PICARRO

PI5310 Analyzer for N_2O, CO, H_2O User Manual

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Picarro Notices

Thank you for purchasing a Picarro product. Your Picarro system is a quality product that has been designed and manufactured to provide reliable performance.

This User Manual (UM) is an important part of your purchase as it will help familiarize you with the system and explain the numerous features that have been designed into it. Please read this manual thoroughly before using your Picarro system.

Please contact Picarro or your authorized Picarro distributor should you have questions regarding specific applications or if you require additional information.

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1. Introduction

1.1 Intended Use

The PI5310 analyzer measures concentrations of N_2O, CO and H_2O using Picarro's patented Cavity Ring-Down Spectroscopy (CRDS). The analyzer can be deployed for air monitoring applications in a lab or in the field, allowing in-situ analysis of trace and ambient amounts of N_2O, CO and H_2O.

1.2 System Overview

Analyzer

Figure 1 shows the analyzer front and back panels. More detailed information on panel features, functions, and connections are in section 4, Hardware Setup.

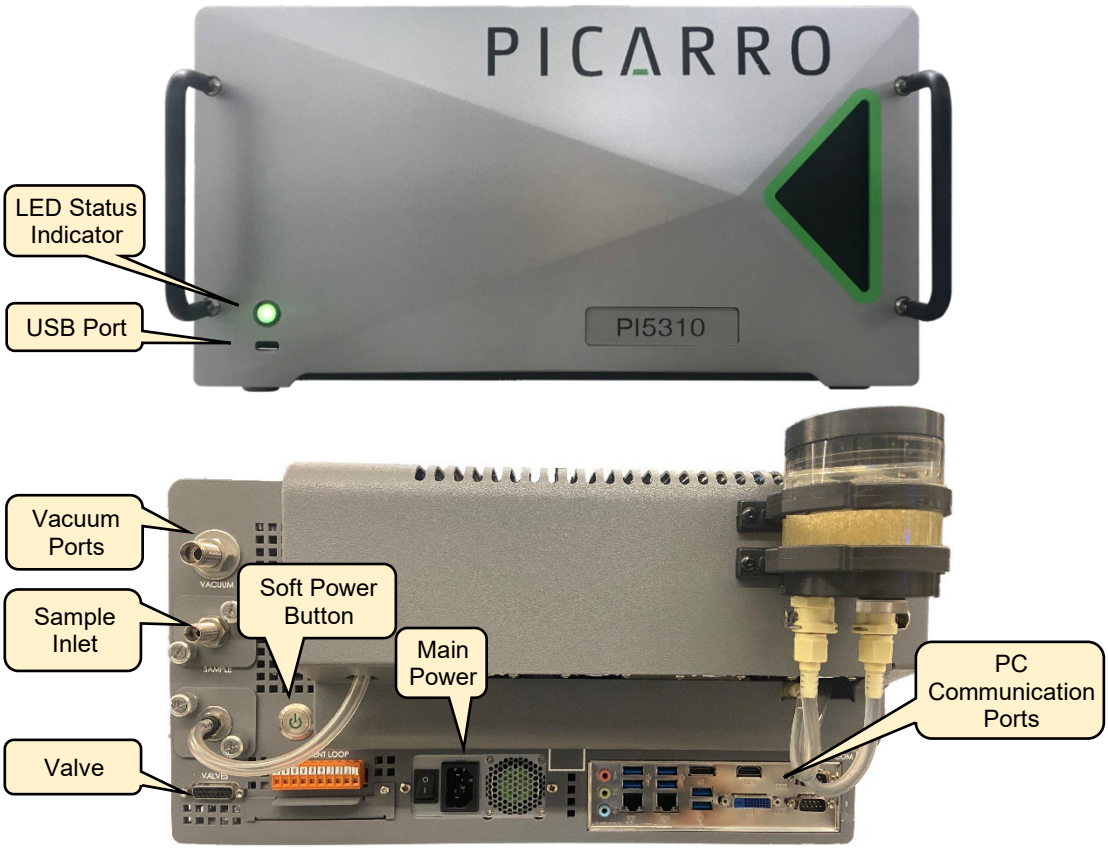


Figure 1: PI5310 Front/Back Panels

Front Panel Operating Status

The LED indicator on the front panel shows the current operating state of the analyzer. Figure 2 describes the status indicator states. The status states and colors are also linked to the System Alarm Panel on the CRDS Data Viewer Screen. See Section 5 Analyzer Basic Operation.

Figure 2: PI5310 LED Status Indicator

A2000 Vacuum Pump

The A2000 vacuum pump (Figure 3) is used to maintain cavity pressure inside the analyzer. The pump should be connected and running whenever the analyzer is in use.

Figure 3: A2000 Vacuum Pump – Side Views

1.3 Analyzer Specifications

Table 1: PI5310 Specifications

Parameter	Specification
Measurement Technique	Cavity Ring-Down Spectroscopy (CRDS)
Primary Gases Measured	N_2O (Nitrous Oxide), CO (Carbon Monoxide), H_2O (Water)

Parameter	Specification
Weight: Analyzer Weight: Pump	32.2 kg (71 lbs.) – Should be lifted by two people. A2000: 6.5 kg (14.4 lbs)
Dimensions - Analyzer	Length: 76.8 cm (30.25”) Width: 42.24 cm (16.63”) Width with Rack Mount Rails: 44.78 cm (17.63”) Height: 22.23 cm (8.75”), Height with Feet: 23.5 cm (9.25”)
Dimensions – A2000 Pump	Length: 27.9 cm (11”) Width: 10.2 cm (4”) Height: 19.1 cm (7.5”)
Clearance	Front: 15 cm (6”); Rear: 15 cm (6”)
Ambient Temperature Range	Operating: 10 °C to 35 °C (50 °F to 95 °F) Storage: -10 °C to 50 °C (14 °F to 122 °F)
Ambient Humidity Range	< 85% RH non-condensing
Sample Pressure	300 to 1000 Torr (40 to 133 kPa)
Sample Flow Rate	200 sccm
Maximum Altitude	3,048 m (10,000 ft – Operation)
Required Accessories	Included: Pump (external), Supplied by Customer: keyboard, mouse, LCD monitor
Operating System	Linux
Data Outputs	RS–232, Ethernet, USB, Data Streaming: Optional Analog 4–20 mA
Installation	Benchtop or 48.3 cm (19”) rack mount
Power Requirements Mains Supply Voltage Fluctuation	100 – 240 VAC; 50 – 60 Hz (auto-sensing) 250 W Max 150 W (pump) ±10% of the nominal voltage
Minimum Rated Circuit Amperage	10A @ 115 VAC 5A @ 230 VAC
Liquid Ingress Protection	None

1.4 Acronyms

This manual includes various acronyms. For definitions, see below:

Table 2: Acronyms, Formulas, Units, and Symbols

Acronym	Definition
” (as in 1/4”)	Inches
°C	degrees Celsius
<	Less Than
>	Greater Than
A	Ampere Accessory (internal use). Used in model names i.e. A0302
AC	Alternating Current
cm	centimeters
CO_2	Carbon Dioxide
COM	Communication Port
CRDS	Cavity Ring-Down Spectroscopy
CSV	Comma Separated Values
CPU	Central Processing Unit
DAS	Data Acquisition System (the Analyzer)
DC	Direct Current
DVI	Digital Visual Interface
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
ft.	Length in feet;1 ft. = 12” or 12 inches (30.48 cm)
GUI	Graphical User Interface
H_2O	Water, Water Vapor
HDF	Hierarchical Data Format
Hz	Hertz
ID	Inside Diameter (i.e., .5” ID) or Identification (i.e., Slave ID)
kg	Kilograms

Acronym	Definition
kPa	Kilopascal
lbs	pounds
m	Meters or month
mA	Milliampere
max	Maximum
min	Minimum
mL	Milliliter
mK	Millikelvin
mm	millimeters
N/C	No Connection
NC	Normally Closed
NO	Normally Open
OD	Outside Diameter
P	Pressure
PDF	Portable Document Format
PFA	Perfluoroalkoxy – A chemically resistant polymer, suitable for use with sticky and aggressive gases
PN / P/N	Part Number
ppb	parts per billion
ppm	parts per million
PSI (psi)	Pounds per Square Inch
PSIG	Pounds per Square Gauge
Pws	Water vapor pressure
RH	Relative Humidity
RJ-45	Registered Jack (physical network interface)
RS232	Recommended Standard 232 (serial communication protocol)
SCCM	Standard cubic centimeters per minute
SS / SST	Stainless Steel

Acronym	Definition
TCP/IP	Transmission Control Protocol/Internet Protocol
Torr	Torricelli (unit of pressure equal to 1/760 atmosphere)
UM	User Manual
USB	Universal Serial Bus
UPS	Uninterruptible Power Supply
VA	Volt Ampere
VAC	Volts of Alternating Current
VDC	Volts of Direct Current
W	Watts
WLM	Wavelength Monitor

1.5 Text Conventions

The following conventions are used in the manual.

- *Italic* text identifies screen names and emphasizes important text or certain features.
- ***Bold Italic*** text identifies section reference links.
- **Bold** text is for actions to take (such as clicking on a UI button), caution and warning statements, and text you should type or select in screens.

2. Safety

2.1 Warning Symbols

Icon notes and warnings are used throughout this manual. The purpose of these icons is to provide a visual convention to alert you important information. They indicate dangers to either the operator or to the analyzer, and other important information.

Table 3: Warning/Information Icon Types

Icon	Description
 NOTE	**NOTE** is important information that you should be aware of before proceeding.
 WARNING	**LASER WARNING** alerts you of a laser danger.
 DANGER	**DANGER** indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.
 WARNING	**WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or severe injury.
 CAUTION	**CAUTION** alerts user of a potential danger to equipment or to the user.
 WARNING	**HAZARDOUS VOLTAGE** alerts user to areas that may expose a user to electrical energy that is high enough to cause injury or death.
 CAUTION	**HOT SURFACE** alerts user to potential injury from hot surfaces.
 REMINDER	**REMINDER** is a helpful hint for procedures listed in the text.

2.2 General Safety

CDRH Certification

This Picarro Analyzer complies with 21 CFR Chapter 1, sub-chapter J, and is classified as a Class 1 laser system when all panels and covers are on.

CE Certification

This Picarro Analyzer complies with European safety standards and the instrument is affixed with a CE label. This CE label is located on the back panel of the instrument.

- **CE**: IEC EN61010-1:2010 (safety) and EN61326-1:2013 (EMC) requirements for electrical equipment for measurement, control, and laboratory use.

WARNING

Using this analyzer in a manner not specified by Picarro may result in damage to the analyzer and render it unsafe to operate.

WARNING

The analyzer is for indoor use only and has an ingress protection rating of IPx-0. It is NOT protected against exposure to water including dripping, spraying, splashing or immersion.

WARNING

Do not operate in an explosive atmosphere! Do not operate in the presence of flammable gases or fumes.

CAUTION

This analyzer contains no user-serviceable components except the particulate filter, CPU fan, and A2000 vacuum pump diaphragms and valves. To order user-replaceable parts and access video replacement instructions, see section 12, Maintenance.

Do not attempt other repairs; instead, report all problems to Picarro Customer Service or your local distributor. Please contact Picarro if you have any questions regarding the safe operation of this equipment.

CAUTION

Do not replace the mains supply power cord with an inadequately rated cord.

WARNING

If mounting in a 19” rack, this analyzer cannot support itself using a front rack mount kit alone. It must be supported by a shelf, or by user-provided “L” type support brackets.

CAUTION

Equipment Damage: Exceeding gas inlet pressure or temperature specifications could result in damage to the instrument. In the case of higher input pressure or flow, configuring a sampling bypass manifold system is recommended.

Use a 'tee' at the gas inlet and exhaust the remainder of the gas stream appropriately.

WARNING

The inlet gas connector on the back panel of the Analyzer, and its immediate vicinity, runs hot during operation of the analyzer. Take care when connecting gas lines or working at the rear of the instrument to wear protective gloves or avoid contact with these surfaces.

CAUTION

Equipment Damage: Do not disconnect the AC power to the analyzer, vacuum line, or the AC power to the External Vacuum Pump while analyzer is operating. Damage may be caused by current surges if power is applied while attaching or removing cables.

WARNING

This analyzer weighs 32.2 kg (71 lbs). Use the technique described below (or follow your local regulations) when lifting the analyzer.

- **Before lifting, inspect the unit for slippery substances or sharp edges.**
- **Lift with two people, one on each side of the analyzer.**
- **Crouch down and stay close to the unit. Always keep your back as straight as possible.**
- **Position your feet for sturdy balance. Lift with your legs, not your back.**
- **Do not twist the back while carrying the unit. Rotate direction with hip joints.**
- **Lower the unit by bending at the knees.**

2.3 Laser Safety

WARNING

This equipment is classified as a Class 1 laser product with an embedded 3B laser in accordance with EN 60825-1:2014. Do not to open the enclosure where this label is placed; there are no user serviceable parts inside.

The following Laser Safety Label is affixed to the outer cover of the analyzer.

Figure 4: Laser Safety Label – Affixed to Outside Cover of Analyzer

WARNING

The laser is a Class 3B when exposed.
Only operate or service this device in accordance with the instructions in this guide, and only open the device in an approved laser safe service area using appropriate laser-safety glasses.

The following Laser Safety Label (Figure 5) is affixed to the inside of the analyzer:

Figure 5: Laser Safety Label – Affixed to Inside of Analyzer

CAUTION

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

3. Unpacking

3.1 Inspect the Shipping Container

Picarro products are inspected and tested before leaving the factory. Their packing containers have been designed to keep the equipment safe from damage during transit.

Picarro SI5000 series shipping containers consist of:

- A wooden crate with metal clamps
- Layers of protective foam

Figure 6: Shipping Container with Clamps Installed/Removed

1. To open the crate, use a claw hammer to remove the metal shipping clamps.
2. Inspect the condition of the crate and packing materials upon arrival. The crate houses the analyzer and the external pump. Even if the crate shows some external damage, it will protect the instrument under most circumstances.

   If the equipment inside the container does appear to be damaged, photograph all the evidence of damage and contact Picarro, sending the photographs as soon as possible.
3. Keep all packing materials so the instrument can easily be returned Picarro if necessary.

3.2 Unpack Components

While unpacking each shipping box:

- Inspect each item to ensure it is not damaged.
- If items are missing, contact Picarro.
- Keep the shipping materials to reuse when transporting the analyzer.
- Contact Picarro for options on transporting systems to remote labs.

WARNING

The analyzer weighs 32.2 kg (71 lbs). Use the technique outlined on Page 20 when lifting or moving the analyzer.

Figure 7: PI5310 Shipping Box Contents

Table 4: PI5350: Shipping Container Contents

Item (qty)	Description
Analyzer (1)	Includes all the data acquisition, control, and communications hardware and firmware to perform all gas handling, spectral collection, and analysis.
Vacuum Pump (1)	Provides vacuum required for sample gas sequencing into and out of the analyzer.
Vacuum Hose (1)	Hose to connect the pump to the analyzer.
AC Power Cables (1)	A power cable with connectors appropriate to your country is provided; one for the analyzer and one for the pump. **Note:** The analyzer automatically adjusts to local voltage, but the vacuum pump voltage must be selected. See *Section 4.3,* Analyzer Preparation.
Slide Rails	1 Pair of slides and hardware for 19” rack mounting.
Control Cable Kit (1)	For external solenoid valves.
Nut (1) and Ferrules (2)	For connecting input line to analyzer gas input.
Coolant	1 bottle of Koolance 702 liquid coolant.
Document Packet (1)	Includes this user manual and certificate of compliance (not shown).

4. Hardware Setup

Read this entire section before proceeding. Refer to Figure 16 in the following section for installation.

4.1 Items/Tools Required

- 9/16'' open end wrench
- 11/16'' open end wrench
- Phillips head screwdriver (for rack mounting)
- 2.5 mm Allen wrench (for rack mounting)
- Pump
- Power Cord for analyzer and pump
- Coolant for chiller

4.2 Installation Safety

WARNING

Two-person lift required: The analyzer weighs 32.2 kg (71 lbs). When lifting the analyzer, use the technique described on Page 20 (or follow your local regulations).

CAUTION

When the analyzer is being integrated to an external system, the safety of that system is the responsibility of the assembler of that system.

WARNING

Equipment Damage: Do not attach electrical power to or start the analyzer until after attaching and turning on the External Vacuum Pump. Do not disconnect the vacuum line while the analyzer is running. Failure to do so could result in damage to the optics.

WARNING

Picarro sells certain USB enabled devices, such as GPS, which are approved for use. Do not connect USB hubs or unauthorized USB devices (except flash drives, mice, and keyboards) to the USB ports. Unauthorized USB devices may interfere with the normal functioning of the analyzer.

Warning

When using compressed gases, follow all appropriate safety conventions, including use of eye protection, physical restraint of cylinders, etc.

CAUTION

Lines connected to the 1/4” Swagelok sample inlet connector must not exceed 15 PSIG of pressure.

WARNING

Operating at concentrations above the intended ranges may render the instrument unsafe to operate, maintain, service or dispose of.

WARNING

Any light emitted from the front panel Status Indicator, regardless of color or state, shown in Figure 14 indicates one or more lasers are on.

CAUTION

During installation, do not position the analyzer so that it is difficult to operate the electrical disconnecting device (such as an emergency off (EMO) switch or breaker).

WARNING

If mounting in a 19” rack, this analyzer cannot support itself using a front rack mount kit alone. It must be supported by a shelf, or by user-provided “L” type support brackets.

CAUTION

Use the AC power cables supplied with the analyzer or a similarly rated cable. Check with Picarro technical support if you have questions about power cable replacement. An inadequately rated power cable can result in equipment damage.

CAUTION

Cords shall be RATED for the maximum current for the equipment and the cable used shall meet the requirements of IEC 60227 or IEC 60245. Cords certified or approved by a recognized testing authority are regarded as meeting this requirement. The connector type used should be: IEC320 C13.

CAUTION

If the analyzer has been stored at less than 10 °C, allow the components to equalize to room temperature before starting the installation process.

CAUTION

Equipment Damage: It is imperative that the analyzer have adequate ventilation and/or cooling to maintain the ambient temperature below 35 °C when operating. Do not place the pump or the instrument in any enclosure without providing adequate forced air flow.

Do not plug or block any perforations in the chassis of the instrument. Do not put anything near the instrument that will impede the air flow. Failure to provide adequate airflow, especially clearance at the front and rear panels, to ensure proper airflow and/or cooling to the analyzer will result in overheating of the analyzer causing a shutdown and potential damage. There should be 6" (15 cm) of clearance in the front and back of the analyzer.

To determine if the ventilation is adequate in an enclosure, monitor the temperature of the air near the instrument and adjust ventilation so that the ambient temperature is within specification. As a guide, the ambient temperature of the air around the instrument cannot exceed the specifications listed below.

Thermal Specifications	Min	Max	Description
Ambient Operating Temperature	10 °C	35 °C	Worst-case environmental limits (unless otherwise specified)

4.3 Analyzer Preparation

Ventilation Considerations

The instrument and pump require adequate ventilation in order to function properly. Do not plug or block any perforations in the chassis of the instrument. Don't place anything near the instrument that will impede the air flow.

Positioning

NOTE

The unit is shipped with rubber feet installed for benchtop use. Alternatively, it can be mounted in an equipment rack using the drawer-style rails included in the shipping crate. If the rails are used, the rubber feet must be removed so the unit can fit in a standard 5U rack opening. For instructions, see Section 4.5, Rack Mount Instructions

4. Remove the analyzer and the external vacuum pump from the shipping container.
5. Install the analyzer in a rack or place it on a cart or table.
6. Place the external vacuum pump near the analyzer in a rack, or on a cart or table.

CAUTION

If you rack-mount the analyzer, be sure to support it with a shelf or the provided rails; the analyzer cannot support itself on the front rack mounting brackets alone.

7. Unpack the analyzer accessories (vacuum line, cable kit, manual, and certificate of compliance).

NOTE

Store the certificate of compliance in a safe place. It may be required if you contact Picarro for service or questions.

8. Remove the caps from the analyzer Sample inlet and Vacuum connection ports.
9. Remove the caps from the pump vacuum inlet. Save the caps for reuse in case the analyzer and pump is stored, moved, or shipped.

Set A2000 Pump Input Voltage

10. If using an A2000 vacuum pump, set its input voltage to the correct level for your area by rotating the voltage selector switch located on the side of the pump next to the fuse holder (Figure 8).

Figure 8: Vacuum Pump Voltage Selection

4.4 Connections – A2000 Pump and Gas Inlet

Follow instructions in this section when using an A2000 pump with your analyzer.

Pump Connections

Refer to Figure 9 when using an A2000 pump with your analyzer.

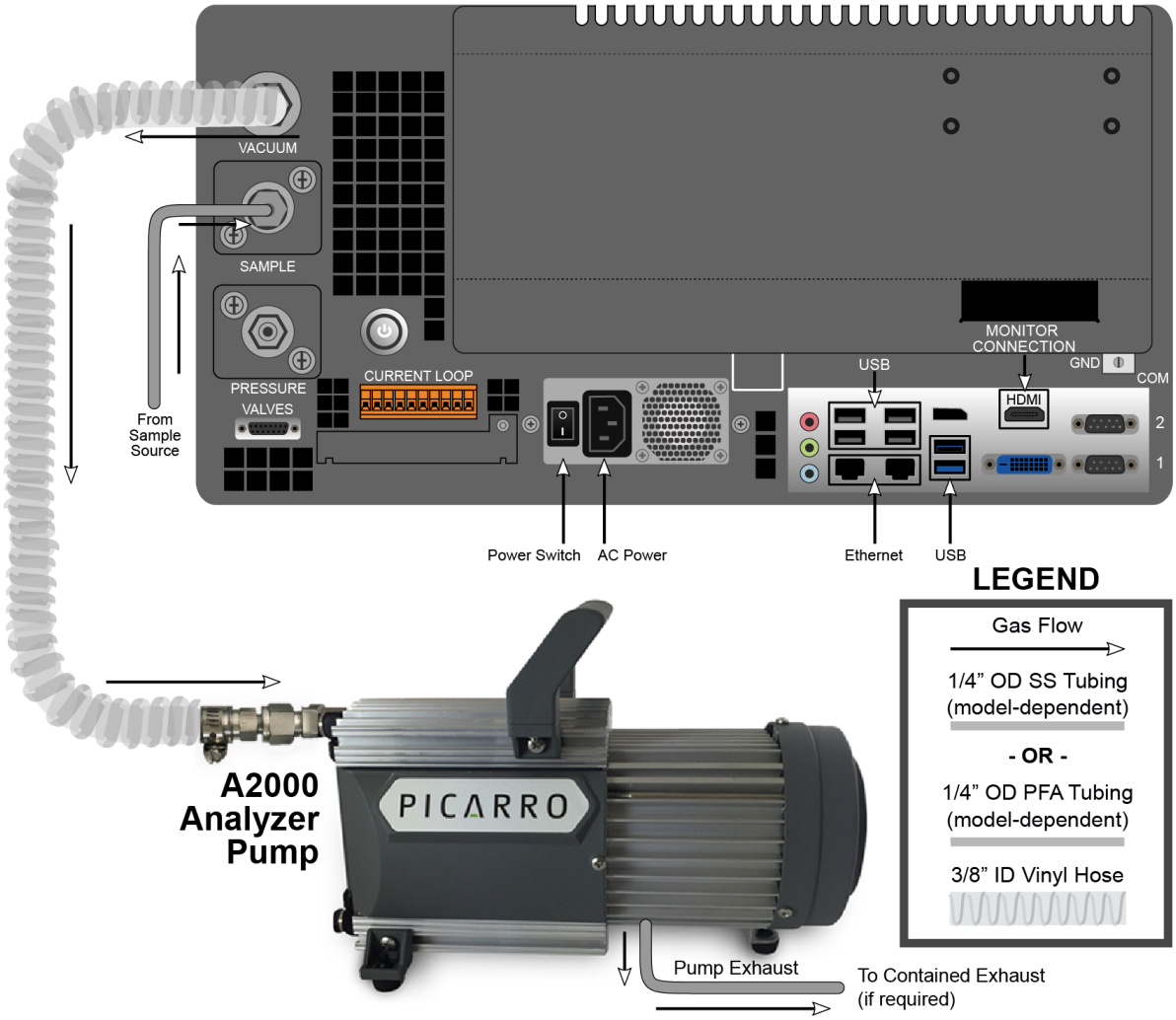


Figure 9: Analyzer Setup with A2000 Pump

CAUTION

When working with hazardous gases, remove the pump exhaust muffler and adapt a tube to the vacuum pump exhaust port (shown in Figure 9) and direct the exhaust to a safe place for venting the mixture of sample gases. For instructions, see APPENDIX F – Setting up Contained Exhaust Flow.

1. Connect the provided vacuum line between the analyzer port labeled **VACUUM** and the pump vacuum inlet.
2. If working with hazardous gases, see ***APPENDIX F*** – for instructions on directing the pump exhaust to a safe venting environment.

Sample Gas Inlet Connections

There are two types of sample Inlet connections which are model-dependent.

- Analyzers that have stainless steel (SST) sample inlet connectors.
- Analyzers that have PFA sample inlet connectors.

Sample Gas Inlet Connection (SST Tubing)

1. Use 1/4” OD SST tubing and connector sets to connect from sample source to the sample inlet.
2. Place the two ferrules inside the nut as shown below.

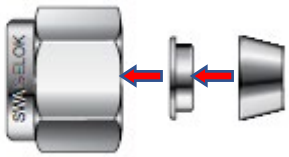


Figure 10: Orientation of Inlet Nut and Ferrules (SST Tubing)

3. Loosely connect the nut to the INLET on the back panel of the analyzer, being careful not to let the ferrules fall out.
4. Insert the tubing into the back of the nut and through the ferrules, feeding it in as far as possible without deforming the tubing.
5. Hand tighten the nut.
6. Using a 9/16" wrench (not included), tighten the nut 1-1/4 turns.

When reconnecting SST tubing

7. Inspect the ferrules. If you see any damage, replace the ferrules and follow the directions above for making a new connection.
8. If there is no damage, hand tighten the connector to the analyzer sample inlet.
9. Using a 9/16" wrench, tighten the nut 1/6 of a turn (60°).

Sample Gas Inlet Connection (PFA Tubing)

When making a new PFA gas inlet connection:

1. Use 1/4” OD PFA tubing and connector sets to connect from sample source to the sample inlet.
2. Place the two PFA ferrules inside the PFA nut as shown in Figure 11.

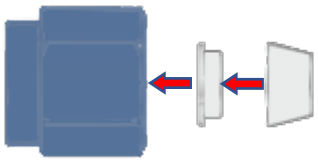


Figure 11: Orientation of Inlet Nut and Ferrules (PFA Tubing)

3. Loosely connect the nut to the INLET on the back panel of the analyzer, being careful not to let the ferrules fall out.
4. Insert the tubing into the back of the nut and through the ferrules, feeding it in as far as possible without deforming the tubing.
5. Hand tighten the nut.
6. Using a 5/8" wrench, tighten the nut 1-1/6 turns (1 full turn plus another 60°).

When reconnecting PFA tubing

1. Inspect the ferrules. If you see any damage, replace the ferrules and follow the directions above for making a new connection.
2. If there is no damage, hand tighten the connector to the analyzer sample inlet.
3. Using a 5/8" wrench, tighten the nut 1/6 of a turn (60°).

4.5 Rack Mount Instructions

When mounting the analyzer in a standard 5U rack opening, use these instructions.

WARNING

If mounting in a 19” rack, this analyzer cannot support itself using a front rack mount kit alone. It must be supported by a shelf, or by user-provided “L” type support brackets.

1. Remove the rack-mounting rails from shipping crate and remove packaging.
2. Extend each rail. Press the blue **PUSH HERE** button and remove the narrow inner slide from the assembly.

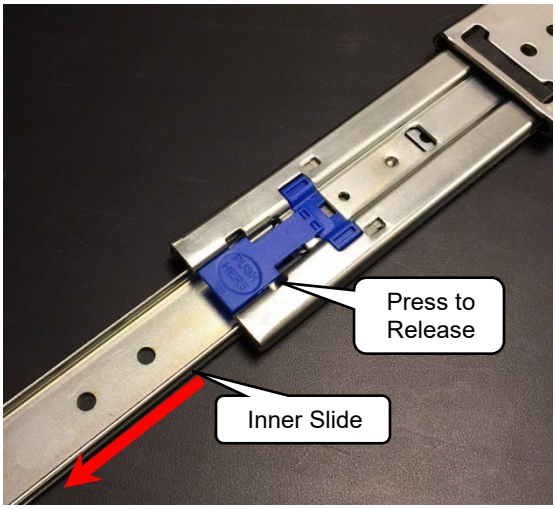


Figure 12: Inner Rail Slide Removal

1. Attach the inner slide to side of of the analyzer (Figure 13) using four included M4 x 8 button-head screws.
2. Repeat on the other side of the analyzer.

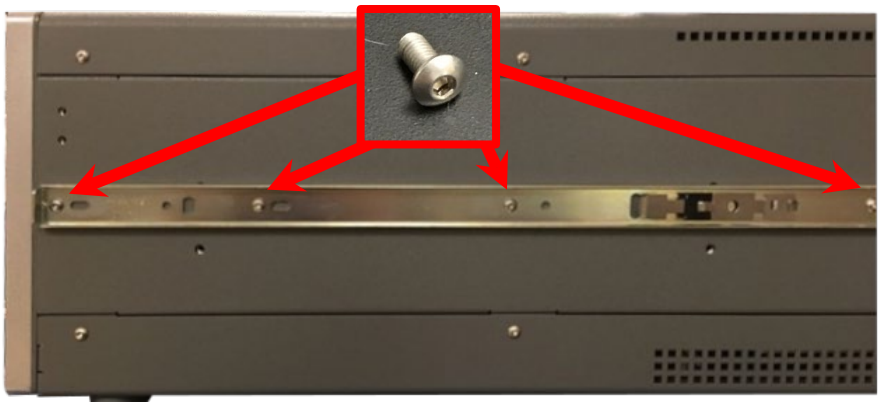


Figure 13: Attaching Inner Slide Rails to Analyzer

3. Attach a front panel restraint (Figure 14) to each side of the analyzer using two included M4 x 8 button-head screws.

Figure 14: Locking Bracket Installed

4. Mount the outer rails to the rack (Figure 15) using supplied hardware at each end, or according to rack design.

NOTE

Equipment racks vary, and some customization may be necessary.

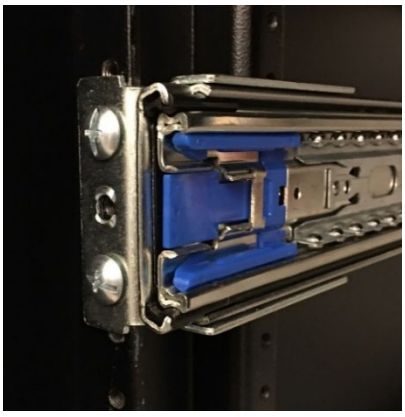


Figure 15: Outer Rail Mounted to Rack

5. Remove the rubber feet from the analyzer using a Phillips screwdriver. This may be necesssary to prevent clearance issues with adjacent instruments within the rack.

WARNING

This analyzer weighs 47 lbs (21.3 kg) When lifting the analyzer, use the technique described in the Safety section of this document (or follow your local regulations) .

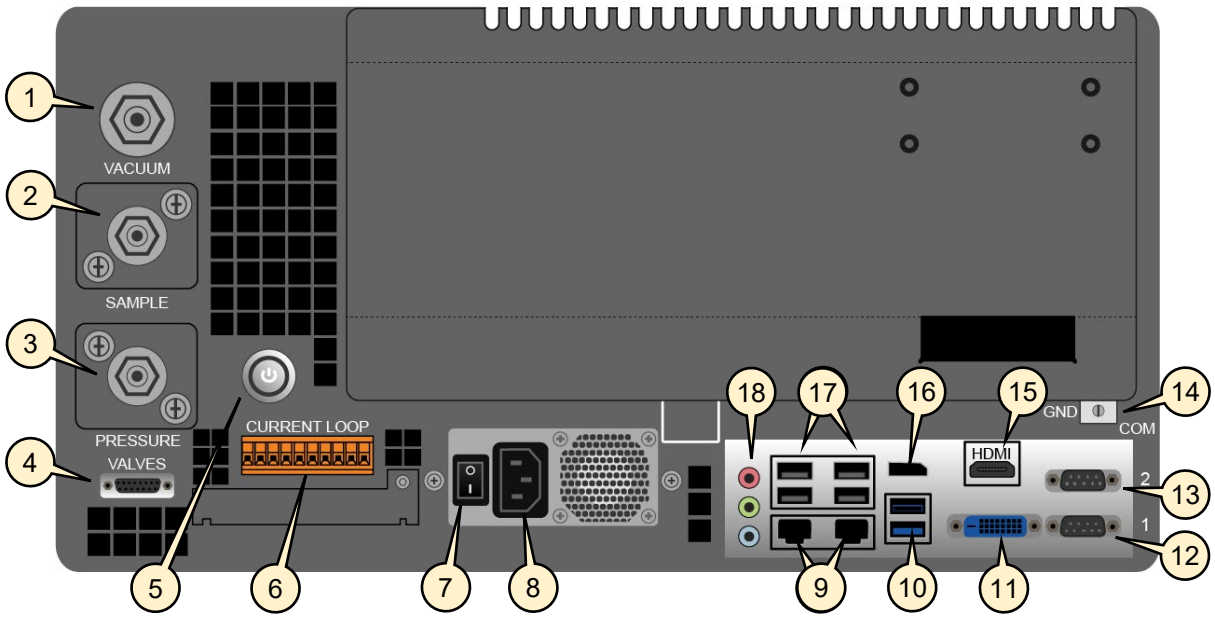
6. Using two people to lift the analyzer, engage inner rails on analyzer with outer rails in rack, and slide analyzer into place.
7. Secure the locking brackets (Figure 14) to the rack frame.

4.6 Electrical Connections

Refer to Figure 16 for connection points.

NOTE

This section is designated as Electrical Safety Task Type 2: Equipment is energized. Energized circuits are covered or insulated.



1. External Vacuum Port to Vacuum Pump
2. Gas Sample Inlet
3. Analyzer pressurized air inlet connection
4. Solenoid valve cable connection
5. On/Standby switch with indicator LED
6. 4-20 mA Output screw terminal block
7. Rocker power switch
8. AC Line power receptacle
9. Ethernet Ports – RJ-45 (2 ea.)
10. USB-2 Ports
11. DVI-D Video Monitor Port
12. Serial port for command interface (COM1)
13. Serial port for streaming data (COM2)
14. Ground binding post
15. HDMI Port
16. Display Port
17. USB Ports (4 ea.)
18. Audio In/Out Ports

Figure 16: Annotated Rear Panel Diagram

1. Connect a monitor to the HDMI port at the back panel. The analyzer will detect the connection and adjust the resolution to match the monitor.
2. Connect a mouse and keyboard to a pair of USB ports.
3. Connect the provided AC power cable from the analyzer to the power source.

NOTE

The analyzer has a universal power supply that automatically adjusts to power sources ranging from 100-240 VAC, 50/60 Hz, 10 A max.

NOTE

The A2000 pump does not automatically adjust to power sources. If using the A2000 vacuum pump, ensure its input voltage is set to the correct level for your area by rotating the voltage selector switch located on the side of the pump next to the fuse holder (see Figure 6).

4. Check that the A2000 pump voltage input switch is set correctly.
5. Connect the provided AC power cable from the vacuum pump to the power source.
6. If used, connect the valve cable from the analyzer back panel to any solenoid valves.
7. If used, connect rotary valve (A0311 or A0311-S) to COM2 with its provided serial cable.

4.7 Chiller Laser Cooling

A chiller with a 50 mL water buffer tank is installed for reliable and efficient laser cooling. Please note the following:

- The coolant in the buffer tank is partially filled when shipped. Follow the instructions below before you begin measurements.
- Instrument must be powered off for water tube reconnections and water fill, refill, or drain.
- Check and confirm the flowing movement of coolant every six months or whenever a disconnection and reconnection of the buffer tank occurs.
- Inspect the water level in the reservoir every six months; add or refresh coolant in case of water loss or contamination.
- A bottle of coolant (manufacturer: Koolance, part number: LIQ-702CL-B) is shipped with the analyzer.

- Do not use water as coolant. Contact Koolance (https://koolance.com) for replacement bottles. Koolance has re-sellers in Asia, Australia, Europe, Canada, and the United States.
- The safety data sheet for LIQ-702CL-B is included in APPENDIX J – SDS for Koolance LIQ-702.

Chiller Setup

1. Inspect the water buffer tank for possible cracks, and external water tube breakage.

WARNING

If damage is observed, stop, and contact Picarro support to get the damage repaired before adding coolant.

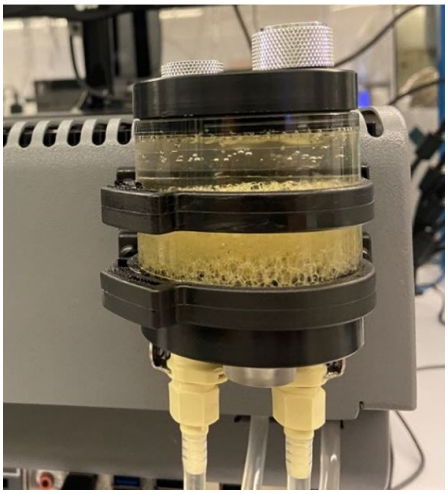


Figure 17: Reservoir Connections at Time of Shipment

2. Rotate the black top lid counter-clockwise to open the tank as shown in Figure 18.

Figure 18: Reservoir Inspection

3. Fill the reservoir so that the coolant covers the sponge and reaches the last thread for the top lid. See Figure 19.

Figure 19: Proper Coolant Level in Reservoir

4. Disconnect the quick connect fittings shown in Figure 17. To release the quick connect fittings, push down on the metal tab of one fitting and pull the fittings apart. Attach each fitting to the bottom of the reservoir as shown in Figure 20.

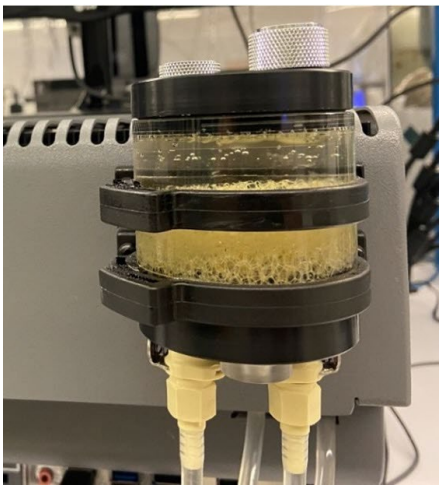


Figure 20: Reservoir Connected and Ready to Run

5. Power on the analyzer per Startup, Section 5.1 and check the coolant level while flowing. If the level drops below the level of the sponge in the reservoir, add coolant to full level directly from either one of two top venting ports.
6. To inspect the coolant flow, open the tank as shown in Figure 21, use a hex drive or a long pin to pinch the sponge, and reveal the two openings on the bottom of the reservoir. Make sure bubbles are forming.

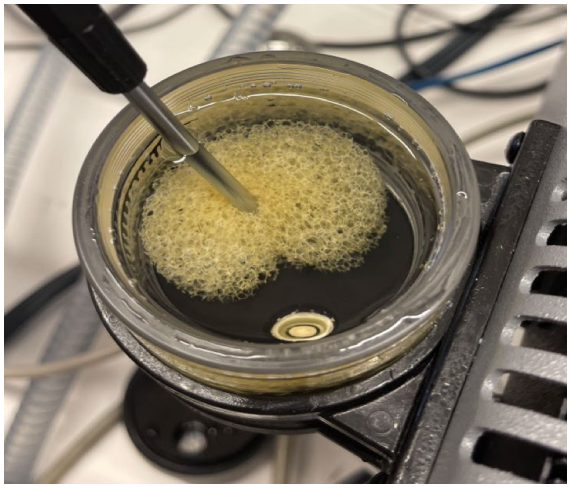


Figure 21: Confirmation of Coolant Flow

7. Replace the lid and tighten it clockwise.

WARNING

To turn off the analyzer, follow Shutdown, Section 5.2. Never remove the vacuum while the system is running. Doing so can damage the instrument which is not covered under warranty.

Chiller Maintenance

With TEC chiller, one buffer tank containing circulation coolant fluid is used for effective laser heat dispersion. The general industrial heat transfer medium, Koolance LIQ-702 is used, see ***APPENDIX J – SDS for Koolance LIQ-702***.

The coolant should be maintained in proper level with refilling, or replacement if it is contaminated.

NOTE

Coolant level should be checked monthly on its level which is due to evaporation or other loss. If the level is no more than half of full tank and the liquid is clear, adding coolant is needed.

Adding Coolant

Open the top two sealing ports, add only proper coolant to its maximal level of coolant buffer tank. This can be done when the analyzer is in operation.

NOTE

Coolant clarity should be checked annually. The turbid coolant liquid indicates contamination. If the liquid is not transparent and the sponge in dark yellow, coolant replacement is needed.

Coolant Replacement

Approximately 50 mL of fresh coolant is needed. Use the following procedure to replace the coolant within the chiller.

1. Turn off the analyzer.
2. Disconnect the two quick connectors from the bottom of the buffer tank.
3. Remove the tank from its holder, open the top lid, dump all coolant, wash the sponge.
4. Install tank back to its folder, put sponge back, seal top lid
5. Open the two top sealing ports, add coolant to full level.
6. Connect the two quick connectors fully back to position. Make sure there are no kinks along the tubes.

NOTE

The reference coolant flow rate is typically as 0.25 lpm (liter per minute). A minimal flow rate of 0.15 lpm or above is required for laser cooling.

5. Analyzer Basic Operation

This section explains how to operate the analyzer using the GUI. It describes system startup, shutdown, and recovery procedures, desktop features. GUI Functions are detailed in section

WARNING

Using this analyzer in a manner not specified by Picarro may result in damage to the analyzer and render it unsafe to operate.

CAUTION

During operation, do not position the analyzer so that it is difficult to operate the electrical disconnecting device (such as an emergency off (EMO) switch or breaker).

NOTE

The illustrations shown in this chapter are for example only. What is shown on your instrument is dependent on the model analyzer in use and may differ.

5.1 Startup

1. Make sure the pump vacuum hose is connected between the analyzer and pump.

CAUTION

Always turn on the external pump before powering up the analyzer. This ensures a safe start-up sequence.

2. Verify the power cable to vacuum pump is plugged in.
3. Switch power on at the pump.
4. Verify the power cable to the analyzer is fully inserted into the power receptacle.
5. At the analyzer back panel, press the main power switch to the **ON (I)** position.
6. Press the round **On/Standby** button on the rear panel. The LED indicator (Figure 2) illuminates green.

   The software starts automatically, and the analyzer displays the Picarro Launch Pad as shown Figure 25.

NOTE

On a cold start, upon reaching this screen, there will be a 30-second countdown, after which the analyzer will automatically start in CRDS mode, or the previous selection if manually overridden. The user can click anywhere or click any key on the keyboard to stop the countdown. To start the CRDS Data Viewer manually, see the section Home Menu.

When initialization is complete, the CRDS Data Viewer GUI displays and provides displays graphs for N_2O, CO, and H_2O as shown in Figure 22. This section describes the Data Viewer, the analyzer's main screen.

After the Data Viewer loads, the analyzer warms up before starting measurements. During this warmup period the System Alarm box flashes yellow and the Cavity Temperature, Cavity Pressure, and Box Pressure displays. For more information, see section ***6.5 Instrument Status***.

When the analyzer is warm, the data screens switch to displaying N_2O, CO, and H_2O concentrations. The System Alarm box becomes solid green and a 'Measuring…' message displays in the Measurement Status field.

Analyzer initialization is complete, the Data Viewer screen displays, and sampling begins. Figure 22 shows the Data Viewer measurements for nitrous oxide, carbon monoxide, and water.

Data is saved automatically whenever the analyzer produces data. The data displayed on the CRDS is the continuous real time read-out from the analyzer. A user-relevant subset of this data is stored in:

/home/picarro/I2000/Log/Archive/YYYY-MM-DD/DataLog_User/

where Y = year, M = month, D = day. Further details can be found section ***8, File Management***.

In order to measure discrete samples (such as individual gas bags) or from multiple locations (when switching valves draw in ambient air from different heights) a separate software window (coordinator) is used to control the sample source and match the corresponding real time read out with the sample source. Depending on system configuration, coordinator programs may not be included.

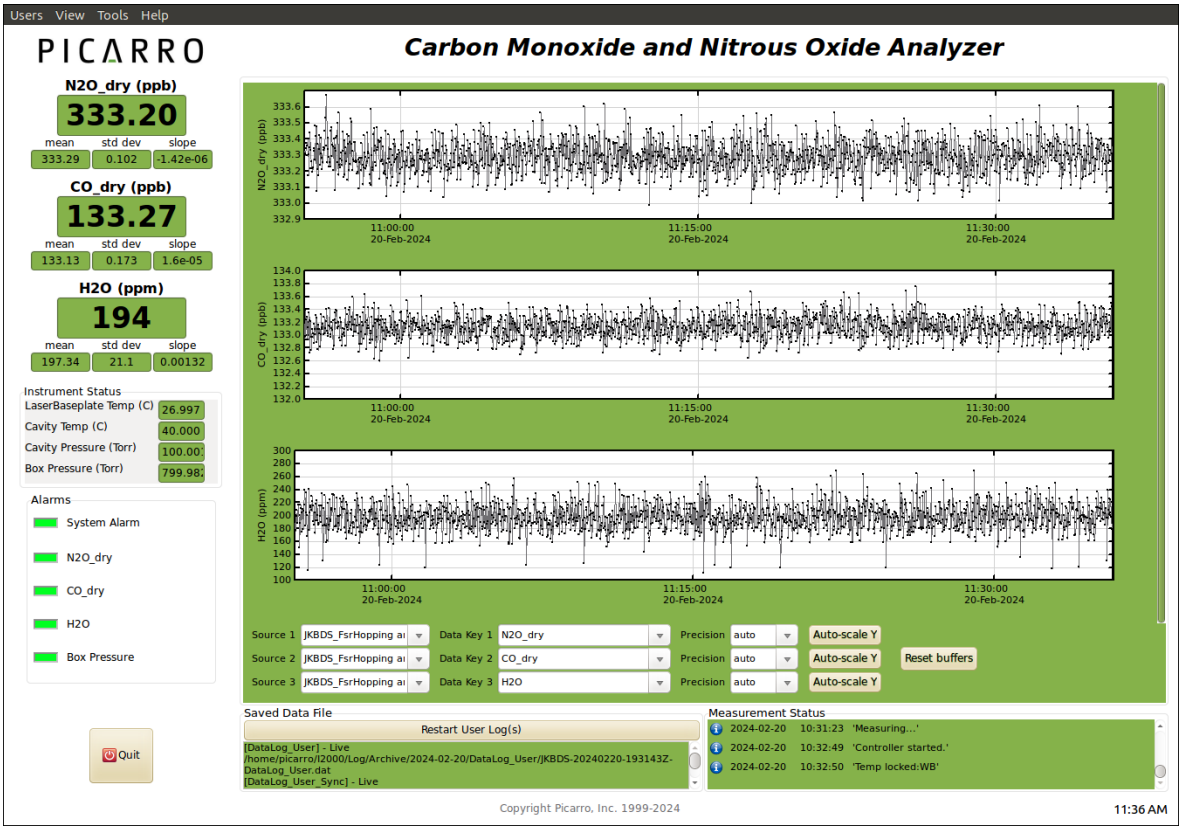


Figure 22: GUI/Data Viewer Screen

5.2 Shutdown

This section describes how to safely shutdown the analyzer using dry gas, closing the CRDS application, and powering off the instrument from the Picarro Launch Pad.

CAUTION

A flow of clean, dry gas should always be directed to the instrument for several minutes prior to shutting down. Trapping a high-moisture content gas sample in the cavity can cause condensation damage to the mirrors as the instrument cools from its operating temperature.

CAUTION

Do not turn off the pump or disconnect the vacuum line while the instrument is operating.

Flow Clean, Dry Gas (When Using an A2000 Pump)

7. With the pump still running, switch to a source of clean, dry gas at the sample inlet and allow it to run until the water channel reading on the GUI falls below 2000 ppm. This will prevent any damage from condensation to the cavity surfaces. This dry gas may be from a tank (target 2-3 PSIG pressure) or from a desiccant column like the DrieRite column, C0360, sold on store.picarro.com).

Shutdown (CRDS Data Viewer)

8. Click on the **Quit** button from the botom left side of the Data Viewer window.
9. A message displays prompting the user to confirm the shutdown. Once confirmed, the analyzer software and hardware will turn off.

   Note you must be logged in to shut down the analyzer.

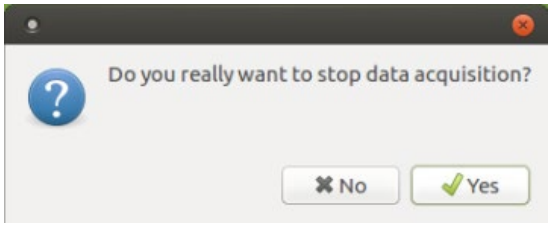


Figure 23: Analyzer Shutdown Dialog

10. Manually turn off the pumps and dry gas only if system requires it.

NOTE

Leave any dry gas or desiccant attached to the inlet during this process.

11. From the Picarro Launch Pad select **Power Off** to tun off the hardware.
12. When the instrument fans audibly turn off, and when the green power button light on the front of the instrument turns off, shut off the pump manually from the rocker switch located on the pump.

5.3 Analyzer Restart after Electrical Power Outage

If power to the analyzer is cut-off for any reason the analyzer will cease operation. However, when the power is reapplied, the analyzer will restart automatically, the Picarro software tools will properly close out previous files and open new files for data collection so that previously collected data, instrument diagnostics and other parameters recorded up to the time of power outage are retained.

If short power outages are common in the user location, Picarro recommends using an uninterrupted power supply (UPS) to protect the data stream and the health of the cavity.

5.4 Picarro Launch Pad

The Picarro Launch Pad is the entry point for starting and using the analyzer. It provides access to the CRDS Data Viewer, tools, configuration settings, and administrative controls for the instrument such as managing user accounts. This section provides an overview of the Picarro Launch Pad's key features with additional information throughout this manual.

Home Menu

When the analyzer is powered on the Picarro Launch Pad automatically starts and displays the Home menu. To manually start the analyzer from the Picarro Launch Pad, single click on the **N2O-CO** button or wait 30 seconds while the acquisition software auto starts and initializes as shown in Figure 24.

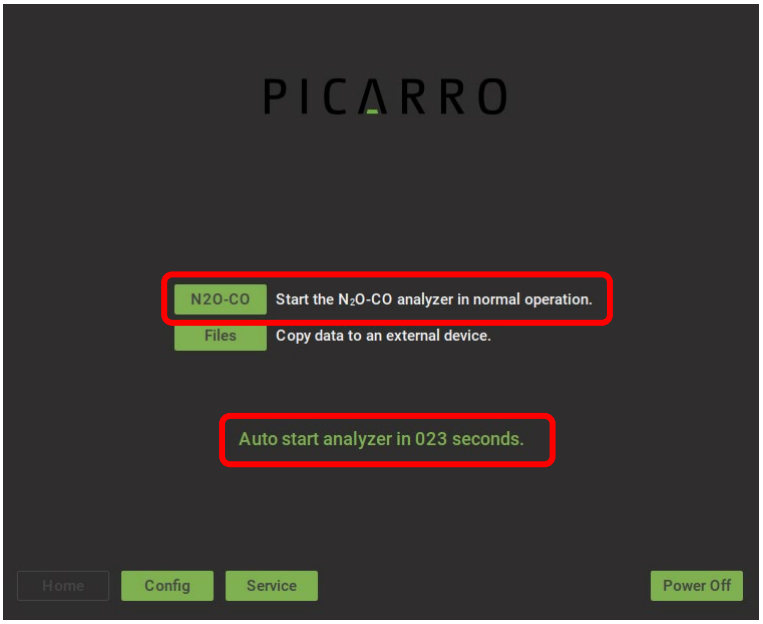


Figure 24: Picarro Launch Pad/Loading Screen

Use the buttons on the Home screen to use the following features as shown Figure 25. The **Files**, **Config**, **Service**, and **Power Off** buttons are password protected to prevent accidental shutdown or configuration changes.

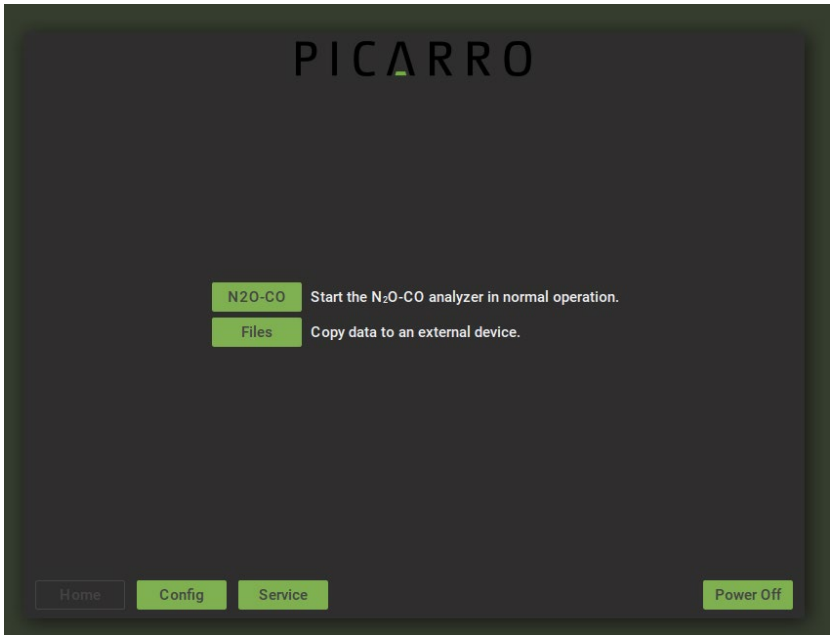


Figure 25: Picarro Launch Pad/Home Menu

The Home menu provides the following options:

- **N2O-CO** – Starts the analyzer in normal operation.
- **Files** – Copies data to an external device (user credentials required). See the following Files Manager section for more information.
- **Power Off** – Performs a soft shutdown (user credentials required).

File Manager

The File Manager is accessible from the Picarro Launch Pad from the Home menu or directly from the CRDS Data Viewer Tools menu using the **Files** button. Follow the procedure to copy data to an external drive.

1. On the home page, click on **Files**.
2. Login using user credentials.
3. Plug in an external USB drive.
4. In the bottom right-hand corner, select mount and choose the desired drive. After selecting, files will be populated on the right side with from the USB drive
5. Using the upper left-hand corner drop down menu, select the type of file: **Data**, **Screenshot**, **User History, Validation Report**.

6. Highlight and select the desired files.
7. Click **Copy** to copy or move to transfer file to USB drive.
8. Unmount the USB drive when file transfer/copy is complete.

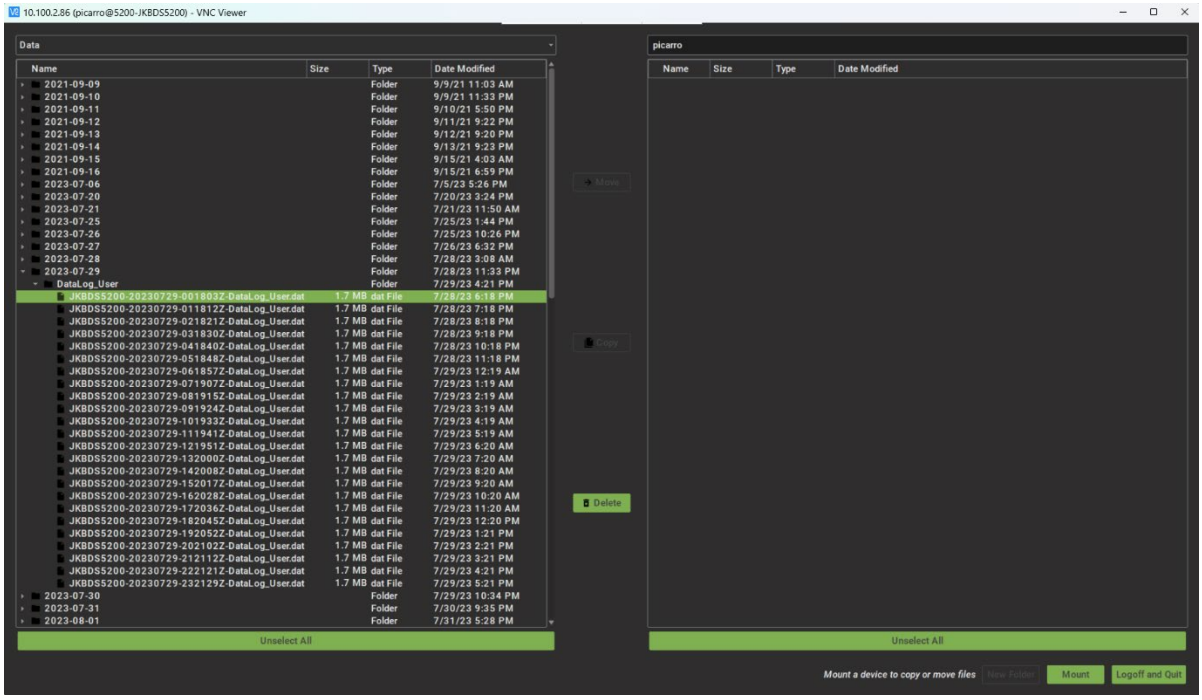


Figure 26: Transfer Files Dialog

Configuration Menu

The Configuration menu provides access to various tools and configuration settings. This section describes the Configuration menu's features and is accessible by performing the following procedure.

1. Shut down the data viewer software by clicking the **Quit** button and allow the analyzer to return to atmospheric pressure and stop measurements.
2. From the home screen, click on the **Config** button to configure the analyzer.
3. Log in with a user name and password. Note a user account with appropriate access is required.

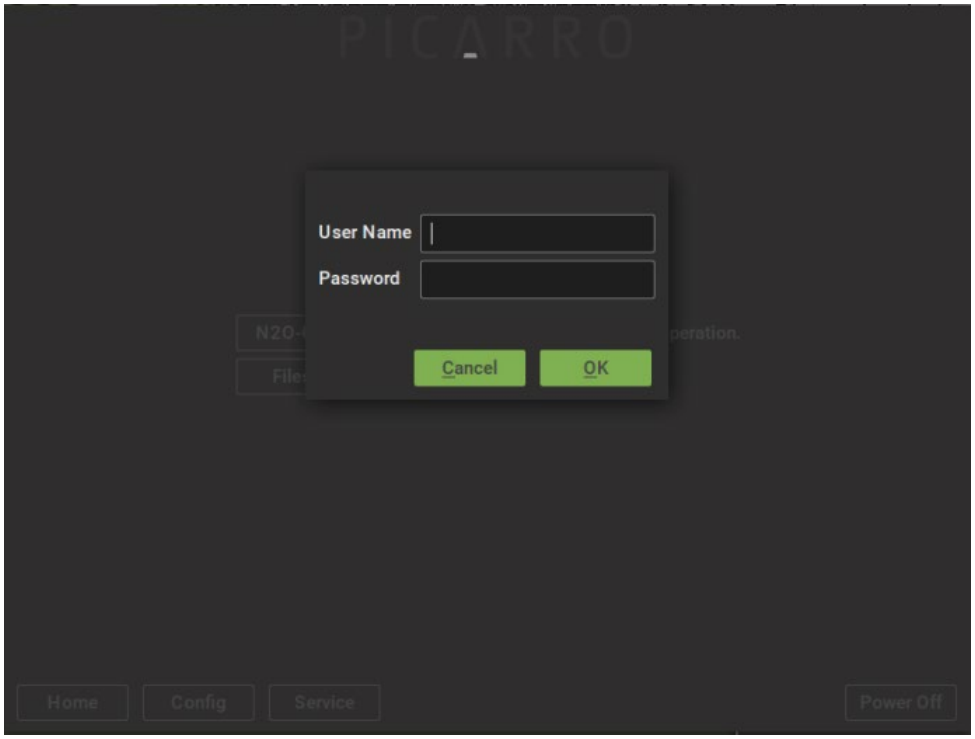


Figure 27: The Config Login Dialog

4. The Configuration Menu displays.

Figure 28: Configuration Menu

NOTE

If the analyzer is operating in measurement mode, only DataViewer and User options are accessible from the Config menu. To access the full menu, restart the analyzer or stop measurement mode by selecting Shift key from the keyboard and clicking the Quit button from the CRDS Data Viewer.

Network

Click the Network button to view the Network Settings Tool. Note requires login.

Figure 29: Login: Network Settings Tool

The Network Settings Tool displays.

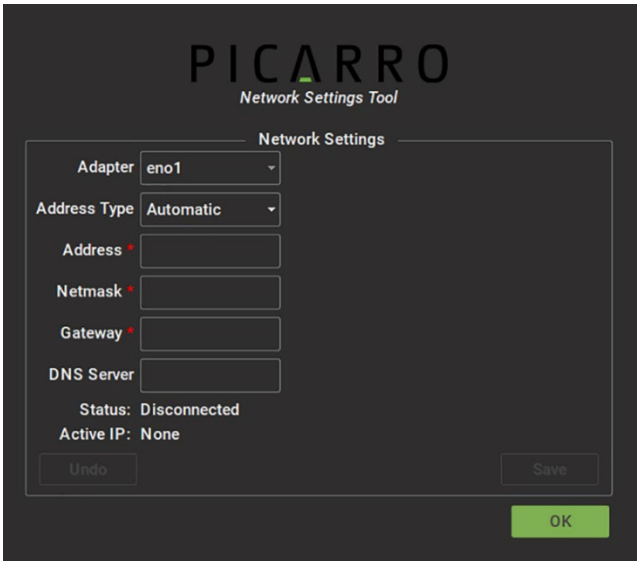


Figure 30: Network Settings Tool

Use the Network menu to:

- Select ethernet adapter
- Select IP address type
- If Static IP is selected, enter the applicable address, netmask, gateway, and/or DNS server
- View the network connection status and active IP address

Clock

Click the **Clock** button; the Set Time and Time Zone dialog displays.

NOTE

The time can only be changed when the analyzer has just been turned on from being completely off, and before the data acquisition warm-up process begins.

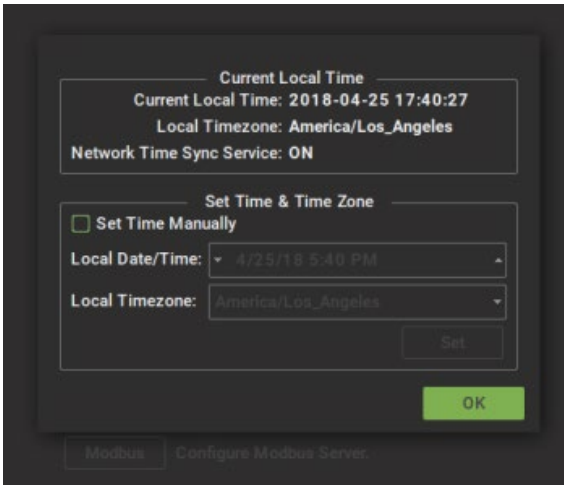


Figure 31: Clock Set Dialog

Use the Clock dialog to:

- Set the clock for a new time zone.
- Manually set the correct time.

Set the Local Time Zone

1. Click on the **Local Timezone** drop-down and select the location you want. The **Local Date/Time** field changes to the date and time for the location you selected.
2. Click **Set** to save the changes and return to the Config menu.

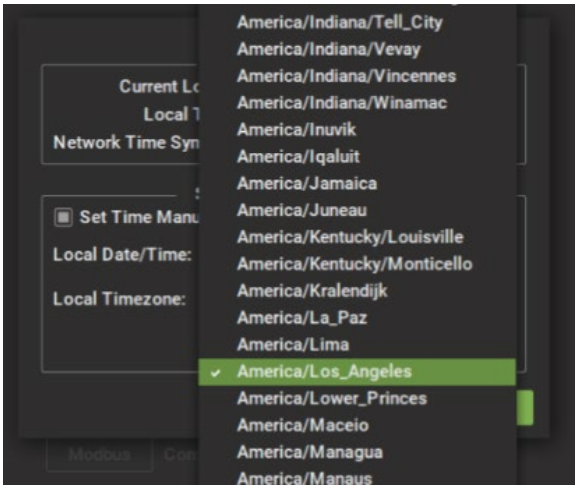


Figure 32: Clock Set Menu

Manually Set the Time

Use the **Set Time Manually** check box to manually reset the clock to the correct date and time when the clock is set to the wrong time.

1. Check the **Set Time Manually** check box.
2. Click **Set** to save the changes and return to the Config menu.

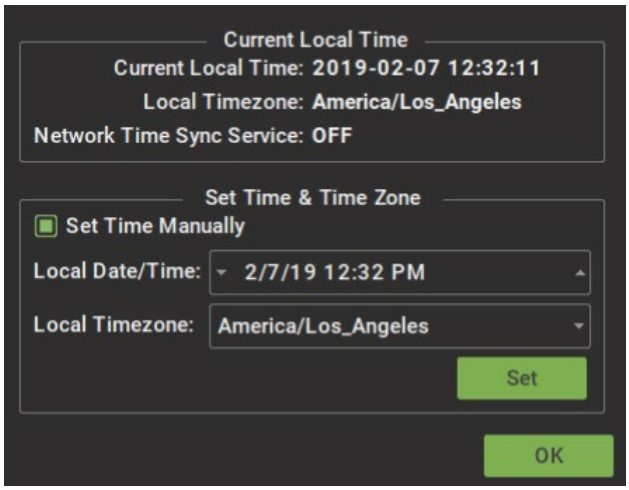


Figure 33: Clock Set Dialog

DatViewer

The Data File Viewer software allows concatenating multiple files into one file to provide historical trends over a specified time of measurement. For detailed information, see ***APPENDIX E – Data File Viewer***.

Serial Port

Allows configuration of the ASCII Serial Port by setting the Data Out and Command Interface parameters that are used for RS-232 serial communication. For more information about the about the Serial Port menu, see ***Chapter 10, Serial Communication.***

Users

Provides access to the User Management Tool for managing user accounts, security settings and user history. Requires a password to obtain entry. For more information, ***Chapter 7, User Management***.

Modbus

Allows configuration of the Modbus communication protocol. For more information, see ***Chapter 9, Modbus Communication***.

Backup Restore

Provides a mechanism for backing up and restoring system settings.

Service Menu

The service menu is password protected and allows for service tasks to be performed by trained Picarro personnel only.

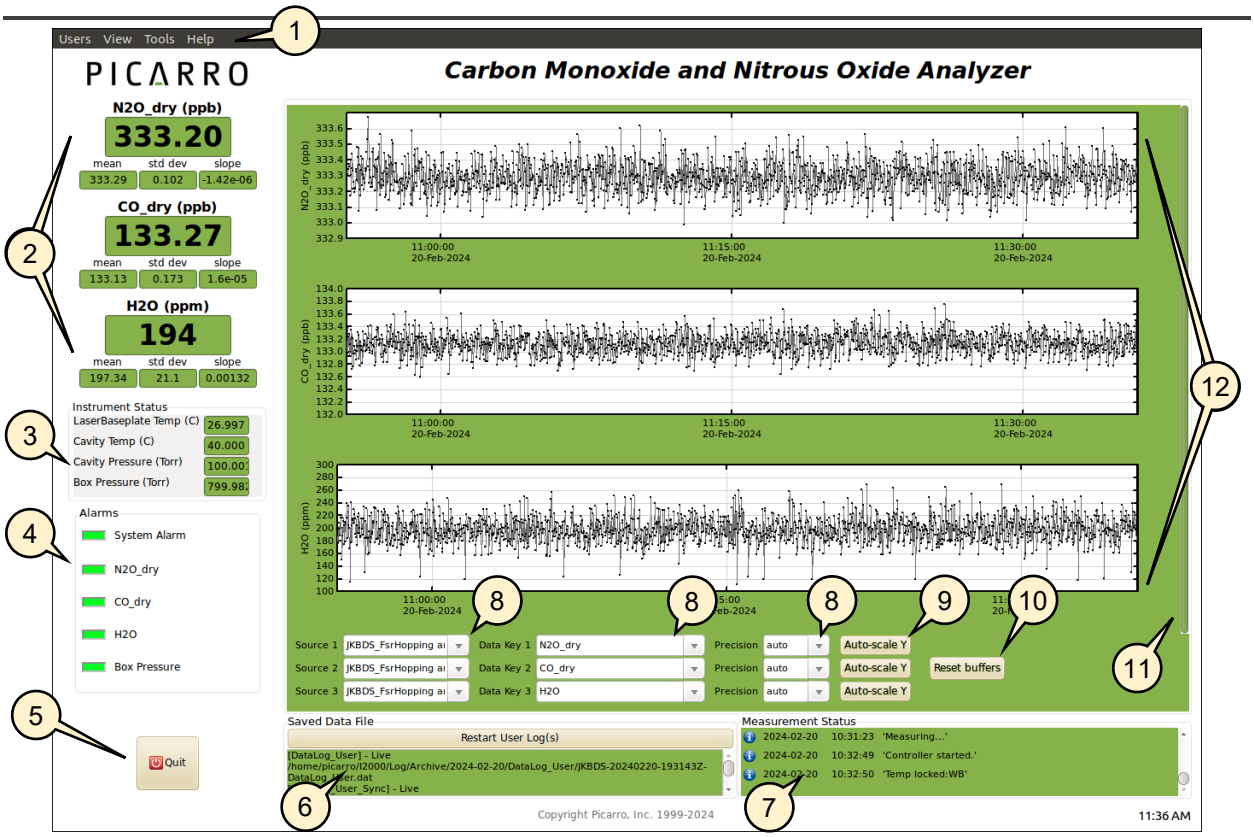
6. List of GUI Functions

NOTE

The illustrations shown in this chapter are for example only. What is shown on your instrument is dependent on the model analyzer in use and may differ.

6.1 GUI Overview

The features of the GUI in Figure 34 are described in the following sections.



1. Users, View, Tools, and Help menus
2. Digital Readouts and Statistics
3. Instrument Status
4. Alarm Panel
5. Quit Button
6. Data Log; Filename, and Path
7. Status Log Window
8. Data Source, Data Key, and Precision pull-down menus for data window content
9. Axis Auto Scaling
10. Reset Data Buffer
11. Data Buffer Level Meter
12. Data Windows

Figure 34: Layout of PI5310 Analyzer GUI

6.2 Users, View, Tools, and Help Menus

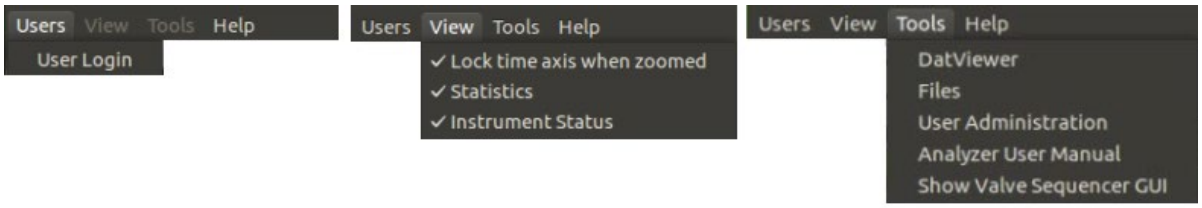


Figure 35: CRDS Toolbar Options

User Menu

Left clicking on the Users menu displays the drop-down User Login or User Logout. Depending on your level of access, different menu items are enabled.

View Menu

The View menu provides the following options that can be enabled. Note that when toggled on, a checkmark displays to indicate the enabled feature.

- **Lock/Unlock time access when zoomed** – When locked, forces the data windows to display the same time scale during zoom.
- **Show/hide Statistics** – Displays the measurement statistics.
- **Show/hide Instrument Status** – Displays the instruments status.

Tools Menu

Use the Tools drop-down menu to plot data, copy data, perform user admin tasks, calibrate the instrument, or show/hide the valve sequencer GUI. The Tools menu features are as follows:

- **DatViewer** – Allows plotting of data saved in *.dat and *.h5 files.
- **Files** – Copies data to an external drive using the File Manager.
- **User Administration** – Provides access to User Management options for managing user accounts, policies, viewing histories and profiles.
- **Analyzer User Manual** – Opens the user manual in PDF format.
- **Show Valve Sequencer GUI** – Toggle to display the external valve sequencer window (use alt-tab to bring it to the front).

Help Menu

About: Displays the version number of the instrument.

6.3 Alarms Panel

This panel is used to monitor the status of the internal instrument alarms. These indicators are gas concentration alarms, such as “N2O Too High/Low” depending on instrument configuration. The gas concentration alarm icons are off (grayed) when the respective concentrations are below a certain value, and they are illuminated red when the respective concentrations are above/below a certain value.

CAUTION

High/low alarm settings are not intended as a safety measure as configured at the factory, either with respect to human health or the health of the analyzer. It is up to the customer to determine the meaning and level of a “high” or “low” value based on their application.

Figure 36: Alarm Panel

Alarm Panel Indicators are colored as follows:

- **System Alarm**:
  - Green when the analyzer is measuring properly
  - Flashing Yellow when the analyzer is warming up
  - Yellow when not warming up properly
  - Red when not operating properly
- **Measurement Range Alarm**:
  - Green when concentration is within analyzer measurement range
  - Red when above analyzer measurement range
- **Custom Range Alarm**:
  - Green when within boundaries set by the user
  - Red when not within boundaries set by the user
  - Grey when alarm is disabled by the user (these are disabled by default)

To view the alarm set points for a gas, click on the indicator next to that gas. The Alarm Set dialog displays.

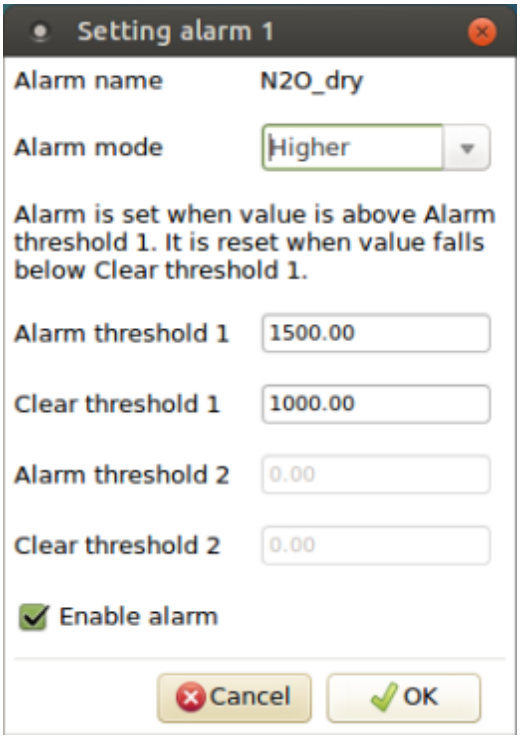


Figure 37: Alarm Set Dialog

This features allows reading or changing the alarm settings and the ability to enable it or change the set point. The indicator illuminates when the concentration goes above the set point and resets (indicator off) below the set point. The alarm modes for gasses are:

- Higher
- Lower
- Inside
- Outside

Type the value you wish to set the alarm to and click the OK button or Cancel if you do not wish to change the alarm value. If you do nothing, the dialog box will disappear, and the alarm value will remain unchanged. The units are those that appear in the GUI graph.

6.4 Digital Readouts

Displays the latest value recorded for the selected Data Key for each Data Window. Changing the Data Key changes the Digital Readout as well as the Data Window view.

If the Show Statistics entry is enabled in the View menu, the mean, standard deviation, and slope of the data in the graph is dynamically calculated and indicated below the digital concentration readout. These numbers change to reflect statistics of whatever data is in the data window. Zooming into a section of existing data will show the statistics statically for that time period, while the digital readout above the statistics continues to update with the latest value. See section ***6.13, Graph Zooming*** for more information.

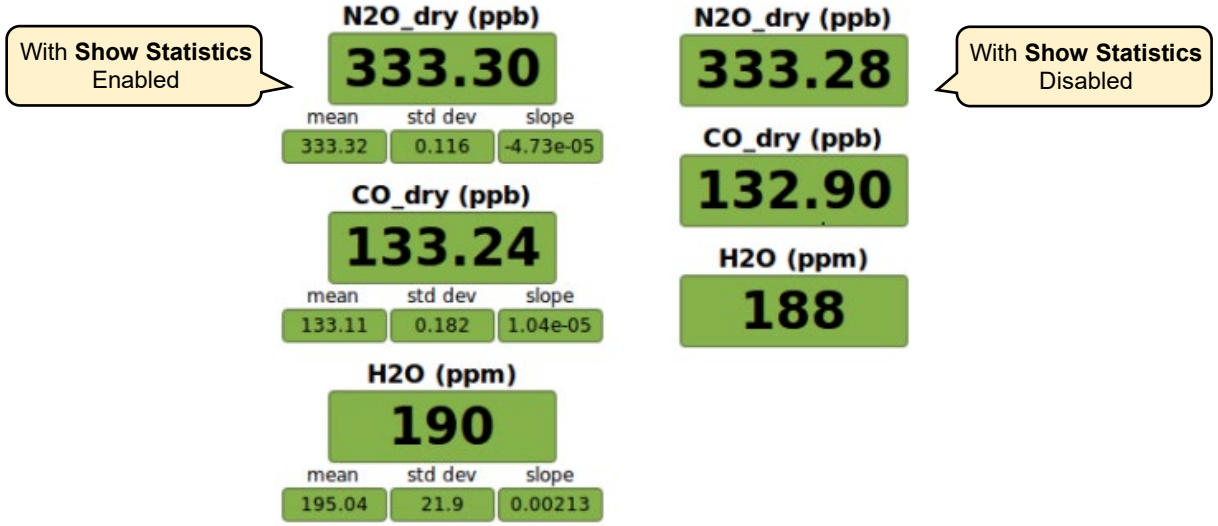


Figure 38: Digital Readouts Panel

6.5 Instrument Status

If these parameters are enabled through the Show Instrument Status entry in the View menu on the main toolbar, digital readouts for Warm Box temperature, Cavity Temperature, Cavity Pressure, and Box Pressure are displayed to the left of the main trend graphs.

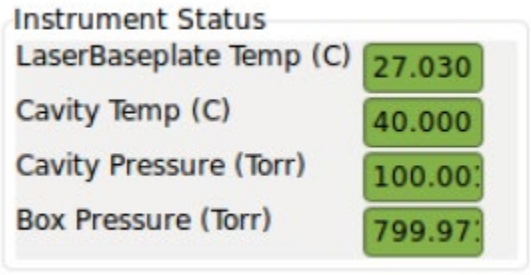


Figure 39: Instrument Status Panel

6.6 Shutdown and Stop User Log(s) Buttons

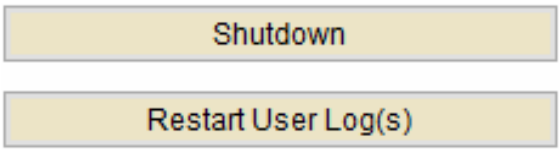


Figure 40: Shutdown/Stop User Log

Quit Button:

Shuts down the analyzer. See section ***5.2 Shutdown***.

Restart User Log(s) Button

The Analyzer automatically records all data collected on the instrument as .dat files. These are described further in section ***8, File Management***.

To start a new data file (time-coded to the current second), click the **Restart User Log(s)** button. The new file name should be visible beneath the button in a few seconds.

Data Log Filename and Path

The filename and path of the active data log is displayed in this pane. The indicator is grayed-out when there is no active data log before gas measurement reporting begins. A new file is generated when the instrument starts reading gas concentrations, (e.g., “153719”) and subsequently at 1 hour increments (e.g., “163719”, “173719”). A new day folder (e.g., “2021\07\16”) will be generated at midnight, as will month and year folders at the appropriate times.

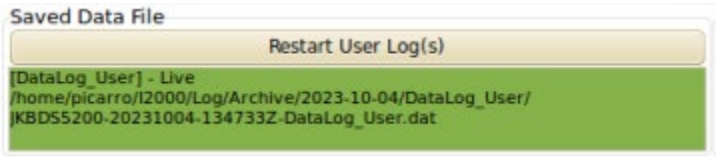


Figure 41: Data Log Filename and Path Panel

6.7 Data Window

The data window displays a graph of any stream of data vs. system time, with a format of hh:mm:ss. The user can select which data streams are displayed using combinations from the **Data Source** and **Data Key** pull down menus. The precision displayed can be adjusted using the Precision menu. Auto-Scaling of the Y-axis is also available. Clicking any **Autoscale** button autoscales its Y-axis if the plot hasn’t done this automatically.

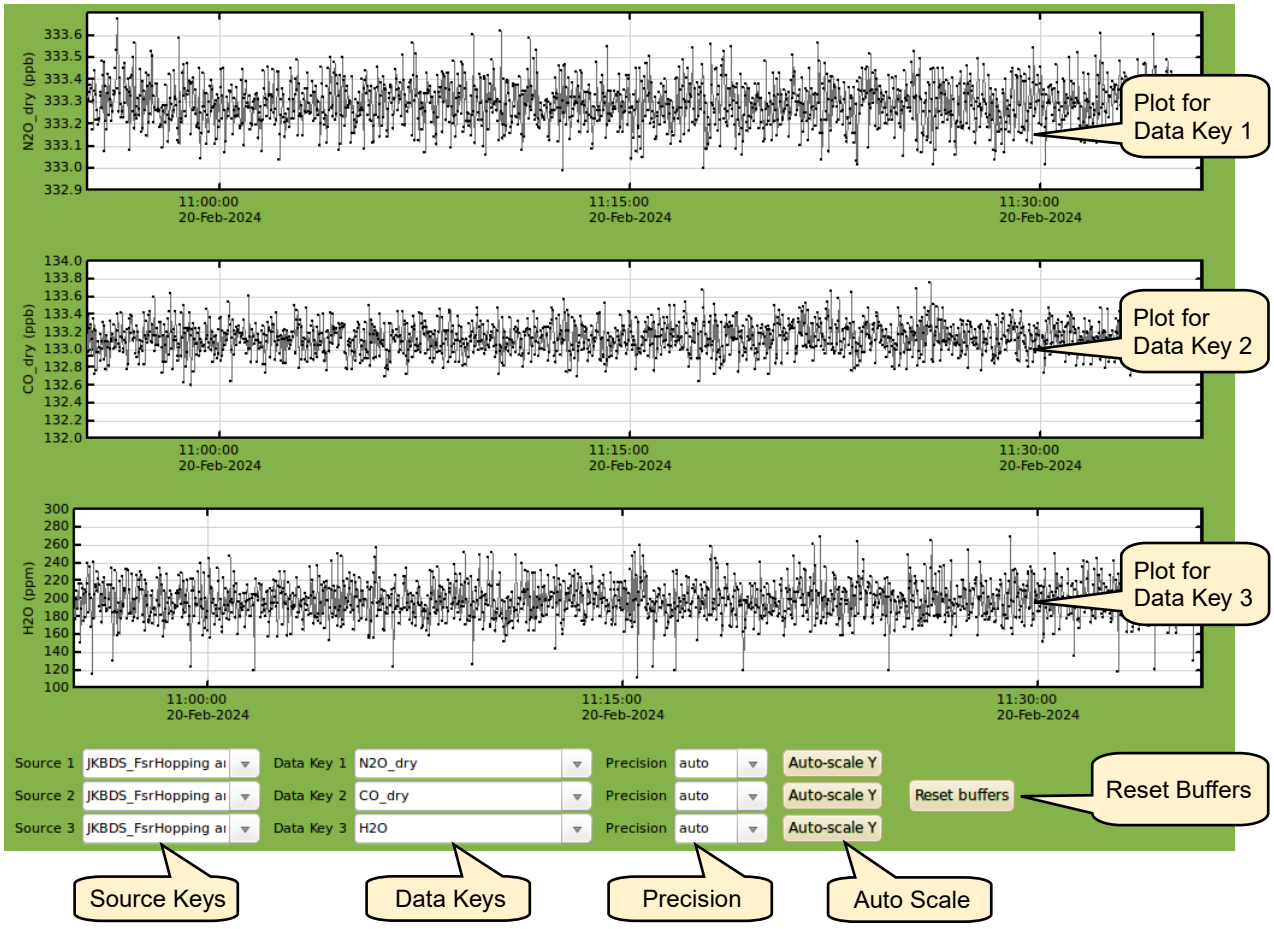


Figure 42: Data Window Panel for N_2O, CO, and H_2O

6.8 Data Source and Data Key Pull Down Menus

Data Source and Data Key menus (Figure 43) enables selection of the data stream that is viewed in the data window.

- Gas concentrations if 'instrument Analysis' (where instrument represents the system installed) is selected.
- Sensor Readings: If "Sensors" is selected, the analyzer's optical cavity pressure or temperature can be viewed, as well as the temperature of the electronics of the analyzer ("DASTemp", not directly controlled), and the temperature of the analyzer's wavelength monitor, indicated as "WarmBoxTemp."

Figure 43: Data Source and Data Key Pull Down Menus

6.9 Precision Pulldown Menu

Click on the pull-down to select the precision displayed on the y-axis; between 0 and 4 digits of precision or auto. The currently selected precision is displayed during operation. This does not affect the precision of the saved data in the data log files or results files. Auto precision is sufficient for nearly all applications.

Figure 44: Precision Pull-down Pane

6.10 Analyzer Status Log

This window displays instrument status messages, in the following form: **YYYY-MM-DD HH:mm:ss**, then '**Generic message text**'.

Common Status Log Messages

Following are the most common messages that appear:

- **Pressure Stabilizing/Locked**: Displayed when the valve control system begins to allow flow through the analyzer and stabilizes the pressure inside the cavity.
- **Temperature Locked**: WB: When the temperatures of the warmbox have stabilized.

  This is typically the longest step in the startup sequence. Startup: Depending on ambient temperature, the analyzer and its hotbox temperature set point, this step may take as little as 20, or as much as 60 minutes. Restart: If the instrument is only stopped briefly, this may take a few seconds to a few minutes.

- **Preparing to Measure**: Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds. The instrument will continue to scan and report concentration measurements until the instrument is shut down.
- **Measuring**: This is the normal mode of operation after startup has completed.

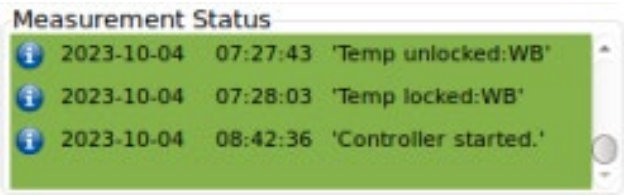


Figure 45: Analyzer Status Log

6.11 Data Buffer Level Meter

The meter to the right of the Data Window (Figure 46) indicates how much of the internal memory of the GUI is used to retain historical data collected with the instrument. There is an internal limit of a finite number of points. Once that number of data points is collected, the buffer is full, and old data is removed from the buffer as new data is collected. This buffer affects only the data displayed in the data window, not the data stored in any files. This buffer is empty upon instrument startup and can also be emptied by pressing the **Reset buffers** button in the lower-right-hand corner of the GUI.

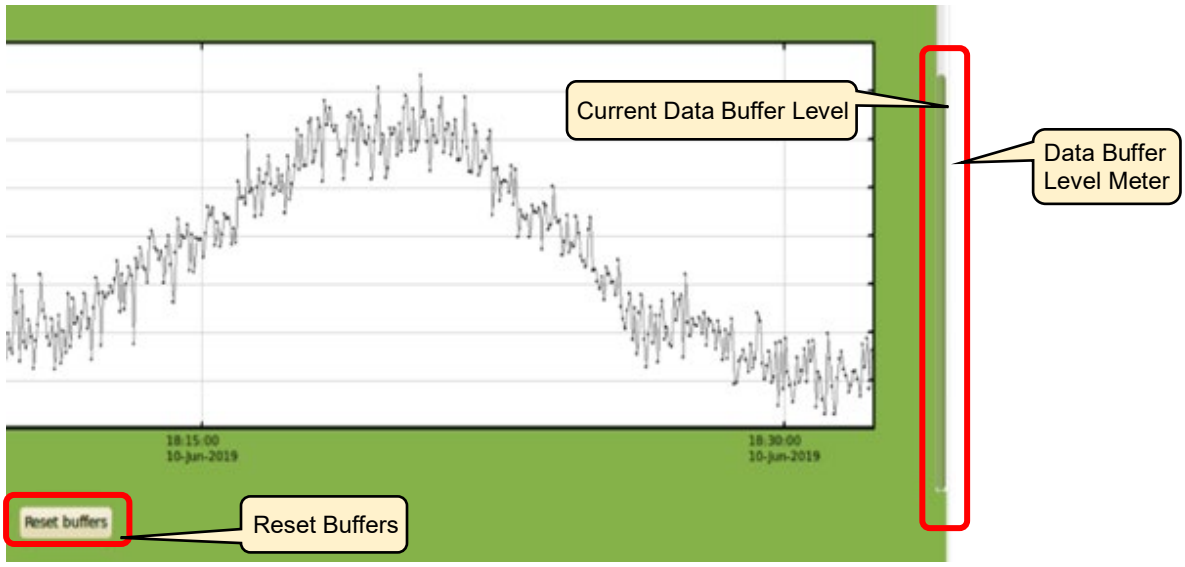


Figure 46: Data Buffer Level Meter and Reset Buffers Button

6.12 Reset Buffers Button

Click the **Reset Buffers** button to clear the internal data buffer of the GUI (this clears the current data traces from the graphs). This has the effect of clearing all data in the data window. Pressing this button has no effect on any of the data log files stored by the instrument.

6.13 Graph Zooming and Panning

Zooming In/Out

To zoom in on a specific region of the graph, move the cursor to the area of interest, **click/hold** the left mouse button, **then drag** as desired to create a box that covers the region of interest (see Figure 47). When the box is drawn, release the left button and the boxed area will automatically scale to fill the data window.

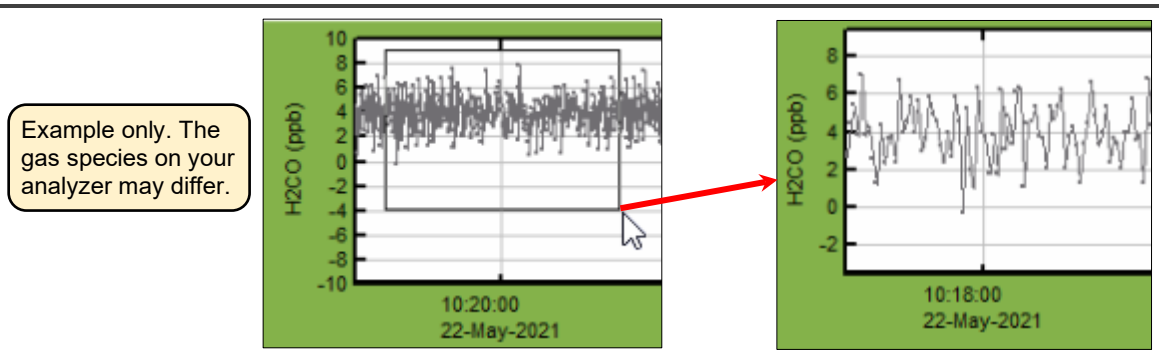


Figure 47: Data Graph Zoom Function

To zoom back out to see all data in the buffer, **double-click the left button** within the graph display. **To zoom out indefinitely**, **right click**. Right clicking multiple times zooms out further. **To auto scale** the y-axis of either graph, use the **Auto-Scale** buttons below the graph as shown in Figure 48.

To Zoom the X and Y axes: hold down the control button and move the cursor up/down or left/right using the right mouse button

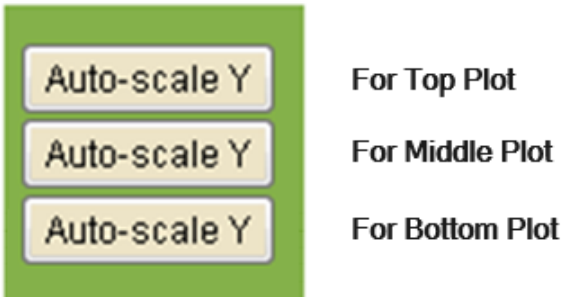


Figure 48: Auto-scale Buttons

Lock/Unlock Time Axis

Zoom and pan features are often useful when time axes are locked, and the user wishes to align the Y axis in multiple plots. To lock or unlock the time axis of each graph during zooming, from the **View** menu, **select Lock time axis when zoomed** or **Unlock time axis**.

Panning

To pan the data in the X or Y axis: hold down the control button and drag the cursor using the left mouse button.

7. User Management

7.1 Overview

User management includes:

- Managing user accounts, such as adding users and changing passwords.
- Setting user policies, such as password requirements and session duration.
- Viewing and saving user histories.

There are three user roles defined in the system: operator, technician, and administrator. The permissions are as follows:

Table 5: User Accounts/Functions

Function	Not Signed In	Operator	Technician	Administrator
View Data Viewer	x	x	x	x
Set Alarms		x	x	x
Configure Data Viewer (partial)		x	x	x
Quit Measuring		x	x	x
Quit (software shutdown)		x	x	x
Configure Data Viewer (full access)				x
User Management				x

User management settings are available from the **Tools** menu in the Data Viewer or by using the **Picarro Launch Pad**. Use one of the following procedures.

From the Data Viewer:

1. From the **Users** menu, select **User Login**.
2. Login as an administrator (default user name is admin; default password is admin).
3. From the **Tools** menu, select **User Administration** to view the User Management a shown in Figure 49.

From Picarro Launch Pad:

1. Select the **Config** and **Users** button.
2. From the **User Management Tool** login as an administrator (default user name is admin; default password is admin).
3. The User Management window displays with the following tabs: **User Accounts**, **User Policies**, and **User History**.

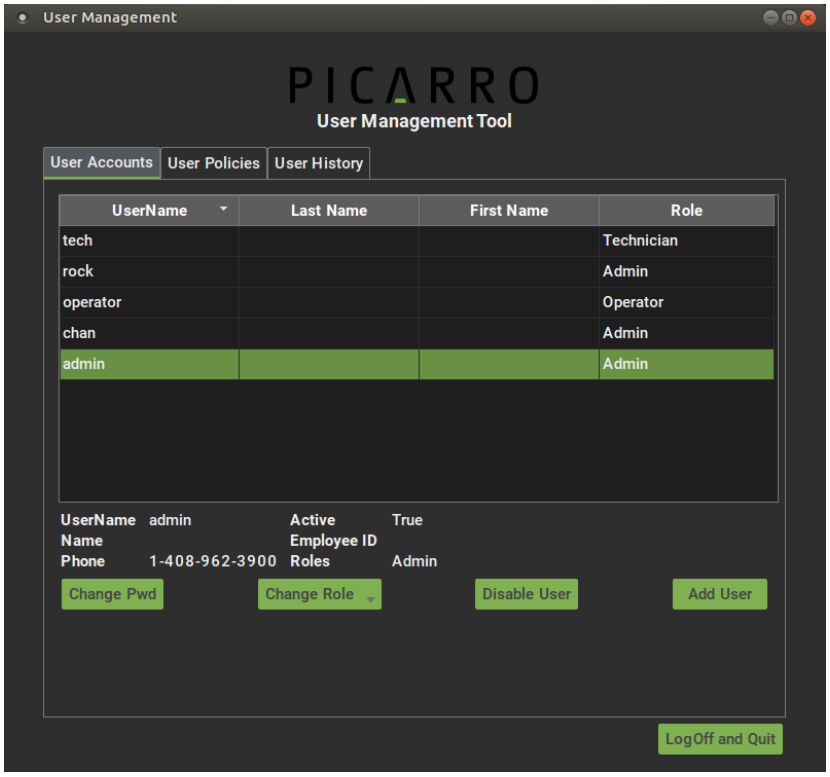


Figure 49: User Management/User Accounts Tab

7.2 Managing User Accounts

The following features are available from the User Accounts tab and are further described in this section:

- Change user passwords
- Change user roles
- Disable users
- Add new users

NOTE

The default user names that are provided with the analyzer are tech, operator, and admin. The default passwords are tech, operator, and admin, respectively. User names and passwords are both case sensitive.

Changing a User Password

1. In the **User Management** window, click the **User Accounts** tab.

   From the list of users, click the user you want to change and select the **Change Pwd** button. The user account information displays.

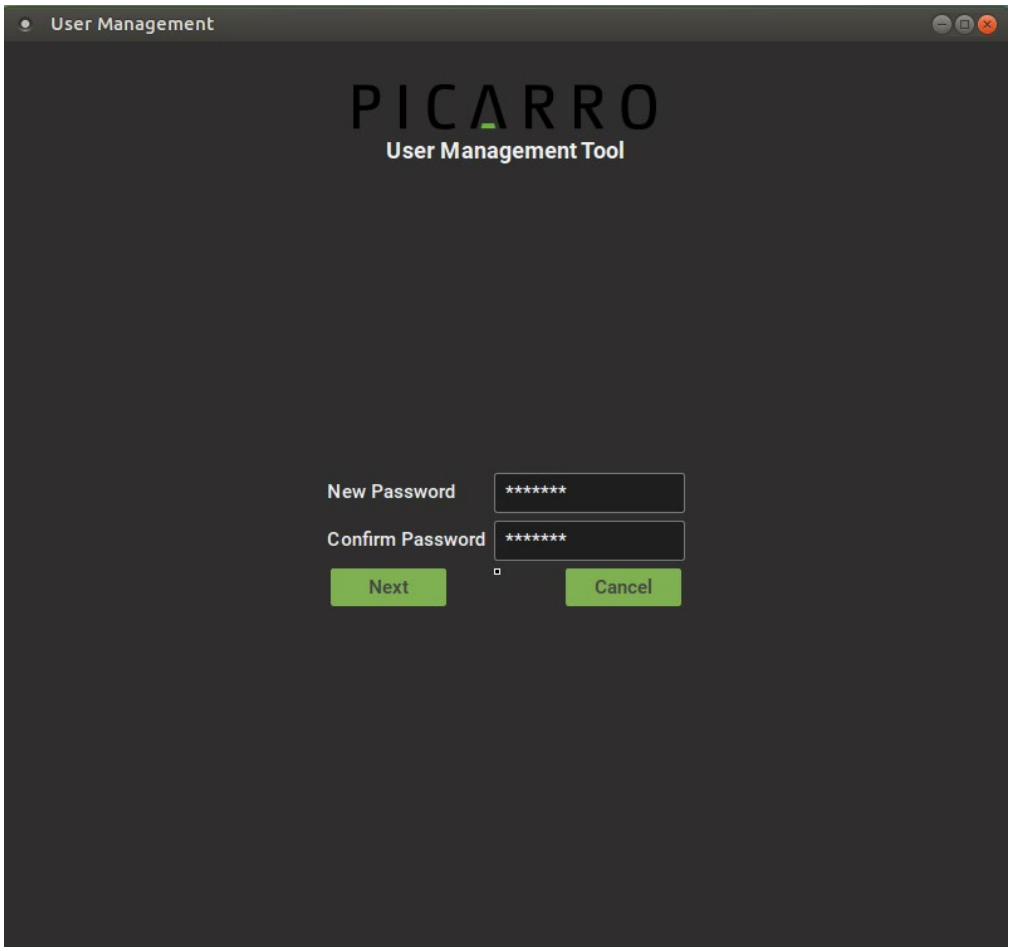


Figure 50: Change Password

3. In the **New Password** field, enter the new password.

   Passwords are case sensitive. Additional rules for passwords can be set in the **User Policies** tab. For more information, see ***7.3 Setting User Policies***.

4. In the **Confirm Password** field, re-enter the password.

5. Click **Next** to save the password

Changing a User's Role

1. In the **User Management** window, click the **User Accounts** tab.
2. From the list of users, click the user you want to change.
3. From the **Change Role** drop-down, select the new role and click **Ok** when prompted.

   The role is now changed to the desired setting.

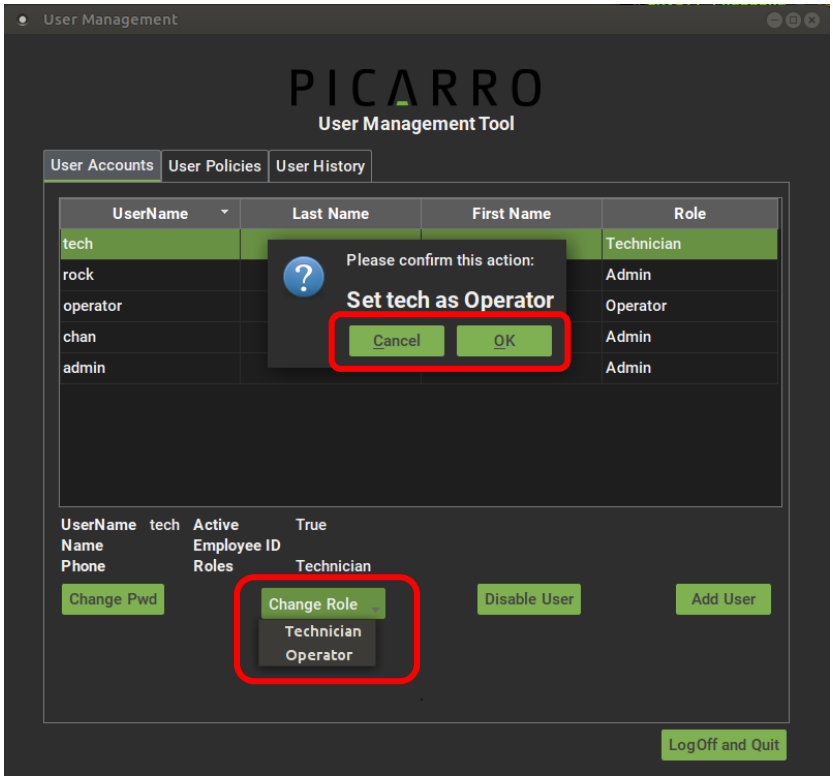


Figure 51: Change Roles

Disabling a User Account

Users cannot be deleted from the system, but they can be disabled to prevent access to the software. See Figure 52 for more information.

1. In the **User Management** window, click the **User Accounts** tab.
2. From the list of users, click a user name.
3. Click **Disable User**; this will prompt you to confirm your choice.
4. Click **OK** to confirm the action.

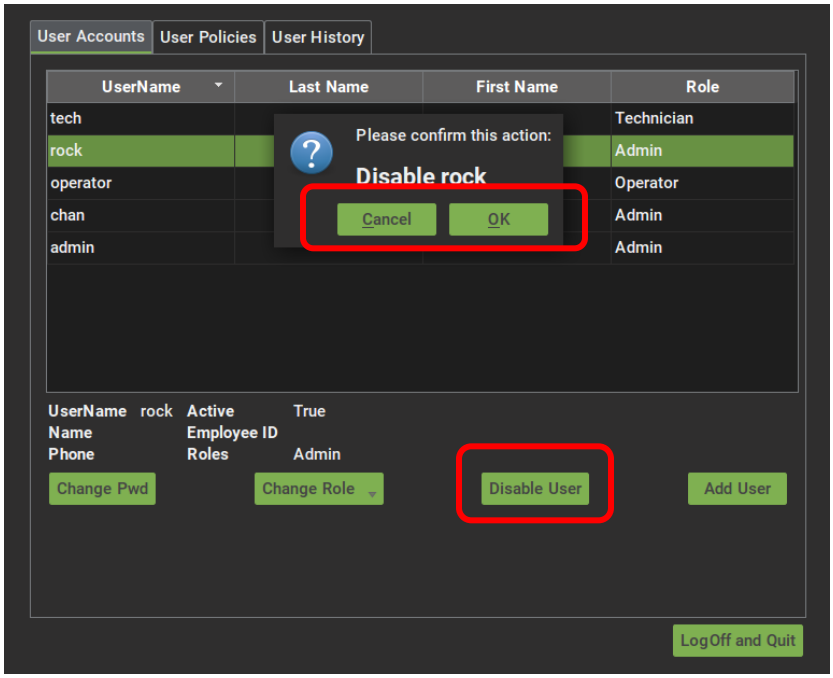


Figure 52: Disable Users

Adding a User

1. In the **User Management** window, click the **User Accounts** tab.
2. Click **Add User**; this will display the Add User screen.

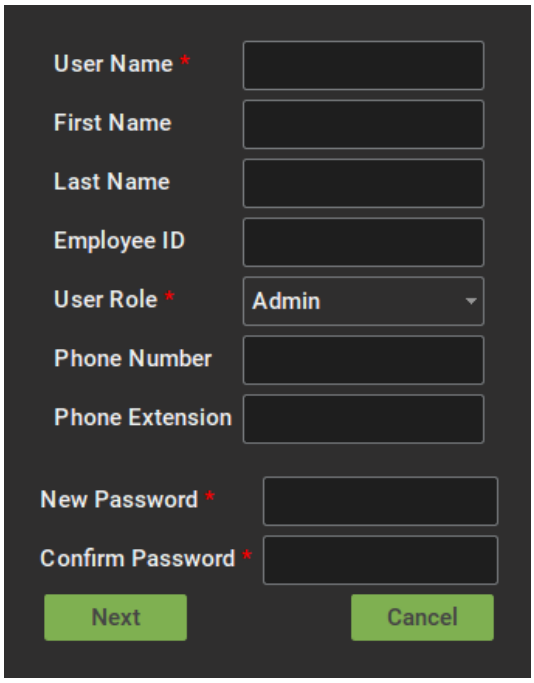


Figure 53: Add User

3. Fill in the fields in the Add User window.
4. Click **Next** to open the New User Account dialog.
5. Review the user information and click **OK** to accept or **Cancel** to go back and edit the information.

7.3 Setting User Policies

1. In the User Management window, click the **User Policies** tab.
2. Make any changes. For more information, see the following section **User Policy Descriptions**.
3. Click **Save**. If you typed an incorrect value and want to undo any changes and revert back to the last saved configuration, click **Revert**.

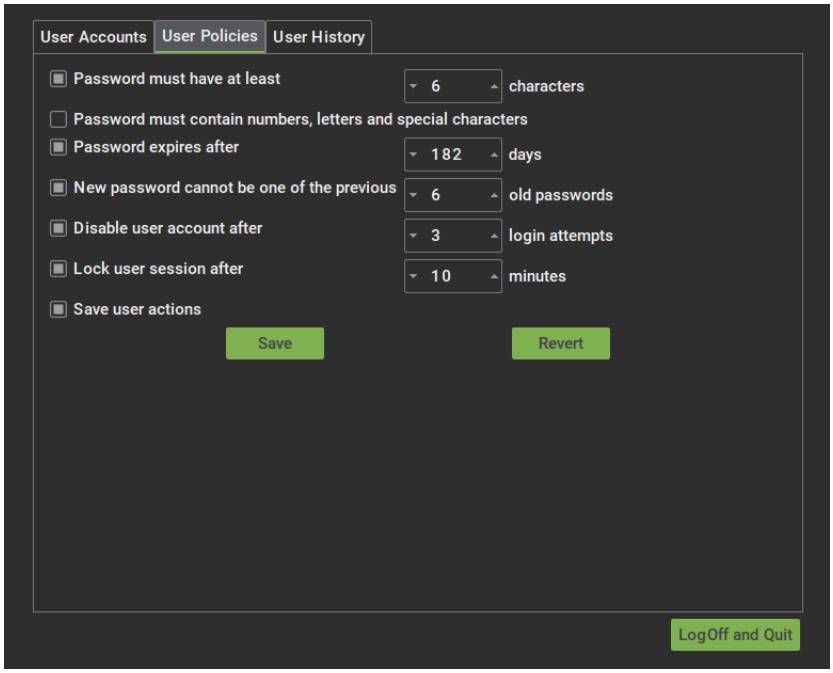


Figure 54: User Policies Tab

User Policy Descriptions

The following table provides descriptions for the various user policies.

Table 6: User Policies

Policy	Description
Password length	Specify that the length of passwords (6–15 characters) or turn off the length requirement.
Password complexity	When selected, all new passwords must have at least one number, one letter, and one special character. This will not impact existing passwords.
Password expiration	When selected, any passwords that reach the selected maturity will expire. Any user signing in with an expired password will be required to create a new password.
Previous passwords	When set, prevents a user from reusing a recent password. The system can remember up to 10 old passwords.
Limit login attempts	Tell the system to disable a user account after a set number of failed password attempts. The failed attempts are counted until the user successfully logs in. Once disabled, an admin will have to enable the account.
Lock session	When set, the system will automatically logoff any user after a set period of inactivity, requiring the user to sign in again.
Change password	Allows the user to change their own password.
Change phone number	Allows the user to change phone number and restrictions.
Change email	Allows user to change their email address.
Change name	Allows the user to change first and last name.
Save user actions	When enabled, user actions (such as logging in) will be saved in the User History.

7.4 Viewing User History

1. In the User Management window, click the **User History** tab to see a list of all the logged events.

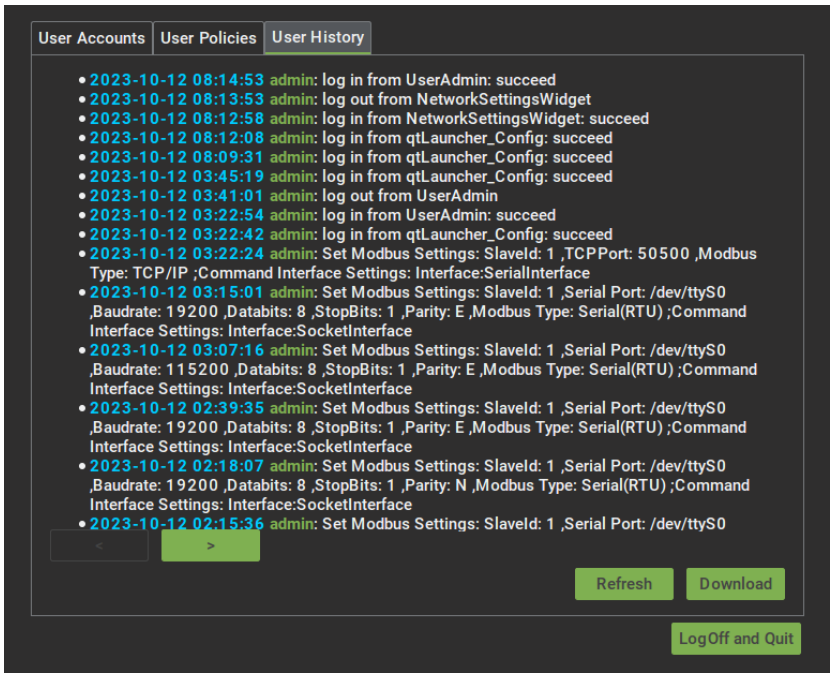


Figure 55: User History Tab

2. Click the < and > buttons to navigate through the history (if the button is grayed out, then there are no additional pages).
3. To make sure the content is up to date, click **Refresh**.
4. To copy the user history onto a USB drive, click **Download**. This laucnhes the File Manager, which will prompt to login. See File Manager on page 45 for details on copying files from the analyzer.

8. File Management

The Picarro Analyzer generates ASCII-format text output files that are updated after each batch of concentration measurements is complete. The data files are stored primarily in DataLogger folders and are also mirrored in folders which retain more situational data. Some analyzers also produce discrete measurements stored in separate isotope data folders. All user data is archived, compressed, and retained, either shortly after the measurements or at a later point, to optimize space on the hard drive.

8.1 Data Archive

The archive directory is:

/Home/Picarro/I2000/Log/Archive

This archive stores daily measurement and RDF data. Each folder is designated by date (YYYY-MM-DD) and has subdirectories:

DataLog_Private, **DataLog_User**, **EventLogs**, and **WBCAL**.

The Data Log files are in a simple text format (white-space delimited) with a DAT file extension. By default, each file stores one hour of data.

Certain instruments may contain additional sub-folders under: /Home/UserData relating to time synced file formats, soil flux, or GPS data, among others. If the user has any questions about this file structure, they can contact Picarro Support.

There are complete data files which include additional information beyond the concentration data including parameters such as instrument temperatures and pressure, set points and spectroscopic information. This information is generally not useful to the user, but can be useful for diagnostic purposes and is stored in the following directory:

home/picarro/I2000/Log/Archive/yyyy-mm-dd/DataLog_Private

The archive files are in a HDF5 format, a more efficient data storing format with an .h5 file extension.

8.2 Data File Name

The file name is generated from the analyzer serial number, the date, and the time when the file was started. The specific time stamp will depend upon the time the instrument was started and began measuring sample gas, so files seldom begin exactly at the top of the hour. For example:

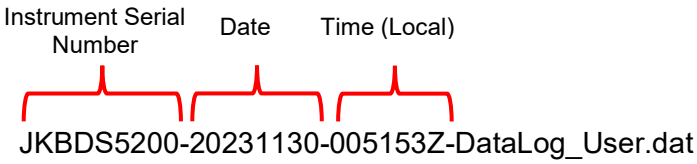


Figure 56: Example Data File Name

- **JKBDS5200** is the analyzer serial number
- **20231130** is the date, in format yyyymmdd (to allow chronological sorting of data files).
- **005153** is the time the file was started in the computer's local time 00:51:53, formatted as hhmmss using a 24-hour clock. Note that the time stamp of samples within the file is usually recorded in UTC (GMT) relative to the local time. For example, an analyzer in California will usually have a time stamp (UTC) within the file that is 8 hours ahead of the time stamp in the file name itself (UTC - 8).

8.3 File Archiving

Picarro instruments will not delete data. Some instruments will, however, compress and archive older data to conserve hard drive space. Raw data file archiving frequency and details can be modified in the file:

Home/Picarro/I2000/AppConfig/Config/Archiver/Archiver.ini.

CAUTION

To avoid losing data, discuss with Picarro support before attempting any changes to the Archiver.ini file.

For each file type, there are various items along with some recommended default settings which may vary by file type:

- **Directory = */Home/Picarro/I2000/Log/Archive***

  Optionally specifies which directory to find files to archive.

- **MaxCount = -1**

  Specifies how many files to keep. A setting of -1 indicates that there is no maximum number of files. Generally, -1 is used in conjunction with a maximum size limit, below.

- **MaxSize_MB = 1500**

  Specifies that a maximum of 1.5 GB of data is to be kept before the system begins to archive old data.

- **Compress = True/False**

  Specifies if archived files are to be zipped – recommended setting is true to save hard drive space. True means files are zipped, false means files are not zipped.

- **AggregationCount = 0**

  If compression is set to TRUE, specifies how many files to be included in each zip archive.

- **StorageMode = FIFO**

  First in first out. Specifies that old data is archived first.

- **Quantum = 4**

  Generally, should not be changed. Specifies the files to be sorted by year\month\day\hour in the archived directory structure.

9. Modbus Communication

Modbus is a client/server data communication protocol to support communication to and from multiple devices connected to the same cable. Modbus can be configured for TCP/IP on port 50500 or RTU utilizing the analyzer's COM1 port. See the following section on how to configure Modbus communication.

9.1 Configuring Modbus Communication

1. From the Picarro Launch Pad, select **Config** followed by the **Modbus** button to configure the Modbus server as shown in Figure 57.

NOTE

Note the Config menu requires login to access the configuration menu. Log in with a user name and password.

Figure 57: Settings/Modbus Configuration

This displays the Modbus Settings window shown in Figure 58.

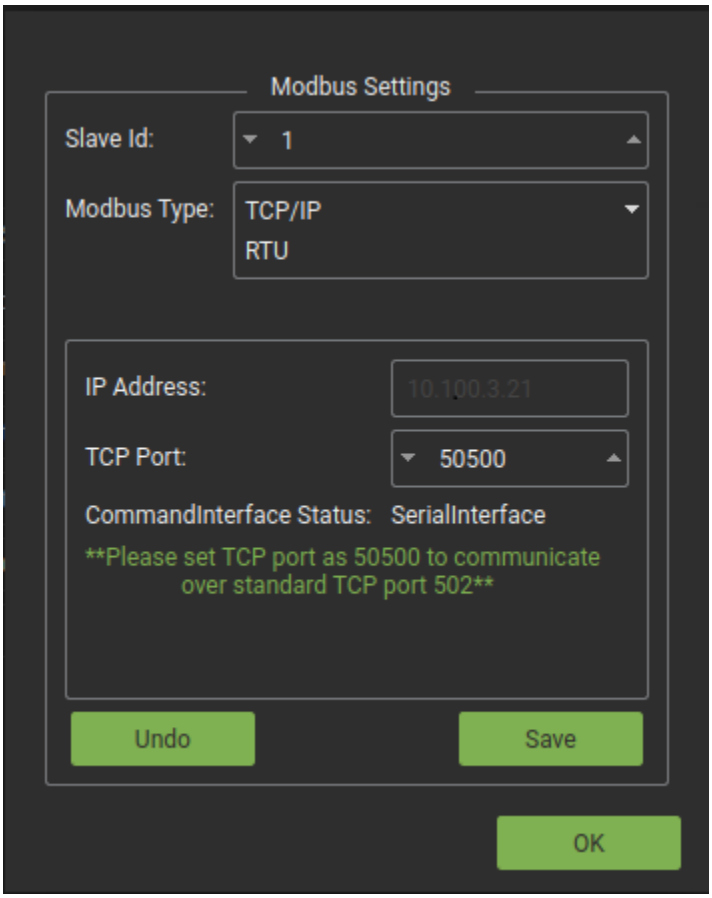


Figure 58: Modbus Settings Window

From the Modbus Settings window the following configuration options are available:

- **Slave ID** – The analyzer's Slave ID.
- **Modbus Type** – Modbus Communication Protocol: TCP/IP or RTU. For more information, see section ***9.2 Modbus Data Registers Overview and Setup***.

TCP Port – Designates the TCP port if TCP/IP is selected.

Additionally, the window displays the CommandInterface Status. However, if Modbus Type is set to RTU, then the CommandInterface on COM 1 is disabled.

9.2 Modbus Data Registers Overview and Setup

This section describes the basic types of MODBUS data registers and setup information.

Table 7: MODBUS Register Types

Name	Size	Access
Input Register	16 bits	Read-only
Holding Register	16 bits	Read-write
Discrete Input	1 bit	Read-only
Coils	1 bit	Read-write

Setup Notes for Modbus TCP

- MODBUS is configured for TCP/IP on port 50500.
- When MODBUS is configured on port 50500, communication is also possible via port 502.
- If MODBUS is configured as TCP/IP and the IP address of analyzer is changed, the user needs to restart the host application to run MODBUS with the updated IP address.
- MODBUS over TCP/IP does not support privileged ports (0 to 1023), except for port 502.

Setup Notes for Modbus RTU

- MODBUS RTU uses the analyzer's COM1 port.
- To establish connection between master and slave over MODBUS RTU, user needs to establish connection using "Straight Through Cable".
- When MODBUS is configured for RTU, CommandInterface on COM1 will be disabled.

9.3 Modbus Register Maps Overview

- Data returned is in big endian format if it utilizes more than one Modbus register.
- If input register functionality is not available for a given analyzer type, the instrument will return value as "NaN" for float values and "False" for 1-bit registers.

- Memory map is continuous memory. If a user tries to read a register address for which functionality is not available, it will return “0”. For example, reading address “0” for coil registers returns “0” since the address does not exist.
- If a user tries to read a register address outside of maximum register memory map, the request will return an exception. For example, reading address 156 for coil register will return exception code “0x02” (Illegal address).
- System time is in milliseconds since 0001-01-01 AD.

9.4 Input Register Map

Most of the readings in Picarro analyzer are the float type and need 32-bit data. Each parameter utilizes two registers, out of which the first one will be storing MSB and the second one will be storing the LSB of the float number.

Table 8: Input Registers

Address	Description	Units	Type	Comments
1-6	Time stamp	Unitless	String	Long value return as 12byte string. Date will be in format YYMMDDHHMMSS
7-8	N2O Concentration	ppb	Float	
9-10	N2O_ID	ppb	Integer	8 for N_2O
11-12	N2O_30sec	ppb	Float	
13-14	N2O_2min	ppb	Float	
15-16	N2O_5min	ppb	Float	
17-18	N2O_Maximum	ppb	Float	
19-20	N2O_Minimum	ppb	Float	
21-22	CO Concentration	ppb	Float	
23-24	CO_ID	ppb	Integer	5 for CO
25-26	CO_30sec	ppb	Float	
27-28	CO_2min	ppb	Float	
29-30	CO_5min	ppb	Float	
31-32	CO_Maximum	ppb	Float	
33-34	CO_Minimum	ppb	Float	

Address	Description	Units	Type	Comments
35-36	H2O Concentration	ppm	Float	
37-38	H2O_ID	ppm	Integer	0 for H_2O
39-40	H2O_30sec	ppm	Float	
41-42	H2O_2min	ppm	Float	
43-44	H2O_5min	ppm	Float	
45-46	H2O_Maximum	ppm	Float	
47-48	H2O_Minimum	ppm	Float	
49-200	Reserved			
201-202	CavityPressure	Torr	Float	
203-204	CavityTemp	oC	Float	
205-206	DasTemp	oC	Float	
207-208	EtalonTemp	oC	Float	NaN
209-210	WarmBoxTemp	oC	Float	NaN
211-212	OutletValve	Unitless	Integer	
213-214	Gas1_instrCal_slope	Unitless	Float	NaN
215-216	Gas1_instrCal_offset	Unitless	Float	NaN
217-218	Gas1_userCal_slope	Unitless	Float	NaN
219-220	Gas1_userCal_offset	Unitless	Float	NaN
221-222	Gas2_instrCal_slope	Unitless	Float	NaN
223-224	Gas2_instrCal_offset	Unitless	Float	NaN
225-226	Gas2_userCal_slope	Unitless	Float	NaN
227-228	Gas2_userCal_offset	Unitless	Float	NaN
229-230	Gas3_instrCal_slope	Unitless	Float	NaN
231-232	Gas3_instrCal_offset	Unitless	Float	NaN
233-234	Gas3_userCal_slope	Unitless	Float	NaN
235-236	Gas3_userCal_offset	Unitless	Float	NaN
237-238	Gas4_instrCal_slope	Unitless	Float	NaN
239-240	Gas4_instrCal_offset	Unitless	Float	NaN
241-242	Gas4_userCal_slope	Unitless	Float	NaN
243-244	Gas4_userCal_offset	Unitless	Float	NaN

Address	Description	Units	Type	Comments
245-300	Reserved			
301-302	Etalon1	Unitless	Float	NaN
303-304	Etalon2	Unitless	Float	NaN
305-306	Ratio1	Unitless	Float	NaN
307-308	Ratio2	Unitless	Float	NaN
309-310	Reference1	Unitless	Float	NaN
311-312	Reference2	Unitless	Float	NaN
313-386	Reserved			
387-388	Errors	Integer	Float	
389-390	Measurement_Status	Integer	Float	

9.5 Discrete Input Register Map

The following table describes the discrete input registers. Please note the following:

- All data unit are unitless unless otherwise noted.
- All data types are floats unless otherwise noted.
- All unused addresses are reserved.

Table 9: Discrete Input Registers

Address	Description
1	MasterSystemStatus
2-5	Reserved
6	CavityPressureStatus
7	CavityTempStatus
8	WarmBoxTempStatus
9-72	Reserved
73	Incomplete_GAS1_spectrum
74	Incomplete_GAS2_spectrum
75	Incomplete_GAS3_spectrum
76	Incomplete_GAS4_spectrum

Address	Description
77	Incomplete_GAS5_spectrum
78	Incomplete_GAS6_spectrum
79	Incomplete_GAS7_spectrum
80	Incomplete_GAS8_spectrum
81	GAS1_baseline
82	GAS2_baseline
83	GAS3_baseline
84	GAS4_baseline
85	GAS5_baseline
86	GAS6_baseline
87	GAS7_baseline
88	GAS8_baseline
89	GAS1_performance
90	GAS2_performance
91	GAS3_performance
92	GAS4_performance
93	GAS5_performance
94	GAS6_performance
95	GAS7_performance
96	Reserved

9.6 Holding Register Map

The following table describes the holding registers.

Table 10: Holding Registers

Address	Description	Type	Comments
1-4	SystemTime	Integer	Integer representing milliseconds from 1AD January 1st to now
5-8	UserName	String	
9-12	Password	String	

Address	Description	Type	Comments
13-200	Reserved		
201-202	User data 1	Float	
203-204	User data 2	Float	
205-206	User data 3	Float	
207-208	User data 4	Float	
209-210	User data 5	Float	
211-212	User data 6	Float	
213-214	User data 7	Float	
215-216	User data 8	Float	
217-218	User data 9	Float	
219-220	User data 10	Float	
221-222	User data 11	Float	
223-224	User data 12	Float	
225-226	User data 13	Float	
227-228	User data 14	Float	
229-230	User data 15	Float	
231-232	User data 16	Float	
233-234	User data 17	Float	
235-236	User data 18	Float	
237-238	User data 19	Float	
239-240	User data 20	Float	

9.7 Coil Register Map

Table 11: Coil Register Map

Address	Description	Type	Function
1	EnergizeSolenoidValve1	Float	get_system_time
2-115	Reserved	Float	
116	ShutDownHost	Float	MODBUS_ParkInstrument
117	ShutDownInstrument	Float	MODBUS_ShutdownInstrument

Address	Description	Type	Function
118-150	Reserved		
151	GetTime	Float	get_system_time
152-154	Reserved		
155	SetPassword	Float	Change_UserPassword
156	Logout	Float	MODBUS_UserLogoff
157-200	**Reserved**		
201	GetUserData_1	Float	GetUserData_1
202	SetUserData_1	Float	SetUserData_1
203	GetUserData_2	Float	GetUserData_2
204	SetUserData_2	Float	SetUserData_2
205	GetUserData_3	Float	GetUserData_3
206	SetUserData_3	Float	SetUserData_3
207	GetUserData_4	Float	GetUserData_4
208	SetUserData_4	Float	SetUserData_4
209	GetUserData_5	Float	GetUserData_5
210	SetUserData_5	Float	SetUserData_5
211	GetUserData_6	Float	GetUserData_6
212	SetUserData_6	Float	SetUserData_6
213	GetUserData_7	Float	GetUserData_7
214	SetUserData_7	Float	SetUserData_7
215	GetUserData_8	Float	GetUserData_8
216	SetUserData_8	Float	SetUserData_8
217	GetUserData_9	Float	GetUserData_9
218	SetUserData_9	Float	SetUserData_9
219	GetUserData_10	Float	GetUserData_10
220	SetUserData_10	Float	SetUserData_10
221	GetUserData_11	Float	GetUserData_11
222	SetUserData_11	Float	SetUserData_11
223	GetUserData_12	Float	GetUserData_12
224	SetUserData_12	Float	SetUserData_12

Address	Description	Type	Function
225	GetUserData_13	Float	GetUserData_13
227	GetUserData_14	Float	GetUserData_14
228	SetUserData_14	Float	SetUserData_14
229	GetUserData_15	Float	GetUserData_15
230	SetUserData_15	Float	SetUserData_15
231	GetUserData_16	Float	GetUserData_16
232	SetUserData_16	Float	SetUserData_16
233	GetUserData_17	Float	GetUserData_17
234	SetUserData_17	Float	SetUserData_17
235	GetUserData_18	Float	GetUserData_18
236	SetUserData_18	Float	SetUserData_18
237	GetUserData_19	Float	GetUserData_19
238	SetUserData_19	Float	SetUserData_19
239	GetUserData_20	Float	GetUserData_20
240	SetUserData_20	Float	SetUserData_20

NOTE

- Data is in big-endian format if it utilizes more than one Modbus register.
- If input register functionality is not available for analyzer type, analyzer will return value as NaN for float values.
- Memory map is continuous memory, so if user try to read address for which functionality is not available it will return “0” (for example reading address “0” for coil register).
- If user tries to read address outside of maximum register memory map, request will be exception (for example reading address 156 for coil register).

10. Serial Communication

The Serial Port Menu is accessible from the Config Menu and displays the configurations of COM1 (used for Command Interface, query-based data output) and COM2 (used for Data Streaming). Users need to set the COM port protocol by using the Serial Port Configuration feature located from the Picarro Launch Pad, Config, and selecting the **Serial Port** button.

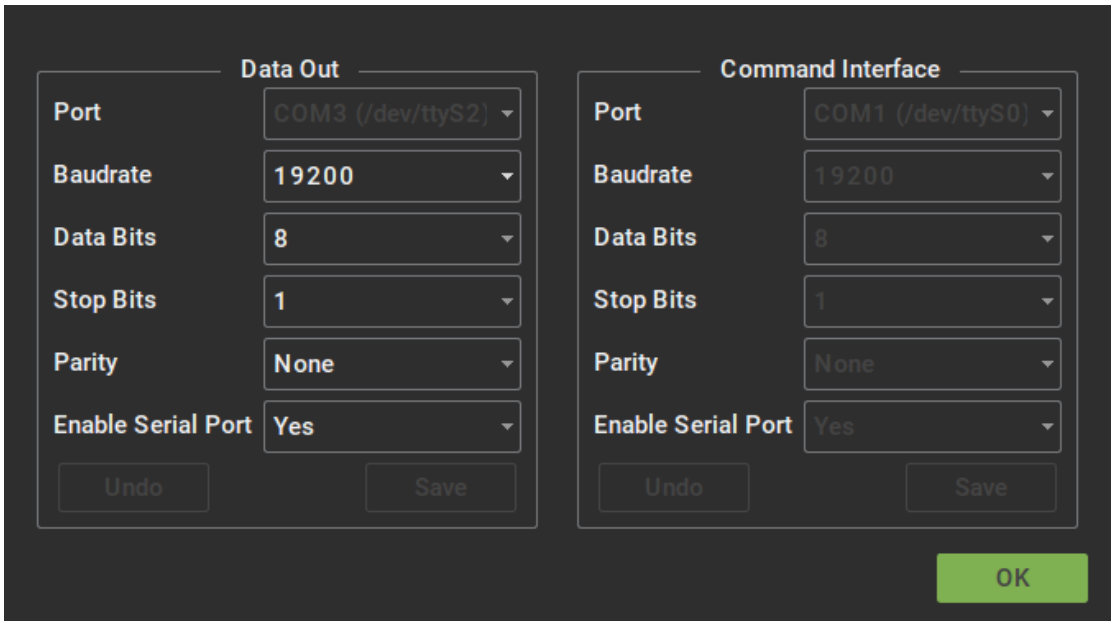


Figure 59: Default Serial Port Configuration

The Serial Port Configuration windows provides the following settings:

- **Port** – Indicates the desired communication port.
- **Baud Rate** – Number of bit transfers per second.
- **Data Bits** – Number of data bits in a communication packet, or a single byte transfer.
- **Stop Bits** – Number of bits used to signal the end of a communication packet.
- **Parity** – Sets the parity bit to Even, Odd, Mark, Space, or None.
- **Enable Serial Port** – Enables or disables the communication port specified in the Port field.

After making any changes, select **Save** to apply the changes or **Undo** to revert to the previous configuration. Click **OK** to close the window.

10.1 COM1 (Command Interface) Protocol

The Command Interface defines query-based data communication through COM1. The default data list and serial port setting for the PI5310 are:

/home/picarro/I2000/AppConfig/Config/CommandInterface/CommandInterface_JKBDS.ini

```
meas_label =
N2O,N2O_dry,CO,CO_dry,H2O,c13o2,interval,ValveMask,OutletValve,SpectrumID,DasTemp,CavityPressure,CavityTemp,BoxPressure

[SERIALINTERFACE]
port = /dev/ttyS0        #COM1
baudrate = 19200
bytesize = 8
parity = 'N'
stopbits = 1
timeout = 1
xonxoff = 0
rtscts = 0
```

Output Frequency: Data is output when command is sent to COM1 via RS232.

Example data output: _MEAS_GETCONC and _MEAS_GETCONCEX

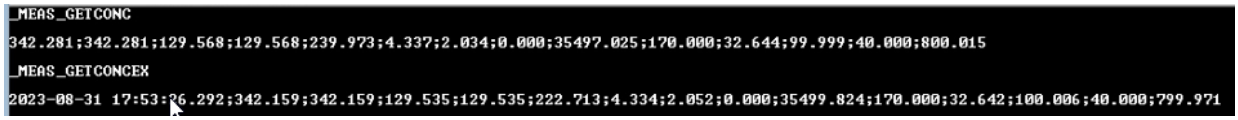


Figure 60: Data Output Example

10.2 COM2 (Data Manager) Data Streaming Protocol

The Data Manager defines the data streaming through the serial port, normally as COM2. Once enabled, the listed data is streamed through the designated COM port.

/home/picarro/I2000/AppConfig/Config/DataManager/DataManager_JKBDS.ini

```
[SerialOutput]
#PollChar = "x"
Enable = True          # Disable when this COM2 is used for other control.
Port = /dev/ttyS1 #COM2
Baud = 19200
DataBits = 8
StopBits = 1
Parity = N
…
```

The default list for PI5310 is as follows. Users may edit the list for desired output.

Format ="%15.2f %10.4f %10.4f %10.4f %10.4f %10.4f %10.4f %10.4f %10.4f %10.4f %10.4f\r\n"
time/N2O/CO/H2O/c13o2/interval/CavityPressure/CavityTemp/BoxPressure/DasTemp/ValveMask

Output Frequency:

About 2 seconds.

Example of data streaming output: * COM3 is the computer's com port.

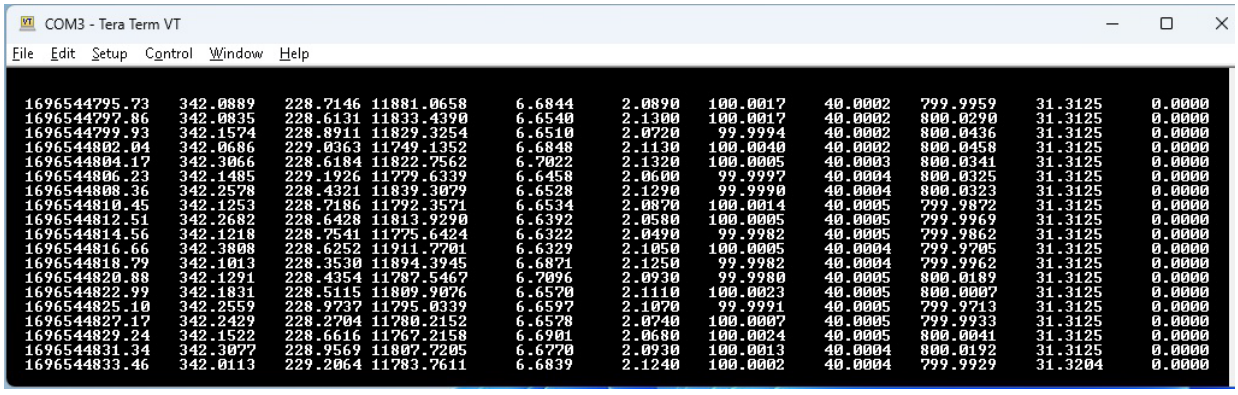


Figure 61: Data Streaming Output

11. Troubleshooting

The following section lists problems that may be encountered during installation and operation of the analyzer. The corresponding step-by-step procedures provide resolution in most cases. If, after attempting these procedures, the problem remains unresolved, please contact Picarro Customer Service at (408) 962-3990 or support@picarro.com.

11.1 Power LED on Analyzer Does Not Illuminate

Context: Turning on the analyzer by momentarily depressing its front panel power switch should apply power. The green power LED is illuminated when it detects the correct power levels.

1. Check that the AC power cord is attached and plugged into a working outlet.
2. Check that the rear on-off switch near the AC power cord is in the ON position **(I)**.
3. Press and hold the front panel power switch for at least 5 seconds as the analyzer may take several seconds to respond.

11.2 Sample Pressure not Controlled to Appropriate Value for Concentration Measurements

Context: Under normal operation, the cavity pressure is automatically locked to the correct value by means of electronically controlled inlet and outlet valves. The message “Pressure Locked” on the front panel display and the user interface indicates that the cavity pressure is at the appropriate value. Should either of the messages “Pressure high” or “Pressure low” be displayed, the cavity pressure is out of its correct operating range.

1. The “Pressure low” message indicates that there is insufficient gas available at the inlet of the analyzer. Check the inlet plumbing to the analyzer and ensure that the pressure at the inlet is within the specifications. Check for blockages in the lines, or regulators that are turned off, especially by removing all items upstream of the inlet to see if the pressure returns to the spec. If removing plumbing from upstream of the instrument inlet doesn’t work, the inlet particulate filter may need to be replaced. See section ***12, Maintenance*** for more information.
2. The “Pressure high” message indicates that gas cannot be removed from the analyzer at a sufficient rate. Check the vacuum line between the analyzer and the power vacuum unit for leaks. Failure of the vacuum pump, injecting dilution gas at excessive pressure, or excessive pressure at the inlet can also cause this problem.

12. Maintenance

The advanced, rugged design of Picarro Analyzers provides stable, long-term operation with minimal service or maintenance. Except for the following items, the analyzer and pump are not user serviceable. Should either appear to malfunction, please refer to the Troubleshooting Guide or contact Picarro Support (support@picarro.com).

As described below, users may obtain preventive maintenance components as part of a service plan, as part of a designated PM kit, or individually from the Picarro store.

12.1 Service Plans

In addition to basic telephone and email support and remote diagnostics, service plans include additional warranty, factory repairs, and parts. Plans are available for purchase by contacting sales@picarro.com. The following service plans are available for the PI5310 and G5000 analyzers:

- **W3105 Premium Service Plan**: Extended warranty; free factory repair; free field replaceable parts. See data sheet for complete terms and conditions.

12.2 Particulate Filter Replacement

There are two user-replaceable filters in the PI5310 analyzer. One is located behind the **Sample** inlet, and another is located behind the **Pressure** inlet. Both are accessible from the back panel by releasing the captive screws and sliding the filter out of its bay within the analyzer. This section describes filter replacement for the Sample and Pressure inlets. Replacement filter kits can be purchased from Picarro.

NOTE

Gasses at the *Sample* inlet is filtered by *two* in-line, sub-micron particulate filters before they reach the measurement cavity. The inner filter is *NOT* user replaceable. It is located within a heated pressure-box. If the inner filter fails, contact Picarro for service or repair.

The outer filter (located just behind the Sample inlet) is user-replaceable.

CAUTION

The inner filter (in the sample path) is NOT user replaceable. Do NOT open the analyzer. Inner filters must be replaced by a Picarro certified technician. USER REPLACEMENT OF THE INNER FILTER OR BREAKING THE ANTI-TAMPER TAPE ON THE INNER FILTER VOIDS THE WARRANTY.

Symptoms of a Clogged Filter

Filters can become clogged with continual use.

If liquid water is sucked into the inlet line, it may clog the filter and impede the flow (usually for a few days) until it evaporates.

Some symptoms of a clogged filter are:

- The analyzer pressure is low
- Low flow into the analyzer, causing unusual measurements
- Response time is slower than usual

Solutions for Water Incursion

Do NOT turn off the analyzer when a filter is wet or replace a wet filter. Liquid water in the filter can cause condensation on the optics if the analyzer is allowed to cool when the filter is wet.

- Dry the filter by running Clean Dry Air (CDA) through the analyzer. If the analyzer functions normally after drying, a filter replacement is not necessary.
- If drying the filter does not solve the problem, replace the filter.

Required Parts and Tools

- S3266 PI/SI5000 User Maintenance Kit
- 9/16 open end wrench
- Flathead screwdriver for releasing captive screws (if needed).

Pressure Inlet Port Particulate Filter Replacement

1. Shut down the analyzer by following ***Section 5.2, Shutdown***, and move the analyzer to a clean work environment.
2. Release the captive screws (Figure 62) and slide the filter assembly out of the analyzer filter bay. There may be some resistance as the filter is removed. This is due to the frictional resistance of the male quick-disconnect O-rings within the female receptacle.

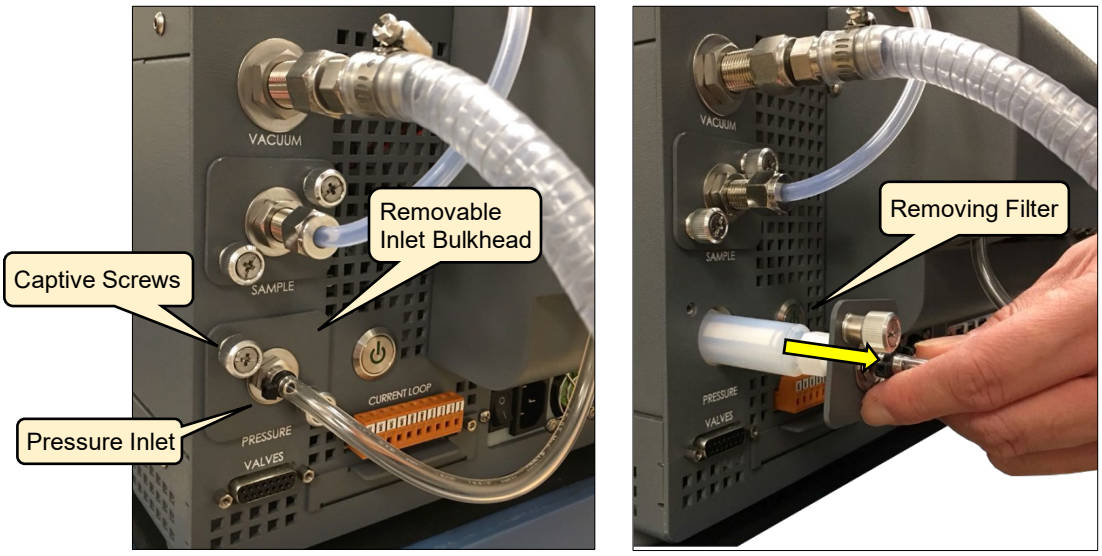


Figure 62: Pressure Inlet Port

3. Figure 63 shows the pressure inlet port filter assembly after removal. It is not necessary to remove the hose from the barbed inlet port.

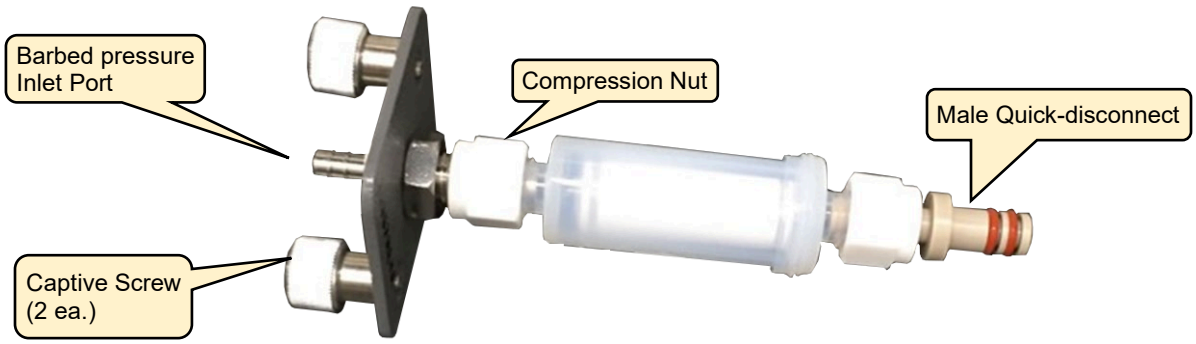


Figure 63: Pressure Inlet Filter Assembly – Removed from Housing

4. Remove the old filter from the bulkhead assembly by loosening the compression nut (Figure 64). Remove the ferrules and discard.

Figure 64: Removing Filter from Pressure Inlet Bulkhead

5. Remove the male quick-disconnect from the filter outlet by loosening the compression nut (Figure 65). Remove the ferrules and discard.

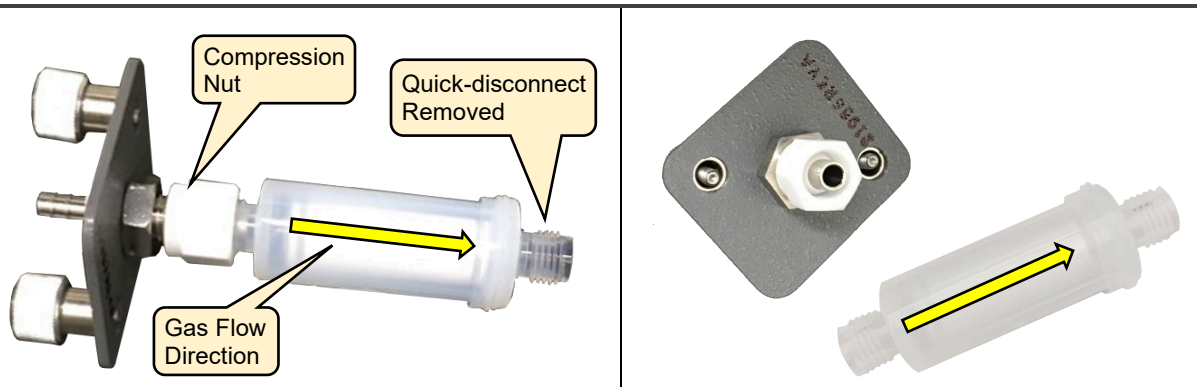


Figure 65: Filter Removed from Pressure Inlet Bulkhead

6. Install the new ferrules onto the bulkhead compression fitting.
7. Attach a new filter to the bulkhead compression fitting.

   Ensure the flow direction arrow on the filter is pointing away from the bulkhead compression fitting. Also ensure the tube and ferrules are fully seated into the filter fitting before fully tightening the nut.
8. Tighten the nut on the fitting until the final bit of thread is just showing past the nut (Figure 66).

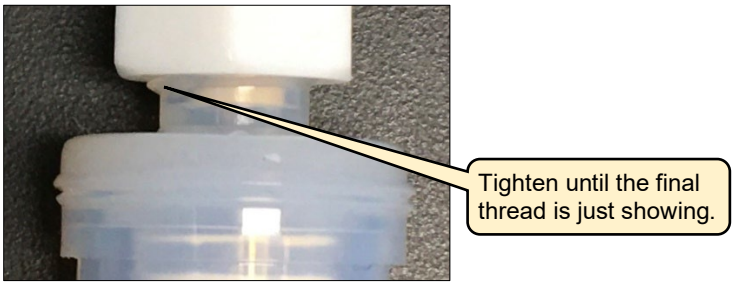


Figure 66: Tightening the Filter Fittings

9. Install the new ferrules onto the quick disconnect fitting.
10. Reinstall the male quick disconnect to the new filter. Ensure the tube and ferrules are fully seated into the filter fitting before fully tightening the nut.
11. Tighten the nut on the fitting until the final bit of thread is just showing past the nut (Figure 66).
12. Slide the completed assembly into the analyzer filter bay and secure the plate by tightening the captive screws.

    Note that when the filter assembly is about half an inch from the analyzer chassis, you will meet resistance as the male quick-disconnect enters its receptacle. You will need to firmly push it inward to fully seat the assembly. Then the captive screws can be tightened.

Sample Inlet Port Particulate Filter Replacement

1. Release the captive screws (Figure 67) and slide the filter assembly out of the analyzer filter bay. There may be some resistance as the filter is removed. This is due to the frictional resistance of the male quick-disconnect O-rings within the female receptacle.

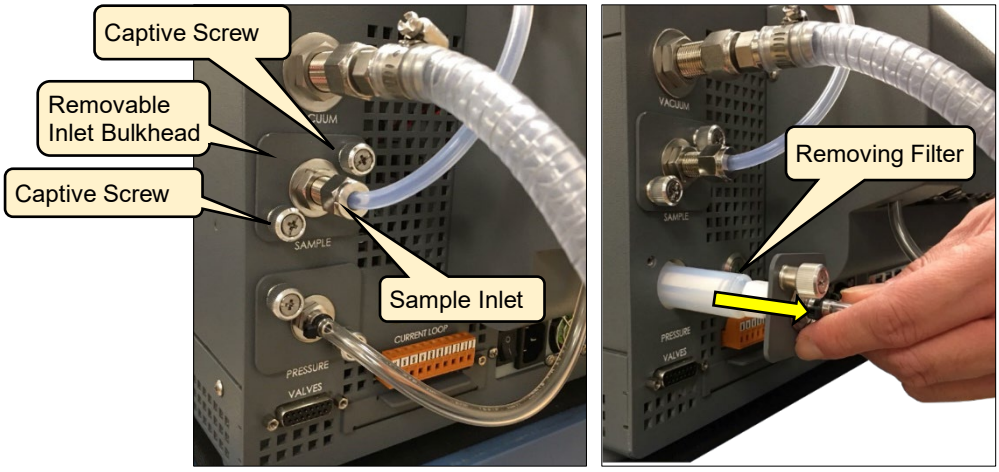


Figure 67: Sample Inlet Port

2. Figure 68 shows the sample inlet filter assembly after removal. It is not necessary to remove the hose from the sample inlet port.

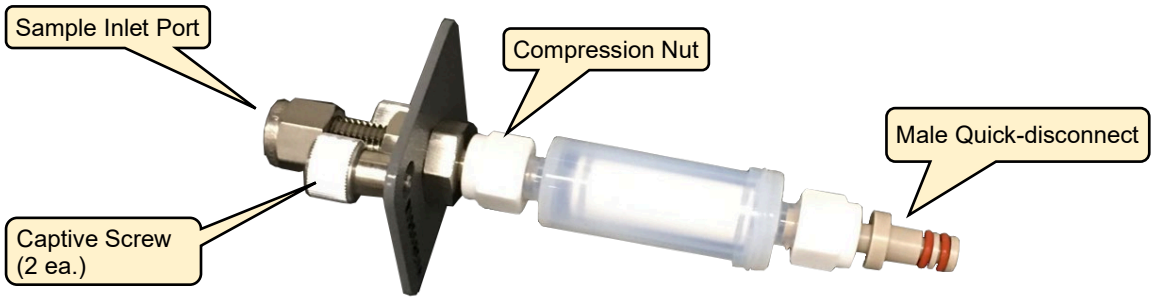


Figure 68: Sample Filter Assembly – Removed from Housing

3. Remove the old filter from the bulkhead assembly by loosening the compression nut (Figure 69). Remove the ferrules and discard.
4. Remove the male quick-disconnect from the filter outlet by loosening the compression nut (Figure 70). Remove the ferrules and discard.

Figure 69: Removing Filter from Sample Inlet Bulkhead

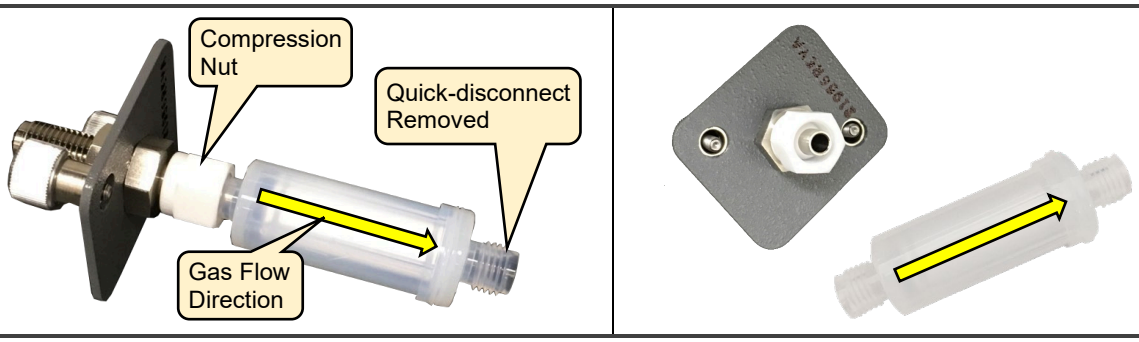


Figure 70: Filter Removed from Sample Inlet Bulkhead

5. Install the new ferrules onto the bulkhead compression fitting.
6. Attach a new filter to the bulkhead compression fitting.

Ensure the flow direction arrow on the filter is pointing away from the bulkhead compression fitting. Also ensure the tube and ferrules are fully seated into the filter fitting before fully tightening the nut.

7. Tighten the nut on the fitting until the final bit of thread is just showing past the nut (Figure 66 above).
8. Install the new ferrules onto the quick disconnect fitting.
9. Reinstall the male quick disconnect to the new filter. Ensure the tube and ferrules are fully seated into the filter fitting before fully tightening the nut.
10. Tighten the nut on the fitting until the final bit of thread is just showing past the nut (Figure 66).
11. Slide the completed assembly into the analyzer filter bay and secure the plate by tightening the captive screws.
    - Note that when the filter assembly is about half an inch from the analyzer chassis, you will meet resistance as the male quick-disconnect enters its receptacle. You will need to firmly push it inward to fully seat the assembly. Then the captive screws can be tightened.

A2000 Pump Rebuild Kit

The pump rebuild kit is the only component not currently sold as part of a preventive maintenance kit because the replacement frequency is not strictly annual (frequency depends on pump usage).

The A2000 pump diaphragms and valves are user-replaceable. Use the following link to order rebuild kits and to find the instructional video and supporting maintenance document.

- Pump Rebuild Kit: Used with SI2xxx, G2xxx analyzers (except Flight and Flux analyzers)

  S2009 Rebuild Kit for A2000 Vacuum Pump – If viewing this manual as a paper hard copy, enter the following URL in your browser:

  http://store.picarro.com/For-Analyzer/Pump/Rebuild-kit-for-Picarro-A2000-vacuum-pump.html

12.3 Cleaning and Decontamination

Clean the outside of the analyzer with a clean dry cloth. Users should never access or clean the inside of a Picarro analyzer. For decontamination, run clean dry air (CDA) through the analyzer. If the analyzer does not decontaminate after running CDA for several hours, contact Picarro.

13. Transportation and Storage

If the analyzer is transported or stored, use the following procedure to prepare and repack it into the original packaging.

CAUTION

When shipping or relocating the analyzer, it is important to protect it from mechanical shocks. Failure to do so can compromise its performance. When shipping the analyzer, use its original packaging only.

13.1 Shutdown and Preparation

CAUTION

A flow of clean, dry gas should always be directed to the instrument for several minutes prior to shutting down. Trapping a high-moisture content gas sample in the cavity can cause condensation damage to the mirrors as the instrument cools from its operating temperature. See section 5.2, Shutdown for specific shutdown instructions for your model analyzer.

1. Click on the **Quit** button located on the left bottom side of the Data Viewer window.
2. A window displays (Figure 62) prompting the user to confirm the shutdown. Click **Yes** to continue with the shutdown process.

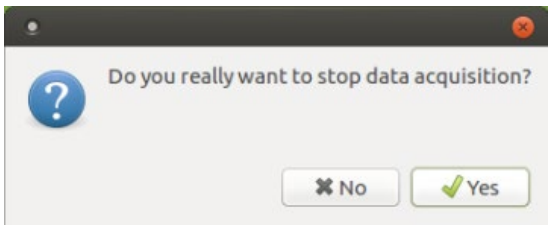


Figure 71: Stop Data Acquisition/Shutdown

3. Manually turn off the pumps and dry gas (if used).
4. Disconnect all tubing and electrical connections from the analyzer.
5. To prevent contamination and possible damage to the connection threads, place protective caps on all gas connections.

13.2 Packing

1. Place the analyzer in a plastic bag with a package of desiccant. Seal the bags with tape. If shipping the pump, do the same for it.
2. Pack the analyzer and pump in the original shipping containers ensuring that all the foam pieces are in place to protect the analyzer during shipping.

APPENDIX A – Alarm Status

ALARM_STATUS is a data column output by the instrument to warn the user when the instrument measures a gas that could produce data that falls outside of the operational range of the instrument. Falling outside of the operational range of the analyzer can cause the instrument to perform with a lack of precision, accuracy, or data rate. ALARM_STATUS is a flag nominally set to 0 when measuring “ordinary” ambient air and can be set to a number corresponding to a binary mask of a specific alarm.

The following table provides the alarm status bit assignments.

Table 12: Alarm Status Bit Assignment

Bit	7	6	5	4	3	2	1
Alarm	Cavity Pressure	Cavity Temp	LaserBase plateTemp	Box Pressure	[H_2O]	[CO_dry]	[N_2O]
Nominal	100 ± 0.05 Torr	40 ± 0.01 Degree C	27 # ± 0.1 Degree C	800 ± 1 Torr	< 22000 ppb	< 1500 ppb	< 1500 ppb
# Some hot operated lasers may be set to higher laser baseplate temperature.							

Each decimal ALARM_STATUS reading converts to binary and uses the above table to identify the detailed alarm as single or combination.

The following table provides several examples.

Table 13: Alarm Status Definitions

ALARM_STATUS	Binary Mask	Alarm Definition
0	0000000	All alarm cleared; analyzer is in normal operation.
1	0000001	N_2O_dry concentration is over 1500 ppb.
6	0000110	CO_dry concentration is over 1500 ppb, and H_2O concentration is over 22000 ppm.
32	0100000	Cavity Temperature is out of setting range.
64	1000000	Cavity Pressure is out of setting range.

APPENDIX B – Data Log Columns

Below is a table that describes all columns contained in the data log. The data log provides a complete set that has all outputs produced by the analyzer and includes the User Logs described above and found in:

/home/picarro/I2000/Log/Archive/YYYY-MM-DD/DataLog_User/

Table 14: PI5310 Data Log Columns

Data Key	Units	Definition
ALARM_STATUS	unitless	Alarm status bit mask (see APPENDIX B – Data Log Columns)
ALARM_WORD_0	unitless	
BoxPressure	Torr	Coolbox pressure reading
BoxPressureLock	unitless	Status of coolbox pressure locking in range
CO	ppb	Raw CO concentration reading in gas stream
CO_dry	ppb	CO concentration reading (dry) in gas stream
CavityPressure	Torr	Sample pressure in cavity
CavityTemp	oC	Averaged temperature of cavity body
CavityTemp1	oC	Cavity temperature #1 (by front cavity mirror)
CavityTemp2	oC	Cavity temperature #2 (between #1, #3)
CavityTemp3	oC	Cavity temperature #3 (between #2, #4)
CavityTemp4	oC	Cavity temperature #4 (by rear cavity mirror)
ChillerTemp	oC	Coolant temperature in TEC cooler block
CoolBoxAuxTec	unitless	Coolbox TEC control signal
CoolBoxHeatsink1Temp	oC	Front TEC heatsink temperature in coolbox
CoolBoxTec	NA	
DasTemp	oC	Temperature sensor on DAS – PCBA, ~ +6 offset to environmental temperature

Data Key	Units	Definition
DetectorAdc	unitless	Baseline ADC signal from detector
FDC_ALARM	NA	
FRAC_DAYS_SINCE_JAN1	days	Days since January 1, 1970
FRAC_HRS_SINCE_JAN1	hours	Hours since January 1, 1970
H2O	ppm	H_2O concentration reading in gas stream
INST_STATUS	unitless	Instrument status bit flag
InletValve	unitless	Inlet valve current signal for coolbox pressure control
JULIAN_DAYS	seconds	Time assigned since January 1, 4713 BC
LED_STATE	unitless	LED state for front panel
Laser1Current	unitless	Laser current signal sent to Laser
Laser1Tec	unitless	TEC signal for laser temperature control
Laser1Temp	oC	Laser temperature
LaserBaseplateTec	oC	NA
LaserBaseplateTemp	unitless	NA
MPVPosition	unitless	Multi-port valve state selected
N2O	ppb	Raw N_2O concentration reading in gas stream
N2O_dry	ppb	Raw N_2O concentration reading (dry) in gas stream
OutletValve	unitless	Outlet valve current signal for cavity pressure control
P_stable	unitless	Whether cavity pressure is steadily controlled
Pcavity	Torr	Pressure in measurement cavity
Pcavitystd	Torr	Standard deviation of pressure in cavity over one measurement
SpectrumID	unitless	Number assigned to measurement of species. 170 for PI5310.
ValveMask	unitless	Binary valve mask of triggered solenoid valve

Data Key	Units	Definition
allLow	unitless	Binary flag if all gas concentrations are low
base1	ppb/cm	Base lose in peak1 (N_2O) spectral region.
base31	ppb/cm	Base lose in peak31 (H_2O) spectral region.
base40	ppb/cm	Base lose in peak40 ($^{13}CO_2$) spectral region.
base50	ppb/cm	Base lose in peak50 (CO) spectral region.
c13o2	ppm	Raw $^{13}CO_2$ concentration reading in gas stream
c13o2_dry	ppm	$^{13}CO_2$ concentration reading in gas stream with dry correction
co_fineLaserCurrent	unitless	Fine laser current at the peak of CO spectral line
co_fsrIndex	ppb	Fsr index of CO peak within whole acquired spectra
copts	unitless	Number of points on CO absorption peak
cords	unitless	Number of ring-downs on CO absorption peak
di_rms	unitless	RMS of fineLaserCurrent to fsrIndex 2nd order polynomial fit
dm_latency	seconds	Time for data to move through Datamanager
fitBackground	ppb/cm	Averaged detector background to last raw ringdown traces, 4x
fit_time	seconds	Duration to fit data to model
gaps	unitless	Number of gaps in the spectra within last measurement interval
interval	seconds	Duration for one-point measurement
max_cavity	Torr	Maximal cavity pressure within last measurement interval
max_diff_cavity	Torr	Maximal cavity pressure difference with last measurement
max_fitter_latency	seconds	Duration to fit data to model

Data Key	Units	Definition
min_cavity	Torr	Minimal cavity pressure difference with last measurement
mode_span	unitless	Number of modes in fit region
n2o_fineLaserCurrent	unitless	Fine laser current at the peak of N_2O spectral peak
n2opts	unitless	Number of points on N_2O absorption peak
n2ords	unitless	Number of ring-downs on N_2O absorption peak
ngroups	unitless	Number of fsr group modes in fit region
ntopper	unitless	Number of points at the CO peak
numpoints	unitless	Number of ringdowns in spectra
peak1	ppb/cm	Peak absorption of N_2O feature
peak31	ppb/cm	Peak absorption of H_2O feature
peak40	ppb/cm	Peak absorption of $^{13}CO_2$ feature
peak50	ppb/cm	Peak absorption of CO feature
peak_height	ppb/cm	Peak height of CO absorption peak
pzt_adjust	unitless	PZT adjustment after each measurement
pzt_mean	unitless	PZT average value in each measurement
pzt_offset	unitless	Effective PZT value with adjustment
range_shift	fsr	Spectra offset in FSRs from nominal position
rejected	point	Number of ringdowns rejected by fsr-hopping grouping filter
res_pre	unitless	Residuals after fitter scheme #0 (pre-fit)
resa	unitless	Residuals after fitter scheme #3-5 (reference for N_2O peak fit)
resb	unitless	Residuals after fitter scheme #6 (reference for CO peak fit)
residuals	unitless	Residuals after fitter scheme #1 (pre-fit)
shifta	cm-1	Base shift after fitter scheme #3-5
shiftb	cm-1	Base shift after fitter scheme #6

Data Key	Units	Definition
spect_duration	seconds	Duration to collect spectrum
spect_latency	seconds	Duration to send spectrum
str1	unitless	Raw strength of peak#1 (N_2O) without any corrections
str1_dry_TC	unitless	Strength of peak#1 (N_2O) with temperature, interference, and dry corrections. Converts to N2O_dry with its scaling factor.
str1_spec	unitless	Strength of peak#1 (N_2O) with temperature and interference corrections. Converts to N_2O with its scaling factor.
str1_spec_raw	unitless	Last good “str1_spec” without cavity pressure burst
str31	unitless	Raw strength of peak#31 (H_2O) without correction.
str31_spec	unitless	Strength of peak#31 (H_2O) with interference correction. Converts to H_2O with its scaling factor.
str31_spec_raw	unitless	Last good “str31_spec” without cavity pressure burst
str40	unitless	Raw strength of peak#40 ($^{13}CO_2$) without correction.
str40_dry_TC	unitless	Strength of peak#40 ($^{13}CO_2$) with temperature and dry corrections. Converts to c13o2_dry with its scaling factor.
Str40_spec	unitless	Strength of peak#40 ($^{13}CO_2$) with interference correction. Converts to c13o2 with its scaling factor.
str40_spec_raw	unitless	Last good “str40_spec” without cavity pressure burst
str50	unitless	Raw strength of peak#50 (CO) without any corrections
str50_dry_TC	unitless	Strength of peak#50 (CO) with temperature, interference, and dry corrections. Converts to CO_dry with its scaling factor.

Data Key	Units	Definition
str50_spec	unitless	Strength of peak#50 (CO) with temperature and interference corrections. Converts to CO with its scaling factor.
str50_spec_raw	unitless	Last good “str50_spec” without cavity pressure burst
time	seconds	Current time in EPOCH format
timestamp	milliseconds	Current time, (time*1000 + 62135596800000)
tipstd	ppb/cm	Loss standard derivation of peak RD-group at CO peak#50
tiptop	ppb/cm	Loss average of peak RD-group at CO peak#50
y1	cm-1	Linewidth of N_2O peak
y31	cm-1	Linewidth of H_2O peak
y40	cm-1	Linewidth of $^{13}CO_2$ peak
y50	cm-1	Linewidth of CO peak

APPENDIX C – Enabling/Disabling Data Output

The instrument provides customization on data output. Several data outputs can be enabled and disabled. Here is the instruction.

1. Back up the following .ini file. Users can always use the original one for recovering.
2. Modify the applications section as shown below. Adding "#" in front of the highlighted lines disables the application load; removing the "#" enables the application. Avoid any random mistyping or errors in this file.
3. Restart the computer to make the changes effective.

The .ini file resides in the following directory:

/home/picarro/I2000/AppConfig/Config/Supervisor/supervisorEXE_JKBDS.ini

[Applications]

EventManager	= 50000
Driver	= 50010
Archiver	= 50060
RDFreqConverter	= 50015
SpectrumCollector	= 50075
FsrHoppingController	= 50016
Fitter1	= 50180
MeasSystem	= 50070
DataManager	= 50160
SampleManager	= 50080
InstMgr	= 50110
AlarmSystem	= 50100
ValveSequencer	= 50200 # COM#2 by default, upper port of right-bottom of rear panel
CommandInterface	**= 50120 # COM#1 by default, lower port of right-bottom of rear panel**
4to20Server	**= 50290 # COM#4 by default, on motherboard**
QuickGui	= # 50220
DataLogger	= 50090
#Controller	= 50050
ModbusServer	**=**
BackupSupervisor	=
FileEraserSimplified	=

……

APPENDIX D – Analog Current Signal Output

Four channels of 4-20 mA current analog output are available on the back of the analyzer. By default, the settings for the four channels are as follows:

Table 15: Analog Signal Output Settings

	Iout0	Iout1	Iout2	Iout3
Monitoring	N_2O_dry	CO_dry	H_2O	Cavity Pressure
Units	ppb	ppb	ppm	Torr
Min	0.0	0.0	0.0	0.0
Max	2000.0	2000.0	50000.0	1000.0

- **N_2O** – Indicates the N_2O concentration reading in parts per billion (ppb)
- **CO** – Indicates the CO concentration reading in parts per billion (ppb)
- **H_2O** – Indicates H_2O in ppm
- **CavityPressure** – Indicates the cavity pressure in Torr

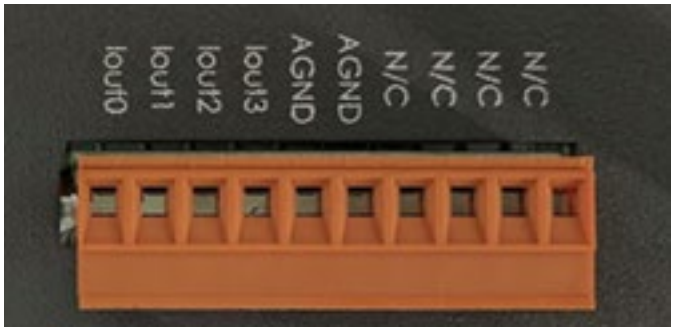


Figure 72: 4–20 mA Output with Terminal Connector in Place

Conversion from current readings to measurement value:

Measurement = Min + [I(reading, mA) – I0 (4 mA)] / 16 (mA) * (Max- Min)

For example, channel#0 reading of 6.735 mA indicates:

N_2O (ppb) = 0 + (6.735-4.0) / 16 * (2000.0-0.0) = 341.875.

Channel#3 reading of 7.805 mA indicates:

H_2O (ppm) = 0 + (7.805-4.0) / 16 * (500000.0-0.0) = 118,906.3.

D.1 Connecting the 4–20mA Signal Output

1. Using your fingers, pull the 4–20 mA terminal connector straight back away from the analyzer (Figure 64).
2. Use a small flathead screwdriver to loosen the slotted retaining screw for each desired terminal.
3. Insert the stripped end of the wire into the terminal slot and tighten the retaining screw.

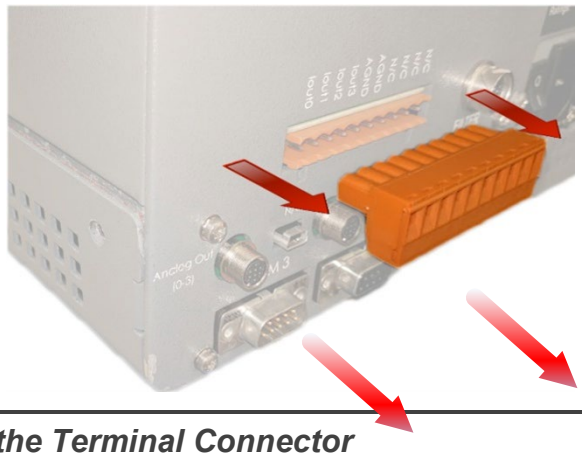


Figure 73: Removing the Terminal Connector

4. Repeat for each desired terminal.
5. Slide the terminal connector back onto the analyzer with the retaining screws facing down; there should be a soft click when the connector is set into its proper position.

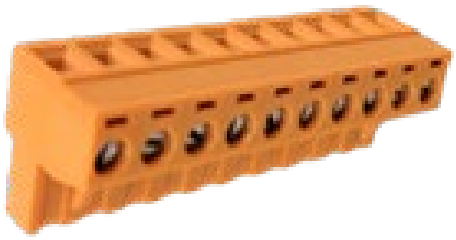


Figure 74: Terminal Connector Retaining Screws

NOTE

If shielding is desired, connect the drain wire of the shielded cable to the ground lug on the back panel. Do not connect the shield to the ground pins of the 4–20 mA connector. Connect only one end of your shielded cable to the ground lug to avoid 99ground loops.

APPENDIX E – Data File Viewer

E.1 Quick Start Guide

The following sections introduce the user to all possible functionalities of the Data File Viewer in detail. This section describes the most common, simple use case.

The Data File Viewer software allows the user to concatenate multiple one-hour files into one larger file, enabling the user to observe trends over several days of measurements.

1. To start, translate the UserData files from DAT to H5. The **Batch Convert option** (B) allows users to select any folder containing instrument data from a given day.

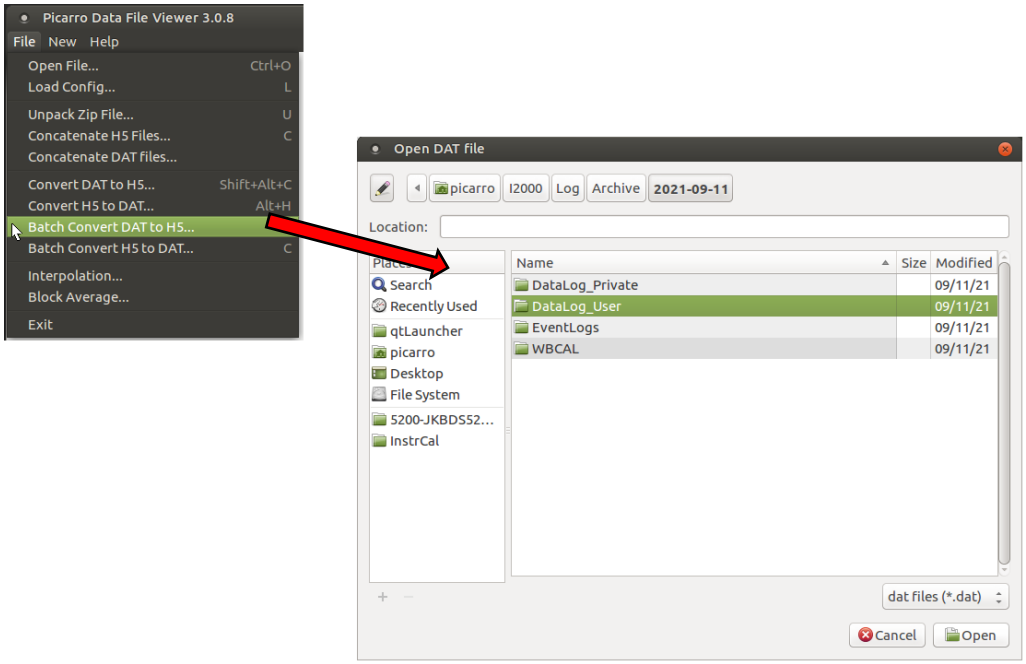


Figure 75: Batch Convert DAT to H5 – Navigation

2. In the source folder there are now copies of the original files translated into the H5 format.
3. From **File** menu select **Concatenate H5 Files** (C) to combine the H5 files into a time series. Take care to select exactly the same folder in the file viewer window.
4. In the **Select Variables** window, click **All** to move over all variables for concatenation.

If concatenating large records, the user can instead select only a few variables by clicking the variable name on the left dialogue and clicking the double arrow button. Confirm by clicking **OK**.

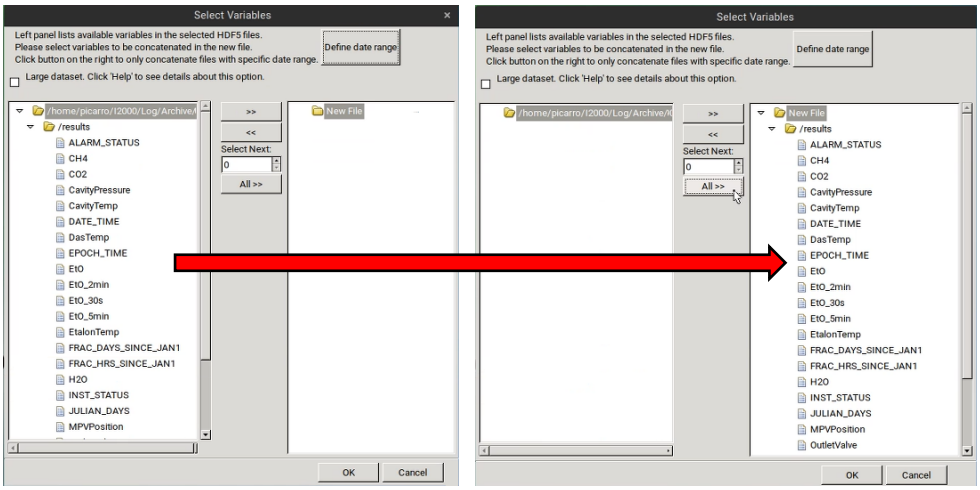


Figure 76: Selecting Variables for Concatenation

5. The user will then be asked to confirm the file name for the concatenated data. The default location is the parent folder for the selected day, and the filename by default describes the time span of the measurements within. Successful concatenation is indicated by the filename automatically being displayed in the main data file viewer window as shown in Figure 68.

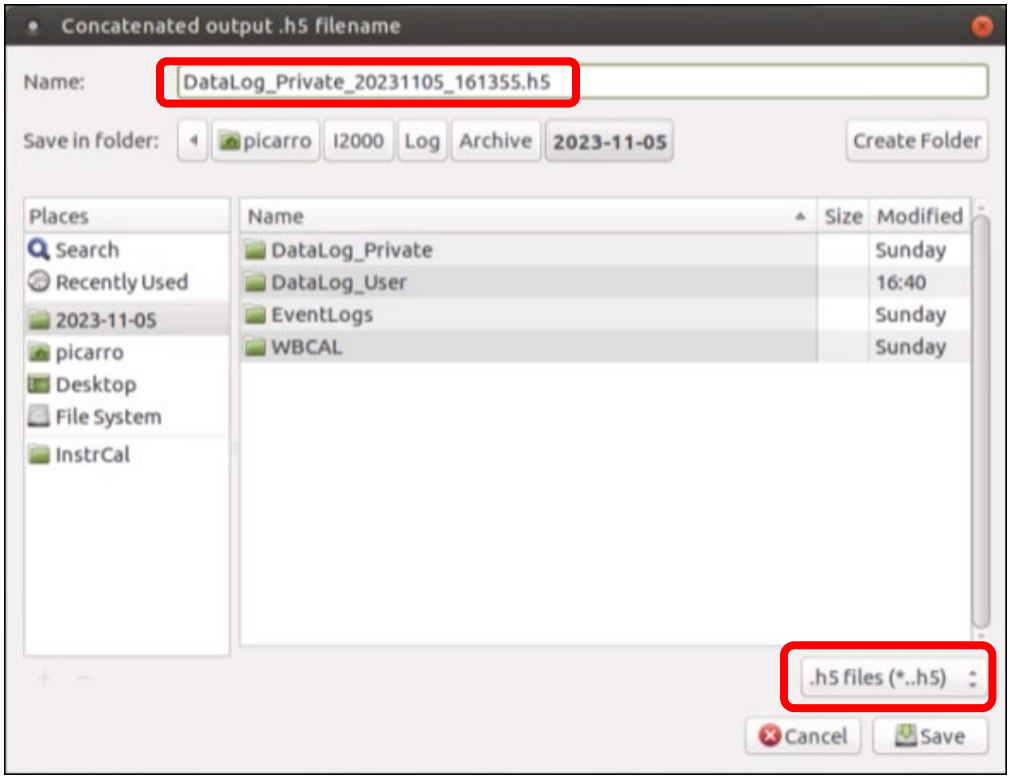


Figure 77: Concatenated Output .h5 Filename

NOTE

You can concatenate several days into one larger file, either by following steps 1-3 for selected folders, or by copying all their DAT files into a new folder and performing steps 1-5 just once.

6. With the file now opened, the user can select how many **Time Series** to display on the screen.

Figure 78: Time Series Selection Options

7. In the new window that displays, select the variables from the **Var Name** dropdown on the right of each plot. Deselect **Autoscale** y if the data stream has a large amount of variability in the Y-axis.

   Please read the following sections to learn more about features of the Data File Viewer.

E.2 Data File Viewer Overview

The Picarro Data File Viewer software is located from the Picarro Launch Pad, Home menu. This software allows you to graph and to conduct statistical analysis of the raw data. Additional functions include Allan Variance plot and quadratic or polynomial fittings. The Picarro Data File Viewer includes two main menus: File and New (Figure 70, Figure 71).

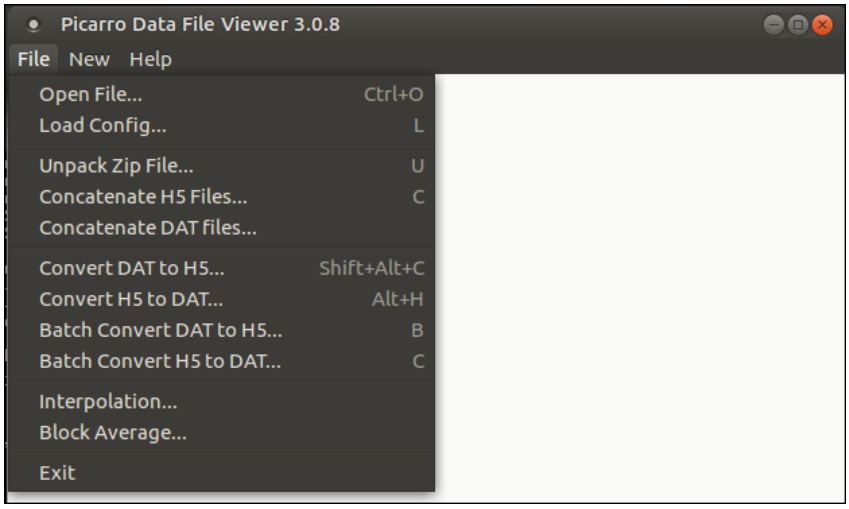


Figure 79: Picarro Data File Viewer – File Menu

E.3 File Menu

This section describes the functions available from the Data File Viewer File menu.

Open File

File > Open File: Opens a Picarro data file (HDF5 format) for data analysis and visualization. After opening the data file, you can create a new time series plot. Refer to section C.4, New – Time Series Plot for more information.

Load Config

File > Load Config: Loads a configuration file (.ini format) to restore parameters of a workplace. Refer to Save Configuration for more information.

Unpack Zip File

File > Unpack Zip File: Use to concatenate all H5 files inside the zip file into a single H5 file. Refer to Concatenate H5 Files below for details.

Concatenate H5 Files

File > Concatenate H5 Files: Use to concatenate multiple files and zip archives of H5 files into a single H5 file. Navigate to the desired folder or use the **Define Date Range** button to specify a date range of files to concatenate. See next section **Define Date Range** for more information.

After selecting the path of the data files, Data File Viewer will automatically search an H5 file in the specified zip/folder and look for all available variables in the H5 file. The variables are then listed in the **Select Variables** window in the left panel (as shown in Figure 72), and users can use the **>>** button to move variables to the right panel for concatenation.

E.4 New Menu

Use the **New** menu to create a time series plot up to three frames.

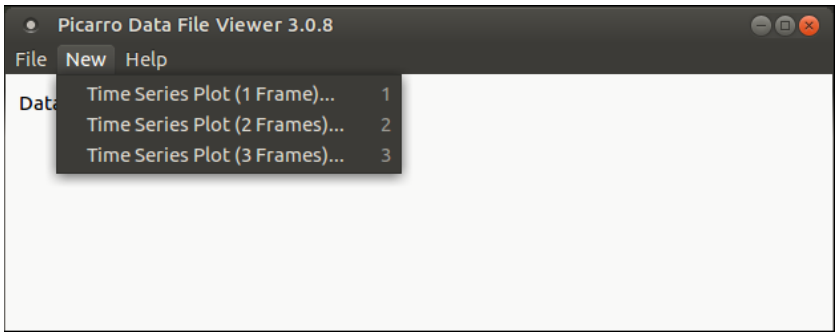
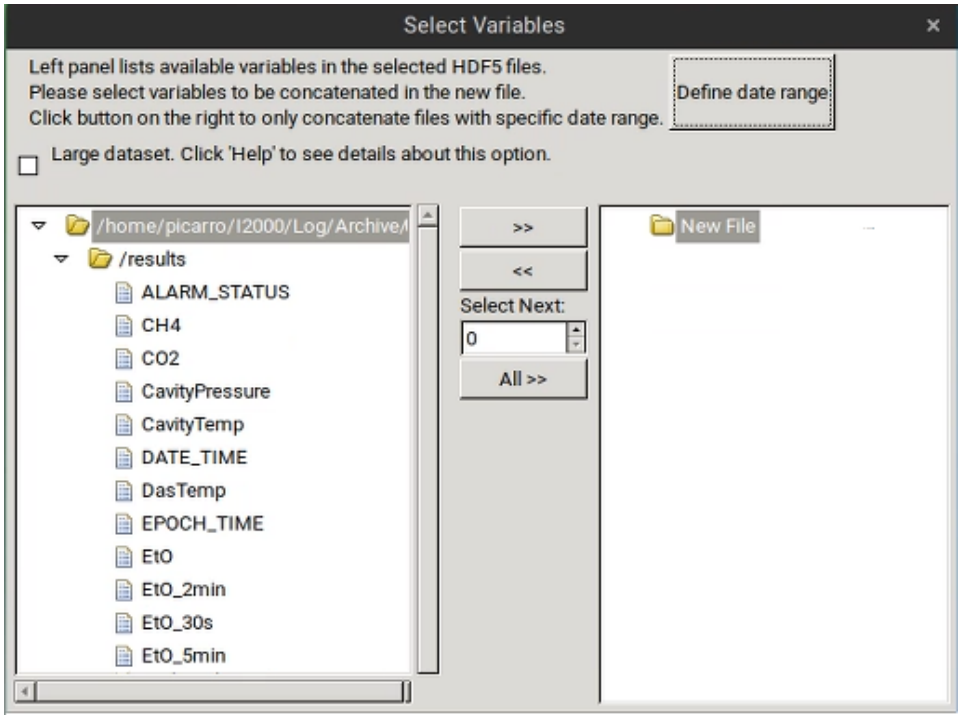


Figure 80: Picarro Data File Viewer – New Menu



Note: this screenshot is for example only. The species selections shown on your analyzer may vary.

Figure 81: Select Variables Form

Define Date Range

Data File Viewer can search data files within the desired date range and then concatenate such files into an H5 file.

By default, TimeZone is set to your local time zone. However, if data were taken elsewhere, select the time zone where data was taken.

Select **File > Concatenate H5 Files**, and click **Define Date Range** to specify the desired date range as shown in Figure 73.

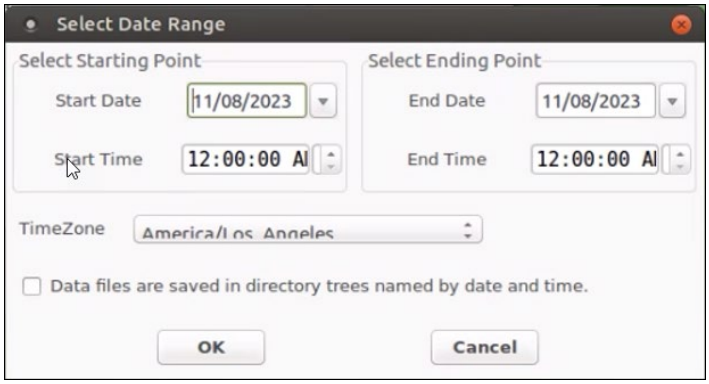


Figure 82: Define Date Range Dialog

Picarro software saves data in directories that are named by the creation year, month, and day as shown in Figure 74. Select Data files are saved in directory trees named by date and time option if the target folder has this file structure. This allows Data File Viewer to only search folders within the desired date range, which can substantially reduce processing time.

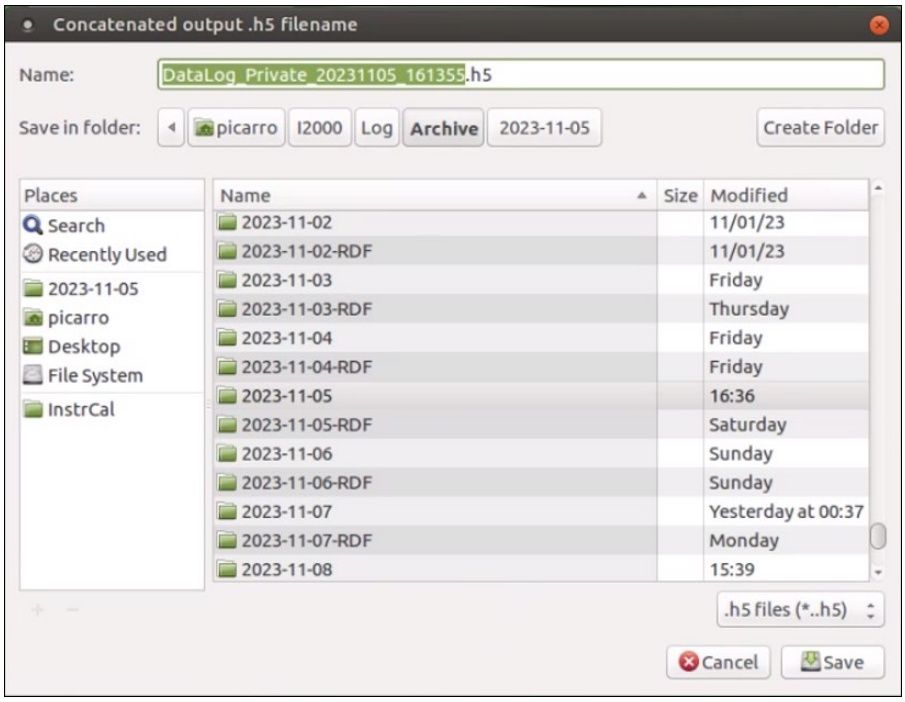


Figure 83: File Structure of Data File Viewer

NOTE

To save processing time, Data File Viewer does not open data files, but only determines data acquisition time based on the file name.

CAUTION

Do not define a time range for data files whose names have been changed.

NOTE

Data File Viewer does not concatenate data files exactly within the defined time range. This is because the time extracted from file name is different from the data acquisition time. To not miss data points, Data File Viewer expands the specified time range, so the resulting dataset normally has a wider time range than the user specification.

Convert DAT to H5

Select **File > Convert DAT to H5** to convert a file in DAT format to HDF5 format. These formats are described below:

- **DAT Format**: DAT files accepted by DatViewer store tabular data (numbers and text) in plain text.
  - Each line of the file is a data record. Each record consists of one or more fields separated by whitespaces.
  - The first line of the data file indicates column names.
  - There must be a field “EPOCH_TIME” to store the acquisition epoch time (expressed as seconds since Jan 1, 1970) of the data. Otherwise, the first and second fields must be “DATE” and “TIME.” The “DATE” field must have the format “mm/dd/yyyy” or “yyyy-mm-dd,” and the “TIME” field must have the format “HH:MM:SS(.sss)” where (.sss) is an optional fraction of seconds.
- **HDF5 Format**: HDF5 is a data model, library, and file format for storing and managing data. (See the HDF5 Home Page on the HDF Group website https://www.hdfgroup.org for more information.) When converting DAT to HDF5 format, Data File Viewer creates a table named “results” to the contained data.

Convert H5 to DAT

Select **File** > **Convert H5 to DAT** to convert a file in a HDF5 format to DAT. These formats are described in Convert DAT to H5.

NOTE

Data File Viewer does not concatenate data files exactly within the defined time range. This is because the time extracted from file name is different from the data acquisition time. To not miss data points, Data File Viewer expands the specified time range.

Interpolation

Interpolation describes the method for constructing data points with a range of a discrete set of known data points. Select **File > Interpolation** to perform interpolation on a time grid with a constant interval.

Block Average

Select **File** > **Block Average** to divide a dataset into small blocks based on a user-defined block size. The average is calculated for data in each block, and the results are saved in a new H5 file.

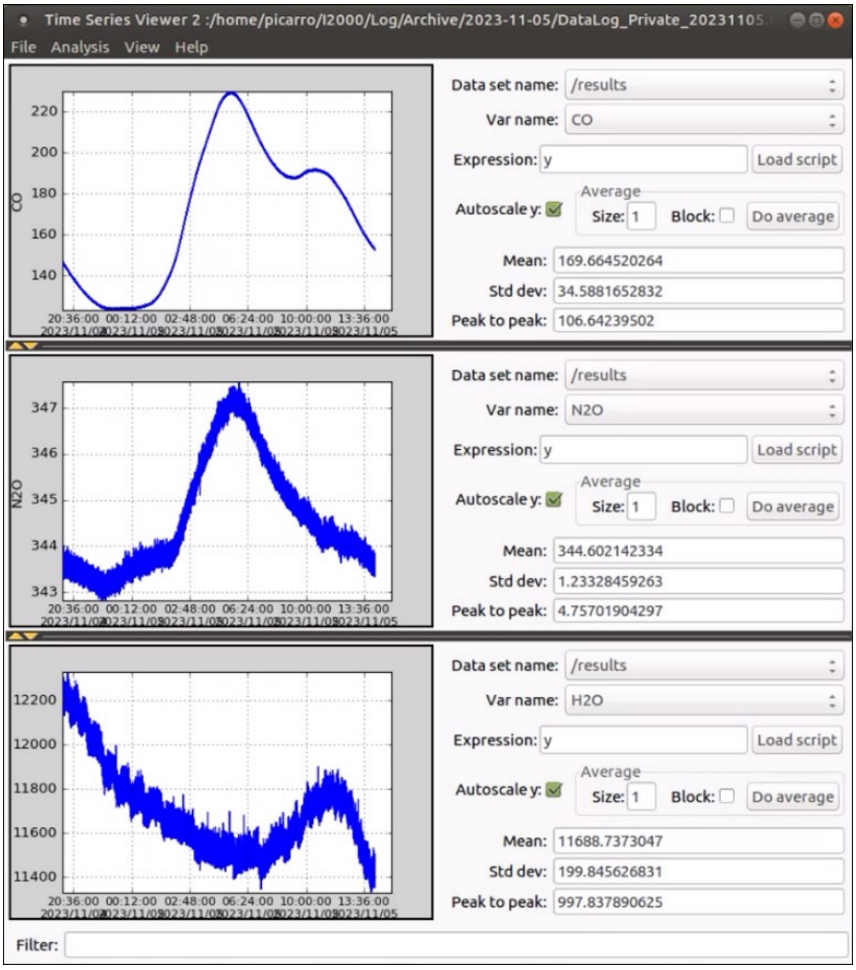
NOTE

The specified block size must be greater than the average data interval.

Because the data interval is normally not a constant (unless interpolation is performed), fluctuations in the data interval will affect block averaging if the block size is comparable to the average data interval.

E.5 New – Time Series Plot

You can specify to include create time-series plots with one, two, or three frames. New plots display in the Time Series Viewer.



Note: this screenshot is for example only. The species shown on your analyzer may vary.

Figure 84: Time Series Viewer

The next section describes the options available on the Time Series Viewer menu bar. Refer to The Time Series Viewer Canvas or more information on the Time Series Viewer UI features and options.

E.6 Time Series Viewer Menus

This section describes the Time Series Viewer menu options.

Time Series Viewer File Menu

Use the File menu to save a configuration or take a screenshot.

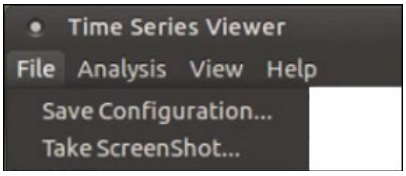


Figure 85: Time Series Viewer – File Menu

Save Configuration

Click **File** > **Save Configuration** to open the **Feature Capture** form. With this form, you can save figure properties, expressions, filters, and other settings to a configuration file so that it can be easily loaded in the future.

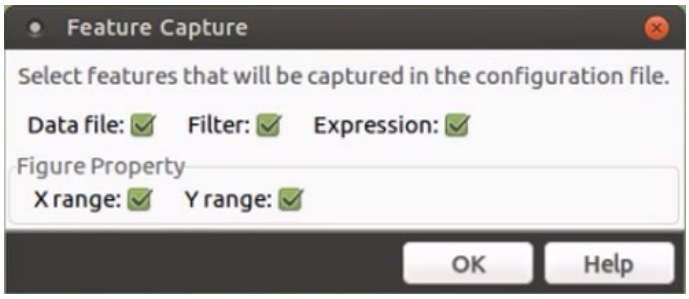


Figure 86: Time Series Viewer – Feature Capture

CAUTION

If a feature is not captured, it will be omitted when the configuration file is loaded.

Depending on the features captured, loading a configuration file can have different effects. For example:

- If all features are captured, a saved workplace is reproduced.
- If a data file is not captured, saved parameters are applied to the data file in memory.
- If an expression is not captured, plots will not be transformed.
- If X (Y) range is not captured, figures are auto-scaled on the x (y) axis.

Take Screenshot

Use **File** > **Take ScreenShot** to take a screenshot of the Time Series Viewer and save it as a .png to a specified file.

Time Series Viewer Analysis Menu

Use the Analysis menu to calculate statistics, generate a histogram, and to plot correlations and Allan Standard deviations.

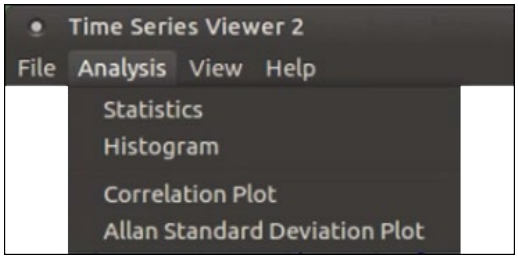


Figure 87: Time Series Viewer – Analysis Menu

Statistics

Use **Analysis** > **Statistics** to calculate mean, standard deviation, and peak to peak for all plots in the current window.

Histogram

Use **Analysis** > **Histogram** to generate a histogram of data as shown in Figure 79 below.

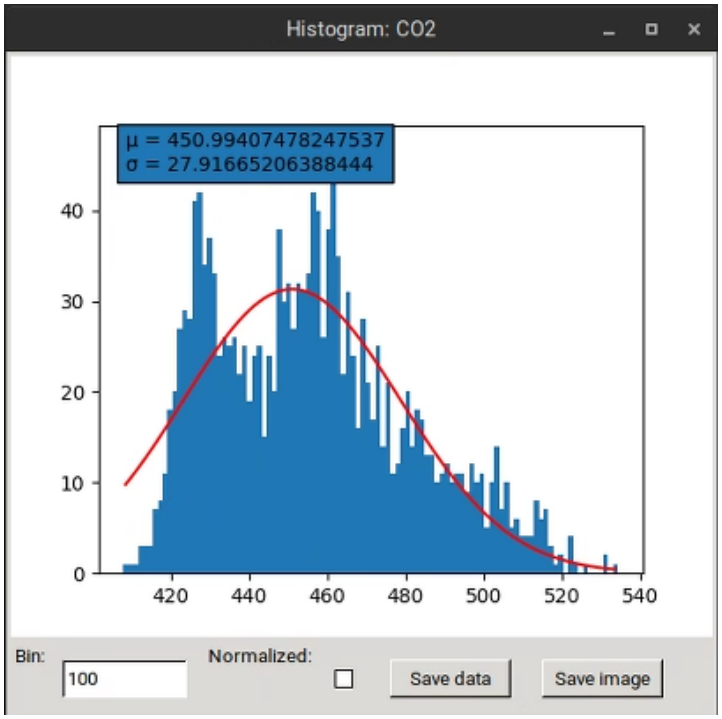


Figure 88: Histogram Window – CO_2

Histogram Window Features:

- **Red Line** – A Gaussian function fitted to the histogram. Fitting results of μ and σ are shown in the top-left corner of the plot.

- **Bin** – Specifies the number of intervals that the range of values is divided into.
- **Normalized** – When selected, the sum of the histograms is normalized to 1.
- **Save data** – Saves histogram data to a CSV file.
- **Save image** – Saves the histogram image as a JPEG, PNG, or PDF file.

Correlation Plot

Use **Analysis** > **Correlation Plot** to plot Y-axis data in one frame versus that in the other. This can be used when two or more frames exist in the current Time Series Plot window.

Allan Standard Deviation Plot

Use **Analysis** > **Allan Standard Deviation Plot** to create an Allan Standard Deviation plot (versus a standard deviation plot) for data in the current window. See Allan Variance Wikipedia page for more information.

Time Series Viewer View Menu

Use the **View** menu to view X-axis information in date-time, minute, or hour format.

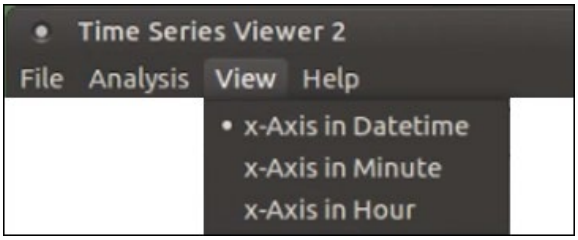


Figure 89: Time Series Viewer – View Menu

NOTE

When switching from Datetime to Minute or Hour, the X-axis data is subtracted from the earliest point shown in the panel and then converted to the desired unit.

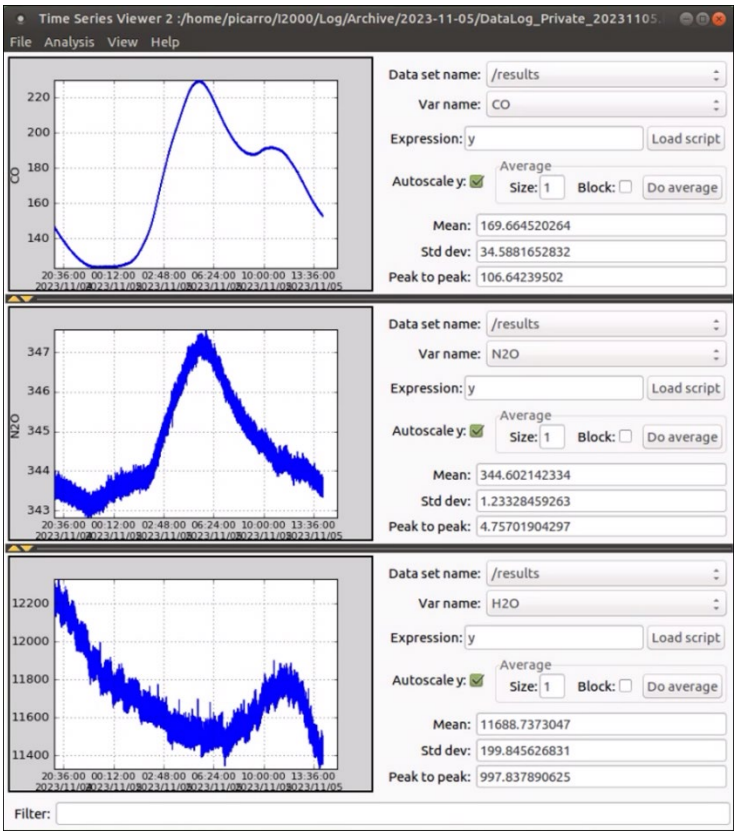
The Time Series Viewer Canvas

The Time Series Viewer canvas (Figure 79 below) is comprised of interactive graphs and a variety of configuration options.

Mouse Options and Graph Transform

The following mouse actions can be used in the canvas graphs:

- Left-click and drag: Zooms into the selected area of the plot.
- Left-click and drag with the SHIFT key down: Pans the plot.
- Left-click and drag with CTRL key down: Zooms out from the plot.
- Left-click and drag with ALT key down: Stretches the plot.
- Right-click: Opens an additional menu. Refer to the Right-click menu below in the next section.



Note: this screenshot is for example only. The species shown on your analyzer may vary.

Figure 90: Time Series Viewer Canvas

Right-click Menu

Right-clicking on the canvas opens a pop-up menu:

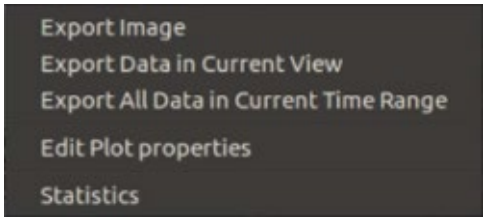


Figure 91: Canvas Right-click Pop-up Menu

Export Image – Exports the current plot as a JPEG, PNG, or PDF file.

Export Data in Current View – Exports only date/time and the selected variable in the current view to an HDF5 or CSV file.

Export All Data in Current Time Range – Exports all variable columns of the selected dataset in the current time range to an HDF5 file. Refer to Concatenate H5 Files on Page 108 for more information.

Edit Plot properties – Opens the **Image Editor form** (Figure 83), where the following options can be specified.

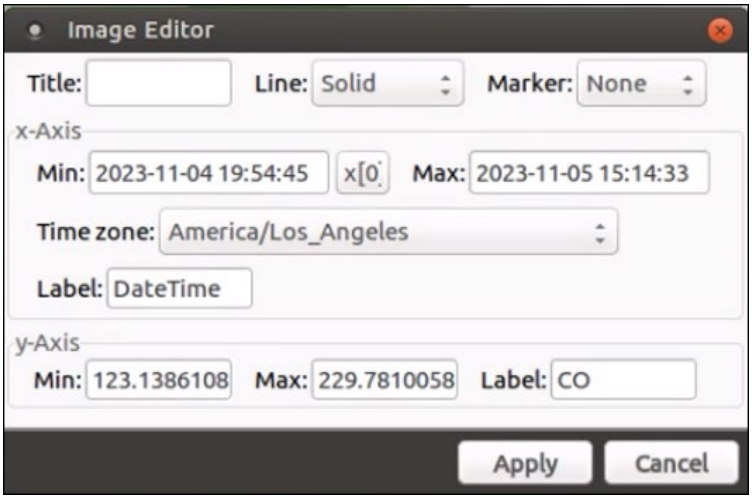


Figure 92: Image Editor Form

Image Editor Form Options:

- **Title** – Edits the title of the plot.
- **Line** – Specifies the line pattern of the plot. If None is selected, the data points will be plotted without connecting lines.
- **Marker** – Specifies the marker type to indicate data points. If None is selected, data points will not be shown.
- **x-Axis** – Min and Max: Specifies the minimum and maximum date range for the X-axis.
- **x[0]** – Sets the earliest time of the dataset as the minimum of the X-axis.
- **Time zone** – Sets the time zone for date/time variables. This defaults to the local time zone.
- **Label** – Specify labels for the X-axis and the Y-axis.
- **y-Axis** – **Min and Max**: Specifies the minimum and maximum of data displayed on the Y-axis.

Dataset Name and Var Name

An HDF5 file can store one or more tables. Each of these tables is called a Dataset. A table can contain one or more columns. Each column is called a variable (Var).

Use the **Dataset name** drop down (Figure 84) to select the dataset that is used for this time series graph. Use the **Var name** drop down to select the column in the dataset to use in the graph.

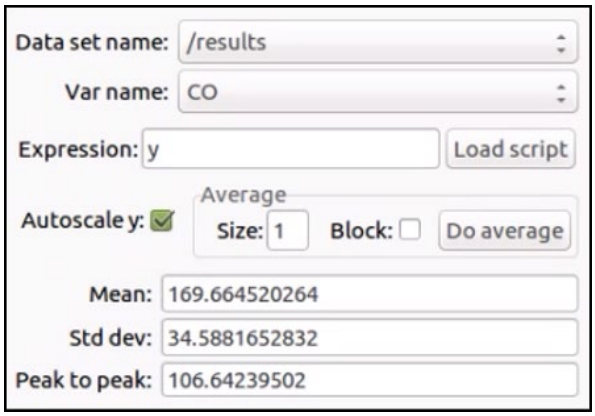


Figure 93: Time Series Viewer Dataset Options

Autoscale Y

When the **Autoscale Y** option is selected, the Time Series Viewer will autoscale on the Y-axis to make sure that all data within the range of the X axis is displayed. This feature can make it hard to see small signals when large signals blow the Y axis out, so it is often advisable to deselect this checkbox for dynamic or spikey datasets.

Average

If **Block** is selected, a block average is calculated when you click the **Do average** button. Otherwise, a moving average is calculated.

For a block average, **Size** specifies block size in unit of a minute. For a moving average, **Size** specifies subset size in unit of data points.

REMINDER

Averaging is performed after the filter and expression are performed.

Mean, Std Dev, and Peak to Peak

The **Mean, Std dev** (Standard deviation) and Peak to peak fields (Figure 84) provide all the statistical information of data in the current view.

Correlation/XY Plot

The Correlation/XY Plot window (Figure 85) includes two menu items: File and Analysis. For details about the File menu, see ***Save Configuration on page 116***.

REMINDER

The canvas in this plot is interactive. For details about the plot canvas, see The The Time Series Viewer Canvas on page 118.

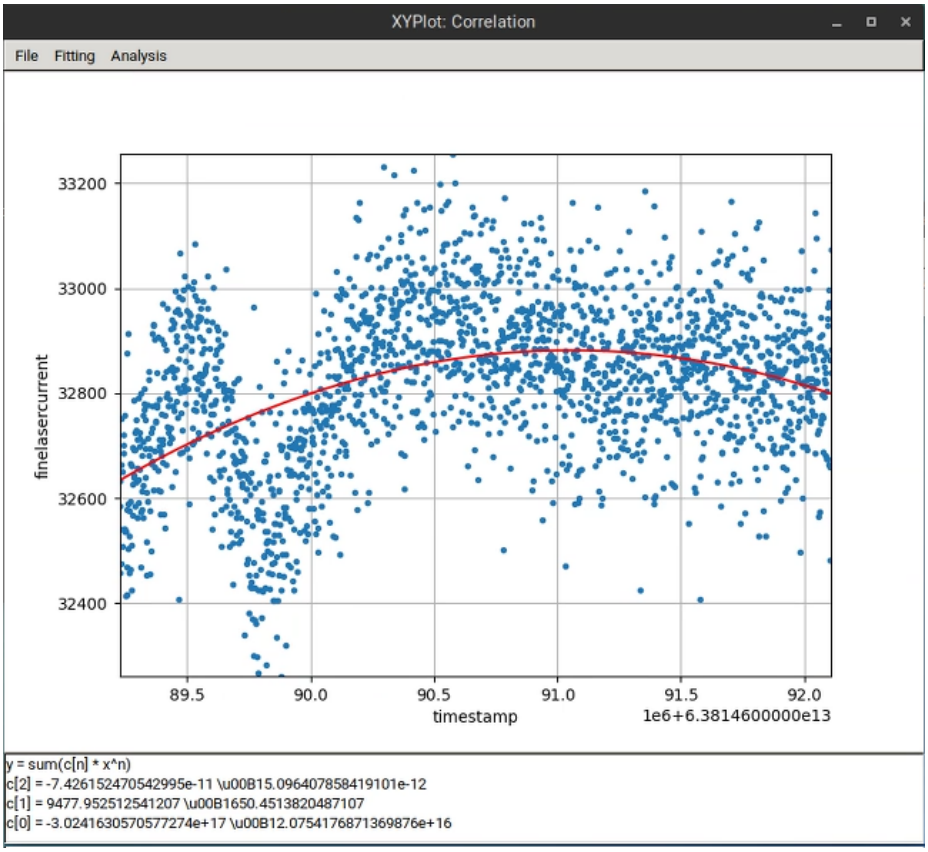


Figure 94: Correlation XY Plot

Fitting Menu

The Fitting menu (Figure 86) includes three options: **Fitting, Integration**, and **Statistics**.

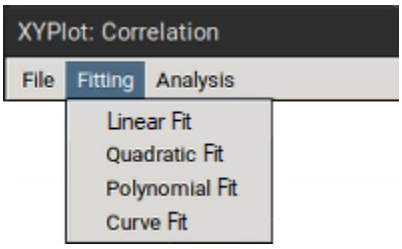


Figure 95: Fitting Menu

Fitting allows you to specify one of four fitting methods to include in the Correlation/XY plot:

Linear Fit – Specifies to fit to linear function:

$y = c1x + c0$

Quadratic Fit – Specifies to fit to quadratic function:

$y = c2x2 + c1x + c0$

Polynomial Fit – Specifies to fit polynomial function of degree n:

$y = \Sigma cnxn$

Curve Fit – Specifies to use non-linear least squares to fit an arbitrary function to data.

Analysis Menu

The Analysis menu has two options: Integration and Statistics.

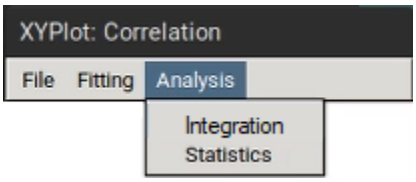


Figure 96: Analysis Menu

- **Integration** – Calculates area under the curve using the composite trapezoidal rule.
- **Statistics** – Calculates mean, standard deviation, and peak to peak for data in the current view.

After applying any of the above Analysis options, the results, statistics, or fitting function with coefficients are displayed in the lower portion of the Correlation Plot window (Figure 88).

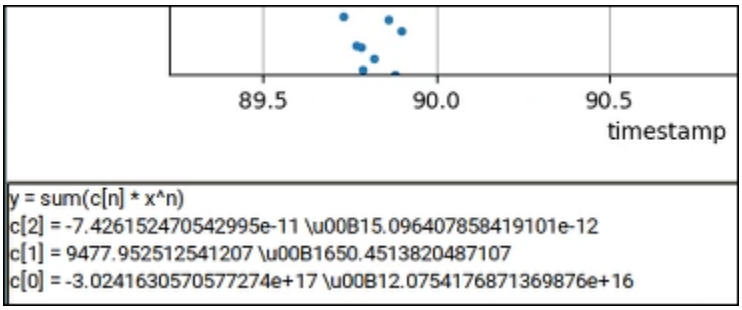


Figure 97: Results of Quadratic Fitting

APPENDIX F – Setting up Contained Exhaust Flow

F.1 Introduction

The A2000 vacuum pump is shipped with a noise dampener attached to the exhaust port. When a hazardous gas exhaust line from the pump is needed, it requires replacing the noise dampener with an adapter that allows a 1/4” OD exhaust tubing connection. Use the following instructions when installing a pump exhaust line.

Figure 98: A2000 Pump Vacuum and Exhaust Ports

F.2 Tools and Parts Required

- Long flathead screwdriver (6” x 5/16” recommended)
- 9/16” open end wrench
- Swagelok ISO parallel thread adaptor 1/4"-1/8” SS-400-1-2RS (Picarro PN 22928)
- Swagelok gasket SS-2-RS-2V (Picarro PN 22929)
- 1/4" tubing and stainless-steel ferrule set
- Snoop leak-detection fluid or similar soap solution

F.3 Directions

1. Remove the noise dampener fitting from the bottom of the pump using a long flathead screwdriver (Figure 90).

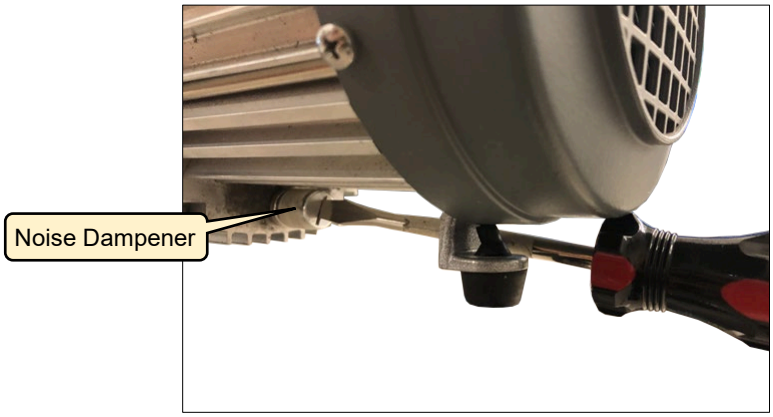


Figure 99: Pump Noise Dampener Removal

2. Slide the adapter gasket PN 22929 onto the adapter fitting PN 22928 (Figure 91), screw it into the pump exhaust port, and then tighten it 1/4 turn using a 9/16” wrench.
3. Remove the Swagelok nut and ferules from the adapter fitting to ensure their orientation is as shown below, then loosely reattach to the adapter.
4. Slide the 1/4” exhaust tubing into the Swagelok nut and ferules until the tubing is fully seated, then using a 9/16" wrench, tighten the nut approximately seven flats (420 degrees).

   A guide to this process can be found on the Picarro Video Gallery here: https://mktg.picarro.com/acton/media/39674/picarro-video-gallery

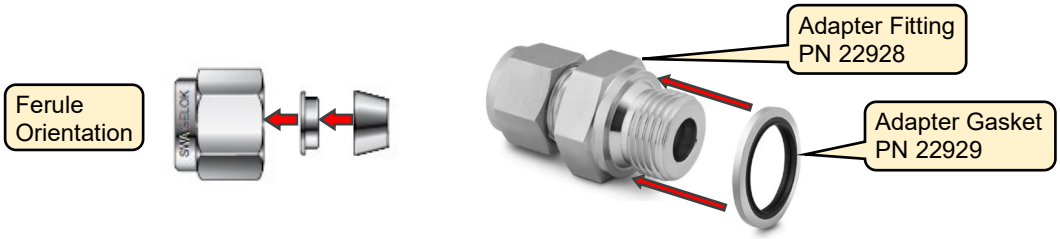


Figure 100: Pump Exhaust Line Adapter Fittings

5. With the pump running on room air, apply Snoop leak detection fluid to the installed exhaust components to confirm that the system is leak tight. Instructions for leak testing using Snoop can be found in this video:

   https://vimeo.com/375518688 (go to time 5:20 in the video)

APPENDIX G – External Valve Sequencer

G.1 Introduction

The Picarro analyzer can control two types of valves:

- **Rotary Selector Valve**: Digitally controlled valve used to send selected flow from one of many inputs (up to 16) into the analyzer.
- **Solenoid Valves**: DC voltage powered valve with normally open (NO) and normally closed (NC) positions. These can be 2-way or 3-way valves.

Both types of valves can be simultaneously controlled through a common software interface called the External Valve Sequencer (described in section G.7, External Valve Sequencer Software Overview) which is available from the Tools menu on the GUI.

Picarro offers two rotary valve and two solenoid valve solutions:

- **A0311** – 16-Port Distribution Manifold.
- **A0311-S** – 16-Port Distribution Manifold (Silco) which is optimized for use with sticky and reactive gases.
- **S3112** – 3-Way stainless steel solenoid valve with 1/4” fittings.
- **S3136** – 3-Way stainless steel solenoid valve with 1/8” fittings.

G.2 A0311 16-Port Distribution Manifold

Compatibility

The A0311 (Figure 92) is broadly compatible with most Picarro analyzers except for those with known surface and chemical compatibility issues (such as the G2103, SI2103, SI2108, SI2104, SI2205, G2307, G2509, and PI2114).

Function

The A0311 and External Valve Sequencer GUI makes it easy to program the sequence and duration of sample intake from various attached sampling lines, flasks, or bags. The manifold is controlled using either the Picarro analyzer GUI or an external hand-pad (included with the A0311).

The A0311 samples up to 16 gas sources. During operation, the selected line is routed through the valve into the analyzer. The 15 lines that are not selected terminate in the valve.

For detailed instructions on integrating the A0311 with your analyzer, refer to the 16-Port Manifold, User Manual, Including A0311, A0311-S, A0310 (P/N 40-0038).

NOTE

Figure 101: A0311 – 16-port Distribution Manifold

G.3 A0311-S 16-Port Distribution Manifold (Silco)

Compatibility

The A0311-S (Figure 93) is broadly compatible with all Picarro analyzers but is optimized for use with sticky and reactive gases in the following platforms, nominally:

- G2103, SI2103, SI2108, SI2104, SI2205, G2307, G2509, and PI2114

Function

For users who require faster response performance, the A0311-S is a 16-Port distribution manifold with a flow through valve for reduced memory effects. Designed to optimize response time in the presence of reactive gases, the A0311-S uses SilcoNert® coated components, PFA tubing, and an additional vacuum pump.

The sampling duration and sequence is easily programmed through the Picarro External Valve Sequencer GUI. This design is ideal for fast switching between different locations for specialty applications in Semiconductor, Pharmaceutical, Environmental research, and other industries.

NOTE

For detailed instructions on integrating the A0311-S with your analyzer, refer to the 16-Port Manifold, User Manual, Including A0311, A0311-S, A0310 (P/N 40-0038).

Figure 102: A0311-S – 16-Port Sequencer – Fast Multiport Gas Sampler

G.4 Valve Control Configurations

For all models of Picarro analyzers, the rotary valve control is disabled in the factory default setting. The solenoid valve control, however, is enabled by default for all solenoid valve connectors.

To configure an analyzer for operation with an A0311 rotary valve, the user must first confirm that the COM port chose on the back of the instrument for connection to the rotary valve is consistent with the COM port specified in the **Data Manager**. Refer to section ***10.2 COM2 (Data Manager) Data Streaming Protocol*** for instructions to change to rotary valve configuration (the Valve Sequencer MPV field) and to ensure the correct COM port is enabled.

CAUTION

Only use supported 12V, <500 mA, solenoids (listed above in section G.1). Using unsupported solenoids may result in damage to the power board.

G.5 Setting Up Solenoid Valves

The Valve Sequencer software can control up to six solenoid valves. Each valve should operate using 12 VDC with a maximum quiescent current of 500 mA. Most analyzers come with a valves cable that can be connected to the solenoid valves, and if not, one can be purchased by contacting support@picarro.com.

CAUTION

Be careful to avoid shorting the solenoid valve output pins, as this will blow the relays on the power board, requiring a costly replacement.

The valve connector cable should be connected to the 15-pin connector at the lower left corner of the analyzer. There are six pairs of wires with connectors

labeled V1, V2, … V6 with 2-pin female Molex connectors (Molex #43020-0200) for connection to the solenoid valves. For valves wired with matching Molex connectors, connect V1 to the solenoid valve 1, V2 to solenoid valve 2, etc. Do not connect the solenoid valve to the analyzer ground – use only the provided electrical connectors.

G.6 Setting up a Rotary Selector Valve

The (null modem) 9-pin female connector cable should be attached to its corresponding 9-pin male port (COM 2) on the analyzer. The other end of the cable connects to the 9-pin port on the A0311. Please note the 9-pin connector cable is not supplied with the instrument – only as part of the A0311 kit.

G.7 External Valve Sequencer Software Overview

The External Valve Sequencer software allows the user to define a sequence of (repeating) steps within which rotary valve positions and/or solenoid valve positions can be defined uniquely at each step.

Opening the Sequencer

From the CRDS Data Viewer, Users dropdown menu login using your username and password. Then, from the Tools drop-down menu, select Show Valve Sequencer GUI. The Picarro valve sequencer window displays (Figure 94), but typically sitting behind the main GUI. Hitting alt-tab brings the Valve Sequencer GUI to the front.

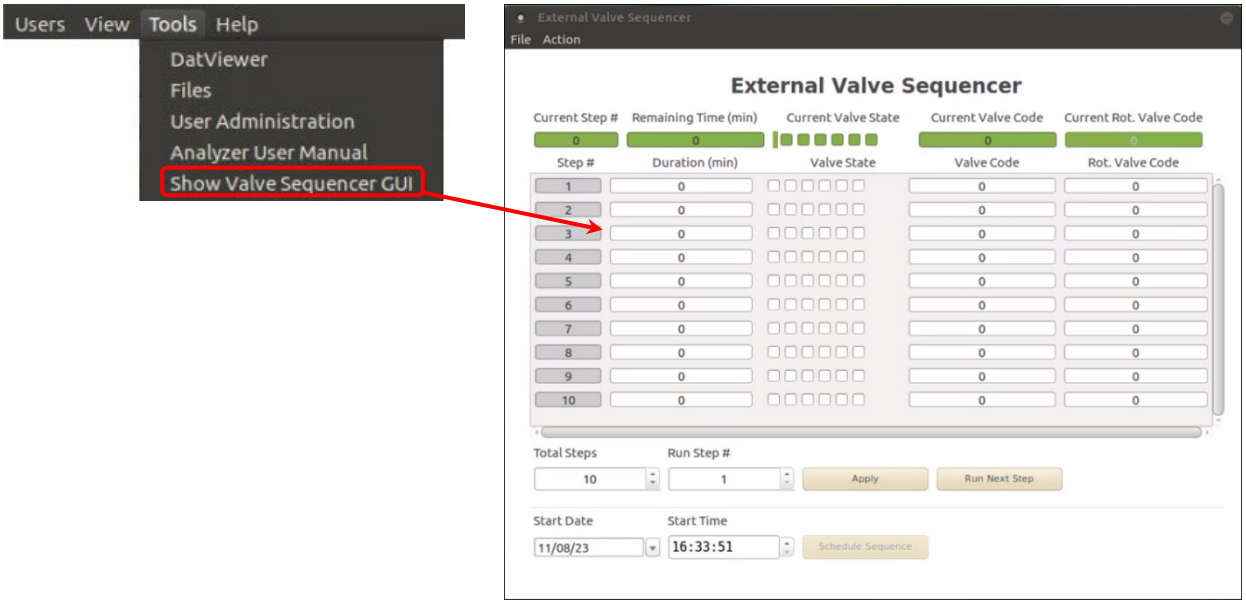


Figure 103: Launching the Valve Sequencer GUI

Valve Sequencer UI Menus

The sequencer GUI provides the dropdown menu choices shown here.

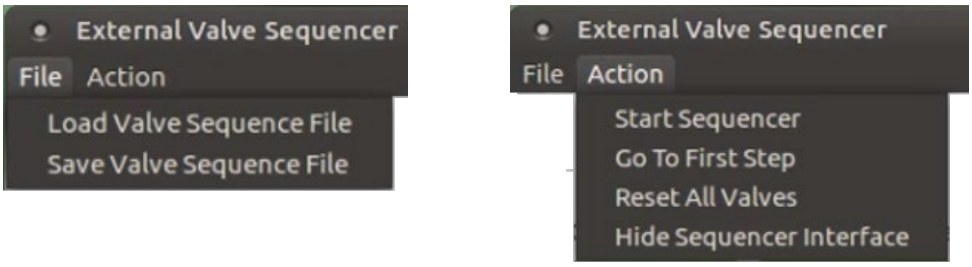


Figure 104: Valve Sequencer UI Dropdown Menus

For the following functional descriptions, Figure 96 shows a full view of an example sequencer UI.

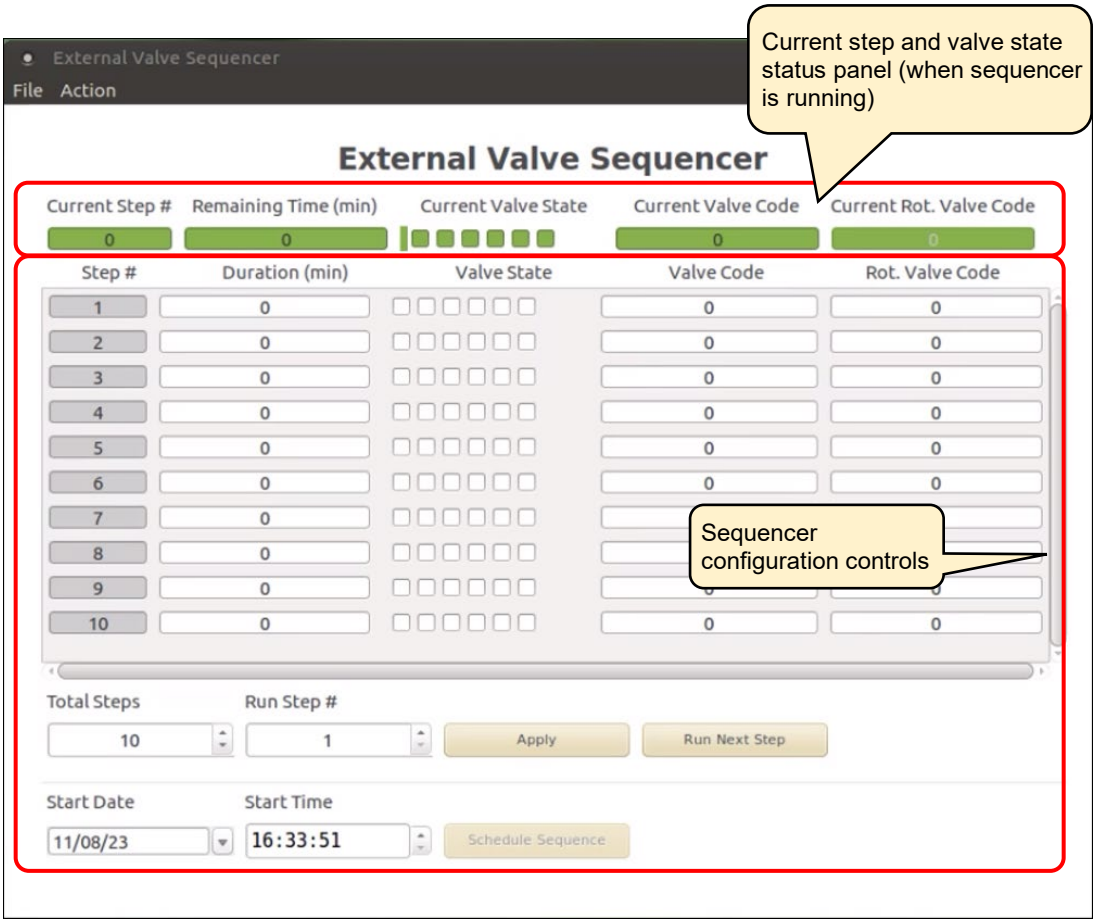


Figure 105: External Valve Sequencer UI

The Current Step #, the Remaining Time (min), and the Current Valve State are shown in the topmost row of the valve sequencer command window. The duration of each step is set in decimal minutes; for example, 15 seconds would be entered in as 0.25 minutes.

While a sequence is inactive, Current Step # will typically read “0.” Once the user has selected **Start Sequence** from the Action menu, or once the user clicks **Apply** from the GUI, the Current Step value will change to 1, corresponding to the first step defined below it, and will continue through the steps, returning to Step 1 once the last step is completed.

If a user wishes to perform a set of steps only once, they may set a final step with a very long duration, or wait until the sequence is finished, and at the end of the last step, click **Stop Sequence** from the Action menu.

Under Action, the **Go to First Step** menu item restarts the sequence from step 1. When the first step in the sequence starts, the “Current Step” value will change to “1”. This will begin the sequence if the sequence is currently active.

G.8 Programming and Saving a Valve Sequence

Each “step” in the sequence can be used to set the rotary valve to a given position or activate selected solenoid valve(s) for a set period. Multiple steps can be carried out in sequential order to switch between different gas sources, flush out a manifold, or to perform other gas handling operations.

1. Create the number of desired steps in the sequence by clicking the up/down arrow for Total Steps.
2. For each step, select the box for each solenoid valve to be opened. The checkmark in the Current Valve State window indicates a solenoid valve is set to its “normally closed” value in the case of a 3-way, or to its “open” value in the case of a 2-way on/off valve. The positions from left to right correspond to solenoid valves V1 to V6.
3. The rotary selector valve position can be set in the column labeled Rot. Valve Code. Enter the number that corresponds to the desired valve position. A value of 1 in this field corresponds to position 1 on the rotary valve. Only one rotary position can be selected per step.
4. The upper right box, Current Rot. Valve Code, displays the current value while a sequence is active. It should be white if a rotary valve is connected, turned on, and detected by the software. If the box is grayed out, the rotary valve is not detected (if so, consult your rotary valve manual).
5. For each step, set the desired Duration. This is determined by the value entered in the Duration (min) field, where the duration of the step is in minutes. If duration values are set to <0.1 minutes, they may not be carried out accurately.
6. The Valve Code column (not used with the rotary valves) is a configuration-dependent, read-only display field that shows the total state of that particular step in a numerical binary sum of form 2 (Valve Number -1). When powered, the following valve values are produced, and then added together for the final Valve Code.

   Valve 1 Powered = 2(Valve number-1) = 2(1-1) = 1

   Valve 2 Powered = 2(Valve number-1) = 2(2-1)= 2

   Valve 3 Powered = 2(Valve number-1) = 2(3-1)= 4

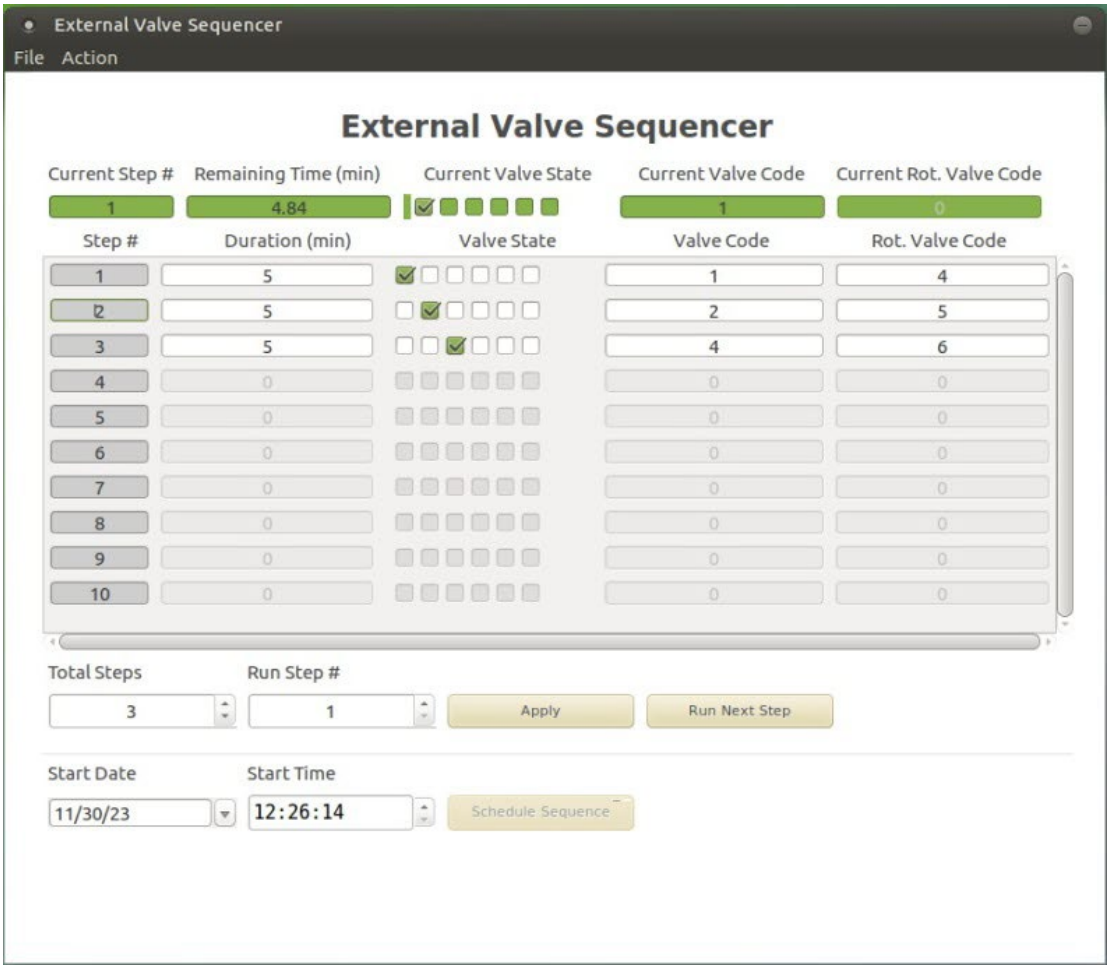
   Valve 4 Powered = 2(Valve number-1) = 2(4-1) = 8

   Valve 5 Powered = 2(Valve number-1) = 2(5-1)= 16

   Valve 6 Powered = 2(Valve number-1) = 2(6-1)= 32

The maximum displayable value is 63 (=1+2+4+8+16+32), when valves 1-6 are all powered. All other combinations of valves are unique binary sum values which denote the specific combination of any of the six valves.

This Valve Code value active at a particular point in time can be shown in the main Picarro software GUI as SolenoidValves or sometimes ValveMask (this may require going to Settings > Service Mode > password picarro). The Rotary valve code can be displayed as MPVPosition.



Above is a 15 minute valve sequence. It opens 5 minutes for each solenoid valve (#1, #2 and #3), and each of rotary valve (#4, #5 and #6).

Figure 106: Example 15 Minute Sequence

7. Once the valve sequence has been programmed, it can be saved by selecting Save Valve Sequence File under the File menu (Figure 93). The sequence may be saved with any name the user chooses.

G.9 Loading and Running a Saved Sequence

Loading a Saved Sequence

1. Under the File menu, select **Load Valve Sequence**.

   All the sequence files are in:

   /Home/Picarro/I2000/InstrConfig/ValveSequencer/Name of the Sequence File

2. To load an existing valve sequence file, select the desired sequence name.

   If the user has been running a different sequence from the one that was loaded, the user needs to press Run Next Step to initialize the newly selected sequence, or alternately go to File > Go To First Step and Start Sequencer.

Running a Sequence

1. Under the **Action** menu, select **Start Sequencer**.

   This selection will change to Stop Sequencer once the sequence starts. (The sequencer should be activated if it was disabled, but not necessarily to change from one sequence to another.) The sequence will repeat itself indefinitely until disabled or the software is exited.

2. Once the sequencer is running, the user can select **Hide Sequencer Interface** under the Action menu; the sequence will continue to run even with the UI hidden, and will automatically continue if the instrument ever loses power from the wall and restarts after power is restored. (However, the timing of the sequence will be offset relative to the intended cadence.)

3. To bring the sequencer interface back into view, from the main Picarro GUI, go to **Tools** > **Show/hide Valve Sequencer** again.

Skipping Steps or Advancing to a Particular Step

If desired, the valve sequence can be forwarded to the next step of the sequence by clicking the **Run Next Step** button on the UI. To jump to a particular step, increment the **Run Step #** field and click **Apply**.

Stopping the Sequencer

1. Under the **Action** menu, select **Stop Sequencer**.

   This will leave all valves in their current state. In some situations, it is convenient to program the last step in the sequence to be a safe or default valve state.

2. Should the user need to put the solenoid or rotary valves into a safe/default state, the sequencer can be advanced to the last step using the Run Next Step button.

Resetting Valves

Under the Action menu, selecting Reset All Valves will deactivate/reset all valves to their default state.

G.10 Scheduling a Sequence

Users may schedule a sequence to start at a particular time in the future, often at the top of the hour, or at midnight for a recurring sequence with an hourly or daily cadence. The Schedule Sequence button is typically greyed out when the user shows the valve sequencer because the start time has passed. To begin a run in the future, select the desired date under Start Date, and the desired time under Start Time. When both values are in the future, the Schedule Sequence button will become active, and the user may click it. When the scheduled time arrives, the sequence will start automatically.

APPENDIX H – Relative Humidity Conversion

H_2O Concentration (C) is reported in units of parts per hundred or percent (%) and is a volumetric fraction of water vapor to total (wet) gas. Via the ideal gas law, the concentration can be related to the water vapor pressure (PW) and the total pressure (P).

$$C_{wet} = 100 \cdot \frac{P_W}{P}$$

A popular way to express volumetric concentration when working with humidity is in terms of total (dry) gas.

$$C_{dry} = 100 \cdot \frac{P_W}{(P - P_W)}$$

The two concentration definitions can be related by

$$C_{dry} = \frac{100 \cdot C_{wet}}{(100 - C_{wet})} \quad \text{or} \quad C_{wet} = \frac{100 \cdot C_{dry}}{(100 + C_{dry})}$$

Relative Humidity (RH) is the percentage of water vapor pressure to the saturated water vapor pressure (PWS).

$$RH = 100 \cdot \frac{P_W}{P_{WS}}$$

There are several empirically generated equations that provide the saturation vapor pressure as a function of temperature (T). A simple and effective relationship for use within a temperature range of -45 °C to 60 °C is provided by the Mangus formula with coefficients adjusted by Sonntag [1].

$$P_{WS} = \alpha \cdot e^{\left(\frac{\beta \cdot T}{T + \lambda}\right)}$$

Where, α = 4.584 Torr, β = 17.62 and λ = 243.12 °C

Combining the equations shown above yields the final relationship for converting the wet and dry definitions of concentration to relative humidity.

$$RH = C_{wet} \cdot \frac{P}{\alpha} \cdot e^{-\left(\frac{\beta \cdot T}{T + \lambda}\right)} = \frac{100 \cdot C_{dry}}{(C_{dry} + 100)} \cdot \frac{P}{\alpha} \cdot e^{-\left(\frac{\beta \cdot T}{T + \lambda}\right)}$$

For example, a wet concentration of 1.5% H20 at 18.0 °C and 760.0 Torr yields a relative humidity of 73.8%.

A dry concentration of 1.5% at 18.0 °C and 760.0 Torr yields a relative humidity of 72.7%.

[1] Sonntag D.: Important New Values of Physical Constants of 1986, Vapour Pressure Formulations based on the ITS-90 and Psychrometer Formulae; Z. Meteorol.70 (1990) 5, 340-344

APPENDIX I – Introduction to CRDS Technology

Picarro analyzers use time-based, optical absorption spectroscopy of the target gases to determine concentration in a sample. They are based on wavelength-scanned cavity ring-down spectroscopy (WS-CRDS), a technology in which light travels many times through the sample, creating an exceptionally long effective path length for the light to interact with the target gas, thus enabling excellent detection sensitivity in a compact and rugged instrument.

The Picarro analyzer is comprised of two modules:

- The Analyzer contains the spectrometer, sample chamber, and a computer with a hard drive to store and analyze data. The single analyzer module controls the operation of the system and converts spectroscopic measurements into gas concentration data.
- The External Vacuum Pump draws the sample gas through the instrument.

I.1 Cavity Ring-Down Spectroscopy (CRDS)

Nearly every small gas-phase molecule (e.g., CO_2, H_2O, H_2S, NH_3) and isotopologue (e.g., $H_2{}^{18}O$, $^{13}CO_2$, 15N14N16O) uniquely absorb specific wavelengths of near-infrared light. The strength of the light absorption is related to the concentration of a molecule in a sample and the distance that light travels through the sample, called the path length.

Conventional infrared spectrometers are typically only sensitive enough to detect trace gases at levels in the part-per-million. Cavity Ring-Down Spectroscopy (CRDS), on the other hand, is one thousand to one million more times sensitive.

The increased sensitivity of CRDS is due to the design of the sample cavity and the time-based measurement. In the cavity, a series of mirrors reflects the infrared light through the sample, increasing the path length. For a Picarro cavity of only 25 cm in length, the effective path length of the cavity can be over 20 kilometers.

In Picarro analyzers, light from a single-frequency laser enters a cavity where three mirrors reflect the laser light as seen in Figure 99. The light enters through the mirror closest to the laser, bounces off the angled mirror in the lower right corner of the cavity, travels to the hemispherical mirror at the top of the cavity, bounces toward the mirror in the lower left corner of the cavity, and then returns to the first mirror. This motion becomes a continuous traveling light wave, which is represented by the dark orange path in Figure 98.

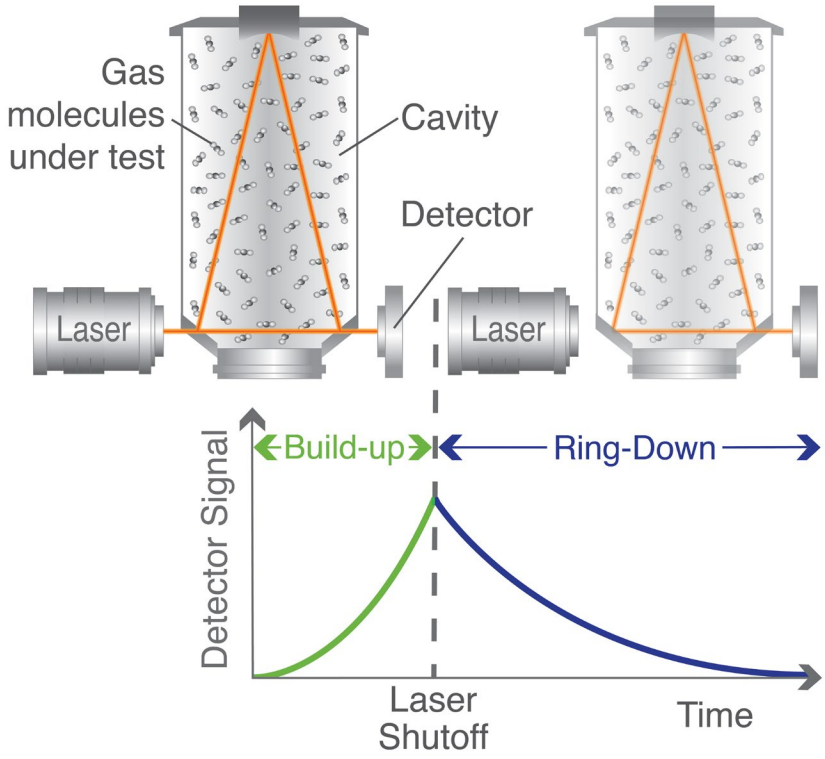


Figure 107: Schematic of Picarro CRDS Analyzer Cavity

When the laser is on, the cavity quickly fills with laser light. A small amount of laser light is transmitted through the mirror closest to the photodetector, which turns the incident light into a signal that is directly proportional to the light intensity in the cavity.

When the photodetector signal reaches a threshold level (in a few tens of microseconds), the laser is turned off. The light contained within the cavity continues to bounce between the mirrors (about 40,000 times). Since the mirrors have slightly less than 100% reflectivity (99.999%), the light inside the cavity steadily leaks out of the cavity. The intensity of the light reaching the detector decreases, falling exponentially until it reaches zero. This decay, or “ring-down,” is measured in real time by the photodetector.

I.2 Relating Ring-Down Time to Absorption Intensity

The time it takes to ring-down is inversely related to the total optical loss in the cavity, including the strength of molecular absorption at a given wavelength of light. For an empty cavity, the time it takes for the intensity to decrease by a given percent is determined solely by the reflectivity of the mirrors. A cavity containing gas that absorbs light will have a shorter ring-down time than an empty cavity. As

the light circulates in a cavity with a gas sample, the molecular absorption by the gas results in a decrease of the light intensity.

Determining absorption intensity at a specific wavelength requires comparing the ring-down time of an empty cavity to the ring-down time of a cavity that contains gas (Figure 99). A cavity can be empty if it contains no gas; it will also appear empty if the molecules of the sample inside the cavity do not interact with the specific wavelength of light.

Picarro instruments gather measurements from an “empty” cavity by switching the light to wavelengths that are not absorbed by the target molecules. The analyzer subsequently measures ring-down times at wavelengths that are absorbed by the target gas. The analyzer automatically and continuously compares these two types of ring-down times, and the software uses those comparisons to calculate absorption intensities.

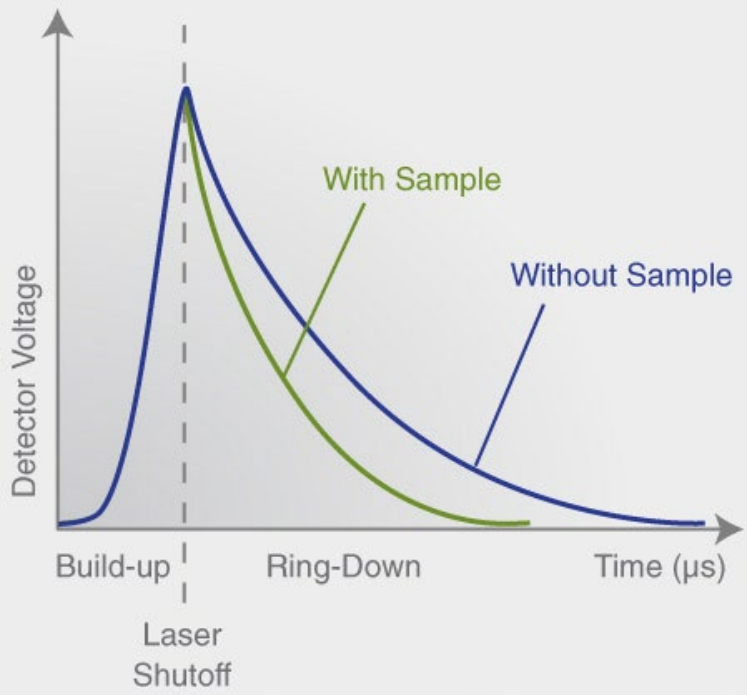


Figure 108: Light Intensity as Function of Time in CRDS System

I.3 Converting Absorption Intensity to Concentration

Plotting the absorbance at each measured wavelength generates an optical spectrum. This spectrum contains absorbance peaks that are unique to each molecule in the sample. The height of a particular absorption peak is proportional to the concentration of a molecule that generated the signal.

The height of the peak is calculated by subtracting the maximal absorbance from the baseline absorbance. Figure 100 shows a plot of ideal optical spectra with a clean, uniform baseline on either side of the absorption peak.

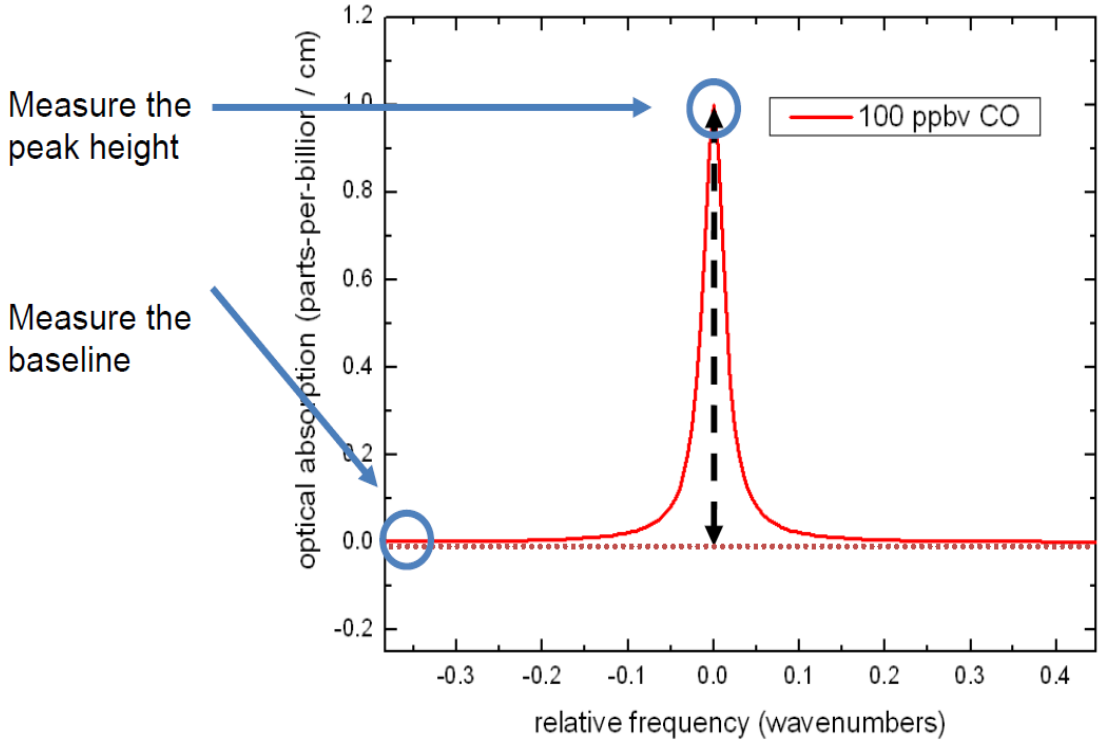


Figure 109: Absorption Spectral Curve

However, optical spectra often contain several absorption lines, nested closely together. A particular absorption peak may be visible between lines, but the absorption may not return to the baseline before it rises in response to another molecule.

Picarro analyzers calculate the baseline underneath a poorly resolved peak by modeling the absorption peaks from other surrounding molecules and subtracting contributions from neighboring peaks to the absorption intensity.

I.4 Spectral Precision and High Sensitivity Measurements

Picarro analyzers contain two features that provide high spectral precision:

- A proprietary wavelength monitor (WLM) that measures the absolute laser wavelength to a precision that is a few orders of magnitude narrower than the spectral linewidth: Picarro's patented WLM measures absolute laser wavelength to a precision more than 1,000 times narrower than the observed Doppler-broadened linewidth for small gas-phase molecules.

The instruments lock the laser to the WLM, and then the monitor tunes to wavelengths known to be maximally and minimally absorbed by the target molecule. The result is closely clustered absorption intensities, measured at wavelengths just before peak absorption, at peak absorption, and just after peak absorption, as the absorbance returns to the baseline.

- Precise temperature and pressure control in the sample cavity: Accurate absorption measurements at precisely known wavelengths account for little unless the temperature and pressure of the CRDS measurement cavity are known. The observed line intensity and shape depend on the temperature and pressure inside the sample cavity. Small temperature and pressure instabilities can result in large concentration errors due to fluctuating peak heights and baselines. To completely minimize instrument measurement drift, temperature and pressure must be actively stabilized to constant values.

For precise temperature control, the sample cavity is surrounded by layers of thermally insulating material to provide a high degree of passive thermal stability. The cavity is further actively stabilized by means of a solid-state heating system locked to the output of a thermal sensor. This enables the temperature of the cavity to be within 20 mK of the set temperature.

For precise pressure control, the cavity pressure is monitored using a high-linearity pressure transducer. The system computer uses this pressure data in a feedback loop to control proportional valves that adjust the inlet and outlet gas flow of the cavity.

APPENDIX J – SDS for Koolance LIQ-702

A PDF copy of this SDS from Koolance is available at koolance.com.

KOOLANCE
www.koolance.com

LIQ-702 Coolant Fluid

Safety Data Sheet

according to the REACH Regulation (EC) 1907/2006 amended by Regulation (EU) 2020/878
Issue date: Aug 31, 2023 Version: 1.0

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product form : Mixture
Trade name : LIQ-702xx Coolant Fluid ("xx" signifies liquid color)

1.2. Relevant identified uses of the substance or mixture and uses advised against

1.2.1. Relevant identified uses

Main use category : General industrial heat transfer medium

1.2.2. Uses advised against

Restrictions on use : Do not use the product for any other purpose

1.3. Details of the supplier of the safety data sheet

Manufacturer
Koolance Korea
Koolance Bld, 40, Deokcheon-ro 34, Manan-gu, Anyang-si, Gyeonggi-do, South Korea 14088
T (U.S.) +01 253-249-7669 - F (U.S.) +01 253-249-7453
https://www.koolance.com

Europe - Only Representative (Not An Importer)
KTR Europe GmbH
65760, Mergenthalerallee 77, Frankfurt/Eschborn, Germany.
T+49 6196-887170

1.4. Emergency telephone number

Emergency number : Kontaktieren Sie die nationalen Helpdesks, Liste der Telefonnummern: ÖSTERREICH (Wien) +43 1 515 61 0, BELGIEN (Brüssel) +32 070 245 245, BULGARIEN (Sofia) +359 2 9888 205, Kroatien +385 1 2348 342 TSCHECHISCHE REPUBLIK (Prag) +420 224 919 293 oder +420 224 915 402, DÄNEMARK (Kopenhagen) 82 12 12 12, Estland (Tallinn) 112, FINNLAND (Helsinki) +358 9 471 977, FRANKREICH (Paris) +33 1 45 42 59 59, DEUTSCHLAND (Berlin) +49 30 19240, GRIECHENLAND (Athen) +30 210 77 93 777, UNGARN (Budapest) +36 80 201 199, ISLAND (Reykjavik) +354 543 2222 oder 112, IRLAND (Dublin) +353 1 8379964 oder +353 1 809 2166, ITALIEN (Rom) +39 06 305 4343, LETTLAND (Riga) 112 oder +371 6704 2473, LITAUEN (Vilnius) +370 5 236 20 52 oder +370 687 53378, Luxemburg + 352 70 245 245, MALTA +356 2122 4071, NIEDERLANDE (Bilthoven) +31 30 274 88 88, NORWEGEN (Oslo) 22 591300, POLEN (Danzig) +48 58301 65 16 oder +48 58 349 2831, PORTUGAL (Lissabon) 808 250 143, RUMÄNIEN (Bukarest) +40 21 3183606 SLOWAKEI (Bratislava) +421 2 54 77 416 6, SLOWENIEN (Ljubljana) + 386 41 650 500, SPANIEN +34 91 562 04 20 (spanische Sprache) oder +34 91 768 98 00 (Sie können Englisch beantragen), SCHWEDEN (Stockholm) 112 oder +46 10 456 6700 (Mo-Fr 9.00-17.00 Uhr), VEREINIGTES KÖNIGREICH (London) 112 oder 0845 4647 (NHS Direktwahl)

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Skin corrosion/irritation, Category 2	H315
Serious eye damage/eye irritation, Category 2	H319

Full text of H- and EUH-statements: see section 16

Adverse physicochemical, human health and environmental effects

Causes skin irritation. Causes serious eye irritation.

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2.2. Label elements

Labelling according to Regulation (EC) No. 1272/2008 [CLP]

Hazard pictograms (CLP) :

GHS07

Signal word (CLP) : Warning

Hazard statements (CLP) : H315 - Causes skin irritation.
H319 - Causes serious eye irritation.

Precautionary statements (CLP) : P264 - Wash hands, forearms and face thoroughly after handling.
P280 - Wear protective gloves/protective clothing/eye protection/face protection/hearing protection.
P302+P352 - IF ON SKIN: Wash with plenty of water.
P305+P351+P338 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P321 - Specific treatment (see supplemental first aid instruction on this label).
P332+P313 - If skin irritation occurs: Get medical advice/attention.

2.3. Other hazards

Contains no PBT/vPvB substances ≥ 0.1% assessed in accordance with REACH Annex XIII
Contains no PBT/vPvB substances ≥ 0.1% assessed in accordance with REACH Annex XIII

Component	
Propylene Glycol (57-55-6)	This substance/mixture does not meet the PBT criteria of REACH regulation, annex XIII This substance/mixture does not meet the vPvB criteria of REACH regulation, annex XIII
Potassium Phosphate Dibasic (7758-11-4)	This substance/mixture does not meet the PBT criteria of REACH regulation, annex XIII This substance/mixture does not meet the vPvB criteria of REACH regulation, annex XIII
Sodium Molybdate (7631-95-0)	This substance/mixture does not meet the PBT criteria of REACH regulation, annex XIII This substance/mixture does not meet the vPvB criteria of REACH regulation, annex XIII
Meta-toluic Acid (99-04-7)	This substance/mixture does not meet the PBT criteria of REACH regulation, annex XIII This substance/mixture does not meet the vPvB criteria of REACH regulation, annex XIII

The mixture does not contain substance(s) included in the list established in accordance with Article 59(1) of REACH for having endocrine disrupting properties, or is not identified as having endocrine disrupting properties in accordance with the criteria set out in Commission Delegated Regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at a concentration equal to or greater than 0,1 %

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable

3.2. Mixtures

Name	Product identifier	%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Water	CAS-No.: 7732-18-5 EC-No.: 231-791-2	70 – 75	Not classified
Propylene Glycol	CAS-No.: 57-55-6 EC-No.: 200-338-0	25 – 30	Skin Irrit. 2, H315 Eye Irrit. 2, H319
Potassium Phosphate Dibasic	CAS-No.: 7758-11-4 EC-No.: 231-834-5	≤ 1	Acute Tox. 4 (Oral), H302 Acute Tox. 3 (Inhalation:dust,mist), H331

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Name	Product identifier	%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Sodium Molybdate	CAS-No.: 7631-95-0 EC-No.: 231-551-7	≤ 1	Acute Tox. 4 (Inhalation:dust,mist), H332 STOT RE 2, H373
Meta-toluic Acid	CAS-No.: 99-04-7 EC-No.: 202-723-9	≤ 1	STOT RE 2, H373 Aquatic Chronic 2, H411

Full text of H- and EUH-statements: see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove person to fresh air and keep comfortable for breathing.

First-aid measures after skin contact : Wash skin with plenty of water. Take off contaminated clothing. If skin irritation occurs: Get medical advice/attention.

First-aid measures after eye contact : Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

First-aid measures after ingestion : Call a poison center or a doctor if you feel unwell.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/effects after skin contact : Irritation.

Symptoms/effects after eye contact : Eye irritation.

4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Water spray. Dry powder. Foam. Carbon dioxide.

5.2. Special hazards arising from the substance or mixture

Hazardous decomposition products in case of fire : Toxic fumes may be released.

5.3. Advice for firefighters

Protection during firefighting : Do not attempt to take action without suitable protective equipment. Self-contained breathing apparatus. Complete protective clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Emergency procedures : Ventilate spillage area. Avoid contact with skin and eyes.

6.1.2. For emergency responders

Protective equipment : Do not attempt to take action without suitable protective equipment. For further information refer to section 8: "Exposure controls/personal protection".

6.2. Environmental precautions

Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

Methods for cleaning up : Take up liquid spill into absorbent material.

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Other information : Dispose of materials or solid residues at an authorized site.

6.4. Reference to other sections

For further information refer to section 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Ensure good ventilation of the work station. Avoid contact with skin and eyes. Wear personal protective equipment.

Hygiene measures : Wash contaminated clothing before reuse. Do not eat, drink or smoke when using this product. Always wash hands after handling the product.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store in a well-ventilated place. Keep cool.

Incompatible products : reducing materials.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

8.1.1 National occupational exposure and biological limit values

Propylene Glycol (57-55-6)	
Croatia - Occupational Exposure Limits	
Local name	Propane-1,2-diol
GVI (OEL TWA) [1]	474 mg/m³ ukupno pare i čestice 10 mg/m³ samo čestice
GVI (OEL TWA) [2]	150 ppm ukupno pare i čestice
Regulatory reference	Pravilnik o zaštiti radnika od izloženosti opasnim kemikalijama na radu, graničnim vrijednostima izloženosti i biološkim graničnim vrijednostima (NN 1/2021)
Ireland - Occupational Exposure Limits	
Local name	Propane-1,2-diol [Propylene glycol]
OEL TWA [1]	470 mg/m³ total (vapour and particulates) 10 mg/m³ particulates
OEL TWA [2]	150 ppm total (vapour and particulates)
Regulatory reference	Chemical Agents Code of Practice 2021
Latvia - Occupational Exposure Limits	
Local name	Propilēnglikols (1,2-propāndiols)
OEL TWA	7 mg/m³
Regulatory reference	Ministru kabineta 2007. gada 15. maija noteikumiem Nr. 325
Lithuania - Occupational Exposure Limits	
Local name	Propilenglikolis
IPRV (OEL TWA)	7 mg/m³
Regulatory reference	LIETUVOS HIGIENOS NORMA HN 23:2011 (Nr. V-695/A1-272, 2018-06-12)

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Propylene Glycol (57-55-6)	
Poland - Occupational Exposure Limits	
Local name	Propano-1,2-diol
NDS (OEL TWA)	100 mg/m³ pary i frakcja wdychalna
Remark	Frakcja wdychalna – frakcja aerozolu wnikająca przez nos i usta, która po zdeponowaniu w drogach oddechowych stwarza zagrożenie dla zdrowia.
Regulatory reference	Dz. U. 2018 poz. 1286
United Kingdom - Occupational Exposure Limits	
Local name	Propane-1,2-diol
WEL TWA (OEL TWA) [1]	474 mg/m³ 10 mg/m³
WEL TWA (OEL TWA) [2]	150 ppm
Regulatory reference	EH40/2005 (Fourth edition, 2020). HSE
Norway - Occupational Exposure Limits	
Local name	Propan-1,2-diol
Grenseverdi (OEL TWA) [1]	79 mg/m³
Grenseverdi (OEL TWA) [2]	25 ppm
Regulatory reference	FOR-2021-06-28-2248

Sodium Molybdate (7631-95-0)	
Belgium - Occupational Exposure Limits	
OEL TWA	0.5 mg/m³
France - Occupational Exposure Limits	
VME (OEL TWA)	5 mg/m³
VLE (OEL C/STEL)	10 mg/m³
United Kingdom - Occupational Exposure Limits	
WEL TWA (OEL TWA) [1]	5 mg/m³
WEL STEL (OEL STEL)	10 mg/m³
USA - ACGIH - Occupational Exposure Limits	
ACGIH OEL TWA	0.5 mg/m³ (Respirable fraction)

8.1.2. Recommended monitoring procedures

No additional information available

8.1.3. Air contaminants formed

No additional information available

8.1.4. DNEL and PNEC

No additional information available

8.1.5. Control banding

No additional information available

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8.2. Exposure controls

8.2.1. Appropriate engineering controls

Appropriate engineering controls:
Ensure good ventilation of the work station.

8.2.2. Personal protection equipment

Personal protective equipment symbol(s):

8.2.2.1. Eye and face protection

Eye protection:
Safety glasses

8.2.2.2. Skin protection

Skin and body protection:
Wear suitable protective clothing

Hand protection:
Protective gloves

8.2.2.3. Respiratory protection

Respiratory protection:
In case of insufficient ventilation, wear suitable respiratory equipment

8.2.2.4. Thermal hazards

No additional information available

8.2.3. Environmental exposure controls

Environmental exposure controls:
Avoid release to the environment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Liquid
Colour	:	Not available
Odour	:	Not available
Odour threshold	:	Not available
Melting point	:	Not applicable
Freezing point	:	Not available
Boiling point	:	> 98 °C
Flammability	:	Non flammable.
Explosive limits	:	Not available
Lower explosion limit	:	Not available
Upper explosion limit	:	Not available
Flash point	:	118 °C (Cleveland open cup). No flash occurred under 93ºC (Tag closed cup)
Auto-ignition temperature	:	Not available
Decomposition temperature	:	Not available
pH	:	7 – 8 at 20ºC; Sample H2O = 1:5 (V/V)
Viscosity, kinematic	:	2.3 mm²/s at 20°C
Solubility	:	Soluble at 20ºC
Partition coefficient n-octanol/water (Log Kow)	:	Not available
Vapour pressure	:	Not available
Vapour pressure at 50°C	:	Not available
Density	:	1.042 g/cm³

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Relative density	:	Not available
Relative vapour density at 20 °C	:	1.03
Particle characteristics	:	Not applicable

Water (7732-18-5)	
Boiling point	100 °C
Vapour pressure	2300 Pa 25°C

Propylene Glycol (57-55-6)	
Boiling point	187.6 °C
Flash point	104 °C (Closed cup, 1000 hPa, EU Method A.9: Flash-Point)
Auto-ignition temperature	> 400 °C (1000 - 1001 hPa, EU Method A.15: Auto-ignition Temperature (liquids and gases), T2)
Vapour pressure	0.2 hPa (25 °C, EU Method A.4: Vapour Pressure)
Vapour pressure at 50 °C	1.8 hPa (Antoine equation)
Particle size	Not applicable (liquid)

Potassium Phosphate Dibasic (7758-11-4)	
Boiling point	Not applicable (melting point > 300 °C)
Flash point	Not applicable (solid)
Auto-ignition temperature	Not applicable
Vapour pressure	Not applicable (melting point > 300 °C)
Particle size	No data available in the literature

Sodium Molybdate (7631-95-0)	
Flash point	Not applicable

Meta-toluic Acid (99-04-7)	
Boiling point	263 °C
Flash point	159 °C (1013.25 hPa, EU Method A.9: Flash-Point)
Auto-ignition temperature	500 °C (T1)
Vapour pressure	0.00019 hPa (25 °C, OECD 104: Vapour Pressure)

9.2. Other information

9.2.1. Information with regard to physical hazard classes

No additional information available

9.2.2. Other safety characteristics

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

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10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

No dangerous reactions known under normal conditions of use.

10.4. Conditions to avoid

None under recommended storage and handling conditions (see section 7).

10.5. Incompatible materials

No additional information available

10.6. Hazardous decomposition products

Under normal conditions of storage and use, hazardous decomposition products should not be produced.

SECTION 11: Toxicological information

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Acute toxicity (oral) : Not classified
Acute toxicity (dermal) : Not classified
Acute toxicity (inhalation) : Not classified

Water (7732-18-5)	
LD50 oral	> 90000 mg/kg bodyweight
LD50 dermal	> 90000 mg/kg bodyweight

Propylene Glycol (57-55-6)	
LD50 oral rat	22000 mg/kg (Rat, Male / female, Experimental value, Oral)
LD50 dermal rabbit	> 2000 mg/kg bodyweight (24 h, Rabbit, Experimental value, Dermal, 14 day(s))
LC50 Inhalation - Rat	> 44.9 mg/l air Animal: rat, Guideline: other:, Remarks on results: other:

Potassium Phosphate Dibasic (7758-11-4)	
LD50 oral rat	> 2000 mg/kg bodyweight (OECD 420: Acute Oral toxicity – Acute Toxic Class Method, Rat, Female, Experimental value, Oral, 14 day(s))
LD50 oral	1700 mg/kg bodyweight
LD50 dermal rat	> 2000 mg/kg bodyweight (OECD 402: Acute Dermal Toxicity, 24 h, Rat, Male / female, Experimental value, Dermal, 14 day(s))
LD50 dermal	> 2500 mg/kg bodyweight
LC50 Inhalation - Rat	> 0.83 mg/l (OECD 403: Acute Inhalation Toxicity, 4 h, Rat, Male / female, Read-across, (maximum achievable concentration), Inhalation (dust), 14 day(s))

Sodium Molybdate (7631-95-0)	
LD50 oral rat	4000 mg/kg (Rat, Oral, Source: BIG)
LD50 oral	2689 mg/kg (OECD TG 401, GLP)
LD50 dermal rat	> 2000 mg/kg bodyweight Animal: rat, Guideline: OECD Guideline 402 (Acute Dermal Toxicity), Remarks on results: other:
LC50 Inhalation - Rat	> 2.1 mg/l (4 h, Rat, Inhalation)
LC50 Inhalation - Rat (Dust/Mist)	> 5.05 mg/l/4h

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Meta-toluic Acid (99-04-7)	
LD50 oral rat	> 2000 mg/kg bodyweight Animal: rat, Guideline: OECD Guideline 401 (Acute Oral Toxicity)

Propylene Glycol (57-55-6)	
pH	6.5 – 7.5 (50 %)

Skin corrosion/irritation	:	Causes skin irritation. pH: 7 – 8 at 20°C; Sample H2O = 1:5 (V/V)
Serious eye damage/irritation	:	Causes serious eye irritation. pH: 7 – 8 at 20°C; Sample H2O = 1:5 (V/V)
Respiratory or skin sensitisation	:	Not classified
Germ cell mutagenicity	:	Not classified

Potassium Phosphate Dibasic (7758-11-4)	
pH	9.2

Sodium Molybdate (7631-95-0)	
pH	9 – 10 (5 %)

Propylene Glycol (57-55-6)	
In vivo	Chromosomal abnormality test using mammalian bone marrow cells: Negative (rat, male)
In vitro	Bacterial reverse mutation test: Negative (TA92, TA94, TA98, TA100, TA1535, and TA1537, with metabolic activation system)

Carcinogenicity	:	Not classified
Reproductive toxicity	:	Not classified
STOT-single exposure	:	Not classified
STOT-repeated exposure	:	Not classified

Propylene Glycol (57-55-6)	
NOAEL (subchronic, oral, animal/male, 90 days)	443 mg/kg bodyweight Animal: cat, Animal sex: male

Potassium Phosphate Dibasic (7758-11-4)	
NOAEL (oral, rat, 90 days)	1000 mg/kg bodyweight Animal: rat, Guideline: OECD Guideline 422 (Combined Repeated Dose Toxicity Study with the Reproduction / Developmental Toxicity Screening Test)

Sodium Molybdate (7631-95-0)	
NOAEC (inhalation, rat, dust/mist/fume, 90 days)	> 0.1 mg/l air Animal: rat, Guideline: OECD Guideline 413 (Subchronic Inhalation Toxicity: 90-Day Study)
STOT-repeated exposure	May cause damage to organs through prolonged or repeated exposure.

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Meta-toluic Acid (99-04-7)	
NOAEL (oral, rat, 90 days)	100 mg/kg bodyweight Animal: rat, Animal sex: female, Guideline: OECD Guideline 422 (Combined Repeated Dose Toxicity Study with the Reproduction / Developmental Toxicity Screening Test)
STOT-repeated exposure	May cause damage to organs through prolonged or repeated exposure.

Aspiration hazard : Not classified

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Viscosity, kinematic	2.3 mm²/s at 20°C

Potassium Phosphate Dibasic (7758-11-4)	
Viscosity, kinematic	Not applicable (solid)

11.2. Information on other hazards

No additional information available

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : The product is not considered harmful to aquatic organisms nor to cause long-term adverse effects in the environment.

Hazardous to the aquatic environment, short–term (acute) : Not classified

Hazardous to the aquatic environment, long–term (chronic) : Not classified

Not rapidly degradable

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LC50 - Fish [1]	8700 mg/l Pimephales promelas
EC50 - Crustacea [1]	7921 mg/l Daphnia magna
EC50 72h - Algae [1]	1634 mg/l Selenastrum capricornutu

Propylene Glycol (57-55-6)	
LC50 - Fish [1]	40613 mg/l (96 h, Oncorhynchus mykiss, Static system, Fresh water, Experimental value)
LC50 - Fish [2]	51400 mg/l Test organisms (species): Pimephales promelas
EC50 - Crustacea [1]	18340 mg/l Ceriodaphnia dubia (EPA 600/4-90/0-27, statistic test, fresh water)
EC50 72h - Algae [1]	24200 mg/l Test organisms (species): Pseudokirchneriella subcapitata (previous names: Raphidocelis subcapitata, Selenastrum capricornutum)
EC50 72h - Algae [2]	19300 mg/l Test organisms (species): Skeletonema costatum
EC50 96h - Algae [1]	19000 mg/l Test organisms (species): Pseudokirchneriella subcapitata (previous names: Raphidocelis subcapitata, Selenastrum capricornutum)
EC50 96h - Algae [2]	19100 mg/l Test organisms (species): Skeletonema costatum
ErC50 algae	24200 mg/l (OECD 201: Alga, Growth Inhibition Test, 72 h, Pseudokirchneriella subcapitata, Static system, Fresh water, Experimental value, GLP)

Potassium Phosphate Dibasic (7758-11-4)	
LC50 - Fish [1]	> 100 mg/l Test organisms (species): Oncorhynchus mykiss (previous name: Salmo gairdneri)
EC50 - Crustacea [1]	> 100 mg/l (OECD 202: Daphnia sp. Acute Immobilisation Test, 48 h, Daphnia magna, Static system, Fresh water, Read-across, Nominal concentration)

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Potassium Phosphate Dibasic (7758-11-4)	
EC50 72h - Algae [1]	> 100 mg/l Test organisms (species): Desmodesmus subspicatus (previous name: Scenedesmus subspicatus)
ErC50 algae	> 100 mg/l (OECD 201: Alga, Growth Inhibition Test, 72 h, Desmodesmus subspicatus, Static system, Fresh water, Read-across, Nominal concentration)
Sodium Molybdate (7631-95-0)	
LC50 - Fish [1]	644.2 mg/l (OECD 203: Fish, Acute Toxicity Test, 96 h, Pimephales promelas, Semi-static system, Fresh water, Experimental value)
EC50 72h - Algae [1]	356.9 mg/l (ISO 10253, Phaeodactylum, Static system, Salt water, Weight of evidence, Growth rate)
Meta-toluic Acid (99-04-7)	
LC50 - Fish [1]	82 mg/l (OECD 203: Fish, Acute Toxicity Test, 96 h, Oryzias latipes, Semi-static system, Fresh water, Experimental value)
EC50 - Crustacea [1]	75 mg/l (OECD 202: Daphnia sp. Acute Immobilisation Test, 48 h, Daphnia magna, Static system, Fresh water, Experimental value)
EC50 72h - Algae [1]	18 mg/l Test organisms (species): Pseudokirchneriella subcapitata (previous names: Raphidocelis subcapitata, Selenastrum capricornutum)
EC50 72h - Algae [2]	10 mg/l Test organisms (species): Pseudokirchneriella subcapitata (previous names: Raphidocelis subcapitata, Selenastrum capricornutum)
LOEC (chronic)	22 mg/l Test organisms (species): Daphnia magna Duration: '21 d'

12.2. Persistence and degradability

Propylene Glycol (57-55-6)	
Persistence and degradability	Biodegradable in the soil. Readily biodegradable in water.
Biochemical oxygen demand (BOD)	0.96 – 1.08 g O_2/g substance
Chemical oxygen demand (COD)	1.63 g O_2/g substance
ThOD	1.69 g O_2/g substance
Potassium Phosphate Dibasic (7758-11-4)	
Persistence and degradability	Biodegradability: not applicable.
Chemical oxygen demand (COD)	Not applicable (inorganic)
ThOD	Not applicable (inorganic)
Sodium Molybdate (7631-95-0)	
Persistence and degradability	Biodegradability: not applicable.
Chemical oxygen demand (COD)	Not applicable
ThOD	Not applicable
BOD (% of ThOD)	Not applicable

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Meta-toluic Acid (99-04-7)	
Persistence and degradability	Biodegradability in soil: no data available. Readily biodegradable in water.

12.3. Bioaccumulative potential

Water (7732-18-5)	
Partition coefficient n-octanol/water (Log Pow)	-1.38

Propylene Glycol (57-55-6)	
BCF - Fish [1]	0.09 mg/l
Partition coefficient n-octanol/water (Log Pow)	-1.07 (Experimental value, EU Method A.8: Partition Coefficient, 20.5 °C)
Bioaccumulative potential	Not bioaccumulative.

Potassium Phosphate Dibasic (7758-11-4)	
Bioaccumulative potential	Not bioaccumulative.

Sodium Molybdate (7631-95-0)	
BCF - Fish [1]	4.9 (28 day(s), Oncorhynchus tshawytscha, Fresh water, Weight of evidence)
BCF - Other aquatic organisms [1]	164.3 (Mollusca, Fresh water, Weight of evidence)
Bioaccumulative potential	Low potential for bioaccumulation (BCF < 500).

Meta-toluic Acid (99-04-7)	
BCF - Fish [1]	3.162 mg/l (21-day Daphnia chronic toxicity no effect concentration)
Partition coefficient n-octanol/water (Log Pow)	2.37 (Practical experience/observation)
Partition coefficient n-octanol/water (Log Kow)	2.37
Bioaccumulative potential	Low potential for bioaccumulation (Log Kow < 4).

12.4. Mobility in soil

Propylene Glycol (57-55-6)	
Surface tension	71.6 mN/m (21.5 °C, 1.01 g/l, EU Method A.5: Surface tension)
Organic Carbon Normalized Adsorption Coefficient (Log Koc)	0.46 (log Koc, Calculated value)
Ecology - soil	Highly mobile in soil.

Potassium Phosphate Dibasic (7758-11-4)	
Surface tension	No data available in the literature
Ecology - soil	No (test)data on mobility of the substance available.

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Meta-toluic Acid (99-04-7)	
Ecology - soil	No (test)data on mobility of the substance available.

12.5. Results of PBT and vPvB assessment

LIQ-702 Coolant Fluid
Contains no PBT/vPvB substances ≥ 0.1% assessed in accordance with REACH Annex XIII

12.6. Endocrine disrupting properties

Adverse effects on the environment caused by endocrine disrupting properties : The mixture does not contain substance(s) included in the list established in accordance with Article 59(1) of REACH for having endocrine disrupting properties, or is not identified as having endocrine disrupting properties in accordance with the criteria set out in Commission Delegated Regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at a concentration equal to or greater than 0,1 %

12.7. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste treatment methods : Dispose of contents/container in accordance with licensed collector's sorting instructions.

SECTION 14: Transport information

In accordance with ADR / IMDG / IATA / ADN / RID

ADR	IMDG	IATA	ADN	RID
14.1. UN number or ID number				
Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
14.2. UN proper shipping name				
Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
14.3. Transport hazard class(es)				
Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
14.4. Packing group				
Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
14.5. Environmental hazards				
Not regulated	Not regulated	Not regulated	Not regulated	Not regulated
No supplementary information available				

14.6. Special precautions for user

Overland transport
Not regulated

Transport by sea
Not regulated

Air transport
Not regulated

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Inland waterway transport
Not regulated

Rail transport
Not regulated

14.7. Maritime transport in bulk according to IMO instruments

Not applicable

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

15.1.1. EU-Regulations

REACH Annex XVII (Restriction List)

EU restriction list (REACH Annex XVII)		
Reference code	**Applicable on**	**Entry title or description**
3(b)	LIQ-702 Coolant Fluid ; Propylene Glycol	Substances or mixtures fulfilling the criteria for any of the following hazard classes or categories set out in Annex I to Regulation (EC) No 1272/2008: Hazard classes 3.1 to 3.6, 3.7 adverse effects on sexual function and fertility or on development, 3.8 effects other than narcotic effects, 3.9 and 3.10

REACH Annex XIV (Authorisation List)

Contains no REACH Annex XIV substances

REACH Candidate List (SVHC)

Contains no substance on the REACH candidate list

PIC Regulation (Prior Informed Consent)

Contains no substance subject to Regulation (EU) No 649/2012 of the European Parliament and of the Council of 4 July 2012 concerning the export and import of hazardous chemicals.

POP Regulation (Persistent Organic Pollutants)

Contains no substance subject to Regulation (EU) No 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants

Ozone Regulation (1005/2009)

Contains no substance subject to REGULATION (EU) No 1005/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 September 2009 on substances that deplete the ozone layer.

VOC Directive (2004/42)

DIRECTIVE 2004/42/CE Annex II : B/a (Vehicle refinishing products - Preparatory and cleaning) Maximum allowed concentration : 850 g/l VOC
Maximum content of VOC : 312.60 g/l VOC

Explosives Precursors Regulation (2019/1148)

Contains no substance subject to Regulation (EU) 2019/1148 of the European Parliament and of the Council of 20 June 2019 on the marketing and use of explosives precursors.

Drug Precursors Regulation (273/2004)

Contains no substance(s) listed on the Drug Precursors list (Regulation EC 273/2004 on drug precursors)

15.1.1. National regulations

France

Labelling of building products or products used for wall or floor coatings and paints and varnishes concerning their emissions of volatile pollutants (Order of 19 April 2011) :

Information on the level of emissions of volatile substances into interior air, presenting a risk of toxicity through inhalation, on a classification scale from A+ (very low emissions) to C (strong emissions)

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Occupational diseases	
Code	Description
RG 84	Conditions caused by liquid organic solvents for professional use: saturated or unsaturated aliphatic or cyclic liquid hydrocarbons and mixtures thereof; liquid halogenated hydrocarbons; nitrated derivatives of aliphatic hydrocarbons; alcohols; glycols, glycol ethers; ketones; aldehydes; aliphatic and cyclic ethers, including tetrahydrofuran; esters; dimethylformamide and dimethylacetamine; acetonitrile and propionitrile; pyridine; dimethylsulfone and dimethylsulfoxide

Germany

Employment restrictions	:	Observe restrictions according Act on the Protection of Working Mothers (MuSchG). Observe restrictions according Act on the Protection of Young People in Employment (JArbSchG).
Water hazard class (WGK)	:	WGK 1, Slightly hazardous to water (Classification according to AwSV, Annex 1).
Hazardous Incident Ordinance (12. BImSchV)	:	Is not subject of the Hazardous Incident Ordinance (12. BImSchV)

Netherlands

ABM category	:	B(4) - low hazard for aquatic
organisms SZW-lijst van kankerverwekkende stoffen	:	None of the components are listed
SZW-lijst van mutagene stoffen	:	None of the components are listed
SZW-lijst van reprotoxische stoffen – Borstvoeding	:	None of the components are listed
SZW-lijst van reprotoxische stoffen – Vruchtbaarheid	:	Koolance - Sodium Molybdate is listed
SZW-lijst van reprotoxische stoffen – Ontwikkeling	:	None of the components are listed

Switzerland

Storage class (LK)	:	LK 10/12 - Liquids
CH - VOC (SR 814.018)	:	0.000000000000000 %

15.2. Chemical safety assessment

No chemical safety assessment has been carried out

SECTION 16: Other information

Abbreviations and acronyms:	
ADN	European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ATE	Acute Toxicity Estimate
BCF	Bioconcentration factor
BLV	Biological limit value
BOD	Biochemical oxygen demand (BOD)
COD	Chemical oxygen demand (COD)
DMEL	Derived Minimal Effect level
DNEL	Derived-No Effect Level
EC-No.	European Community number
EC50	Median effective concentration
EN	European Standard
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IMDG	International Maritime Dangerous Goods
LC50	Median lethal concentration

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Abbreviations and acronyms:	
LD50	Median lethal dose
LOAEL	Lowest Observed Adverse Effect Level
NOAEC	No-Observed Adverse Effect Concentration
NOAEL	No-Observed Adverse Effect Level
NOEC	No-Observed Effect Concentration
OECD	Organisation for Economic Co-operation and Development
OEL	Occupational Exposure Limit
PBT	Persistent Bioaccumulative Toxic
PNEC	Predicted No-Effect Concentration
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
SDS	Safety Data Sheet
STP	Sewage treatment plant
ThOD	Theoretical oxygen demand (ThOD)
TLM	Median Tolerance Limit
VOC	Volatile Organic Compounds
CAS-No.	Chemical Abstract Service number
N.O.S.	Not Otherwise Specified
vPvB	Very Persistent and Very Bioaccumulative
ED	Endocrine disrupting properties

Data sources : ECHA (European Chemicals Agency).

Full text of H- and EUH-statements:	
Acute Tox. 3 (Inhalation:dust,mist)	Acute toxicity (inhalation:dust,mist) Category 3
Acute Tox. 4 (Inhalation:dust,mist)	Acute toxicity (inhalation:dust,mist) Category 4
Acute Tox. 4 (Oral)	Acute toxicity (oral), Category 4
Aquatic Chronic 2	Hazardous to the aquatic environment – Chronic Hazard, Category 2
Eye Irrit. 2	Serious eye damage/eye irritation, Category 2
H302	Harmful if swallowed.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H331	Toxic if inhaled.
H332	Harmful if inhaled.
H373	May cause damage to organs through prolonged or repeated exposure.
H411	Toxic to aquatic life with long lasting effects.
Skin Irrit. 2	Skin corrosion/irritation, Category 2
STOT RE 2	Specific target organ toxicity – Repeated exposure, Category 2

The classification complies with : ATP 12

Safety Data Sheet (SDS), EU

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

APPENDIX K – Limited Warranty

Picarro, Inc. warrants its Products to be free from defects in material and workmanship and to perform in the manner and under the conditions specified in the Product specifications for twelve (12) months from shipment.

This warranty is the only warranty made by Picarro with respect to its Products and no person is authorized to bind Picarro for any obligations or liabilities beyond this warranty in connection with its Products. This warranty is made to the original Purchaser only, is non-transferable and may only be modified or amended by a written instrument signed by a duly authorized officer of Picarro. Sub-systems manufactured by other firms, but integrated into Picarro Products, are covered by the original manufacturer's warranty and Picarro makes no warranty, express or implied, regarding such sub-systems. Products or parts thereof which are replaced or repaired under this warranty are warranted only for the remaining, un-expired portion of the original warranty period applicable to the specific Product replaced or repaired.

WARRANTY DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER WRITTEN, ORAL, OR IMPLIED, AND SHALL BE THE PURCHASER'S SOLE REMEDY AND PICARRO'S SOLE LIABILITY IN CONTRACT OR OTHERWISE FOR THE PRODUCT. PICARRO EXPRESSLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

The Purchaser's exclusive remedy with respect to any defective Product shall be to have Picarro repair or replace such defective Product or credit the Purchaser's account, whichever Picarro may elect in its sole discretion. If it is found that any Product has been returned which is not defective, the Purchaser will be notified, and such Product returned at the Purchaser's expense. In addition, a charge for testing and examination may, at Picarro's sole discretion, be made on any Product so returned.

These remedies are available only if: 1) Picarro is notified in writing by the Purchaser promptly upon discovery of a Product defect, and in any event within the warranty period; 2) Picarro's examination of such Product discloses to Picarro's satisfaction that such defects actually exist and the Product has not been repaired, worked on, altered by persons not authorized by Picarro, subject to misuse, negligence or accident, or connected, installed, used or adjusted otherwise than in accordance with the instructions furnished by Picarro.

The following warranty conditions shall apply to all Picarro, Inc. products unless amended by a written instrument signed by a duly authorized officer of Picarro:

ADJUSTMENT – No electrical, mechanical, or optical adjustments to the product(s) are permitted.

PARTS AND LABOR - New or factory-built replacements for defective parts will be supplied for twelve (12) months from date of shipment of the product. Replacement parts are warranted for the remaining portion of the original warranty period. There will be no charge for repair of products under warranty where the repair work is done by Picarro, Inc.

NOT COVERED BY THE WARRANTY – Damage to any optical surface from improper handling or cleaning procedures. This applies specifically to those items subjected to excess laser radiation, contaminated environments, extreme temperature, or abrasive cleaning. Damage due to ESD, abuse, misuse, improper installation or application, alteration, accident, negligence in use, improper storage, transportation, or handling. No warranty shall apply where the original equipment identifications have been removed, defaced, altered or where there is any evidence of alterations, adjustments, removal of protective outer enclosure, any attempt to repair the product by unauthorized personnel or with parts other than those provided by Picarro, Inc.

CLAIMS ASSISTANCE - Call Picarro, Inc. Customer Service or your local distributor for assistance. Give our representative the full details of the problem. Helpful information or shipping instructions will be provided. If requested, estimates of the charges for non-warranty or other service work will be supplied before work begins.

RETURN PROCEDURE - Customers must obtain a Return Merchandise Authorization Number from Picarro, Inc. prior to returning units. Products being returned for repair must be shipped in their original shipping cartons to avoid damage.

About Picarro

Picarro is a leading provider of solutions to measure greenhouse gas (GHG) concentrations, trace gases, and stable isotopes across many scientific applications, along with the energy and utilities markets. Our patented Cavity Ring-Down Spectroscopy (CRDS) is at the heart of all Picarro instruments and solutions, enabling the detection of target molecules at part per billion or better resolution.

Product Support

Utilize Picarro support resources for product support. Join the Picarro community to ask questions and get answers, search the document library for datasheets and user manuals, download software, and purchase products and replacement parts.

Access to online User Manuals is available to all registered Picarro customers with login credentials. If you do not yet have an account, please email us at support@picarro.com to request access. Note must be a registered user and logged in to access the following resources:

- Picarro Document Library
- Picarro Community (Forums)
- Picarro Software Downloads
- Picarro Literature (Scientific Resources)
- Picarro Web Store

Contact Picarro for questions regarding specific applications and additional information.

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