PI2114 Analyzer User Manual

H^2O^2

PICARRO

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Revision History

Revision	Date	Notes
F	September 2025	The operating system now runs on Ubuntu 20 Linux. Text, screenshots, and content structure were updated. This release also adds documentation for Research & Compliance mode, setup tools and communication, analog signal output, analog current signal output, Data File Viewer, contained exhaust flow, external valve sequencer, remote analyzer access, Linux keys and commands, and additional power requirements for 4–20 mA operation.

Picarro Notices

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

This User Manual 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

The Picarro PI2114 Hydrogen Peroxide Analyzer is designed for the accurate measurement of residual vaporized hydrogen peroxide, H_2O_2, in units of parts per billion (ppb). The unit uses Picarro's patented Cavity Ring-Down Spectroscopy (CRDS) and wavelength monitoring to facilitate precise and continuous monitoring of vaporized hydrogen peroxide. The analyzer can detect levels of concentration as low as 3.3 ppb to ensure optimal manufacturing conditions.

NOTE

In addition to this User Manual, the following documentation is required when installing the PI2114 analyzer:

Installation/Operational Qualification of the Picarro PI2114 Hydrogen Peroxide Analyzer, Document Number 50-0016.

This document (also referred to as "IQ/OQ") provides instructions and the method of documentation to verify that the Picarro PI2114 has been installed and operates in accordance with the requirements of Picarro Instruments.

1.1 System Overview

This section provides an overview of the analyzer, related components, and specifications.

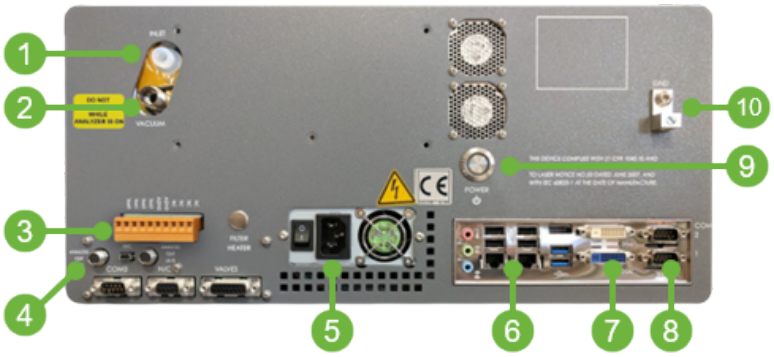
1.1.1 Analyzer

The following figure displays the analyzer front and back panels. More detailed information on panel features, functions, and connections are in Chapter 4, Hardware Setup.

1 LED Status Indicator

2 USB Port

Figure 1 - PI2114 Front Panel



1. Sample Inlet
2. Vacuum Ports
3. 4–20 mA Output
4. Analog Outputs
5. Power Connector and Switch
6. USB and Ethernet Ports
7. Display Ports
8. Serial Ports
9. Soft Power Button
10. Ground Connection

Figure 2 - PI2114 Back Panel

1.1.2 Front Panel Operating Status

The LED indicator on the front panel shows the current operating state of the analyzer. The following figure 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 .

Figure 3 - LED Status Indicator

1.1.3 A2000 Vacuum Pump

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

Figure 4 - A2000 Vacuum Pump - Side Views

1.2 Analyzer Specifications

Table 1 - PI2114 Specifications

Parameter	Specification
Measurement Technique	Cavity Ring-Down Spectroscopy (CRDS)
Weight: Total Weight: Analyzer Weight: Pump	61.9 lbs. (28.1 kg), including external pump and vacuum tubing 21.3 kg (47 lbs.) – Should be lifted by two people. 6.5 kg (14.4 lbs)
Dimensions - Analyzer	Depth: 61.9 cm (24.38”) Width: 44.5 cm (17.5”) (17.75” with rails) Height: 20.1 cm (7.88”) Height with Feet: 21.3 cm (8.38”)
Dimensions – A2000 Pump	Length: 27.9 cm (11”) Width: 10.2 cm (4”) Height: 19.1 cm (7.5”)
Ambient Humidity Range	< 85% RH non-condensing
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)
Maximum Altitude (During operation)	3,048 m (10,000 ft. – Operation)

Parameter	Specification
Front/Rear Clearance	Front: 15.3 cm (6”); Rear: 15.3 cm (6”)
Primary Gases Measured	H_2O_2
Sample Flowrate (at 760 torr (101 kPa)	<1 slm
Required Accessories	Included: Pump (external), keyboard, mouse Supplied by Customer: LCD monitor
Operating System Data Outputs	Windows 10 RS–232, Ethernet, USB, Analog (optional) 0-10 V
Installation	Benchtop or 48.3 cm (19”) rack mount
Power Requirements Startup Power Steady-state Power	100 – 240 VAC; 50/60Hz (auto-sensing) <260 W at start-up, (Analyzer and Pump) 110 W (Analyzer) 150 W (A2000 Pump)
Minimum Rated Circuit Amperage	10A @ 115 VAC 5A @ 230 VAC
Liquid Ingress Protection	None

1.3 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
%	Percentage
±	Plus–minus sign

Acronym	Definition
<	Less than
>	Greater than
≤	Less than or equal to
≥	Greater than or equal to
A	Ampere
AC	Alternating Current
ASCII	American Standard Code for Information Interchange
bar	Metric unit of pressure. 1 bar = 100,000 pascals (Pa)
CH_4	Methane
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)
DIO	Digital Input/Output
DVI	Digital Visual Interface
EMO	Emergency Off
°F	Degrees Fahrenheit
ft.	Length in feet;1 ft. = 12” or 12 inches (30.48 cm)
GUI	Graphical User Interface
H_2O	Water, Water Vapor
HB	Hotbox

Acronym	Definition
HDF	Hierarchical Data Format
HDMI	High-Definition Multimedia Interface
Hz	Hertz
ID	Inside Diameter (i.e., .5” ID) or Identification (i.e., Slave ID)
I/O	Input/output
kg	kilograms
kPa	Kilopascal; unit of pressure; 1 kPa = 0.145 PSI
lbs	pounds
m	Meters or month
mA	Milliampere
max	Maximum
min	Minimum
mK	Millikelvin
mm	millimeters / millimetre
N/C	No Connection
NC	Normally Closed
NH_3	Ammonia
NO	Normally Open
NTP	Network Time Protocol
OD	Outside Diameter
P	Pressure
PC	Personal Computer
PDF	Portable Document Format
PFA	Perfluoroalkoxy – A chemically resistant polymer, suitable for use with sticky and aggressive gases

Acronym	Definition
PN	Part Number
ppb	parts per billion
ppm	parts per million
PSI (psi)	Pounds per Square Inch
PSIG	Pounds per Square Gauge
PTFE	Polytetrafluoroethylene
Pws	Water vapor pressure
RH	Relative Humidity
RJ-45	Registered Jack (physical network interface)
RS232	Recommended Standard 232 (serial communication protocol)
SNTP	Simple Network Time Protocol
sec	Seconds
SS/SST	Stainless Steel
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 Alternating Current
VDC	Volts Direct Current
W	Watts
WB	Warmbox
WLM	Wavelength Monitor

1.4 Text Conventions

The following conventions are used in the manual.

- *Italic* text identifies screen names and to emphasize 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

The following chapter provides an overview of warning symbols used in this document, general safety guidelines for using the analyzer, and acquired certifications.

2.1 Warning Symbols

The purpose of these icons is to provide a visual convention to alert you of important information. They indicate dangers to either the operator or to the product, and other important information. The following symbols are used in this manual.

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.

WARNING

HAZARDOUS VOLTAGE alerts user to areas that may expose a user to electrical energy that is high enough to cause injury or death.

WARNING

LASER WARNING alerts user of a laser danger.

CAUTION

CAUTION alerts user of a potential danger to equipment or to the user.

HOT SURFACE

HOT SURFACE alerts user to potential injury from hot surfaces.

NOTE

The NOTE is important information to be aware of before proceeding.

REMINDER

REMINDER is a helpful hint for procedures listed in the text.

2.2 General Safety

This section describes the CDRH and CE certifications for class 1 lasers and regulatory conformity for the European Union.

2.2.1 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.

2.2.2 CE Certification

This Picarro analyzer complies with the European standards and the instrument is affixed with a CE label. This CE label is located on the rear of the instrument.

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

This analyzer is for indoor use only and has an ingress protection rating of IPx-0. Analyzer 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

The 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 .

Do not attempt repairs; instead, report all problems to Picarro Customer Support 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.

⚠ HOT SURFACE

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 47 lbs. (21.3 kg). Use the technique described below when lifting the analyzer.

1. Before lifting, inspect the unit for slippery substances or sharp edges.
2. Lift with two people, one on each side of the analyzer.
3. Crouch down and stay close to the unit. Always keep your back as straight as possible.
4. Position your feet for sturdy balance. Lift with your legs, not your back.
5. Do not twist the back while carrying the unit. Rotate direction with hip joints.
6. 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 5 - Laser Safety Label – Affixed to Outside Cover of Analyzer

⚠ WARNING

The laser is a Class3B 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 is affixed to the inside of the analyzer:

Figure 6 - Laser Safety Label – Affixed to Inside of Analyzer

⚠ WARNING

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

⚠ WARNING

Any light emitted from the front panel status indicator, regardless of color or state, indicates one or more lasers are on.

3 Unpacking

3.1 Inspect the Shipping Containers

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 shipping containers consist of:

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

Figure 7 - 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

This analyzer weighs 47 lbs. (21.3 kg). Use the technique described below when lifting the analyzer.

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

3.3 Contents

NOTE

The following shipping contents may arrive in one or more shipping containers.

Table 3 - Shipping Contents

Part (qty)	Description
 Analyzer (1)	Includes all the data acquisition, control, and communications hardware and firmware to perform all gas handling, spectral collection, and analysis.
 AC Power Cables (1)	A power cable with connectors appropriate to your country is provided. **Note:** The analyzer automatically adjusts to local voltage.

Part (qty)	Description
 Control Cable Kit (1)	For external solenoid valves.
 Nut (1) and Ferrules (2)	For connecting input line to analyzer gas input.
 Vacuum Hose (1)	Hose to connect the pump to the analyzer.
 Rails (1 set)	Mounting rails for cabinet installation.
 Keyboard and Mouse (1)	Monitor is not included.

Part (qty)	Description
 Document Packet (1)	Includes this user manual and certificate of compliance (not shown).
 A2000 Vacuum Pump (1)	Provides vacuum required for sample gas sequencing into and out of the analyzer.
 AC Power Cable (1)	A power cable with connectors appropriate to your country is provided. **Note:** The vacuum pump voltage must be selected. See in section .
 Pump Manual (1)	Detailed instructions for pump.

4 Hardware Setup

Read this entire section before proceeding. Refer to Figure 17 in the following section for installation.

4.1 Required Components and Tools

- 9/16" open end wrench
- 11/16" open end wrench
- 5/8" open end wrench
- Phillips head screwdriver (for rack mounting)
- 2.5 mm Allen wrench (for rack mounting)
- Pump
- Power Cord for analyzer and pump

4.2 Installation Safety

WARNING

Two-person lift required: The analyzer weighs 21.3 kg (47 lbs). When lifting the analyzer, use the technique described 2.2 General Safety (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.

⚠ WARNING

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 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.

⚠ CAUTION

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.

⚠ CAUTION

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			Worst-case environmental limits (unless otherwise specified)

4.3 Analyzer Preparation

4.3.1 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.

4.3.2 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 4.5 Rack Mount Instructions

1. Remove the analyzer and the external vacuum pump from the shipping container.
2. Install the analyzer in a rack or place it 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.

3. Place the external vacuum pump near the analyzer in a rack, or on a cart or table.

4. 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.

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

4.3.3 Set A2000 Pump Input Voltage

1. 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.

1. Fuse
2. Input Voltage Selector

Figure 8 - Vacuum Pump Voltage Selection

4.4 A2000 Pump and Gas Inlet Connections

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

4.4.1 Pump Connections

Refer to the following figure when using an A2000 pump with your analyzer.

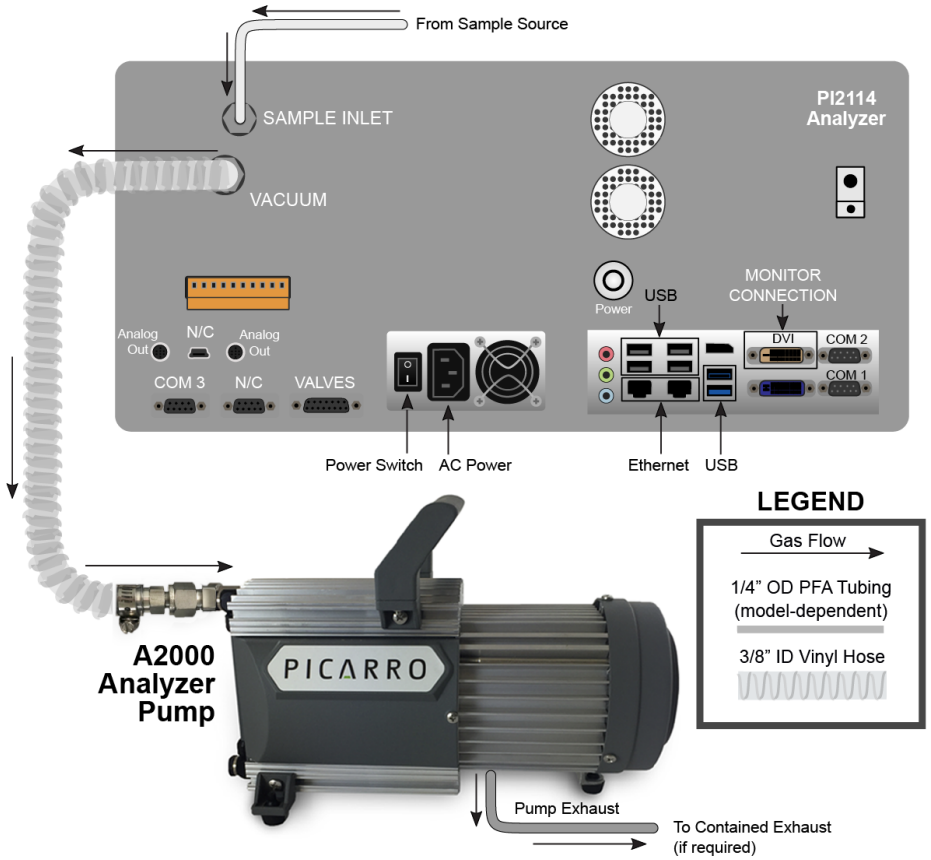


Figure 9 - Analyzer Setup with A2000 Pump

⚠ CAUTION

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

4.4.2 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.

4.4.3 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.

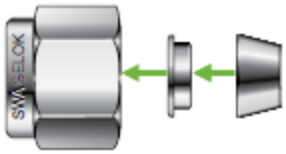


Figure 10 - Orientation of Inlet Nut and Ferrules (SST Tubing)

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°).

4.4.4 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 the following figure.

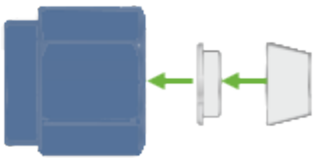


Figure 11 - Orientation of Inlet Nut and Ferrules (PFA Tubing)

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°).

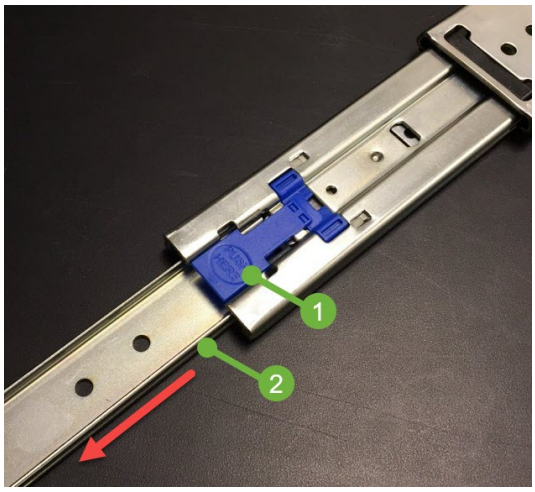
4.5 Rack Mount Instructions

SI and PI series analyzers can be mounted in a standard 5U rack opening using slide rails or rack mount kit using additional shelf to support the weight of the analyzer. Use one the following procedures for the desired mounting configuration.

4.5.1 Rack Mount (Slide Rails)

Follow these instructions to mount the analyzer using slide rails.

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.



1. Press to Release
2. Inner Slide

Figure 12 - Inner Rail Slide Removal

3. Attach the inner slide to side of the analyzer as shown in the following figure using four included M4 x 8 button-head screws.
4. Repeat on the other side of the analyzer.

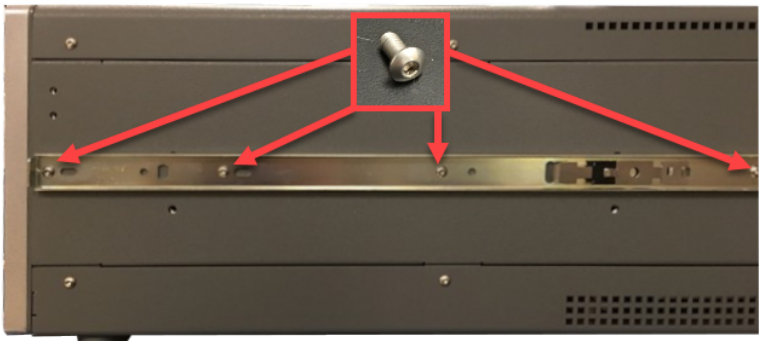
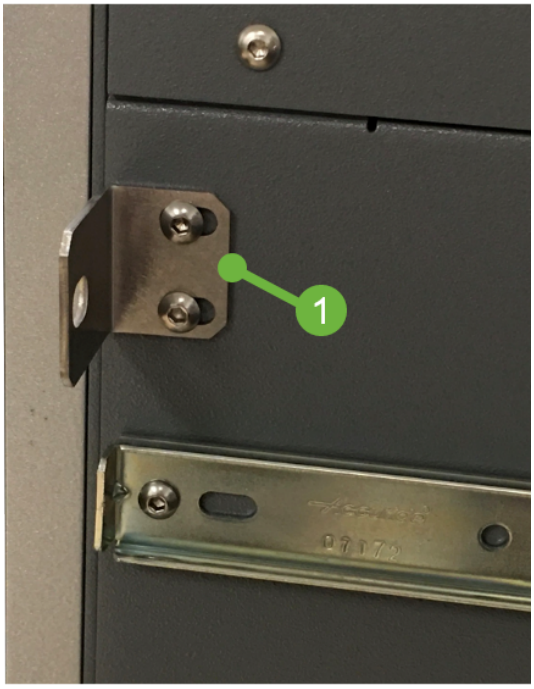


Figure 13 - Attaching Inner Slide Rails to Analyzer

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



1 Front Panel Restraint

Figure 14 - Front Panel Restraint Installed

6. Mount the outer rails to the rack using supplied hardware at each end, or according to rack design.

Figure 15 - Outer Rail Mounted to Rack

NOTE

Equipment racks vary, and some customization may be necessary.

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

WARNING

Two-person lift required. 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) .

8. Use two people to lift the analyzer, engage the inner rails on analyzer with outer rails in rack, and slide analyzer into place. Then secure the front panel restraints (Figure 14) to the rack frame.

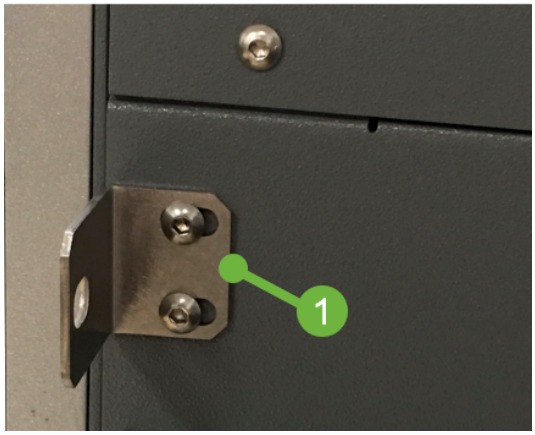
4.5.2 Rack Mount (Mount Kit)

Follow these instructions to mount the analyzer using the mount kit.

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. Using the mount kit, attach a front panel restraint (locking bracket) to each side of the analyzer using two included M4 x 8 button-head screws.



1 Front Panel Restraint

Figure 16 - Front Panel Restraint Installed

2. Install the additional user supplied shelf or "L" brackets to support the weight of the analyzer as recommended.
3. Use two people to lift the analyzer into place. Then secure the front panel restraints (Figure 14) to the rack frame

NOTE

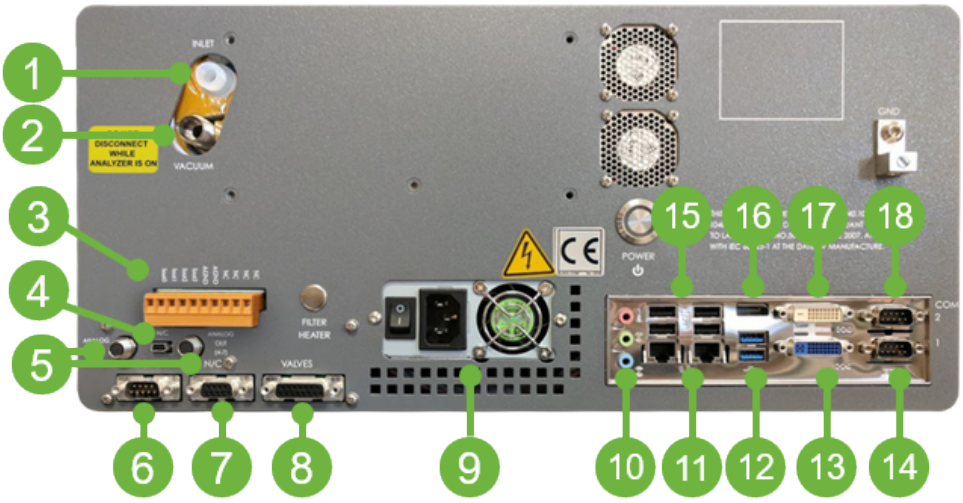
If needed, perform any additional steps to secure the analyzer per the user supplied support guidelines.

4.6 Electrical Connections

Refer to the following figure 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 Inlet PFA Fitting
3. 4–20 mA Signal Output
4. USB for Logic Board (Not connected)
5. Analog EIC Output (Optional upgrade)
6. COM 3 Port (Connected but typically not used)
7. DIO (Only for PAL autosamplers; not used with this instrument; not connected)
8. Valve Control Port (Solenoid valves)
9. AC Power Input and Power ON Switch
10. Audio In/Out Ports
11. Ethernet Ports – RJ-45 (2 ea)
12. USB Ports (2 ea)
13. DVI-D Video Monitor Port
14. COM 1 Port
15. USB Ports (4 ea)
16. Display Port
17. DVI-D Video Monitor Port (typical)
18. COM 2 Port (Rotary valve – A0311, A0311-S)

Figure 17 - 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.

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 Chapter 6, GUI Functions.

⚠ 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. If needed, press the round **Soft Power** button on the rear panel. The LED indicator illuminates green. See 1.1.1 Analyzer .

The **Picarro Launch Pad** user interface displays and the **CRDS Data Viewer** (Figure 18) automatically starts within 30 seconds. For more information about the CRDS Data Viewer features, see Chapter 6, GUI Functions.

The analyzer will not begin producing data until the cavity temperature and pressure have reached their operational set points. A message will display in the Status Log window (Figure 18, bottom panel) when each set point is reached. An explanation of the most common status log messages can be found in 6.10 Measurement Status Log.

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:

where **Y** = **year**, **M** = **month**, **D** = **day**. For more information see, .

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.

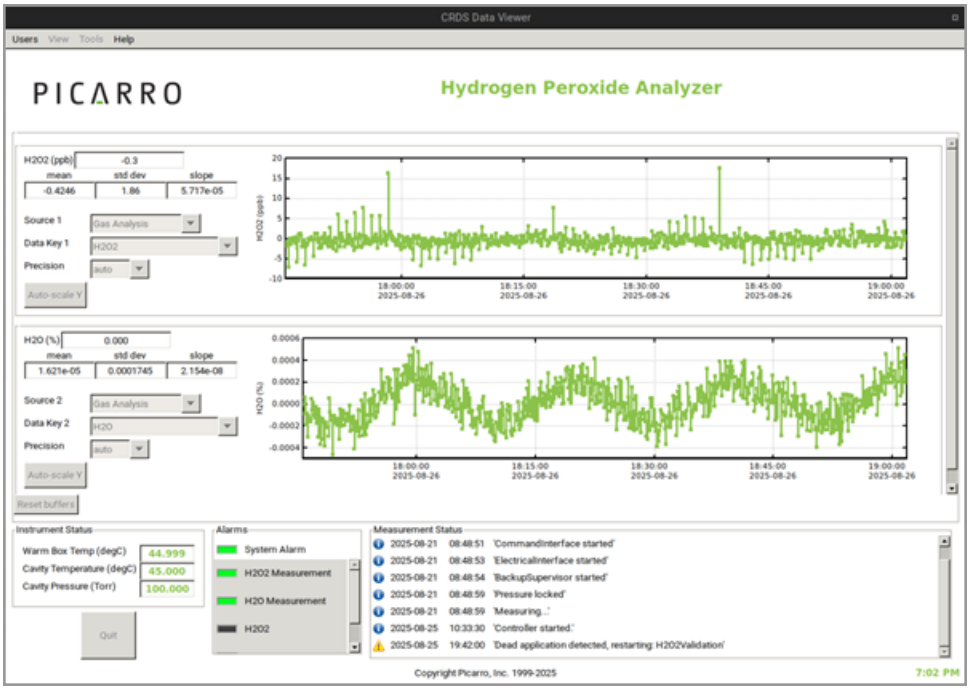


Figure 18 - CRDS Data Viewer Screen

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.

1. 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).
2. From the **CRDS Data Viewer** select the **Quit** button located in the lower left corner of the window.
3. A message displays prompting the user to confirm the shutdown. Once confirmed, the CRDS Data Viewer turns off.

NOTE

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

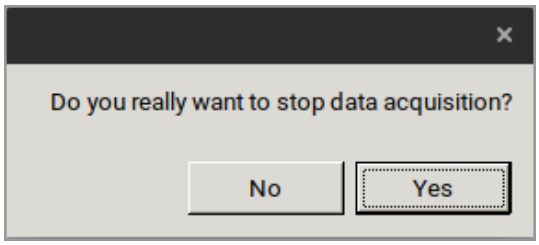


Figure 19 - Stop Data Acquisition Confirmation

4. From the **Picarro Launch Pad** select **Power Off** to tun off the hardware.
5. 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.

6. 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, 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.

NOTE

Picarro Launch Pad features vary depending on user account types. Each section describes the account type that is required for each of the main menu options.

5.4.1 Home Menu

Account Type: All Users

The Picarro Launch Pad automatically starts in Guest account mode and displays the home menu upon startup of the analyzer. Note several options are not accessible until you login with a user account. The Home menu options are provided, as shown in the following figure.

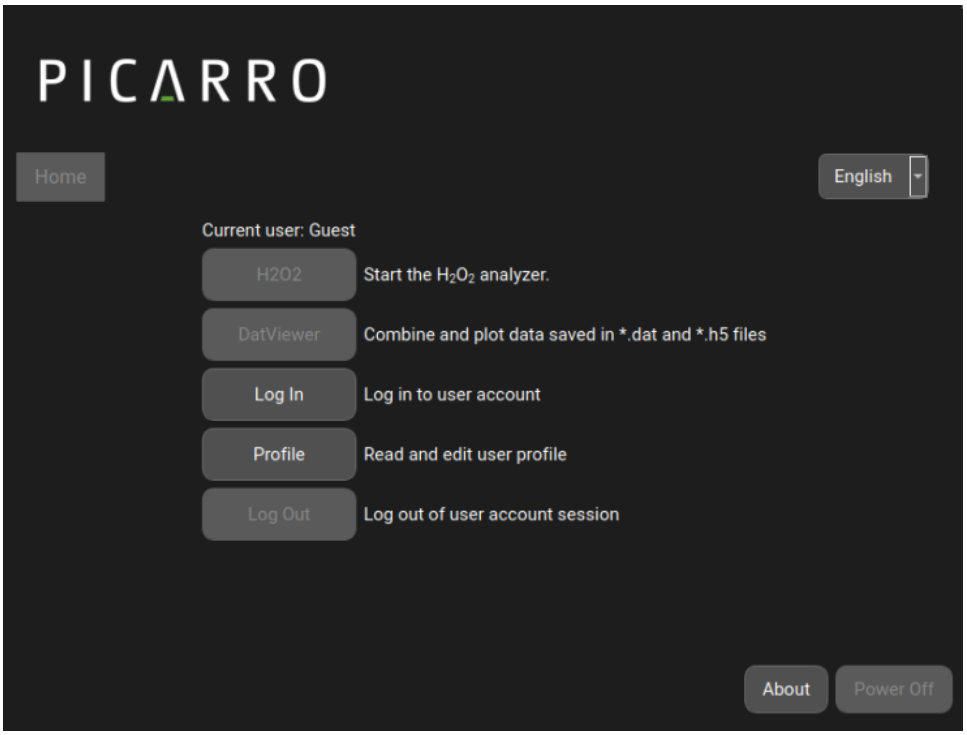


Figure 20 - Picarro Launch Pad/Home Menu

- **H2O2** – Starts the analyzer and launches the CRDS Data Viewer.
- **DatViewer** — When clicked, a window opens that allows you to convert between *.dat and H5 data files and to make various graphical representations of your data over time periods longer than what is available in the software buffer. The instructions on using the Data File Viewer software are described in Chapter E, Data File Viewer. Note requires login to the Picarro Launch Pad.
- **Log In** — Provides access to the Picarro Launch pad and tools associated with a specified user account.

NOTE

Note options vary with different types of user accounts.

- **Profile** — Provides access to the User Management Tool to allow regular users to change their own password and administrators to manage user accounts.
  Log Out — Concludes the user account session.

NOTE

Requires a password to obtain entry. For more information, see 7.4 Viewing My Profile and 7 User Management.

5.4.2 Tools Menu

Account Type: Operators, Technicians, and Administrators

The Tools menu provides additional utilities for the instrument and include the following options as shown.

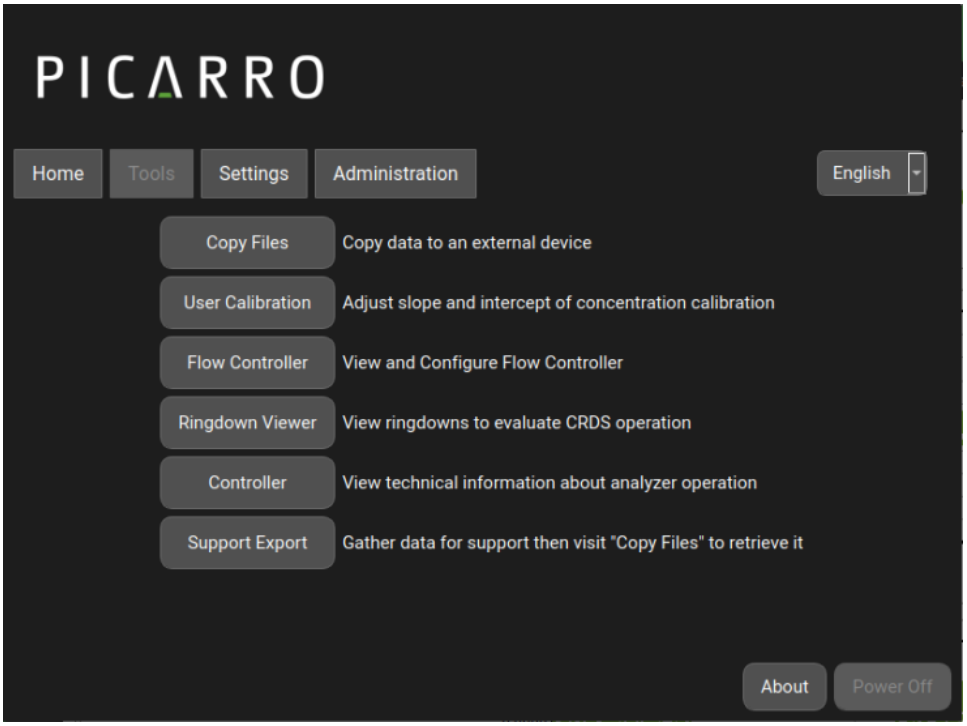


Figure 21 - Picarro Launch Pad/Tools Menu

- **Copy Files** — Allows data to be copied to an external device. Requires technician or administrator permissions.
- **User Calibration** — Provides Picarro Data Recalibration tool to adjust slope and intercept of concentration calibration.
- **Flow Controller** — View and configure flow controller for desired gas flow rate.
- **Ringdown Viewer** — Provides visual ring-downs for evaluation of CRDS operations.
  Controller — Displays the Cavity Ring-Down Spectrometer Controller to view technical information about the analyzer operation.
- **Support Export** — Opens the CRDS Diagnostic Data Collector tool to curate support data for troubleshooting.

File Manager (Copy Files)

1. On the home page, click on **Files**.
2. From the Picarro Launch Pad, click on the **Tools** menu and **Copy Files** button.
3. Login using user credentials.
4. Plug in an external USB drive.
5. 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
6. Using the upper left-hand corner drop down menu, select the type of file: **Data**, **Screenshot**, **User History**, **Validation Report**.
7. Highlight and select the desired files.
8. Click **Copy** to copy or move to transfer file to USB drive.
9. Unmount the USB drive when file transfer/copy is complete.

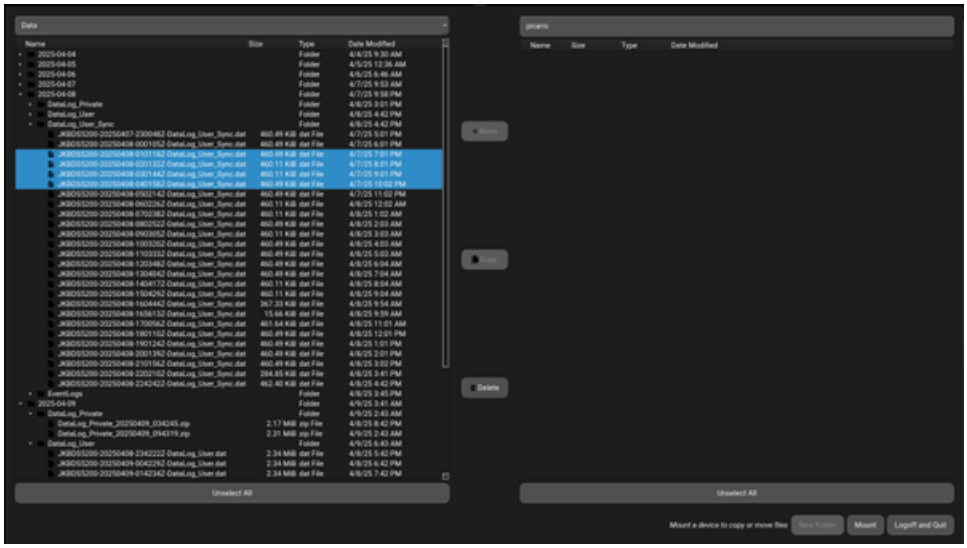


Figure 22 - Transfer Files Dialog

5.4.3 Settings Menu (Setup Tools)

Account Type: Technicians and Administrators

The Settings menu provides various configuration options for the analyzer and is described in detail in Chapter B, Setup Tools and Communication.

5.4.4 Administration Menu

Account Type: Administrators

The Administration menu provides the following options.

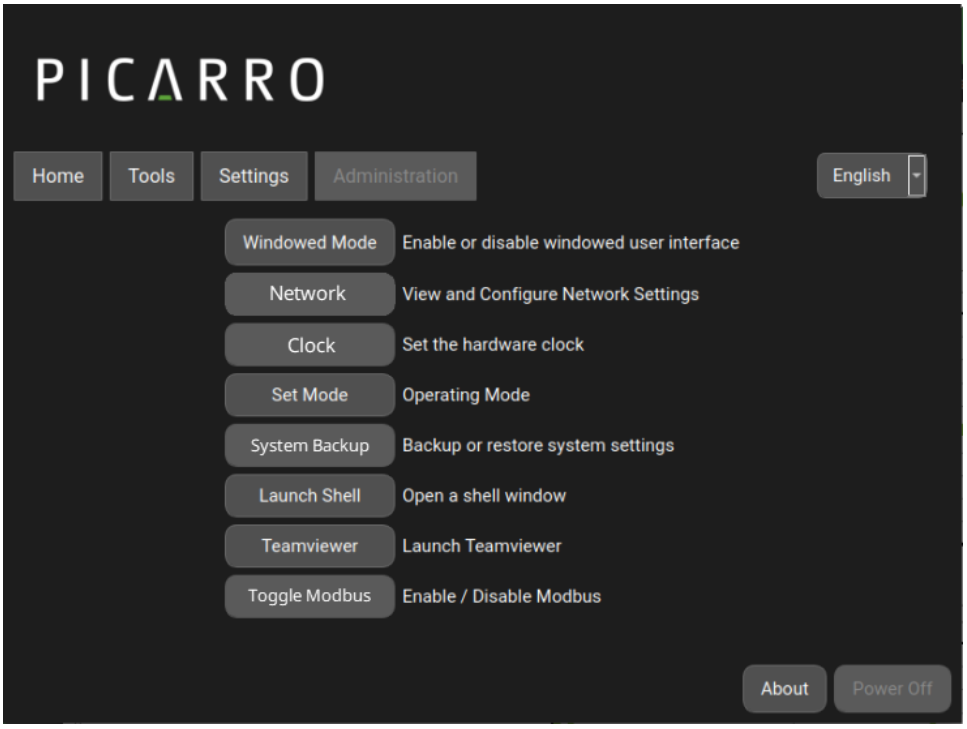


Figure 23 - Picarro Launch Pad/Administration Menu

- **Windowed Mode** — Displays the Picarro Launch Pad and utilities as windows within the user interface.
- **Network** — Provides configuration of network settings.

- **Clock** — Sets the time of the hardware clock.

NOTE

The clock, date, and network settings are not accessible if the instrument is running. Use one of the following procedures to access these settings.

Option 1:
You can access the clock and other system settings when starting the analyzer and logging in within 30 seconds of the Picarro Launch Pad Home screen appearing. This will pause the automatic launch of the drive. After configuring the settings, return to the Home screen to start the analyzer.

Option 2:
If the instrument is running, users can access the clock and other system settings by selecting Shift (keyboard) + Quit button from the CRDS Data Viewer Screen. This action will stop the software and driver, allowing access to the settings. Note: Disabling the driver is necessary only to access the clock settings. Using the Quit button alone is sufficient to access other system settings, and it is recommended to keep the driver running whenever possible.

- **Set Mode** — Sets the mode of operation to Research or Compliance. For more information, see the following section 5.4.5 Research and Compliance Modes.
  System Backup — A mechanism for backing up or restoring system settings.
- **Launch Shell** — Opens a command line interface.
- **TeamViewer** — Allows access to control the analyzer from another computer enabling remote work. For more information, see H Remote Analyzer Access.
- **Toggle Modbus** — Allows enabling and disabling of the Modbus interface for configuration of the communication protocol.

5.4.5 Research and Compliance Modes

The PI2114 analyzer operates in two primary modes: **Research Mode** and **Compliance Mode**. Each mode enables specific functions designed to match the requirements of its use case. Certain features are common to both modes, while others differ depending on the operating environment.

Research Mode

When operating in **Research Mode**, the following additional options are available:

CRDS Tools Menu

- **User Calibration** — Allows the user to perform system calibration.
- **Data Log Files** — Provides access to stored data logs.

- **Show Valve Sequencer GUI** — Opens the graphical interface for valve sequencing.

Picarro Launch Pad

- **DatViewer** — Enables review and analysis of .dat files.

Compliance Mode

When operating in **Compliance Mode**, the following differences apply:

Picarro Launch Pad

- **Copy Files** — Used to export data in both .dat and .pdf formats.

> **NOTE**
>
> **PDF generation is not available in Research Mode, as it can reduce system performance.**

Features Common to Both Modes

Regardless of whether the system is running in Research or Compliance Mode, the following rules apply:

User Calibration

- May also be launched from the Picarro Launch Pad.
- Requires user authentication before a new calibration can be applied.

User Action Logging

- All user actions are logged in both modes for traceability and auditing.

6 GUI Functions

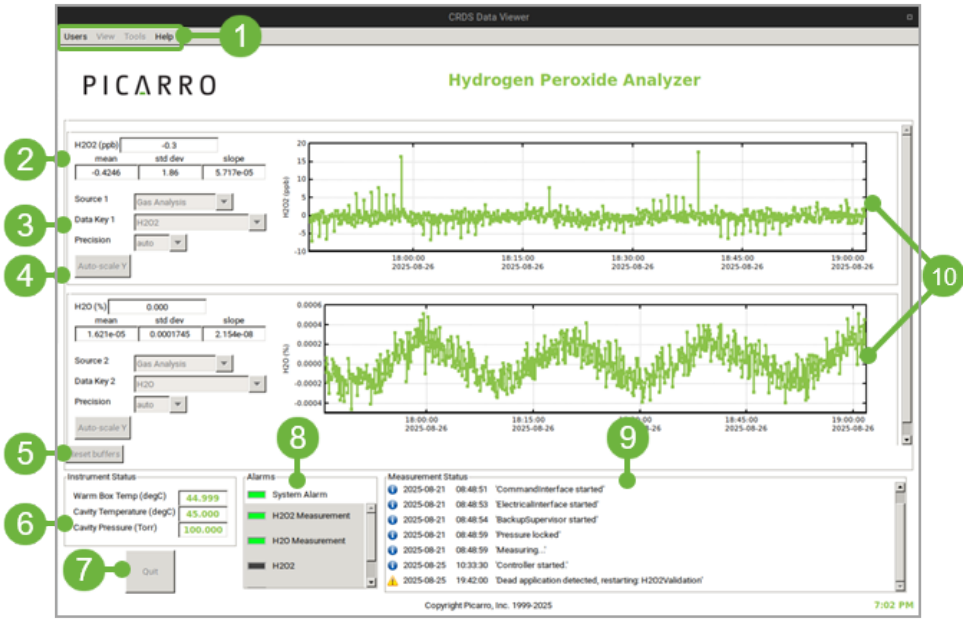
This chapter describes the GUI features of the CRDS Data Viewer.

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 as shown below are described in the following sections.



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

Figure 24 - CRDS Data Viewer GUI

6.2 Users, View, Tools, and Help Menus

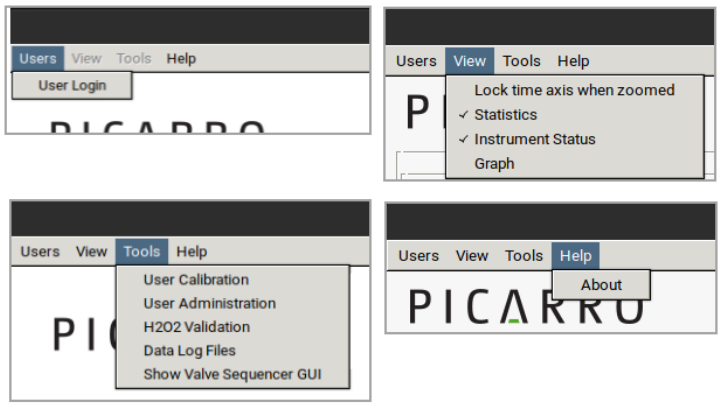


Figure 25 - CRDS Toolbar Options

6.2.1 User Menu

- **User Login** — Provides access to the CRDS Data Viewer. If you do not have an account one can be created by an administrator.
- **User Logout** — Disables access to the CRDS Data Viewer functions.

6.2.2 View Menu

The View menu provides the following options that can be enabled. Note that when toggled on, a check mark 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.
- **Statistics** — Toggles the measurement statistics display, see the 6.4 Digital Readouts.
- **Instrument Status** — Toggles the instruments status display. See the 6.5 Instrument Status.

- **Graph** — Set the desired number of line graphs to be visible on the CRDS Data Viewer.

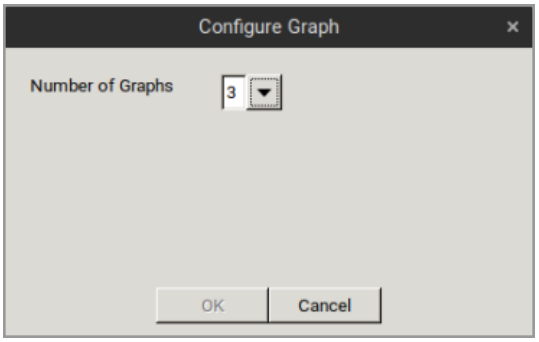


Figure 26 - Configure Graph Window

NOTE

The data buffer resets when the number of graphs are changed.

6.2.3 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:

- **User Calibration** — Opens the password protected user calibration window (default password is picarro).
  User Administration — Provides access to User Management options for managing user accounts, policies, viewing histories and profiles.
- **H2O2 Validation** — Launches the System Validation window to allow testing of the instrument to determine if it is operating as expected. For more information, see 11 Instrument Validation.
- **Data Log Files** — Copies data to an external drive using the File Manager.
- **Show Valve Sequencer GUI** — Toggle to display the external valve sequencer window (use alt-tab to bring it to the front).

6.2.4 Help Menu

- **About** — Displays the software release version 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.

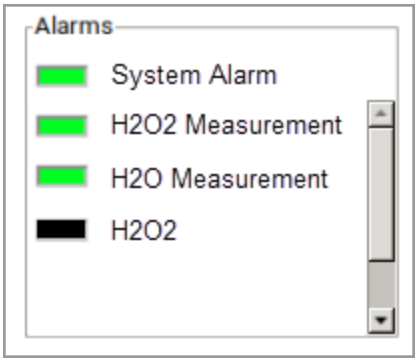


Figure 27 - Alarm Panel

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 point, click on the **Alarm Icon** and a dialog box displays indicating the alarm setting and allows the user to enable it or change the setpoint.

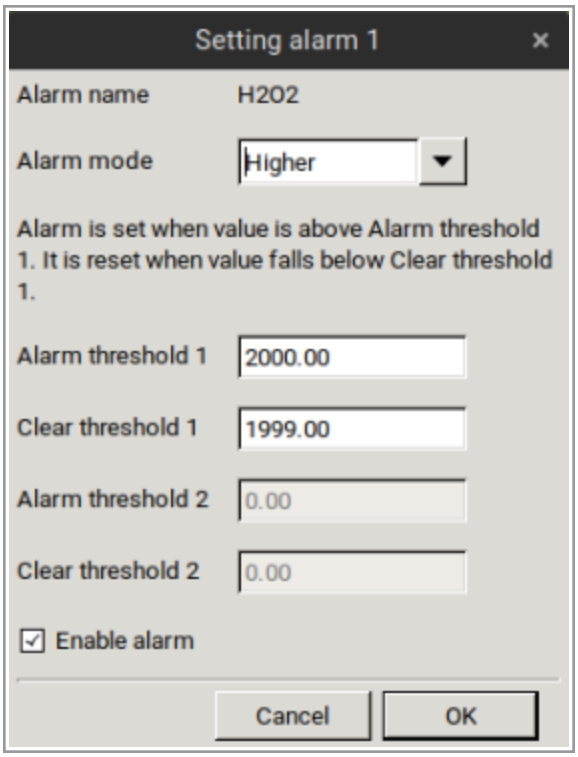


Figure 28 - Alarm Set Dialog

This feature 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 gases are:

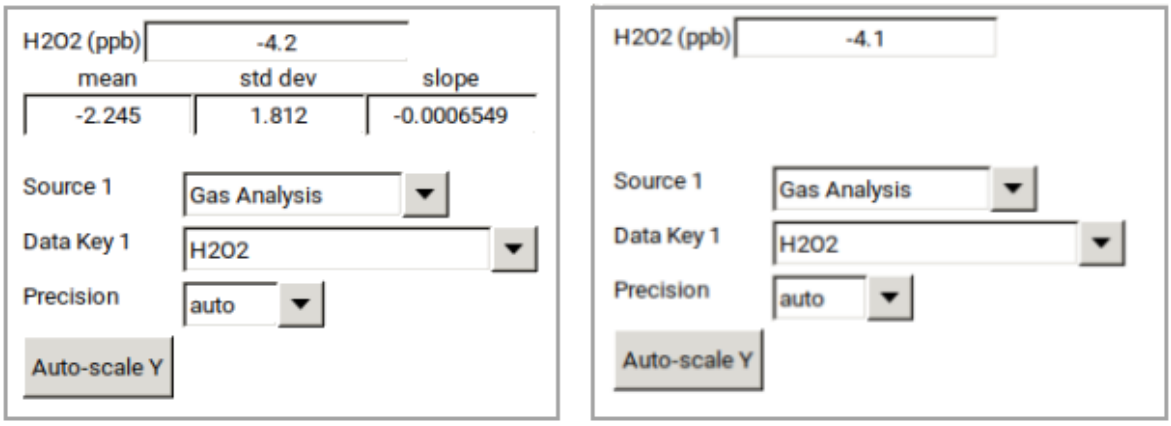
- Higher
- Lower
- Inside
- Outside

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 **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 6.12 Graph Zooming and Panning for more information.



1 With Show Statistics Enabled

2 With Show Statistics Disabled

Figure 29 - Digital Readouts Panel

6.5 Instrument Status

If these parameters are enabled through the **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 below the digital readouts panel.

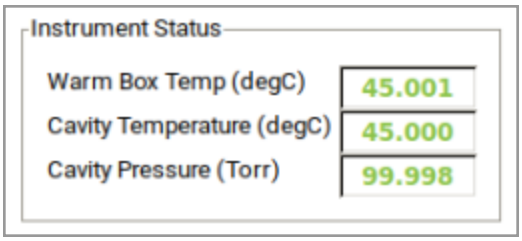


Figure 30 - Instrument Status Panel

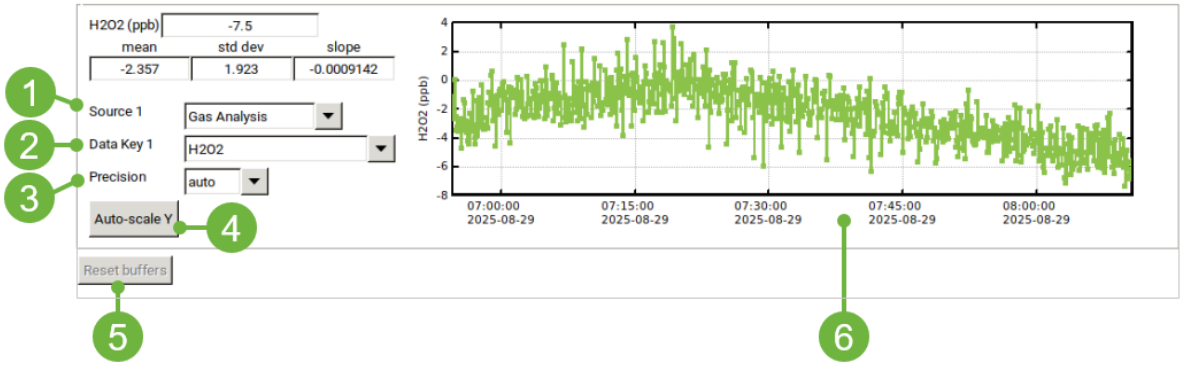
6.6 Quit Button

Shuts down the analyzer. See 5.2 Shutdown .

Figure 31 - CRDS Quit Button

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 scales its Y-axis if the plot hasn't done this automatically.



1. Source Keys
2. Data Keys
3. Precision
4. Auto Scale
5. Reset Buffers
6. Plot for Data Key

Figure 32 - Data Window Panel

6.8 Data Source and Data Key Pull Down Menus

Data Source and Data Key menus 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 **Sensor** 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."

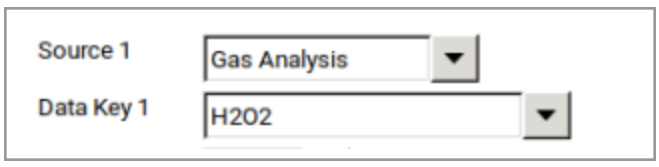


Figure 33 - Data Source and Data Key Pull Down Menus

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.

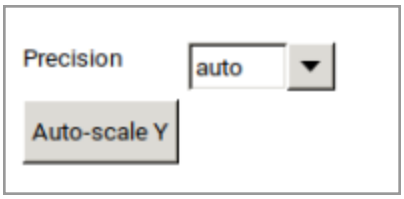


Figure 34 - Precision Pull-down Pane

6.10 Measurement Status Log

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

6.10.1 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.

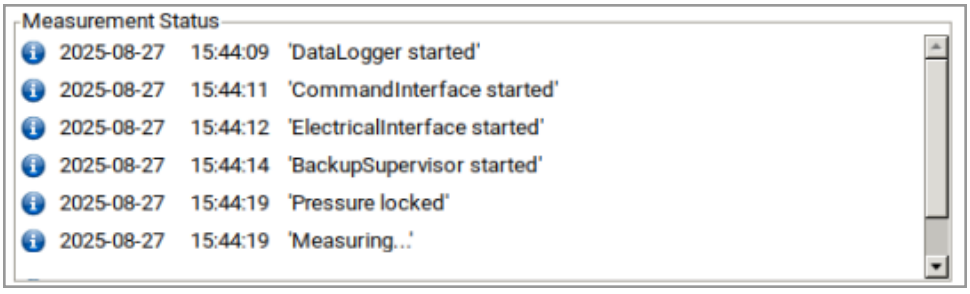


Figure 35 - Measurement Status Log

6.11 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.

6.12 Graph Zooming and Panning

6.12.1 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. When the box is drawn, release the **left** button and the boxed area will automatically scale to fill the data window.

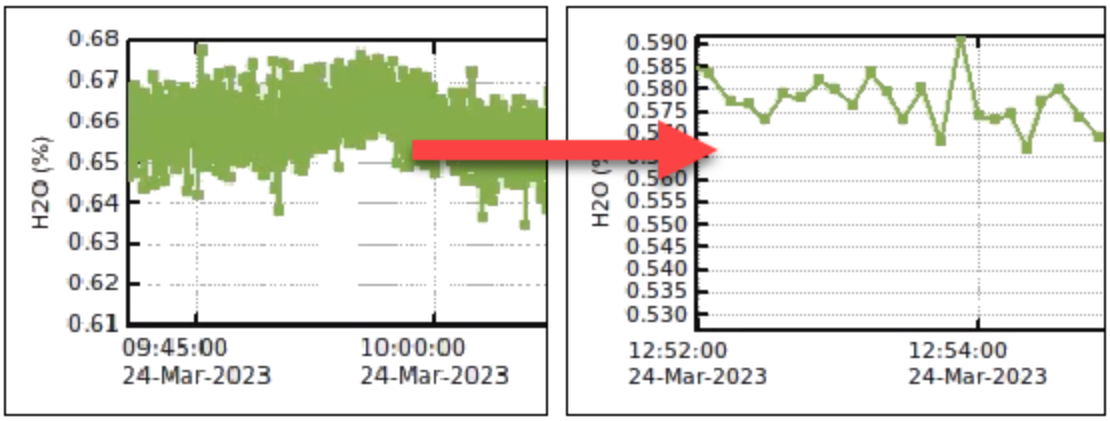


Figure 36 - Data Graph Zoom Function

To **zoom 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 as shown in the following figure.

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 37 - Auto-scale Buttons

6.12.2 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**.

6.12.3 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

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 4 - User Accounts and Functions

Function	Not Signed In	Operator	Technician	Administrator	Service (System Manager*)
View Data Viewer	●	●	●	●	●
Set Alarms		●	●	●	●
Configure Data Viewer (partial)		●	●	●	●
Quit Measuring		●	●	●	●
Quit (software shutdown)		●	●	●	●
Configure Data Viewer (full access)			●	●	●
User Management			●	●	●
Software Management (installation and uninstallation)					●
**Contact Picarro support at support@picarro.com to obtain Service (System Manager) access.*					

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 38.

From Picarro Launch Pad:

1. Login to the **Picarro Launch Pad** as an administrator (default user name is **admin**; default password is **admin**).
2. Select **Administration** and **User Accounts**.
3. From the **User Management Tool** login as an administrator (default user name is **admin**; default password is **admin**).
4. The User Management window displays and has four tabbed states: **User Accounts**, **User Policies**, **User History** and **My Profile**.

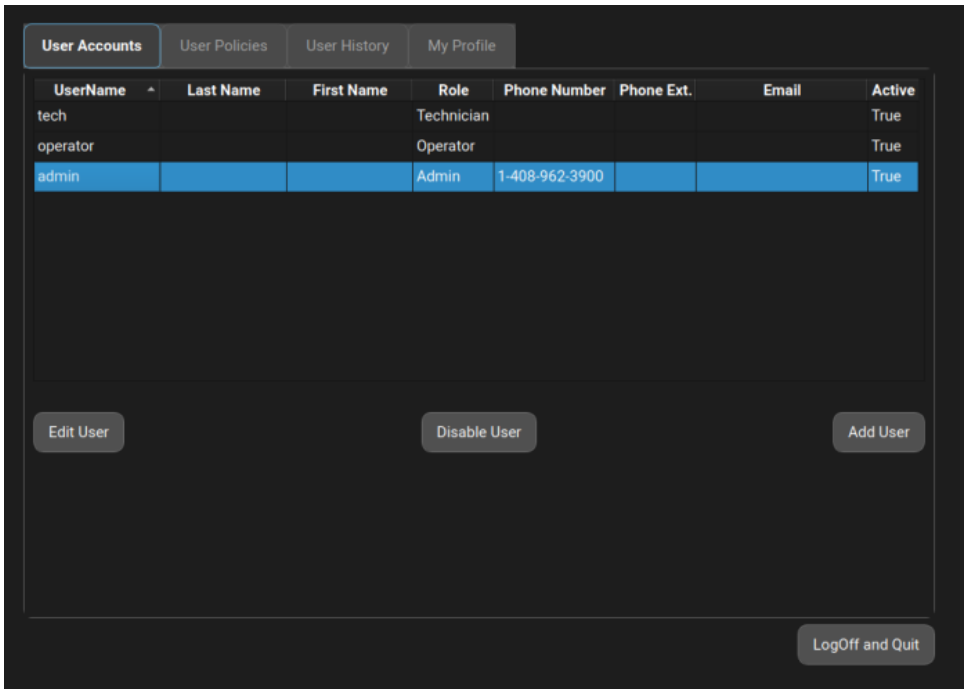


Figure 38 - User Management Window

7.1 Managing User Accounts

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

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

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.

7.1.1 Changing a User Password

1. In the **User Management** window, click the **User Accounts** tab.
2. From the list of users, click the user you want to change and select the **Edit User** button. The user account information displays.

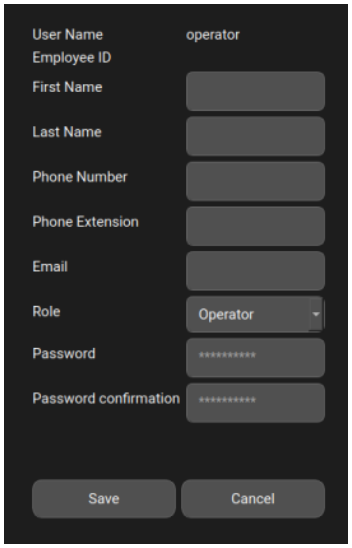


Figure 39 - Change Password

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

NOTE

Passwords are case sensitive. Additional rules for passwords can be set in the User Policies tab. For more information, see 7.2 Setting User Policies

4. In the **Password Confirmation** field, re-enter the password.
5. Click **Save** to save the password.

NOTE

To change your own password for your account, see 7.4 Viewing My Profile.

7.1.2 Changing a User's Role

1. In the User Management window, click the **User Accounts** tab.
2. From the list of users, select the user you want to change and click the **Edit User** button.
3. From the **Role** field, select the new role and click **Save**.

   The role is now changed to the desired setting.

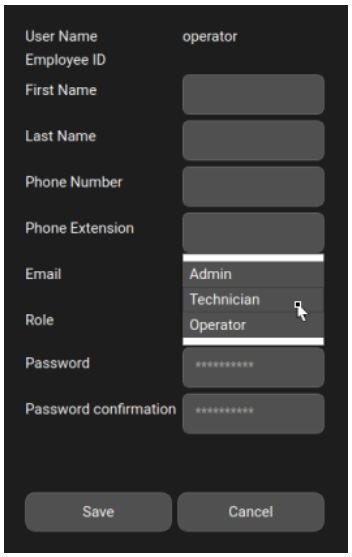


Figure 40 - Change Roles

7.1.3 Disabling a User Account

Users cannot be deleted from the system, but they can be disabled to prevent access to the software. Use the following procedure to disable a user.

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

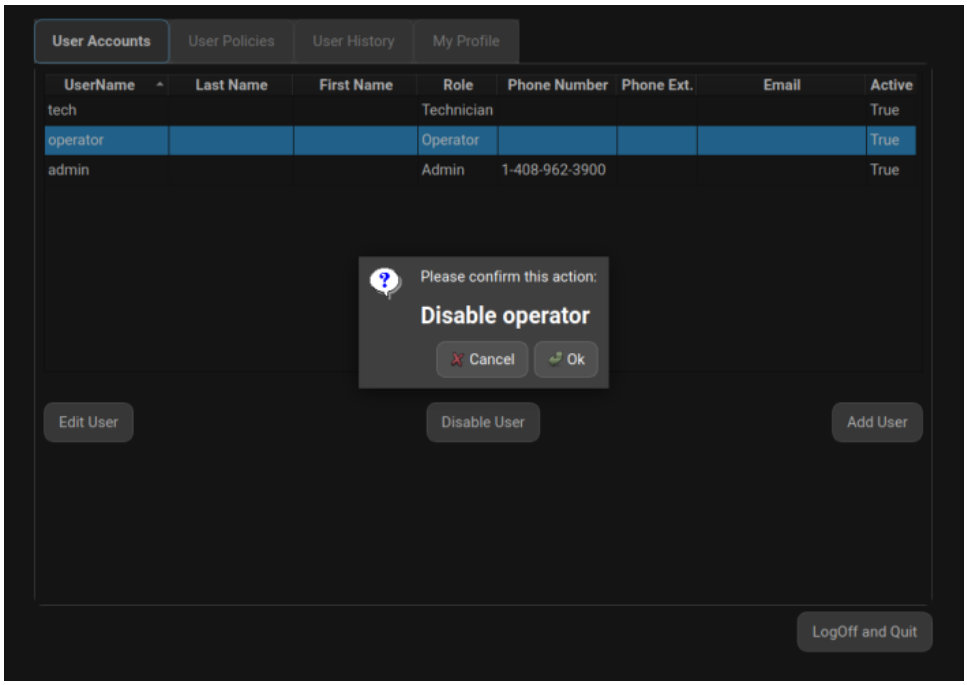


Figure 41 - Disable Users

7.1.4 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.

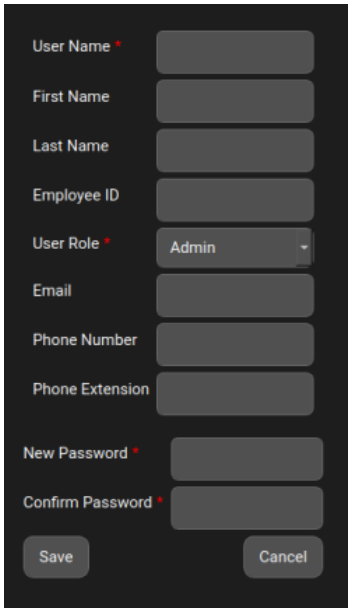


Figure 42 - Add User

3. Fill in the fields in the **Add User** window.
4. Click **Save** 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.

7.2 Setting User Policies

1. In the **User Management** window, click the **User Policies** tab.
2. Make any changes. For more information, see the following 7.2.1 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**.

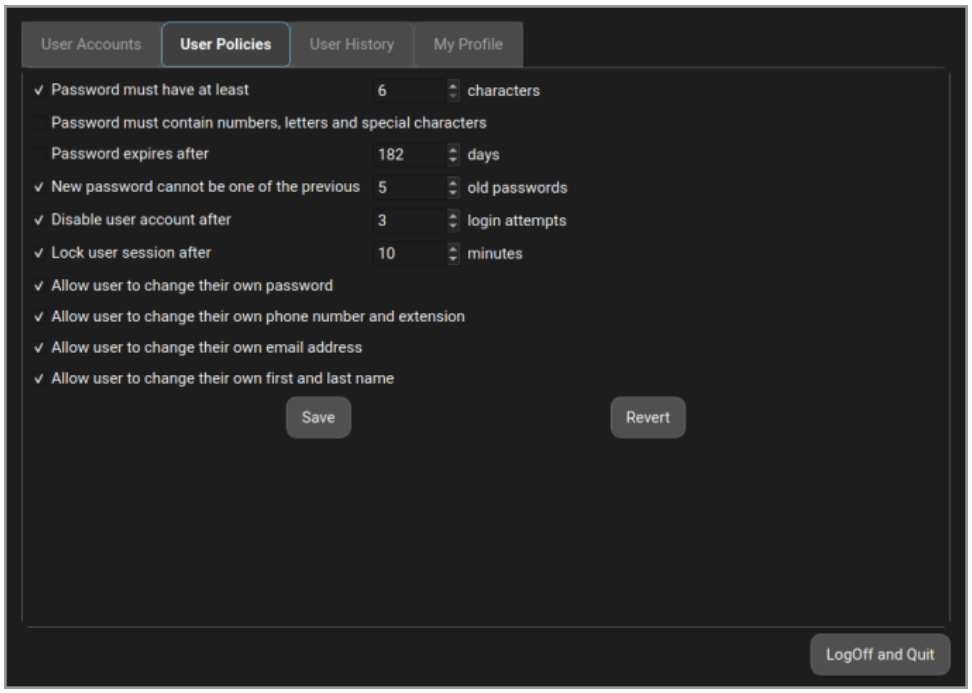


Figure 43 - User Policies Tab

7.2.1 User Policy Descriptions

The following table provides descriptions for the various user policies.

Table 5 - 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.

7.3 Viewing User History

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

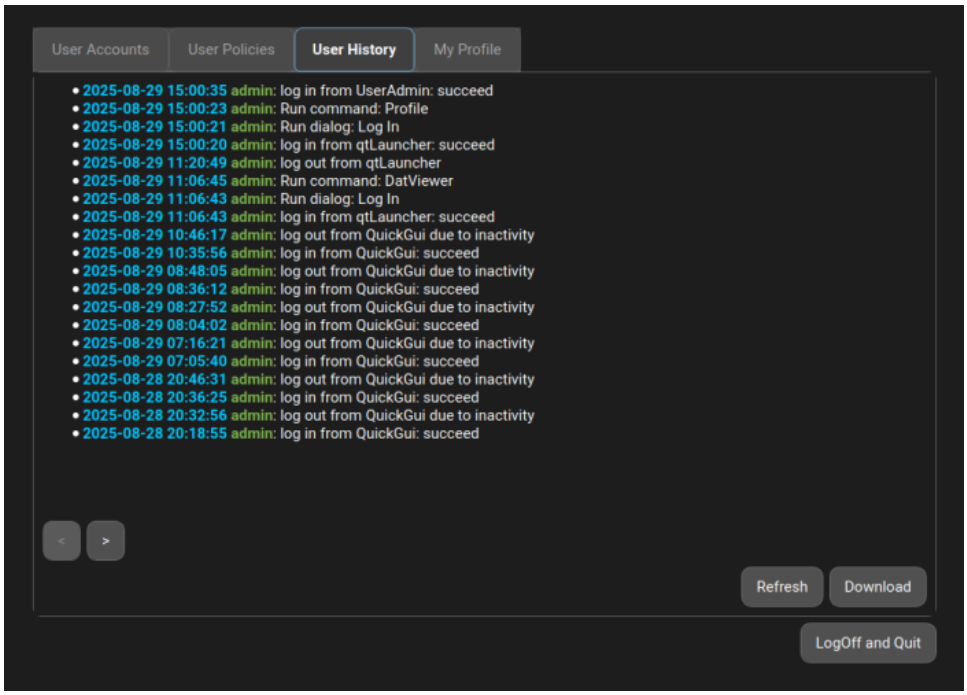


Figure 44 - User History Tab

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 launches the File Manager, which will prompt to login. See File Manager (Copy Files) for details on copying files from the analyzer.

7.4 Viewing My Profile

The **My Profile** tab provides information about the user that is currently logged into the system. The change password, phone number, email and name options are available to the user if these settings were enabled in the **User Policies** tab by an administrator. The user can use these options to edit their own profile information.

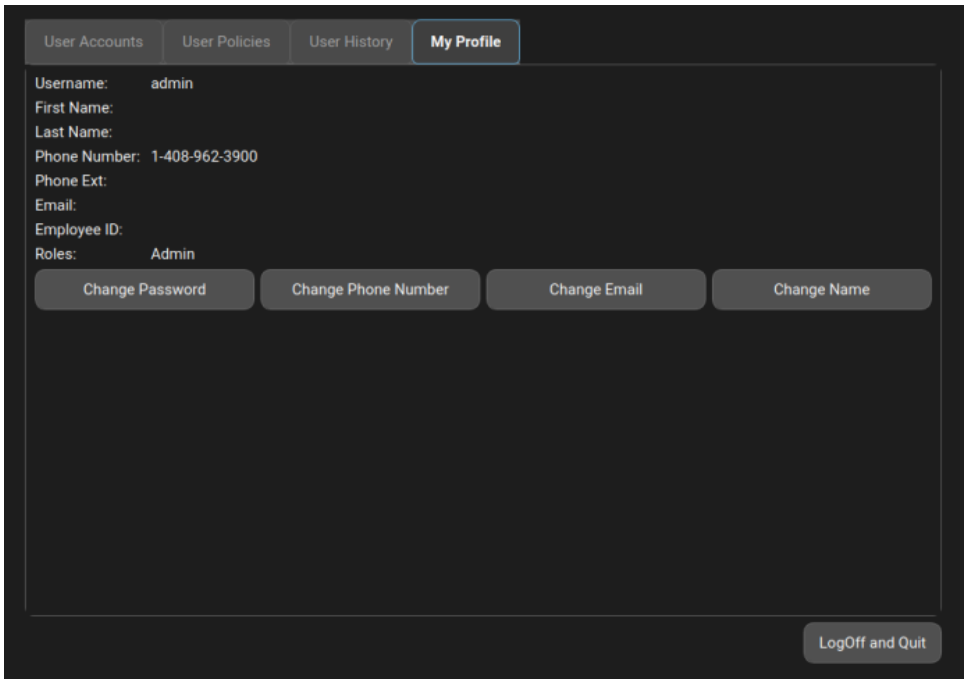


Figure 45 - My Profile Tab

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, DataLog_User_Sync, EventLogs, and **WBCAL**.

The Data Logger 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.

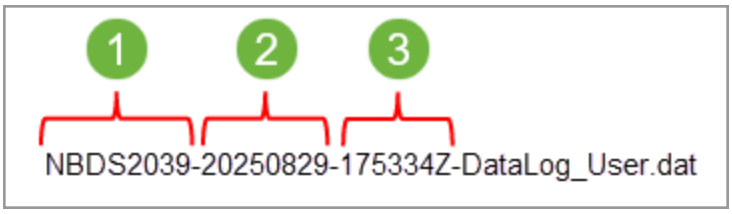
There are complete data files which include additional information beyond the concentration data including parameters such as instrument temperatures and pressure, set points and spectroscopic information. This information is generally not useful to the user, but can be useful for diagnostic purposes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



1 Instrument Serial Number
2 Date
3 Time (Local)

Figure 46 - Example Data File Name

- **NBDS2039**: the analyzer serial number
- **20250829**: the date, in format yyyymmdd (to allow chronological sorting of data files).
- **175334**: the time the file was started in the computer's local time **17:53:34**, 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

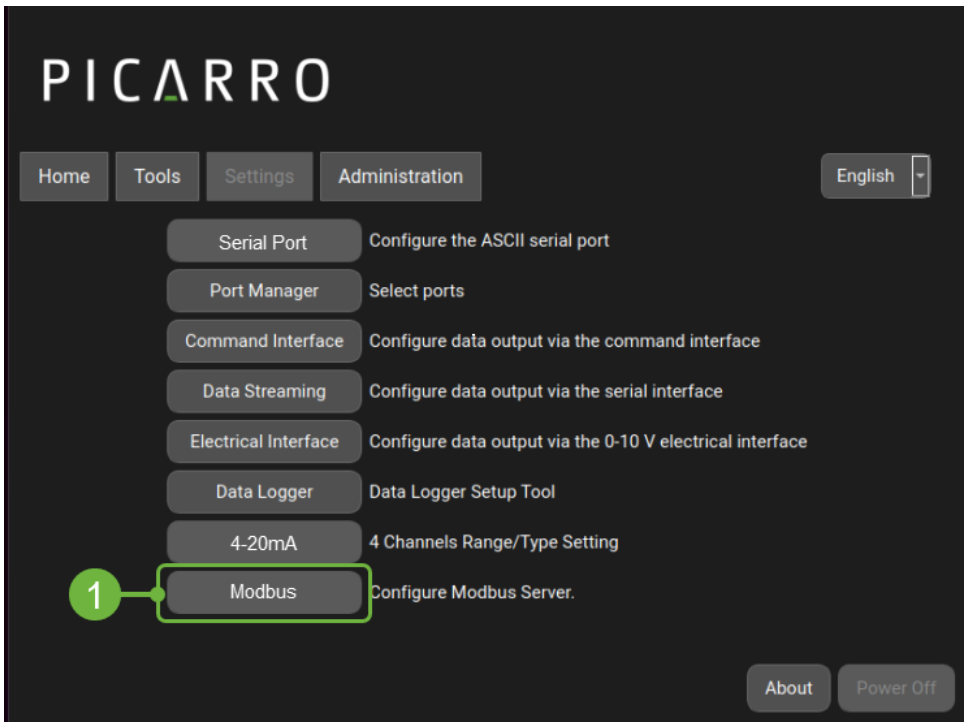
Modbus is a client/server data communication protocol to support communication to and from multiple devices connected to the same cable. Modbus can be configured for TCP/IP on port 50500 or RTU utilizing the analyzer's COM1 port. See the following section on how to configure Modbus communication.

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 the following figure.

NOTE

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



1 Modbus button

Figure 47 - Settings/Modbus Configuration

This displays the Modbus Settings window shown in Figure 48.

Figure 48 - Modbus Settings Window

2. From the Modbus Settings window the following configuration options are available:
   - **Slave ID** — The analyzer's Slave ID.
   - **Modbus Type** — The 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 6 - 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

9.2.1 Modbus TCP Setup Notes

- 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.

9.2.2 Modbus RTU Setup Notes

- 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 is disabled.

9.3 Modbus Register Maps

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

Table 7 - Input Registers

Address	Description	Units	Type	Comments
1-6	Time stamp		String	Long value return as 12byte string. Date will be in format YYMMDDHHMMSS
7-8	H2O2 Concentration	ppb	Float	

Address	Description	Units	Type	Comments
9-10	H2O2_ID	Unitless	Float	Gas ID code 14 identifies gas at register 7 as H_2O_2
11-12	H2O2, 30sec trailing average	ppb	Float	
13-14	H2O2, 2min trailing average	ppb	Float	
15-16	H2O2, 5min trailing average	ppb	Float	
17-18	H2O2, max (full scale range)	ppb	Float	Value is 100,000 ppb or 100 ppm
19-20	H2O2, min	ppb	Float	Value set to 0
21-22	Concentration of H2O	%	Float	Water is measured in absolute %, not to be confused with relative humidity
23-24	H2O_ID	Unitless	Float	Gas ID code 00 identifies gas at register 20 as H_2O
25-26	H2O, 30sec trailing average	ppm	Float	
27-28	H2O, 2min trailing average	ppm	Float	
29-30	H2O, 5min trailing average	%	Float	
31-32	H2O, max (full scale range)	ppm	Float	Value is 50,000 (5%)
33-34	H2O, min	ppm	Float	Value is set to 0
35-36	Concentration of CH4	ppb	Float	
37-38	CH4_ID	Unitless	Float	Gas ID code 04 identifies gas at register 34 as CH_4

Address	Description	Units	Type	Comments
39-40	CH4, 30sec trailing average	ppb	Float	
41-42	CH4, 2min trailing average	ppb	Float	
43-44	CH4, 5min trailing average	ppb	Float	
45-46	CH4, max (full scale range)	ppm	Float	Value is set at 200 ppm
47-48	CH4, min	ppm	Float	Value is set at 0
49-50	Reserved			
51-52	Reserved			
53-54	Reserved			
55-56	Reserved			
57-58	Reserved			
59-60	Reserved			
61-62	Reserved			
63-64	Reserved			
65-66	Reserved			
67-68	Reserved			
69-70	Reserved			
71-72	Reserved			
73-74	Reserved			
75-76	Reserved			
77-78	Reserved			
79-80	Reserved			
81-82	Reserved			

Address	Description	Units	Type	Comments
83-84	Reserved			
85-86	Reserved			
87-88	Reserved			
89-90	Reserved			
91-92	Reserved			
93-94	Reserved			
95-96	Reserved			
97-98	Reserved			
99-100	Reserved			
101-102	Reserved			
103-104	Reserved			
105-106	Reserved			
107-108	Reserved			
109-110	Reserved			
111-112	Reserved			
113-114	Reserved			
115+116	Reserved			
117-118	Reserved			
201-202	Cavity Pressure	Torr	Float	
203-204	Cavity Temperature	deg C	Float	
206-207	DAS Temperature	deg C	Float	
207-208	Etalon Temperature	deg C	Float	

Address	Description	Units	Type	Comments
209-210	Warm Box Temperature	deg C	Float	
211-212	Outlet Valve	dig counts	Float	
213-214	Instrument cal slope, H2O2		Float	
215-216	Instrument cal offset, H2O2		Float	
217-218	User cal slope, H2O2		Float	
219-220	User cal offset, H2O2		Float	
221-222	Instrument cal slope, H2O		Float	
223-224	Instrument cal offset, H2O		Float	
225-226	User cal slope, H2O		Float	
227-228	User cal offset, H2O		Float	
229-230	Instrument cal slope, CH4		Float	
231-232	Instrument cal offset, CH4		Float	
233-234	User cal slope, CH4		Float	
235-236	User cal offset, CH4		Float	
237-238	Reserved			
239-240	Reserved			

Address	Description	Units	Type	Comments
241-242	Reserved			
243-244	Reserved			
245-246	Reserved			
247-248	Reserved			
249-250	Reserved			
251-252	Reserved			
253-254	Reserved			
255-256	Reserved			
257-258	Reserved			
259-260	Reserved			
261-262	Reserved			
263-264	Reserved			
265-266	Reserved			
267-268	Reserved			
269-270	Reserved			
271-272	Reserved			
273-274	Reserved			
275-276	Reserved			

Address	Description	Units	Type	Comments
387	Error Code		int	Error for each control command of COIL • NO_ERROR = 0 • ERROR_HANDLER_ERROR = 1 • ERROR = 2 • NO_SUDO_USER_PRIVILEGE = 3 • NO_USER_EXIST = 7 • USERNAME_PASSWORD_ INCORRECT = 9 • USER_DISABLED = 10 • ADMIN_RIGHT_REQUIRES = 11 • PASSWORD_LENGTH_ERROR = 12 • PASSWORD_FORMATE_ERROR = 13 • PASSWORD_REUSE_ERROR = 14
388	Measurement Status		int	ledState = 0 red, system error, gas conc. measurements invalid ledState = 1 solid yellow, need service, gas conc. measurements might be ok ledState = 2 blinking yellow, not in reporting mode by system ok, like during warmup ledState = 3 green, system ok, gas conc. measurements accurate

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 8 - Discrete Input Registers

Address	Description
6	Pressure locked
7	Cavity temperature locked
8	Warm box temperature locked
73	Reserved
74	Reserved
75	Reserved
76	Reserved
77	Reserved
78	Reserved
79	Reserved
80	Reserved
81	Reserved
82	Reserved
83	Reserved
84	Reserved
85	Reserved
86	Reserved
87	Reserved
88	Reserved
89	Reserved
90	Reserved
91	Reserved
92	Reserved
93	Reserved

Address	Description
94	Reserved
95	Reserved
96	Reserved

9.6 Holding Register Map

The following table describes the holding registers.

Table 9 - Holding Registers

Address	Description	Units	Type	Comments
1-4	System time		int	Integer representing milliseconds from 1AD January 1st to now
5-8	User Name		String	
9-12	Password		String	
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	

Address	Description	Units	Type	Comments
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

The following table describes the coil registers.

Table 10 - Coil Register Map

Address	Description	Units	Comments
116	Quit host application		
117	Shutdown Instrument		It will take approximately 2 min to shutdown
151	Get system time		After this please read Sync Time holding register
152	User login (Coming in near future)		Before executing this command, user needs to set user name and user password holding register
155	Update user password (Coming in near future)		Before executing this command follow the steps below: 1. Login as admin using User Login functionality if not logged in already. 2. Set user name and password holding register.
156	User logout (Coming in near future)		
201	Get User data 1		

Address	Description	Units	Comments
202	Set User data 1		
203	Get User data 2		
204	Set User data 2		
205	Get User data 3		
206	Set User data 3		
207	Get User data 4		
208	Set User data 4		
209	Get User data 5		
210	Set User data 5		
211	Get User data 6		
212	Set User data 6		
213	Get User data 7		
214	Set User data 7		
215	Get User data 8		
216	Set User data 8		
217	Get User data 9		
218	Set User data 9		
219	Get User data 10		
220	Set User data 10		
221	Get User data 11		
222	Set User data 11		
223	Get User data 12		
224	Set User data 12		
225	Get User data 13		

Address	Description	Units	Comments
226	Set User data 13		
227	Get User data 14		
228	Set User data 14		
229	Get User data 15		
230	Set User data 15		
231	Get User data 16		
232	Set User data 16		
233	Get User data 17		
234	Set User data 17		
235	Get User data 18		
236	Set User data 18		
237	Get User data 19		
238	Set User data 19		
239	Get User data 20		
240	Set User data 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.
- Registers in Red are coming in nearthe near future.
- Memory map is continuous memory, so if user trytries 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).

9.8 Gas ID Map

The Gas ID input registers return a two-digit code to identify the gas species being measured.

Table 11 - Gas ID Map

Address	Species	Description
00	H2O	Water
01	NH3	Ammonia
02	H2S	Hydrogen sulfide
03	CO2	Carbon dioxide
04	CH4	Methane
05	CO	Carbon monoxide
06	C2H2	Acetylene
07	C2H4	Ethylene
08	N2O	Nitrous oxide
09	CH2O	Formaldehyde
10	HF	Hydrogen fluoride
11	O2	Oxygen
12	HCl	Hydrogen chloride
13	C2H6	Ethane
14	H2O2	Hydrogen peroxide

10 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 Support at +1 408 962 3991 (US) or +31 85 888 1650 (International) or support@picarro.com.

10.1 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.

10.2 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. **Pressure low** — 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 Chapter 12, Maintenance for more information.
2. **Pressure high** — 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

11 Instrument Validation

11.1 Validation Overview

When required, the validation procedure can test that the instrument is operating as expected.

Validation is performed using low-concentration methane in place of hydrogen peroxide. Methane has the following advantageous characteristics:

- Available as a certified, NIST-traceable standard
- Non-hazardous at relevant concentrations.
- Stable indefinitely.
- Gaseous across the operational range of the instrument.
- Has an absorption feature immediately adjacent to H_2O_2.

The validation procedure is based on sequentially introducing zero air and three methane standards. The H_2O_2 signal in zero air is measured to evaluate the zero offset for the H_2O_2 spectroscopic model.

Separately, the methane concentrations in zero air and in each standard cylinder are measured, and a linear regression is calculated to demonstrate the linearity and zero-accuracy of the analyzer. As any system performance problems that would affect the accuracy of the H_2O_2 slope (span) will likewise affect the slope for methane, this procedure provides a means of rapidly validating system performance using certified standards.

It will take approximately 60 minutes for data acquisition and analysis.

11.2 Required Supplies

Instrument validation requires the following:

- Four cylinders of input gases:
- One cylinder of zero air (dry synthetic hydrocarbon-free air).
- Three methane standard cylinders. Three cylinders of methane, each with a different concentration, certified within +/- 2% composition uncertainty. We recommend concentrations of 7, 50, and 100 ppm.
- Four regulators (one for each cylinder being used). Each regulator should be capable of accurately delivering 2–3 psi (0.1–0.2 bar) of line pressure.
- Sufficient tubing to connect the regulator(s) to the instrument. We recommend using ¼" OD PTFE or PFA tubing when working with hydrogen peroxide. While not required for work with methane, Picarro recommends using the same material in this procedure to avoid inadvertent use of inappropriate tubing in later work with hydrogen peroxide.
- Suitable adjustable or fixed wrenches for making gas-line connections.

Please contact Picarro for further information about the supplies and accessories required for instrument validation.

11.3 Safety

Of the concentrations used here, methane poses zero health, reactivity, or flammability risks. Follow all safety conventions appropriate for work with compressed gases, including use of eye protection, physical restraint of cylinders, etc.

11.4 Validation Procedure

1. Allow the system to reach operating temperature and pressure settings. (See 5.1 Startup).
2. Attach regulators to the gas sources and adjust their output line pressures so they are within the range of 2–3 psi (0.1–0.2 bar).
3. From the *Users* menu, select **User Login** and sign in (requires technician or administrator privileges).
4. From the *Tools* menu, select **H_2O_2 Validation**. Login to the System Validation tool as an administrator (default user name is **admin**; default password is **admin**).

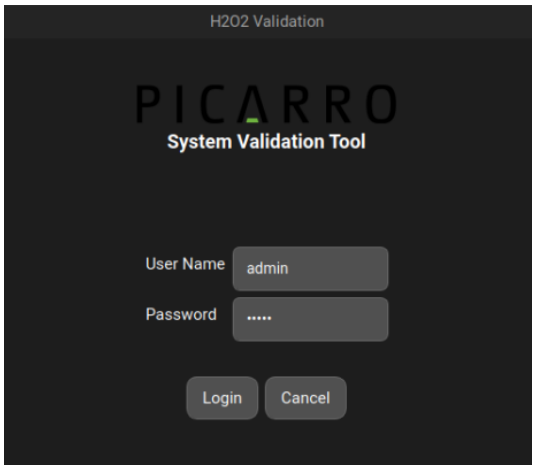


Figure 49 - System Validation Login

The Introduction to System Validation window displays. (Figure 50 - Beginning System Validation).

5. Click **Next**. The first-time validation is run, this will display the *Edit Cylinders* page (Figure 51 - Edit Cylinders). Use this page to specify the concentrations and uncertainties of the cylinders being used in this procedure. See Table 12 - Cylinder Button Functions for action definitions. On subsequent uses, the system will remember the saved values and skip directly to the Zero-Air Measurement step.
6. If this is the first-time performing system validation, enter the information for each of the cylinders you are going to use. Note that the uncertainty value is typically provided by the supplier for each cylinder.

If validation has been run before, use this window to verify that the concentrations match the cylinders to be used and make any necessary updates.

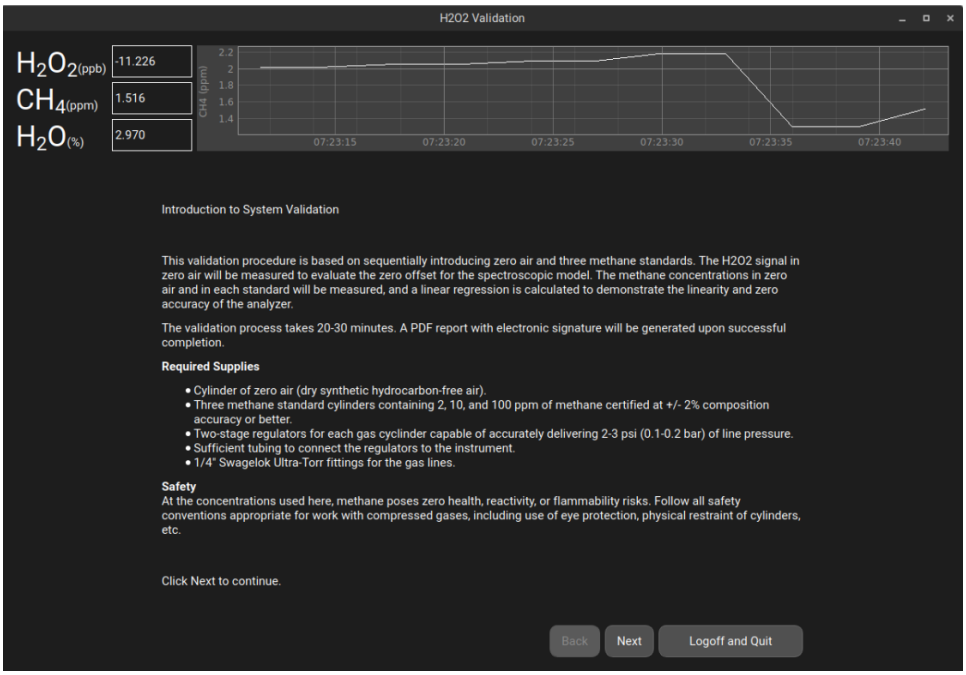


Figure 50 - Beginning System Validation

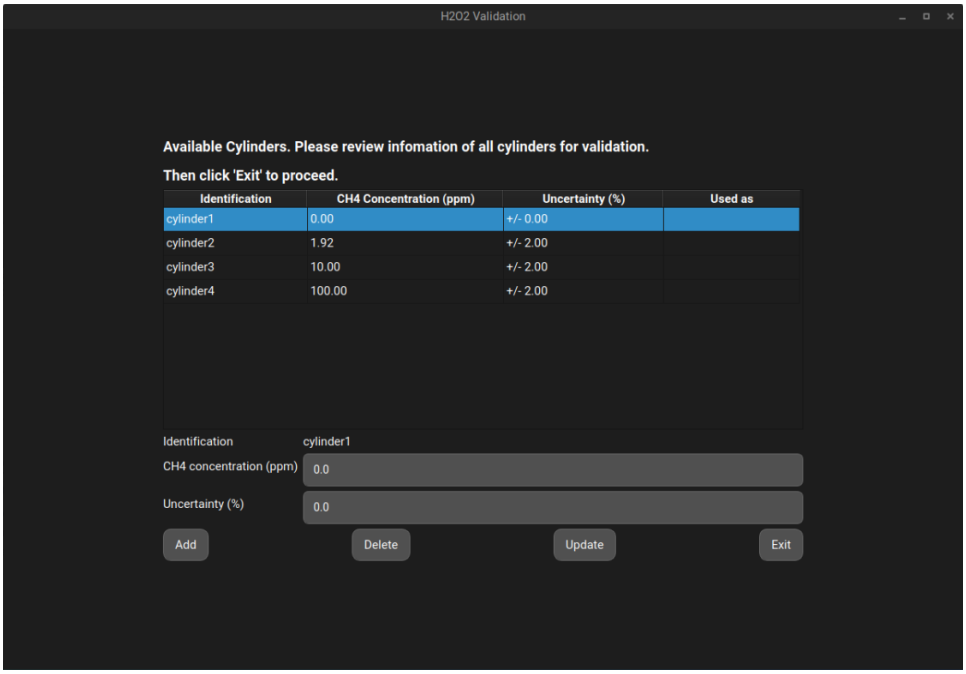


Figure 51 - Edit Cylinders

Table 12 - Cylinder Button Functions

Button	Function
Add	Add a new cylinder to the list.
Delete	Remove the highlighted cylinder from the list. (Click a cylinder to highlight it.)
Update	Click a cylinder, make changes to the values shown at the bottom of the table, and click **Update** to save the updated values.
Exit	Exit the cylinder setup and return to validation.

1. Once the cylinders are set up, click **Exit** to continue to Figure 52 - Zero Air Measurement Preparation.

Figure 52 - Zero Air Measurement Preparation

2. If this is not the first-time running validation on this system, click **Edit Cylinder** and verify the settings for the cylinders being used in this procedure (see steps 5–7).
3. Select the zero-air cylinder from the *Select Cylinder* list.
4. Open the valve on the zero-air cylinder.
5. Connect the zero-air cylinder to INLET on the back of the analyzer. (See 4.4 A2000 Pump and Gas Inlet Connections).
6. Click **Next** to begin measurement. This will take several minutes. Once it has finished with measuring the cylinder, it will show a confirmation dialog that measurement is complete (Figure 53 - Zero-Air Measurement).

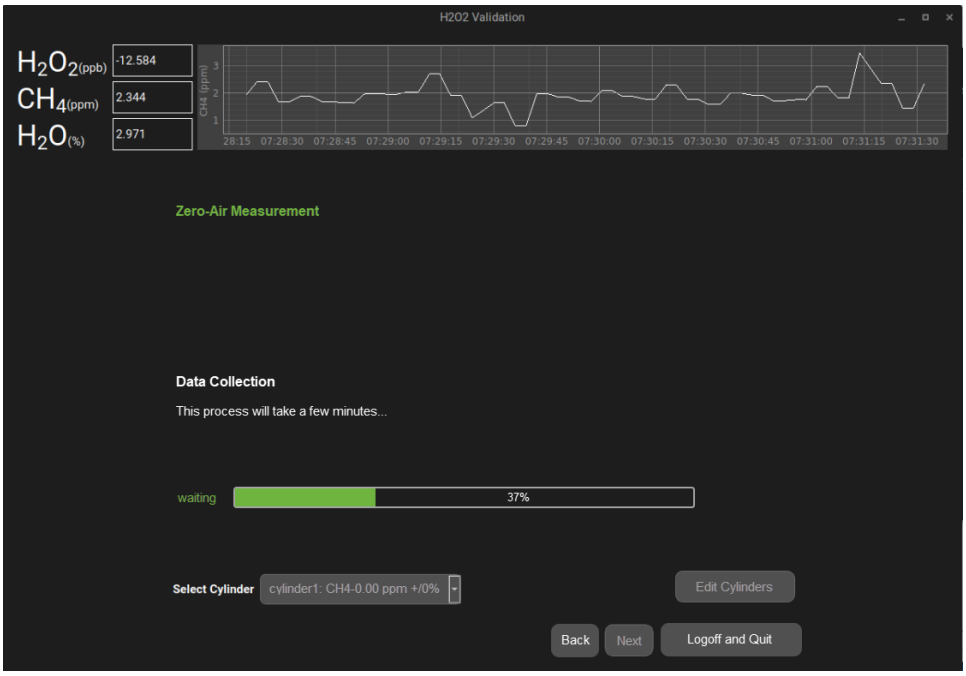


Figure 53 - Zero-Air Measurement

When the measurement is complete, the system will prompt you:

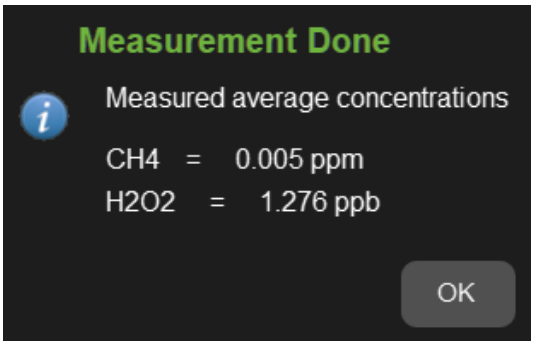
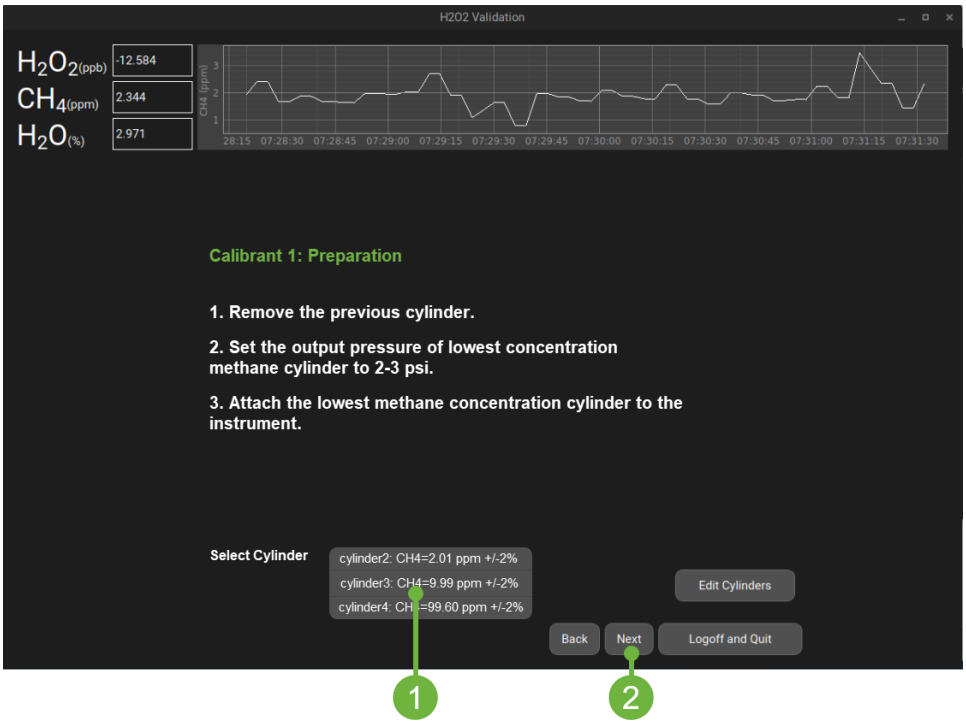


Figure 54 - Measurement Done Dialog

7. Click **OK** to proceed to the next step, Figure 55 - Calibrant 1 Preparation.
8. Disconnect the zero-air cylinder from the analyzer INLET.
9. Close the valve on the zero-air cylinder.
10. Open the valve on the first methane cylinder (the regulator should already be set to 2–3 psi).
11. Connect the cylinder to the analyzer INLET.
12. Select the cylinder from the *Select Cylinder* list.



1 Select the cylinder

2 Click Next.

Figure 55 - Calibrant 1 Preparation

13. Click **Next** to begin measuring the first cylinder (Figure 56 - Calibrant 1 Measurement in Progressshows data collection underway).

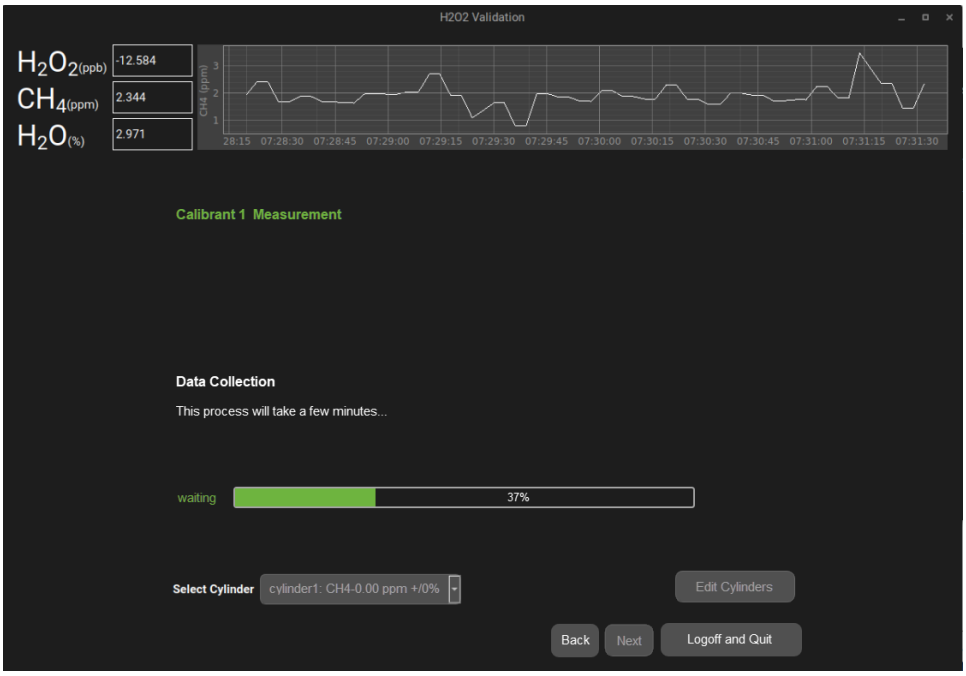


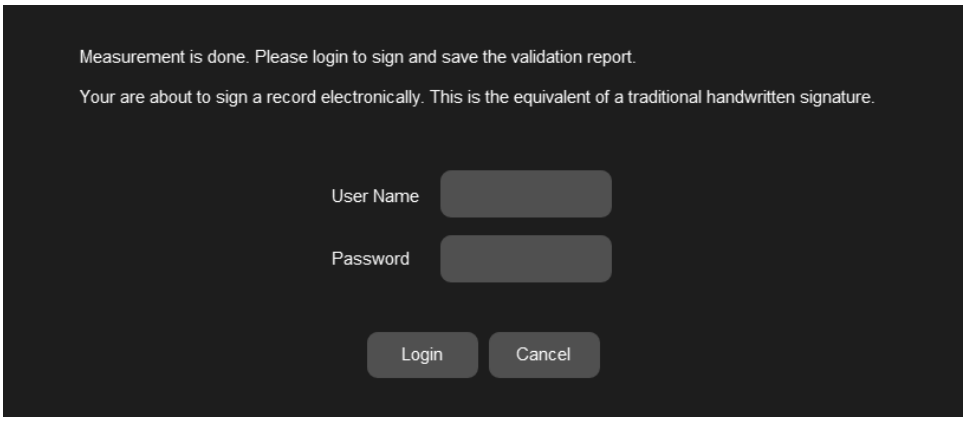
Figure 56 - Calibrant 1 Measurement in Progress

14. Follow the prompts to finish measuring the first methane cylinder and to prepare and measure the next two methane cylinders. After the last cylinder has been measured, the system will prompt you to sign in again as a digital signature (11 Instrument Validation).

⚠ CAUTION

When switching cylinders, follow these steps to avoid damaging the instrument:

- **Do not turn off the gas valve before disconnecting the cylinder from the analyzer.**
- **Before connecting the next cylinder, make sure its regulator is set to 2–3 psi (0.1–0.2 bar) and open the regulator valve before connecting it to the analyzer INLET.**
- **Refer to 4.4 A2000 Pump and Gas Inlet Connections for information on connecting to the INLET.**



Digital signature is required after all cylinders have been measured.

Figure 57 - Digital Signature Window

15. Enter your user name and password (must have technician or administrator privileges) and click Login to display the validation results.

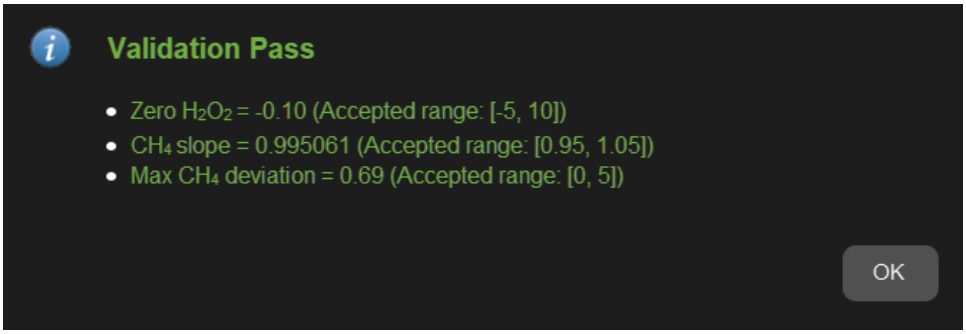


Figure 58 - Validation Results

16. Click **OK** to clear the dialog and view a preview of the Validation Report as shown below.

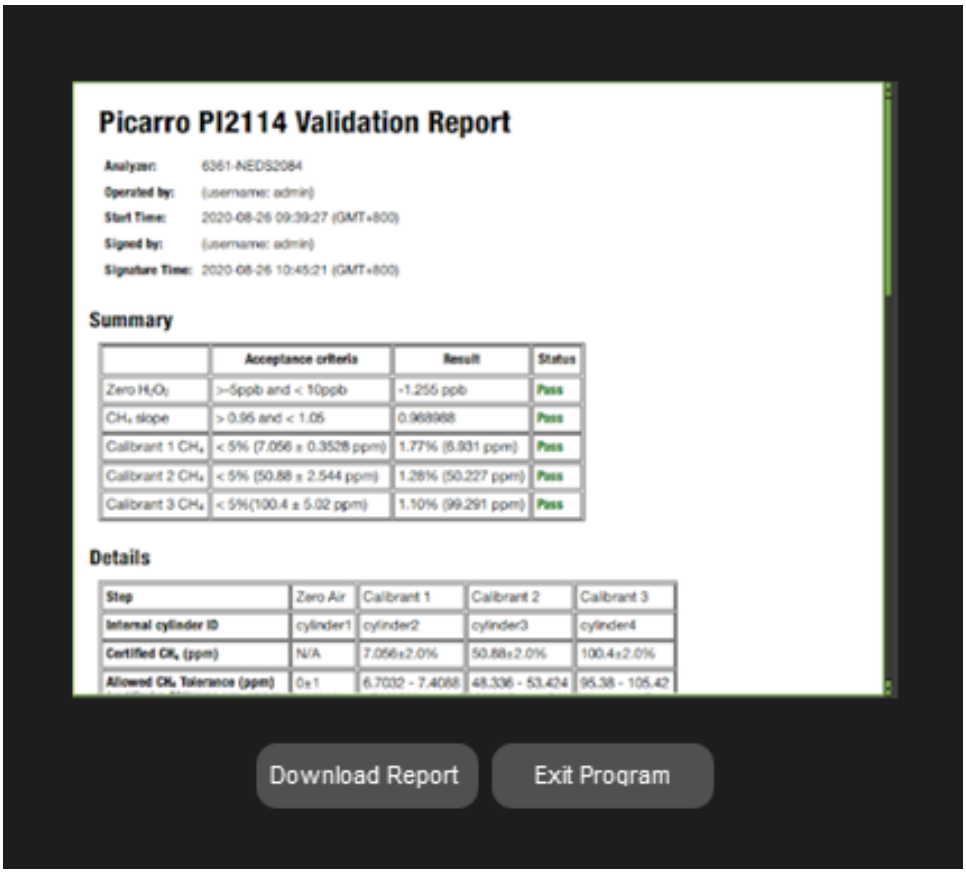


Figure 59 - Validation Report

17. To copy the Validation Report to a USB flash-memory drive, click **Download Report**.

    Downloading the report will prompt you to sign in to the File Manager, which you can use to copy the report to a USB drive. See 8 File Management.

18. To return to the Data Viewer, click **Exit Program**.
19. Disconnect the last methane cylinder, making sure to disconnect it before closing the cylinder's valve.

11.5 Example of Results from Validation

In the examples shown below, we collected data using four cylinders with nominal methane concentrations of 0, 7, 50, and 100 ppm.

Approximately five minutes of data were acquired for each concentration. Scaling for the relative sensitivity difference between methane and H_2O_2 (methane produces spectra 70-fold weaker) these standards are comparable to 0, 100, 715, and 1430 ppb of H_2O_2 in terms of their utility in evaluating the fundamental performance characteristics of the instrument.

Picarro PI2114 Validation Report

Analyzer: 6361-NEDS2084
Operated by: (username: admin)
Start Time: 2020-08-26 09:39:27 (GMT+800)
Signed by: (username: admin)
Signature Time: 2020-08-26 10:45:21 (GMT+800)

Summary

	Acceptance criteria	Result	Status
Zero H_2O_2	>-5ppb and < 10ppb	-1.255 ppb	Pass
CH_4 slope	> 0.95 and < 1.05	0.988988	Pass
Calibrant 1 CH_4	< 5% (7.056 ± 0.3528 ppm)	1.77% (6.931 ppm)	Pass
Calibrant 2 CH_4	< 5% (50.88 ± 2.544 ppm)	1.28% (50.227 ppm)	Pass
Calibrant 3 CH_4	< 5%(100.4 ± 5.02 ppm)	1.10% (99.291 ppm)	Pass

Details

Step	Zero Air	Calibrant 1	Calibrant 2	Calibrant 3
Internal cylinder ID	cylinder1	cylinder2	cylinder3	cylinder4
Certified CH_4 (ppm)	N/A	7.056±2.0%	50.88±2.0%	100.4±2.0%
Allowed CH_4 Tolerance (ppm) (certified ± 5%)	0±1	6.7032 - 7.4088	48.336 - 53.424	95.38 - 105.42
Observed average CH_4 (ppm)	0.008	6.931	50.227	99.291
CH_4 SD (ppm)	0.0996	0.1113	0.1172	0.1225
CH_4 deviation (%) (certified - observed)	N/A	1.771	1.284	1.104
Observed H_2O_2 (ppb)	-1.255	-1.696	-3.070	-4.661
Observed H_2O (%)	0.002	0.003	0.001	0.001

CH_4 slope: 0.988988 **CH_4 R^2:** 0.999999
CH_4 intercept (ppm): 0.034 **Zero air CH_4 (ppm):** 0.008
H_2O_2 equivalent (ppb): 0.48 **H_2O_2 measured zero (ppb):** -1.255

Figure 60 - Validation Report – Page 1

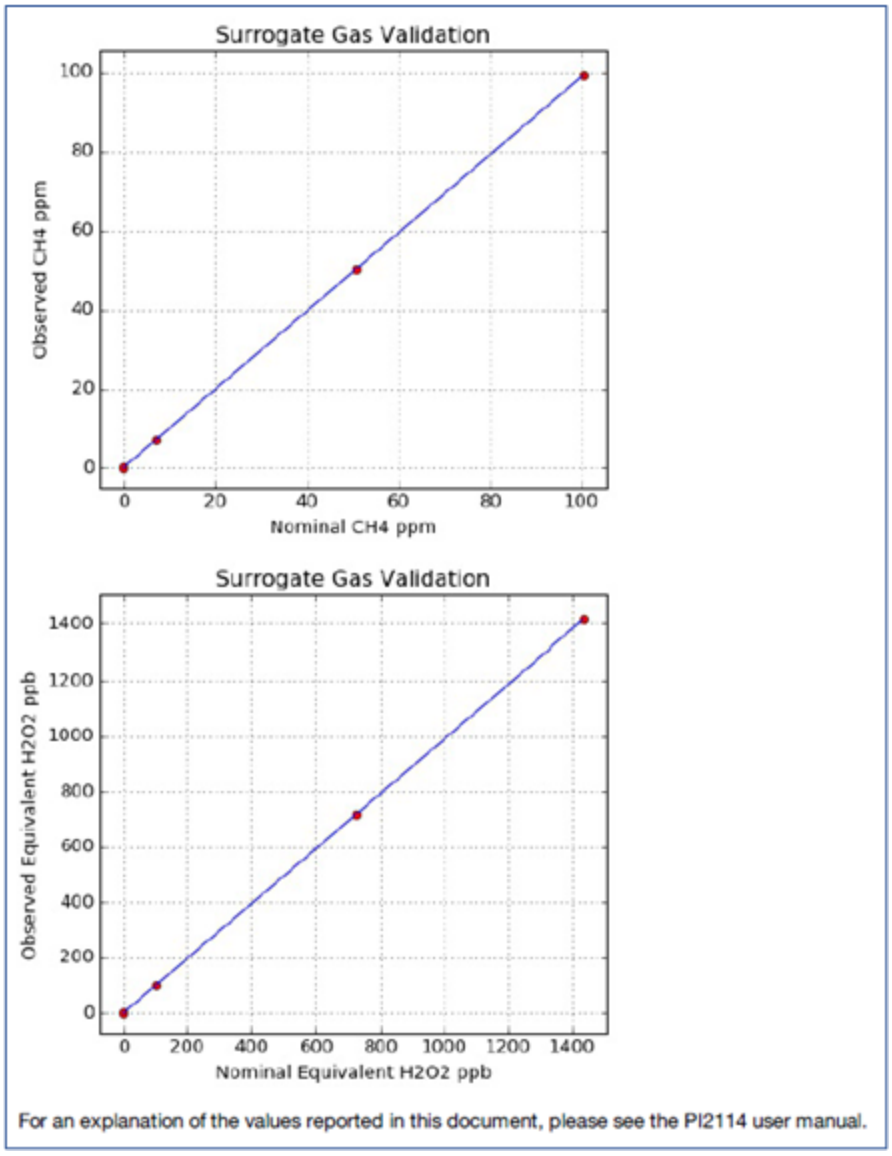


Figure 61 - Validation Report – Page 2

11.6 If the Analyzer Does Not Pass

If the analyzer fails the validation test, check the nominal CH_4 on page one of the report against the actual CH_4 concentration and uncertainty for the reference cylinders.

If there is a discrepancy, run the test again, correcting the discrepancies on the *Edit Cylinder* step.

If the analyzer did not pass and there is no discrepancy between the nominal values of the calibrants in the report and the values of the cylinders used during validation, contact Picarro. See back page for contact information.

12 Maintenance

The advanced, rugged design of Picarro analyzers provides stable, long-term operation with minimal service or maintenance. With the exception of 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 Customer Support.

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 an annual preventive maintenance kit and can be purchased by contacting sales@picarro.com. The three service plans are as follows:

- **W3101 Essential Service Plan** — Free yearly maintenance kit; 50% discount on Field Replaceable Parts; 10-20% Discounted factory repair. See data sheet for complete terms and conditions.
- **W3102 Premium Service Plan** — Free yearly maintenance kit; Extended warranty; Free factory repair; Free Field Replaceable Parts. See data sheet for complete terms and conditions.
- **W3103 Commercial Service Plan** — Free yearly maintenance kit; Extended warranty; Free factory repair; Free Field Replaceable Parts; Loaner instrument; Free yearly prevention maintenance visit; Complimentary remote refresher training. See data sheet for complete terms and conditions.

12.2 Preventive Maintenance Kits

Preventive maintenance kits can be purchased by contacting support@picarro.com. The maintenance kits all include the following elements:

Replacement CPU Fan; particulate filter (Stainless Steel or Teflon); dust filter; replacement screws for instrument cover panels; Ball-Point Hex L-Keys; Anti-Static Wrist Strap.

The kits come in three forms depending on the instrument being serviced.

- **S3092** — Yearly Maintenance Kit for GHG, L2xxx, and EtO
- **S3093** — Yearly Maintenance Kit for PI2114
- **S3094** — Yearly Maintenance Kit for HAPs G2xxx User-Replaceable Hardware

12.3 User-replaceable Hardware – Individual Components

This section provides a list of components that are self-serviceable. These items can be purchased online through the Picarro store by using the links below.

12.3.1 Particulate Filter

The inlet particulate filter is user-replaceable. Use the following link to order replacements and to find the instructional video and supporting maintenance document.

Parts

- **Stainless Steel Filter (for all models except those that measure HF, NH_3, CH_2O, HCl and H_2O_2):**
  S1020 Particulate Filter Kit – If viewing this manual as a paper hard copy, enter the following URL in your browser:
  https://store.picarro.com/Particulate-filter-kit-all-models-except-HF-NH3
- **Teflon Filter: For models that measure NH_3, HF, CH_2O, HCl and H_2O_2**
  S1021 Particulate Filter Kit – If viewing this manual as a paper hard copy, enter the following URL in your browser:
  https://store.picarro.com/Particulate-filter-teflon-for-NH3-HF._3

Instructions

- **Video:** Replacing Your Inlet Particulate Filter
  https://www.picarro.com/environmental/videos/replacing_your_inlet_particulate_filter
- **Manual:** Inlet Particulate Filter Maintenance Guide
  https://www.picarro.com/environmental/inlet_particulate_filter_maintenance_guide

12.3.2 CPU Fan

The analyzer CPU fan is user-replaceable. Use the following link to order replacements and to find the instructional video and supporting maintenance document.

Parts

- **CPU Fan for MI990 Motherboards:**
  S3267: PI5000 CPU Fan Replacement Kit. Includes the S3263 (CPU Fan) and required tools for replacement.nstructions

Instructions

- **Video:** CPU Fan Replacement
  https://www.picarro.com/environmental/videos/cpu_fan_replacement
- **Manual:** CPU Fan Replacement for Picarro Analyzers

12.3.3 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.

Parts

- **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:
  https://store.picarro.com/Rebuild-kit-for-Picarro-A2000-vacuum-pump

Instructions

- **Manual:** A2000 Pump Maintenance Guide
  https://www.picarro.com/environmental/a2000_pump_maintenance_guide

12.3.4 A0702 Pump Rebuild

The A0702 recirculation pump (if used with your analyzer) is not user serviceable. Instead, these pumps may be exchanged once they reach the end of their diaphragms' operational life. Please contact support@picarro.com to coordinate this exchange.

12.4 Cleaning

Clean the outside of the analyzer with a clean dry cloth. Only certified service technicians should access or clean the inside of the analyzer.

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, relatively 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 5.2 Shutdown , for specific shutdown instructions for your model analyzer.

20. Click on the **Quit** button located on the left side of the Data Viewer window.
21. A window displays prompting the user to confirm the shutdown. Click **Yes** to continue the shutdown process.

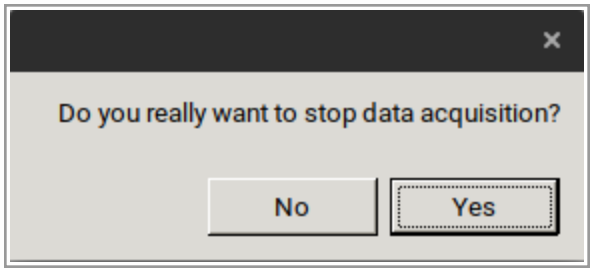


Figure 62 - Stop Data Acquisition/Shutdown

22. Confirm the level of water vapor prior to shutdown. Click **No**, if the analyzer was dried before shutdown. Click **Yes**, if the analyzer requires dry gas to reduce the moisture content.

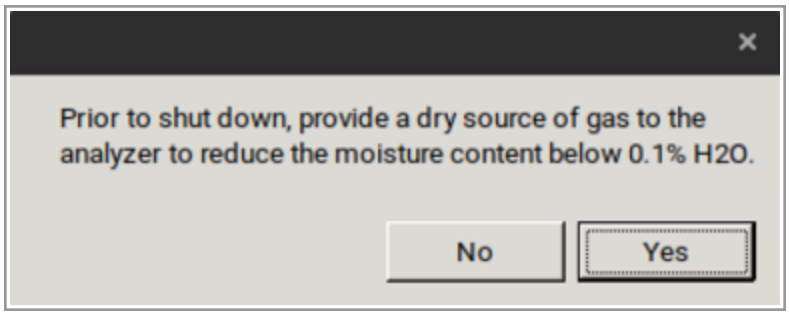


Figure 63 - Reduce Moisture Content/Shutdown

Once confirmed, the analyzer software and hardware will turn off.

23. Manually turn off the pumps and dry gas (if used).
24. Disconnect all tubing and electrical connections from the analyzer.
25. To prevent contamination and possible damage to the connector 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.

A Measurement Status Messages

Table 13 - Measurement Status Messages

Message	Description
Aborting[DR1] …	
Disabling Data Manager	Exiting measuring state.
Leaving Measuring	
Measuring	This is the normal mode of operation. The analyzer will scan and report concentration measurements until it is shutdown.
Parking	Entering parking state, system is venting cavity prior to shut down.
Parking Sample	Entering parking state, system is venting cavity prior to shut down.
Preparing Sample Manager	
Preparing to Measure	Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds.
Pressure = %d Torr	Dynamic reporting of pressure as instrument is shut down.
Pressure stabilizing	The valve control system is allowing flow through the analyzer and is stabilizing the pressure inside the cavity.
Pressure Locked	The valve control system has stabilized the pressure inside the cavity.
Pressure Unlocked	
Purge Complete	
Putting Data Manager in warming mode	Exiting measuring state.
Reset	
Restart Measuring	This is the normal mode of operation. The analyzer will scan and report concentration measurements until it is shutdown.
Sample prepare complete	

Message	Description
Shutdown	
Starting	
Temp and Pressure Stabilizing	Entering warming state.
Temperature Locked: HB	The temperature of the “hot box” (HB – the chamber containing the analyzer’s optical cavity and gas handling system) is stable. Achieving stability is typically the longest step in the startup sequence. It may take from 5 to 60 minutes to lock, depending on the ambient temperature and how much time has elapsed since the unit was shut down.
Temperature Locked: WB	The temperature of the “warm box” (WB – the chamber containing the electronics and wavelength monitor) is stable.
Temperature Unlocked: HB	
Temperature Unlocked: WB	
Uploading warmbox cal to DAS…	Entering warming state.
Warming…	

B Setup Tools and Communication

B.1 Analyzer Settings and Tools

The **Analyzer Setup Tools** is accessed by using the **Picarro Launch Pad** and **Settings** button. These set of tools allow the user to configure data file saving details, including which data elements are written to data files, digital data output (via serial port or TCP/IP), and optionally configured electrical interface for additional measurement monitoring.

NOTE

You must be logged in as a technician or administrator to access the Analyzer Setup Tools under Settings.

The settings of the Setup Tool are explained in the next pages in brief. A more in-depth description of the material is provided in the subsequent sections. If you have any questions about the Setup Tool, please contact Picarro or refer to Picarro Community for further details: https://www.picarro.com/support/community.

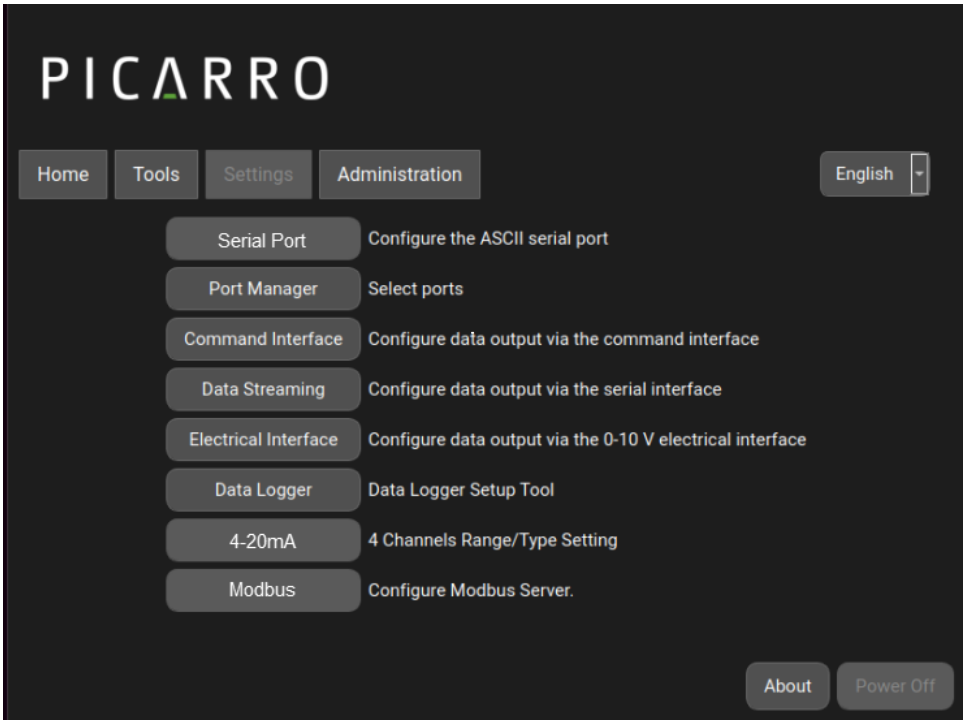


Figure 64 - Analyzer Setup Tools

NOTE

Before running any of the setup tools, the instrument software must be stopped. From the CRDS Data Viewer, select the Quit button and click Yes when prompted to stop data acquisition. The Setup Tool options are now active.

B.1.1 Serial Port

The **Serial Port** menu is accessible from the 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.

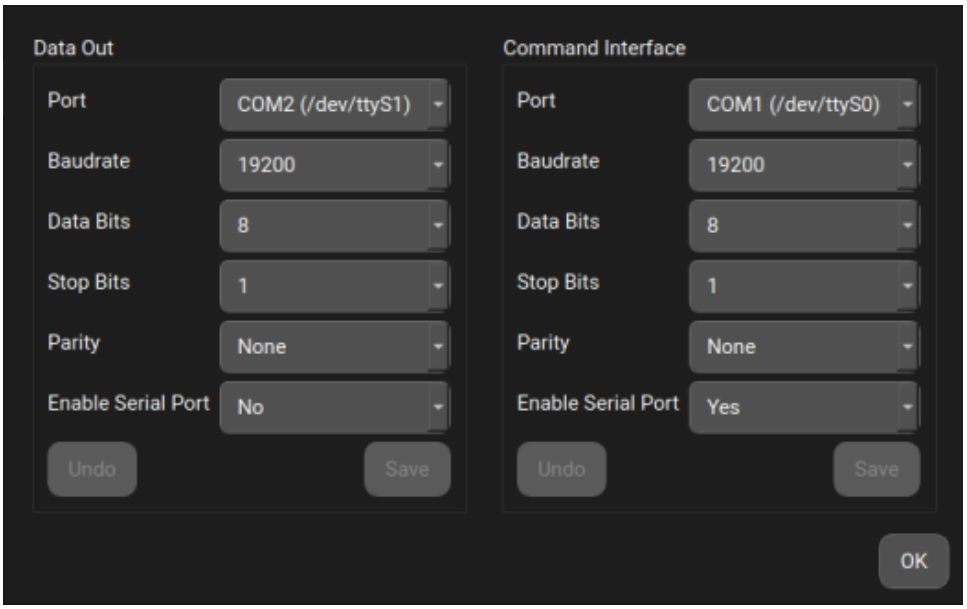


Figure 65 - Serial Port Settings

Configure the ASCII serial port by setting the Data Out and Command Interface parameters that are used for RS-232 serial communication.

The following options are provided:

- **Port** — Indicates the desired communication port.
- **Baudrate** — Specifies the rate at which bits are transmitted.
- **Data Bits** — Specifies the number of data bits to transmit.
- **Stop Bits** — Specifies the number of bits used to indicate the end of a byte.
- **Parity** — Indicates the type of parity checking.
- **Enable Serial Port** — Enables or disables the communication port specified in the Port field.

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

B.1.2 Port Manager

The **Port Manager** allows you to control digital data output/input by using the serial port or TCP/IP.

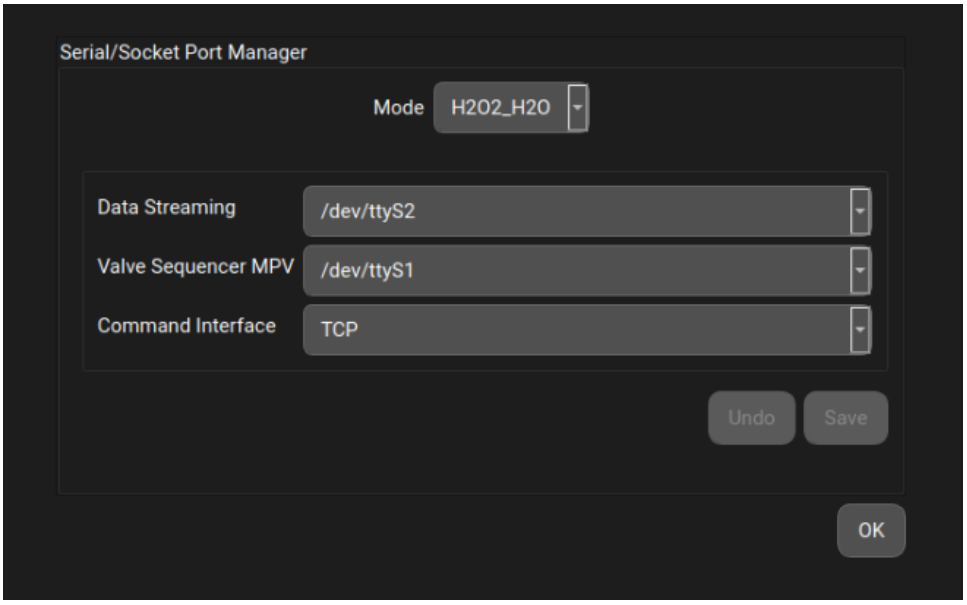


Figure 66 - Serial/Socket Port Manager Settings

The following options are available within the Port Manager menu. Note **/dev/ttyS*** is a naming convention for serial ports on Linux. **/dev/ttyS0** indicates the first serial port (COM1), **/dev/ttyS1** suggests the second (COM2), and so on.

- **Data Streaming** — The port you want your data to stream through.
- **Valve Sequencer MPV (Multi Position Valve)** — The port you want to connect your MPV.
- **Command Interface** — The port you want to connect your command-line interface. Make sure there are no COM port conflicts before clicking **Save**.

After making changes, select **Save** to put these changes into effect and click **OK** to close the window.

B.1.3 Command Interface — Specifying Digital Data Output

The **Command Interface** allows you to specify the data elements that are sent by using COM port/TCP (specified in the Port Manager).

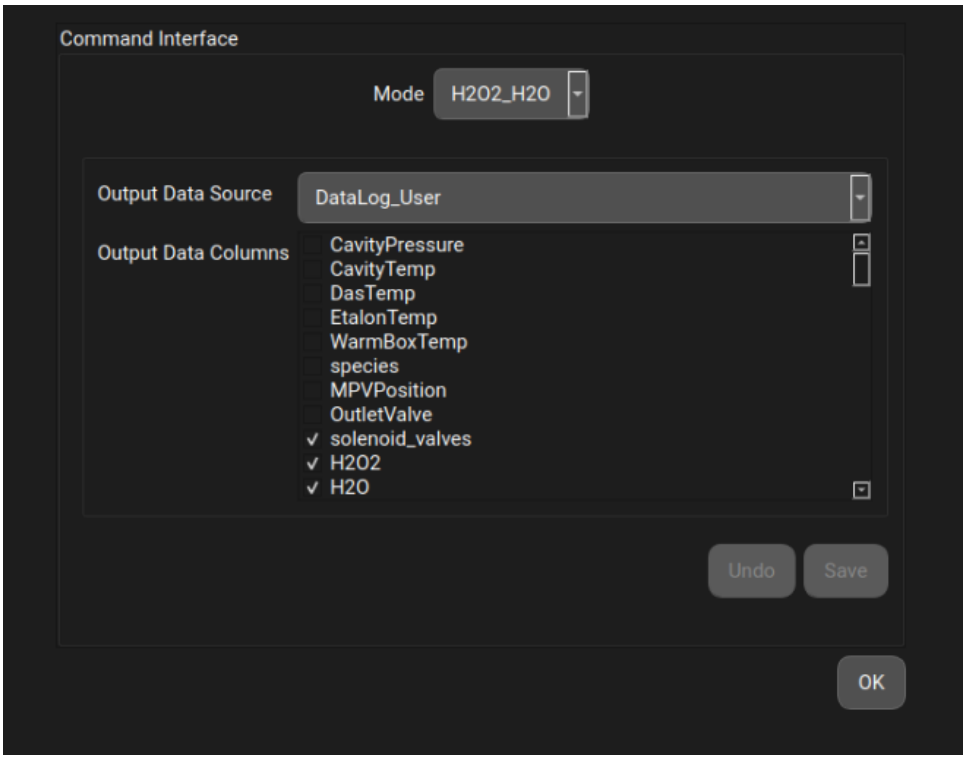


Figure 67 - Command Interface Settings

Two types of data can be specified here:

Output Data Source:

- Datalog_User
- DataLog_User_Sync (relevant only for Flux G2311-f analyzers)

Output Data Columns:

- The data columns are output in the order they are checked, e.g., H_2O, could come before CO_2. The Command Interface enables an external device to send a set of predetermined commands to a Picarro analyzer. The Picarro returns data or metadata on the basis of the command received.

After making the appropriate changes, click **Save** to put changes into effect and then **OK** to close the window.

B.1.4 Data Streaming— Specifying Digital Data Output

The **Data Streaming** menu allows you to specify the data elements that you want to send by using COM port (specified from the Port Manager).

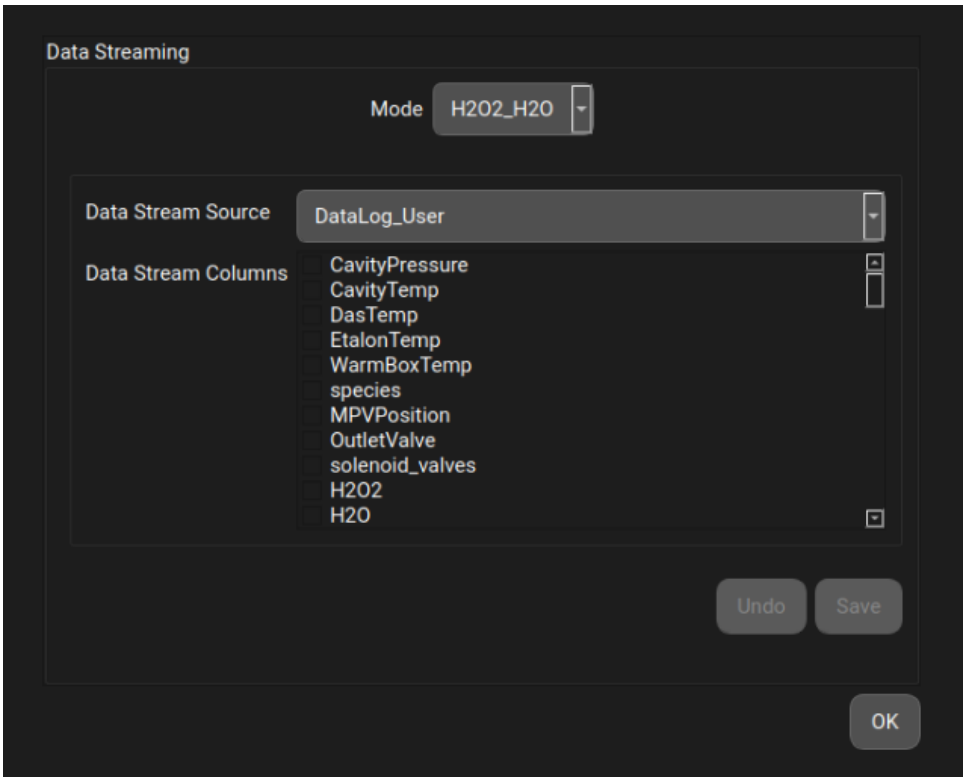


Figure 68 - Data Streaming Settings

Two types of data can be specified here:

Output Data Source:

- Datalog_User
- DataLog_User_Sync (relevant only for Flux G2311-f analyzers)

Output Data Columns:

- The data columns are output in the order they are checked, e.g., H_2O, comes before CO_2. Command Interface enables an external device to send a set of predetermined commands to a Picarro analyzer. The Picarro returns data or meta-data on the basis of the command received.

NOTE

Data Streaming outputs data continuously, whereas the Command Interface needs commands to output data.

After making the appropriate edits, click **Save** to put changes into effect and then **OK** to close the window.

B.1.5 Data Logger

The **Data Logger** allows the user to configure various data file saving details, including which data elements are written to data files.

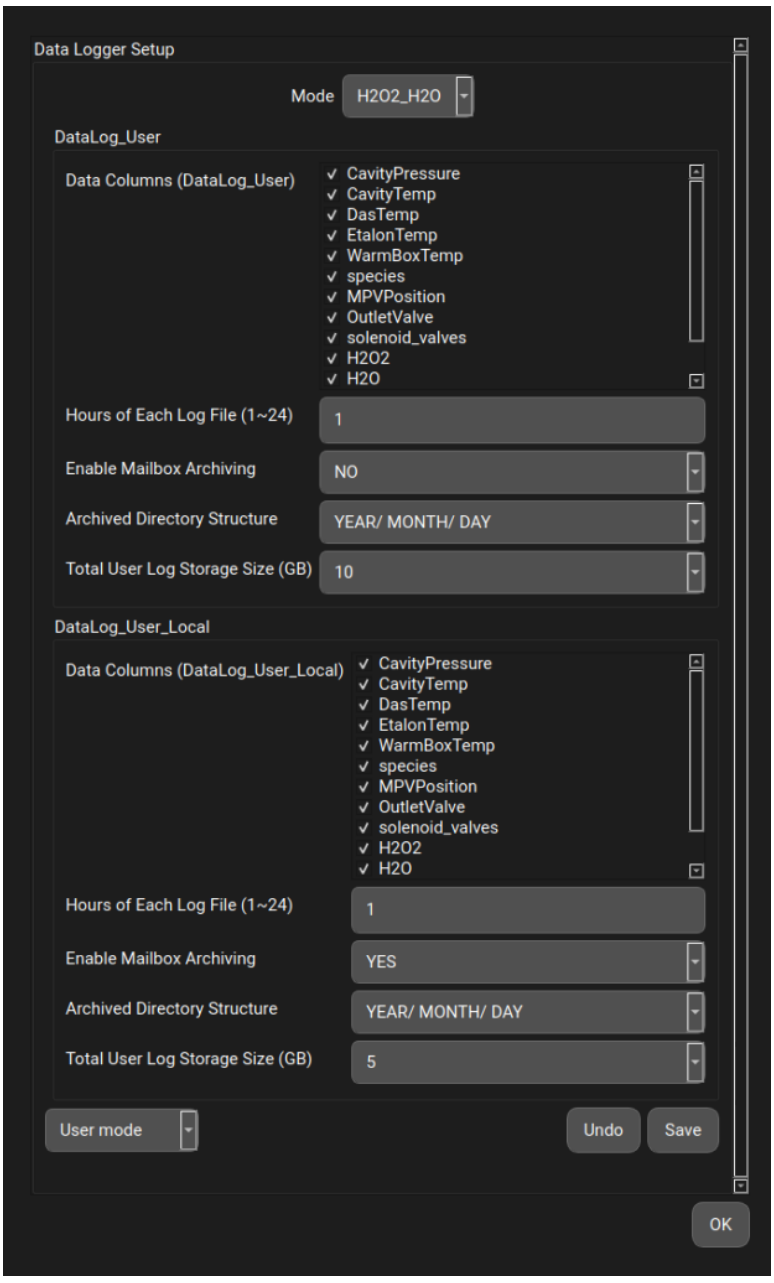


Figure 69 - Data Logger Setup Settings

The following data file options can be specified:

- **Data Columns** — Controls which data elements are written to data files.
- **Hours of Each Log File** — Controls the size of each data document.

- **Enable Mailbox Archiving** — Enables archiving of data in the mailbox folder: */home/picarro/I2000/Log/Archive/DataLog_Mailbox*
- **Archived Directory Structure** — Specifies part of naming convention for data documents.
- **Total User Log Storage Size (GB)** — Specifies the size of storage allowed for User Data (Recent Data).
- **Mode** — Changes the way the analyzer fits and displays data in the data viewer on the basis of gas matrix, species reported, precision, and dynamic range.

After making the appropriate edits, click **Save** to put changes into effect and then **OK** to close the window.

B.2 Serial Communication

The analyzer supports an RS-232 physical command interface, which can be used to control the instrument and to retrieve concentration data. Not all features of the instrument are available on the serial interface.

For details on using the serial command interface, please see the Picarro Analyzer Remote Interface Programming Guide.

NOTE

This command set may also be used across a TCP/IP interface through an Ethernet connection. Please contact Picarro for further details if needed.

B.2.1 Remote Data Access

Using the RemoteAccess.ini file, the analyzer can be configured to automatically:

- Send data from the instrument to a list of e-mail accounts.
- Measure the offset of the host computer system clock from a set of Internet time servers and (optionally) to resynchronize the clock based on this information.

The Internet connection need not be permanent and may be a dial-up connection accessible by using a user-supplied USB modem. The task of sending data and/or synchronizing the clock on the analyzer is performed using the */home/picarro/I2000/HostExe/RemoteAccess.exe* program.

Each time that the RemoteAccess.exe program runs, it appends information to a log file, which keeps a record of the results of the time synchronization and of the files sent by e-mail. The RemoteAccess.exe program is configurable by means of an initialization file, which includes information such as the login credentials for the dial-up connection, the e-mail account, and the list of time servers.

The initialization file is:

/home/picarro/I2000/AppConfig/Config/UtilitiesRemoteAccess/RemoteAccess.ini

It should be placed in the same directory as the executable RemoteAccess.exe. The file has one required section named LOGGING and optional sections named NTP and EMAIL. The logging section has a single key Logfile whose value is the path to the log file. Once this log file exceeds 64 Kbytes in length, it is backed up, appending a numeric extension to the file name, and a new file is opened. A total of ten backup log files are kept.

B.2.2 NTP

The NTP section controls querying the Internet time servers using the SNTP protocol (RFC4330) and the resetting of the clock on the host computer. If the section is not present, time synchronization is not carried out. The keys Server1, Server2, etc., are used to specify the URLs of the time servers. If the UpdateClock key is set to “true,” the offset is applied to the host clock. Otherwise, the offset is recorded, but the host clock is not changed.

B.2.3 Email

The EMAIL section controls the sending of the data files as e-mail attachments. If the section is not present, e-mail messages are not sent. The key Directory specifies the directory that contains the data files. When the program is run, files in this directory are sent to the specified recipients and the files are deleted. To avoid problems with incomplete files, programs that place files into this directory should do so using an atomic operation, such as a rename. The Server key is set to the name of an RFC2821- compliant SMTP server that sends the e-mail messages.

The From key is the e-mail address from which the messages are sent. Note that some SMTP servers check that the source is permitted to send email while others allow any name in this field. The collection of e-mail addresses to which copies of the e-mail is sent is specified by the keys To1, To2, etc. The Subject key is used to fill the subject field in the email header and may be set to any string. Depending on the SMTP server, it may be necessary to use authentication before e-mails can be sent, as described in RFC2554. If such authentication is not needed, the key UseAuthentication is set to false. If this key is set to true, two additional keys Username and Password must also be specified for the e-mail account.

C Analog Signal Output

This analyzer is configured with an optional Electrical Interface Card (EIC) that provides 4 analog signals for monitoring various measurement results and analyzer parameters.

Two circular connectors, on the back panel of the analyzer (are available for analog output. The pinout for each connector is listed in the table below.

The following figure shows the analog channel connectors on the back of the analyzer.

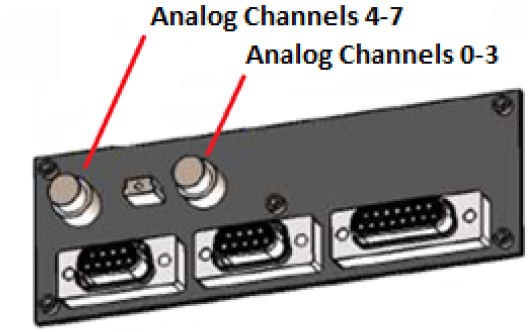


Figure 70 - Analog Channel Connectors

Two external cables (for the analog channel connectors) are provided with the analyzer. The mating connector is part number HR25-7TP-8P(72)

C.1 Analog Signal Pin Mapping

The following table lists the analog pinouts and provides the analog pinout map.

Table 14 - Analog Pinout Table

Pin	Function		Pin	Function
1	GND 0		1	GND 4
2	Channel 0		2	Channel 4
3	GND 1		3	GND 5
4	Channel 1		4	Channel 5
5	GND 2		5	GND 6
6	Channel 2		6	Channel 6
7	GND 3		7	GND 7
8	Channel 3		8	Channel 7

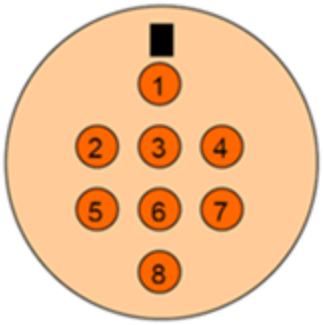


Figure 71 - Analog Pin Map

C.2 Configuration

+1 volt indicates 0 in all cases: Each channel has a +1 volt offset. Treat <=0 volts as an error. This helps prevent reading the wrong values because of improper wiring (ground loops).

Example for Channel 0: 1V = 20 ppb with a 1V offset. 9v x 200 ppb/V = 180 ppb = 1.8 ppm.

The following table provides the master analog configuration.

Table 15 - Analog Configuration Master

Channel	Parameter	Output Scale (<1V indicates error)	Conversion All channels have a +1V offset (+1V=0)	Indicating Range 1V to 10V or 0 to 90 ppb
0	H_2O_2 concentration	0-10V	10 ppb/V	0 to 90 ppb
1	H_2O_2 concentration	0-10V	100 ppb/V	0 to 0.9 ppm
2	H_2O_2 concentration	0-10V	2 ppm/V	0 to 18 ppm
3	H_2O concentration	0-10V	2%/V	0 to 18 ppm
4	DAS Temp	0-10V	$10^oC/V$	0 to 90^oC
5	None	NA	NA	NA
6	None	NA	NA	NA
7	None	NA	NA	NA

D Analog Current Signal Output

Four channels of 4-20 mA current analog output are available on the back of the analyzer.

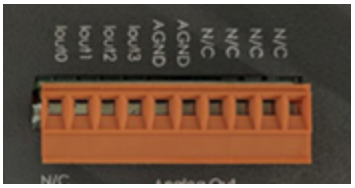


Figure 72 - 4–20 mA Output with Terminal Connector

Table 16 - Signal Output Settings

	Iout0	Iout1	Iout2	Iout3
Monitoring	H_2O_2	Cavity Temperature	DAS Temperature	Cavity Pressure
Units	ppb	Degrees C	Degrees C	Torr
Min	0.0	0.0	0.0	0.0
Max	1000.0	100.0	100.0	1000.0

- **H_2O_2** — Displays the H_2O_2concentration reading in parts per billion (ppb)
- **CavityPressure** — Displays the cavity pressure in degrees Celsius
- **DasTemp** — Displays the internal logic board temperature in degrees Celsius
- **CavityPressure** — Displays the cavity pressure in Torr

D.1 Connecting the 4–20mA Signal Output

To connect to the output:

1. Using your fingers, pull the 4–20 mA terminal connector straight back away from the analyzer.

Figure 73 - Removing the Terminal Connector

2. Use a small slotted screwdriver to loosen the retaining screw for the desired terminal.

Figure 74 - Terminal Connector Retaining Screws

3. Insert the stripped end of the wire into the terminal.
4. Tighten the retaining screw.
5. Repeat for each desired terminal.
6. 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.

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 the shielded cable to the ground lug to avoid ground loops.

D.2 Power Requirements

The 4-20 mA analog current signal output requires an additional user supplied power supply for operation. See the following diagram for more information.

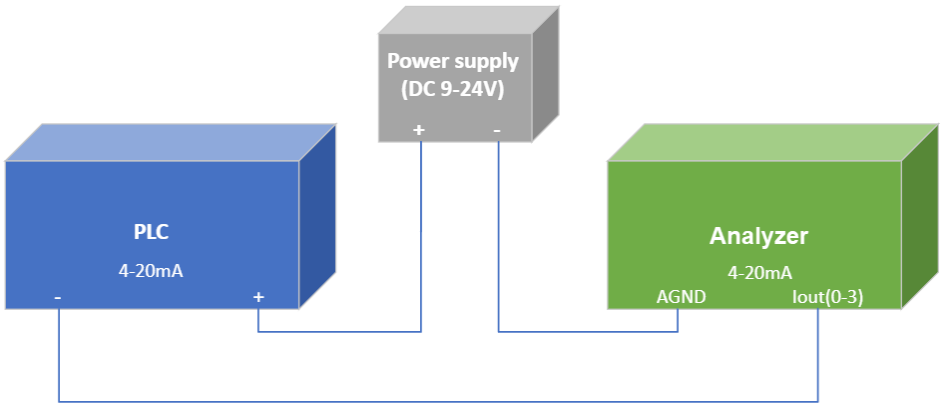


Figure 75 - 4-20 mA Power Requirements

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 user s to select any folder containing instrument data from a given day.

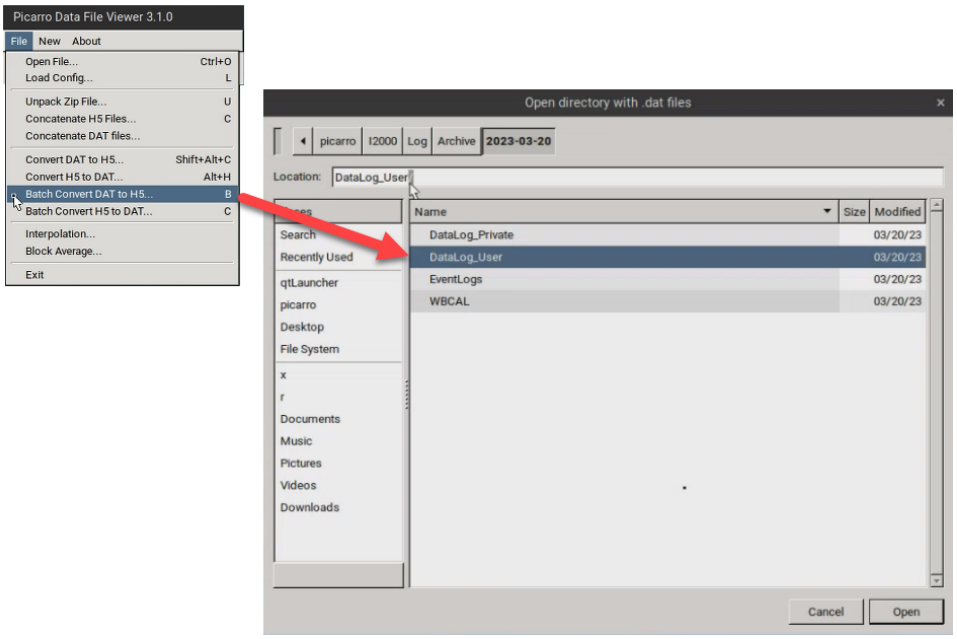


Figure 76 - Batch Convert DAT to H5 – Navigation

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**.

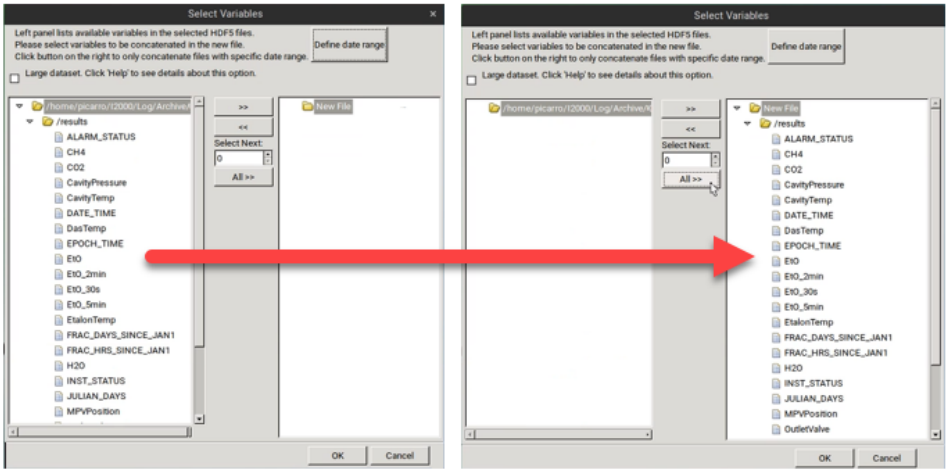


Figure 77 - Selecting Variables for Concatenation

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 the following figure.

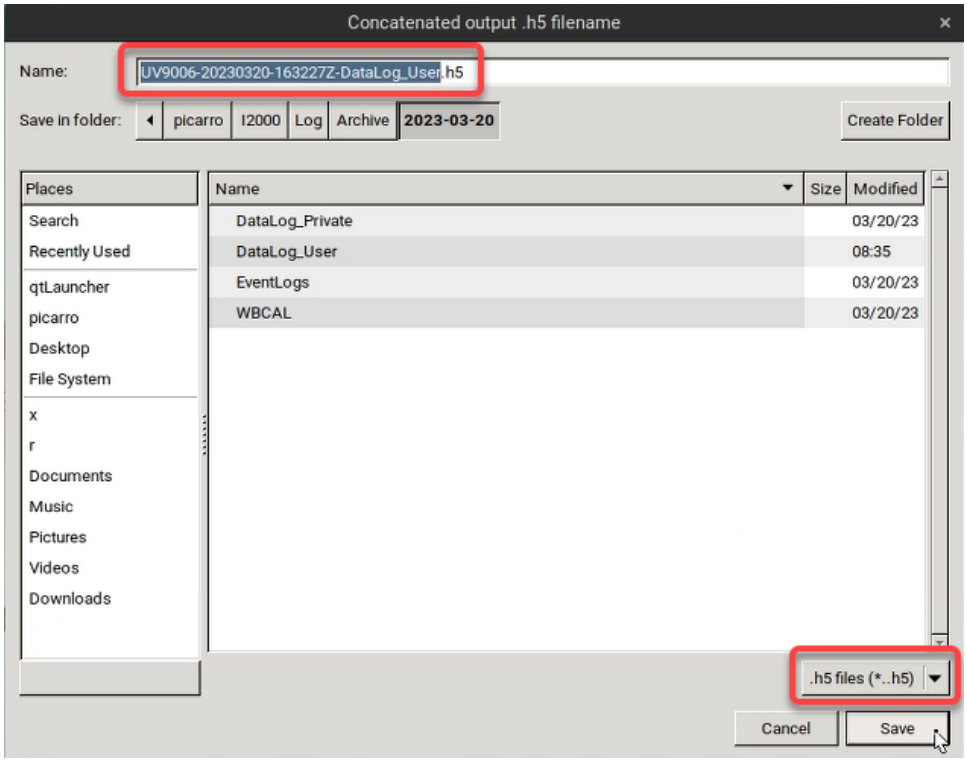


Figure 78 - Concatenated Output .h5 Filename

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.

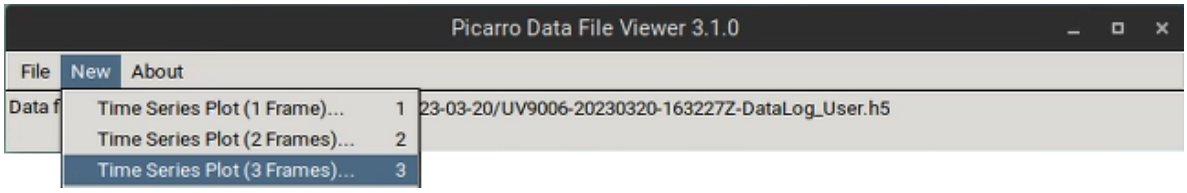


Figure 79 - Time Series Selection Options

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.
8. 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.

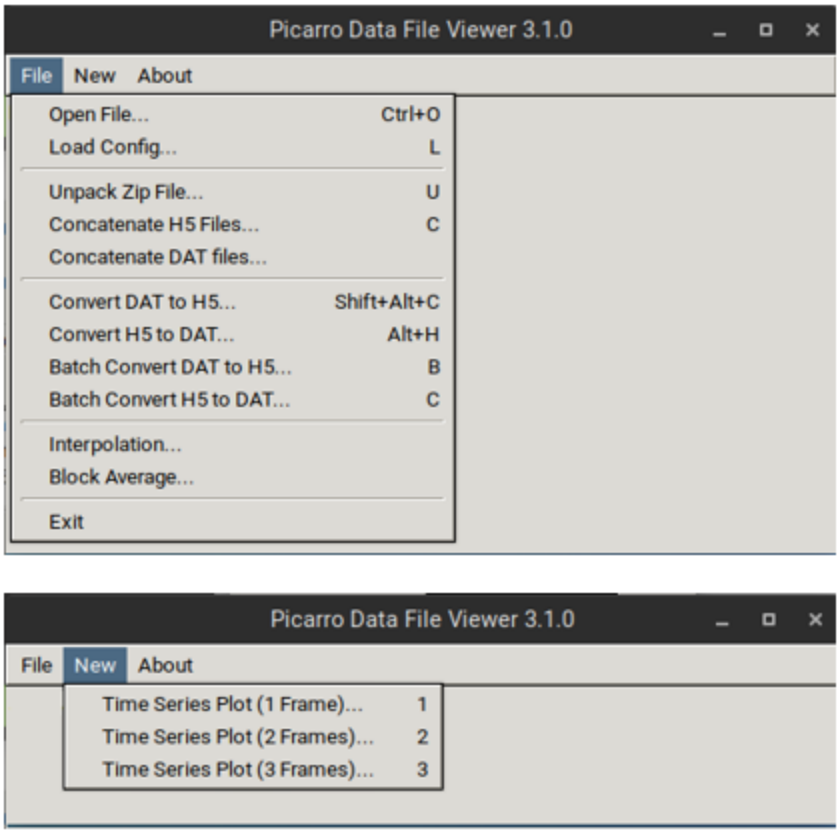


Figure 80 - Picarro Data File Viewer – File and New Menus

E.2.1 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 E.2.2 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 E.3.1 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 Define Date Range).

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, and users can use the **>>** button to move variables to the right panel for concatenation.

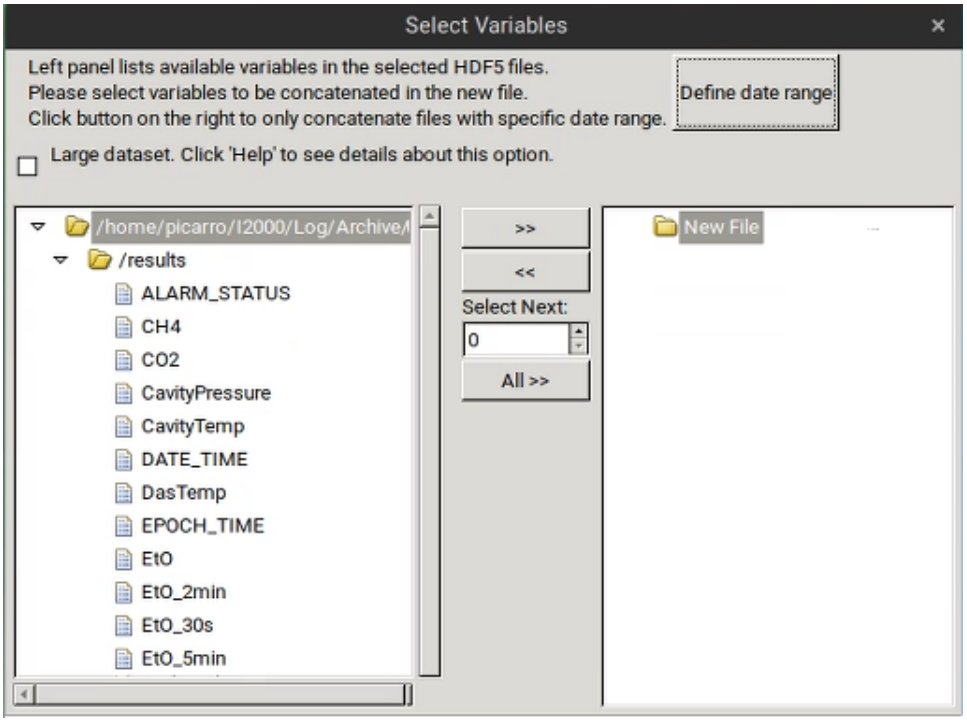


Figure 81 - Select Variable Form

NOTE

This screenshot is for example only. The species selections shown on your analyzer may vary.

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 the following figure.

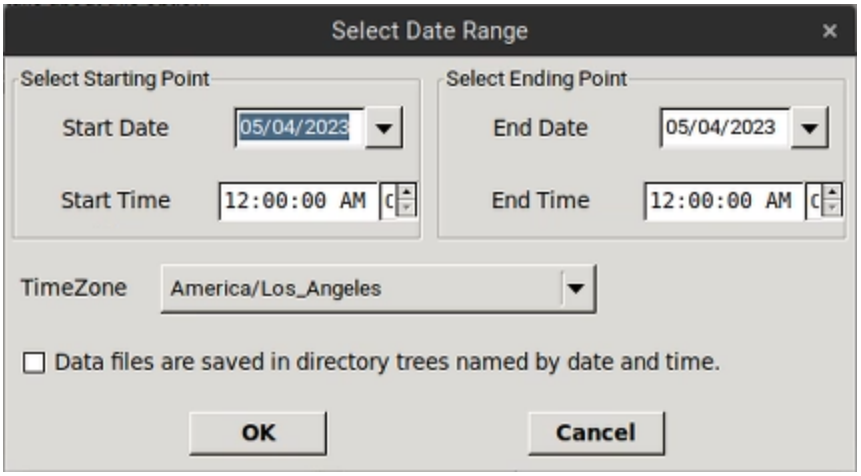


Figure 82 - Define Date Range Dialog

Picarro software saves data in directories that are named by the creation year, month, and day. 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.

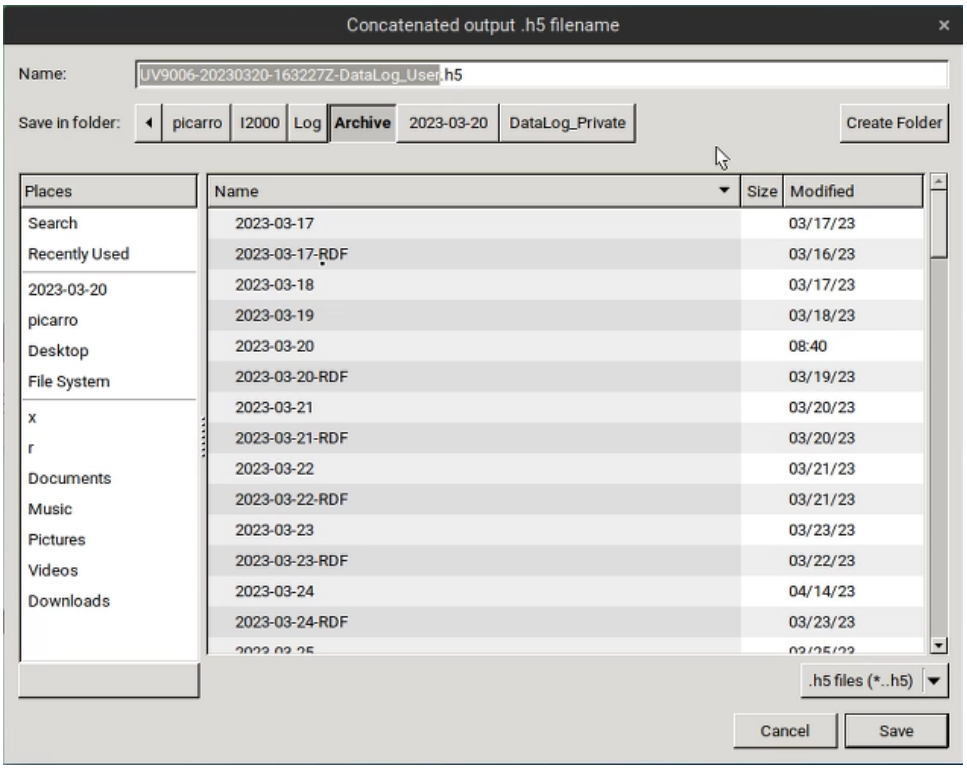


Figure 83 - File Structure of Data File Viewer

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 data set 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 data set 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.2.2 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.

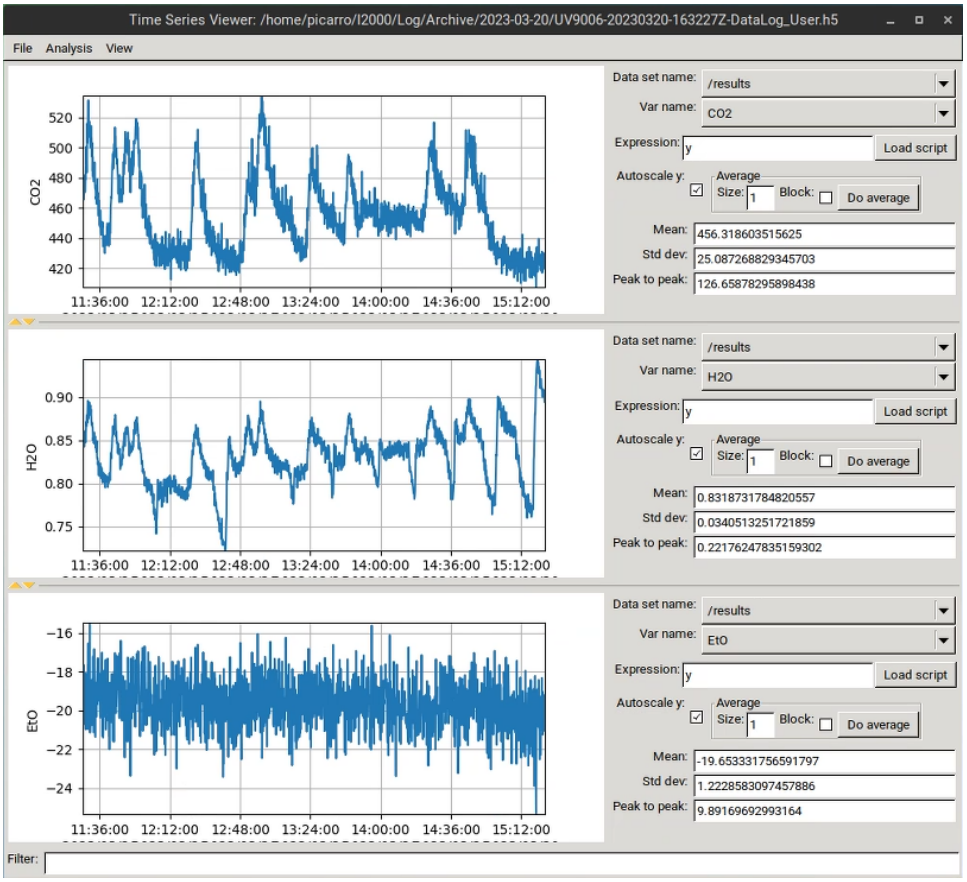


Figure 84 - Time Series Viewer

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.3 Time Series Viewer Menus

The Time Series Viewer form includes the following menus:

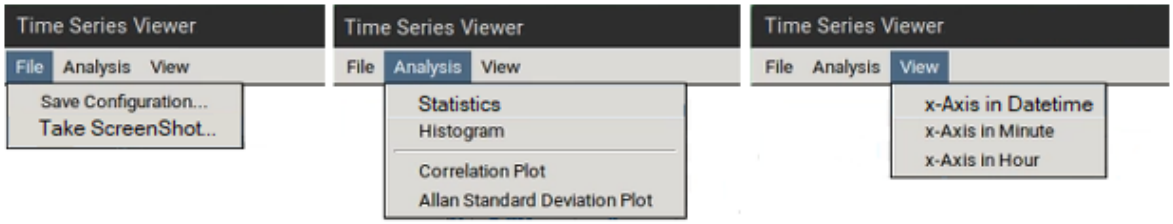


Figure 85 - Time Series Viewer Menus

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

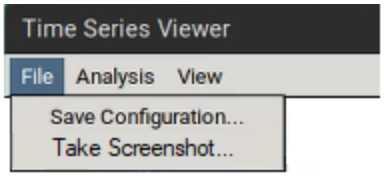


Figure 86 - Time Series Viewer – File Menu

E.3.1 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.

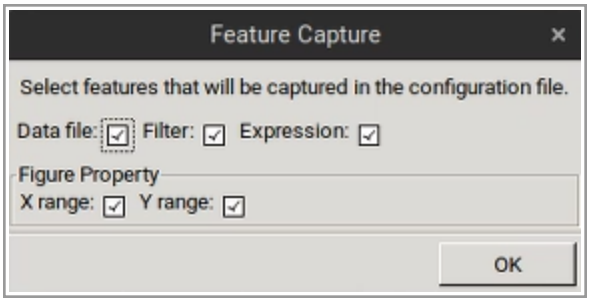


Figure 87 - Time Series Viewer – Feature Capture

⚠ 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.

E.3.2 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.

E.3.3 Time Series Viewer Analysis Menu

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

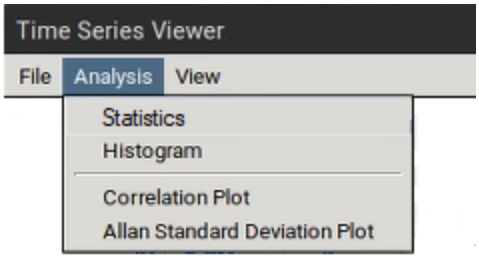


Figure 88 - Time Series Viewer – Analysis Menu

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.

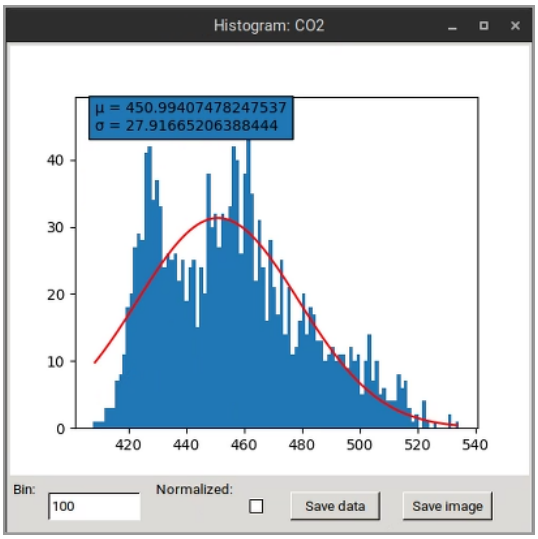


Figure 89 - Histogram Window

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/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. See the Correlation/XY Plot for details.

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.

E.3.4 Time Series Viewer View Menu

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

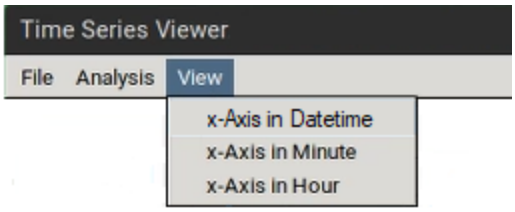


Figure 90 - Time Series Viewer – View Menu

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.

E.3.5 The Time Series Viewer Canvas

The Time Series Viewer canvas is comprised of interactive graphs and a variety of configuration options.

NOTE

This screenshot is for example only. The species shown on your analyzer may vary.

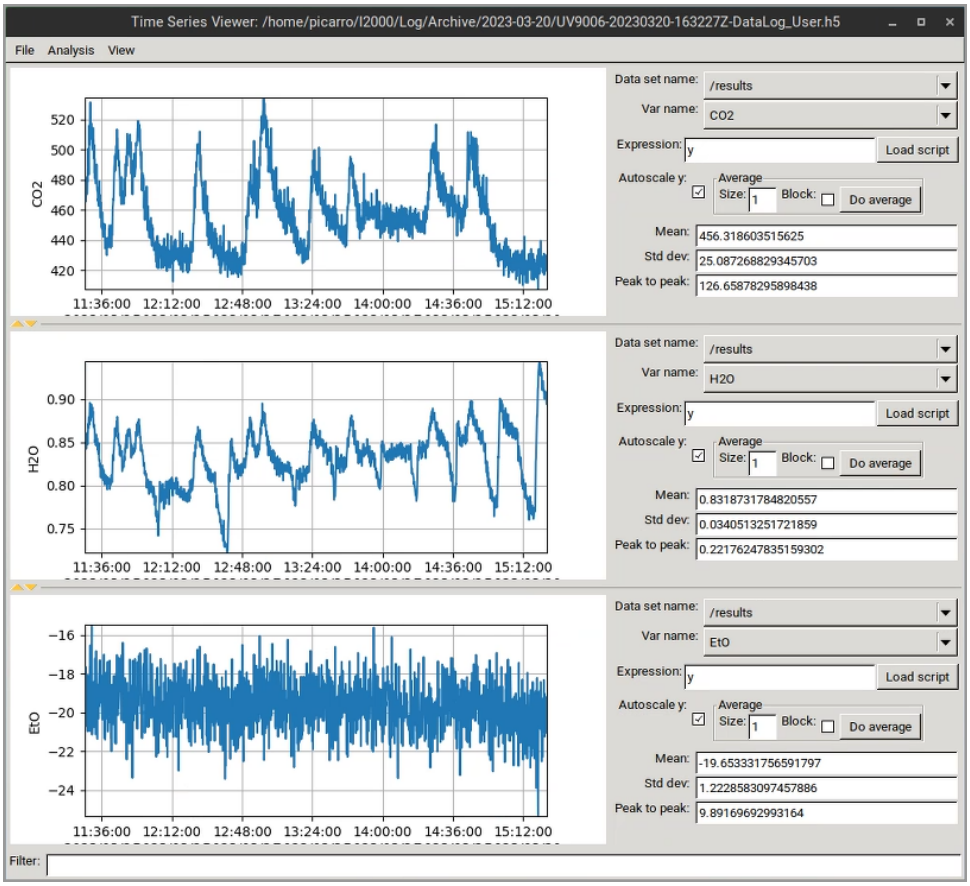


Figure 91 - Time Series Viewer Canvas

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.

Right-click Menu

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

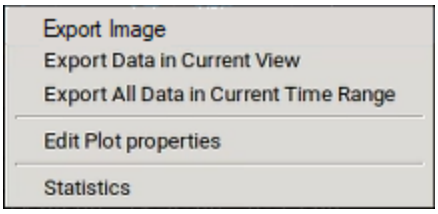


Figure 92 - Canvas Right-click Pop-up Menu

The following options are available from the right-click 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 81 for more information.
- **Edit Plot Properties** — Opens the Image Editor form where the following options can be specified.

Image Editor

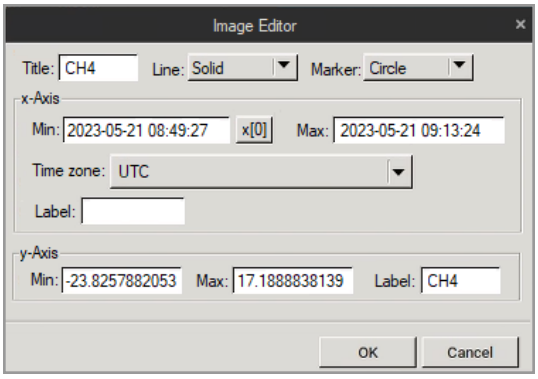


Figure 93 - Time Series Viewer Image Editor

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 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.

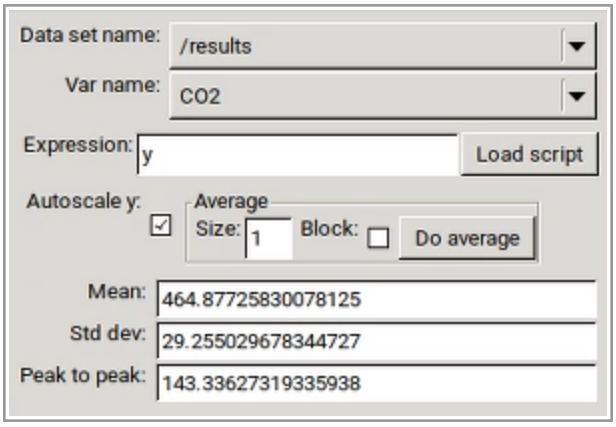


Figure 94 - Time Series Viewer Dataset Options

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 check box 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 94) provide all the statistical information of data in the current view.

Correlation/XY Plot

The **Correlation/XY Plot** window includes three menu items: **File**, **Fitting** and **Analysis**. For details about the File menu, see E.3.1 Save Configuration and E.3.2 Take Screenshot. Fitting and Analyst are described below.

REMINDER

The canvas in this plot is interactive. For details about the plot canvas, see E.3.5 The Time Series Viewer Canvas.

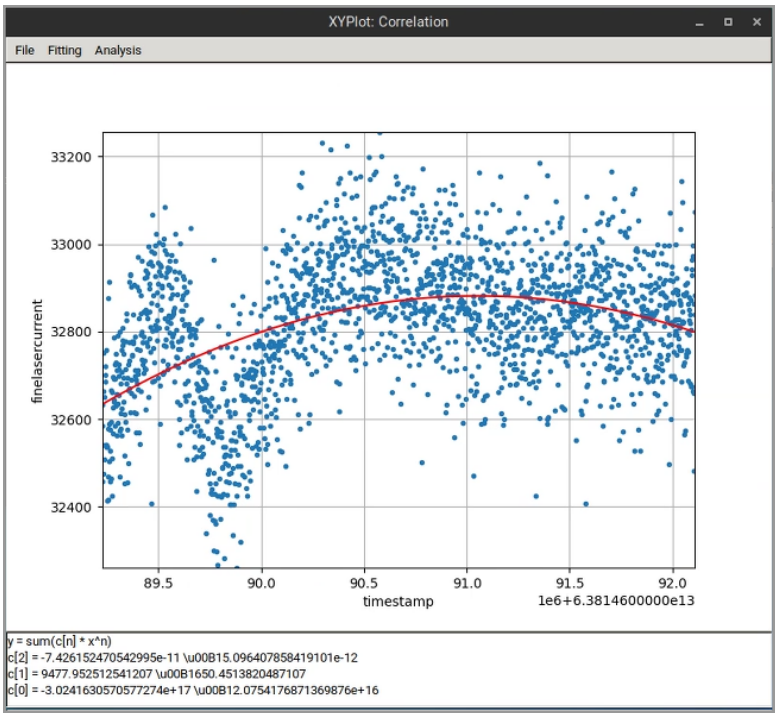


Figure 95 - Correlation XY Plot

E.3.6 Fitting Menu

The Fitting menu includes three options which are described below.

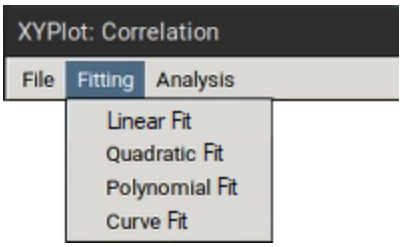


Figure 96 - Fitting Menu

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.

E.3.7 Analysis Menu

The Analysis menu has two options: **Integration** and **Statistics**.

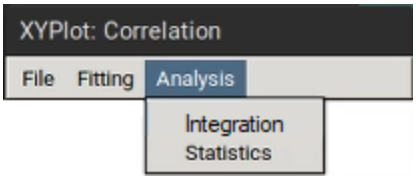


Figure 97 - Analysis Menu

- **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.

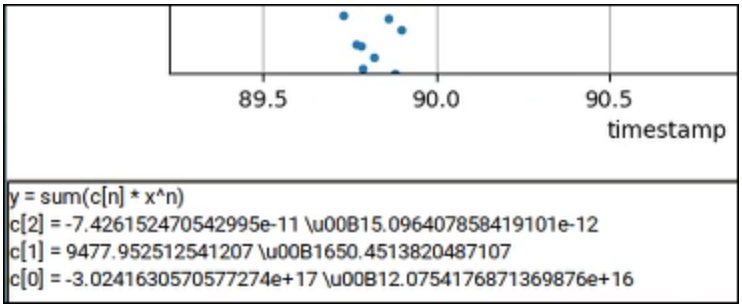


Figure 98 - Results of Quadratic Fitting

F Setting up Contained Exhaust Flow

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.

1 Exhaust Port with Noise Dampener

2 Vacuum Port

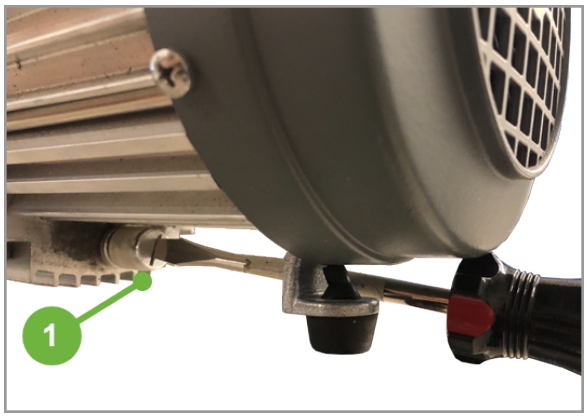
Figure 99 - A2000 Pump Vacuum and Exhaust Ports

F.1 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.2 Directions

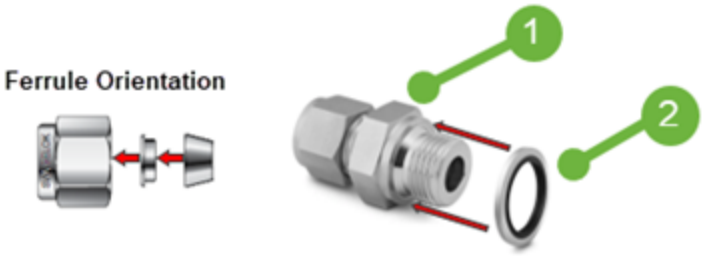
1. Remove the noise dampener fitting from the bottom of the pump using a long flathead screwdriver (Figure 100).



1 Noise Dampener

Figure 100 - Pump Noise Dampener Removal

2. Slide the adapter gasket PN 22929 onto the adapter fitting PN 22928 (Figure 101), 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).



1 Adapter Fitting PN 22928

2 Adapter Gasket PN 22929

Figure 101 - 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)

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 G.6 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

G.2.1 Compatibility

The A0311 (Figure 102) 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).

G.2.2 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.

NOTE

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).

Figure 102 - A0311 – 16-port Distribution Manifold

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

G.3.1 Compatibility

The A0311-S (Figure 103) 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

G.3.2 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 103 - A0311-S – 16-Port Sequencer – Fast Multiport Gas Sampler

G.4 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 replacement or repair.

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.5 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.6 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.

G.6.1 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, but typically sitting behind the main GUI. Hitting alt-tab brings the Valve Sequencer GUI to the front.

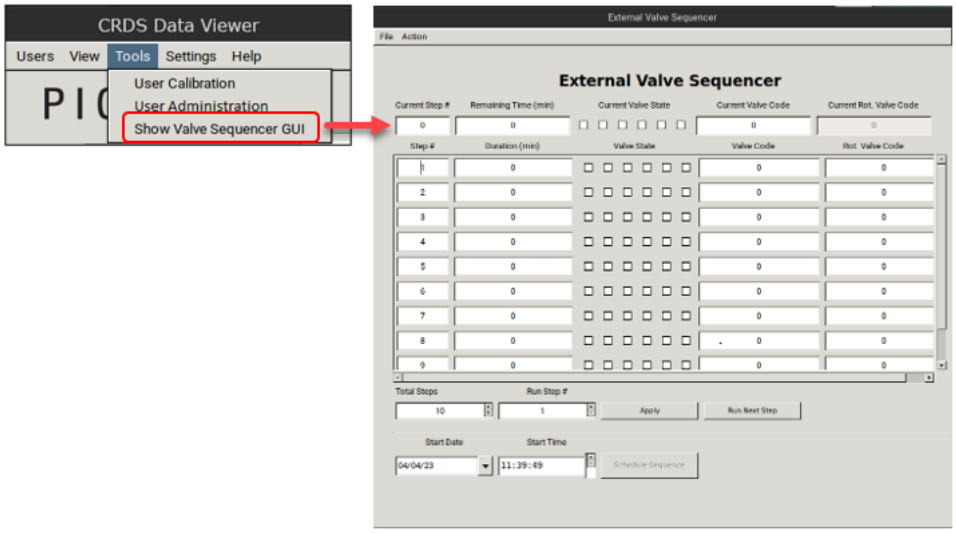


Figure 104 - Launching the Valve Sequencer GUI

G.6.2 Valve Sequencer UI Menus

The sequencer GUI provides the following dropdown menu options.

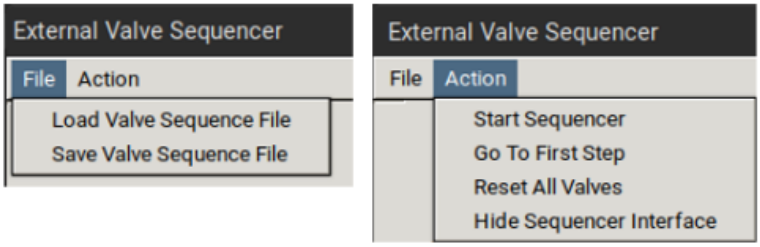
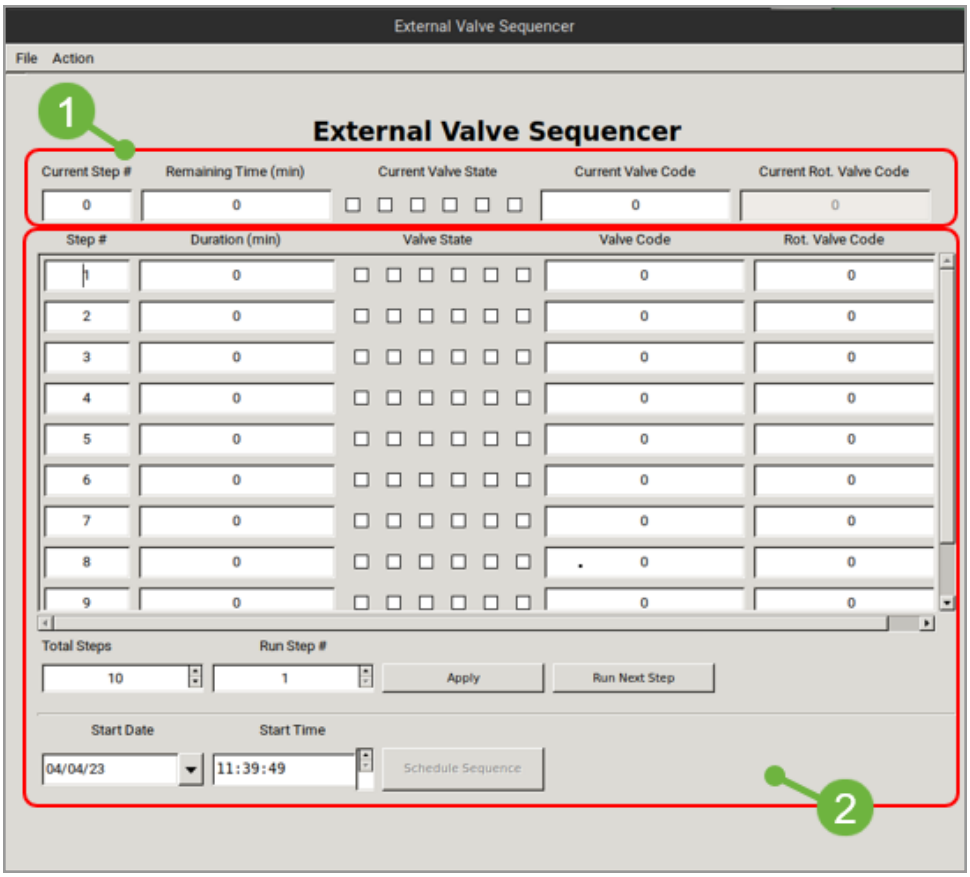


Figure 105 - Valve Sequencer UI Dropdown Menus

The following figure provides functional descriptions of the External Valve Sequencer UI.



1. Current step and valve state status panel (when sequencer is running)
2. Sequencer configuration controls

Figure 106 - 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.7 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 valves 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 check mark 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 = $2^{(\text{Valve number-1})} = 2^{(1-1)} = 1$
   Valve 2 Powered = $2^{(\text{Valve number-1})} = 2^{(2-1)} = 2$
   Valve 3 Powered = $2^{(\text{Valve number-1})} = 2^{(3-1)} = 4$
   Valve 4 Powered = $2^{(\text{Valve number-1})} = 2^{(4-1)} = 8$
   Valve 5 Powered = $2^{(\text{Valve number-1})} = 2^{(5-1)} = 16$
   Valve 6 Powered = $2^{(\text{Valve number-1})} = 2^{(6-1)} = 32$

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**.

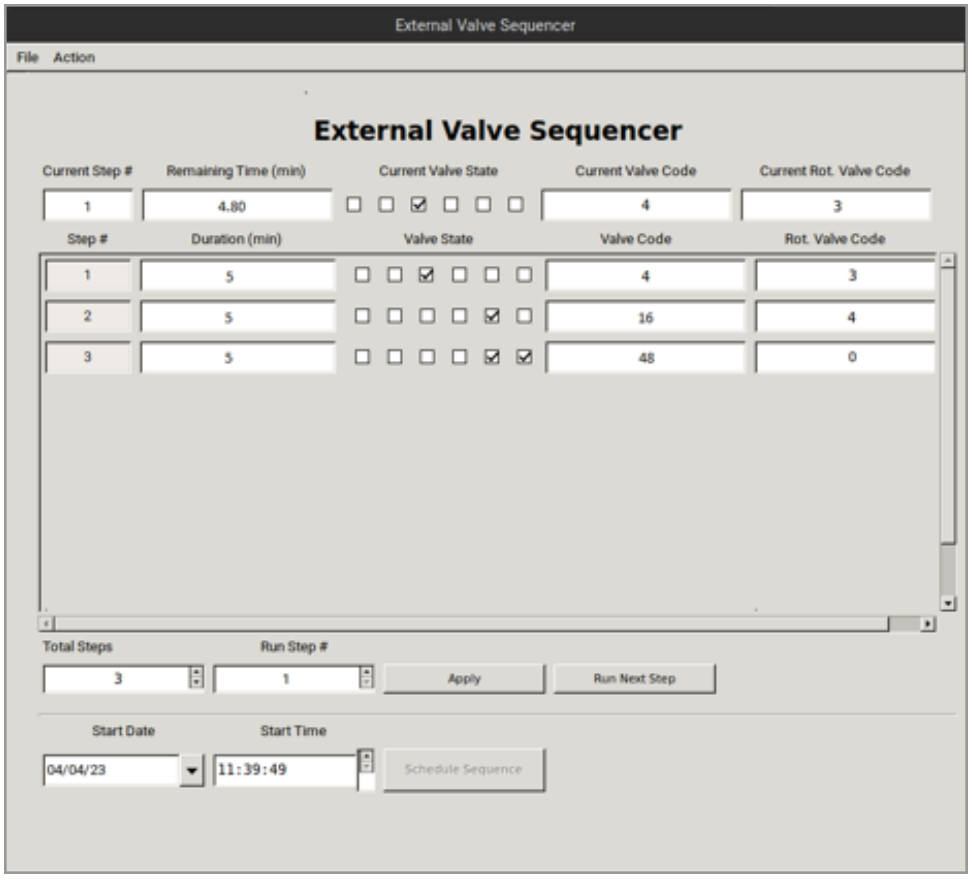


Figure 107 - Example 15 Minute Sequence

NOTE

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).

7. Once the valve sequence has been programmed, it can be saved by selecting **Save Valve Sequence File** under the **File** menu (Figure 105). The sequence may be saved with any name the user chooses.

G.8 Loading and Running a Saved Sequence

G.8.1 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**.

G.8.2 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.

G.8.3 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**.

G.8.4 Stopping the Sequencer

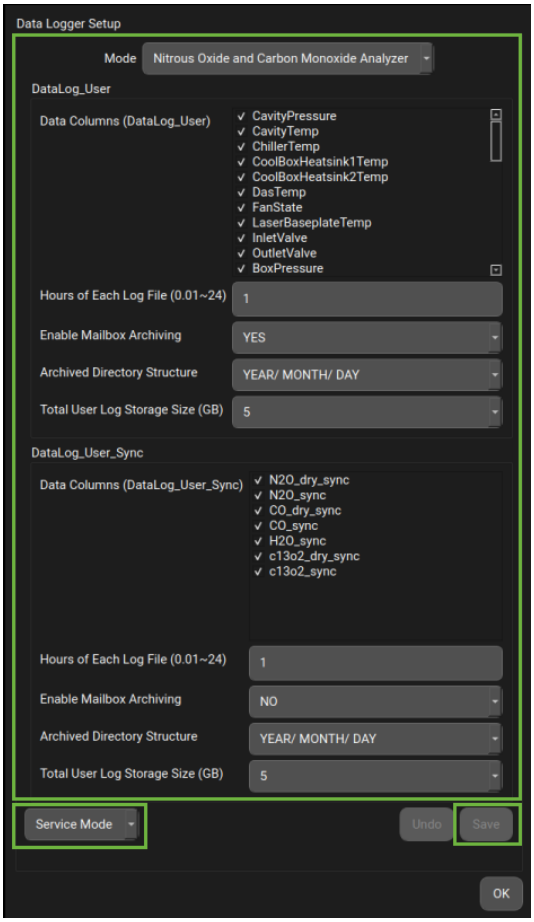
1. Under the **Action** menu, select **Stop Sequencer**.

   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.

G.8.5 Resetting Valves

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



G.9 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.

H Remote Analyzer Access

Remote access allows you to access and control the analyzer from another computer from anywhere, enabling troubleshooting, file access, and remote work. This guide covers TeamViewer® and RealVNC®which are third-party applications.

NOTE

The analyzer comes with TeamViewer and RealVNC preinstalled. However, you must install the application you plan to use on the device you want to control from.

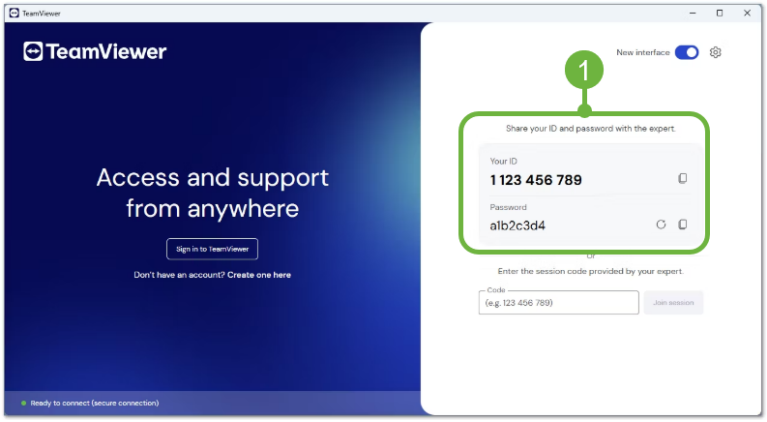
H.1 TeamViewer

The TeamViewer application allows remote viewing of the analyzer and data access.

H.1.1 Locating ID and Password

TeamViewer requires and ID and password to establish a remote connection. Use the following procedure to locate the ID and password of the remote computer (analyzer).

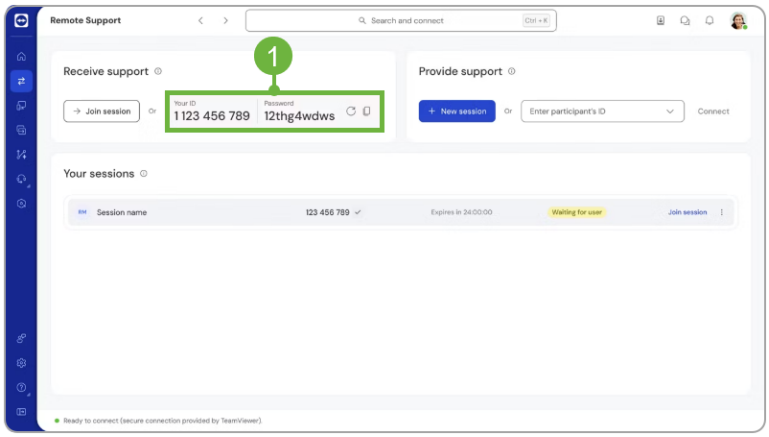
1. On the analyzer, open **TeamViewer**. If you are not logged in, the ID and password are displayed in the main interface.



1 ID and Password

Figure 108 - TeamViewer Main Interface

2. When logged in, the ID and Password displays in the **Remote Support** window.



1 ID and Password

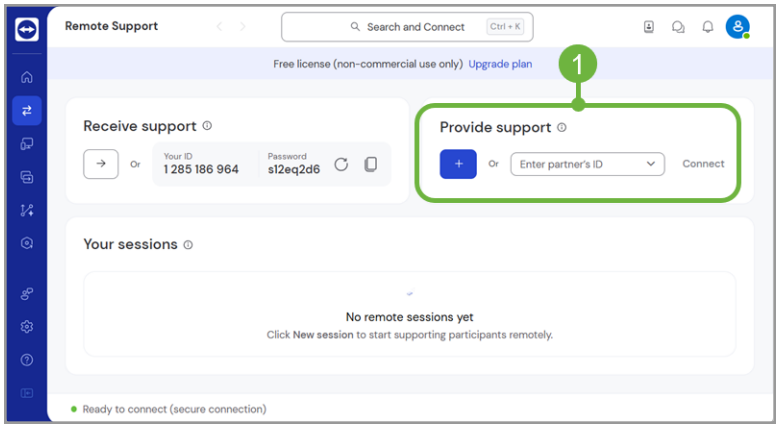
Figure 109 - TeamViewer Remote Device ID & Password

3. Note the **ID** and **Password** of the remote computer (analyzer) for use in the next step.

H.1.2 Connecting to Remote Computer (Analyzer)

Now that you have the ID and the password, use the following procedure to connect to the remote computer (analyzer).

1. If not already installed, download and install TeamViewer on the device you wan to connect from.
2. Open **TeamViewer Remote** and sign in.
3. Go to the **Remote Support** menu on the left-hand side of the interface.
4. Within the **Provide Support** section, enter the remote device's ID and click **Connect.**



1 ID field and Connect button

Figure 110 - TeamViewer Entering Remote Device ID & Password

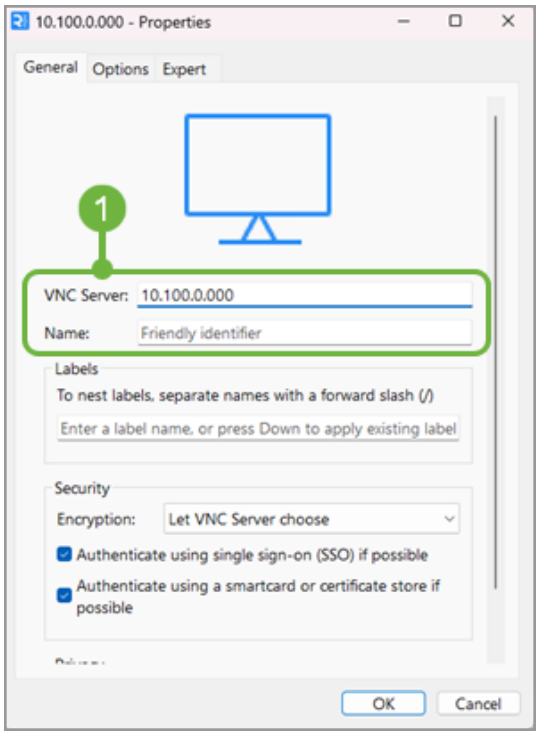
5. Now enter the remote device's password and click **Connect**.

   You successfully connected your remote device (analyzer).

H.2 RealVNC

The RealVNC application allows remote viewing only. Data access is not available. Follow the procedure to connect to the remote computer (analyzer) using RealVNC.

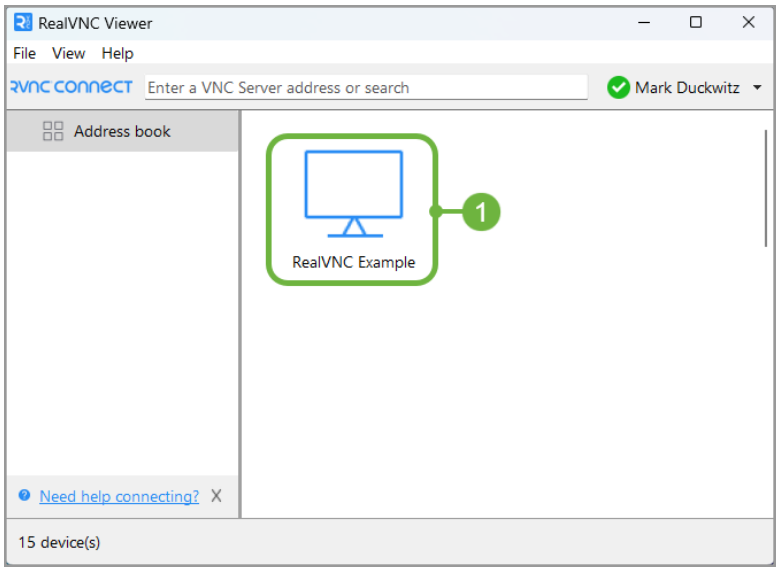
1. If not already installed, download and install RealVNC Viewer on the device you wan to connect from.
2. Open **RealVNC Viewer** and sign in.
3. From the toolbar select **File** and New **Connection**.
4. Enter the IP address of the remote computer (analyzer) and a name if desired. Click **OK**.



1 Enter IP address and description

Figure 111 - RealVNC Properties

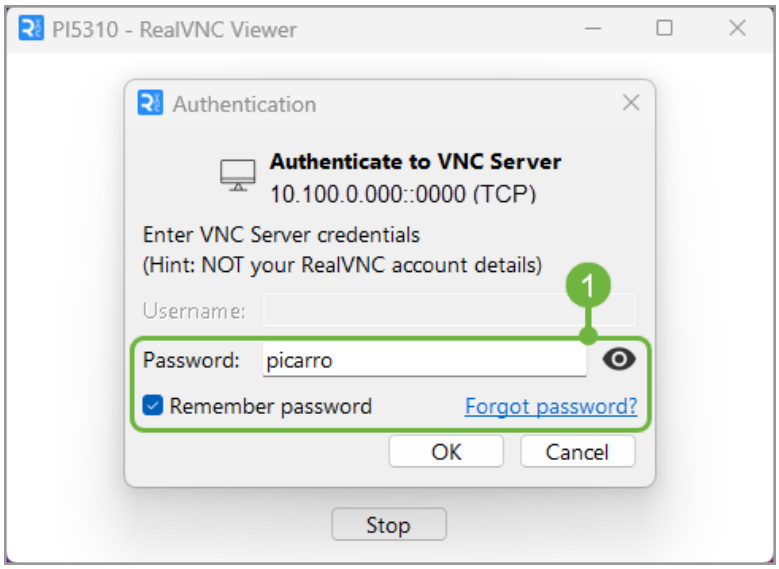
5. From the main menu, double click on the **Computer** to establish a remote connection.



1 Remote connection (analyzer)

Figure 112 - RealVNC Remote Connection Entries

6. From the Authentication window enter **picarro** for the password and select **Remember password**. Click **OK**.



1 Enter and save password

Figure 113 - RealVNC Authentication

You successfully connected your remote device (analyzer).

I Linux Keys and Commands

This section describes the Linux Ubuntu shortcut keys and terminal commands. Each entry specifies its function, syntax, and usage context. The following keys and commands are available for reference and application.

I.1 Keyboard Shortcuts

The following table provides useful shortcut keys.

Table 17 - Shortcut Keys

Keys	Description
Alt + Tab	Switches between running applications
Alt + F2	Run command
Alt + Space	Shows current window operations
Alt + F7	Moves current windows with keyboard
Ctrl + Alt + Up/Down	Switches between virtual workspaces
Super + Drag	Moves window
Super + Up	Maximize window
Super + Down	Undo maximize window
Super + D	Show desktop
Screenshots (/home/picarro/pictures)	
PrintScreen	Captures entire screen
Alt + PrintScreen	Captures current window
Screen Recordings (/home/picarro/videos)	
Alt + Shift + Ctrl + R	Enables recording

I.2 Command Terminator

Options for opening the Linux command Terminator:

- Alt + F2, type **gnome-terminal** and enter.
- On desktop open space, right-click and select **Open in Terminal**.
- From Picarro Launch Pad, Administration tab, select **Launch Shell**.

I.3 Commands

The following table provides useful shell line commands.

NOTE

Linux commands are case sensitive. The command must be exact for the system to recognize and execute it.

Table 18 - Linux Shell Line Commands

Keys	Description
> picarroMenu	Opens Picarro OS utilities.
>lsb_release –a	Prints certain Linux Standard Base (LSB) and distribution information.
>xrandr	Lists all available display output interfaces and its state (DP, DVI, HDMI).
>xrandr --output DP1 --auto	Enables DPI with auto setting. DPI is the video streaming port.
>xrandr --output eDP1 --off	Disables eDPI, the virtual display generated when no monitor is connected.
> ps –ax | grep python	Lists running Python processes.
> kill ###	Terminates running process.
> nautilus	Opens file manager, {Ctrl+L ...shows address bar}.
>caja	Opens file manager, {Ctrl+L ...shows address bar}.
>gedit	Opens text editor.
>ip -br a	Brief IP report.
>du -sh	Summarizes file space usage in current directory.
>df -h	Report file system disk space usage.
Remote Access	
>teamviewer	Opens TeamViewer
>anydesk	Opens AnyDesk

J 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% H_2O 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

K Introduction to Technology

Picarro analyzers use time-based, optical absorption spectroscopy of the target gases to determine concentration. They are based on wavelength-scanned cavity ring-down spectroscopy (WS-CRDS), a technology in which light re-circulates many times through the sample, creating a very long effective path length for the light to interact with the sample, 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.

K.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., $H_2{}^{18}O$, $^{13}CO_2$, $^{15}N^{14}N^{16}O$) 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 1. 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 1.

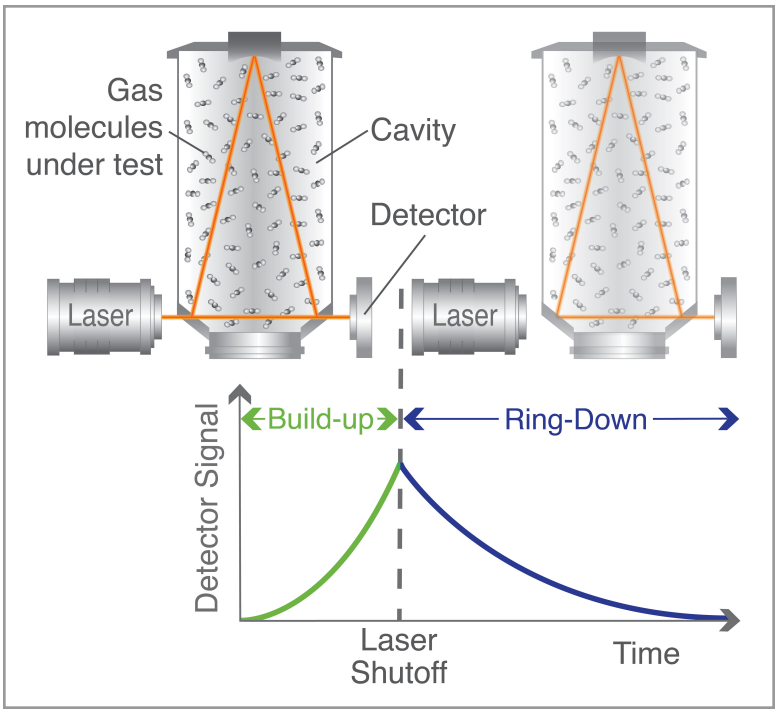


Figure 114 - Schematic of the Picarro CRDS analyzer cavity

When the laser is on, the cavity quickly fills with laser light. A small amount of the 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.

K.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. 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.

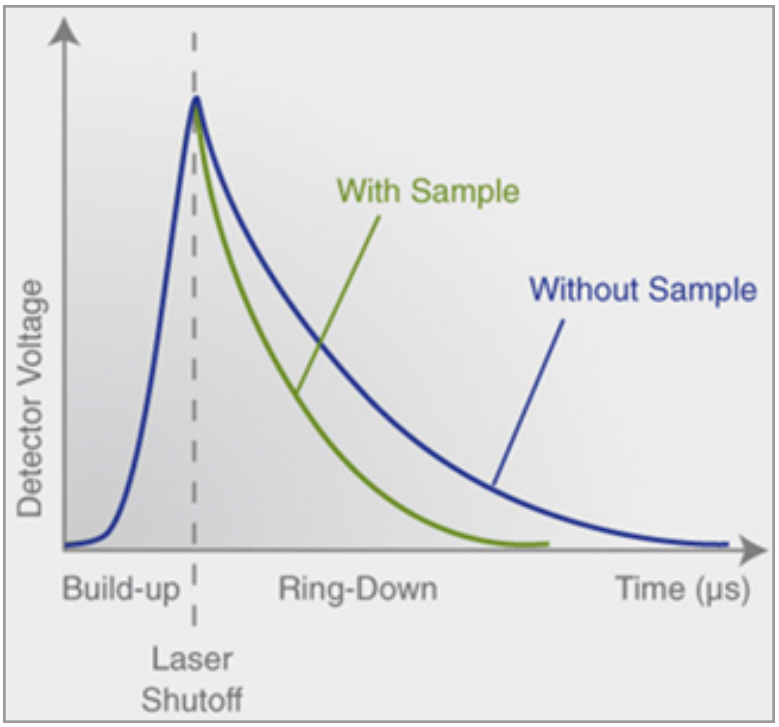


Figure 115 - Light intensity as a function of time in a CRDS system

K.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 116 shows a plot of ideal optical spectra with a clean, uniform baseline on either side of the absorption peak.

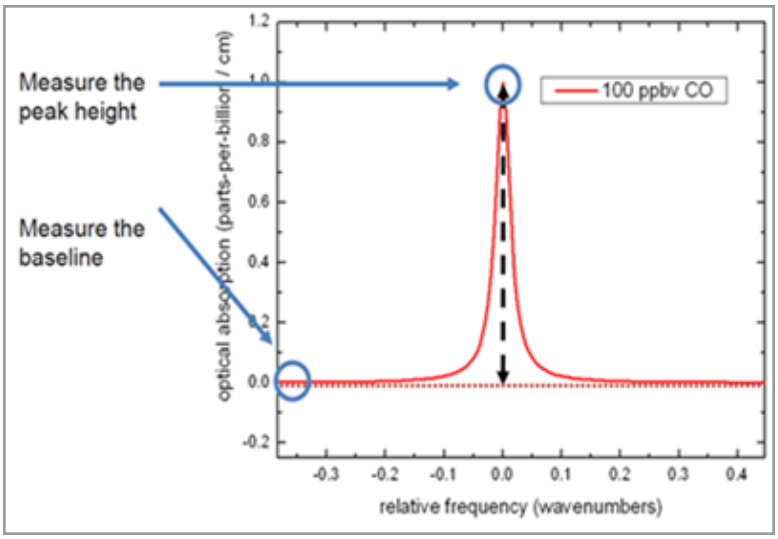


Figure 116 - Absorption Spectral Curve

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.

K.4 Spectral Precision and High Sensitivity Measurements

Picarro analyzers contain two features that provide high spectral precision:

- 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.

L Limited Warranty

Limited Warranty for Picarro Products and Peripherals. Picarro warrants that during the Warranty Period the Picarro Products and Peripherals will be free from substantial defects in material and workmanship under normal uses, and will substantially conform to Picarro's published Specifications for the Product. "Specification" means the then current user guide, technical specification or other product documentation prepared by Picarro (and does not include marketing collateral). This limited warranty extends only to the original end-user ("Customer") of the Product.

Warranty Period. The Warranty Period commences upon shipment of the Product and the Warranty Period continues for a period of 13 (thirteen) months (for shipments directly to customers) or 15 (fifteen) months (for shipments to a Picarro partner).

Warranty Remedies. Customer's sole and exclusive remedy and the entire liability of Picarro and its suppliers under this limited warranty will be, at Picarro's option, repair of the Product; or shipment of a replacement Product within the warranty period and according to Picarro's replacement process; or a refund of the purchase price if the Product is returned to Picarro, freight and insurance prepaid. Picarro replacement parts used in Product replacement may be new or equivalent to new.

In the event Picarro repairs or replaces the Product under this warranty, then the Warranty Period will be extended for the longer of a) ninety (90) days, or b) the period of time during which Customer has been unable to use the Product based upon the date on which the Customer or partner first reported to Picarro the problem giving rise to the warranty claim.

As part of the Limited Warranty, during the Warranty Period Picarro may provide: (1) telephone and email technical support, including remote log-in capabilities during Picarro's regular support hours and (2) software updates that Picarro generally makes available without additional cost. Picarro will provide all parts and services required to repair or replace the Product, provided that repairs will be performed remotely or at Picarro's factory. Picarro reserves the right to use local, authorized partners to assist in providing warranty repairs and/or factory returns and End Customer will cooperate with such local partners.

Picarro's obligations hereunder are conditioned upon the return of the defective Product in accordance with Picarro's then-current Return Material Authorization (RMA) procedures. Customer or partner will pay for shipping of the Product to Picarro, and following repair of the Product Picarro will pay for return shipment to the Customer or partner under Incoterm DDP. Any other costs of shipment will be Customer's or partner's responsibility. Customer must follow instructions provided by Picarro for packaging and shipping the Product.

Warranty Restrictions. The above Product warranty does not apply if the Product (a) has been altered, except by Picarro or by Customer with Picarro's prior written approval, (b) has not been installed and used in accordance with Picarro's Specification, (c) has been subjected to abnormal physical or electrical stress, abnormal environmental conditions, misuse, negligence, or accident; (d) is licensed for beta, evaluation, testing or demonstration

purposes; and (e) does not extend to recovery or replacement of any data from any medium. The Warranty Periods for spare parts, consumables and RMA repairs are not included in this document and are described under the Support Service Terms document.

Disclaimer: Picarro disclaims all other warranties, either express or implied, including warranties of fitness for a particular purpose. Except as set forth in this document, or as otherwise expressly agreed in writing by Picarro, there are no other warranties applicable to Picarro Products.

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 community forums and software downloads are available only for registered Picarro customers with login credentials. If you do not have an account, you can register by using the community and software download links below.

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