DUSTTRAK™ ENVIRONMENTAL MONITOR MODELS 8540-M, 8542-M, 8543-M

OPERATION AND SERVICE MANUAL

P/N 6008408, REVISION F MARCH 2018

CONTENTS

Safety Information

Laser Safety

- Models 8540-M/8542-M/8543-M DustTrak™ Environmental Monitors are Class I laser-based instruments.
- During normal operation, you will ***not*** be exposed to laser radiation.
- Precaution should be taken to avoid exposure to hazardous radiation in the form of intense, focused, visible light.
- Exposure to this light may cause blindness.

Take these precautions:

- ***DO NOT*** remove any parts from the DustTrak Environmental Monitor unless you are specifically told to do so in this manual.

W A R N I N G

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

W A R N I N G

If the DustTrak monitor is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

When operated according to the manufacturer's instructions, this device is a Class I laser product as defined by U.S. Department of Health and Human Services standards under the Radiation Control for Health and Safety Act of 1968. A certification and identification label like the one shown below is affixed to each instrument.

Chapter 1

Product Overview

DustTrak™ Environmental Models 8540, 8540-M, and 8542-M and DustTrak DRX Environmental Models 8543 and 8543-M Monitors are data-logging, light-scattering laser photometers that provide real-time mass concentration readings for aerosol contaminants such as dust, smoke, fumes and mist. These instruments use a sheath air system that isolates the aerosol in the optics chamber to keep the optics clean for improved reliability and low maintenance. These monitors offer a suitable solution for long-term outdoor monitoring, construction and environmental clean-up sites.

DustTrak Environmental Monitors (Model 8540-M, and 8542-M)

The DustTrak Environmental Monitors are continuous, real-time, single-channel, 90° light-scattering laser photometers that are used to determine the mass concentration of aerosols. A robust, long-life pump allows for the use of a variety of size-selective inlet conditioners to measure aerosol concentrations corresponding to PM_{10}, or $PM_{2.5}$.

DustTrak DRX Environmental Monitors (Model 8543-M)

The DustTrak DRX Environmental Monitors are continuous, real-time light-scattering laser photometers that simultaneously measure size-segregated mass fraction concentrations corresponding to PM_1, $PM_{2.5}$, and PM_{10}—something no other monitor can do. The instrument combines both particle cloud (total area of scattered light) and single particle detection to achieve mass fraction measurements. This size-segregated mass fraction measurement technique is superior to either a basic photometer or optical particle counter (OPC). It delivers the mass concentration of a photometer and the size resolution of an OPC.

The DustTrak Environmental Monitors are designed to operate inside the TSI Environmental Enclosure (Model 854030) which has an International Protection Marking of IP44. The DustTrak Environmental Monitor should not be used outdoors without an appropriate weather-proof enclosure.

Models 8540-M, 8542-M, and 8543-M MCERTS Certified Monitors

If you are using a DustTrak™ Environmental Monitor Model EDTPM10M, EDTPM2.5M or EDTDRXM, these Models are designed and set up to meet MCERTS (Monitoring Certification Scheme) certification for indicative instruments. **The following must be installed for these model products to meet the MCERTS Indicative Certification:**

EDTPM10M: MCERTS PM10 Indicative Certification

- ❑ 8542-M Photometer
- ❑ 854030 Environmental Enclosure
- ❑ 854040 Omni-directional Inlet w/Water Trap
- ❑ 854020 PM10 Impactor
- ❑ 854041 Heated Inlet
- ❑ PCF set at 0.53 (preset at the factory). It is recommended that the instrument is run with a Photometric Correction Factor (PCF) of 0.53. However, the application of a site specific correction factor may be used if a significant decrease in the expanded uncertainty can be demonstrated.

EDTPM2.5M: MCERTS PM2.5 Indicative Certification

- ❑ 8540-M Photometer
- ❑ 854030 Environmental Enclosure
- ❑ 854040 Omni-directional Inlet w/Water Trap
- ❑ 854021 PM2.5 Impactor
- ❑ 854041 Heated Inlet
- ❑ PCF set at 0.33 (preset at the factory). It is recommended that the instrument is run with a Photometric Correction Factor (PCF) of 0.33. However, the application of a site specific correction factor may be used if a significant decrease in the expanded uncertainty can be demonstrated.

EDTDRXM: MCERTS PM10 and PM2.5 Indicative Certification

- ❑ 8543-M Photometer
- ❑ 854030 Environmental Enclosure
- ❑ 854040 Omni-directional Inlet w/Water Trap
- ❑ 854041 Heated Inlet
- ❑ PCF PM2.5 set at 0.47, PM10 set at 0.53 (preset at the factory). It is recommended that the instrument is run with a Photometric Correction Factor (PCF) of 0.53. However, the application of a site specific correction factor may be used if a significant decrease in the expanded uncertainty can be demonstrated.

Chapter 2

Unpacking and Parts Identification

Carefully unpack the Model 8540 / 8540-M / 8542-M / 8543 / 8543-M DustTrak™ Environmental Monitor from the shipping container. Use the tables and illustrations below to make certain that there are no missing components. Contact TSI immediately if anything is missing or damaged.

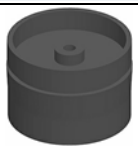
Unpacking the DustTrak Monitor

Compare all the components you received with those listed in the table below. If any parts are missing, contact TSI.

Item	Qty	Part Number	Description
	1	8540 8540-M 8542-M 8543 8543-M	DustTrak Environmental Monitor DustTrak DRX Environmental Monitor
	1	1090014	Data Analysis Software CD-ROM
	1	1303740	USB cable
	1	801856	24V DC power supply *Included only when 8540-WPS or 8543-WPS is ordered*

Item	Qty	Part Number	Description
	1	6008408	Operation and Service Manual
	1	N/A	Calibration Certificate

User Replaceable Internal Parts

Item	Part Number	Description
	854044	Sheath Air Filter
	854043	Pump
	NA	37-mm, 2-piece, static conductive cassette

Zefon can also supply pre-weighed filter media for gravimetric sampling.

Optional Accessories

Item	Part Number	Description
	854030	Environmental Enclosure *See 854030 manual for enclosure accessory options*
	801905	Netronix™ Thiamis™ 1000 Communication Node
	854040	Omni-directional Inlet w/Water Trap Bottle
	854041	Heated Inlet Sample Conditioner
	854034	Enclosure Power Supply

Item	Part Number	Description
	854042	Water Trap Bottle
	854020	PM_{10} Impactor
	854021	$PM_{2.5}$ Impactor
	854022	$PM_{1.0}$ Impactor

Parts Identification for the DustTrak Environmental Models 8540 / 8540-M / 8542-M / 8543 / 8543-M

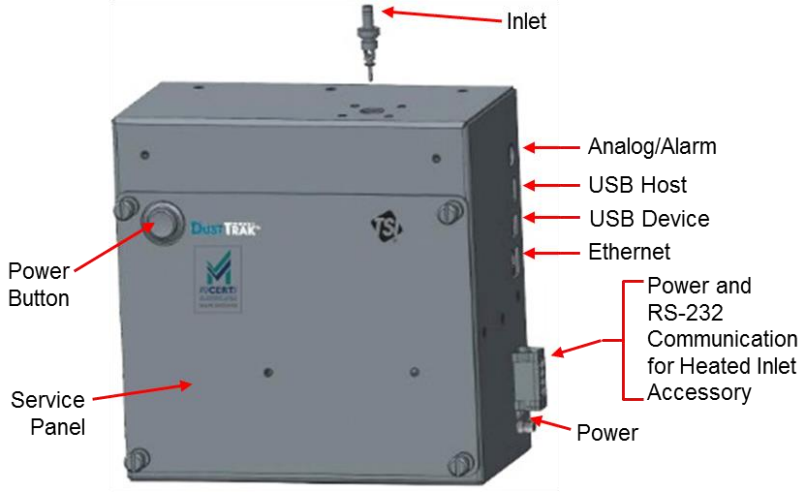


Figure 1: Features on Models 8540/8540-M/8542-M/8543/8543-M

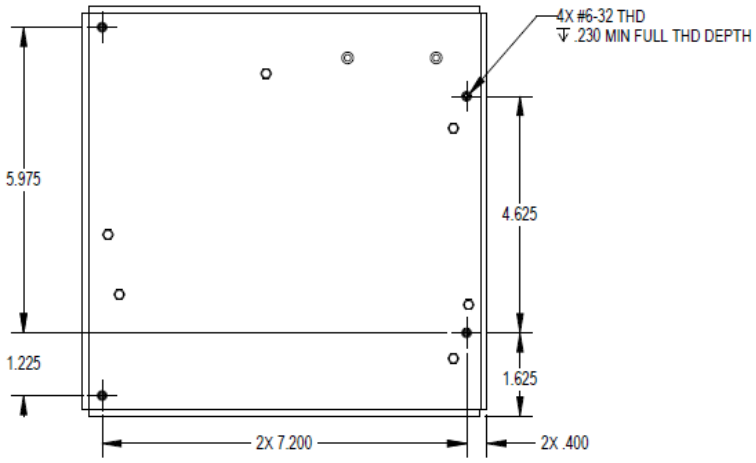


Figure 2: Back panel interface control dimensions

Figure 3: View of back panel with mounting holes shown

Holes are pre-drilled in the back of the photometer to enable users to develop their own mounting bracket for attaching the photometer into an alternate enclosure.

Mounting the photometer using these holes will need quantity four (4) #6-32 screws that penetrate no deeper than 0.230” into the back panel of the photometer.

Chapter 3

Setting Up

Environmental Enclosure

The DustTrak Environmental Monitor is designed to be mounted inside in the environmental enclosure. The TSI 854030 Environmental Enclosure has been designed specifically to protect the DustTrak Environmental Monitor and its accessories. See *Environmental Enclosure Model 854030 Operation and Maintenance Manual* (P/N 6008410) for more details and installation instructions.

Figure 4: Environmental Enclosure

Supplying Power to the DustTrak Environmental Monitor

One method for supplying power to the instrument is to use the 24V power supply (TSI P/N 801856). Simply fasten the barrel connector to the instrument as shown in Figure 5. This power supply (and a region specific power cord) is included if model numbers 8540-WPS or 8543-WPS are ordered. This power supply is mainly used to power the instrument when it is not mounted inside of the enclosure and communication is required for diagnostics and programming.

W A R N I N G

DO NOT connect the optional Thiamis 1000 accessory (TSI P/N 801905) to the instrument when using this 24V power supply. Damage to the modem will occur.

Figure 5: Instrument power connection

If the instrument is installed into the 854030 Environmental Enclosure, power options include AC Power Supply (854034), AC power supply included with enclosure heater (854033), Rechargeable Battery Power System (854036), and Solar Power System (854060).

Omni-directional Inlet Column

Optional accessory 854040

See the Quick Start Guide installing impactors PM_{10} (854020), $PM_{2.5}$ (854021), PM_1 (854022) onto the omni-directional inlet for details.

Figure 6: Inlet, water trap and base with connection rings

Zero Calibration of Instrument

The DustTrak Environmental Monitor has the ability to automatically "Zero" the instrument readings at programmed intervals. "Zeroing" the instrument resets the photo detector, to a signal that represents no particles flowing through the optics. Over time, photometric light-scattering instrument readings can drift due to changes in temperature and aerosol build up in the optics. Programming regular "Zero" events corrects the photometric signal to account for these changes.

The DustTrak Environmental Monitor automatically performs a zero calibration when the instrument begins any programmed run and the auto zero function has been enabled. Use the instructions detailed in Chapter 4 for enabling auto zero and configuring the automatic interval using the TrakPro software.

Instrument Setup and Operation Options

Figure 7: Setting up instrument and operating options

Press the power button to turn on instrument. The button will turn blue, indicating the instrument has power and is turned on.

To turn instrument off, hold the power button for 10 seconds and then release. The blue indicator light in the power button will turn off, indicating the instrument has shut down.

Use the DustTrak Checkout Software or Netronix™ Environet (both explained below) to read the instrument status, program instrument, and activate instrument programmed runs.

The DustTrak instrument can be setup and controlled using one of three options:

- Use TrakPro™ Data Analysis Software to configure instrument, run instrument and download data. Quick start information for using TrakPro software is shown in the section below.
- Use a Netronix™ Thiamis™ Communication Node and web-based application Environet to setup and control the DustTrak monitor remotely. See Netronix quick start guides for Netronix installation and set-up.
- Use the DustTrak monitor's command set to develop a custom program for setting up and controlling the DustTrak monitor. See the command set information in Appendix B.

DustTrak Checkout Application

- DustTrak Checkout Application enables a “virtual screen” for the DustTrak monitor. Instrument data, flow calibration, zero calibration, instrument diagnostics, etc., can be viewed or performed through the use of the checkout software.
- This software can be used as part of your field installation process to ensure the instrument is functioning properly, when Netronix™ is not being used or a web accessed device is not immediately available during field installation.

Open DustTrak Checkout executable file and follow the steps to run the installation wizard**.**

Notes

- The DustTrak Checkout Application can also be downloaded from the TSI website. Follow the on-screen instructions to download the software.
- Your computer must have the current version of TrakPro software to access the proper drivers to communicate with this Checkout Application.

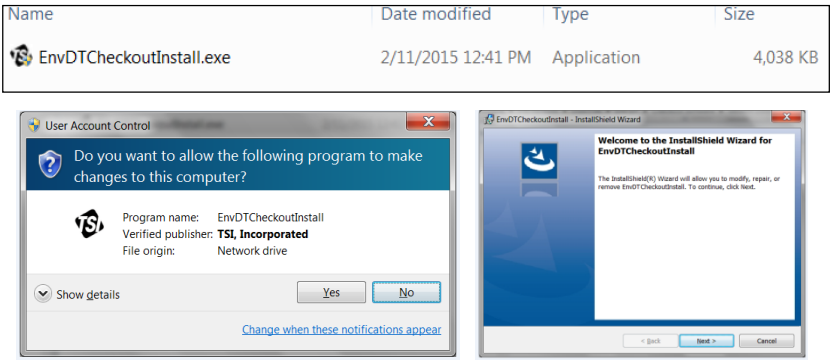


Figure 8: Checkout Application – Setup screen

DustTrak Checkout Application

After installing the application, plug the provided USB cable into the “USB B” port on the instrument and plug the other end into your computer. Power on the instrument and click the **Connect** button. The USB IP address and instrument information will appear when connected.

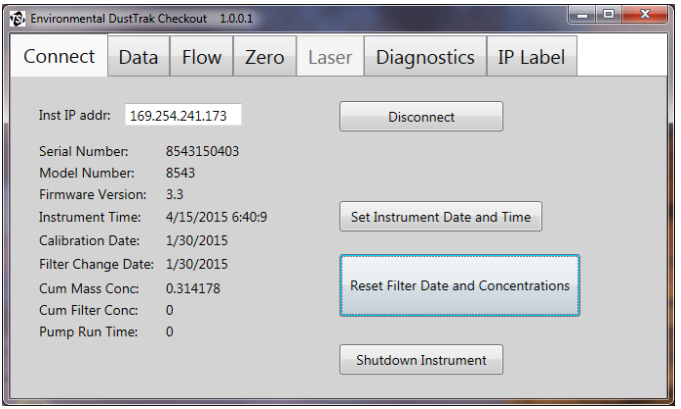


Figure 9: Checkout Application – Connect tab

Click the **Data** tab to access the current instrument readings.

Clicking the green arrow will start the instrument pump to begin sampling in Survey Mode. No data will be logged onto the instruments memory while running in Survey Mode.

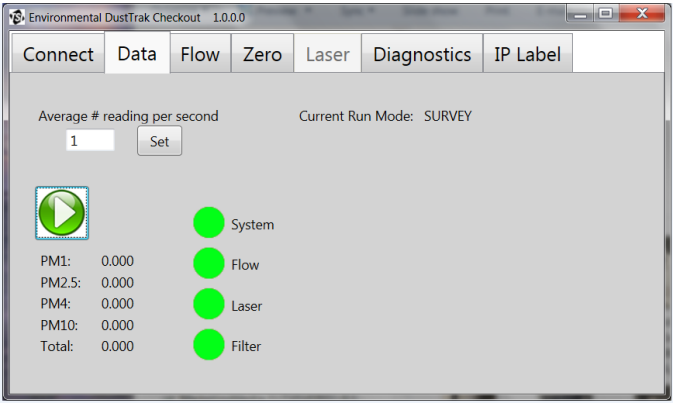


Figure 10: Checkout Application – Data tab

Click on the **Flow** tab to adjust the pump flow rate.

Figure 11: Checkout Application – Flow tab

Click the green arrow to start the pump, allowing for a change to the flow setpoint. The flow setpoint is factory set to 3 L/min total flow. 2 L/min of the total flow is measured aerosol flow. 1 L/min of total flow is split off, filtered, and used for sheath flow. There is an internal ΔP flowmeter in the DustTrak instrument that controls flow rate to ±5% of the factory setpoint. TSI recommends checking the flows with an external flow reference meter, especially when collecting data.

1. Attach a flow calibrator (reference flowmeter) to inlet port. You may use a bubble buret, mass flowmeter, dry piston or rotameter as flow measurement devices.
2. Click on the up or down arrows to achieve desired flow on the reference flowmeter. Each click of the up or down arrow will change the flow about 1%. Allow time between button presses to let pump change to the new flow rate.
3. Click **Save** once the desired flow rate is achieved. Select **Undo** to return to the factory setpoint.

Note – Models 8540, 8540-M, 8542-M
The flow rate can be adjusted from approximately 1.5 to 4.0 L/min. If needed, this feature can be used to adjust the flow rate to a value other than the factory setpoint, allowing for the use with 3rd party size selective inlets (cyclones or impactors) that may require a different flow rate.

Note – Models 8543, 8543-M
The flow rate can be adjusted from approximately 1.5 to 4.0 L/min. This feature allows you to re-adjust the flow rate, if needed, to 3.0 L/min. The flow rate for the DRX models should remain fixed at 3.0 L/min. No size-selective inlets or cyclones should be installed on the inlet of the instrument during its normal operation.

Click on the **Zero** tab to manually perform a zero calibration for the instrument. Click **Start Zero** to start the zeroing process.

The “Last Zero” and “New Zero” values do not represent particle count or aerosol mass. These values are associated with the signal received by the photometric sensor when no particles are passing through the optics.

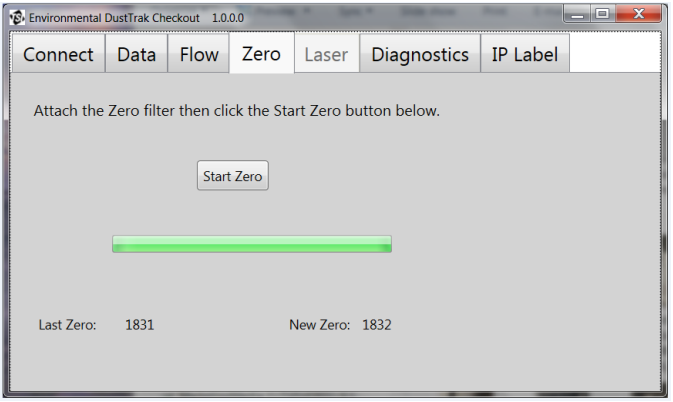


Figure 12: Checkout Application – Zero tab

The **Laser** tab is only accessible in password-protected “Engineering Mode.” Changes made to the Laser setting will directly affect the calibration, the instrument response, and is available only to TSI technicians.

The **Diagnostics** tab opens a command window that can be used to send instructions to the instrument. Click **Send** or press the **Enter** key to send the command to the instrument. See the Communication Settings in Appendix B.

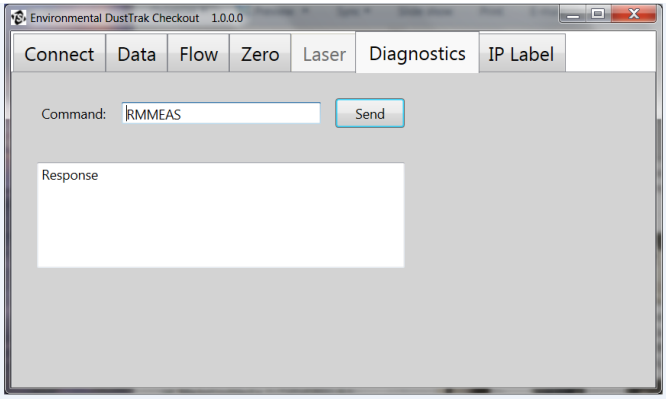


Figure 13: Checkout Application – Diagnostics tab

The **IP Label** tab opens a printer connection box and displays the instrument IP address.

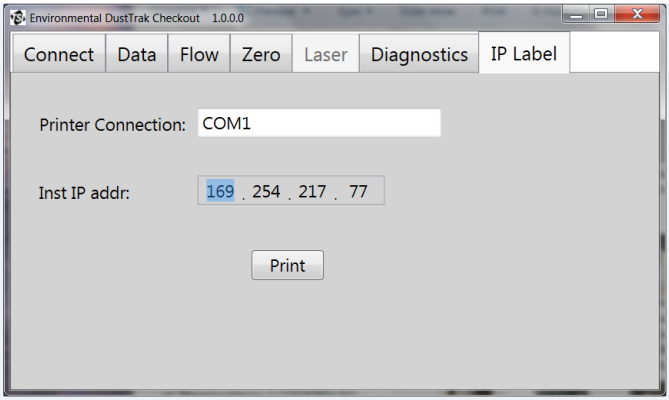


Figure 14: Checkout Application – IP Label tab

The **IP Addressing** tab can be used to change the settings for the instruments Ethernet IP address. After making changes, click **Save** for the settings to take effect.

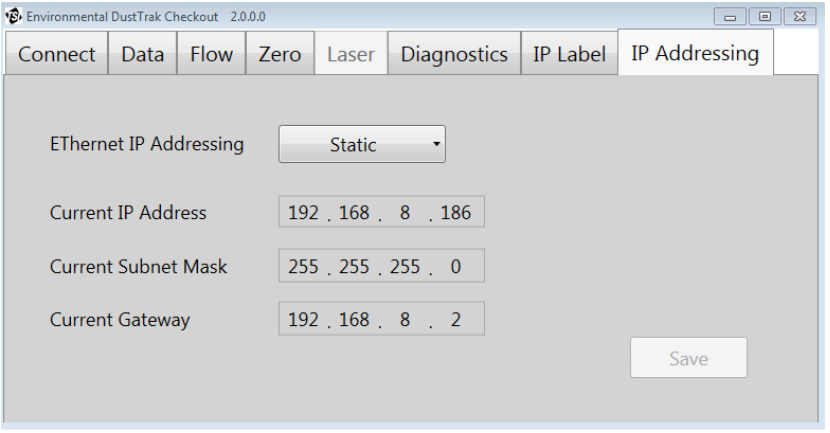


Figure 15: Checkout Application – IP Addressing

Chapter 4

TrakPro Software Quick Reference

Connecting to the Computer

The TrakPro software can be used to preprogram the instrument, download data, view and create raw data and statistical reports, create graphs, and combine graphs with data from other TSI instruments that use TrakPro software. Connect the USB host port of a Microsoft Windows®-based computer to the USB device port on the side of the DustTrak Monitor.

Installing TrakPro Data Analysis Software

The following sections describe how to install the software and set up the computer.

Note
To use TrakPro software with the DustTrak Monitor, the PC must be running Microsoft® Windows® and the computer must have an available Universal Serial Bus (USB) port.

1. Insert the TrakPro Data Analysis Software CD into the CD-ROM drive. The install screen starts automatically.

Note
If the software does not start automatically after a few minutes, manually run the program listed on the label of the CD using the **Run** command on the Windows® Start Menu.

2. Follow the directions to install TrakPro software.

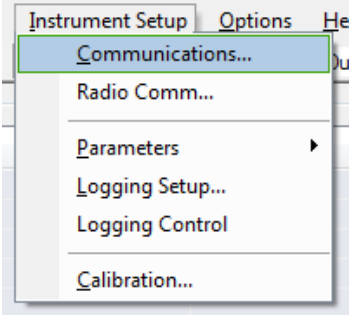
TrakPro software contains a comprehensive installation guide. TSI recommends printing out this guide prior to starting the TrakPro software installation on your computer, so it may be consulted during the installation. The TrakPro Software manual is located in the “Help” file in TrakPro software. There is no separately printed TrakPro Data Analysis software manual.

®Microsoft and Windows are registered trademarks of Microsoft Corporation.

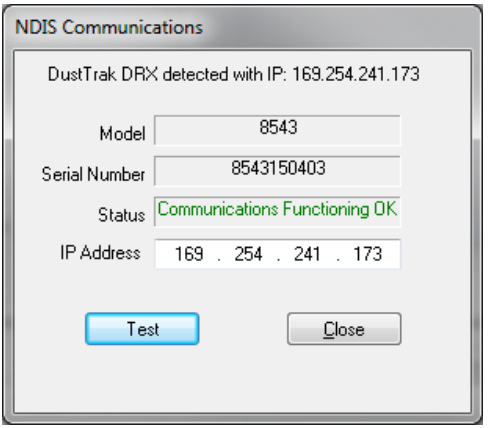
TrakPro Software Steps

Establishing Communications with the Instrument

Open up TrakPro software and select **Instrument Setup -> Communications**.

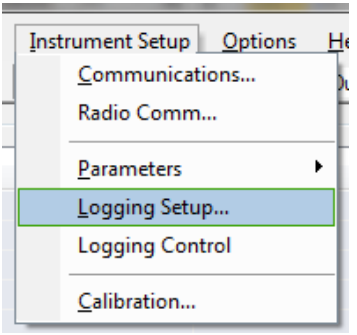


The software will automatically find the instrument, as shown in the dialog.



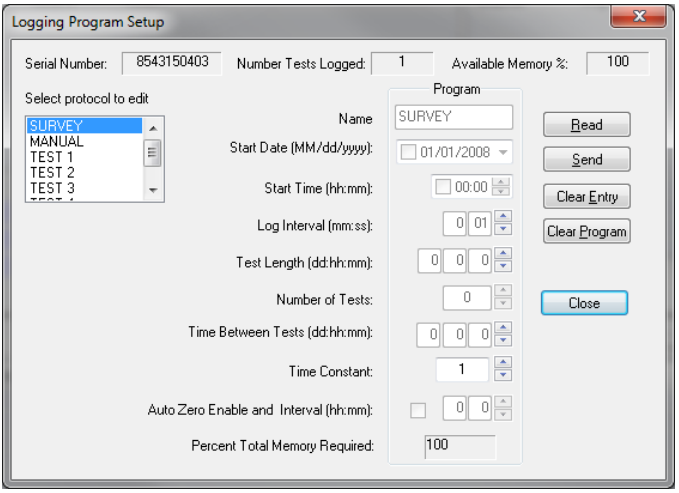
Configuring the Logging Parameters

Select **Instrument Setup -> Logging Setup**.

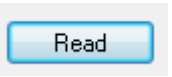


This will open a dialog allowing for the configuration of the different instrument run modes. The sampling mode options include Survey mode, Manual Mode and Program Logs 1-5.

Survey	Survey Mode runs a real time, continuous active sample, but does not log data.
Manual	Manual Log sets the instrument to log data for a specified run time.
Log Modes	Log Mode starts and stops the instrument at specified times, run for a specified test length, and perform multiple tests of the same length with a specified time period between tests.



Press the **Read** button to get the current log modes from the instrument.



Update the log modes to meet logging requirements. Details on log modes are in table below.

Survey Mode Options	
Time Constant	Time Constant can be set from 1 to 60 seconds.
Auto Start on Power Up	When set to “Yes”, unit will start a measurement upon being powered on, if the unit was set to “Survey” when it was turned off. When set to “No”, the unit will be in idle when it is powered on.

Manual Mode Options	
Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Test Length	Test length can be set from 1 minute to the limit of the data storage.
Time Constant	Not used for the 8540/8540-M/8542-M/8543/8543-M models.

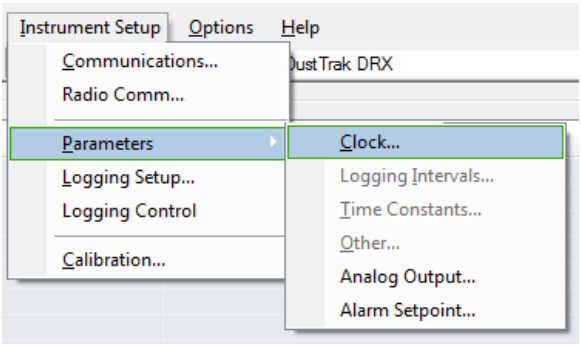
Program Log Options	
Log Name	Enter descriptive name for the log mode.
Start Date	Select the date and the test will start. Select the check box to use Start Date, option to use programmed start date, or bypass programmed start date.
Start Time	Select the time the test will start. Select the check box to use Start Time, option to use programmed start time or bypass programmed start time.
Log Interval	The log interval can be set from 1 second to 60 minutes. It is the amount of time between logged data points.
Test Length	From 1 minute to the limit of the data storage.
Number of Tests	1 to 999.
Time between Tests	1 minute to 30 days.
Time Constant	Not used for the 8540/8540-M/8542-M/8543/8543-M models.

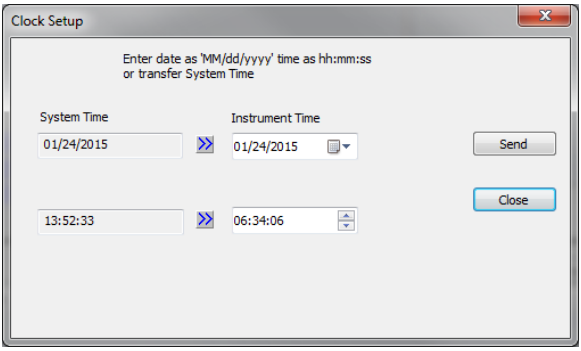
Program Log Options	
Auto Zero Interval	Interval between re-zeroing the instrument using the built in autozero functionality. Use the check box to enable use of autozeroings.

Once the log modes have been updated, press the **Send** button to send the new log modes to the instrument.

If using a programmed start time and start date, update the instrument date and time to ensure the logging starts as planned.

Select **Instrument Setup -> Parameters -> Clock** to set the time.





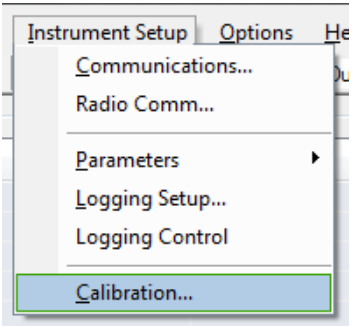
Setting User Calibration Factors

In most cases, a user calibration factor of 1 for photometric and size cal (DRX only) will be sufficient. Use the following instructions to change the instruments User Cal, if an improved calibration factor is required.

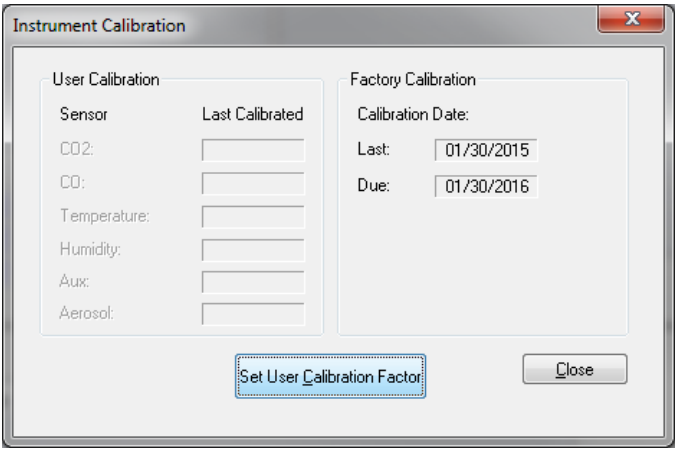
Set User Calibration Factor allows you to store and use 10 different calibration factors. In addition, there are preprogrammed factory defaults, one is the “Ambient Cal” and the other is the “Factory Cal” (8540-M, 8542-M and 8543-M also have an MCERTS cal). The “Ambient Cal” is appropriate for outdoor ambient dust or fugitive dust monitoring. The “Factory Cal” is the calibration to ISO 12103-1, A1 Arizona test dust for which a calibration certificate is provided with the instrument. The “Factory Cal” is appropriate for most workplace aerosol monitoring. Factory Cal can be set by simply setting both the size correction factor (DRX model only) and the photometric calibration factor to 1.

Use the following steps to get to the user cal functionality:

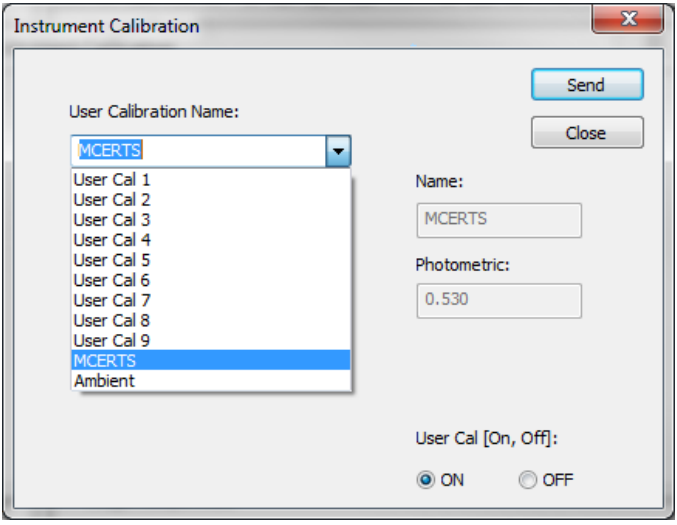
Select **Instrument Setup -> Calibration**.



Click the **Set User Calibration Factor** button to access the instrument calibration settings.



In this dialog, you can select the factory ambient cal or customizable user cals 1 through 10, (1 through 9 for MCERTS models 8540-M, 8542-M and 8543-M). User Cals 1 through 10 can be used to set custom user calibration factors.



Four variables can be set for each user calibration.

Name	User can input a custom description for the custom User Calibration.
Photometric Calibration Factor	Changes the factory calibration of particle signal, based on Arizona Road Dust, to actual aerosol being measured.
Size Calibration Factor	Changes the factory calibration of the particle distribution, based on Arizona Road Dust, to actual aerosol being measured. This is for the DRX only. A setting of 1 works for most situations.
User Cal [on,off]	Selecting **On** will activate current user calibration and deactivate the previously selected user calibration.

Determining a new Photometric Calibration Factor

In most situations, the DustTrak monitor with its built-in data logging capability can provide very good information on how the concentration of an aerosol changes for different processes over time. Factory calibration to the respirable fraction of standard ISO 12103-1, A1 test dust is fairly representative of a wide variety of workplace aerosols. Because optical mass measurements are dependent upon particle size and material properties, there may be times in which a custom calibration would improve your accuracy for a specific aerosol.

Determining an aerosol-specific photometric calibration requires that you determine a true mass concentration (e.g., gravimetric analysis) for the aerosol you want to measure. The true mass concentration is used to calculate the custom calibration factor for that aerosol. Once you have a custom calibration factor, you can reuse it each time you make measurements in the same aerosol environment.

Determining the Calibration Factor for a Specific Aerosol

The DustTrak monitor is factory calibrated to the respirable fraction of standard ISO 12103-1, A1 test dust. The DustTrak monitor can be easily calibrated to any arbitrary aerosol by adjusting the custom calibration factor. The DustTrak monitor's custom calibration factor is assigned the value of 1.00 for the factory calibration to standard ISO test dust. This procedure describes how to determine the calibration

factor for a specific aerosol. Using the value of 1.00 will always revert back to the factory calibration.

To determine a new calibration factor you need some way of accurately measuring the concentration of aerosol, hereafter referred to as the reference instrument. A gravimetric analysis is often the best choice, though it is limited to nonvolatile aerosols.

To make an accurate calibration you must simultaneously measure the aerosol concentration with the DustTrak monitor and your reference instrument.

1. Zero the DustTrak monitor.
2. Put the instrument in Manual Log (Manual Logging is reviewed later in this section).
3. Set the logging interval. One minute (i.e., “01:00”) is often a good choice.
4. Co-locate the DustTrak monitor and the reference sampler together so that they are measuring from the same area.
5. Start sampling aerosol with both instruments at the same time.

Note
Greater accuracy will be obtained with longer samples. The time you permit for sampling often depends on the reference instrument and characteristics of the measured aerosol. It may take some time to collect sufficient aerosol onto a filter cassette for accurate gravimetric analysis. Refer to instructions of your reference instrument for sampling times.

6. Stop sampling with both instruments at the same time.
7. Record the DustTrak monitor average concentration by viewing the sample average by downloading the saved data to TrakPro software.
8. Determine the mass concentration in mg/m^3 from your reference instrument. For gravimetric sampling this means weighing the gravimetric sample.

Notes
• If you installed a gravimetric filter into the DustTrak monitor and are; therefore, using the DustTrak monitor to obtain a gravimetric sample, the flow rate used to compute the concentration should be 2 L/min, not 3 L/min since only 2 L/min of aerosol flow reaches the filter. • To ensure proper fit into the DustTrak gravimetric holder, TSI recommends using conductive, polypropylene, 2-piece 37-mm cassette housings.

9. Compute the new calibration constant, NewCal, using the following formula:

$$\text{NewCal} = \left(\frac{\text{Reference Concentration}}{\text{DustTrak Concentration}}\right) \cdot \text{CurrentCal}$$

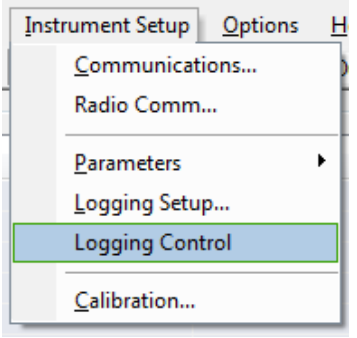
10. Enter the new value into one of the custom user cals and turn that cal “on” using the radio button.

Starting a DustTrak Sample Run

Once a log mode is set and a calibration mode selected, the DustTrak monitor can be started using TrakPro software. To start a sample, perform the following steps.

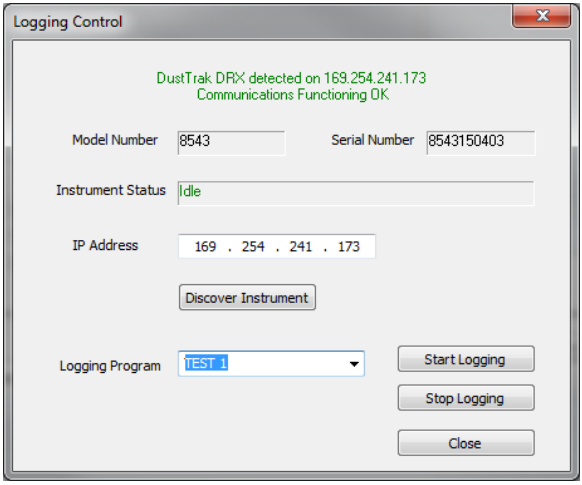
First select Logging Control

Select **Instrument Setup -> Logging Control**.

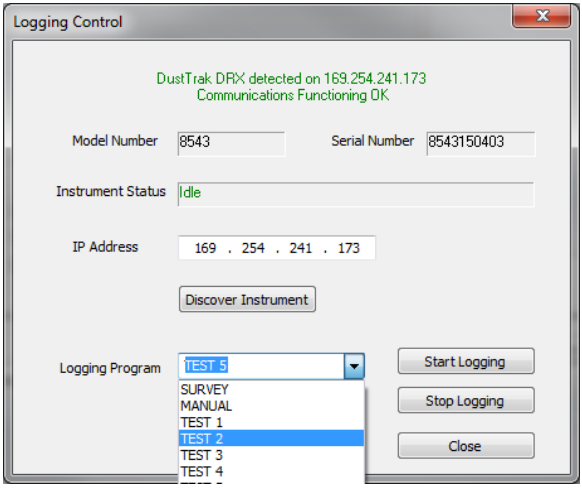


Next, establish communication with the instrument

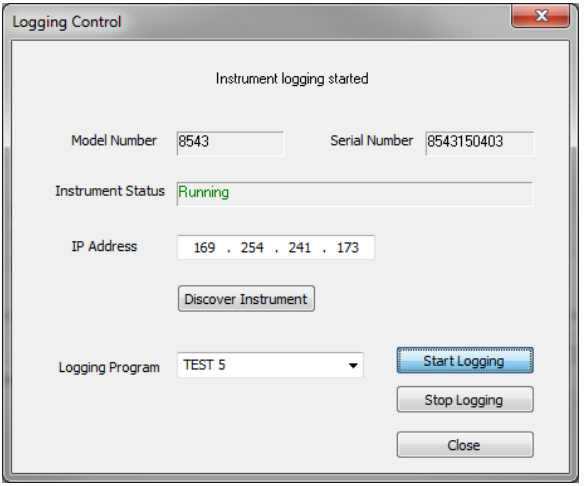
Press the **Discover Instrument** button.



Select your desired log mode from the Logging Program drop-down menu.



Press **Start Logging** to begin the logging.



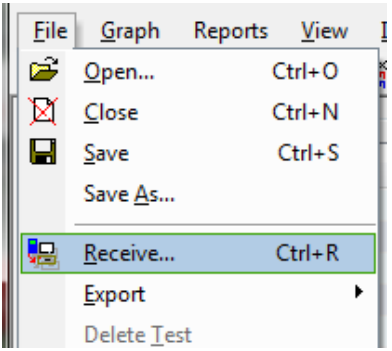
Note

If a start date and start time is selected, the instrument will not immediately start with the logging and will remain in idle unit the targeted date and time.

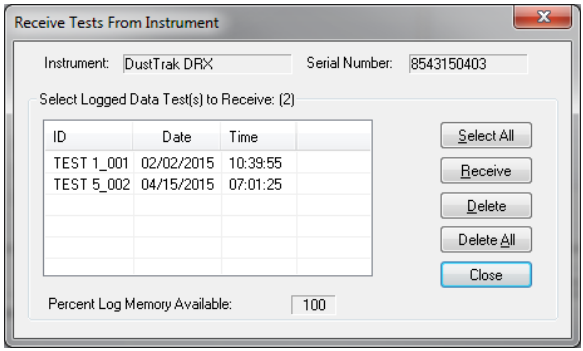
Downloading Data

Once the data has been logged to the instrument, it can be down loaded into TrakPro software.

Select **File->Receive** to download data from the instrument.



This will allow for the downloading of some or all of the data stored on the insturment.



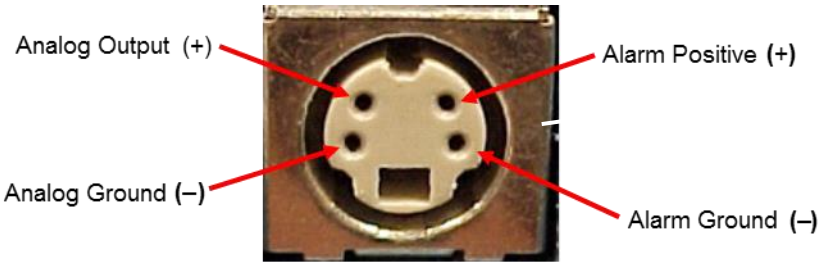
Viewing, Graphing and Exporting Data

Read the TrakPro software help files for information on how to view, graph and export the DustTrak data.

Local Analog/Alarm Output

The DustTrak Environmental Monitor has an Analog/Alarm Output connection on the side of the instrument.

The pin-outs for wiring are shown below.



4-pin miniDIN connector

Cable Wiring Diagram	
Brown Wire	Analog Ground
Orange Wire	Analog Out
Red Wire	Alarm (+)
White Wire	Alarm (-)
Black Wire	Shield

Figure 16: Cable Wiring Diagram

Wiring the Analog Output

System specifications:

- Output voltage: 0 to 5 VDC. With a maximum output of 15 mA.
- Output Current 4 mA to 20 mA with a maximum load impendence of 250 ohms.
- Correct polarity must be observed (see pin-outs above).

Wiring the Alarm

System specifications:

- Maximum voltage: 15 VDC (**DO NOT USE AC POWER**)
- Maximum current: 1 Amp
- Correct polarity must be observed (see pin-outs above)
- The alarm switch, located inside the DustTrak monitor must be located on the ground side of the alarm system.

W A R N I N G S

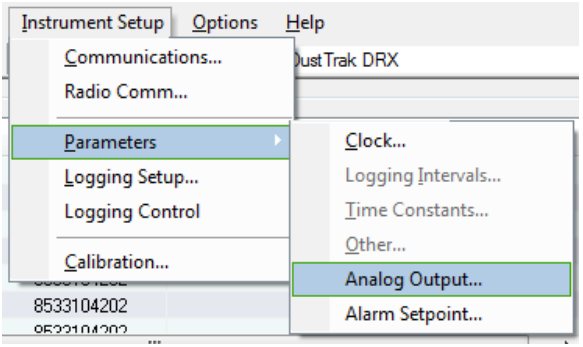
- The Alarm Output function should ***not*** be used to detect hazardous conditions or to provide an alarm for protecting human life, health, or safety.
- When connected to the analog out and alarm out connector, you **must** use safety certified equipment and/or power sources.

C a u t i o n

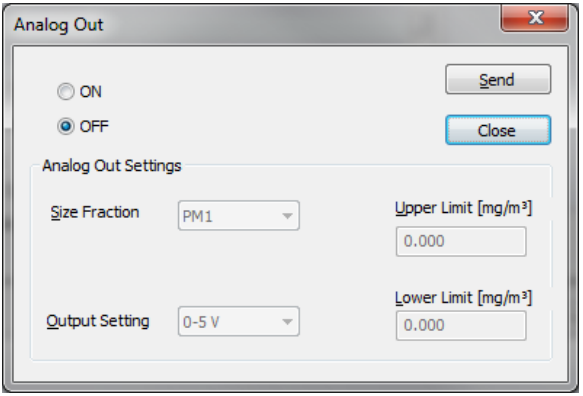
The alarm switch must ***not*** be wired to AC power! Failure to install the user alarm properly could damage the DustTrak instrument and/or void the instrument warranty! Please read and follow all instructions before wiring or operating the user alarm.

Using TrakPro Software to Program the Analog Output

Use TrakPro software to configure the Analog output. Select **Instrument Setup -> Parameters -> Analog Output…** to get to the Analog output dialog.



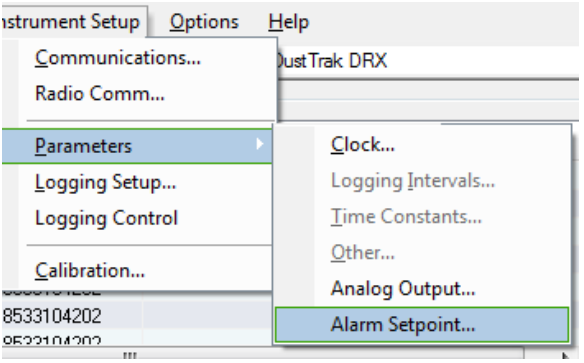
This dialog will allow for the turning on/off and configuring of the analog output.

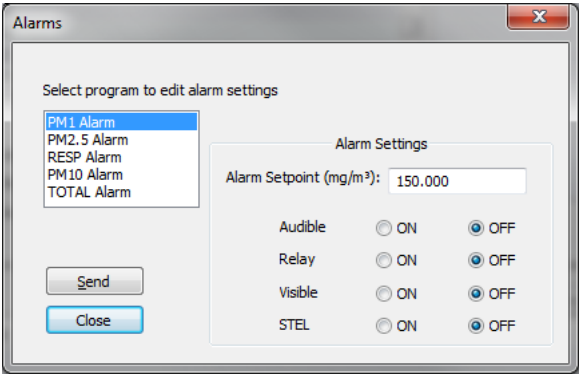


Analog out [On, Off]	Turns analog out port on.
Size Fraction	Selects the size channel that will drive the analog out. DRX Models 8543 or 8543-M only.
Output Setting [V, mA]	Select 0–5 V or 4–20 mA.
Lower Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 0 V or 4 mA.
Upper Limit [mg/m^3]	Mass concentration reading of the selected channel that will correspond to 5 V or 20 mA.

Using TrakPro Software to Program Alarm Setpoints

Use TrakPro software to setup the Alarm Setpoints. Select **Instrument Setup -> Parameters -> Alarm Setpoint…** to get to the alarm settings dialog.





Note

The Alarm is dependent on the logging interval. For the DustTrak Environmental Monitor to alarm as soon as the Alarm Setpoint is exceeded, the logging interval must be set as low as possible (i.e., 1 second or 2 seconds). If a long test duration does not permit setting such a short logging interval, use the STEL alarm instead. The STEL is always based on 1 second concentrations and is independent of the logging interval. For more details on the STEL alarm, see section below on STEL.

In Survey mode, the alarm is dependent on the time constant.

Alarms can be set of each mass channel for the DRX Models 8543 / 8543-M (PM_1, PM_2, Resp, PM_{10} and Total). Alarms can only be set for the Total channel for the standard DustTrak Models 8540 / 8540-M / 8542-M.

Alarm Setpoint [mg/m^3]	The alarm setpoint is the mass concentration level upon which the alarm1 is triggered. Alarm will trigger if the mass concentration, taken at the logging interval, rises above the setpoint.
Relay [On, Off]	When the relay alarm is turned on, unit will close its local relay switch when Alarm level is surpassed. Relay alarm can only be linked to one mass channel at a time for the DRX models 8543 / 8543-M.
STEL [On, Off]	When the STEL alarm is turned on, STEL data will be collected when Alarm level is surpassed. STEL alarm can only be linked to one mass channel at a time for the DRX models 8543 / 8543-M. See following STEL Note.
Audible [On, Off]	When the audible alarm is turned on, the instrument will activate internal beeper when the alarm level is surpassed. Audible alarm can only be linked to one mass channel at a time for the DRX models 8543 / 8543-M.
Visible [On, Off]	Not used for the 8540 / 8540-M / 8542-M / 8543 / 8543-M models.

STEL Alarm

STEL stands for **S**hort **T**erm **E**xposure **L**imit. When a STEL alarm is selected, the instrument will inspect the data on a second by second basis, independent from the selected logging interval. If the mass exceeds the STEL limit, a STEL event triggers and the following actions will be taken.

Data	Data will be taken of the STEL alarm channel at a 1 minute logging interval for **15 minutes**. This data will be stored in a separate file named STEL_XXX, where XXX will be matched to the logged data file. The instrument will also continue to log the mass concentration data at the logging interval selected.
STEL Alarm repeat	If the instrument remains over the STEL limit after the 15 minute interval, or if the instrument exceeds the STEL limit later during the sample period, additional STEL files will be generated.

STEL Data can be downloaded in TrakPro software similar to the standard data.

Chapter 5

Maintenance

The DustTrak Environmental Monitor can be maintained in the field using the instructions below.

TSI recommends the DustTrak Environmental Monitor be returned to the factory for annual calibration. For a reasonable fee, TSI will quickly clean and calibrate the unit and return it to you in “as new” working condition, along with a Certificate of Calibration. This “annual checkup” helps ensure that the instrument is always in good operating condition.

WARNING

The only user-serviceable parts inside the DustTrak Environmental Monitor are the gravimetric filter, pump, and sheath flow filter accessible behind the removable service panel.

The instrument case should only be opened by TSI or a TSI approved service technician.

Note

To maintain the MCERTS certification, it is required that the MCERTS model photometers (8540-M, 8542-M, 8543-M) be recalibrated on a yearly cycle.

Maintenance Schedule

The DustTrak Environmental Monitor requires maintenance on a regular basis. Table 1 lists the factory recommended maintenance schedule.

Some maintenance items are required each time the DustTrak monitor is used or on an annual basis. Other items are scheduled according to how much aerosol is drawn through the instrument. For example, TSI recommends cleaning the inlet sample tube after 350 hours of sampling a 1 mg/m^3 concentration of aerosol. This recommendation should be pro-rated according to how the instrument is used. 350 hours at 1 mg/m^3 is the same amount of aerosol as 700 hours at 0.5 mg/m^3 or 175 hours at 2 mg/m^3, etc.

Table 1. Recommended Maintenance Schedule

Item	Frequency
Clean the inlet nozzle*	350 hr. at 1 mg/m^{3*}
Replace internal HEPA filter	Every 6 months
Return to factory for cleaning and calibration	Annually

*Pro-rated, see discussion above.

The DustTrak Environmental Monitor keeps track of the accumulated amount of aerosol drawn through it since its last cleaning.

Cleaning the Inlet

The inlet should be cleaned based on the schedule in Table 1.

1. Turn the DustTrak monitor off.
2. Remove the 4 screws and the inlet mounting ring.
3. Unscrew the black inlet nozzle from the instrument (Figure 17).

Figure 17: Unscrew Inlet Nozzle

4. Use a cotton swab to clean the outside of the inlet nozzle body. You may dampen the swabs with water or a light solvent (e.g., isopropanol). Clean the inner diameter of the nozzle by using a small brush, along with a light solvent. Dry the nozzle by blowing it out with compressed air, or let it air-dry thoroughly.

Note
Be *careful* not to blow particles into the DustTrak monitor inlet port.

Figure 18: Do NOT Blow into Instrument

5. Screw (hand-tighten) inlet nozzle back into instrument.

Cleaning and Oiling Impactors

Follow the recommended Impactor cleaning interval for size selective Impactors as shown below. These impactors are used with models 8540, 8540-M, and 8542-M DustTrak Environmental instruments.

Recommended impactor maintenance interval is every two months except where the “average dust concentration” level indicated in the table shows the impactor should be cleaned more frequently:

Average dust concentration (mg/m^3)	Impactor maintenance interval
0.015	97 days
0.025	60 days
0.035	42 days
0.050	30 days
0.100	16 days
0.150	10 days
0.250	6 days
0.400	4 days

1. Unscrew Impactor. Check O-ring on the impactor base.
2. Clean outside and inside of Impactor and the impactor plate using a clean brush and a light solvent. Dry impactor parts by blowing it out with compressed air, or let it air-dry thoroughly.
3. Apply two drops of oil (included) to the impactor plate. Do ***not*** over-fill impaction plate.

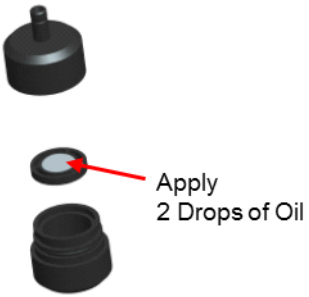


Figure 19: Apply Two Drops of Oil to Impactor Plate

4. Screw (hand-tighten) impactor back together.

Replacing the Internal Sheath Air (HEPA) Filter

Recommended to replace the internal sheath air filter after every six months of use.

1. Turn the instrument off.
2. Open Instrument Service Panel.

Figure 20: Open instrument service panel

3. Disconnect and remove old sheath air filter from the instrument.

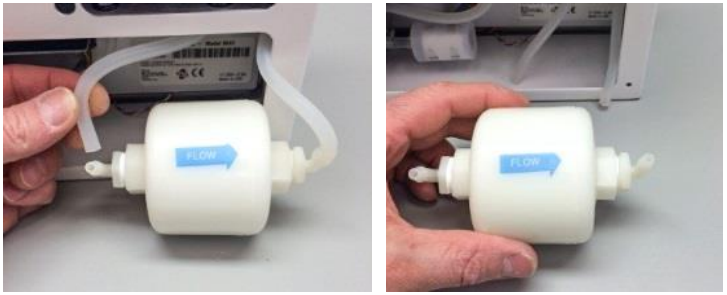


Figure 21: Disconnect and remove old sheath air filter

4. Replace with new filter (PN 854044). Ensure tubing coming from the “Y” connects to the inlet side of the filter as indicated by the Flow arrow.

Figure 22: Replace with new filter

5. Replace cover and return to service.

Figure 23: Replace cover

6. **It is important to reset the instruments filter change date and cumulative filter mass concentration after replacing the Sheath air filter.** Resetting the filter concentration may clear the filter error condition shown in the Data tab of DustTrak Checkout Software. Reset the date and concentration by performing the following:

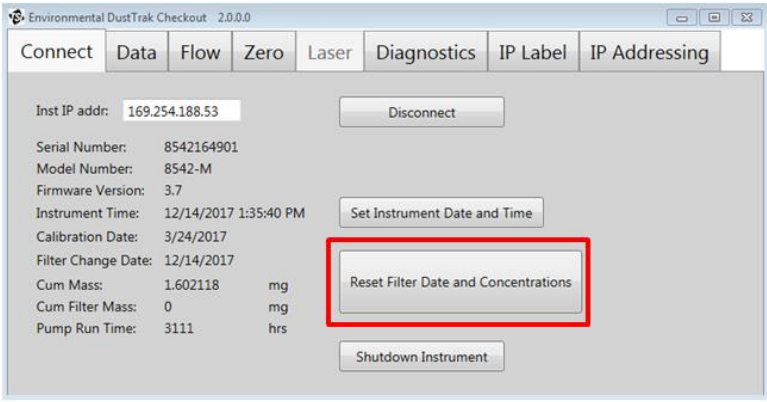
    a. Power the instrument.

    b. Open the DustTrak Checkout software.

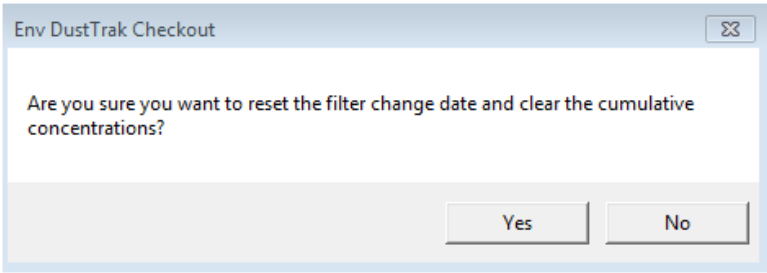
    c. Connect the provided USB cable to the instrument and your personal computer.

    d. Click **Connect**.

e. Click **Reset Filter Date and Concentrations**.



f. A Dialog box will appear confirming that you would like to reset the change date and the cumulative concentration. Click **Yes** to reset the cumulative filter concentration to zero.



g. The Checkout software will now show, **zero for the Cum Filter Mass Concentration** and the current date for the Filter Change Date.

Replacing Pump

If the pump stops working it can be removed and replaced in the field. See Quick Start Guide included with Replacement Pump (854043) for additional details.

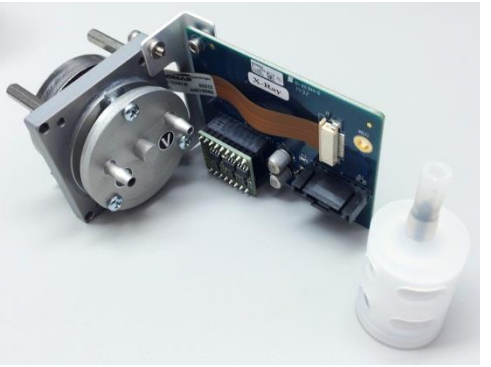


Figure 24: Replacement pump (854043)

First remove Photometer from the Environmental Enclosure following the applicable steps:

1. Disconnect all cabling from photometer.
2. Remove inlet column. If inlet column includes a heated inlet, remove ferrite from the heated inlet cable and carefully pull the heated inlet cable through the key hole on the mounting ring when removing the inlet column (Figure 25a).
3. Loosen retainer ring on top of enclosure while holding photometer (Figure 25b).
4. Pull photometer down and out of enclosure.

Figure 25: (a) Heated inlet cable;
(b) remove retainer ring and lower photometer

5. Have a replacement pump (P/N 854043) available.
6. Open instrument service panel.

Figure 26: Open instrument service panel

7. Remove the four Phillips head screws from the left-side panel.

Figure 27: Remove screws from left side panel

Note
Remove only the raised-head screws. **DO NOT** remove any screws with heads flush to the surface.

8. Pull the pump from the enclosure and detach tubing, muffler, and cable.

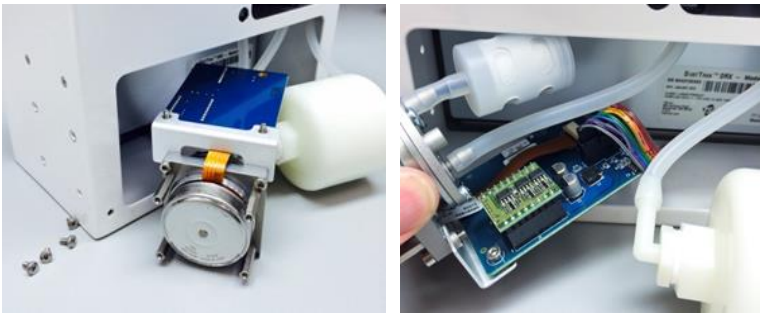


Figure 28: Pull pump from enclosure and detach tubing, muffler, and cable

9. Attach the muffler to P, tubing to V, and cable to the new pump.

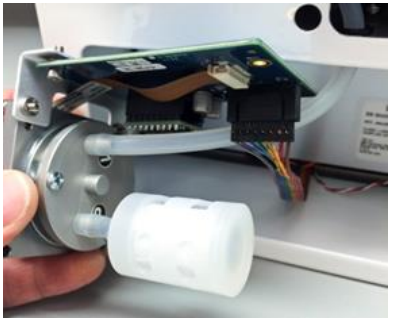


Figure 29: Attach muffler

10. Orientate pump inside instrument with muffler (port P) located in the lower position (Figure 30).

Figure 30: Pump orientation

11. Secure the new pump inside the instrument case with the four Phillips head screws.

Figure 31: Secure new pump

12. Replace photometer service panel and reinstall photometer inside Environmental Enclosure following the steps above in reverse order.

Replacing Internal 37-mm Sampling Cassette

The internal 37-mm sampling cassette can be used to conduct sampling for gravimetric or analytical analysis. The instrument comes with a blank cassette containing a mesh sieve to keep large particulate out of the instrument pump. Save this cassette and the filter. The DustTrak Environmental Monitor is designed to have this cassette in place. The flow path will be compromised without this cassette.

On occasion, this cassette should be removed and the mesh screen cleaned by blowing with compressed air or rinsing under running water and allowing the filter to dry before replacing the cassette. The maintenance interval will vary depending on the aerosol concentration being sampled. TSI recommends initially checking this screen **monthly** until the accumulation rate is understood. The screen should be changed out before it is completely coated with aerosol buildup.

TSI does not provide the filter media for gravimetric or analytical sampling. When requesting cassette with filter media for gravimetric sampling, ask for a 37-mm, 2-piece, static conductive plastic cassette to ensure proper fit inside the DustTrak monitor.

1. To remove cassette, open instrument service panel to access the sampling cassette. Internal sampling cassette is located in the upper right opening.

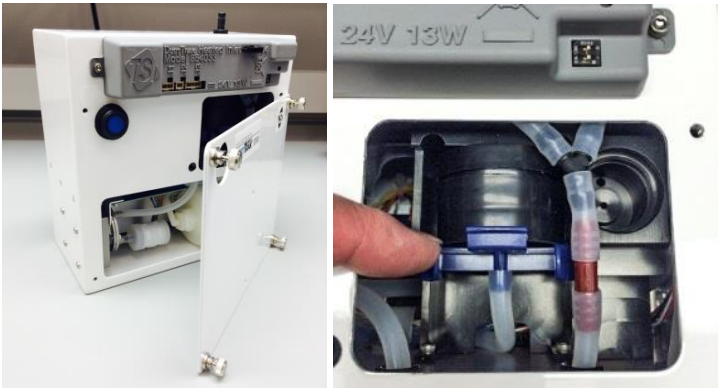


Figure 32: Remove sampling cassette

2. Pinch the blue clip to release the bottom cassette holder and remove cassette from the holder.

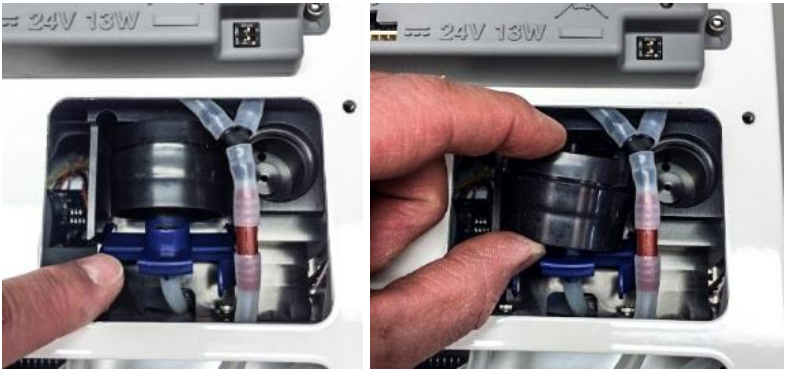


Figure 33: Release and remove cassette holder

3. Inspect top inlet fitting and blue cassette holder for broken pieces or missing seals.

Figure 34: Inspect top inlet fitting and blue cassette holder

4. Install a blank cassette for DustTrak monitor operation or a pre-weighed, 37-mm, 2-piece, conductive cassette with the appropriate filter media for the analysis to be performed.
5. Make sure the Cassette snaps securely into the inlet port on the top of the cassette holder and the bottom clip snaps securely into place. If the connection is loose, air will leak resulting in inaccurate sampling results.

Figure 35: Snap cassette securely into inlet port

Return Shipping to TSI

- Disconnect and remove all accessories.
- Package the instrument in the original shipping container.

Note
If original shipping container is not available, pack instrument securely in a durable shipping carton to prevent damage during shipment. Consult with courier for packing guidance.

- Include printed copy of RMA form inside container with instrument.
- Ship to TSI via trackable shipping method.

Chapter 6

Troubleshooting

The table below lists the symptoms, possible causes, and recommended solutions for common problems encountered with the DustTrak monitor.

Symptom	Possible Cause	Corrective Action
Erratic reading.	Leak	Check connections for leaks
	Dirty inlet port and/or sample tube	Clean inlet port. Clean or replace tubing
	Internal filter(s) not installed properly (leaking)	Inspect internal filter wells to make certain the filters and O-rings are seated properly. Replace internal filters if necessary
DustTrak reading negative concentrations	Zero Drift	Increase autozero frequency
Analog output does not work	Cable/connector not correctly installed	Make sure cable connector is fully seated
	Output wired with reverse polarity	Make sure analog out (+) and analog ground (-) are wired correctly to data-logger
Alarm output does not work	Alarm function not turned on	Turn the alarm function on in TrakPro software
Alarm does not turn on correctly	Alarm setting incorrect	Check the alarm settings in TrakPro software
	Alarm output wired with reverse polarity	Alarm wires are polarized. Voltage input must be wired to alarm input (+)

Symptom	Possible Cause	Corrective Action
Instrument does not store new data	Memory is full	Delete or transfer historic data
	Instrument is in Survey mode	The instrument does not store data in survey mode. Can to manual or program log mode
Flow Error is indicated in Data set or on Environet	Flow obstruction	Remove obstruction if still present. Press any key to bypass
	Internal pump failing, indicated by inability to adjust flow rate to full range	Replace pump per instructions in maintenance section
	Filter Cassette clogged or has mass loading	Replace the filter cassette. See the maintenance section of the manual
Laser Error indicated in data set of on Environet	Laser background is too high	Remove and clean inlet nozzle. Pay close attention to the tip of the nozzle that is inserted into the instrument to ensure it is clear of any contamination
	Laser is failing	Factory service may be required
Filter Error indicated in data set or on Environet	Filters need to be replaced	Replaced the filters per instructions in the maintenance section of this manual. Make sure to reset the filter mass and date once the filters have been changed

Note

This is only a warning. The unit will continue to operate normally until the increase in pressure drop across the filter is so high that the pump can no longer maintain the set flow rate.

Appendix A

Specifications

Specifications are subject to change without notice.

8540/8540-M/8542-M/8543/8543-M DustTrak Environmental Monitors are designed to operate inside a weather-proof enclosure, like TSI Model 854030 Environmental Enclosure, sold separately.

Sensor Type	90° light scattering
Range	0.001 to 400 mg/m^3 (models 8540, 8540-M, & 8542-M) 0.001 to 150 mg/m^3 (models 8543 & 8543-M)
Resolution	±0.1% of reading or 0.001 mg/m^3, whichever is greater
Zero Stability	±0.002 mg/m^3 24 hours at 10 sec time constant
Particle Size Range	Approximately 0.1 to 10 µm (8540, 8540-M, 8542-M) / 0.1 to 15 µm (8543, 8543-M)
Flow Rate	3.0 L/min set at factory
Flow Accuracy	±5% factory setpoint Internal flow controlled
Temperature Coefficient	+0.001 mg/m^3 per °C
Operational Temp	0° to 50°C
Storage Temp	-20° to 60°C
Operational Humidity	0–95% RH, non-condensing
Time Constant	Adjustable 1 to 60 seconds
Data Logging	45 days at 1 minute samples
Log Interval	1 second to 1 hour
Physical Size (HWD)	8.25 x 8.25 x 4.25 in. (20.96 x 20.96 x 10.80 cm)
Weight	5.25 lbs (2.38 kg)

Communications	Cellular, Wi-Fi, GPS/GPRS, USB (Host and Device) and Ethernet.
Power	12/24 Volts DC 50 Watts
Analog out	8540/8540-M/8542-M/8543/8543-M: User selectable output 0 to 5 V or 4 to 20 mA User selectable scaling
Alarm Out	8540/8540-M/8542-M/8543/8543-M: Relay or sound buzzer Relay No latching MOSFET User selectable setpoint 5% deadband Connector 4-pin, Mini-DIN connectors
Internal Sampling Cassette	Removable 37-mm, 2-piece, static conductive cassette. *Contact AIHA Accredited Analytical Lab for guidance on selecting the proper filter media for your desired analytical testing.*

Appendix C

DRX Advanced Calibration

The advanced calibration method is employed to yield high size segregated mass concentration accuracy for $PM_{1.0}$, $PM_{2.5}$, Respirable, and PM_{10} size fractions. It involves two gravimetric measurements to obtain PCF and SCF. The two gravimetric measurements can be done in sequence or in parallel, depending on the gravimetric sampling device availability.

Option 1: Serial Gravimetric Calibration

When you have only one set of gravimetric sampling devices, the DustTrak DRX advanced calibration can be performed in two serial steps. The experimental setup is in Figure 36a. The calibration steps are outlined below:

Step 1: PCF Calibration

- Install a $PM_{2.5}$ impactor at the inlet of the external gravimetric filter.
- Co-locate and run the gravimetric sample and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filter.
- Calculate the $PM_{2.5}$ mass concentration ($PM_{2.5\_Grav}$) from the gravimetric filter based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.
- Read the DustTrak DRX monitor average $PM_{2.5}$ mass concentration ($PM_{2.5\_DRX}$) from the screen or through TrakPro Data Analysis Software.
- Calculate the new PCF

$$PCF_{New} = \frac{PM_{2.5\_Grav}}{PM_{2.5\_DRX}} \times PCF_{Old}.$$

- Update the new PCF in user calibration settings.

Step 2: SCF Calibration

- Install a PM_{10} impactor at the inlet of the external gravimetric filter.

- Co-locate and run the gravimetric sample and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filter.
- Calculate the PM_{10} mass concentration (PM_{10_Grav}) from the gravimetric filter based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.
- Read the DustTrak DRX monitor average $PM_{2.5}$ ($PM_{2.5\_DRX}$) and PM_{10} (PM_{10_DRX}) mass concentration from the screen or though TrakPro Data Analysis Software.
- Calculate the new SCF

$$SCF_{New} = \left(\frac{PM_{10\_Grav} - PM_{2.5\_DRX}}{PM_{10\_DRX} - PM_{2.5\_DRX}}\right)^{\frac{1}{3}} \times SCF_{Old}.$$

- Update the new SCF in user calibration settings.

Option 2: Parallel Gravimetric Calibration

When you have two sets of gravimetric sampling devices, the DustTrak DRX monitor advanced calibration can be performed in the parallel configuration as shown in Figure 36b. The calibration steps are outlined below:

1. Install a $PM_{2.5}$ and a PM_{10} impactor at the inlet of the two external gravimetric filters, respectively.
2. Co-locate and run the gravimetric samples and DustTrak DRX monitor simultaneously to collect enough mass on the gravimetric filters.
3. Calculate the $PM_{2.5}$ ($PM_{2.5\_Grav}$) and PM_{10} (PM_{10_Grav}) mass concentrations from the gravimetric filters based on the net mass collected on the filter, sampling time, flow rate, and total liters of air sampled.
4. Read the DustTrak DRX monitor average $PM_{2.5}$ and PM_{10} mass concentration ($PM_{2.5\_DRX}$ and PM_{10_DRX}) from the DRX screen or through TrakPro Data Analysis Software.
5. Calculate the new PCF

$$PCF_{New} = \frac{PM_{2.5\_Grav}}{PM_{2.5\_DRX}} \times PCF_{Old},$$

and the new SCF

$$SCF_{New} = \left(\frac{PM_{10\_Grav} - PM_{2.5\_Grav}}{PM_{10\_DRX} - PM_{2.5\_DRX}}\right)^{\frac{1}{3}} \times SCF_{Old}.$$

6. Update the new SCF and PCF in the user calibration settings.

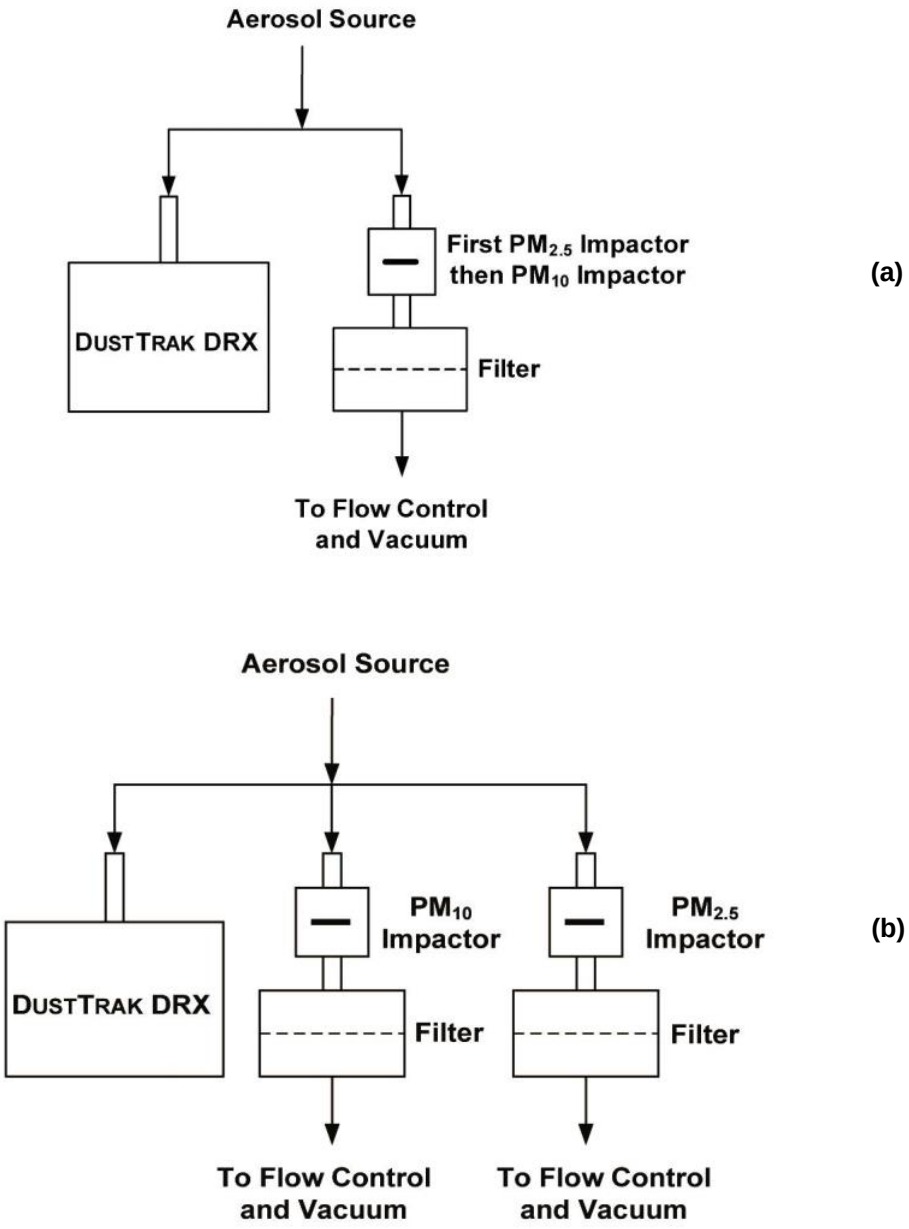


Figure 36: Experimental Setup for
(a) rial and (b) Parallel Gravimetric Calibration