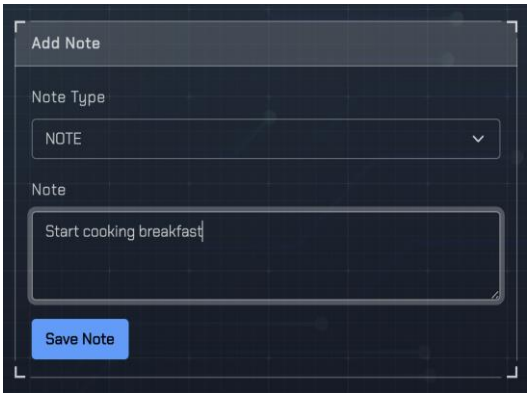


This information is available on the Logger Detail screen.

4.6.7 Create an interim Dataset to check data in more detail

At any time after the session is started you can create a Dataset and look at the data in more detail.

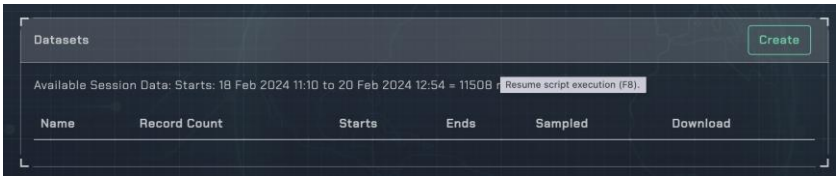
4.6.8 Adding Notes



Notes can be added against individual Loggers in the Logger detail page or in Sessions.

4.6.9 Checking Session Data during a Session

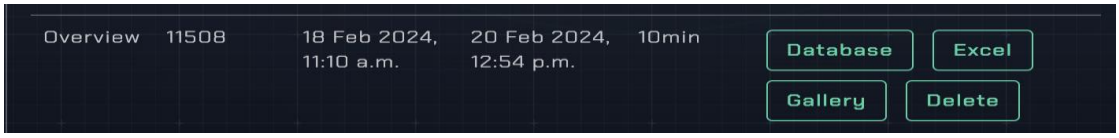
As soon as the session has a start date and at least one of the loggers is supplying data, you can create a dataset and start to look at the data.



A dataset is a subset of the session data with a choice of time period, loggers and sampling period.

When you have made your selection, click *Create Datasets*. The system will generate a set of csv files for download and *Gallery* graphs. This can take some time, depending on the size of data file.

Once the Dataset(s) have been created you get the option to view or download



Database is a csv file suitable for uploading into a database or for further processing. It has one line per time, device_id and record type.
The csv file is # suitable for uploading into an Excel spreadsheet with all devices in the Session on one line for each timestamp.
Gallery displays a number of statistical charts and time plots based on the dataset

4.7 What does the Session Status mean?

- A session starts as ***Pending***. This means it has no Start Date or the Start Date is still in the future.
- Once the Start Date has passed the Session becomes ***Active.***
- When the End Date is reached the Session becomes ***Complete***.The date range for a session can be changed at any time, however if the date range is updated such that existing Datasets would be excluded then the Dataset would need to be deleted first.
- When there will be no change in the date range and no more Datasets, the Session can be marked as ***Archived***.
- When the data in the Session has been processed the Status changes to ***Processed***.

5 Downloading Data

5.1 Data downloading options

There are five options for downloading data, each with a different level of data preparation:

Download	Scaled	Calibrated	Stitched	Processed	Resampled	Multi-Logger
USB Data						
Raw Data						
Processed Data						
Session Dataset						
Cloud-to-Cloud						

- **Downloading raw data from the loggers via USB** This is intended for use where the logger is not connected to the internet, either intentionally as in Offline Mode or where Wifi connection was lost. The data will require some processing to be useful- the data is in integer format and needs scaling to the correct floating point value. The data can then be uploaded to the Cloud and processed.
- **Downloading raw data** from the loggers using the Logger Details page in the Cloud. There will be no corrections or compensation algorithms applied. However, some sensor outputs (CO_2, PM and PNC, barometric pressure, airspeed) are temperature and humidity corrected inside the sensor, so are already T/RH compensated. The only action is scaling to the correct value.
- **Downloading processed data** from the loggers from the Logger Details page in the Cloud. This is the preferred method for downloading data from a single logger.
- **Create a Session and a dataset** with your required configuration and download the data from the Session page in the Cloud
- **Auto download data to your Cloud** - data at the required level can be supplied on either a push or pull basis. Contact NosmoTech to discuss your requirements.

Scaled

Data is stored in the loggers as positive integers so the first step is to rescale the values to their correct value.

Calibrated

Each logger has Calibrations for each sensor that can be modified. These calibrations can be viewed on the Logger Details screen and downloaded for review.

Stitched

Data is stored in two packets - the PM data and data from all other sensors. Stitching Simply combines these two packets into a single record.

Processed
Data is processed to:

- remove any duplicate data
- assign direction to each airspeed
- calculate an airspeed vector [$\sqrt{(x^2 + y^2)}$]
- rescale to other units: ºF; ft/min; in Hg;
- add derived values: White Light W/m^2; humidity dew point and water vapour pressure
- calculate thermal comfort values: equivalent temperature; Heat Index (HI); WBGT
- convert NO_2 sensor currents into ppm

Resampled
When creating datasets from sessions there is an option to resample data with a longer record interval than the Session Record Interval; this is termed Downsampling.
For example: you might record data every 1 minute but create a resampled dataset at 15 minutes to view the data on a graph, to get an overall picture of your session. This is useful when you have large datasets, being the graphing limits of many graphing apps. If certain regions need closer attention, then you can define a new Dataset with a new Sampled Interval and timeframe- you have not lost the original higher resolution data. Also, Fast Log will automatically capture unusual events.
You can also Upsample, going to a faster Record Interval, but this is only likely to be useful if you wish to merge this data with other data that was recorded at a faster Record Interval.

Multi-Logger
When a Session with a network of loggers is downloaded, the data from all loggers will be automatically merged into a single dataset. You can also download separate loggers by selecting a single Logger, specified by its serial number.

5.2 Downloading Data by USB socket

The *BulitAir For Windows* App can download your data without an internet connection.
First, download the **.exe** file. Then, double-click the file to run it. It may take up to 30 seconds until the app is ready to use - wait until the green box has disappeared.
Follow the on-screen instructions to download your Logger's data. The data is in **.csv** format. The name of the downloaded file will contain your Logger's ID and the timestamp of when you downloaded the data.

NOTE: The USB App will ask for start and finish date:time you wish to download, Do not be precise, the App will find the approximate start and stop records, but may be off by several hours. We recommend that you enter a start time earlier and a stop time later than required.

NOTE: The data is raw- not processed. You can upload the file to the *BuiltAir Cloud* for processing.

6 FastLog

The purpose of (patented) FastLog is to capture the sensors' response when there has been an environmental change in the space. FastLog data allows the user to calculate ventilation rates, thermal comfort and air quality parameters using the dynamic response of the space, rather than the normal method employing "steady state" measurements.

6.1 FastLog Trigger

FastLog mode is triggered when there has been a change to the occupation, activity or ventilation in the monitored space: occupancy has changed significantly, the mechanical ventilation has switched ON or OFF, windows or doors have been opened or closed or a new activity has begun (cooking, arts and crafts, decorating). Light, noise and pressure changes are the three readings that correlate with a change in the indoor environment. In the future we may add VOC or CO_2 changes as well.

You need to set a reasonable change of each trigger parameter: noise, light and pressure. FastLog should not trigger if just one person enters or leaves the space and it is possible to turn on a light or make a noise that do not change the environment: a false positive. Algorithms are used to identify an event to trigger FastLog; these will be improved over time.

6.2 FastLog Options

FastLog is triggered by a change in level (compared with the average reading over the previous logging interval). The change is determined as the immediate difference from the average reading of the previous log interval. Access to FastLog configuration screen is from the Logger Details screen in the side menu. To activate these triggers, click the checkbox next to the trigger you want to use. FastLog options are:

ON/ OFF	FastLog can be disabled; we recommend it is allowed to operate
FastLog Interval	Select a time between 5 and 60 seconds. Fast Log is only useful if the Readings are collected rapidly. Default interval is 5 seconds.
FastLog Period	60 minutes is the default; 30 and 90 minute options may be added.
Trigger On/Off	Noise, light and pressure triggers can be separately switched On/Off
Trigger Level	Noise, light and pressure change levels where Fast Log is initiated; ths can be adjusted.

Changing these values will immediately store the values in the cloud. In order to update the Logger, click the Update Logger button and a message will be sent to the logger next time it contacts the cloud to tell it there are new configs to be downloaded.

NOTE: Data is in SPOT format to ensure the time stamp reflects only the current Reading..

TIP: You can separate the records of FastLog events from regular logging records because SPOT measurements are only available for FastLog. Simply sort your downloaded .csv files: (A-Z) on the *Reading Type* column. If you select Spot as your default record format you will not be able to quickly isolate FastLog events so we do not recommend running FastLog while collecting Spot readings.

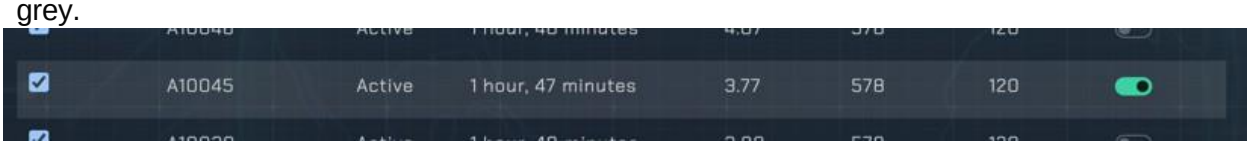
7 Offline Use

The Logger can be configured to record data remotely, without connecting to a network or the internet. This Offline *Mode* is also programmed to operate at lowest power by switching off the comms electronics. Before the Logger can be deployed the Logger must first be connected to the Cloud in order to receive its logging configuration and to switch on *Offline Mode Preferred*.

7.1 Setup before despatch

1. Ensure that the battery is fully charged. Add the Logger to a Session and select the Checkbox next to the Device ID and click *Sync Settings with Loggers* to send your preferred logging settings to the Logger.

2. After the Logger has synced the settings, the line for this logger is grey. Now use the slider to select Off *Pref (Offline Mode Preferred*) and wait for the Logger to receive this change and confirm it. Refresh the screen and wait for the line to turn grey.



3. LED brightness during Offline logging can be set to Hi/ Med/ Low/ Off.

4. You can increase battery life by selecting power reduction options for the four most power-hungry sensors: CO_2, Airspeed, Noise/dB and Particles. Using the Update Divisor Option will reduce power consumption by switching on these four sensors at less frequent intervals than the other sensors. This is explained in Section 1.6.

5. The Logger is now ready to be deployed in the field. The Logger will continue to log data until the battery is depleted so either take the logger out of range of the Border Router (if, for example, you want to leave it charging) or switch it Off by pressing the RESET Button (back of Logger: use the RESET Button Tool or a paperclip) for 2 seconds and the Red LED appears then all LEDs are Off.

7.2 Start Offline Logging

The Logger, when starting a log session, will always try to connect to a Border Router for 5 minutes and then decide, based on the *Offline Mode Preferred* configuration, whether to give up and turn off the comms (*Offline Mode*) or to continue looking for a Border Router (Network Mode).

1. If shipped powered On, then skip this step. On receiving the Logger, turn On the Logger by pressing the RESET Button (back of Logger: use the RESET Button Tool or a paperclip) and data will start to be collected and stored on the logger. Note that the Logger will go through the normal startup procedures looking for a Border Router, but after 5 minutes of looking for a BR, it will go into *Offline Mode*.

2. If the Logger shows Low Power (flashing Red LED) then the user can either plug in any C-USB AC Adaptor (or power bank) or allow the Logger to continue logging- the logger will operate for several days after the Red LED is flashing (this occurs when the battery has dropped below 3.4V). When the battery voltage is below 3.0V then high power sensors are switched Off. The Logger powers Off when the voltage is < 2.5V.

7.3 Downloading the Logger

1. Once the Logger is in *Offline Mode*, the comms will be disabled to reduce power usage, so in order to restore communication after logging you must provide power through the USB-C socket, which is also the socket for downloading data.

NOTE: If you wish to check the status and clock of the Logger before downloading the data, you can restore communication when a Border Router is nearby by pressing the Logger FUNCTION button (short press) and Border Router Pairing Button. The Logger will now connect to the Border Router and data will flow to the BuiltAir Cloud. See Section 1.1 for connecting the Border Router.

2. Run the BuiltAir Download App. Once downloaded, the data can be uploaded to the cloud where calibrations will be applied, and it will then be available to view and download as normal.
3. You can also download the raw data as a .csv file, for transferring to Excel. Remember that the data is not compensated and any calibrations are not included. To compensate and calibrate the date, upload to the Cloud for processing and then download to your PC.

NOTE: Remember that the Logger logs continuously so it will record data during shipping unless the User has switched Off the device completely and the Red LED has shown for a few seconds before all power is disconnected.

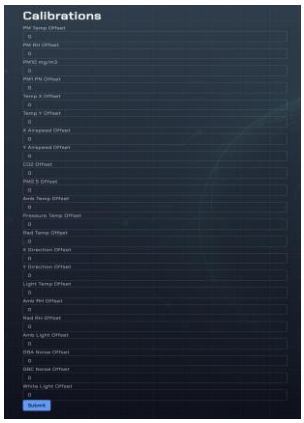
8 Calibrating your Logger

One step when processing data is applying calibration offsets which are specific to each logger. Calibrations are simple offsets only, gain is currently not adjustable.

- Calibration corrections are applied after the data has been uploaded to the cloud and before it is compensated (if required) and sent to the user.
- Calibration settings can be viewed and updated on the *Logger Details* screen.
- The Raw download on the *Device Details* screen does NOT include calibration corrections- the data can be seen before calibrations are applied.
- NOTE: calibrations cannot be applied retrospectively.

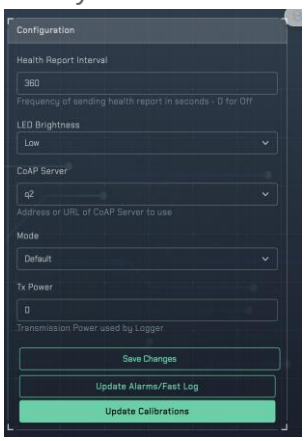
Updating Calibrations

1. Select *Update Calibrations* to update the calibration offsets for this Logger only.
2. Move the sliders to update the offsets for each measurement.
3. Enter the Error or the Baseline/ Zero reading (including the correct + or – sign) for each reading as the calibration value. This value will be subtracted from all readings.
4. When you have entered all the necessary calibration, click the *Update* button to create a new set of calibrations.



Viewing Calibrations

Select *View Calibrations* to see a history of calibrations that applied to this specific Logger.



Calibrations used for Sessions when viewing a Dataset

When a Dataset is created from Session data, a list of the calibrations for that Dataset can be downloaded with the Dataset.

9 USB Utility App

Data can be downloaded direct from the Logger to your PC in a few simple steps:

1. In the BuiltAir Cloud select *Download Resources* from the left menu to download the App. Beware: the file size is greater than 110MB. Choose IOS for Apple based systems or Windows for other PC systems.
2. Launch the App from your PC. The App will load onto your PC and start.
3. Ensure you have connected the Logger to your USB port and that it appears in the list on loading the App. Click Next to get to the menu.
4. Select *Download Data* from the main menu.
5. Decide which times you want to download from your logger. Note that the Start Time and Stop Time are approximate, so give an extra day at each end to ensure you collect the data you need.
6. When requested, select a folder to deposit the .csv file, then start the download. It takes approximately 6 minutes to download a full logger.

You now have two options:

1. The .csv file in your folder is not scaled, calibration corrected or compensated, it is the raw data. You can use this uncorrected data as required. Many measurements such as temperature, humidity, barometric pressure, light, noise and CO_2 do not require compensation, so only require rescaling (eg. 2034 is actually 20.34°C).
2. You can upload the .csv file to the *BuiltAir Cloud* where it will be rescaled, calibrated (if required) and compensated (if required). This data will ~~be stored as the Device number (eg stored as A20061).~~ This data will be available to download from the Device page and is stored in the database so can be used to create Sessions and Datasets.

Data collected from offline use and data collected as part of a connected network are treated the same in terms of data processing.

To upload .csv files to the *BuiltAir Cloud:* select the *Upload Log Files* option in the Cloud Menu and follow the instructions.

Three other options are available in the App:
Set Time: the Logger clock will not have the correct time if the battery has totally drained or if the Logger was in Shipping Mode. The GUI regularly synchronises the clock, but if you are operating offline or wish to set time without connecting to the cloud, then use this option.
Set charging speed: the Logger defaults to Slow Charge (160mA charge current) to avoid heating the Logger. You can select Fast Charge (480 mA) when charging time is important and temperature accuracy is not critical.
Erase Data: the Logger records readings continually when it is powered On, and this may result in large swathes of uninteresting data. You can clear the entire Logger memory , although this is not necessary because the Loger holds 500,000 readings and when full it overwrites the oldest data, so never stops logging. However, it may be advantageous to clear the memory, so long as you have stored relevant data before clearing the memory.

10 Specifications

Sensor Performance

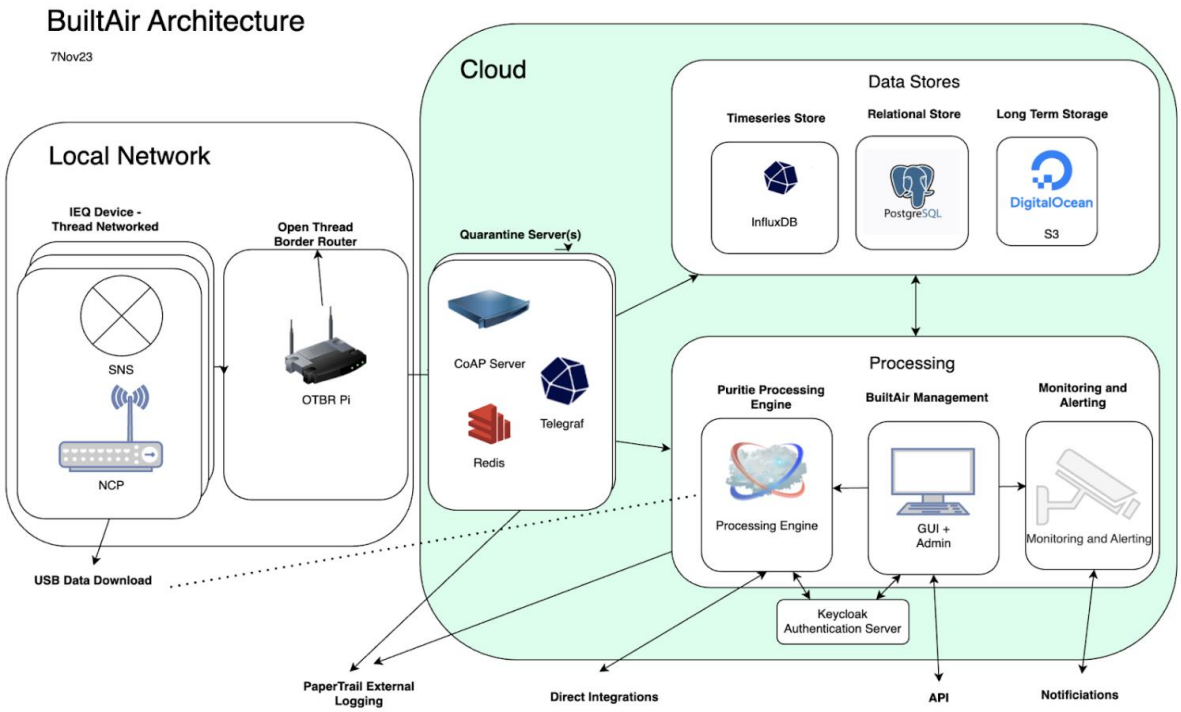
Measurement	Range	Resolution	Accuracy + Precision	Uncertainty (95% CI)	Other Specification
CO_2	400 to 5,000 ppm	1 ppm		±30 ppm ±3% rdg	±10 ppm/ann Or ABC correct
NO_2	4 to 2,000 ppb	1 ppb	±5 ppb RMSE	±20% rdg at TLV	
PM_1 $PM_{2.5}$ PM_{10}	1 to 1,000 µg/m^3	0.1 µg/m^3	<3% repeatability <5% linearity		
PNC_1 $PNC_{2.5}$ PNC_{10}	250 to 1,000,000	1 PN/cm^3			
Ambient temperature	-5 to 50°C	0.01°C	±0.10°C (0 to 60°C)	±0.15°C	
Ambient %RH	0 to 95%RH	0.1%RH	±1.0% (25°C) ±1.5% (0 to 50°C)	±2% RH (<90%RH, 25°C)	<90%RH
Radiant temperature	-5 to 50°C	0.01°C	±0.15°C (0 to 60°C)	±0.2°C	
Barometric pressure	85,000 to 110,000 Pa	1 Pa	±3 Pa (23°C)	±6 Pa (15-55°C)	<±10 Pa/ann; <±1.5 Pa/24 hr
Ambient light Total light	0 to 1000 lx 0 to 12 W/m^2	0.1 lx 0.01 W/m^2		±10% (light type) ±5%	545 nm peak 280-900 nm
Sound pressure	45 to 110 dB	0.1 dB	1.5 dB at 1KHz	2.5 dB	
dB(A) Class 2	30 to 105 dB				
dB(C) Class 2	30 to 110 dB				
Airspeed X and Y	0.10 to 10 m/s	0.01 m/s		0.1 m/s ±3% rdg	

Environmental, Mechanical

Parameter	Specification	Notes
Case dimensions	70 x 94 x 42 mm	Plus 2 mm rubber feet
Case weight	165g	Optional Tera NextPM: 85g
Temperature	0°C to 50°C	Survives -20 to 65°C but is not within performance specs
Relative Humidity	0 %RH to 90 %RH	Non-condensing
Pressure	700 to 1150 hPa	

Electrical

Parameter	Specification	Notes
Battery	Type 21700, 5,000 mAh rechargeable Li-ion	Not user accessible
AC power	5 VDC via USB C socket	<250mA with NextPM
Power consumption	2.2mA to 5mA (Logger only)	PM: 90mA, 250mA w/heater
Battery lifetime	50 days typical, 80 days maximum	Depends on user selected setup
Battery lifetime with PM	60 hours (continuous, heater off) 50 days (15 min PM sampling, heater off)	AC powering is recommended if >60%RH (PM heat switches ON)


BuiltAir Architecture
7Nov23
Cloud
Data Stores
Timeseries Store
Relational Store
Long Term Storage
InfluxDB
PostgreSQL
DigitalOcean
S3
Local Network
IEQ Device -
Thread Networked
Open Thread
Border Router
SNS
NCP
OTBR Pi
Quarantine Server(s)
CoAP Server
Telegraf
Redis
Processing
Puritie Processing
Engine
BuiltAir Management
Monitoring and
Alerting
Processing Engine
GUI +
Admin
Monitoring and Alerting
Keycloak
Authentication Server
USB Data Download
PaperTrail External
Logging
Direct Integrations
API
Notificiations

11 Terms and Definitions

Acquisition Time The sensor sampling time. Relevant to dBA and dBC measurements where fast and slow readings use different sampling times.

Alarm The **Yellow LED** flashes when at least one channel has exceeded the Warning Level. Refer to the Cloud for status of the alarming channel(s). Currently not activated.

Average Log The Logger samples at the Sample Interval rate and calculates min, max and average (MMA) during the Log Interval and stores as a Record. The Time Stamp is the end of the Log Interval period, not the beginning.

Averaging Period The number of seconds over which the average (mean), min and max are calculated. *The Averaging Period is the same as the* ***User Log Interval.***

Backup Log Records are saved sequentially in the Logger memory as a backup that can be retrieved via USB if required. The 16 Mbytes memory stores 500,000 Records.

Calibration Values added in the cloud to the measurements received from the Logger. Currently calibration is a manually entered ± offset to the reading.

Device Configuration (Config) Settings that are specific to a Logger. The user has access to some of the Config settings, others can only be changed by NosmoTech Administration. Configs differ from Settings as Settings apply to a group of Loggers that are part of the same Session.

Device Settings Settings that define the behaviour of all of the Loggers during a Log Session and Fast Log. Device settings are set by the User in the *BuiltAir Cloud*.

Fast Log Fast Log operates in parallel with Log Sessions. Fast Log will only occur if an activity has been detected (termed the *Fast Log Trigger*) by a rapid change in any of the following sensors or a combination of sensors: *barometric pressure, light level* or *noise (sound pressure).*,When a preset *Fast Log Trigger* has been exceeded, then, if *Fast Log* has been selected, the Logger will datalog at a user-selected *Fast Log Interval* (default is 30 seconds). The *Fast Log Period* is 60 minutes.

Fast Log Interval The number of seconds between Spot Readings in *Fast Log* mode. The interval defaults to 30 seconds with user option to select 2, 5, 10, 15, 30 or 60 seconds.

Fast Log Trigger Threshold (High/Low) A rapid change in a reading, specifically pressure, noise or light. This is the change, not the absolute value. Fast Log is initiated if a *Fast LogTrigger* is detected.

Health Check Data Data shared between the Logger and Cloud to check Logger status.

Log Session User defined time period that logging occurs. If a user wants to change any setting then the Log Session must be stopped before settings can be changed.

Log Period (Session) Time between Start Log and Stop Log: the total recording time.

Low Power Mode This option reduces power by increasing the Log Interval for the higher power sensors (CO_2, PM, airspeed, noise). User can specify which sensors operate at longer log intervals.

Min/ Max/ Average (MMA) Log Record type that includes the average (Mean), minimum and maximum readings during that Log Interval.

Project: Set of planned Logging Sessions to solve a built environment problem, map out a building, or investigate a research question. A Project will typicallycontain many Sessions.

Reading Value from a single sensor at a specific time.

Record Readings that all relate to a single time- includes all Readings for a single Logger. Each record has a unique sequential number and Time Stamp. Includes Min, Max, Average if selected.

Record Interval , but I am not going to explain what each option means. (Session) The period (in seconds or minutes) between Records in a Logging session. Same as User Log interval.

Record Type There are three Record Types: Spot Log (instantaneous readings), Average Log, and Min/Max/Avg (MMA) Log.

Resample Interval Data from a Session can be resampled at a Record Interval different than the initial (Session) Record Interval. This allows rapid scanning of large datasets by setting the Resample Interval much longer than the Log Interval.

Session A period during which a network of Loggers will synchronously record readings. Session settings define how sessions start, stop, the logging interval and data format for all of the loggers in the session. Individual loggers can have different log intervals or can be synchronised.

Sample Interval (Internal) The interval between readings taken by the Logger to determine Minimum, Maximum and Average (MMA) Readings. The Sample Interval is set in the Logger firmware and is not User adjustable. See Section 4.6.3.

Spot Log Record type where only the reading at the time of the log interval is recorded. Spot Log is the only Record Type allowed for Fast Log because Readings change rapidly during Fast Log periods.

Start Log time Set as Minute:hr:date. There is an option for Immediate Start Log: *Today*.

Stop Log time Set as Minute:hr:date. It is also possible to specify *Continuous* for logging without a Stop Log Time. There is an option to stop logging immediately, labelled T*oday*.

Timestamp User sets the Start Log and Stop Log times with one minute resolution. Records include a Time Stamp with 1 second resolution.

Update Divisor To extend battery life, high power sensors (PM at 80mA, airspeed at 4 mA and CO_2 and noise at 1 mA each) can be switched On less frequently than the Logging interval, to save power when operating under battery power. If you are powering continuously by the USB-C socket then you do not need to worry about saving mA to extend battery life. The frequency of switching on for these four sensors is set by the **Update Divisor**. This parameter is set to the number of seconds between recording that sensor's readings. You can specify up to 3600 seconds (1 hour). For example, a setting of 300 for the PM means it will record PM data every 5 minutes. Note that the Logger will not be averaging over the entire period, it will be averaging only during its short stabilised time and then it will switch off. The GUI has set minimum and maximum allowed divisor values so if you input a value that is not accepted then change your proposed Update Divisor time (in seconds).

User Log interval The time (in seconds or minutes) between Records; this time is selected by the user. Same as (Session)Record Interval and Averaging Period.

12 Future Use

A suite of BuiltAir Loggers, recording data for one day, one week, three months will provide a significant amount of data, but what to do with all of this data? A few ideas on data analysis are listed here. Please also share your experience in data analysis and propose other tools/ algorithms/ statistics/ maps that improve the usefulness of the BuiltAir Net.

The Loggers measure both radiant and ambient temperatures, humidity, and airflow, so PMV and PPD can be calculated if you know the clothing and activities of the occupants. WBGT, HI and Effective Temperature are already calculated automatically in the BuiltAir Cloud, but with assumptions about Clo and Activity Level. PMV and PPD can be mapped against WBGT and the Effective temperature to set temperatures in each space, also paying attention to local air flow discomfort.

Air change rate (ACH or ACR) can be calculated from the CO_2 response in Fast Log mode; this is an important parameter. It is also worth comparing ACH with the response time of gases, fine particles ($PM_{2.5}$) and coarse particles (PM_{10}-$PM_{2.5}$).

Monitor when the pressure changes to identify when the ventilation switches on; compare the measured ACH with expected ACH to check for failing dampers.

Set one of the Loggers in an open window and monitor air infiltration and exfiltration: the airflow sensors tell both magnitude and direction of flow.

Monitor particle and CO_2 concentrations in a room when there is no mechanical ventilation. Is there a correlation between occupancy levels and particle concentration?

Set a fast Record Interval and monitor all the parameters near a cooking appliance and in a far corner of the kitchen. Multiple Loggers can give airflow patterns and help to educate cooks on generated aerosols and SOAs from frying and braising.

Ensure that at least one Logger is located outside, preferably near the inlet duct when monitoring a mechanically ventilated space. Indoor air pollution is the sum of outdoor pollutants and indoor generated pollutants, so tracking the difference quantifies internally generated pollutants. CO_2 concentration should be calculated as [indoor-outdoor], not just the indoor concentration.

Monitor the pressure difference between adjacent rooms to calculate infiltration/ exfiltration between rooms. An entire floor can be mapped because the barometric pressure sensor has 1 Pa resolution and about 5Pa variance, letting you measure the small pressure differences that drive room-room infiltration by determining the absolute pressure in each space.

Monitor $PM_{2.5}$ and ventilation cycles over long periods to determine HVAC filter efficiency over time and to determine seasonal effects.

13 Troubleshooting

13.1 Setting up the BuiltAir Network

My Logger won't connect to the Network

First check that the Border Router (BR) is active and has formed a Thread Network. Without this there is no network to join.

Check the BR LED states: Red LED: BR is powered; Green LED: connected to WiFi - note that you can still connect to the Open Thread network with the green light Off but not to the cloud; Blue LED Flashing - in Pairing Mode

My Logger's red LED is flashing, what does it mean?

The Red LED will flash to indicate your battery is low. Provide power to the Logger by the USB-C socket. The Red LED will now flash every 5 seconds to indicate it is charging. Once the battery is fully charged the LED will stop flashing. Charging may take up to 30 hours.

There are no lights on my Logger

If the Logger is in Offline Mode, there will be an occasional flash of the green LED to confirm it is still alive. If there are no LEDs for more than 30 seconds then: the Logger is switched Off, the Logger battery is discharged, or the Logger is in Shipping Mode.

Provide power to the USB-C socket and press the Logger FUNCTION button to turn it on. If the battery is very low then it may take a while before there is enough power and the Red LED is Flashing. Providing power both charges the battery and takesthe Logger out of Shipping Mode, if it was in Shipping Mode. If this does not work then press the Reset button on the back of the Logger with the Reset Tool or a paperclip. See Section 1.5.

How long does it take for the BR to be fully alive after I plug in?

The BR may take up to 45 seconds to boot up full before you can put it in pairing mode (left button), but only about 10 seconds before you can put it in Access Point mode (right button) and the network will appear in the list about 5 seconds later. However, the Thread network is not yet started, so we recommend that you wait 45 seconds before trying to connect. If a Logger was previously connected to the BR it takes about 1 minute to reconnect.

How do I know if my Logger is in Offline Mode?

If *Offline Mode Preferred* has been set On, the Logger will go into Offline Mode after 5 minutes of not being able to connect to a BR. At this point the blue LED will turn Off. So if your logger blue LED is Off and the green LED flashes occasionally, then it is in Offline Mode.

How long does it take for my Logger to connect to the Network?

Assuming the BR is in Pairing Mode (the blue LED is flashing) and the Logger blue LED is slow pulsing, then press the Logger FUNCTION button about once a minute: it takes about 30 seconds to connect to the network and for the blue LED to start double flashing.

How long does the BR stay in pairing mode?

The BR stays in pairing mode for 5 minutes.

13.2 Questions about the BuiltAir System

A few common questions about the Loggers and data are answered below.

What is the difference between Settings and Configs?

Settings apply to the group of BuiltAir Loggers that are participating in the same Session. This means that All Loggers are recording the same data mode (Avg or MMA) at the same Log Interval, time synchronised. Configurations apply to the parameters for a single BuiltAir Logger, including Calibration and FastLog settings.

What is the difference between Raw Data and Processed Data?

Raw Data is data received from the Loggers with only rescaling. Also, Raw Data is displayed as two packets- the PM data is shown on a separate row from the other sensors' data. Processed Data has been reformatted, calibrated, rescaled or calculated. See Section 5.

What is Resampled Data?

Resampling is an option to reformat the data for an interval different to the Record Interval. For example, you can log your data at 5 seconds but then resample it to 1 minute or even 1 hour to get an overview. Another use is merging the Logger data with another set of data with a different Sample Period. the Logger data timing can be resampled to match. **Downsampling** converts data to a longer interval. The mean (Average) is recalculated. **Upsampling** is converting data to a shorter Sample Period, Data is linearly interpolated. The Sample Period is set when a Dataset is created on the Session screen. See Section 4.

Why does it take so long to change settings or configs in my Logger?

Communication is scheduled by the Loggers, so the Cloud must wait for the Logger to send data to the Cloud, then the Cloud acknowledges and sends updates. These updates can be, for example, requests for the Logger to sync their settings or configs, or perform a software update. So if the Logger is sending data every 5 seconds the turnaround time might be only be 10 seconds. But if the Logger is only sending data every 10 minutes, then response times may be slow, depending on when the next data is sent.

How do I ensure my Logger and BR firmware are up to date?

The BuiltAir Cloud includes Over-the-Air (OTA) remote firmware updating. Connect your Logger to the Cloud via the BR. Select your Device in the BuiltAir Cloud. The right column includes *Update Firmware NCP* (the NCP is the Comms microprocessor) and *Update Firmware SNS* (the SNS is the sensor interface microprocessor). Select first NCP and wait for the GUI to reply that it has updated he firmware the nselect Update Firmware SNS and the GUI will ensure your Logger has the latest SNS firmware. The firmware issue numbers are listed just below the *Update* options.

14 Care and Maintenance, Service, Warranty, Contact Us

14.1 Care and Maintenance

There are no user serviceable parts. The battery does not need replacing and the sensors do not need any maintenance.

If the Logger needs cleaning the this must be wiped very carefully, using a damp cloth (no detergent or soap). DO NOT wipe the Logger top PCB with sensors and avoid getting water into the case through the ventilation slots: there are many sensors next to the ventilation slots.

The PM and BR can be wiped with a damp cloth but avoid getting water into the interior.

If any of the rubber feet are lost then either remove the rest of the feet (the rubber feet provide a better platform on flat surfaces, but are not critical to performance) or request replacements.

14.2 Service

If the PM cable is damaged, then contact NosmoTech for a replacement cable or return the PM device to Nosmotech for servicing. If the PM fan (the only moving component) makes an unusual noise then return under warranty (if within 12 months) for servicing.

Should any device need servicing then contact NosmoTech, informing us of the problem. Send the device(s) to the address below, prepaid. Do not return your AC adaptor.

Should you lose the PM baseplate then email us and we will post to you a replacement. Should you lose the Reset Tool, you can use a paper clip to press the Reset Button (back of the Logger).

14.3 Accessories

There are currently no accessory components.

14.4 Warranty

NosmoTech Limited warrants that devices, excluding software and under normal interior use and service as described in the User's Manual, shall be free from materials and workmanship for twelve (12) months from the date of shipment to the customer. This limited warranty excludes the following:

- Electrochemical gas sensors, which are warranted by the sensor supplier
- Battery, if replaced with a different brand or type of lithium battery
- Repaired or replaced parts are warranted for 120 days from shipment to the customer

This warranty does not cover calibration requirements. NosmoTech warrants that the device is correctly calibrated at the time of manufacture. Devices returned to NosmoTech for calibration are not covered by this Warranty.

This Warranty is VOID if devices are misused, including use outside of the temperature and humidity ranges, sited outside and unprotected from rain and high humidity, opened and then incorrectly reassembled or damaged, located near a heat source that exceeds the temperature range, subjected to accidental or intentional misuse, or is not properly cleaned or maintained according to the requirements of this manual.

Software is not warranted but NosmoTech will endeavour to ensure the latest version of software is available to customers.

NosmoTech will not be responsible for loss of profit, business interruption or any incidental or consequential damages. NosmoTech will not be responsible for dismantling, installation or reinstallation charges or costs.

Goods returned for NosmoTech under warranty or for repair or calibration shall be at customer's risk of loss. If product is returned to the customer, this will be at NosmoTech's risk of loss. Do not return your AC adaptor.

If returning a Logger, most shippers require that Lithium batteries are shipped safely. The Logger Shipping Mode electrically isolates the Lithum battery making it safe to ship. To go to Shipping Mode: Press the RESET Button (back of Logger: use the RESET Button Tool or a paper clip) for 10 seconds. The Red then Yellow LEDs will switch On, then finally the Red LED will blink, then all LEDs will switch Off. You are now in Shipping Mode.

Return product, prepaid, to: NosmoTech for servicing or warranty:

14.5 Contact Us

Contact us through our email: support@nosmotech.com

Correspondence, and product return should be mailed to:

NosmoTech Ltd. 11 The Crescent Cambridge CB3 0AZ UK

NosmoTech reserves the right to change specifications without prior notice.

User Manual Release 2.1.1 May 2025 www.nosmotech.com