TROLEX

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PROTECT IT.



D1+

USER MANUAL

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1. GENERAL DESCRIPTION

The Trolex **XD1+ Personal Dust Monitor** is designed to provide detailed real-time data on airborne particulate levels so that users can take appropriate actions to stay safe and ensure personnel are fully protected from particulate-related health hazards.

The **XD1+** allows users to monitor respirable particulate matter values (PM) to indicate and warn of harmful personal exposure in working environments. Measurement information is displayed on device in the form of custom short-term exposure limit (STEL) or long-term exposure limit / time-weighted average (TWA) audio visual alarms.

Precise data is collected for the selected particulate matter value, enabling detailed concentration profiling and analysis using the Trolex **BreatheLITE** and **BreatheMOBILE** application software.



TX8061 XD1+

2. FEATURES

- Personal, wearable dust monitor
- Designed to provide early warning of personal exposure to airborne particulates
- On device early warning alerts for increased particulate levels
- PM1, 2.5, 4.25 and 10 measurement ranges
- 0.1 µm to 10 µm particle sizing range
- Low-end sensor resolution, measuring down to 0.1 µm
- Custom Logging Intervals from 10 seconds to 60 seconds
- On-device audio / visual alarms
- Custom alarm set points
- Custom STEL and TWA period alarm thresholds
- On-device self-check routine
- Battery operated, rechargeable (16 hours+)
- On-device data logging
- Live data readout via BreatheLITE application
- Data analytics functions via **BreatheLITE** and **BreatheMOBILE** applications
- Range of personal mounting options
- Low maintenance

2.1 Intended use

The **XXD1+** is a personal monitor designed for use in a range of applications and environments. The product alerts users to the change in particulate levels relative to predefined thresholds and limits, to ensure appropriate action is taken.

It's intended for the **XXD1+** to be personally mounted to provide waring and indication on particulate data in real-time or collected for subsequent analysis. The **XXD1+** is designed to be low maintenance and does not use pumps or filters in operation as found in other particulate sampling devices.

2.2 Limits of use

To ensure optimum performance and safe operation, the XD1+ must be operated according to the limits and instruction detailed in the technical data section of this user manual. Operation outside of these limits may result in damage to the equipment or failure to achieve the performance specification.

Trolex will not be liable for any injury or damage caused by incorrect installation, setup, operation, or maintenance resulting from a failure to follow the procedures and safety instructions provided in this user manual.

Note: Operating the XD1+ at extremes of the specified temperature limits may reduce the operating lifetime of the product.

3. PRODUCT SAFETY

The following symbols are used in this manual or on the equipment to indicate procedures that, if not followed correctly, may result in personal injury or damage to equipment.



WARNING!

Alerts the user to a potentially hazardous procedure or practice which if not followed correctly can result in serious personal injury or injury of others.



CAUTION!

Alerts the user to a procedure or practice which if not followed correctly can result in damage to the system or ancillary equipment.



WARNING! – LASER RADIATION

The use of controls, adjustments, or procedures other than those specified in this user manual may result in exposure to hazardous optical radiation.

4. DANGER FROM PROCESS

It is possible that the XD1+ could be installed or operated in environments that contain process particulates which can be hazardous to health.

Unless process conditions are known to be entirely safe, suitable precautions such as the use of breathing apparatus or environmental purging / detoxifying should be employed before entry is made into the installation or maintenance environment.

Note: This product variant is not designed for use with Flammable or Explosive dust in combustible concentrations. In the event of potential combustible concentrations becoming present in a non-hazardous location, this variant of the XD1+ must be powered down.

It is the responsibility of the installer to risk assess the suitability of the instrument for installation and use in the intended application.

5. SAFETY PROCEDURES

Always observe the safety precautions detailed in this user manual. Personnel installing, operating or maintaining the equipment are responsible for their personal safety and correct handling of the equipment in accordance with all safety instructions detailed or those outlined in local guidelines.

The XXD1+ has been designed to be as simple to install and commission as possible. Nevertheless, installation in working environments can be challenging and correct set up is critical to the function of the instrument.

It is important that you carefully read the entire product User Manual before using and installing the XXD1+ for the first time and keep it in a safe place for future reference.

Refer to the **Certification and Conformity** section of this user manual and to the relevant certificates for any installation parameters and special conditions of safe use. The installation or use of the XXD1+ must only be carried out by competent personnel. Observe the national safety regulations issued, for example, by the employers' liability insurance association, social security institutions, occupational safety and health authorities or other safety organisations.

The XXD1+ is a personal safety device and it is the operator's responsibility to respond accordingly to any warnings, alarms or alerts in accordance with site regulations and instructions. Follow all warnings and instructions marked on the instrument.

Retain these instructions in a safe and known place for future use.

5.1 Laser safety precautions

The XXD1+ is rated via the *Class 1* 'Laser Safety Guideline' under all conditions of normal use.

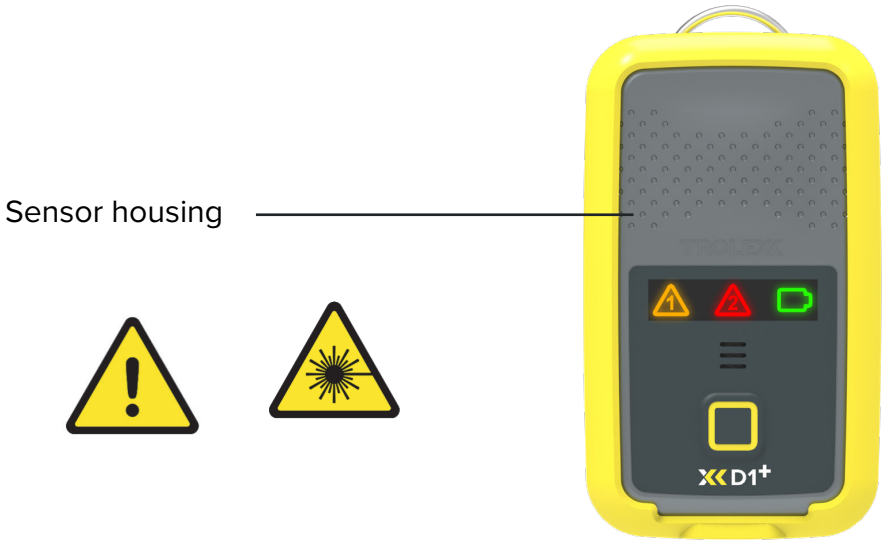
Class 1 laser products may contain laser systems of a higher class but there are adequate engineering control measures to ensure that access to the beam is not permitted during normal use.



WARNING – *Class 3B* laser radiation: **do not** open the laser housing when the laser is powered on as it may result in eye damage from directly viewing the laser beam.

The XXD1+ complies with:

- IEC 60825-1 2014
- 21 CFR-1040.10 and 1040.11

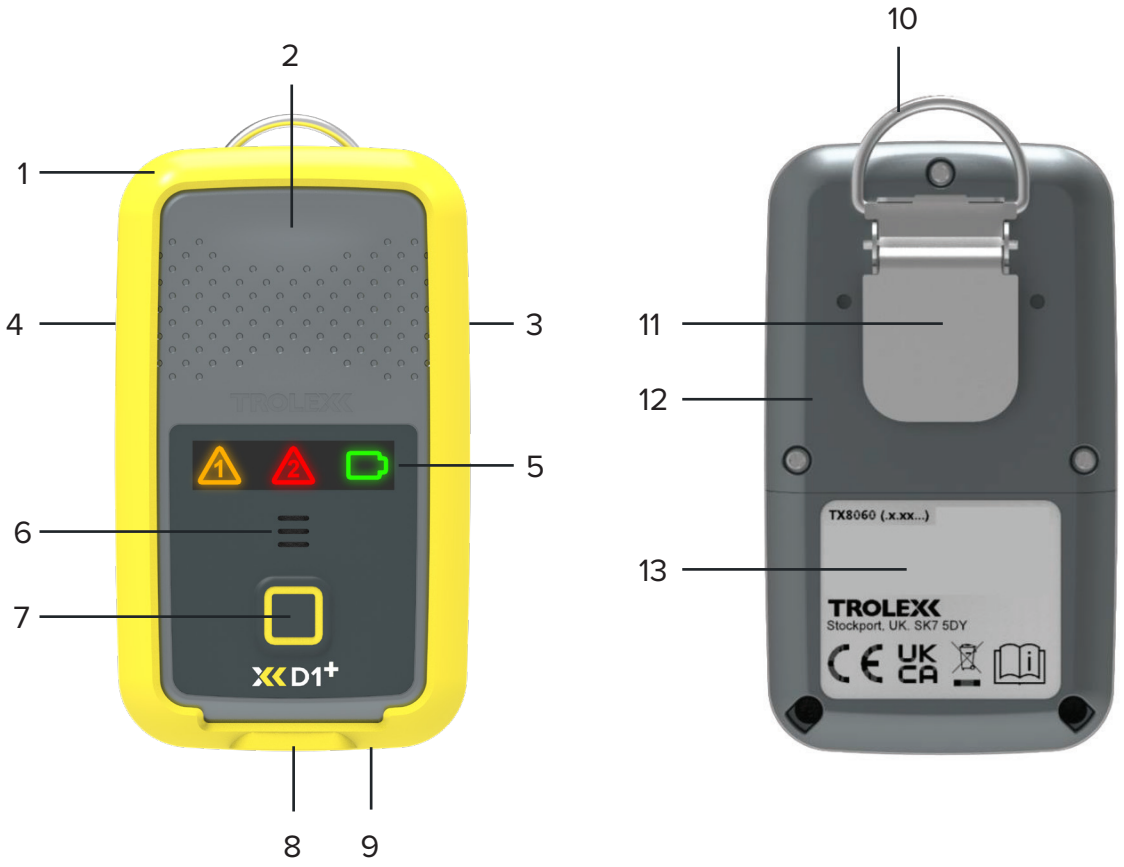


WARNING – There are no user-serviceable parts inside the XXD1+ sensor housing. Servicing should only be carried out by Trolex or an approved service technician.

6. DEVICE COMPONENTS

The XD1+ designed with end users in mind and allows for quick, robust, and instant installation to suit all applications. The product uses a sensor that is located inside the main housing that provides isolation and ingress protection between the particle flow path and control circuits.

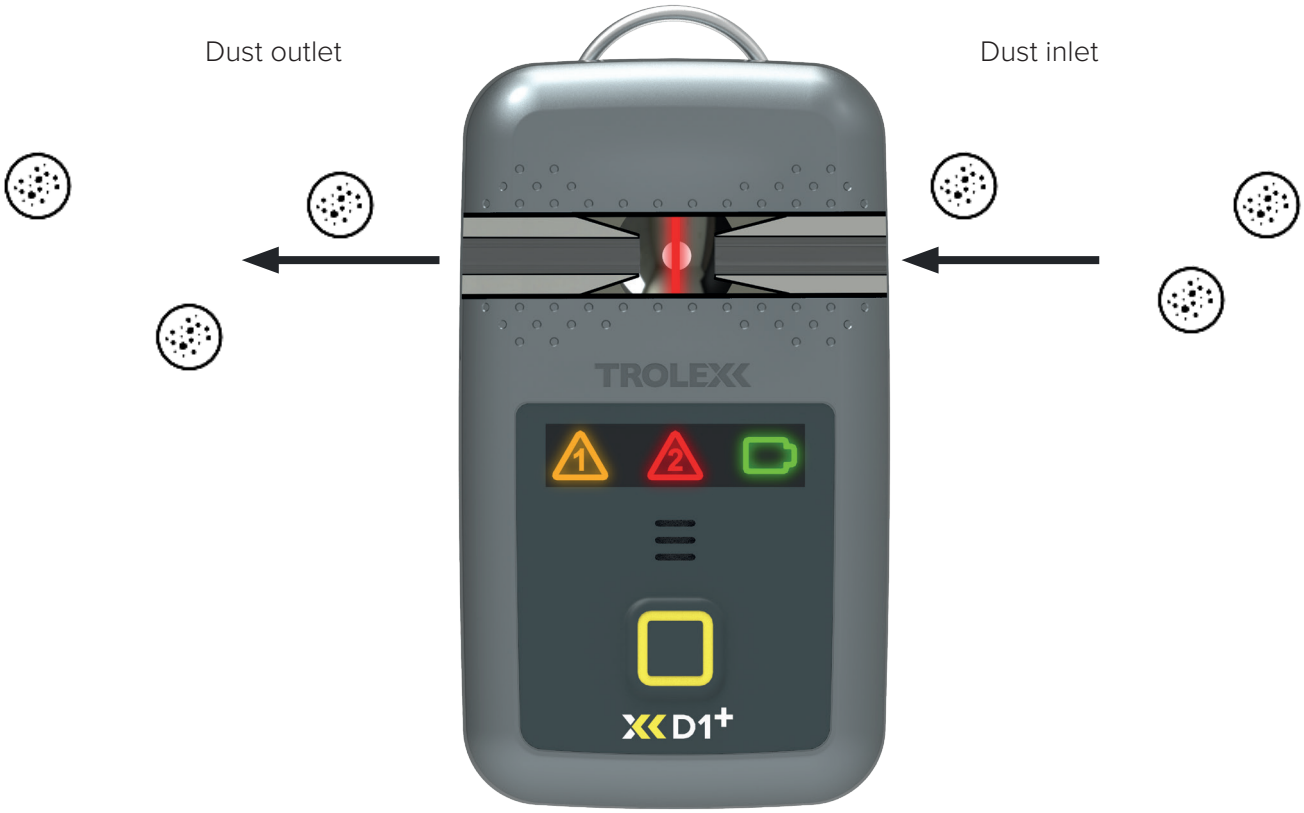
The following details highlight the main features of **XD1+ Personal Dust Monitor**.



1. Protective boot
2. Main housing
3. Inlet
4. Outlet
5. LED user interface
6. Sounder outlet
7. On / off function switch
8. USB C connector
9. Device reset button
10. Mounting loop
11. Aligator clip
12. Sensor housing
13. Product label

6.1 Particulate flow path

The XD1+ has been designed to allow for the free sampling of particulate concentrations using an unrestricted flow path as highlighted below. It is recommended that routine inspection and visual checks of the particle inlet and outlet is carried out to ensure it is free from any restrictive materials or ingress.



WARNING – There are no user-serviceable parts inside the XD1+ sensor housing. Servicing should only be carried out by Trolex or an approved service technician.

Care should be taken during normal operation to ensure that the device is not subject to unnecessary shock or impact levels.

7. CERTIFICATION AND CONFORMITY

7.1 Compliance

The XXD1+ complies with the following European Union Directives and United Kingdom Regulations:

EMC Directive 2014/30/EU
EMC Regulations 2016 S.I. 2016/1091

- **EN 61326-1:2013**
- **EN 61000-6-2:2019**
- **EN 61000-6-3:2007+A1:2011**
- **EN 62368-1:2020+A11:2020**
- **EN IEC 62311:2020**

Radio Equipment Directive 2014/53/EU
Radio Equipment Regulations 2017 S.I. 2017:1206

- **EN 61000-6-3:2007+A1:2011**
- **EN 62368-1:2020+A11:2020**
- **EN IEC 62311:2020**

RoHS Directive 2011/65/EU
RoHS Regulations 2012 S.I. 2012/3032

7.2 Product label

The following information is highlighted on the product label, accessible on the rear of the XXD1+ as highlighted in **section 6**.



8. TECHNICAL INFORMATION

8.1 Product specification

Particulate sensing parameters

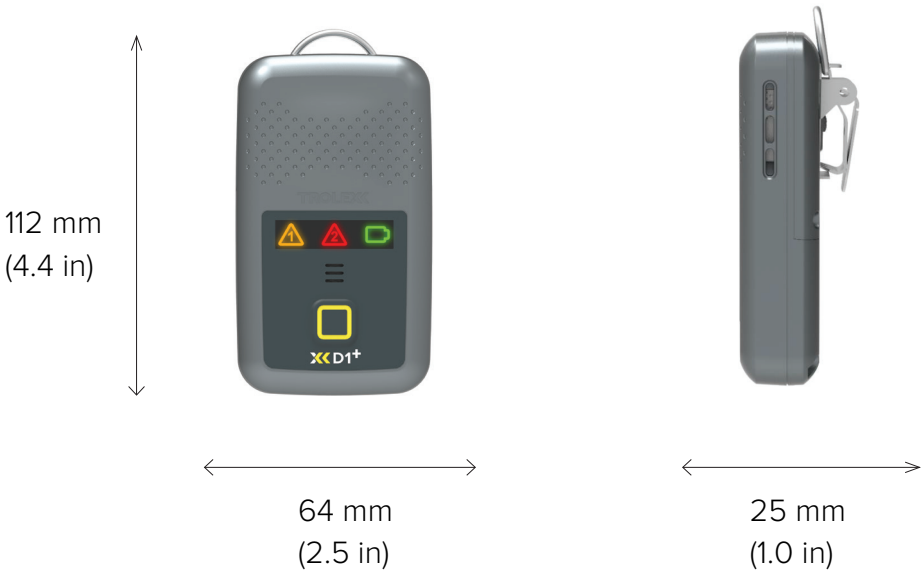
Sensing technology	OPC light-scatter photometer
Particulate measurements	0.1 µm to 10 µm
PM measurement capability	PM1.0, PM2.5, PM4.25 and PM10
Operating range*	Up to ~150 mg/m^3
PM density range	0.8 g/ml to 8.0 g/ml (default: 1.65 g/ml)
Units of measurement	µg/m^3 – logged on-device mg/m^3 or µg/m^3 – **BreatheLITE** / **BreatheMOBILE** application
PM measurement units	µg/m^3 – logged on-device mg/m^3 or µg/m^3 – **BreatheLITE** / **BreatheMOBILE** application
Sampling interval	Custom 1 second intervals (default 10 seconds)
Flow rate	0.1 L/min (typical)
Accuracy	± 10%

*The **XXD1$^+$** may define particulate measurement peak trends up to the quantity specified depending on operating environment.

Technical specification

Sensing technology	OPC light-scatter photometer
Particulate measurement	0.1 µm to 10 µm (PM1, PM2.5, PM4.25, PM10)
Particle count accuracy	±10%
Operating temperature Optimum performance Maximum performance	 10 °C to 40 °C -10 °C to 50 °C
Humidity Optimum performance Maximum performance	 20% - 80% RH, non-condensing 0% - 95% RH, non-condensing
Housing material	PC/ABS polymer housing
Ingress protection	Main enclosure: IPX4 Particle flow path: IP4X
Weight	170 g
Data connections	USB-C connector (charging and data transfer) Bluetooth LE 5.3
Connectivity	**BreatheLITE** PC application **BreatheMOBILE** application
User options	STEL and TWA alarm setpoints Latching alarms Particulate measurement
Operating range	Up to ~150 mg/m^3
Particulate density range	0.8 g/ml to 8.0 g/ml (default 1.65 g/ml)
Units of measurement	µg/m^3 – Logged on device µg/m^3 or mg/m^3 – **BreatheLITE** application
Sampling interval	Custom 1 second intervals (default 10 seconds)
Flow rate	0.1 L/min
User interface/alarms	Visual icon illumination (STEL, TWA, battery indication) Audible (85 dB) Vibration alert
Self-test	Sensor hardware, circuitry and battery test on activation ‘Push to test’ during operation
Response test	Custom particle compliance test
Battery capacity	8.2 Wh lithium ion
Battery run time	16 hours (full health at ambient)
Charging temperature limits	0 °C to 45 °C
Charging time	0% to 90%: 2 hours 0% to 100%: 3 hours
Max. charge current	1.5 A
Memory capacity	1 GB (6 months data logging at 10 second intervals)
Product fixing/body mounting	Personal mounting clip, Klick Fast stud options
Certification	UKCA and CE compliant

8.2 Product dimensions



8.3 Mounting details

The XD1+ is supplied with an alligator mounting clip as standard. A Klick Fast stud is available to allow the XD1+ to be compatible with a range of wearable, wall and pole fixing kits (see product data sheet for additional fixing kit details).



XD1+ alligator clip.

9. DEVICE CONFIGURATION

9.1 Default settings

The XD1+ has been programmed with factory default settings prior to delivery which have been detailed in the table below.

Default device settings can be manually changed as required using the Trolex **BreatheLITE** and **BreatheMOBILE** application.

Serial number	ABCDEFG123 (Trolex custom S/N)
Name	Blank
Operating mode	Normal
Alarm PM size	PM4.25
TWA period (minutes/hours)	8 hours
TWA threshold (µm/m^3)	1,000
STEL period (minutes/hours)	15 minutes
STEL threshold (µm/m^3)	1,000
Log rate (seconds)	10 seconds
Particle density (g/ml)	1.65

Default device settings can be manually changed as required using the Trolex BreatheLITE application.

*It is the user's responsibility to ensure that the XD1+ is configured in relation to local environment operation.

10. FIRST POWER ON

The XD1+ is shipped with a Lithium Ion battery cell that has been factory charged to no more than 30% of operating capacity for transport safety requirements. Before use, ensure that the XD1+ is fully charged using the supplied USB cable.

See **section 14** for further details on charging and device connectivity.

11. DEVICE FUNCTIONALITY

The following information details the operational functionality of the XD1+ device. With simplicity in mind, the XD1+ has been designed around the use of a single press switch and three illumination icons to indicate on-device warnings, battery levels and operating modes.



User interface icon display

The XD1+ has a simple tri-icon graphical interface which is used to communicate on-device warnings, sampling modes, battery indication and a device heartbeat.

Audio alarm

The built-in alarm sounder provides audio warnings at 85 db in conjunction with the illuminated icon interface to alert users to on-device alarm threshold breaches.

Power/function button

A single power and function button is used on the XD1+ for device power on/off, alarm acknowledgement and device self-test.

11.1 User interface icons and indicators



Icon 1



Primary function: STEL warning

Secondary function: Sequence function icon

Icon 2



Primary function: TWA warning

Secondary function: Sequence function icon

Icon 3



Primary function: Battery indication/heartbeat

Secondary function: Sequence function icon

11.2 Operational sequences

The following details the main operational sequences of the XD1+.

Power on



All icons will illuminate white.

Self-test sequence



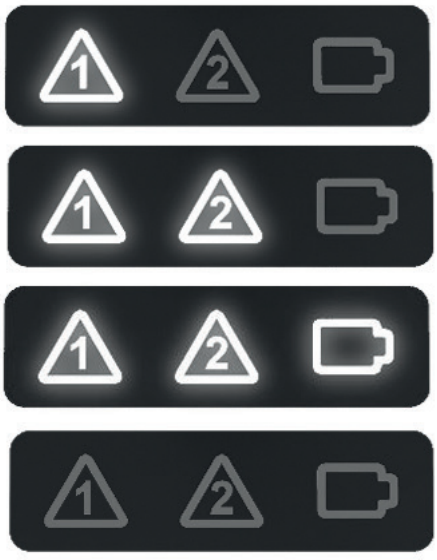
On initial power up, the XD1+ will perform a self-test sequence indicated by a sequential blue flash of each icon.

This is followed by a ‘pass’ indication of flashing green icons and sounder confirmation.



If the self-test fails or identifies any faults during the routine, flashing red icons will be indicated.

Power off



All icons will illuminate white incrementally before the XD1+ powers down.

STEL alarm threshold



Flashing amber warning icon 1 will be illuminated when the STEL threshold is breached.

TWA alarm threshold



Flashing red warning icon 2 will be illuminated when the TWA threshold is breached.

Battery icon



The battery icon will flash green intermittently (3 seconds) to indicate a power status between 100 and 70%.



The battery icon will flash amber intermittently (3 seconds) to indicate a power status between 69 and 40%.



The battery icon will flash red intermittently (3 seconds) to indicate a power status of 39% or lower.

When the XXD1+ reaches a battery level of < 10%, a red warning will flash every second.

Heartbeat



The XXD1+ heartbeat is indicated via the intermittent flashing (3 seconds) of the battery icon.

11.3 Power on sequence

The XD1+ has been designed to be simple to operate and the following information details the power on sequence. On device power on, please note that the XD1+ will automatically run the following sequence.

Note: Before first power on, ensure that the XD1+ is fully charged using the charger provided.

1. **Device power on**

   The XD1+ will switch on and run the start-up routine.

2. **Device self-test**

   The XD1+ will automatically run a self-test sequence and indicate a pass / fail result.

Auto-particulate sensing

The XD1+ will automatically begin sensing and recording operation environment particulate levels.

Note: The XD1+ is designed to begin particulate sampling as soon as the power on and start up routine is complete. STEL / TWA calculations, alarm warnings and data recording are immediately active alongside particulate sampling following the power on sequence.

To power on the XD1+, follow the steps below.

1. Press and hold the function button on the front of the XD1+ to initiate the power on sequence.

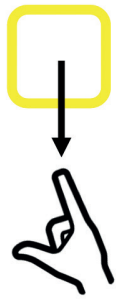


Hold

2. Release the function button on the front of the XD1+ when all icons are illuminated white.



Power on



Release

3. The XD1+ will perform a self test routine to check the sensor element, electronic circuitry and battery health.



Start up self-test routine

4. Following the self-test routine the XD1+ will display a “Pass” / “Fail” result via an audible visual alarm.



Self-test result

5. The XD1+ will automatically begin to sample particulate concentrations.



Sample routine

11.4 Power off sequence

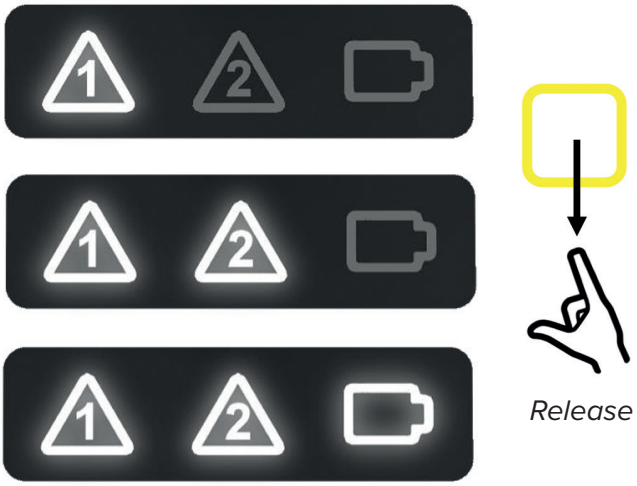
To power down the **XD1+**, follow the steps below.

1. Press and hold the function button on the front of the **XD1+** to initiate the power OFF sequence.



Hold

2. Release the function button on the front of the **XD1+** when all icons are illuminated white.



Release

Power off routine

3. The **XD1+** will power down.



Power off

11.5 Instrument self-test routine

On initial power on, the **XD1+** is programmed to perform a set of initialisation tests which are listed and described below. The device will perform the self-test routine every time it is switched on, with results displayed in the form of green flashing icons for a pass result and red flashing icons when an error is identified.

Refer to **section 11.2** for sequence illumination details.

- **Sensor comms check**

  Ensures communications and correct functionality of the OPC sensor.

- **Device hardware check**

  Ensures functionality of the internal electronic hardware.

- **Device battery check**

  Ensures that the internal battery pack is functional and calibrated for use.

- **Data logging comms test**

  Ensures communications and correct functionality of the XXD1+ internal memory storage.

- **EEPROM memory test**

  Ensures communications and functionality of the EEPROM is correct and that custom defined user settings are not lost.

11.6 User initiated ‘self-test’ routine’

At any point during normal operation, the XXD1+ can run the ‘self-test’ routine to ensure system functionality.

To perform a ‘self-test’, press and hold the power button until all three function icons are blue, at this point, release the power button and the device will initiate the ‘self-test’ sequence.

‘Self-test’ results

After the self-test routine has been performed, the XXD1+ will indicate the result via illuminated icon status.

Refer to **section 11.2** for “Pass” / “Fail” illumination details.

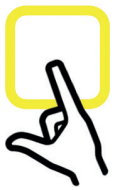
Note: On return of a “Pass” result, the XXD1+ will automatically continue with sensing operation.

On return of a “Fail” result, the XXD1+ will check if the fault is recoverable and repeat the ‘self-test’. This will take place up to a maximum of four times before the device will return a fatal error indication. In the unlikely case of fatal error indication, it is recommended to contact the Trolex service team.

To activate the self-test routine, follow the steps below.

1. Press and hold the function button on the front of the XD1+ to initiate the function sequence.



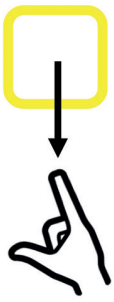


Hold

Power off routine

2. Release the function button on the front of the XD1+ when all icons are illuminated blue.





Release

Start up self-test routine

3. Following the self-test routine the XD1+ will display a “Pass” / “Fail” result via an audible visual alarm.



Self-test result

4. The XD1+ will automatically begin to sample particulate concentrations.



Sample routine

11.7 Accidental activation of power/function switch

The XD1+ has a single power / function switch that has been designed for all device input operations. All positive inputs are completed via a press, hold and release functionality and during normal operation accidental activation of the power swich, via a single press and release, is unlikely.

In the event that the XD1+ power / function switch is accidentally activated during operation, the device will alert the user to the prolonged button press and hold via a series of sequential audio alarms.

Once the power / function switch is released, the XD1+ will automatically perform a self-test and revert to normal sensing operation.

11.8 Power management

The XD1+ uses a single battery icon to identify the battery life of the device. The internal battery has a 16-hour operating capacity when fully charged and it is recommended that the device is charged between shifts to ensure maximum operational charge during use.

During normal operation, the battery indication icon is used to display the following battery status.

Green flashing icon (intermittent at 3-second intervals)

When the XD1+ is displaying a green flashing icon, the battery charge level is between 100 and 70%.



Amber flashing icon (intermittent at 3-second intervals)

When the XD1+ is displaying an amber flashing icon, the battery charge level is between 69 and 40%.



Red flashing icon (intermittent at 3-second intervals)

When the XD1+ is displaying a red flashing icon, the battery charge level is between 39 and 10%.

When the battery decreases below 10%, the red flashing icon will blink at 1-second intervals.



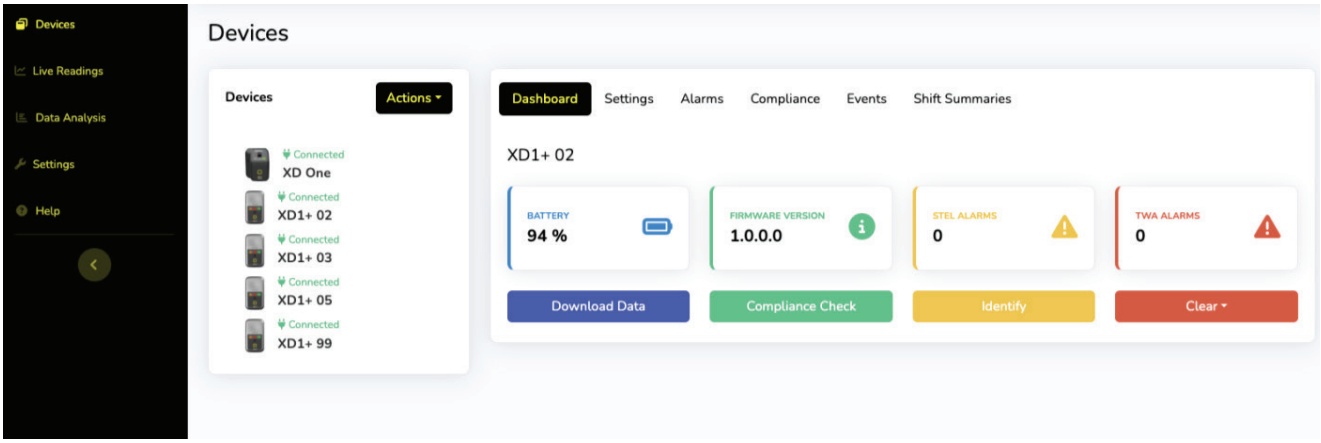
11.9 Low-power shut down

An automatic low power shut down is initiated when the battery level reaches 0%. The XD1+ will alert the user to a low power shut down by running the power off sequence described above.

If an attempt is made to power on the device without sufficient battery charge, the XD1+ will immediately run the shutdown sequence again.

11.10 Detailed battery indication

The XD1+ gives an on-device visual indication of operational battery life whilst in use; however, a detailed battery percentage level can be accessed by connecting the device directly to the accompanying **BreatheLITE** software application and navigating to the dashboard as highlighted below.



11.11 Battery calibration

The battery health is continuously monitored during normal operation and is calibrated when the battery is fully charged. If for any reason the battery is fully depleted, the XD1+ will lose the current stored battery calibration data.

Fully charging the XD1+ will recalibrate the battery monitoring functionality

12. OPERATING MODES

The XD1+ has 4 user-selectable operating modes for use in varying environments and reporting requirements.

- Normal (default)
- In-cab
- Data log
- Live data

12.1 Power management

'Normal' mode captures and records data at the specified logging interval, allowing the XD1+ to provide real-time warnings and alarms on changing particulate levels.

'Normal' mode is intended for use when the XD1+ device is used to monitor individual personal exposure to particulate levels within a working environment.

When configured to 'Normal' mode and connected via USB interfaces, the XD1+ will power down its particulate sensor to allow for faster charging and data download.

This operating mode is indicated through the flashing of the battery indication symbol during normal operation.

The use of the XD1+ in 'Normal' mode allows for both real-time alerting and on-device data capture to take place simultaneously. The XD1+ is designed to allow warning alarms to be set against a single Particulate Measurement (PM) value, however the device itself will log sensor data for the following sizes for offline review.

- PM1.0
- PM2.5
- PM4.25
- PM10.0

When recording PM readings to the internal memory, the XD1+ will log the maximum value for each size at the specified logging interval.

In 'Normal' mode, the user selected alarm PM size readings are taken every second and used to update the applicable STEL and TWA calculations which are then checked against the configured alarm thresholds.

12.2 'In-cab' mode

The **XD1+** 'In Cab' mode allows for the same operating functionally as 'Normal' mode, however, it allows the particulate sensor and device warnings to remain active when connected or powered via USB interfaces which allows the device to be continuously used in a vehicle.



This mode is indicated via the solid illumination of the battery symbol during operation as highlighted.

The **XD1+** will turn itself off after 5 minutes after USB power has been removed to save power.

12.3 'Data log' mode

The **XD1+** 'Data log' mode follows the operational functionality of 'Normal' mode, but readings are not checked against alarm threshold levels and on-device warnings / alarms will not trigger.



This mode is intended for use during passive monitoring of environments where data is captured for download and post-analysis using the **BreatheLITE** software.

This mode is indicated via 2 turquoise illuminated icons as highlighted.

12.4 'Live readout' mode

The 'Live readout' mode allows the **XD1+** to stream live particulate data to the **BreatheLITE** software via USB connection.



Particulate data is also logged to the internal memory for download and analysis as required.

This mode is indicated by 2 violet illuminated icons as highlighted.

13. ALARM WARNINGS AND CALCULATIONS

The **XD1+** uses 2 LED icons alongside audio sequences to alert users to changing levels of airborne particulates as highlighted below.



If a threshold is breached during operation, the following alarm sequence is used to alert users to act based on the change in the working environment.

'Icon 1': Short-term exposure limit (STEL) alarm

The **XD1+** will flash the amber STEL icon alongside an audible alarm (2 beeps per second).

'Icon 2': Long-term exposure limit / time-weighted average (TWA) alarm

The **XD1+** will flash the red TWA icon alongside an audible alarm (3 beeps per second).

In the event that both alarms are triggered simultaneously, the TWA alarm will take priority.

Note: The **XD1+** is factory programmed with the following default STEL and long-term exposure limit / TWA alarm warning thresholds:

- STEL alarm warning threshold – 1,000 µm/m^3 over 15 minutes
- TWA alarm warning threshold – 1,000 µm/m^3 over 8 hours

The default threshold limits have been defined based on a quarter of the permissible limit for most respirable dusts as outlined in the EH40/2005 guidelines.

Advice outlined in EH40/2005 states that where no specific short-term exposure limit is listed, a figure three times that of long-term exposure limit should be used. However, always refer to local guidelines and legislation to ensure that alarm warning thresholds are set at appropriate and permissible values for the intended operating environment.

13.1 Alarm calculations

The XD1+ uses the following calculation for the monitoring of STEL threshold breach.

STEL, where STEL TIME is in minutes:

$$STEL = \frac{\sum_{n=0}^{STEL\ TIME} PM_Reading(n)}{STEL_TIME}$$

The XD1+ uses the following calculation for the monitoring of long-term exposure reading/ TWA threshold breach.

TWA, where TWA TIME is in minutes:

$$TWA = \sum_{n=0}^{\infty} \frac{PM_Reading(n)}{TWA_TIME}$$

Note: The TWA calculation will reset on device power cycle, the sum is calculated on device start up and initial sampling to the current run time and will accumulate until the device is switched off.

13.2 Alarm acknowledgement

In the event that a warning alarm is triggered, the XD1+ will auto-latch to ensure that a conscious action is made to acknowledge the warning. During alarm state, users can acknowledge triggered alarms which will silence the audio alarm, however, the LED warning indication will remain illuminated (solid) to indicate the alarm conditions are still present.

It is only at the point of particulate level decrease to below the permissible threshold, 95% of the alarm set point, will the alarm reset and illuminated LED switch off.

To acknowledge a latched alarm, press, hold and release the power button after 2 seconds which will confirm response via an LED sequence. (Scrolling Illumination of alarm colour, followed by a scrolling green sequence).

Note: If an alarm is not acknowledged by the user, the XD1+ will remain latched with the illuminated LED and audio warning indefinitely.

The XD1+ device will only re-alarm on increasing or continued particulate levels above the permissible threshold, after the original alarm has been user acknowledged and self-cleared.

14. CONNECTIVITY

The XD1+ has been designed to be connected via the single USB port for battery charging, device configuration, live operating modes, and data review purposes.



14.1 Charging

The XD1+ device is charged via the on-device USB Port and cable provided. It is recommended that the XD1+ is charged using a wall adapter where possible to ensure that the maximum power is delivered to the battery in the shortest timeframe.

The XD1+ can be charged via a PC USB port, however, please note that this will take significantly longer to charge due to standard PC USB power delivery limitations.

The following sequence is displayed on the XD1+ during battery charging and is used to indicate the battery charge level. The XD1+ charge sequence will run at differing speeds for fast (wall adapter) or slow (PC USB) charging.

The XD1+ will display 2 solid white icons and a flashing green battery indication once charging is complete.



XD1+ charge sequence.



Fully charged indication (flashing green icon).

Note: When the XXD1+ is operated in 'Live' or 'In-cab' modes and consequently connected via USB during operation, the sequence highlighted above does not apply. These modes are designed to function during continued power of the XXD1+ unit via a USB or 12 to 24 V vehicle charger.

14.2 Data and charging dock

The Trolex XXD1+ has been designed to be paired with the Trolex multiway data and charging dock which allows multiple devices (up to 5) to be connected to the Trolex **BreatheLITE** Mac and PC application.



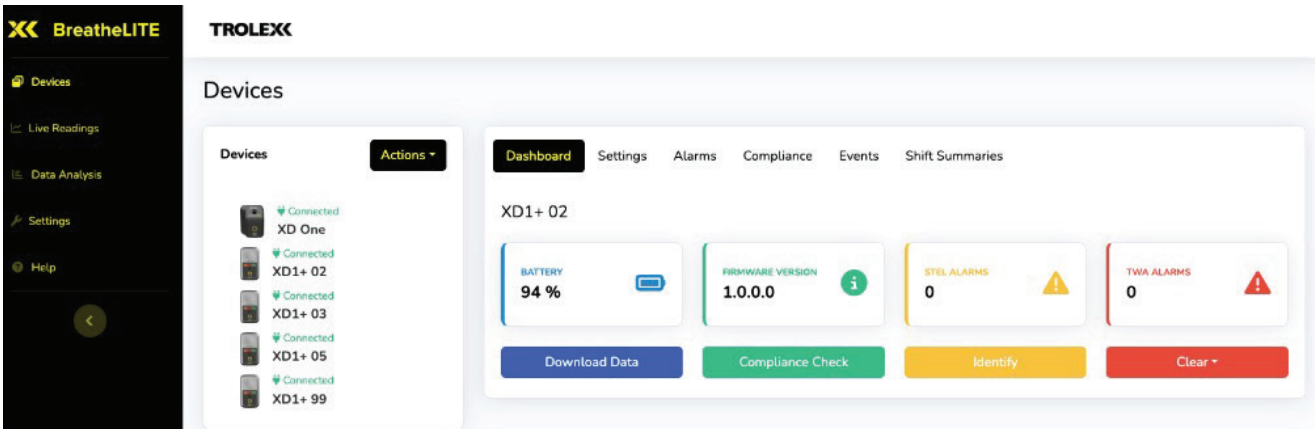
Connecting the data and charging dock to your PC allows for fast download and collection of device data, automatically recognising each device as it is located within any connecting slot. In addition, the dock charges each XXD1+ device when connected to ensure that they are fully charged between each operation.

14.3 Trolex BreatheLITE software

BreatheLITE serves as the dashboard interface for the **XD1+** and allows users to connect single and multiple devices.

Connecting the **XD1+** to the Trolex **BreatheLITE** software allows for easy device navigation, set-up and custom threshold setting as required. **BreatheLITE** is also used to store, view and analyse collected data from a single location and is an essential tool to support the maintenance of the **XD1+**.

Application information, details and a help section is available on download of the software.

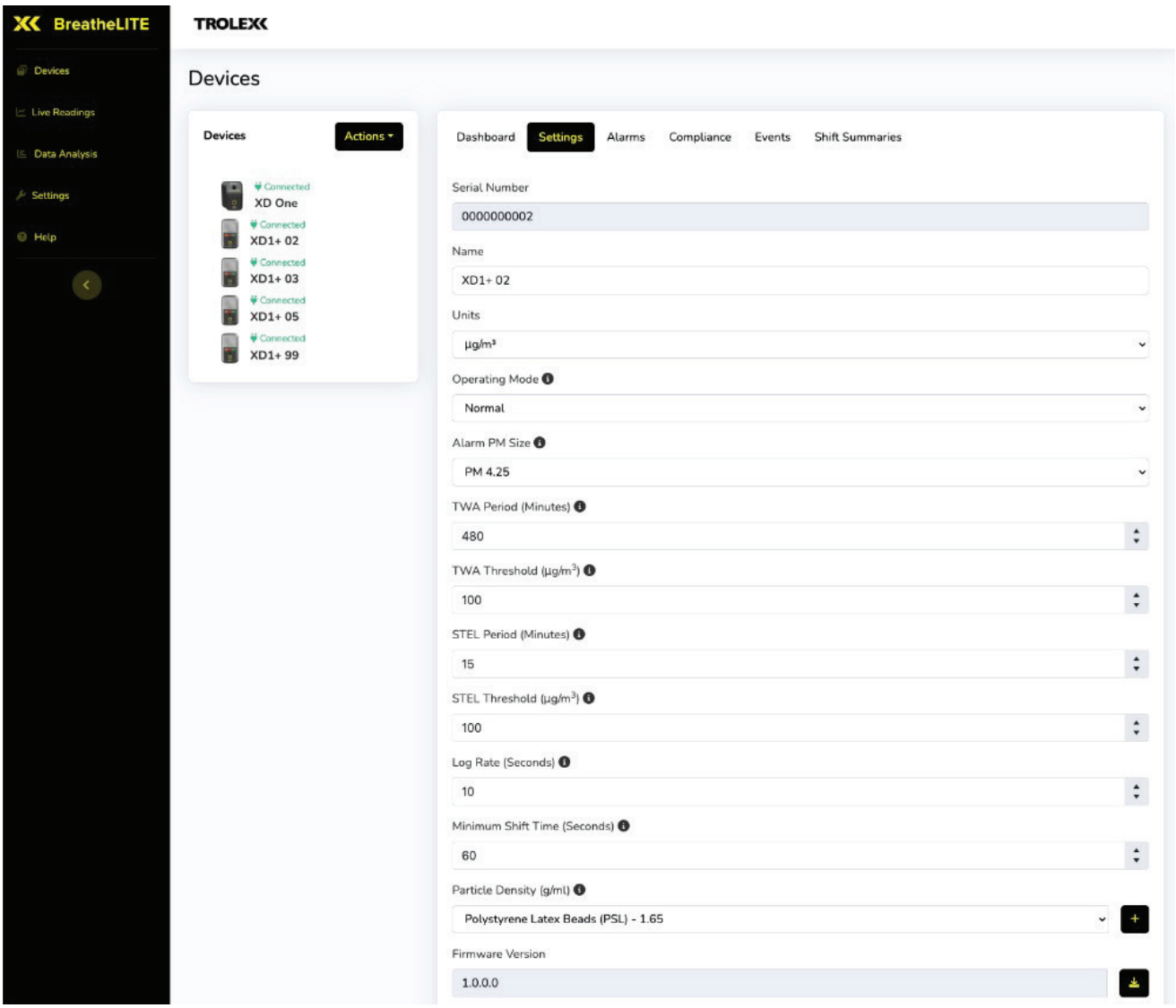


The Trolex **BreatheLITE** software can be downloaded by following the supporting information at www.trolex.com.

14.4 Configuration

The **XD1+** can be connected to the **BreatheLITE** software where users can setup the following parameters:

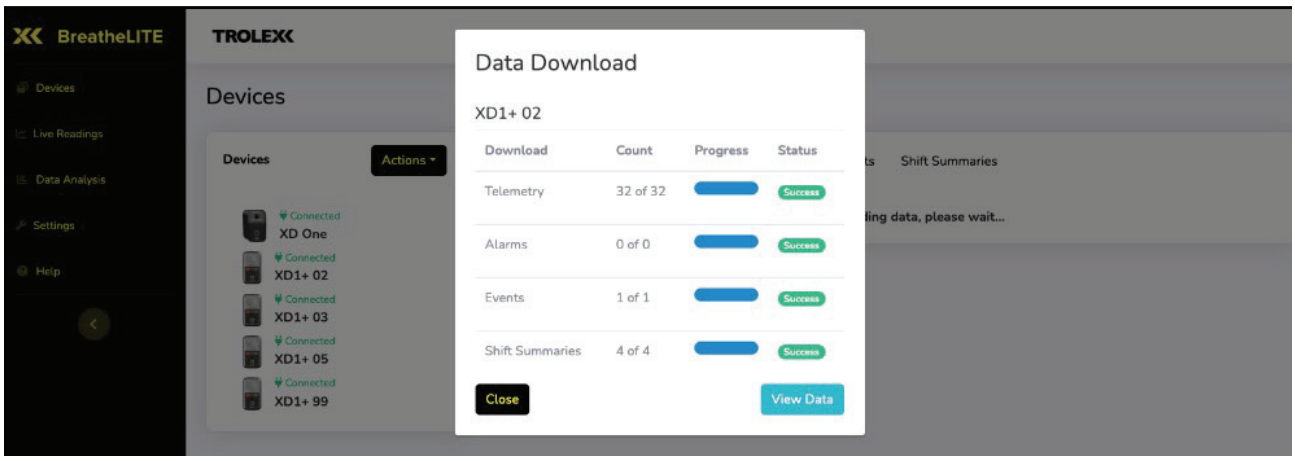
- Device name
- Com port
- Operating mode
- Alarm PM size
- TWA period (minutes / hours)
- TWA threshold (µg/m^3)
- STEL period (minutes/hours)
- STEL thershold (µg/m^3)
- Log rate (seconds)
- Particle density (g/ml)



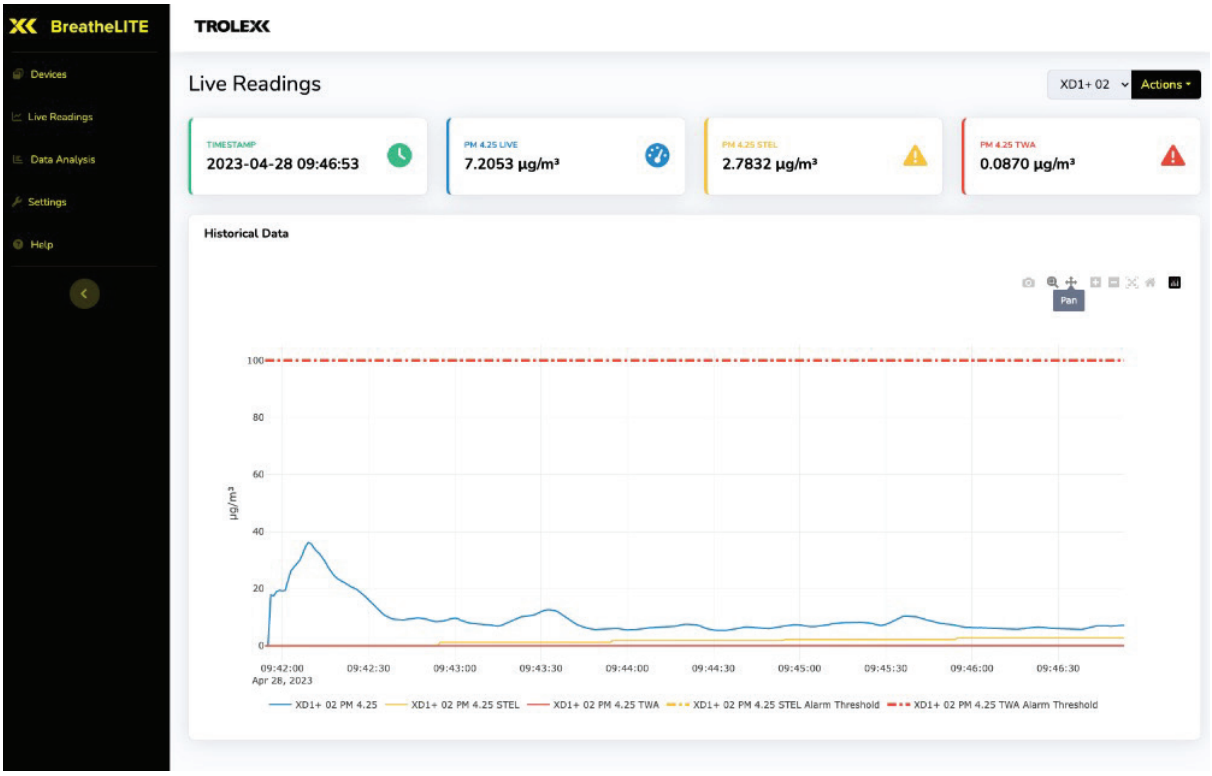
Note: For further details, please refer to the **BreatheLITE** in application help on device configuration

14.5 Data download

The **XXD1+** is designed to collect particulate data information during operation for download, review and analysis as required via the **BreatheLITE** application as highlighted below.



On download of captured data, the **BreatheLITE** application allows particulate information to be reviewed or live readings to be visualised using the data analysis tool set as highlighted below.



Note: For further details, please refer to the **BreatheLITE** in application help on data download and analysis.

14.6 Updating firmware

On instruction and release of updated operating firmware by Trolex, the XD1+ can be locally updated by connecting to the **BreatheLITE** software. Trolex will notify users of the latest update and accompanying release notes, and provide further instruction on updating XD1+ devices.

15. MAINTENANCE

The maintenance of the XD1+ must only be carried out by competent personnel. All maintenance and repair must be considered with reference to the local safety regulations and authorities.

The XD1+ contains no user-serviceable components and the limits of user maintenance are outlined in the following information.

15.1 Visual checks

Periodic visual checks should be carried out to assess if there are any issues or faults arising with the XD1+ device. Periodically, unsure devices are checked for the following:

1. Any external damage to the device. Plastic parts should not be cracked or broken which could affect the IP rating of the product.
2. Any obstruction to the particulate inlet / outlet.
3. Any damage or wear to the main product membrane, LED icons and power/function switch.
4. Any damage to the USB data / charge port.
5. Any damage to USB cable that is periodically connected to the XD1+ device.
6. Any damage to mounting hardware, clips, or fixings.
7. Labels on the product are still in place and are not peeling or discolouring.

15.2 Device cleaning

As part of the routine maintenance schedule and during use in high dust loaded environments, it is recommended that the XD1+ sensor is cleaned from time to time following the steps below:

1. Wipe down the XD1+ inlet surfaces with a damp cloth to remove any external dust and debris.
2. Using canned compressed clean air, spray the device inlet for 10 to 15 seconds to clean the dust path.



15.3 Cleaning labels

It is recommended to periodically clean the instrument with a damp cloth, to ensure the instrument user interface and keypad is clean and legible.

15.4 Particulate entry/exit apertures

The particulate exit aperture is protected by a stainless-steel grille to minimise the ingress of flora and fauna into the **XD1+** device. It is recommended that the grille is checked and cleaned during maintenance periods to ensure that it has not become clogged with ingress that may obscure the particulate sensing airflow.

15.5 Compliance audit check

The **XD1+** has been designed with an inbuilt compliance check routine / test to allow for the infrequent checking of device functionality against a selection of sized reference particulates.

The compliance check uses certified sample material that can be passed through the sensor to ensure that all sensing and sizing parameters are functioning as intended. Reference material with a specific size spread allows each sensing region to be populated with reference data during the process.

To run the compliance check sequence, connect the **XD1+** to the **BreatheLITE** software application, position in the supplied compliance base and cover with the particulate dispersion hood before selecting the automated test routine within the device maintenance menu.

The use of the compliance base and particulate dispersion hood allows for units to be isolated within a known volume during testing as highlighted below.



1. Insert the **XD1+** into the compliance dock.



2. Cover with particulate dispersion hood.



3. Run **BreatheLITE** compliance check.

The routine must be carried out using the Trolex Compliance Pack+ required to conduct the procedure, including:

- Reference particle sizes (Reference material)
- Dosing bottle

Sized reference material is used to periodically test specific operational aspects of the **XD1+** during the compliance audit check.

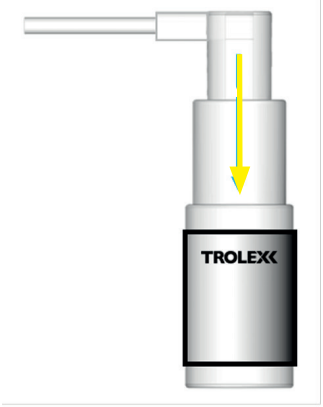
Once the **XD1+** is connected to the **BreatheLITE** software, and the compliance audit test has been selected from the maintenance menu follow the on-screen instructions to dose the device with reference particulate material.

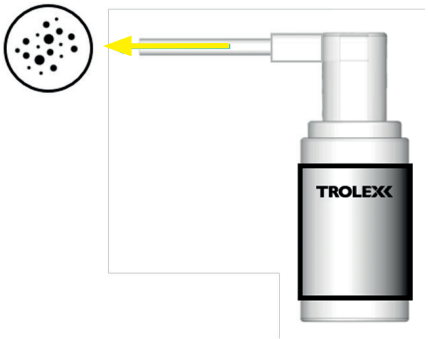


Note: The dosing bottle is a dispersing mechanism for the sample particulate material. Please ensure that these components are kept in a clean and dry environment, free from moisture and contaminants.

It is important to 'prime' the dosing bottle by shaking it vigorously to ensure the reference material is free to disperse into the hood.

To dose the reference material into the particulate dispersion hood, use the built-in pumping mechanism several times to active dosing.





15.6 Compliance audit check: Results

BreatheLITE is designed to return a “Pass” / “Fail” result based on the compliance audit check results and operational threshold for the applicable particulate sizes. This is displayed on completion of the check and is detailed in the device log of each connected **XXD1+**.

Return of a “Pass” result

On return of a “Pass” result, the particulate sensor is functioning as expected and normal monitoring operation can resume.

Return of a “Fail” result

1. Run a sensor cleaning operation as highlighted in **section 15.2**.
2. Repeat the compliance audit check sequence and note the test result.
3. On return of a “Pass” result, the particulate sensor is functioning as expected and normal monitoring operation can resume.
4. On One unit return of a repeat “Fail” result, please contact Trolex direct to discuss support or servicing of the **XXD1+**.

15.7 Preventative maintenance

In some circumstances, a routine preventative maintenance schedule should be used to ensure that the performance of the device is upheld. The following table should be used as guidance to the level of unit maintenance required based on environmental dust loadings.

Dust loading	Average dust loading in mg/m^3	Expected maintenance schedule
Low	Up to 5 mg/m^3	6 to 12 months
Medium	Up to 10 mg/m^3	3 to 6 months
High	10 mg/m^3 or above	1 to 3 months

Note: Trolex understands all particulate types are different and therefore this matrix should be used as a continual maintenance guide only, operational environments may be different. It is recommended that an assessment of the site environmental and operating conditions is carried out from time to time to support the required frequency of a routine maintenance schedule.

15.8 Atomised particulate suppression and mist spray

It is recommended that the **XXD1+** is operated with location and proximity consideration relating to atomising dust suppression systems. Instrument readings will include atomised or misted sizes that pass through the **XXD1+** sensor, within the particle detection range.

16. TROUBLESHOOTING

If an issue is non-resolvable based on the information below, please contact the Trolex product support team.

16.1 Recoverable errors

In the unlikely event that the XD1+ encounters a recoverable operating error, the device will log the event and automatically take appropriate action to resolve the issue.

It is recommended that on notification of recovery from an error, previous data capture and device settings are checked before continued operation.

User settings and configurations may need to be redefined using the **BreatheLITE** software.

16.2 Non-recoverable fatal errors

In the unlikely event that the XD1+ encounters a non-recoverable operating error, the device will cease normal operation and alert the user to the issue via flashing red LED's and an audible sequence as shown below.



In the case of a rare and non-recoverable fatal error, please contact the Trolex service team for support as detailed in.

16.3 Device fault codes

The following codes relate to on-screen warnings that the XD1+ will display when a fault is encountered during normal operations.

Sequence	Fault name	Fault description	Fault check
	Internal memory corruption	A corruption in the XD1+ internal memory was detected. Loss of data occured, or readings cannot be recovered.	The device will automatically format its memory and continue its. operation.
	Internal memory full	The XD1+ device's internal memory is full.	Download and clear the device data event and and alarm logs.
	Particulate sensor data error	The data received from the particulate sensor was found to be corrupt. The XD1+ will ignore this reading, log the event and continue its operation. If this occus more than 4 times, the XD1+ will alert the user and enter an error state.	Contact Trolex or an approved distributor.

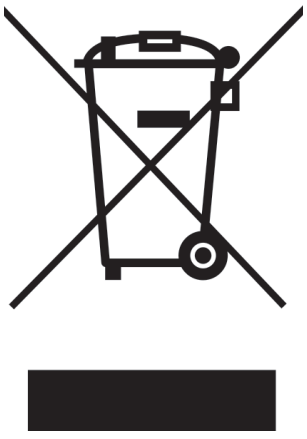
	Device settings corruption	A corruption in the XD1+ device settings was detected.	The device will automatically revert to factory defaults and continue its operation.
	Particulate sensor electronic failure	The XD1+ has detected an electronic hardware failure of the particulate sensor. The XD1+ will alert the user and enter an error state.	Contact Trolex or an approved distributor.
	Internal memory electronics failure.	The XD1+ has detected an electronic failure of the internal memory. The XD1+ will alert the user and enter an error state.	Contact Trolex or an approved distributor.

17. GLOSSARY AND DEFINITIONS

Flow rate	The volume of air mixture which passes per unit time.
IP	Ingress protection.
µg/m^3	Microgram per cubic metre. The concentration of an air pollutant given in micrograms (one-millionth of a gram) per cubic meter of air.
mg/m^3	Milligram per cubic metre. The concentration of an air pollutant given in milligrams (one-thousandth of a gram) per cubic metre of air.
OPC	Optical particulate counter.
PPM	Parts per million.
Particulate matter (PM)	General term for a mixture of solids and liquid droplets suspended in the air from typical processes including combustion, industrial activities or natural sources.
TSP	Total suspended particulate.

18. DISPOSAL

18.1 Waste of Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU)



This symbol, if marked on the product or its packaging, indicates that this product must not be disposed of with general household waste.

In the European Union and many other countries, separate collection systems have been set up to handle the recycling of electrical and electronic waste.

At the end of the product's life, do not dispose of any electronic sensor, component or instrument in the domestic waste. Contact Trolex or the distributor for disposal instructions.

19. GET IN TOUCH

19.1 Technical support

Our UK technical services team are available to provide expert ongoing technical assistance and technical support packages tailored to your specific requirements.

Please contact our technical services team:

Telephone: +44 (0)161 483 1435

Email: service@trolex.com

19.2 Feedback

If you have any suggestions for improvements or amendments, or find errors in this publication, you can contact marketing@trolex.com directly.

DISCLAIMER

The information provided in this document contains general descriptions and technical characteristics of the performance of the product. It is not intended as a substitute for and is not to be used for determining suitability or reliability of this product for specific user applications. It is the duty of any user or installer to perform the appropriate and complete risk assessment, evaluation and testing of the products with respect to the specific application or use. Trolex shall not be responsible or liable for misuse of the information contained herein. When instruments are used for applications with technical safety requirements, the relevant instructions must be followed.

All pertinent state, regional, and local safety regulations must be observed when installing and using this instrument. For reasons of safety and to help ensure compliance with documented system data, only Trolex or its affiliates should perform repairs to components.

Trolex Ltd. reserves the right to revise and update this documentation from time to time without obligation to provide notification of such revision or change. Revised documentation may be obtainable from Trolex.

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At Trolex, we save lives.

We believe that no person should risk their life to earn a living.

We aim to become the world's leading name in health and safety technology through pioneering products that provide real-world benefits to our customers whenever workers operate in hazardous environments.

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