DUSTCANARY 420 - PERSONAL DUST DETECTOR

Quick start manual v3.2 5/9/23

For use with

Firmware versions 1.58 to 1.66
Application software builds 4XX

www.DustCanary.com

Version Control

This version 310 guide reflects the following product changes and improvements and replaces version 2.0

DustCanary 420 wearable (1.58 firmware and higher)

- In 'sleep' mode the Bluetooth and Battery menus can now be accessed without need to switch the instrument on (dust detection mode)

- The Bluetooth identifier for the device is now displayed under the Bluetooth On menu on the screen

- Two pushes on the Yellow command button are required to start 'dust detection' from sleep mode

Browser application (version 1.1.464 and higher)

- View saved session graph and navigate / zoom / pan / export graph within the app without the need to export data to spreadsheet and use excel to create a graph

- New 'App Settings' to enable / disable features

- Import of previously exported XLSX files

- Backup / Restore a full browser system

Introduction

This quick start guide is for the DustCanary Trend 420 'personal dust alarm' and aims to provide sufficient information for a new user to operate this wearable safety device. This guide also refers to the DustCanary 420 as 'The device'

Device description and overview of functionality

The DustCanary Trend 420 dust alarm makes a real time qualitative measurement of respirable dust (mass concentration of particles less than 4 um in diameter) and activates alarms based on these readings. Real time qualitative respirable dust levels are displayed and may be transferred to a PC via Bluetooth wireless communication.

The device is a compact wearable dust alarm, comprising, power supply, sensor and associated electronics in a single enclosure. The device is designed to be convenient to use and is generally worn within an individual's breathing zone (attached to clothing with a secure clothing clip) avoiding the need for tubes connected to waist worn pumps.

key features are

- Warning and High dust alarms tied to audible and visual alarms

- Respirable dust levels monitored and displayed

- OLED display and menu

- Bluetooth coms for configuration and data transfer to PC via DustCanary browser application software

The device is powered by a rechargeable 5V Li ion battery.
The battery provides power for at least 12 hours of operation (16 hours when new) and is recharged over 4 hours via a USB C lead connected to a power source (PC or mains plug).

The **DustCanary browser application software** which runs within either the Microsoft Edge or Google Chrome browsers is used to configure the device and view and record respirable dust levels – See Appendix A

Page	Contents

Getting started

- Preparation

    o Initial battery recharge:

    The device is provided with a battery which is not fully charged to comply with airfreight regulations. To charge the battery

    - Connect device to a USB C cable at the base of the device via a laptop or charging plug.

    - Charging is indicated by the left-hand LED flashing blue. Once fully charged (which takes 4 hours @1A from a low charge state) the LED illuminates constant blue. A fully charged battery will give a minimum, of 12 hours operation even after 200 recharge cycles.

    o Mounting the device

    The device should be mounted on the exterior clothing of the individual to be monitored. Typically, the device is clipped to the outside of a wearer clothing at the lapel level within the breathing zone of the individual (300mm of the nose). The device should be positioned with the air sampler inlet pointing forward and horizontal so it is exposed to similar aerosol to that breathed by the individual.

    In applications where there is interest is to monitor the dust level at a particular location over time the device can be permanently powered with the USB C cable. The device should be mounted on a tripod or orientated so that it is mounted in a vertical position with its inlet pointing in the horizontal.

    o Recharging the battery

    The battery should be recharged overnight between uses with a USB C cable. A full battery has sufficient capacity for over 12 hours of operation. If used in a fixed location the device may be permanently powered by a USB-C cable.

    The battery charge level is shown on the display. The Green LED will start to flash green (and give an intermittent audible alarm) when the battery life is less than 1 hour remaining.

Operating the device

The device is normally used in the field without a PC and then data is transferred via a PC at the end of the day. The instrument is controlled by two buttons on the left-hand side of the front case

- The **upper black button** (immediately left of the screen)– is used for menu scroll through the displayed screens

- The **lower yellow button** – is used to turn ' dust detection' **on/off** and **enter** commands (exit, mute and toggle Bluetooth on/off)
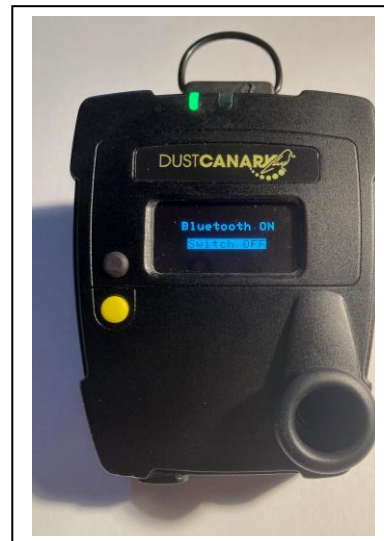
To conserve battery life, the display remains illuminated for 30 seconds and can be reactivated by pushing either button

The device's alarms and data recording become live whenever 'dust detection' is switched on and the green LED is illuminated

Switching 'Dust Detection' On

- 'Dust Detection' may be switched on and off by pressing the yellow ON/OFF button on the front of the device and holding for 2 seconds. When the unit is switched on the display becomes active (initialising and showing the firmware version) and the green LED is constantly illuminated. You may also here a faint noise from the fan which draws a sample into the sensor.

- If the unit does not switch on when the yellow ON/OFF button is first depressed, the unit is first exiting 'stand- by' mode. Repeat the 2 second press on the yellow ON/OFF button until there is a beep.

- The green LED remains illuminated whenever the unit is 'dust detection' mode , and only flashes green when the battery needs recharging (less than 1 hour of operation left)

Switching Device off/Standby mode

- To switch the device off and put it into standby mode press down on the same yellow button for 2 seconds. The display will show 'Shutting down' and the LEDS will all switch off. The background noise associated with the device fan will stop.

- In 'stand by' mode the menu scrolls between Bluetooth and Battery level menus. The green LED is NOT illuminated when in stand by mode and no dust detection or recording occurs.

Alarms

- o If alarms are enabled (via user settings in DustCanary application software), alarms are active whenever the instrument is in 'Dust Detection' mode and the green LED is constantly illuminated.

- o On going into an alarm state the device

    - o Gives an audible alarm (which can be muted by selecting the enter button)

    - o Shows a visual alarm

        - ▪ Red LED indicates High Dust Alarm

        - ▪ Yellow LED indicates Warning Alarm

    - o Displays the Alarm state on the display

- o Alarm levels are set considering the normal dust level experienced by an individual when dust controls are working correctly. They may in certain circumstances   set at higher levels than short term Work Exposure Limits (WELs) since this   increased dust exposure contribution to the 15 minute average is only for the period where preventative action is not taken (which is generally in seconds).

Respirable dust measurement

- The DustCanary uses an advanced optical particle counter (OPC) sensor module to make a real time measurement of respirable dust. A replaceable respirable foam filter may be fitted to the inlet of the device to filter out larger particles than 4um before they enter the OPC module and hence extend its life.

- The valid measurement range of the device is 0.001 to 10mg/m3, although the device monitors records respirable dust levels up to 15mg/m3

- The sensor module should be replaced atleast every 3 years (please consult DustCanary for recommendations on replacement periods for different dust loadings and applications)

Data recording

- o Data is stored automatically within the device whenever the instrument is in dust detection mode (indicated by constant green LED) . Different recording sessions are created each time 'dust detection' is switched on and off and these may be downloaded and viewed as excel graphs using the DustCanary application software (see appendix A)

- o The default recording rate is every 5 seconds, however this may be changed in the range 1- 60 seconds using the DustCanary application software

- The 15 minute rolling average of dust levels is also calculated by the DustCanary application software and may be graphed in addition to the recorded data. This rolling average is a good indicator of respiratory dust exposure. This data may be used to complement periodic compliance sampling and give confidence that exposure is being controlled between compliance samples

Qualitative dust measurement

- The device provides a qualitative real time measurement of respirable to dust which complement the average compliance result from a periodic gravimetric sample (to MDSH 14/4 in UK). The results should not be used to replace gravimetric sampling results but instead be used to extend knowledge and improve safety by:

  - providing incites to the dynamics of dust levels over time (during a gravimetric sample and also on other days)

  - giving visibility to changes in dust at any time that the device is used.

  - Monitoring personal exposure to respirable dust over shorter periods of time than can be measured with gravimetric sampling

- The quality of the calibration maybe improved by comparing the average instrument reading from the device to the average obtained from a gravimetric sample operating over the same period of time

- The device should be returned to DustCanary for a calibration check once a year. There is a reminder message 'calibration due' which is reset to appear 12 months after the last calibration. The instrument may still be used for measurement while this message is displayed but with higher uncertainty applied to the results - See calibration section

DustCanary 420 menu structure

- On entering 'Dust detection' mode by depressing the yellow button the device goes through a 20 second Intialising process and displays the version of the firmware code being run in the device

- The Green LED will also be illuminated, indicating that the device is detecting and recording dust levels

The top **BLACK** button should be pressed to toggle between the menus which appear in the following circular order:

Menu	Display message (and alternatives)	Comment
Bluetooth	Bluetooth ON DCXXXXXX (the device's serial no) Bluetooth OFF	Bluetooth must be switched on for communication with DustCanary application software
Alarm settings	Warning alarm dust level in mg/m^3 High dust alarm level in mg/m^3 Or Alarm 'not set'	If alarms are enabled (set) thresholds are displayed here The DustCanary application software is used to change the alarm settings (thresholds, holdoff period and alarm enabled or not) – see Appendix B
Battery	% charged Charging (if connected via a USB C connector to a power source)	Device shuts down when battery is <10% 12 hours operation on 100%
Alarm status	No dust alarm Warning alarm High dust alarm Dust protection mode (if activated) Sensor error	Message depends on alarm state
Dust level	0.0XX mg/m^3	The qualitative respirable dust level monitored by the device, updated every 1 second and displayed to 2 significant figures The maximum value displayed and recorded is 15mg/m3

- In standby mode (green LED off), the top **Black** button toggles the display between the Bluetooth and Battery menu

Menus displays are

- **Bluetooth** - this is where Bluetooth can be switched on or off

o The current Bluetooth state is shown on the top line. To change state, press the Yellow COMMAND button (lower yellow button)

o When Bluetooth is on, the Bluetooth identifier, in the format DCXXXXXX, is also displayed (this is the same as device's serial number which is printed on the rear label)

o **Alarm settings** – the current settings levels for the warning and/ or high dust alarms (if set)

o To change alarm setting, switch Bluetooth on and connect to DustCanary browser software (see appendix A)

o **Battery level** – the current charge state of the battery between 0 and 100%. Battery life between recharges is >12 hours.

o Recharge when battery <20%

o The current **alarm state** is displayed **or No dust alarm** if no alarm

o The **dust level is** displayed in mg/m^3

o To view the trend of dust levels within recorded sessions , switch the Bluetooth ON and connect to DustCanary application software (see Appendix A)

Service requirements

Regular maintenance

- The device should be kept clean and excess dust deposits removed by a soft brush, cloth or vacuum

- Excess dust on the inlet to the device should NEVER be blown into the device, since this may contaminate the optical sensor – excess dust should be removed with a vaccuum

Optional Pre – inlet filter

- The device has an aerolic filter to remove larger particles to protect the optical sensor from contamination (these are particles greater than 10um in size which are not included in the respirable dust measurement anyway)

- In cases where the dust level is regularly greater than 1mg/m3 this aerolic filter will not be able to cope over the long term and it is advisable to install an optional prefilter on the inlet. This removes particles greater than 4um in size and does not effect the measurement. This filter should be replaced after 40 hours of operation above 1mg/m3 or every month which ever happens first.

Device sensor checks

The device continuously monitors the condition of its sensor to ensure a valid measurement. Should there be a failure of the sensor, the device automatically shuts down. The condition behind any sensor failure is recorded in the alarm log and may be ascertained by downloading the session, exporting an XLXs file for the session and reviewing the 'dust log' tab. The alarm state is displayed in the last column.

Please note that if the alarm state is prefixed with 'OPC degraded', this is not a failure and should not be a cause for concern unless it is happening more than 25% of the time

	A	B	C	D	E	F
	DEVICE	DATE + TIME	TIME	QUALITATIVE DUST LEVEL	QUALITATIVE 15M AVERAGE	ALARM STATE
	DCCCCCCD	2023/06/02 08:08:36	8:08:36	0.36250	0.36250	OPC_DEGRADED, OPC_FAN_ERROR
	DCCCCCCD	2023/06/02 08:08:41	8:08:41	0.45870	0.41060	SENSOR_OK
	DCCCCCCD	2023/06/02 08:08:46	8:08:46	0.34080	0.38733	SENSOR_OK
	DCCCCCCD	2023/06/02 08:08:51	8:08:51	0.12400	0.32150	SENSOR_OK
	DCCCCCCD	2023/06/02 08:08:56	8:08:56	0.37210	0.33162	SENSOR_OK

Failure states of the sensor are

- Laser error

- Memory error

- T/ RH error

- Fan error

Sensor replacement is normally required to solve a persistent sensor failure condition . Please contact DustCanary

Calibration

Annual calibration

- The device should be recalibrated annually by returning the unit to DustCanary Ltd or its International service partners. The sensor is calibrated against a reference instrument over a range of representative dust concentrations

- The device is programmed to display a reminder when a calibration is due. The instrument continues to operate after this message is displayed and users should be conscious that until recalibrated any resulting data from the device may be less reliable

Response test

- The response of the device may be checked with a Smoke Alarm tester. The aerosol cannister is position approx. 20cm from the inlet to the device and an aerosol is sprayed towards the device

- The following functionality may be checked

    o Operation of the warning and High dust alarms

    o Display of dust level (the exact dust reading is not considered for this test, unless specific procedures are followed to create a repeatable aerosol concentration by spraying into a dilution chamber for a defined time, allowing the aerosol to mix fully with the air in the dilution chamber before the device to pull a sample from the chamber – please consult Dustcanary for further guidance)

Appendix **A**

DustCanary Browser Application software (version 4xx)

The DustCanary application software https://app.dustcanary.com provides the following features:
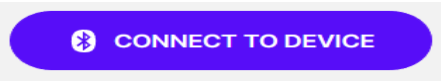
- Configuration of device settings (alarms, recorded sessions logging intervals etc)

- Download of recorded sessions from the device, plot of dust graphs. and export of data into XLXS and CSV formats and NIOSH's EVADE software

- Live View of data for fixed location installations and demonstrations

The PC must be connected to the internet when first running the application, however further connection is not required to run the application with a device (unless accessing browser application updates)

To run software

- Ensure Bluetooth on DustCanary device is ON by scrolling through its menu until Bluetooth menu is displayed and toggling select button until menu reads' Bluetooth ON'

- Run https://app.dustcanary.com within Microsoft Edge browser (note the application does NOT currently support use within Chrome) - *is this still true?*
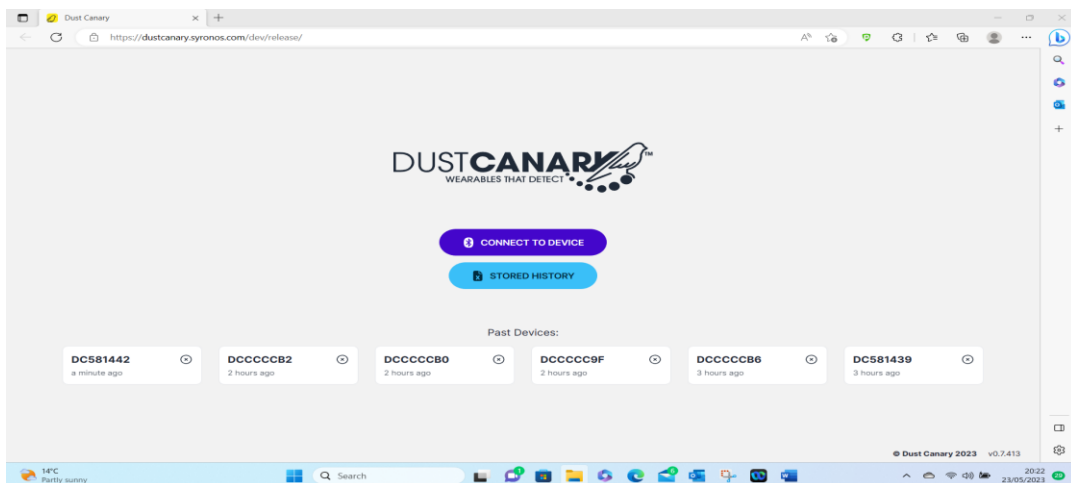
- Select

- Select 'DC XXXX' where XXXX is serial No of device (as on device screen and back label) and then 'PAIR'

- The display will show 'connecting' and then 'preparing' before moving to the 'Device recording' tab on the left hand menu

Should there be any problems in connecting, switch the Bluetooth off and on within the DustCanary device. exit the app before repeating the above

Live View

The Live View tab is used to show current results from the device. It is a useful screen to familiar-iise oneself with the device, see operating parameters and demonstrate functionality.
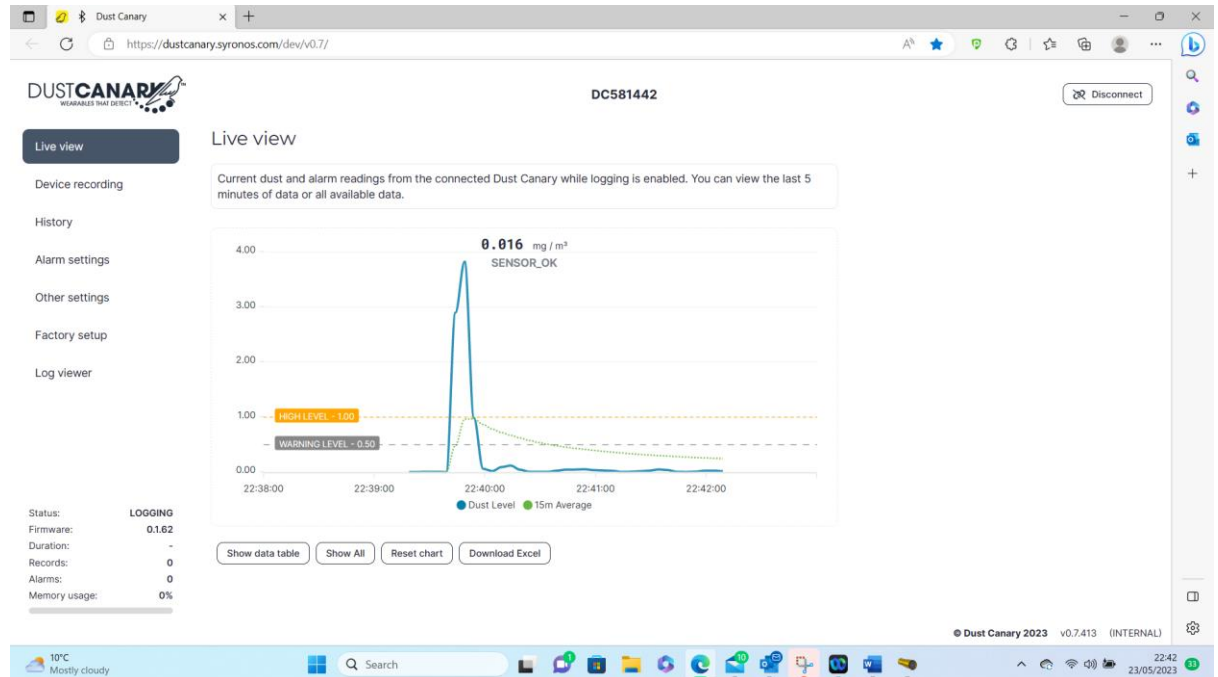
- Select the Live View tab on the top left of the screen to graph the current dust level against time

  - The alarm thresholds (for alarms that are enabled) are displayed on the same graph, as a dotted line

- Operating parameters of the device are also displayed at the bottom left of the screen

Status:	LOGGING
Firmware:	0.1.62
Duration:	-
Records:	0
Alarms:	0
Memory usage:	0%

- Dust levels shown on Live View may be downloaded as an Excel file . However the recorded sessions of data in the device cannot be accessed with LIVE View and must be accessed with different menus

  - For recorded sessions the Device recording and History tabs are used to download and review recorded sessions

To configure the device

To change the dust alarm settings select 'ALARM settings'
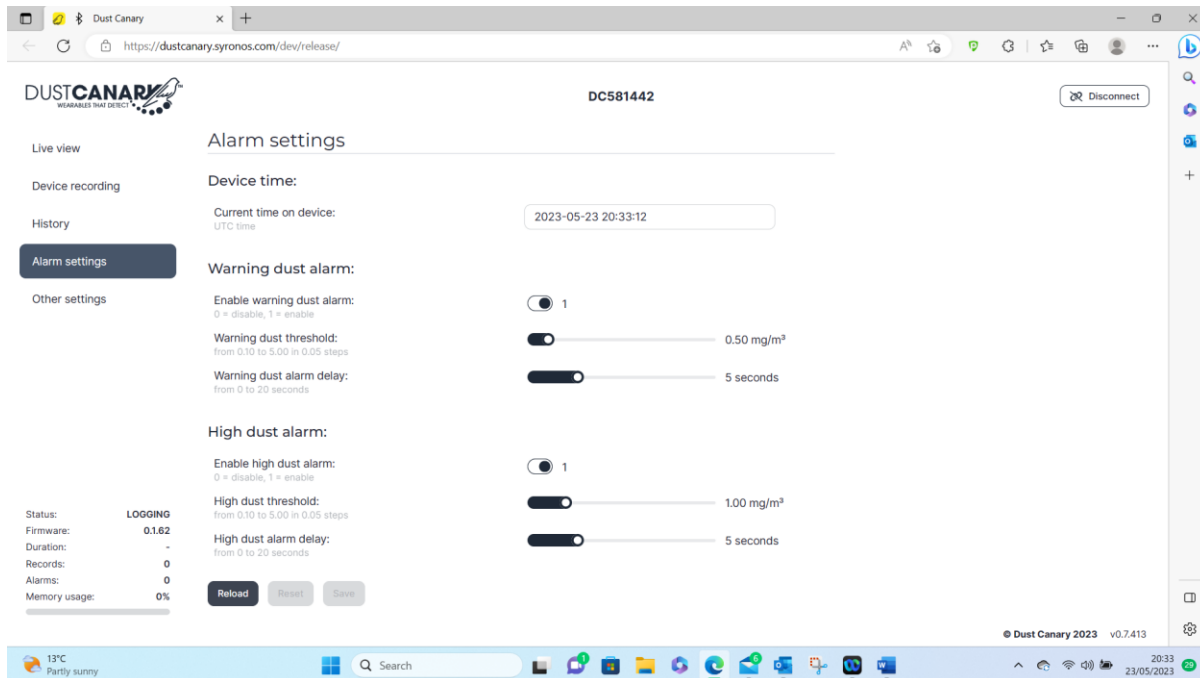
Warning and Hi dust alarms may be set independently. When the DustCanary 420 is used for making surveys both alarms are normally switched off, however when the instrument is used as a safety device to warn wearers of elevated dust levels, warning and /or hi alarms should be enabled. When set, alarm conditions activate an audible buzzer and visible alarm LEDS in the DustCanary 420.

Dust alarm levels should be set considering normal dust levels in the plant and set to warn when dust levels increase above controlled conditions.

Alarm settings are configured by sliding the indicator bars to the required values and then saving with the SAVE button. Alarm Settings that can be changed are

- Enable warning dust alarm - O is Off , 1 is On
- Warning dust threshold (increments of 0.05 from 0 to 5mg/m^3)
- Warning dust alarm delay (use if you wish to avoid short duration dust pulses creating alarms)
- high dust alarm - O is Off, 1 is On
- High dust threshold (increments of 0.05 from 0 to 5mg/m^3)
- High dust alarm delay (use if you wish to avoid short duration dust pulses creating alarms)

Once changed setting must be SAVED to transfer settings to the device

If the current time on the device is not set correctly, a menu which gives the option to synchronise to the time in the PC will appear when first connecting to the device

15

To change recording and advanced settings, select 'Other settings'
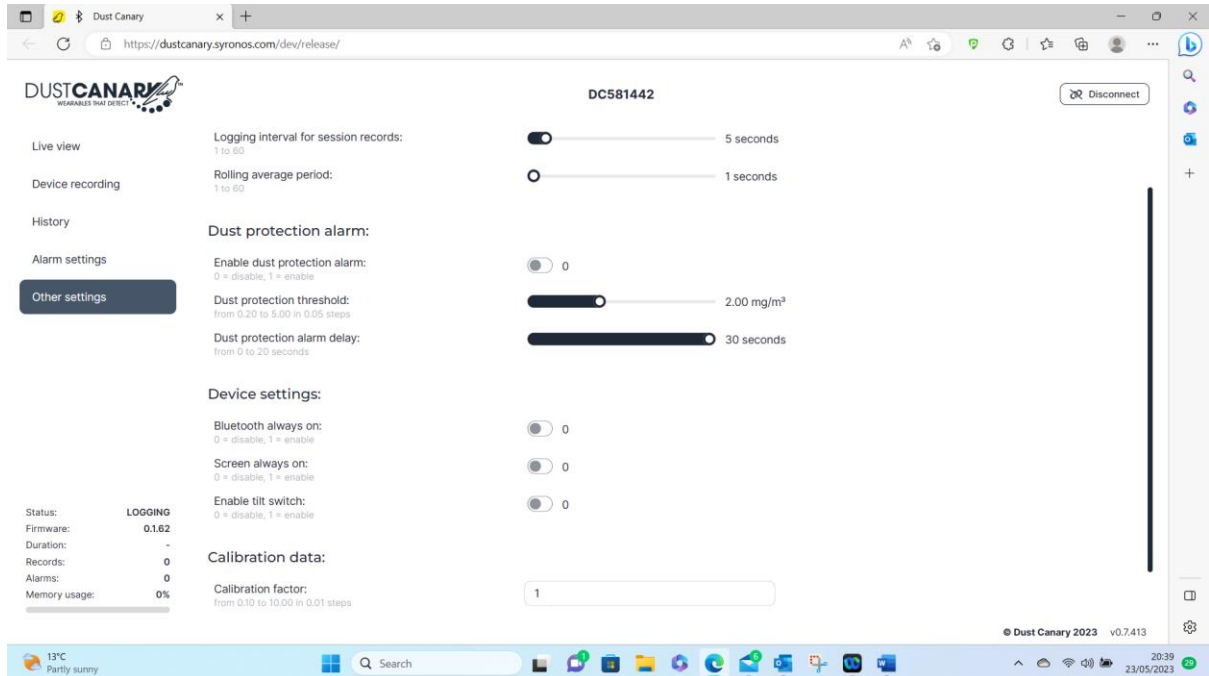
This screen is used to configure the following setting which should be <mark>SAVED</mark> after any required change to transfer these settings back into the DustCanary 420 device

- Logging interval – this is the time period between recording of dust levels and also the refresh rate of the plotted dust signal on the Live view

    o The logging interval should normally be set to 5 seconds. It may be reduced to 1 second if high resolution dust profiles are required, but this will slow down the transfer of recorded data (Sessions)

- Rolling average – the averaging period applied to the raw dust measurment. – this is increased If the dust signal is too noisy to interpret

- Dust Protection alarm levels – this high alarm is used to protect the sensor from avoidable contamination at elevated dust levels

    o In dust protection mode the alarm on the device activated and the sensor is put in sleep mode, where it swiches off its sampling fan, until the alarm is 'muted' /overridden by the wearer when normal operation continues

    o Typical settings for dust protection mode are threshold of 3mg/m^3 and alarm delay of 30 seconds to allow the sensor to detect short duration elevated dust levels but not suffer contamination if dust levels persist for more than 30 secs

- Device settings

  - In order to conserve battery life both the bluetooth connection and device display are switch off after 30 seconds of not being used

    - 'Bluetooth always on' can be set so that live data can be continuously streamed.

    - 'Screen always on' may be set when wishing to have a permanent display of the dust level (without the need to push a button to reactivate the display)

  - The tilt switch functionality which inverts the display when the device is upside down (as happens when it is pivoted around the clip for its display to read by its wearer) can be disabled. **Please note the tilt switch feature is not available on products shipped before July 2023.**

- Calibration factor **(please consult DustCanary before changing this setting)**

  - This is a calibration scaling factor which may be applied to the qualitative output of the device to improve data quality when comparisons to reference gravimetric (weighed dust samples) are available

  - The calibration factor is calculated as the ratio of the average dust result from a gravimetric sample to the averaged signal from the DustCanary. The device should be located close to the gravimetric sampler inlet and operated for the same period of time as the sampler.

  - Care should be taken in adjusting the calibration factor at dust concentrations less than 0.5mg/m3 where the uncertainty of the gravimetric sampler may be significant.

  - **The calibration factor should not normally be changed without prior consultation with DustCanary**

To transfer recorded sessions from device and review and report data

Overview

    1) Sessions

        a. The device records data in separate 'sessions' each time 'dust detection' is switched on and off. The session is made up of records of the dust level over time and includes a session header which summarises how the device is configured

        b. The device has sufficient memory for a working week of data recording, but it is recommended to transfer the data to the application at the end of each day of use to avoid longer data download processes

    2) Data transfer and graphing

        • There are two steps in creating and viewing files from the recorded sessions

            1) **Downloading** recorded sessions from the device to the browser application, where the data is stored locally

            2) **Graphing** a time plot of the dust signal from the **History** of downloaded sessions

    3) Analysis of recorded data with external programs

    Sessions which have been downloaded may also be **exported** from the **History** of downloaded sessions to external software

        • **Excel** may be used to analyse the recorded data in detail and provides an alternative method to create a time plot of dust signal which is used to give incite to dust peaks and variability in dust levels

        • Where video has been taken simultaneously (eg with a Helmet camera) NIOSH's **Evade software** synchronises the dust and video gives extra visibility to what exactly was happening during the session.

1) **Downloading sessions** from device

Select 'Device recording' tab to view the recorded sessions of data in the device

- o To download session select the ⟳ symbol

- o To view sessions which have not been downloaded yet, Toggle the 'Show New Only' /'Show All' tab to show 'new only' Those not yet downloaded are shown with a ⟳ symbol in the right hand column

- o Once all required sessions have been downloaded, the memory in the DustCanary 420 can be cleared by selecting [🧹 Clear Memory]

2) Selecting downloaded sessions from History

- o Select 'History' tab to view the sessions which have downloaded to the app.

- o Note: Sessions which have been previously downloaded can also be accessed without the need to connect a device to the app

3) Viewing a Graph of the dust signal

- Hover the cursor over the right hand column of the session to be graphed to bring up the 'View recording' menu as follows
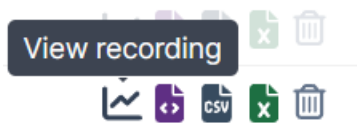
- Select 'view recording' and a graph of the dust signal vs time will be produced
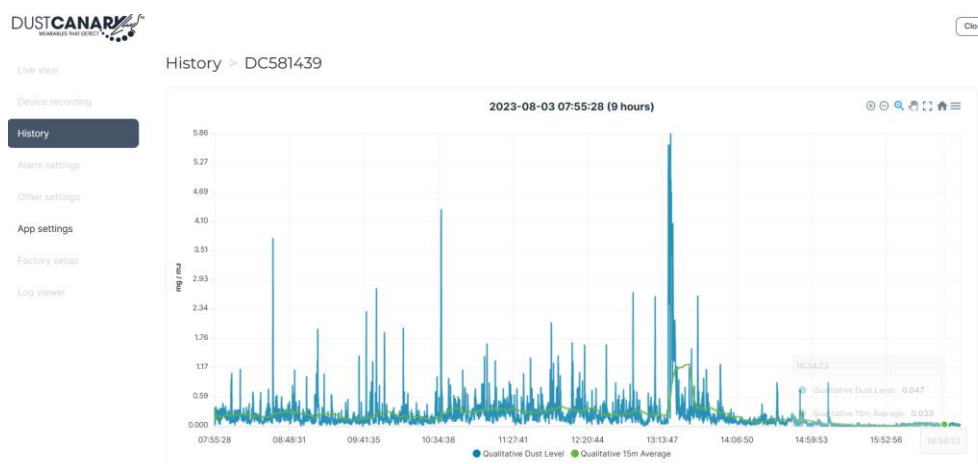
- To exit the graph and return to the menu click on the **History** tab

- To window in on a particular part of the graoh click and drag the cursor over the required section

- The ⊕ ⊖ ⚲ ✋ ⌞⌝ ⌂ ≡   icons at the top right of the screen support

    o Zoom in and Zoom Out

    o Panning   in on particular parts of the graph

    o Reload complete graph

    o Superimpose alarm theshold levels on the graph

    o Download of image in svg, png and csv formats

4) Exporting and reviewing with Excel

o Select the [X] symbol on the required session and an excel file will be downloaded with the filename

    o `DCXXXXXX YYYY-MM-DD HH-mm NNNNNN.xlsx`, where NNNNNN is the number of records

o Open file within downloads to view the Excel file

o Within Excel select

   Enable Editing   in the top line menu

o View the 'Session summary' and to assist later referral to the file, consider adding details of

    o Wearer

    o Activity

    o Observations

o To create a graph of the dust level vs time, select the 'Dust Log' tab at the bottom of the spreadsheet
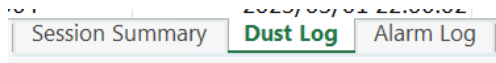
- Select the data in column C, D and E for graphing by clicking on each column header, holding down the keyboard Ctrl Key at the same time
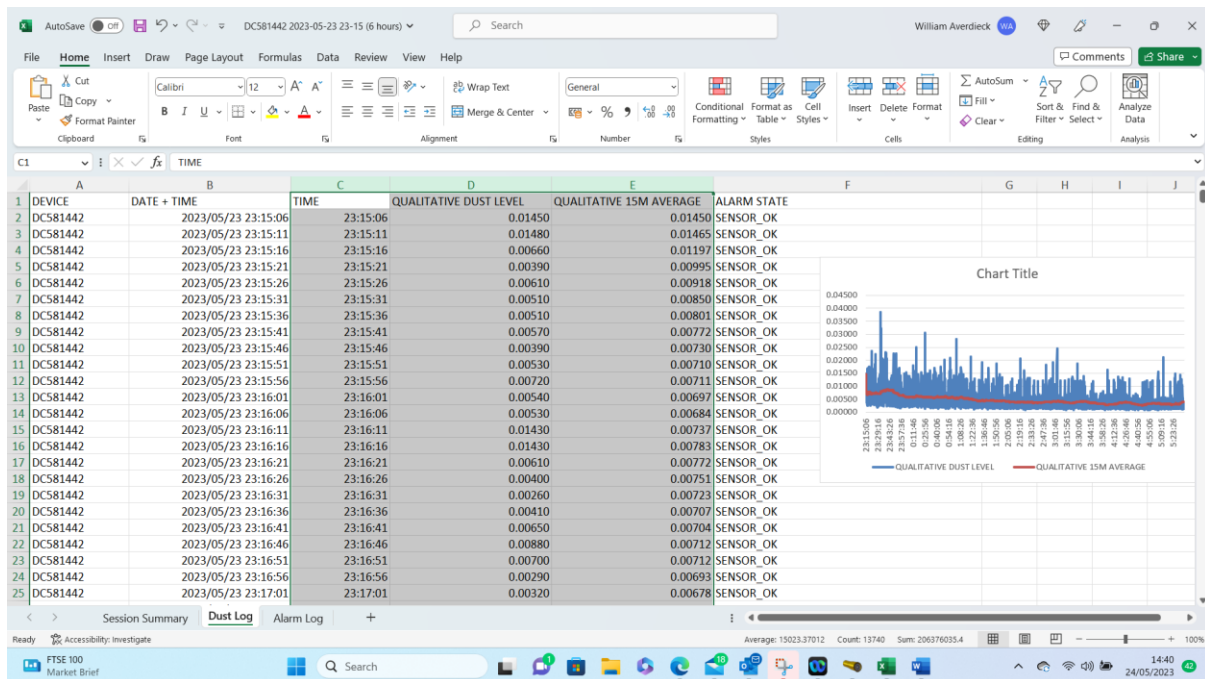

In the Excel Menu above the spreadsheet select

INSERT

then (as in screen below)

then   2D line (as in screen shot below)

When 2Dline graph is selected/ the graph is drawn below showing dust level and 15 min average dust vs time for the duration of the session

- o The 15 minute average may be useful for linking trends in dust to work patterns

- o Select Alarm log to view history of alarms during the session

- Note that 'OPC degraded, OPC fan error' is related to sampling fan transition at sensor start up and shut down and is not a cause of error

- o Remember to SAVE the spreadsheet in an appropriate location for a permanent record and to capture notes added in session header and any graphs created

5) Importing an Excel file (if required this feature should be enabled within the APP settings)

Files previously exported from the browser app to excel can be reimported. This also provides a method to share files between users

- Select the [Import Excel file] tab at the bottom of the list of sessions within the History page and select required file (please note: file name and contents structure must be in the same format as originally created by the browser app when the file was exported)

|							
48	DC581439	2023-06-27 09:08:37	an hour	815	0		
49	DCCCCCCD	2023-06-27 09:11:40	an hour	799	0		
50	DC581442	2023-06-28 17:45:41	14 hours	10,100	2		
51	DC58142B	2023-06-28 17:45:48	14 hours	10,099	2		
52	DC58142B	2023-07-06 10:14:04	3 minutes	41	0		
53	DC581439	2023-07-10 08:07:43	9 minutes	108	0		
54	DC581439	2023-07-10 09:52:18	a few seconds	6	0		
55	DC581442	2023-07-11 06:27:36	32 minutes	385	0		
56	DC58142F	2023-07-13 08:53:15	2 minutes	9	0		
57	DCCCCCCD	2023-07-26 09:06:02	an hour	809	0		
58	DCCCCCCD	2023-07-26 11:49:21	16 minutes	188	0		
59	DC584AD7	2023-08-15 12:34:02	3 hours	1,985	2		
60	DCCCCCB5	2023-08-15 15:04:35	8 minutes	93	0		
61	DC58141E	2023-09-07 11:07:10	22 minutes	264	0		
62	DC58141E	2023-09-07 11:35:30	4 minutes	50	0		

[Import Excel file]

6) Exporting a file to NIOSH's Evade software for synchronising with video (if required this feature should be enabled in the App settings)

- From the History tab

  o Export a CSV file by selecting [csv icon] and then import into EVADE software

  o Alternatively (and less time consuming) select [icon] and   Export directly into EVADE.

    ▪ Select the .dcf file which is downloaded

- ▪ This will download (if not already used before) and run the Evade program (this may take a while)
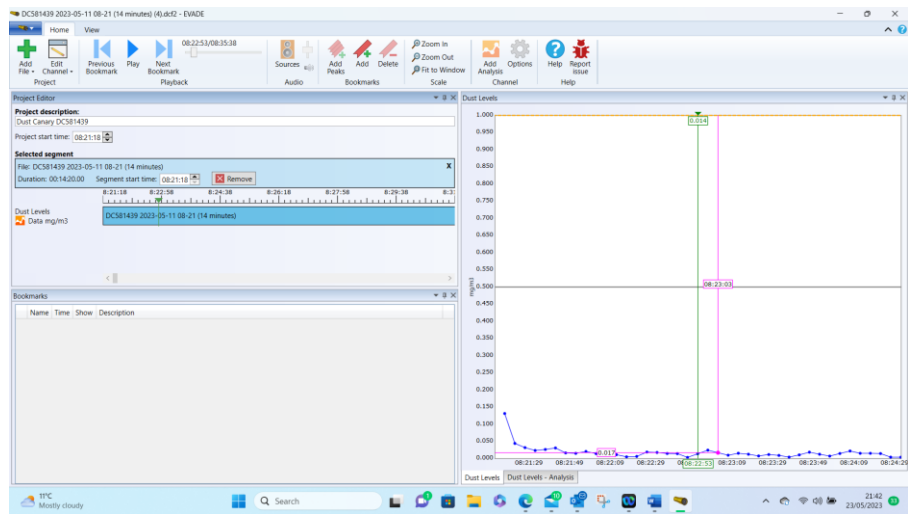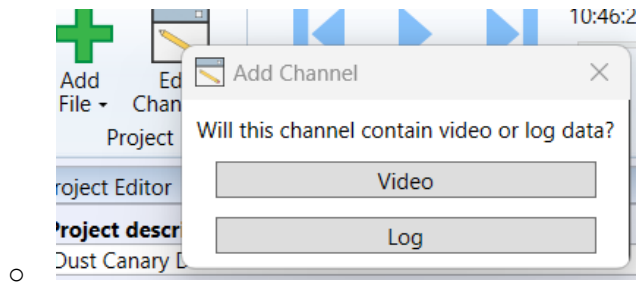

- o To select the dust file open the tab below by clicking on the arrow on the top left of the screen, Open project and then select downloaded file
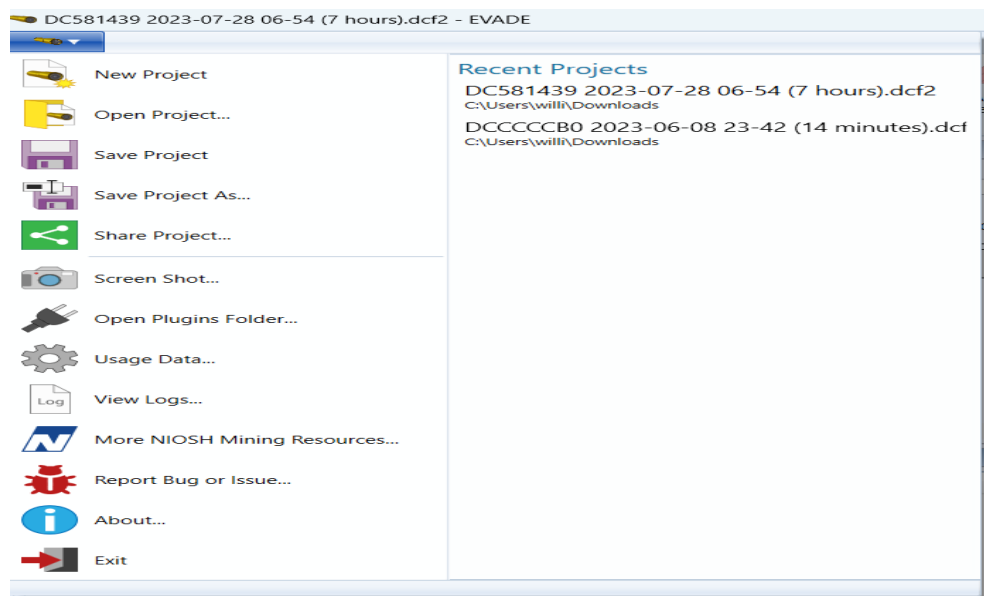
- o
- o
- o to add video select

- o Select Video

o

App Settings

The App settings tab allows the user to select which features of the software are shown or hidden to the user

- This includes

    o   Showing the Bluetooth addresses of devices previously connected to the browser app in the connection screen

    o   Import of excel files

    o   Export of CSV files

    o   Export of files to NIOSH evade software (for link with video images)

- In addition a Backup feature allows all settings and files to be saved to a single file which can be saved or emailed. This file can be Restored on the same or a different machine also providing a convenient method of sharing data between sites.
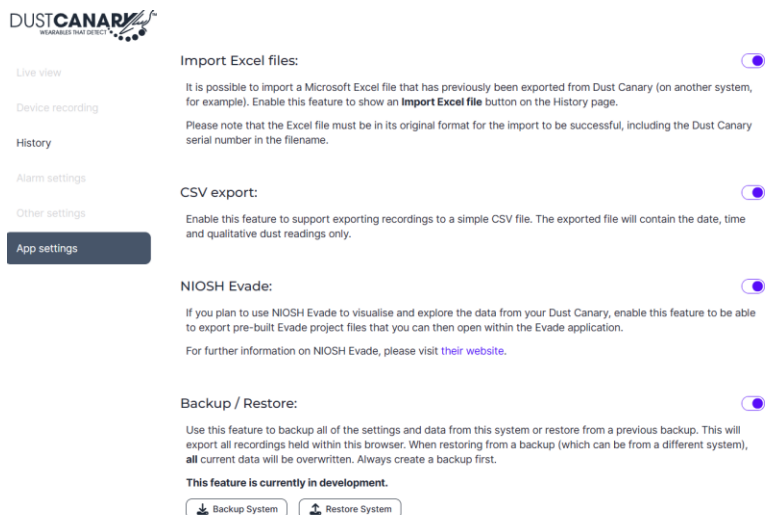
For further support please contact DustCanary Ltd

www.DustCanary.com

info@Dustcanary.com