USER MANUAL

Aurora NE Series

Multi Wavelength Nephelometers

Version: 1.3

acoem

acoem.com

This page is intentionally blank

Table of Contents

List of Figures

List of Tables

List of Appendices

Manufacturer's Statement

Thank you for selecting the Acoem Australasia Aurora NE Series Multi Wavelength Nephelometers.

The Aurora NE series is the next generation of Acoem Australasia designed and manufactured nephelometers. The Aurora NE Series will perform Multi Wavelength Nephelometers measurements over a range of 0 - 20,000 Mm^{-1} with a low detection limit.

This User Manual provides a complete product description including operating instructions, calibration, and maintenance requirements for the Aurora NE-100 Single Wavelength Nephelometer. The Aurora NE-300 Multi Wavelength Nephelometer, and the Aurora NE-400 Multi Wavelength Polar Nephelometer.

Reference should also be made to the relevant local standards which should be used in conjunction with this manual. Some of these standards are listed in this manual.

If, after reading this manual you have any questions or you are still unsure or unclear on any part of the Aurora NE Series, please do not hesitate to contact Acoem Australasia or your local Acoem Australasia distributor.

Please help the environment and recycle the pages of this manual when you have finished using it.

Notice

The information contained in this manual is subject to change without notice. Acoem Australasia reserves the right to make changes to equipment construction, design, specifications and/or procedures without notification.

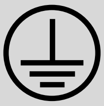
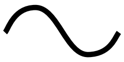
Ecotech Pty. Ltd. has changed its trading name to Acoem Australasia.

Safety Information

Read all the safety information in this section prior to using the equipment. To reduce the risk of personal injury caused by potential hazards, follow all safety notices and warnings in this documentation.

The following internationally recognised symbols are used on Acoem Australasia equipment:

Table 1 – Internationally Recognised Symbols

	Protective conductor terminal	IEC 60417-5019
	Alternating current	IEC 60417-5032
	Caution, hot surface	IEC 60417-5041
	Caution, risk of danger to user and/or equipment Refer to any accompanying documents	ISO 7000-0434
	Caution, risk of electric shock	ISO 3864-5036

These symbols will also be found throughout this manual to indicate relevant safety messages.

Note: Notes are used throughout this manual to indicate additional information regarding a particular part or process.

If the equipment is used for purposes not specified by Acoem Australasia, the protection provided by this equipment may be impaired.

Important Safety Messages

Disconnect Power Prior to Service

Hazardous voltages exist within the instrument. Do not remove or modify any of the internal components or electrical connections whilst the mains power is ON.

Always unplug the equipment prior to removing or replacing any components.

Replacing Parts

Replacement of any part should only be carried out by qualified personnel, using only parts specified by Acoem Australasia, as these parts meet stringent Acoem Australasia quality.

Mains Supply Cord

Do not replace the detachable mains supply cord with an inadequately rated cord. Any mains supply cord that is used with the instrument must comply with the safety requirements (250 V/10 A minimum requirement). A mains power cord with a protective earth conductor must be used.

Ensure that the mains supply cord is maintained in a safe working condition.

Do Not Expose Equipment to Flammable Gases

This equipment is not intended for use in explosive environments, or conditions where flammable gases are present. The user should not expose the equipment to these conditions. Do not introduce any flammable gases into the instrument, otherwise serious accidents such as explosion or fire may result.

Electromagnetic Compliance

The instrument lid should be closed when in normal operation, to comply with EMC regulations.

Means of Lifting/Carrying Instrument

This instrument is a heavy and bulky object. Two persons should lift/carry the object, otherwise use proper lifting equipment. Proper lifting techniques should be used when moving the instrument.

Internal Components

Do not insert a rod or finger into the cooling fans, otherwise injury may result.

Do not energise the instrument until all conductive cleaning liquids, used on internal components, are dried up.

Warranty

This product has been manufactured in an ISO 9001 facility with care and attention to quality.

The product is subject to a 24-month warranty on parts and labour from the date of shipment. The warranty period commences when the product is shipped from the factory. Filters and other consumable items are not covered by this warranty.

Each instrument is subjected to a vigorous testing procedure prior to despatch and will be accompanied with test sheet that contains the results from all the tests perform. This instrument is shipped fully calibrated , thereby enabling the instrument to be installed and ready for use without any further testing on site.

Service & Repairs

Our qualified and experienced technicians are available to provide fast and friendly service between the hours of 8:30 am - 5:00 pm AEST Monday to Friday. Please contact either your local distributor or Acoem Australasia regarding any questions you have about your instrument.

Service Guidelines

This manual is designed to provide the necessary information for the setup, operation, testing, maintenance and troubleshooting of your instrument.

Should you still require support after consulting the documentation, we encourage you to contact your local distributor for support.

To contact Acoem Australasia directly, please e-mail our Technical Support Specialist group at support.au@acoem.com or to speak with someone directly:

Please dial 1300 364 946 if calling from within Australia.

Please dial +61 3 9730 7800 if calling from outside of Australia.

Please contact Acoem Australasia and obtain a Return Material Authorisation (RMA) number before sending any equipment back to the factory. This allows us to track and schedule service work and to expedite customer service. Please include this RMA number when you return the equipment, preferably both inside and outside the shipping packaging. This will ensure you receive prompt service.

When shipping instrumentation, please also include the following information:

- Name and phone number
- Company name
- Shipping address
- Quantity of items being returned
- Model number/s or a description of each item
- Serial number/s of each item (if applicable)
- A description of the problem and any fault-finding completed
- Original sales order or invoice number related to the equipment

Shipping Address:

Attention Service Department

Acoem Australasia

1492 Ferntree Gully Road,

Knoxfield, VIC Australia 3180

Product Compliance and Approvals

The Aurora NE Series Multi Wavelength Nephelometers, as manufactured by Acoem Australasia, complies with the essential requirements of the directives listed below (including CE compliance). The respective standards have been applied:

Low Voltage Directive (LVD) Directive 2014/35/EU

EN 61010-1:2010	Safety requirements for electrical equipment, for measurement, control and laboratory use - General requirements

Electromagnetic Compatibility (EMC) Directive 2014/30/EU

EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use - EMC requirements - General requirements

Radio Equipment Directive (RED) 2014/53/EU

EN 300 328 V2.1.1	Wideband transmission systems - Data transmission equipment operating in the 2.4 GHz ISM band and using wide band modulation techniques

Regulatory Compliance Mark (RCM) - Australia

AS/NZS 4268:2017	Radio equipment and systems - Short range devices - Limits and methods of measurement
ARPANSA **Radiation Protection Standard**	Maximum Exposure Levels to Radiofrequency Fields - 3 kHz to 300 GHz - Radiation Protection Series Publication No. 3: 2002

This integrating Nephelometer is also certified to a number of measurement standards - refer to Section 1.2.6.

Manual Revision History

Manual PN: M010068

Current revision: 1.3

Date released: 10 October 2024

Description: User Manual for the Aurora NE Series Multi Wavelength Nephelometers

This manual is the full user manual for the Aurora NE Series Multi Wavelength Nephelometers. This manual contains all relevant information on theory, specifications, installation, operation, maintenance and calibration. Any information that cannot be found within this manual can be obtained by contacting Acoem Australasia.

This manual uses cross reference links extensively throughout this manual. The hot keys below will greatly reduce the amount of time scrolling between references:

- You can access the links by pressing the following:
  - > CTRL + LEFT MOUSE CLICK: Move to the link location

- You can switch between links by pressing the following:
  - > ALT + LEFT ARROW KEY: Returns you to the previous Link
  - > ALT + RIGHT ARROW KEY: Swaps back

Table 2 – Manual Revision History

Edition	Date	Summary
1.1	August 2022	Initial Release for Certification
1.2	December 2022	Public Release
1.3	June 2024	Additional changes for build 300

1. Introduction

1.1 Description

The Aurora NE Series Multi Wavelength Nephelometers will measure, continuously and in real-time, light scattering in a sample of ambient air due to the presence of particulate matter (specifically, the scattering coefficient σ_{sp}). There are three different instrument variations that are used for various applications.

Aurora NE-100: Single Wavelength Nephelometer

While this instrument performs a single wavelength measurement, the light source provides the possibility to select one of three different wavelengths without having to change the light source.

This is ideal for fast and accurate measurements of full scattering where the target wavelength may be selected for:

- 450nm (Blue): Fine and ultra fine particulates (wood fires, automobiles, etc.)
- 525nm (Green): Visibility
- 635nm (Red): Large particulates (e.g. pollen, sea salt). (Note: for 635nm the Wide Bandwidth PMT option is required.)

Aurora NE-300: Three Wavelength Nephelometer with Backscatter-

This instrument measures light scattering simultaneously at three wavelengths (450nm, 525nm & 635nm), as well as backscatter (90° - 173°). Forward scatter can be calculated by subtracting backscatter from fullscatter. The fullscatter and backscatter measurements can be combined to allow for a more in-depth analysis of particle scattering such as:

- Scattering enhancement factor (when used with the ACS 1000)
- Scattering Ångstrom exponent calculations
- Determination of single scattering albedo

Aurora NE-400: Three Wavelength Polar Nephelometer

The polar nephelometer measures light scattering simultaneously at three wavelengths (450nm, 525nm & 635nm). It is unique in that it has a backscatter shutter that can be set to any angle between 5° through to 90° at up to 20 different positions. When the backscatter shutter is positioned at a specific angle the nephelometer measures the light scattering from that angle, through to 173°. Each measurement cycle also includes a full scatter measurement without the backscatter shutter in position.

Example
A scattering angle set to 20° will measure all the scattering from 20° to 173°. A scattering angle at 30° will measure all the scattering from 30° to 173°.

The difference between these two angles gives the light scattering for the polar segment of 20° - 30°.

Common Features

All the Aurora NE Series instruments include an internal sample pump and flow sensor for accurate flow control. Valves for automatic zero and span calibration, as well as for sample bypass are internal. These calibrations and checks are fully automatic when initiated by the user, allowing different intervals and times to be selected.

Temperature, pressure and humidity are monitored in real-time to provide accurate measurements.

All options and configurations are available from an easy-to-use menu system on the 7” color touch screen display. Data can be collected thru multiple formats for ease of analysis.

This section will describe the specifications of the instrument, as well as the main components and techniques used to obtain accurate scattering measurements.

1.2 Specifications

1.2.1 Measurement

Table 3 – Aurora NE Series Measurement Specifications

Specification.	Aurora NE-100	Aurora NE-300	Aurora NE-400
Range	0 to 20,000 Mm^{-1}		
Truncation Angle	7.3° – 172.7°		
Wavelengths	450nm or 525nm or 635nm selectable	450nm, 525nm, 635nm simultaneously	450nm, 525nm, 635nm simultaneously
Selectable Angles	0° only	2 angles. 0° and 90°.	Up to 20 angles. 0° to 90° with minimum 1° increments.
Zero Noise 635nm (0°)	0.05** Mm-1	0.05* Mm-1	0.05* Mm-1
Zero Noise 525nm (0°)	0.05* Mm-1	0.05* Mm-1	0.05* Mm-1
Zero Noise 450nm (0°)	0.05* Mm-1	0.05* Mm-1	0.05* Mm-1
Zero Noise 635nm (90°)	NA	0.05* Mm-1	0.05* Mm-1
Zero Noise 525nm (90°)	NA	0.05* Mm-1	0.05* Mm-1
Zero Noise 450nm (90°)	NA	0.05* Mm-1	0.05* Mm-1
Zero Noise 635nm (10 - 89°)	NA	NA	0.05* Mm-1

Specification.	Aurora NE-100	Aurora NE-300	Aurora NE-400
Zero Noise 525nm (10 - 89°)	NA	NA	0.05* Mm-1
Zero Noise 450nm (10 - 89°)	NA	NA	0.05* Mm-1
Sample flow rate (Internal Pump)	2 to 9 slpm		
Sample flow rate (MFC Option)	NA	2 to 17 slpm	

*** Kalman Filtered Sigma.**

**** Wide bandwidth PMT option Installed only.**

1.2.2 Power Requirements

Operating Voltage

- 100 - 240 VAC (± 10%)
- 50 - 60 Hz (autoranging)
- Overvoltage Category II
- 24 VDC for non-mains operation

Power Consumption

- 120 VA max (typical at start-up), 80 VA after warm-up (NE-300 and NE-400 standard configuration)
- 100 VA max (typical at start-up) 60 VA after warm-up (NE-100 standard configuration)

* Standard configuration is with the sample heater off and flow set to 5 lpm.

1.2.3 Operating Conditions

- Ambient Temperature: -20 to 45 °C (-4 to 113 °F)
- Relative Humidity: 10 to 95% (non-condensing)
- Pollution Degree: 2 (for indoor operation)
- Maximum Altitude1: 2000 m above sea level

Not intended for outdoor use.

1.2.4 Communications

Bi-Directional

[1] For higher altitude contact Acoem Australasia for support/assistance.

- RS232 port #1: Multidrop port used for multiple instrument connections on a single RS232.
- RS232 port #2: Multidrop port used for multiple instrument connections on a single RS232.
- USB port: Type B connection.
- TCP/IP: Ethernet digital communication.

Bluetooth: Future Option (TBA)

Analog Output

- Six menu selectable 16 Bit analog voltage outputs: (0 - 5 VDC).

Analog Input

- Four menu selectable 16 Bit analog voltage inputs (0 - 5 VDC) CAT I rated.

Digital Output

- Four menu selectable digital outputs: Open drain max 500 mA each @ 12 VDC (max total output 2 A).

Digital Input

- Four menu selectable digital inputs (0 - 5 VDC), CAT I rated.

Data Storage

- **USB memory stick:** Optional, Internal, Removable for data logging, event logging, calibration and configuration storage. Also used for firmware updating.
- **Micro SD Card 16 GB**: External, Removable for data logging, event logging, calibration and configuration storage.

1.2.5 Physical Dimensions

Case Dimensions

- Width: 730 mm (29.8")
- Height: 260 mm (10.2 ") plus inlet and vent connections
- Depth: 240 mm (9.5")
- Weight: 14.1 kg

1.2.6 Certifications

TBA

1.3 Nomenclature

Span	When gas of known Rayleigh factor is passed through the instrument and measured as a reference. This is often used to perform a precision check or calibration of the upper range of the instrument.
Zero	When air with no particulate matter is passed through instrument and measured as a reference. This measurement is used to ascertain the effect of air (CO_2, CO etc) on scattering coefficient. This is often used to perform a precision check or calibration of the lower range of the instrument.
Calibration	The process of adjusting the instrument using a reference of span or zero to ensure the correct measurement of light scattering.
Zero Noise	This is the calculated standard deviation of the scattering measurements during a zero process.
σ_{sp}	The scattering of light due to particles. This is the measurement made by the instrument.
LED	Light Emitting Diode. Used as a source of light at a specific wavelength.
LCD	LCD (Liquid Crystal Display) is a type of display module.
Vent	Used as an exhaust path for the calibration gas during span precision checks or calibrations at ambient pressure.
Sample Air	Sample air is defined as the unfiltered sample that enters the instrument to be measured. It is drawn through the system via the sample pump and exhausted out the exhaust port.
Exhaust Air	Exhaust air is the sample air after it has passed through the measurement cell or bypass valves and expelled out of the instrument via the sample pump.
ID and OD	These are measurements of tubing. ID is the internal diameter of the tubing, OD is the outer diameter.
Multidrop	A configuration of multiple instruments connected via the same RS232 cable.
Photomultiplier Tube	A highly sensitive device which can detect extremely low levels of light (photons) and multiply the electrical signal to a point where it can be accurately measured. This is often referred to as a PMT.

Bootloader	A program that checks whether the current firmware is valid, executes the instrument warm-up. The bootloader can be entered from the Factory menu. The bootloader enables various low level recovery tools, including updating the firmware from a USB stick.
PCA	Printed Circuit Assembly. An electronic circuit mounted on a printed circuit board to perform a specific electronic function.
Slpm	Standard litres per minute. This is the flow referenced to standard temperature and pressure conditions. For the purposes of this manual, all flows are referenced to 0 °C and 101.3 kpa (1 atm).
Lpm	Volumetric litres per minute. This is the volumetric flow corrected for ambient temperature and pressure conditions.
Particulate	Natural or anthropogenic matter existing in the atmosphere. Typically, are greater than 1um in diameter.
Aerosol	A suspension of fine solid particles or liquid droplets, in air or another gas. Typically, are less than 1um in diameter.
Widget	An application, or a component of an interface, that enables a user to perform a function or access a service.

1.4 Background/Theory

Nephelometers have been used extensively to measure the light scattering effects of particulates and aerosols in the atmosphere. Airborne particulates are a major contributor to air pollution, which has a large influence on human health and lifestyle.
Light scattering measurements in the wilderness can also be used for the detection of wild fires or the monitoring of visibility.

In the high altitude of the Earth's atmosphere, scattering from Aerosols and cloud build-up influence the sun's penetration of radiation onto the lower parts of the Earth. Radiation that is reflected back into space is caused by back scattering of aerosols and gas molecules, where as radiation that is directed toward the Earth is the result of forward scattering. The presence of water molecules in the atmosphere can also influence the optical properties of aerosols.

Both health and climate change are of a major concern to researchers and governments today.
The ACOEM Aurora NE series of Nephelometers can be used to measure light scattering for all of these important applications.
The dimension of scattering (σ_{sp}) is inverse length. The Aurora NE Series Multi Wavelength Nephelometers reports σ_{sp} in units of the inverse megameter (Mm^{-1}) = 10^{-6} m^{-1} (inverse meters).

1 Mm^{-1} = 10^{-3} km^{-1} (inverse kilometres) = 10^{-6} m^{-1} (inverse metres).

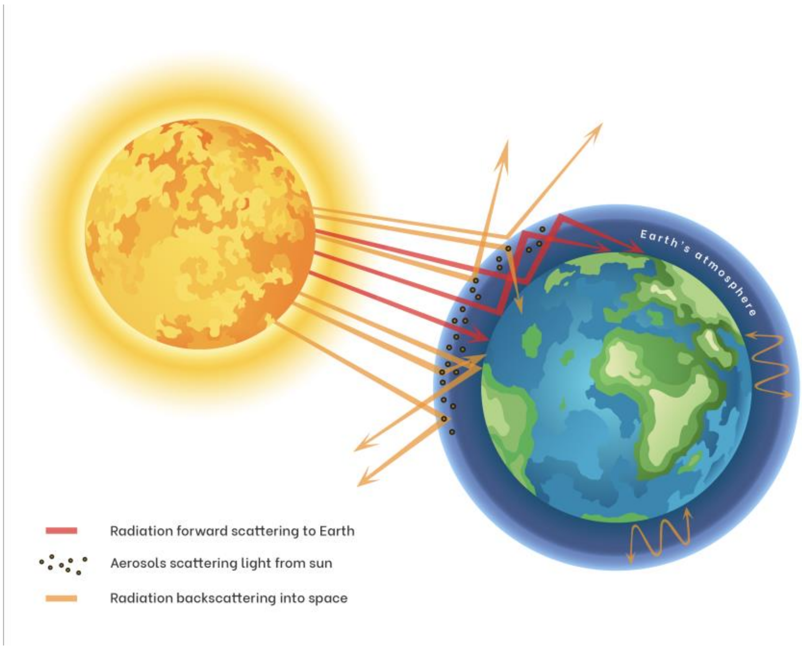


Figure 1 – Scattering Influence on the Earth

1.4.1 Background – Light Scattering

1.4.1.1 Extinction Coefficients (σ_{ext})

Attenuation of light (that is, reduction in its intensity) is usually expressed using the Beer-Lambert law:

$$I = I_0 e^{-\sigma_{ext} x}$$

Equation 1 Beer-Lambert Law

where:

I_0 = initial light intensity,
I = intensity after distance x,
X = distance,
σ_{ext} = the attenuation, or extinction coefficient.

Note: Sometimes the symbol b is used instead of σ_{ext}.

The relationship between extinction coefficient and visual range is expressed in Koschmieder's Formula:

$$L_v = 3.912/\sigma_{ext}$$

Equation 2 Koschmieder's Formula

where:

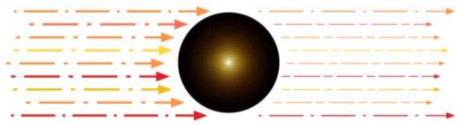
L_v = visual range,
σ_{ext} = extinction coefficient.

The larger the value of σ_{ext}, the more rapidly the light is attenuated (i.e., reducing visibility).

1.4.1.2 Assumptions

Light may be attenuated either by scattering off objects or by absorption by objects. Thus, the extinction coefficient σ_{ext} may be broken down into a scattering coefficient σ_{scat} and an absorption coefficient σ_{abs}:

$$\sigma_{ext} = \sigma_{scat} + \sigma_{abs}$$



Equation 3 Light Attenuation Equation

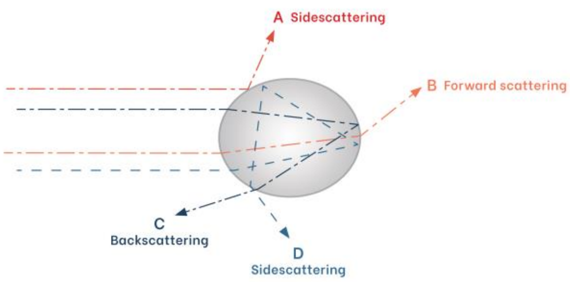


Figure 2 – Light Scattering and Absorption

For light attenuation in the atmosphere, the objects responsible can be either gas molecules or airborne particles. The scattering and absorption coefficients may therefore be further broken down into:

$$\sigma_{scat} = \sigma_{sg} + \sigma_{sp}$$

Equation 4 Scattering Coefficient

and $$\sigma_{abs} = \sigma_{ag} + \sigma_{ap},$$

Equation 5 Absorption Coefficient

where the subscripts denote:

s: scattering
a: absorption
g: due to gas molecules
p: due to particulate matter.

For example, σ_{sp} is the extinction coefficient due to scattering from particulate matter. Scattering due to gas molecules (coefficient σ_{sg}) is also called 'Rayleigh scattering'.

NO_2 is the most significant gaseous absorber and soot the most significant particulate absorber. However, except in extremely high concentrations, the effects of absorption are negligible compared to the effects of scattering. Therefore, to a very good approximation,

$$\sigma_{ext} \approx \sigma_{scat} = \sigma_{sg} + \sigma_{sp}.$$

Equation 6 Relationship of Extinction Coefficient with Scattering Coefficient

It is σ_{scat} that the Aurora NE Series measures directly. When the instrument performs a zero adjust in particle-free air (that is, where only Rayleigh scattering is present), the σ_{sg} component of σ_{scat} is subtracted leaving σ_{sp} as the reported parameter.

Higher particulate concentrations mean more scattering, so σ_{sp} is a good measure of particulate pollution.

In urban situations σ_{sp} will be much greater than Rayleigh scattering (σ_{sg}). σ_{sp} is therefore also a good measure of atmospheric visibility.

1.4.1.3 Effects of Wavelength

Absorption and scattering are dependent on the wavelength of the incident light. The Aurora NE Series uses a light source emitting light at three different wavelengths in the visible range. The three wavelengths (red 635 nm, green 525 nm and blue 450 nm) all produce differential scattering and are affected differently by particles of different size, shape and composition.

- 450 nm (blue) interacts strongly with fine and ultrafine particulates (e.g., wood fires and automobiles).
- 525 nm (green) interacts strongly throughout the human range of visibility (e.g., smog, fog and haze).
- 635 nm (red) interacts strongly with large particulate matter (e.g., pollen and sea salt).

This allows partial characterisation and in-depth analysis of the type of particulates and their effects within the environment. These different wavelengths overlap in measurements and do not directly measure differences in particulate composition.

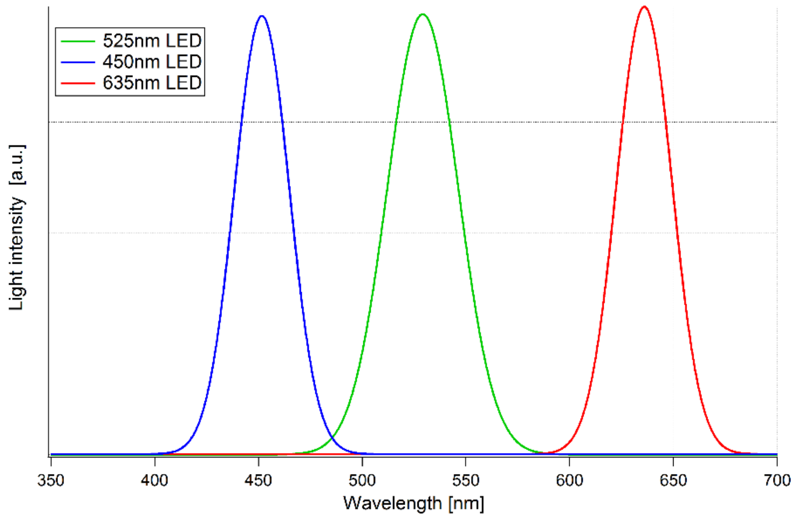


Figure 3 – Optical Spectrum of Aurora NE Series

1.4.1.4 Effects of Humidity

Above about 60% relative humidity, particles collect water droplets and appear to grow because of the water vapour condensing on them and changing their optical properties, hence scattering more light.

Thus, the Aurora NE Series is equipped with a sample heater that, if enabled, will heat the sample as its humidity approaches the target setpoint as defined by the user. This decreases the relative humidity and evaporates the water droplets. The heater is limited to 40°C so as not to destroy the aerosol sample.

Switching on the heater (dry measurement) would give a more reliable measure of airborne pollutant concentrations, as this evaporates (much of) the water droplets. Switching off the heater (wet measurement) would give a more reliable measure of the true scattering of aerosols.

Hydroscopic properties of aerosols can be studied with more accurate control of the sample humidity. Using the ACOEM ACS-1000 Aerosol Conditioning System interfaced with an Aurora NE-300 or NE-400 can be used to calculate the scattering enhancement factor of aerosols.

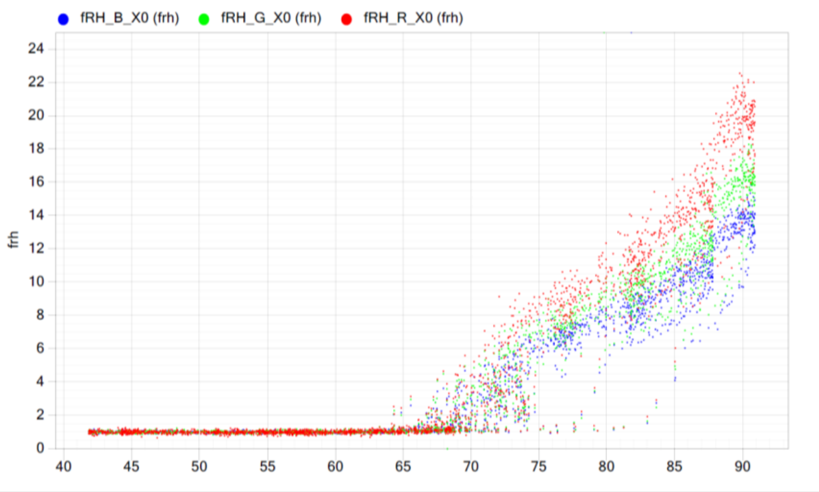


Figure 4 – Example of Aerosol Scattering Enhancement Factor

1.4.2 Measurement Theory

The Aurora NE Series Nephelometers are designed to measure the optical properties of particulates in a controlled environment.

Ambient sample air is drawn into the measurement cell by the sample pump. The light source illuminates the sample air in the measurement cell. The measurement cell is made so that it provides a dark background. When gaseous and particulate components of the sample are illuminated, they will cause the light to scatter. The baffles inside the optical chamber are positioned so that only light scattered inside a narrow cone will reach the photomultiplier tube. The photomultiplier tube produces electrical signals proportional to the intensity of the incident light. Hence, the signal produced by the photomultiplier tube is a representation of the scattering coefficient of the sample air.

During normal operation there are three main measurements being made: Dark count, Shutter count and Measure count.

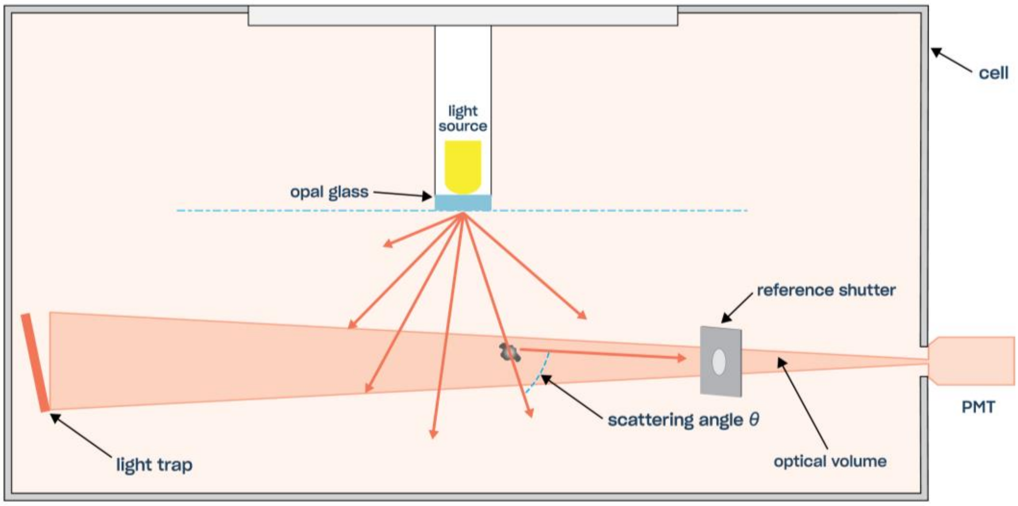


Figure 5 – Light Path, Full Scatter

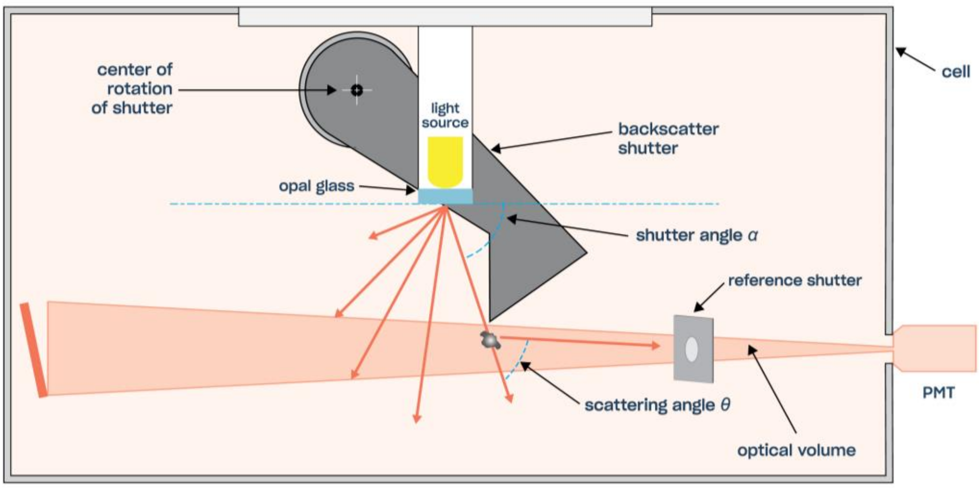


Figure 6 – Light Path, With 90° Backscatter

1.4.2.1 Shutter Count

Periodically, the reference shutter mounted inside the cell is closed for a number of seconds. During this time, there is a direct light path from the light source to the shutter and then to the PMT. The shutter glass is made of a material with a known transmittance that allows the Aurora NE Series to adjust for variations in the measuring system. This measurement does not rely on air scattering. The results from the shutter measure are stored as the **shutter count** and should be in the order of 1M to 10M for each wavelength. The shutter count measurement is made approximately every 60 seconds depending on the setup of the instrument.

1.4.2.2 Dark Count

The light source periodically flashes on and off in less than 1 second. When the light source is off, the PMT measures the **dark count**. That is, the background light incident upon the PMT when the light source is off. Ideally, this value should be 0, however readings up to 1,000 are possible, as are small fluctuations.

1.4.2.3 Measure Count

The measure count is taken when the shutter is open, and the light source is on. The measured counts from the PMT are a result of scattering due to gaseous and particulate matter inside the measurement volume as well as internal reflections and background noise. As the concentration of scattering components inside the cell increases, so do the measure counts. Typical measure counts can vary from 10,000 to 500,000. The measure count is measured for each wavelength, and the dark count is subtracted. The measure count will be at its lowest during zero measurement, which should be at least 10,000 for each wavelength.

1.4.2.4 Measure Ratio

The measure ratio (MR) is the ratio between the Measure count (C_m) and the shutter count (C_{sh}).

$$MR = \frac{C_m}{C_{sh}}$$

For example, If C_m = 15,000 & C_{sh} = 1,200,000, then MR = 12.5×10^{-3}.

Because the C_{sh} is a stable known source, the MR is directly proportional to σ_{scat}.

If there are changes in the measurement system (i.e., Light source intensity or temperature), then both C_m & C_{sh} will change proportionally. Therefore, the MR will remain constant. However, if the σ_{scat} of the sample changes, then only the C_m will vary.

1.4.2.5 Light Source Illumination

The Light Source design and function is different for each of the Aurora NE series instruments. In an ideal situation the light source should produce a distribution of light that resembles a cosine function, known as a Lambertian Distribution. The opal glass diffusor provides a natural distribution close to this from the high intensity LED array. Physical constraints of the measurement cell design mean that the light source illumination is only effective from 7° to 173°. 7° is referred to as the truncation angle. Due to these non/idealities of the instrument, the readings have to be corrected for truncation. The correction is a simple procedure and it is detailed in Mueller et al,2007, AMT for the Aurora 4000 Nephelometer.

1.4.2.5.1 Full Scatter Distribution:

The Aurora NE-100, NE-300 & NE-400 all produce the Full scatter distribution from 7° to 173°. The NE-100 does not have the backscatter shutter, where as the NE-300 and NE-400 achieve Full Scatter by setting the backscatter shutter to the 0° position.

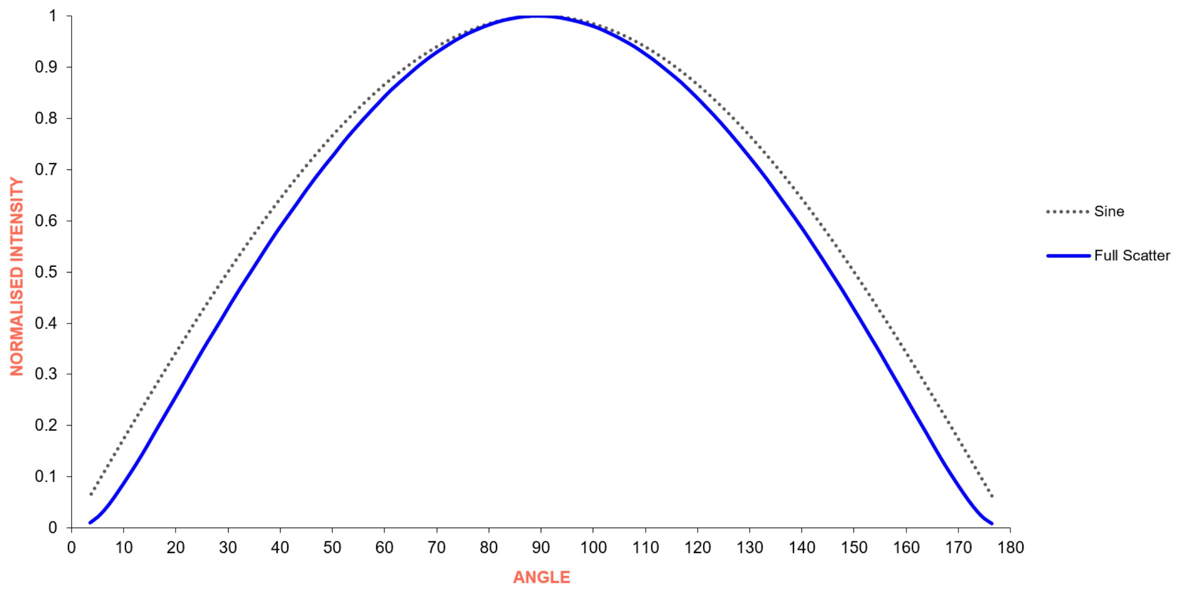


Figure 7 – Full Scatter Lightsource Distribution

1.4.2.5.2 Back Scatter Distribution:

The Aurora NE-300 & NE-400 both produce the Back scatter distribution where the backscatter shutter moves into position to shade the output of the light source so that the light distribution is from 90° to 173°.

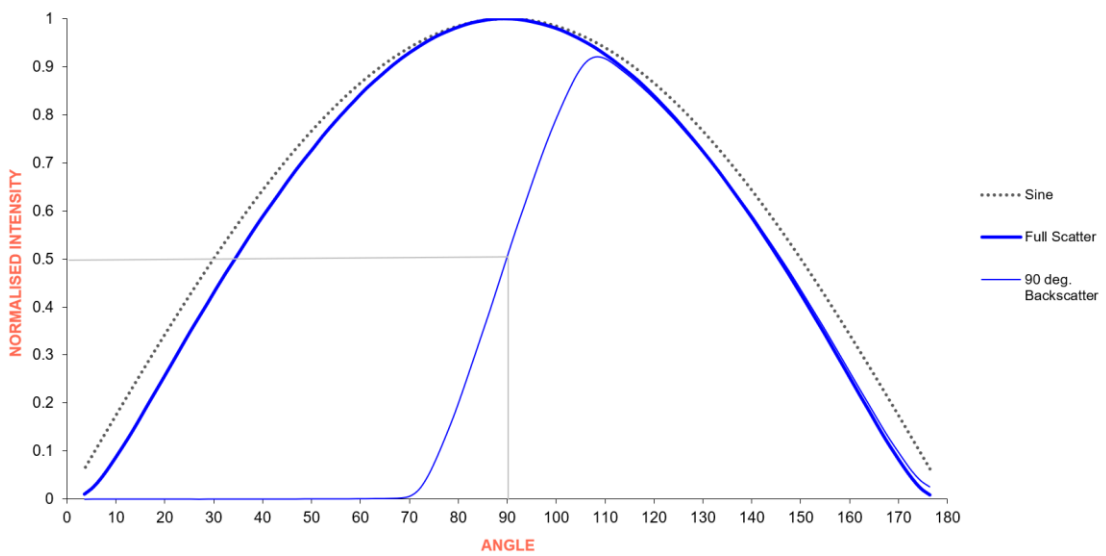


Figure 8 – Backscatter Light source Distribution (90°)

1.4.2.5.3 Polar Scatter Distribution:

The Aurora NE-400 can produce multiple sectors (up to 20) of Back scatter distribution when the backscatter shutter moves into different positions to shade the output of the light source. This allows the light distribution to be measured at multiple angles from 90° to 173°.

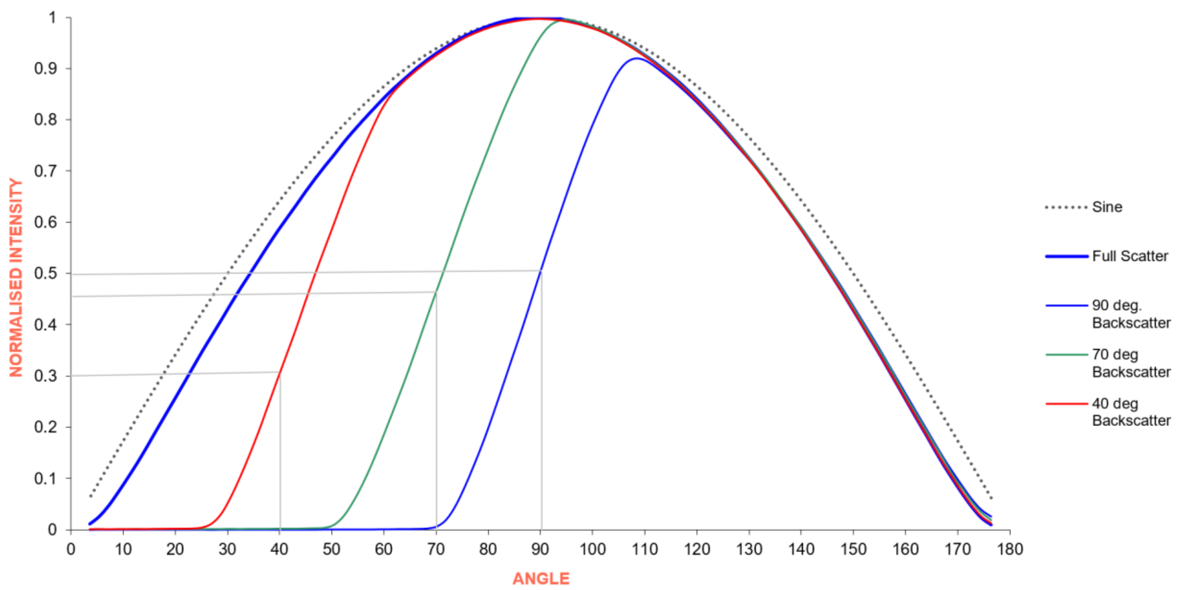


Figure 9 – Polar Scattering (40º, 70º & 90º)

1.4.3 Measurement sequence

The Aurora NE Series Nephelometers all have a similar measurement sequence; however, the timing for these events will change depending on the setting of the wavelengths, angles and measurement periods.

1.4.3.1 NE-100

The Aurora NE-100 Single Wavelength Nephelometer measurement process is completed with three main steps:

- Dark Count measurement.
- Shutter Count measurement (Red, Green or Blue, repeated R times).
- Measurement Cycle (repeated N times).

The Measurement Cycle comprises of the following:

- Dark Count measurement.
- Measure Count measurement at 0° (Red, Green or Blue).

The timing of the measurement process is based on the following settings in the Calibration menu under the Measurement Settings:

- Dark Period: Dark Count Measurement time (Default = 300ms).
- Measure Period: Measure Count Measurement time (Default = 600ms).
- Repeat Reference: R, Shutter Count measurement repeats (Default = 4).
- Repeat Scattering: N, Measurement Cycle repeats (Default = 60).

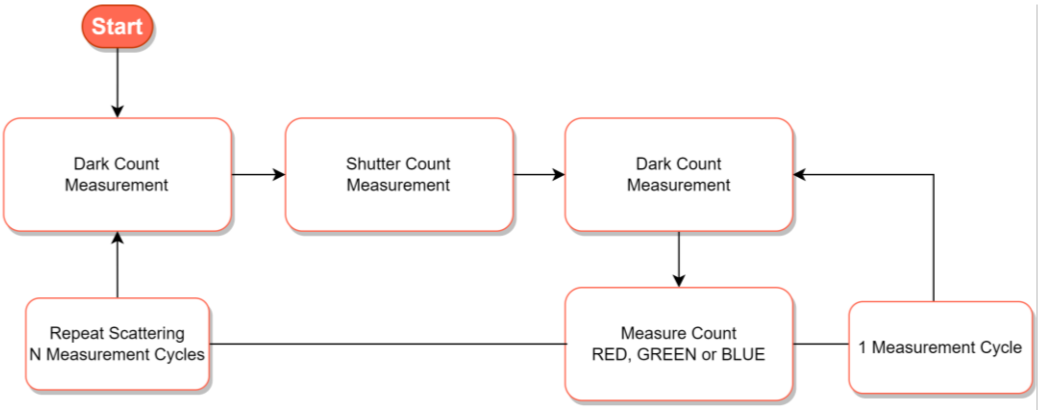


Figure 10 – Aurora NE-100 Measurement Sequence

1.4.3.2 NE-300

The Aurora NE-300 Multi Wavelength Nephelometer measurement process is completed with three main steps:

- Dark Count measurement.
- Shutter Count measurement (Red, Green and Blue, repeated R times).
- Measurement Cycle (repeated N times).

The Measurement Cycle comprises of the following:

- Move the Backscatter Shutter to the 0° position.
- Dark Count measurement.
- Measure Count measurement at 0° (Red, Green and Blue).
- Move the Backscatter Shutter to the 90° position.
- Measure Count measurement at 90° (Red, Green and Blue).

The timing of the measurement process is based on the following settings in the Calibration menu under the Measurement Settings:

- Dark Period: Dark Count Measurement time (Default = 300ms).
- Measure Period: Measure Count Measurement time (Default = 600ms).
- Repeat Reference: R, Shutter Count measurement repeats (Default = 2).
- Repeat Scattering: N, Measurement Cycle repeats (Default = 30).

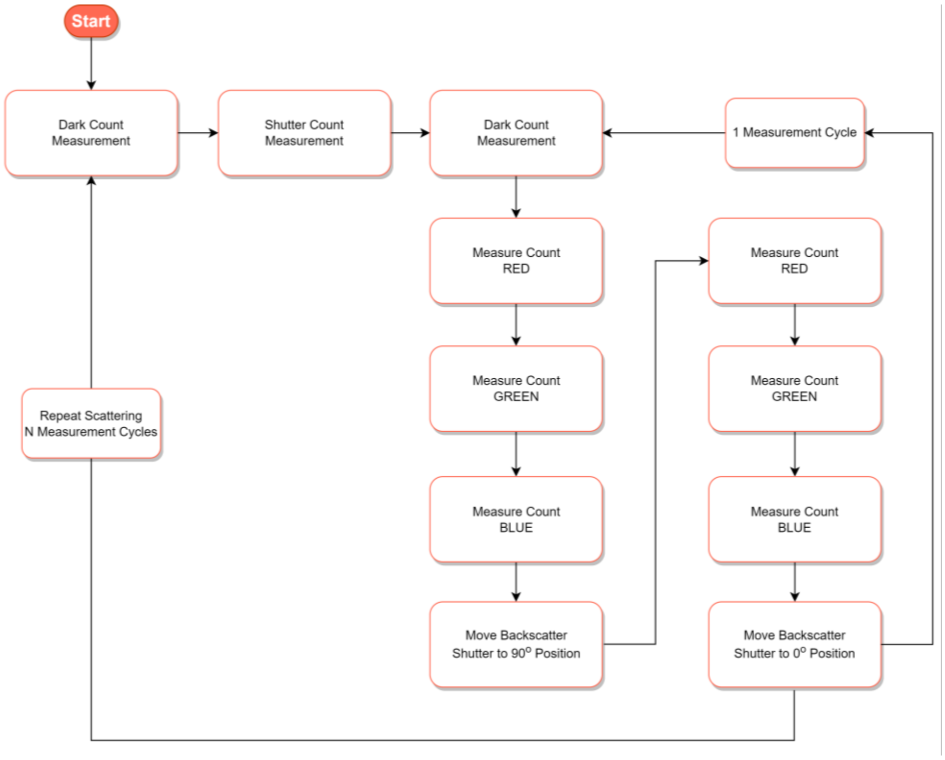


Figure 11 – Aurora NE-300 Measurement Sequence

1.4.3.3 NE-400

The Aurora NE-400 Multi Wavelength Polar Nephelometer measurement process is completed with three main steps:

- Dark Count measurement.
- Shutter Count measurement (Red, Green and Blue, repeated R times).
- Measurement Cycle (repeated N times).

The Measurement Cycle comprises of the following:

- Move the Backscatter Shutter to the 0° position.
- Dark Count measurement.
- Measure Count measurement at 0° (Red, Green and Blue).
- Move the Backscatter Shutter to the next angle 10° to 90° (depending on which angles are selected).
- Measure Count measurement at 10° to 90° (depending on which angles are selected) (Red, Green and Blue).

The timing of the measurement process is based on the following settings in the Calibration menu under the Measurement Settings:

- Dark Period: Dark Count Measurement time (Default = 300ms).
- Measure Period: Measure Count Measurement time (Default = 150ms).

- Repeat Reference: R, Shutter Count measurement repeats (Default = 4).
- Repeat Scattering: N, Measurement Cycle repeats (Default = 4).

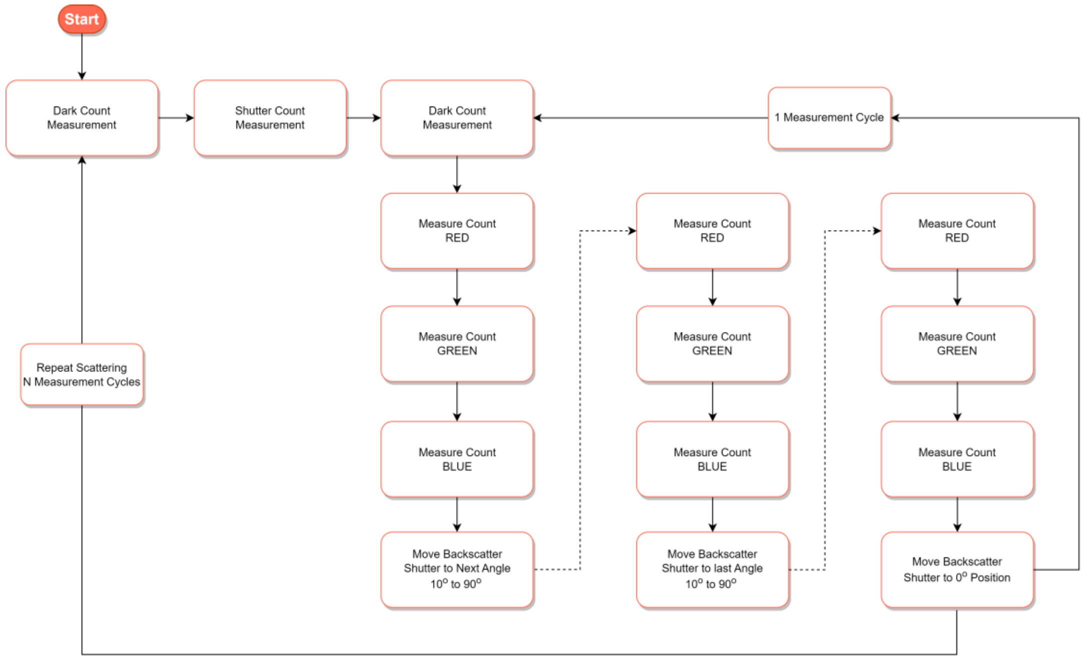


Figure 12 – Aurora NE-400 Measurement Sequence

1.4.4 Filtering

The Aurora NE Series Multi Wavelength Nephelometers have various filtering options for on screen display, data storage, data reporting and calibration. All filters operate independently and can be used simultaneously. The filtering is only applied to the scattering and measure ratio calculations.

1.4.4.1 Kalman Filter

The digital Kalman filter provides an ideal compromise between response time and noise reduction for the type of signal and noise present in the instrument.

The Kalman filter enhances measurements by modifying the filter time base variable, depending on the change rate of the measured value. If the signal is changing rapidly, the instrument is allowed to respond quickly. When the signal is steady, a long integration time is used to reduce noise. The system continuously analyses the signal and uses the appropriate filtering time.

1.4.4.2 Rolling Average

The Rolling Average filter is the average of readings based on a user settable window. The window is not in units of time but is based on the number of measurement cycles. As an example, for the NE-400 with 18 angles, if the Rolling Window is set to 20, and the approximate time for one measurement cycle is 16 seconds, then the Rolling Average period will be approximately 320 seconds.

1.4.4.3 Fixed 5 minute

The Fixed 5 minute filter is the average of readings over a 5 minute period.

1.4.4.4 Fixed 1 minute

The Fixed 1 minute filter is the average of readings over a 1 minute period.

1.4.4.5 None

When the filtering is set to None, there is no filtering applied to the readings and are considered raw.

1.4.5 Calibration Theory

This section explain how the raw measurements of the Auror NE series Nephelometers are converted to real values for scattering.

1.4.5.1 Calculating the calibration curve

The following is an example of a typical calibration of full scattering using CO_2 calibration gas at a wavelength of 525nm. The same principles apply for other wavelengths and angles.

During a full calibration, two points are measured:

- The span point is measured with CO_2 or another calibration gas.
- The zero point is measured with particle free air.

During the calibration, the Aurora NE Nephelometer measures the amount of photon scattered by the particles and air (measure counts, C_m) and the number of photons produced by the light (through an optical filter, shutter counts, C_{sh}). Note that both the measure counts and the shutter counts are already corrected for the dark count of the PMT. The nephelometer also measures the sample temperature (ST) and barometric pressure (BP). The nephelometer then calculates the measure ratio (MR), which corresponds to the amount of light scattered by the aerosol (particles + air), normalized by the light source intensity.

$$MR = \frac{C_m}{C_{sh}}$$

Equation 7

A typical example of the obtained values is as follows:

Table 4 – Calibration Data

Nephelometer readings	Span	Zero
C_m	13692	11582
C_{sh}	1200000	1200000
MR (C_m/C_{sh})	0.01141	0.009651667
ST- Temp (K)	300.2	300.2
BP - pressure (mBar)	1004	1004

The calibration then aims at creating a relationship between the MR and the aerosol scattering coefficient.

At STP (273.15 K, 1013.25mBar) and wavelength 525nm, the CO2 scattering coefficient is known:

σ_{scat} for CO_2 = 2.61 x 14.82 = 38.68 x 10^{-6} m

σ_{scatt} (CO2) at the measured temperature and pressure is then, using the ideal gas law:

$$\sigma_{scatt}(CO2)|_{TP} = \frac{\sigma_{scatt}(CO2)|_{STP} \times 273.15 \times Pressure}{Temperature \times 1013.25}$$

Equation 8

Where:

- $\sigma_{scatt}(CO2)|_{STP}$ is the CO2 scattering coefficient at standard pressure and temperature.
- Pressure is the measured pressure in mBar.
- Temperature is the sample temperature in K.
- The standard pressure and temperature are T=273.15 K, P=1013.25mBar

Taking our example:

$$\sigma_{scatt}(CO2)|_{TP} = \frac{38.68 \times 273.15 \times 1004}{300.2 \times 1013.25} = 34.87338\ Mm^{-1}$$

Equation 9

In the same way, the $\sigma_{scatt}(ZeroAir)|_{STP}$ can be calculated and corresponds to the scattering coefficient of the particle free air at the measured pressure and temperature.

At STP (273.15 K, 1013.25mBar) and a wavelength 525nm, the particles free air scattering coefficient is known:

σ_{scat} for particle free air (Air Rayleigh) = 14.82×10^{-6} m

$$\sigma_{scatt}(ZeroAir)|_{TP} = \frac{\sigma_{scatt}(Air)|_{STP} \times 273.15 \times Pressure}{Temperature \times 1013.25}$$

Equation 10

And in the case of our example:

$$\sigma_{scatt}(ZeroAir)|_{TP} = \frac{14.82 \times 273.15 \times 1004}{300.2 \times 1013.25} = 13.36152$$

Equation 11

These values can then be used to draw the calibration curve and retrieve the calibration coefficients:

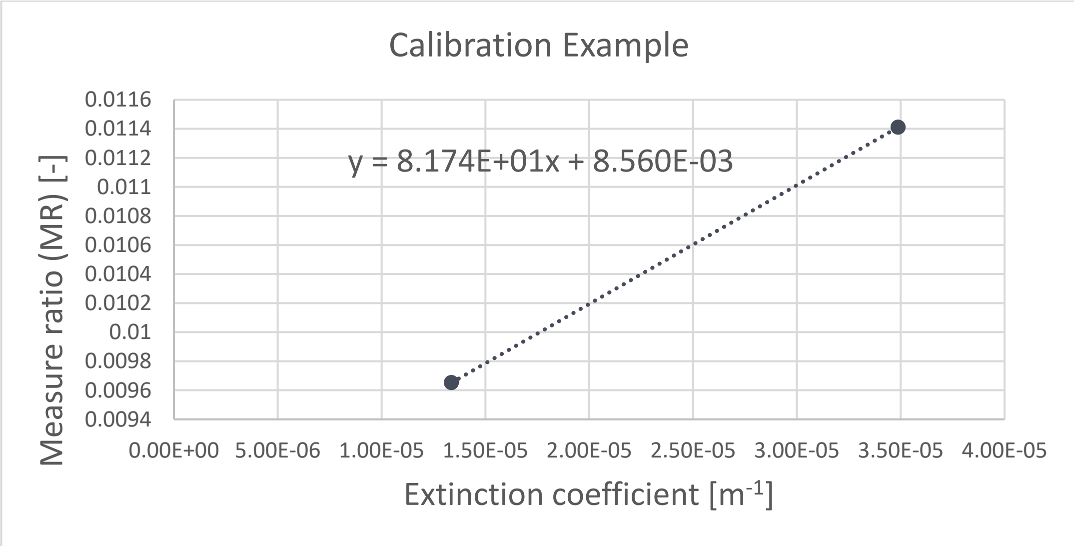


Figure 13 – Aurora NE Calibration Curve

In this example, the calibration coefficients are:

M = 81.74

C = $8.56 * 10^{-3}$

1.4.5.2 Calculating the ST Correction coefficient

The reference shutter count measurement is used for correct for the light output dependence on temperature from the light source. However, the optical alignment of the nephelometer is also dependent on temperature and has to be corrected for. The ST Correction coefficient is a constant used for each wavelength to perform this correction on the calculated measure ratio.

In order to find this (assumed linear) dependence, we perform two calibrations with CO_2, one at ambient temperature and the other one at 50°C. We then find ST correction by minimizing the difference between the corrected scattering coefficients at the two temperatures such as:

$$\sigma_{corr\ (273°K)} - \sigma_{corr\ (323°K)} = 0$$

With

$$\sigma_{corr\ (T°K)} = \frac{MR_{corr} - C}{M} \times \frac{273.15\ \times\ P}{T\ \times 1013.25}$$

Equation 12

$$MR_{corr} = MR \times \left[1 + ST_{corr} * \left(\frac{T}{273} - 1\right)\right]$$

Equation 13

And T is in kelvin

1.4.5.3 Calculating the scattering coefficients from the raw counts

Every measurement cycle, the Aurora NE nephelometer calculates the particle's light scattering coefficient by following these steps:

1. ***Calculating the measure ratio (MR) from shutter counts C_{sh} and measure counts C_m***

$$MR = \frac{C_m}{C_{sh}}$$

Equation 14

Where:

C_m is the measure count

C_{sh} is the shutter count

Note that both the measure and the shutter counts are already correct for the dark count (i.e. the dark count has been subtracted).

The measure ratio is then corrected for residual temperature dependency that the shutter count does not catch (optical alignment of the cell change).

2. ***Calculating the MR corrected for residual temperature dependence***

$$MR_{corr} = MR \times \left[1 + ST_{corr} * \left(\frac{T}{273} - 1\right)\right]$$

Equation 15

Where:
- T is the temperature in kelvin
- ST_{corr} is the residual temperature dependence (ST Correction Coefficient factory setting)

3. ***Calculating the aerosol scattering coefficient from the MR corrected***

The extinction scattering coefficient (gas + particle) is then calculated from the calibration curve:

$$\sigma_{scatt}|_{TP} = \frac{MR_{corr} - C}{M}$$

Equation 16

Where:
- C is the calibration coefficient offset
- M is the calibration coefficient slope

4. ***Correcting for standard temperature and pressure***

The aerosol scattering coefficient must be then be corrected for standard temperature and pressure (if the option is selected in the menu):

$$\sigma_{scatt}|_{STP} = \sigma_{scatt}|_{TP} \times \frac{T}{P} \times \frac{1013.25}{273.15}$$

Equation 17

Where:

- T is the ambient temperature in kelvin. The actual value may vary depending on the user selection.
- P is the ambient pressure in mBar

5. ***Calculating the particle scattering coefficient from the aerosol scattering coefficient***

The air Rayleigh must then be subtracted to obtain the scattering coefficients of the aerosol particles:

$$\sigma_{sp}\big|_{STP} = \sigma_{scatt}|_{STP} - 14.82 \times 10^{-6}$$

Equation 18

1.4.5.4 Calibration Gas Properties

Table 2 lists the ratios of Rayleigh scattering coefficients for the supported calibration gases, relative to the air at different wavelengths and at STP (273.15°K, 1013.25mBar).

Table 3 and 4 give the actual Rayleigh scattering coefficients for full scatter and backscatter read by the Aurora during calibration, i.e. without the air light scattering contribution.

Table 5 – Calibration Gas Constants

Calibration Gas Constants							
Wavelength	Rayleigh	CO_2	FM200	SF6	r12	r22	r134
	1	2.61	15.3	6.74	15.31	7.53	7.35
450	27.46	71.67	420.14	185.08	420.41	206.77	201.83
525	14.82	38.68	226.75	99.89	226.89	111.59	108.93
635	6.92	18.07	105.95	46.64	105.95	52.14	50.90

Table 6 – Full Scattering Calibration values

Aurora Readings Full Scattering						
Wavelength	CO_2	FM200	SF6	r12	r22	r134
450	44.21	392.68	157.62	392.95	179.31	174.37
525	23.86	211.93	85.07	211.93	96.77	94.11
635	11.15	99.02	39.72	99.02	45.22	43.97

Table 7 – Backscatter Calibration values

Aurora Readings Backscatter						
Wavelength	CO_2	FM200	SF6	r12	r22	r134
450	22.11	196.34	78.81	196.34	89.66	87.19
525	11.93	105.97	42.54	105.97	48.39	47.06
635	5.58	49.51	19.86	49.51	22.61	21.99

1.5 Instrument Description

The major components of the Aurora NE Series Multi Wavelength Nephelometers are described below:

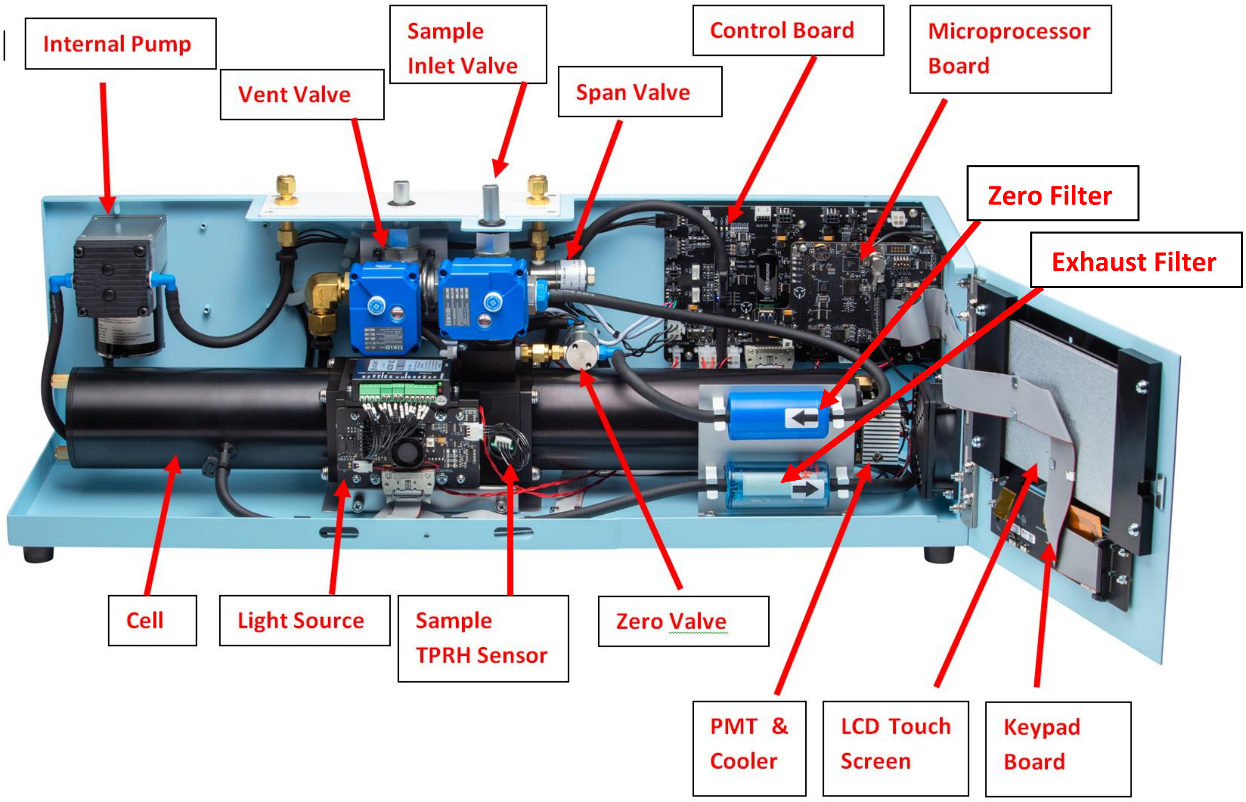


Figure 14 – Major Components of Aurora NE Series

1.5.1 Main Enclosure

The main enclosure is a sturdy aluminium construction with powder coating for additional protection. The LCD and keypad are mounted on a hinged door for easy access to the filters without removing the cover.

1.5.1.1 Removable Cover

The removable cover should always be installed during normal operation for optimal performance. When required for service and maintenance, the cover can be removed by removing the three mounting thumb screws.

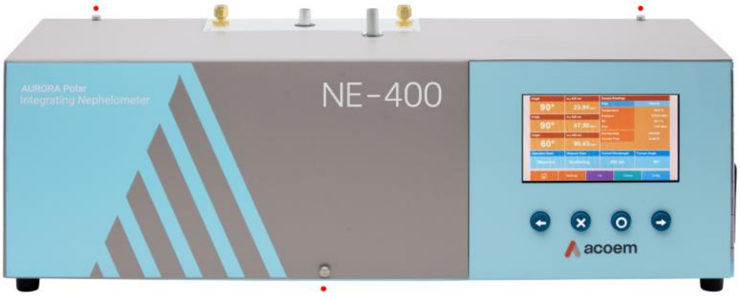


Figure 15 – Mounting Screw Locations

1.5.2 Power Supply

The external, auto ranging power supply is rated at 100 to 250 VAC, 50 or 60 Hz. This means that it a can be connected to any domestic mains supply anywhere in the world via a standard IEC mains connector. The output is 24 VDC at 6.67 A Max.

Figure 16 – 24 VDC Power Supply

1.5.3 Measurement Cell Assembly

The measurement cell assembly is made up of a number of sub-components that are common to all instrument types. Each one is described in the following sections.

- Measurement Cell
- PMT
- Sample Heater
- Light Source
- Sample Temperature / Pressure / RH sensor
- Reference shutter

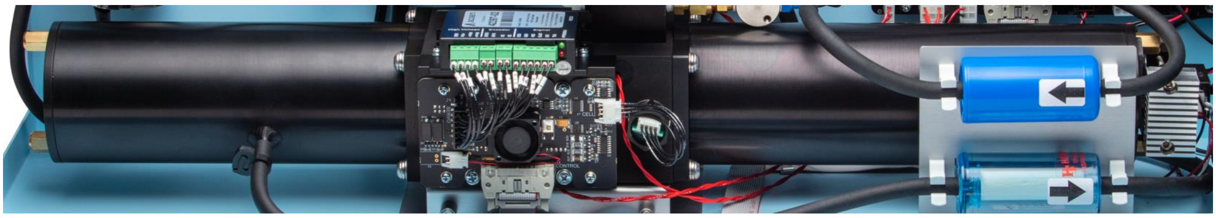


Figure 17 – NE-300 Measurement Cell assembly

1.5.3.1 Measurement Cell

The measurement cell is a critical part of the Instrument. It is within the cell that the optics, the electronics and the pneumatics all come together. The cell is pneumatically and optically sealed to prevent stray light and air from entering. It is made of black anodised aluminium with a special coating of matte black paint on the inside to reduce internal light reflections. The left-hand end of the Measurement Cell contains the light trap, which is a black glass mounted on an angle to absorb and reflect light.

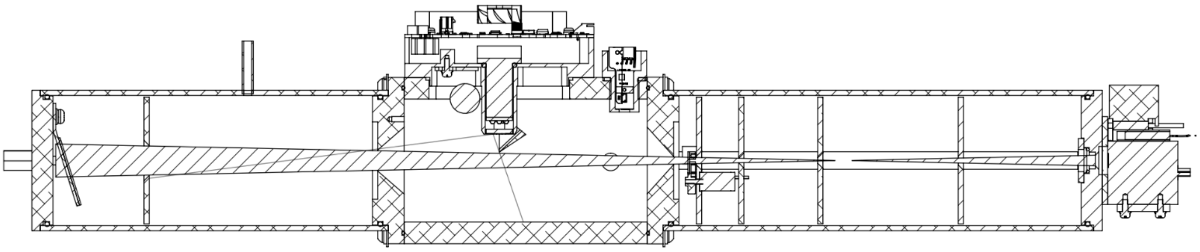


Figure 18 – NE-300 Measurement Cell cross section

1.5.3.2 PMT/Cooler Assembly

The PMT (Photo Multiplier Tube) is used to measure the light (photons) resulting from scattering. It is actually a photon counting head and produces an electrical signal (frequency) proportional to the incident light. The output frequency of the PMT ranges from 0 Hz to 10,000,000 Hz. The High voltage supply to operate the PMT is internally generated within the PMT.

1.5.3.2.1 NE-100 PMT

The Aurora NE-100 Single Wavelength Nephelometer uses a PMT that can be used in the optical range of 450nm to 525nm. This PMT will detect measurements that are in the 635nm range, however, its sensitivity is low in this range and will produce noisy results. If there is a requirement to measure at 635nm, then it is recommended to order the Wide Bandwidth PMT Option.

Figure 19 – NE-100 Single Wavelength PMT

1.5.3.2.2 NE-300 & NE-400 PMT

Figure 20 – NE-300 & NE-400 PMT and Cooler

The Aurora NE-300 and NE-400 Multi-Wavelength Nephelometers both use a PMT with a broad bandwidth in the optical range of 450nm to 635nm. This PMT is also fitted with a cooler assembly to keep the PMT cooler during warmer operating temperatures. This helps the reduce the dark count and noise of the PMT which is sensitive to temperature.

The Cooler assembly is mounted on the PMT is controlled by the controller board. Typically, the temperature is kept below 20^{o}C.

1.5.3.3 Sample Heater

The sample heater (when enabled), controls the temperature or RH of the sample measurement. There two sets of heaters: One on the cell body and one on the sample inlet just below the inlet valve. The sample temperature and RH sensor is mounted in the cell next to the light source wall.

The microprocessor controls the duty cycle of the sample heater to ensure that the sample air in the cell is maintained at the desired set point for temperature or RH.

Figure 21 – Sample Heater Location

1.5.3.4 Light Source

The construction of the Light Source is similar for all the Aurora NE series Nephelometers. The main difference is that the NE-100 Light Source does not have the backscatter shutter capabilities.

1.5.3.4.1 NE-100 Light Source Assembly

The light source uses an array of high-powered LEDs (Light Emitting Diodes) of specific wavelengths: Red (635nm), Green (525nm) and Blue (450nm). LEDs are used because they provide a stable source of illumination with great reliability. They are mounted on a heatsink for better stability and also to keep the heating of the sample to a minimum.

The Intensity of the LEDs is controlled by the Control PCA. Intensity settings and other parameters related to the Light Source calibration are stored on this board using internal memory.

The LED array is housed in a black housing, which can be easily removed for cleaning purposes. On the front of the Light Source housing there is an opal glass diffuser. This diffuser ensures that the LEDs produce light with a repeatable Lambertian distribution.

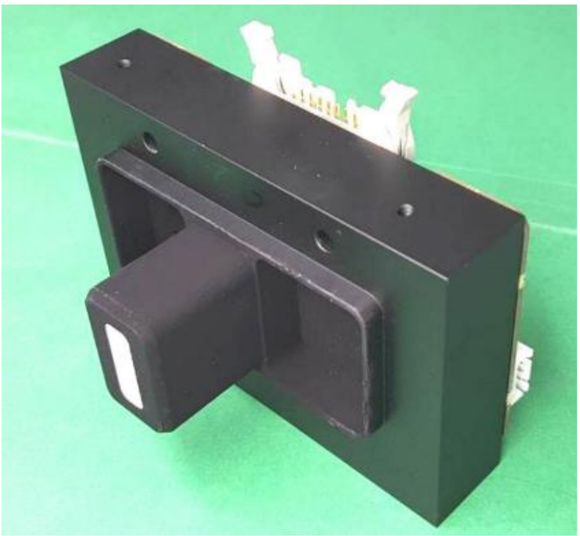


Figure 22 – NE-100 Light Source

1.5.3.4.2 NE-300 Light Source Assembly

The NE-300 Light Source uses the same LED construction as the NE-100. However, the NE-300 Light Source has the Backscatter Shutter which is moved into position using a servo motor. The backscatter shutter position is calibrated for 90° illumination and then stored on the light source control PCA.

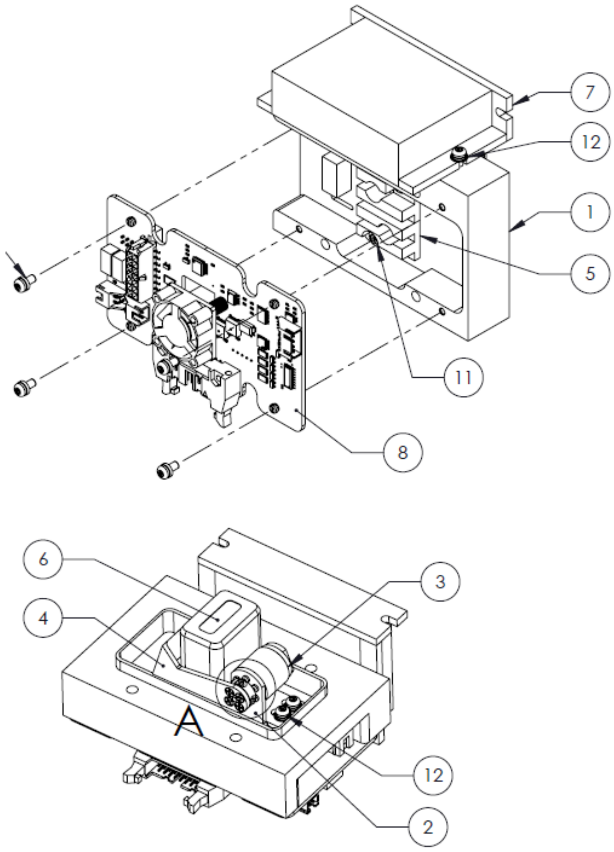


Figure 23 – Three Wavelength Light Source with Backscatter

- Light Source Housing
- 3. Backscatter Shutter Servo Motor
- 4. Backscatter Shutter Arm
- 5. LED Heatsink Assembly
- 6. Opal Glass Diffusor
- 7. Servo Motor Controller
- 8. Light Source Control PCA

1.5.3.4.3 NE-400 Light Source Assembly

The Light Source for the NE-400 if very similar to the NE-300; however, the calibration of the backscatter positioning is required to cover all the angles. This calibration curve is stored on the light source control PCA and is unique for each light source.

The Backscatter Shutter moves in and out of the light path to different locations so that the amount of light is integrated over up to twenty different angles between 0° and 90°. The shutter is moved by a servo motor which is controlled by the motor controller.

Figure 24 – NE-400 Light Source

1.5.3.5 Sample Temperature/Pressure/RH Sensor

The Accurate measurement of the sample temperature, pressure and RH is measured using the digital TPRH sensor. It is mounted on the front side of the measurement cell for easy access and connects to the light source assembly control PCA located beside it.

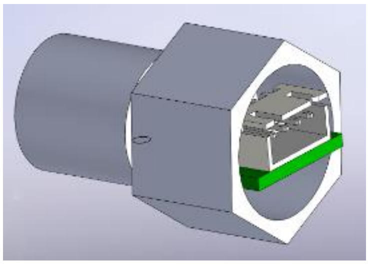


Figure 25 – Sample Temperature/Pressure/RH Sensor

1.5.3.6 Reference Shutter

The reference shutter is used to periodically check the operation of the Aurora NE Series and to compensate for any variations in the light source intensity. The reference shutter consists of a rotary solenoid and a glass diffusor with known transmittance. It is mounted on a rotary solenoid and is switched in and out of the optical path. Typically, when the shutter is switched in, it will give a shutter count of around 1M to 5M (though this number can vary depending on PMT sensitivity and light source intensity).

Figure 26 – Reference Shutter Assembly

1.5.4 Microprocessor & Control PCA

The microprocessor and control PCA's are the heart of the Aurora NE Series. The microprocessor PCA takes the raw count data from the PMT and converts them to real σ_{sp} values. It internally logs the data and stores it on the SD card or USB memory stick. It provides RS232, USB, and Ethernet communications, as well as analog and digital I/O signals. The microprocessor PCA controls the color touchscreen LCD and buttons, allowing the user to view and modify all system parameters. The firmware (program) loaded on the microprocessor PCA can be upgraded via the USB memory stick. It also contains a real-time clock for data logging and automatic calibration control. The calibration parameters and user settings are also stored in the onboard FLASH and can be saved or uploaded from the SD or USB memory stick.

The control PCA manages all the pumps, valves heaters, and light source. It also has an onboard flow sensor to measure the sample flow. The control board provides stable power to the various components and includes an electronic fuse for protection.

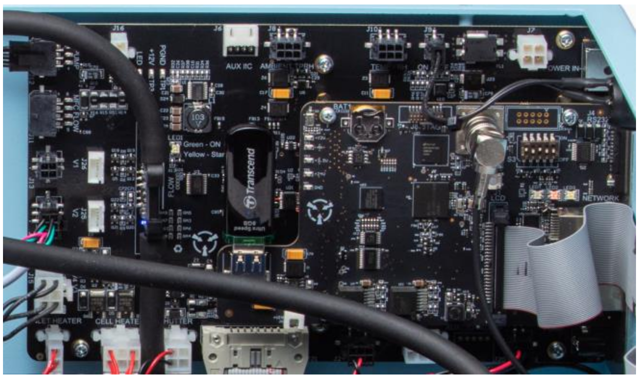


Figure 27 – Microprocessor PCA and Control PCA

1.5.5 Inlet Ball Valve

The inlet valve is a +12 V motor actuated ball valve which is operated during span and zero calibrations. The Inlet valve works in conjunction with the other valves to bypass the sample flow around the measurement cell during the calibration while maintaining constant flow at the inlet to the instrument. This is important when the sample inlet is connected to a common manifold that is shared by other aerosol instruments.

1.5.6 Vent Ball Valve

The vent valve is a +12 V motor actuated ball valve which is operated during span calibrations. The vent valve works in conjunction with the other valves to bypass the sample flow around the measurement cell during the calibration while still maintaining constant flow at the inlet to the instrument. The vent valve provides a vent path for the calibration gas to flow through the measurement cell at ambient pressure.

1.5.7 Span Valve

The span valve is a +12 V solenoid valve which is opened during a span calibration or span precision check to allow the calibration gas air to pass into the measurement cell for calibration. This valve works in conjunction with the other valves to perform the calibration.

1.5.8 Zero Valve

The zero valve is a +12 V solenoid valve which are opened during a zero calibration or zero precision check to allow the sample air (via the zero filter, refer to Section 1.5.10) to pass into the measurement cell during zero calibration or zero precision checks. This valve works in conjunction with the other valves to perform the calibration.

1.5.9 Internal Sample Pump

The internal sample pump is a 24 V brushless diaphragm pump which provides years of reliable operation. The internal pump's speed is controlled by the microprocessor PCA, and the flow is measured by the on-board flow sensor mounted on the control PCA to provide an accurate flow control loop. The internal sample pump can be set to a flow between 2 - 8 lpm for reliable flow control.

1.5.10 Zero Filter

The zero filter works in conjunction with the sample pump and valves to provide the particle free air during a zero calibration and zero precision check. Its filtration efficiency is 100% removing particles down to 0.01 micron in size.

1.5.11 Sample Exhaust Filter

The sample exhaust filter is located on the exhaust of the measurement cell and is used to remove particulates from the sample air to prevent contaminate of the flow sensor and sample pump. Its filtering element is visible, making it easy to see when it is dirty and in need of replacement.

Its filtration efficiency is greater than 95% removing particles down to 0.1 micron in size.

1.5.12 Colour Touchscreen Display

The Aurora NE Series Multi Wavelength Nephelometers uses a colour touchscreen LCD and buttons to simply navigate through the menu structure. This allows the user to set up many of the features of the instrument, as well as providing real-time visual status of the instrument's performance. The four buttons on the front panel and the LCD all interface to the LCD/Keypad PCA, and all the signals are transferred via the flat ribbon cable to the microprocessor PCA.

1.5.13 External Connections

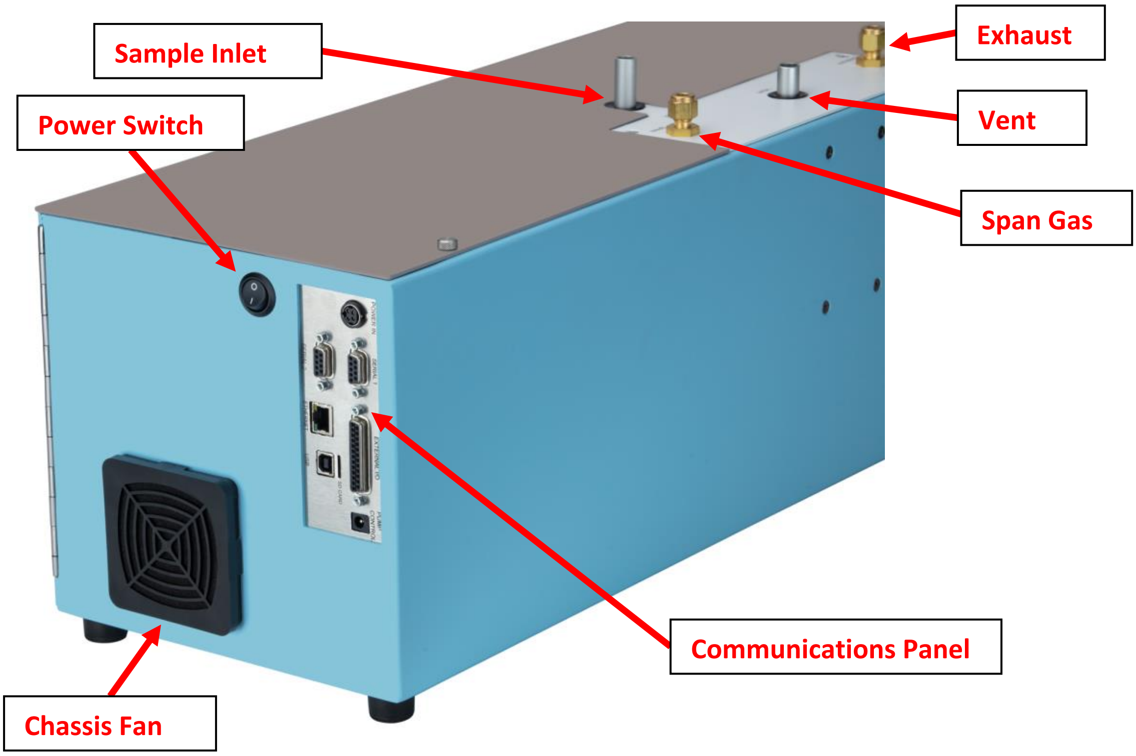


Figure 28 – External Connections Diagram

1.5.13.1 Power Switch

When you turn off the switch, it stops the power and systems inside from working. However, even when the switch is off, there is still some power (+24 volts) running internally.

1.5.13.2 Sample Inlet

The 1/2" aluminium port is where the main sample inlet is connected. The inlet has an O-ring seal and can be removed and replaced with a longer inlet tube if required. During transport or storage, this port should be closed with the supplied black rubber caps to prevent insects and debris from getting into the cell.

1.5.13.3 Vent Outlet

This 1/2" aluminium port is where span gas is vented during a span calibration or span precision check. It provides a path for the calibration gas to purge through the cell without restriction. The vent can be connected to additional1/2" tubing if the calibration gas is required to be vented outside the room. The vent has an O-ring seal and can be removed and replaced with a longer inlet tube if required. During transport or storage, this port should be closed with the supplied black rubber caps to prevent insects and debris from getting into the vent ball valve.

1.5.13.4 Span Gas

This 1/4" brass fitting is used for connecting the calibration (span) gas to the instrument. Refer to Section 5 for instructions on the correct connection of the calibration setup.

1.5.13.5 Exhaust

This 1/4" brass fitting is where the exhaust from the internal pump exits the instrument. It can be left disconnected. If additional noise suppression from the pump is required, then a longer length of tubing can be connected here.

If the MFC and external pump option is installed, then this 1/4" brass fitting is where the external pump pneumatic tube is connected to.

1.5.13.6 Chassis Fan

The chassis fan on the PMT end of the enclosure is used to remove heat generated by the PMT cooler assembly. If the cooler is not enabled, then the chassis fan can also be used to keep the internal chassis temperature of the instrument lower. This is important when wanting to minimize the difference between sample and chassis temperature. The chassis fan can be enabled and disabled in the hardware menu. It is operated at 24 VDC and has protective grills.

1.5.13.7 Power & Communications Panel

The communications panel is located on the right-hand side of the instrument. It provides convenient access to the power connection as well as all the communication connections.

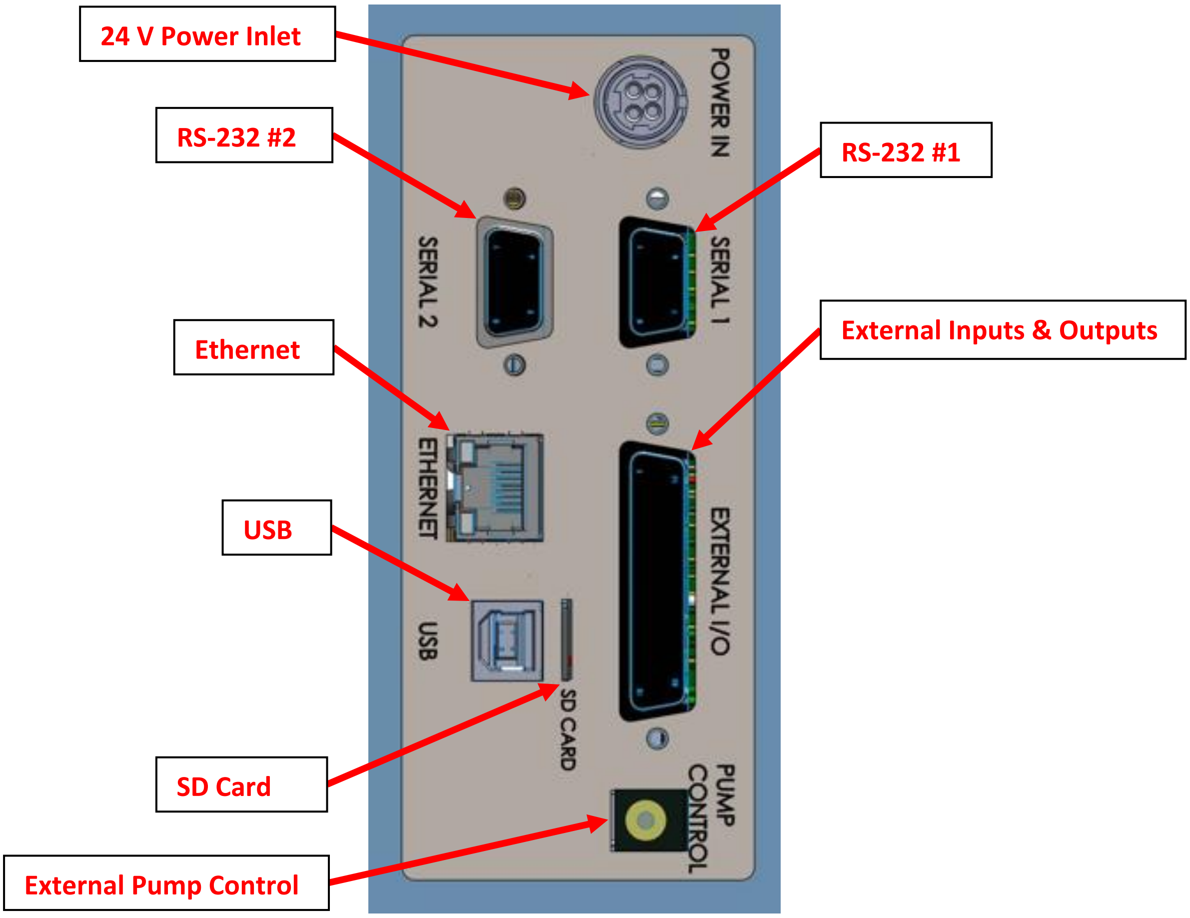


Figure 29 – Power and Communication Panel Diagram

POWER IN

The power inlet is where the 24 V external power supply is connected. This supplies all the power for the instrument. The Power switch is located next to the connector and must also be turned on (switched down) for the instrument to operate.

SERIAL 1

This port is a multi-drop serial port and can be used for simple RS-232 communication with a data logger or for data download.

SERIAL 2

This port is a multi-drop serial port and can be used for simple RS-232 communication with a data logger or for data download.

USB

This port can be used for communication with the instrument through a standard USB type B connection.

SD CARD

The SD CARD is used to store logged data, configuration files and event files. It can be removed and the data copied onto a computer.

TCP/IP Network

This port is best used for remote and real-time access to the instrument when a network is available.

External I/O

The analog/digital port sends and receives analog/digital signals to and from other devices. These signals are commonly used to activate external devices or provide warning alarms.

Analog Outputs

The instrument is equipped with six user definable analog outputs. The outputs are menu selectable as voltage outputs of 0 - 5V for each.

Analog Inputs

The instrument is also equipped with four analog voltage inputs (0 - 5 VDC CAT 1) with resolution of 16 bits plus polarity.

CAUTION

Exceeding these voltages can permanently damage the instrument and void the warranty.

Digital Status Inputs

The instrument is equipped with four logic level inputs (0 - 5 VDC CAT 1) for the external control of zero/span calibration sequences or other states.

CAUTION

Exceeding these voltages can permanently damage the instrument and void the warranty.

Digital Status Outputs

The instrument is equipped with four open drain outputs, which will convey instrument status conditions and warning alarms such as no flow, sample mode, etc.

CAUTION

Exceeding 12 VDC or drawing greater than 400 mA on a single output or a total greater than 2 A across the four outputs can permanently damage the instrument and void the warranty.

External Pump Control

This output is used to control the external pump controller kit for when an external pump is used in conjunction with the MFC option. Contact ACOEM for more details.

This page is intentionally blank.

2. Installation

2.1 Initial Check

Packaging

The Aurora NE Series is transported in packaging specifically designed to minimize the effects of shock and vibration that may occur during transportation. Acoem Australasia recommends that the packaging be kept if there is a likelihood that the instrument is going to be relocated.

Note: The black and red caps that seal the pneumatic connections during transport must be removed prior to operation. It is suggested that these caps be stored in a ziplock bag and placed inside the chassis for future use when relocation or storage of the instrument is required.

Items Received

With the delivery of the Aurora NE Series, the user will receive the following:

Table 8 – List of Items Received

Item Name	Part No.	Image
Aurora NE-400, NE-300 or NE-100	E010107, E010104 or E010101	Refer to Figure 30, callout 7.
24 V Power Supply	P010023	Refer to Figure 30, callout 11.
ACOEM Resources USB Stick	H030137-01	Refer to Figure 30, callout 10.
Manual (hardcopy optional)	M010068	-
SD Memory Card 32GB	H030136	Refer to Figure 30, callout 9.
USB Cable	COM-1440	Refer to Figure 30, callout 8.
Data Sheet/Calibration Report		Refer to Figure 30, callout 12.
Power Lead (120 V)*	C040007	Refer to Figure 30, callout 2.
Power Lead (240 V)*	C040006	Refer to Figure 30, callout 1.
	C040008	Refer to Figure 30, callout 3.
	C040009	Refer to Figure 30, callout 4.
	C040010	Refer to Figure 30, callout 5.
	C040054	Refer to Figure 30, callout 6.

*The power lead received depends on the power supply of the country (120 V or 240 V).

Note: Check that all these items have been delivered undamaged. If any item appears damaged, contact your supplier before turning the instrument ON.

Note: It is recommended to kept packaging material for transport or storage purpose.

Figure 30 – Received Items

2.1.1 Opening the Instrument

Open the front door of the enclosure to check the interior of the instrument. The door has a magnetic latch and can be opened by lightly pressing the door inwards and letting it spring open. Ensure that all pneumatic and electrical connectors are connected and that there are no loose items inside. If any visible and obvious damage exists, contact your supplier and follow the instructions in the "Claims for Damaged Shipments and Shipping Discrepancies" section at the front of this manual.

Check the interior of the instrument with the following steps:

1. Remove the transit thumb screw located on the front door, refer to Figure 31.

Figure 31 – Transit Thumb Screw Location

2. Open the front door. The access panel is held in place by a magnetic latch and can be opened by lightly pressing the panel inwards and letting it spring open, refer to Figure 32 .

Figure 32 – Front Door Release Location

Figure 33 – Front Access Panel Open

3. Remove the remaining three or four thumb screws (depending on the chassis version) from the chassis lid and lift upwards, refer to Figure 34.

Figure 34 – Chassis Lid Thumb Screw Location

4. Lift the lid vertically and evenly upwards until it is clear of the chassis, refer to Figure 35.

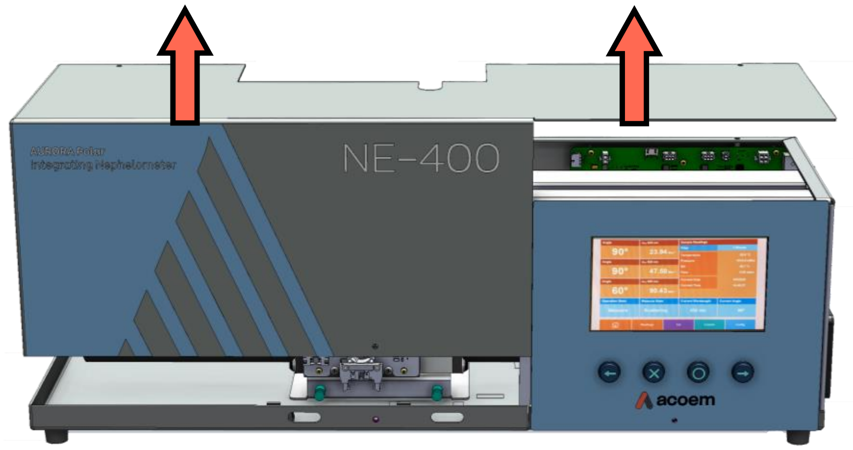


Figure 35 – Removing the Lid

5. Check that all pneumatic and electrical connectors are connected and that there are no loose items inside. If any visible and obvious damage exists, contact your supplier and follow the instructions in the claims for Damaged Shipments and Shipping Discrepancies section at the front of this manual.
6. Return the lid to the chassis and return the thumb screws to their original locations.

2.2 Instrument Installation

2.2.1 Installation Considerations

When installing the instrument, keep the following points in mind:

- **Location:** Place the instrument in a temperature-controlled area (like an air-conditioned room) with minimal dust and moisture to ensure it works well and lasts long.
- **Mounting:** Install the instrument on a stable table or use the optional wall mount bracket to mount it on a wall. See section 2.2.4.
- **Clearance:** Do not place anything on top of or against the instrument.
- **Access:** Ensure easy access to the front display, and keep the right-side panel (where the fan is) unobstructed.
- **Enclosure Lid:** Always secure the enclosure lid with screws during normal operation.
- **Sample Inlet:** Connect the sample inlet to a common particulate sampling manifold or use its sample inlet. Avoid sharp bends or long horizontal sections in the sample path. See section 2.2.3.
- **Local Guidelines:** Follow local guidelines for the proper location of the sample inlet. See section 2.2.2.

Note: Power Switch: The power ON/OFF switch is on the side of the instrument. Make sure it is easily accessible after installation.

2.2.2 Siting and Sampling

When choosing a location for the installation of an Aurora NE Series, it is best to consult the requirements from your local regulatory authority.

As a suggestion, the Australian Standard AS2922 -1987 provides the following requirements for the sampling inlet position:

- Between 2 and 5 metres above the ground.
- At least one horizontal meter and one vertical meter from supporting structures or walls.
- With 120° of clear sky above the sampling inlet.
- With an unrestricted airflow of 270° around the inlet, or 180° if the inlet is on the side of a building.
- 20 metres from trees.
- With no boiler or incinerator flues nearby.

2.2.3 Sample Inlet Installation

The sample inlet is the most important connection to the Aurora NE series nephelometer. Every installation is different. Figure 36 shows the ideal situation where the sample inlet is kept straight so that there are no changes in direction of the particulate sample. This is an example only that includes the wall mounting bracket, rain cap and insect screen, PM 2.5 size selective inlet, 2-meter aluminium tubing, roof flange and silicone tubing. Other variations may include longer flexible silicon tubing to offset the connection to the nephelometer. Not all installations will use the PM2.5 size selective inlet. Some installations will require the connection to a common sample inlet manifold that is connected to other instruments used for aerosol monitoring.

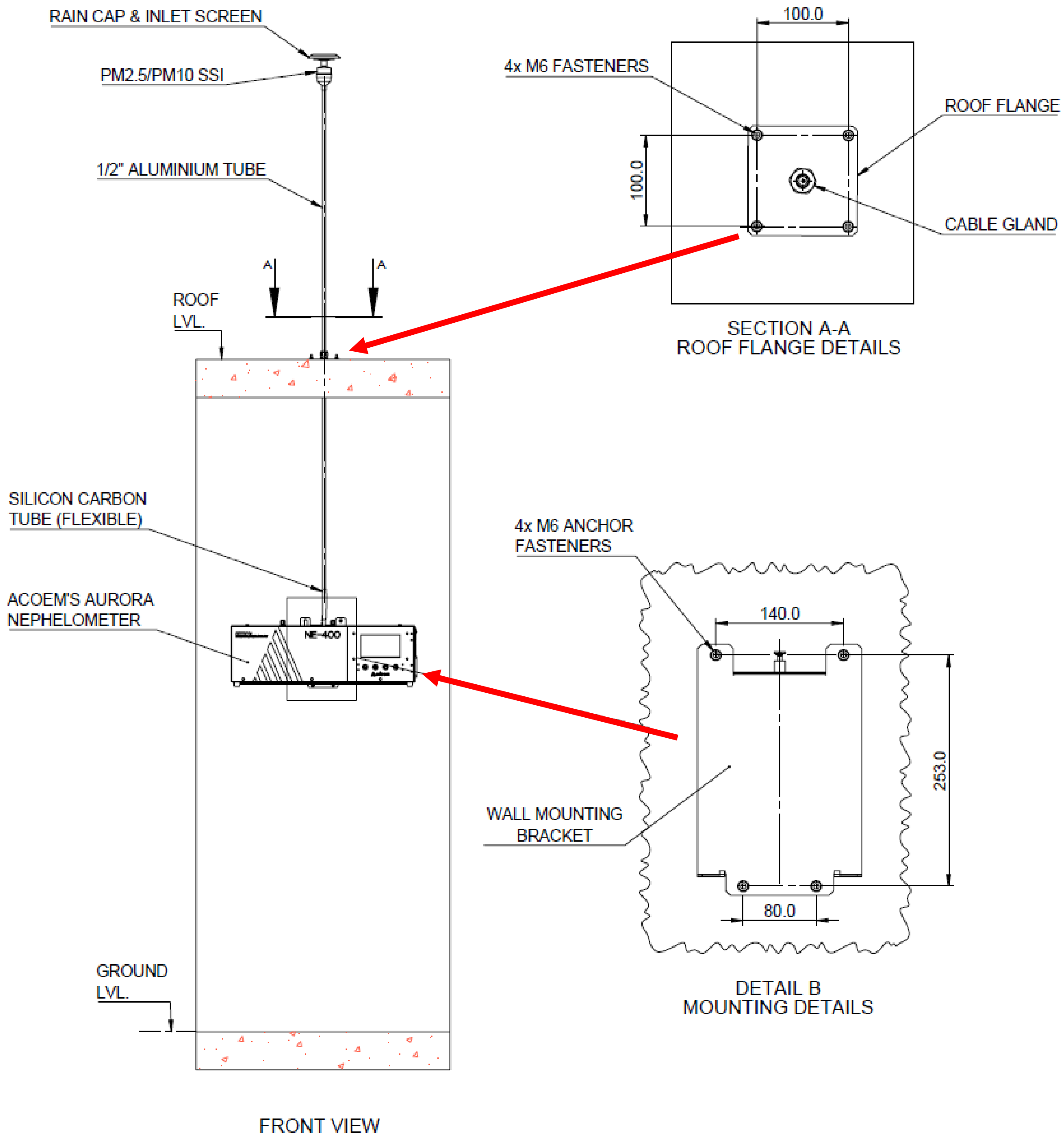


Figure 36 – Sample inlet Installation

2.2.4 Wall Mounting Bracket Installation

The wall mounting bracket option is used to mount the Aurora NE to a flat vertical surface. There are two versions of this option: Factory Installed and user installed. For the factory-installed version (E010112), the anti-rotation panel is already installed. Proceed straight to step 3 in Figure 42.

For the user-installed version (E010113), the anti-rotation panel will need to be changed. Proceed to step 1 in Figure 37 – Wall Mount Bracket Installation Step 1Figure 36.

Step 1: Remove the four M5 CSC screws in the top of the anti-rotation panel and remove the panel. See Figure 36.

Step 2: Replace the anti-rotation panel with the new panel supplied with the wall mounting bracket. This new panel has a rectangular cutout for the top of the wall mounting bracket. Insert the four M5 CSC screws and tighten to hold the new anti-rotation panel. See Figure 38.

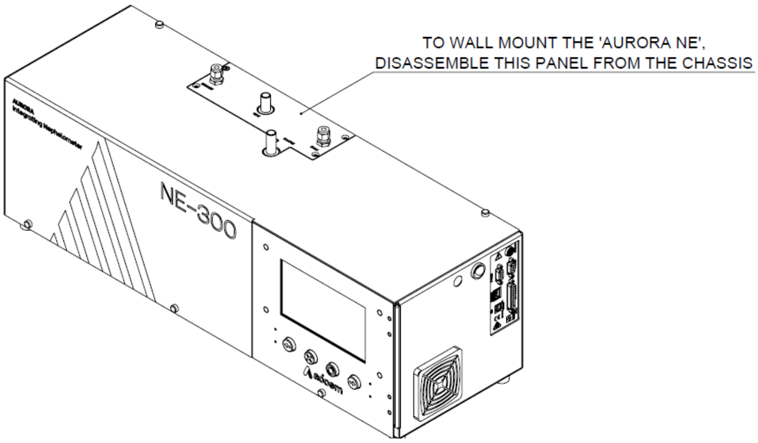


Figure 37 – Wall Mount Bracket Installation Step 1

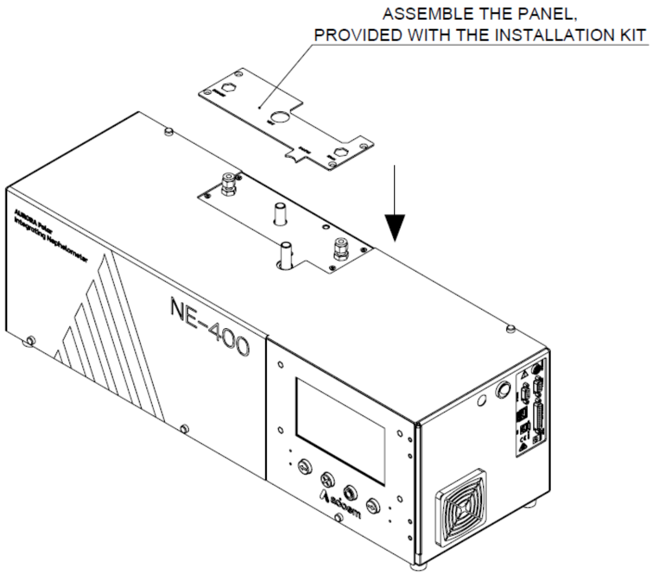


Figure 38 – Wall Mount Bracket Installation Step 2

Step 3: Mount the wall mounting bracket to the vertical wall at a suitable height and location, making sure that it is straight and the sample inlet tube can be lined up directly with the sample inlet of the nephelometer. Four anchor fasteners will need to be installed into the wall. These need to be of suitable size (at least M6) and strength to hold the wall mounting bracket and nephelometer. Concrete or brick walls will need to use Dyna-bolts and a plaster wall will need to use a heavy-duty plaster anchor.

When the wall mounting bracket is securely installed, mount the nephelometer onto this bracket by first locating the two small slots at the bottom of the chassis. Then insert these on the bottom of the wall mounting bracket. Then rotate the nephelometer chassis up until the top of the wall mounting bracket slides into the anti-rotation panel. Tighten the large thumb screw on the top of the wall mounting bracket so that it securely holds the nephelometer in place. See Figure 39.

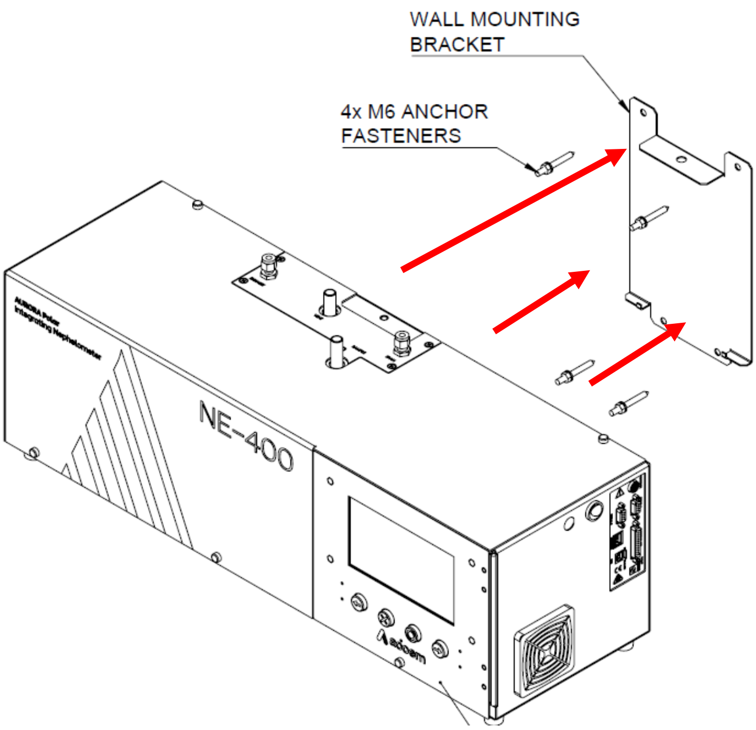


Figure 39 – Wall Mount Bracket Installation Step 3

2.3 Instrument Set-up

After installing the instrument, the following procedures should be followed to ready the instrument for monitoring.

2.3.1 Power Connections

CAUTION
Always unplug the equipment prior to removing or replacing any components.

CAUTION
Do not replace the detachable mains supply cord with an inadequately rated cord. Any mains supply cord that is used with the instrument must comply with the safety requirements (250 V/10 A minimum requirement).

CAUTION
Ensure that the mains supply cord is maintained in a safe working condition.

CAUTION
When connecting the mains power to the instrument, the following must be adhered to otherwise the safety and the reliability of the instrument may be compromised.

- A Three-pin mains power lead with a protective earth conductor **MUST** be used.
- The mains power outlet (wall socket) must be in the range of 100 - 240 VAC, 50 - 60 Hz.
- The mains power outlet must be protected by an earth leakage protection circuit.
- Use only the supplied 24 V power supply pack supplied with the instrument.
- Plug the 4-pin connector of the power supply into the Power In connector on the side panel, with the flat side facing the front of the instrument.
- To remove the power connector, slide the black outer housing of the connecter to unlock and then pull straight out.
- The power switch is located next to the Power In connector and must also be turned on (switched down) for the instrument to operate.

Figure 40 – Power Connector removal

2.3.2 Pneumatic Connections

Figure 41 – Pneumatic Ports

The Aurora NE Series instrument has four pneumatic port connections: SPAN, SAMPLE, VENT, and EXHAUST.

Span Port

- **Purpose:** Connects to the calibration (span) gas delivery system.
- **Connection:** Uses a 1/4" brass fitting. Ensure it is tightly fastened to prevent calibration gas leaks.
- **Setup:** Follow the calibration section instructions (refer to Section 5) for the correct setup and connection of the calibration gas.

Sample Port

- **Purpose:** Main sample inlet connection.
- **Connection:** 1/2" aluminium port with an O-ring seal.
- **Maintenance:** The inlet can be removed and replaced with a longer tube if needed.
- **Storage/Transport:** Close this port with the supplied black rubber cap to prevent insects and debris from entering the cell.

Vent Port

- **Purpose:** Vents span gas during calibration or precision checks.
- **Connection:** 1/2" aluminium port with an O-ring seal.
- **Maintenance:** The vent can be connected to additional 1/2" tubing if the calibration gas needs to be vented outside. It can also be replaced with a longer tube if required.
  Storage/Transport: Close this port with the supplied black rubber cap to prevent insects and debris from entering the valve.

Exhaust Port

- **Purpose:** Where the exhaust from the internal pump exits.
- **Connection:** 1/4" brass fitting.
- **Usage:** This port can be left unconnected. For additional noise suppression, connect a longer length of tubing.

General Good Practice

- **Ensure Tight Connections:** Make sure all fittings are securely fastened to avoid leaks.
- **Proper Storage:** Use the supplied black rubber caps for the sample and vent ports during transport or storage to keep out insects and debris.
- **Accessibility:** Ensure all ports are easily accessible for maintenance and connection purposes.
- **Follow Guidelines:** Adhere to the manufacturer’s guidelines for installation and maintenance to ensure optimal performance and longevity of the instrument.

CAUTION

The exhaust port is pressurised and should never be blocked or restricted.
Ensure the red cap is removed after shipping.

2.3.3 Communications Connections

There are a number of ways to communicate with the instrument, refer to Section 4 for further details.

2.3.4 Instrument Set-up

The Aurora NE Series Multi Wavelength Nephelometers will be delivered in a default configuration that in most installations will be suitable. The user may want to change some settings to suit their specific needs or regulations. Listed below are the factory settings.

Table 9 – Factory Settings

Instrument Setting	Factory Setting	Manual Section
Normalisation Temperature	0°C	Refer to section 3.4.3.1
Sample Flow	6.0 slpm	Refer to section 3.4.5.5.1
Sample Heater	Off	Refer to section 3.4.5.5.1
Cooler Temperature	>20°C (for NE-300 & NE-400 only)	Refer to section 3.4.5.5.1
Calibration Gas	CO_2	Refer to section **Error! Reference source not found.**
Cal Purge	15 to 30 minutes (depending on instrument settings)	Refer to section **Error! Reference source not found.**
Number of Angles	0 for NE-100, 2 for NE-300, 18 for NE-400.	Refer to section 3.4.3.1

Instrument Setting	Factory Setting	Manual Section
Filter (Calibration)	Kalman	Refer to section 3.4.3.2

The instrument is shipped fully calibrated. Transportation, vibration, and atmospheric conditions may cause some short-term drift in the instrument's calibration. On initial power up the instrument measurements should be close to what is expected. It is good to check for any abnormal readings or errors that may have arisen from transportation by operating the instrument for a couple of hours. However, if the instrument is being setup for long-term measurements, then a full calibration must be performed.

2.4 Transporting/Storage

Transporting and storage of the instrument should be done with great care. It is recommended that the packaging the Instrument was delivered it should be used when transporting or storing.

When transporting or storing the instrument the following points should be followed:

1. Turn OFF the instrument and allow it to cool down for 10 minutes at least.
2. Disconnect all connections of pneumatic pipe, power cables and communication cables from the instrument.
3. If the instrument is wall mounted, remove it from the wall mount bracket.
4. Make sure all the 4 pneumatic ports are blocked using the supplied caps and plugs. This will prevent insects from making a home inside the cell.

Figure 42 – Pneumatic Ports Plugged and Capped

5. Place the instrument back into a plastic bag with desiccant packs and seal the bag (ideally the bag supplied upon delivery).
6. Place the instrument back into the original foam and box it was delivered in. If this is no longer available find some equivalent packaging that provides protection from damage. Make sure there is plenty of packing under the base of the instrument to support the heaviest part of the instrument.
7. Make sure any accessories supplied with the instrument such as the power supply, are kept in the box as well so that nothing is lost.

Note: Acoem Australasia recommends to use the same packing material in which the instrument is delivered.

8. The instrument is now ready for long-term storage or transportation.

This page is intentionally blank.

3. Operation

3.1 Warm-Up

When the instrument is first turned ON it must go through a short period of adjustments and warmup. No measurements are taken during this warm-up period.

The following activities occur during warm-up:

Electronics Initialisation

On power up, then main microcontroller will establish communications with the main hardware components such as the light source, sensors, LCD and converters to check that they are functioning.

Sample Flow

The sample pump speed will slowly increase until the desired sample flow setpoint is reached.

PMT Cooler

The PMT cooler supply will increase until the cooler temperature reaches its set point or its maximum output.

Sample Heater

If enabled, the sample heater will begin heating the sample until the desired temperature or RH setpoint is reached. This will take a number of minutes. The beginning of the measurement process is not dependent on it.

Reference Shutter

On warm up the reference shutter will be enabled and the LEDs will be pulsed so that an initial reference shutter count can be made, as well as allowing the LEDs to warm up.

PMT Cooler

The PMT cooler supply will increase until the cooler temperature reaches its set point or its maximum output. This is not applicable for NE-100.

3.2 Measurement

The Aurora NE Series Multi Wavelength Nephelometers will continually cycle through a sequence of measurements to provide the parameters needed to calculate the final scattering measurements. Refer to section 1.4.3 (Measurement Sequence) for sequence details for each instrument type.

3.3 General Operation Information

The primary interaction with the instrument is through the colour touch screen on the front panel. This interface allows the user to changes settings, obtain readings, view diagnostics and perform calibrations.

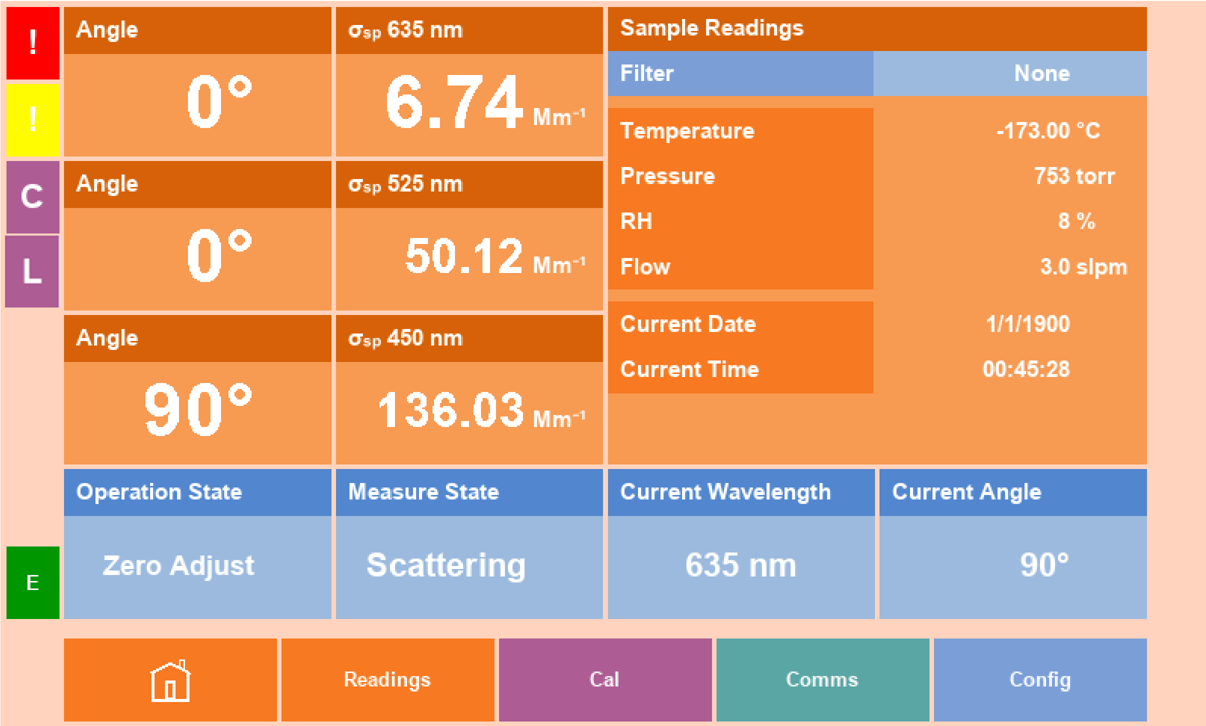


Figure 43 – Example - Colour Touch Screen for an Aurora NE-400

The user interface is designed to be interactive. Learning a few underlying concepts will make it much easier to navigate.

3.3.1 Objects

There are several kinds of objects used on the screen. Objects are generally only visible when they make sense; for instance, the alert on the left side of the screen that indicates the calibration mode only appears when the instrument is in a calibration mode.

Table 10 – List of Screen Objects

Object Name	Object Description
Fields	Display a number or text string
Buttons	Perform an action
Switches	A simple on-off button that shows its current state (green for on, red for off)
Alerts	An alert
Panels	A list of fields and buttons with a scroll bar to reveal more items

Object Name	Object Description
Menus	Pop-up menus
Dialogs	Pop-up dialog boxes
Single Field Widget	Display a number or text string within its own panel
Keypad	Pop-up keypad to enter numerical data

3.3.2 Pages

Each screen is a page, with a name and a unifying concept. Pages are coloured according to their general area of concern.

The general screen layout has a row of navigation buttons across the bottom, and a column of alerts on the left-hand edge.

The rest of the page will be dedicated to showing information. Usually, this consists of one or more fields and panels.

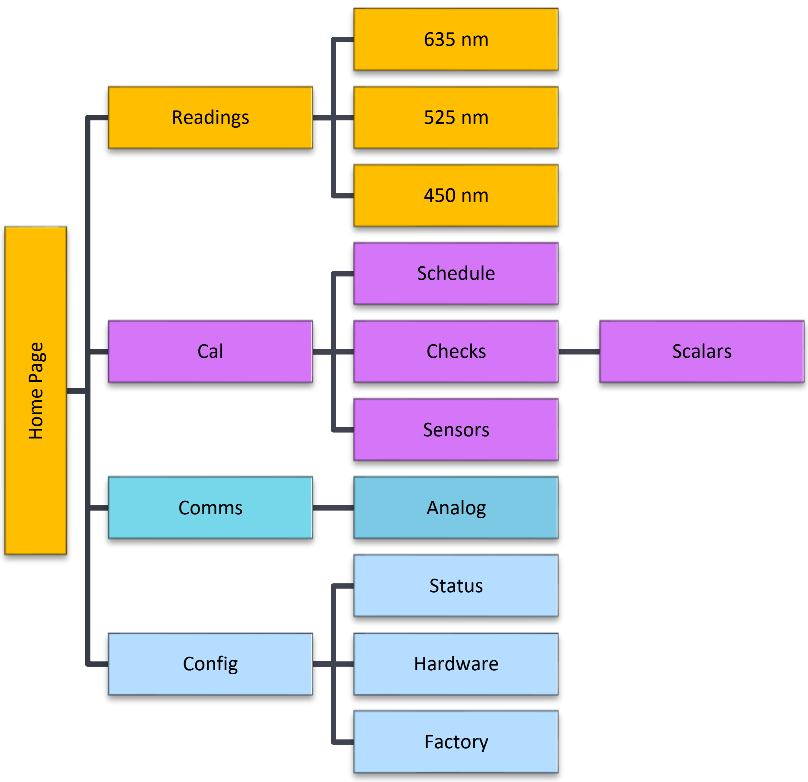


Figure 44 – Page Structure

3.3.2.1 Navigation buttons

Each button shows the name of the page it will open. Once a page is opened, the navigation row will show its child pages, if this page has any; otherwise, it will show its siblings.

The current selected page button will be the same colour as the background; touching the button again will move back up one page. The Home page button is always the first button. However, you can also touch and hold any navigation button to open a menu showing your current location and use that to go to any higher or lower page.

3.3.2.2 Alerts

The alert system along the left side of the screen is intended to make you aware of certain events. Generally speaking, any of these buttons will open a dialog box that has more detail. Once the event is resolved the alert will disappear.

Table 11 – List of Alerts

Alert Name	Alert Description
E	An event has occurred, such as the user changing a system parameter.
!	There is a current error
!	There is a current warning
C	The system is currently in a calibration state
L	The system is currently performing a Leak Check

3.3.3 Interactions

The user interface operates off on two general concepts, touch and hold. Those objects that you can interact with may use one or both of these methods, depending on what they need to do.

3.3.3.1 Touch

Touching an object on the screen will usually activate its primary purpose. For buttons, this does the action associated with the button; for switches, it will change the state of the switch; for fields, it will often allow you to edit the object by entering a new number or making a selection from a list.

3.3.3.2 Hold

Holding the touch for half a second will bring up the secondary interactions with the object. This almost always means opening a menu.

Figure 45 – Touch and hold feature

3.4 Pages, Menus & Panels

3.4.1 Home Page

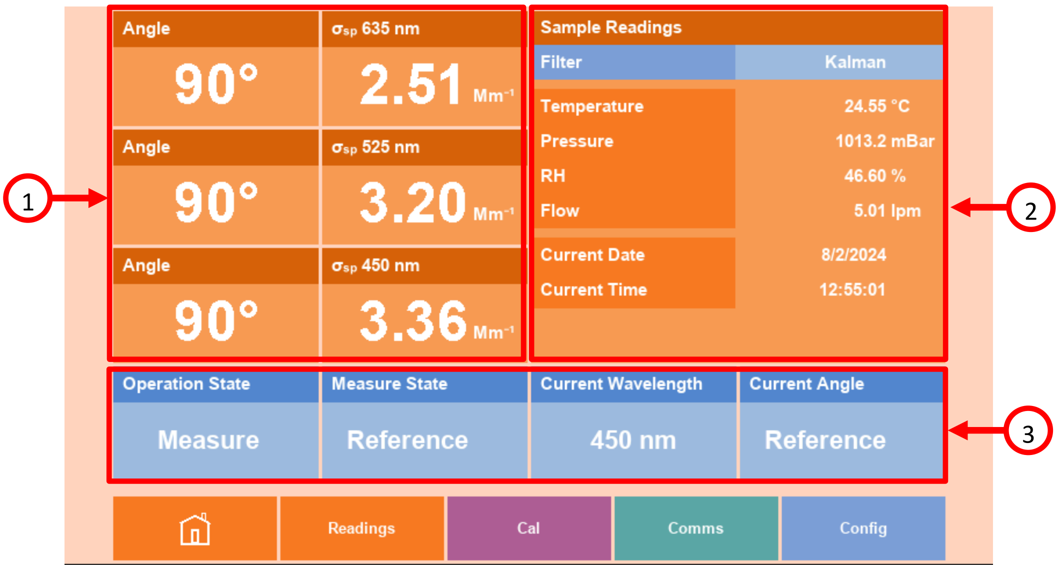


Figure 46 – Home Page (NE-400)

The home page for the Aurora NE Series is divided into three areas; **current readings (1)**, **sample readings (2)** and **instrument state (3)**. The data displayed in these areas will vary depending on the instrument type.

3.4.1.1 Current Readings

For the NE-100, there is a single field widget for the chosen full scatter wavelength that is updated after every measurement cycle.

Figure 47 – Current Reading Single Field Widgets (NE-100)

For the NE-300, the widgets display all the readings for each full scatter wavelength as well as the readings for the backscatter measurements. These are updated after every measurement cycle.

Figure 48 – Current Reading Single Field Widgets (NE-300)

For the NE-400, the current angle for each wavelength is displayed on the left, followed by the sigma for that angle on the right. The angle values will cycle through all the measured angles as they are taken. Each angle and sigma are presented in a single field widget.

Figure 49 – Current Reading Single Field Widgets (NE-400)

Note: If you use the press and hold method on any of the three sigma widgets you will get a pop-up menu that allows you to change the decimal places for all sigma values.

3.4.1.2 Sample Readings

Some basic information is presented in this panel, represented by the following fields:

- The filter type applied to the displayed readings
- The current sample temperature, pressure, RH, and flow within the measurement cell
- The current date and time

These parameters are continually updated and are the same for each instrument type.

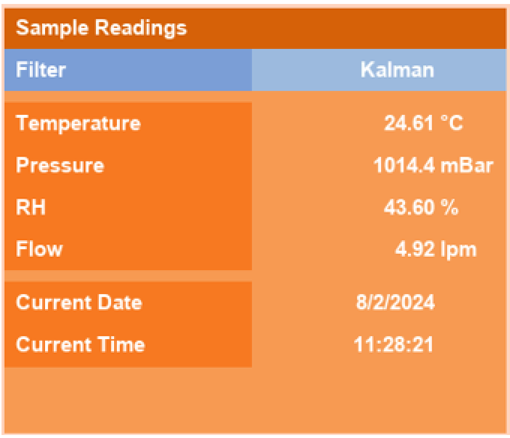


Figure 50 – Sample Readings Panel

Note: The filter can be changed at any time; the Aurora calculates all of the filtered values (None, Kalman, 1 minute, 5 minutes, and Rolling Average) for every measurement. The filter selection merely controls which one is displayed.

3.4.1.3 State

The blue single field widgets at the bottom indicate the current state of the measurement:

- Operation Measure mode or a calibration operation

- Measure — Reference, dark count, or scattering
- Wavelength — Currently being measured 635nm, 525nm, 450nm. (NE-300 and NE-400 only)
- Angle — Currently being measured (Full or Back for NE-300) (0 to 90 for NE-400)

Figure 51 – State Single Field Widgets

3.4.2 Readings

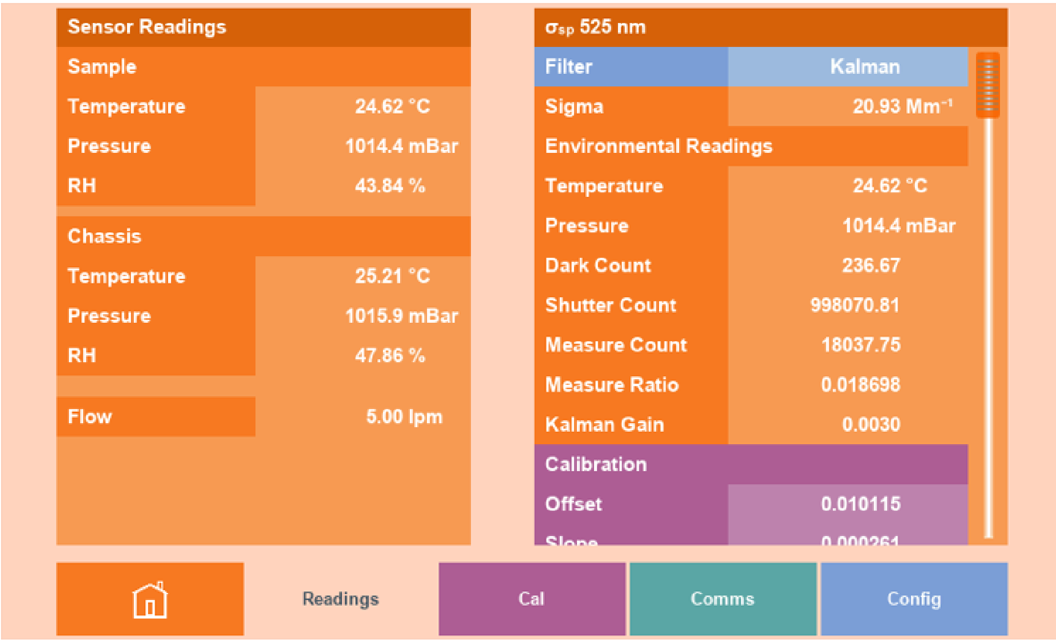


Figure 52 – Readings Page (NE-100)

This page shows all of the environmental sensor and sigma readings. The information on this page will vary depending on the instrument type.

Note: If the Aurora NE Series is configured to measure its full complement of three wavelengths and twenty angles, the panel on the right will be quite long. Use the scroll bar to move up and down the list.

3.4.2.1 Sensor Readings

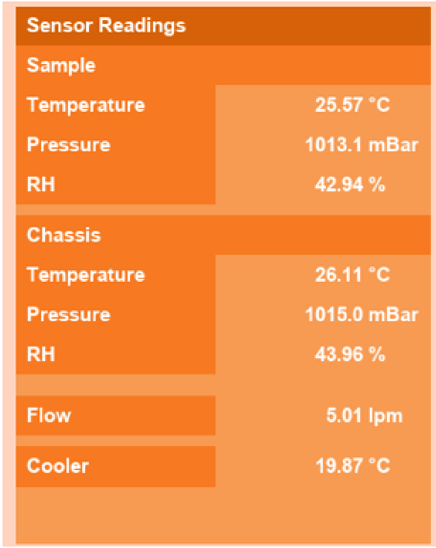


Figure 53 – Sensor Readings Panel

The environmental sensor information is presented in this panel. The information is grouped by headings and represented by the following fields depending on what hardware is enabled and instrument type:

Sample

- The current sample temperature, pressure, RH

Chassis

- The current chassis temperature, pressure, RH

Flow

- The current sample flow

Cooler

- The current PMT cooler temperature (NE-300 and NE-400 only)

Note: If you use the press and hold method on any of these readings you will get a pop-up menu that allows you to change the decimal places and units.

3.4.2.2 Sigmas NE-100

The sigma information is presented in this panel for the selected wavelength. There is no angle information because the NE-100 only measures Full scattering at one wavelength. All the parameters used in the calculation of this sigma are listed as follows:

- Wavelength
- Filter Type
- Sample Temperature and Pressure
- Dark count, Shutter count and Measure count
- Measure ration and Kalman gain
- Calibration Offset, Slope and St Correction
- Measurement time

Figure 54 – Sigma Panel NE-100

Scroll to the bottom of this panel to see all the information.

3.4.2.3 Sigmas NE-300

This panel displays all the Full and Back scattering measurements for each wavelength.

All the parameters used in the calculation of each sigma (similar to Figure 54) are found in the wavelength child pages (635nm, 525nm, or 450nm). Touching one of the wavelength pages will display two panels. The left panel is for Full scattering and the right panel is for Back scattering for that wavelength.

Figure 55 – Readings Page (NE-300)

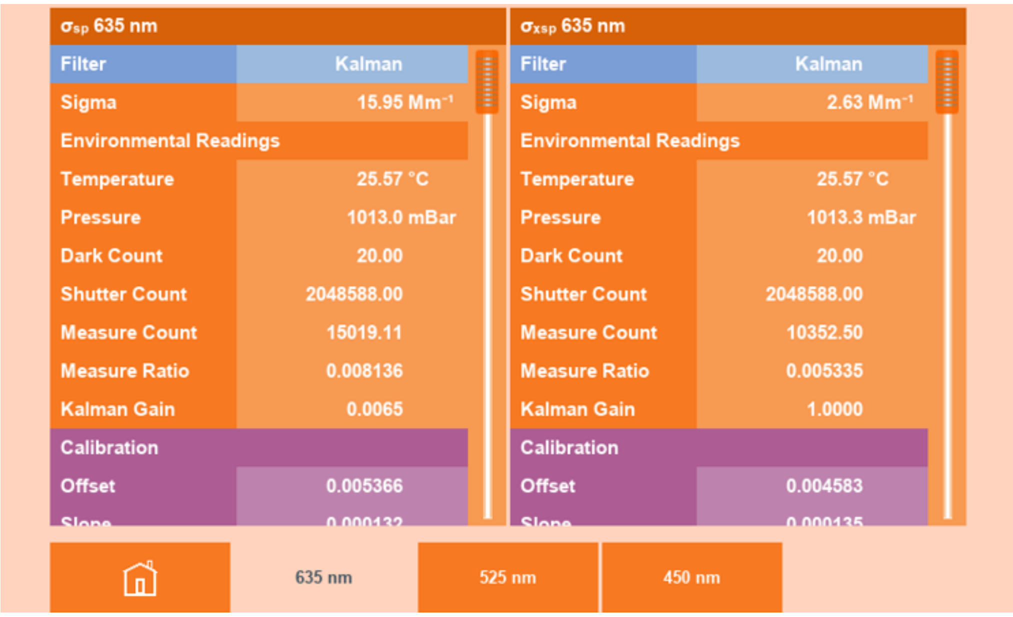


Figure 56 – Sigma Child Page NE-300 (635nm)

Scroll to the bottom of each panel to see all the information.

3.4.2.4 Sigmas NE-400

This panel displays the scattering measurements for each wavelength and angle. Scroll to the bottom of the Sigmas panel to see all the readings.

Figure 57 – Readings Page (NE-400)

> **Note:** If the Aurora NE-400 is configured to measure its full complement of three wavelengths and up to twenty angles, this panel will be quite long. Use the scroll bar to move up and down the list.

Touching one of the wavelength child pages (635nm, 525nm, or 450nm) will display All the parameters used in the calculation of the sigma for that wavelength and angle. Similar to Figure 54.

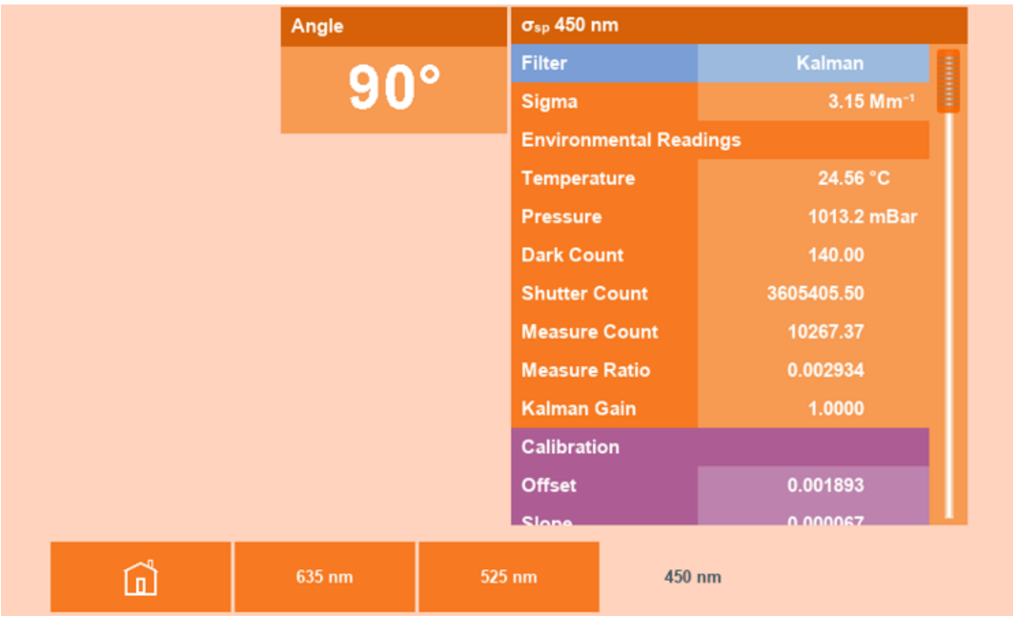


Figure 58 – Sigma Child Page NE-400 (450nm, 90°)

By touching the Angle single field Widget, a popup menu will appear allowing the user to select which angle's information is displayed on the wavelength panel. The number of angles that appear in the popup menu list will depend on the number of angles selected in the measurement settings panel on the Cal page (refer to Section 3.4.3).

3.4.3 Cal

The Cal page and child pages allow configuration of the measurement and calibration activities. This page is broken up into three main sections: **Measurement Settings** panel, **Calibration Settings** panel, and the **Calibration Files** button. The child pages are **Schedule**, **Checks** & **Scalers** and **Sensors**. These pages will vary depending on the instrument type and whether Enable Service Menus is activated. (See Section 3.4.5.5.1 for details on how to Enable Service Menus in the Config Page).

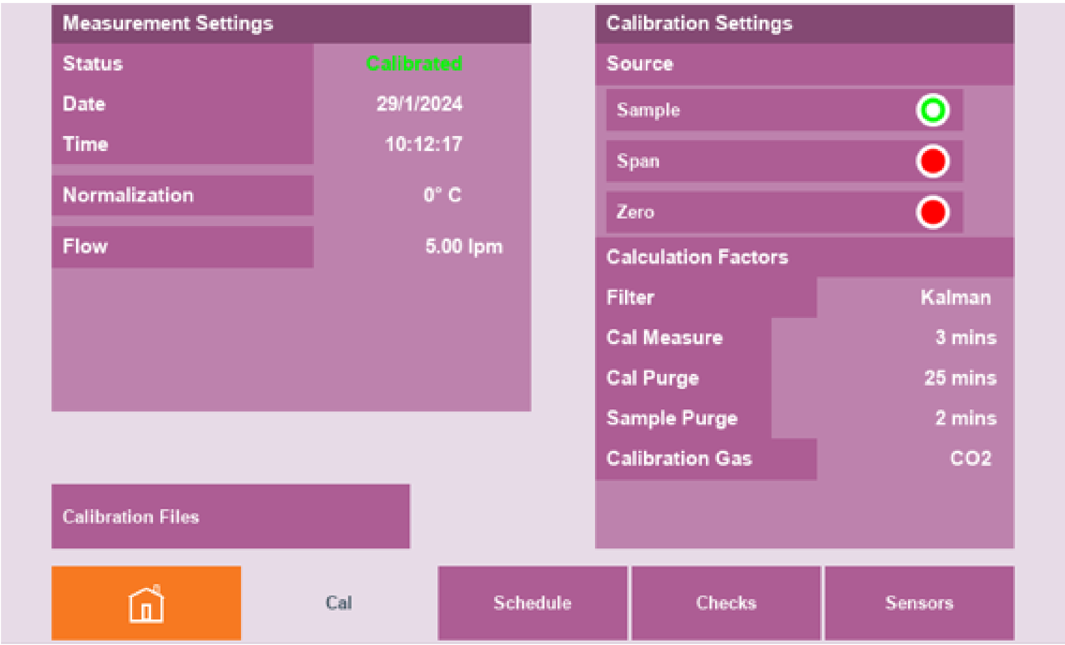


Figure 59 – Calibration Page (NE-100)

Note: It is important to refer to section 5 (Calibration) for details on the of the instrument setup, before commencing a calibration. In many situations, it is common to set the instrument so that it is performing a scheduled daily zero and span precision check, whereas span calibrations are performed manually on a less frequent basis. Consult your local regulatory bodies for direction on calibration requirements as well.

3.4.3.1 Measurement Settings

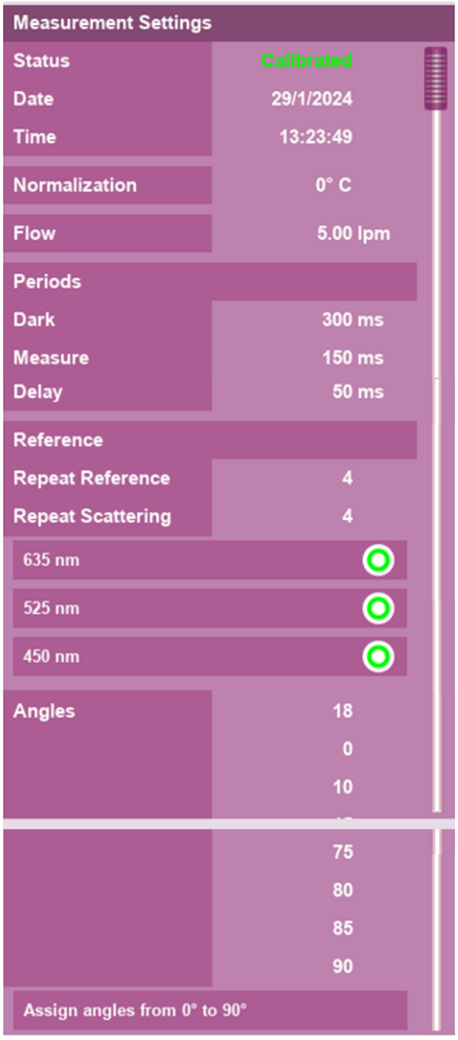


Figure 60 – Measurement Settings Panel NE-400 (Service Menus enabled)

The measurement settings panel contains a series of parameters that are critical to the operation and calibration of the instrument.

The information is represented by the following fields:

- **Status**: - The status field lets you know if the system has been fully calibrated. If relevant measurement settings have been changed, the status will change to Uncalibrated. You can manually over-ride it if you are certain your calibration is still valid.
    - **Date, Time: -** The date and time of the last valid calibration. These fields only appear when the status is set to calibrated.

- **Normalization**: - The normalization temperature used in the calibration (0, 20, or 25 °C) is shown.
- **Flow**: - The sample flow rate of the instrument is set here. Further parameters relating to sample flow can be set in the Hardware child page, refer to section 3.4.5.5. Note that the flow rate of the calibration gas is set independently.

- **Periods**: - The time periods for the measurement control the LEDs. These are factory settings and should not be changed without advice. These parameters are only displayed then Service Menus are enabled.
    - **Dark**: - The period when the LEDs are off and is a background reference measurement recorded as the Dark Count.
    - **Measure**: - The period when the LEDs are on during scattering measurements for each wavelength. This results in the calculation of the Measure Count.
    - **Delay**: - The additional amount of time the LED is on before photon counting commences (allowing the LED output to stabilize).
- **Reference**: - These parameters are only displayed then Service Menus are enabled and cannot be edited.
    - **Repeat Reference**: - Controls how many averages are in the reference measurement resulting in the calculation of the Shutter Count
    - **Repeat Scattering**: - Controls how many complete scattering measurements (each wavelength/angle combination) are done before the reference is recalculated.
- **Wavelengths - 635 nm, 525 nm, 450 nm**: - These buttons are only displayed then Service Menus are enabled. The wavelength buttons control which wavelengths are included in the measurement. Normally for the NE-300 and NE-400, all three are of interest. For the NE-100, only one wavelength can be selected at a time and the 635 nm measurements requires the wide bandwidth PMT option.
- **Angles**: - For the NE-100, no information is displayed here. For the NE-300, two buttons will appear for Fullscatter (0°) and Backscatter (90°).

  For the NE-400, the Angle field controls how many angles are measured. This value can be from 1 to 20. Below this is the list of actual angles that will be measured, specified in degrees. It is strongly advised that the angles be in ascending order. The **Assign angles from 0° to 90°** button will automatically fill out the angle list for you in even increments. The Reference Parameters will change automatically to suit the number of angles selected.

When changes are made to the Measurement Settings, two buttons appear (refer to Figure 61). Selecting Cancel will revert the changes without any effect; selecting Accept will cause a popup confirmation box to appear giving the user a second chance to revert the changes. selecting Accept will stop the current measurement cycle and restart it with the new settings It will also cause the calibration status to change to uncalibrated (refer to Figure 62 and Figure 63).

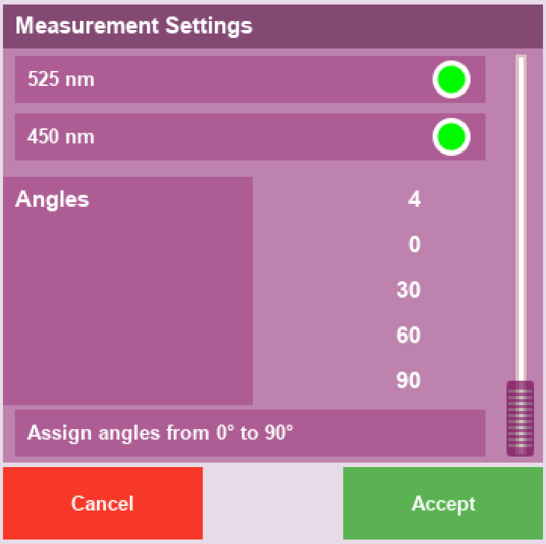


Figure 61 – Cancel and Accept Buttons for Measurement Settings Panel (NE-400)

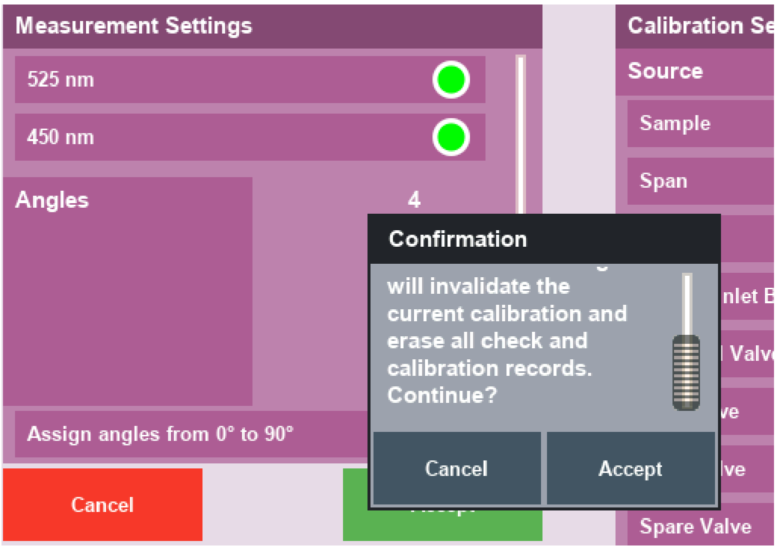


Figure 62 – Popup Confirmation Box

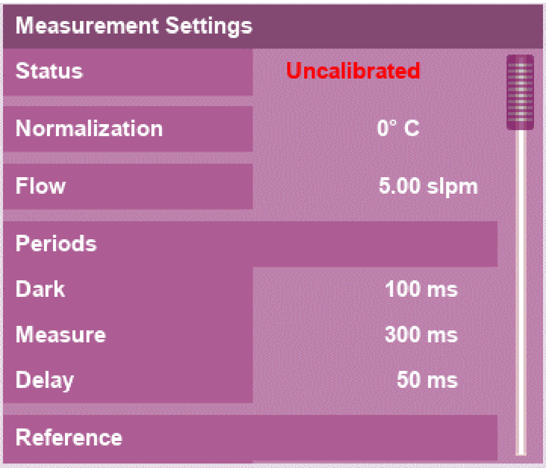


Figure 63 – Status Changing to Uncalibrated

3.4.3.2 Calibration Settings

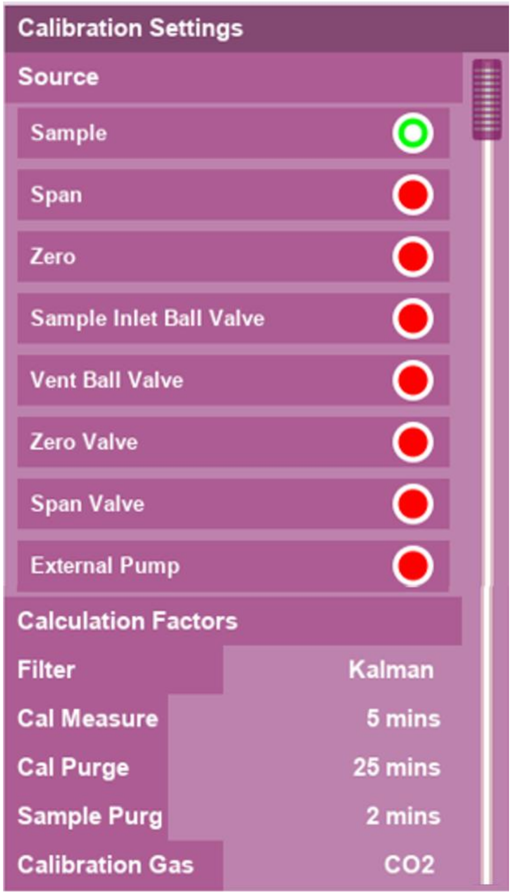


Figure 64 – Calibration Settings Panel (Service Menus enabled)

The calibration settings panel has a series of buttons and settings to control the source of the measurement sample as well as the duration of the calibration sequence. The Calibration Settings panel is the same for all instrument types.

The information is represented by the following headings and fields:

- **Source**: - The indication of the status of the valves used to control the measurement source. When Service Menus are enabled, the status of the four internal valves will be displayed.
  - **Sample**: - Default setting. The measurement cell is continually filled with ambient sample air from the sample inlet. All other valves will be off.
  - **Span**: - The measurement cell is filled with calibration gas from the Span port connection. The sample inlet flow will bypass the measurement cell. The Sample Inlet Ball valve, Vent Ball valve and Span valve will all turn on.
  - **Zero**: - The measurement cell is filled with filtered air from the sample inlet. The Sample Inlet Ball valve and Zero valve will both turn on.

The source can be changed manually or in response to a scheduled calibration or precision check. Scheduled calibrations will change the valves automatically. Manually pressing any one of these valve buttons will turn on the valve and override any previous setting. Be sure not to press these during a calibration. These buttons are only for troubleshooting.

Note: Changing the valves takes approximately 5 seconds, during which time the valve switches will turn grey to indicate they are in transition.

- **Calculation Factors**: - Entries that determine how long a calibration will take and how the instrument will respond. These settings will be different for each instrument type. See section 5 for a list of these settings.
  - **Filter**: - The filter type used to calculate the calibration measurements. None, Kalman, 1 Minute, 5 Minute or Rolling Average. Kalman is the recommended default setting. If selecting Rolling Average, the Rolling window is set in the Config page. This filter setting is independent of the filter setting on the Readings Page.
  - **Cal Measure**: - The period of time the calibration is measured over after the Cal Purge period has ended.
  - **Cal Purge**: - The amount of time to purge the measurement cell with Span or Zero gas before a measurement is taken. This time must be sufficient to allow the readings to stabilize and will be different for each instrument type.
  - **Sample Purge**: - The period of time to allow the measurement cell to fill with sample air after a calibration has been completed.
  - **Calibration Gas**: - Sets the type of Calibration (Span) Gas used to calibrate the instrument. CO2, FM200, R-12, R22, or R-134 are the common types. You must correctly identify the Calibration Gas connected to the Span port before commencing a calibration.

3.4.3.3 Calibration Files

Figure 65 – Calibration Files Button

The Calibration Files button opens a dialog box that saves and loads calibration data specific to the instrument. This page is the same for all instrument types. Calibration files can be saved automatically or manually. From this page, the files can only be named with two numeric digits. However, if the storage medium is removed, then the filenames can be changed to more complex names using a PC. The purpose of this page is to keep backup copies of know instrument calibration data. The Calibration Files can be saved to either the SD card or the USB memory key.

If performing maintenance on an instrument, it might be useful to back up the configuration file before the work has commenced.

For the NE400, the most likely use of this feature is to support changing between the number and degree of angles measured. For instance, you might configure the NE-400 to measure two angles, perform a full calibration, and then take a few minutes of measurements to verify the instrument is performing as expected. Then you might reconfigure the instrument to measure 20 angles, instruct it to recalibrate, and leave it running for a few hours.

If you saved both calibrations to named files (such as 00 and 20), you could easily switch back and forth between the two configurations for quick measurements or extended measurements.

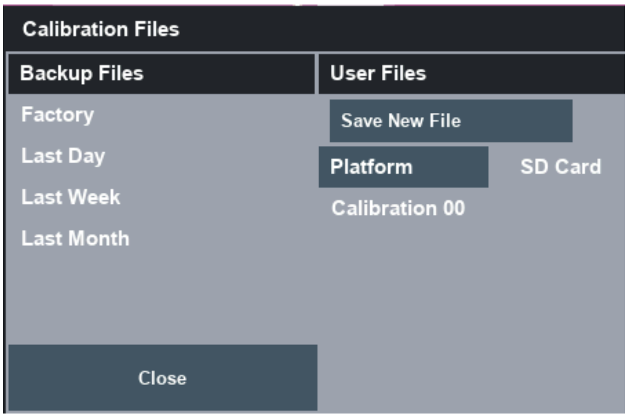


Figure 66 – Calibration Files Dialog Box

3.4.3.3.1 Backup Files

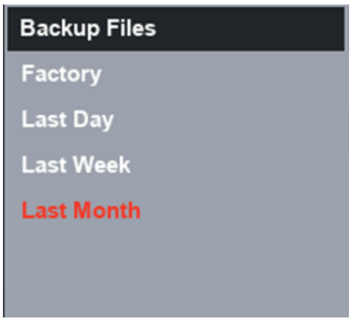


Figure 67 – Backup Files

The backup files section of the calibration files dialog box allows the user to load, a factory backup, last day, last week, or last month. The factory option is a backup of the Aurora NE Series as it left the factory. The last day, last week, and last month are automatic backups made by the instrument. This can be useful for troubleshooting to get you back to a known working calibration.

The backup files are stored on internal memory. To view them, they need to be copied to the USB key. When you use the press and hold method on any one of the mentioned fields the field will change to a light blue background and you get an additional popup menu with the option to load or copy the file.

If one of the files appears RED, it means it has not been saved yet and cannot be loaded.

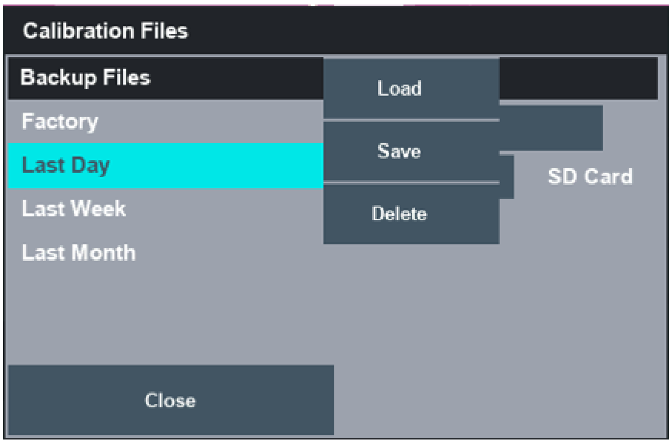


Figure 68 – Last Day Backup File Load/Save/Delete Popup Menu

Selecting load will popup a confirmation dialog box with information about the configuration file (refer to Figure 69). Selecting Accept on the confirmation dialog box will proceed to load the calibration.

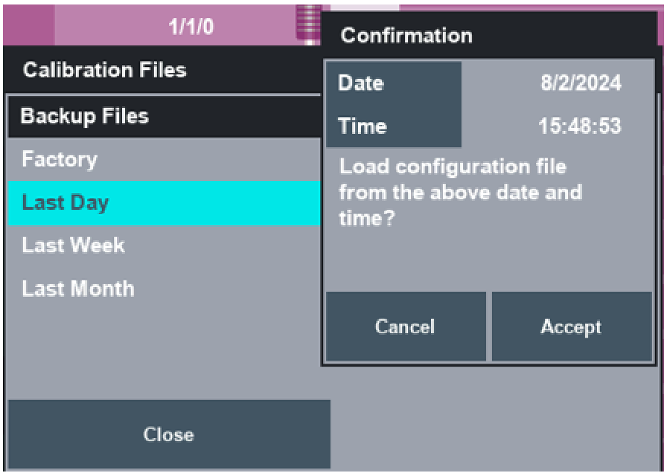


Figure 69 – Last Day Backup File Load Confirmation Dialog Box

Selecting Save will copy the file to the USB.

3.4.3.3.2 User Files

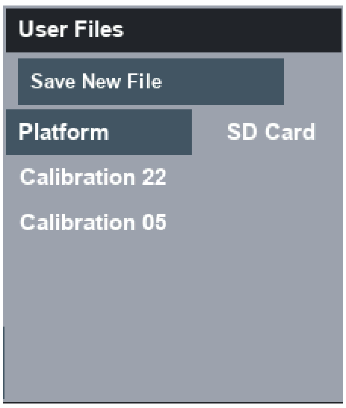


Figure 70 – User Files

In the user files section of the calibration files dialog box, we have a button to save new calibration file configurations, we have a field labelled platform that allows the user to select where the files are stored and under that, we have a running list of calibration saves the user has manually made using the save new file button.

To save a new calibration configuration press the save new file button. This will popup a save dialog box.

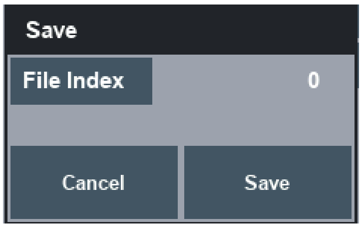


Figure 71 – Save Dialog Box

Using the touch method on the file index will bring up the keypad. Using the keypad type in the number for the calibration save form 0 – 99, then press the Enter key.

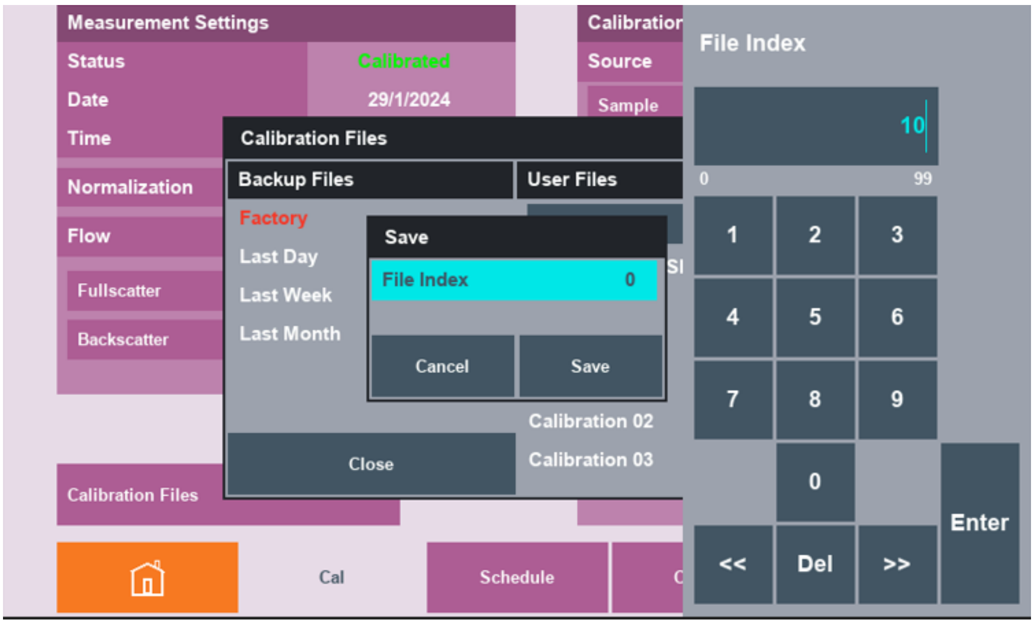


Figure 72 – Changing File Index From 0 to 10

After the save button is pressed a new calibration save is created and added to the end of the list.

Note: New configuration saves are added to the end of the list and are displayed in the order they were saved, not in ascending or descending order.

Selecting any of the Calibration configuration saves from the list with the touch and hold method will popup a menu with the following items, load, save delete, and copy.

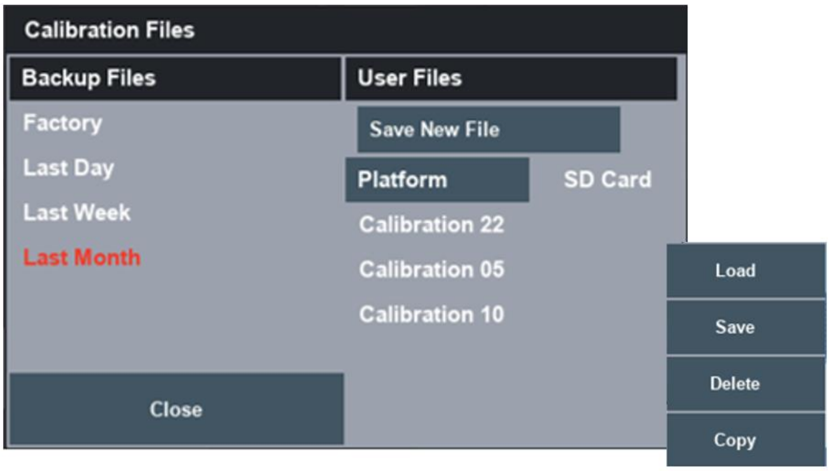


Figure 73 – Calibration Configuration Popup Menu

Note: The user can have a total of 100 calibration saves as the list increases the dialog box will be quite long. Use the scroll bar to move up and down the list.

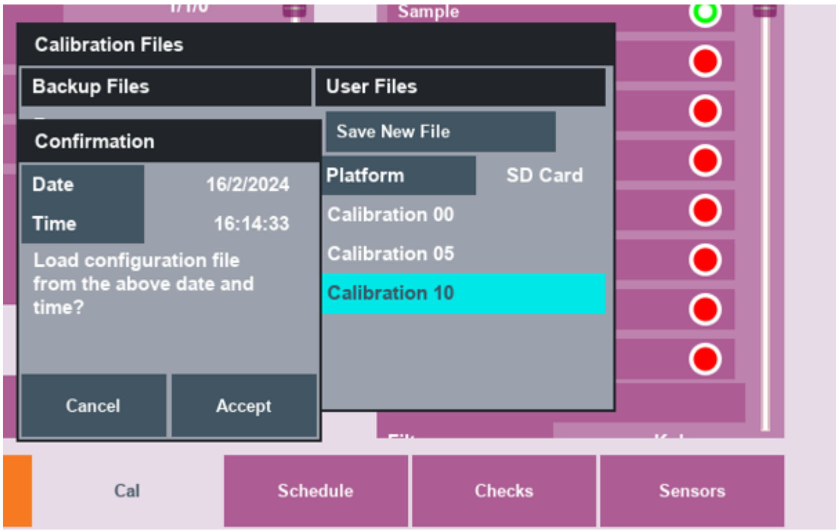


Figure 74 – Calibration Configuration Load Confirmation

Selecting load will popup a confirmation dialog box information regarding the save. Selecting cancel will reject the action and selecting accept will load the user settings.

Selecting save will popup a confirmation dialog box requesting to override the configuration with the current user settings. Selecting cancel will reject the action and selecting accept will override the saved user settings with the current user settings.

Selecting delete will popup a confirmation dialog box quiring the deletion of the user setting configuration. Selecting cancel will reject the action and selecting accept will delete the file removing it from the list.

Selecting copy will immediately copy the selected file to the USB memory key.

3.4.3.4 Schedule

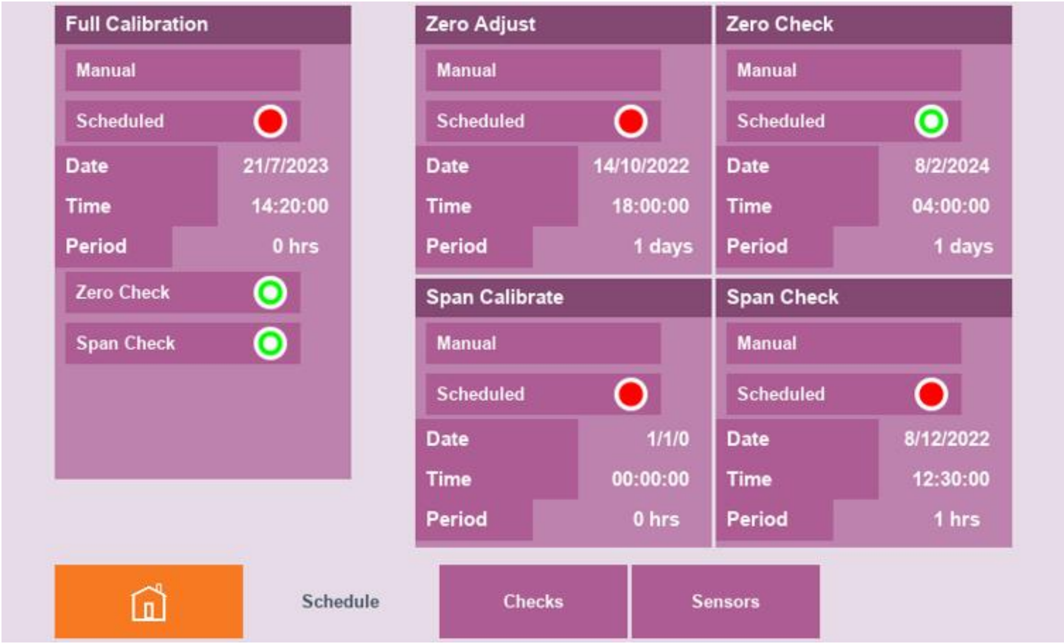


Figure 75 – Calibration Schedule Child Page

The schedule child page allows for the scheduling of calibrations and precision checks. This child page is broken up into five panels, **Full Calibration**, **Zero Adjust**, **Zero Check**, **Span Calibrate,** and **Span Check**. Each of these five calibrations can be initiated independently or combined as one sequence if the Full Calibration method is chosen. Editing the menu of each panel is the same for each and is explained in detail for the Full Calibration below. Only the sequence of events will be different. These settings are the same for each instrument type.

Note: The date and time on each panel are when the next scheduled calibration will occur. To see calibrations that have already been done, go to the checks child page (refer to Section **Error! Reference source not found.**).

Calibrations or checks can either be triggered immediately with the manual button or scheduled for a later time and date. Specifying a period other than “0” will repeat the calibration at regular intervals. Press and hold the Period to select between “days” or “hours”.

3.4.3.4.1 Full Calibration

A full calibration will combine four different calibrations into one sequence. That is: - **Zero Adjust** then **Zero Check** then **Span Calibrate** and then **Span Check**. These results will be stored in the Checks child page (Section **Error! Reference source not found.**). The Zero Check and Span Check is only included if the radio buttons for these are enabled (Green).

Note: If a field with a radio button is red, it is disabled. If it is green, it is enabled. Touching the radio button will alternate its state.

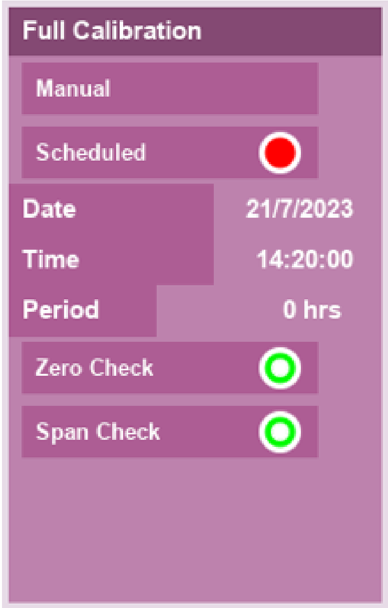


Figure 76 – Full Calibration Panel

3.4.3.4.1.1 Manual Full Calibration

Pressing the Manual button will bring up a confirmation dialog box to commence a Full Calibration.

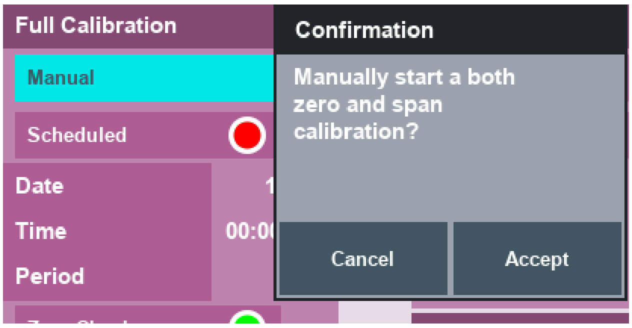


Figure 77 – Manual Full Calibration Confirmation Dialog Box

Selecting Cancel will revert the calibration without any effect; selecting Accept will proceed to start the calibration sequence. When the calibration sequence is started the calibration alert icon will appear on the left of the page. See Figure 81.

3.4.3.4.1.2 Scheduled Full Calibration

The Scheduled Full calibration require four parameters to be set before the calibration will begin.

- **Date** – Enter the date that you want the calibration to begin. Format – D/M/YYYY. Pressing the Now key will automatically enter the current date.
- **Time** – Enter the time that you want the calibration to begin. Format – HH/MM/SS. Pressing the Now key will automatically enter the current time.
- **Period** – Selects the period of time between repeated calibrations. Setting to 0 hrs will only initiate the calibration once. Press and hold to select Hours or Days.

- **Scheduled** – this button must be pressed (Green) in order for the scheduled calibration to commence at the set time.

Once the calibration commences, it will continue in the same sequence as the manual calibration.

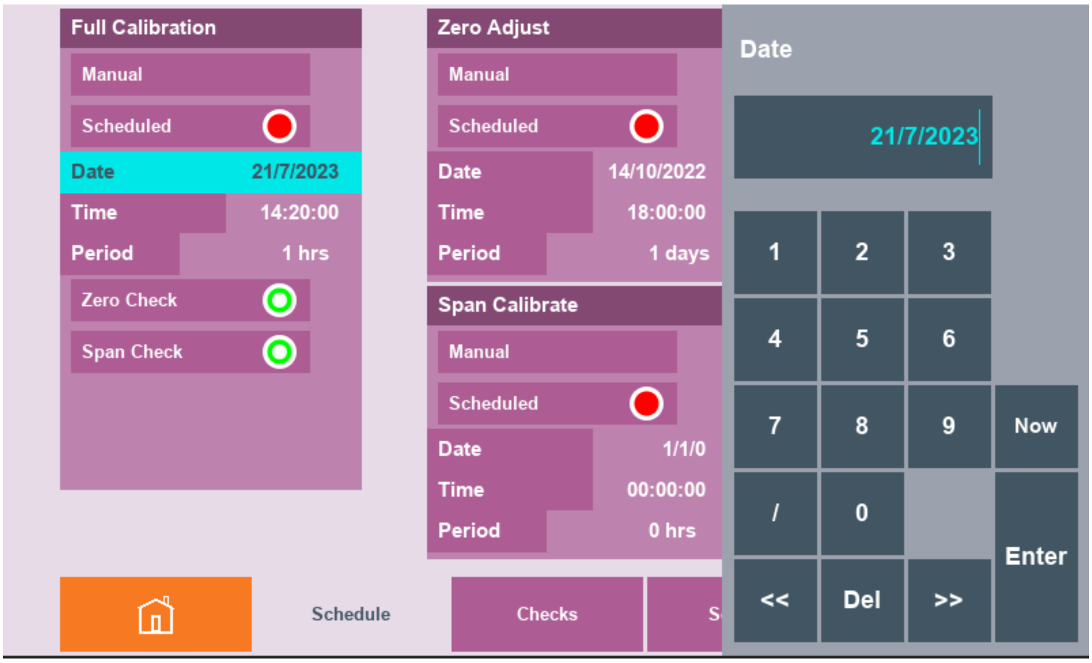


Figure 78 – Setting Scheduled Calibration Date

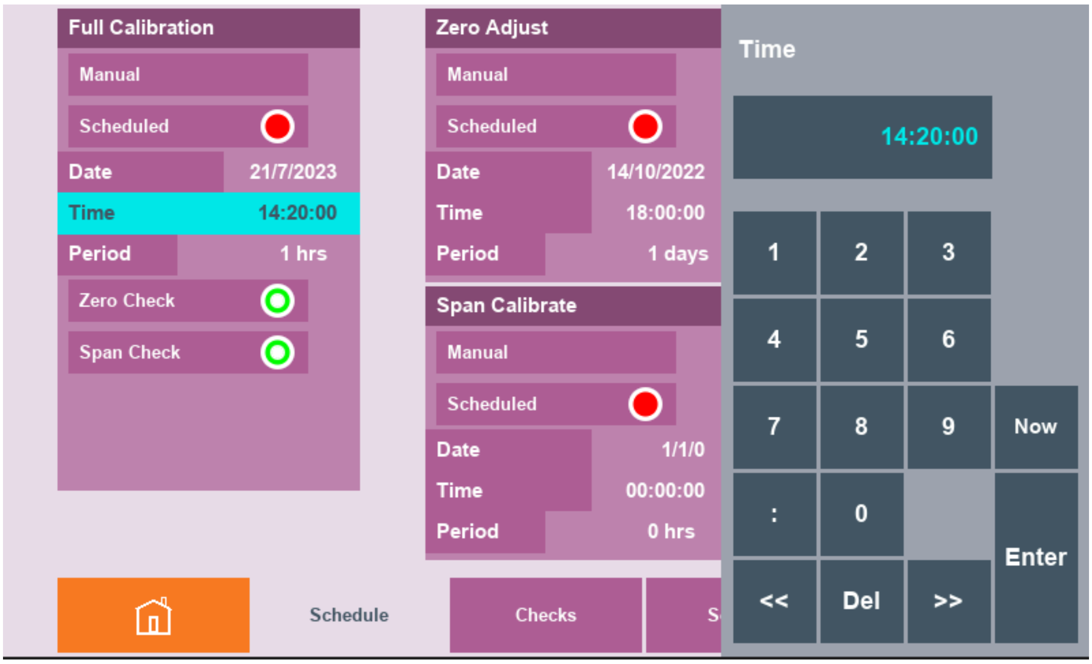


Figure 79 – Setting Scheduled Calibration Time

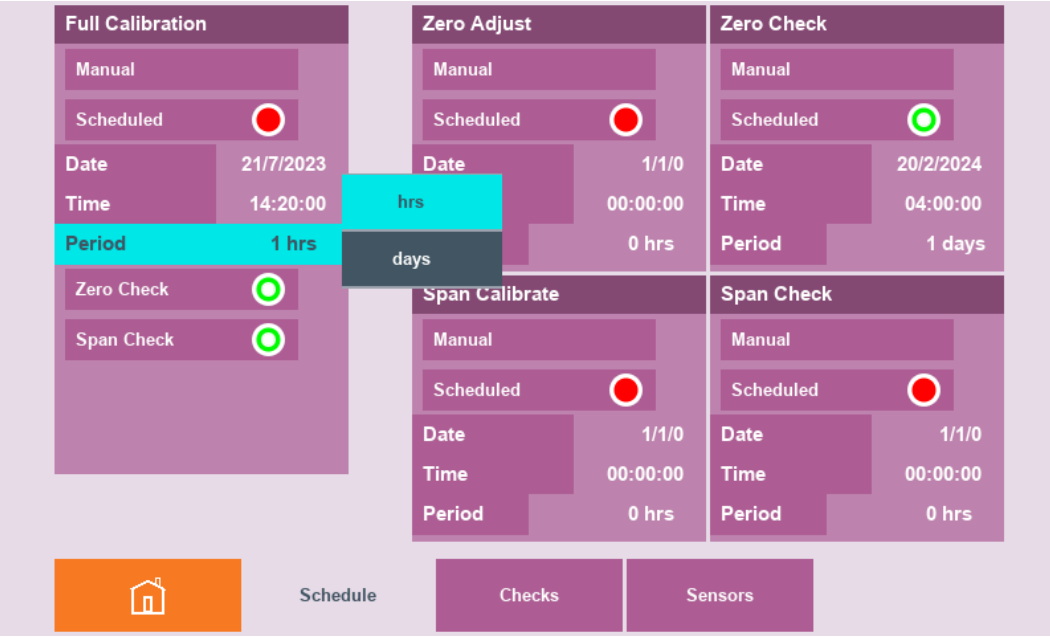


Figure 80 – Setting Scheduled Calibration Period

When the calibration sequence is started (either Manually or Scheduled) the calibration alert icon will appear on the left of the page.

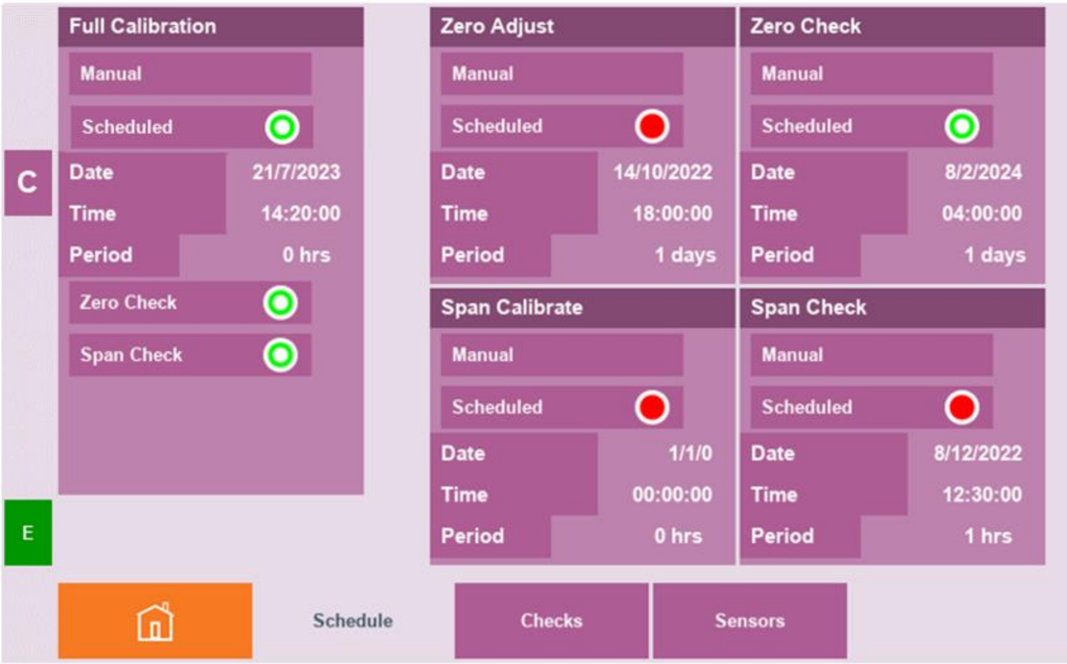


Figure 81 –Started Full Calibration

Pressing the calibration alert will popup a manual calibration dialog box. The dialog box presents the current task, state of the task and time remaining of the task in seconds. It also has a stop calibration button. The current task will change according to which state of the full calibration it is in.

3.4.3.4.1.3 Stop Calibration

If a calibration has started and you decide that you want to stop it, The Stop Calibration function on the popup dialog box can be pressed.

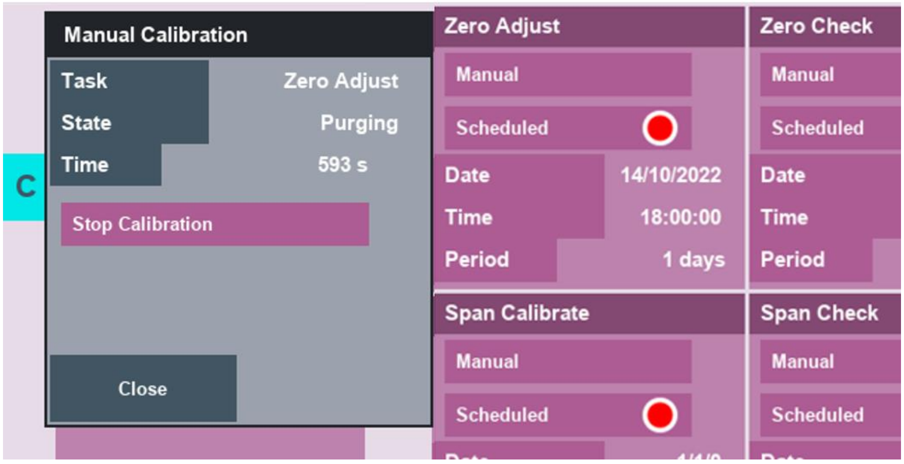


Figure 82 – Manual Calibration Dialog Box

Pressing the stop calibration button will popup a confirmation dialog box, selecting cancel will close the dialog box and continue with the calibration, selecting accept will change source valves back to sample and change the state to complete and run a sample purge.

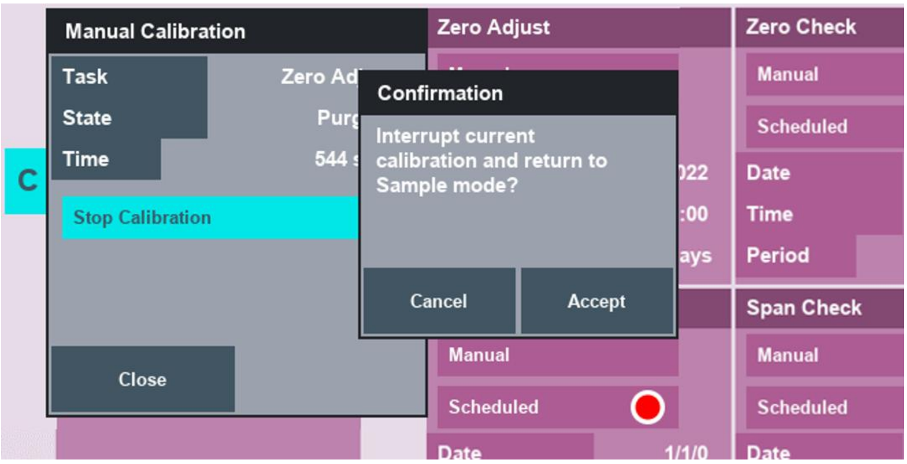


Figure 83 – Stop Calibration Confirmation Dialog Box

Note: Pressing stop calibration again will override the purge state and completely stop the calibration.

3.4.3.4.2 Zero Adjust

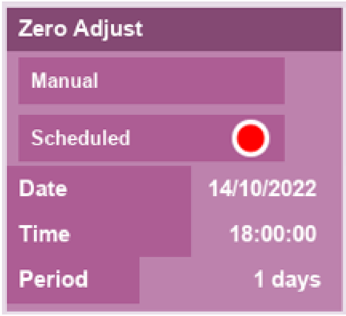


Figure 84 – Zero Adjust Panel

This panel is used to schedule or manually perform a zero calibration. The Zero Adjust can be initiated or stopped using the same methods as the Full Calibration.

Zero adjust will change the source from sample to zero and then purge the measurement cell full of zero air. After the Cal Purge period has elapsed, it will measure the current readings for the period of the Cal Measure setting. The instrument will adjust the calibration offset for all wavelengths and angles and then return the source to the sample measure mode.

The result of the Zero Adjust is stored in the Checks Page and will display the measured readings before the calibration offset adjustment was made.

3.4.3.4.3 Zero Check

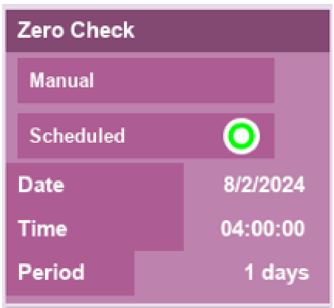


Figure 85 – Zero Check Panel

This panel is used to schedule or manually perform a zero check. The Zero Check can be initiated or stopped using the same methods as the Full Calibration.

Zero Check will change the source from sample to zero and then purge the measurement cell full of zero air. After the Cal Purge period has elapsed, it will measure the current readings for the period of the Cal Measure setting. The instrument will then store the measured readings in the Checks Page. There is no adjustment of the calibration offset.

Then the source will return to the sample measure mode.

3.4.3.4.4 Span Calibrate

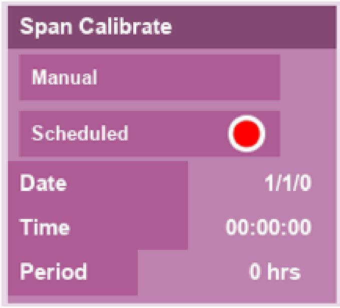


Figure 86 – Span Calibrate Panel

This panel is used to schedule or manually perform a span calibration. The Span Calibrate can be initiated or stopped using the same methods as the Full Calibration.

The Span Calibrate will change the source from sample to span and then purge the measurement cell full of Calibration Gas. After the Cal Purge period has elapsed, it will measure the current readings for the period of the Cal Measure setting. The instrument will adjust the calibration slope for all wavelengths and angles and then return the source to the sample measure mode.

The result of the Span Calibrate is stored in the Checks Page and will display the measured readings before the calibration slope adjustment was made.

3.4.3.4.5 Span Check

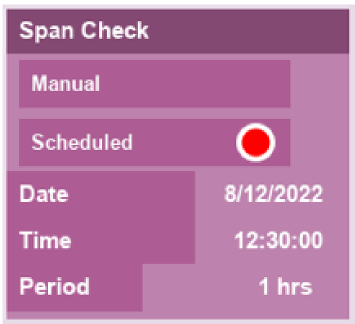


Figure 87 – Span Check Panel

This panel is used to schedule or manually perform a span check. The Span Check can be initiated or stopped using the same methods as the Full Calibration.

Span Check will change the source from sample to span and then purge the measurement cell full of Calibration Gas. After the Cal Purge period has elapsed, it will measure the current readings for the period of the Cal Measure setting. The instrument will then store the measured readings in the Checks Page. There is no adjustment of the calibration slope. Then the source will return to the sample measure mode.

3.4.3.5 Checks

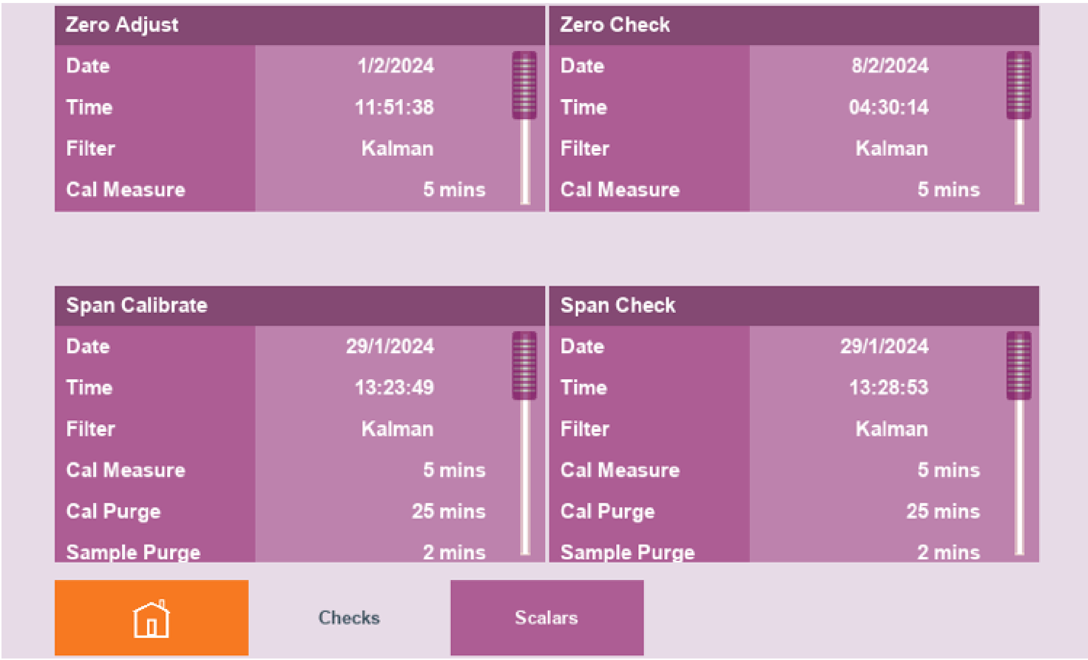


Figure 88 – Calibration Checks Child Page NE-400

The checks child page displays the status of the most recent calibrations initiated from the Schedule child page. It is made up of four panels; **Zero Adjust, Zero Check, Span Calibrate, and Span Check**.

Each panel contains all the calibration settings at the time of the calibration. The format is the same for each type of calibration and is similar for each instrument type.

The parameters recorded are: -

- **Date** – When the calibration was completed
- **Time** – When the calibration was completed
- **Filter** – Type of filter used during the calibration
- **Cal Measure** – From the Calibration Settings panel at the time the calibration was initiated
- **Cal Purge** – From the Calibration Settings panel at the time the calibration was initiated
- **Sample Purge** – From the Calibration Settings panel at the time the calibration was initiated
- **Calibration Gas** – Type of calibration used for the calibration
- **Normalization** – From the Calibration Settings panel at the time the calibration was initiated
- **Temperature** – Recorded from the sample temperature sensor when the calibration was completed
- **Pressure** – Recorded from the sample pressure sensor when the calibration was completed
- **Angle**
    - For NE-100 there is no angle setting. 0° is assumed
    - For the NE-300, Full or Back can be selected

- For the NE-400–

- **Sigma** – The measured Sigma for each wavelength and selected angle when the calibration was completed
- **Measure Count** – The recorded measure count for each wavelength and selected angle when the calibration was completed

Figure 89 – Span Check Panel NE-400 Showing 0°

Using the touch method on the angle field on any of the panels will create a popup menu with the angles to select from. Selecting a new angle from the angle popup menu will now display that angles data for all four panels.

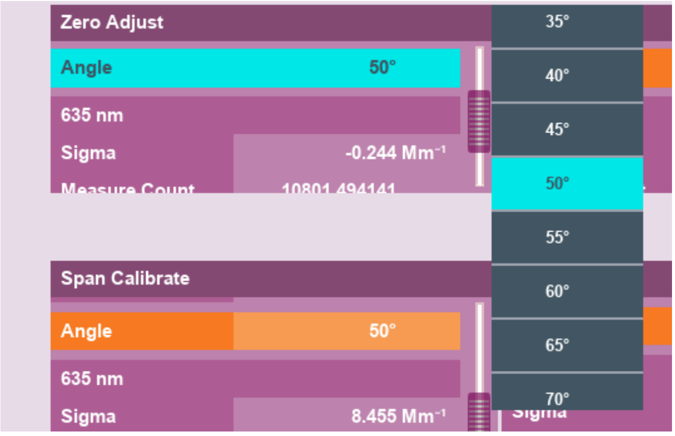


Figure 90 – Checks Child Page Angles Popup Menu

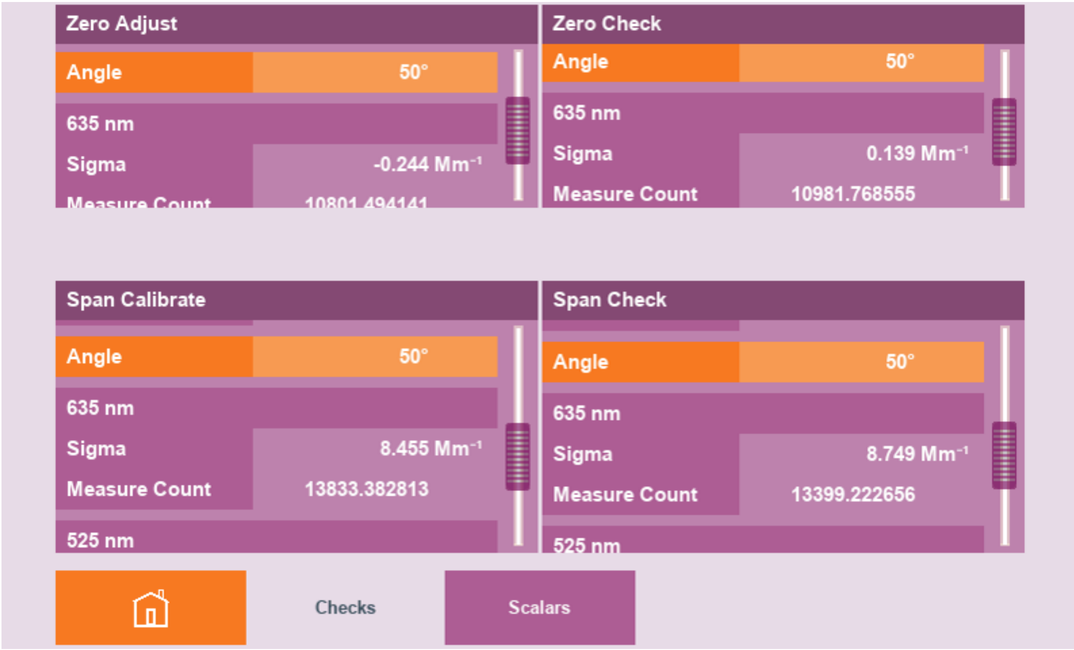


Figure 91 – Angle changed from 0° to 50°

Zero Adjust

Displays the results and setting from the most recent Zero Adjust. The sigma readings displayed are measurements prior to any adjustment of the calibration offset.

Zero Check

Displays the results and setting from the most recent Zero Check. The sigma readings displayed are measurements at the end of the check.

Span Calibrate

Displays the results and setting from the most recent Span Calibration. The sigma readings displayed are measurements prior to any adjustment of the calibration slope.

Span Check

Displays the results and setting from the most recent Span Check. The sigma readings displayed are measurements at the end of the check.

3.4.3.6 Scalars

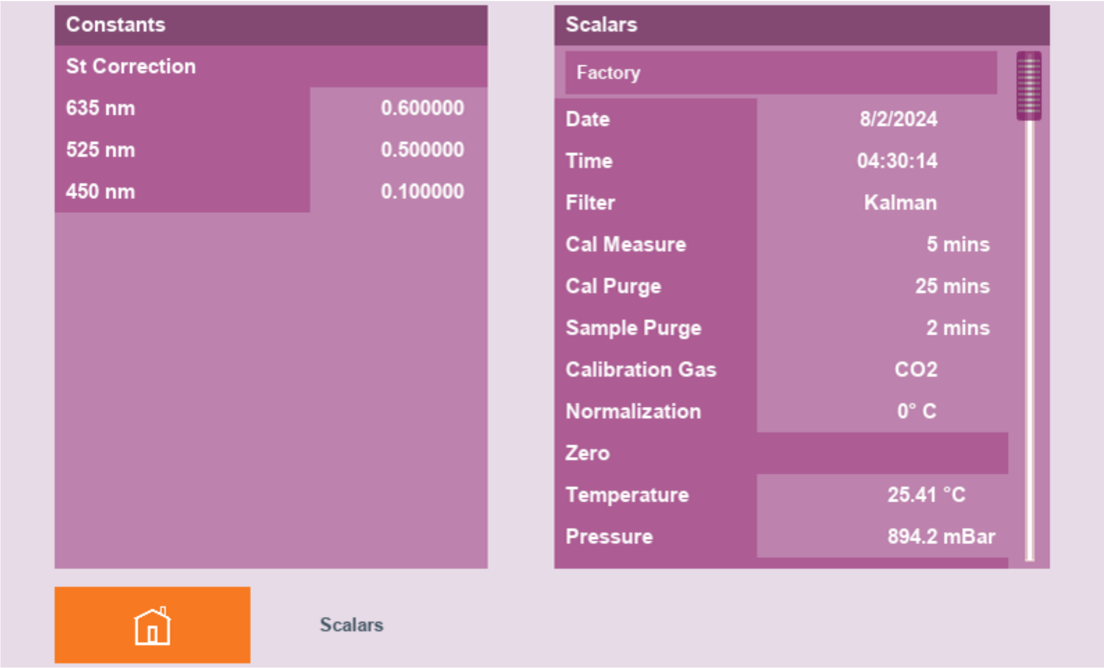


Figure 92 – Scalars Child Page

The scalars child page (only available from the Checks child page) shows all of the numeric factors of the last actual calibration (whether it was a full calibration, zero adjust, or span calibration). This page is broken into two panels, the constants panel and the scalars panel. The format of this page is the same for all instrument types.

3.4.3.6.1 Constants

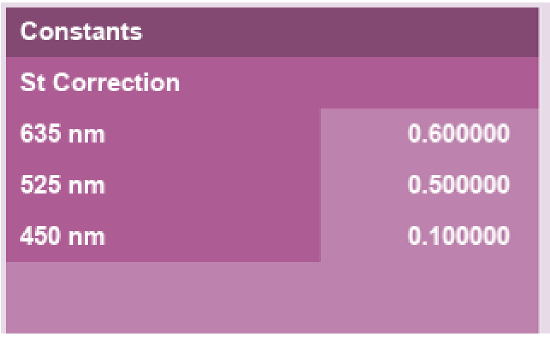


Figure 93 – Constants Panel

These are factory-specified temperature correction values and should not be changed. They help to compensate for temperature drift. There is a different value for each wavelength and can vary from instrument to instrument. The values shown are typical default values.

3.4.3.6.2 Scalars

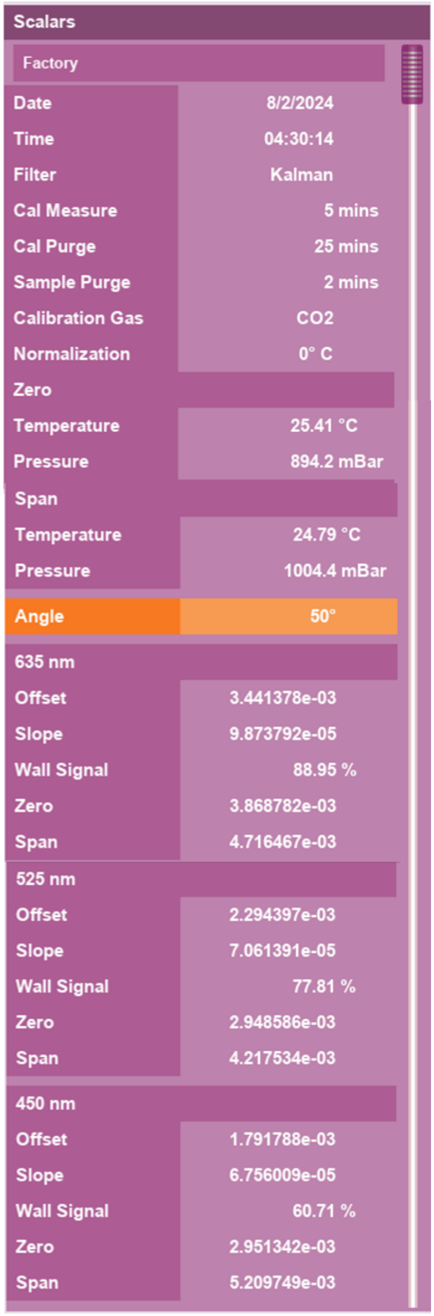


Figure 94 – Scalars Panel

In addition to the calibration settings and environmental readings at the time of calibration, this panel shows the various calculated values for each wavelength and angle. This panel exists for troubleshooting; you should not normally need to interact with it. The same information is stored in the Parameter Dump. Important information such as Wall signal, Calibration Slope, and Offset can be found here.

The factory button at the top of the panel will restore calibration values to the factory defaults. Do not press this unless you are completely resetting the instrument and are going to perform a full calibration.

3.4.3.7 Sensors

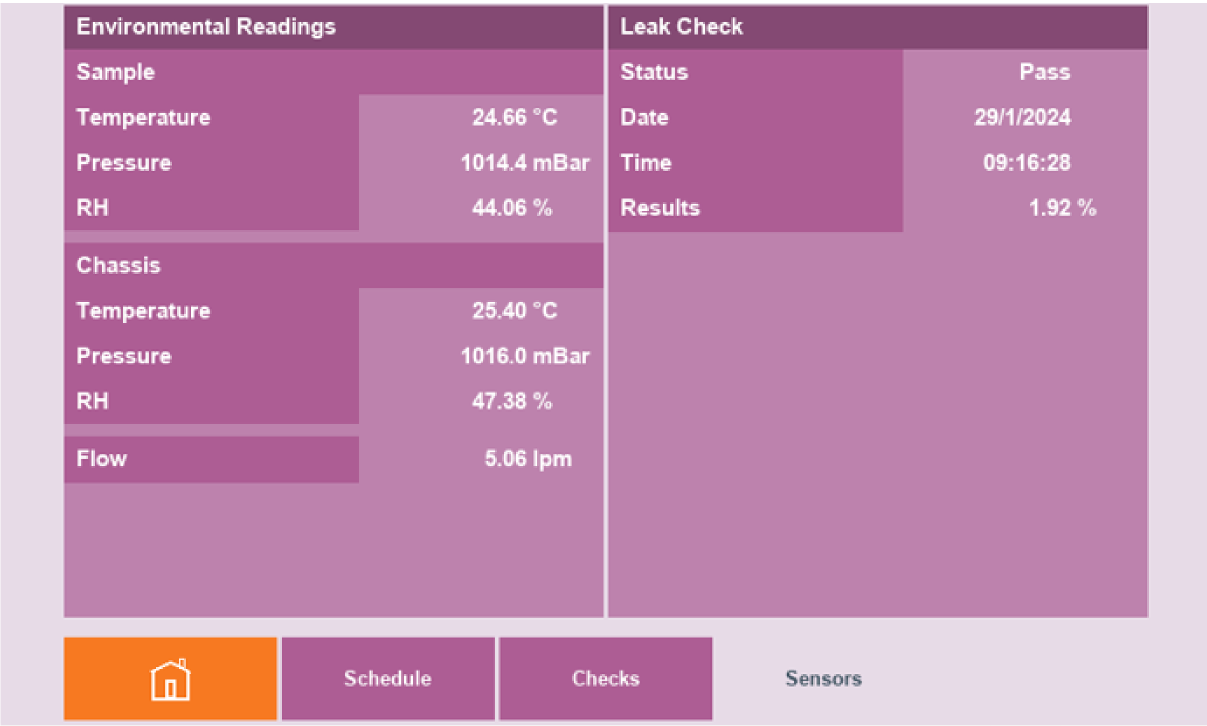


Figure 95 – Sensors Child Page

The sensors child page has two panels, **Environmental Readings** and **Leak Check**. This page is the same for all instrument types. This page is important as it is where the environmental sensors can be calibrated and a leak check performed.

3.4.3.7.1 Environmental Readings

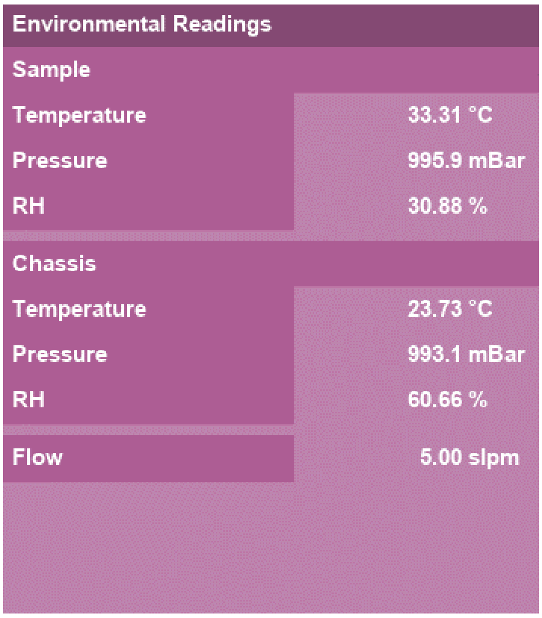


Figure 96 – Environmental readings Panel

The Environmental Readings panel shows the current sensor reading updated every second. The information is grouped by headings and represented by the following fields:

Sample

- The current sample temperature, pressure, RH measured inside the measurement cell.

Chassis

- The current chassis temperature, pressure, RH measured on the microprocessor board.
- The current sample flow measured on the control board.

The user can use the touch and hold method on each field to change the definition of that field. This includes the fields units, decimal places, and sensor calibration.

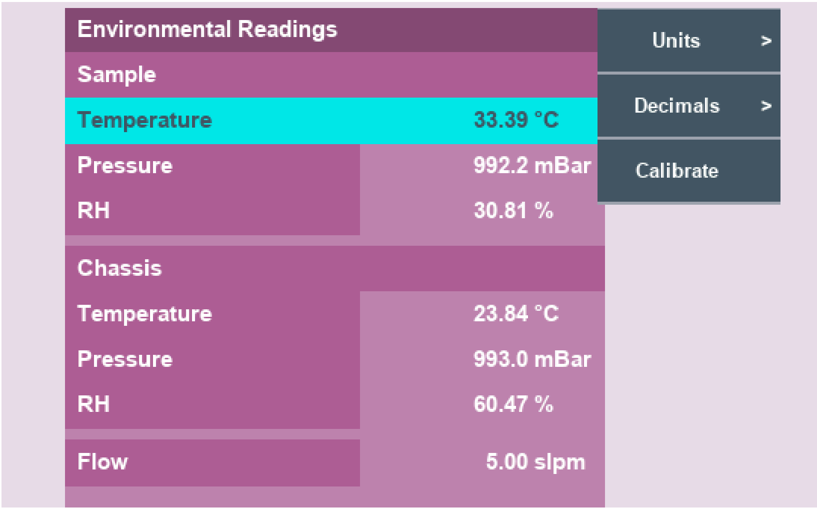


Figure 97 – Sample Temperature Popup Menu

Touching the unit's menu item expands the available options.

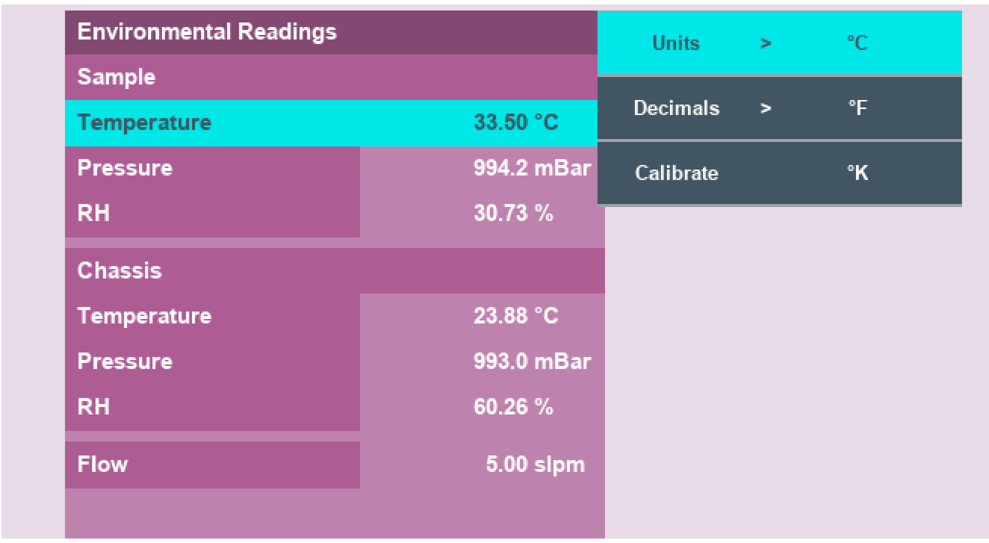


Figure 98 – Sample Temperature Popup Menu Units Expanded

Touching the decimals menu item expands the available options.

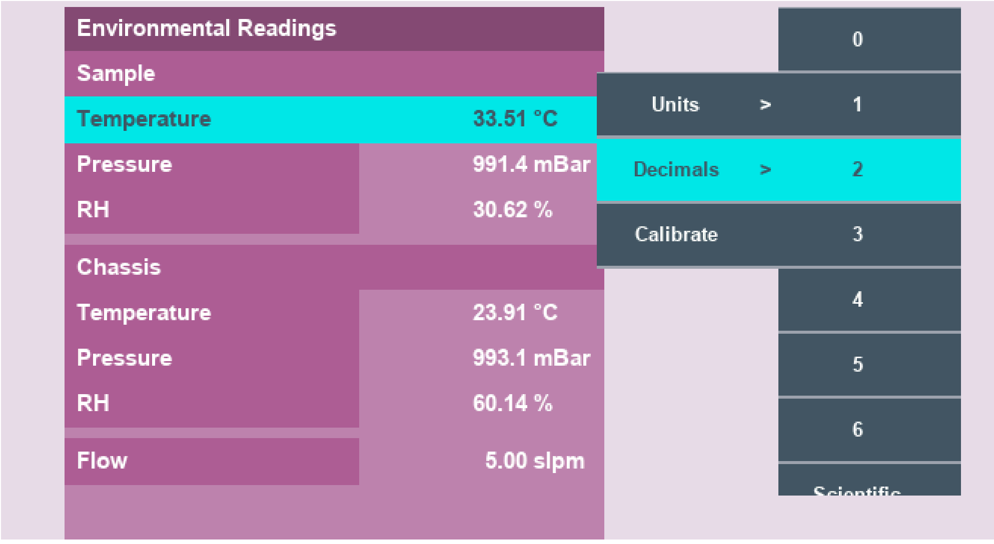


Figure 99 – Sample Temperature Popup Menu Decimals Expanded

Note: There are a number of options to select from for the decimal places menu, use the touch and hold method followed by a drag up or down to view the full menu.

Touching the calibrate menu item will popup a calibration dialog box allowing the user to calibrate the sensor. This will be covered in more detail in the calibration section (refer to Section 5).

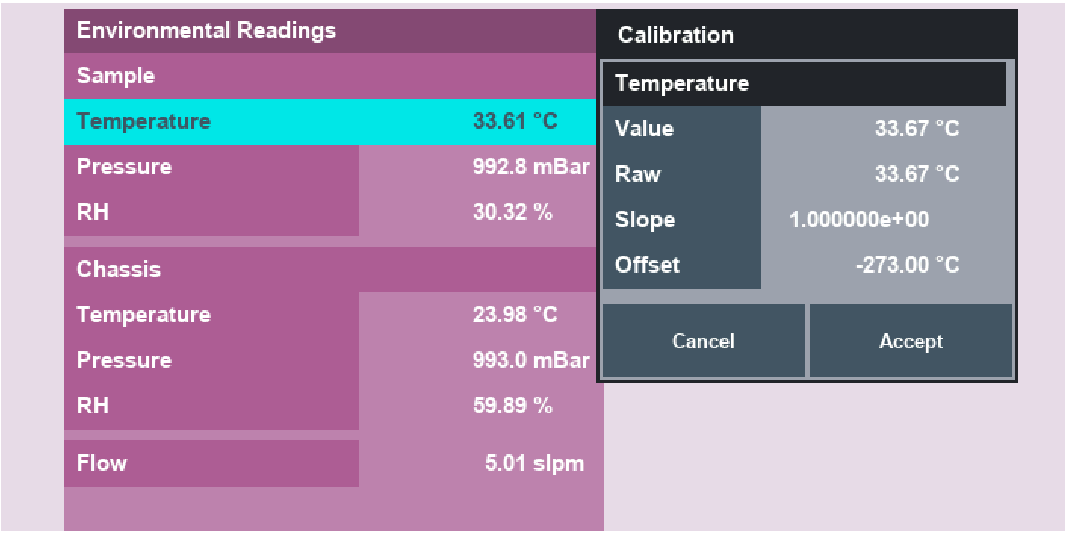


Figure 100 – Sample Temperature Calibration Dialog Box

Selecting cancel will close the dialog box and revert any changes, selecting accept will apply the changes to the sensor.

3.4.3.7.2 Leak Check

The Leak Check panel displays the result of the latest Leak Check. For details on performing a leak check see the section 6.4.10.

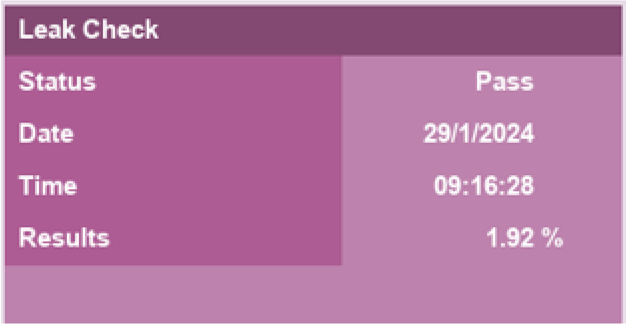


Figure 101 – Leak Check Panel

The information displayed is:

- **Status** – Pass or Fail from the latest leak check
- **Date** – Date that the last leak check was performed
- **Time** – Time that the last leak check was performed
- **Result** – The calculated result from the last leak check

To commence a leak check, the Service Menus need to be enabled, then the Leak Check panel will change allowing it to be started. Additional information will be displayed but cannot be edited.

3.4.4 Comms

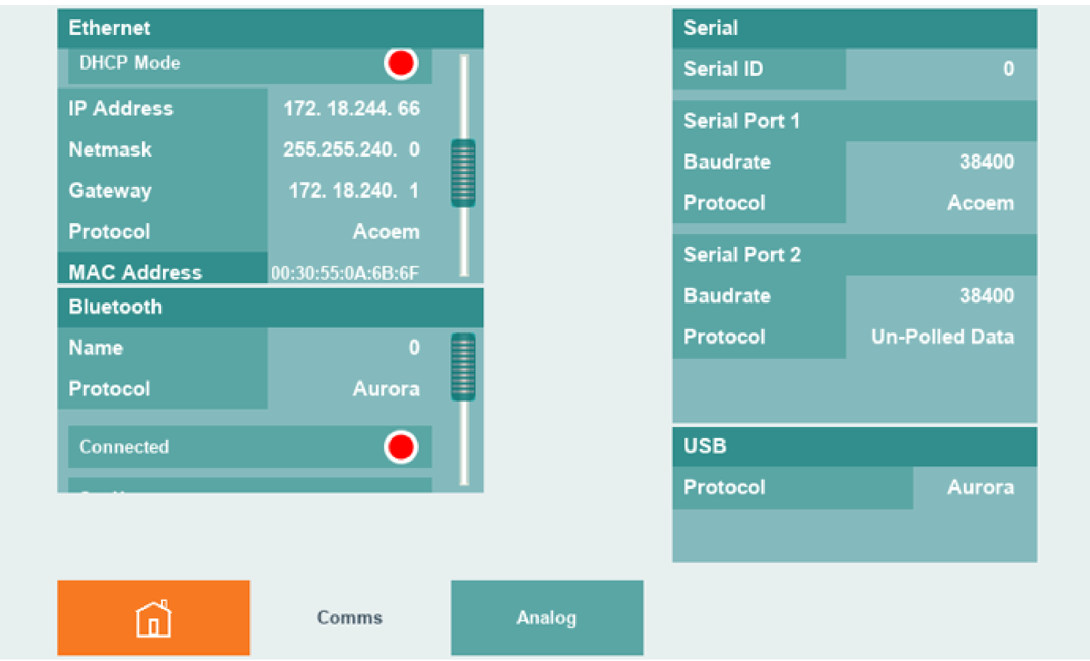


Figure 102 – Comms Page

The communications page and child pages control the settings for various interfaces. The comms page is made up of four panels; **Ethernet**, **Serial, Bluetooth,** and **USB**.

3.4.4.1 Ethernet

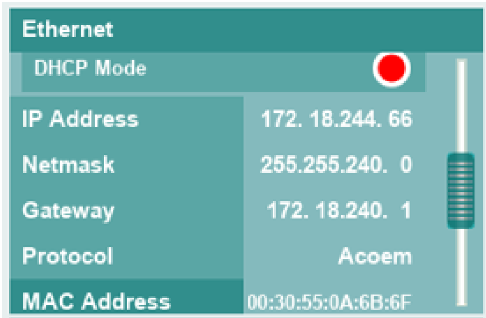


Figure 103 – Ethernet Panel

The Ethernet panel has all the information relating to the specific settings of the ethernet port. These fields can be altered to suit the users network configuration.

DHCP mode means the instrument requests an IP address from its gateway.

Protocol selects how the instrument communicates: either the Aurora legacy protocol (not recommended) or the Acoem protocol.

The **IP Address, Netmask Gateway, and MAC Address** are displayed for this hardware and can be use for setting up the network connection. This is described in more detail in the Communication Section (refer to Section 4).

Note: A Figure 152ll the IP addresses are taken as an example. Contact your ISP for available IP addresses.

3.4.4.2 Bluetooth

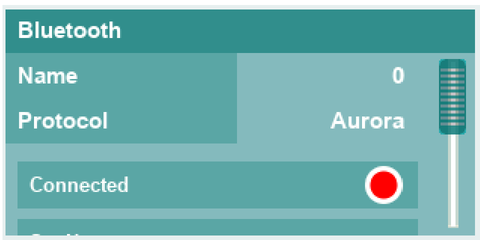


Figure 104 – Bluetooth Panel

This option is not available at the time of writing this manual.

3.4.4.3 Serial

The Serial panel provides details for setting up the serial ports. There are two RS232 communication ports available on the Aurora NE series. They both have identical capability but operate independently. They are the same for each instrument type. For details on connecting to these ports, please refer to the section 4.1.

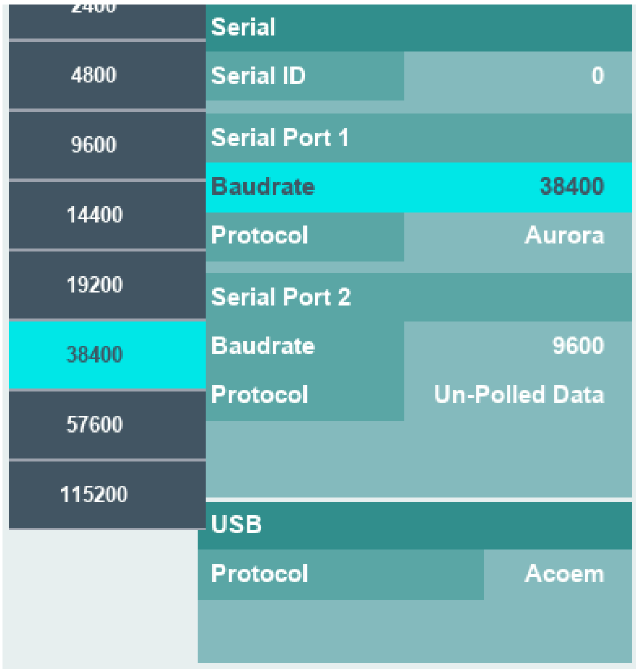


Figure 105 – Serial Panel Baudrate selection

The information displayed is:

- **Serial ID** – Unique instrument communications address. (0 – 9) It is used in multi-drop configurations. If not using a multi-drop cable it is recommended to leave this value at 0.
- **Baudrate** – RS232 communications speed. 1200 to 115200 baud.
- **Protocol** – The protocol field selects how the instrument communicates: either the Aurora legacy protocol (not recommended) or the Acoem protocol (recommended). Refer to the Appendix for details of these protocols.
    - Un-Polled Data – Only one serial port can be configured for this operation. Data will be transmitted out the selected port at a fixed interval and format. The interval and format are identical to that which is set in the Datalog Parameters, refer to section 3.4.5.2.

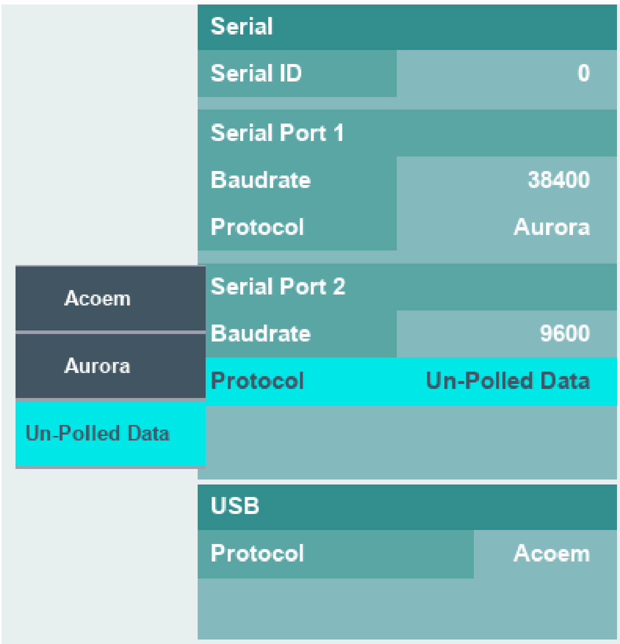


Figure 106 – Serial Panel Protocol selection

3.4.4.4 USB

There is one USB type B communications port on the side of the Aurora NE series. It can be used for connection to another computer running Acoem Congrego or Airodis software. Refer to section 4.2 for details on using USB communications.

Figure 107 – USB Panel

- **Protocol** – The protocol field selects how the instrument communicates: either the Aurora legacy protocol (not recommended) or the Acoem protocol (recommended). Refer to the Appendix for details of these protocols.

3.4.4.5 Analog

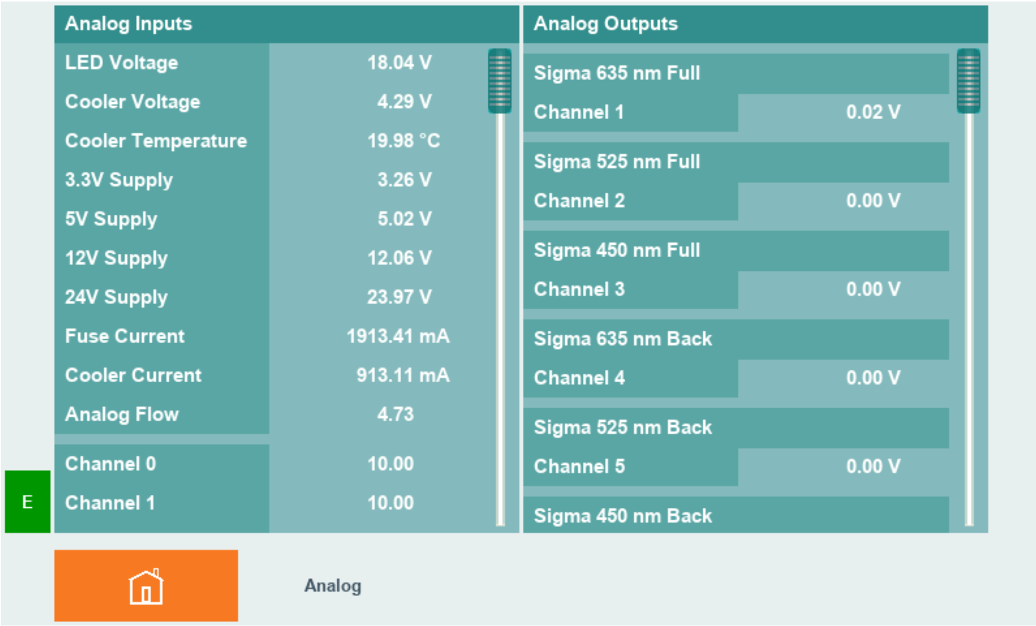


Figure 108 – Analog Child Page

The Analog communications child page contains two panels. Analog inputs and Analog Outputs. These are the same for each instrument type.

3.4.4.5.1 Analog Inputs

Figure 109 – Analog Inputs Panel

Each of the Analog Inputs in the system are displayed as fields on this panel. Most are internal and do not need configuring. Scroll down to see the readings from the external analog inputs (Channel 0 to Channel 3). If you enable service menus (refer to Section 3.4.5), extra information is available to enable you to edit the slope and offset and reference voltage for external analog inputs. Refer to section 4.4 for details on connecting external Analog Inputs.

3.4.4.5.2 Analog outputs

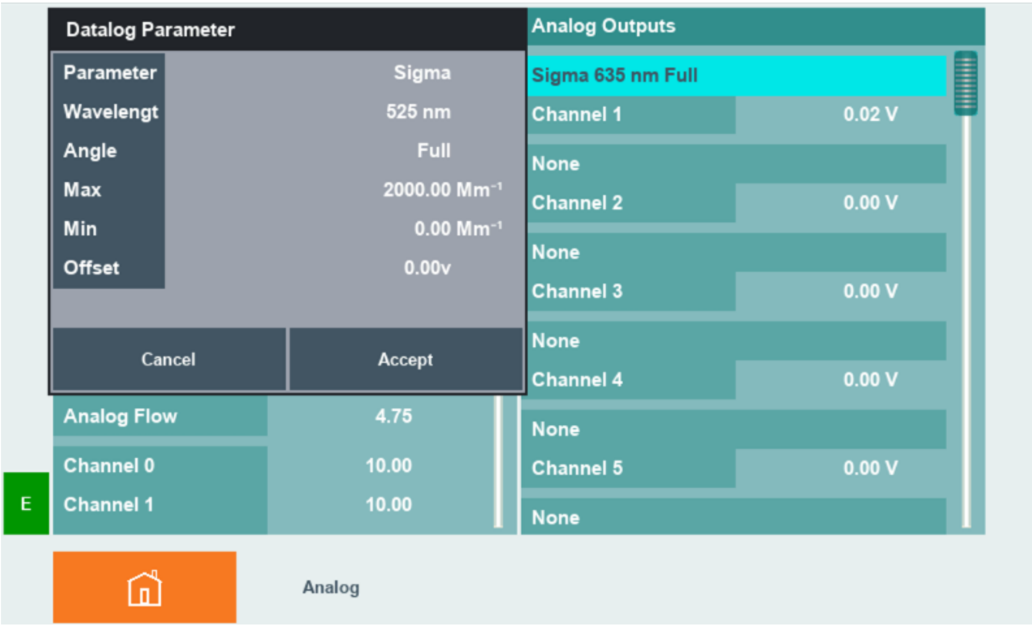


Figure 110 – Analog Outputs Setup Panel

Each of the Analog Outputs in the system are displayed as fields on this panel. Each field has a heading that can be selected using the touch method. Doing so will popup a Datalog Parameter menu where the parameter, max, min, and offset can be configured. If Sigma is selected as a parameter, then the wavelength and angle can also be selected.

Currently, there is no method for calibrating any of the analog outputs.

Using the touch method on the channel field will bring up the num pad, a value can be entered between 0-5 to simulate the analog output value.

3.4.4.6 Digital

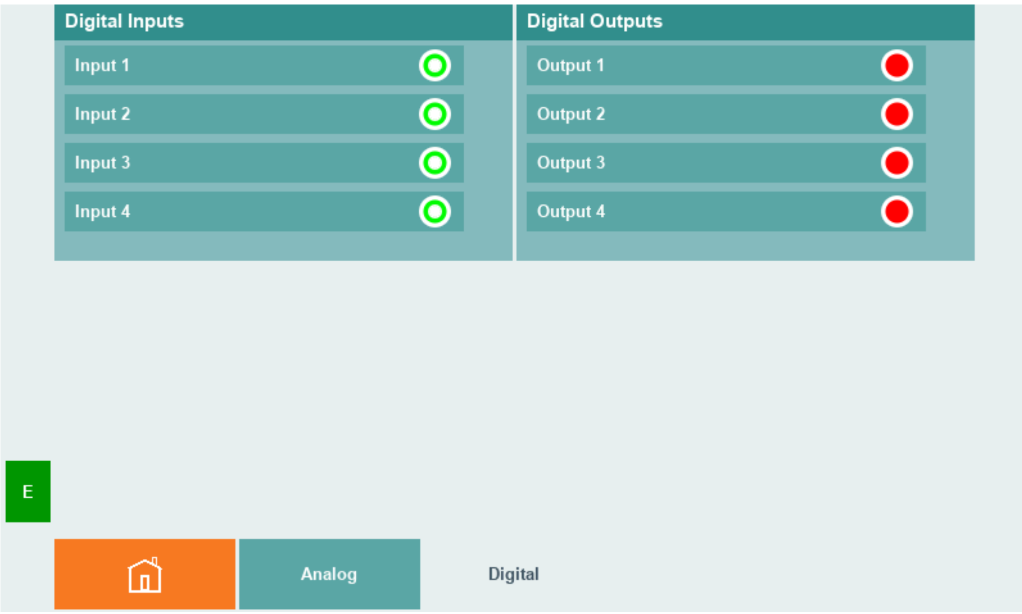


Figure 111 – Digital Child Page

The Digital communications child page contains two panels. Digital Inputs and Digital Outputs. These are the same for each instrument type. This page is only available when service menus are enabled. The Digital Inputs and Digital Outputs are connected to the twenty-five-way IO connector on the side of the instrument. Refer to section 4.4 for connection details. There is limited functionality for these at the present time.

3.4.5 Config

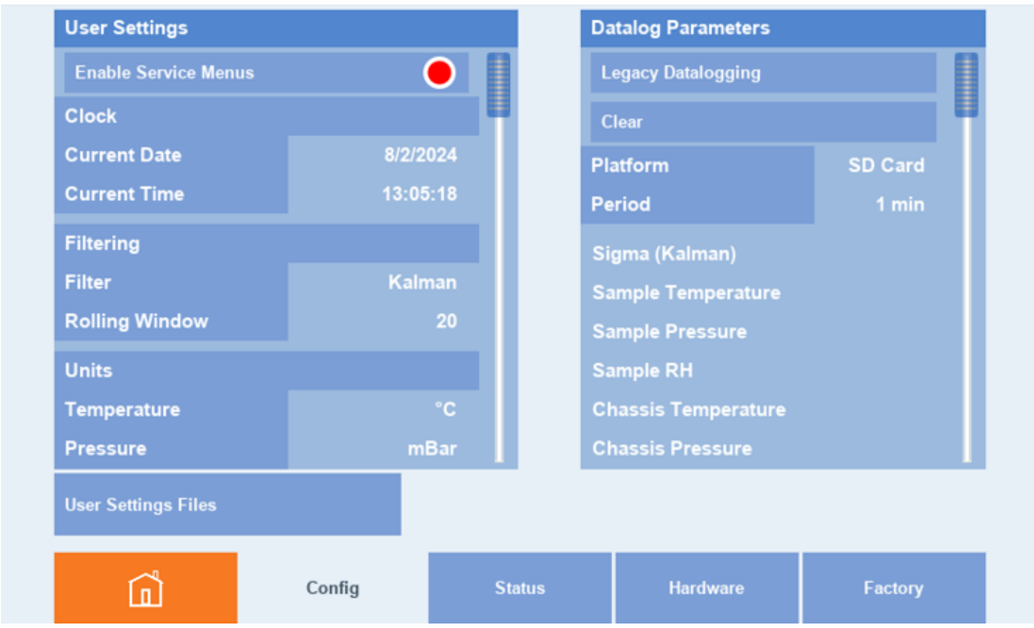


Figure 112 – Config Page

The Config page manages the user settings and data logging configuration. It has two panels and a button; the **User Setting** panel, **Datalog parameters** panel, and the **User Settings Files** button.

The configs child pages, status, hardware and factory are primarily intended for technician use.

3.4.5.1 User Settings

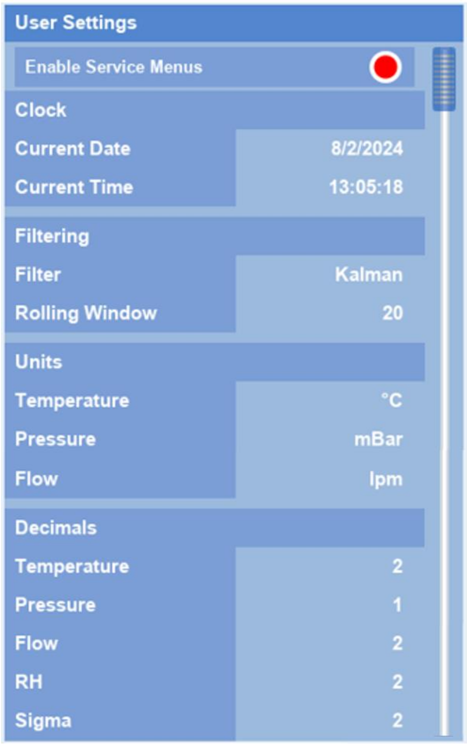


Figure 113 – User Settings Panel

The user settings information is presented in this panel. The information is grouped by headings and represented by the following fields and buttons:

Clock

- **Current Date** – Enter the current date with the format – D/M/YYYY by pressing the current date field. A popout keypad will open.
- **Time** – Enter the current time with the format – HH/MM/SS by pressing the current time field. A popout keypad will open.

Filtering

- **Filter** – Select the filter type which is the same as the Filter field on the home page – it changes what data is displayed. All filters operate in parallel and are selected by pressing the filter field.
- **Rolling Window** – This is the number of measurement cycles that are used for calculating the Rolling Average filtered data. Pressing the Rolling window field will present a popout list to select from.

Note: The filter can be changed at any time; the Aurora calculates all of the filtered values (None, Kalman, 1 minute, 5 minutes, and Rolling Average) for every measurement. The filter selection merely controls which one is displayed.

Units

- **Temperature** – Select the temperature units by pressing the temperature field**. °C, °F or °K**.
- **Pressure** – Select the pressure units by pressing the pressure field. **Torr, psi, mBar, atm, Kpa**.
- **Flow** – Select the flow units by pressing the flow field. **ccm or lpm**.

Decimals

- The number of decimal places for the presentation of temperature, pressure, flow, RH and sigma readings as they are presented in the various menus. Pressing each field will display a popout list to choose from.

Note: Pressing and holding any of these fields in other menus will allow the units and decimals to be changed at any time.

3.4.5.1.1 Enable Service Menus

At the top of the user settings panel there is a radio button to enable service menus. Touching this button will toggle the radio button and activate (green) or deactivate (red) the service menus.

Figure 114 – Enabled Service Menus button

By default, they are disabled. When enabled, they allow additional access to key parameters and functions that are used for diagnostics or service work. Leak check is one example. With disabled, it will help prevent unintentional changes to the instrument's settings.

3.4.5.2 Datalog Parameters

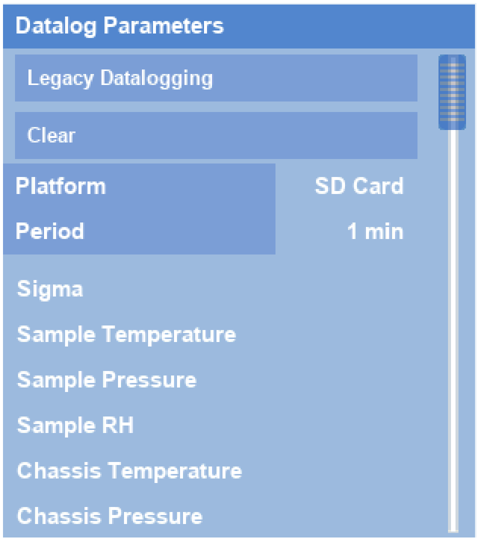


Figure 115 – Datalog Parameters Panel

The datalog parameters information is presented in this panel. The information is represented by the following fields, parameter list and buttons:

- **Legacy Datalogging** – This button sets the Aurora NE Series to emulate an Aurora 1000, 3000, or 4000 as closely as possible. This may be useful for legacy installations but it does not take full advantage of the power of the Aurora NE Series.
- **Clear** – Will erase all set parameters. It will not delete the data stored.
- **Platform** – Determines where the data log files are stored. **None**, **SD Card** or **USB** key. The SD Card is recommended as it is faster and much larger.
- **Period** – How often data is logged and stored. A time interval can be specified, or you can choose "All" which means that data will be logged after every measurement cycle (all wavelengths and angles) has been completed.
- **Parameters** – To change what is logged simply touch one of the existing parameters or the None at the end. A dialog box appears allowing you to specify the parameter.

Refer to section 4.5 for more details on setting up Datalogging.

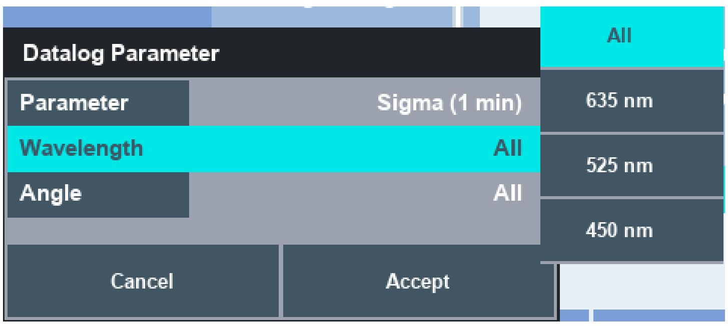


Figure 116 – Datalog Parameter Dialog Box

Be aware that simply asking for some parameters (such as Sigma) means logging up to sixty parameters; a sigma for every measured wavelength and angle. You can specify a smaller subset by selecting just one wavelength and/or one angle to be logged.

> **Note:** The system can log any combination of filtered values, regardless of what is being displayed on the main menu (since all filtered values are maintained throughout the measurement cycle).

3.4.5.3 User Setting Files

Figure 117 – User Settings Files Button

The User Settings Files button opens a dialog box that saves and loads User Settings specific for the instrument. This page is the same for all instrument types. User Settings files can be saved automatically or manually. From this page, the files can only be named with two numeric digits. However, if the storage medium is removed, then the filenames can be changed to more complex names using a PC. The purpose of this page is to keep backup copies of known instrument settings. The User Settings Files can be saved to either the SD card or the USB memory key.

If performing maintenance on an instrument, it might be useful to back up the User Settings file before the work has commenced.

Using the touch method press the user setting files button. This will popup a user settings dialog box.

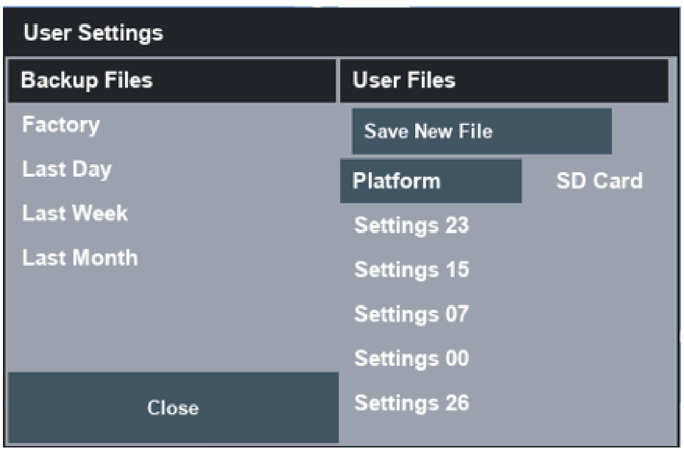


Figure 118 – User Settings Files Dialog Box

User setting configurations can be saved, loaded, copied to USB, or deleted using this dialog box.

The factory file restores the user settings to the way it was when it left the factory.

3.4.5.3.1 Backup Files

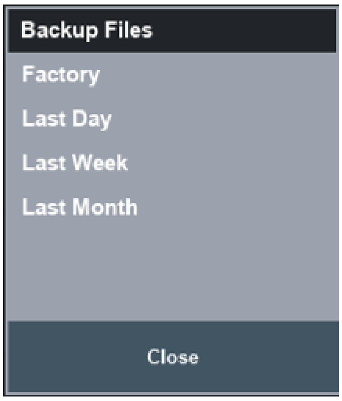


Figure 119 – Backup Files

The backup files section of the user settings dialog box allows the user to load, a factory backup, last day, last week, or last month. The factory option is a backup of the Aurora NE Series as it left the factory. The last day, last week, and last month are automatic backups made by the instrument. This can be useful for troubleshooting to get you back to a known working setup.

The backup files are stored on internal memory. To view them, they need to be saved to the USB key. When you use the press and hold method on any one of the mentioned fields the field will change to a light blue background and you get an additional popup menu with the option to load or copy the file.

When you use the press and hold method on one of the Backup Files, it will change to a light blue background and you get an additional popup menu with the option to Load, Save, or Delete the file. Service menus need to be enabled to do this.

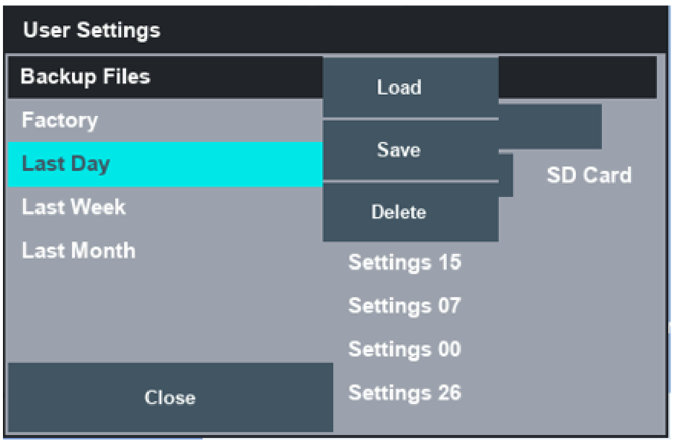


Figure 120 – Backup File Load/Save/Delete Popup Menu

Selecting load will popup a confirmation dialog box with information about the user setting configuration. Selecting Accept on the confirmation dialog box will proceed to load the selected user settings.

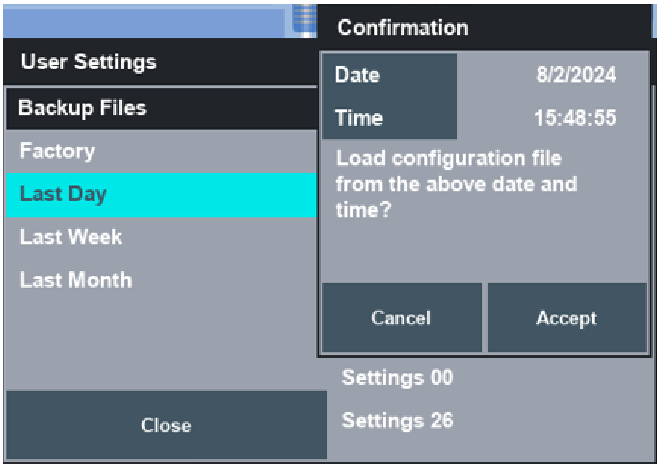


Figure 121 – Backup File Load Confirmation Dialog Box

Selecting save will copy the file to the USB.

3.4.5.3.2 User Files

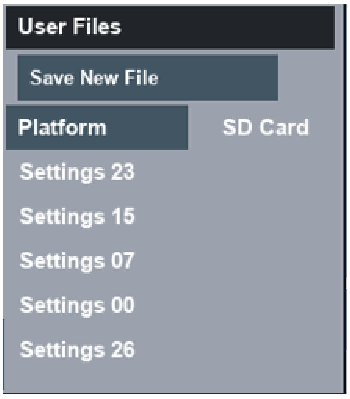


Figure 122 – User Files

In the user files section of the user settings dialog box, we have a button to save a new user setting configuration, we have a field labelled platform that allows the user to select where the files are stored and under that, we have a running list of user setting configuration saves the user has manually made using the save new file button.

To save a new calibration configuration press the save new file button. This will popup a save dialog box.

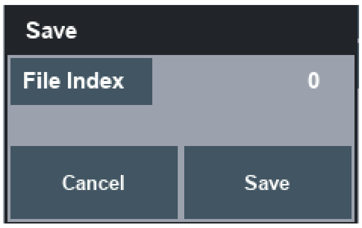


Figure 123 – Save Dialog Box

Using the touch method on the file index will bring up the keypad. Using the keypad type in the number for the user setting configuration save, form 0 - 99, then press the Enter key.

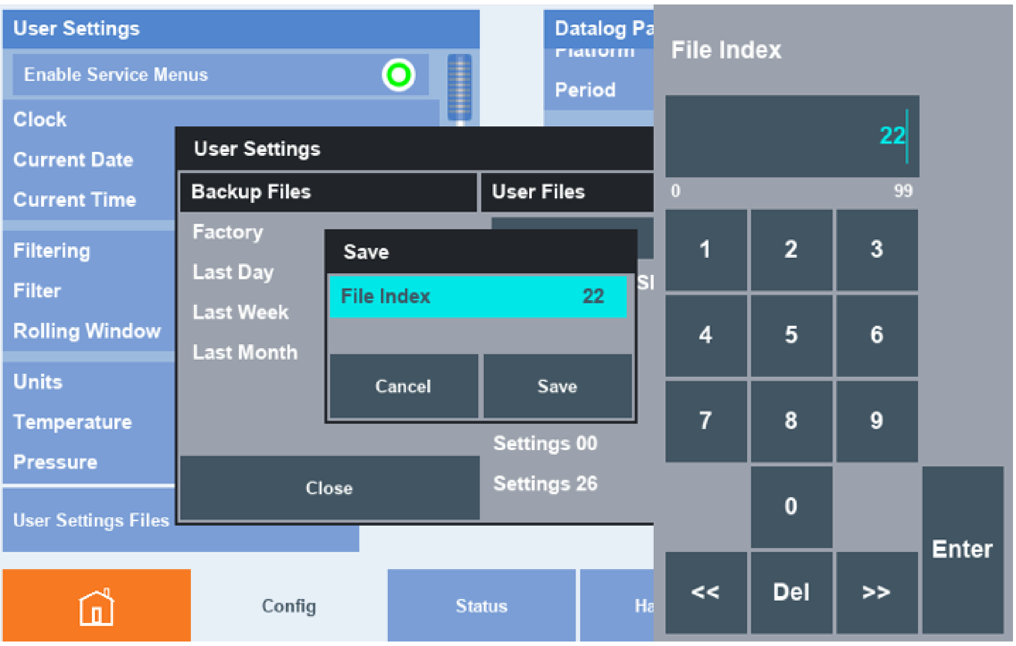


Figure 124 – Changing File Index From 0 to 22

After the save button is pressed a new user setting configuration save is created and added to the end of the list.

Note: New configuration saves are added to the end of the list and are displayed in the order they were saved, not in ascending or descending order.

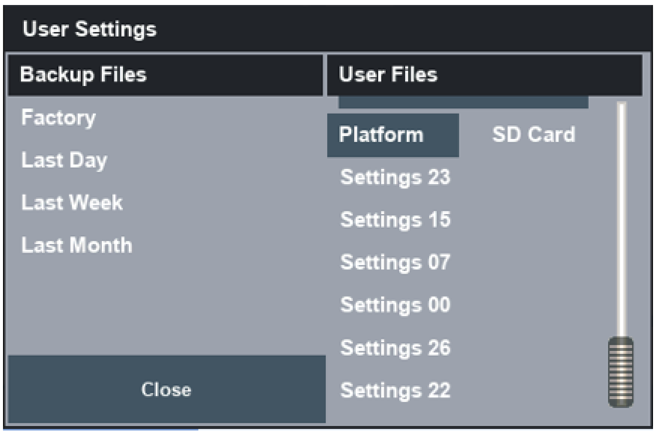


Figure 125 – New User Setting Configuration Save

Note: The user can have a total of 100 user setting configuration saves as the list increases the dialog box will be quite long. Use the scroll bar to move up and down the list.

Selecting any of the user setting configuration saves from the list with the touch and hold method will popup a menu with the following items, load, save delete and copy.

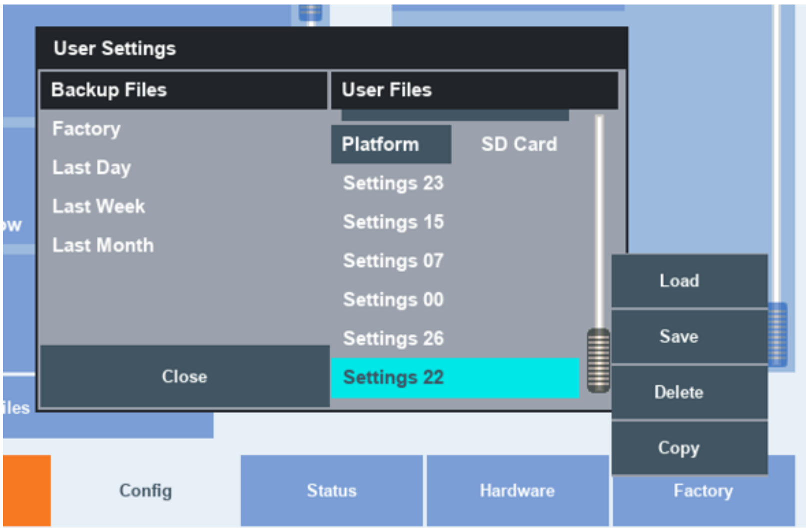


Figure 126 – User Settings Configuration Popup Menu

Selecting load will popup a confirmation dialog box with information regarding the save. Selecting cancel will reject the action and selecting accept will load the user settings.

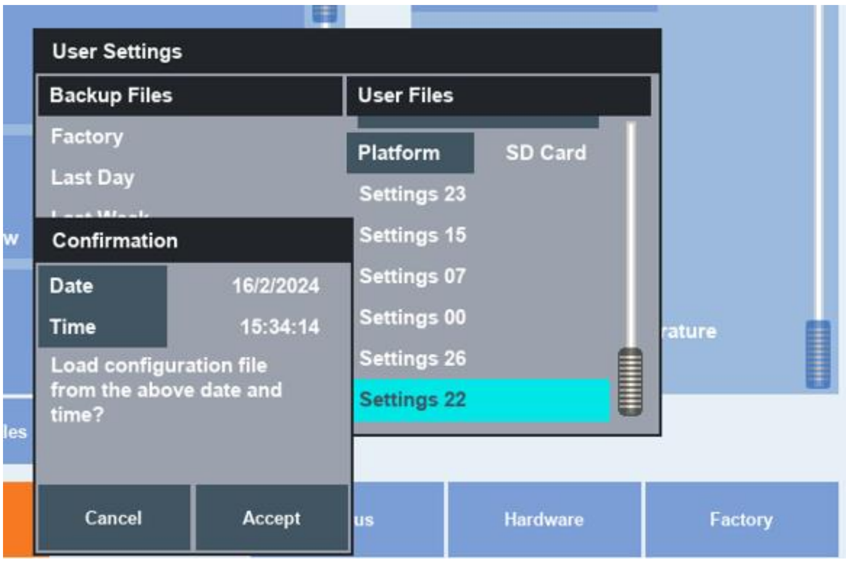


Figure 127 – User Settings Configuration Load Confirmation

Selecting save will popup a confirmation dialog box requesting to override the configuration with the current user settings. Selecting cancel will reject the action and selecting accept will override the saved user settings with the current user settings.

Selecting delete will popup a confirmation dialog box quiring the deletion of the user setting configuration. Selecting cancel will reject the action and selecting accept will delete the file removing it from the list.

Selecting copy will immediately copy the selected file to the USB memory key.

3.4.5.4 Status

The Status page reflects the current status of the instrument as well as a history of previous events. The two panels on this page are the same for each instrument type.

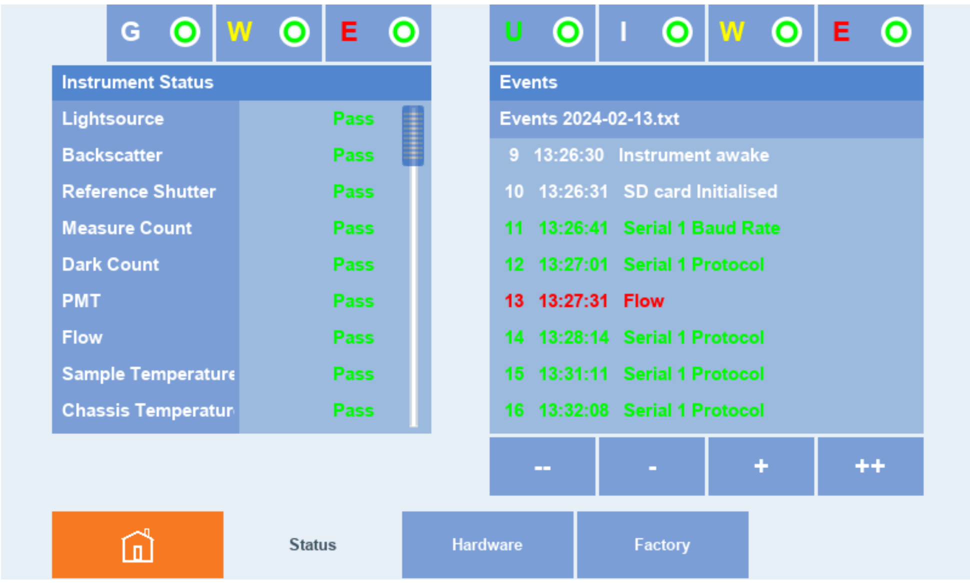


Figure 128 – Status Child Page

3.4.5.4.1 Instrument Status

The Instrument status panel contains a list of all possible errors and their current status. Pass or Fail. The three buttons across the top allow sorting what statuses are displayed.

- **G** General (White), **W** Warnings (Yellow), **E** Errors (Red)

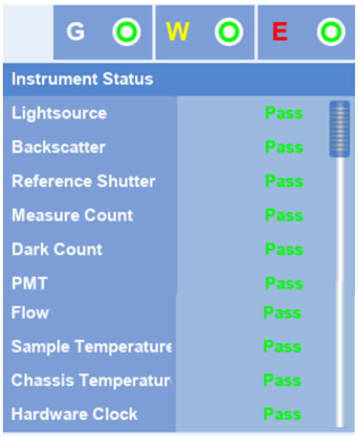


Figure 129 – Instrument Status Panel

Pressing one of the status fields will open a popup dialog box displaying more details on the criteria for the error or status. These status indications coincide with the Alerts that appear on the left side of the screen.

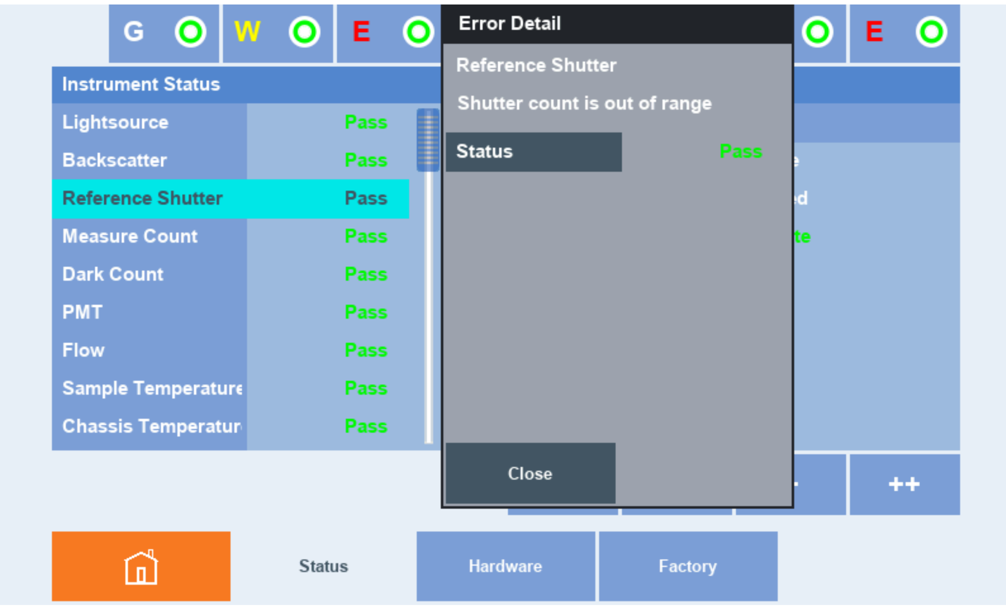


Figure 130 – Instrument Status Popup Dialog Box for Error Detail

3.4.5.4.2 Events

The Events panel shows the event log for the instrument. By default, it points to the current date and time and updates as new events are added. You can use the buttons at the bottom to scroll up or down the list one line or one page at a time; holding down the page buttons will jump to the top or bottom of the list. The events are numbered incrementally for each day.

Pressing on one of the event fields will open a Popup Dialog Box displaying more details about the event including the time the event occurred.

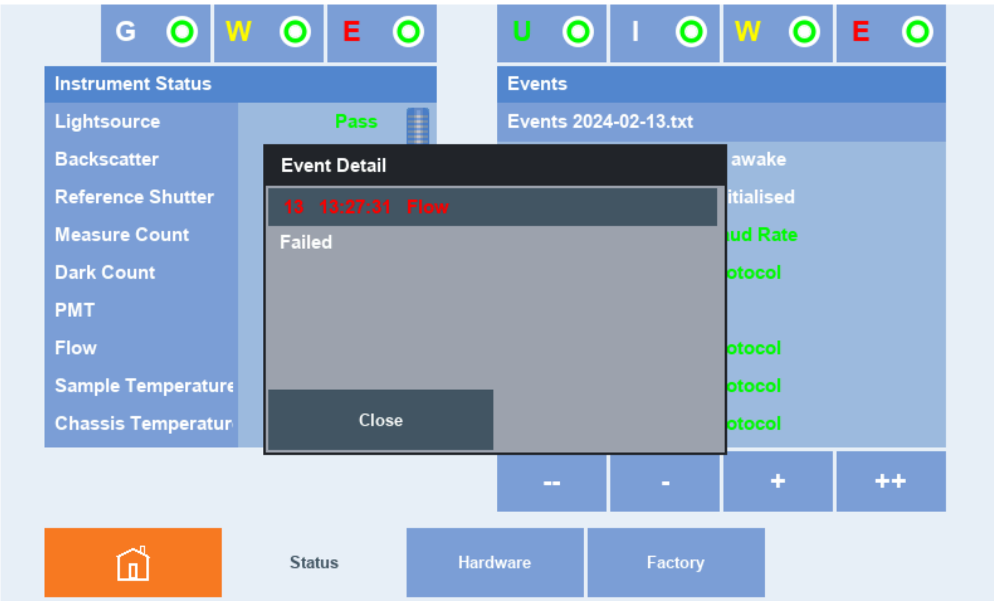


Figure 131 – Events Panel Popup Dialog Box

Figure 132 – Event Panel Navigation Buttons

The four buttons at the top allow filtering of what events are displayed.

- U User events (Green) – Displays any user interaction through the user interface.
- I Instrument events (White) – Displays automatic events initiated by the instrument.
- W Warnings (Yellow) – Displays minor errors.
- E Errors (Red) – Displays major errors where intervention may be required by service personnel. If the error is corrected, then this will also be displayed.

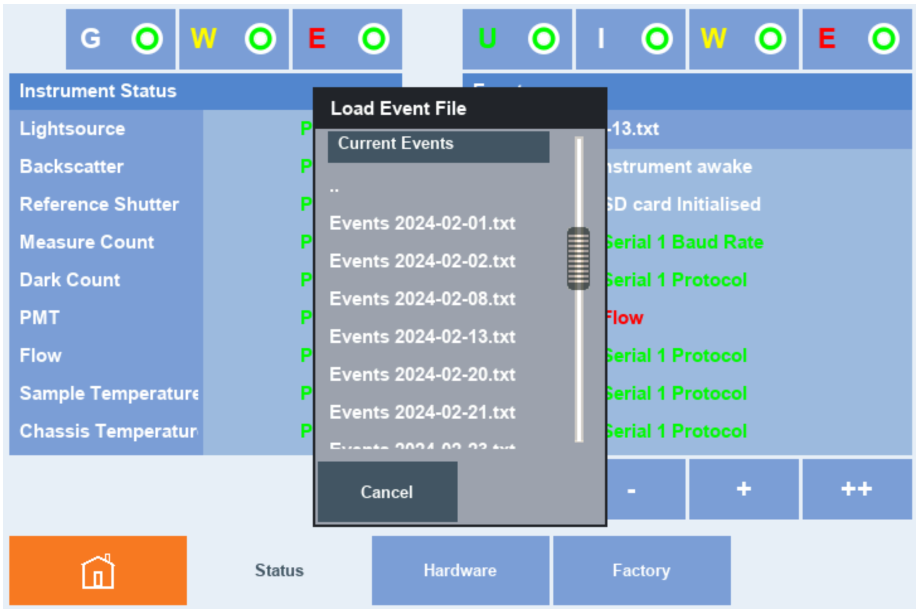


Figure 133 – Load Events file window

There is a new event file created every day. The name of this file is displayed in the top of the events panel. Touching this file field will open a popup window displaying a list of files for every day. Press and hold one of these files to either load it, so that its contents are displayed in the Events Panel, or select Copy to copy the file to the USB memory key.

3.4.5.5 Hardware

The Hardware child page manages the settings in relation to the installed hardware and options. It has two panels and a button; the **Hardware** panel, **Installed Options** panel and the **Hardware Files** button.

These panels are primarily intended for technician use and at times may require the service menus to be enabled. They are similar for each instrument type.

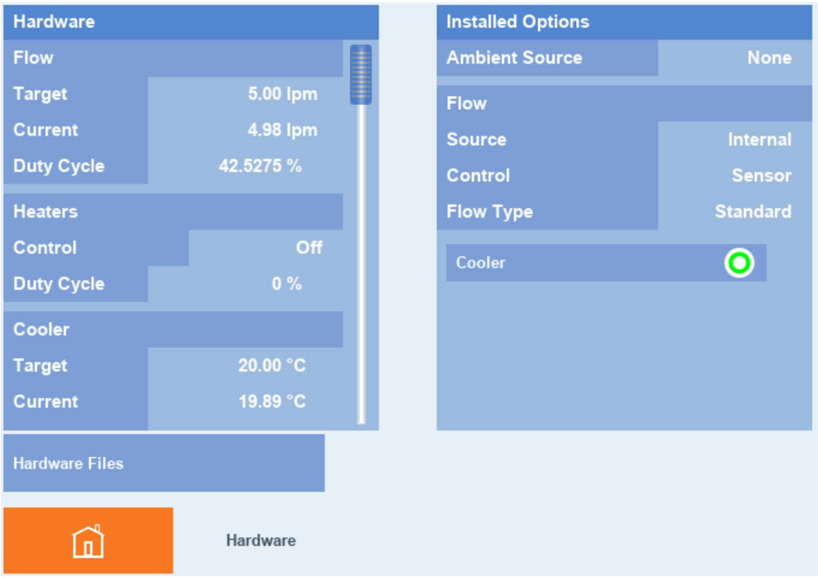


Figure 134 – Hardware Child Page

3.4.5.5.1 Hardware Panel

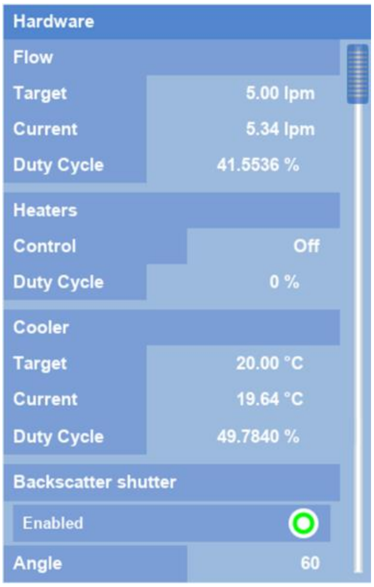


Figure 135 – Hardware Panel

The Hardware panel is grouped by headings and is represented by the following fields and buttons.

Flow

- **Target** – Setpoint for the sample flow as measured at the sample inlet. Touching this field will open a keypad to enter the desired flow rate.
- **Current** – Measured sample flow rate from the flow measurement sensor with calibration factors applied. If volumetric flow is selected, this will display the calculated volumetric flow.

- **Duty Cycle** – The percentage of power applied to the Internal Sample Pump in order to maintain the sample flow at the desired Target. The Duty Cycle (0% to 100%) is calculated by an internal PID control Algorithm.

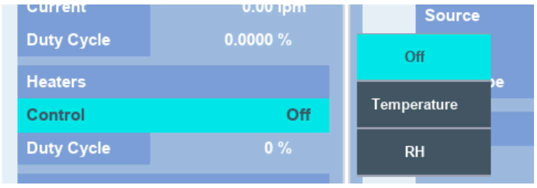


Figure 136 – Heater Control Popup Selection

Heaters.

The sample heater has two potential functions. Control the sample to a constant temperature of up to 40°C. Control the sample RH to below a setpoint of 20% to 80% through heating making sure the temperature does not exceed 40°C. The menu will change depending on which control is chosen. If Off is selected, then no heating will occur and the sample will follow ambient conditions.

- **Control** – Off, Temperature or RH Control
- **Target** – Setpoint for either the Temperature or RH control. Touching this field will open a keypad to enter the desired target. This field will not be displayed if Off is selected as the control.
- **Current** – Measured Sample Temperature or Sample RH from inside the measurement cell. This field will not be displayed if Off is selected as the control. Any calibration factors for this sensor will be applied.
- **Duty Cycle** – The percentage of power applied to the cell and inlet heaters in order to maintain the desired Control and Target. The Duty Cycle (0% to 100%) is calculated by an internal PID control Algorithm. This field will be set to 0% if Off is selected as the control.

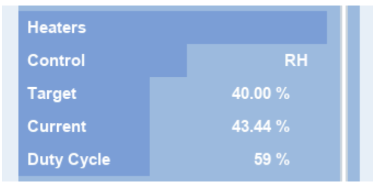


Figure 137 – Heater Control Set To RH

Cooler (NE-300 and NE-400 only)

The peltia cooler mounted on the PMT is used to keep the PMT below ambient temperatures. This will help reduce the dark count and additional noise. It has limited cooling capacity and cannot operate in reverse. These fields will only be displayed if the cooler is enabled in the Installed Options panel.

- **Target** – Setpoint for the Cooler mounted on the PMT. Touching this field will open a keypad to enter the desired Temperature. 20°C is the factory setting but can be changed to suit the ambient conditions.
- **Current** – Measured cooler temperature from sensor mounted on the PMT.

- **Duty Cycle** – The percentage of power applied to the peltia cooler in order to maintain the cooler temperature below the desired Target. The Duty Cycle (0% to 100%) is calculated by an internal PID control algorithm.

Backscatter Shutter

Enabled – This button allows the user to disable the Backscatter shutter operation. Then no Backscatter or angle readings will be recorded other than at 0°. **It is strongly advised NOT to disable this function**.

This feature is not available on the NE-100 as it has no Backscatter shutter.

Angle

Displays the current scattering angle being measured. This feature is not available on the NE-100 as it has no Backscatter shutter.

> **Note:** If the service menus are enabled, then the Hardware panel will display many more parameters in relation to the Reference Shutter, System Timing, and the Kalman Filter. It is strongly recommended **NOT** to change any of these parameters unless advised by Acoem technical support.

3.4.5.5.2 Installed Options Panel

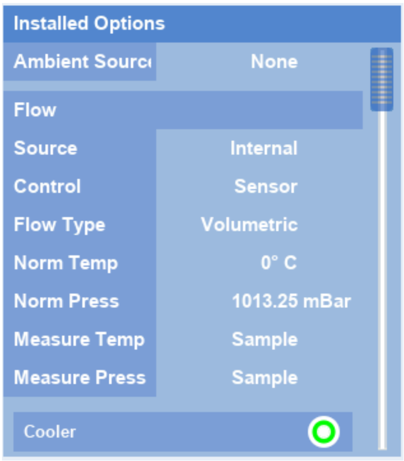


Figure 138 – Installed Options Panel (Service Menus Enabled)

The Installed Options panel is grouped by headings and is represented by the following fields and buttons. Having service menus enabled will allow access to all these key menus.

Ambient Source

The Ambient Source allows provision for the connection of an external Temperature, RH or Pressure sensor to be mounted outside of the enclosure in close proximity to the sample inlet that may be mounted on the roof of a monitoring station. This will allow more accurate volumetric flow control through a size selective inlet. This option is not available at the time of writing this manual. Contact Acoem for further details.

Flow

- **Source** – This is set to Internal for using the internal sample pump. If using the MFC option, set to External so that an external pump or vacuum source can be used. Contact Acoem for further details.
- **Control** – This is the nature of the flow measurement. By default, it is set to Sensor as the onboard flow sensor is used to measure the flow. If the MFC was installed, then MFC would be selected.
- **Flow Type** – Standard or Volumetric. If Volumetric is selected then the following fields will be displayed:
    - **Norm Temp** – Normalisation temperature used in the calculation of the volumetric flow. 0°C, 20°C or 25°C.
    - **Norm Press** – Normalisation pressure used in the calculation of the volumetric flow. Fixed at 1013.25mBar.
    - **Measure Temp** – Sensor location used in the temperature measurement for the calculation of volumetric flow. **Sample** (inside measurement cell), **Chassis** (mounted on the microprocessor board) or **Ambient** (Mounted outside near inlet. TBA). Sample is the default setting.
    - **Measure Press** – Sensor location used in the pressure measurement for the calculation of volumetric flow. **Sample** (inside measurement cell), **Chassis** (mounted on the microprocessor board) or **Ambient** (Mounted outside near inlet. TBA). Sample is the default setting.

Note: MFC option is not available at the time of writing this manual. Contact Acoem for further details.

Cooler (NE-300 and NE-400 only)

The Cooler button can be used to disable the PMT Cooler. Note that this may result in greater noise in elevated temperatures if disabled.

3.4.5.5.3 Hardware Files Button

The Hardware Files button operates in the same manner as the Calibration and User Setting files mentioned in **sections 3.4.3.3 3.4.3.3and 3.4.5.3**. Please refer to these sections for greater details on file operations.

The Hardware Files button will open a dialog box that saves and loads hardware settings specific to the instrument. This page is the same for all instrument types. Hardware files can be saved automatically (Backup Files) or manually (User Files). From this page, the files can only be named with two numeric digits. However, if the storage medium is removed, then the filenames can be changed to more complex names using a PC. The purpose of this page is to keep backup copies of known instrument hardware setup. The Hardware Files can be saved to either the SD card or the USB memory key.

If performing maintenance on an instrument, it might be useful to back up the hardware file before the work has commenced.

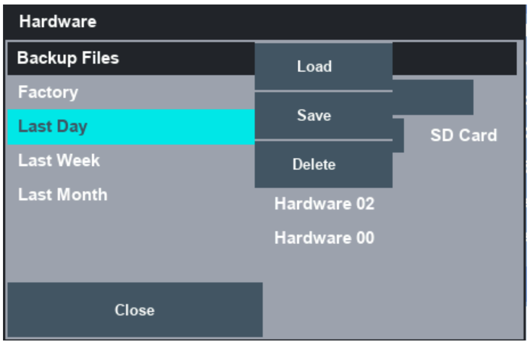


Figure 139 – Hardware Backup file Options

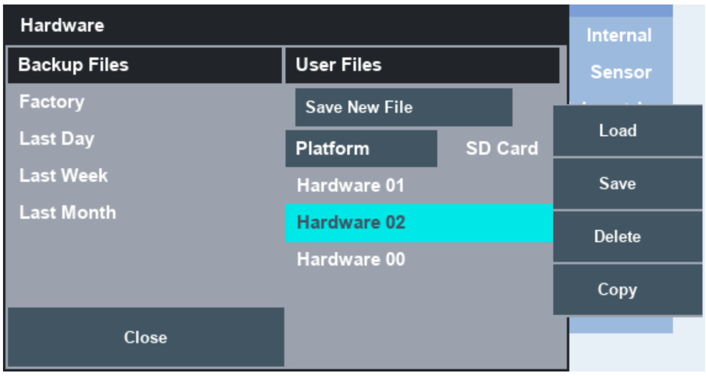


Figure 140 – Hardware User Files Options

3.4.5.5.4 PIDs, Power, Emulation

There are three Hardware child pages available when the service menus are enabled. **PIDs**, **Power** and **Emulation**. These pages generally are not required to be used for normal operation.

The PID page contains settings and details for the three control PIDS for Temperature, Flow, and Cooler. It also includes a control for enabling or disabling the chassis fan.

The Power page allows manual operation of power to various parts of the circuitry.

The Emulation page contains settings to manually emulate readings and controls.

Note: It is strongly recommended **NOT** to change any of these parameters unless advised by Acoem technical support.

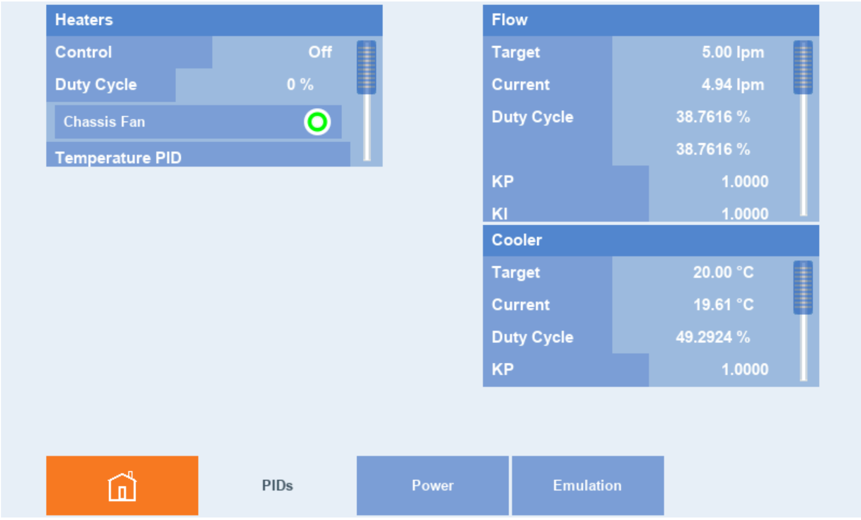


Figure 141 – PIDs Child Page

3.4.5.6 Factory

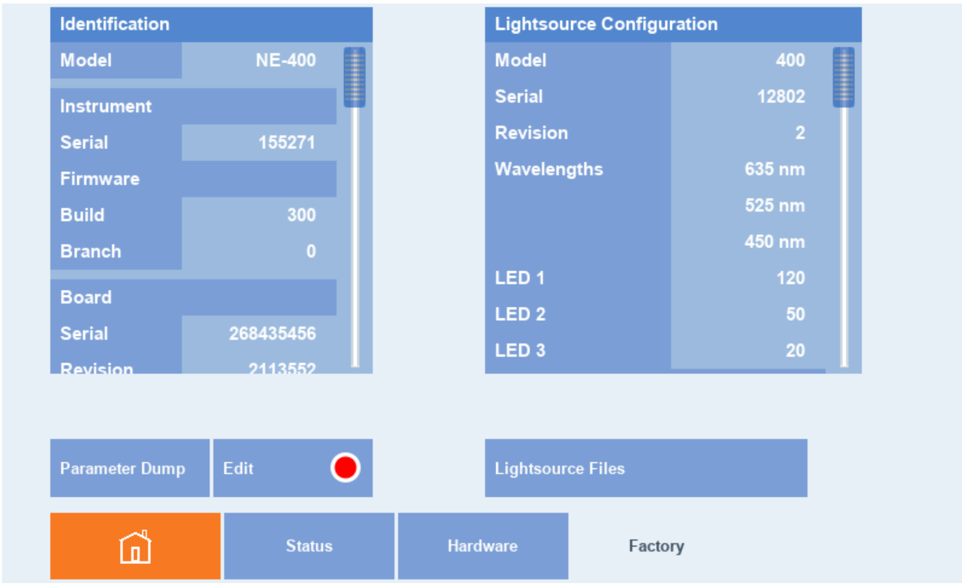


Figure 142 – Factory Child Page (Service Menus enabled)

This page contains information unique to the instrument factory setup. Generally, this page is not required to be used for normal operation. It has two panels and three buttons; the **Identification** panel, **Lightsource Configuration** panel the **Parameter Dump, Edit and Lightsource Files** buttons.

These panels are primarily intended for technician use and at times may require the service menus to be enabled. They are not the same for each instrument type.

3.4.5.6.1 Identification Panel

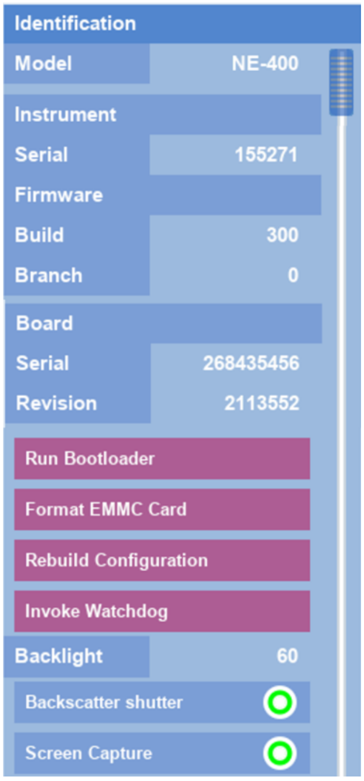


Figure 143 – Identification Panel (Service Menus Enabled)

The identification information is presented in this panel. The information is grouped by headings and represented by the following fields and buttons:

- **Model** – Identifies the model of the instrument. NE-100, NE-300 or NE-400. Factory setting

Instrument

- **Serial** – The serial number allocated to this instrument. Factory setting

Firmware

- **Build** – The build version of the firmware installed on the instrument.
- **Branch** – The branch version of the firmware installed on the instrument.

Board

- **Serial** – The serial number of the microprocessor PCA installed in the instrument. Factory setting
- **Revision** – The Revision of the microprocessor PCA installed in the instrument. Factory setting

Microprocessor operations

- o **Run Bootloader** – Stops ALL the instruments applications and enters the instruments Bootloader page. This page is used for loading firmware. See section 6.5.
- o **Format EMMC Card** – Will erase all data stored on the internal EMMC card, including all status and event recordings, and re-format it.

- o **Rebuild Configurations** – Will load default settings into all the parameters. The instrument would require complete re-calibration after doing this. Or you can re-load known good configuration files from a previous calibration.
- o **Invoke Watchdog** – This tests the automatic watchdog restart feature.

- **Backlight** – The backlight brightness of the touch screen is adjusted here. Touching this field will open a keypad dialog to enter a value between 0 and 100%.
- **Backscatter shutter** –This button allows the user to disable the Backscatter shutter operation. Then no Backscatter or angle readings will be recorded other than at 0°. **It is strongly advised NOT to disable this function**
- **Screen Capture** –When enabled, the user can take screenshots of a screen by touching the top right corner of the screen. A BMP image will be copied to the USB memory key.

3.4.5.6.2 Light Source Configuration Panel

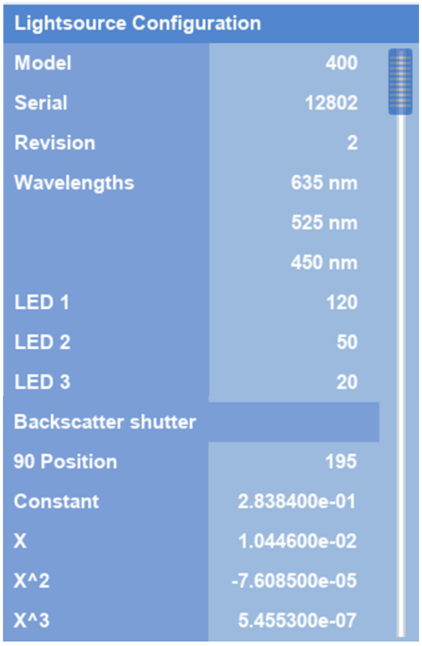


Figure 144 – Lightsource Configuration Panel (Service Menus Enabled)

This panel has specific information that is stored inside the light source specific to its calibration and instrument type. These parameters must not be changed unless instructed by ACOEM technical support team. The information is grouped by headings and represented by the following fields:

- **Model** – Identifies the model of the light source and it must match the instrument model in the Identification pane. NE-100, NE-300 or NE-400. Factory setting
- **Serial** – The serial number allocated to the Light Source installed in the instrument
- **Revision** – The Revision of the Light Source design
- **Wavelengths** – The available wavelengths on the installed Light Source.635 nm, 525 nm, 450 nm

- **LED 1, LED 2, LED 3** – The Intensity setting of each series of LEDs for each wavelength installed in the instrument. LED1 = 635nm, LED = 525nm, LED3 = 450nm. Adjustment is from 1 to 254.

Backscatter shutter (NE-300, NE-400 only)

- **90 Position** – The Factory calibration for the 90-degree shutter position. NE-300 and NE-400. Factory calibrated.
- **Constant, X, X^2, X^3** – Third order polynomial coefficients for the calibration of the NE-400 Polar Light Source. Factory calibrated.

3.4.5.6.3 Lightsource Files Button

The Lightsource Files button operates in the same manner as the Calibration and User Setting files mentioned in **sections 3.4.3.3 and 3.4.5.3**. Please refer to these sections for greater details on file operations.

The Lightsource Files button will open a dialog box that saves and loads the Lightsource settings shown in the Lightsource Configuration panel. Lightsource files can be saved automatically (Backup Files) or manually (User Files). From this page, the files can only be named with two numeric digits. The purpose of this page is to keep a backup copy of the current Lightsource setup. These Files can be saved to either the SD card or the USB memory key although this information is also stored on the lightsource.

If a new Lightsource was to be installed, then is should come with different settings.

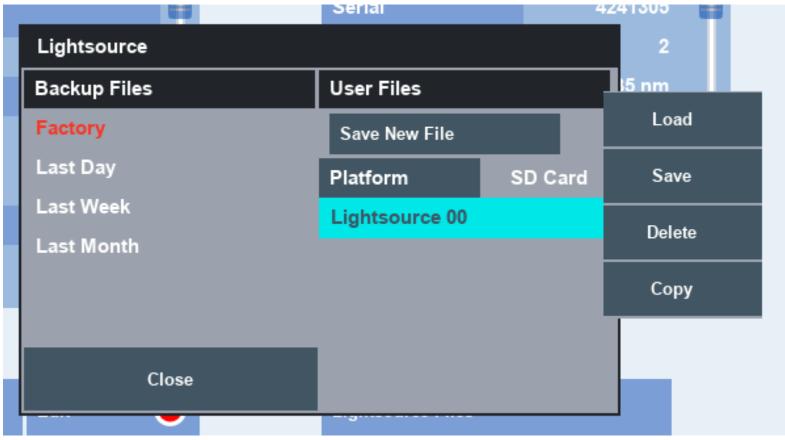


Figure 145 – Lightsource User Files Options

3.4.5.6.4 Parameter Dump

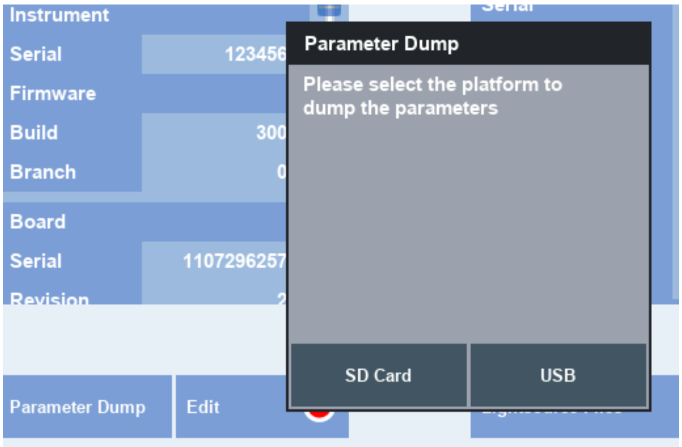


Figure 146 – Parameter Dump Storage Location Selection

The Parameter Dump is a feature of the Aurora NE series that allows a manual download of ALL instrument parameters. It is similar to the EE Dump feature in the Aurora series, only more detailed. These include all the parameters from the Calibration, Settings, Hardware and Lightsource Configuration files. If the user is experiencing issues with the instrument, the ACOEM Technical Support Team will ask for a Parameter Dump.

When the Parameter Dump button is pressed, a dialog box will open asking where to store the Parameter Dump file. SD card or USB memory key. Once selected, the file transfer will take up to 10 seconds to complete, then a warning box will open telling you that the Parameter Dump has finished. Then press exit and remove the storage medium if needed.

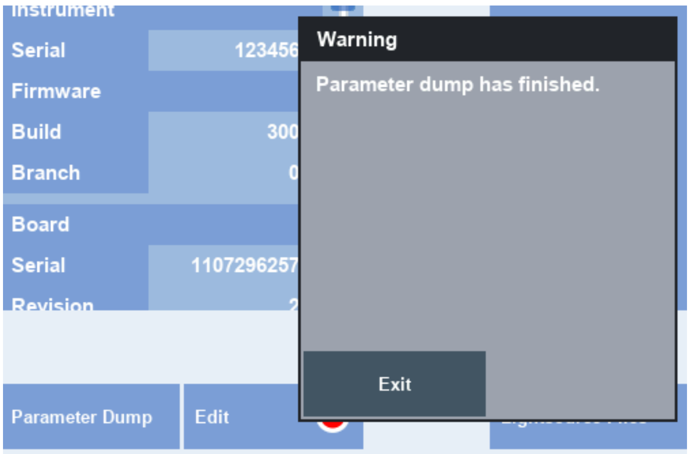


Figure 147 – Parameter Dump Completed

The Parameter Dump is a text file and will be stored under the Report sub folder on the storage device. Each file is date and time stamped.

Note: The Edit button is reserved for Factory purposes.

This page is intentionally blank.

4. Communications

Figure 148 – Communication Ports

The Aurora NE Series Multi Wavelength Nephelometers has a number of different interfaces for communication with other equipment (RS232, USB, 25 pin digital/analog input/output, and TCP/IP network). Bluetooth will be optional. A demonstration version of Acoem Australasia's Airodis software is included with the instrument, enabling basic data downloads and remote operation from a PC running a supported MS Windows operating system. The full version of Airodis is available separately and includes automated data collection, data validation and complex reporting by multiple users. The following sections of this manual contain details on setting up and communicating with the instrument.

4.1 RS232 Communication

RS232 communication is a very reliable way to access data from the instrument and is recommended for use in connection to a data logger for 24/7 communication. Both RS232 ports are configured as DCE and can be connected to DTE (Data Terminal Equipment such as a data logger or computer).

Both ports support multidrop arrangement (a configuration of multiple instruments connected via the same RS232 cable where the transmit signal is only asserted by the instrument that is spoken to).

For reliable multidrop RS232 communications follow these guidelines:

- Verify that the Serial ID is set to a unique value which is different to the other instruments in the chain.
- All of the instruments in the multidrop chain must have the same baud rate and communication protocol settings. A maximum of 9600 baud rate is recommended.
- The multidrop RS232 cable should be kept to less than three meters in length.
- A 12K ohm terminating resistor should be placed on the last connector of the cable (connect from pin 2 to pin 5 and from pin 3 to pin 5.
- The shielding of the multidrop cable must be continuous throughout the cable.
- The shielding of the multidrop cable must only be terminated at one end. It should be connected to the metal shell of the DB 9-way connector.

Note: If not using multiple instruments on the multidrop cable and there is only one instrument connected to one serial port, then the 12K resistor is not required and faster baudrates can be used.

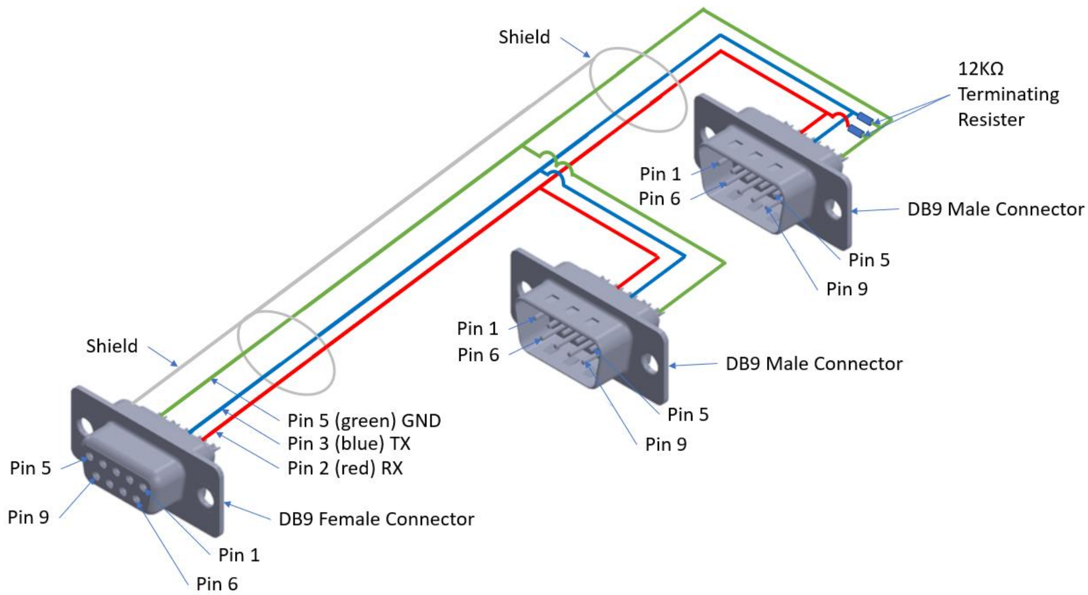


Figure 149 – RS-232 Multidrop Cable Example

4.1.1 Serial Connection Setup

When setting up a serial connection follow the following procedure:

1. Access the Comms page
2. Locate the serial panel

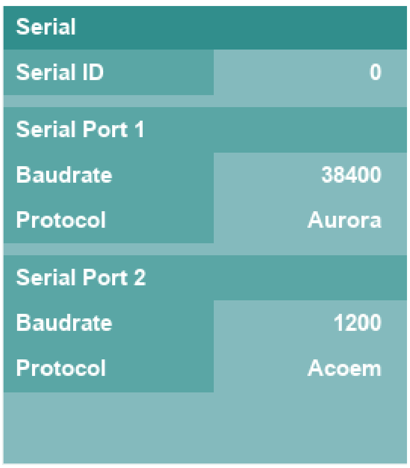


Figure 150 – Serial Connection Setup, Serial Panel

3. Edit the Serial ID if you plan to have several Aurora NE instruments on the one serial port or leave it at 0 as default.
4. Select the baudrate to suit your application.
5. Choose the protocol; Aurora or Acoem. Aurora is a legacy and won't give you the full benefits of the Aurora NE Series
6. Connect a standard straight-through RS-232 cable male end of the connector into the female port on the instrument.

7. Connect the female end of the RS-232 cable to an available COM port on your selected device.
8. Change the settings on the selected device, they need to match the instrument setup made during steps 3, 4, and 5.

Note: If for any reason any of the details do not match the connection will not work.

The instrument is now ready to receive and send data via the serial port.

4.2 USB Communication

This is ideal for irregular connection to a laptop running Acoem Australasia's Airodis software to download logged data and remotely control the instrument. Due to the nature of USB, this is a less reliable permanent connection as external electrical noise can cause USB disconnection errors on a data logger.

Once the connection has been made between the Aurora NE Series and a PC, windows will automatically install a driver and set up a VSP (Virtual Serial Port). You will need to check the device manager to determine the number of the new serial port.

Note: Only the ACOEM protocol is supported for USB communication

4.2.1 Setup Airodis to Communicate with Aurora NE over USB

USB

Below is an example of Airodis setup for a USB connection. Ensure the protocol under the USB heading is set to Acoem on the Aurora NE.

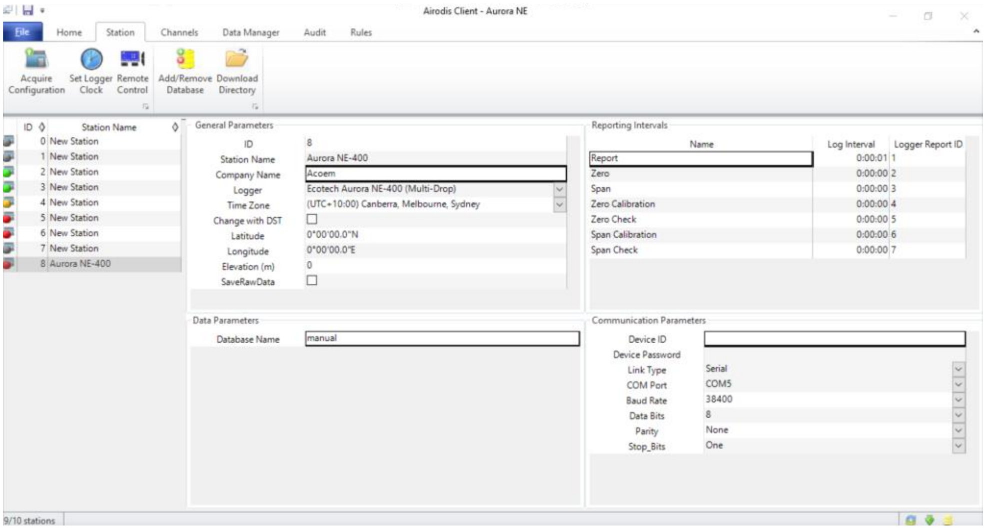


Figure 151 – USB Set-Up (Airodis)

Communications can be tested by selecting "Set Logger Clock" from the Station toolbar. If communications are good, the time of both the PC and the Aurora NE will be displayed. Cancel or proceed to set the time if required.

4.3 TCP/IP Network Communication

Instruments can be accessed using a TCP/IP connection. Figure 152 shows examples of some possible configurations for remote access.

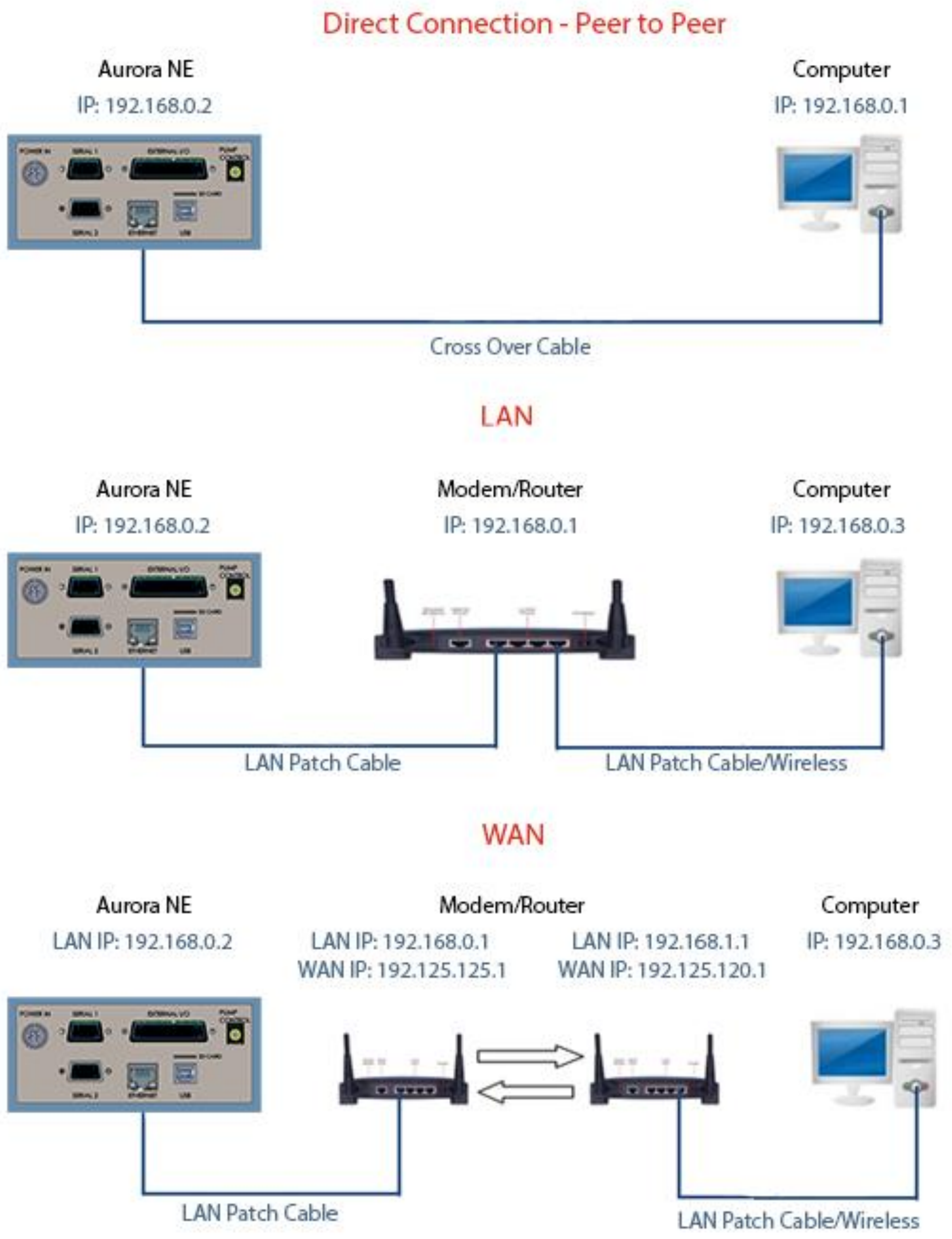


Figure 152 – Example of Typical Network Setups

Note: In Figure 152 all the IP addresses are taken as an example. The WAN IP addresses are normally provided by your ISP. Whereas, the LAN IP addresses can be set manually to any range which is within the subnet of the Modem/Router/switch.

Use a cross-over LAN cable to connect the instrument directly to a computer, or a standard LAN cable for connection to a Modem/Router/Switch as shown in Figure 152. The computer could be connected to the Modem/Router using either CAT5 cable or a wireless connection, but the instrument must be connected using CAT5/6 cable.

4.3.1 Setting Network Port Setup

When setting up a Network connection follow the following procedure:

1. Access the comms page
2. Locate the ethernet panel

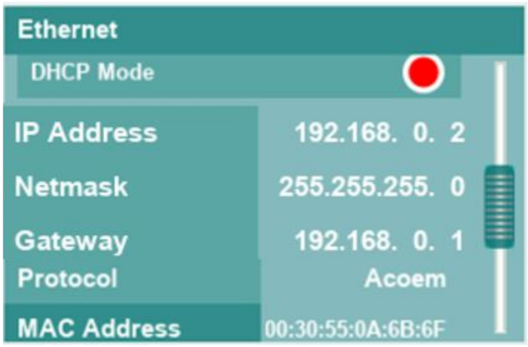


Figure 153 – Example of Ethernet Panel

3. Touch the IP address and using the keypad set the IP address
4. Touch the Netmask and using the keypad set the Netmask
5. Touch the Gateway and using the keypad set the Gateway
6. Choose the protocol; Aurora or Acoem. Aurora is a legacy and won't give you the full benefits of the Aurora NE Series
7. Depending on the network type use a crossover cable for a peer-to-peer connection or a patch cable for all other network types
8. The MAC address can be used to set up a static IP address. Contact your IT Department

Note: If your IT department uses DHCP to assign IP address, touch the DHCP mode radio button at the top of the ethernet panel an available IP address will be assigned and displayed.

Note: The address assigned using the DHCP mode may change if the port is disconnected or the DHCP mode radio button it toggled. It may also change if the IP address lease time expires.

4.3.2 Setup Airodis to Communicate with Aurora

LAN

Below is an example of Airodis setup for a LAN network. Ensure the IP address is set to the same as on the instrument **Network Menu**.

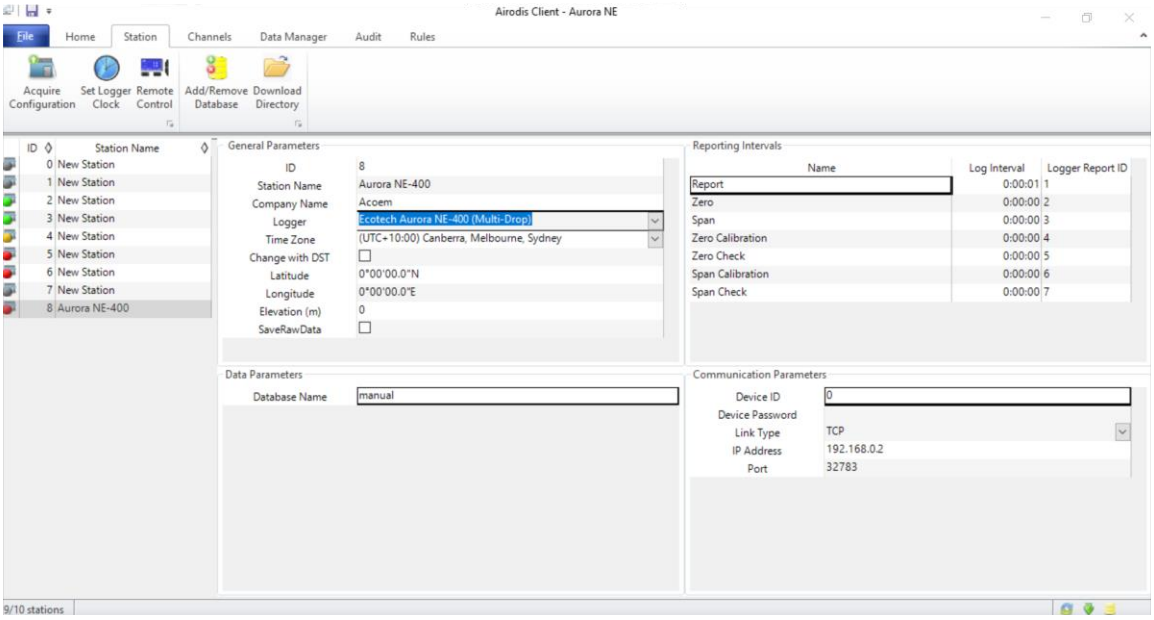


Figure 154 – LAN Network Set-Up (Airodis)

Below is an example of Airodis setup for a WAN network. Ensure the IP address is set the same as on the remote modem/router.

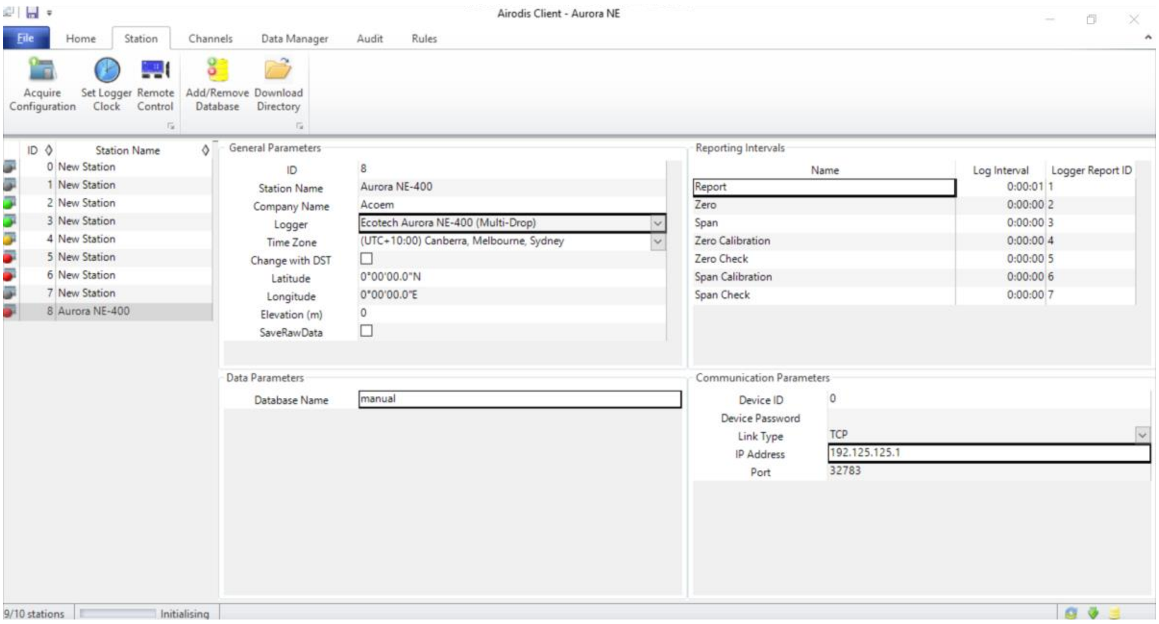


Figure 155 – WAN Network Set-Up (Airodis)

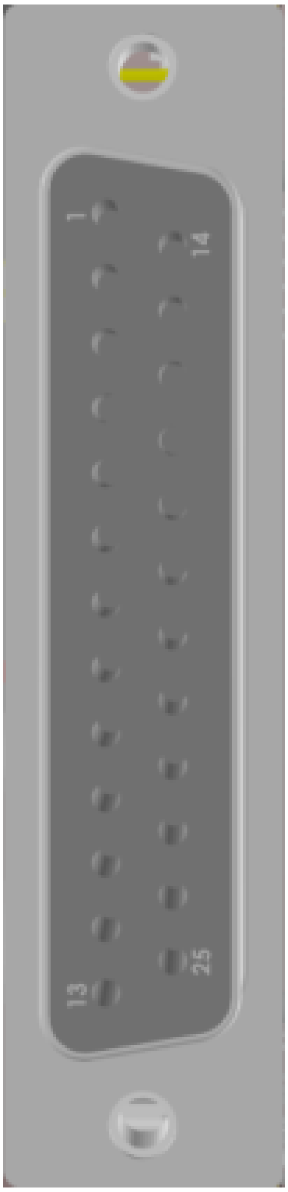
Communications can be tested by selecting “Set Logger Clock” from the Station toolbar. If communications are good, the time of both the PC and the Aurora NE will be displayed. Cancel or proceed to set the time if required.

4.4 Analog and Digital Communication

The 25-pin analog and digital I/O port on the side panel of the instrument can be use to connect to external data logging systems, PLC, or other computer equipment for control and data recording.

The connector has four main Functions. Analog Outputs, Analog Inputs, Digital Inputs, and Digital Outputs. The diagram below shows the pin numbers and their function.

Table 12 – External IO 25-Way connections

Aurora NE Side Connector Pins	Top Row Pin Number	Bottom Row Pin Number	Function
	1		Ground
		14	Analog Output 1
	2		Analog Output 2
		15	Analog Output 3
	3		Analog Output 4
		16	Analog Output 5
	4		Analog Output 6
		17	Ground
	5		Analog Input 1
		18	Analog Input 2
	6		Analog Input 3
		19	Analog Input 4
	7		Digital Input 1
		20	Digital Input 2
	8		Digital Input 3
		21	Digital Input 4
	9		+ 5V Power Supply
		22	Ground
	10		Digital Output 1
		23	Digital Output 2
	11		Digital Output 3
		24	Digital Output 4
	12		Ground
		25	+12V Power Supply
	13		Ground

4.4.1 Analog Outputs

The instrument is equipped with six analog outputs that can be set to provide 0 – 5 V voltage outputs. The analog outputs are tied to user-selected parameters. See section 3.4.4.5.2 for further details on setting these.

4.4.2 Analog Inputs

The instrument is also equipped with four analog inputs with a resolution of 16 bits, accepting a voltage between 0 - 5 V. These are measured via a ADC on the control board and have some surge protection to ensure static/high voltage do not damage the main controller PCA. See section 3.4.4.5.1 for further details on setting these.

4.4.3 Digital Status Inputs

The instrument is equipped with four logic-level inputs for the external control of the instrument such as Zero or Span sequences. Each input has a terminating resistor which can be either PULL UP or PULL DOWN. This is set using the jumper JP1 (DIO HI or LO) on the Control PCA. There is limited functionality for these at the present time.

4.4.4 Digital Status Outputs

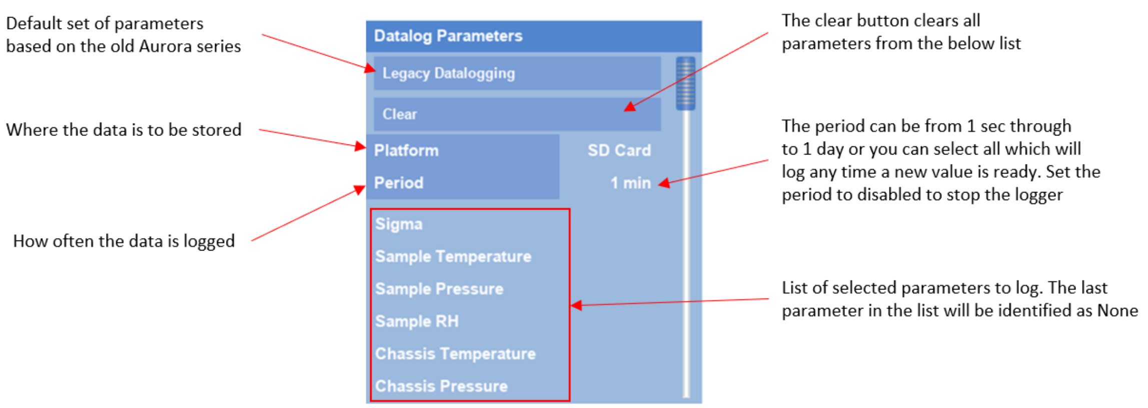
The instrument is equipped with four open drain outputs which will convey instrument status condition warning alarms such as no flow, sample mode, etc. There is limited functionality for these at the present time.

CAUTION

The analog and digital inputs and outputs are rated to CAT I.

Exceeding 12 VDC or drawing greater than 400 mA on a single output or a total greater than 2 A across the four outputs can permanently damage the instrument and void the warranty.

4.5 Logging Data



When the user receives the instrument from the factory it will have a default set of parameters already setup in the internal data logger. These select few parameters have been chosen for their relevance in assisting in troubleshooting the instrument.

The internal datalogger can have a maximum of 32 parameters selected. Keep in mind that for the NE-300 and NE-400, some of those parameters are lists of numbers rather than a single number (i.e., the Sigma/All/All on a NE-300 can have up to six different numbers: Sigma 450 nm 0°, Sigma 525 nm 0°, Sigma 635 0°, Sigma 450 90°, etc.).

The Aurora NE Series has a logging capacity for more than +10 years of 1 second data. Remember though, that large amounts of data will take longer to download and store. 1 minute logging is recommended for most applications.

Data is stored on either the SD card or USB memory stick depending on the platform selected in the datalog parameters panel. A new file is created for each day or when the instrument is powered up or logging parameters are changed.

4.5.1 Configure Instrument Internal Logging

This section will assume the parameters have been cleared and you are starting from scratch. The logging settings are stored in the Settings Configuration file and can be stored or retrieved at another time.

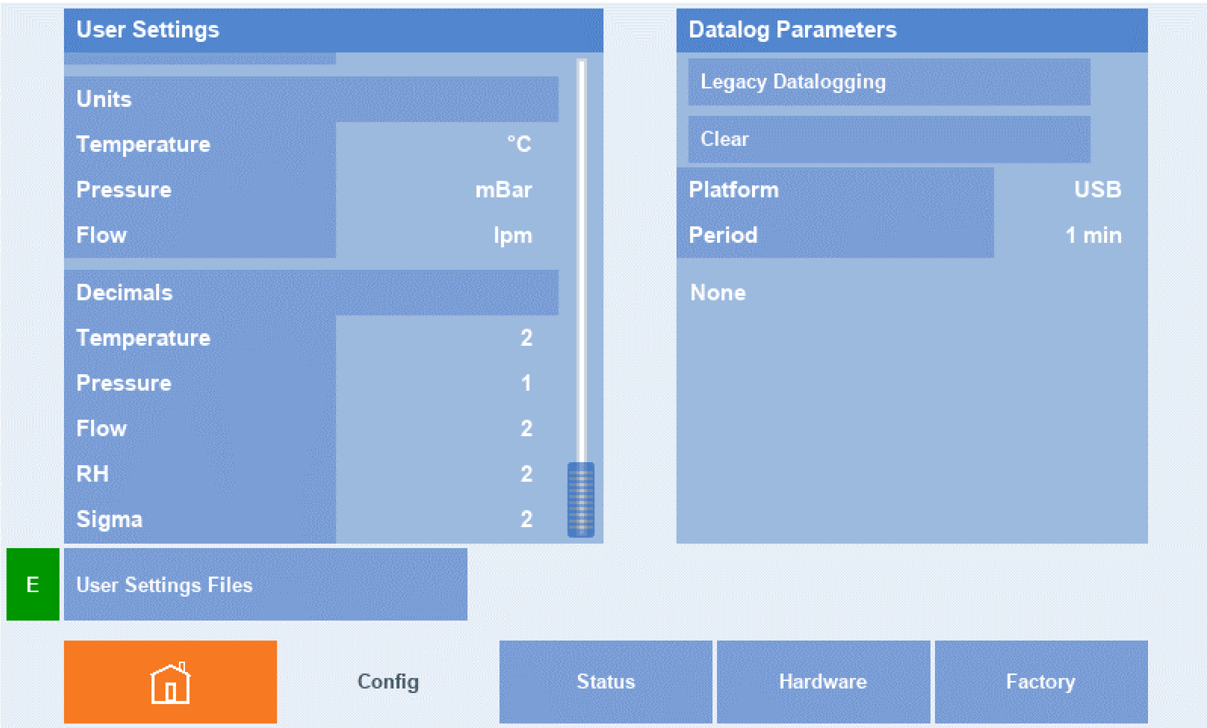


Figure 156 – Cleared Parameter Logging List

In order to log data, the user must follow the following procedure:

1. First specify where the data is to be stored using the platform field. USB or SD Card.

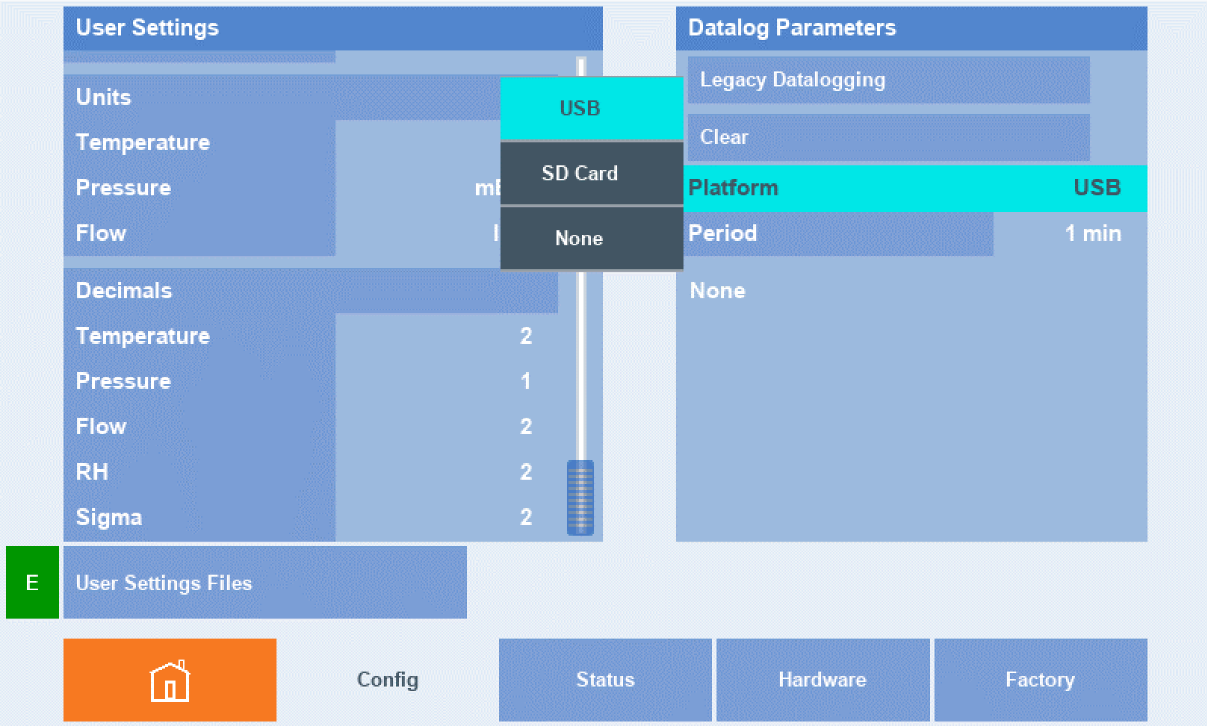


Figure 157 – Data Logger Storage Location

2. Select the period (interval) at which the parameters will be logged using the period field

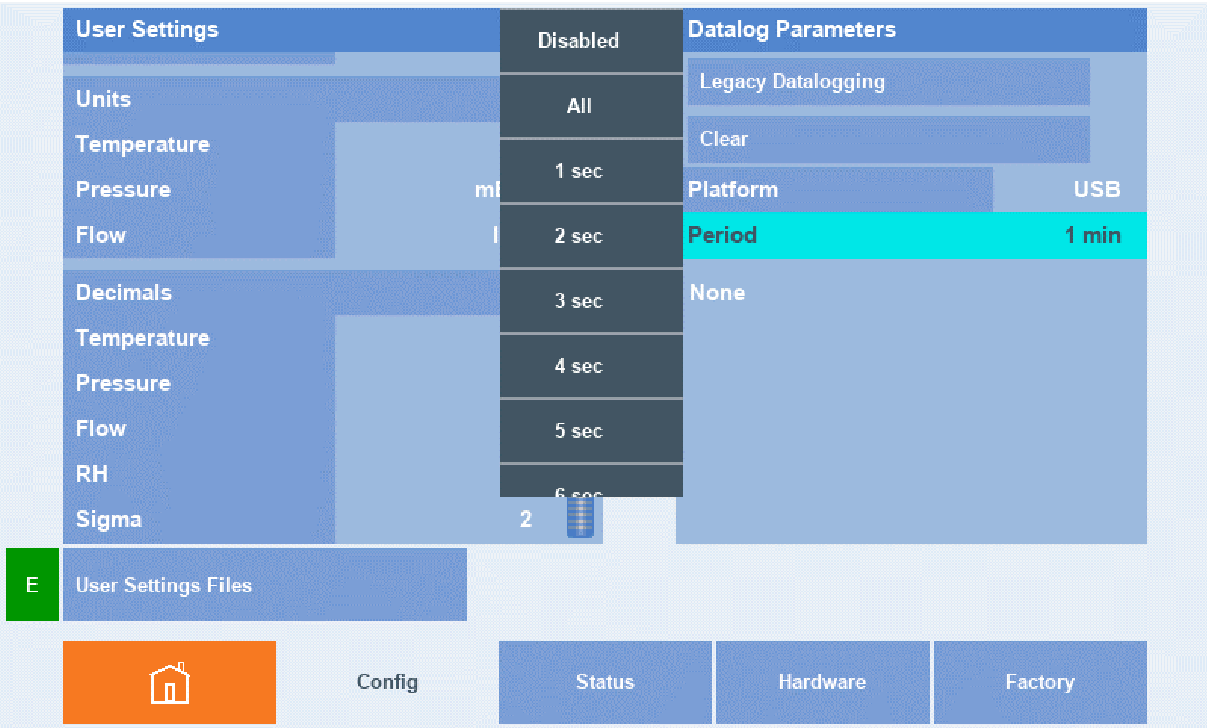


Figure 158 – Data Logging Interval

3. In the bottom half of the datalog parameters panel is the list of parameters that will be logged ending in none. Touch none to add a new parameter to the list or touch any of the parameters currently in the list to edit them. This will popup a datalog parameter dialog box.

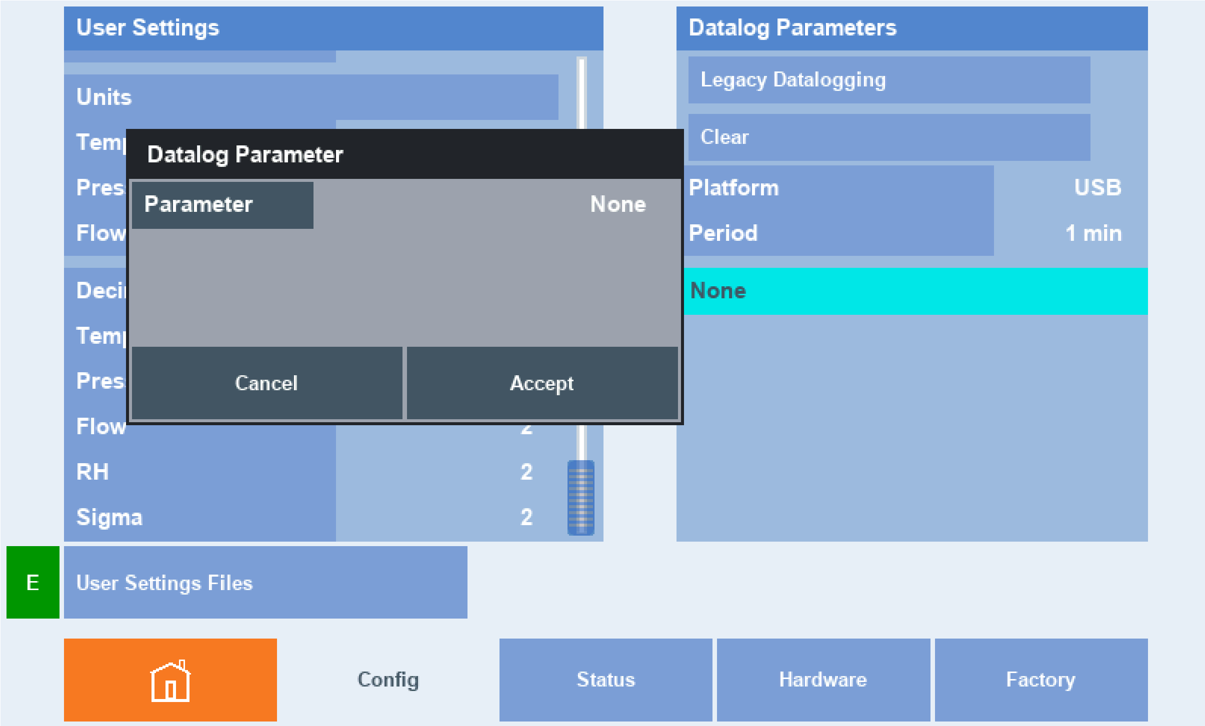


Figure 159 – Datalog Parameter Dialog Box

4. Select none, and a list will pop-up with the available parameters to select from

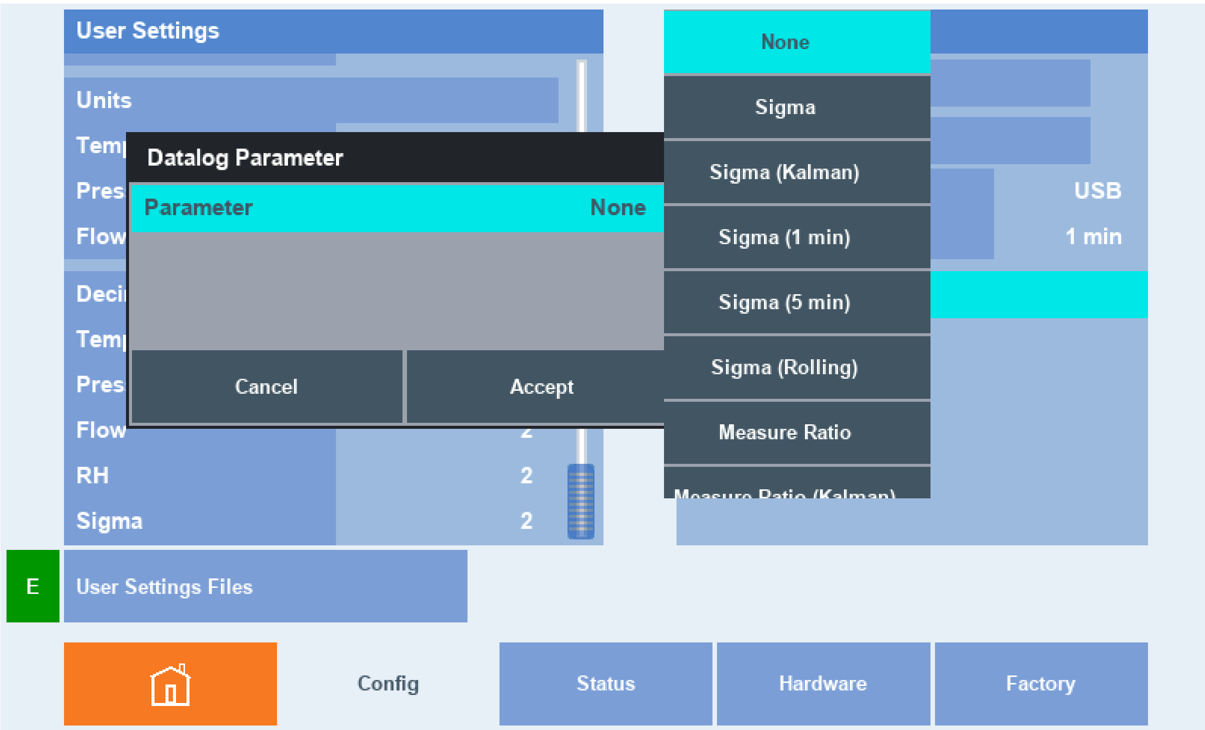


Figure 160 – Datalog Parameter Dialog Box Parameter Selection

5. Select a parameter to log. For this example, we will choose Sigma.

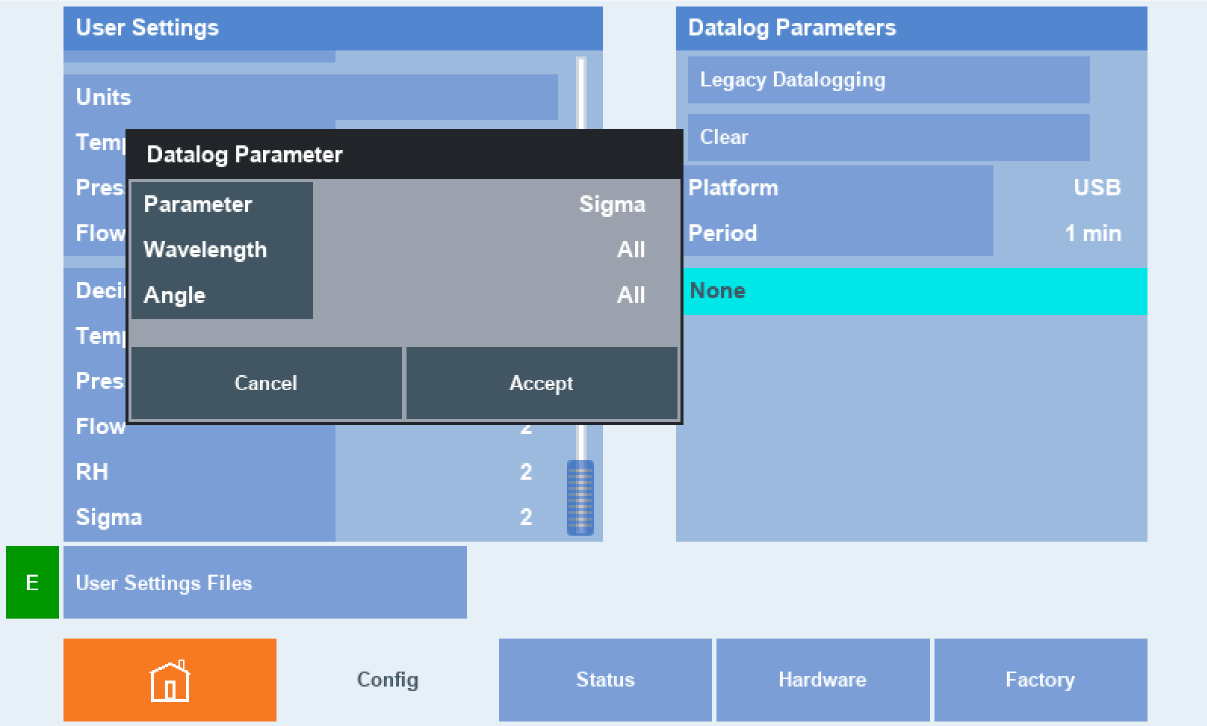


Figure 161 – Example Parameter Selection

6. Press accept to add your selected parameter to the list. Just below the datalog parameters panel a set of buttons will appear; Accept and Cancel. Selecting accept will save the changes and selecting cancel will revert the changes. On choosing Accept the datalogging will re start and a new file created.

Figure 162 – Accepting Datalog Changes

7. Repeat steps 4- 6 to continue to add new parameters to the list or edit current parameters.
8. Select an existing parameter and change it to none to remove it from the list.

4.5.2 Data Collection

Internally logged data is stored as a text CSV (Comma Separated Variable) file. It can be collected or downloaded by two means.

- o Media removal by removing the USB od SD card from the instrument. Inserting it into a PC with a USB or SD card reader. Locating the Year, Month, Day folder with the desired data file. And loading it into MS EXCEL for evaluation.

- Acoem Aorodis software by downloading over a RS232, USB or TCPIP connection. Refer to section 4 for setup details.

This page is intentionally blank.

5. Calibration

5.1 Overview

The following sections describe how to calibrate all the sensors and measurements for the Aurora NE Series Nephelometers. The procedure is the same for all instrument types. Different settings for each instrument are shown in the tables.

The process of calibration to ensure accurate scattering measurement is:

1. Sample Temperature Sensor Calibration. (Section 5.2.2)
2. Sample Pressure Sensor Calibration. (Section 5.2.3)
3. Leak Check. (Section 6.4.10.1)
4. Full Gas Calibration. (Section 5.5)

Other sensors that need calibrating but do not influence the scattering measurement calibration are as follows:

- Sample RH. (Section 5.2.4)
- Chassis Temperature, Pressure, and RH. (Section 5.3)
- Sample Flow. (Section 5.4)

5.2 Sample Sensor Calibration

5.2.1 Pre-Sample Sensor Calibration

To calibrate the sample Temperature/Pressure/Relative Humidity sensor first you need to remove it from the cell body by following this procedure.

1. In the Config - Hardware menu, check that the Heater control is set to off.
2. Switch off the Aurora NE.
3. Open the door and remove the lid. Follow the instructions in Section 2.1 (Opening the instrument)
4. Locate the Pressure, Temperature, and Relative Humidity sensor on the front side of the cell, refer to Figure 163

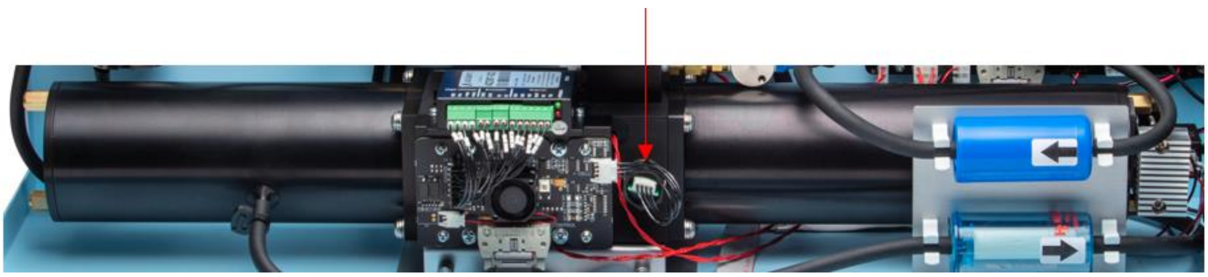


Figure 163 – Location of Temperature Pressure RH Sensor

5. Disconnect the wiring loom from the sensor body, and unscrew the sensor from the cell body.

> **Note:** This may take several turns before being able to remove as the threaded body of the Temperature Pressure RH Sensor is quite long.

6. Once the sensor is removed from the cell body reconnect the wiring loom and rest the sensor in the chassis then power up the instrument.

5.2.2 Sample Temperature Calibration

Follow the procedure in the section 5.2.1 to remove the sensor before attempting a calibration.

1. Place a calibrated temperature reference as close as possible to the sample Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.
2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Sample select the temperature with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu.
4. This will popup a calibration dialog box.

> **Note:** Ensure the units of measure setup for the sample Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated temperature reference and press enter.
6. The calibration adjustment of the temperature is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.2.3 Sample Pressure Calibration

Follow the procedure in the section 5.2.1 to remove the sensor before attempting a calibration.

1. Place a calibrated pressure reference as close as possible to the sample Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.
2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Sample select the pressure with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu.
4. This will popup a calibration dialog box

> **Note:** Ensure the units of measure setup for the sample Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated pressure reference and press enter.
6. The calibration adjustment of the pressure is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.2.4 Sample Relative Humidity Calibration

Follow the procedure in the section 5.2.1 to remove the sensor before attempting a calibration.

1. Place a calibrated RH reference as close as possible to the sample Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.

2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Sample select the RH with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu.
4. This will popup a calibration dialog box.

Note: Ensure the units of measure setup for the sample Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated pressure reference and press enter.
6. The calibration adjustment of the pressure is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.2.5 Post Sample Sensor Calibration

Once the calibration of the sample Temperature/Pressure/Relative Humidity sensor is complete reinstall the sensor following this procedure.

1. Switch off the Aurora NE.
2. Disconnect the wiring loom from the sensor body and screw the sensor back into the cell body.

Note: Ensure the washer is still on the sensor before reinstalling it into the cell body.

Note: This may take several turns to tighten as the threaded body of the Temperature Pressure RH Sensor is quite long.

3. Once the sensor is replaced reconnect the wiring loom.
4. Replace the lid back onto the Aurora NE chassis following the instructions in Section 2.1.
5. Close the door and power up the Aurora NE.
6. Perform an automated leak check. Refer to section 6.4.10.1.

5.3 Chassis Sensor Calibration

The chassis Temperature Pressure RH Sensor is not used for any calculations of the readings, so it is not essential that it is calibrated. The Factory calibration is usually sufficient. The sensor is located in the top left-hand corner of the microprocessor PCA and cannot be removed.

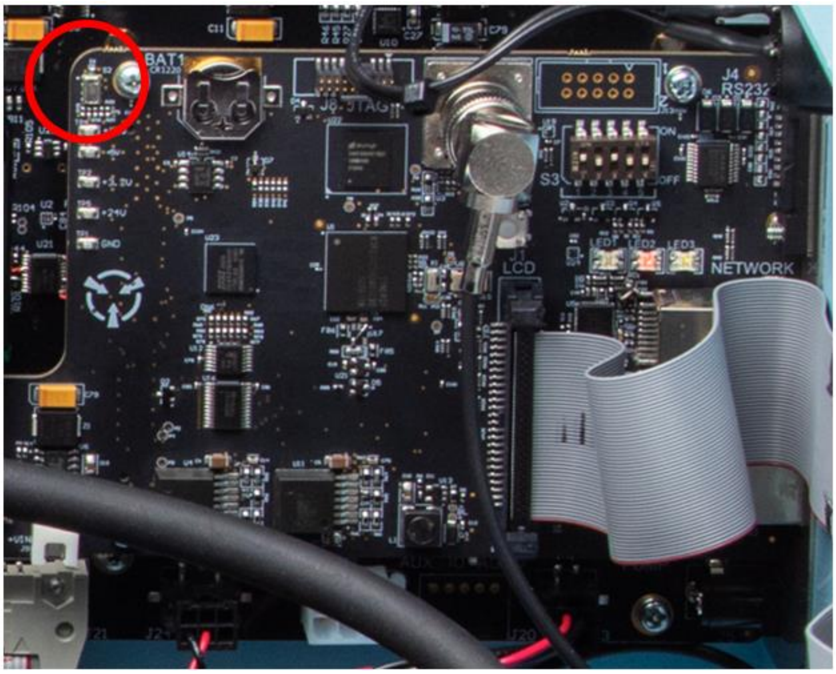


Figure 164 – Location of The Chassis Temperature Pressure RH Sensor

5.3.1 Chassis Temperature Calibration

Follow the procedure to remove the sensor before trying to calibrate the sensor.

1. Place a calibrated temperature reference as close as possible to the chassis Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.
2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Chassis select the temperature with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu.
4. This will popup a calibration dialog box.

Note: Ensure the units of measure setup for the chassis Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated temperature reference and press enter.
6. The calibration adjustment of the temperature is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.3.2 Chassis Pressure Calibration

Follow the procedure to remove the sensor before trying to calibrate the sensor.

1. Place a calibrated pressure reference as close as possible to the chassis Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.
2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Chassis select the pressure with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu.

4. This will popup a calibration dialog box.

Note: Ensure the units of measure setup for the chassis Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated pressure reference and press enter.
6. The calibration adjustment of the pressure is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.3.3 Chassis Relative Humidity Calibration

Follow the procedure to remove the sensor before trying to calibrate the sensor.

1. Place a calibrated RH reference as close as possible to the chassis Temperature Pressure RH Sensor and allow time for the two sensors to stabilise.
2. Navigate to the Cal page then the sensors child page, on the Environmental Readings panel under the heading Chassis select the RH with the press and hold method.
3. This will popup a menu, select calibrate from the bottom of the menu
4. This will popup a calibration dialog box

Note: Ensure the units of measure setup for the chassis Temperature Pressure RH Sensor and the calibrated reference are the same.

5. Select the value field in the calibration dialog box and using the keypad enter the value of the calibrated pressure reference and press enter.
6. The calibration adjustment of the pressure is made automatically, select cancel to revert any changes or Accept to confirm and apply the calibration.

5.4 Flow Calibration

The Aurora NE has an internal pump and internal flow sensor with PID feedback control. Flow can be measured as standard or volumetric. The Volumetric flow calculations are done automatically. The following procedures are used to calibrate the flow sensor which in turn determines the rate of the flow generated by the internal pump. There are two methods of flow calibration. Single point and multipoint. Flow calibration should be performed:

- After routine maintenance or repair
- When the external flow check has found the flow to be outside the normal range
- When a new pump has been installed
- When the instrument is reset to factory defaults

5.4.1 Single Point Flow Sensor Calibration

If the instrument is to be operated at one flow point, and there is no size selective inlet installed, then it is sufficient to calibrate the flow at only one point as slight variations in flow will not influence the measures scattering readings. This procedure will check the zero flow measurement and adjust the slope of the calibration curve to compensate for the measured flow from a calibrated flow meter.

Equipment Required

- Calibrated Flow Meter (Use a flow meter with a 0 - 10 lpm range set to volumetric flow)

Procedure

1. Navigate to the Config page and then to the Hardware child page. Ensure the flow settings on the Installed Options panel are set as per Figure 171**Error! Reference source not found.**.

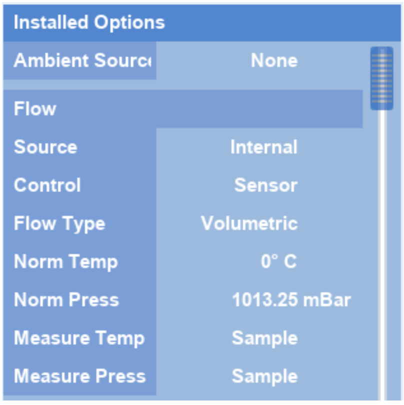


Figure 165 – Internal Pump Flow Settings

2. Connect the outlet of the calibrated flow meter to the sample port of the Aurora NE. Make sure the calibrated flow meter measurement is set to volumetric.

Note: It is advised to use a filter on the inlet of your flow meter for extra protection. Check that there are no kinks in the tubing from the flow meter to the Aurora NE.

Note: If you do not have a volumetric flow meter and are using a mass flow meter, then set the flow type to Standard in Figure 165.

3. Navigate to the Cal page. The flow field on the measurement settings panel is where you can change the flow set point for the single point flow calibration. You can also change the flow setpoint on the Hardware child page.
4. Set the flow to 0 lpm allow the system to stabilise ~2 min. Check that the value is within 0.1 lpm.
5. Set the flow to the desired setpoint for your application. In most cases 6.0 lpm will be sufficient.
6. Allow the system to stabilise ~2 min. Record the measured flow from the flow meter.
7. Navigate to the sensor's child page and on the environmental readings panel press and hold the flow field. A menu will popup. Select calibrate.
8. This will popup a Flow calibration dialog box. It contains the setpoint value, the raw measured flow from the internal flow sensor, and the slope and offset of the calibration curve.
9. Enter the flow measurement from the external flow meter into the Value field. Make sure the units are the same. See Figure 172.

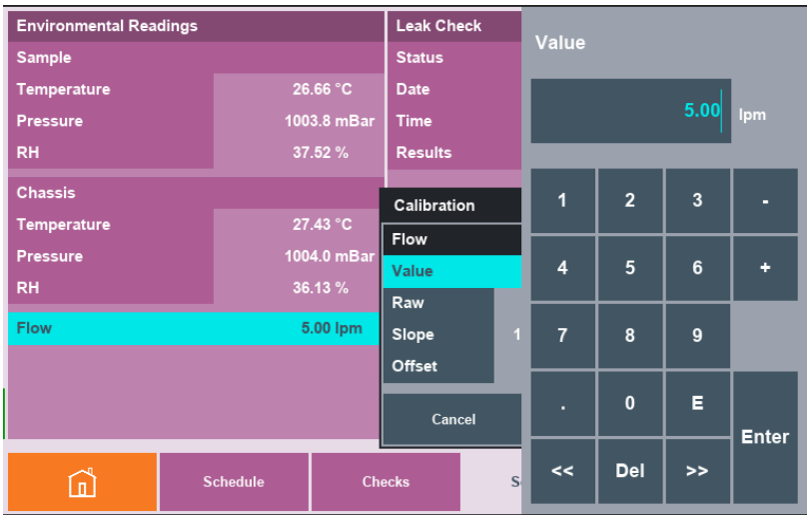


Figure 166 – Flow Calibration Popup

10. When you press enter, the dialog box will calculate a new calibration slope. Select accept to apply the calibration or cancel to abort. See Figure 167.

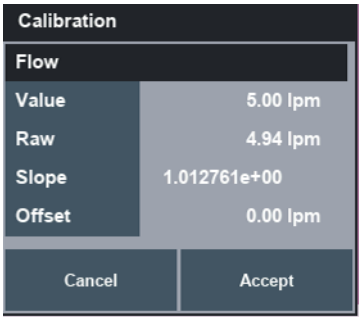


Figure 167 – Flow Calibration Slope and Offset

11. The PID control will then adjust the pump speed so that the measured flow from the external flow meter is close to the measured flow from the internal flow sensor.
12. If the readings still do not agree, then repeat this calibration sequence from step 3.

5.4.2 Multipoint Flow Sensor Calibration

This procedure will step the user through a multipoint flow calibration check defining the characteristics of the flow system, the results of which will be used to plot a line of best fit and generate a slope and offset for the calibration. This is important if the instrument is going to be operated at different flow settings or with a size selective inlet option.

Equipment Required

- Calibrated Flow Meter (Use a flow meter with a 0 - 10 lpm range set to volumetric flow)

Procedure

1. Navigate to the Config page and then to the Hardware child page. Ensure the flow settings on the Installed Options panel are set as per refer to in Figure 171**Error! Reference source not found.**.

2. Connect the outlet of the calibrated flow meter to the sample port of the Aurora NE. Make sure the calibrated flow meter measurement is set to volumetric.

Note: It is advised to use a filter on the inlet of your flow meter for extra protection. Check that there are no kinks in the tubing from the flow meter to the Aurora NE.

3. Navigate to the Cal page. The flow field on the measurement settings panel is where you can change the flow set point for the multipoint flow calibration. You can also change the flow setpoint on the Hardware child page.

Note: The next set of steps will be used to generate the dataset used to calculate the new slope and offset.

4. Set the flow to 0 lpm allow the system to stabilise ~2 min. Record the value.
5. Set the flow to 3 lpm allow the system to stabilise ~2 min. Record the value.
6. Set the flow to 4 lpm allow the system to stabilise ~2 min. Record the value.
7. Set the flow to 5 lpm allow the system to stabilise ~2 min. Record the value.
8. Set the flow to 6 lpm allow the system to stabilise ~2 min. Record the value.
9. Set the flow to 7 lpm allow the system to stabilise ~2 min. Record the value.
10. Set the flow to 8 lpm allow the system to stabilise ~2 min. Record the value.
11. Plot the data set of expected Vs actual and graph using a XY scatter plot. Add a trendline, a linear line of best fit, displaying the equation on the chart but do no set the intercept.

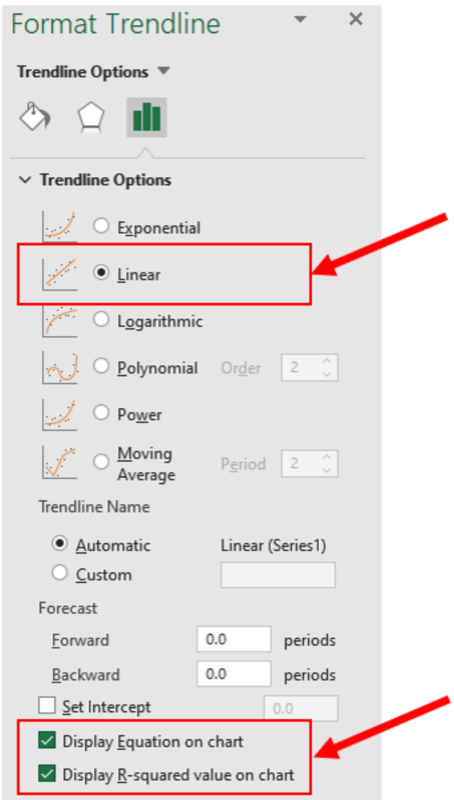


Figure 168 – Trendline Format Settings

Expected	Pre Cal - Actual	% Error	Duty Cycle (%)
8	7.37	7.88	71.4%
7	6.45	7.86	56.0%
6	5.55	7.50	45.0%
5	4.7	6.00	36.0%
4	3.94	1.50	29.37%
3	3.127	-4.23	25.50%

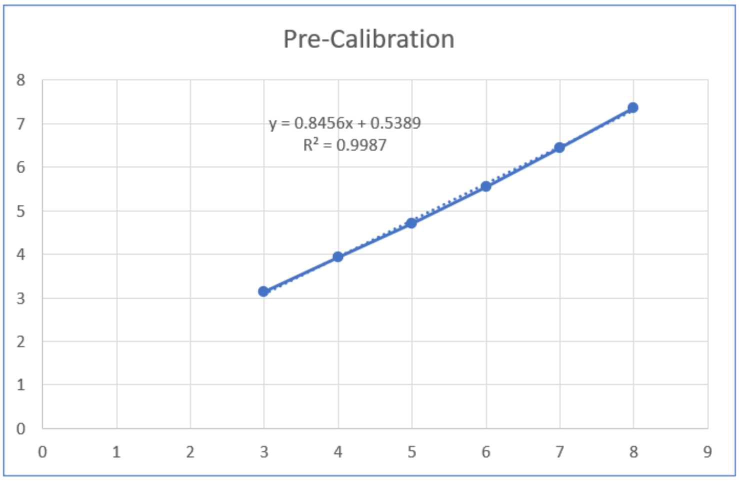


Figure 169 – Example of Pre-Calibration Flow Graph

12. The equation on the graph is y=mx+c where m is the slope and c are the offset.
13. Navigate to the sensor's child page and on the environmental readings panel press and hold the flow field. A menu will popup select calibrate.
14. This will popup a calibration dialog box. In the slope and offset fields enter the corresponding values obtained from the equation and select accept to apply the calibration or cancel to abort.
15. The 8 lpm flow point should now automatically adjust to match that of the calibrated flow meter. Allow the system to stabilise ~2 min. Record the value.
16. Repeat steps 9,8,7,6,5 and 4 to verify the calibration is correct.

Expected	Post Cal - Actual	% Error	Duty Cycle (%)
8	7.985	0.19	83.14
7	6.977	0.33	63.85
6	5.86	2.33	48.54
5	4.874	2.52	37.74
4	3.973	0.68	31.51
3	3.062	-2.07	22.51

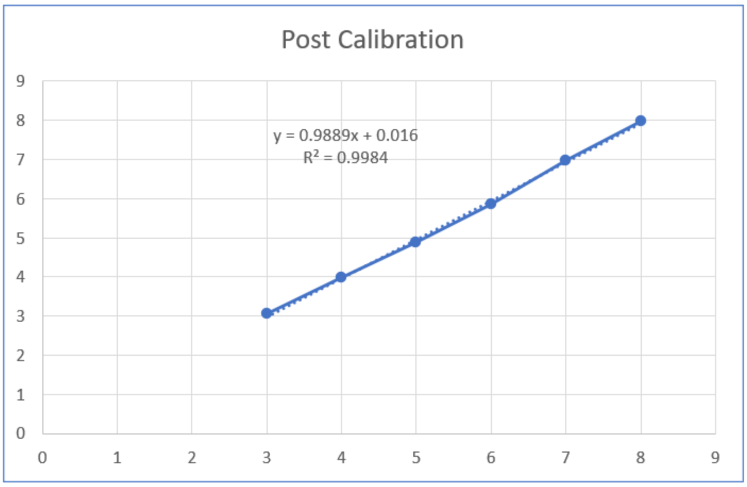


Figure 170 – Example Post Calibration Flow Check

5.4.3 MFC Option Calibration

This option is not available at the time of releasing this manual. Please contact ACOEM for further details.

5.5 Full Calibration (Span and Zero)

The full calibration performs a two-point calibration on the Instrument. The span point uses calibration gas, the zero point use internally filtered particle free air taken from the sample inlet. A full calibration will modify both the span and zero points on the calibration curve. Due to the high stability of the instrument, this type of calibration only needs to be performed approximately every 3 months using calibration gas. Typically, FM200 is used for the full calibration. A full calibration can be performed once the following setup is completed.

5.5.1 Connecting the Calibration Gas

This section explains the setup of the gas calibration system.

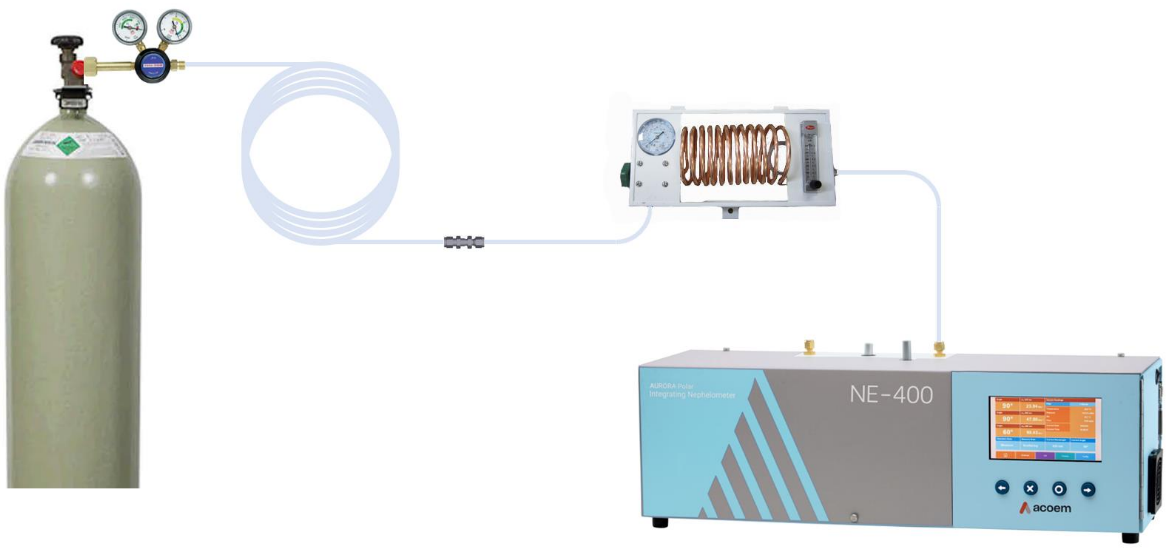


Figure 171 – Gas Delivery System

Note: Consult your local regulations for the positioning of the gas cylinder.

When setting up your calibration system, you will need to consider the following:

- Overall design of the system for functionality and safety.
  - First and foremost, consult your local regulations for the positioning of the cylinder.
  - In most cases the gas cylinders should be located outside the building and secured to a solid wall.
  - If required, the Vent port can be connected to a 1/2" length of tubing to vent calibration gasses outside an enclosed room.
- Gas Cylinder size, gas and purity and accessories
  - For daily or weekly precision checks, we recommend using a CO_2 gas cylinder for its known Rayleigh scattering coefficient.
    - > For best precision check results we recommend purchasing a gas cylinder of high purity (99.9%) grade CO_2

> The CO_2 calibration gas cylinder should be fitted with a CO_2 specific brass regulator.

- For a span calibration we recommend using FM200 gas which is known for its higher Rayleigh scattering coefficient.
    > For best calibration results we recommend purchasing a gas cylinder of high purity (99.9%) FM200.
- The FM200 gas cylinder should be fitted with an isolation valve.

Note: Compared to the CO_2 gas the FM200 gas is expensive, care should be taken when calibrating so as not to waste any unnecessarily.

- Gas conditioning and delivery system
    - The system should include at least 1 meter of coiled metal tubing. This is used to bring the gas temperature to room temperature, especially if a refrigerant gas is used.
    - From the metal coil connect tubing to a flow regulator and from the outlet of the flow regulator to the span port on the Aurora NE
    - It is recommended to add a DFU in line with the gas outlet before it enters the Aurora NE Span Port
    - Before connecting to the Aurora NE span port, purge some gas through the span line to remove the air inside the tubing and set the appropriate flow for the Gas type listed in Table.
    - Connect your calibration gas to the “span gas” port on the top of the Aurora NE. No connection is required for the Zero Air as the Aurora has its own internal filters.

Note: An optional Calibration kit (H020331) is available, which provides all the necessary connections to connect the gas cylinder to the Aurora. The recommended gas delivery system is shown in Figure 165.

Table 13 – Calibration Gas Flow Rate

Flowmeter Scale (Indicated) l/min of Air	FM200 (Actual) l/min	CO_2 (Actual) l/min
1	0.6	0.9
2	0.9	1.7
3	1.3	2.5
4	1.8	3.3
5	2.2	4.2

5.5.2 Configuration Setup

Refer to Section 3.4.3.4.1 for full details on setting up the Full calibration from the menu.

Navigate to the Cal page, make sure that the following calculation factor settings on the calibration settings panel (Table 14), are set before scheduling or manually starting a calibration. They will all impact the overall calibration calculation.

Table 14 – Calibration Settings - Calculation Factors

Calculation Factors	NE-100	NE-300	NE-400
Filter	Kalman	Kalman	Kalman
Cal Measure (mins)	5	5	5
Cal Purge (mins)	15	20	30
Sample Purge (mins)	2	2	2
Calibration Gas:	FM200	FM200	FM200

1. **Filter:** For best results set the filter type to Kalman.
2. **Cal Measure**: The period of time the calibration is measured over after the Cal Purge period has ended.
3. **Cal Purge**: The amount of time to purge the measurement cell with Span or Zero gas before a measurement is taken. This time must be sufficient to allow the readings to stabilize and will be different for each instrument type as shown in Table 14.
4. **Sample Purge**: The period of time to allow the measurement cell to fill with sample air after a calibration has been completed.
5. **Calibration Gas**: Set to the type of calibration gas you are using for the full calibration. Generally, CO_2 or FM200.

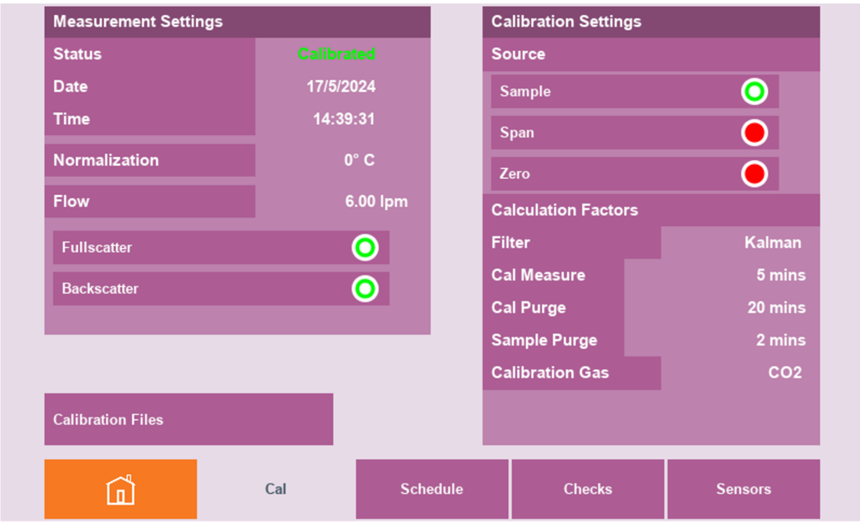


Figure 172 – Calibration Settings Child Page

Navigate to the Schedule child page. If you want to measure the zero and span check results after each calibration point, then enable the Zero Check and Span Check buttons in the Full Calibration panel as shown in Figure 76.

5.5.3 Procedure

Before beginning the Full calibration, open the cylinder shutoff valve on your calibration gas. When the calibration is complete it is advised to close the cylinder shutoff valve.

Navigate to the Cal page then the Schedule child page, under the full calibration panel, press the manual button. Press the accept button to confirm your selection to commence the calibration. These steps are explained in more detail in sections 3.4.3.4.1.1 & 3.4.3.4.1.2.

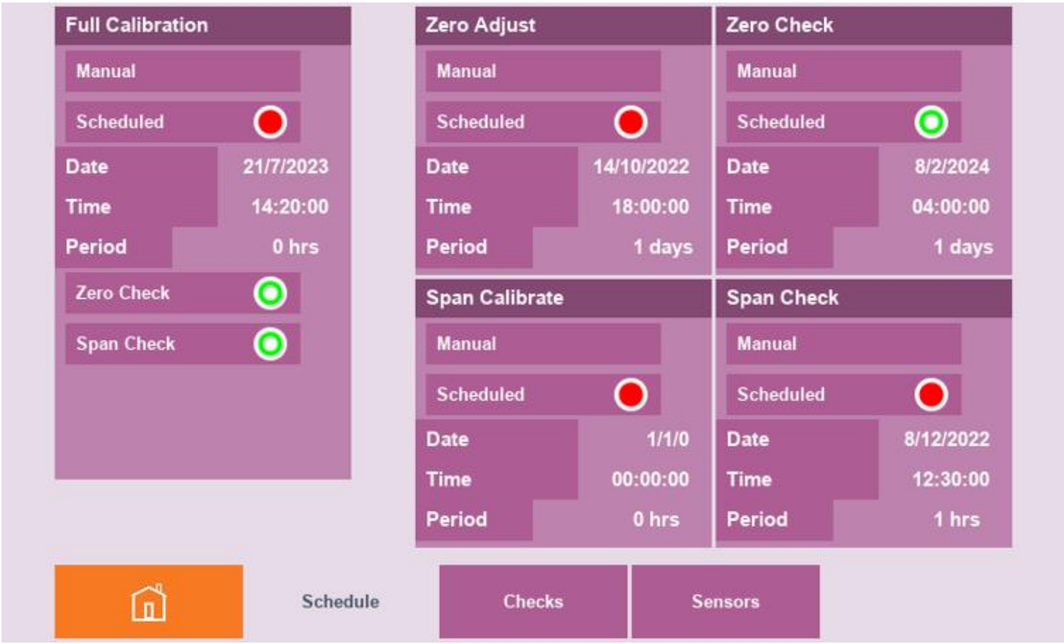


Figure 173 – Calibration Schedule Child Page

The full calibration will combine four different calibration steps into one sequence as follows and shown in Figure 174:

1. Zero Purge (Duration = Cal Purge. 20 minutes)
2. Zero Measure (Duration = Cal Measure. 5 minutes) Result stored as Zero Adjust on the Checks page.
3. Zero Adjust (Duration = 1 second). Calibration offset is re-calculated.
4. Zero Measure (Duration = Cal Measure. 5 minutes) Result stored as Zero Check on the Checks page.
5. Span Purge (Duration = Cal Purge. 20 minutes)
6. Span Measure (Duration = Cal Measure. 5 minutes) Result stored as Span Calibrate on the Checks page.
7. Span Calibrate (Duration = 1 second). The calibration slope is re-calculated.
8. Span Measure (Duration = Cal Measure. 5 minutes) Result stored as Span Check on the Checks page.
9. Sample Purge (Duration = Sample Purge. 2 minutes)

10. Sample Measure (Duration = continuous)

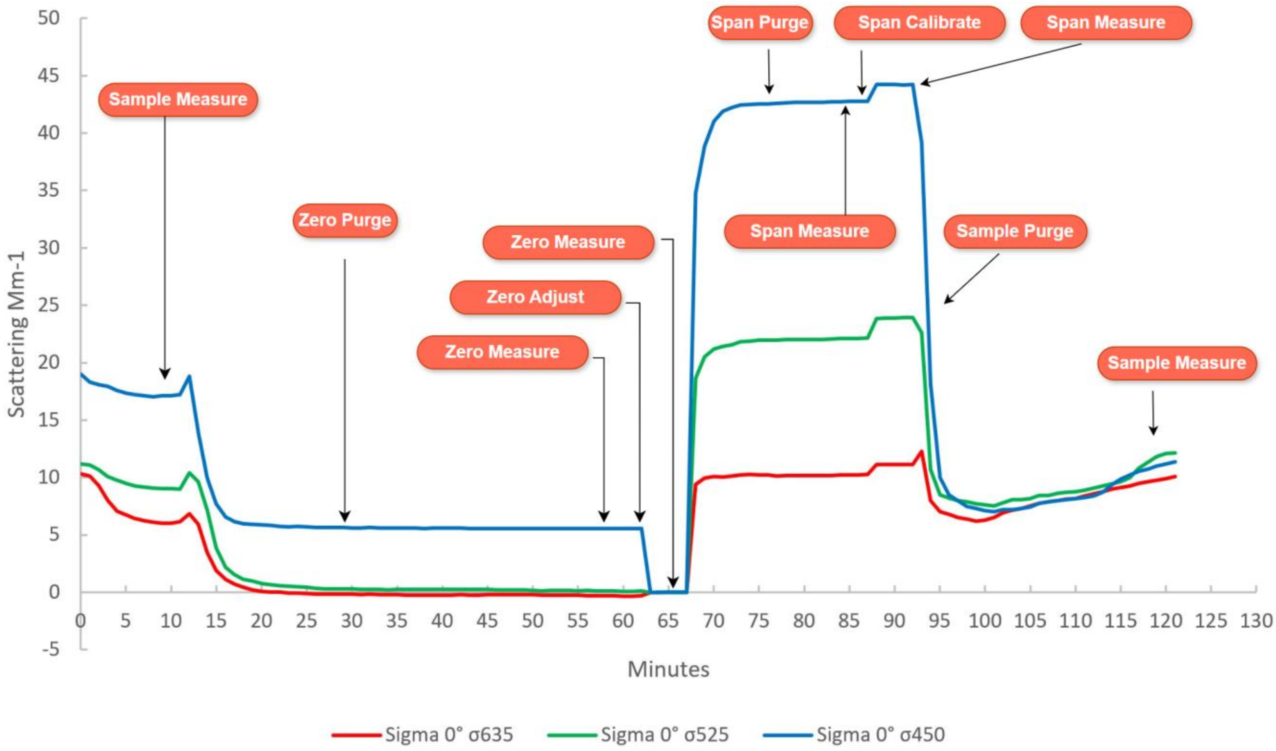


Figure 174 – NE-300 Full Calibration Graph

5.5.4 Verification

When the calibration is complete, navigate to the Cal page and then the Checks child page. The results of the Zero Adjust, Zero Check, Span Calibrate and Span Check will be there for each wavelength and angle measured. Refer to Section **Error! Reference source not found.**.

5.6 Precision Check (Span and Zero)

The zero check and span check are a single-point precision check on the Instrument. The span point uses calibration gas, the zero point use internally filtered particle free air taken from the sample inlet. The calibration curve will not be modified at any point during this process. Even though this is a highly stable instrument it is advised for long-duration measurements that a nightly span and zero precision check be carried to ensure the validity of the data captured over the period since the last valid calibration.

Note: Refer to your local standard for compliance requirements.

5.6.1 Configuration Setup

Typically, CO_2 is used for the precision checks. The setup of the calibration system in the section 5.5.1 is the same for the precision check. The only difference is that the CO_2 cylinder shutoff valve is left open if doing regular precision checks.

Navigate to the Cal page, make sure that the following calculation factor settings on the calibration settings panel (Table 15), are set before starting a calibration.

Table 15 – Calibration Settings - Calculation Factors – Precision Check

Calculation Factors	NE-100	NE-300	NE-400
Filter	Kalman	Kalman	Kalman
Cal Measure (mins)	5	5	5
Cal Purge (mins)	10	15	25
Sample Purge (mins)	2	2	2
Calibration Gas:	CO_2	CO_2	CO_2

Generally, the Cal purge time for a precision check using CO_2 can be set shorter than for a full calibration.

5.6.2 Procedure

There are two methods to start a precision check, scheduled and manual. The same method as for the Full calibration.

Navigate to the Cal page then the Schedule child page, under the Zero Check or Span Check panel, press the manual button. Press the accept button to confirm your selection to commence the calibration. These steps are explained in more detail in sections 3.4.3.4.3 & 3.4.3.4.5.

The Zero Check will proceed as follows:

1. Zero Purge (Duration = Cal Purge. 15 minutes)
2. Zero Measure (Duration = Cal Measure. 5 minutes) Result stored as Zero Check on the Checks page.
3. Sample Purge (Duration = Sample Purge. 2 minutes)
4. Sample Measure (Duration = continuous)

The Span Check will proceed as follows:

1. Span Purge (Duration = Cal Purge. 15 minutes)
2. Span Measure (Duration = Cal Measure. 5 minutes) Result stored as Span Check on the Checks page.
3. Sample Purge (Duration = Sample Purge. 2 minutes)
4. Sample Measure (Duration = continuous)

5.6.3 Verification

When the Precision check is complete, navigate to the Cal page and then the Checks child page. The results of the Zero Check and Span Check will be there for each wavelength and angle measured. Refer to Section **Error! Reference source not found.**.

5.7 Zero Adjust and Span Calibrate

The zero adjust and span calibrate are single-point calibrations of the Instrument. The span point uses calibration gas, the zero point use internally filtered particle free air taken from the sample inlet. The zero adjust will change the offset of the calibration curve. The span calibrate will change the slope of the calibration curve.

5.7.1 Configuration Setup

Typically, FM200 is used for the Span Calibration. The same setup for a full calibration as in the section 5.5.1 is used for the span calibrate procedure.

Navigate to the Cal page, make sure that the following calculation factor settings on the calibration settings panel (Table 16), are set before starting a calibration.

Table 16 – Calibration Settings - Calculation Factors – Span Calibrate

Calculation Factors	NE-100	NE-300	NE-400
Filter	Kalman	Kalman	Kalman
Cal Measure (mins)	5	5	5
Cal Purge (mins)	15	20	30
Sample Purge (mins)	2	2	2
Calibration Gas:	FM200	FM200	FM200

Generally, the Cal purge time for a precision check using CO_2 can be set shorter than for a full calibration.

5.7.2 Procedure

There are two methods to start a zero adjust or span calibrate, scheduled and manual. The same method as for the Full calibration.

Navigate to the Cal page then the Schedule child page, under the Zero Adjust or Span Calibrate panel, and press the manual button. Press the accept button to confirm your selection to commence the calibration. These steps are explained in more detail in sections 3.4.3.4.2 & **Error! Reference source not found.**.

The Zero Adjust will proceed as follows:

1. Zero Purge (Duration = Cal Purge. 20 minutes)
2. Zero Measure (Duration = Cal Measure. 5 minutes) Result stored as Zero Adjust on the Checks page.
3. Zero Adjust (Duration = 1 second). Calibration offset is re-calculated.

4. Sample Purge (Duration = Sample Purge. 2 minutes)
5. Sample Measure (Duration = continuous)

The Span Calibrate will proceed as follows:

1. Span Purge (Duration = Cal Purge. 20 minutes)
2. Span Measure (Duration = Cal Measure. 5 minutes) Result stored as Span Calibrate on the Checks page.
3. Span Calibrate (Duration = 1 second). The calibration slope is re-calculated.
4. Sample Purge (Duration = Sample Purge. 2 minutes)
5. Sample Measure (Duration = continuous)

5.7.3 Verification

When either the zero adjust or the span calibrate is complete, navigate to the Cal page and then the Checks child page. The results of the Zero Adjust and Span Calibrate will be there for each wavelength and angle measured. Refer to Section 3.4.3.5.

This page is intentionally blank.

6. Service

6.1 Additional Safety Requirements for Service Personnel

In addition to the Safety Information stated previously, service personnel are also advised of the following:

- Documentation must be consulted in all cases where caution symbol is marked, in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them. Refer to Table 1 – Internationally Recognised Symbols.
- Do not energise the instrument until all conductive cleaning liquids, used on internal components, are dried up.
- Do not replace the detachable mains supply cord with an inadequately rated cord. Any mains supply cord that is used with the instrument must comply with the safety requirements (250 V/10 A minimum requirement).

6.2 Maintenance Tools

To perform general maintenance on the Aurora NE Series the user may require the following equipment:

- Customizable Test Equipment Case PN: H070301
- Digital Multimeter & Leads (DMM) PN: E031081 & E031082
- Barometer PN: E031080
- Thermometer & Humidity Probe PN: E031078 & E031079
- Flow Meter (Select Range)

  Range: 0 - 10 slpm
- Computer/Laptop and Connection Cable for Diagnostic Tests
- 1.5 mm Hex Key
- Span Gas Source
- General Hand Tools
- Phillips Head Screwdrivers.
- Flat ended Screwdriver.
- Adjustable wrench.
- Black cloth or plastic bag.
- Bright LED Torch.
- CRC CO Contact Cleaner.
- Lint and grease free tissues or cloth.

6.3 Maintenance Schedule

The maintenance intervals are determined by compliance standards that differ in various regions. The following is recommended by Acoem Australasia as a guide. Compliance with local regulatory or international standards is the responsibility of the user.

Table 17 – Maintenance Schedule

Interval *	Task Performed	Section
Nightly	Precision Check (Span and Zero)	5.6
3 Monthly	Full Calibration (Span and Zero)	5.5
6 Monthly	Inspect Sample Inlet	6.4.4
	Inspect Zero Filter	6.4.6
	Inspect Sample Exhaust Filter	6.4.7
	Measurement Cell Cleaning	6.4.8
	Leak Check	6.4.10
	Clock Check	6.4.2
Yearly	Calibrate Sample Temperature, Pressure & RH Sensor	5.2
	Calibrate Sample Flow Sensor	5.4
	Enclosure Cleaning	6.4.3
	Pump Filter Replacement	6.4.4
	Clean Optical Chamber	6.4.9
	Zero Noise Test	6.4.11
	Check Light Source	6.4.12
	Replace Clock Battery	6.4.14

* Suggested intervals for maintenance procedure are a guide only and may vary with sampling intensity and/or environmental conditions. Refer to your local regulatory standard for your personalised maintenance schedule.

6.4 Maintenance Procedures

6.4.1 Precision Check

To ensure the instrument is running appropriately precision checks must be performed regularly (every day or week depending on local regulations). A precision (calibration) check involves performing a span and zero calibration check (which can be performed automatically or manually), then navigating to the Home page –> Schedule page –> Checks child page and checking the results in the Span Check and Zero Check panels. The results of the precision check will determine if further action is required. See Table 18. Refer to Section 5.6 for details on performing a precision check.

Table 18 – Precision Check Criteria

Precision Check Type	Allowable Tolerance	Action Required
Zero Check	±0.5 Mm^{-1} within 7 days	Do Zero Adjust Refer to section 5.7
Span Check	±2% within 7 days*	Do Full Calibration Refer to section 5.5

Note:
* 2% Tolerance is calculated from the calibration gas used (FM200) not the precision gas (CO_2)

6.4.2 Clock Check

It is important to check the clock time and date and synchronise it with a reference to ensure data logging, event logs, and schedules occur accurately. The date and time can be viewed from the home page on the sample readings panel or in the Config page under the User Settings panel.

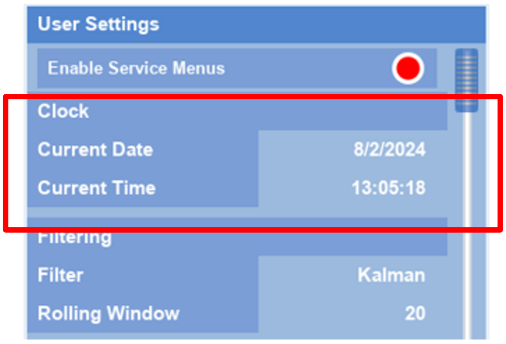


Figure 175 – Date and Time Adjustment

To adjust the clock, navigate to the config page. On the User Settings panel under the heading Clock, there are two fields; current date and current time. Touch either of these fields and using the keypad change the date or time respectively.

If the Aurora NE is connected to ACOEM Airodis software, then you can use the Set Logger Clock feature in the Station Tab to synchronise the time with the Airodis server.

6.4.3 Enclosure Cleaning

The enclosure can be cleaned using clean dry oil-free, lightly moistened lint-free cloth or compressed air or a vacuum with a detailing brush connection.

1. If using compressed air, take the instrument to an open area outside.
2. Ensure all ports are caped or blocked.

3. Remove the lid and use the compressed air to blow the dust from the instrument, going from right to left.

Do not use any solvents or harsh cleaning chemicals during this process.

6.4.4 Sample Inlet Cleaning

The sample inlet and insect trap require cleaning on a regular basis due to its exposure to ambient conditions.

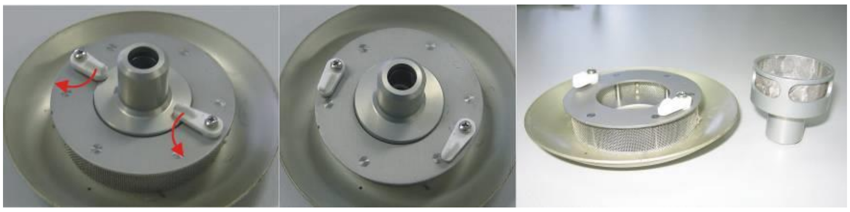


Figure 176 – Sample Inlet Cleaning

1. Remove the insect trap from the inlet.
2. Turn the two white handles so that they are not holding the central filter in place (see Figure 176).
3. Remove the central filter and clean both the inner and outer filters with warm water. Allow them to dry.
4. Inspect the O-rings inside the inlet to make sure they are not cracked or damaged.
5. Place the inner filter back into the insect trap, return the handles to their original position, and return the insect trap to the inlet.

6.4.5 Pump Filter Replacement

The pump filter sits inside the chassis just below the brass fitting on the exhaust port near the pump. It acts as a muffler for the internal pump so sealing is not critical. Because the filter is on the exhaust of the pump and the inlet to the pump always has filtered air, it is unlikely that this filter will need replacing.

If the filter appears to be grey on its membrane, then consider replacing it as follows:

1. Loosen the 1/4" brass nut inside the chassis (bottom of brass fitting) until the DFU is free to move. This should only take a couple of turns to free the DFU.
2. Pull the filter down to remove it from the fitting.
3. On the lower half of the filter remove the black tubing by first releasing the hose clamp (the hose clamp can be released by pushing the two halves in opposite directions) and then pulling off the tubing.
4. Correctly dispose of the DFU and replace it with a new DFU.
5. Ensure the hose clamp is sitting on the black hose before connecting to the new DFU. Secure the clamp by pressing the two halves together.
6. Insert the other end of the DFU back into the brass fitting until the end of the DFU hits the tube stop.

7. Hand-tighten the 1/4" brass nut until the DFU is firmly in place and won’t easily pull out. This half of the DFU is held in place by a Teflon ferrule. Do not over-tighten the brass nut or you will deform and damage the Teflon ferrule.

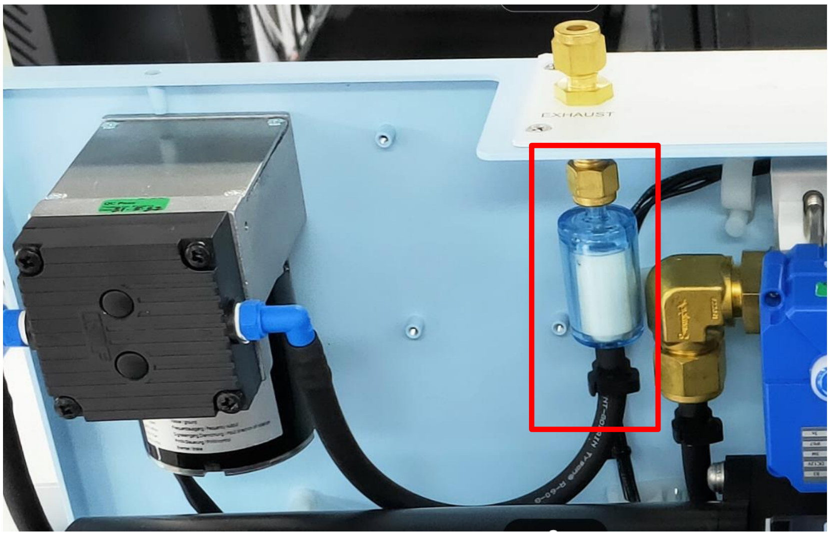


Figure 177 – Pump Filter

6.4.6 Zero Filter Replacement

The zero filter sits inside the chassis and is easily accessible using the chassis door. Its inline flow path is between the sample ball valve and the zero solenoid. It is mounted in the top of the filter bracket just inside the chassis door. This filter is 99.99% efficient at filtering particulate matter. It is used to produce the particulate fee zero air for the zero-precision check and zero adjust. The filter can be replaced with the following steps:

1. Switch the Aurora NE off and open the front door.
2. Note the orientation of the disposable filter. There should be a sticker with a large black arrow on a silver background pointing away from the PMT.
3. Remove the filter, using one hand to support the top left corner of the bracket and the other hand to pull the filter on the supported side. The black tube will pop out of the bracket along with one side of the filter.
4. Repeat the above step for the right-hand side.
5. With the filter now free from the bracket, hold it in one hand and with the opposing hand remove the black tubing by first releasing the hose clamp and pulling slowly but firmly, as the tubing begins to give way don’t pull as hard.
6. Correctly dispose of the DFU and replace it with a new DFU.
7. Holding the new DFU in one hand reconnect the black tubing to each end making sure the hose clamp is firmly attached.
8. Align the DFU with the bracket as it was before you took it out. Using two hands support the back of the bracket while using your thumbs to push the DFU into the clips.

Figure 178 – Zero and Exhaust Filters

6.4.7 Exhaust Filter Replacement

The Exhaust filter sits inside the chassis and is easily accessible using the chassis door. Its inline flow path is between the exhaust of the cell and the inlet on the internal pump. It is mounted in the bottom of the filter bracket just inside the chassis door. This filter is 95% efficient at filtering particulate matter. It is used to protect everything in the flow path after the cell such as valves and flow sensor and internal pump. The filter can be replaced with the following steps:

1. Switch the Aurora NE off and open the front door.
2. Note the orientation of the disposable filter. There should be a sticker with a large black arrow on a silver background pointing towards the PMT.

Note: The flow direction indicated on the DFU is opposite to how the device is intended to be used. Be sure to follow the sticker's flow direction not the printed direction. We do this so that the particulate matter is clearly visible to the user for serviceability. As the filter becomes loaded it will appear darker in colour on its membrane.

3. Remove the filter, using one hand to support the top left corner of the bracket and the other hand to pull the filter on the supported side. The black tube will pop out of the bracket along with one side of the filter.
4. Repeat the above step for the right-hand side.
5. With the filter now free from the bracket, hold it in one hand, and with the opposing hand remove the black tubing by first releasing the hose clamp and pulling slowly but firmly, as the tubing begins to give way don't pull as hard.
6. Correctly dispose of the DFU and replace it with a new DFU.
7. Holding the new DFU in one hand reconnect the black tubing to each end making sure the hose clamp is firmly attached.
8. Align the DFU with the bracket as it was before you took it out. Using two hands support the back of the bracket while using your thumbs to push the DFU into the clips.

6.4.8 Measurement Cell Cleaning

The below procedure outlines the steps required to clean the measurement cell.

1. Switch off the Aurora NE.
2. Open the door and remove the lid. Follow the instructions in Section 2.1 (Opening the instrument)
3. Unplug the light source ribbon cable connected to the bottom side of the light source by placing your hands on top of the cell body and using your thumbs to evenly press each side of the cable release tabs outwards, ejecting the ribbon cable.

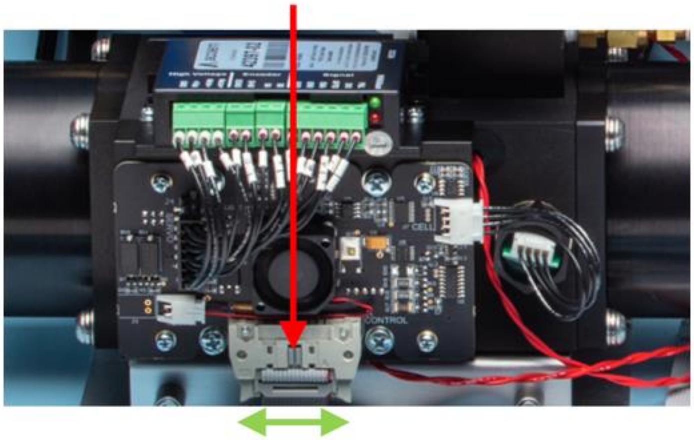


Figure 179 – Ejecting Light Source Ribbon Cable

4. Unplug the Pressure, Temperature, and Relative Humidity sensor on the front side of the cell by gently but firmly pulling the cable.

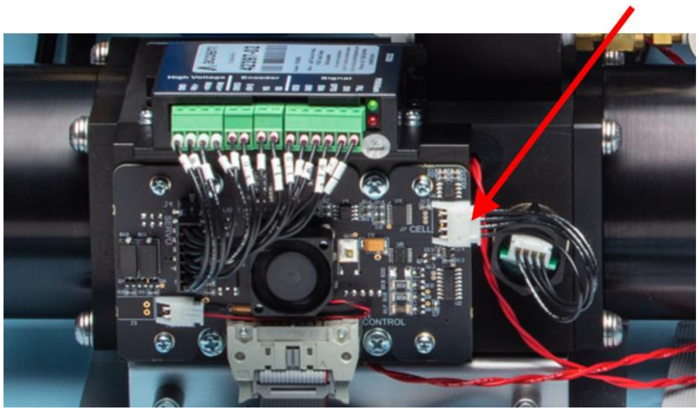


Figure 180 – Location of Pressure, Temperature and Relative Humidity Sensor Cable

5. Remove the four M4 screws securing the light source to the cell body.

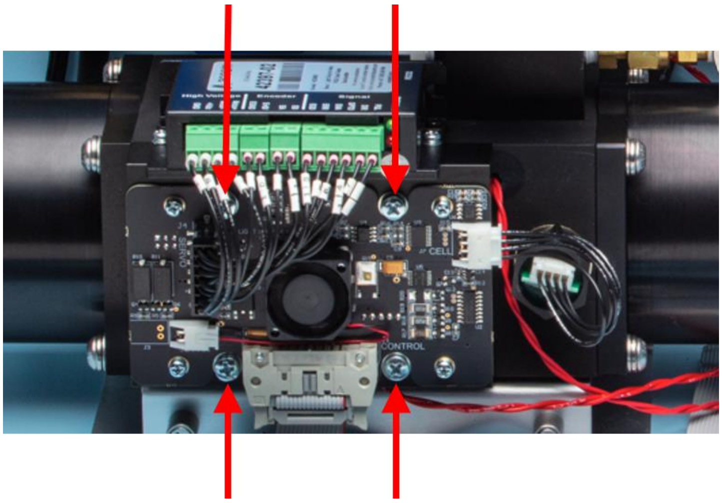


Figure 181 – Location of Light Source Screws

6. Even with the four screws removed the light source will be held in place only by the O-ring seal. Gently break the seal and gently pull the light source straight out. Great care should be taken to prevent any damage to the backscatter shutter from catching on the top of the cell opening. Place the removed light source in a safe place resting it upside down on the servo motor controller side.

Figure 182 – light Source Resting Position

Note: Ensure the O-ring within the light source is not lost or misplaced

7. Inspect the surface area of the light source that sits inside the cell. Check the paint quality and overall condition as well as the integrity of the backscatter shutter. If dusty lightly run the microfiber glove over the light source window and backscatter shutter until clean.

Note: Using a bright torch can really help identify dusty areas.

8. Using a torch and a microfiber glove remove the dust from the inside of the cell paying special attention to the bottom right-hand side of the cell body.

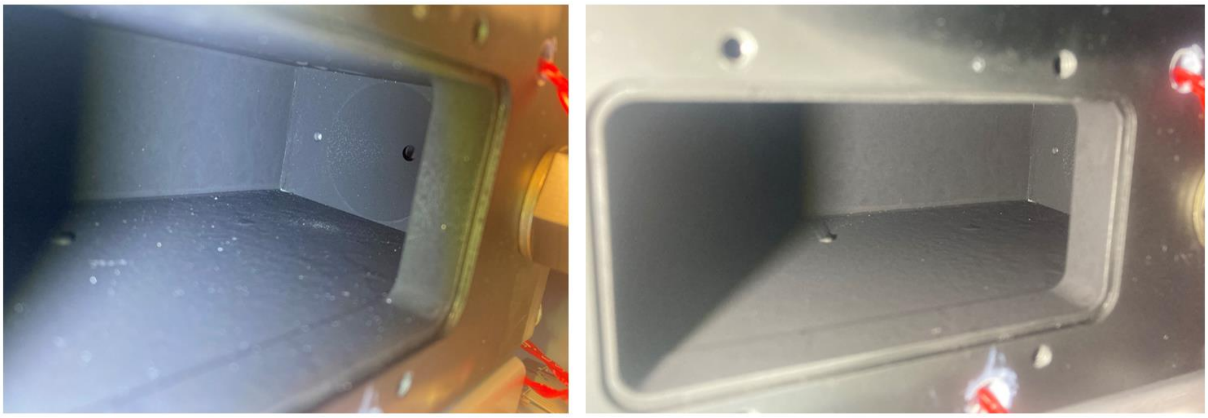


Figure 183 – Cell Body Clean Before and After

Note: Do not leave fingerprints or any residue within the cell.

9. Inspect the integrity of the O-ring, looking for cracks, damage to the sealing face surface, and dust. Replace if required.
10. Ensure the O-ring is sitting correctly around the light source housing and carefully replace the light source (servo motor controller site up) back into the cell body. Care needs to be taken not to catch the backscatter shutter on the cell body or scratch any surface of the two assemblies.
11. Place the screws in finger tight, and inspect the assembly to ensure no wires are pinched and the assembly is sitting flush. Then tighten the screws gradually and evenly in a crisscross pattern until tight.
12. Reconnect the light source ribbon cable to the bottom side of the light source by first placing the cable into the connector and then using your hands on top of the cell body use your thumbs to evenly press the centre of the cable (green arrows). The release tabs will automatically lock into place with a solid click for each side.

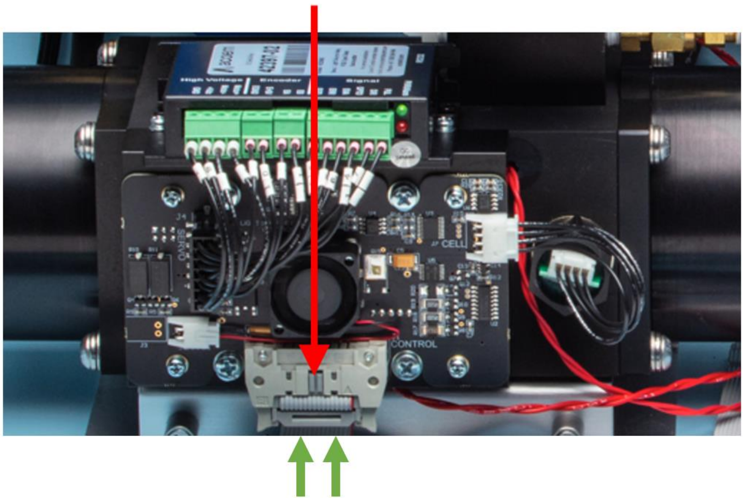


Figure 184 – Connecting Light Source Ribbon Cable

13. Reconnect the Pressure, Temperature, and Relative Humidity sensor on the front side of the cell by gently but firmly pushing the cable into the connector.
14. Always perform a leak check and full calibration after removing the light source.

6.4.9 Optical Chamber Cleaning

Cleaning of the optical chamber requires addressing the following sub-assemblies:

PMT Assembly

Reference Shutter Assembly

Light Source Cleaning

Light Trap Mirror

The following sections cover the procedures for removing the optical cell and outlines the steps required to gain access to the internal assemblies mentioned above for optical chamber cleaning.

6.4.9.1 Optical Chamber Removal

1. Switch off the Aurora NE.
2. Open the door and remove the lid. Follow the instructions in Section 2.1 (Opening the instrument).
3. Remove the exhaust tubing from the cell (3) making sure not to overly stretch it. Release the hose clamp first. The tubing on (1) and (2) points of the inlet sample manifold may also be removed if it makes it easier to remove the cell.

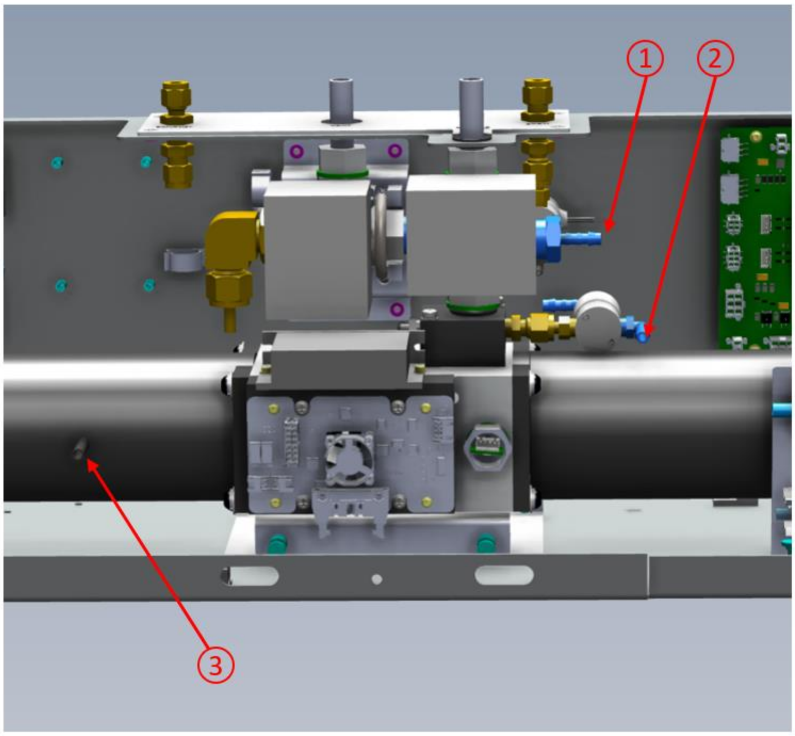


Figure 185 – Location of Tubing to be Removed

4. Remove the sample inlet tube in the direction of the blue arrow.

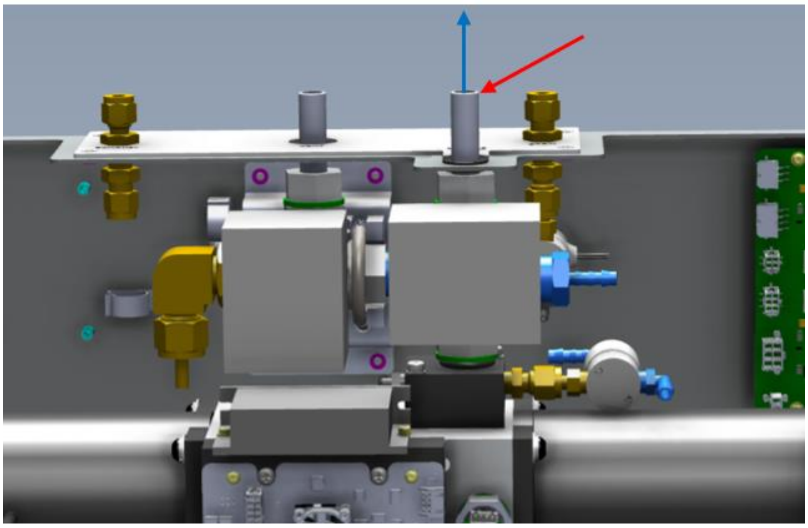


Figure 186 – Sample Inlet Tube Location

5. Remove the filter holder bracket by unscrewing the 2 captive screws and then place on one side.

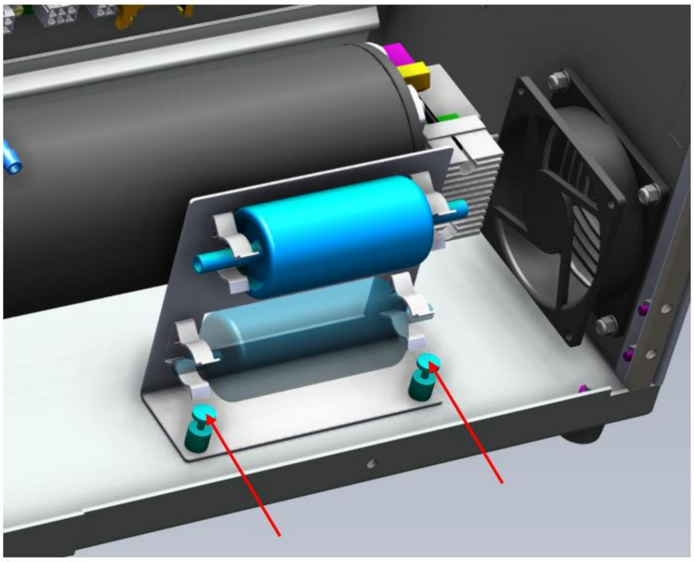


Figure 187 – Filter Holder Captive Screw Location

6. Disconnect the following connectors:
    a. Light source ribbon cable
    b. Heater connecter from J17 & J18 on the Control PCA
    c. PMT Cooler cable from J22 on the Control PCA
    d. PMT signal and power connectors from J14 & J6 on the Microprocessor PCA
7. Using a long M4 screwdriver, loosen the captive screws on the cell bracket two at the front and two at the back, all accessed from the front. Refer to Figure 188.

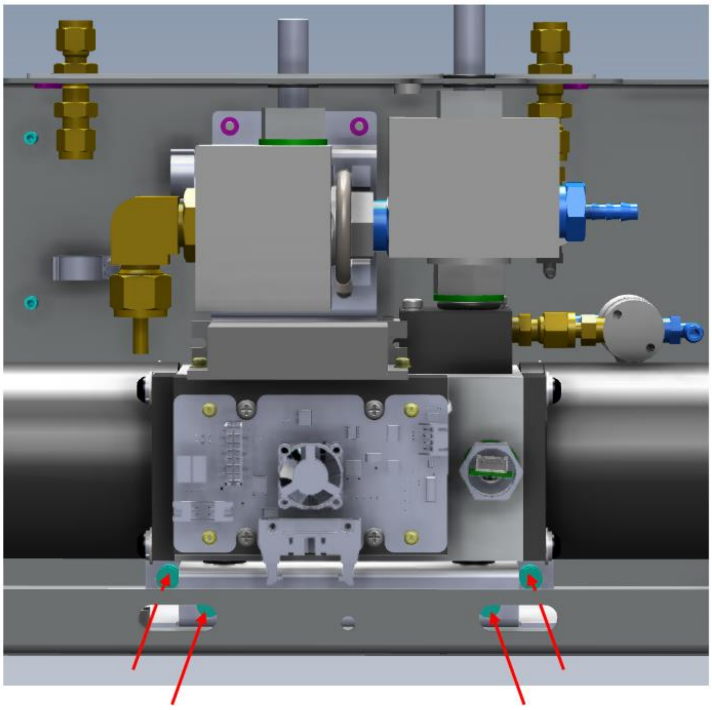


Figure 188 – Indication of Access for Cell Bracket Captive Screws

8. Slide the cell forward and to the left (be careful not to damage the light source ribbon cable) Just enough to be able to access the two screws that secure the sample manifold to the cell.
9. Remove the two M4 screws from the top of the sample manifold.

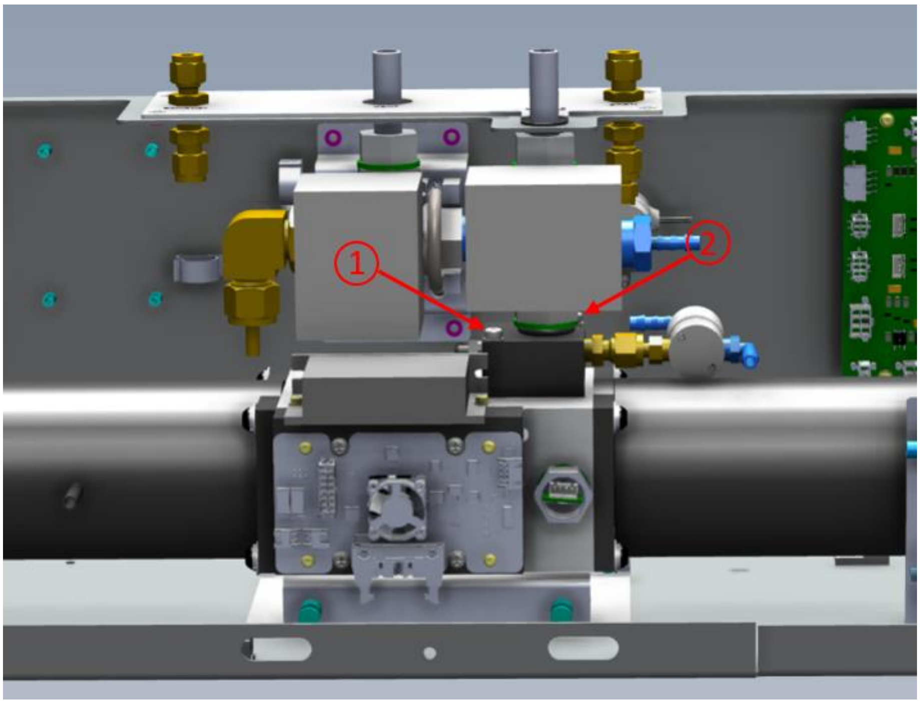


Figure 189 – Location of Sample Manifold Screws

10. The manifold is now only held in place by an O-ring. Lift the sample manifold off the cell and place it on top of the chassis directly above (ball valve side up) with some bubble wrap under it for protection. The tubing still connected should just be long enough to allow for this.

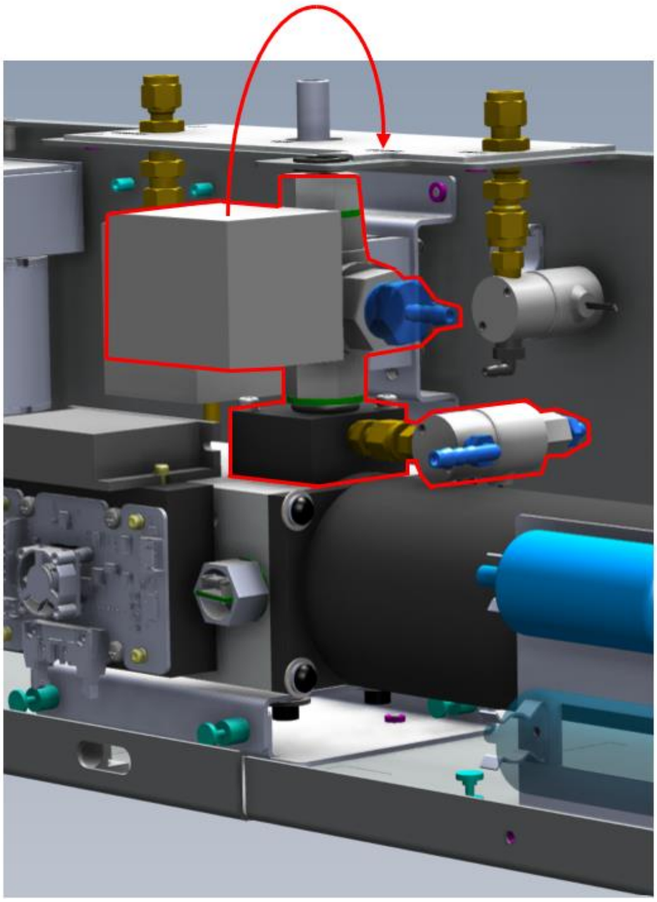


Figure 190 – Placement of Sample Manifold Assembly

11. Remove the optical cell from the chassis.

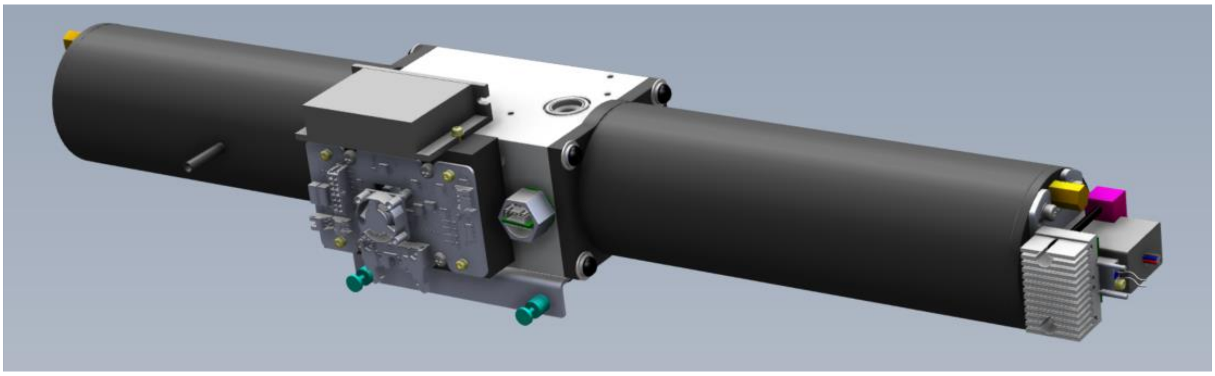


Figure 191 – Image of Extracted Optical Cell

6.4.9.2 Optical Cell Cleaning

1. Remove two brass nuts from each end of the optical cell.

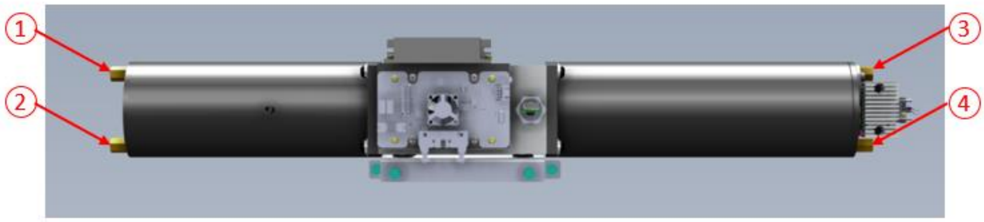


Figure 192 – Location of Brass Nuts

2. Move the PMT end plate away from the tube casing breaking the O-ring seal.

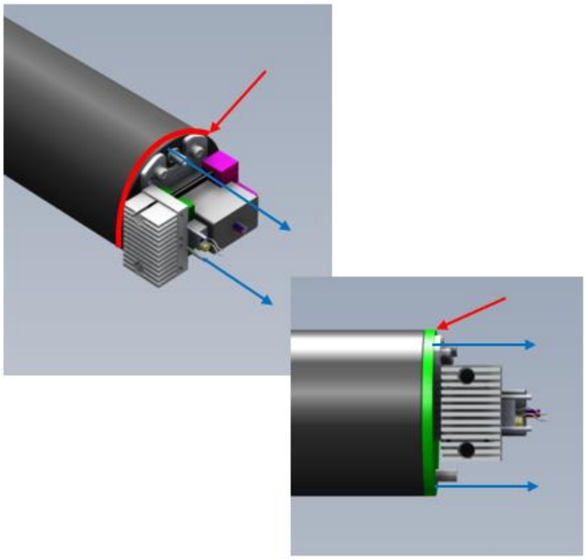


Figure 193 – PMT Endplate Removal

CAUTION

The PMT is sensitive to light, caution should be taken to reduce the amount of light exposed to the PMT such as a darkened room or damage will occur to the PMT.

Note: The endplate is held in by a friction fit of the surrounding O-ring. You may need to use plastic shims to aid in breaking the seal. Once the seal of the O-ring is broken stop removing the endplate.

3. In a darkened area use a dark cloth to cover the PMT and endplate. Proceed to remove the endplate and cover the PMT window with a dark cloth. Place to one side with the PMT window face down on a soft cloth.

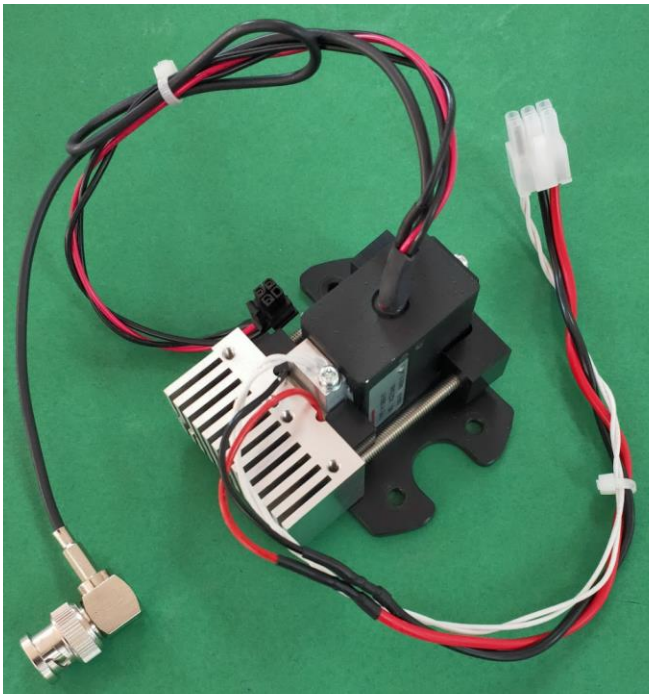


Figure 194 – Covered PMT Window

4. Remove the tube casing PMT end. Support the top of the optical cell with one hand and with the other hand firmly grip the twist of the tube casing while slightly pulling away from the block until you break the seal of the O-ring. Then stop and go to the next step.

Note: The tube casing is held in by a friction fit of the surrounding O-ring. You may need to use plastic shims to aid in breaking the seal. Once the seal of the O-ring is broken stop removing the tube casing and proceed with the next step.

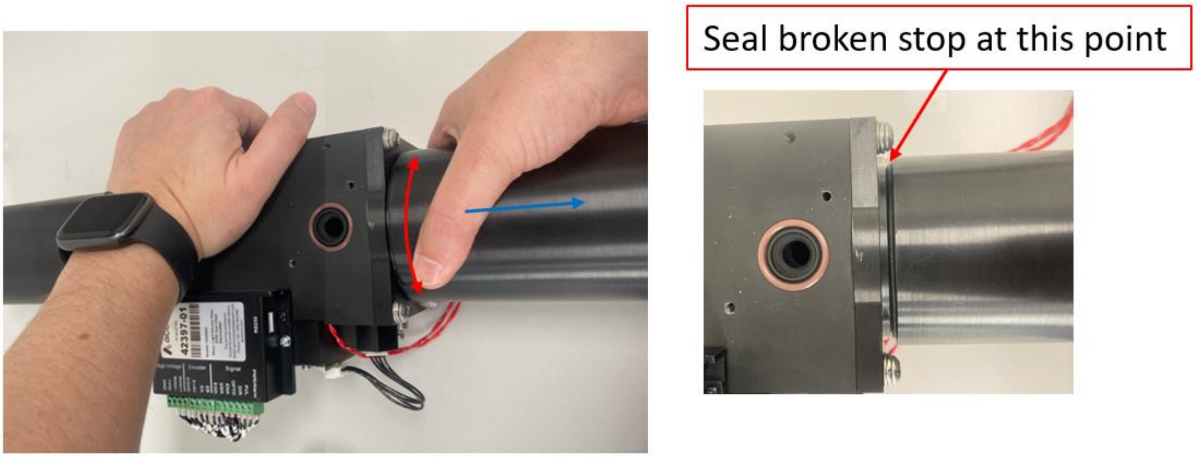


Figure 195 – Tube Casing Removal – PMT End

5. Change your grip and have one hand support the front of the tube casing and your other hand support the back. Pull the tube casing away from the block taking care not to scratch the surface of the baffles or the inside of the tube casing. Place to one side.

6. Remove the light trap endplate. Place to one side.

Note: The endplate is held in by a friction fit of the surrounding O-ring. You may need to use plastic shims to aid in breaking the seal. Once the seal of the O-ring is broken stop removing the endplate.

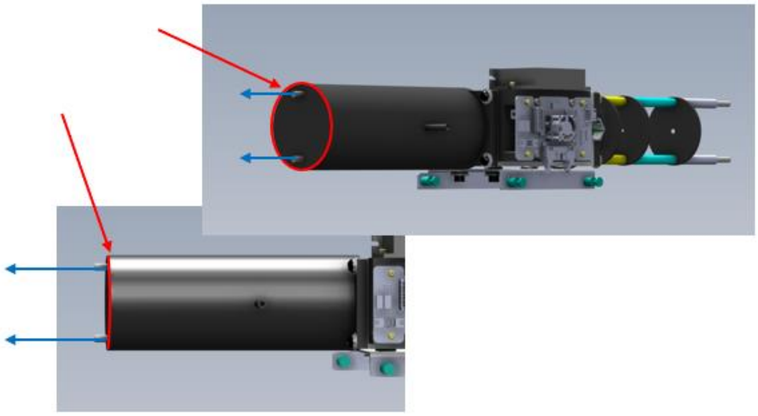


Figure 196 – Light Trap Endplate Removal

7. Remove the tube casing light trap end. Support the top of the optical cell with one hand and with the other hand firmly grip the twist of the tube casing while slightly pulling away from the block until you break the seal of the O-ring. Then stop and go to the next step.

Note: The tube casing is held in by a friction fit of the surrounding O-ring. You may need to use plastic shims to aid in breaking the seal. Once the seal of the O-ring is broken stop removing the tube casing and proceed with the next step.

8. Change your grip and have one hand support the front of the tube casing and your other hand support the back. Pull the tube casing away from the block taking care not to scratch the surface of the baffles or the inside of the tube casing. Place to one side.

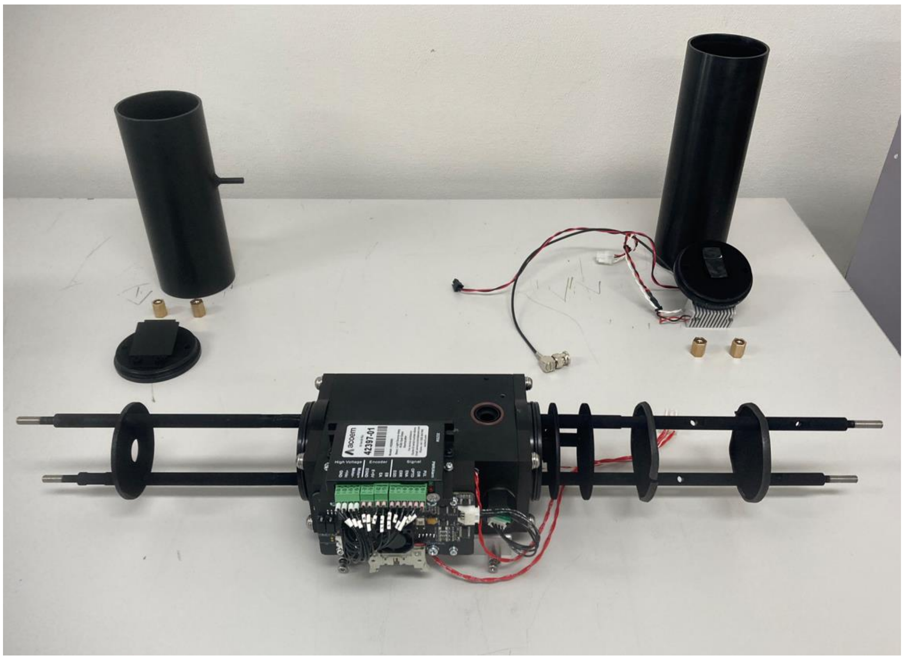


Figure 197 – Endplates and Tube Casings Removed

9. Remove the temp, pressure and RH sensor and the light source.
    a. Remove the cable connecting the TPRH sensor to the light source (red arrow) and unscrew the sensor from the block (green arrow) turning the sensor housing counter clockwise.

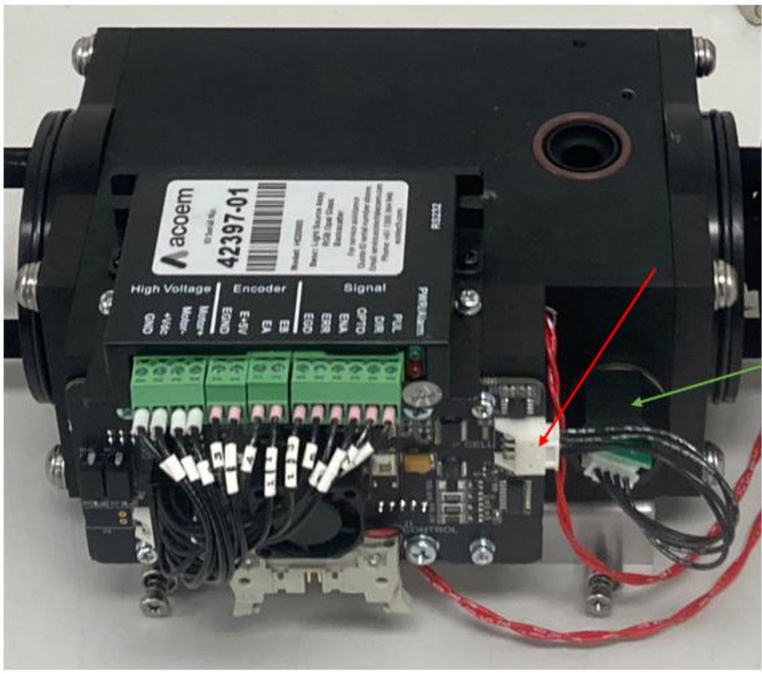


Figure 198 – Location of TPRH Sensor and Cable

    b. Remove the four screws securing the light source and replace them with the guiding pins then gently pull out the light source.

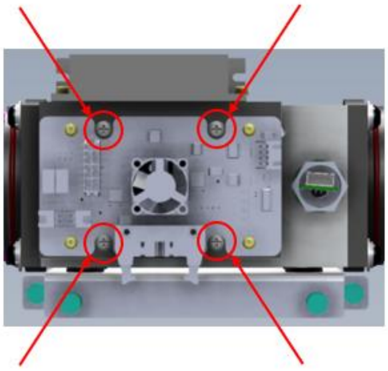


Figure 199 – Location of Light Source Screws

10. The optical cell is now fully exposed. Inspect the quality of the paint on the spacers and baffles, with clean dry oil-free air remove any built-up dust, inspect all painted surfaces of the removed assemblies, clean the light trap mirror, check the condition of the O-rings and replace, if necessary, check the thermal paste on the heaters and replace if necessary.

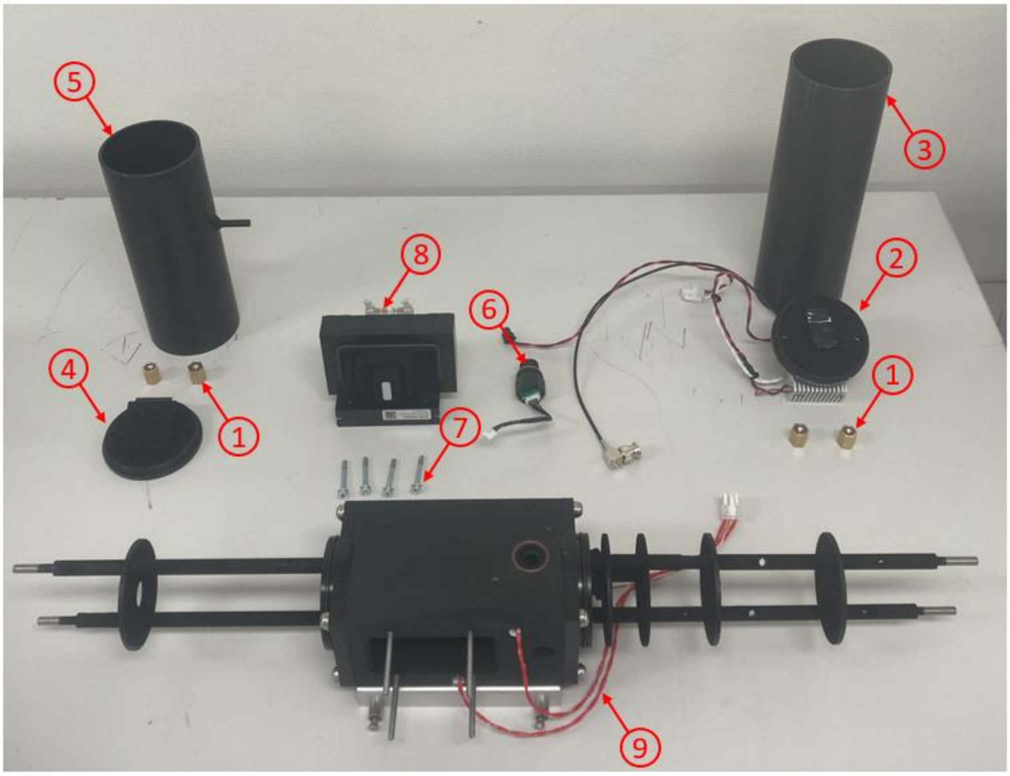


Figure 200 – Disassembled Optical Cell Parts Identification

1. Brass nuts
2. PMT end cap assembly
3. Tube casing (PMT end)
4. Light trap end cap assembly
5. Tube casing (light trap end)

6. Temp, pressure, RH sensor
7. Light source screws
8. Light source assembly
9. Exposed optical cell

6.4.9.3 PMT Assembly Cleaning

The following procedure focus specifically on the PMT assembly and assumes you have already completed the procedures in the section 6.4.9.1 and 6.4.9.2, removing and cleaning the optical cell.

1. The PMT is light sensitive, continue to cover the PMT between inspections to ensure that the PMT's exposure to light is minimized.
2. Carefully inspect the quartz window trying to minimize the exposure to light. If you can see fingerprints or it appears to be dirty, clean it with a precision electronic cleaning solvent that leaves no residue, low toxicity, and has a CO_2 propellant (CRC CO Contact Cleaner). DO NOT USE Isopropanol (IPA).
3. Spray a small amount of the electronic cleaning solvent on a lint-free tissue or cotton bud, then quickly apply it to the quartz window.

Note: Take care when applying the solvent not to rub off the black paint.

4. Using a fresh section of the lint-free tissue or a fresh cotton bud to remove any excess solvent and clean the window.
5. Re-inspect the window trying to minimise the exposure to light.

6.4.9.4 Reference Shutter Cleaning

The following procedure focus specifically on the reference shutter assembly and assumes you have already completed the procedures in the section 6.4.9.1 and 6.4.9.2, removing and cleaning the optical cell.

1. Clean the reference shutter glass with a lint-free tissue or cotton bud and warm clean water, then leave to dry. If the baffles are dirty, clean them in a similar manner or by using compressed air.

6.4.9.5 Light Source Cleaning

The following procedure focus specifically on the light source assembly and assumes you have already completed the procedures in the section 6.4.9.1 and 6.4.9.2, removing and cleaning the optical cell.

1. Clean the opal glass window of the light source with a lint-free tissue or cotton bud and warm clean water, then leave to dry.
2. Gently inspect the operation of the backscatter shutter and the condition of the painted surface. Remove any dust build-up using a microfiber cloth or by using compressed air.

6.4.9.6 Light Trap Mirror

The following procedure focus specifically on the light trap mirror assembly and assumes you have already completed the procedures in the section 6.4.9.1 and 6.4.9.2, removing and cleaning the optical cell.

1. Be very careful not to touch the mirror surface.
2. Inspect the light trap mirror surface using a very bright torch (e.g., LED type), and viewing it from various angles. Look for signs of white streaks or dust in the center of the glass.
3. If the glass surface does need cleaning, use a precision electronic cleaning solvent which leaves no residue, low toxicity, and has a CO_2 propellant (CRC CO Contact Cleaner). DO NOT USE Isopropanol (IPA).
4. Spray the electronic cleaning solvent on the surface of the glass, then quickly using a lint-free tissue, remove the solvent in one continuous sweep covering the full width of the glass. Then re-inspect the mirror with a torch to ensure there is no residue.

Figure 201 – Light Trap Mirror Cleaning

> **Note:** Surface dust can be cleaned by lightly blowing with clean dry oil free air or using a horsehair camera lens cleaner.

6.4.9.7 Sample Path Cleaning

The following procedure focus specifically on the sample manifold assembly and assumes you have already completed the procedures in the section 6.4.9.1 removing the optical cell.

1. Make sure the Aurora NE was in sample measure mode before turning off the instrument. This will ensure that the sample inlet ball valve is left in the open position for cleaning.
2. Clean the sample manifold by using compressed air blown through the inlet or cotton bud with a long stem and warm clean water, then leave to dry.

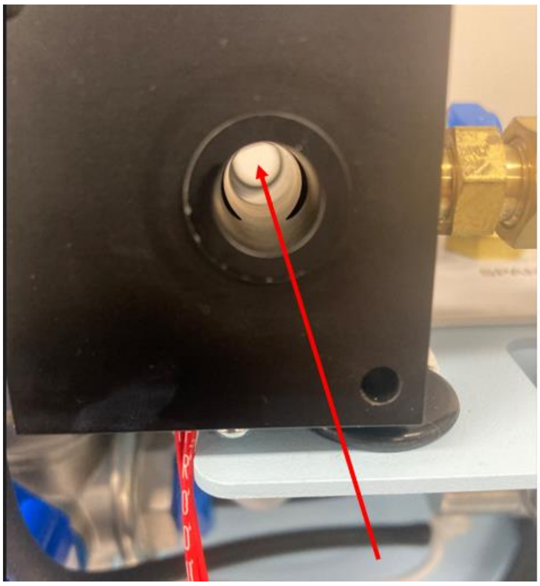


Figure 202 – Sample Manifold Cleaning

6.4.9.8 Optical Cell Reassembly

The following procedure focus specifically on the optical cell reassembly and assumes you have already completed the procedures in the section 6.4.9.1 and 6.4.9.2, removing and cleaning the optical cell.

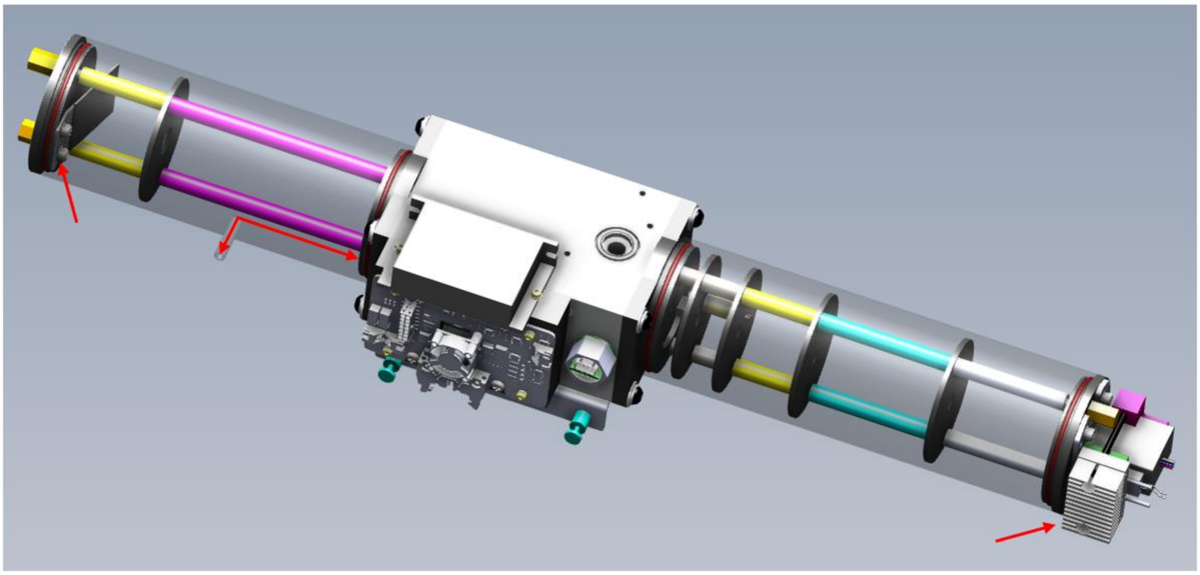


Figure 203 – Optical Cell Transparent Tube Casing

1. With all parts of the chamber cleaned and dry, it is now time to reassemble the optical chamber back to its original condition.
2. Using the guiding pins gently slide the light source back into place on the block. Remove the guide pins and replace the M4 screws.
3. Replace the temp, pressure, and RH sensor back into the block turning the sensor housing clockwise until hand tight. Then reconnect the cable to the light source PCA.

4. Replace the tube casing (light trap end) by sliding it back over the baffles taking care not to damage the paint. Refer to Figure 203 for the orientation of the casing (sample exhaust side closest to the block). Supporting the casing with both hands will give the best result. Once the casing reaches the block end you will need to change your hand placement, one hand used to support the block while twisting the casing with the other hand while also pushing towards the block. Care should be taken not to pinch the O-ring or your leak check will fail.
5. Place the light trap end plate over the threaded stubs and into the tube casing. Refer to Figure 203 for the direction of the light trap. Wiggle and press into place. Care should be taken not to pinch the O-ring or your leak check will fail.
6. Screw on the two brass nuts along with the small O-rings and tighten hand tight. The seal of the threaded stub is done by the small O-ring against the face of the end plate.
7. Replace the tube casing (PMT end) by sliding it back over the baffles taking care not to damage the paint. Supporting the casing with both hands will give the best result. Once the casing reaches the block end you will need to change your hand placement, one hand used to support the block while twisting the casing with the other hand while also pushing towards the block. Care should be taken not to pinch the O-ring or your leak check will fail.
8. Place the PMT end plate over the threaded stubs and into the tube casing. Refer to Figure 203 for the direction of the PMT assembly (heat sink of the PMT facing the light source side). Wiggle and press into place. Care should be taken not to pinch the O-ring or your leak check will fail.
9. Screw on the two brass nuts along with the small O-rings and tighten hand tight. The seal of the threaded stub is done by the small O-ring against the face of the end plate.

6.4.9.9 Optical Cell Installation

1. Replace the optical cell into the chassis, and position the optical cell slightly forward and to the left (be careful not to damage the light source ribbon cable).
2. Replace the sample manifold ensure the O-ring is still in place on the optical cell and secure with the two M4 screws.

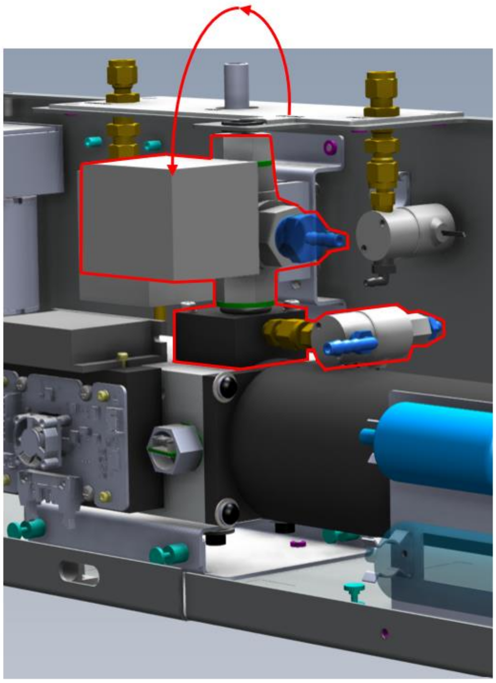


Figure 204 – Replacing the Sample Manifold Assembly

3. Slide the optical cell and sample manifold back and to the right until the two brackets align. Using a long M4 screwdriver, tighten the captive screws on the cell bracket two at the front and two at the back, all accessed from the front. Refer to Figure 205.
4. Reconnect the following connectors:
   a. Light source ribbon cable
   b. Heater connecter to J17 & J18 on the Control PCA
   c. PMT Cooler cable to J22 on the Control PCA
   d. PMT signal and power connectors to J14 & J6 on the Microprocessor PCA
5. Replace the filter holder bracket by tightening the 2 captive screws.

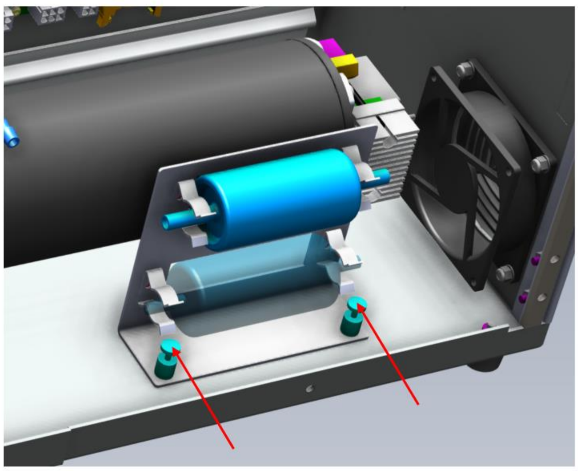


Figure 205 – Replacing the Filter Holder Bracket

6. Re-insert the sample inlet tube.

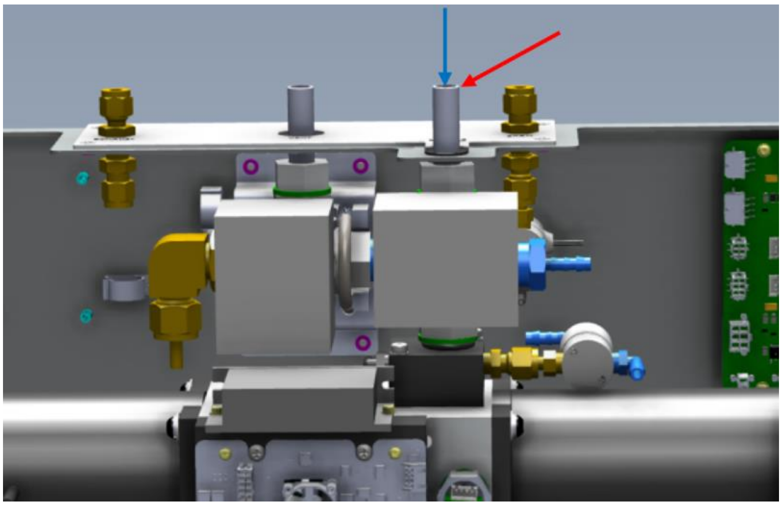


Figure 206 – Replacing Sample Inlet Tube

7. Connect the tubing to the following points on the optical cell and the sample manifold.

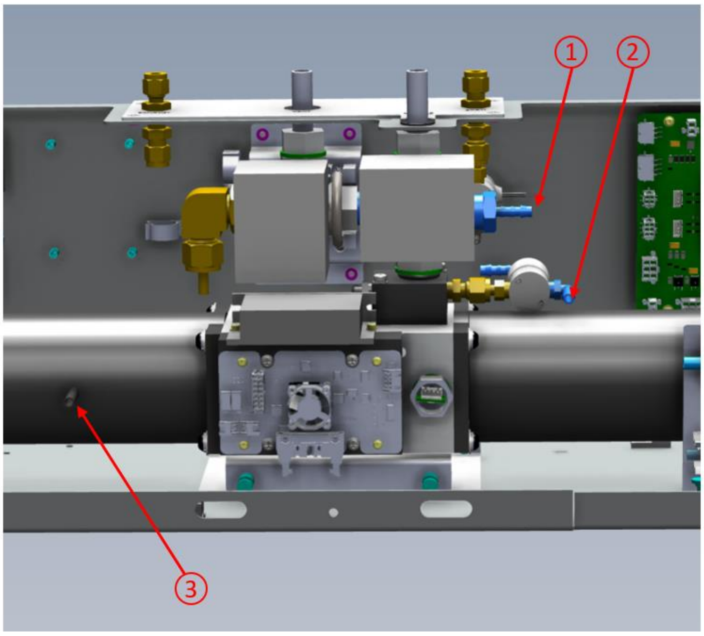


Figure 207 – Reconnecting Tubing

8. Conduct a leak check (refer to Section 6.4.10). When the leak check has passed replace the lid and close the door.
9. Conduct a full calibration, then normal operation can begin.

6.4.10 Leak Check

There are two methods to perform a leak check. method “A” will use an automated process controlled by the microprocessor which should be the first option. Method “B” is a faster method that should be used for troubleshooting should method "A" fail. Method “A” should be used first.

6.4.10.1 Method "A" – Automated Leak Check.

This leak test is automated and will record the results in the configuration files.

1. Some preparation is required, before commencing the automated leak check, disconnect anything connected to the sample inlet, the vent, and the span gas ports.
2. From the home page touch the config button to navigate to the Config page.
3. On the config page user setting panel, enable service menus (green radio button).
4. Navigate back to the home page, then navigate to the Cal page then the Sensors child page.
5. On the leak check panel touch Start, this will create a popup dialog box seeking confirmation that you want to start the leak check. Selecting Cancel will close the dialog box and cancel the operation accept will stop the normal instrument measurement.

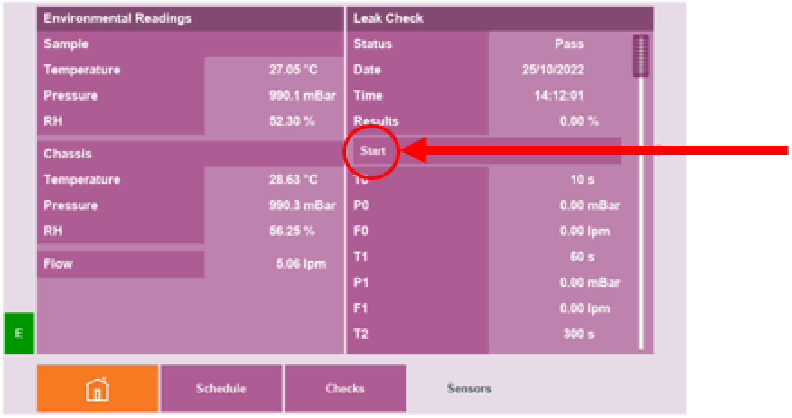


Figure 208 – Location of Leak Check Start Button

6. Using the two black 1/2" rubber caps, block the sample inlet port and vent port. Also, make sure the Span gas port is disconnected.

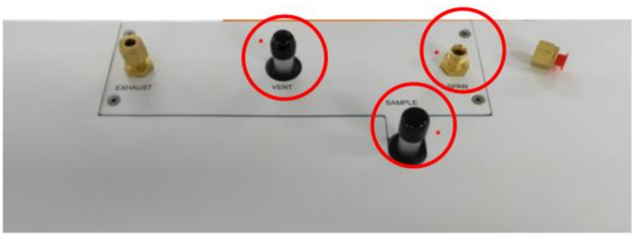


Figure 209 – Image of Port Preparation

7. Another pop up dialog box will ask to confirm that the above action has been done. Select Accept.
8. Some valves will change and the pump will start evacuating the cell for 1 minute.
9. If sufficient pressure reduction is not achieved a pop up dialog box will appear saying slow leak and asking if you want to try again. Select Accept to try again or Cancel to Abort the Check.
10. If sufficient pressure reduction is achieved, the Leak Check will continue for 5 minutes measuring the change in pressure. If the test passes you will be prompted to Accept and complete the test. The pass target is 2%.

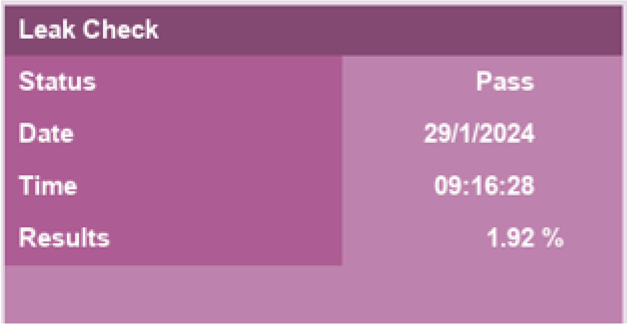


Figure 210 – Leak Check Pass

11. When the test is complete Disconnect the two black 1/2" rubber caps and re-connect the sample inlet and Span Gas line.
12. The results of the Leak Check will be displayed at the top of the menu when the test is complete. These results are stored in the calibration file.
13. Navigate to the Config page (Home page –> Config page) and on the user setting panel, disable service menus (red radio button).
14. If Method A fails, you can use Method B to assist with trouble shooting to resolve the leak.
15. Always use Method A as the final Method before moving on to the next step.

6.4.10.2 Method "B" – Manual Leak Check

This procedure assumes you have followed method "A" and it has failed.

Stage 1

1. Switch off the power to the instrument.
2. Make sure nothing is connected to the span port or vent Port.
3. Apply a 1/2" black rubber cap to the sample Inlet port on the top of the instrument.
4. Switch on the instrument and observe the sample flow and pressure on the home page.
    a. The sample pump will slowly increase to maximum speed.
    b. The Sample pressure will decrease to less than 150 mBar.
    c. The Sample Flow will decrease to less than 0.1 slpm.

Figure 211 – Example of Pressure and Flow

5. If all these conditions are met within 5 minutes, then the leak check has passed Stage 1.

Stage 2

1. Navigate to Cal page –> Calibration Settings panel, and open the vent ball valve, to release the cell pressure.
   a. The sample pressure should return to ambient.
   b. The sample flow should remain at less than 0.1 slpm.
2. If all these conditions are met within 1 minute, then the leak check has passed Stage 2.
3. Remove the 1/2" black rubber cap from the sample Inlet port.
4. Navigate to Cal page –> Calibration Settings panel, and close the vent ball valve, to return to normal operation.
   a. The sample Pressure should be at Ambient readings.
   b. The sample Flow should return to the target set point.
5. Leak Test Method “B” is now complete.

6.4.11 Zero Noise Test

Calculating the zero noise is the best way to confirm the operational performance of the Aurora NE Series. The following procedure explains how to do this for all Instrument types:

1. Operate the Instrument at room temperature for at least 30 minutes before starting this test.
2. If the instrument has undergone maintenance and the cell has been cleaned, then perform a full calibration first.
3. Set the Aurora NE Series into zero-measure mode from the Calibration Settings panel.
4. Navigate to the In the Datalog Parameters panel (Home page –> Config page –> Datalog Parameters panel), set the Period to 1 minute and make sure all the Kalman sigma channels are being logged.
5. Allow the Aurora NE Series to continue running on zero air for a minimum period of 12 hours, uninterrupted.

6. When the 12 hours are complete, download all the zero data to a PC either via ACOEM Airodis software or insert the SD card into the PC.
7. Using MS Excel, import the data into a new spreadsheet.
8. For the scattering data use the STDEV.S() command in Excel to calculated the Standard Deviation of the zero data over a 12 hours period for each of the scattering parameters.
9. This calculated standard deviation is the zero noise value for that particular angle and wavelength.
    a. For the NE-100, there is only one channel to be calculated. This channel should pass.
    b. For the NE-300, there are 6 channels for calculation. All channels should pass.
    c. For the NE-400, there are potentially 60 channels for calculation. It is not realistic that all channels will pass at the same time. It is considered that the average of all the channels combined should be below the noise limit.
10. If the zero noise is less than 0.05 Mm^{-1}, then the instrument is considered to be in good working order. If the instrument zero noise is above 0.05 Mm^{-1}, then this could be due to a number of factors:

- Pneumatic leak in the cell or plumbing,
- Light leak near the PMT,
- Dirty measurement cell or optical chamber,
- Low-intensity light source,
- Dirty light trap mirror,
- Noisy PMT,
- Excessive temperature variation.

6.4.12 Light Source Test and Adjustment

The intensity of the LED lightsource may decrease slowly with time. The performance of the light source and backscatter shutter can be verified without having to remove the light source from the optical cell. The following procedures are simple checks which can be done to ensure optimum performance. Ultimately, calculating the zero noise is the best way to confirm the overall operational performance of the Aurora NE Series.

6.4.12.1 NE-100 Light Source Test

Lightsource Configuration	
Model	100
Serial	12803
Revision	2
Wavelengths	635 nm
	525 nm
	450 nm
LED 1	50
LED 2	90
LED 3	20

Figure 212 – NE-100 Lightsource Configuration Panel

Note: The Aurora NE-100 light source has three wavelengths. Only one wavelength can be tested at a time. Choose only the wavelength that you are measuring with.

1. Navigate to the Config –> Factory page. In the Lightsource Configuration panel Confirm that the Model is 100.
2. Confirm that the listed Wavelengths are 635 nm, 525 nm & 450 nm in that order.
3. Confirm that the LED 1, LED 2 & LED 3 setting is not 0 or 255.
4. Now select Home page –> Cal page –> Calibration Settings panel, and set the Source to Zero.
5. The instrument will now sample Zero air so that the LEDs can be checked for optimum performance. Allow 5 minutes to stabilise.
6. From the home page touch the config button to navigate to the Config page.
7. On the config page user setting panel, Enable Service Menus (green radio button).
8. Touch home to return to the Home page –> Cal page –> Measurement Settings panel.
9. Scroll down until you find the three wavelength settings.

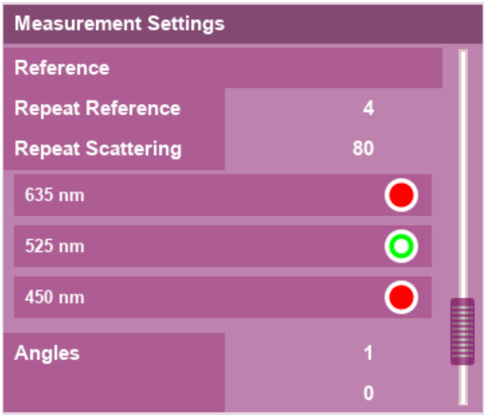


Figure 213 – Example of NE-100 Wavelength Selection

10. Confirm that your desired wavelength is selected. Figure 213 shows 525 nm as the most common selection. If you need to change the wavelength, press the desired wavelength radio button and Accept.
11. After 5 minutes of zero measure operating, return to the Home screen, Select Readings –> 525 nm, and take note of the Measure Count. (Not Measure Count Raw) and Shutter Count (Not Shutter Count Raw).
12. If the displayed measure count for the 525 nm wavelength is not in the correct range (10,000 – 30,000, see Table 19), adjust the LED 2 setting in the Lightsource Configuration panel to increase or decrease the measure counts.
13. Repeat the changes of the LED 2 setting by step 5 until the measure counts and Shutter Counts are in the correct range and check that the LED 2 setting is also in the correct range as indicated in Table 19.
14. When adjusting LED 2, aim to keep it as low as possible.
15. Any changes made in the Lightsource Configuration panel will require confirmation. Press Accept when it appears.

Table 19 – NE-100 Lightsource target settings

Wavelength	LED Setting	Measure Count	Shutter Count
635 nm LED 1*	10 - 200	10,000 – 30,000	1,000,000 – 4,000,000
635 nm LED 1	10 - 250	2,000 – 10,000	> 100,000
525 nm LED 2	10 - 200	10,000 – 30,000	1,000,000 – 4,000,000
450 nm LED 3	10 - 200	10,000 – 30,000	1,000,000 – 4,000,000

*NE-100 with Wide Bandwidth PMT option installed (E010200).

Note: The Shutter Counts will only update every 30 - 60 seconds.

16. If other wavelengths are being used, follow the same sequence to adjust them. Use Table 19 as a target for these settings.

17. When the adjustments have been completed, navigate to the Home page –> Cal page –> Calibration Settings panel, and set the Source to Sample.

6.4.12.2 NE-300 Light Source Test

Figure 214 – NE-300 Lightsource Configuration Panel

1. Navigate to the Config –> Factory page. In the Lightsource Configuration panel Confirm that the Model is 300.
2. Confirm that the listed Wavelengths are 635 nm, 525 nm & 450 nm in that order.
3. Confirm that the LED 1, LED 2 & LED 3 setting is not 0 or 255.
4. Confirm that the 90 Position is in the range of 180 to 200. (This is unique for each lightsource and must not change without factory calibration).
5. Now select Home page –> Cal page –> Calibration Settings panel, and set the Source to Zero.
6. The instrument will now sample Zero air so that the LEDs can be checked for optimum performance. Allow 5 minutes to stabilise.
7. From the home page touch the config button to navigate to the Config page.
8. On the config page user setting panel, Enable Service Menus (green radio button).
9. Touch home to return to the Home page –> Cal page –> Measurement Settings panel.
10. Scroll down until you find the three wavelength settings.

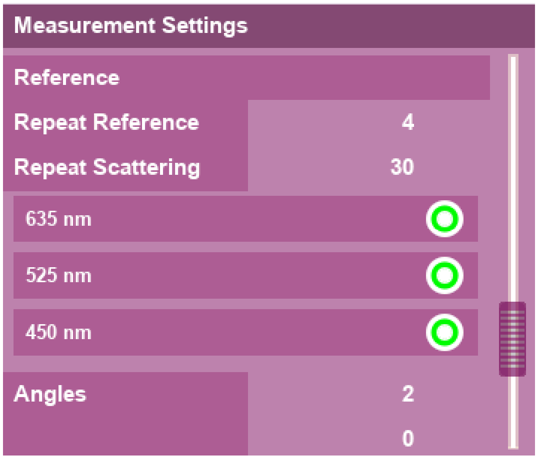


Figure 215 – Example of NE-300 Wavelength Selection

11. Confirm that your desired wavelength is selected. Figure 215 shows all three wavelengths enabled which is the most common selection for a NE-300.
12. After 5 minutes of zero measure operating, return to the Home screen, Select Readings –> 635 nm, 525 nm, or 450 nm, and take note of Measure Count 0°, Measure Count 90°. and Shutter Count. (Do Not use the Raw Count that only appears when service Menus are enabled).
13. If the displayed measure count for the selected wavelength is not in the correct range as per Table 20, adjust the corresponding LED setting in the Lightsource Configuration panel to increase or decrease the measure counts.
14. Repeat the changes of the LED setting for each wavelength by step 5 until the measure counts and Shutter Counts are in the correct range and check that the LED setting is also in the correct range as indicated in Table 20.
15. When adjusting the LED setting, aim to keep it as low as possible for each wavelength.
16. Any changes made in the Lightsource Configuration panel will require confirmation. Press Accept when it appears.

Table 20 – NE-300 Lightsource target settings

Wavelength	LED Setting	Measure Count 0°	Measure Count 90°	Shutter Count
635 nm LED 1	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000
525 nm LED 2	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000
450 nm LED 3	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000

Note: The Shutter Counts will only update every 30 - 60 seconds.

17. Follow the same sequence to adjust each wavelength. Use Table 20 as a target for these settings.
18. When the adjustments have been completed, navigate to the Home page –> Cal page –> Calibration Settings panel, and set the Source to Sample.

6.4.12.3 NE-400 Light Source Test

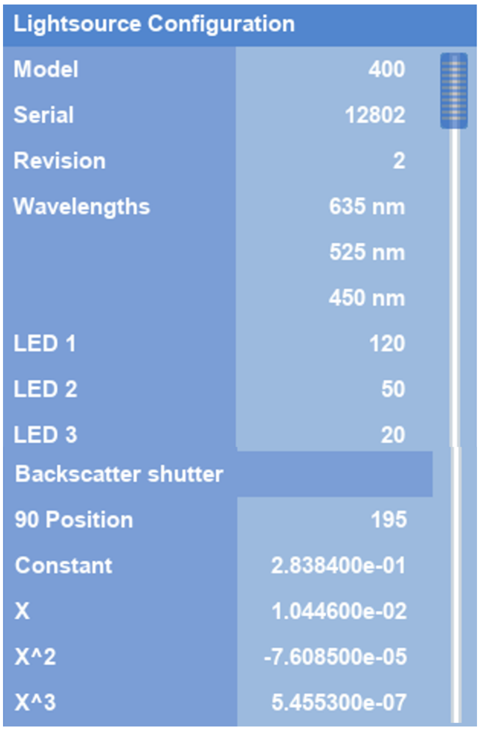


Figure 216 – NE-400 Lightsource Configuration Panel

1. Navigate to the Config –> Factory page. In the Lightsource Configuration panel Confirm that the Model is 300.
2. Confirm that the listed Wavelengths are 635 nm, 525 nm & 450 nm in that order.
3. Confirm that the LED 1, LED 2 & LED 3 setting is not 0 or 255.
4. Confirm that the 90 Position is in the range of 180 to 200. (This is unique for each lightsource and must not change without factory calibration).
5. Confirm that four polar polynomials (Constant, x, x2 x3) are not set to 0 and that they have values similar in magnitude to those shown in Figure 216. (These are unique for each lightsource and must not change without factory calibration).
6. Now select Home page –> Cal page –> Calibration Settings panel, and set the Source to Zero.
7. The instrument will now sample Zero air so that the LEDs can be checked for optimum performance. Allow 5 minutes to stabilise.
8. From the home page touch the config button to navigate to the Config page.
9. On the config page user setting panel, Enable Service Menus (green radio button).
10. Touch home to return to the Home page –> Cal page –> Measurement Settings panel.
11. Scroll down until you find the three wavelength settings.

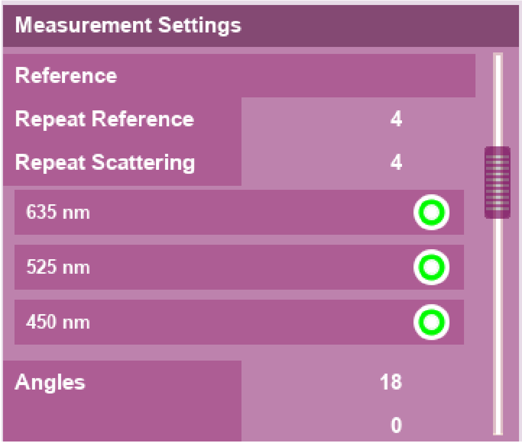


Figure 217 – Example of NE-400 Wavelength Selection

12. Confirm that your desired wavelength is selected. Figure 217 shows all three wavelengths enabled which is the most common selection for a NE-400.
13. After 5 minutes of zero measure operating, return to the Home screen, Select Readings –> 635 nm, 525 nm, or 450 nm, and take note of Measure Count 0°, Measure Count 90°. and Shutter Count. (Do Not use the Raw Count that only appears when service menus are enabled).
14. If the displayed measure count for the selected wavelength is not in the correct range as per Table 20, adjust the corresponding LED setting in the Lightsource Configuration panel to increase or decrease the measure counts.
15. Repeat the changes of the LED setting for each wavelength by step 5 until the measure counts and Shutter Counts are in the correct range and check that the LED setting is also in the correct range as indicated in Table 20.
16. When adjusting the LED setting, aim to keep it as low as possible for each wavelength.
17. Any changes made in the Lightsource Configuration panel will require confirmation. Press Accept when it appears.

Table 21 – NE-400 Lightsource target settings

Wavelength	LED Setting	Measure Count 0°	Measure Count 90°	Shutter Count
635 nm LED 1	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000
525 nm LED 2	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000
450 nm LED 3	10 - 200	14,000 – 30,000	10,000 – 12,000	1,000,000 – 4,000,000

Note: The Shutter Counts will only update every 30 - 60 seconds.

18. Follow the same sequence to adjust each wavelength. Use Table 21 as a target for these settings.
19. When the adjustments have been completed, navigate to the Home page –> Cal page –> Calibration Settings panel, and set the Source to Sample.

Note: The Measure Counts for the intermediate angles between 0° and 90° will gradually decrease as the angle increases from 0° to 90°.

6.4.13 Full Calibration and Precision Checks

Normally when all maintenance procedures have been completed, the instrument will require a Full Calibration. This information is covered in Sections 5 and 5.5.

6.4.14 Clock Battery Replacement

Over the life of the instrument at some point, the backup battery may need to be replaced. The frequency will depend on how the instrument is used. Instrument stored for long periods without power will reduce the overall life of the backup battery. The following procedure covers how to check, extract, and replace the battery.

6.4.14.1 Clock Battery Check

The Clock battery located at BAT1 on the microprocessor board is used to maintain the real time clock setting when the Aurora NE is disconnected from power.

To check the clock battery, you will require a mustimeter.

1. Using a multimeter set to Volts DC, measure the clock battery voltage on the microprocessor PCA by placing the negative probe on TP1 (GND) and the positive probe on the top of the battery.

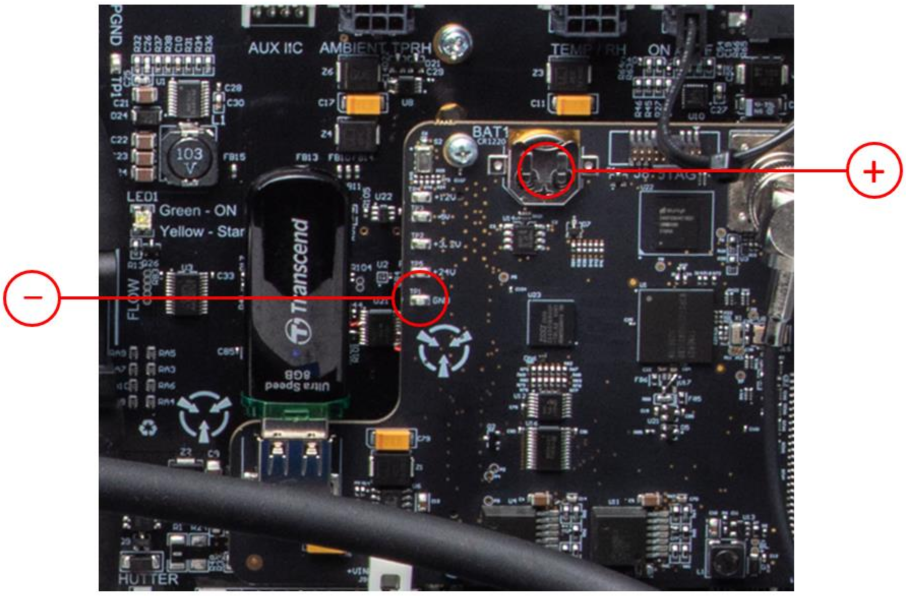


Figure 218 – Polarity of Clock Battery Test Points

2. The battery voltage measured between TP1 and the top of the holder should be between 2.0 V and 3.6 V.
3. If the voltage is close to 2.0V, it is recommended that the battery be replaced as shown in the following section.

6.4.14.2 Clock Battery Removal

1. Before removing the battery, some preparation is required. Using some clear packing tape, cut a square size section of the tape and place it to one side sticky side up.
2. Be mindful of ESD (electrostatic discharge) when working near the microprocess PCA, ensure you are wearing appropriate clothing and you are sufficiently grounded, such as the use of an anti-static strap.
3. Switch off the power to the instrument.
4. Locate the BAT1 battery holder located on the microprocessor PCA. With the aid of a toothpick (something nonconductive) carefully extracts the cell battery from the holder.

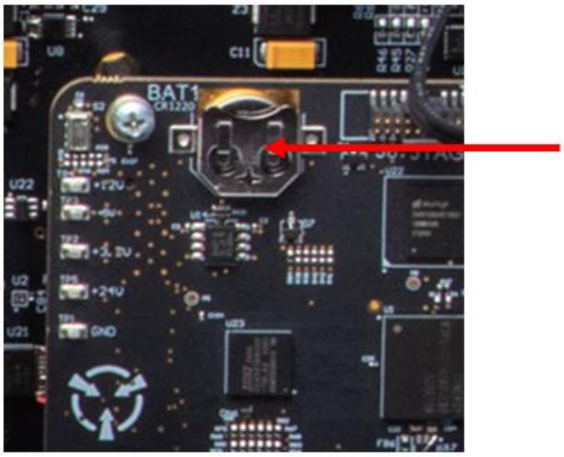


Figure 219 – Location of Battery Holder

5. Place the extracted battery onto the left half of the packing tape (sticky side).
6. Fold the tape over and seal the battery within. This will prevent the battery from shorting or making contact with other batteries.
7. Dispose of the battery in the correct manner (refer to your local standards for Lithium battery disposal).

6.4.14.3 Clock Battery Replacement

This procedure assumes you have followed the clock battery removal procedure.

1. Ensure power to the instrument is still off.
2. Install the CR1220 3 V Lithium battery (PN: B040023) into the BAT1 battery holder positive (“+”) side up (facing towards the user), taking care not to bend the battery holder.
3. Check the battery voltage (refer to Section 6.4.14.1).
4. Switch on the power to the instrument.
5. Select Config. In the User Settings Panel, set the Current Date by touching the date.

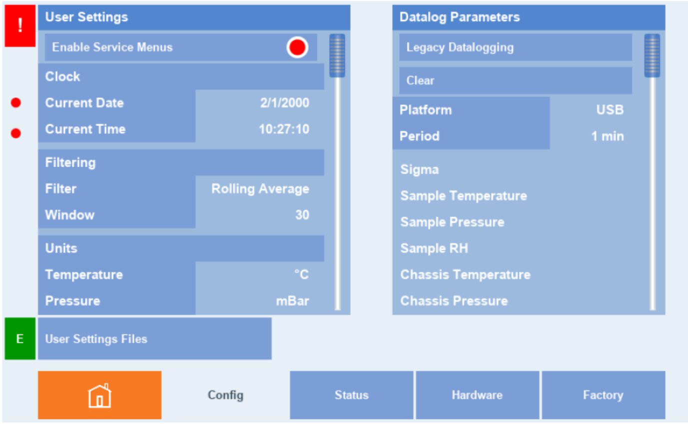


Figure 220 – Example of Current Date and Time

6. Repeat the same for the Current Time.
7. Touch the Home button to return to the home page and check that the time and date are correct and that the time is incrementing.
8. Switch off the power to the instrument for 1 minute.
9. Switch on power to the instrument and check that the time and date are still correct.

6.5 Firmware Upgrading

Firmware upgrades provide access to new features as they are developed by Acoem. Upgrading the firmware is a simple process.

Before upgrading the firmware, make sure you have backup copies of four Configuration Files: Calibration, Settings, Hardware, and Lightsource Files.

6.5.1 Enter Bootloader mode

The bootloader is an application that runs every time the instrument is powered up. It checks the integrity of the firmware before launching the familiar Aurora application. The bootloader also provides the option of upgrading to new firmware.

1. From the home page touch the config button to navigate to the Config page.
2. On the config page user setting panel, Enable Service Menus (green radio button).
3. Navigate to the Config page then the Factory child page. In the Identification panel, touch the Run Bootloader button.
4. A popup dialog box will appear asking you to Accept to reboot the system and access the bootloader. Select Accept.
5. The instrument will immediately return to the bootloader.

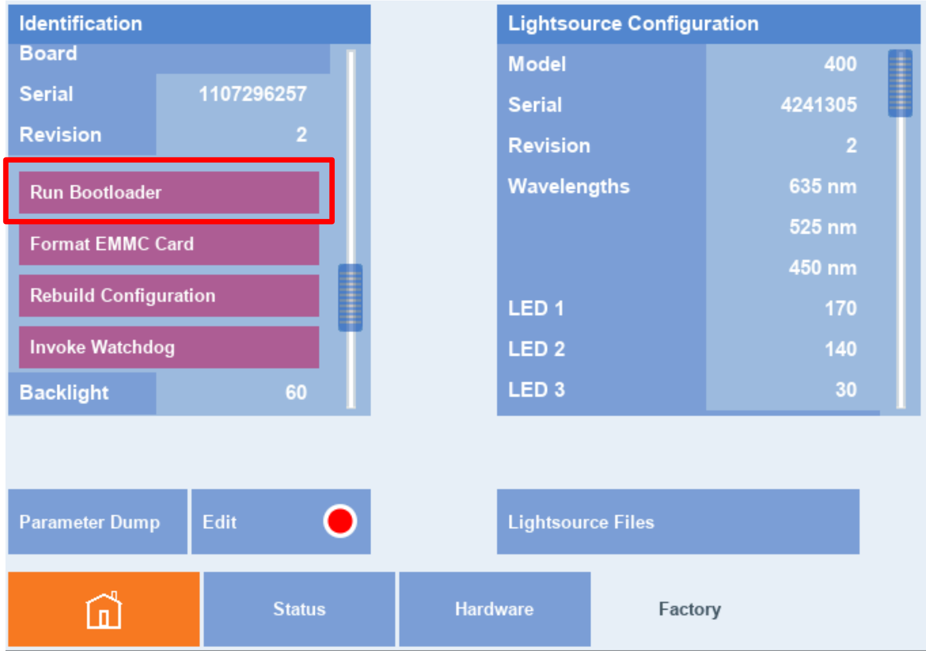


Figure 221 – Run Bootloader Button

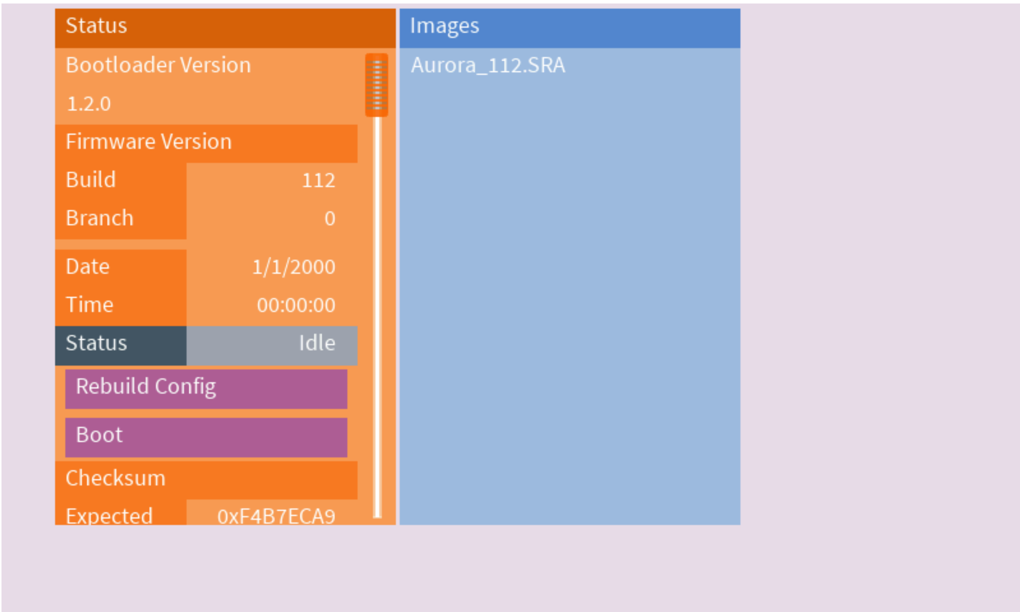


Figure 222 – Bootloader Page

6.5.2 Prepare the USB Memory Stick

Remove the USB memory stick and copy the new `Aurora_XXX.SRA` firmware file (where XXX is the build number) to the directory /FIRMWARE. Reinsert the USB memory stick and wait until the images panel list shows the contents of the USB memory stick.

> **Note:** Contact ACOEM for the latest firmware release for the Aurora NE Series.
> The same Firmware file can be used for each instrument type.
> Version 300 or greater will be required.

6.5.3 Load the firmware

Touch and hold the desired firmware file. From the pop-up menu, select Load. When the flashing process is complete, the instrument will reboot and run the new firmware.

If the instrument does not re start, press the Boot button on the bootloader status panel.

6.5.4 Troubleshooting

If something goes wrong the instrument will reboot in bootloader mode. The most common cause is an incompatible configuration; try pressing the Rebuild Config button and then the Boot button. After the application starts you can reload your configuration file to restore the original state. Make sure you have made backup copies of your configuration files before you do this.

Contact Acoem technical support for assistance if required.

This page is intentionally blank.

7. Troubleshooting

Before troubleshooting any specific issues, Acoem Australasia recommends ensuring the instrument has successfully completed its warm-up routine. The Instrument status panel in the Config – Status page, contains a list of possible errors and their current status. Pass (Green) or Fail (red). If a parameter is failing, press and hold the status and a popup dialog box will open displaying additional information. Refer to Table 22 for guidance on how to resolve the problem.

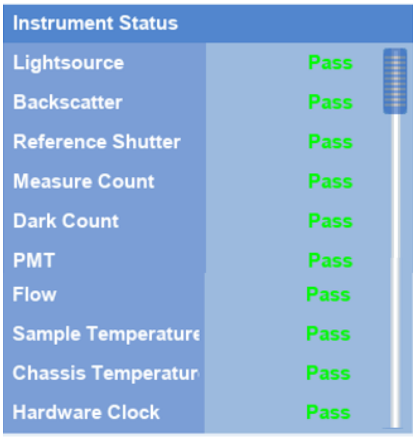


Figure 223 – Instrument Status Panel

Table 22 – Common Errors and Troubleshooting

Error Message/Problem	Cause	Solution
Light Source	Multiple possibilities	Refer to section 7.1
Backscatter	Multiple possibilities	Refer to section 7.2
Reference Shutter	Multiple possibilities	Refer to section 7.3
Measure Count	Multiple possibilities	Refer to section 7.4
Dark Count	Multiple possibilities	Refer to section 7.5
PMT	Multiple possibilities	Refer to section 7.6
Flow	Multiple possibilities	Refer to section 7.7
Sample Temperature	Multiple possibilities	Refer to section 7.8
Chassis Temperature	Multiple possibilities	Refer to section 7.9
Hardware Clock	Multiple possibilities	Refer to section 7.10
Noisy/unstable readings	Multiple possibilities	

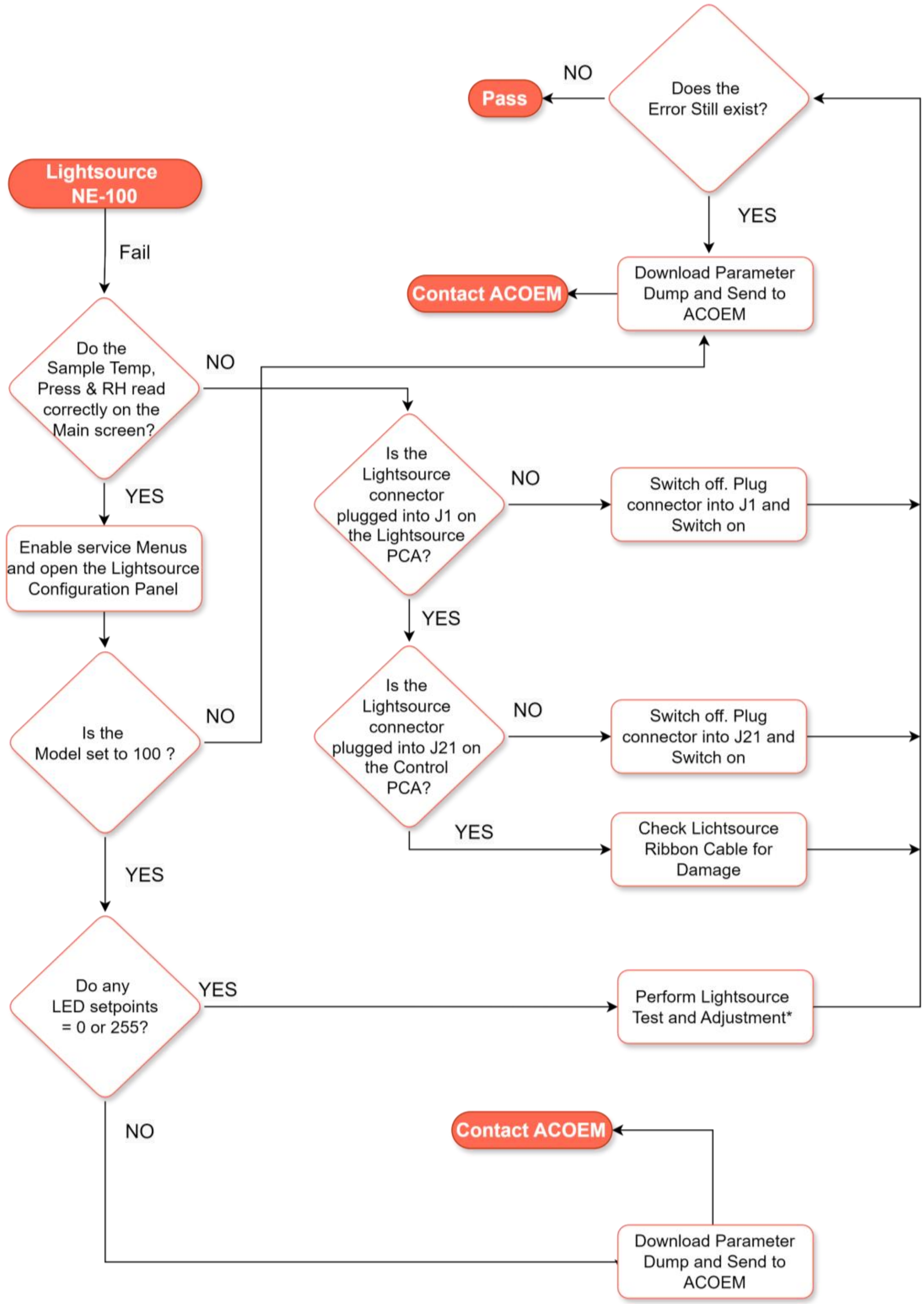
From section 3.4.5.4.1. Need to address these errors: (Flow charts*)

Plus additional common faults are not in the status menu: ?????

7.1 Lightsource

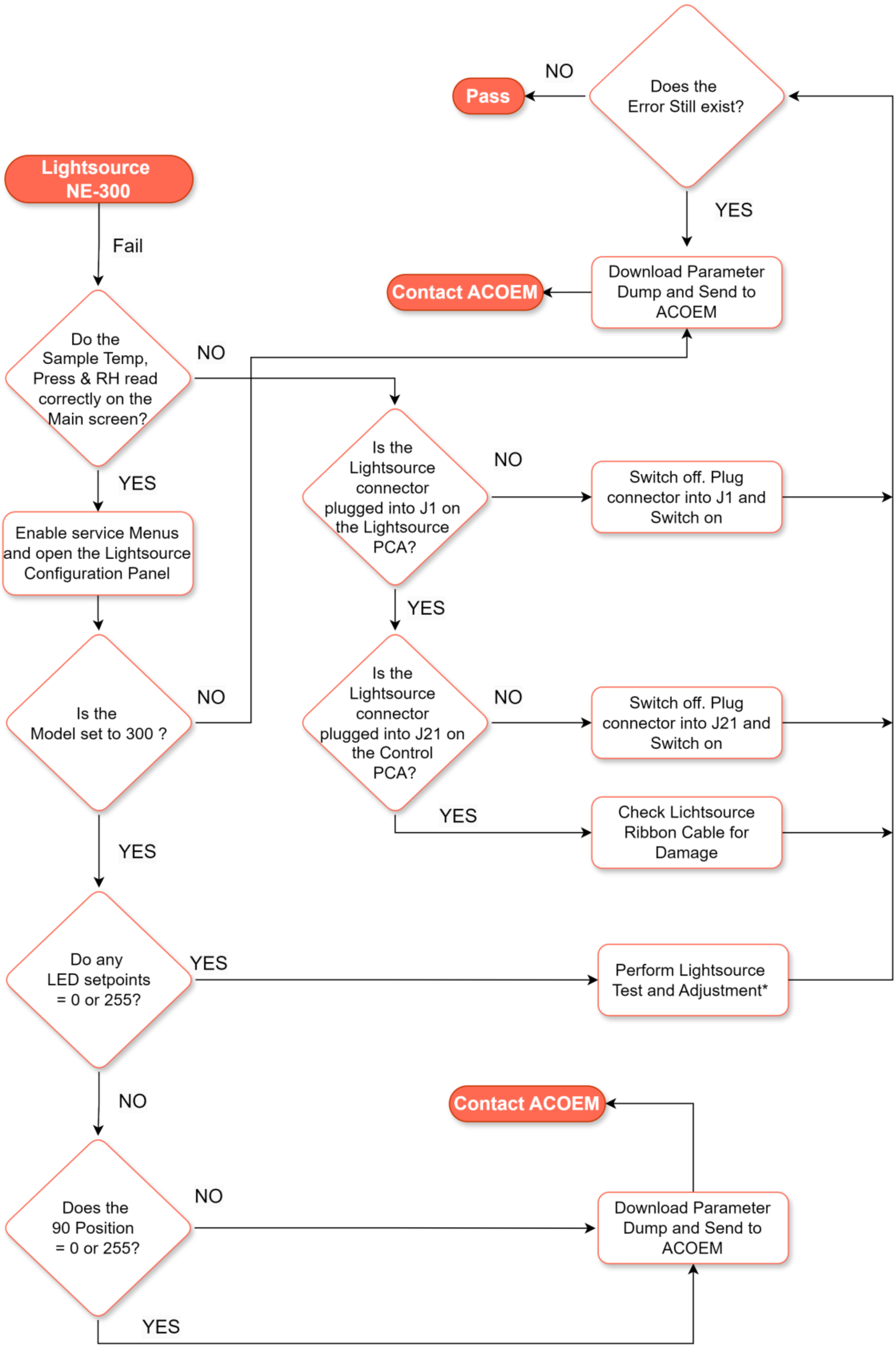
When the Lightsource error appears, the action to take will depend on the instrument type.

7.1.1 NE-100 Lightsource



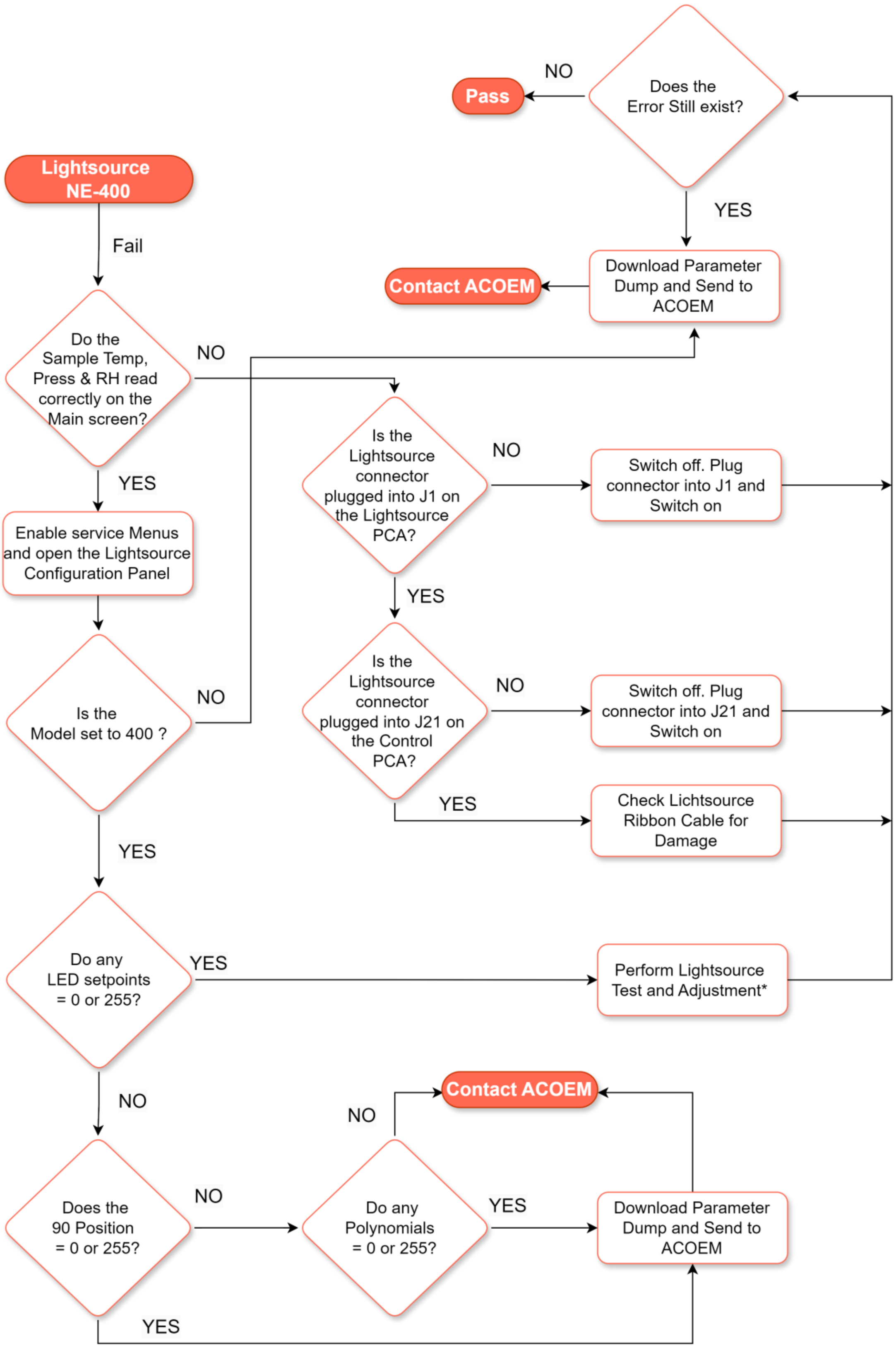
* Lightsource Test and Adjustment Section 6.4.12.

7.1.2 NE-300 Lightsource



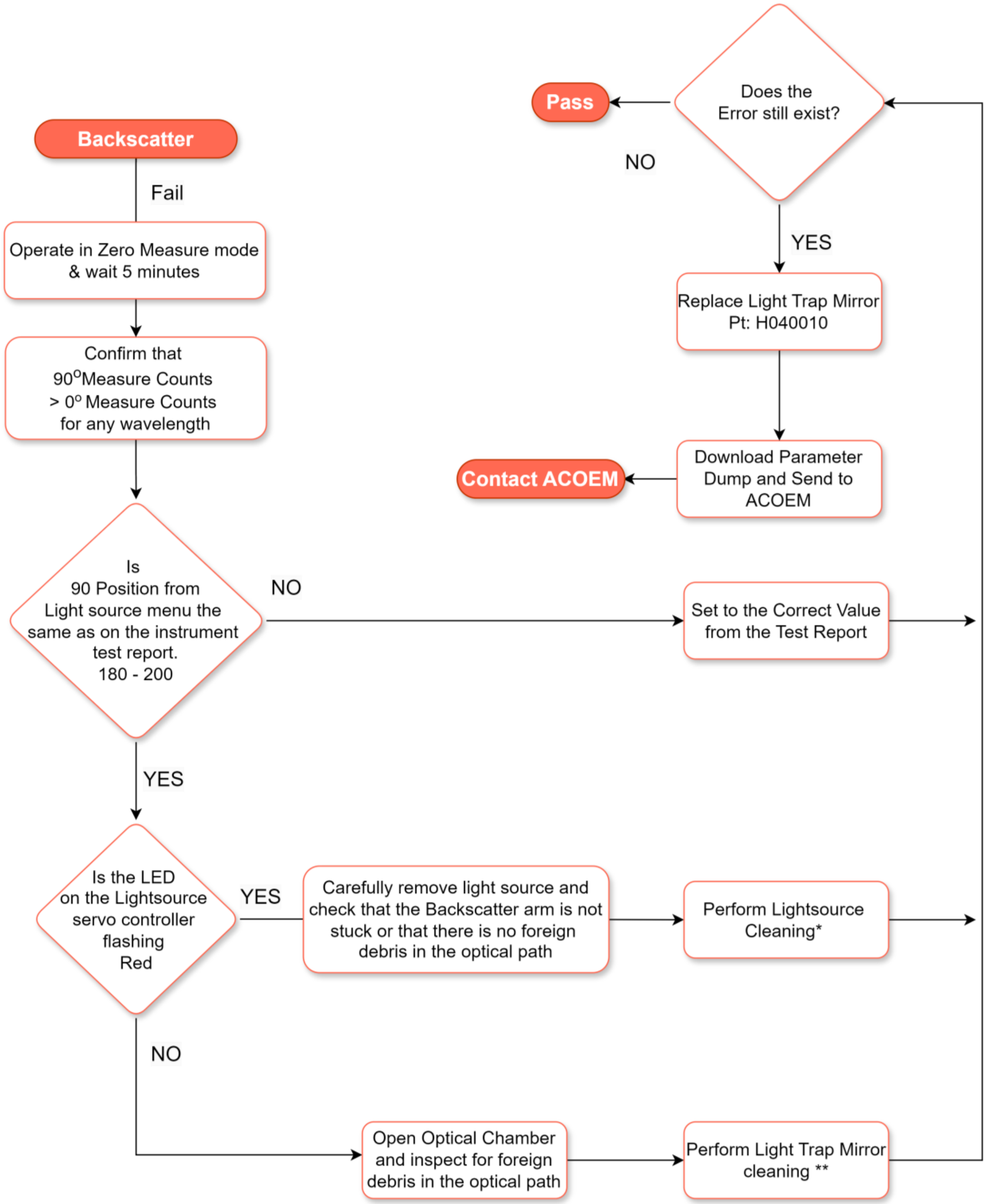
* Lightsource Test and Adjustment Section 6.4.12.

7.1.3 NE-400 Lightsource



* Lightsource Test and Adjustment Section 6.4.12.

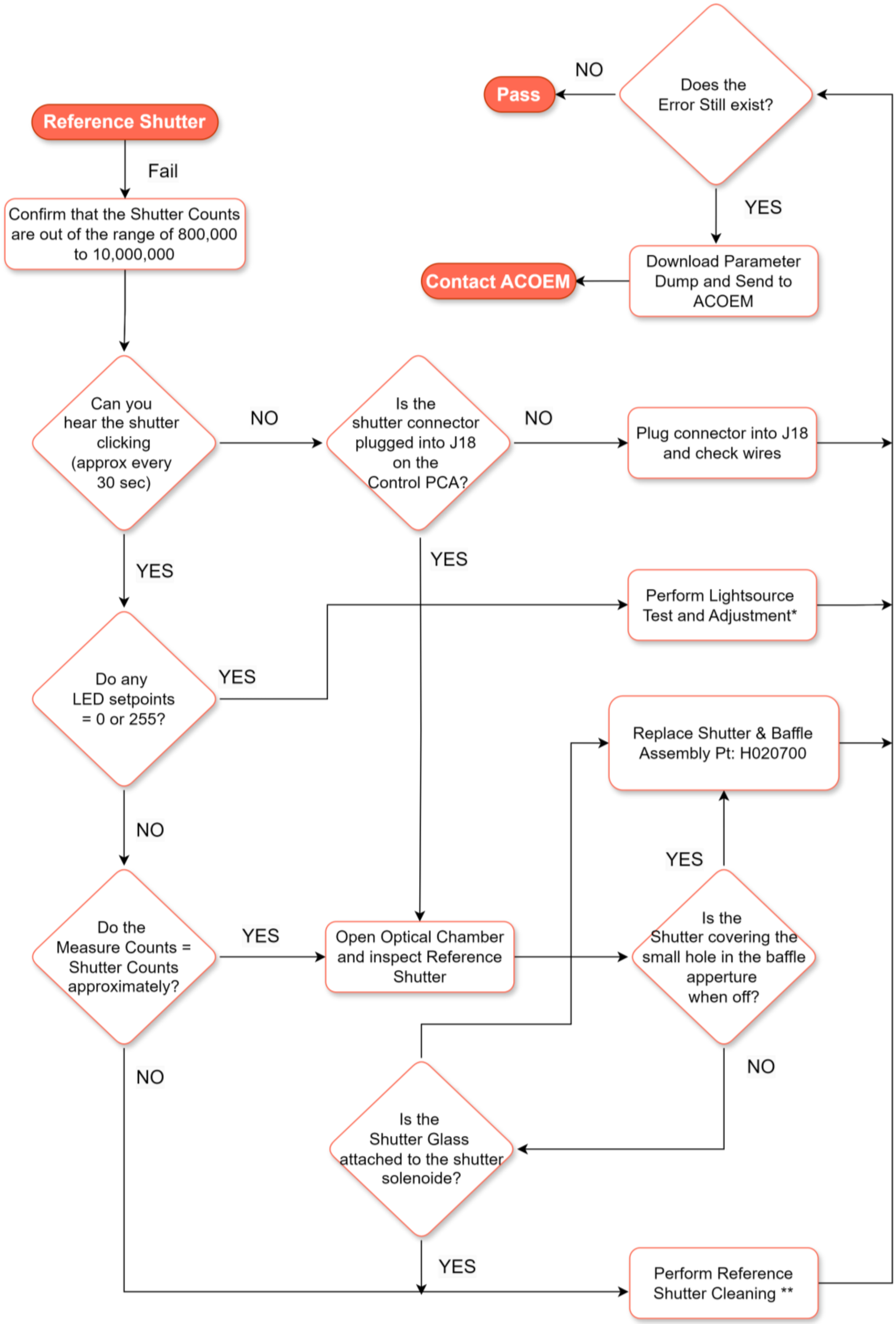
7.2 Backscatter



*Lightsource Cleaning Section 6.4.9.5

**Light Trap Cleaning Section 6.4.9.6

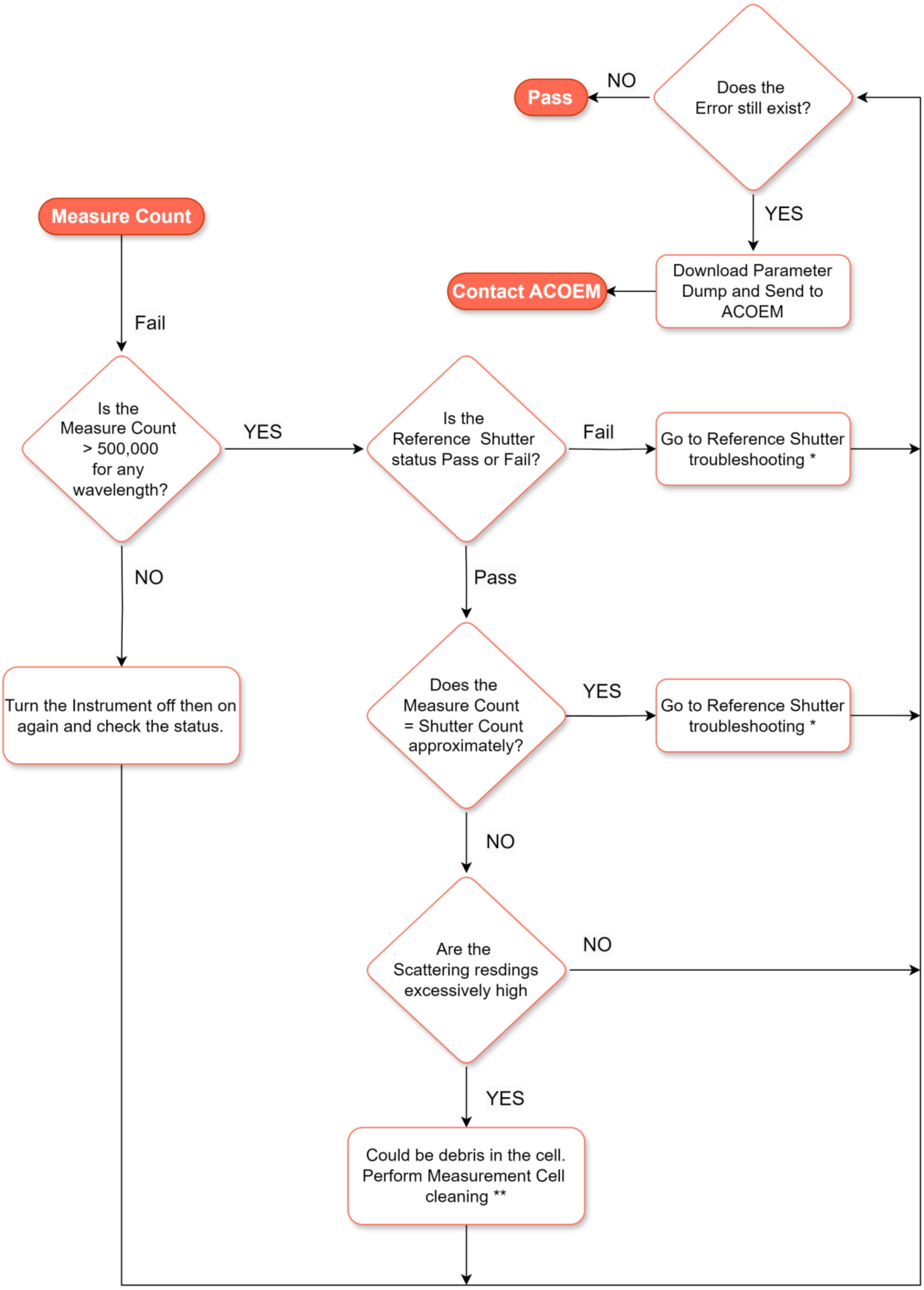
7.3 Reference Shutter



*Lightsource Test and Adjustment Section 6.4.12

** Reference Shutter Cleaning Section 6.4.9.4

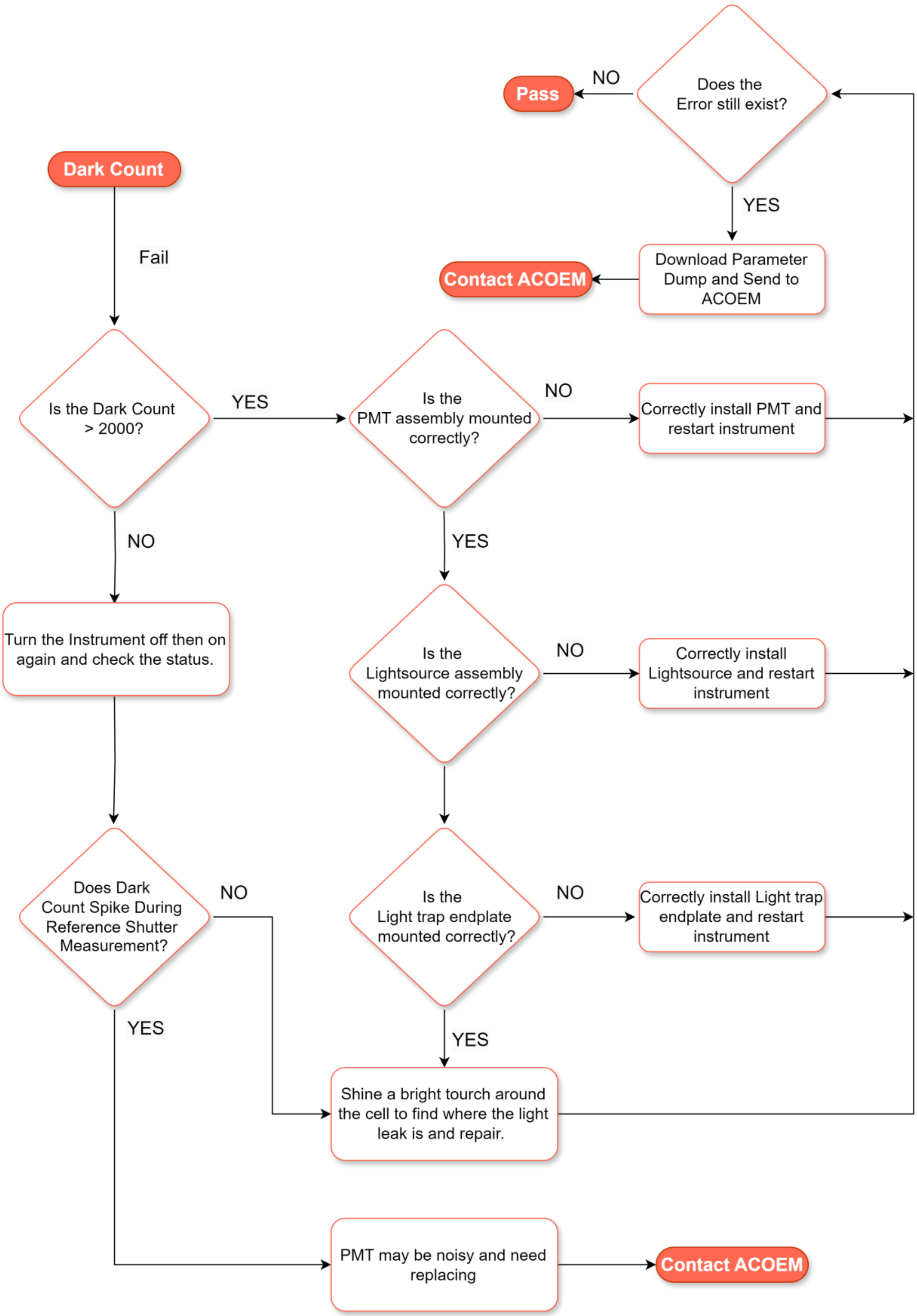
7.4 Measure Count



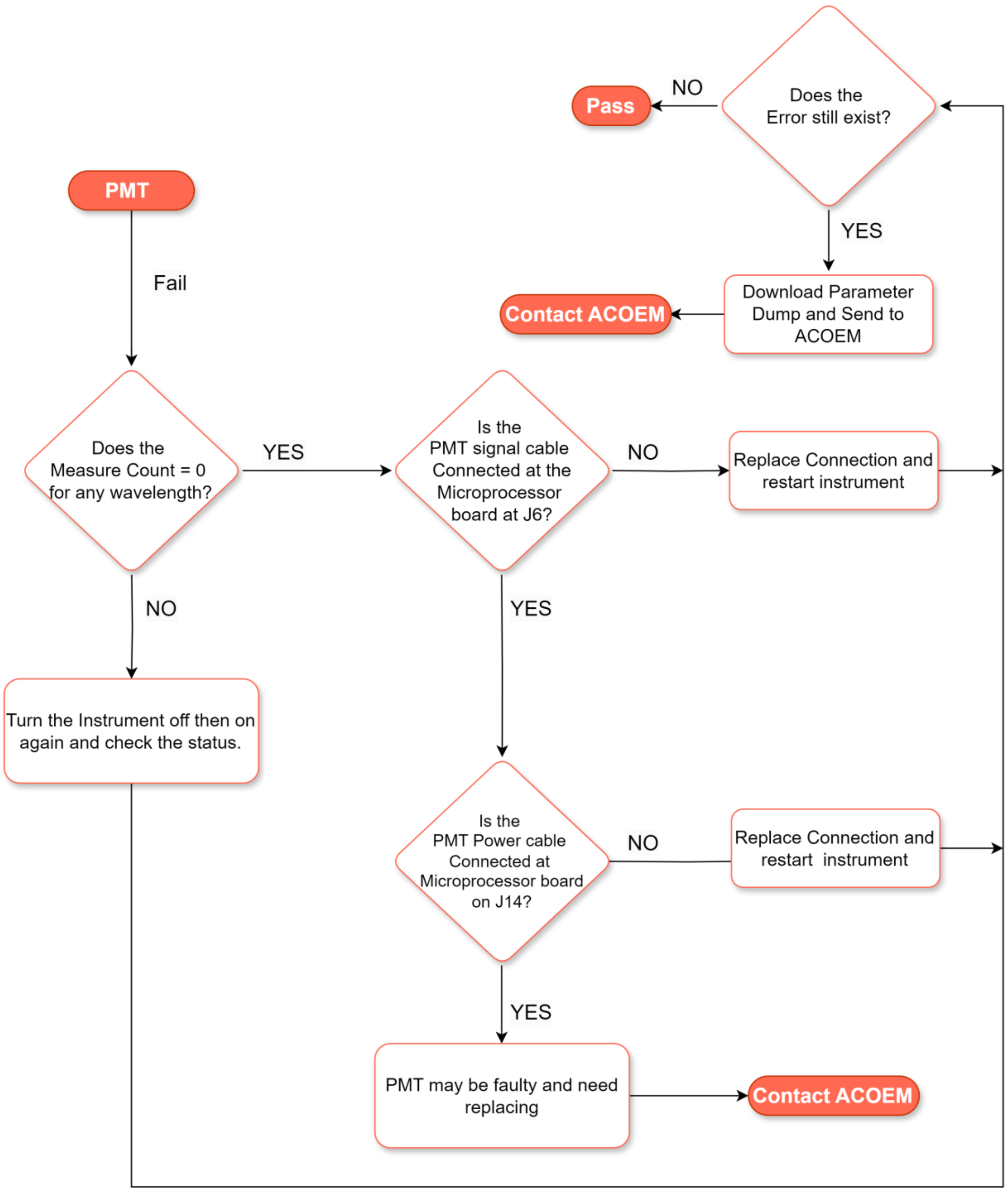
* Reference Shutter troubleshooting Section 7.3

** Measurement Cell Cleaning Section 6.4.8

7.5 Dark Count

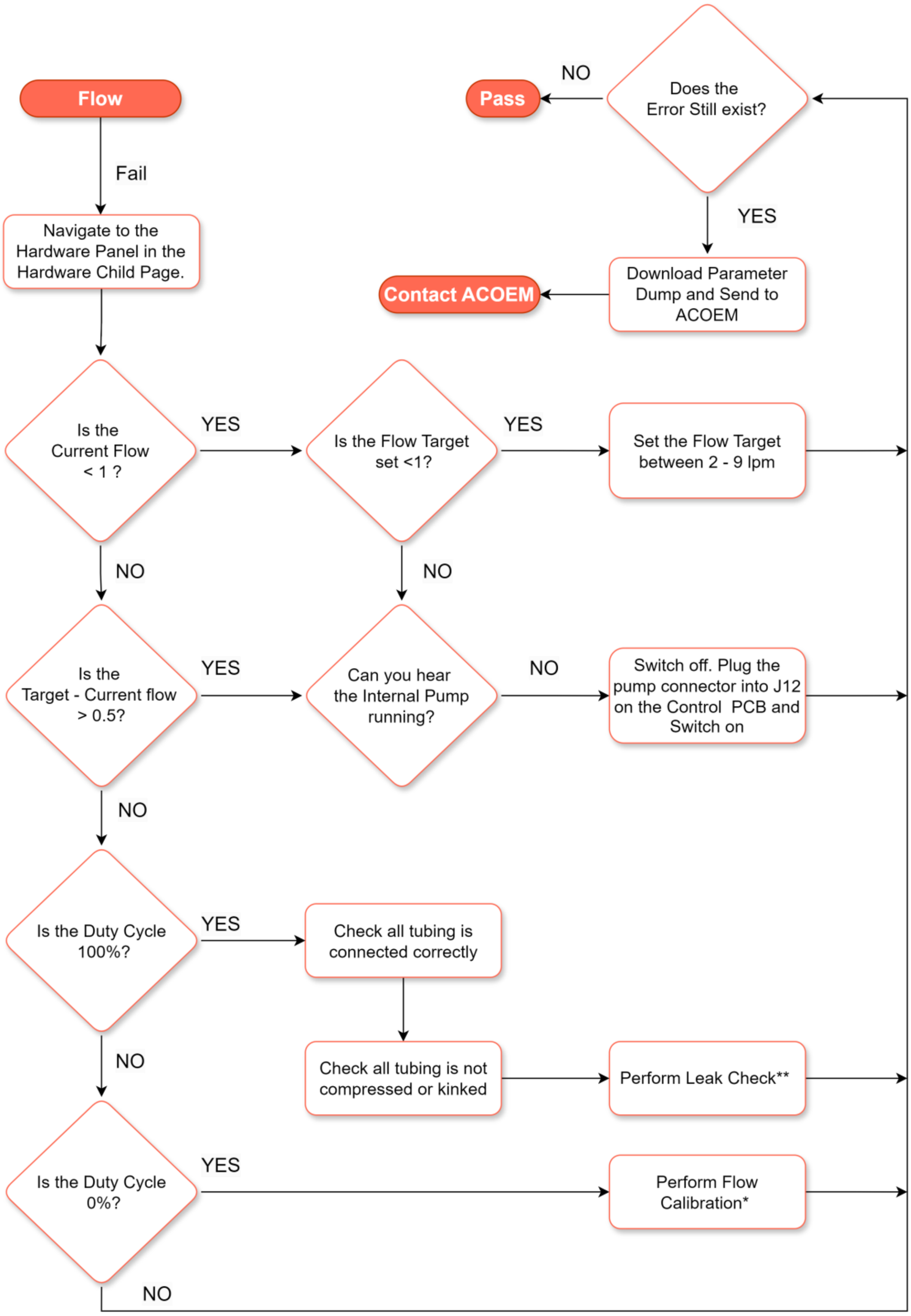


7.6 PMT



PMT
Fail
Does the Measure Count = 0 for any wavelength?
YES
NO
Turn the Instrument off then on again and check the status.
Is the PMT signal cable Connected at the Microprocessor board at J6?
NO
Replace Connection and restart instrument
YES
Is the PMT Power cable Connected at Microprocessor board on J14?
NO
Replace Connection and restart instrument
YES
PMT may be faulty and need replacing
Contact ACOEM
Does the Error still exist?
NO
Pass
YES
Download Parameter Dump and Send to ACOEM
Contact ACOEM

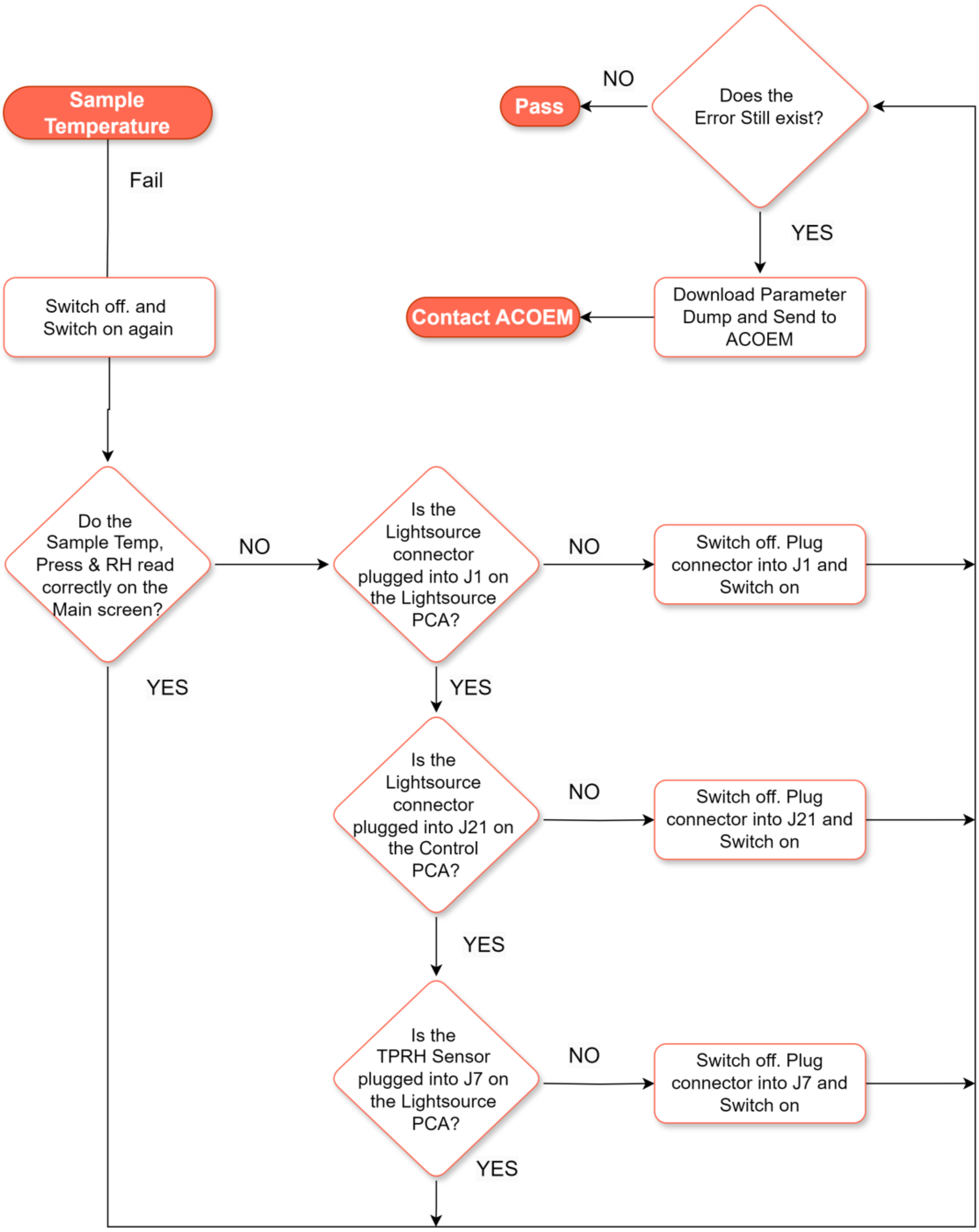
7.7 Flow



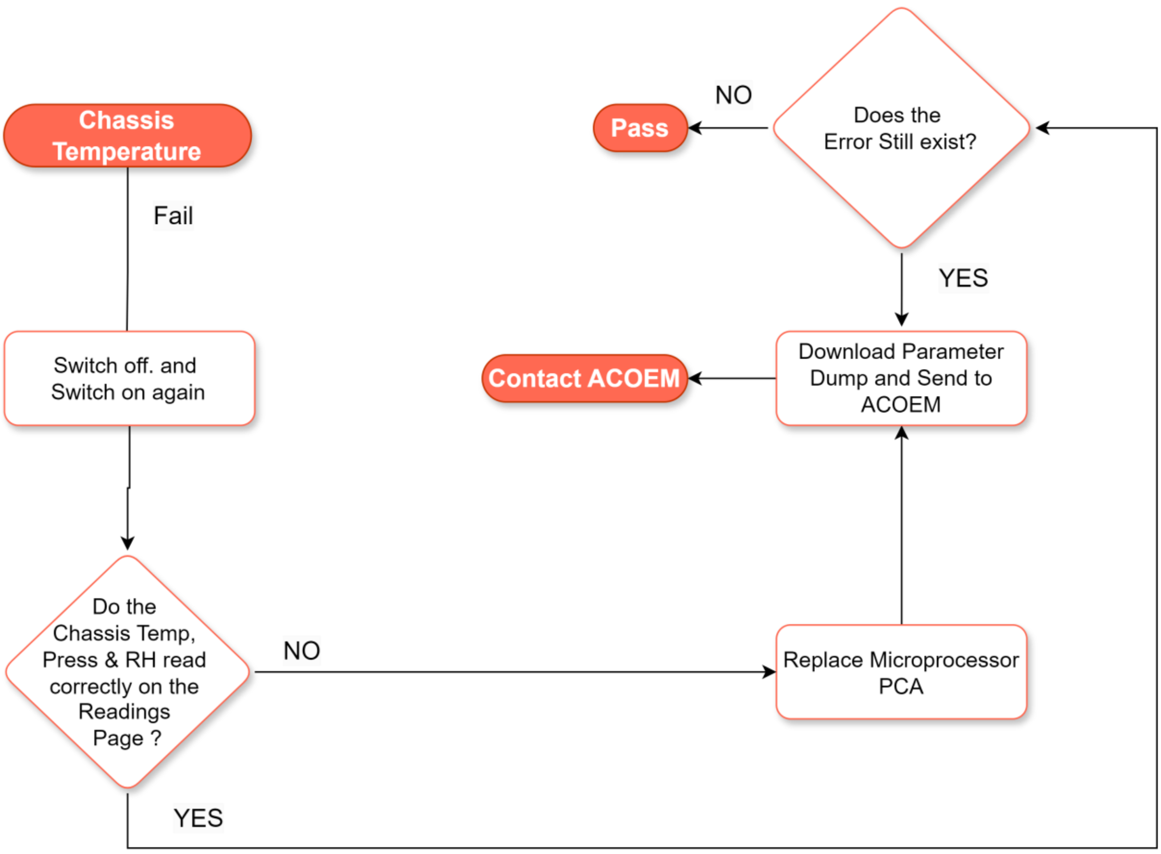
* Flow Calibration Section 5.4.1

** Leak Check Section 6.4.10.1

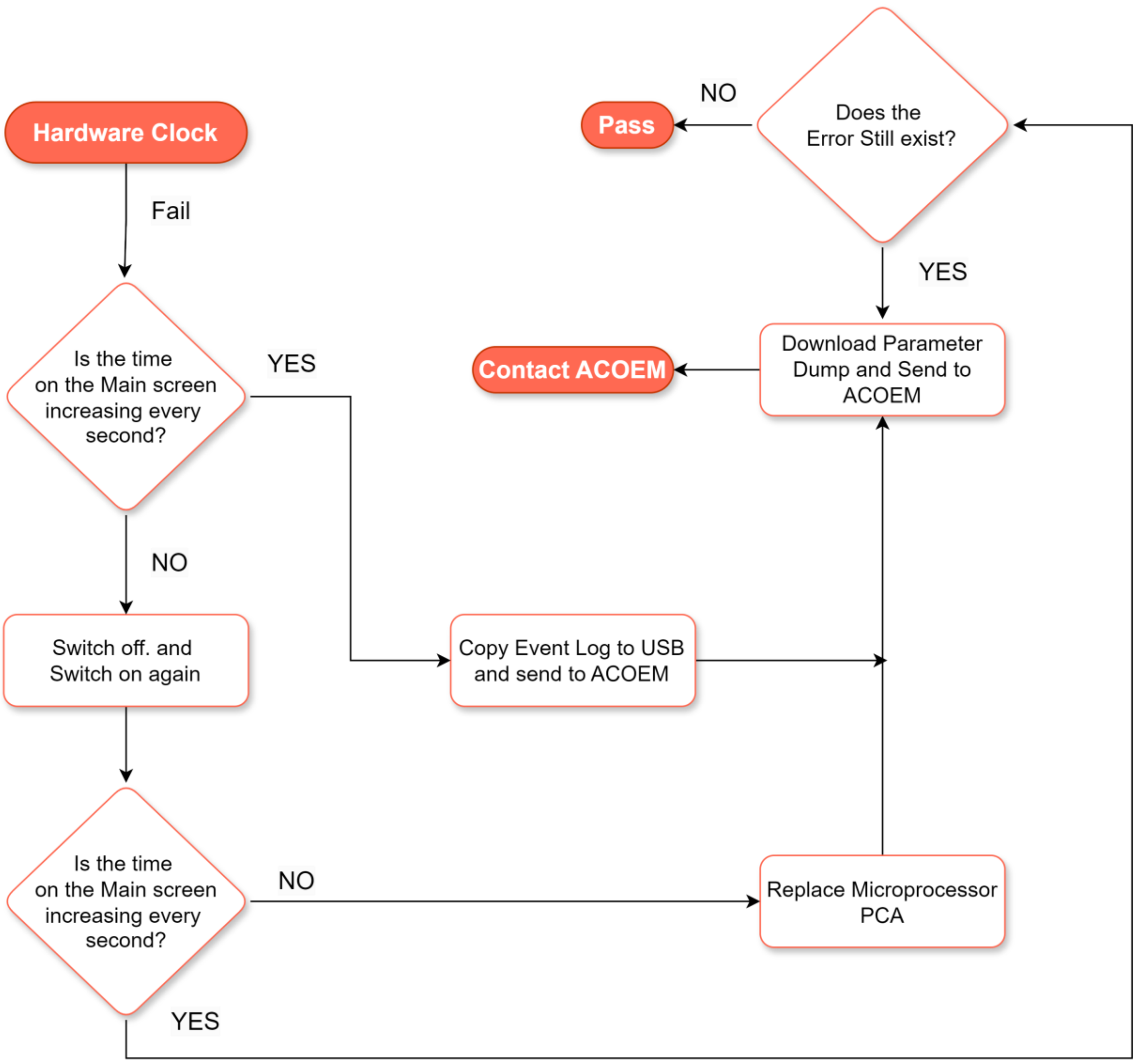
7.8 Sample Temperature



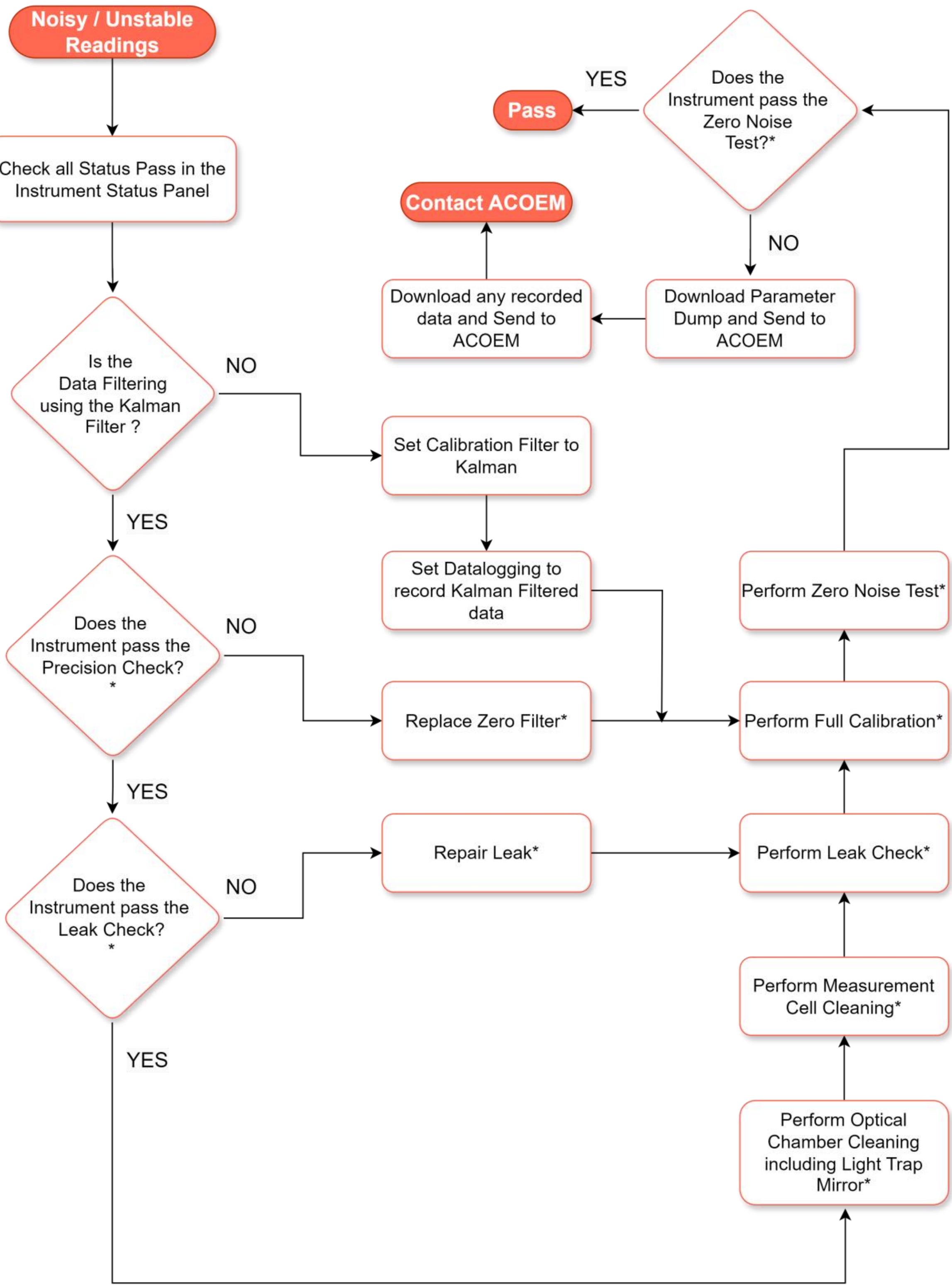
7.9 Chassis Temperature



7.10 Hardware Clock



7.11 Noisy / Unstable Readings



*Refer to Section 6.4 for Maintenance Procedures.

8. Optional Extras

This section contains information on optional kits and installed options.

Mass Flow Control 20 LPM	Refer to Section 8.1.
External Pump 240 VAC	Refer to Section 8.2
External Pump 110 VAC	Refer to Section 8.3
Wall Mount Bracket	Refer to Section 8.4
Roof Flange	Refer to Section 8.5
Rain Cap Inlet and Screen	Refer to Section 8.6
1/2" Inlet Tubing extensions	Refer to Section 8.7
PM_{10} Inlet (3 LPM)	Refer to Section 8.8
$PM_{2.5}$ Inlet (3 LPM)	Refer to Section 8.9
External Pump Controller Kit	Refer to Section 8.10
Service Kit	Refer to Section 8.11
Calibration Kit	Refer to Section 8.12
Black Silicone Carbon Tubing	Refer to Section 8.13
Wide Bandwidth PMT	Refer to Section 8.14
Ambient Temp & RH Sensor	Refer to Section 8.15

8.1 Mass Flow Control 20 LPM (PN: E010110)

The MFC option allows the Aurora NE to precisely control flow up to 20 LPM with the fitment of a 20L Mass Flow Controller, MFC control PCA, cabling, and an external pump.

Note: At the time of writing this manual, this option is still under development and is not available for sale yet. Contact ACOEM for Further updates.

8.2 External Pump 240 VAC (PN: P030004)

The optional 240 VAC pump assembly is designed to be used in conjunction with the External Pump Controller and MFC option to provide stable vacuum and flow for correct operation of the MFC up to 20 LPM.

Note: At the time of writing this manual, this option is still under development and is not available for sale yet. Contact ACOEM for Further updates.

8.3 External Pump 110 VAC (PN: P030005)

The optional 110 VAC pump assembly is designed to be used in conjunction with the External Pump Controller and MFC option to provide stable vacuum and flow for correct operation of the MFC up to 20 LPM.

Note: At the time of writing this manual, this option is still under development and is not available for sale yet. Contact ACOEM for Further updates.

8.4 Wall Mount Bracket (PN: E010112, E010113)

The wall mounting bracket option is used to mount the Aurora NE to a flat vertical surface with a purpose-made bracket that allows the Aurora NE to be quickly installed or uninstalled on a wall. There are two versions of this option. Refer to section 2.2.4 for installation instructions.

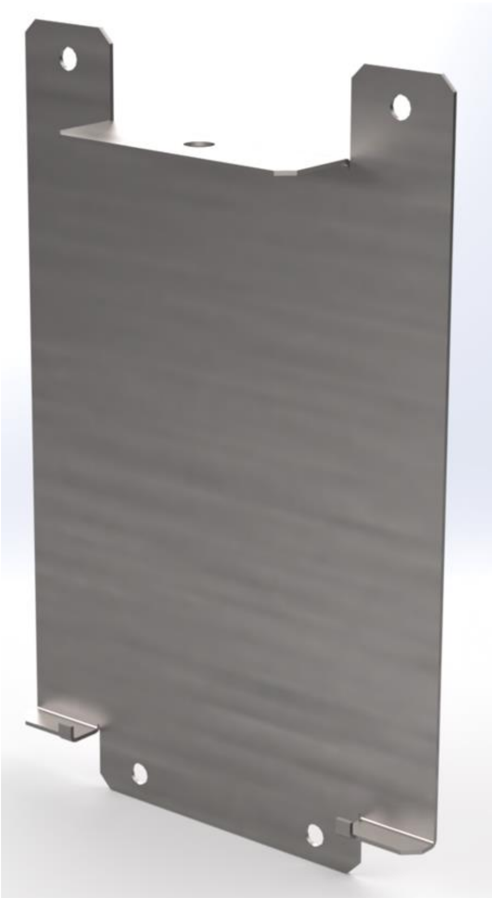


Figure 224 – Wall Mounting Bracket

8.5 Roof Flange (PN: E010130)

The roof flange kit allows weatherproof sealing of a roof penetration and allows a 1/2" tube to be passed through for sampling from the external ambient environment. Silicone sealant is required to seal the flange to the outside roof so that no rain can leak in. Refer to section 2.2.3.

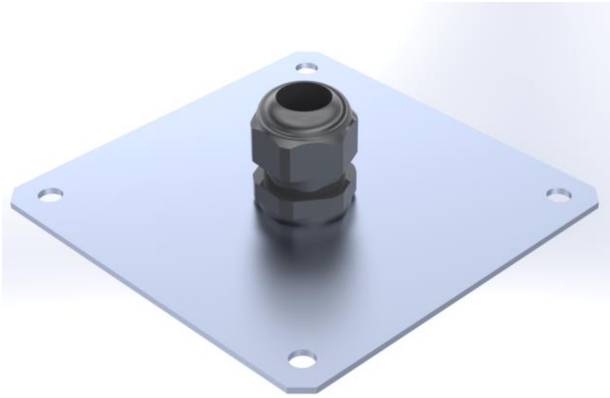


Figure 225 – Roof Flange

8.6 Rain Cap Inlet and Screen (PN: E010131)

A purpose-made assembly that installs to a 1/2" tube sample line and is used to prevent excessive moisture and insects from entering the 1/2" tube sample line. The inlet can be removed for regular cleaning. See section 6.4.4. Refer to section 2.2.3.

Figure 226 – Rain Cap inlet and Screen

8.7 1/2" Inlet Tubing Extension (PN: H020320, H020321, H020322 , H020323)

This option has various lengths of 1/2" anodized aluminium tube that can be used to connect the sample inlet of the Aurora NE to the Rain Cap and Screen that is mounted outside the monitoring station. Generally, they will penetrate the roof via the Roof Flange. The lengths available are listed in Table 23. Refer to section 2.2.3.

Table 23 – Inlet Tubing options

Part number	Length	Description
H020320	0.8m	½" Aluminium Inlet tube, insulated, 0.8m length with silicone tubing for joining
H020321	1.0m	½" Aluminium Inlet tube, un-insulated, 1.0m length
H020322	1.5m	½" Aluminium Inlet tube, un-insulated, 1.5m length
H020323	2.0m	½" Aluminium Inlet tube, un-insulated, 2.0m length

8.8 PM_{10} Inlet (3 LPM) (PN: H020449)

The PM_{10} Inlet assembly is designed to selectively remove particles larger than the nominal size of 10um from the sample at the designed flow rate of 3 LPM. The Inlet is designed to adapt to the 1/2" sample tube extensions and includes the Rain Cap Inlet and Screen (E010131). When the PM_{10} Inlet is used, the sample flow target must be set to 3.0 lpm and the flow type to volumetric on the Hardware page. Refer to section 2.2.3.

Figure 227 – PM10 Inlet

8.9 $PM_{2.5}$ Inlet (3 LPM) (PN: H020450)

The $PM_{2.5}$ Inlet assembly is designed to selectively remove particles larger than the nominal size of 2.5um from the sample at the designed flow rate of 3 LPM. The Inlet is designed to adapt to the 1/2" sample tube extensions and includes the Rain Cap Inlet and Screen (E010131). When the $PM_{2.5}$ Inlet is used, the sample flow target must be set to 3.0 lpm and the flow type to volumetric on the Hardware page. Refer to section 2.2.32.2.3.

Figure 228 – PM2.5 Inlet

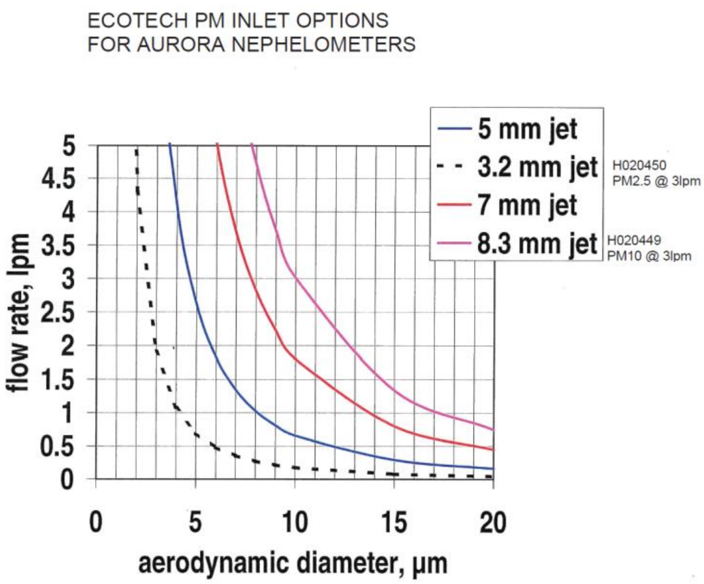


Figure 229 – PM Inlet Characteristics

8.10 External Pump Controller Kit (PN: E010115)

The external pump controller kit is designed to connect the Pump Control output of the Aurora NE to control a suitable 110/240VAC pump (P030004/P030005) so the pump only runs when required and removes the need for the user to manually turn the pump on and off. This is used with the 20 lpm MFC option only.

Note: At the time of writing this manual, the MFC option is still under development and is not available for sale yet. Contact ACOEM for Further updates.

8.11 Maintenance Kit (PN: E010120)

This maintenance kit is required when performing routine maintenance on the instrument. Depending on the environment, instrument condition and maintenance schedule, not all items in this option may be used for each scheduled service. Refer to section 9.1 for more details on the contents of this option.

8.12 Calibration Kit (PN: H020331)

The Gas Calibration Kit is used for controlling the flow of the calibration gas during a Span Calibration or Precision Check. This option includes additional tubing for temperature stabilization, a Pressure valve, Ball type flowmeter, DFU, tubing, a 1/4inch Swagelock to refrigerant type adaptor, and gas venting tubing to remove calibration gas from the vent outlet to the ambient air.

Refer to Section 5.5.1 for connection of the calibration gas.

Note: Calibration Gas cylinder and regulator are to be provided locally.

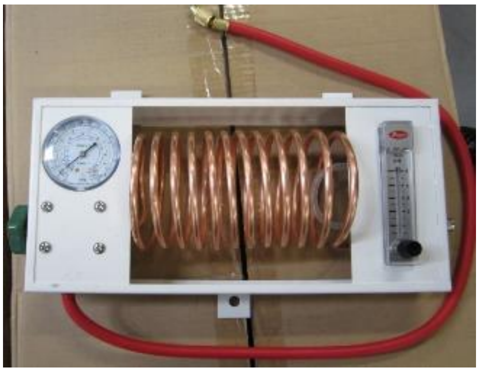


Figure 230 – Gas Calibration Control Kit

8.13 Black Silicone Carbon Tubing (PN: T010031)

Carbon-impregnated silicone tubing is designed to provide a leak-free, static-free connection between 1/2" aluminium tubing sections such as the sample inlet tube and 1/2" aluminium tubing extensions. The black silicone carbon tubing is anti-static and provides a suitable path for aerosols.

8.14 Wide Bandwidth PMT (PN: E010200)

The Wide Bandwidth PMT option is only used with the NE-100 single wavelength nephelometer. if the customer wants to measure scattering at the 635nm wavelength of this instrument, then this option should be installed as it will provide better signal level and noise performance at the 635nm wavelength.

8.15 Ambient Temp & RH Sensor (PN: E010111)

Note: At the time of writing this manual, this option is still under development and is not available for sale yet. Contact ACOEM for Further updates.

This page is intentionally blank.

9. Parts List and Schematics

9.1 Maintenance Kit

This maintenance kit is required when performing routine maintenance on the instrument. Depending on the environment that the instrument is operating, this maintenance may need to be carried out more often than mentioned in Section 6.3.

Table 24 – Aurora NE Series Annual Maintenance Kit - (PN: E010120)

Part Description	Part Number	Quantity	Locations Used
O-RING 1 15/16 X 3/32, BS135,	25000420-2	1	Light Source
BATTERY, 3V, COIN CELL TYPE	B040023	1	Microprocessor PCA, BT1
SAFETISS, LINT FREE WIPES	C060002	-	Cell Cleaning
LENS TISSUE, THOR LABS,	C060023	1	Optics Cleaning
FILTER, DFU, 0.01 MICRON,	F010034	1	Zero Filter
FILTER, 0.1 MICRON, 95%, DFU,	F010038	1	Exhaust Filter
WASHER DOWTY, SS, VITON,	H080208	1	Sample Temp, Pressure & RH Sensor
O-RING, 1/2ID X 1/16W,	O010008	4	Sample Inlet Valve, Vent Exhaust Valve
O-RING, 1/4ID X 1/16W,	O010015	4	Cell end nuts
O-RING 0.799ID X 0.103W, BS117	O010029	1	Between Sample inlet manifold and cell
O-RING BS148, DURO 70, NITRILE	ORI-1007	4	Optical Chamber
V-RING, V10A, VITON,	ZRU-22006361	1	PMT
Vacuum Hose Spring Clamp	H030421	5	Zero Filter, Exhaust Filter, Optical Chamber exhaust

9.2 Consumables

Parts shown as consumables below may require replacement over the course of the instrument's lifespan depending use and environmental conditions.

Table 25 – Aurora NE Series Consumables

Consumable	Part Number
Zero Filter 99.99% (0.01 Micron)	F010034
Pump Filter 95% (0.1 Micron)	F010005
Exhaust Filter (23 Micron)	F010038
Light Trap Mirror Assembly	H040010
Vacuum Hose Spring Clamp	H030421

9.3 Instrument Parts List

List of Aurora NE Series components and part numbers for reference.

Note: Before referring to the spare part number confirm the part number and its location in the attached drawings.

Table 26 – Spare Parts List (Main Components)

Part Description	Part Number
NE-100 Microcontroller PCA Spare Part	C010060-10
NE-300 Microcontroller PCA Spare Part	C010060-30
NE-400 Microcontroller PCA Spare Part	C010060-40
Control PCA Spare Part	C010061-50
LCD PCA Spare Part	C010062-50
Touch Screen LCD Display Spare Part	D010003-50
Light Source Assembly (NE-400)	H020660-02
Light Source Assembly (NE-300)	H020660
Light Source Assembly (NE-100)	H020660-01
Cell Assembly	H020670
PMT Assembly with Cooler (NE-300 & NE-400)	H020650
PMT Assembly (NE-100)	H020651
Door Assembly Spare Part	H020090
Internal Sample Pump	H020635
Sample Manifold Block	H020626
Span and Zero Valve Assembly	H020630
Sample Ball Valve Assembly (Crimp Ends Only No Connector)	H020625
Vent Ball Valve Assembly	H020620
3V Backup Battery (Coin Cell Type)	B040023
24V Power Supply 160W	P010023
Light Trap Mirror Assembly	H040010

Table 27 – Spare Parts List (Filters)

Part Description	Part Number
Exhaust Filter (23 Micron)	F010038
Zero Filter 99.99% (0.01 Micron)	F010034

Part Description	Part Number
Pump Filter 95% (0.1 Micron)	F010005

Table 28 – Spare Parts List (Cables/Heaters/Coolers/Sensors)

Part Description	Part Number
Light Source Cable	C020163
Front Door Cable	C020164
Power Switch Cable	C020165
Sample Manifold Block Heater Assembly	C020171
Dual Cell Heater Assembly	C020170
Cooler Thermistor Assembly Spare Part (NE-300 & NE-400)	C020169

Table 29 – Spare Parts List (O-rings/Seals)

Part Description	Part Number
BS135 (1 15/16" x 3/32") O-ring	25000420-2
1/2" Nitrile Dowty Seal Bonded Steel Washer	F030116
1/2" ID x 1/16" W O-ring	O010008
3/4" ID x 1/8" W O-ring	O010049
3" ID x 1/16" W O-ring	O010009
0.426 ID x 0.070 W O-ring	O010011
1/4" ID x 1/16" W O-ring	O010015
BS148 Nitrile Duro 70 O-ring	ORI-1007
BS117 (0.799 ID x 0.103 W) O-ring	O010029
V10A Viton V-ring	ZRU-22006361
3/8" Viton Dowty Seal Bonded Stainless Steel Washer	H080208

Table 30 – Spare Parts List (Fittings/Tubing/Clamps)

Part Description	Part Number
0.38" OD Hose Clamp	028-080270
1/4" ID PTFE Ferrule	F030028
6 mm Nylon Tee Hose Fitting	FIT-09-NYP1406
1/4" ID Swagelok Bulkhead Fitting	28290400-1
1/2" Brass Ferrule to 1/4" Tube Stub Swagelok Port Connector	28440804-1
1/2" Adjustable Brass BSPP to 1/2" Tube Elbow Fitting	F030113
1/2" Blue Nylon BSPT Male Connector to 6 mm Hose Fitting	F030119
1/2" Aluminium BSPP to 1/2" Tube Adapter	H020622

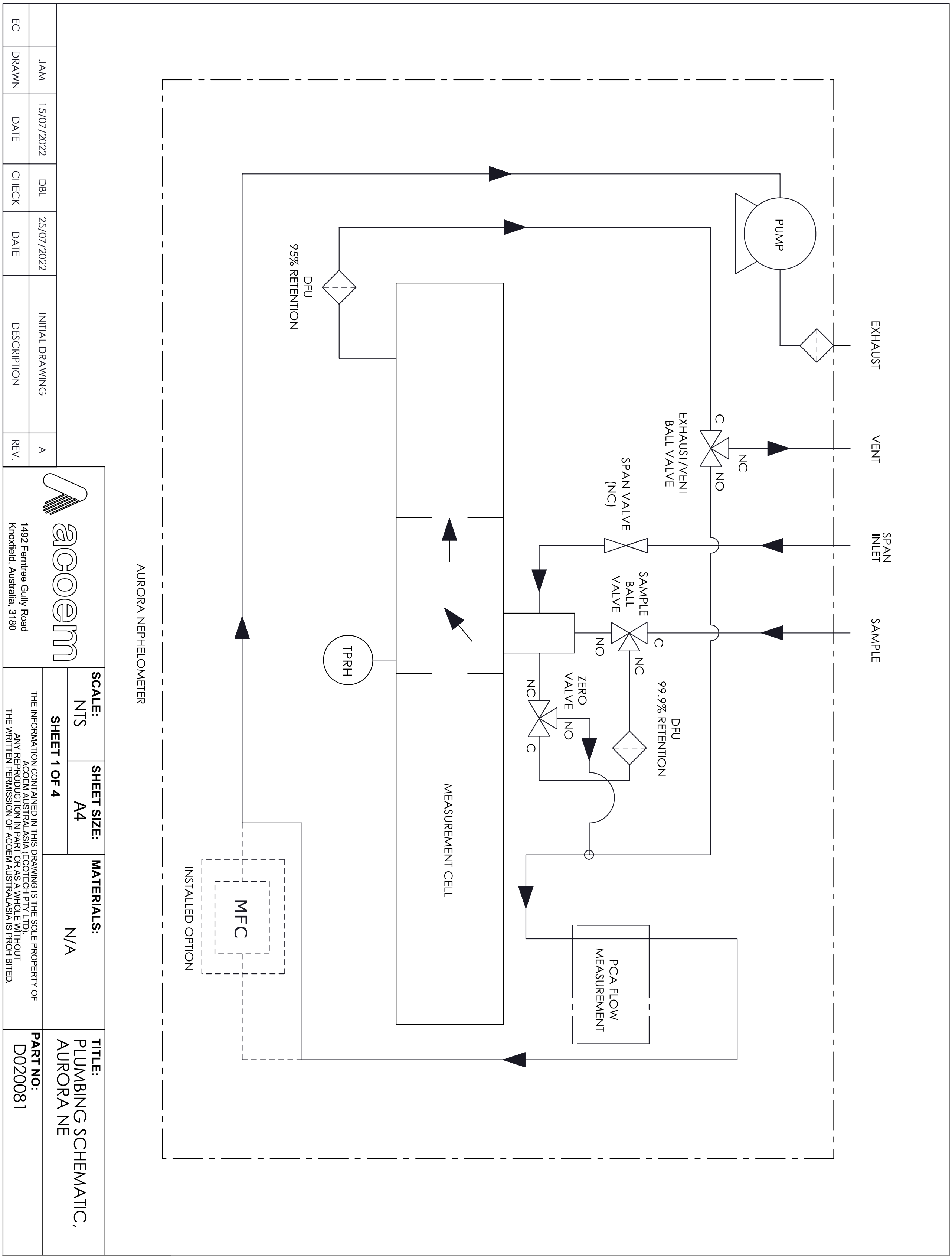
Part Description	Part Number
Black Nylon Elbow Fitting	F030003
1/2" Tube for Sample or Vent Inlet	H020627
1/4" Brass Stub to 1/8" NPT Adapter	28590402-1
1/4" Brass Swagelok Nut	28800400-1
1/4" Brass Swagelok Ferrule	28820400-1
1/8" Blue Nylon BSPT Male Elbow to 6 mm Hose Fitting	F030118
1/4" OD, 1/8" ID Black Norprene Tubing (Unit Per ft)	T010021
3/8" OD, 1/4" ID Black Norprene Tubing (Unit Per ft)	T010030

Table 31 – Spare Parts List (Misc.)

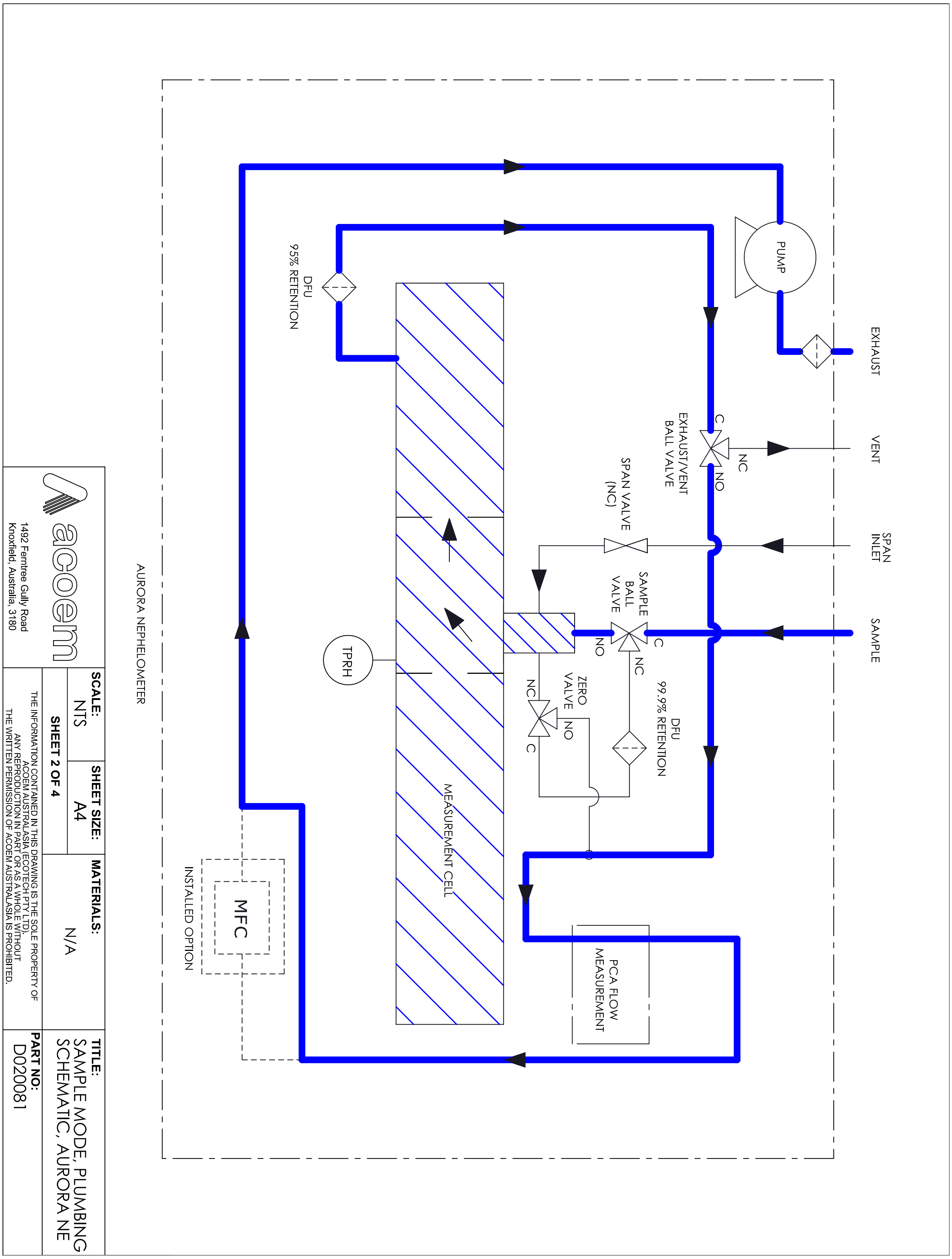
Part Description	Part Number
PMT Bracket (NE-100)	H020016
PMT Bracket Plastic (NE-300, NE-400)	H020016-01
Chassis Fan 24 V (80 mm x 80 mm) Spare Part	F020002-50
M4 x 9 mm Stainless Steel Thumb Screw	F050113
M3 x 20 mm Brass Plated Female to Female Hex Spacer	F050142
Chassis Foot Bumper (9/16" High)	H010039
NE-100 Chassis Lid Assembly Spare Part	H020082-31
NE-300 Chassis Lid Assembly Spare Part	H020082-30
NE-400 Chassis Lid Assembly Spare Part	H020082-40
Magnetic Push Latch	H020088
Chassis Pneumatic Port Anti Rotation Panel	H020089
LCD Screen Bracket (Hinge End)	H020085
LCD Screen Bracket (Latch End)	H020084
Flat Cable Split Ferrite with Adhesive Base	H030124
Filter Bracket Spare Part	H020091-50
Peripheral Name Plate for Chassis Side Panel	H020092
Cell Mounting Bracket (Chassis side)	H020673
32 GB Micro SD Memory Card	H030136
3/4" OD, 1/2" ID Rubber Grommet for Sample or Vent Inlet	H030190
Thermo Electric Cooler Heatsink (NE-300 & NE-400)	H020696
Thermo Electric Cooler Mounting Bracket (NE-300 & NE-400)	H020697
Thermo Electric Cooler Spacer (NE-300 & NE-400)	H020698
Plate for Thermistor (NE-300 & NE-400)	H020699
PMT Sensor (H10682-67) Spare Part	H020652

Part Description	Part Number
Light Source Fan Assembly 12 V (25 mm x 25 mm)	H050031
Quartz Window	859-073900
M3 x 6 mm Nylon Thumb Screw	F050036
Cell Mounting Bracket (Cell side)	H020672
Shutter & Baffle Assembly	H020700
3/8" OD, 1/4" ID Silicone Grommet	H030079
Light Trap Mirror Assembly	H040010
M6 x 15 mm Brass Nut for Cell End Plates	HAR-M900376
Aurora NE Shipping Carton (800 mm x 300 mm x 340 mm)	B010017
Aurora NE Packaging End Cap	B010036
Aurora NE Packaging Mid Cap	B010037
Aurora NE Plastic Bag	B020001
25g Desiccant Pack	C050012
Green Resources USB Memory Stick	H030137
Internal Sample Pump Rebuild Kit	P031014

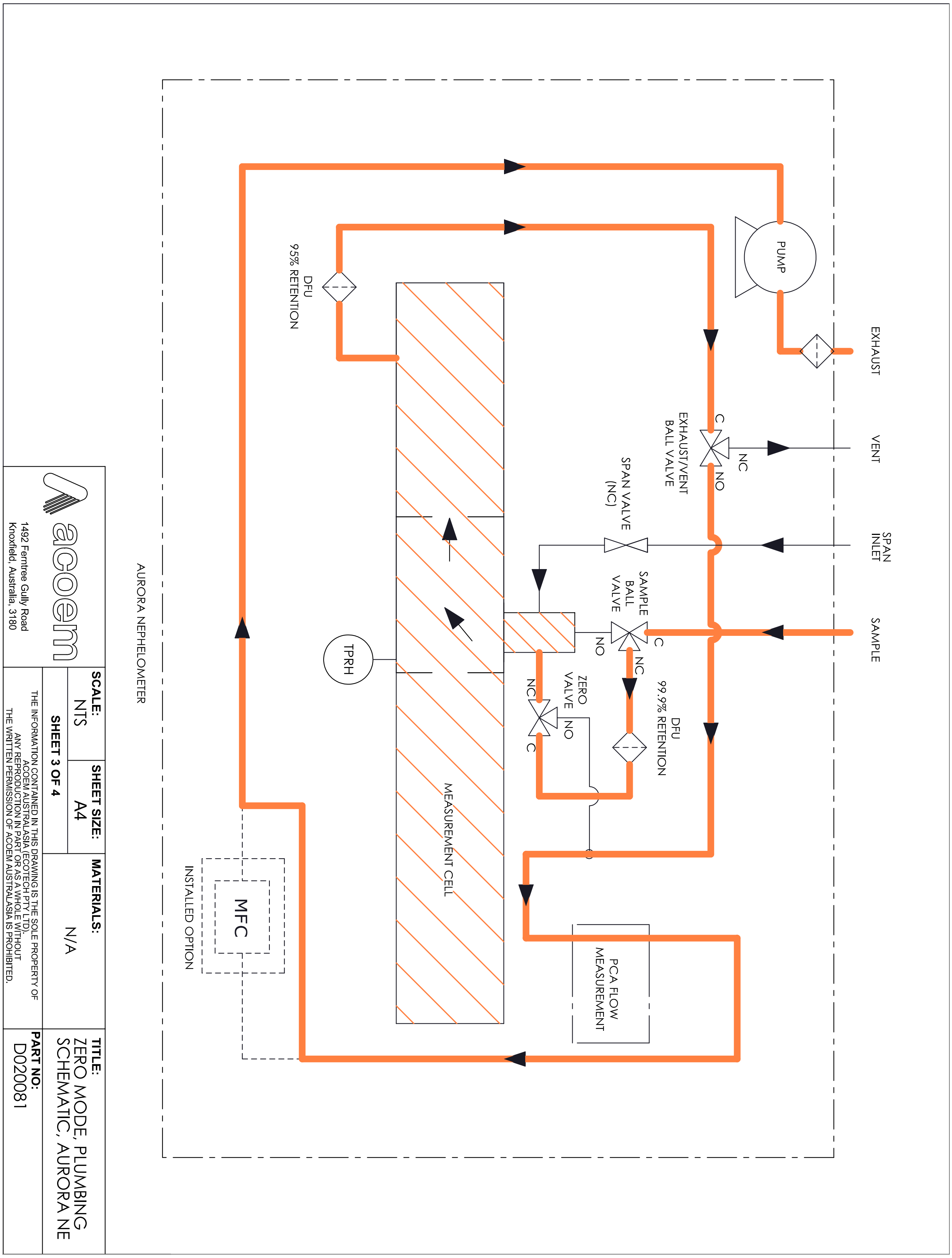
9.4 Plumbing Schematic General - (PN: D020081)



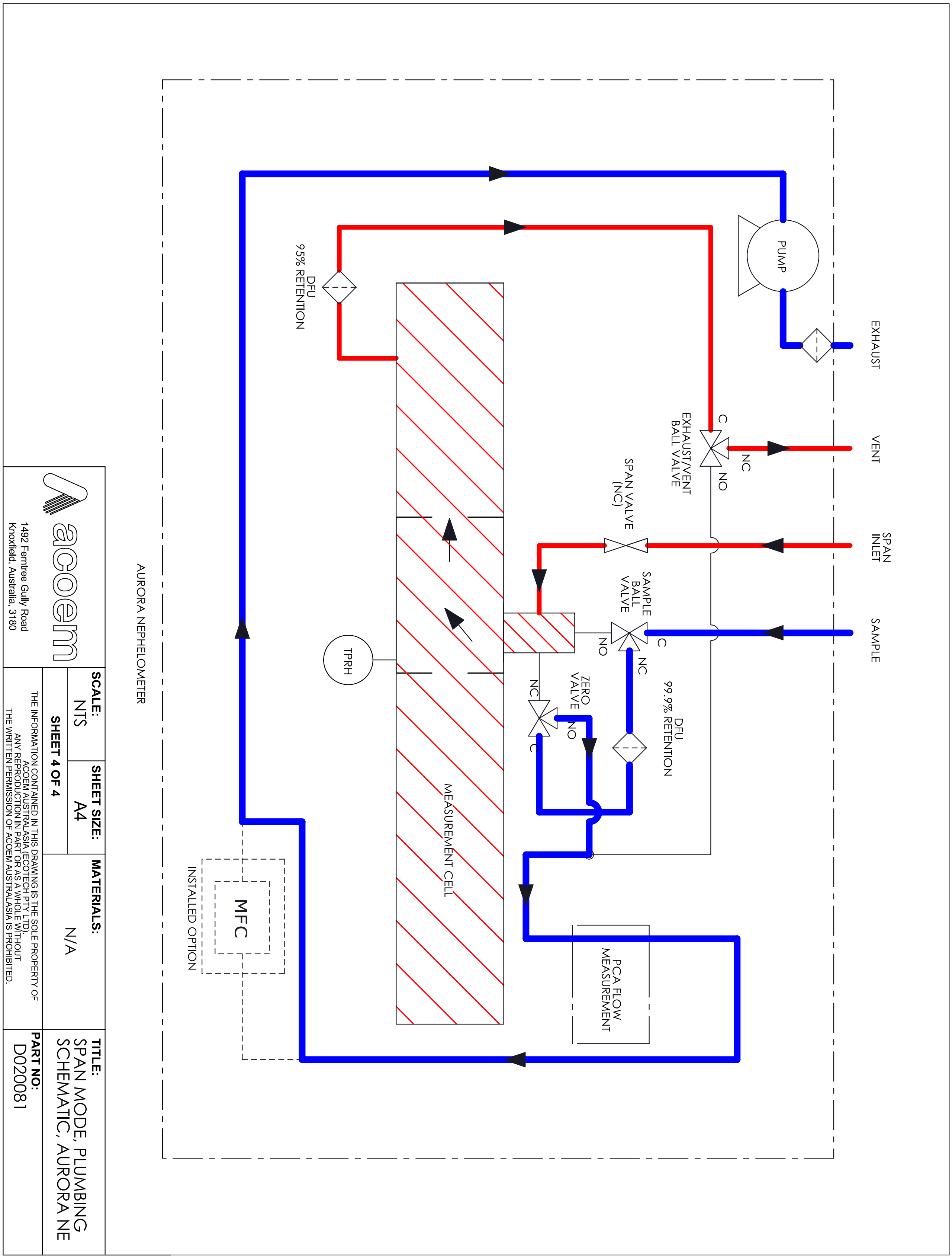
9.5 Plumbing Schematic Sample Path - (PN: D020081)



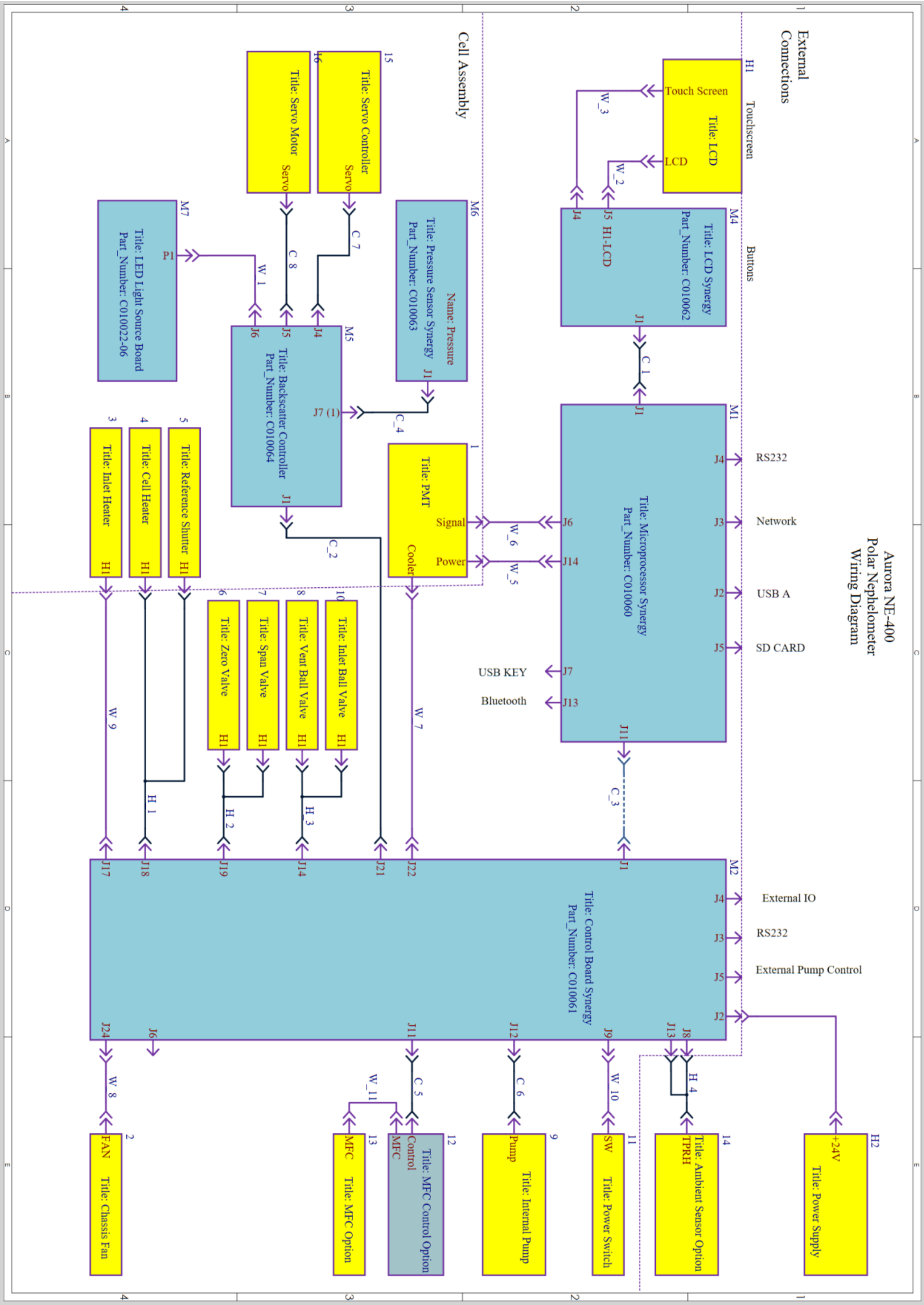
9.6 Plumbing Schematic Zero Path - (PN: D020081)



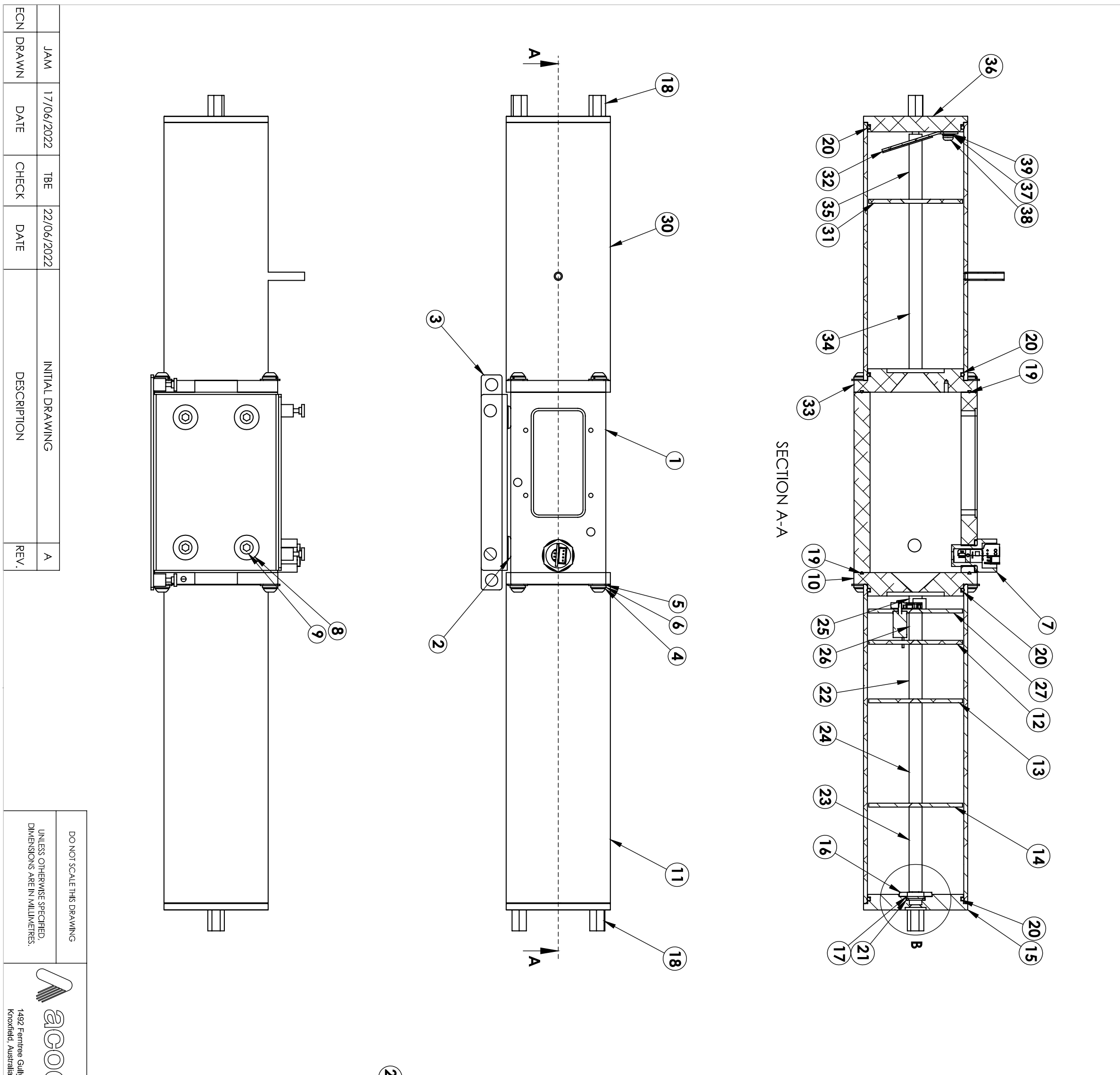
9.7 Plumbing Schematic Span Path - (PN: D020081)

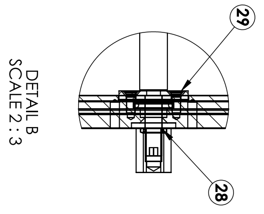


9.8 Block Wiring Schematic - (PN: D020150)



9.9 Cell Exploded View – (PN: H020670)





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020671	CELL BODY, AURORA SYNERGY	1
2	28001142	GROMMET BUNA-N,1/4ID,5/8OD,1/1	4
3	H020672	BRACKET, CELL MOUNTING, AURORA	1
4	M6X20BH	M6x20 BUTTON HEAD SOCKET SCREW	8
5	FAS-M6SS-12	WASHER, FLAT, M6 , SS	8
6	FAS-M6SS-13	WASHER, SPRING, M6, SS	8
7	H020675	TEMP, RH & PRESSURE SENSOR ASSY, CELL, AURORA NE	1
8	6 mmx19	WASHER OD=19 ID=6	4
9	SHCSM6BY16	BOLT, SHCS, M6x16, SS	4
10	HAR-M900364	CELL END PLATE, PMT END	1
11	HAR-M900358	80MM TUBE CASING PMT END	1
12	H020693-02	BAFFLE, 2.5mm, CELL, AURORA SYNERGY	1
13	HAR-M900352	3MM BAFFLE, M9003.	1
14	HAR-M900353	5MM BAFFLE	1
15	H020692	END PLATE, PMT, CELL, AURORA	1
16	HAR-M900373	CAP, QUARTZ WINDOW	1
17	859-073900	QUARTZ WINDOW	1
18	HAR-M900376	NUT, M6 END PLATE M9003 MACHINED BRASS	4
19	O010009 - swept	O-RING 3.0ID X 0.07W, NITRILE	2
20	ORI-1007	O-RING BS148, NITRILE	4
21	O010011	O-RING 0.426ID X 0.070W	1
22	H020011	42mm Spacer	2
23	H020013	SPACER, PMT END, CELL, 67mm, AURORA	2
24	H020014	SPACER, CELL, 77mm, AURORA	2
25	H020685	SPACER, 10mm, CELL, AURORA SYNERGY	2
26	H020686	SPACER, 21mm, CELL, AURORA SYNERGY	2
27	H020700	SHUTTER BAFFLE ASSEMBLY, CELL, AURORA NE	1
28	O010015	O-RING 1/4ID X 1/16W, VITON	4
29	FAS-M3-SS-10	M4X6 CSK PHILIPS SCREW	3
30	H020681	TUBE, COVER, LIGHT TRAP END, CELL, AURORA	1
31	HAR-M900354	17MM BAFFLE	1
32	H040010	MIRROR ASSY, LIGHT TRAP, CELL, AURORA	1
33	H020683	CELL END PLATE, LIGHT TRAP END	1
34	H020684	SPACER, 127MM, CELL, AURORA	2
35	H020012	SPACER, LT END, CELL, 52mm, AURORA	2
36	H020682	END PLATE LIGHT TRAP END	1
37	FAS-M4SS-21	WASHER, SPRING, M4, SS	2
38	FAS-M4SS-2	M4x8 SS PAN PHILLIPS	2
39	FAS-M4SS-22	M4 FLAT WASHER, SS	2

ECN	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.
	JAM	17/06/2022	TBE	22/06/2022	INITIAL DRAWING	A

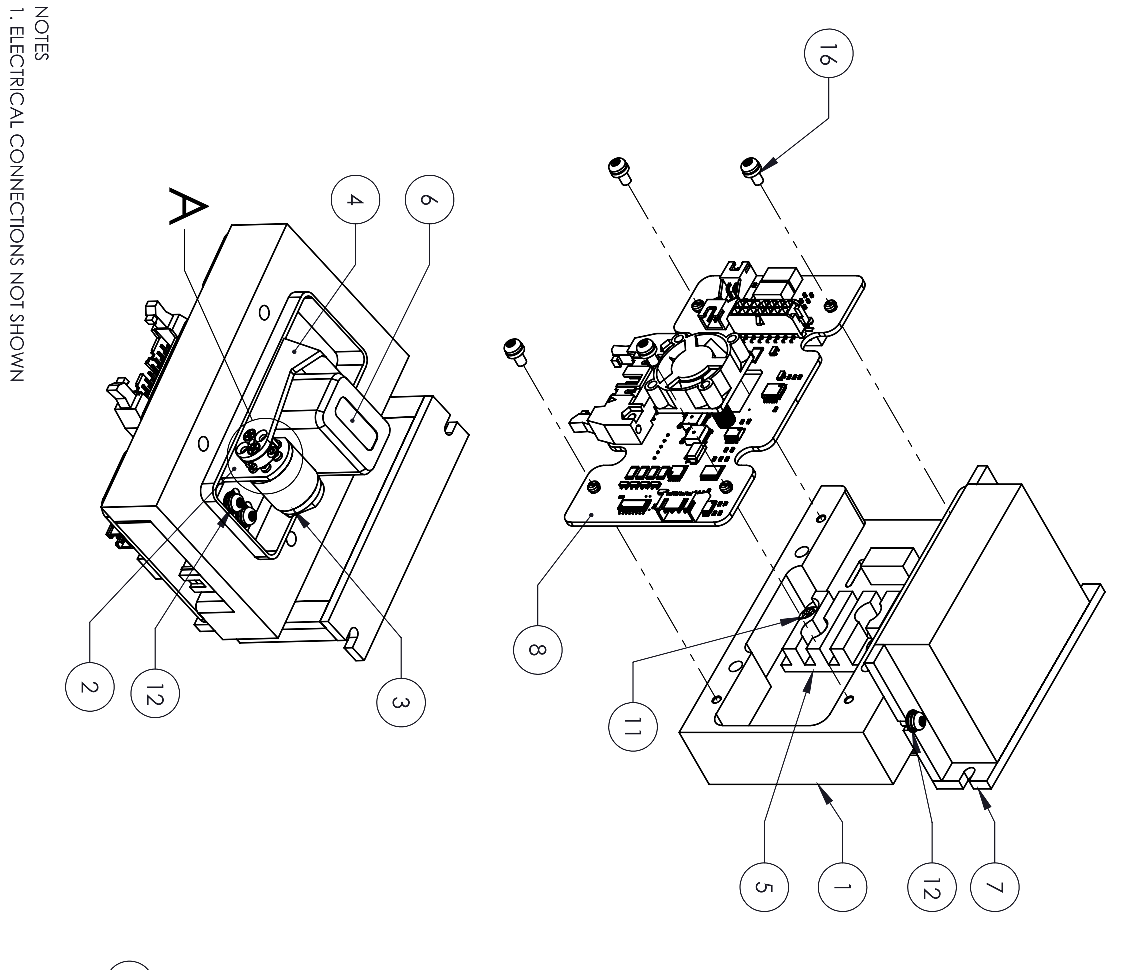
DO NOT SCALE THIS DRAWING
UNLESS OTHERWISE SPECIFIED. DIMENSIONS ARE IN MILLIMETRES.

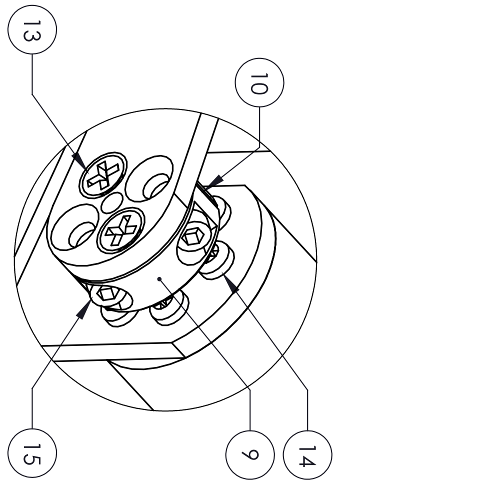
acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 1:3 | SHEET SIZE: A3 | SHEET 1 OF 1
MATERIALS: SEE BOM
TITLE: CELL ASSEMBLY, AURORA NE
PART NO: H020670

9.10 Light Source Assembly (NE-400, NE-300) – (PN: H020660)

NOTES
1. ELECTRICAL CONNECTIONS NOT SHOWN





DETAIL A
SCALE 2 : 1

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020661	HOUSING, LIGHT SOURCE, CELL, AURORA	1
2	H020272	BRACKET, SERVO, BACKSCATTER, BRACKET, SERVO, BACKSCATTER, AURORA	1
3	M020004	MOTOR, BRUSHED, 6VDC, 17mm DIA, WITH ENCODER	1
4	H020663	SHUTTER, BACK SCATTER, AURORA SYNERGY	1
5	H020665	LIGHT SOURCE LED PLUG ASSEMBLY	1
6	H020073	DIFUSER, OPAL, BACKSCATTER, AURORA	1
7	M020005	CONTROLLER, MOTOR, SERVO, DCS303-L	1
8	C010064	PCA, LIGHT SOURCE, AURORA NE	1
9	H020274	BACKSCATTER SHUTTER HUB CAP	1
10	H020275	BACKSCATTER SHUTTER HUB THREAD	1
11	SEMSPH4BY10	M4X10 SEMS PAN HEAD PHILLIPS SCREW	2
12	F050018	M3X8 SEMS PAN HEAD PHILLIPS SCREW	4
13	CSK M2 by 5	M4X6 CSK PHILLIPS SCREW	2
14	PH1.6BY4	M2X5 PAN HEAD PHILLIPS SCREW	6
15	F050124	SCREW, M1.6 x 1.5, SOCKET HEAD CAP, SS	2
16	F050011	M3X6 SEMS PAN HEAD PHILLIPS SCREW	4

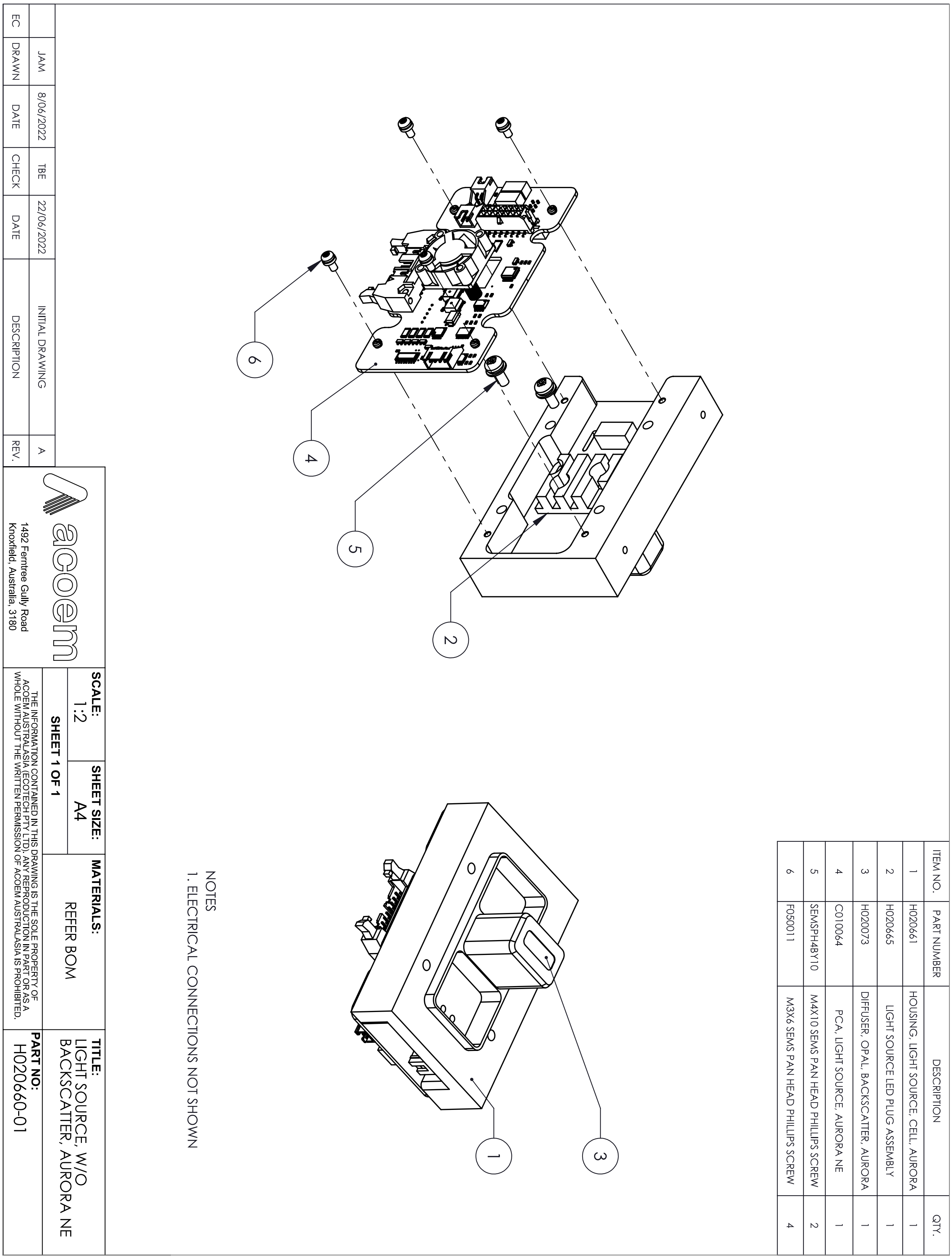
REV.	DESCRIPTION	DATE	CHECK	DATE	DRAWN	EC
A	INITIAL DRAWING	22/06/2022	TBE	8/06/2022	JAM	

acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 1:2
SHEET SIZE: A4
SHEET 1 OF 1
MATERIALS: REFER BOM

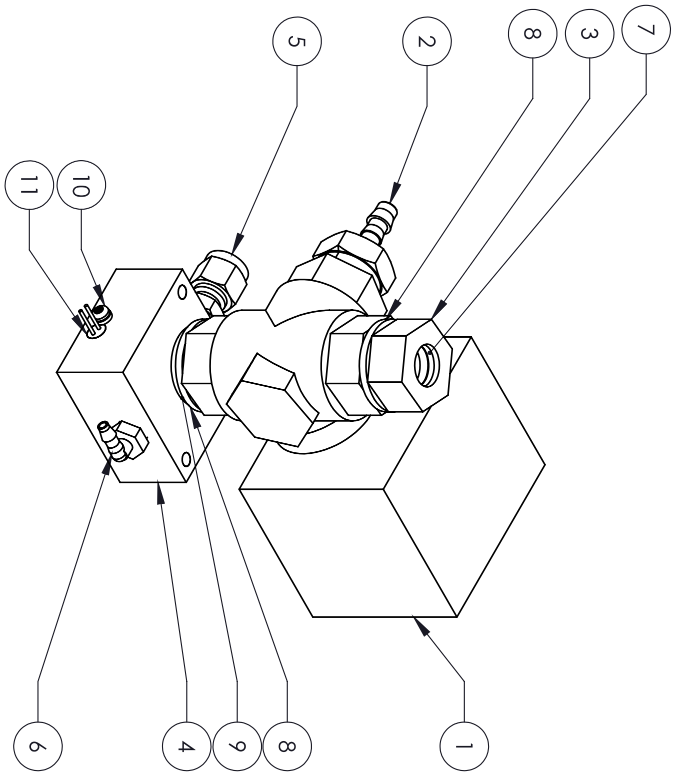
TITLE: LIGHT SOURCE ASSEMBLY, BACKSCATTER, AURORA NE
PART NO: H020660

9.11 Light Source Assembly (NE-100) – (PN: H020660-01)



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020661	HOUSING, LIGHT SOURCE, CELL, AURORA	1
2	H020665	LIGHT SOURCE LED PLUG ASSEMBLY	1
3	H020073	DIFFUSER, OPAL, BACKSCATTER, AURORA	1
4	C010064	PCA, LIGHT SOURCE, AURORA NE	1
5	SEMSPH4BY10	M4X10 SEMS PAN HEAD PHILLIPS SCREW	2
6	F050011	M3X6 SEMS PAN HEAD PHILLIPS SCREW	4

9.12 Sample Ball Valve Assembly – (PN: H020625)



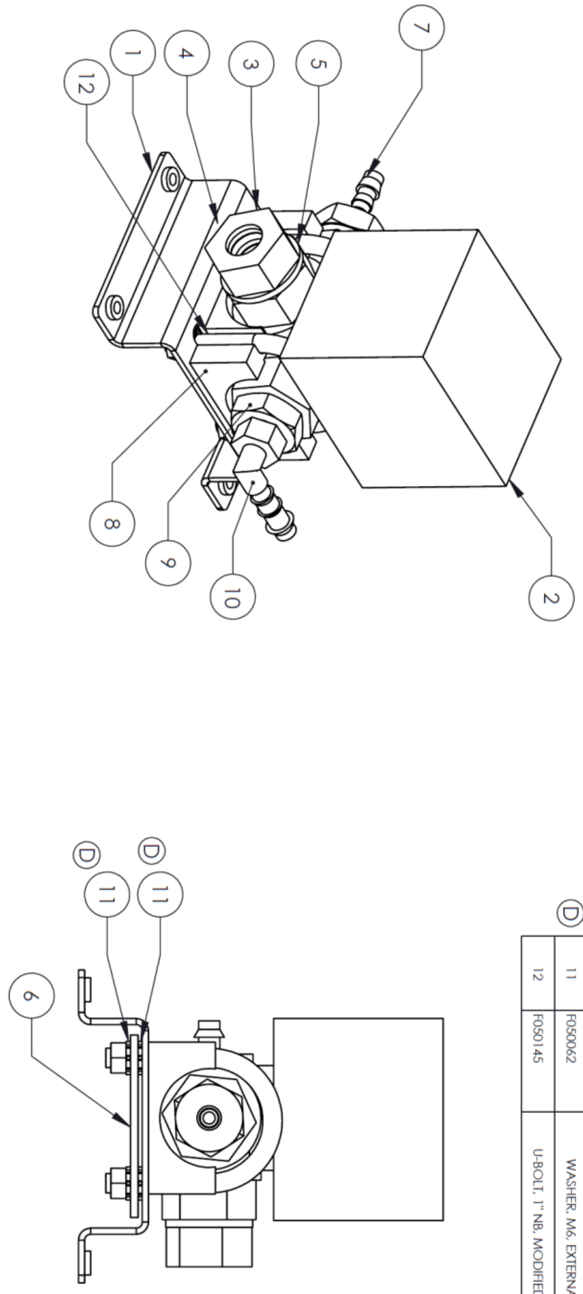
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020479-1	Actuated 1/2" 3-Way Ball Valve	1
2	F030119	FITTING, 1/2BSPT - 6mm BARB, NYLON, BLUE	1
3	H020622	ADAPTOR, 1/2BSPP- 1/2"TUBE	1
4	H020626	MANIFOLD, INLET, AURORA	1
5	28100402-1	FITTING, SWAGELOK, MALE CONNECTOR, 1/4T - 1/8NPT, BRASS	1
6	F030003	FITTING, BARB ELBOW, 1/8NPT - 1/8 BARB, BLACK NYLON	1
7	O010008	O-RING, VITON	2
8	F030116	WASHER, DOWTY, 1/8BSPP, NITRILE	2
9	O010049	O-RING, BS-210, VITON, DURO 90	1
10	F050011	M3X6 SEMS PAN HEAD PHILLIPS SCREW	1
11	C030275	HEATER, CARTRIDGE, 24VDC, 10W,1/4OD X 1 1/2	1

EC	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.
	JAM	7/06/2022	TBE	20/06/2022	INITIAL DRAWING	A

acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 1:2
SHEET SIZE: A4
MATERIALS: REFER BOM
SHEET 1 OF 1
TITLE: INLET VALVE ASSEMBLY, AURORA NE
PART NO: H020625

9.13 Vent Ball Valve Assembly – (PN: H020620)



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020621	BRACKET, VENT/EXHAUST VALVE, AURORA SYNERGY	1
2	H020479-1	Actuated 1/2" 3-Way Ball Valve	1
3	H020622	ADAPTOR, 1/2BSPP- 1/2" TUBE	1
4	O010008	O-RING, VITON	2
5	F030116	WASHER, DOWTY, 1/8BSPP, NITRILE	1
6	H020623	PLATE, BACKING, VENT VALVE BRACKET, AURORA SYNERGY	1
7	F030119	FITTING, 1/2BSPT - 6mm BARB, NYLON, BLUE	1
8	H020624	CRADLE, BALL VALVE, AURORA NE	1
9	F030121	FITTING, BUSH, 1/2 BSPP - 1/4 BSPT, BRASS	1
10	F030122	FITTING, 1/2BSPT - 6mm BARB, NYLON, BLUE	1
11	F050062	WASHER, M6, EXTERNAL STAR ID 6.4	8
12	F050145	U-BOLT, 1" NB, MODIFIED, SUIT H020620	2

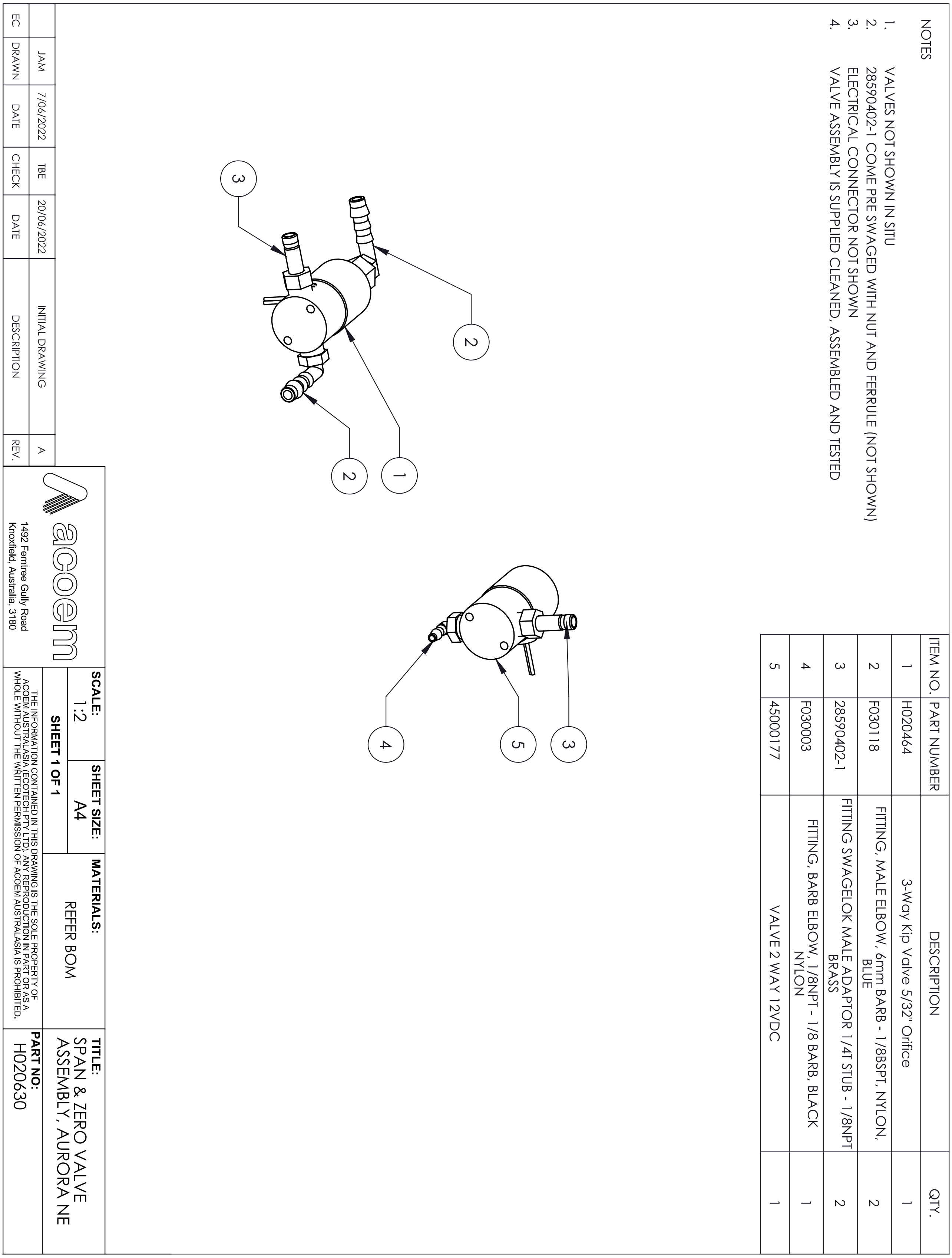
D

EC	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.
7621	MJN	21/03/2024	SRI	21/03/2024	ADDED STAR WASHERS AS PER ECN	D
7568	SRI	03/05/2023	SKS	03/05/2023	BRASS ELBOW & PORT CONNECTOR REPLACED WITH A BUSH & 6MM NYLON BARB ELBOW	C
7533	JAM	15/09/2022	TBE	3/11/2022	ADDED CRADLE BRACKET AS PER ECN	B
	JAM	13/05/2022	TBE	20/06/2022	INITIAL DRAWING	A

acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 1:2
SHEET SIZE: A4
SHEET 1 OF 1
MATERIALS: REFER BOM
TITLE: VALVE ASSEMBLY, EXHAUST/VENT, AURORA
PART NO: H020620

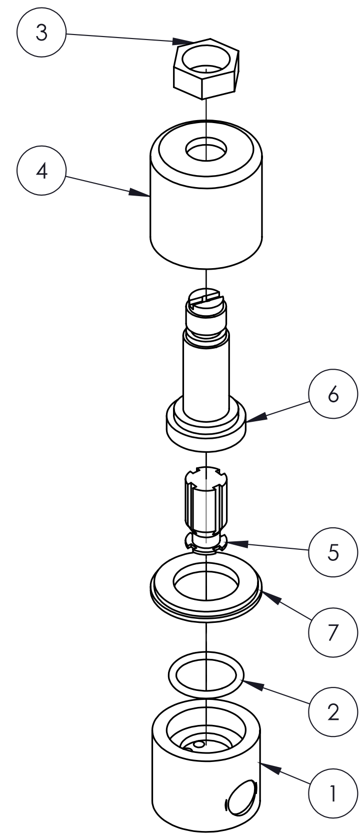
9.14 Span & Zero Solenoid Valve Assembly – (PN: H020630)



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	H020464	3-Way Kip Valve 5/32" Orifice	1
2	F030118	FITTING, MALE ELBOW, 6mm BARB - 1/8BSPT, NYLON, BLUE	2
3	28590402-1	FITTING SWAGELOK MALE ADAPTOR 1/4T STUB - 1/8NPT BRASS	2
4	F030003	FITTING, BARB ELBOW, 1/8NPT - 1/8 BARB, BLACK NYLON	1
5	45000177	VALVE 2 WAY 12VDC	1

9.15 Solenoid Span Valve 2 way – (PN: 45000177)

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BASE	BASE, VALVE, 2 WAY, 12 VDC	1
2	O010023	O-RING BS038, SILICONE	1
3	NUT	NUT, VALVE, 2 WAY, 12 VDC	1
4	COIL	SOLENOID COIL, VALVE, 2 WAY, 12 VDC	1
5	PLUNGER	PLUNGER, VALVE, 2 WAY, 12 VDC	1
6	STEM	STEM, VALVE, 2 WAY, 12 VDC	1
7	WASHER	WASHER, VALVE, 2 WAY, 12 VDC	1



STEPS TO REPLACE O-RINGS:

1. SECURE THE 2-WAY VALVE UPRIGHT INTO A LARGE VICE WITH PROTECTION AROUND ITS BODY TO PREVENT SCRATCH OR DAMAGE TO VALVE
2. REMOVE NUT FROM THE TOP OF THE 3-WAY VALVE USING A 9/16" SPANNER
3. LIFT OFF THE SOLENOID COIL FROM THE 2-WAY VALVE THEN UNSCREW THE SHAFT FROM THE BASE USING ACOEM TOOL #T030010. WHILE UNSCREWING TAKE CARE THAT THE INTERNAL PLUNGER DOES NOT FALL OUT
4. REPLACE THE INTERNAL O-RING WITH O010023
5. ASSEMBLE THE SHAFT ALONG WITH PLUNGER BACK IN ITS POSITION AND TIGHTEN USING TOOL TO 45IN/LB.
6. ASSEMBLE THE SOLENOID ONTO THE VALVE.
7. REPLACE THE NUT AND TIGHTEN TO 20IN/LB.

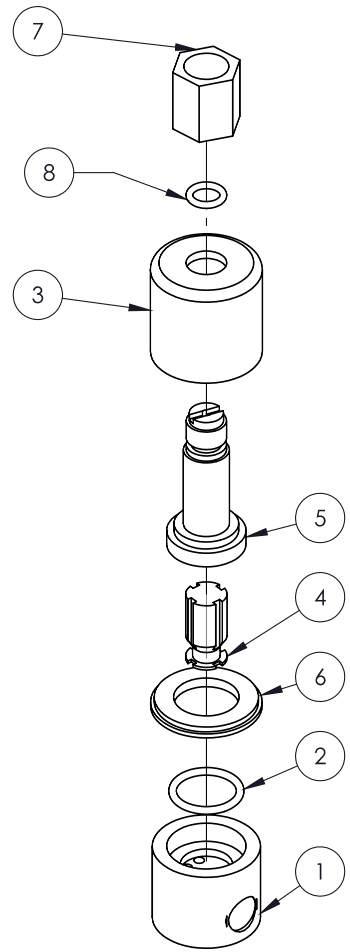
	JAM	8/12/2022	MLT	8/12/2022	INITIAL DRAWING	A
EC	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.

acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 2:3	SHEET SIZE: A4	MATERIALS: REFER BOM	TITLE: VALVE, 2 WAY, 12VDC, BASE MOUNTED
SHEET 1 OF 1			
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF ACOEM AUSTRALASIA (ECOTECH PTY LTD). ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF ACOEM AUSTRALASIA IS PROHIBITED.			PART NO: 45000177

9.16 Solenoid Zero Valve 3 Way – (PN: H020464)

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BASE	BASE, VALVE, 3 WAY, 12 VDC	1
2	O010023	O-RING BS038, SILICONE	1
3	COIL	SOLENOID COIL, VALVE, 3 WAY, 12 VDC	1
4	PLUNGER	PLUNGER, VALVE, 3 WAY, 12 VDC	1
5	STEM	STEM, VALVE, 3 WAY, 12 VDC	1
6	WASHER	WASHER, VALVE, 3 WAY, 12 VDC	1
7	NUT	NUT, 1/8NPT, 3 WAY VALVE	1
8	O010015	O-RING 1/4ID X 1/16W, VITON	1



STEPS TO REPLACE O-RINGS:

1. SECURE THE 3-WAY VALVE UPRIGHT INTO A LARGE VICE WITH PROTECTION AROUND ITS BODY TO PREVENT SCRATCH OR DAMAGE TO VALVE
2. REMOVE NUT FROM THE TOP OF THE 3-WAY VALVE USING A 9/16" SPANNER
3. REMOVE THE SMALL O-RING FROM THE STEM USING A SEAL PICK
4. LIFT OFF THE SOLENOID COIL FROM THE 3-WAY VALVE THEN UNSCREW THE SHAFT FROM THE BASE USING ACOEM TOOL #T030010.
   WHILE UNSCREWING TAKE CARE THAT THE INTERNAL PLUNGER DOES NOT FALL OUT
5. REPLACE THE INTERNAL O-RING WITH O010023
6. ASSEMBLE THE SHAFT ALONG WITH PLUNGER BACK IN ITS POSITION AND TIGHTEN USING TOOL TO 45IN/LB.
7. ASSEMBLE THE SOLENOID TO THE VALVE
8. REPLACE THE SMALL EXTERNAL O-RING WITH O010015
9. REPALCE THE NUT AND TIGHTEN TO 20IN/LB.

EC	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.
	JAM	8/12/2022	MLT	8/12/2022	INITIAL DRAWING	A

acoem
1492 Ferntree Gully Road
Knoxfield, Australia, 3180

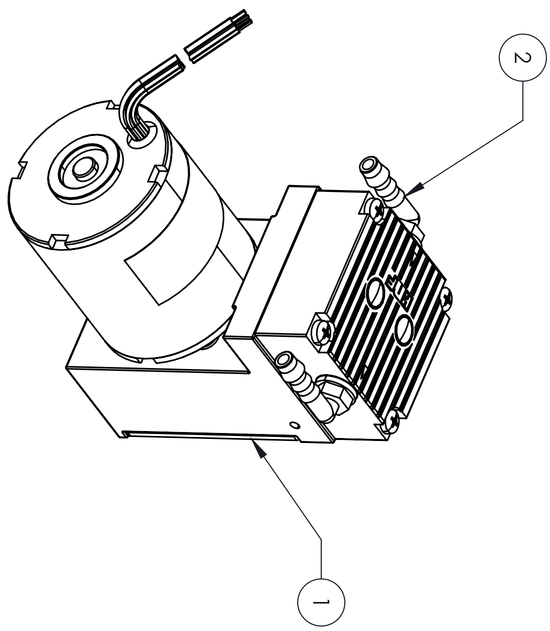
SCALE:	SHEET SIZE:	MATERIALS:	TITLE:
2:3	A4	REFER BOM	VALVE, 3 WAY, 12VDC, KIP, BASE MOUNTED
SHEET 1 OF 1			PART NO: H020464

9.17 Internal Sample Pump Assembly – (PN: H020635)

NOTES

1. ELECTRICAL CONNECTOR NOT SHOWN
2. PUMP ASSEMBLED IS SUPPLIED ASSEMBLED AND TESTED

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	P030021	PUMP, DIAPHRAGM, KNF, 24V BLDC	1
2	F030118	FITTING, MALE ELBOW, 6mm BARB - 1/8BSPT, NYLON, BLUE	2



EC	DRAWN	DATE	CHECK	DATE	DESCRIPTION	REV.
	JAM	8/06/2022	TBE	22/06/2022	INITIAL DRAWING	A

acoem

1492 Ferntree Gully Road
Knoxfield, Australia, 3180

SCALE: 1:2

SHEET SIZE: A4

SHEET 1 OF 1

MATERIALS: REFER BOM

TITLE: PUMP ASSEMBLY, AURORA NE

PART NO: H020635

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF ACOEM AUSTRALASIA (ECOTECH PTY LTD). ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF ACOEM AUSTRALASIA IS PROHIBITED.

This page is intentionally blank.

Appendix A. Acoem Protocol

Add appendix details:

A.1 Packet Format

All Serial, USB, and Network requests sent to the Instrument and received in response from the instrument will be in the following packet format to ensure data is reliable.

Differences from Advanced Protocol command

- Message length field is denominated in bytes, not parameters
- Message length field is 2 bytes instead of 1
- Maximum message length is 4,000 bytes instead of 255
- Checksum is calculated across the entire message, excluding only the checksum and EOT bytes
- Commands are reordered and many legacy commands are no longer supported

Table 32 – Acoem Protocol Packet Format

Byte Number	1	2	3	4	5..6	7..10	11	12
Description	STX	Serial ID	Command	ETX	Message Length MSB…LSB	Message Data MSB…LSB	Checksum	EOT

Data is sent in Big-endian format; that is, the most significant byte is the first byte, followed by the less significant bytes. This is the same format that is used in the regular Advanced Protocol when sending multi-byte data such as IEEE representation of floating-point numbers.

Where:

<STX>	ASCII Start of Text = 0x02 hex.
Serial ID	The Serial ID, a feature intended to support multi-drop serial communications. This allows sending a command on a shared serial line and only getting a response from the correct instrument. For simplicity, a command with a Serial ID 0 will affect all listening instruments, regardless of their Serial ID setting.
<ETX>	ASCII End of Text = 0x03 hex.
Message length	Number of bytes in the message data. Typically, a multiple of 4.
Checksum	XOR of all bytes except Checksum and EOT.
<EOT>	ASCII End of Transmission = 0x04 hex.

Example

A basic request for Primary gas data would be as follows:

Table 33 – Example: Acoem Protocol Primary Gas Request

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	4	?
4	ETX	3	?
5	Message length MSB	0	?
6	Message length LSB	4	?
7	Parameter ID MSB	0	?
8	Parameter ID MSB-1	0	?
9	Parameter ID MSB-2	0	?
10	Parameter ID LSB	50	?
11	Checksum	54	
12	EOT	4	

And a sample response:

Table 34 – Example: Acoem Protocol Primary Gas Response

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	4	?
4	ETX	3	?
5	Message length MSB	0	?
6	Message length LSB	8	?
7	Parameter ID MSB	0	?
8	Parameter ID MSB-1	0	?
9	Parameter ID MSB-2	0	?
10	Parameter ID LSB	50	?
7	Parameter Value MSB (IEEE representation of 1.0)	63	?
8	Parameter Value MSB-1	128	?
9	Parameter Value MSB-2	0	?
10	Parameter Value LSB	0	?
11	Checksum	133	
12	EOT	4	

A.2 List of Commands

Table 35 – List of Commands

Cmd#	Name	Description
0	Error	Error message from the instrument
1	Get Instrument Type	Returns the model and options for an analyser.
2	Get Version	Returns the instrument firmware version.
3	Reset	Restarts the analyser
4	Get Values	Returns the current value of various analyser parameters.
5	Set Values	Sets various analyser parameters.
6	Get Logging Config	Returns all the parameters currently being logged
7	Get Logged Data	Used to collect historical data from the instrument

A.3 Commands

A.3.1 Error (0)

If the command byte of a response is 0, it indicates an error has occurred.

Table 36 – Format: Communication Error

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	0
4	ETX	3
5	Message length MSB	0
6	Message length LSB	4
7	Error code MSB	n
8	Error code LSB	n
9	Checksum	varies
10	EOT	4

Table 37 – Error Codes

Err #	Description
0	Checksum failed

Err #	Description
1	Invalid command byte
2	Invalid parameter
3	Invalid message length
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Media not connected
9	Media busy

Table 38 – Example: Error Response

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	0	2⊕0=2
4	ETX	3	2⊕3=1
5	Message length MSB	0	1⊕0=1
6	Message length LSB	4	1⊕4=5
7	Error code MSB	0	5⊕0=5
8	Error code LSB (0 = Bad checksum)	0	5⊕0=5
9	Checksum	5	
10	EOT	4	

A.3.2 Get Instrument Type (1)

This command requests details on the type of analyser being communicated with.

Differences from Advanced Protocol command

- The Advanced Protocol command sent bytes instead of 4-byte words.

A.3.2.1 Command

The message length must be zero.

Table 39 – Format: Get Instrument Type Command

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	1
4	ETX	3
5	Message length MSB	0
6	Message length LSB	0
7	Checksum	varies
8	EOT	4

A.3.2.2 Response

The response is 4 integers: Model, Variant, Sub-Type, and Range.

Table 40 – Format: Get Instrument Type Response

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	1
4	ETX	3
5	Message length MSB	0
6	Message length LSB	16
7	Model MSB	n
8	Model MSB-1	n
9	Model MSB-2	n
10	Model LSB	n
11	Variant MSB	n
12	Variant MSB-1	n
13	Variant MSB-2	n
14	Variant LSB	n
15	Sub-type MSB	n
16	Sub-type MSB-1	n
17	Sub-type MSB-2	n
18	Sub-type LSB	n
19	Range MSB	n

Byte Number	Description	Value
20	Range MSB-1	n
21	Range MSB-2	n
22	Range LSB	n
23	Checksum	varies
24	EOT	4

Table 41 – Aurora Instrument Types

Serinus	Value
Model	158
Variant	100 300 400
Sub-type	0
Range	0

Table 42 – Serinus Instrument Types

Serinus	Value
Model	131
Variant	10 = S10 30 = S30 40 = S40 50 = S50 60 = S60 200 = Serical
Sub-type	0 = S10, S30, S40, S50, Serical 1000 1 = S11, S31, S51, Serical 2000 2 = S42, Serical 3000 3 = S43, S53 4 = S44, S54 5 = S55 6 = S56 7 = S57
Range	0 = Standard 1 = High 2 = Trace

A.3.3 Get Version (2)

This command requests the current firmware version running on the analyser.

Additional Differences from Advanced Protocol Command

- The Advanced Protocol command responded with major, minor, and revision numbers.

A.3.3.1 Command

The message field must be empty. The response is a 4-byte unsigned integer Build number and an 4-byte integer Branch number.

Table 43 – Format: Get Version Command

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	2
4	ETX	3
5	Message length MSB	0
6	Message length LSB	0
7	Checksum	varies
8	EOT	4

A.3.3.2 Response

Table 44 – Format: Get Version Response

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	2
4	ETX	3
5	Message length MSB	0
6	Message length LSB	8
7	Build MSB	0
8	Build MSB-1	0
9	Build MSB-2	0
10	Build MSB	0
11	Branch MSB	0
12	Branch MSB-1	0

Byte Number	Description	Value
13	Branch MSB-2	0
14	Branch MSB	0
15	Checksum	varies
16	EOT	4

A.3.4 Reset (3)

This command forces the analyser to do a full restart. The message field must contain the exact string “Really” to ensure spurious rests aren’t received.

Differences from Advanced Protocol command

- The Advanced Protocol command sent a zero-message length response before restarting.

A.3.4.1 Command

Table 45 – Format: Reset Command

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	3
4	ETX	3
5	Message length MSB	0
6	Message length LSB	6
7	Checksum	’R’
8	Checksum	’E’
9	Checksum	’A’
10	Checksum	’L’
11	Checksum	’L’
12	Checksum	’Y’
13	Checksum	varies
14	EOT	4

A.3.4.2 Response

There is no response to this command.

A.3.5 Get Values (4)

This command requests the value of one or more instrument parameters.

Differences from Advanced Protocol command

The Advanced Protocol command sent id/value pairs instead of just values

A.3.5.1 Command

The message field contains the 4-byte indexes of the requested parameter, as described in the List of Parameters (hence the message length must be at least 4). Up to 500 indexes can be sent in a single message (a maximum message length of 2,000).

Table 46 – Format: Get Values (X values)

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	4
4	ETX	3
5	Message length MSB	4 * X
6	Message length LSB	
7	Parameter 1 ID MSB	n
8	Parameter 1 ID MSB-1	n
9	Parameter 1 ID MSB-2	n
10	Parameter 1 ID LSB	n
…	Repeat X times	…
…	Checksum	varies
…	EOT	4

A.3.5.2 Response

All parameters respond with the 4-byte value (either IEEE or integer), depending on the parameter.

Table 47 – Format: Get Values Response (X values)

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	4
4	ETX	3
5	Message length MSB	4 * X
6	Message length LSB	
7	Parameter Value MSB	n
8	Parameter Value MSB-1	n

9	Parameter Value MSB-2	n
10	Parameter Value LSB	n
…	Repeat X times	…
…	Checksum	varies
…	EOT	4

Example

This command requests parameter 1 twice (purely for demonstration), which is the current time and date on any instruments. It has a serial ID of 0, a message length of 8 bytes, and a checksum of 8.

Table 48 – Example: Get Values Request

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	4	?
4	ETX	3	?
5	Message length MSB	0	?
6	Message length LSB	8	?
7	Parameter 1 ID MSB	0	?
8	Parameter 1 ID MSB-1	0	?
9	Parameter 1 ID MSB-2	0	?
10	Parameter 1 ID LSB	1	?
11	Parameter 2 ID MSB	0	?
12	Parameter 2 ID MSB-1	0	?
13	Parameter 2 ID MSB-2	0	?
14	Parameter 2 ID LSB	1	?
15	Checksum	4	
16	EOT	4	

Table 49 – Example: Get Values Response

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	4	?
4	ETX	3	?
5	Message length MSB	0	?

Byte Number	Description	Value	Checksum
6	Message length LSB	16	?
7	Parameter 1 Value MSB	?	?
8	Parameter 1 Value MSB-1	?	?
9	Parameter 1 Value MSB-2	?	?
10	Parameter 1 Value LSB	?	?
11	Parameter 2 Value MSB	?	?
12	Parameter 2 Value MSB-1	?	?
13	Parameter 2 Value MSB-2	?	?
14	Parameter 2 Value LSB	?	?
15	Checksum	?	
16	EOT	4	

A.3.6 Set Values (5)

This command sets the value of an instrument parameter.

A.3.6.1 Command

The message field contains the 4-byte index of the requested parameter, as described in the List of Parameters, followed by the 4-byte value to set the parameter to (in other words, the Set Value command format looks exactly like the Get Value response, but with a different command number).

Up to 500 indexes can be supplied in a single request. Most (but not all) parameters can be set.

A.3.6.2 Response

There is no response to this command.

A.3.7 Get Logging Config (6)

This command returns the list of parameter IDs currently being logged. It is sent with zero message data length.

The first 4-byte word of the response data is the number of fields being logged (0..500); each following 4-byte word is the ID of the parameter.

A.3.7.1 Command

Table 50 – Format: Get Logging Config Command

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	6

Byte Number	Description	Value
4	ETX	3
5	Message length MSB	0
6	Message length LSB	0
7	Checksum	varies
8	EOT	4

A.3.7.2 Response

Table 51 – Format: Get Logging Config Response

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	6
4	ETX	3
5	Message length MSB	0..500
6	Message length LSB	
7	Parameter Count MSB	n
8	Parameter Count MSB-1	n
9	Parameter Count MSB-2	n
10	Parameter Count LSB	n
11	Parameter 1 ID MSB	n
12	Parameter 1 ID MSB-1	n
13	Parameter 1 ID MSB-2	n
14	Parameter 1 ID LSB	n
…	Repeat for N parameters	…
…	Checksum	varies
…	EOT	4

A.3.8 Get Logged Data (7)

This command requests all logged data over a specific date range.

Additional Differences from Advanced Protocol Command

- All fields are 4 bytes (the old protocol used 1-byte field count, 1-byte IDs, and 3-byte values)
- The timestamp proceeds the field count (instead of the other way around)
- Logging Period and Instrument Operation are new fields that precede the timestamp

- Header information and data are sent as separate records

A.3.8.1 Command

For the initial command, the message length is 8, with the first four bytes being the start date and the last the end date. Both times are in the Time Stamp format (see below). After that there are three different forms of the command to get the next data, repeat the last block, or cancel the download; each of these forms only has a message length of 4.

After initiating a download, send the Get Logged Data command with a single 4-byte message to either receive the next packet of records (0), repeat the previous packet (1), or cancel the download (2).

When there are no more data records in the requested range, the receive next packet command returns a Retrieve Data command with a zero-length message field. Subsequent requests for next, last, or cancel will return the INVALID_PARAMETER error.

> **Note:** The data will be retrieved from the USB or SD card as dictated by the instrument's current logging set-up.

Table 52 – Format: Get Logged Data Initial Request

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	7
4	ETX	3
5	Message length MSB	0
6	Message length LSB	8
7	Start Timestamp MSB	?
8	Start Timestamp MSB-1	?
9	Start Timestamp MSB-2	?
10	Start Timestamp LSB	?
11	End Timestamp MSB	?
12	End Timestamp MSB-1	?
13	End Timestamp MSB-2	?
14	End Timestamp LSB	?
15	Checksum	varies
16	EOT	4

Table 53 – Format: Get Logged Data Command

Byte Number	Description	Value
1	STX	2

Byte Number	Description	Value
2	Serial ID	varies
3	Command	7
4	ETX	3
5	Message length MSB	0
6	Message length LSB	4
7	Command MSB	0
8	Command MSB-1	0
9	Command MSB-2	0
10	Command LSB	varies
11	Checksum	varies
12	EOT	4

Table 54 – Get Logged Data Commands

Err #	Description
0	Next packet When there are no more data records in the requested range, the Send Next command returns a Retrieve Data command with a zero-length message field.
1	Repeat the last packet If a packet fails its checksum test, then it can be easily be re-sent (as many times as necessary). However, only the last packet can be re-sent; to request other packets it is necessary to restart the download.
2	Cancel download There is no response to this command. It is not necessary to terminate a download, as sending any other command will cancel the download and execute the new command (this includes sending the initial Get Logged Data command, or a download request with a different range: they will be treated as new commands).

Table 55 – Example: Get Logged Data Initial Request

Byte Number	Description	Value	Checksum
1	STX	2	$0 \oplus 2=2$
2	Serial ID	0	$2 \oplus 0=2$
3	Command	7	?
4	ETX	3	?
5	Message length MSB	0	?
6	Message length LSB	8	?
7	Start Timestamp MSB	?	?

Byte Number	Description	Value	Checksum
8	Start Timestamp MSB-1	?	?
9	Start Timestamp MSB-2	?	?
10	Start Timestamp LSB	?	?
11	End Timestamp MSB	?	?
12	End Timestamp MSB-1	?	?
13	End Timestamp MSB-2	?	?
14	End Timestamp LSB	?	?
15	Checksum	?	
16	EOT	4	

Table 56 – Example: Get Logged Data Next Record Request

Byte Number	Description	Value	Checksum
1	STX	2	0⊕2=2
2	Serial ID	0	2⊕0=2
3	Command	7	?
4	ETX	3	?
5	Message length MSB	0	?
6	Message length LSB	4	?
7	Command MSB	0	?
8	Command MSB-1	0	?
9	Command MSB-2	0	?
10	Command LSB (0 = next packet) (1 = repeat previous packet) (2 = cancel download)	0	?
11	Checksum	2	
12	EOT	4	

A.3.8.2 Response

The response is a list of records; each record starts with a record type, instrument operation, two reserved bytes, timestamp, logging period, field count, and then a number of id or value fields equal to the field count. There may be multiple records in a single response (up to the message length of 4,000 bytes).

Most values are 4 bytes, though the record type, instrument operation, and reserved fields are single bytes; the timestamp is in Time Stamp format; the field count is the number of parameter ID or Value fields; parameter IDs are integers; parameter Values are IEEE floating point numbers, signed integers, or unsigned integers as specified by the List of Parameters.

The message length of the packet is the total byte count for the entirety of the message payload (including the field count and record count/operation/reserved bytes/timestamp/period). The message field must be parsed to determine how many records are contained in it. The end of a record is signified only by the timestamp for the next record.

A packet may not contain all 4K of message data. This could be because the next record was too large to fit into the current packet, or because the date range has been exhausted and there are no more records to send. The only way to distinguish between these cases is to request the next packet: if that returns with zero length message data, then the date range is completed (otherwise it will return with more records).

It is important to note there are two kinds of records, header and data.

Header Records

The first record sent will always be a header record. This means it has 001 in the record type field. Every following data parameter is a parameter ID, used to identify the data fields in the data records.

It is possible to receive multiple header records in a single packet. It is also possible to receive header records with no following data records if no data was logged before the user changed the configuration.

Note that the parameter IDs returned will vary depending on what was logged; each individual record can contain up to 500 IDs in any combination.

The timestamp, logging period, and instrument operation fields of a header record are undefined and should not be used.

Data Records

Once a header record is received, data records (where the record type field is 000) will contain data that corresponds to the header information. Each field must be interpreted according to its specified data type.

If the logged data changes, then the instrument will send a new header record.

Calibration Records

In addition to logging records at every specified interval, the completion of a calibration state (zero or span/calibration or check) will log a unique data record with an appropriate CURRENT_OPERATION value. Note that if logging is completely disabled, these calibration records are also disabled.

Table 57 – Format: Get Logged Data Response

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	7

Byte Number	Description	Value
4	ETX	3
5	Message length MSB	0
6	Message length LSB	varies
7	Record 1 Record Type (0 or 1)	n
8	Record 1 Instrument Operation	n
9	Record 1 Reserved for future expansion	n
10	Record 1 Reserved for future expansion	n
11	Record 1 Timestamp MSB	n
12	Record 1 Timestamp MSB-1	n
13	Record 1 Timestamp MSB-2	n
14	Record 1 Timestamp LSB	n
15	Record 1 Logging Period MSB	n
16	Record 1 Logging Period MSB-1	n
17	Record 1 Logging Period MSB-2	n
18	Record 1 Logging Period LSB	n
19	Record 1 Number of ID/Value fields MSB	n
20	Record 1 Number of ID/Value fields MSB-1	n
21	Record 1 Number of ID/Value fields MSB-2	n
22	Record 1 Number of ID/Value fields LSB	n
23	Record 1 Parameter 1 ID or Value MSB	n
24	Record 1 Parameter 1 ID or Value MSB-1	n
25	Record 1 Parameter 1 ID or Value MSB-2	n
26	Record 1 Parameter 1 ID or Value LSB	n
…	Repeat for N Parameter ID or Value fields	…
…	Repeat for N Records	…
…	Checksum	varies
…	EOT	4

Table 58 – Format: Get Logged Data Response (no more records)

Byte Number	Description	Value
1	STX	2
2	Serial ID	varies
3	Command	7
4	ETX	3

Byte Number	Description	Value
5	Message length MSB	0
6	Message length LSB	0
7	Checksum	varies
8	EOT	4

A response of 2 records with 2 parameters, might look like this:

Table 59 – Example: Get Logged Data Response

Byte sequence	Description
002 000 007 003	Header information (STX, serial ID, command, ETX)
000 064	Message length (64 bytes)
001	Record type –001 for header. The first record for a data download request will always be a header record.
000	Instrument Operation. For a header record, this should be ignored.
000	Reserved for future operation.
000	Reserved for future operation.
? ? ? ?	Timestamp of record. For a header record, this should be ignored.
000 000 000 000	Logging period (in seconds). For a header record this should be ignored.
000 000 000 002	Number of parameter ID fields to follow.
000 024 243 018	ID of the first parameter
000 000 019 138	ID of the second parameter
000	Record type –000 for data. This is the start of the first data record.
000	Instrument Operation. This value is the same as CURRENT_OPERATION.
000	Reserved for future expansion.
000	Reserved for future expansion.
? ? ? ?	Timestamp of first data record
000 000 000 000	Logging period (in seconds). This value is the same as DATALOG_PARAM_INTERVAL_SECONDS. Note that calibration data always has a period of 0.
000 000 000 002	Number of parameter value fields to follow

Byte sequence	Description
063 140 204 205	The floating-point value of the first parameter
064 012 204 205	The floating-point value of the second parameter
000	Record type –000 for data. This is the start of the second data record.
000	Instrument Operation. This value is the same as CURRENT_OPERATION.
000	Reserved for future expansion.
000	Reserved for future expansion.
? ? ? ?	Timestamp of second data record
000 000 000 000	Logging period (in seconds). This value is the same as DATALOG_PARAM_INTERVAL_SECONDS. Note that calibration data always has a period of 0.
000 000 000 002	Number of parameter value fields to follow
063 140 204 205	The floating-point value of the first parameter
064 012 204 205	The floating point value of the second parameter
? 004	Checksum and EOT

A.4 List of Aurora Parameters

The Aurora exclusively uses the Expanded Advanced Protocol to report parameters and download data, as it has a very long list of reportable values. Note that measurement parameters are not listed by ID, as there are too many of them; rather, a formula is provided for constructing the ID of measurement parameters (see Constructed Parameters, below).

All of these parameters can be requested with Get Values; a limited subset of them can be logged to the USB flash drive for later downloading via the Retrieve Data command.

Parameters are either Float, Signed, or Unsigned. Note that all parameters are 4 bytes, from MSB to LSB.

Table 60 – Aurora data types

Data type	Description
Float	IEEE floating point representation
Signed	Signed 32-bit integer
Unsigned	Unsigned 32-bit integer

The current list of parameters follows. Note that this list may be added to, particularly for troubleshooting and diagnostics.

Constructed Parameters

The Aurora has a vast array of measurement parameters. Rather than list every single possible ID, a formula is used to calculate the ID for measurement parameters.

Parameter ID = Base ID * 1,000,000 + Wavelength * 1,000 + Angle

Thus, the ID 1635000 corresponds to the Sigma for wavelength 635 nm at 0 degrees; 6520090 would be the measure ratio for wavelength 520 degrees at angle 90.

The Aurora 1000 and 3000 log Fullscatter and Backscatter instead of degree. They use the same equation, substituting an angle value for Fullscatter and Backscatter.

Fullscatter = 0 degrees

Backscatter = 90 degrees

Thus ID 1635000 is the Fullscatter Sigma for wavelength 635 on an Aurora 1000 or 3000; 1635090 would be the Backscatter Sigma.

Note that not all of these IDs are valid at any given time; the Aurora can only return a value for wavelengths or angles it is actually measuring. The parameters WAVELENGTH_1..3 will return the wavelengths installed, and the parameter ANGLE_1..20 will return the current angles being measured.

When downloading stored data, the parameter ID will always be for the data as it was taken.

The base IDs include all of the stages of the calculation of the sigma reading for troubleshooting and diagnostics. Most users will only be interested in the Sigma or Measure Ratio.

Table 61 – Aurora Base IDs for Constructed Parameters

Base ID	Description	Data type	Notes
1	Sigma	Float	The scattering value
2	Sigma (Kalman)	Float	The scattering value with a Kalman filter applied
3	Sigma (1 min)	Float	The scattering value with a 1 minute filter
4	Sigma (5 min)	Float	The scattering value with a 5 minute filter
5	Sigma (Rolling)	Float	The scattering value with a rolling average filter
6	Measure ratio	Float	Measure ratio
7	Measure ratio (Kalman)	Float	Measure ratio with a Kalman filter
8	Measure ratio (1 min)	Float	Measure ratio with a 1 minute filter
9	Measure ratio (5 min)	Float	Measure ratio with a 5 minute filter
10	Measure ratio (Rolling)	Float	Measure ratio with a rolling average filter
11	Measure count	Float	Measure count in mHz
12	Measure count raw	Unsigned	Raw photon count

Base ID	Description	Data type	Notes
13	Dark count	Float	Measure count in mHz during dark period
14	Dark count raw	Unsigned	Raw photon count during dark period
15	Shutter count	Float	Measure count in mHz during shutter period
16	Shutter count raw	Unsigned	Raw photon count during shutter period
17	Temperature	Float	Temperature in C at the time of measurement
18	Pressure	Float	Pressure in mBar at the time of measurement
19	ST Correction	Float	ST correction applied to this measurement
20	Calibration slope	Float	As applied to this measurement
21	Calibration offset	Float	As applied to this measurement
22	Rayleigh correction	Float	As applied to this measurement
23	Period	Float	In ms; the measurement period time
24	Wavelength	Float	In nm
25	Angle	Float	In degrees
26	Kalman gain	Float	Current Kalman gain value (unitless)
27	Data set index	Unsigned	A distinguishing index for troubleshooting and diagnosis. Each measurement is incremented by 1, skipping over zero. After 2 billion measurements this will wrap around to 1 again. It is restarted at 1 every time the instrument is rebooted.

Table 62 – Aurora Parameters

#	Description	Notes
0	None	Not a valid parameter
1	Clock	Current time (in Time Stamp format)
1000	USER_CONFIG_DISPLAY	N/A (this value merely denotes the beginning of a new block of parameters)
1001	UNIT_SELECTION_READINGS	0 = Mm-1
1002	UNIT_SELECTION_TEMPERATURE	0 = C 1 = F 2 = K
1003	UNIT_SELECTION_FLOW	0 = SCCM 1 = SLPM
1004	UNIT_SELECTION_PRESSURE	0 = Torr 1 = PSI 2 = Mbar 3 = atm 4 = Kpa

1005	UNIT_SELECTION_HUMIDITY	0 = %
1006	DECIMAL_SELECTION_READINGS	0..6 = decimal places 7 = scientific notation
1007	DECIMAL_SELECTION_TEMPERATURE	
1008	DECIMAL_SELECTION_FLOW	
1009	DECIMAL_SELECTION_PRESSURE	
1010	DECIMAL_SELECTION_HUMIDITY	
2000	USER_CONFIG_DATALOG	N/A
2001	DATALOG_PARAM_INTERVAL	0 = disabled (no datalogging) 1 = every measurement 2 = 1 second 3 = 2 seconds … 31 = 1 day
2002	DATALOG_PARAM_INTERVAL_SECONDS	The datalogging interval in seconds. Note that Disabled and All are not indistinguishable. 0 = disabled 0 = every measurement 1..8600 = number of seconds between logged records
2003	DATALOG_PARAM_INDEXES	N/A
2004	DATALOG_PARAM_INDEX_1	The parameter # being logged. Note that the Wavelength and Angle indexes control how many actual values are logged for construction parameters. I.e., a 3100 with Wavelength = all and Angle = all will log
2005	DATALOG_PARAM_INDEX_2	
2006	DATALOG_PARAM_INDEX_3	
2007	DATALOG_PARAM_INDEX_4	
2008	DATALOG_PARAM_INDEX_5	
2009	DATALOG_PARAM_INDEX_6	
2010	DATALOG_PARAM_INDEX_7	
2011	DATALOG_PARAM_INDEX_8	
2012	DATALOG_PARAM_INDEX_9	
2013	DATALOG_PARAM_INDEX_10	
2014	DATALOG_PARAM_INDEX_11	
2015	DATALOG_PARAM_INDEX_12	
2016	DATALOG_PARAM_INDEX_13	
2017	DATALOG_PARAM_INDEX_14	
2018	DATALOG_PARAM_INDEX_15	
2019	DATALOG_PARAM_INDEX_16	
2020	DATALOG_PARAM_INDEX_17	

2021	DATALOG_PARAM_INDEX_18	
2022	DATALOG_PARAM_INDEX_19	
2023	DATALOG_PARAM_INDEX_20	
2024	DATALOG_PARAM_INDEX_21	
2025	DATALOG_PARAM_INDEX_22	
2026	DATALOG_PARAM_INDEX_23	
2027	DATALOG_PARAM_INDEX_24	
2028	DATALOG_PARAM_INDEX_25	
2029	DATALOG_PARAM_INDEX_26	
2030	DATALOG_PARAM_INDEX_27	
2031	DATALOG_PARAM_INDEX_28	
2032	DATALOG_PARAM_INDEX_29	
2033	DATALOG_PARAM_INDEX_30	
2034	DATALOG_PARAM_INDEX_31	
2035	DATALOG_PARAM_INDEX_32	
2036	DATALOG_PARAM_WAVELENGTH_INDEXES	N/A
2037	DATALOG_PARAM_WAVELENGTH_INDEX_1	Each logging parameter may represent several logged values. 0 = all currently defined wavelengths 1 = first wavelength only 2 = second wavelength only 3 = third wavelength only
2038	DATALOG_PARAM_WAVELENGTH_INDEX_2	
2039	DATALOG_PARAM_WAVELENGTH_INDEX_3	
2040	DATALOG_PARAM_WAVELENGTH_INDEX_4	
2041	DATALOG_PARAM_WAVELENGTH_INDEX_5	
2042	DATALOG_PARAM_WAVELENGTH_INDEX_6	
2043	DATALOG_PARAM_WAVELENGTH_INDEX_7	
2044	DATALOG_PARAM_WAVELENGTH_INDEX_8	
2045	DATALOG_PARAM_WAVELENGTH_INDEX_9	
2046	DATALOG_PARAM_WAVELENGTH_INDEX_10	
2047	DATALOG_PARAM_WAVELENGTH_INDEX_11	
2048	DATALOG_PARAM_WAVELENGTH_INDEX_12	
2049	DATALOG_PARAM_WAVELENGTH_INDEX_13	
2050	DATALOG_PARAM_WAVELENGTH_INDEX_14	
2051	DATALOG_PARAM_WAVELENGTH_INDEX_15	
2052	DATALOG_PARAM_WAVELENGTH_INDEX_16	
2053	DATALOG_PARAM_WAVELENGTH_INDEX_17	
2054	DATALOG_PARAM_WAVELENGTH_INDEX_18	
2055	DATALOG_PARAM_WAVELENGTH_INDEX_19	
2056	DATALOG_PARAM_WAVELENGTH_INDEX_20	

2057	DATALOG_PARAM_WAVELENGTH_INDEX_21	
2058	DATALOG_PARAM_WAVELENGTH_INDEX_22	
2059	DATALOG_PARAM_WAVELENGTH_INDEX_23	
2060	DATALOG_PARAM_WAVELENGTH_INDEX_24	
2061	DATALOG_PARAM_WAVELENGTH_INDEX_25	
2062	DATALOG_PARAM_WAVELENGTH_INDEX_26	
2063	DATALOG_PARAM_WAVELENGTH_INDEX_27	
2064	DATALOG_PARAM_WAVELENGTH_INDEX_28	
2065	DATALOG_PARAM_WAVELENGTH_INDEX_29	
2066	DATALOG_PARAM_WAVELENGTH_INDEX_30	
2067	DATALOG_PARAM_WAVELENGTH_INDEX_31	
2068	DATALOG_PARAM_WAVELENGTH_INDEX_32	
2069	DATALOG_PARAM_ANGLE_INDEXES	N/A
2070	DATALOG_PARAM_ANGLE_INDEX_1	Each logging parameter may represent several logged values. 0 = all currently defined angles 1 = first angle only 2 = second angle only … 20 = twentieth wavelength only
2071	DATALOG_PARAM_ANGLE_INDEX_2	
2072	DATALOG_PARAM_ANGLE_INDEX_3	
2073	DATALOG_PARAM_ANGLE_INDEX_4	
2074	DATALOG_PARAM_ANGLE_INDEX_5	
2075	DATALOG_PARAM_ANGLE_INDEX_6	
2076	DATALOG_PARAM_ANGLE_INDEX_7	
2077	DATALOG_PARAM_ANGLE_INDEX_8	
2078	DATALOG_PARAM_ANGLE_INDEX_9	
2079	DATALOG_PARAM_ANGLE_INDEX_10	
2080	DATALOG_PARAM_ANGLE_INDEX_11	
2081	DATALOG_PARAM_ANGLE_INDEX_12	
2082	DATALOG_PARAM_ANGLE_INDEX_13	
2083	DATALOG_PARAM_ANGLE_INDEX_14	
2084	DATALOG_PARAM_ANGLE_INDEX_15	
2085	DATALOG_PARAM_ANGLE_INDEX_16	
2086	DATALOG_PARAM_ANGLE_INDEX_17	
2087	DATALOG_PARAM_ANGLE_INDEX_18	
2088	DATALOG_PARAM_ANGLE_INDEX_19	
2089	DATALOG_PARAM_ANGLE_INDEX_20	
2090	DATALOG_PARAM_ANGLE_INDEX_21	
2091	DATALOG_PARAM_ANGLE_INDEX_22	
2092	DATALOG_PARAM_ANGLE_INDEX_23	

2093	DATALOG_PARAM_ANGLE_INDEX_24	
2094	DATALOG_PARAM_ANGLE_INDEX_25	
2095	DATALOG_PARAM_ANGLE_INDEX_26	
2096	DATALOG_PARAM_ANGLE_INDEX_27	
2097	DATALOG_PARAM_ANGLE_INDEX_28	
2098	DATALOG_PARAM_ANGLE_INDEX_29	
2099	DATALOG_PARAM_ANGLE_INDEX_30	
2100	DATALOG_PARAM_ANGLE_INDEX_31	
2101	DATALOG_PARAM_ANGLE_INDEX_32	
2200	DATALOG_MEDIA	The current media for capturing the data log 0 = SD Card 1 = USB Flash drive
2201	DATALOG_LAST_DOWNLOAD	Aurora Legacy Datalogging only
3000	USER_CONFIG_COMMS	N/A
3001	SERIAL_1_ID	Identifying number (signed int)
3002	SERIAL_1_BAUD_RATE	Baud rate (1200,..115200)
3003	SERIAL_1_PROTOCOL	0 = Advanced 1 = Aurora Legacy 2 = Modbus (not supported yet) 3 = Bayern Hessen (not supported yet) 4 = EC9800 (not supported yet)
3004	SERIAL_2_ID	As above
3005	SERIAL_2_BAUD_RATE	As above
3006	SERIAL_2_PROTOCOL	As above
3007	NETWORK_DHCP_MODE	0 = false 1 = true
3008	NETWORK_PROTOCOL	As above
3009	NETWORK_IP_ADDRESS	Unsigned int where bytes 0...3 specify the address
3010	NETWORK_NETMASK	
3011	NETWORK_GATEWAY	
4001	MEASUREMENT_NUMBER_OF_WAVELENGTHS	Wavelengths being measure (1..3)
4002	MEASUREMENT_NUMBER_OF_ANGLES	Angles being measured 1100: 1 3100: 1..2 4100: 1..20
4003	MEASUREMENT_WAVELENGTHS	N/A
4004	MEASUREMENT_WAVELENGTH_1	Wavelength value in nm (450, 525,635)

4005	MEASUREMENT_WAVELENGTH_2	
4006	MEASUREMENT_WAVELENGTH_3	
4007	MEASUREMENT_ANGLES	N/A
4008	MEASUREMENT_ANGLE_1	Angle value in degrees (0..90) The 1100 only reports one angle (always 0) The 3100 reports two angles (always 0 and 90) called forescatter and backscatter The 4100 can report up to 20 angles
4009	MEASUREMENT_ANGLE_2	
4010	MEASUREMENT_ANGLE_3	
4011	MEASUREMENT_ANGLE_4	
4012	MEASUREMENT_ANGLE_5	
4013	MEASUREMENT_ANGLE_6	
4014	MEASUREMENT_ANGLE_7	
4015	MEASUREMENT_ANGLE_8	
4016	MEASUREMENT_ANGLE_9	
4017	MEASUREMENT_ANGLE_10	
4018	MEASUREMENT_ANGLE_11	
4019	MEASUREMENT_ANGLE_12	
4020	MEASUREMENT_ANGLE_13	
4021	MEASUREMENT_ANGLE_14	
4022	MEASUREMENT_ANGLE_15	
4023	MEASUREMENT_ANGLE_16	
4024	MEASUREMENT_ANGLE_17	
4025	MEASUREMENT_ANGLE_18	
4026	MEASUREMENT_ANGLE_19	
4027	MEASUREMENT_ANGLE_20	
4028	MEASUREMENT_DARK_PERIOD	Dark time (ms)
4029	MEASUREMENT_LIGHT_PERIOD	How long the LED is on for a measurement (ms)
4030	MEASUREMENT_DELAY_PERIOD	How long the LED is on before a measurement starts (warm up and stabilization time) (ms)
4031	MEASUREMENT_REFERENCE_AVERAGES	Number of averages in each measurement (1..12)
4032	MEASUREMENT_SCATTERING_CYCLES	Number of complete measurement cycles (all wavelengths and angles) before the reference measurement is repeated (1..90)
4033	CURRENT_WAVELENGTH	The wavelength currently being measured (nm)
4034	CURRENT_ANGLE	The angle currently being measured (degrees)

4035	CURRENT_OPERATION	The operating state of the instrument. These stats flag logged data as part of normal measurement or a calibration state. 0 = Normal monitoring data 1 = Zero calibration data 2 = Span calibration data These states only appear when a calibration state is completed. A single record will be captured with the user-defined parameters and one of the following current operation values. 3 = Zero adjust completed 4 = Zero check completed 5 = Span calibration completed 6 = Span check completed
4036	CURRENT_STATE	The current state of the measurement: 0 = Initializing 1 = Dark period 2 = Reference measurement 3 = Scattering measurements
5001	CURRENT_SAMPLE_TEMPERATURE	K
5002	CURRENT_SAMPLE_PRESSURE	mBar
5003	CURRENT_SAMPLE_RH	%
5004	CURRENT_CHASSIS_TEMPERATURE	K
5005	CURRENT_CHASSIS_PRESSURE	mBar
5006	CURRENT_CHASSIS_RH	%
5007	CURRENT_AMBIENT_TEMPERATURE	K
5008	CURRENT_AMBIENT_PRESSURE	mBar
5009	CURRENT_AMBIENT_RH	%
5010	FLOW	SLPM
6001	ANALOG_INPUT_LED_VOLTAGE	V
6002	ANALOG_INPUT_COOLER_VOLTAGE	V
6003	ANALOG_INPUT_COOLER_TEMPERATURE	V
6004	ANALOG_INPUT_3_3_V_SUPPLY	V
6005	ANALOG_INPUT_5_0_V_SUPPLY	V
6006	ANALOG_INPUT_12_0_V_SUPPLY	V
6007	ANALOG_INPUT_24_0_V_SUPPLY	V
6008	ANALOG_INPUT_FUSE_CURRENT	mA
6009	ANALOG_INPUT_COOLER_CURRENT	mA

6010	ANALOG_INPUT_ANALOG_FLOW	V
6011	ANALOG_INPUT_MFC_FLOW	SLPM
6012	ANALOG_INPUT_AMBIENT_RH	%
6013	ANALOG_INPUT_AMBIENT_TEMP	K
6014	ANALOG_INPUT_SPARE	N/A
6015	ANALOG_INPUT_1	V
6016	ANALOG_INPUT_2	V
6017	ANALOG_INPUT_3	V
6018	ANALOG_INPUT_4	V
7001	DIGITAL_INPUT_1	0..1
7002	DIGITAL_INPUT_2	0..1
7003	DIGITAL_INPUT_3	0..1
7004	DIGITAL_INPUT_4	0..1
7005	DIGITAL_OUTPUT_1	0..1
7006	DIGITAL_OUTPUT_2	0..1
7007	DIGITAL_OUTPUT_3	0..1
7008	DIGITAL_OUTPUT_4	0..1

A.5 Time Stamp Format

All time stamps are in the following bit-wise format. This manages to fit an un-ambiguous date and time into a single 4-byte unsigned integer.

Note the following limits:

Seconds	0..59
Minutes	0..59
Hours	0..23
Date	1..31
Month	1..12
Year	0..63 (implies adding 2000)

<table>
<tr><th colspan="8">3</th><th colspan="8">2</th><th colspan="8">1</th><th colspan="8">0</th></tr>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="6">YEAR</td><td colspan="4">MONTH</td><td colspan="5">DATE</td><td></td><td colspan="4">HOUR</td><td colspan="4">MIN</td><td colspan="2"></td><td colspan="6">SEC</td></tr>
</table>

This page is intentionally blank.

Appendix B. Aurora Protocol

This document contains an explanation of the available commands and their syntax.

Note: The commands are case sensitive and need to be uppercase for them to work correctly.

B.1 Command: ID

Polls the Aurora NE for the instrument type, the current software/firmware version and the unique factory allocated identification number of the Aurora NE.

Syntax:

ID{<Serial ID>}<cr>

Response:

Aurora NE-XXX{<model ID>} v{<firmware version>} ID #{<instrument Serial ID>}<CR><LF>

Example:

Sending:	ID0<CR>
Possible Responce:	Aurora NE-100 v5.0 ID #220838<CR><LF>
	Aurora NE-300 v5.0 ID #220838<CR><LF>
	Aurora NE-400 v5.0 ID #220838<CR><LF>

Related Commands:

Pressing CONTROL-T also gives the same response.

B.2 Command: ***B

Erases the data log memory.

Note: This command will only work if you have applied the Legacy Datalogging. Activated by pressing the Legacy Datalogging button on the datalog Parameters panel on the Config page.

Syntax:

***B<CR>

Response:

OK<CR><LF>

B.3 Command: ***D

Downloads the new content of the data log. The number of responses will depend on how many entries are in the data log that have not yet been downloaded.

Syntax:

***D<CR>

Response:

Multiple comma separated data entry: Time, Status, Type, scattering values for each wavelength & angle, air temp, cell temp, humidity, and pressure <CR><LF>

Example:

18/6/2022
16:01:00,60,0,2.142656e+01,3.311639e+01,3.764827e+01,1.825488e+01,3.121719e+01,3.300115e+01,1.529951e+01,2.430883e+01,2.693074e+01,1.408008e+01,1.487485e+01,1.997404e+01,2.971700e+02,1.013510e+03,3.926000e+01,2.972700e+02,1.018760e+03,4.552000e+01,3.978850e-02,5.406347e-02,6.493426e-02,3.913681e-02,5.493057e-02,6.418353e-02,4.013822e-02,5.521182e-02,6.538633e-02,4.344866e-02,5.233796e-02,6.638738e-02,9.000056e+01,4.371852e+05,3.804421e+05,4.145539e+

B.4 Command: ***R

Rewinds to the beginning of the data log. The next ***D command will download the entire contents of the data log.

Syntax:

***R<CR>

Response:

OK<CR><LF>

B.5 Command: **PS

Programs the unique factory allocated identification number of the Aurora NE into memory. This ID number can be found on the Identification pane on the Factory child page.

Syntax:

**{<Serial ID>}PS{space}{<instrument serial ID>}<CR>

Response:

OK<CR><LF>

Example:

Sending: **0PS_123456<CR>

Responce: OK<CR><LF> (and sets the instrument serial ID to 123456.)

B.6 Command: **B

Re-Boot test. When initiated the Watchdog timer will be activated and cause the Aurora 4000 microprocessor to re-boot. The same as pressing the reset button on the microprocessor board.

Syntax:

**{<Serial ID>}B<CR>

Response:

OK<CR><LF>

Example:

Sending: **0B<CR>

Response: Will re-boot the Aurora NE

B.7 Command: VI

Reads up to 100 different parameters from the Aurora NE microprocessor. Ideal for data logging devices which can poll the instrument for its data.

Syntax:

VI{<Serial ID>}{<voltage input parameter number>}<CR>

Response:

{<sign>}{<parameter value>}<CR><LF>

Arguments:

<sign> = <space> if positive, <-> if negative. (if the output is an ASCII character, then there is no <sign>.

<parameter value> = a value which can be either an ASCII character string, or a decimal number to six decimal places.

<voltage input parameter number> = one of the following from Table 63 – Table 63:

Table 63 – VI voltage input numbers

Voltage input number	Description
00	Current Monitoring State (Major.Minor) 2 decimal places for minor.
03	Scat coefficients. Mm-1 in current reporting preference
04	Dark count (moving average).
05	Dark count last reading.
16	Sample relative humidity in current reporting preference.
18	Sample temperature in current reporting preference.
19	Sample pressure in current reporting preference.
20	Chassis relative humidity in current reporting preference.
21	Chassis temperature in current reporting preference.
22	Chassis pressure in current reporting preference.
28	Wavelengths
32	Backscatters
37	Backscatters Measurement counts in current reporting preference
40	Backscatter Measurement Ratio in current reporting preference
41	Flow in current reporting preference
64	Date format setting
65	Temp unit setting
66	Pressure unit setting
68	Major state
68	Minor state
71	Span/zero measure mode status. 000 = measure, 016 = span, 032 = zero.
80	Clock date in current reporting preference
81	The clock time in hh:mm:ss format
84	Kalman gain (first angle only)
90	Digital output status – PortD
98	Number of angles, angle 1, angle 2, etc.
99	Real-time parameters obtained as one comma delimited string.

This page is intentionally blank

acoem

acoem.com