

aeroqual⁸⁰

Dust Sentry & AQS 1 User Guide



User Guide Revision History

Date	Revision number	Description of change	Affected Sections
June 2017	1	First release	-
September 2017	2	NO2 and VOC added	1, 1.1
May 2018	3	Calibration section updated	5.0
February 2019	4	Combining AQS, Dust Sentry, Dust Sentry Profiler	All
October 2019	5	New internal components and layout, handle Updated specifications Added US power cable New 3 rd party sensor power and data interface Added Sierra modem New "lease mode" Updated location of pumps	1.0 1.6 2.5 2.7 4.2 5.0 12.2
November 2019	6	Direct-read NO ₂ module replaces Ox module. Calibration steps updated for NO ₂ module.	7 12.1 12.5
February 2020	7	NO2 and VOC specs Pole mounting options updated Reset Network USB updated VOC flowrates corrected	1.5 3.1 4.4 7
August 2020	8	Surveyor's tripod mounting	3.5
June 2023	9	Added PCX module and combined and removed sections	All
March 2024	10	Updated PCX module documentation Added PDI Core documentation	2 6.2 6.3

Alternative sources of information and help

In addition to this user guide, Aeroqual offers other sources of information which can assist in the operation of the monitors. The Aeroqual website contains brochures, technical notes, frequently asked questions, and user guides.

<https://www.aeroqual.com>

Aeroqual's training website contains a comprehensive document library of technical notes and service and calibration templates to download and print. The training website has detailed descriptions of service activities and calibration and installation examples and is updated regularly. Video tutorials are featured heavily.

<https://support.aeroqual.com/>

For technical support, contact the Aeroqual distributor in your local country. If local technical support is not available contact the Aeroqual support team: support@aeroqual.com.

Where possible, references to further material will be provided throughout this document.



	Online reference	support.aeroqual.com
	Online videos	www.youtube.com/@aeroqual47

Table of Contents

1	Introduction	6
1.1	Overview	6
1.2	Particulate Measurement Options.....	7
1.3	Gas Modules	8
1.4	Optional external sensors	8
1.5	Dimensions.....	9
1.6	Specifications	10
2	Quick Setup Guide.....	12
2.1	Preparation.....	12
2.2	Pre-planning	14
2.3	Unpacking	14
2.4	Assembly.....	15
2.5	Power Requirements.....	15
2.6	Powering On/Off.....	17
2.7	Connecting auxiliary sensors	17
3	Mounting and Site Positioning Guidelines	21
3.1	Mounting.....	21
3.2	Inlet height.....	22
3.3	Measurement Interference	22
3.4	Safety	22
3.5	Surveyor's tripod mounting	22
4	Connectivity	25
4.1	Aeroqual Connect (via Direct WIFI / LAN)	25
4.2	Aeroqual Cloud (via Network WIFI / Modem)	26
4.3	Communication settings.....	30
4.4	Resetting the communication settings back to factory settings	31
5	Software	32
5.1	Manage Data.....	32
5.2	Calibration and Service	34
5.3	Configure Instrument.....	34
5.4	Diagnostics and Advanced.....	34
5.5	Administration.....	36
6	Setup, Service, and Maintenance	37
6.1	General.....	37
6.2	PDI Core.....	40
6.3	Nephelometer and Particle Profiler Modules	44
6.4	PCX Modules	58
6.5	Gas Modules	69
6.6	Scheduled Maintenance.....	75
7	Calibration.....	76

7.1	Gas module calibration	76
7.2	Particulate Module Calibration	87
8	Troubleshooting	90
9	Copyright.....	92
10	Compliance	92
11	Warranty	92
12	Appendix	93
12.1	Mains wiring color guide.....	93
12.2	Calibration Records.....	94

1 Introduction

1.1 Overview

The Dust Sentry and AQS 1 (referred to herein as a 'monitor') are flexible air quality monitoring systems that can be configured to target specific applications of interest in industrial, urban environment and regulatory applications.

The monitor incorporates key technology features that allow it to deliver data with very strong correlation to EPA-approved monitors – 'Near Reference' – over extended periods of time, several years with appropriate maintenance.

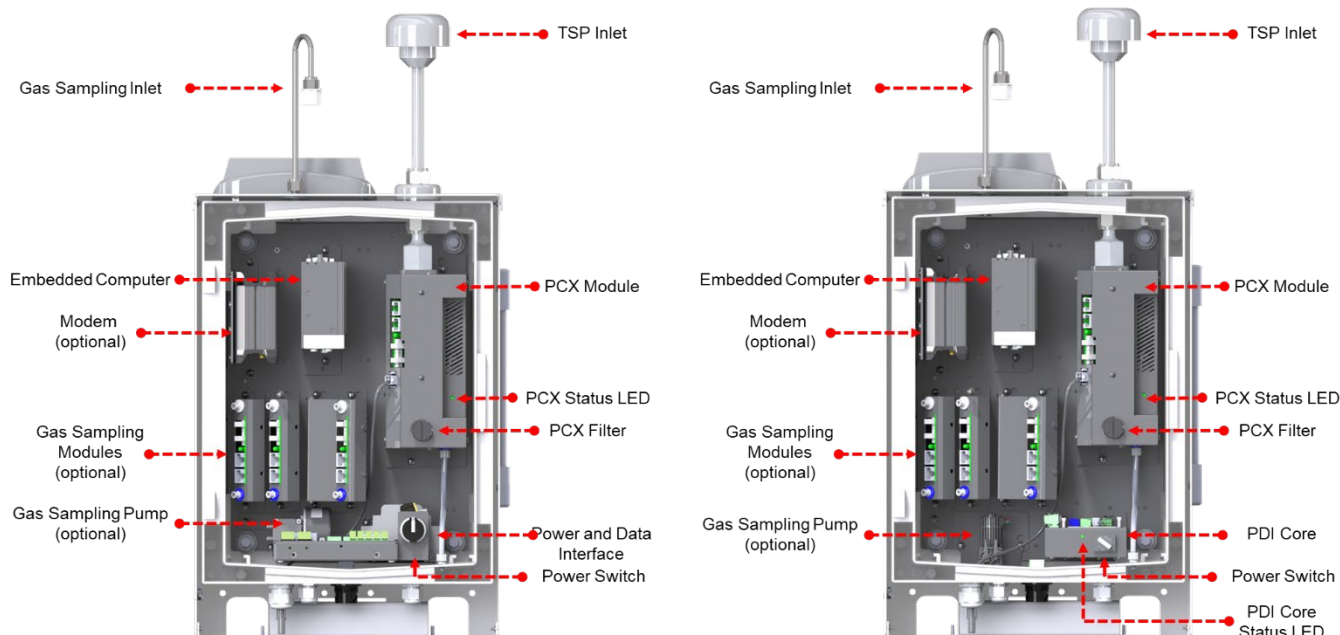
Housed in a rugged, lockable weatherproof (IP 65) enclosure. The monitor includes an embedded PC, modem and full software system for remote technical support, data management and analytics.

The instrument is designed to connect to **Aeroqual's Cloud** software suite (purchased separately) which enables remote access to the monitor, a project management toolset, and online technical support. This can be accessed through a web browser, such as Microsoft Edge, Firefox, Chrome, or Safari. Alternatively, users have the option to connect directly to the embedded PC, which runs a proprietary monitor operating system called **Aeroqual Connect**.

Product	Particulate Measurement			Gas Measurement
	Nephelometer	Profiler	PCX	
Dust Sentry Pro	-	PM ₁ , PM _{2.5} , PM ₁₀ and TSP	-	Not Available
Dust Sentry	PM ₁ or PM _{2.5} or PM ₁₀ or TSP	-	PM ₁ , PM _{2.5} , PM ₄ , PM ₁₀ and TSP and 6 size counts	Not Available
AQS 1	PM ₁ or PM _{2.5} or PM ₁₀ or TSP	PM ₁ , PM _{2.5} , PM ₁₀ and TSP	PM ₁ , PM _{2.5} , PM ₄ , PM ₁₀ and TSP and 6 size counts	O ₃ , NO ₂ , CO, VOC, H ₂ S, SO ₂ , CH ₄

AQS PCX with Power and Data Interface

AQS PCX with PDI Core



1.2 Particulate Measurement Options

An Aeroqual Dust Sentry or AQS 1 can be equipped with several different options for measuring particulate matter including a Nephelometer, a Profiler, or a PCX module.

1.2.1 Particle Nephelometer Module

The Aeroqual Particle Nephelometer Module combines a laser nephelometer with a high-precision sharp cut cyclone. The sharp cut cyclone physically selects particles of a target size by causing all particles greater than a certain size to drop out of the air stream. The particles that remain in the air stream then continue to the nephelometer. A nephelometer is an optical device that uses light scattering to measure particle mass. The light source is a visible laser diode and scattered light is measured in the near forward angle using focusing optics and a photo diode. The amount of scattered light is proportional to the mass of particles in the air stream. The nephelometer module is capable of measuring PM₁, PM_{2.5} or PM₁₀ when equipped with an appropriate cyclone, or total suspended particulate (TSP) when no cyclone is equipped. When the monitor is configured with a nephelometer and PM₁₀ sharp-cut cyclone, the Dust Sentry and AQS 1 carry a MCERTS certification.

1.2.2 Particle Profiler Module

Aeroqual Profilers are optical particle counting devices that use scattered light to size and count particles. The amount of light scattered is converted to a voltage pulse, and the amplitude of the pulse is calibrated to a particle diameter. The particles are assigned to one of eight particle counts channels based on their diameter. Particle counts from each channel are used to calculate mass using proprietary algorithms. This allows particle profilers to calculate PM₁, PM_{2.5}, PM₁₀ and TSP simultaneously. The particle counts channels can also be reported if required. Flow adjustments must be made manually with this device.

1.2.3 PCX Module

The PCX module is a light scattering based, optical particle counter like the Profiler module, with several important advantages. The PCX module has the capability to report 5 particle mass channels (PM₁, PM_{2.5}, PM₄, PM₁₀, and TSP) in addition to 6 particle count channels (optional) and includes several 'smart' features that improve the performance while reducing operator burden.

- **Integrated Flow Management:** Active flow control maintains the flow rate at a steady 1 L/min, ensuring all particles are sized and counted correctly, and minimizing setup and maintenance time by reducing the need for flow checks.
- **Dynamic Heater Control:** The PCX module has an integrated inlet heater that can be controlled dynamically if the PCX module is equipped with a temperature and humidity sensor measuring the ambient conditions. This allows for automatic control to the minimum required temperature (and subsequently power consumption) to reduce humidity interference, resulting in increased power savings.
- **Advanced Failure Warning:** The PCX module can automatically notify you in the event maintenance may be required. By monitoring and recording the amount of particulate through the module, the instrument can notify you when a filter may require replacement. The system will also monitor pump speed relative to module flow rate and can raise a warning in the event a pump may soon need replacing. For further detail on the failure warnings please see *Section 6.4.9*.

1.3 Gas Modules

Aeroqual's gas modules are a reliable and accurate solution for monitoring gaseous pollutants. The gas modules come pre-calibrated from the factory and are traceable to NIST Standard Reference Materials. They can also be calibrated in the field against US EPA protocol gas standards, if necessary.

In addition to particulate matter monitors can be configured to monitor up to 3 of the following gases:

- O₃
- NO₂
- CO
- VOC
- H₂S
- SO₂
- CH₄

Note: Gas module are only available in an Aeroqual AQS, however Dust Sentry and Dust Sentry Pro can be upgraded to work with gas modules.

1.4 Optional external sensors

The monitors can integrate several external sensors such as weather sensors, solar radiation, and noise sensors. These sensors are mounted outside the monitor enclosure. The external sensors below are available factory tested and ready to connect to the monitors.



Cirrus
MK427
noise
meter



Vaisala
WXT536
weather
station



Gill Instruments
Windsonic



Li-Cor LI-200
Pyranometer



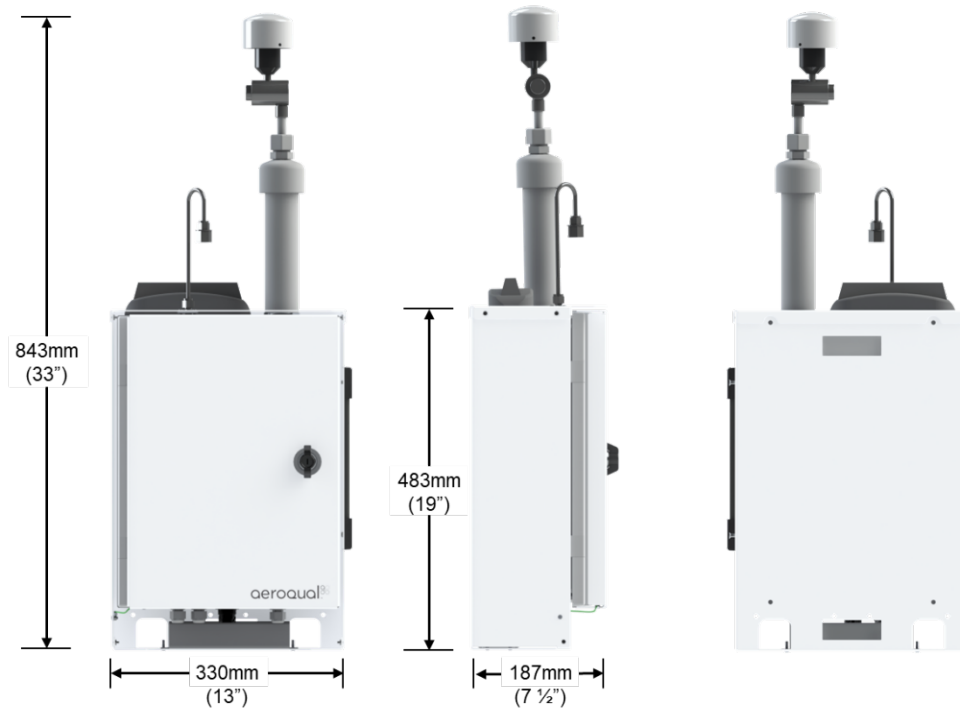
Airmar 200WX

See Section 2.7 for wiring external sensors.

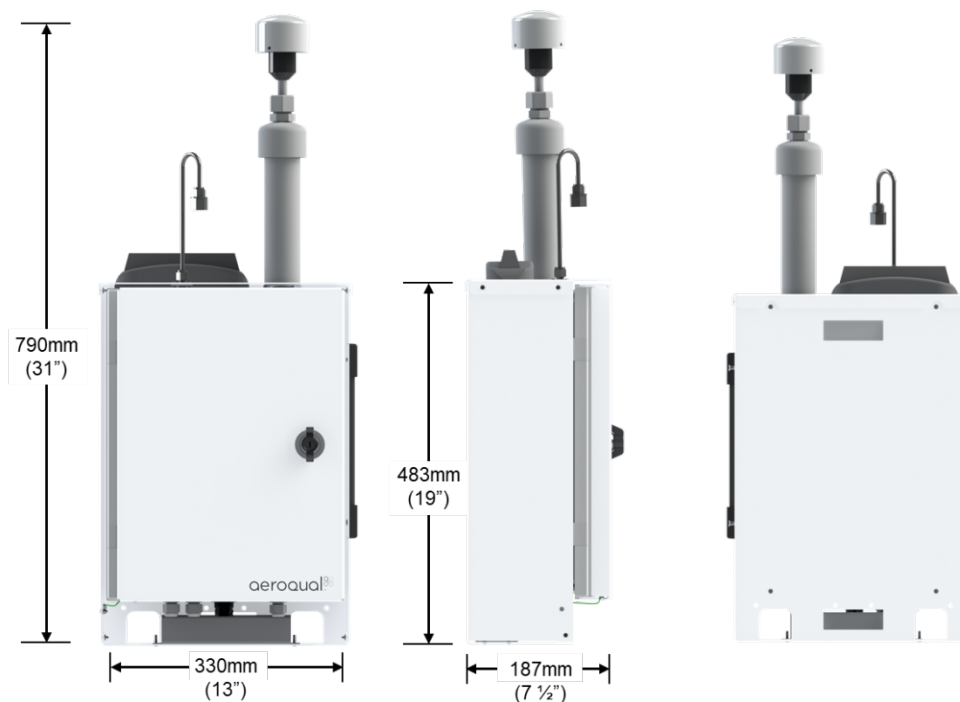
1.5 Dimensions

These dimensions are for a visual representation only, for full details see Section 1.6 Specifications.

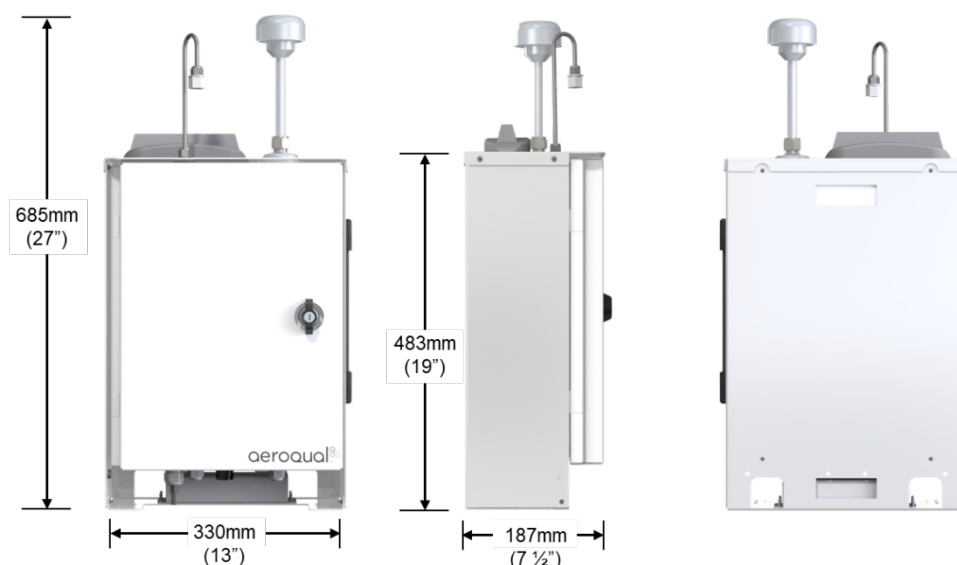
Dimensions for DS, or AQS1 **with Nephelometer Module**:



Dimensions for DS Pro or AQS1 **with Profiler Module**:



Dimensions for DS, or AQS1 **with PCX Module**:



Dimensions are in millimetres and (Inches).

1.6 Specifications

Specifications are subject to change, please check www.aeroqual.com for the current specifications.

Particulate Measurement	DS / AQS <i>with Nephelometer</i>	DS Pro / AQS <i>with Profiler</i>	DS/AQS <i>with PCX</i>
Measurement technology	Near forward angle laser scattering nephelometer	Right angle laser scattering particle counter	Right angle laser scattering particle counter
Particle Counts	N/A	Optional Particulate Counts: 0.3, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10 microns (counts range: 0-100,000 counts/L)	Optional Particulate counts: 0.3, 0.5, 1.0, 2.5, 5.0, 10 microns
Particle Mass Measurement PM1 PM2.5 PM4 PM10 TSP Simultaneous?	Range / $\mu\text{g}/\text{m}^3$ 0 – 60,000 0 – 60,000 N/A 0 – 60,000 0 – 60,000 No	Range / $\mu\text{g}/\text{m}^3$ 0 - 200 0 – 2000 N/A 0 - 5000 0 - 5000 Yes	Range / $\mu\text{g}/\text{m}^3$ 0 - 30,000 0 - 30,000 0 - 30,000 0 - 30,000 0 - 30,000 Yes
Accuracy	$\pm(2 \mu\text{g}/\text{m}^3 + 5\%$ of reading)	$\pm (5 \mu\text{g}/\text{m}^3 + 15\%$ of reading)	,< 5% of reading
Precision	$\pm 1\%$ of reading	Not Tested	$\pm 3\%$ of reading
Lower Detectable Limit (2σ)	$<1 \mu\text{g}/\text{m}^3$		$0.1 \mu\text{g}/\text{m}^3$
Display Resolution	$0.1 \mu\text{g}/\text{m}^3$	$0.1 \mu\text{g}/\text{m}^3$	$0.1 \mu\text{g}/\text{m}^3$
MCERTS certified	PM ₁₀	No	Pending
SCAQMD Rule 1466	Pre-approved	No	Pre-approved
Auto zero check	Yes	No	Yes
Auto flow control	No	No	Yes
Sample flow	2 LPM	1 LPM	1 LPM
Recommended factory calibration interval	24 months	12 months	24 months

Operating temperature ⁽¹⁾	-10 °C to +50 °C (14 °F to 122 °F)	-10 °C to +45 °C (14 °F to 113 °F)	-10 °C to +45 °C (14 °F to 113 °F)
Heated inlet	Yes	Yes	Yes
Other			
Connect / Cloud software	Yes	Yes	Yes
Power consumption ⁽¹⁾	30-36.6W	30-36.6W	15 to 27 W ⁽¹⁾
Dimensions ⁽³⁾ H x W x D (Inches)	843 x 330 x 187 mm (33 x 13 x 7 ½ ")	790 x 330 x 187 mm (31 x 13 x 7 ½ ")	685 x 330 x 187 mm (27 x 13 x 7 ½ ")
Weight ⁽⁴⁾	<14 kg (30.9 lbs) ⁽⁴⁾	<14 kg (30.9 lbs) ⁽⁴⁾	<14 kg (30.9 lbs)

⁽¹⁾ Power consumption based on typical configuration, excludes 3rd party sensors.

⁽²⁾ Configuration and ambient condition dependent.

⁽³⁾ Dimensions are for enclosure with inlet fitted.

Gas measurement specifications for AQS only

Gas Measurement	Range (resolution)
Ozone	0 - 500 ppb (0.1 ppb)
Nitrogen Dioxide	0 - 500 ppb (0.1 ppb)
Carbon Monoxide	0-25 ppm (0.001 ppm)
Volatile Organic Compounds Low	0 - 500 ppb (0.1 ppb)
Volatile Organic Compounds High	0 - 30 ppm (0.01 ppm)
Hydrogen Sulfide	0-10,000 ppb (0.1 ppb)
Sulfur Dioxide	0-10,000 ppb (0.1 ppb)
Methane	0-100 ppm (0.01 ppm)
Gas calibration interval	As required

2 Quick Setup Guide

2.1 Preparation

2.1.1 Before the monitor arrives (for full pre-planning details see Section 2.2)



1. Visit the site and assess monitor location and suitability

- Site will be representative of the pollutants you intend to measure.
- Site is secure but with adequate access.
- Site is appropriately open to all wind directions.
- If you are planning a permanent deployment, check that there is nothing nearby which could change and affect your project – like trees, planned buildings or new roads and other potential interferences.



2. Ensure power is available on site

- Ensure power is available. Both Mains and Solar power can be used, but these will need to be available and/or installed before the monitor arrives.
- When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely.
- Allow for 2 power outlets, one for the monitor and one for calibration equipment.

NOTE: Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.



3. Install any additional infrastructure required for the installation

- Mounting location and method has been identified. Most sites will require a way of securely mounting the monitor. Pole Brackets (50.8 mm / 2" 304 Stainless U-Bolt) are included to mount the monitor on a pole, anchored to the ground. Small platforms have also been used successfully too.
- If you have ordered Auxiliary sensors (Weather, noise etc.) you will need to provide a means of mounting these also. You will need to supply a pole and fixings to mount the sensor. Siting may be subject to local regulations.
- Check you have the required tools.



4. Confirm communications specification (WIFI and/or cellular)

- Check communications specifications and how the monitor software will be accessed on site
- For cellular access, purchase a dynamic IP network SIM card with at least 1 GB data / month.



5. Plan for your time on site

- When setting up for the first time allow at least four hours on site.
- Allow for travel time to and from the site.
- Confirm site operation times available for access.
- Confirm personal protective equipment (PPE) that may be required on site.



6. Read the user guide

- Familiarise yourself with the assembly steps.
- Confirm the method of data access that will be supplied with the monitor (e.g. Aeroqual Connect or Aeroqual Cloud).
- Send any questions about things you are unsure about to technical@aeroqual.com



7. Write a checklist

- Write your own checklist to ensure a smooth installation and setup.
- Include any reporting requirements that will be required.

2.1.2 After the monitor arrives



1. Unpack the monitor and inspect

- Inspect the packaging and monitor for damage. Section 2.3
- Check all items have been supplied

NOTE: Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor.



2. Mount monitor

- Mount the monitor to your platform or pole. Section 2
- Attach the PM inlet. Section 6.2
- Attach the gas inlet. Section 5.1
- Open the door and check that all tubing, power and data connections are secure.



3. Power on the unit

- Turn on the unit. Section 2.6
- Check that the Status LEDs on the modules, Embedded PC and Modem (if fitted) are on and green.
- Check that the sampling pump (PM only) or pumps (PM and Gas) are running.



4. Set up Wi-Fi / Modem and connect to the monitor

- Connect to Aeroqual Connect Section 4.1
- Connect to Aeroqual Cloud Section 4.2



5. Check sampling flow rates

- Put the monitor into Service mode Section 6.1.5
- Write a comment in the Journal that you are on site for monitor commissioning. Section 6.1.6
- Check the sampling system for leaks, rectify any leaks. Section 6.5.3
- Check and adjust gas module flow rates to specification. Section 6.5.6
- Check PM inlet flow rates. Section 6.3.2



6. Attach optional auxiliary sensors

- If you have purchased any auxiliary sensors (Weather, Noise) mount these and run the cabling through the external glands and connect to the AUX module. Section 2.7



7. Document setup in Journal

- Note in the Journal that commissioning is complete. Section 6.1.6
- Exit Service mode. Section 6.1.5

2.1.3 Installation and commissioning

Commissioning is the process of setting up a new monitor to work correctly on site. It is important that the correct procedure for commissioning the monitors is followed to ensure reliable monitor operation and to meet or exceed your data quality objectives. All monitors are supplied with a traceable factory calibration. This calibration is applicable to the commissioning phase and accordingly Aeroqual does not recommend an initial calibration as part of monitor commissioning.

Aeroqual provides a commissioning procedure which should be completed during this period. This report details the tasks carried out during commissioning and can be used to demonstrate correct commissioning to end customers.

The commissioning procedure is available from: <https://support.aeroqual.com>

NOTE: Please allow at least 30 min for the monitor to warm up to counter the effects of humidity.

2.1.4 Complete the Commissioning report and provide to customer

This report details the settings of the monitor at the time of commissioning. The completed report should be provided to the customer, along with the factory logbook which is provided with every monitor.

2.2 Pre-planning

The monitors require only basic assembly out of the box.

- Wire a mains AC power cable
- Attach particulate inlet
- Attach gas inlet
- Attach third party sensors (where supplied)
- Configure modem (where supplied)

Aeroqual recommends these steps be performed in an office or laboratory as part of a quality control check of the monitor to make sure the monitor has arrived undamaged and the flow system, electrical system and communication system are working as expected.

Some of the steps described here will be repeated in the field as part of the installation and commissioning process.

After these steps have been carried out, the Monitor can be safely transported to the monitoring site for installation and commissioning.

Key points to consider for assembly and first power up:

- The monitors run on single-phase mains AC power 100 - 260 VAC (standard), or if required a regulated 12 VDC. For more details see Section 2.5.

Configuration used for power calculations: base unit, PCX, O₃ module, modem, heater off / heater on.

- Outside of the United States you need to supply a mains power cable and local plug, Aeroqual recommends a residual current device (RCD) be used to protect against power spikes.
- You will need a Phillips head screwdriver, and if you have an external sensor, you will also need a small flat blade screwdriver.
- There is no software to download and install, and no cables are required for communication. Communication to the monitor is through your web browser on your laptop, tablet or smart phone using WIFI.
- If you have purchased a modem, this needs a local SIM (dynamic IP), the same as you would have in your smart phone, but you must know the APN of your chosen telecommunications provider.

2.3 Unpacking

The monitors are packaged in a cardboard carton with moulded protective inserts.

Dimensions (L x W x H): 62 x 32 x 55 cm (24.4 x 12.6 x 21.6 “)

Weight: < 14 kg (30.8 lbs) (Configuration used for weight calculations: base unit, PCX with TSP inlet, O₃ module, modem, heater off / heater on.

Additional components such as weather or noise sensors will be packaged in additional boxes.

- a) Examine the ShockWatch® label on the side of the shipping box. If the indicator is red do not refuse the shipment. Make a notification on delivery receipt and inspect for damage. If damage is discovered, leave item in original packaging and request immediate inspection from carrier within 15 days of delivery date (3 days international).
- b) Verify the serial number label on the documentation matches the serial label on the monitor – the label is located inside the monitor on the bottom right side.
- c) Verify that all components have been shipped as per the packing slip. Contact your Distributor or Aeroqual if you suspect any parts are missing.



2.4 Assembly

- See Section 6.2 for instructions around setup of monitors with Nephelometer and Profiler Modules
- See Section 6.4 for instructions around setup of monitors with PCX Modules
- See Section 6.5 for instructions around setup of monitors with Gas Modules

2.5 Power Requirements



Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The internal power requires regulated 12 VDC to maintain a constant pump speed. An external mains to 12 VDC power supply is fitted under the enclosure and is supplied with either:

- a) a lead with IP rated electrical connector – wiring of mating connector and lead is required, or
- b) a wired mains lead and plug (United States only).

Where possible, visit the site and assess monitor location and access to power source.

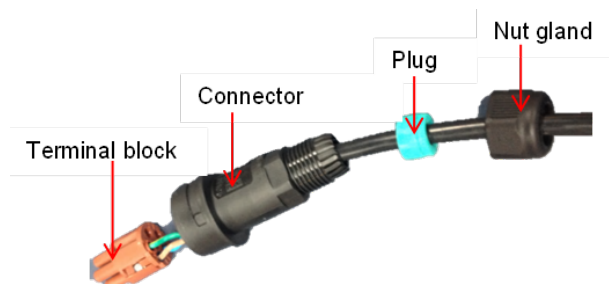
2.5.1 AC power source

Both Mains and Solar power can be used, but these will need to be available and installed before the monitor arrives. When installing power outlets (110 VAC to 230 VAC) for the monitor, they should be weatherproof and installed safely. Install two power outlets, one for the monitor and one for calibration equipment.

NOTE: Outside the United States a power lead with local plug will need to be supplied and wired to a connector supplied with the monitor – see Section 2.5.2.

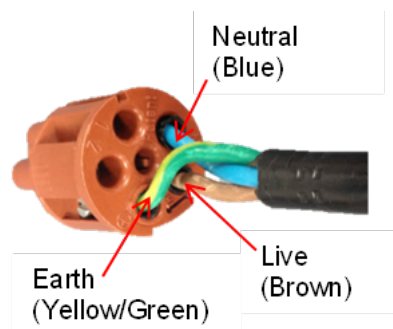
2.5.2 Wiring the power supply connector

1. Locate the power connector terminal which is situated outside the enclosure at the bottom. The power supply will already be wired to the connector however the cable to connect to mains power needs to be wired.

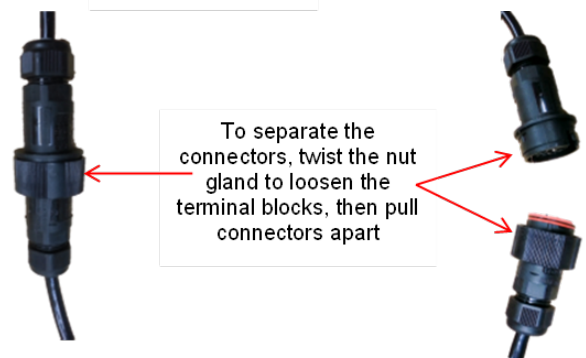


2. Feed the power cable through the nut gland plugs and connector and wire the cable to the terminal block according to the diagram.

Note: A wiring color guide is in Section 12.1



3. Reconnect into the connector ensuring the plugs are fitted securely and the nut gland tightened.



2.5.3 DC power source

Occasionally mains AC power is not available at the site where the Monitor is installed, and an alternative power solution is required. For detailed information on remote powering the monitors a Technical Note is available from <https://support.aeroqual.com>

A battery can be connected to the connector in the front of the PDI Core module as shown in *Figure 2-1*. This input is on a separate fuse (FUSE 2) compared to the mains DC power supply (FUSE 1). A spare fuse is located on the right side of the PDI Core module. The PDI Core module contains an integral DC/DC converter (10-36V input) and a battery voltage monitor to ensure the power supplied to the instrument is reliable.

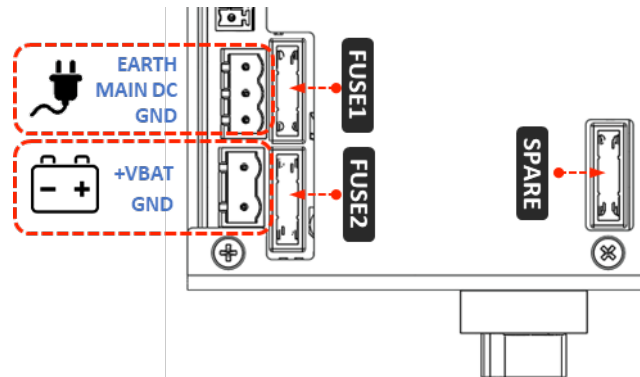


Figure 2-1 Powering the system with a battery and a PDI Core module

The PDI Core also contains a built in backup battery that will allow the system to safely shut down in the event of a power loss. This battery is intended only for safe shut down use and will not allow the instrument to run independently for long periods of time.

The system will switch to backup battery power and initiate the shutdown process described in *Section 6.2.3* if the battery voltage drops below 10.0V. The system will not detect that power has been restored until the voltage has reached 11.0V. The intent of this is to prevent repeated startup/shutdown events in situations where the battery voltage may rise when the load is removed or when a solar power system is insufficiently charging/powering the instrument.

Instruments built pre June 2024 will be equipped with a larger power and data interface as shown below. The battery input can be found in the back middle of the control PCB.

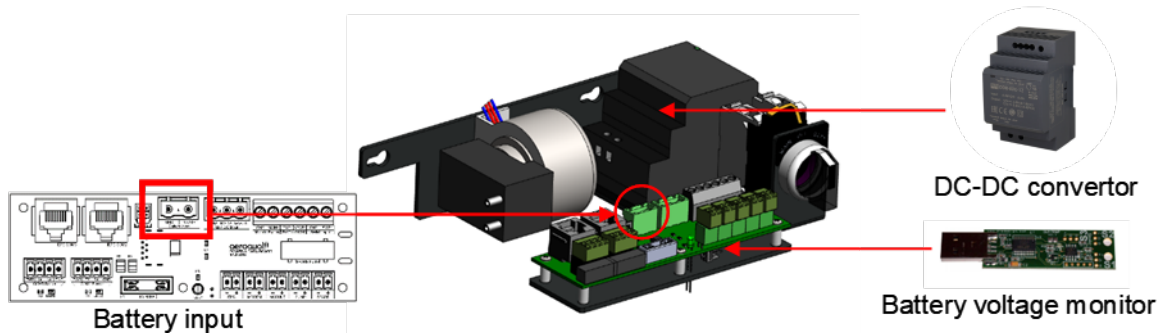


Figure 2-2 DC-DC convertor and battery voltage monitor

2.6 Powering On/Off

The monitor can be easily powered on or off using the rotary switch located at the bottom right-hand corner inside the enclosure.



Figure 2-3 The rotary switch in the MAIN DC position with the PDI Core (LEFT), and in the off position with the older power and data interface (RIGHT)

2.7 Connecting auxiliary sensors

External third-party sensors such as weather stations and noise meters are easily connected to the monitor. To connect third party sensors, feed the sensor cable through a free cable gland on the underside of the monitor and wire it to a plug in an available COM port (indicated below). Third party sensors need to be configured through Aeroqual Connect or Cloud – see *Section Error! Reference source not found.*

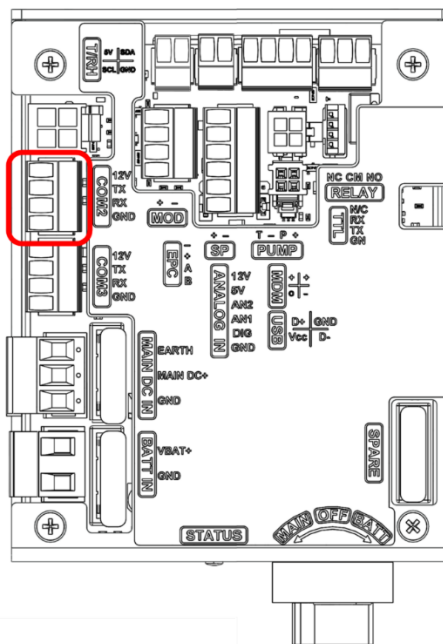


Figure 2-4 Diagram indicating connector on the PDI Core that auxiliary sensors are wired to

2.7.1 Auxiliary sensor wiring diagrams

NOTE: It is recommended that you check the operation of your third party sensor in your office or laboratory prior to site installation. You are not required to feed the cable through the gland to do this.







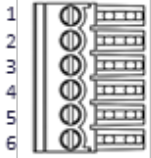
Gill Windsonic 			PWR	
			TX	
			RX	
		SHIELD	GND	
MetOne MSO 			PWR	
			TX	
			RX	
			GND	
Vaisala WXT536 			PWR	
			TX	
			RX	
			GND	
Airmar 200WX 			PWR	
			TX	
			RX	
		SHIELD	GND	
Novalynx 24-200SZ 			1	ANALOG IN 
			3 or 4*	
*Analog inputs must be configured as 4-20mA				

Figure 2-5 Connective auxiliary sensors using PDI Core

Configuration Steps

In the Configure Instrument screen, choose a sensor driver from the drop-down list under External Sensors.

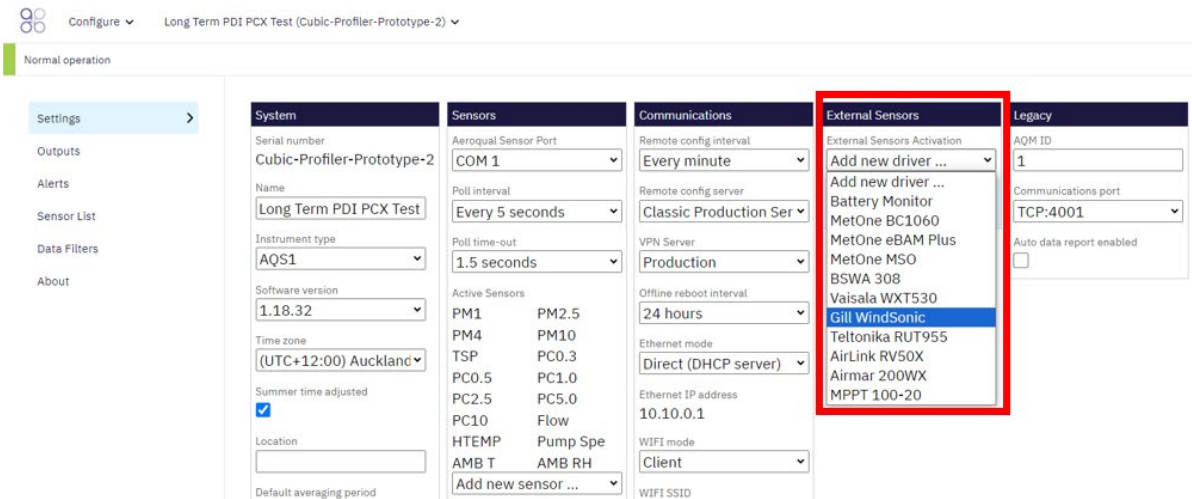


Figure 2-6 Selecting which external sensor to add

After selecting the driver, a new section with the driver will appear in column four and all sensors supported by the driver are added into active sensor list in the Sensors column. Choose the PDI-USB port from the drop-down list under External Sensors.

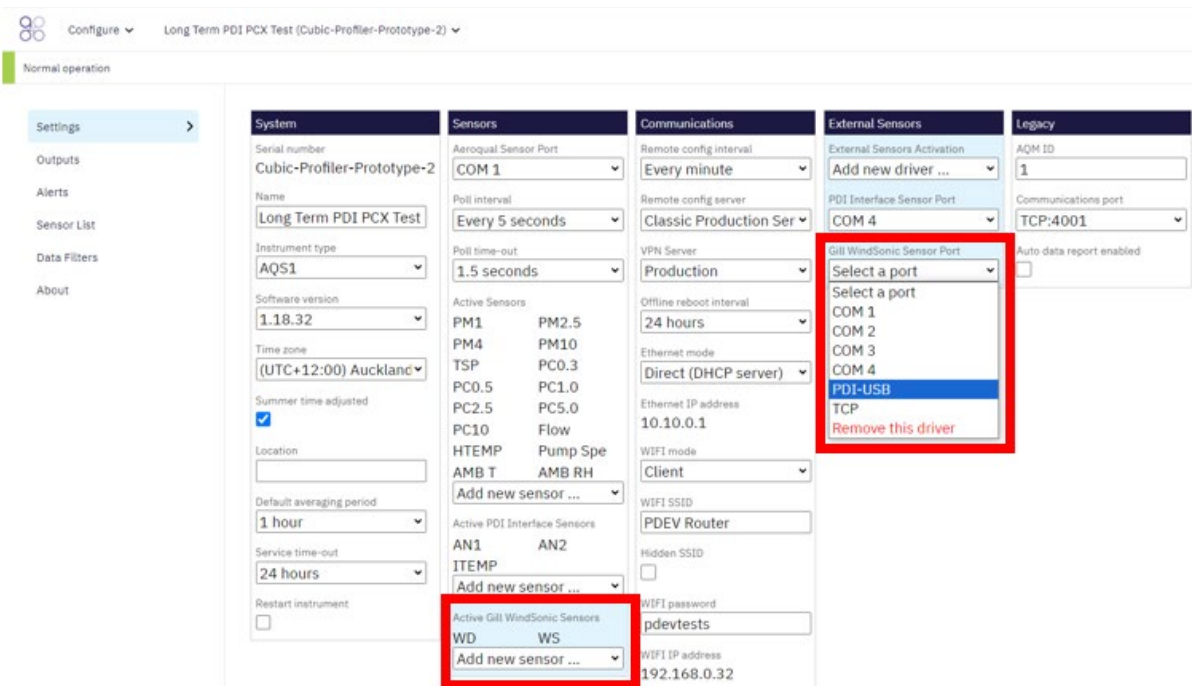
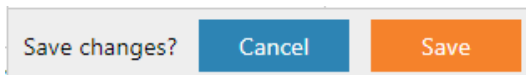


Figure 2-7 Configuring the correct port for the external sensor

Click the Save button at the bottom of the page to save the configuration.



2.7.2 Connecting auxiliary sensors (Monitors pre-Oct 2019)

On monitors' pre-Oct 2019, external sensors such as weather stations and noise meters need to be wired to the green connector plug on the front of the auxiliary module. To connect third party sensors, feed the sensor cable through a free cable gland on the underside of the monitor and wire it to the required auxiliary module according to the wiring diagrams – see Section 2.7.4.

2.7.3 AUX module (Monitors pre-Oct 2019)

In monitors pre-Oct 2019, an AUX module is used to provide power to an external sensor and to process data from the sensor. The AUX module uses a 12-way green connector to connect to the external sensor.



When you are happy with the wiring then apply power and log on to the Aeroqual Connect software as described in Section 4.1 Aeroqual Connect (via Direct WIFI / LAN). After some minutes you should see the parameters associated with the third-party sensor being shown in the software in the APP “Configure Instrument”, view settings then the active sensor column.

To see the data, go to “Manage Data”, then Charts or Table, adjust the “Averaging Period” as required.

NOTE: Retain the certificate of compliance that is shipped with the monitor.

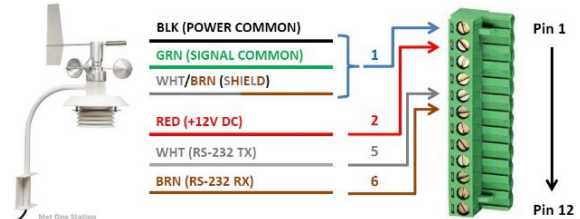
2.7.4 Auxiliary sensor wiring diagrams (Monitors pre-Oct 2019)

IMPORTANT: The auxiliary module orientation may vary, observe the correct numbering order as labelled on the green connector.

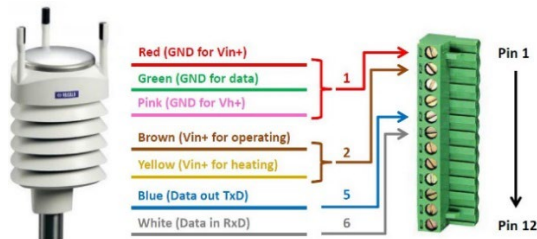
Gill Ultrasonic Wind Sensor



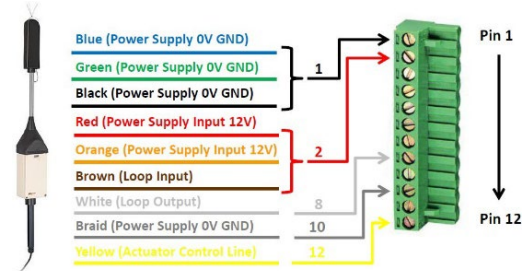
Met One MSO Weather Sensor



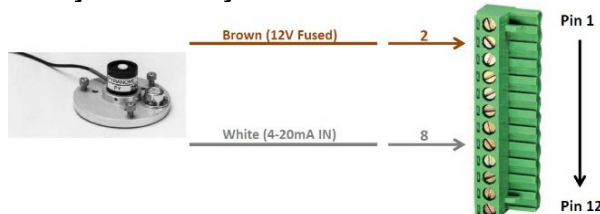
Vaisala WXT536 Weather Sensor



Cirrus MK427 Noise Sensor



Novalynx Silicon Pyranometer



3 Mounting and Site Positioning Guidelines

It is important that the positioning of the monitor is suitable to yield data which is representative of that specific location.

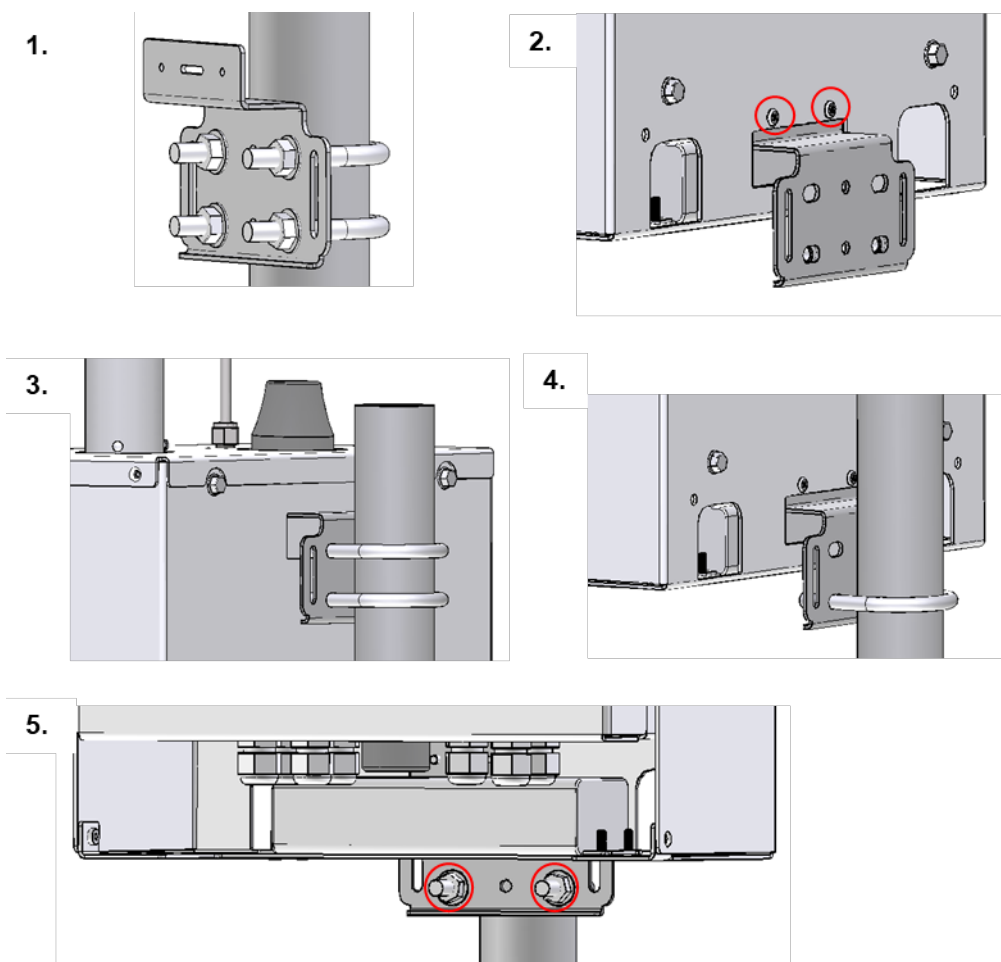
3.1 Mounting

The monitor comes with; 2 x mounting brackets, 3 x U-bolts for 45 mm (1½") diameter poles, 2 x metal bands for pole diameters between 21 - 44 mm (1" - 1½"), and 2 x metal bands for pole diameters between 59 – 82 mm (2 - 3"). The same brackets are used for both pole and wall mounting. To wall mount the monitor the brackets are screwed into the wall instead of using the U-bolts.

For pole mounting:

1. Secure top mounting bracket at a suitable height using the U-bolts or metal bands provided
2. Fix lower mounting bracket to the Dust Sentry chassis with screws
3. Hang the monitor on the top mounting bracket
4. Place U-bolt or metal band through lower mounting bracket
5. Secure bottom mounting bracket using the U-bolts or metal bands provided

NOTE: Only one U-bolt or metal band is required to secure the bottom bracket.



3.2 Inlet height

- If monitoring is related to human exposure, the sampling inlet height should be positioned in the “breathing zone”. This is located between 2 and 15 m (~6’ and 50’) above ground level.
- If monitoring is related to specific emission sources, the position of the sampling inlet can be more flexible. It is more important that there is no obstruction between the approaching air from the emission source and the sampling inlet.
- If more than one monitor, or any other particulate instrument, is being used at the site, the height of the inlets should be uniform.
- If the monitor inlet is the highest point at the site, a lightning rod must be installed to prevent damage to the unit during electrical storms.

3.3 Measurement Interference

The meteorological conditions of the site should be taken into consideration when positioning the monitor. For example:

- There should be no obstruction to the air flow in the predominant wind direction.
- A minimum clear sky angle of 120 degrees is recommended.
- The inlet should be at least 1 meter away from any objects that could potentially influence the airflow characteristics e.g. trees, vertical surfaces or walls.
- Avoid overhead high-voltage cables which may cause electrical interference with the sampling equipment.
- Demolition/construction activities and change to normal transport patterns due to road works etc. can significantly affect the data. Ensure a record of such events is kept to account for unexpected peaks in concentration.

3.4 Safety

The intended data capture rate should be considered when positioning the monitor. If data capture above 90% is essential, the unit should be in an area which has 24-hour access available.

The positioning should allow for routine maintenance checks to be performed safely by personnel.

If using a tripod, ensure the tripod legs are bolted to the ground to prevent the unit from falling.

Ensure the monitor is in a secure location to avoid vandalism or theft.

3.5 Surveyor’s tripod mounting

If needed, Aeroqual can supply a mounting kit that attaches the AQS 1, Dust Sentry or Dust Sentry Pro to a standard surveyor’s tripod. The kit includes one mounting plate, 8 x M4 hex head bolts and nuts, and 6 pegs. You supply your own surveyor’s tripod with standard 5/8” x 11 mounting screw.

1. Lay your monitor on a flat surface.
2. Using the 8 x M4 hex head bolts and nuts, bolt the mounting plate to the monitor through the slots in the bottom of the monitor’s solar shield.

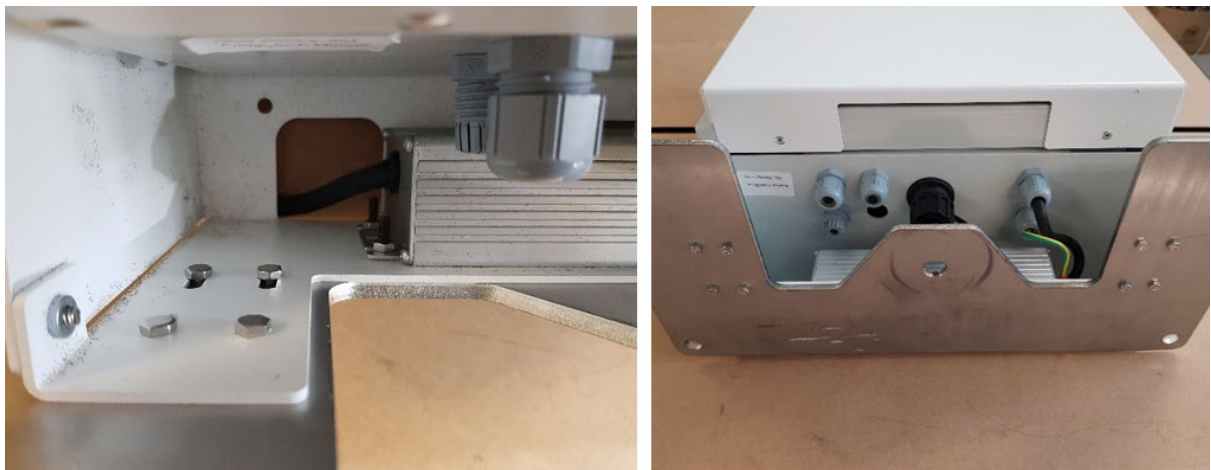


Figure 3-1 M4 bolts are used to connect the tripod mount to the bottom of the monitor

3. Place the tripod in the desired location and secure it to the ground using the 6 provided pegs.



Figure 3-2 A tripod can be secured in the desired location using pegs

4. Attach the monitor to the tripod by screwing the tripod's mounting screw through the threaded hole in the mounting plate. Note: Keep the mounting screw as close to the center of the tripod as possible so that the weight of the monitor is centered over all three legs.

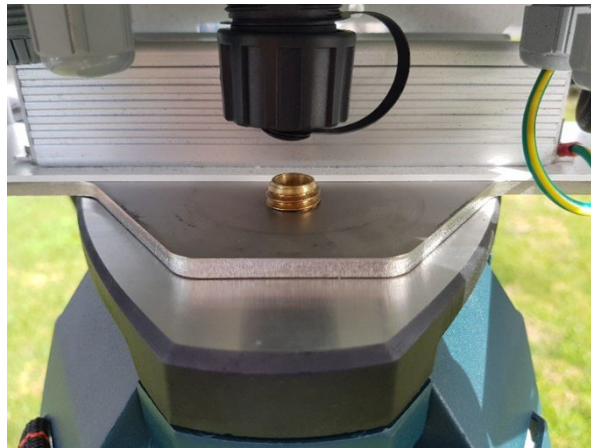


Figure 3-3 The monitor is secured to the tripod by screwing it onto the tripod's mounting screw

5. Check the tripod is firmly secured to the ground. If it's not, there is a danger of the monitor falling over due to wind. If the supplied pegs aren't suitable for the ground type, you might need to find another way to secure the legs.
6. For extra security, attach guy wires to the four holes in the corners of the mounting plate.

7. Check the tripod attachment screw is firmly tightened and that the monitor is centered on the tripod.



Figure 3-4 The monitor should be centered and level on the tripod

4 Connectivity

The monitors use an industrial embedded PC (ePC) for data logging and monitor control. A cellular modem can be fitted to facilitate remote connection and support from Aeroqual technical support – see Section 4.2.2 Connecting using a cellular modem.

There are two ways to connect to your monitors:

Aeroqual Connect (via Direct WIFI / LAN) for initial set up and when access to the internet is limited.

Aeroqual Cloud (via Network WIFI / Modem) for remote access, visibility of all your monitors, and remote technical support from Aeroqual.

Aeroqual highly recommends every monitor is connected to Aeroqual Cloud for the best user experience and additional data features.

Engineers who need to perform service or data analysts who need to view or download data can do so using a web browser on their PC, tablet, or mobile device. There is no software to download and install.

Data Security

The data belongs to you. We look after it in the same way that a bank looks after your money. Who you let access your data is entirely up to you – our job is to carry out your instructions.

If you do choose to store data with us, then here are some of the security assurances we provide:

We use only ISO 27001 approved data centres

Infrastructure is monitored and protected 24/7

Data is accessed via a secure website with 256-bit SSL encryption

User defined passwords

4.1 Aeroqual Connect (via Direct WIFI / LAN)

Aeroqual Connect contains all the tools necessary to view and download the data and maintain and calibrate a single monitor.

No internet connection is required for Aeroqual Connect. Aeroqual Connect is always running on the monitor and can be accessed via WIFI through an internet browser on any device, there is no software to install.



Figure 4-1 Aeroqual Connect Home page

4.1.1 Connect to Aeroqual Connect via Direct WIFI

A few minutes after powering on, you should see a new WIFI network in your device's list of WIFI networks. The WIFI name (SSID) will match your serial number, connect to this network using the password below.

WIFI SSID **AQS1 DDMMYYYY-XXX**

Password: **Aeroqual**

NOTE: If you are accessing the internet on your device using WIFI, you will lose your internet connection.

4.1.2 Connect to Aeroqual Connect via LAN

The monitors can be added to a LAN, in two ways:

- Using the WIFI function to connect to a WIFI network
- Using an Ethernet cable to plug into a LAN network router

When connected to the LAN, the monitor will automatically be assigned an IP address by the LAN router.

You must find out what this IP address is so you can connect to the monitor. The WIFI or wired LAN IP address will likely be in the format: **192.168.XXX.XXX**

If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

4.1.3 Access your monitor on Aeroqual Connect

After connecting your monitor to your device, open an internet browser window and enter **10.10.0.1** in the address bar. You should see the Aeroqual Connect login screen. Log in with the default username and password provided.

URL: **10.10.0.1**

Username: **administrator**

Password: **aqmadmin**

NOTE: Depending on your device WIFI settings, and how long you take to enter complete the steps above, your device may reconnect to the previous WIFI connection.

After logging in to Aeroqual Connect, you will be presented with a screen with five 'apps'; Manage Data, Calibration and Service, Configure Instrument, Diagnostics and Advanced, and Administration. You are now accessing your monitor in "Access Point" mode.

Next, open the Administration page and create a new user and secure password, then delete the default username and password.

4.2 Aeroqual Cloud (via Network WIFI / Modem)

Aeroqual Cloud is cloud-based software. It gives you and other trusted users access to all your monitors via secure third-party servers. Use Cloud to:

- Communicate with your monitor from anywhere in the world at any time
- Use advanced charting features such as wind roses and pollution roses
- Receive fast and comprehensive technical support from your Aeroqual distributor or Aeroqual technical support team.
- Automatically export data to multiple users via email or to an FTP server.
- Securely back up data in case of local data access issues.
- Maintain service records in the Cloud Journal for auditing and engineer certification.

Connection to Aeroqual Cloud makes technical support fast and efficient for the end user.

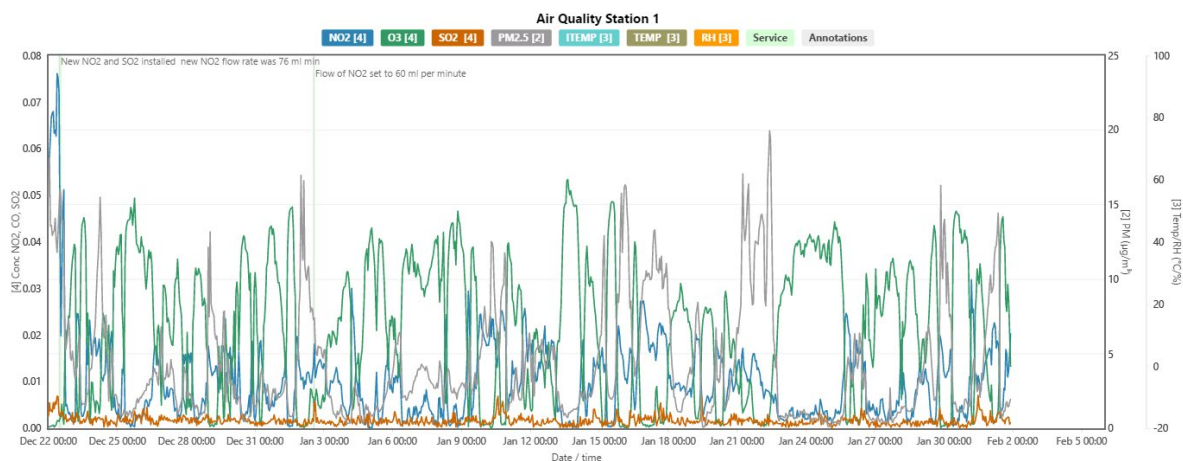


Figure 4-2 Aeroqual Cloud has many useful features such as plotting multiple channels on a single graph.

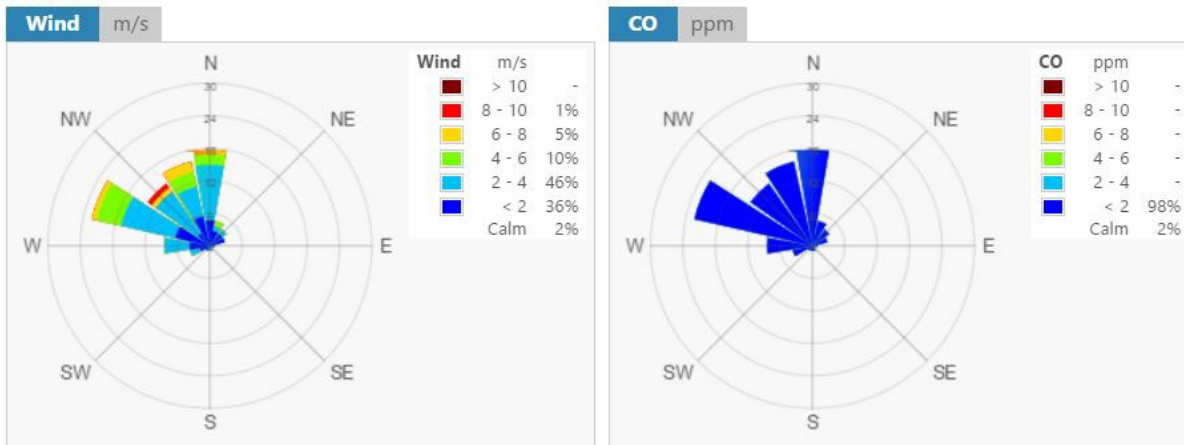


Figure 4-3 Generate advanced graphical presentations such as wind roses and pollution roses.

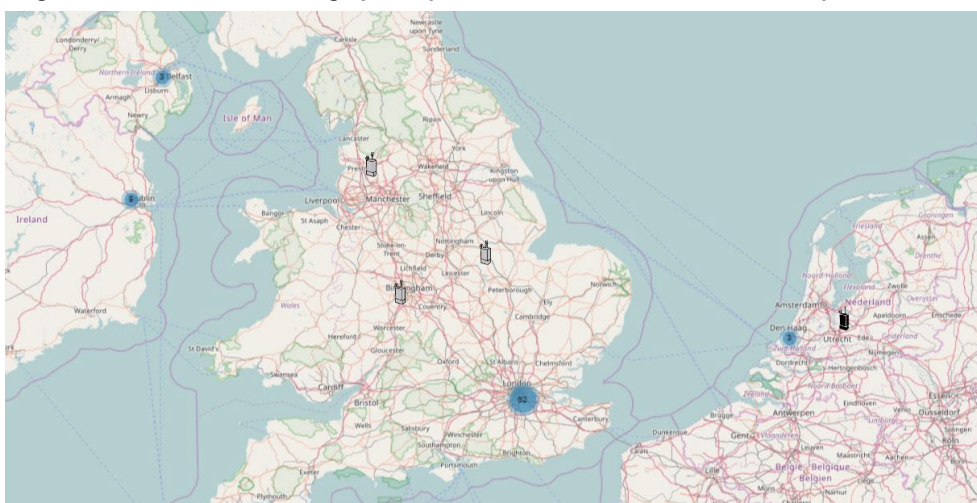


Figure 4-4 Select multiple monitors by region, and plot data from multiple different monitors on the same graph.



Figure 4-5 Receive SMS text alerts directly to your smart phone or by email.

4.2.1 Connecting over a local area network (LAN)

The monitors can be added to a LAN in two ways:

- The WIFI function of the monitor is used to connect to a WIFI network that is connected to the internet.
- An Ethernet cable is used to connect the monitor to router that is connected to a LAN.

When this happens, the monitor will automatically be assigned an IP address by the LAN router.

You must find out what this IP address is so you can connect to the monitor and access the monitor software. The WIFI or wired LAN IP address will likely be in the format: 192.168.XXX.XXX

Figure 4-6 shows the Connect software with an assigned IP address in the address bar in the browser.

If your laptop also has access to the same LAN, then this IP address can be typed into a browser address bar and a connection to the monitor can be established over the LAN connection.

4.2.2 Connecting using a cellular modem for remote communication

The monitors can be fitted with a cellular modem connected to a built-in cellular antenna on the outside roof of the enclosure. The modem requires a SIM card and the modem must be configured.

4.2.3 Set up cellular modem

The DS and AQS 1 are available from the factory with an option of two modems: the Sierra RV50X and the Teltonika RUT955.



Antennas

On the modems there are several types of antenna:

1. **Cellular antenna:** Major cellular antenna (connected to built-in antenna on monitor)
2. **Diversity antenna:** For 3G networks, the second antenna operates as a diversity antenna, providing a second receive path. For 4G networks, the second antenna operates as a MIMO antenna, providing a second receive path and a second transmit path.
3. **GPS antenna:** Used for providing geolocation service data.
4. **WiFi antenna:** if the modem installed has WiFi antenna the modem may be able to act as an access point, however this functionality is not used in the DS/AQS. These connectors should remain disconnected as the WiFi antennas on the monitor are connected to the embedded PC.

Dual SIM

Both modems have the capability of supporting two SIM cards. This may be beneficial for situations where cellular reception is inconsistent and you want to ensure your system is never offline. Users could also use one SIM card initially and later change network operators by configuring the new SIM card to be the Primary SIM card.



Some configuration functionality useful in an Aeroqual monitor is detailed below; however, for a full list of configuration options, please consult the modem manufacturer's documentation available at:

Sierra Wireless: <https://www.sierrawireless.com/>

Teltonika Networks: <https://teltonika-networks.com/>

Remote Configuration

Both modems offer online management portals which allow remote configuration of features. This is available on the Sierra Wireless modem through the AirLink Management Service (ALMS), and on the Teltonika modem through the Teltonika Remote Management System (RMS). Both systems allow you to configure features such as:

- **Power saving features**

These features optimizes idle power consumption. Recommended for customers who require the best power consumption efficiency, for example, battery or solar powered applications. Enabling this feature saves energy by reducing performance where possible.

- **Bandwidth Throttle**

This feature helps you manage your data account by allowing you to configure the AirLink gateway to restrict the real-time available bandwidth. You can:

- Place limits on traffic (uplink, downlink, or both)
- Allow for burst of traffic on the uplink, downlink, or both, while still maintaining the over-all desired bandwidth limit

Traffic that exceeds the limits is dropped. Status fields keep running tallies of data sent and received and the number of uplink and downlink packets dropped.

- **APN**

Note: The first time you power on the modem, the modem will automatically select the most commonly used APN for the Mobile Network Operator identified on the inserted SIM card. This APN is used if no other APN is selected or configured.

The APN the gateway is using for authentication on the mobile network is displayed.

- If a User Entered APN is configured, the User Entered APN is displayed.
- If there is no User Entered APN configured, an automatically selected APN is displayed.
- When the Backup APN is configured, the APN in Use displays the configured Backup APN when it is being used for authentication on the mobile network

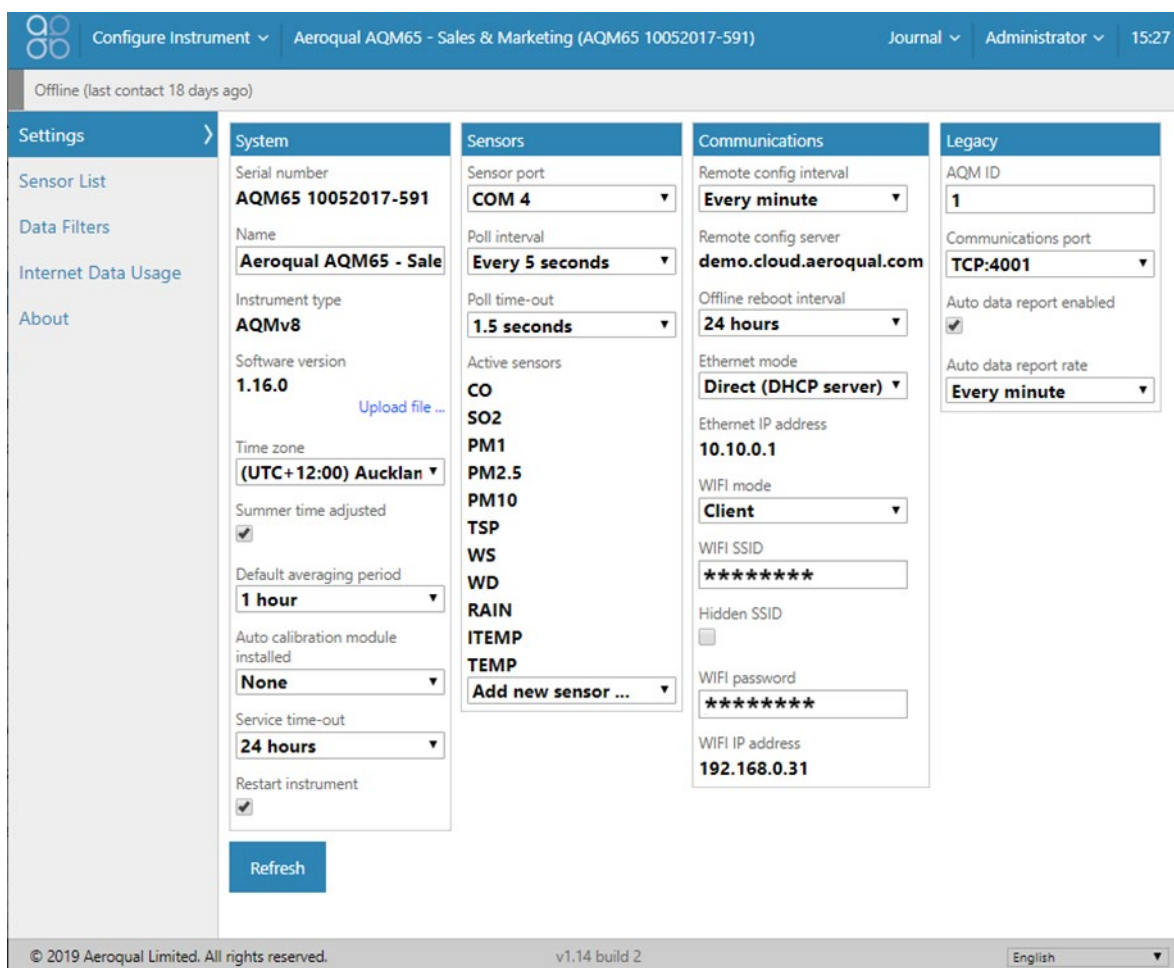


Figure 4-6 Column three in the Configure Instrument page control the communication and connection settings

4.2.4 Ethernet connection

The ePC has a separate wired Ethernet connection, this can be used in several ways:

- To directly connect to a PC
- To connect to a wired LAN via a router
- To connect to an IP modem to provide cellular communication.

The WiFi connection and Ethernet connection are independent from each other, both can be used at the same time. The recommended configuration for connection is to set the WiFi mode to Access Point and the wired Ethernet to Client mode to use with the modem.

To use an ethernet cable, ensure the blue Ethernet cable from the ePC is plugged in to the Ethernet plug in the bottom of the instrument, as shown in Figure 4-7. Ethernet mode is set to DHCP (server) in this method.

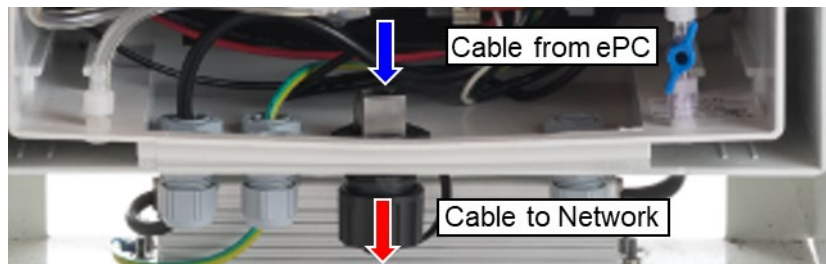


Figure 4-7 To establish a direct connection, a laptop must be connected to the ePC using an Ethernet cable

4.3 Communication settings

Communications	Communications	Communications	Communications
Remote config interval Every minute	Remote config interval Every minute	Remote config interval Every minute	Remote config interval Every minute
Remote config server Production server	Remote config server Production server	Remote config server Production server	Remote config server Production server
Offline reboot interval Disabled	Offline reboot interval Disabled	Offline reboot interval Disabled	Offline reboot interval Disabled
Ethernet mode Auto (DHCP client)	Ethernet mode Auto (DHCP client)	Ethernet mode Auto (DHCP client)	Ethernet mode Direct (DHCP) server
Ethernet IP address 192.168.127.10	Ethernet IP address 192.168.85.177	Ethernet IP address 192.168.127.10	Ethernet IP address 10.10.0.1
WIFI mode Access point	WIFI mode Access point	WIFI mode Client	WIFI mode Client
WIFI SSID AQM65 12031016.444	WIFI SSID AQM65 12031016.444	WIFI SSID Office WIFI	WIFI SSID Office WIFI
WIFI password Aeroqual	WIFI password Aeroqual	WIFI password Office_WIFI_P@#\$wrD	WIFI password Office_WIFI_P@#\$wrD
WIFI IP address 10.10.0.1	WIFI IP address 10.10.0.1	WIFI IP address 192.168.0.158	WIFI IP address 192.168.0.158
a	b	c	d

Figure 4-8 The different connection types require different settings in the Configure Instrument app

- The Ethernet mode is set to Auto (DHCP client). In this configuration the modem can be used. The modem will assign IP address **192.168.127.10** to the ePC. The WIFI mode is set to Access Point so a direct connection to the EPC can be made over local WIFI.
- The Ethernet mode is set to Auto (DHCP client). In this example the ePC has been plugged in an office router using an Ethernet cable. The router has assigned IP address **192.168.85.177** to the ePC. The WIFI mode is set to Access Point so a direct connection to the ePC can be made over local WIFI, the Ethernet mode is set to Auto (DHCP client). In this configuration the modem can be used. The modem will assign IP address **192.168.127.10** to the ePC.
- The WIFI mode is set to Client and is connected to the office WIFI network. The ePC has been given a WIFI IP address **192.168.0.158** by the router This IP address can be entered directly in the browser to connect to the monitors.
- The Ethernet mode is set to Direct (DHCP Server). In this configuration a laptop can be directly connected to the ePC using an Ethernet cable. Enter **10.10.0.1** to connect directly to the monitors.

NOTE: Should you need to reset the communication settings, see the following section, Section 4.4.

4.4 Resetting the communication settings back to factory settings

The monitor communication settings can be set back to factory defaults.

One situation where this might be useful is if the WIFI SSID name or password has been incorrectly entered and therefore the ePC cannot establish a connection to the local WIFI network.

The WIFI settings can be set back to Access Point mode and the monitor will again appear as a WIFI network. Depending on the version of Aeroqual Connect you are using, the SSID name will appear as the monitor “**serial number**” or as “**Aeroqual AQM**”, the reset WIFI password will be “**Aeroqual**”.

To achieve this, you will need a USB flash drive.

1. Create a file on the flash drive called **.resetnetwork.aqm** (yes there is a “dot” at the beginning of the file name).

The file extension must be **.aqm** it cannot be an **.aqm.txt** file.

In Windows OS you can create a new **.txt** document and give the file name **.resetnetwork.aqm**

Check the Type column to make sure it is an **.aqm** file. You might need to unhide file extensions and delete the **.txt** from the end of the file name. Figure 4-9 shows the correct file.

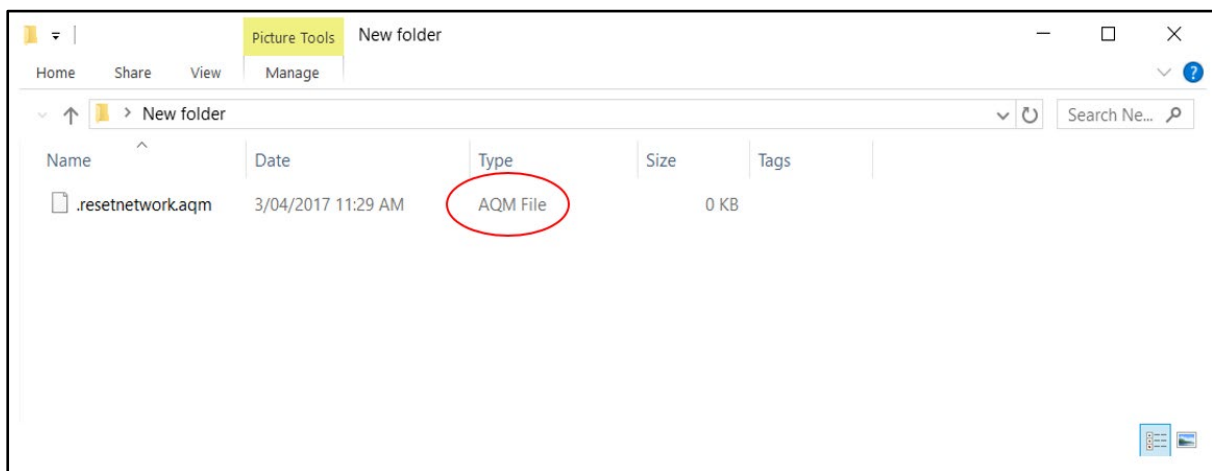


Figure 4-9 Create an empty file called **.resetnetwork.aqm**

2. Then insert the USB drive into any of the USB ports on the ePC.
3. Wait several minutes, the ePC will reboot automatically and then you should see a WIFI network appear called as either the monitor “**serial number**” or “**Aeroqual AQM**” with password **Aeroqual**.
4. You can then remove the USB stick.

5 Software

Data visualisation, monitor configuration, calibration and control of user access is achieved using apps which are accessible from the main page.

Access to the pages, and the individual features within each page is controlled by the monitor licence and the user privileges for the different user types, which are described in Section 5.5.



Figure 5-1 The landing page of Connect after login shows the available pages

5.1 Manage Data

The Manage Data page is used to view data within the browser and to download data (export) data for use in other software. The available features in the Manage Data page will depend upon the monitor licence and the user permission level. The features within the Manage Data page appear in a column on the left-hand side of the screen.

Feature	Aeroqual Licence	User permission required
Charts	Connect / Cloud	User or higher
Table	Connect / Cloud	User or higher
Download data	Connect / Cloud	User or higher
Auto Export	Cloud	Engineer or higher
Manual sync	Connect	Engineer or higher

Table 5-1 Software tools available to different user permissions

5.1.1 Charts

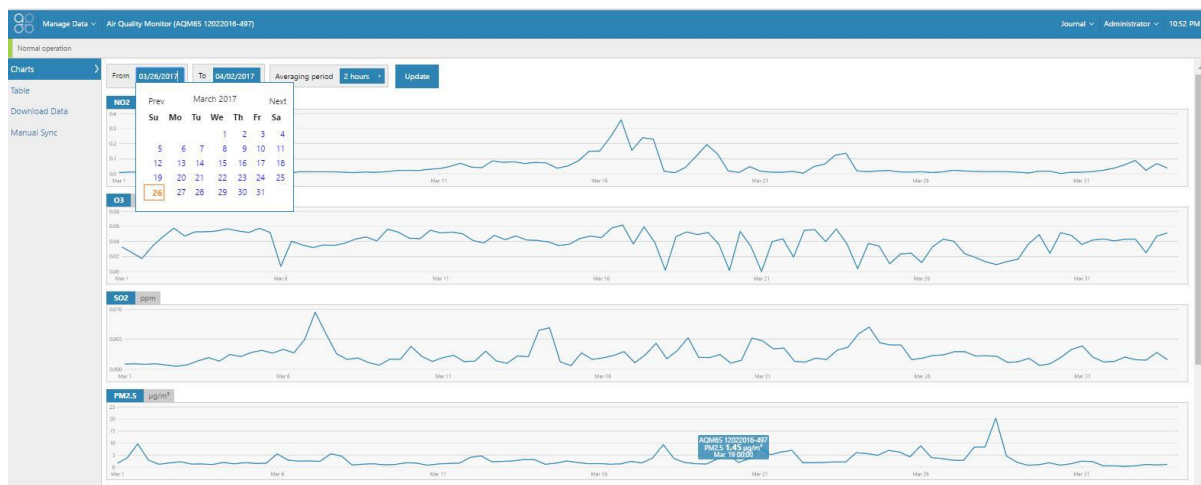


Figure 5-2 The charts tool, in the Manage Data page shows each data channel in a stack of charts

5.1.2 Table

The data from each module can be viewed on screen in a Table. The from and to dates can be selected using a calendar tool, and the averaging period such as daily, hourly or minute can also be selected.

Time	O3 ppm	SO2 ppm	PM2.5 µg/m³	ITEMP °C	TEMP °C	RH %
4/2/2017 10:00 PM		0.000	1.18	30.0	11.13	47.0
4/2/2017 9:00 PM	0.046	0.001	1.22	30.0	11.19	46.6
4/2/2017 8:00 PM	0.049	0.003	1.18	30.0	12.33	43.1
4/2/2017 7:00 PM	0.051	0.003	1.16	30.0	13.60	39.0
4/2/2017 6:00 PM	0.055	0.001	1.04	30.0	15.70	33.2
4/2/2017 5:00 PM	0.053	0.001	1.17	30.0	17.25	32.0
4/2/2017 4:00 PM	0.053	0.001	1.19	30.0	18.07	32.7
4/2/2017 3:00 PM	0.052	0.003	1.11	30.0	19.75	29.9
4/2/2017 2:00 PM	0.121	0.053	1.00	30.0	19.44	29.7
4/2/2017 1:00 PM	0.090	0.051	0.85	30.0	18.91	33.8
4/2/2017 12:00 PM	0.076	0.050	0.88	30.0	16.99	40.1
4/2/2017 11:00 AM	0.055	0.047	0.89	30.0	14.73	46.4
4/2/2017 10:00 AM	0.034	0.045	0.85	30.0	12.24	52.4
4/2/2017 9:00 AM	0.021	0.040	0.76	29.9	10.52	56.0
4/2/2017 8:00 AM	0.012	0.038	0.78	29.9	8.85	63.4
4/2/2017 7:00 AM	0.006	0.036	0.74	29.9	6.10	73.9
4/2/2017 6:00 AM	0.011	0.015	1.45	29.9	5.32	80.6
4/2/2017 5:00 AM	0.014	0.013	1.65	29.9	5.92	81.6
4/2/2017 4:00 AM	0.014	0.020	1.45	29.9	5.76	81.1
4/2/2017 3:00 AM	0.015	0.021	1.27	29.9	5.83	81.3
4/2/2017 2:00 AM	0.024	0.024	0.95	29.9	5.54	79.7

Figure 5-3 The table tool in the Manage Data page shows the data in a table with user configured date range and averaging

5.1.3 Download data

The data can be downloaded by selecting a From and To date and Averaging Period. The format is comma separated values (.csv). This file format can easily be opened in Microsoft Excel.

Time	NO2 (ppm)	O3 (ppm)	SO2 (ppm)	PM2.5 (µg)	ITEMP (°C)	TEMP (°C)	RH (%)	Inlet
1/01/2017 0:00	0.006	0.033	0	1.89	29.9	5.92	75.8	Sample
1/01/2017 0:01	0.006	0.033	0	1.78	29.6	5.97	75.6	Sample
1/01/2017 0:02	0.006	0.033	0	1.7	29.7	5.89	74.1	Sample
1/01/2017 0:03	0.006	0.033	0	2.17	30.1	5.95	70.7	Sample

Figure 5-4 The download data tool in the Manage Data page allows the data to be downloaded at user configured date range and averaging

5.1.4 Manual sync

The manual sync feature allows all the data, and diagnostics and journal entries to be **downloaded from Connect to a PC**. The manual sync file cannot be read by any software. The manual sync file is later **uploaded from a PC to Aeroqual Cloud**.

This feature is used if the Monitor does not have an active data connection to Aeroqual Cloud at the monitoring site, but the data is required to be in Aeroqual Cloud for data storage and so all stakeholders can access the data.

Figure 5-5 shows the Manual Sync download tool in Aeroqual Connect and the Manual Sync upload tool in Aeroqual Cloud.

NOTE: You might need to manual sync multiple times. The first time the “From Date” is “1900”, then it creates a file with a maximum number of records of 1 million. Therefore, the file might only synchronize for a limited dataset. At the end of that sync the “From Date” will show up to where the last data was downloaded. You run the sync command again and it gives you a new file starting at that date and including the max number of records. You keep running this process until you get to today’s date.

These files are then uploaded one by one using the manual sync upload tool in Aeroqual Cloud.

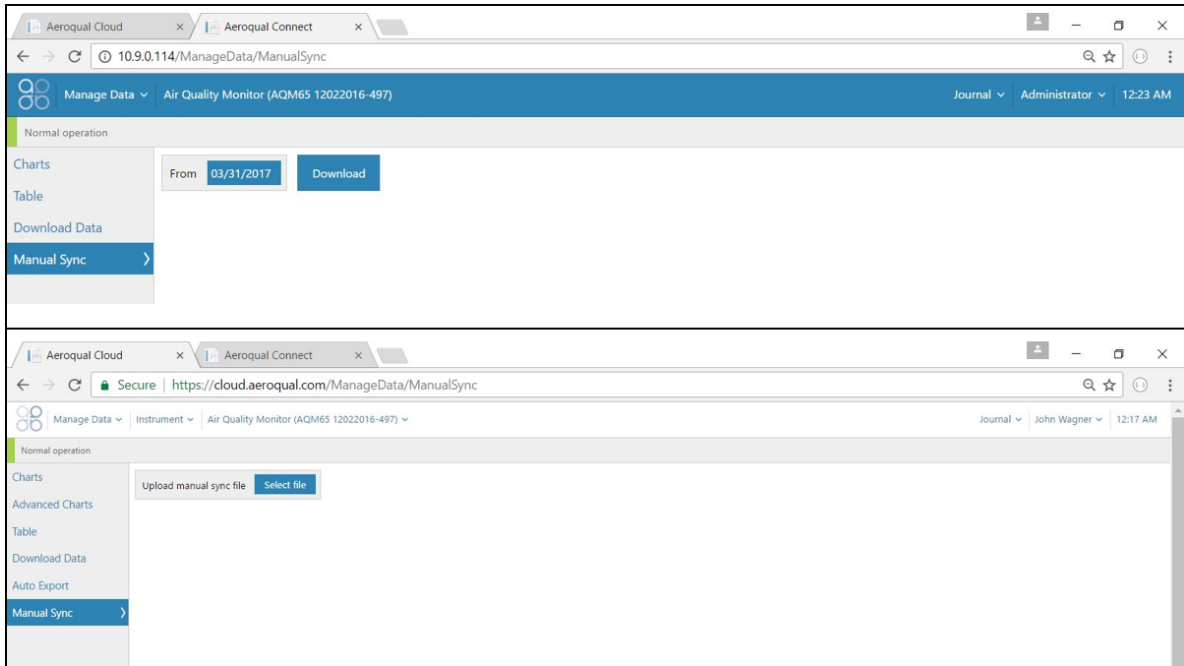


Figure 5-5 The manual sync tool in the Manage Data page allow all data from the Monitor to be manually uploaded to the Cloud if a local data connection is not available.

5.2 Calibration and Service

Aeroqual Licence	User permission required
Connect / Cloud	User or higher

The Calibration and Service page has two functions, Service mode initiation, and changing gain and offset during calibration.

5.2.1 Service Mode button

When a service engineer visits the monitor to perform routine service such as filter changes or flow checks, this can cause the data to read very high or very low. During service activities the monitor can be put into Service Mode by clicking the service mode button. This will tag the data as “service data” which can later be filtered when daily or hourly averages are being calculated.

For further discussion on Service Mode see Section 6.1.5.

5.2.2 Gain and Offset adjustment

Gain and offset adjustments are made as part of the monitor gas calibration procedure.

5.3 Configure Instrument

Aeroqual Licence	User permission required
Connect	Engineer or higher

The Configure Instrument page provides useful information about the monitor, including:

- The list of configured licences.
- When data was last sent to the Aeroqual cloud database.
- The number of text alerts remaining.
NOTE: These come from **cloud.aeroqual.com** not from the monitor.
- Setting measurement units to ppm, ppb, $\mu\text{g m}^{-3}$ or mg m^{-3} , degrees $^{\circ}\text{C}$ or $^{\circ}\text{F}$
- Set up text (SMS) and Email alerts.
- If a module is removed or added, then a software change is required. The software module configuration can be found in the Configure Instrument page.

5.4 Diagnostics and Advanced

Aeroqual Licence	User permission required
Connect	Engineer or higher

The Diagnostics and Advanced Page provides access to monitor and individual module operating parameters and is used by Aeroqual technical support to troubleshoot and diagnose monitor condition. It provides real time information about the status of the modules and allows operational settings of the modules to be viewed or edited.

5.4.1 Diagnostics

Each module can be selected, and real time module operation parameters can be viewed.

5.4.2 Module settings

Each module has a set of operational parameters which control the module. These can be viewed or edited using the module settings dialogue.

IMPORTANT: These settings should not be changed without instruction from Aeroqual.

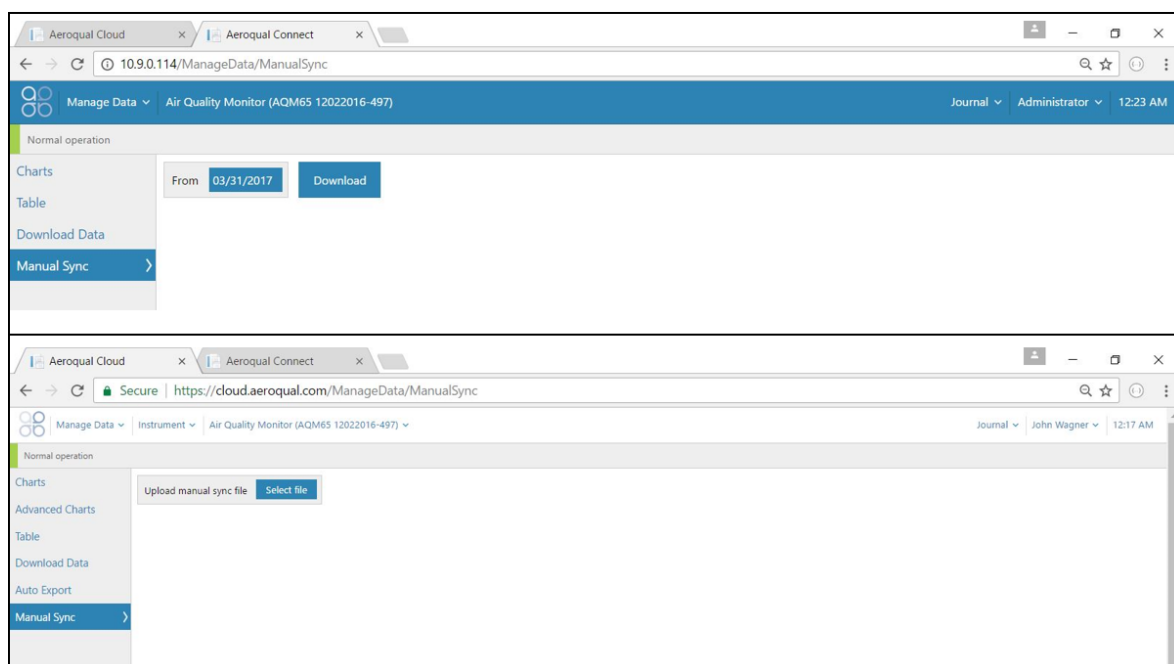


Figure 5-6 The Diagnostics and Advanced page displays real time monitor operational readings and settings which control how the modules are controlled.

5.4.3 Journal

Any changes to monitor settings are automatically recorded in the monitor journal with a date and time stamp and the username of the user who performed the change.

The journal entries are categorised to make it easier to search for specific entries. The categories are selected from the drop-down list.

Service activities such as filter replacements or flow checks are not automatically recorded by the software.

Engineers performing service or calibration can make specific user entries to describe their service activities.

NOTE: Keeping service records is a requirement under Aeroqual's factory warranty

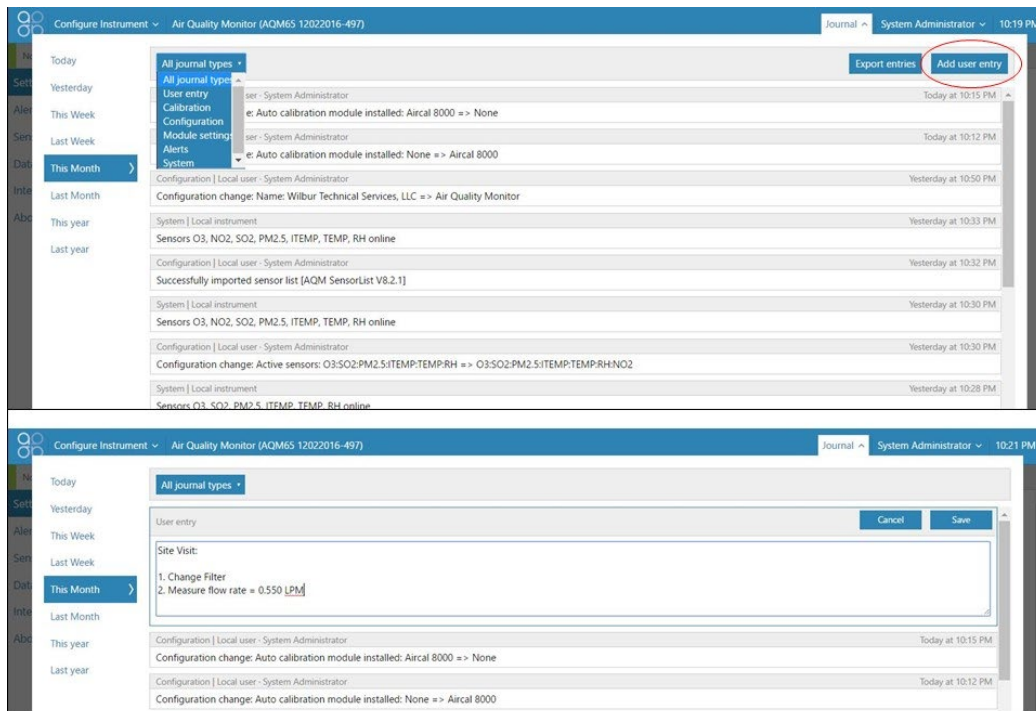


Figure 5-7 The Journal automatically logs software changes. It also allows manual user entries.

5.5 Administration

The monitor ships from the Aeroqual factory with a default username and password:

Username: **administrator**

Password: **aqmadmin**

Security

These access credentials are published in multiple public documents and are only used to first connect to and configure the monitor. Aeroqual recommends that a new Administrator user is created with secure password and the default Administrator user is deleted which will make the monitor more secure.

There are three different user permissions which can be applied to individual users on the monitor. Each individual user of the monitor may be given an individual username and password to access the monitor. There is no limit to the number of users which can be created.

Access / Profile	User	Engineer	Administrator
Can view and download data.	✓	✓	✓
Can perform a calibration and change calibration settings	✓	✓	✓
Has full control over all monitor settings.		✓	✓
Can control access login and password for other users.			✓

Engineers cannot access the Administration Page.

An administrator can access all the pages in Connect and is the only user type who can access the Administration page. New users are created using the Administration Page.

5.5.1 Monitor licences

The Connect software has some features which may need to be enabled through a licence, such as the application programming interface (API) feature and the FTP export feature. For information about Connect features which require a licence, contact the Aeroqual distributor in your local country for technical support.

6 Setup, Service, and Maintenance

Routine service and maintenance are required to ensure the monitor performs optimally.

The frequency of some service activities such as filter changes will depend upon local environmental conditions. Environments with higher particle concentrations, for example, will require more frequent filter changes.



Other service activities such as flow checks and pump replacements can be scheduled at routine intervals and other service activities such as module replacements are performed only when required.

Recommended service frequencies for each service activity are given in Section 6.1.1.

Further detail on each of the service activities can be found on the Aeroqual training website: <https://support.aeroqual.com>

It is very important to keep service records. The Journal is used for this purpose. See Section 4.3 for a discussion of use of the Journal for service record keeping.

Many of the service and maintenance related activities have online resources to assist you in completing these tasks. Please see the links below for additional details:

	Online reference	support.aeroqual.com
	Online video	www.youtube.com/@aeroqual47



Safety requirements

- Replacement of any part should only be carried out by qualified personnel using only parts from the manufacturer
- Surfaces marked with a "Caution, Hot Surface" and an internationally recognised symbol may get hot and deliver burns
- If installed, the particle modules are Class 1 laser products and are not considered dangerous if used correctly. They should not be powered up with the cover removed.

6.1 General

6.1.1 Service frequency guidelines

The frequency of some of the service activities described above can depend upon environmental conditions and upon data quality objectives. Some service activities are required at fixed frequencies (**scheduled maintenance**), and some are performed only as required (**unscheduled maintenance**).

Service intervals will vary depending on site conditions. For instance, particulate matter levels will impact the frequency of filter changes – high PM levels = more frequent filter changes

It is important to change the filter when it gets dirty. Once the local site conditions are understood, a filter change schedule can be developed for that site.

6.1.2 Flow meters and flow measurement

Accurate and precise flow rate measurement is critical for monitor service and calibration. Flow rates can be measured and reported in several different ways. It is important to understand the terminology and equipment associated with flow rate measurement.

6.1.3 Flow meters for gas flow measurement

For gas flow measurements, Aeroqual recommends either the Bios Defender DryCal or the TSI 4040 (AQS R8 HS) flow meter. These can both be used to measure gas flow and particle module flow.



Figure 6-1 Bios Dry Cal and AQS R8 HS high specification flow meters.

6.1.4 Flow meter for PM flow measurements

For PM flow rate measurements, a 0.2 - 2.5 L/min rotameter is suitable, or the flow meters noted above. A rotameter is included in the Dust Sentry service kit (DS R20), but not the AQS service kit (AQS R20). It is also available separately (DS R8).



Figure 6-2 DS R8, 0.2 - 2.5 L/min rotameter for PM flow measurements.

6.1.5 Manual Service Mode

Performing service work on the monitor such as changing filters or measuring flow rates can cause the gas or particle readings to fluctuate. It is important to exclude these data from air quality reports. The monitor can be put in to “Manual Service Mode” by pushing the start button in the Calibration and Service page. This will cause the data to be labelled as “service”, normally the data is labelled as ‘sample’. This is illustrated in Figure 6-3 and allows a data analyst to easily filter out service data when performing quality control, calculating hourly or daily averages, or writing air quality reports.

Time	CO2 (ppm)	H2S (ppm)	PID (ppm)	PM2.5 (µg/m³)	TEMP (°C)	RH (%)	Inlet
13/04/2017 12:10	381	0	0.181	26.8	21.73	69	Sample
13/04/2017 12:11	391	0	0.181	26.84	21.74	68.9	Sample
13/04/2017 12:12	397	0	0.18	27.3	21.74	69.2	Sample
13/04/2017 12:13	396	0	0.18	26.56	21.77	69.3	Sample
13/04/2017 12:14	433	0	0.179	26.13	21.84	69.2	Sample
13/04/2017 12:15	413	0	0.209	26.17	21.9	68.8	Service
13/04/2017 12:16	408	0	0.238	26.73	21.95	68.7	Service
13/04/2017 12:17	401	0	0.221	27.36	21.98	68.5	Service
13/04/2017 12:18	394	0	0.188	28.59	21.97	68.3	Service
13/04/2017 12:19	545	0	0.179	27.45	21.94	68.6	Service

Figure 6-3 The monitor can be put into Service Mode by clicking the button in the Calibration and Service page. This will label the data as "Service" in the inlet column so the data can be filtered.

6.1.6 Journal

All service activities should be documented. The Journal is accessed by clicking the Journal button next to the username at the top right of the screen, then selecting user entry.



Figure 6-4 All service activities can be recorded in the Journal manually.

6.1.7 Maintenance procedures

The following section describes all the common service activities required to ensure good operation of the monitor.

Some of the service activities need to be performed regularly such as filter changes and flow checks, and other service activities are performed only as required. A summary of expected service activities and how often they should be performed is described in Section 6.6.

For each service activity, the tools required are listed and references to additional information on the training website or video website is also given if available.

NOTE: Whenever these service activities are performed it is important to record the activity in the Journal using a manual user entry. See Section 6.1.6

6.1.8 Tools required for regular service and maintenance

Service and maintenance of the monitor requires basic tools such as Phillips head screwdriver and adjustable spanner, and multimeter for checking electrical connections.

The Dust Sentry or AQS monitor service kits (R20) are recommended for maintenance.

6.1.9 Recommended tools for regular servicing and maintenance

- Large and small Phillips head screwdriver and large and small flat head screwdriver
- Gas flow meter AQS R8 HS – Ordered separately, only required for AQS (see Section 6.1.1 for a discussion of requirements for flow meters)
- Rotameter for PM flow DS R8 (included in the Dust Sentry service kit DS R20x)
- Vacuum gauge R23x (Included in both Dust Sentry and AQS R20x Service Kits, also available separately)
- Electrical multi meter (Only required for troubleshooting)
- Adjustable spanner

6.2 PDI Core

6.2.1 PDI Core General Function

The PDI Core module is a new module available in DS and AQS instruments that replaces the Power and Data Interface (PDI) used on previous versions of the instruments. This new module now contains a microcontroller that adds the ability to control inputs and outputs, as well as having a DC/DC converter and battery voltage monitor integrated in a single package with a smaller footprint.

The system also includes a small backup battery that allow the system to safely shutdown in the event of power loss, preserving data. Other functionality introduced with the PDI Core are 2 x user selectable 0-5V or 4-20mA inputs, the ability to schedule operating hours for the instrument, and an input for a TEMP/ RH sensor.

6.2.2 PDI Core Status LED

The PDI Core has a single red, green and blue (RGB) LED that is used to display the status of the PDI Core.

LED Color	PDI Core Status
Green - Solid	Normal Operation
Red - Flashing	No communication between PDI and EPC
Red - Solid	Internal PDI error
Orange - Breathing	System is shutting down
Orange - Flashing	Power loss detected
Blue - Breathing	Scheduled sleep mode
Purple - Breathing	Bootloader mode

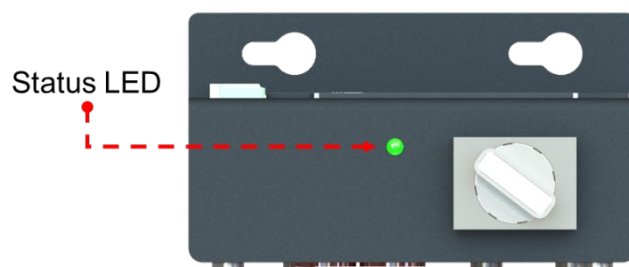


Figure 6-5 - PDI Core Status LED

6.2.3 Safe Shutdown Process

The PDI Core has been programmed to follow a specific logic in the event of power loss and can determine if this is intentional (turning the switch off) or unintentional (e.g. a battery running flat).

- In the event the switch is turned to 'OFF':
 - The shutdown process begins immediately and a shutdown command is sent to EPC

- All modules except the EPC are powered down.
- The LED on the PDI Core will change to a breathing orange during this period
- Once the EPC has shutdown (or 3 minutes has elapsed) the EPC and the PDI Core are turned off.
- In the event of unexpected power loss:
 - The LED on the PDI Core will change to a flashing orange and the system will run for 30 seconds using the backup battery in case the power is restored in that time (i.e. input voltage > 11.0V)
 - If the power is not restored, the shutdown process described above (for manually switching the device off) will begin.

6.2.4 Manual System Controls

- **Remote module power control:**

In the event of a fault, the power to the modules can be remotely toggled on/off using a module setting. To do this change PDI ITEMP setting H0 from 1 to 0. This will turn the modules off. After confirming the modules have turned off, change the value back from 0 to 1 to restore power.

- **Manual override for power:**

If a firmware or hardware fault were to occur that prevents the PDI Core from operating correctly, the user can attempt the manual power overwrite to turn all of the system components on (EPC, modem, PCX, pump, gas modules).

To turn the manual power overwrite ON the jumper on the lefthand side of PDI Core can be moved from the top to the bottom position. Turn the power switch on, if the manual overwrite is successful all the modules should turn on. If this does not turn the modules on, then there is likely a critical hardware fault with PDI Core.

6.2.5 Analog and Digital Inputs

The PDI Core has the functionality to read in 2 analog inputs (AN1 and AN2) and one digital input (3.3V to 5V recognized as HIGH). The analog inputs are user configurable and either input can be 4-20mA or 0-5V. A 6-way header is used for connecting an analog input to the PDI Core, see Figure 6-6 for the pin out.

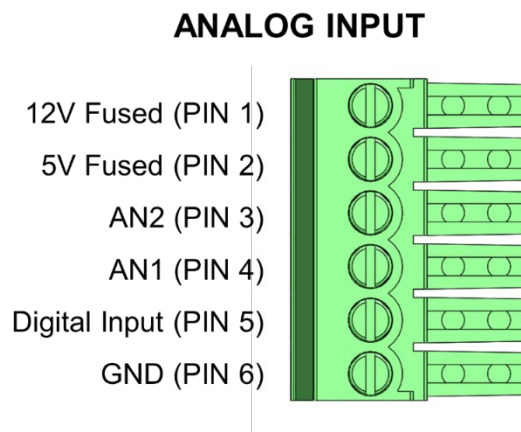


Figure 6-6 Analog Input Header Wiring

The function of AN1 and AN2 can be configured by moving the jumper associated with each channel. When the jumpers are in the right position they are configured as 0-5V and when in the left position they are configured as 4-20mA inputs. The function of each channel can be selected independently

as shown in Figure 6-8 Jumper positions: Left – 0-5V input, Middle – 4-20mA input, Right – combination input.

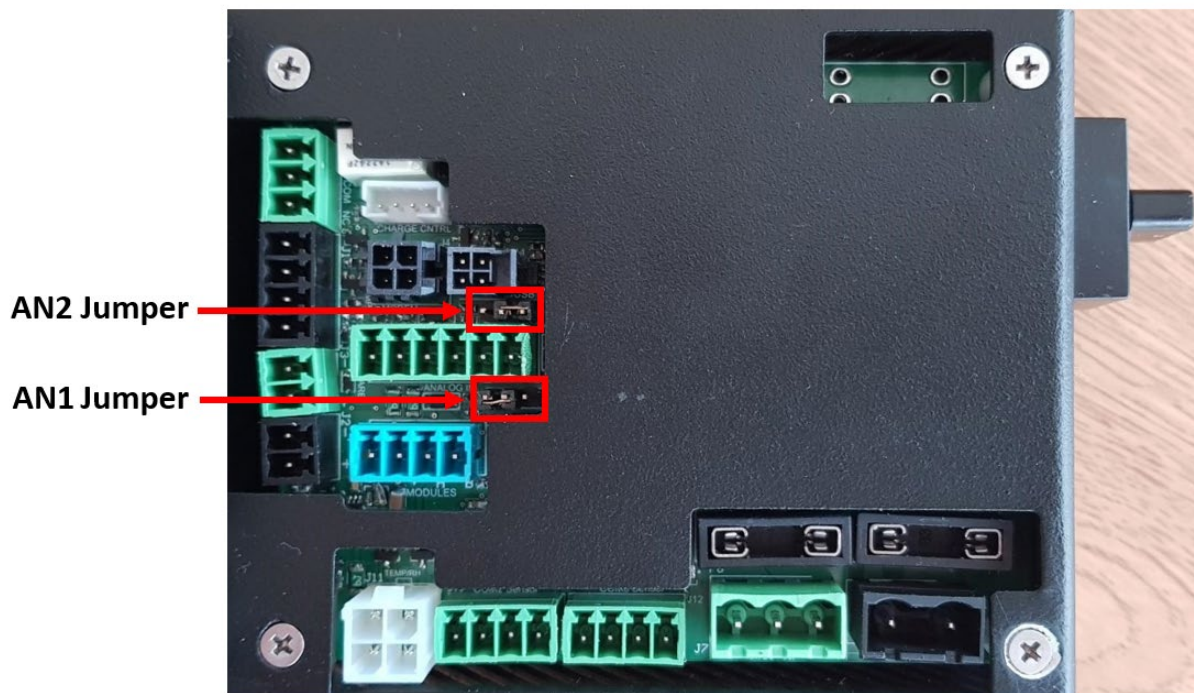


Figure 6-7 Analog jumper position

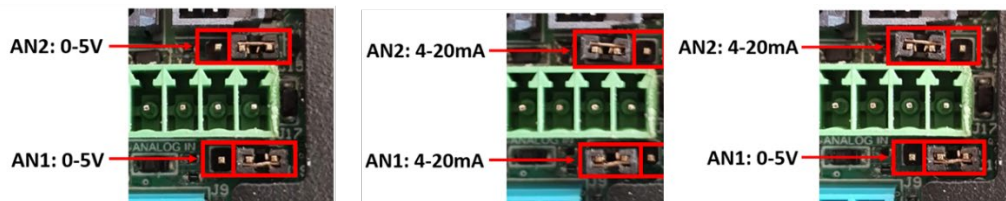


Figure 6-8 Jumper positions: Left – 0-5V input, Middle – 4-20mA input, Right – combination input

6.2.6 Relay Configuration

The PDI Core has a relay output that can be configured in Cloud or Connect to trigger based on a channel's measurement. The relay is capable of handling up to 4A.

To configure the relay output in Cloud or Connect:

1. On the "Configure" page in Cloud or Connect, select the "Outputs" tab.
2. Under the "Output Device Configuration" select "PDI Relay" from the dropdown menu.
3. Select which sensor channel you want to use from the 'Relay 1" dropdown menu as the trigger source.
 - The "Set point" is at which point the relay will turn ON, the "Reset point" is at which point the relay will turn OFF.

In the example shown in Figure 6-9 the relay will turn ON when PM10 readings exceeds $140 \mu\text{g}/\text{m}^3$, when the reading drop below $130 \mu\text{g}/\text{m}^3$ the relay will turn OFF.

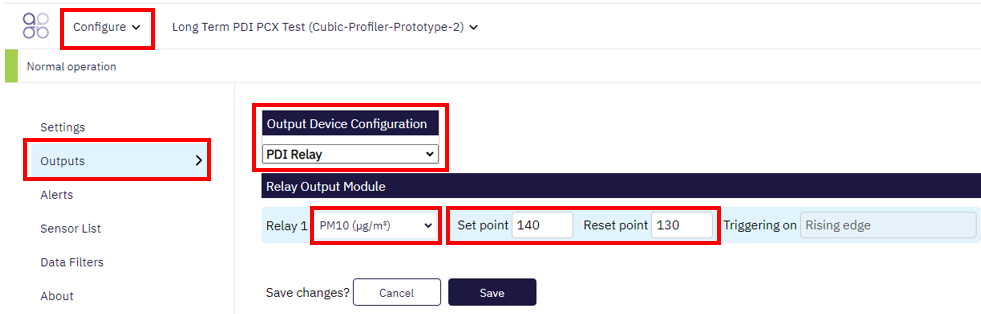


Figure 6-9 Configuring relay in Cloud

To wire the relay in the PDI core uses a 3-way header to breakout the relay contacts from the PCB. The Normally Open (NO), Common (COM) and Normally Closed (NC) positions are shown in Figure 6-10 Relay contacts wiring.

RELAY CONTACTS

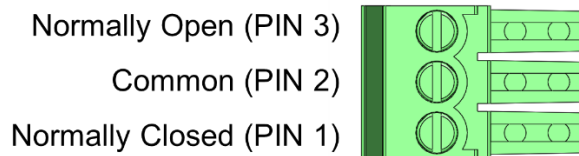


Figure 6-10 Relay contacts wiring

If an external device is to be powered via the relay it can be wired into the Analog Input connector, connecting the 12V or 5V pin to the Common pin as shown in Figure 6-11, and using the GND from the connection on the board. Note that both the 12V and 5V lines on the Analog Input connector are fused at 0.35A. If you require a higher current then an external power source must be used.

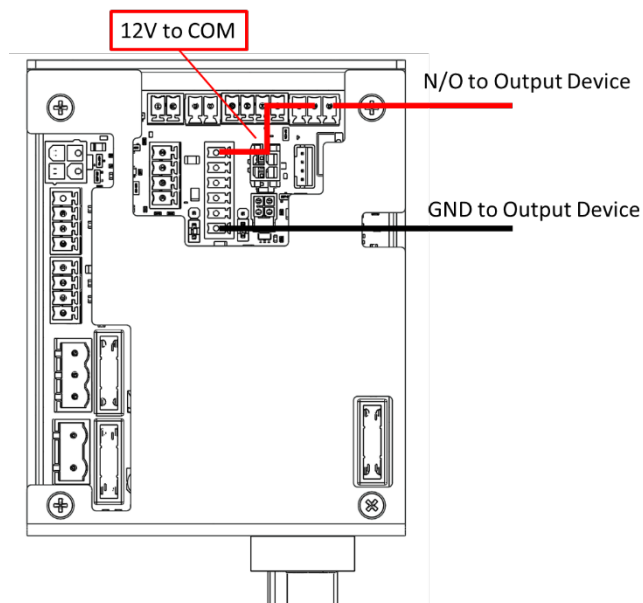


Figure 6-11 Powering a device via the relay

6.2.7 Sleep scheduling

The PDI Core has the capability to turn the instrument on and off at pre-set times. When the instrument is sleeping the power will be turned off to the EPC, modules, modem, external sensors, and pump. The LED on the PDI Core will change to a breathing blue.

- Configuration of the sleep scheduling is done via module settings for PDI ITEM:
 - Enter the desired turn 'ON' time for the system in the H2 field in a format of *hhmm* (24 hour time)
 - Enter the desired turn 'OFF' time for the system as H3 in a format of *hhmm* (24 hour time)
 - Enable the scheduling by setting TIMA to the desired functionality where:
 - TIMA of 0 = always on, do not follow sleep scheduling
 - TIMA of 1 = follow schedule 7 days/week
 - TIMA of 2 = follow schedule weekdays, off for weekends.
- In Figure 6-12 the instrument would turn on at 8:00AM, turn off at 5:00PM, 7 days/week

Module	H0	H1	H2	H3	TIMA	TIMR	TEMA	TEMR	PWML	PWMH	HTR	GAIN
PDIITEMP	1	0	800	1700	1	0	0	0	0	0	0	0

Figure 6-12 Sleep scheduling configuration example

In the event your instrument is sleeping and you would like to wake the instrument early, switch the power switch to OFF on the PDI Core until the (Blue) LED turns completely off, and then back ON.

Turning the Power Switch back on will turn the instrument on and will stay on until the next scheduled sleep time.

6.3 Nephelometer and Particle Profiler Modules

6.3.1 Assemble and attach the PM inlet

The particle sampling inlet is easy to assemble by push fitting the various supplied parts together. If no sharp cut cyclone has been ordered, then only a sampling inlet assembly and TSP head will need to be assembled.



Figure 6-13 Particle sampling inlet parts including (L-R): inlet tube, cyclone adaptor, cyclone, TSP head.

- Turn off power to the monitor during this process – see Section 2.6.
- If not already fitted, attach a PM inlet O-ring to the aluminium retaining ring and apply a small amount of lubricant.



Figure 6-14 Add the O-ring and a small amount of lubricant.

IMPORTANT: The Particle Nephelometer ships from the factory with a thin film of tape or coloured cap which protects the inlet, this must first be removed as shown in Figure 6-15.



Figure 6-15 Remove the protective tape or cap from the PM inlet

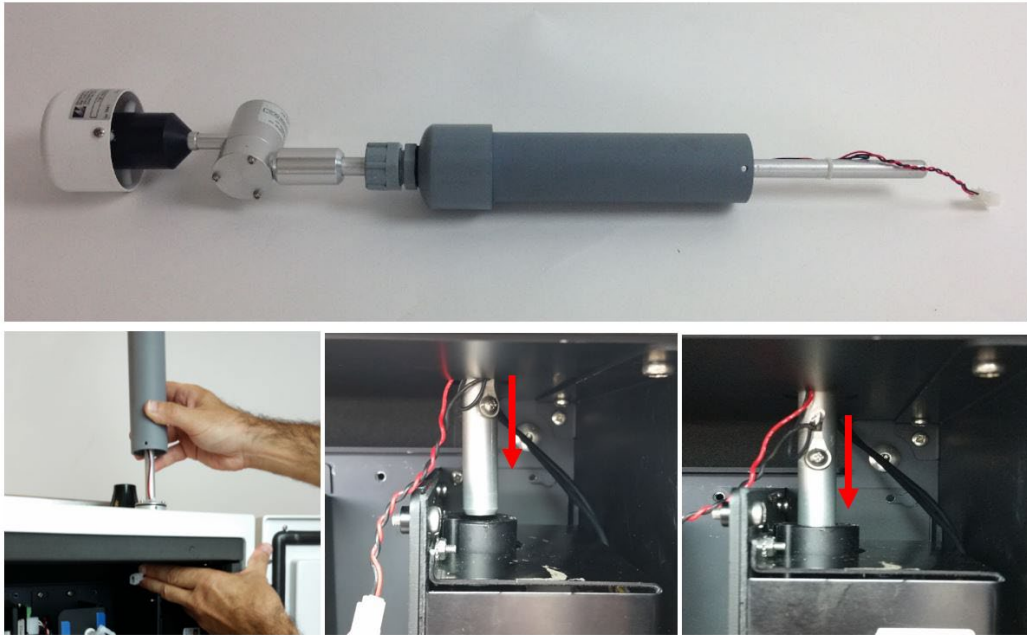


Figure 6-16 Gently feed in the power cable and over the particle engine mounting bracket on the left. The aluminium tube must push all the way into the PM module.

IMPORTANT: Ensure sure that the aluminium inlet tube is pushed all the way into the optical engine block.

- If the aluminium tube does not fully push down into the optical engine block, then create more length in the aluminium tube by removing the grey retaining nut and then sliding up the rubber grommet on the top of the inlet. Replace the nut after you have done this.



Figure 6-17 Create more length to the inlet by sliding the black rubber grommet up the tube.

- You need to make sure you have correctly and securely inserted the aluminium tube fully into the optical engine block.
- When you are satisfied the inlet is fully pushed into the engine block, then connect the heater plug on the inlet to the plug coming from the adjacent particle engine control module.
- Insert the three supplied #6-32 UNC retaining screws to secure the inlet to the aluminium retaining ring
- Push the fuse holder in to the “On” position to begin flowing air through the inlet.
- Then perform a leak check and flow check - see Section 6.4.4 and 6.3.4.



Figure 6-18 During field installation, secure the PM inlet using the retaining screws, then plug in the heater

If the correct flow rate cannot be set, then it may be required to replace the gas sample pump. The pump is part number **AQS R10**. The pump can easily be removed from the bracket for replacement.




IMPORTANT: Use fresh Tygon Tube (CS Tube 10) when re-connecting the tube back on the pump. This is because the barbs on the pump stretch the tube.

The online training website contains details on how to replace the gas sample pump.

6.3.2 Flow check and flow adjustment of the Particle Nephelometer

It is important to maintain the correct flow rate through the Particle Nephelometer. The flow rate of the Particle Nephelometer and Particle Profiler are different.

NOTE: The flow rate of the Particle Nephelometer is 2.0 ± 0.05 LPM

	Tools required	Small Philips head screwdriver, AQS R56 and DS R8/AQS R8 HS or DS R7/AQS R7
	Parts required	None
	Service Interval	Recommended Monthly . (See Section 6.1.1)

1. Enter 'Service Mode' in Aeroqual Connect to ensure that any fluctuations in the data caused from this activity can be excluded from air quality reports.
2. Connect flow adapter to sample inlet by removing the TSP head and pressing the flow adapter onto the top of the cyclone.
 - The AQS R56 includes a flow adaptor which is fitted on the inlet, for the Particle Nephelometer it is fitted above the cyclone as shown in Figure 6-38.



Figure 6-19 When checking the flow rate of the Particle Nephelometer place the flow measurement adaptor above the cyclone.

3. Connect the flow meter to the flow adapter.
 - If using the R7 flowmeter connect as shown with flow going into the monitor. Ensure the flowmeter is configured to read volumetric flow.
 - If using the R8 flowmeter, connect the assembly to the top port of the flow meter (negative flow).



Figure 6-20 Flow meters connected to Particle Nephelometer inlet.

4. Check that the flow rate reads 2.0 LPM \pm 0.05 (between 1.95 and 2.05 LPM).
5. If the flow rate is incorrect, adjust the sample flow by pulling out on the sample flow adjustment valve as shown in Figure 6-21 The flow rate of the Particle Nephelometer is set by adjusting the sample flow adjustment valve and rotating in the indicated direction to adjust the flow until the flow rate is correct.

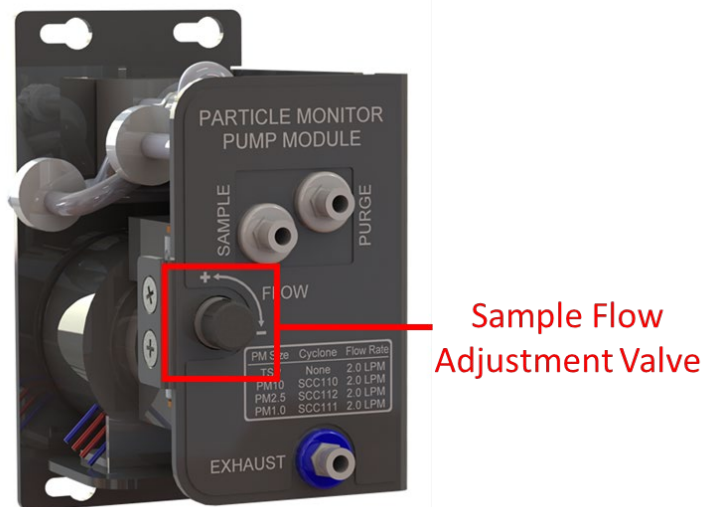


Figure 6-21 The flow rate of the Particle Nephelometer is set by adjusting the sample flow adjustment valve.




Note: If your Particle Nephelometer Pump Module appears different than above you may have an older version. If so, please consult support.aeroqual.com for instructions on how to adjust the flow on this type of module.

6. If you cannot reach the required flow rate, there may be a leak, the sample and purge filters may be dirty, or the pump may need replacing.
7. Record the results of this service activity in the monitor's journal.
8. Exit 'Service Mode'

6.3.3 Flow check and flow adjustment of Particle Profiler

It is important to maintain the correct flow rate through the Particle Profiler. The flow rate of the Particle Nephelometer and Particle Profiler are different.

NOTE: The flow rate of the Particle Profiler is 1.0 ± 0.05 LPM

	Tools required	Small Philips head screwdriver, AQS R56 and DS R8/AQS R8 HS or DS R7/AQS R7
	Parts required	None
	Service Interval	Recommended Monthly .

1. Enter 'Service Mode' in Aeroqual Connect to ensure that any fluctuations in the data caused from this activity can be excluded from air quality reports.
2. Connect flow adapter to sample inlet by removing the TSP head and pressing the flow adapter onto the top of the inlet.



Figure 6-22 Positioning of the flow adapter when checking the flow rate on a Particle Profiler.

3. When measuring (or adjusting) the flow rate of the Particle Profiler it is important to use the buffer chamber to ensure accurate measurement. The buffer chamber is part of the AQS R56 Zero Filter and Flow assembly. It is also part of the R20 Service kits. Figure 6-23 shows the buffer chamber installed between the flow meter and the profiler inlet.



The flow buffer chamber smooths the flow coming from the diaphragm pump.
It is installed between the flow meter and the Particle Profiler inlet

Figure 6-23 When measuring the flow on the Particle Profiler it is important to use the flow buffer chamber.

4. Connect the flow meter to the flow adapter.

- If using the R7 flowmeter connect as shown with flow going into the monitor. Ensure the flowmeter is configured to read volumetric flow.
 - If using the R8 flowmeter, connect the assembly to the top port of the flow meter (negative flow).
5. Check that the flow rate reads 1.0 LPM \pm 0.05 (between 0.95 and 1.05 LPM)
 6. If the flow rate is incorrect, adjust the sample flow by pulling out on the sample flow adjustment valve as shown in Figure 6-24. The flow rate of the Particle Nephelometer is set by adjusting the sample flow adjustment valve and rotating in the indicated direction to adjust the flow until the flow rate is correct.

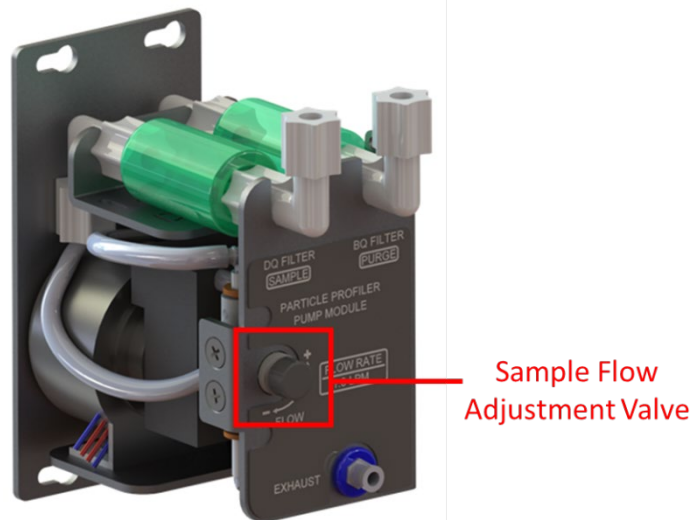





Figure 6-24 The flow rate of the Particle Nephelometer is set by adjusting the purge and exhaust valves.

Note: If your Particle Profiler Pump Module appears different than above you may have an older version. If so, please consult support.aeroqual.com for instructions on how to adjust the flow on this type of module.

7. If you cannot reach the required flow rate, there may be a leak, the sample and purge filters may be dirty, or the pump may need replacing.
8. Record the results of this service activity in the monitor's journal.
9. Exit 'Service Mode'

6.3.4 Leak check Particle Nephelometer and Particle Profiler

If the aluminium inlet is not correctly installed (see Section 6.1) or if the tubing is split, then the PM can have a leak. The vacuum gauge (AQS R23) is used to check for leaks in the Particle Nephelometer system and should be performed as part of regular service.

	Tools required	AQS R23
	Parts required	None
	Service Interval	Recommended Every three months (See Section 6.1.1)

6.3.5 Leak check a Particle Nephelometer

1. Remove the TSP head and install the R23 vacuum gauge above the sharp cut cyclone
2. Fully open the sample flow adjustment valve, located on the face plate of the pump module
3. Block the purge flow by pinching the purge tube
4. The vacuum gauge should reach at least -60 kPa – wait for it to stabilize
5. Then remove power (pull out black and red cable) to the electronics module to turn off the pump.
6. Count how long it takes for the pressure to change by 10 kPa.
7. If the pressure drops by 10kPa in less than 10 seconds then you may have a leak.
 - Check for loose connections, worn seals (o-rings), and split tubing.

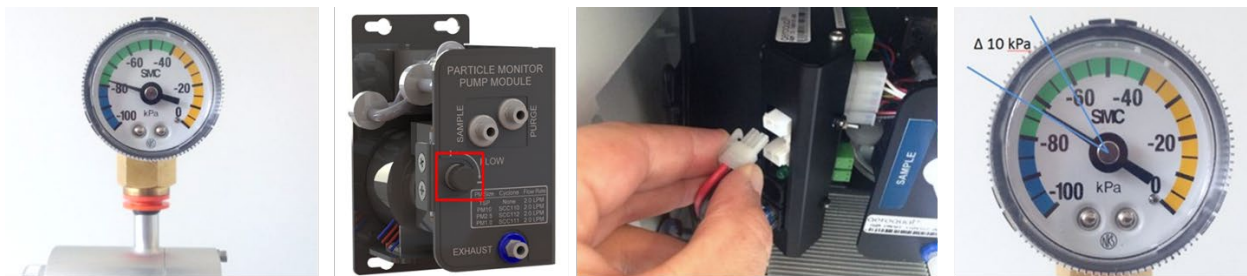


Figure 6-25 Fit the vacuum gauge, adjust the sample flow and pinch the purge flow. Then, stop the pump by removing power from the module, and observe the change in pressure. If the leak rate is greater than 10 kPa in 10 seconds, then there may be a leak in the system. Check all the tube connections.

NOTE: The pressure change (leak rate) should be no more than 10 kPa in 10 seconds.

6.3.6 Leak check a Particle Profiler

1. Fully open the sample valve
2. Remove the TSP inlet and place the vacuum gauge on the inlet
3. Block the purge flow by pinching the purge flow tube.
4. Wait for the vacuum gauge to stabilise
5. Remove black and red power cable from the IO module
6. Time how long it takes the vacuum pressure to drop by 10kPa
7. If the pressure drops by 10kPa in less than 10 seconds then you may have a leak.
 - Check for loose connections, worn seals (O-rings), and split tubing.




Figure 6-26 Adjust the sample valve, install vacuum gauge, and pinch purge flow tubing. Then remove power from module and time how long it takes vacuum pressure to drop by 10kPa.

6.3.7 Zero calibration check of Particle Module

The Particle Nephelometer has an automatic zero calibration function which runs every 12 hours, this procedure automatically changes the zero offset of the Particle Nephelometer.

✂	Tools required	R56, and DS R8 or AQS R8 HS
⚙	Parts required	None

	Service interval	Recommended Monthly . (See Section 6.1.1)
---	------------------	--

The zero response of the Particle Nephelometer can be checked by removing the TSP head and placing the R56 adaptor and zero filter assembly on the inlet above the cyclone as shown in Figure 6-39. The Particle Nephelometer should read between $\pm 3 \mu\text{g m}^{-3}$.

If the zero check shows negative numbers, there may be a problem with the auto zero cycle. See the troubleshooting section. Troubleshooting in Section.

Check that the gain and offset values for the Particle Nephelometer are set to sensible settings. The gain should be between about 0.6 and 4.0. The offset should be 0.000.

See Section 7.2 for a discussion on gain adjustment of the Particle Nephelometer.

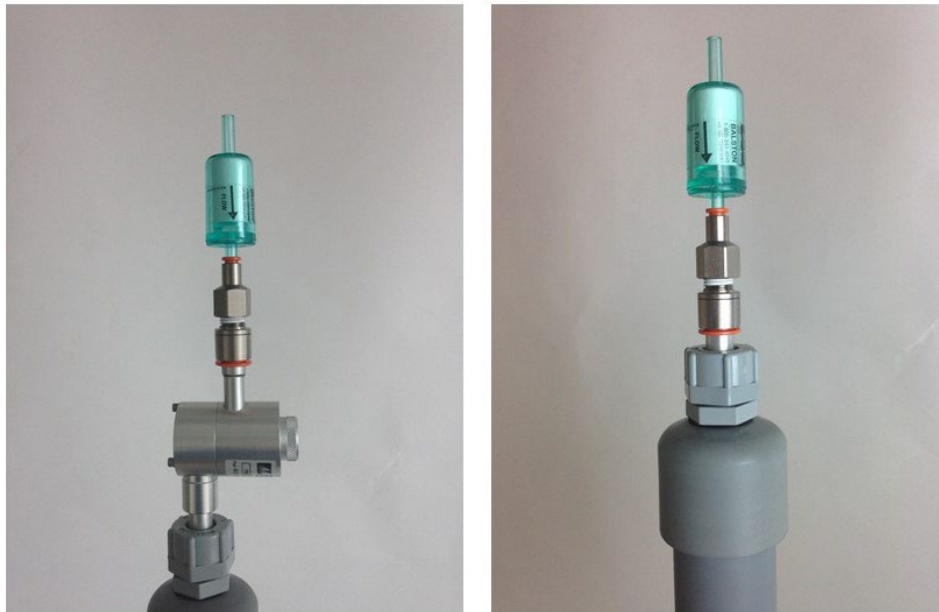





Figure 6-27 The zero filter is fitted above the cyclone for a Particle Nephelometer (left) and directly on the inlet for a Particle Profiler (right).

6.3.8 Replace filter on Particle Nephelometer or Particle Profiler

The Particle Nephelometer and Particle Profiler have filters which need to be replaced. Disconnect the pump module power when replacing the filter..

	Tools required	Large flathead screwdriver
	Parts required	DS R31 (Particle Nephelometer) DS R32 Particle Profiler
	Service Interval	Recommended Monthly (depends on local conditions)

The filters for the Particle Nephelometer are located inside the optical module. Use a large flat head screwdriver to unscrew the filter housing on the front panel of the optical module.

The filters for the Particle Profiler are in a filter casing outside the optical module and within the Particle Profiler Pump Module.

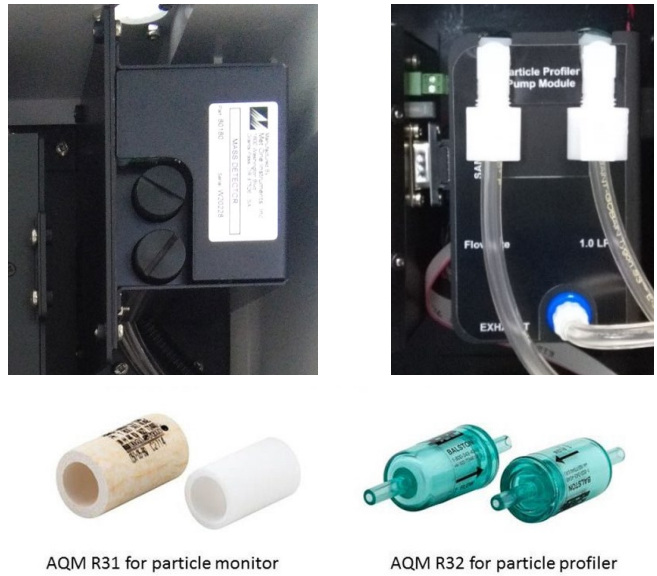


Figure 6-28 The Particle Nephelometer (shown on the left) requires AQS R31 and the Particle Profiler (shown on the right) requires AQS R32.

Section 6.1.1 discusses frequencies for changing the filters on the Particle Nephelometer and Particle Profiler. However, if the filters look visibly blackened, they should be replaced, regardless of the time elapsed.

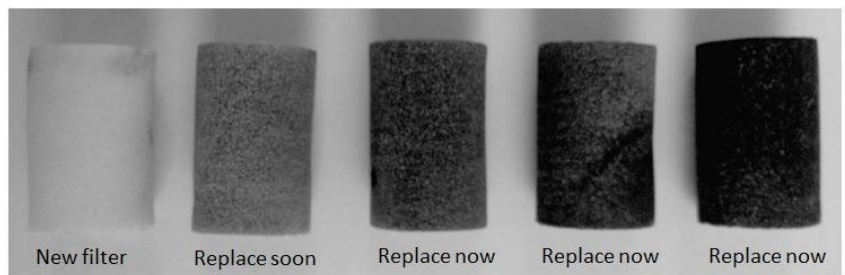


Figure 6-29 The AQS R31 sample filter should be replaced once the filter begins to blacken.

6.3.9 Check the auto zero calibration flow rate of the Particle Nephelometer

The Particle Nephelometer executes an automatic zero calibration every 1440 minutes (24 hours). The auto zero process resets a parameter in the module's settings. The value which is changed is the H0 parameter.

NOTE: The particle profiler does not have this feature.

The auto zero procedure on the Particle Nephelometer causes the baseline to be adjusted. Negative readings on the Particle Nephelometer are often a result of the auto zero cycle failing to work correctly.

The zero cycle works by switching off the sample pump and switching on a zero pump. The flow rate during the zero cycle is reversed and is a positive flow out through the inlet. The flow rate is approximately 0.2 to 0.6 LPM.

This flow rate does not need to be set to a specific value, but it is important that the flow rate is at least 0.2 LPM positive flow out from the inlet.

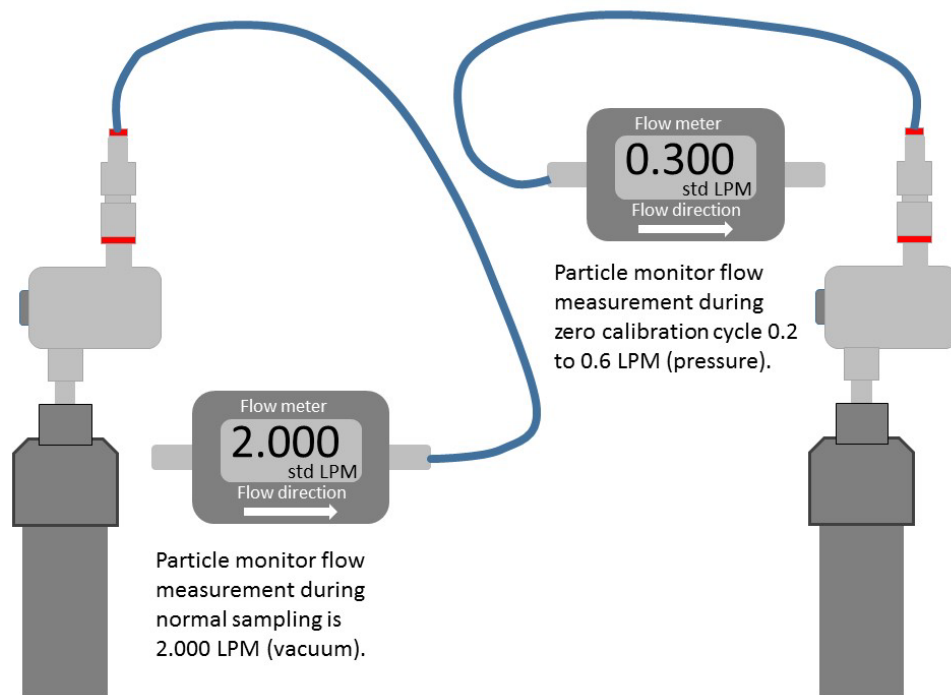


Figure 6-30 When measuring the sample flow of the Particle Nephelometer a vacuum is measured. When measuring the zero flow a positive pressure is measured.

The auto zero can be executed manually by temporarily changing one of the module settings. Once the auto zero cycle is complete the setting needs to be returned to the original setting.

- Go to the Diagnostic and Advanced app in Connect software.
- Select Module settings from the list on the left column
- Locate the Particle Nephelometer settings, these will be either PM10.0 or PM2.5
- Locate the TIMA parameter (it should be 720).
- Change this value to 1 by clicking in the cell and typing 1, then save the setting change.

This will cause the auto zero to start. The flow will change from 2.000 LPM negative flow into the inlet to approximately 0.2 to 0.6 positive flow out from the inlet.

You will need to change the port on the flow meter to measure this flow as shown in Figure 6-39.




- If no flow is measured there may be an issue with the zero cycle or zero pump. See Appendix 1 for trouble shooting.
- Measure the positive flow coming out from the inlet and record this in the journal.

The zero cycle takes approximately 6 minutes to complete.

NOTE: Once the flow has been measured the TIMA parameter must be set back to 720.

6.3.10 Clean the Particle Nephelometer TSP inlet, particle trap and cyclone.

The Particle Nephelometer cyclone uses a small particle trap to remove larger particles. The trap needs to be emptied and cleaned for optimum operation of the Particle Nephelometer. If the particle trap overfills then the entire cyclone needs to be cleaned.

	Tools required	Can of compressed air, cloth
	Parts required	None
	Service interval	Recommended 6 Monthly . (See Section 6.1.1)

The TSP head, particle trap and cyclone disassemble easily for cleaning.



Figure 6-31 The TSP head and cyclone can be disassembled for cleaning.

6.3.11 Replace pumps in pump module

The pumps in the Particle Nephelometer pump module and in the Particle Profiler pump module can easily be replaced.

The Particle Nephelometer contains a sample pump (**AQS R10**) and a purge pump (**AQS R34**). The Particle Profiler only has a sample pump (**AQS R10**)

Typically, the pumps last between 12 and 18 months. However, the pumps should be replaced when the correct flow can no longer be maintained.

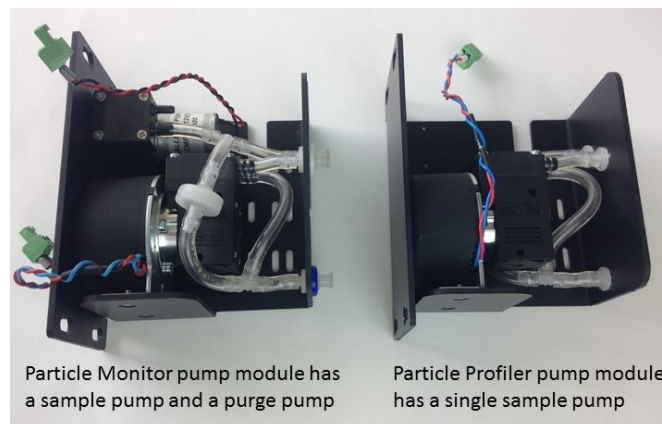


Figure 6-32 The Particle Nephelometer contains two pumps, the Particle Profiler has one pump.

6.4 PCX Module

6.4.2 Assemble and attach PCX inlet




1. Turn off power to the monitor during this process.
2. The PM inlet is held by a ½" Swagelok compression fitting and ships with a cap fitted to prevent debris ingress.
3. Remove the cap from Swagelok fitting.
4. Fit the two o-rings to the grooves in the TSP inlet
5. Press the TSP inlet on to the inlet tube ensuring the o-rings remain in the groove
6. Insert the PM inlet into the Swagelok fitting and carefully tighten. Thread tape is NOT required.



Figure 6-33 Add the O-rings to the PCX. Press the TSP inlet on after.

6.4.3 Replace filter on PCX module

The PCX module has a filter which periodically needs to be replaced. Power down the module before replacing.

	Tools required	Large flathead screwdriver
	Parts required	AQM R32 or AQS R32 or DS R32
	Service Interval	Recommended Monthly (depends on local conditions) See Section 6.1.1 for further discussion on filter change frequencies.

The filters for the PCX are located inside the module. If required, you can use a large flat head screwdriver to unscrew the filter housing on the front panel of the optical module.



Figure 6-34 The PCX module requires an AQM R32

If the filters look visibly blackened, they should be replaced, regardless of the time elapsed or the cumulative PM level.

The PCX module can assist you with determining the required service interval as it records the amount of particulate that has passed through the system.

To view the Cumulative PM through the device, Click on the 'Diagnostics and Advanced' page, and select the 'Diagnostics' tab. The fifth column shows how much PM has passed through the device in mg.

Select parameter: Averaging period:

Time	Flow (L/min)	PWM Value 0	Board Temperature (°C x 10)	Cumulative PM (mg)	Pressure (Pa)	Ambient Temperature (°C x 10)	Inlet
1:13PM	1.001	659.353	280.583	0.108	101245.000	227.250	Sample
1:12PM	1.000	659.572	280.000	0.108	101248.000	227.000	Sample
1:11PM	0.998	659.245	279.000	0.108	101249.000	227.000	Sample
1:10PM	1.000	659.576	278.583	0.108	101251.000	226.417	Sample
1:09PM	1.000	659.166	278.000	0.108	101251.000	226.000	Sample

Figure 6-35 Example data from cumulative PM measured in the PCX module.

When this value exceeds the trigger level, the system will raise the 'Flow Sensor Aging' flag. The trigger level is controlled by the value stored in the module setting 'TEMA' for Flow.

Diagnostics		Module	H0	H1	H2	H3	TIMA	TIMR	TEMA	TEMR	PWML	PWMH	HTR	GAIN
Module Settings >		Flow	1	-1.5	200	700	3	-3	500	0	600	-1	0	1.08

Figure 6-36 TEMA corresponds to the trigger level associated with the Cumulative PM measurement (Flow Aging).

Once the filter has been changed, the cumulative PM value can be re-set by changing the parameter stored in TEMR from 0 to 1.

Diagnostics		Module	H0	H1	H2	H3	TIMA	TIMR	TEMA	TEMR	PWML	PWMH	HTR	GAIN
Module Settings >		Flow	1	-1.5	200	700	3	-3	500	1	600	-1	0	1.08

Figure 6-37 Change TEMR from 0 to 1 in order to reset the Cumulative PM value.

6.4.4 Flow check of the PCX module




The PCX module has a factory integrated flow sensor will automatically check and maintain the flow rate of the module. The current reading can be seen in Aeroqual Cloud by navigating to the monitor's page and going to the 'Diagnostics and Advanced' page, followed by the 'Diagnostics' tab, and selecting the 'Flow' parameter. Alternatively, the flow rate can also be found in the 'Manage Data' page.

NOTE: The target flow rate of the PCX module is 1.0 ± 0.01 LPM

Diagnostics >		Select parameter	Flow	Averaging period	1 minute	Pause	Export		
Module Settings		Time	Flow (L/min)	PWM Value ()	Internal Temperature (°C*10)	Cumulative PM (mg/m³)	Pressure (Pa)	Temperature (°C*10)	Inlet
		2:41 PM	0.999	433.177	319.000	4.441	102208.000	9990.000	319.000
		2:40 PM	0.999	433.144	319.000	4.441	102207.000	9990.000	319.000
		2:39 PM	0.998	433.093	319.000	4.441	102206.000	9990.000	319.000
		2:38 PM	0.998	433.029	319.000	4.441	102206.000	9990.000	319.000
		2:37 PM	0.997	432.930	319.000	4.441	102207.000	9990.000	319.000
		2:36 PM	0.998	432.845	319.000	4.440	102208.000	9990.000	319.000
		2:35 PM	0.999	432.815	319.000	4.440	102209.000	9990.000	319.000
		2:34 PM	0.999	432.795	319.167	4.440	102209.000	9990.000	319.167
		2:33 PM	0.998	432.750	320.000	4.440	102210.000	9990.000	320.000
		2:32 PM	0.999	432.680	320.000	4.440	102209.000	9990.000	320.000
		2:31 PM	0.999	432.640	320.000	4.440	102209.000	9990.000	320.000
		2:30 PM	0.998	432.575	320.250	4.440	102209.000	9990.000	320.250
		2:29 PM	1.000	432.545	321.000	4.440	102209.000	9990.000	321.000
		2:28 PM	1.000	432.538	321.000	4.440	102209.000	9990.000	321.000

Figure 6-11 The PCX module flow rate is visible in the Manage Data and Diagnostics tab of Aeroqual Cloud.

The flow rate as measured by the internal flow sensor should be checked annually to ensure there has been no change.

	Tools required	7/8" spanner, AQS R56 and DS R8 or AQS R8 HS
	Parts required	None
	Service Interval	Recommended Annually . (See Section 6.1.1)

The AQS R56 includes a push fitting which is fitted on the inlet. Older PCX modules have o-rings on the TSP inlet tube and require an additional adaptor to install. Tubing length should be minimized where possible.



Figure 6-38 When checking the flow rate of the PCX replace the inlet with the adapter as shown. Left: Old inlet with O-rings that requires an extra adapter. Right: Current inlet without o-rings on the tube.

1. Remove the PCX TSP inlet, and attach the AQS R56 or AQS R8 HS
2. Compare the flow on the flow meter to the value reported in Connect

NOTE: The value reported by the internal flow sensor is reported as standard flow (rather than volumetric flow). Ensure your flow meter is reporting the same.

3. Calculate the new GAIN for the Flow module using the following formula:

$$\text{GAIN} = \text{Current Gain} \times (\text{Flow Sensor Reading} / \text{PCX Flow Reading})$$

4. Insert the new GAIN into the flow module setting labelled 'GAIN' as shown below




Diagnostics		Module	H0	H1	H2	H3	TIMA	TIMR	TEMA	TEMR	PWML	PWMH	HTR	GAIN
Module Settings	>	Flow	1	-1.5	200	700	3	-3	500	0	600	-1	0	1.08

5. Return to the Diagnostics and Advanced page, and Diagnostics tab
6. Wait 30 seconds for the pump speed to change and stabilized and check
- 7.

6.4.5 Leak check a PCX

Leak checks are not required with the PCX module as the flow in the module is controlled. If the module can achieve the flow rate at the inlet as indicated in *Section 6.4.4* the module will function correctly. If this flow rate is not achievable, please contact Aeroqual or your local distributor for servicing.

6.4.6 Zero calibration check and zero flow check of PCX

	Tools required	AQS R56, and DS R8 or AQS R8 HS
	Parts required	None
	Service interval	Recommended Monthly . (See Section 6.1.1)

6.4.6.1 Check zero baseline of the PCX

The PCX has an automatic zero calibration function which runs at start up and every 24 hours after that, this procedure automatically changes the zero offset of the PCX.

The zero response of the PCX can be checked by removing the PCX TSP inlet and placing the R56 adaptor and zero filter assembly on the inlet above the cyclone as shown in Figure 6-39. The readings for all mass channels should be $<3 \mu\text{g m}^{-3}$.

If the zero check shows negative numbers, there may be a problem with the auto zero cycle. See the troubleshooting section.

Check that the gain and offset values for the PCX (stored in the Calibration and Service page → Calibration tab of Aeroqual Cloud) are set to sensible settings. The gain should be between about 0.6 and 4.0. The offset should be 0.000.

See Section 7.2 for a discussion on gain adjustment of the PCX.



Figure 6-39 The zero filter can be attached to the inlet directly after removing the TSP inlet and O-rings

6.4.6.2 Check the auto zero calibration flow rate of the PCX

The PCX executes an automatic zero calibration at start up (once flow has stabilized) and every subsequent 1440 minutes (24 hours).

The auto zero procedure on the PCX takes 10 minutes by default and causes the baseline to be adjusted. Negative readings on the PCX can be a result of the auto zero cycle failing to work correctly.

The zero cycle works by switching off the sample pump and switching on a zero pump. The flow rate during the zero cycle is reversed and is a positive flow out through the inlet. The flow rate is approximately 1 to 2 LPM.

This flow rate does not need to be set to a specific value, but it is important that the flow rate is at least 1 SLPM positive flow out from the inlet.

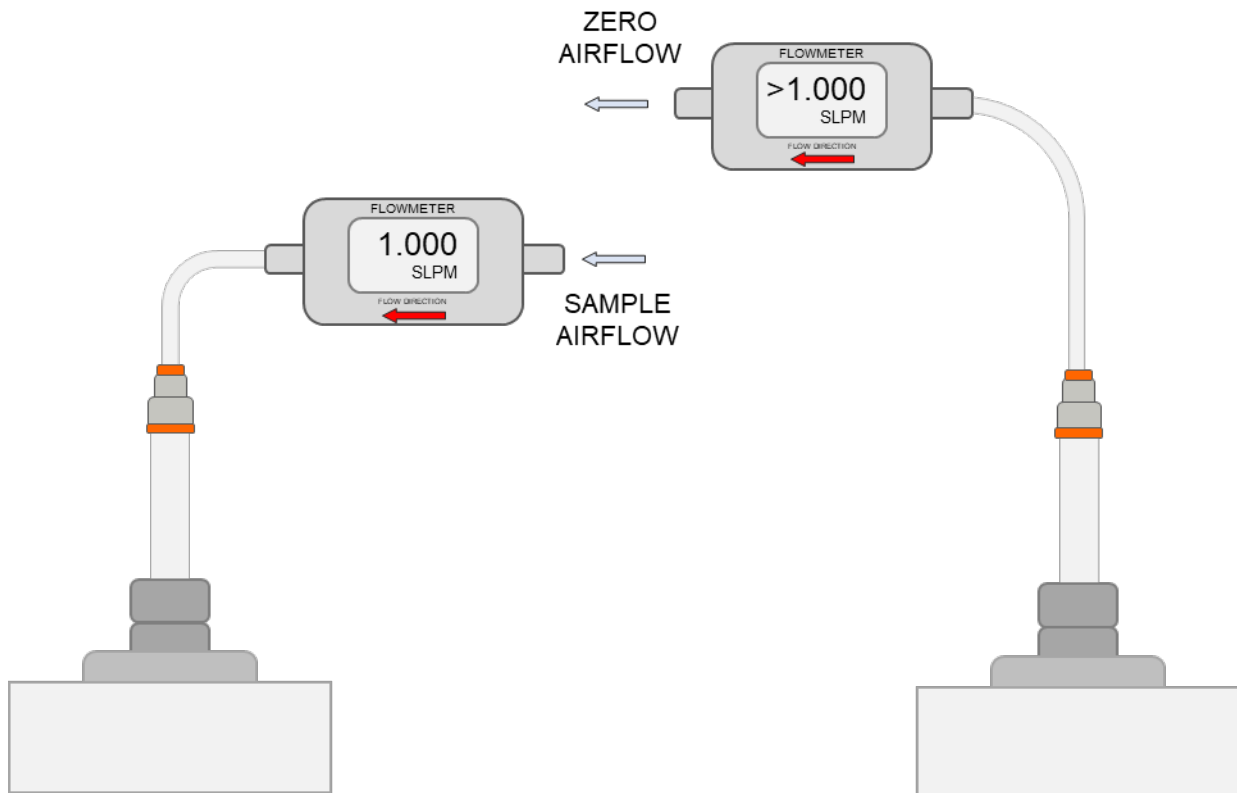
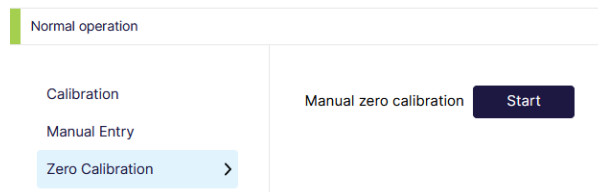


Figure 6-40 When measuring the sample flow of the PCX, a vacuum is measured. When measuring the zero flow, a positive pressure is measured.

The zero can be executed remotely by pressing the manual zero calibration button.



- Change the measurement orientation on the flow meter as shown in Figure 6-40 to measure this flow.
- Go to the 'Calibration and Service' page in Connect software.
- Select the Zero Calibration tab from the list on the left.
- Press this button and wait for the zero calibration to execute.
- This will cause the auto zero to start. The flow will change from 1.000 SLPM negative flow into the inlet to approximately 1 to 2 SLPM positive flow out from the inlet.




NOTE: The internal flow sensor of the PCX module will not report a flow value during zero cycles

If no flow is measured, there may be an issue with the zero cycle or zero pump. See Appendix 1 for trouble shooting.

- Measure the positive flow coming out from the inlet and record this in the journal.
- The zero cycle takes approximately 10 minutes to complete.

6.4.7 Clean PCX TSP inlet

The PCX uses a TSP inlet to protect the monitor from water ingress. This part can be taken apart and cleaned for optimal performance.

	Tools required	Can of compressed air, cloth
	Parts required	None
	Service interval	Recommended 6 Monthly

To disassemble the TSP inlet:

- Loosen the three screws on top of the inlet. The three screws do not need to be removed completely.
- Take the base off
- Remove the insect mesh.

The TSP inlet can be cleaned with a damp cloth and the mesh can be cleaned with a can of compressed air if required, or stiff bristled brush.



Figure 6-41 PCX TSP inlet disassembled for easy cleaning.

Re-assembly follows the same process in the opposite direction. However, the screws should each be tightened gradually in a circle in order to ensure they all thread in properly.

6.4.8 Removing and Installing the PCX Module

The PCX module is held in place inside the monitor with two screws in keyhole slots and secured to the inlet with a Swagelok fitting. To remove a PCX module:

1. Enter 'Service Mode' in Aeroqual Connect to ensure that any fluctuations in the data caused from this activity can be excluded from air quality reports.
2. Disconnect the power and data cables, along with the temperature and humidity sensor cable plugged into the front of the module.
3. Loosen the two screws at the locations shown, which will allow the module to slide down. Note that the screws do not need to be removed completely in order to remove the module

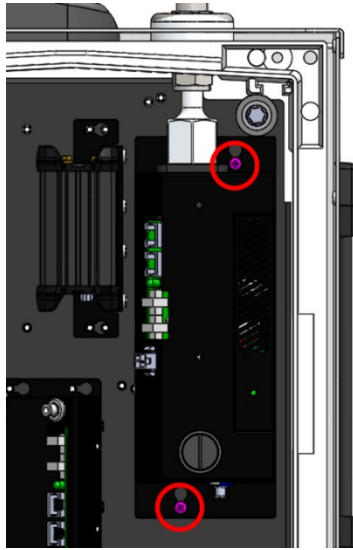


Figure 6-42 The two screws indicated must be loosened to remove the module from the monitor

4. Loosen the Swagelok fitting at the top of the module – this may require a wrench (7/8"). The Swagelok nut should drop down on the inlet when fully removed.
 - If the ferrule remains stuck in the fitting, wiggling the module should dislodge it.
 - Do not disconnect the module by unscrewing the larger hex assembly.

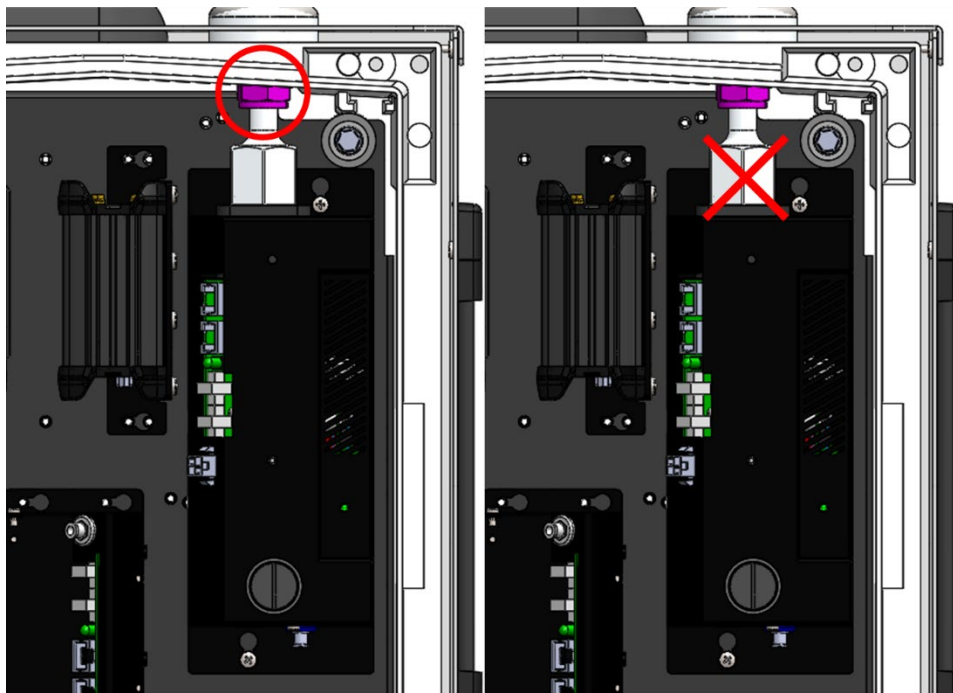


Figure 6-43 The module can be disconnected from the inlet by unscrewing the Swagelok fitting at the top of the module. Do not disconnect the module by unscrewing the larger hex on the inlet.

5. After the Swagelok fitting has been disconnected the module should slide down and disconnect from the backplate via the keyhole slots.

To re-install a PCX module, repeat the above steps in the opposite direction and then complete a leak check as described in Section 6.4.5.

6.4.9 Troubleshooting

6.4.9.1 PCX Specific Error States

The PCX module can provide more detailed error states than previous Aeroqual modules. The table below summarizes which error states the module may present, the possible cause, and the recommend action the user should take.

Measurement Channel	Error State	Possible Cause	Recommended Action
Particle Mass	Sensor due for replacement	PM Sensor cumulative PM exceeded	<ul style="list-style-type: none"> • Check PM sensor connection. • Return module to service center for PM sensor replacement.
	Failure	PM sensor comms error or PM sensor reporting an error	<ul style="list-style-type: none"> • Check PM sensor to see if data is present. If no data, check cable. If data present, return to service center for PM sensor replacement
Particle Counts	Failure	PM sensor comms error or PM sensor reporting an error	<ul style="list-style-type: none"> • Check PM sensor to see if data is present. If no data, check cable. If data present, return to service center for PM sensor replacement.
Flow	Sensor due for replacement	Cumulative PM for flow sensor channel exceeded.	<ul style="list-style-type: none"> • Replace primary filter. • Reset cumulative particulate measurement as described in Section 6.4.3
	Failure	No new data from flow sensor.	<ul style="list-style-type: none"> • Check flow sensor connection. • Manually set flow rate as described in Section 6.4.4
Pump Speed	Sensor due for replacement	Pump PWM outside of expected range	<ul style="list-style-type: none"> • Check system for leaks • Replace pump.
	Failure	Pump PWM is non-zero, but pump speed (tacho) reads zero	<ul style="list-style-type: none"> • Check pump cable connection • Replace pump
HTEMP	Failure	No new data from inlet heater	<ul style="list-style-type: none"> • Check connection to heater • Replace heater
AMB TEMP or AMB RH	Failure	No new data from T/RH sensor	<ul style="list-style-type: none"> • Check connection to T/RH sensor • Replace sensor

6.4.9.2 PCX Status LED

The PCX module contains two LED which indicate module status. The main LED, which is present on all Aeroqual modules, and a secondary LED which can indicate additional states unique to the PCX module.

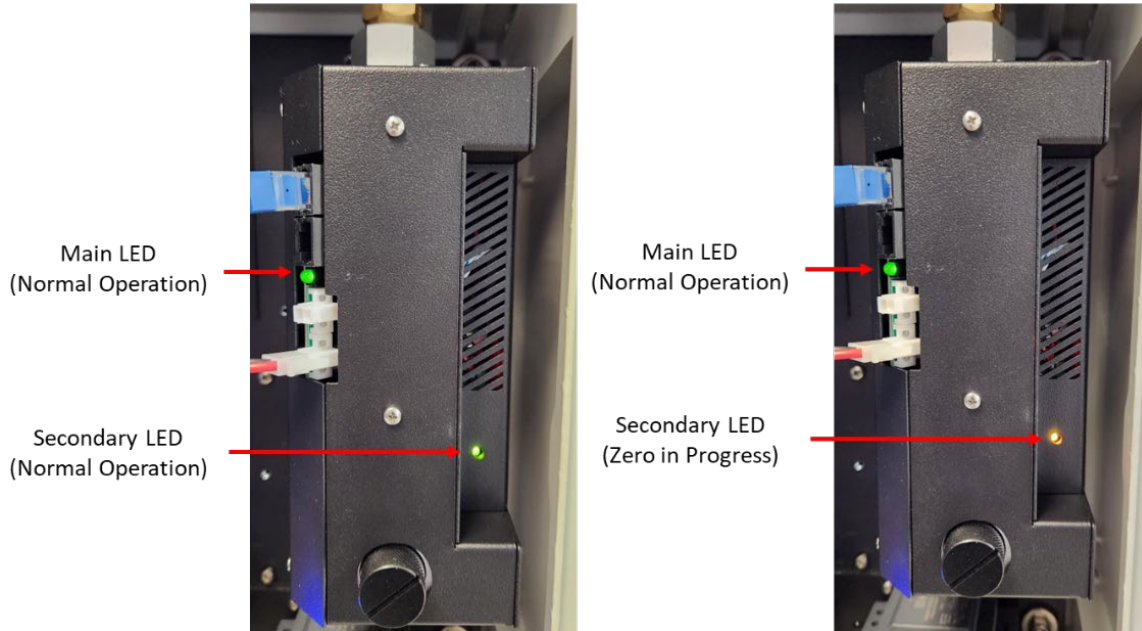


Figure 6-44 LED status lights on the PCX module

	LED Color	Device State
Main LED	Solid Green	Normal operation
	Slow Flashing Green	Device warming up
	Rapid Flashing Green	Sensor failure error
Secondary LED	Solid Green	Normal operation
	Flashing Green	Device warming up
	Solid Red	Sensor failure error
	Flashing Red	Comms error with EPC
	Solid Orange	Zero calibration in progress

6.4.9.3 Manual Flow Control of PCX

In the unlikely event the flow sensor fails, a 'Flow sensor failed' banner will display at the top of Cloud and Connect. In this state the module will try to operate the pump at a default pre-programmed flow level which will be around 1L/min. If this occurs and you desire a more accurate measurement, the flow can be manually set by adjusting the pump speed.

To do this:

1. Check if the flow sensor is reporting as failed, as shown below.

Time	Flow (L/min)	PWM Value (0)	Board Temperature (°C x 10)	Cumulative PM (mg/m³)	Pressure (Pa)	Ambient Temperature (°C x 10)	Inlet
11:40 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:39 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:38 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:37 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:36 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:35 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:34 AM		0.000	286.000	0.108	101232.000	217.000	Sample
11:33 AM		0.000	286.000	0.108	101232.000	217.000	Sample

Figure 6-45 Cloud interface showing a PCX module in a failed state

2. Fit an external flow sensor to the inlet as described in Section 6.4.4
3. Log into Cloud or Connect and navigate to the 'Diagnostics and Advanced' page, and the 'Module Settings' tab
4. Find the 'Flow' module, and enter a PWM value under the PWMH module setting and click save.
 - Valid values are between 200 and 1000.
 - Typical values to achieve a flow rate of 1L/min are around 500-600.
 - A value of -1 (default) puts the system into automatic flow control mode.

Module	H0	H1	H2	H3	TIMA	TIMR	TEMA	TEMR	PWML	PWMH	HTR	GAIN
Flow	1	200	200	700	2	0	2	0	450	500	-1	1.1

Figure 6-46 Manually setting the PWM value for the pump

5. Wait for the flow to change and stabilize as measured on your external flow meter. If you changed the module setting through Cloud it may take a minute or two for the change to propagate through to the device. If done through Connect this should be instantaneous.
6. Adjust the PWM value up or down until you have achieved the target flow rate of 1.00 L/min +/- 0.01.

6.5 Gas Modules

6.5.1 Attach gas inlet



Figure 6-47 Gas inlet removed and attached to the 1/4" Swagelok fitting

- The gas inlet is held by a 1/4 inch Swagelok compression fitting.
- Attach the gas sampling inlet and perform a flow check to make sure the inlet is fitted correctly, and the sample pump is working properly.
- Fit the supplied Kynar inlet filter to the Swagelok nut at the end of the sample cane.

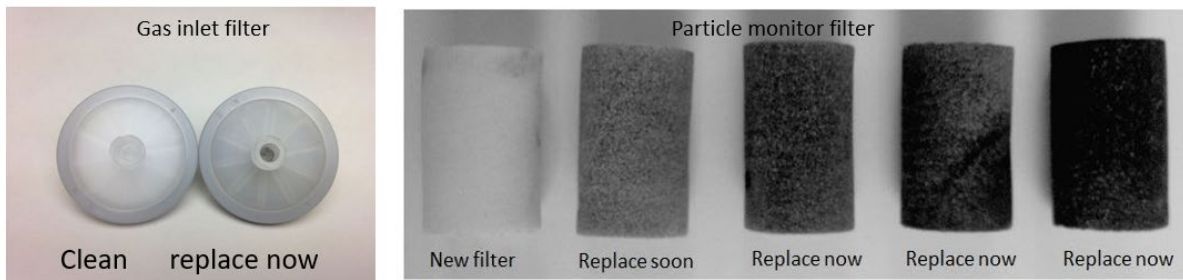


Figure 6-48 Filters should be changed before they get too dirty. The frequency of filter changes will depend upon local site conditions.




Data quality objectives will also influence the service frequencies for some operations. In monitoring situations where data quality objectives are high, for example where monitoring is performed for compliance or where a high amount of scrutiny will be placed on the data, service frequencies may be higher.

It is recommended that the monitor engineer, over time, develops an appropriate servicing schedule for a site.

6.5.2 Replace gas sample inlet filter (AQS with gas only)

The gas inlet filter is held inside the enclosure at the top left. This must be changed to ensure accurate readings. The filter is disposable and can be thrown away.

The filter should be changed when it becomes dirty as shown in Figure 6-49. The frequency of filter changes depends upon local environmental conditions.

	Tools required	None
	Parts required	AQS R12 (bag of 25 filters)
	Service interval	Recommended Monthly (depends on local conditions) See Section 6.1.1 for further discussion on filter change frequencies.

Do not turn off the monitor, this procedure can be done with the monitor turned on.




NOTE: *It is very important to check the monitor inlet flow rate is correct after changing the filter to ensure there are no leaks*



Figure 6-49 The particle filter on the gas inlet can be easily replaced, it should be replaced when it gets dirty as shown in the image on the right (a new filter is shown on the left, dirty filter on the right).

6.5.3 Measure and adjust monitor gas inlet flow rate and module flow rate

Maintaining a consistent flow rate is very important for ensuring accurate measurements. Leaks, or an aging pump may lead to reduced flow. Regularly measuring the flow rate will ensure any changes to flow rate are identified as soon as possible.

	Tools required	AQS R8 HS, Inlet flow adaptor (comes with monitor accessories box) Small Philips head screwdriver
	Parts required	None
	Service interval	Recommended Monthly .

6.5.4 Measure main gas inlet flow rate

- Remove the white inlet fitting containing the mesh filter and attach the inlet flow adaptor.
- Attach a high-quality flow meter such as the AQS R8 HS or Bios Dry Cal. See Section 6.1.1.
- Record the inlet flow rate in the Journal by making a manual user entry.

The gas inlet rate is controlled, for a description of the expected flow rate for the module see the Aeroqual Module Technical Performance Guide.

When the monitor is new, the inlet flow rate is recorded in the monitor logbook which is provided from the Aeroqual factory. The measured flow rate should be equal to the previously measured flow rate which is recorded in the monitor journal.



Figure 6-50 To measure the flow rate, remove the Kynar inlet filter and attach the inlet flow adaptor.

6.5.5 Measure the flow rate of the module

The module flow rate is measured using a high-quality flow meter such as the AQS R8 HS or the Bios Dry Cal. See Section 6.1.1

- Attach the flow meter to the inlet port (white ring) of the gas module
- Reconnect the inlet fitting after measuring the gas module
- Record the flow rate of the module in the Journal by making a manual user entry

6.5.6 Adjust the gas inlet flow rate

If the gas inlet flow rate is found to be lower than expected, it could be because one of the modules has a leak or is blocked.

To check this, perform a flow check on the individual modules as described in Section 6.5.6

If one of the modules is found to be blocked or has a leak, then this will need to be corrected.

If all the modules showed reduced flow, then it is likely that the gas flow pump is aging.

The flow adjustment valve can be used to provide more flow to the module inlets and return the flow rate to the expected flow rate.

Attach a flow meter to the inlet and begin measuring the inlet flow. Adjust pump flow adjustment valve until the monitor inlet flow rate has returned to the expected flowrate. The valve is shown in Figure 6-51.

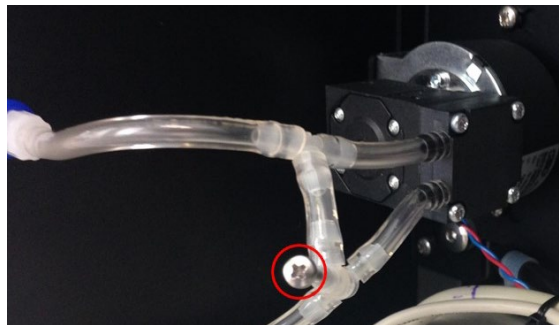


Figure 6-51 The flow adaptor valve is used to adjust the monitor inlet flow to the correct value.

If the correct flow rate cannot be set, then it may be required to replace the gas sample pump. The pump is part number **AQS R10**. The pump can easily be removed from the bracket for replacement.




IMPORTANT: Use fresh Tygon Tube (CS Tube 10) when re-connecting the tube back on the pump. This is because the barbs on the pump stretch the tube.

The online training website contains details on how to replace the gas sample pump.

<https://support.aeroqual.com>

6.5.7 Leak check gas module

If the correct flow rate cannot be achieved through a gas module, this may indicate a leak. An individual gas module can be checked for leaks by using a small diaphragm pump and a flow meter in the configuration shown in Figure 6-52

	Tools required	Diaphragm pump R10, flowmeter DS R8 or AQS R8 HS
	Parts required	None
	Service interval	Only as required. (See Section 6.1.1)

A gas module should be leak tight.

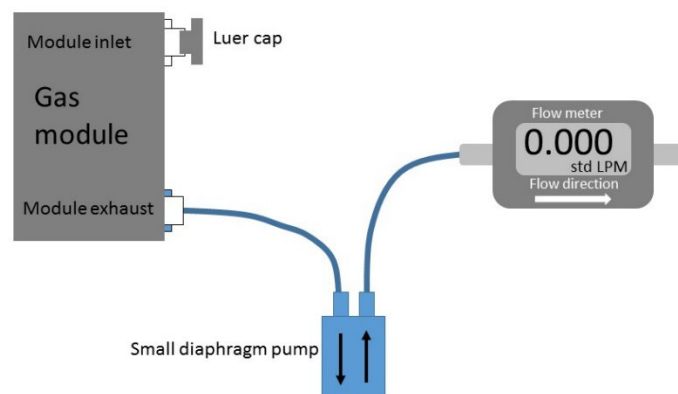





Figure 6-52 A gas module can be checked for leaks by using a diaphragm pump and R7 flow meter

NOTE: If the module is found to have a leak, contact the Aeroqual distributor in your local country for technical support.

6.5.8 Remove and replace a gas module

Replacing the module configuration can be done easily on site.

A change in the module can result in a change of inlet flow rate. It is important to measure the inlet flow rate after the module change and document this in the monitor journal.

	Tools required	Tube Cutter, Large Phillips head screwdriver, AQS R8 HS
	Parts required	Tubing: CS Tube10 CS Tube11, power cable, communication cable, 2x Luer cap
	Service interval	As required

If a module is removed or added, then a software change is required. The software module configuration can be found in the Configure Instrument page. Sensor modules can be added or removed using this tool, shown in **Figure 6-53**.

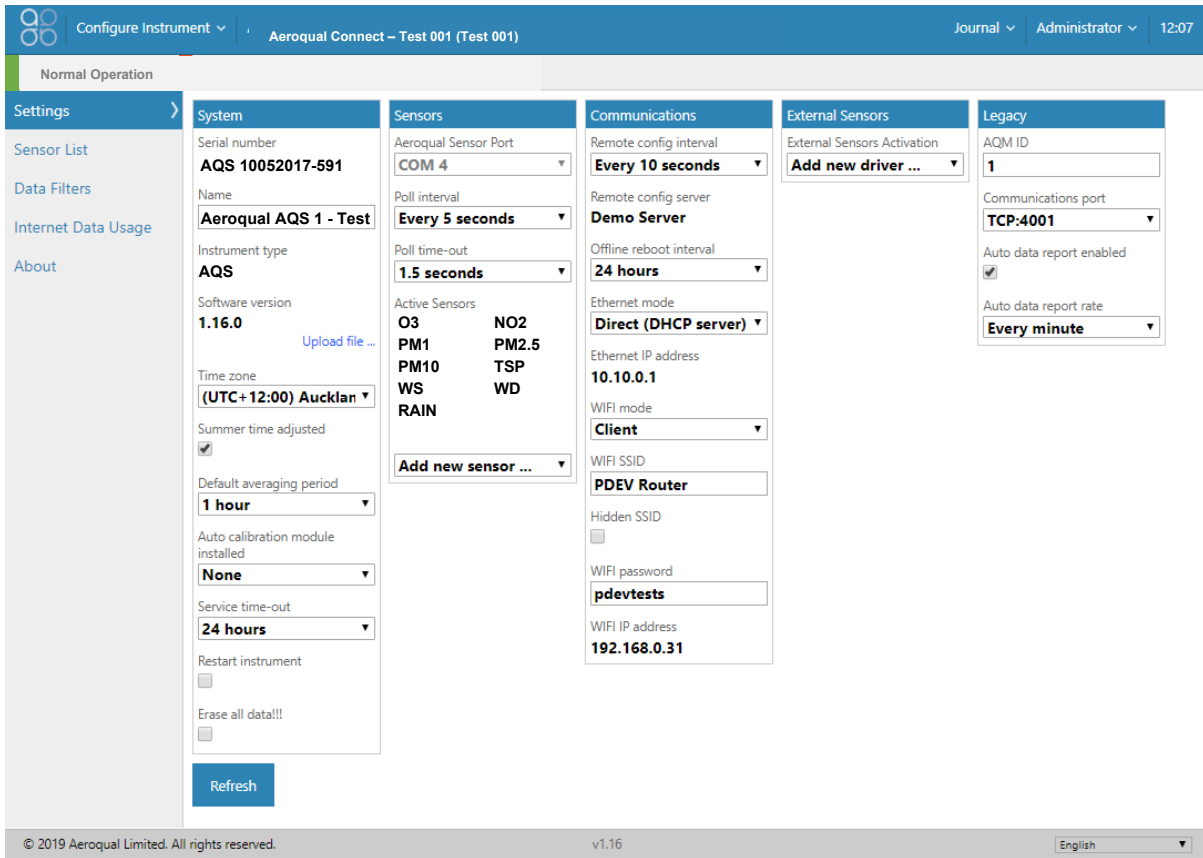


Figure 6-53 Change the module configuration in the software in the Configure Instrument page.

6.5.9 Replacing a module with another of the same type

This can be done with the monitor power left on. There is no software change required when removing a module.

- Disconnect the vacuum and sample lines
- Remove one blue communications cable and one red and black power cable
- Loosen the retaining screws and remove the module
- Replace the module with the new module
- Reconnect the blue communication cable and black and red power cable to ensure all modules have power and communications.

IMPORTANT: Ensure the polarity of the red and black cable is the correct orientation.

- Cap off the vacuum and sample lines using a luer cap
- Remove the module from the sensor list in the software (Configure Instrument page)
- Measure the total inlet flow rate and document this in the journal

6.5.10 Adding a new module

This can be done with the monitor power left on. There is a software change required when adding a module.

You will need one blue communications cable and one black and red power cable.

You need 4 x 10mm M4 screws.

It may be necessary to cut into the sample and exhaust lines in order to add additional gas fittings. For this you will need a tube cutter, **do not use scissors**. You will also need tee fittings and luer fitting, and tubing.

It is important to use the PFA (CS Tube 11) for the gas sampling and Tygon (CS Tube 10) for the exhaust.

It important to use the large barb tee for the exhaust tubing and the small barb tee for the sample tubing.

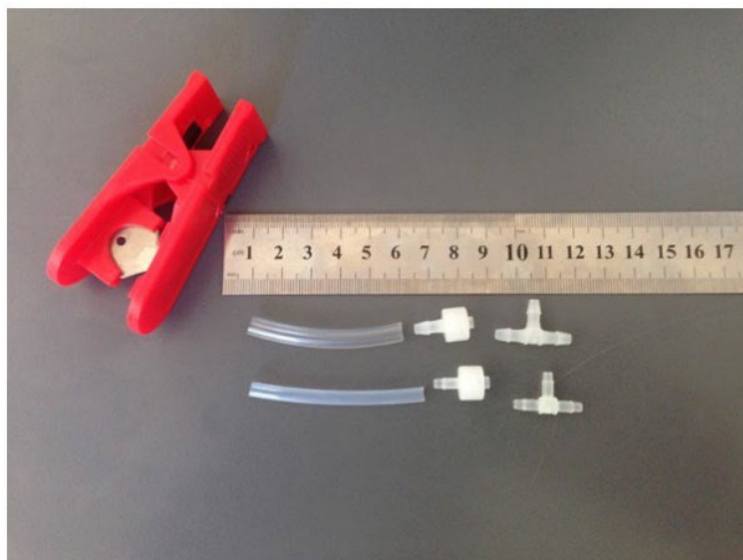


Figure 6-54 Adding a new module requires adding additional sample and exhaust lines.

6.6 Scheduled Maintenance

The service frequencies should be considered conservative. Monitor operators are encouraged to develop a service schedule suitable for their local conditions and data quality objectives.

Service activity	Section	Service frequencies
Gas inlet filter change	6.5.2	4-12 weeks Initially 4 weeks . Later this can be modified to suit local conditions and data quality objectives
PM inlet filter change	6.4.3	4-12 weeks Initially 4 weeks . Later this can be modified to suit local conditions and data quality objectives
Gas inlet flow check	6.5.3	4-12 weeks Initially 4 weeks . Later this can be modified to suit local conditions and data quality objectives
PM inlet flow check	6.4.4	Every 12 months (1 year)
Gas inlet flow adjustment	6.5.6	Adjust as required following gas inlet flow check
PM inlet flow adjustment	6.4.4	Adjust as required following PM inlet flow check
PM leak check	6.4.5	Every 3 months (Quarterly)
PM zero calibration check	6.4.6	Every 3 months (Quarterly)
PM zero calibration flow check	6.4.6	Every 3 months (Quarterly)
PM inlet cleaning	6.4.7	Every 6 months (Half-yearly)
Factory calibration Particle Nephelometer	7.2	Every 12 months (1 year)
Factory calibration Particle Profiler	7.2	Every 24 months (2 year)
Factory calibration PCX Module	7.2	Every 24 months (2 year)
Gas module calibration	5.1	See Section 7.1
Unscheduled maintenance		
Service activity	Section	Service frequencies
Measure flow rate of gas modules	6.5.3	As required following gas inlet flow check
Leak check a gas module	6.5.7	As required following module flow check
Add, remove, replace gas module	6.5.8	As required

Table 6-1 Service frequency guidelines for various service activities.

7 Calibration

NOTE: A calibration record is supplied with the monitor, additional copies can be requested by contacting technical@aeroqual.com

7.1 Gas module calibration

There are three types of calibration of the gas module:

1. **Factory calibration pre-shipment.** All gas modules are calibrated and must meet rigorous performance standards before being shipped. This is captured by the factory calibration certificate. Experience shows that Aeroqual's factory calibration transfers well to the field, meaning that field calibration is not required during initial set up.
2. **Field calibration.** The monitor is designed so that the gas module can be calibrated in the monitor in the field. The field calibration set up and process is very similar to calibration of US / EU EPA approved 'reference' analyzers.

Field calibration is only recommended when:

- a) the gas module is clearly operating out of specification and the appropriate trouble-shooting steps have been taken, or;
 - b) periodical validation of the data is required (recommended for advanced users only).
3. **Factory calibration post-shipment.** At any time, the gas module can be removed from the monitor and returned to the factory or one of our authorised service providers for factory calibration. If the gas module has not been field calibrated, then it is recommended to have the gas module factory calibrated every 12 months

The following instructions relate to field calibration only.

Field calibration is an activity that requires attention to detail and accuracy. You should read this entire calibration section and understand it before starting, even if you are an experienced practitioner.

- The monitor is calibrated using a two-point calibration procedure, first by delivering zero air to the monitor inlet and adjusting the offset, and then delivering span gas to the monitor inlet and adjusting the gain.
- Aeroqual provides all the equipment required to perform field calibration. Aeroqual offers a portable calibrator called the AirCal 1000.
- Offset and gain adjustments are performed using the software tools provided by Aeroqual Connect or Aeroqual Cloud.
- If the AirCal 1000 is being used, there is a separate PC desktop software application which can be downloaded from the website.

Some important considerations for field calibration:

- Gas module calibration is achieved using certified calibration gas and a gas dilution calibrator.
- For ozone, an ozone generator, (ozone calibrator) must be used, Aeroqual recommends the 2B Tech Ozone generator part number AQM O3CAL.
- Aeroqual does not recommend calibration when first commissioning a new monitor. We recommend first calibrating 1-3 months after commissioning.
- The quality of the calibration gas makes a big difference to success of a calibration, only purchase calibration gas from a reputable calibration gas supplier.
- The monitor must be in a stable condition before calibration can be attempted. The monitor must have been running for at least 6 hours before calibration, ideally 24 hours.
- The zero calibration step takes approximately 30 minutes total across all modules. The span calibration takes approximately 30 minutes per-module. Therefore, a monitor with 2 gas modules will take $30 + (2 * 30)$ minutes (approximately 1.5 hours) to calibrate.
- Record keeping is a crucial part of calibration, the journal feature in Connect and Cloud is where calibration record keeping is performed.

Calibration is discussed in detail in the online training. Several supporting videos are also available.

7.1.1 Equipment required

Calibration of the gas modules inside the monitor requires specialist equipment which Aeroqual can provide.

Gas Module	Equipment	Comment
O ₃	O3Cal	Tubing and gas fittings are <u>not supplied</u> with the O3Cal. The calibration tubing and fittings can be ordered separately using part number: AQM CALKIT.
NO ₂	Aeroqual AirCal 1000	Tubing and gas fittings are supplied with the AirCal 1000. Users must supply their own gas cylinders.
CO		
VOC		
H ₂ S		
SO ₂		
CH ₄		

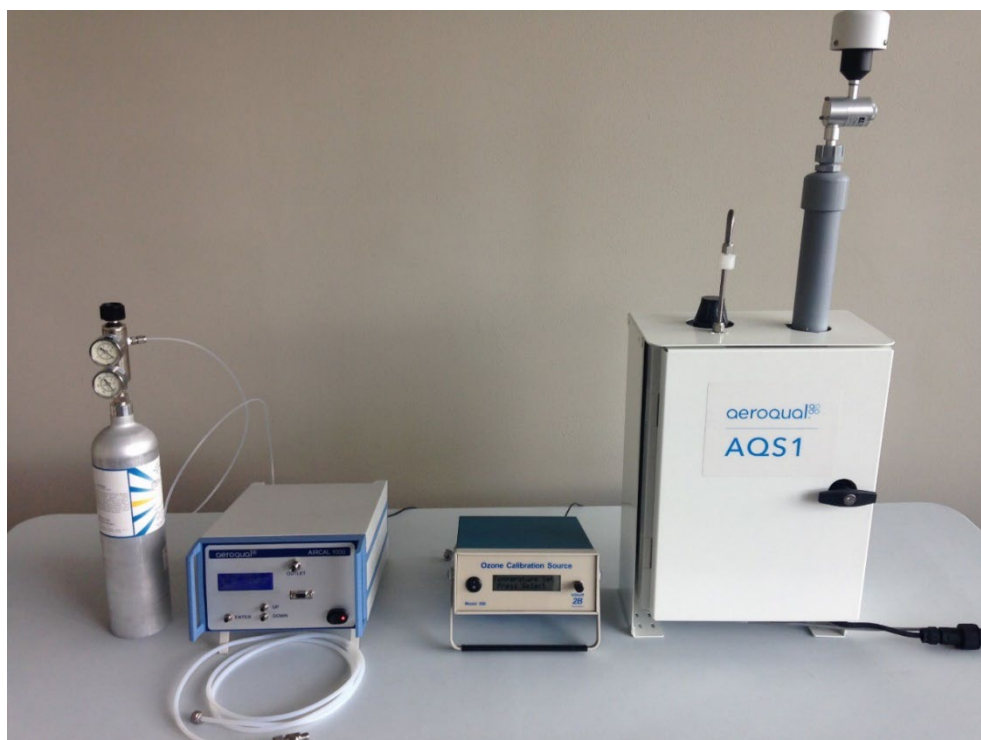


Figure 7-1 Centre: O3Cal Ozone calibrator. Left: AirCal 1000 with NO₂ cylinder from Calgaz.

NOTE: Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.

- Turn on the AirCal 1000 and switch on the pump override switch on the back panel for at least 30 min before starting calibration.
- Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone for at least 30 min before starting calibration, this allows time for the lamp in the ozone generator to stabilise at 0.1 ppm.

7.1.2 Calibration gases

Aeroqual cannot supply calibration gas cylinders, these must be purchased locally. Aeroqual recommends small size portable gas cylinders be purchased from Calgaz: www.calgaz.com.

Calibration gas is purchased at high concentrations, in a balance of air or nitrogen and then diluted to a lower concentration using a gas dilution calibrator such as the Aeroqual AirCal1000. Other gas dilution systems can also be used.

- Span calibration gas must be delivered to the AQS 1 in a balance of Air.

- Gas cylinders can purchased in a balance of Air or Nitrogen (N₂). Calibration gas will be diluted with air (at least 50 x) using a gas dilution calibrator so the final span gas mixture will always be in a balance of air.
- Aeroqual does not recommend calibrating from a cylinder of mixed gases. Only single gases should be used to calibrate the AQS 1.
- Calibration directly from a gas cylinder without dilution is not recommended (except for VOC calibrations using Isobutylene).
- Ozone is calibrated using an ozone calibrator (Ozone cannot be purchased in a cylinder).

AQS 1 Gas Module	Gas used for calibration	Gas module measurement range	Recommended span gas concentration for calibration	Recommended cylinder concentration (AirCal1000 or AirCal8000)
O₃	O ₃	0-500 ppb	100 ppb	Ozone is delivered by an ozone generator
NO₂	NO ₂	0-500 ppb	200 ppb	20 ppm
CO	CO	0-25 ppm	10 ppm	1000ppm
VOC (Low)	Isobutylene C ₄ H ₈	0-500 ppb	200 ppb	20 ppm
VOC (High)	Isobutylene C ₄ H ₈	0-30 ppm	20 ppm	2000 ppm
H₂S	H ₂ S	0-10,000 ppb	500 ppb	50 ppm
SO₂	SO ₂	0-10,000 ppb	500 ppb	50 ppb
CH₄	CH ₄	0-100 ppm	20 ppm	2000 ppm

Table 7-1 Recommended gas cylinder concentrations.

A two-stage pressure regulator is required for use with these gas cylinders. Aeroqual can supply the regulator (Part Number **AIC GASREG01**) for use with C10 fitting. The Aeroqual regulator is shown attached to the Calgaz cylinder in Figure7-1.

7.1.3 Flow meters for gas flow measurement

It is important to have a high-quality flow meter for the gas flow measurement.

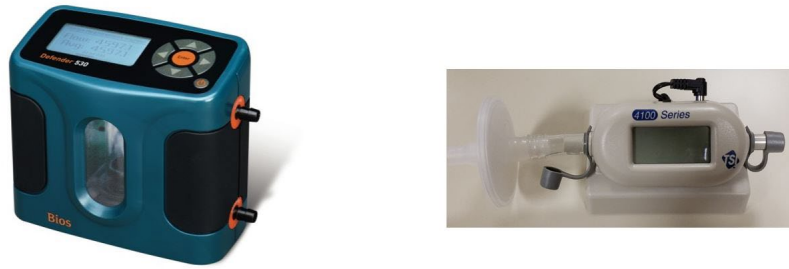


Figure 7-2 Bios Dry Cal and AQS R8 HS high specification flow meters.

7.1.4 Gas module field calibration frequency

Typically, only advanced users will need to field calibrate their monitor. All other users can depend upon 12 monthly factory calibration of the gas module.

For some monitoring applications such as compliance monitoring the calibration frequency may be regulated. Some monitoring applications may require periodical validation of the data and field calibration is the best way to achieve this.

Field calibration frequency is a balance between cost and data quality objectives. Field calibration will incur cost of time and materials. Therefore, more frequent calibration costs more because it requires more time and materials.

At the high-cost end of the spectrum are national ambient monitoring networks. The US EPA Quality Assurance Handbook is a good example of how prescriptive calibration requirements for such applications can be.

Aeroqual makes the following recommendations about calibration frequency for the monitor:

- Follow all local regulatory calibration requirements if these are defined for the monitoring activity.
- Plan routine calibrations at an interval that is consistent with the data quality objectives for your monitoring purpose.
- Field calibration may be necessary if the gas module is operating out of specification and all other trouble-shooting steps have been taken.

Record your observations and calibration results in the calibration records.

The service and calibration forms at the end of this document in Appendix 5 are used with this procedure, information arising from the calibration should be entered into the appropriate sections of the forms.

The Journal feature in Connect/Cloud can also be used to record observations and make comments throughout the calibration process.

Assumptions

This SOP assumes the monitor and calibration equipment are in good working condition and the monitor is “ready for calibration”.

- The monitor has been running for at least 6 hours.
- The gas lines and inlet filter are clean.
- You are familiar with the operation of all the calibration equipment.
- All calibration equipment, such as calibrators and gas bottles are working and within calibration where necessary.

You will need to know:

- The total flow rate measured last time the monitor was serviced. Record this in Table 5.
- The individual gas module flow rates last time the monitor was serviced. Record this in Table 6.

- The current gain and offset for each module. See Figure 3. Record these in Tables 7 and 8 in the Calibration form in Appendix 5.

You will need to bring:

- Gas inlet filters
- Gas dilution calibrator / Zero air generator (combined or separate ozone generator)
- Gas cylinders with suitable gas concentrations
- Flow meter: Aeroqual R7

Before you begin

NOTE: Both the AirCal 1000 and the Ozone calibrator take time to warm up and become stable.

- Turn on the AirCal 1000 and switch on the pump override switch on the back panel for at least 30 min before starting the calibration.
- Turn on the Ozone generator and set it to deliver 0.1 ppm Ozone for at least 30 min before starting the calibration, this allows time for the lamp in the ozone generator to stabilise at 0.1 ppm.

The Calibration screen in the Calibration and Service Page in the Aeroqual software is where you will perform the calibration and change any monitor settings.

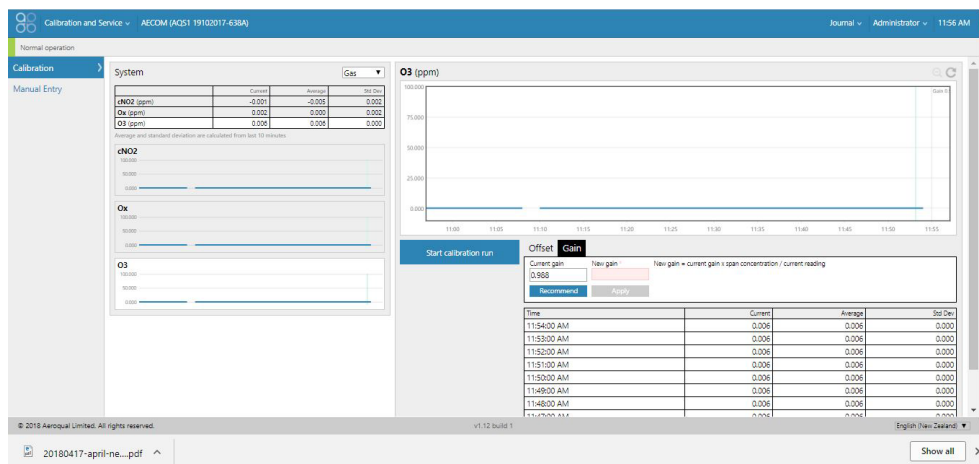


Figure 7-3 The main calibration screen is where the average and standard deviation can be read. This is also where the gain and offset can be read and set.

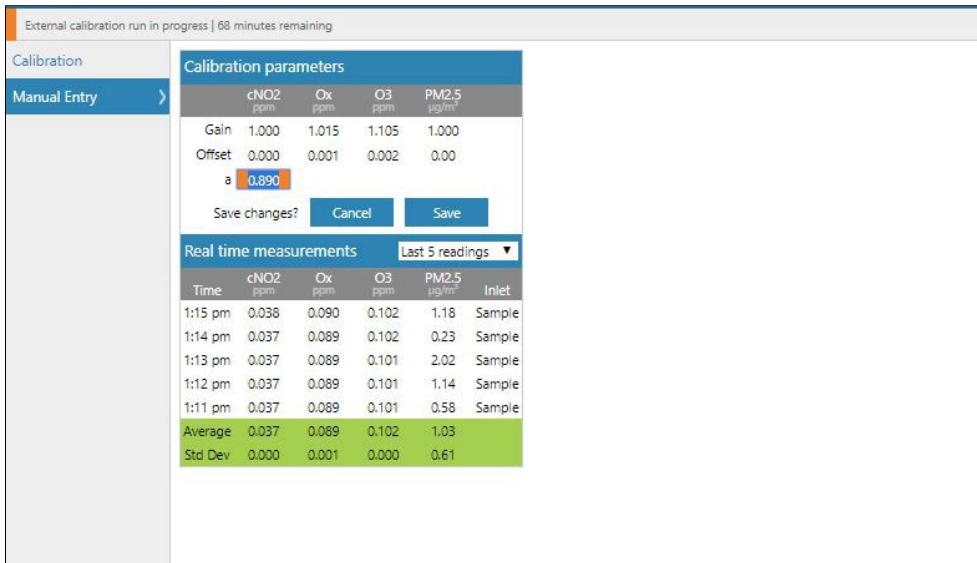


Figure 7-4 The Manual Entry section of the Calibration and Service Page is where the gain and offset and the a value on the NO2 module is set.

NOTE: The connection to the monitor inlet differs depending on whether you are using the AirCal 1000 or the Ozone calibrator. See images below for how the connections differ.

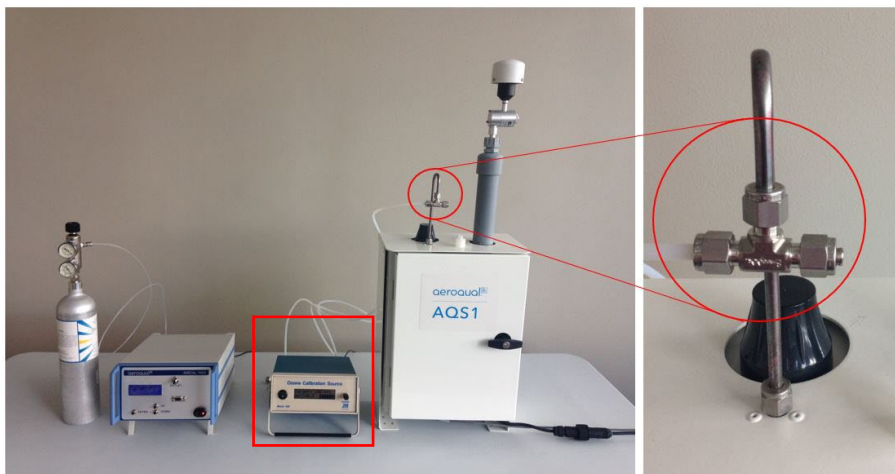


Figure 7-5 When using the Ozone calibrator, make sure the tee fitting is capped.

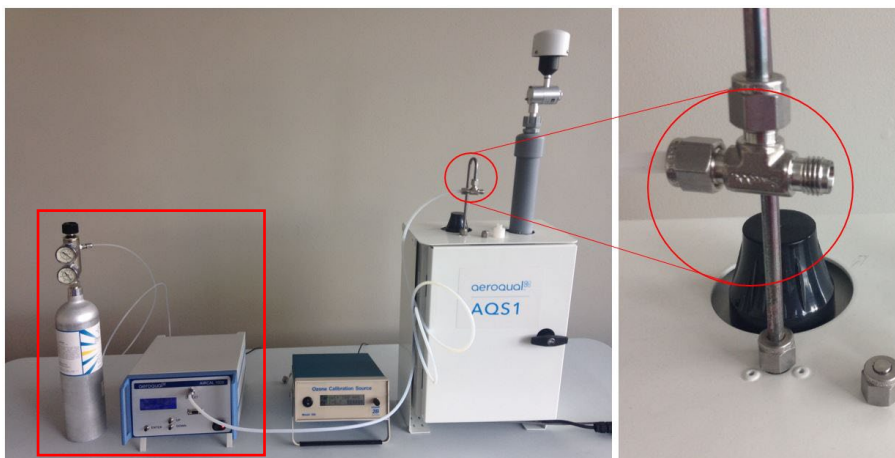


Figure 7-6 When using the AirCal 1000 make sure the tee is un-capped.

7.1.5 Calibration pre-checks:

You will need to record a range of details as part of the calibration process. Use the Calibration Record document in Section 12.2.

The record capture tables are listed below:

Table	Details to record
1	Monitor, customer, and calibration technician details
2	Calibration equipment used
3	Calibration gas details
4	Changes to the local surroundings which may have an impact on the measurements
5	Monitor pre check results

Before you open the door

Monitor pre-checks

- 5.1. Put the monitor into Service Mode.
- 5.2. Check that the gas inlet is secure, if yes pass
- 5.3. Check that the particle inlet is secure, if yes pass
- 5.4. Check that door locks are operational, if yes pass
- 5.5. Measure and record the gas inlet flow rate
- 5.6. Record the previously measured flow rate, this value should be recorded in the monitor journal.
- 5.7. Replace the inlet filters

Open the door

NOTE: To keep the sensor readings stable, minimise the time the door is open.

- 5.8. Replace the inlet filters
- 5.9. Measure and record the inlet flow rate again after changing the filter.
 - If the inlet flow has changed compared to step 5.6, (but less than $\pm 20\%$) since last time it was measured then check the gas connections for obvious leaks, then use the flow adjustment valve to correct the flow.
 - If adjustment was unsuccessful then go to Step 6.
 - If the inlet flow has changed (more than $\pm 20\%$) since last time it was measured (step 5.6) then go to Step 6.

Close the door

- 5.10. Record the final total flow.

7.1.6 Check and adjust module flow rates

Table	Details to record
6	Monitor, customer, and calibration technician details

NOTE: *It is important to have a high-quality flow meter to perform these flow checks. See Section 6.1.1.*

Flow checks in this section are performed separately for each module. One or more modules can fail the flow check, but others can pass. Calibration can continue on modules that pass, modules that fail can be removed and checked without affecting the calibration on the remaining modules.

- 6.1. Check all the individual gas connections for any obvious leaks.
- 6.2. If a leak is found then correct it, go back to Step 5.9.
 - Perform a leak check on the sampling manifold.
- 6.3. If a leak is found then correct it, go back to Step 5.9.
 - Measure the individual flow rates, then add up the flows to equal total module flow. Record the sum of the flows in the last column.
- 6.4. For each module, if the flow rate measured now equals the previously measured flow rate ($\pm 20\%$ LPM) then pass for that module, otherwise fail for that module.
- 6.5. If no specific module is causing a problem and all module flow rates are low, then go to 6.4 otherwise go to 6.6.
 - Adjust the flow rate using the bypass valve, circle yes if valve adjusted
 - Re-measure and record module flow rates for each module.
- 6.6. If the flow rate measured now equals the previously measured flow rate, then pass. Go to zero calibration.
- 6.7. For those modules which do not have the correct flow rate and cannot be corrected with the bypass valve then perform a leak check or check for blockages.
- 6.8. If the problem can be corrected then correct it, otherwise replace the module. Go to zero calibration.
- 6.9. If the problem cannot be resolved, then remove the module and cap off the gas connections. Record fail in the calibration report. Go to zero calibration.

NOTE: *The total flow rate will be reduced because of the module which has been removed.*

7.1.7 Zero Calibration

Table	Details to record
7	Zero calibration results

Zero calibration is performed simultaneously on all gas modules. One or more gas modules may fail a criterion for calibration and others can pass completely. It is acceptable to fail a module but continue with the zero calibration on the remaining modules, and to continue with a span calibration on those modules which passed their zero calibration.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, then the door to the monitor can be opened and the failed modules can be removed for inspection.

Use the AirCal 1000 to deliver zero air, connect the monitor to the AirCal 1000 with the tee open as shown in Figure 5-6.

- 7.1. Record the current offsets in Table 7, column 7.1.1. Start the zero air flowing. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 5-6 with the tee open. Wait for the module to stabilise. This means the standard deviation is within the acceptable range listed in Table 7. Column 7.2.3 I.
- 7.2. If the values have not stabilised, then write fail in the last column in Table 7 column 7.2.7 for this module. Move on to next module and go back to Step 7.2.1.
- 7.3. Record the stabilised reading in Table 7, column 7.2.3 from the 10-minute average.
- 7.4. If the values are within the accepted range, listed in Table 7 column 7.2.3 (b) then no offset adjustment is required, write pass in column 7.2.7. Move on to next module and go to Step 7.2.1.
- 7.5. If the stabilised value is outside the acceptable range then an offset adjustment is required. Calculate and record the new offset using Equation 4.

New offset = Current offset + (AQS gas reading / Gain)

- You can use the calibration page “Recommend” button (Figure 7-3), this will perform the calculation, but you must accept this offset by pushing the “Apply” button, this will upload the new offset.
- 7.6. If the new calculated offset is within the acceptable range listed in Table 7 column 7.2.4 (b) then upload the new offset.
 - If the required offset is outside the recommend limits listed in Table 7 do not upload the offset, write **fail** in column 7.2.7. Move on to next module and **go back to Step 7.2.1**.
 - 7.7. After 2 or 3 minutes record the readings after the new offset has been uploaded. Confirm the readings are within acceptable limits.
 - If yes then **pass**, if not then **fail**. Move on to next module and **go to Step 7.2.1**.

7.1.8 Span Calibration

Table	Details to record
8	Span calibration results

Span Calibration is performed separately in sequence for each gas module. Span calibration should only be performed on modules that have been successfully Zero calibrated.

It is recommended to leave any failed modules running in the monitor throughout the zero and span calibration process. After the calibration is complete on the remaining modules, then the door to the monitor can be opened and the failed modules can be removed for inspection.

- 8.1. Start here for each module. Once all modules have been span calibrated go to Step 9.

Record all initial gains in Table 8 Column 8.1.1

- 8.2. Start the calibration gas flowing at your chosen span point. Make sure there is excess flow out from the tee at the monitor inlet as shown in Figure 7 5.

8.3. Record the span gas concentration. In Table 8 column 8.1.3.

8.4. Wait for the module values to stabilise to the span gas, this means the readings are within the acceptable noise limits listed in Table 8 Column 8.1.5 (c).

- If the values have not stabilised, then write fail in the column 8.1.10. Move on to next module and go to Step 8.1.1.
- If the values are stable and within the accepted range listed in Table 8 Column 8.1.5 (b) then write pass in column 8.1.10. Move on to next module and go to Step 8.1.1.

8.5. If the values are stable but outside the acceptable range listed in Table 8 Column 8.1.5 (b) then a new gain must be calculated and applied.

$$\text{New Gain} = \text{Current Gain} \times (\text{Span concentration} / \text{Gas reading})$$

- You can use the calibration page “Recommend” button (Figure 7 3), this will perform the gain calculation, but you must accept this gain by pushing the “Apply” button, this will upload the new gain.

NOTE: *The calibration page restricts the gain between 0.2 and 5.0. The manual entry screen will allow the gain to be set outside these limits.*

8.6. Calculate and record the ratio of the gain change by using Equation 6. Record the ratio in Table 8, column 8.1.7.

$$\text{Gain Change Ratio} = \text{New Gain} / \text{Current Gain}$$

8.7. If the calculated gain is within acceptable limits listed in Table 8 Column 8.1.5 (d), upload the new gain.

8.8. Confirm the readings are within acceptable limits.

- If yes then write **pass** in column 8.1.10, if not then write **fail**. Move on to next module and **go to Step 8.1.1**.

8.9. Deliver zero air for 10 minutes to purge the gas lines.

NOTE: *Change the gas connection from the AirCal 1000 over to the Ozone calibrator. Make sure to cap the end of the tee as shown in Figure 7-5.*

8.10. Deliver ozone from the ozone calibrator at your chosen span point, Aeroqual recommends 0.1 ppm, make sure the tee is closed using the cap as shown in Figure 7-5.

NOTE: *It takes a while for the ozone delivery to stabilise at the chosen span point, you should have previously set the output of the ozone generator to your chosen span point and left the generator running at this span point for at least 30 min, to allow the output to stabilise.*

8.11. Record the ozone span concentration in Table 8 Column 8.1.3.

8.12. Wait for the O₃ values to stabilise towards O₃ calibration gas, as described in Table 8 Column 8.1.5 (c) If the values have not stabilised then write **fail** in the last column.

8.13. Record the stabilised **O₃ values** in Table 8 Column 8.1.5 from the 10-minute average. If the values are stable and within the accepted range listed in Table 8 column 8.1.5 (b),

then no gain change is required, then write **pass** in column 8.1.10.

8.14. If the values are stable but outside the acceptable range Calculate and record new O₃ gain using Equation 5.

New Gain = Current Gain x (Span concentration / Gas reading)

- You can use the calibration page “Recommend” button (Figure 7-3), this will perform the gain calculation, but you must accept this gain by pushing the “Apply” button, this will upload the new gain.

8.15. Turn off the Ozone gas and return the monitor sampling zero air from the AirCal 1000.

NOTE: *Change the gas connection from the Ozone calibrator over to the AirCal 1000 calibrator. Make sure to remove the cap from the end of the tee as shown in Figure 7-6.*

8.16. If your monitor contains a PID gas module, repeat steps 8.1.2 to 8.1.10 for PID.

7.1.9 Post-calibration checks

Table	Details to record
9	Post-calibration checks

Follow these post-calibration checks and record the results in Table 9 from the Calibration form in Appendix 5.

- 9.1 Disconnect calibration equipment
- 9.2 Record the inlet flow rate
- 9.3 Replace the mesh inlet and cap
- 9.4 Lock door
- 9.5 Secure the site
- 9.6 Take monitor out of service mode and record the time in the form.

7.2 Particulate Module Calibration

Field calibration of your particulate monitor is recommended to achieve the maximum data quality from the instrument.

A calibration against a reference instrument can be undertaken when your Aeroqual monitor is first installed. This ensures readings from the Aeroqual monitor are adjusted for the local particle type, color, and morphology, which can all affect the monitor's readings when compared to the factory calibration.

The adjustment or correction taken after comparing the data from two monitors is commonly known as a 'K-factor'. The procedure for generating a K-factor involves co-locating the Aeroqual monitor next to a reference monitoring instrument.

7.2.1 Factory servicing and calibration

Factory servicing includes cleaning and calibration of the particulate modules. The modules can be removed from the monitor and returned to the factory or an Aeroqual authorised service agent. All Aeroqual Modules need to be returned to the factory or an Aeroqual authorised service agent for service and calibration every 12 months, for Nephelometers, or 24 months for Profilers and PCX.

NOTE: *Field calibration is not a substitute for the specified factory service intervals above. Factory servicing is essential maintenance and check the 'health' of the internal components.*

7.2.2 Field calibration by co-location

In order to perform a field calibration, your Aeroqual monitor must be located at the same site as a **Reference** PM monitor. This is called '**Co-location**' and is widely performed in ambient air quality monitoring to assess the performance of a new monitor. The two monitors are operated for a given period, and their data are compared. An adjustment factor, called '**K Factor**' is then calculated, and applied to the Aeroqual monitor **Gain**. This corrects the data to the known reference monitor.

Field calibration is only as good as the reference data which is used. Using poor quality reference data for calibration will result in poor quality PM data from your Aeroqual monitor. Aeroqual recommends that calibration only be carried out using high quality Reference PM Data.

Important considerations for field calibration:

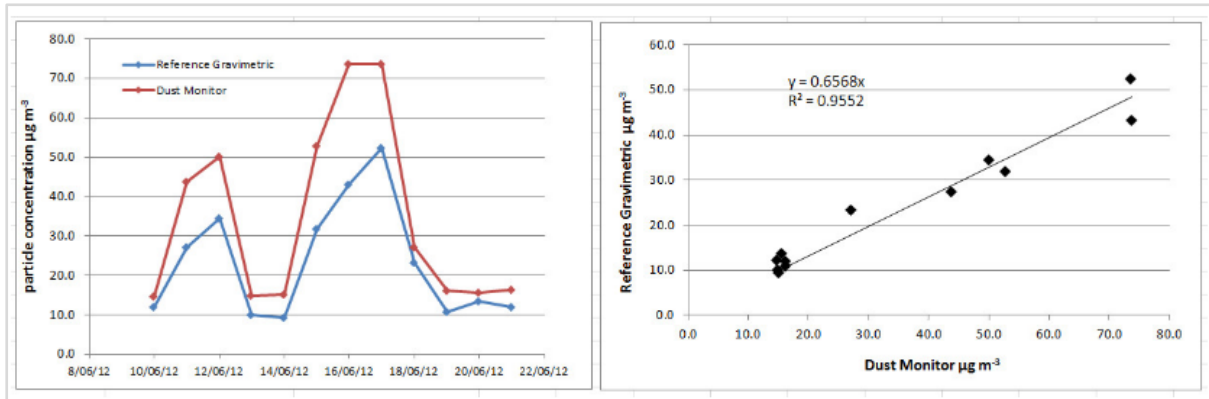
- Location of monitor: The Aeroqual monitor and the Reference monitor need to be located at the same site preferably with their inlets within 10 m of each other and must be sampling at the same height. At reference sites using a monitoring shed, on the rooftop of the shed is usually the best location.
- Monitor set up: Both the Aeroqual monitor and the reference monitor need to be set up in accordance with the manufacturer's recommendations, with correctly set flow rates and fresh filters. If you are using a gravimetric method reference monitor, you must follow appropriate filter conditioning and weighing methods. Perform a zero check on the Aeroqual monitor before starting the co-location calibration.
- Duration of colocation: As a rule, longer is better, as this will give you more data points and therefore more confidence in your field calibration. It's important that the colocation is carried out during the same environmental conditions expected during deployment. 1-2 weeks is preferred and no shorter than 48 hrs.
- Reference monitor selection: The reference monitor should be operated in accordance with local regulations and manufacturer's instructions.
 - GRIMM / BAM / TEOM: These methods are preferred because they provide hourly data. However, BAM and TEOM data can be noisy at hourly averages, so consider using 24 hr averages if PM levels are low.
 - Partisol / High Volume Samplers: These methods can be used but will need to be run for a longer period as they operate on 24 hr averages (i.e. 1 data point per 24 hrs).
 - Non-Reference methods (e.g. Optical, low volume samplers): These methods can be used if their calibration is traceable to a reference method.

7.2.3 Steps to performing a K factor correction

Create a spreadsheet, with 1 column of reference data, and 1 column of Aeroqual data, in the averaging period you have selected, for instance 1 hour or 24 hour averages for the period of your co-location.

Dust Monitor side-by-side calibration data		
10 June to 21 June Monitoring site 1		
Date	Reference Gravimetric, daily mass ug m-3	Aeroqual Dust Monitor daily average ug m-3
10/06/12	12.0	14.8
11/06/12	27.2	43.9
12/06/12	34.5	50.1
13/06/12	10.0	14.9
14/06/12	9.3	15.1
15/06/12	31.7	52.8
16/06/12	43.1	73.7
17/06/12	52.3	73.6
18/06/12	23.2	27.2
19/06/12	10.7	16.2
20/06/12	13.5	15.6
21/06/12	11.9	16.3

- Use a plotting program and plot your 2 data sets in an x-y scatter plot. Add a trend line and equation as below.



- The graph to the left below shows the time series of the two monitors. The graph to the right below shows the slope calculation. In this example the Monitor is reading higher than the reference monitor. The slope of the curve Reference vs Dust Monitor is 0.6568. So, a gain of 0.6568 needs to be applied to the monitor.

The Aeroqual monitor will need a new gain, calculated using the formula below:

$$\text{New Gain} = \text{Old Gain} \times K \text{ Factor}$$

$$\text{New Gain} = 1 \times 0.6568 = 0.6568$$

Upload the new gain into the gain parameter in the gain and offset table using the calibration and service app.

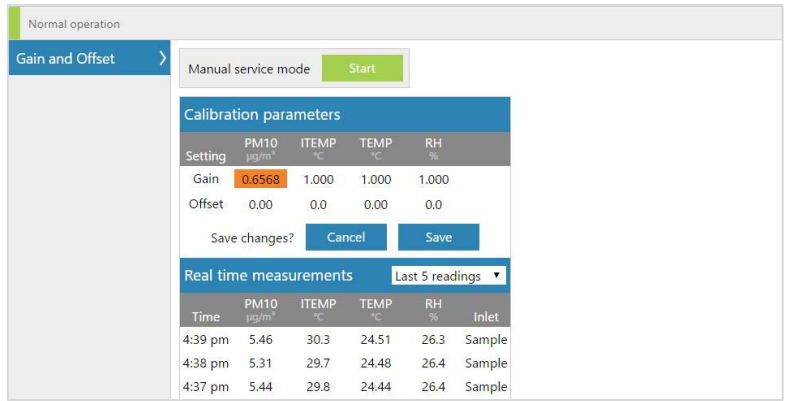



Figure 7-7 Gain adjustment in the calibration screen of Aeroqual Connect.

8 Troubleshooting

The following section provides basic troubleshooting for the monitor. Common problems, and how to solve them are given in Table 8-1

Not all known issues are listed in Table 8-1 especially if not known to Aeroqual when this user guide was written. The Aeroqual training website provides a comprehensive and up to date list of known issues and provides solutions as soon as solutions become available.

	Online reference	https://support.aeroqual.com
---	------------------	---

The Aeroqual technical support team are available to help when required.

	Online reference	support@aeroqual.com
---	------------------	--

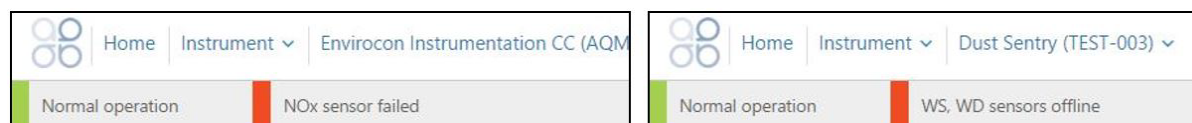
Use manual sync to assist Aeroqual technical support in troubleshooting

When the Aeroqual technical support team are required to help with troubleshooting it is necessary to see a comprehensive dataset from the Dust Sentry or AQS 1. This can easily be achieved if the instrument is online.

If the instrument is not online, use the Manual Sync tool (Section 5.1.4) to upload data to Aeroqual Cloud so the technical support team can provide fast and comprehensive support.

Error conditions reported by Aeroqual Connect and Aeroqual Cloud software

Connect and Cloud software will report two different types of error condition in the banner at the top of the page, these are ‘sensor offline’ and ‘sensor failed’ The error will also be listed in the monitor journal.



Sensor offline

A sensor offline error is usually caused by either a loose power connection or a loose communications connection. Check the module connections are secure. If the power connections and the communications connections are secure, then the issue may be inside the module.

Contact the Aeroqual distributor in your local country for technical support.

Sensor failure

A sensor failure error can occur for different reasons, sometimes this can be related to a sensor parameter exceeding an allowable value.

If you get a ‘sensor failure’ error contact the Aeroqual distributor in your local country for technical support.

Communication errors:

1. Failure to see the WIFI network broadcast by the monitor

If you cannot see the monitor in your list of WIFI networks, it is most likely because the WIFI setting is set to ‘Client Mode’ and is not broadcasting. See section 4.1.

To resolve this, connect to the monitor through the WIFI LAN and then reset the WIFI mode to ‘Access Point’.

Alternatively, the monitor can be reset to factory communication settings by using the USB reset procedure. See section 4.4.

2. Error 500 Database error

An error is known to occur with the internal database which causes the following error report when trying to connect to the monitor. This may be able to be resolved over a remote connection. Or a component in the embedded PC will need to be replaced.

Application Exception

System.Exception

Unable to connect to database!

Description: HTTP 500.Error processing request.

Details: Non-web exception. Exception origin (name of application or object): AeroqualProviders.

Exception stack trace:

```

at Aeroqual.Providers.DataProvider.InitDatabase
(System.String connectionString) [0x000000] in <filename unknown>:0
at Aeroqual.Providers.DataProvider.set_ConnectionString (System.String
value) [0x000000] in <filename unknown>:0
at AeroqualCloud.WebApiApplication.Application_Start () [0x000000] in
<filename unknown>:9
at (wrapper managed-to-native)
System.Reflection.MonoMethod:InternalInvoke
(System.Reflection.MonoMethod,object,object[],System.Exception&)
at System.Reflection.MonoMethod.Invoke (System.Object obj,
BindingFlags invokeAttr, System.Reflection.Binder binder,
System.Object[] parameters, System.Globalization.CultureInfo culture)
[0x000000] in <filename unknown>:0
    
```

If this error occurs contact the Aeroqual distributor in your local country for technical support.

Symptom	Possible Cause	Fault Isolation / Solution	Reference
Gas module Troubleshooting			
Negative readings	Flow leak or incorrect flow		Section 6.5.3
	Dirty inlet gas filter	Change filter	Section 6.4.3
	Incorrect zero calibration	Perform zero calibration	Section 2
Gas readings noisy or unstable	Flow leak or incorrect flow		Section Error! Reference source not found.
	Module is aging	Replace module	Section 6.5.8
Gas readings significantly different than expected	Incorrect gain or offset applied	Check the correct gain has been applied correctly	Section 7.2
	Incorrect calibration performed	Incorrect gas cylinder used, or gain calculated incorrectly	Redo calibration or identify error and correct it
Particle Module Troubleshooting			
PM _{2.5} > PM ₁₀	Incorrect gain applied	Check gain on module	Section 6
	Leak in flow system	Check for leaks	Section 6.4.5
Negative numbers	Auto zero calibration failing	Check baseline calibration of mass channels	Section 6.3.7
Readings lower than expected	Dirty optics	Have module serviced	Section 7.2.1
	Failed laser	Have module serviced	Section 7.2.1
	Dirty sample filters	Change filter	Section 6.4.3

Table 8-1 Common troubleshooting tasks and how to solve them.

9 Copyright

Copyright Aeroqual Limited. All rights reserved. Reproduction, transfer, distribution or storage of part or all of the contents of this document in any form without the prior written permission of Aeroqual Limited is prohibited.

“Aeroqual” is a registered trademark of Aeroqual Limited. Other product and company names mentioned herein may also be trademarks or trade names.

Aeroqual operates a policy of continuous development. Aeroqual reserves the right to make changes and improvements to any of the products described in this document without prior notice.

Under no circumstances shall Aeroqual be responsible for any loss of data or income or any special, incidental, consequential or indirect damages howsoever caused.

The contents of this document are provided "as is". Except as required by applicable law, no warranties of any kind, either express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose, are made in relation to the accuracy, reliability or contents of this document.

Aeroqual reserves the right to revise this document or withdraw it at any time without prior notice. The availability of particular products may vary by region. Please check with the Aeroqual distributor nearest to you.

10 Compliance

1. The Aeroqual AQS 1 complies with the following standards:

EN 61000-6-1:2001

EN 61000-6-3:2001

Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) these devices may not cause harmful interference, and (2) these devices must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult your Aeroqual distributor or an experienced radio/TV technician for help.



11 Warranty

The monitor warranty policy can be found on the main company website: www.aeroqual.com/support/warranty

12 Appendix

12.1 Mains wiring color guide



Caution: The high voltage mains supply must be wired by a certified electrician in compliance with local electrical regulations.

The following table is only intended as a reminder, always check your local guidelines.

Wire	US AC power circuit wiring color codes	UK AC power circuit wiring color codes	IEC (most of Europe) AC power circuit wiring color codes
Live / Phase	Black or Red	Brown or Red	Brown or Black
Neutral	White or Grey	Blue or Black	Blue
Earth / Ground	Green or Green-yellow	Green-yellow	Green-yellow

12.2 Calibration Records

The following records should be used in conjunction with this user guide.

Table 1: Calibration details	
Date Time	
Serial number	
Date of previous calibration	
Customer name	
Site name	
Engineer name	

Table 2: Equipment details		
Equipment	Brand / Model number	Serial number
Gas dilution calibrator:		
Ozone generator		
Zero air source		
Flow meter		
Gas Regulator 1		
Gas Regulator 2		

Table 3: Gas cylinder details					
#	Gas Type	Gas Balance	Manufacturer	Expiry date	Cylinder pressure
1	NO ₂	Air N ₂			
2	Isobutylene	Air N ₂			
3					
4					
5					

Table 4: Site inspection

Check the local surroundings to see if anything has changed which could influence the ongoing ambient gas measurements.

Observations**Table 5: Monitor pre-checks****Before opening the door**

ID	SOP description	Observation / reading	Pass / Fail / Done
5.1	Put monitor into service mode		
5.2	Gas inlet secure		
5.3	Particle inlet secure		
5.4	Door locks are operational		
5.5	Record the flow rate (before opening door)		
5.6	Previously measured flow rate		

After opening the door

5.7	Replace the inlet filters		
5.8	Measure flow rate again		
5.9	Go to section 6 <u>if required</u> then record final inlet flow rate here		

Table 6: Individual module flow rates, leak check manifold and bypass valve

6.1	Check all gas connections	Pass / Fail			
6.2	Leak check sampling manifold	Pass / Fail			
6.5	Flow Rate	NO₂	O₃	PID	Total module flow
	Flow rate last measured				
	Flow rate measured now				
	If flow rate is the same then pass , if changed then fail	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
6.6	Adjust bypass valve	If all the modules show reduced flow and there is no leak, then the adjustment bypass valve can be used.		Yes / No	
6.7	Flow rate measured following adjustment				
	If flow rate is the same as Section 6.3 then pass , if changed then fail .	Pass / Fail	Pass / Fail	Pass / Fail	Pass / Fail
	What was the reason for the change in flow rate?				

Table 7: Zero calibration results

Module	Current offset From monitor settings	Reading after stabilisation 10-minute average	Acceptable reading during zero calibration (ppm) 10 min average	Acceptable standard deviation during zero calibration (10-minute average)	New Calculated offset1	Minimum and Maximum recommended offset (ppm)	Offset uploaded	Reading after offset changed	Pass / Fail
	7.1.1	7.2.3	7.2.3 (b)	7.2.3 (c)	7.2.4	7.2.4 (b)	7.2.5	7.2.6	7.2.7
NO ₂			0.0 0.005	0.002		Max +0.050 Min -0.050			
O ₃			0.0 0.005	0.002		Max +0.050 Min -0.050			
PID			0.0 0.002	0.002		Max +0.05 Min -0.05			
Comments:									

Equation 4: New offset = Current offset + (AQS gas reading / Gain)

Module	Initial gain	Span point	Reading after stabilisation 10-minute average	Acceptable range during span calibration (ppm) 10-minute average	Maximum acceptable noise during span calibration 10 min std deviation	Maximum Minimum recommended gain	New gain ⁵	New a value ³	Ratio of gain change New gain / Initial gain	Gain uploaded	Reading after gain changed	Pass / Fail
	8.1.1	8.1.3	8.1.5	8.1.5 (b)	8.1.5 (c)	8.1.5 (d)	8.1.6	8.1.6 (b)	8.1.7	8.1.8	8.1.9	8.1.10
NO ₂				span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
O ₃				span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				
PID				span ± 5 %	2 % of span	max 5.000 min 0.2		N/A				

Table 9: Calibration Post-checks			
ID	Description	Observation / reading	Pass / Fail / Done
9.1	Disconnect calibration equipment		
9.2	Record total inlet flow rate		
9.3	Replace the mesh inlet and cap		
9.4	Lock door		
9.5	Secure the site		
9.6	Service mode		

About Aeroqual

Every day, environmental professionals around the world are working hard to protect people and planet from the impact of air pollution. Since 2001 Aeroqual has equipped environmental professionals with technology that takes the time and hassle out of air quality monitoring projects. Government, industry, researchers and environmental consultants trust us to deliver actionable data built on industry-leading sensor technology, wirelessly connected to software in a single integrated package. With thousands of successful projects delivered in 70 different countries on all seven continents, our systems process more than six million air quality measurements per day. In 2017 the U.S. Environmental Protection Agency signed a 5-year R&D collaboration agreement with us to accelerate understanding of air sensor technology. In 2022 the agreement was extended for another 5 years with a focus on next generation emissions monitoring.

Just a handful of customers who chose Aeroqual



Aeroqual Limited

460 Rosebank Road, Avondale, Auckland 1026, New Zealand

T: +64 9 623 3013 | e: sales@aeroqual.com

aeroqual.com

100