PI2103 Analyzer User Manual

Ammonia NH_3

PICARRO

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

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

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Revision History

Revision	Date	Notes
A	September 2024	First Edition.
B	October 2024	USB device removed from shipping contents. Not applicable.

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1 Introduction

1.1 Intended Use

The PI2103 analyzer measures concentrations of ammonia (NH_3) using Picarro's patented Cavity Ring-Down Spectroscopy (CRDS) technology to deliver stable measurements of NH_3 with a parts-per-trillion (ppt) lower limit of detection (LOD) and negligible drift. The analyzer can be deployed in a lab or in the field, allowing in-situ analysis for both trace and ambient amounts. See the PI2103 datasheet for more information.

⚠ CAUTION

Any protective equipment shall be used in accordance with the instructions provided by the protective equipment supplier.

NOTE

Users must obtain the MSDS for sample gasses used in the proxy validation procedure for their respective suppliers.

1.2 System Overview

1.2.1 Analyzer Front Panel

The following figure shows the analyzer front and panels. For more information on panel features, functions, and connections, see Chapter 4, Hardware Setup.

Figure 1 - PI2103 Front Panel

The LED indicator on the front panel shows the current operating state of the analyzer. The following table describes the status indicator states.

The five status states and colors are linked to the System Alarm Panel on the CRDS Data Viewer Screen, see 6.3, Alarms Panel.

Table 1 - Front Panel Function

Feature	Color	Dsecription
Status Indicator LED		Off: System is off or has no power.
		Yellow (flashing): Warming up.
		Green: Operating correctly.
		Yellow (steady): not operating correctly.
		Red: Not measuring.
USB Port	NA	For transferring files to a flash drive.

1.2.2 Analyzer Back Panel

Figure 2 - PI2103 Back Panel

1.2.3 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 3 - A2000 Vacuum Pump – Side Views

1.3 Analyzer Specifications

Table 2 - PI2103 Specifications

Parameter	Specifications
Measurement Technique	Cavity Ring-Down Spectroscopy (CRDS)
Weight: Analyzer Weight: Pump	21.7 kg (48 lbs.) – Should be lifted by two people. A2000: 6.5 kg (14.4 lbs)
Dimensions - Analyzer	Depth: 62 cm (24.4”) Width: 43.2 cm (17”) Height with Feet: 21.3 cm (8.4”)
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)

Parameter	Specifications
Front/Rear Clearance	Front: 15.3 cm (6”); Rear: 15.3 cm (6”)
Primary Gases Measured	NH_3 (ammonia)
Sample Flowrate	>1.5 SLPM
Required Accessories	Included: Pump (external), keyboard, mouse Supplied by Customer: LCD monitor
Operating System	Linux
Data Outputs	RS–232, Ethernet, USB, Analog 0-10 V, Modbus and 4-20mA optional
Installation	Benchtop or 48.3 cm (19”) rack mount
Power Requirements Startup Power Steady-state Power Mains Supply Voltage Fluctuation	100 – 240 VAC; 47 – 63 Hz (auto-sensing) <375 W at start-up, (Analyzer and Pump) 120 W (Analyzer) 150 W (A2000 Pump) ±10% of the nominal voltage
Minimum Rated Circuit Amperage	10A @ 115 VAC 5A @ 230 VAC
Liquid Ingress Protection	None

1.4 Acronyms

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

Table 3 - Acronyms, Formulas, Units, and Symbols

Acronym	Definition
“(as in 1/4”)	Inches
°C	degrees Celsius
<	Less Than

Acronym	Definition
>	Greater Than
‰	per mil
A	Ampere
AC	Alternating Current
cm	Centimeters
COM	Communication Port
CRDS	Cavity Ring-Down Spectroscopy
CSV	Comma Separated Values
CPU	Central Processing Unit
DAS	Data Acquisition System (the Analyzer) (Note historical name, may no longer be used)
DC	Direct Current
DIO	Digital Input/Output
DVI	Digital Visual Interface
ESD	Electrostatic Discharge
°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
HDF	Hierarchical Data Format
Hz	Hertz
ID	Inside Diameter
I/O	Input/output
kg	Kilograms
lbs	pounds

Acronym	Definition
M	meters
m	meter
max	Maximum
min	Minimum
mA	Milliampere
mL	Milliliter
mK	Millikelvin
mm	Millimeters
nc	new calibration
N/C	No Connection
NC	Normally Closed
NO	Normally Open
NTP	Network Time Protoc
OD	Outside Diameter
P	Pressure
PC	Personal Computer
PDF	Portable Document Format
PFA	Perfluoroalkoxy Alkane – A chemically resistant polymer, suitable for use with sticky and aggressive gases
PN	Part Number
ppb	parts per billion
ppm	parts per million
PSI (psi)	Pounds per Square Inch
PSIG	Pounds per Square Gauge
P_{ws}	Water vapor pressure

Acronym	Definition
RH	Relative Humidity
RJ-45	Registered Jack (physical network interface)
RS232	Recommended Standard 232 (serial communication protocol)
sec	Seconds
SLPM	Standard Liters Per Minute
SS	Stainless Steel (i.e., tubing)
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 AC power
VDC	Volts Direct Current
W	Watts
WS-CRDS	Wavelength Scanned Cavity Ring-Down Spectroscopy

1.5 Text Conventions

The following conventions are used in the manual.

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

2 Safety

2.1 Warning Symbols

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 that you should be aware of before proceeding.

REMINDER

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

2.2 General Safety

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

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

WARNING

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

⚠ CAUTION

This analyzer contains no user-serviceable components except the particulate filter, CPU fan, and A2000 vacuum pump diaphragms and valves. To order user-replaceable parts and access video replacement instructions, see Chapter 11, Maintenance.

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

⚠ CAUTION

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

⚠ WARNING

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

⚠ CAUTION

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

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

⚠ 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 21.7 kg (48 lbs.). Use the technique described below (or follow your local regulations) 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 4 - Laser Safety Label – Affixed to Outside Cover of Analyzer

WARNING

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

The following laser safety labels are affixed to the inside of the analyzer:

Figure 5 - Laser Safety Labels – Affixed to Inside of Analyzer

CAUTION

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

3 Unpacking

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.

3.1 Inspect the Shipping Boxes

Inspect the condition of all boxes upon arrival. The larger box includes the analyzer and most of the accessories. Even if the outer box shows damage, the inner box holding the analyzer will protect the instrument under most circumstances.

If the equipment does appear to be damaged, photograph the damage and contact Picarro (email pictures) as soon as possible.

NOTE

Keep all packing materials so the instrument can easily be returned Picarro if necessary or transported to another location.

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 46 lbs. (20.9 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.**

NOTE

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

Table 4 - 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.
 **Control Cable Kit (1)**	For external solenoid valves.
 **Nut (1) and Ferrules (2)**	For connecting input line to analyzer gas input.

Part (qty)	Description
 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.
 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.

Part (qty)	Description
 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. Some of the setup instructions in this section are model-dependent.

4.1 Items/Tools Required

- Analyzer and accessories included in shipment
- Pump (model dependent; see specifications in 1.3, Analyzer Specifications) and accessories included in shipment
- 9/16” open end wrench
- 11/16’’ open end wrench
- Power Cords for analyzer and pump

4.2 Installation Safety

WARNING

Two-person lift required: The analyzer weighs 21.7 kg (48 lbs). When lifting the analyzer, use the technique described on page 23 (or follow your local regulations).

CAUTION

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

WARNING

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

WARNING

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

⚠ WARNING

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

⚠ CAUTION

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

⚠ 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

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

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

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

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

⚠ 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.

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

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.
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 (and exhaust port if using an A0702 or S2000 pump). Save the caps for reuse in case the analyzer and pump is stored, moved, or shipped.

4.3.3 Set A2000 Pump Input Voltage

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 as show in the following figure.

1 Input Voltage Selector

Figure 6 - Vacuum Pump Voltage Selection

4.4 Connections – A2000 Pump and Gas Inlet

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

4.4.1 Pump Connections

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

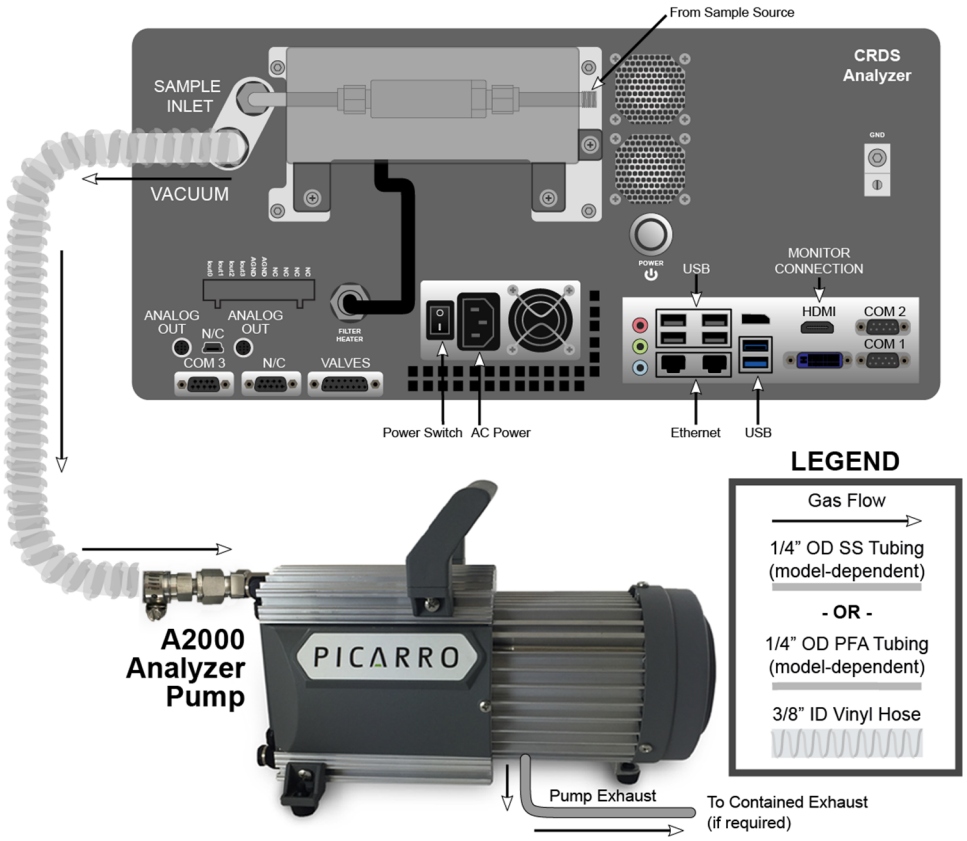


Figure 7 - Analyzer Setup with A2000 Pump

⚠ CAUTION

When working with hazardous gases, remove the pump exhaust muffler and adapt a tube to the vacuum pump exhaust port (Figure 7) and direct the exhaust to a safe place for venting the mixture of sample gases. For instructions, see Appendix B, 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 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.

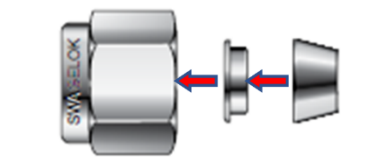


Figure 8 - Orientation of Inlet Nut and Ferrules

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:

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 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.

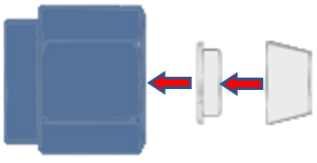


Figure 9 - Orientation of Inlet Nut and Ferrules

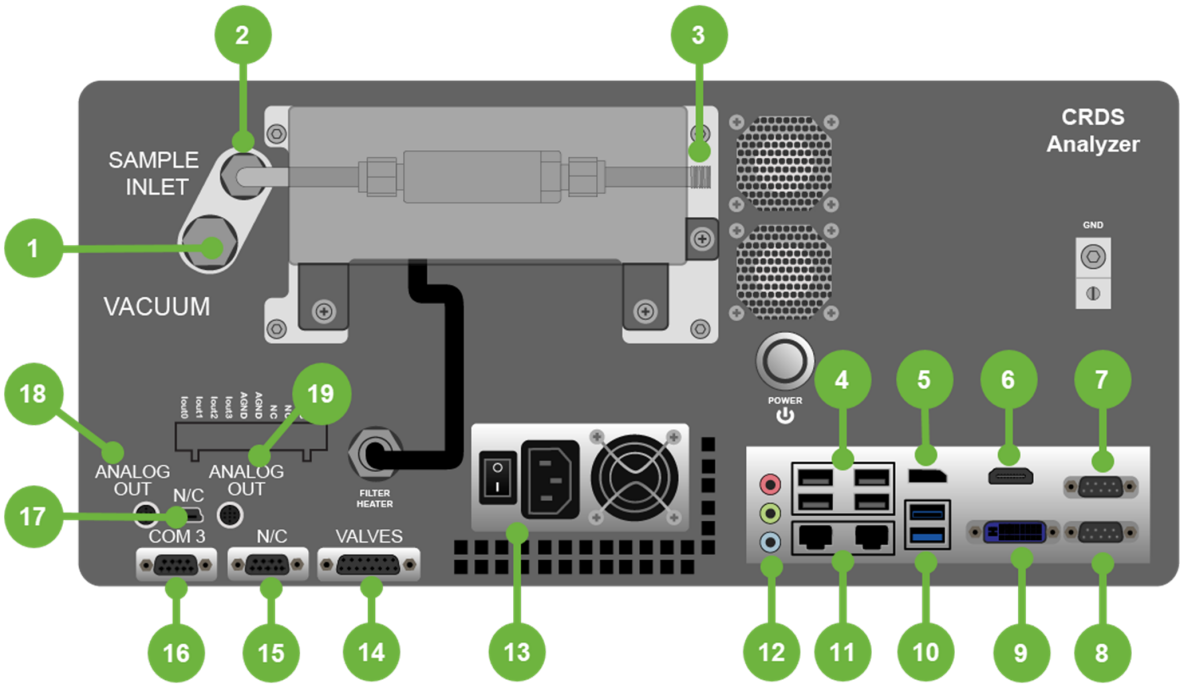
3. Loosely connect the nut to the inlet on the back panel of the analyzer, being careful not to let the ferrules fall out.
4. Insert the tubing into the back of the nut and through the ferrules, feeding it in as far as possible without deforming the tubing.
5. Hand tighten the nut.
6. Using a 5/8" wrench, 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 Electrical Connections

Refer to the following figure for connection points.



1. External Vacuum Port to Vacuum Pump
2. Gas Sample Inlet
3. External Filter (Inlet)
4. USB Ports (4 ea)
5. Display Port
6. HDMI Video Monitor Port
7. COM 2 Port (Rotary valve – A0311, A0311-S)
8. COM 1 Port
9. DVI-D Digital Video Interface
10. USB Ports (2 ea)
11. Ethernet Ports – RJ-45 (2 ea)
12. Audio In/Out Ports
13. AC Power Input and Power ON Switch
14. Valve Control Port (Solenoid valves)
15. DIO (Only for PAL autosamplers; not used with this instrument; not connected)"
16. COM 3 Port (Connected but typically not used.)
17. USB for Logic Board (Not connected)
18. Analog Out 0-10V
19. Analog Out 4-20mA (optional)

Figure 10 - Back Panel Connection Diagram

1. Connect a monitor to one of the DVI monitor ports 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. GUI functions are detailed in section Chapter 6, List of 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. Press the round **On/Standby** button on the rear panel. The LED indicator illuminates green.

The software starts automatically, and the analyzer displays the Picarro Launch Pad as shown in Figure 13.

NOTE

On a cold start, upon reaching this screen, there will be a 30-second countdown, after which the analyzer will automatically start in CRDS mode, or the previous selection if manually overridden. The user can click anywhere or click any key on the keyboard to stop the countdown. To start the CRDS Data Viewer manually, see 5.4.1, Home Menu.

When initialization is complete, the CRDS Data Viewer GUI displays and provides displays graphs for NH_3 as shown in Figure 11. This section describes the Data Viewer, the analyzer's main screen.

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

When the analyzer is warm, the data screens switch to displaying NH_3 concentrations. The System Alarm box becomes solid green and a 'Measuring…' message displays in the Measurement Status field.

Analyzer initialization is complete, the Data Viewer screen displays, and sampling begins. Figure 11 shows the Data Viewer measurements for ammonia.

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

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

where **Y** = **year, M** = **month, D** = **day**

For more information, see Chapter 8, File Management.

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

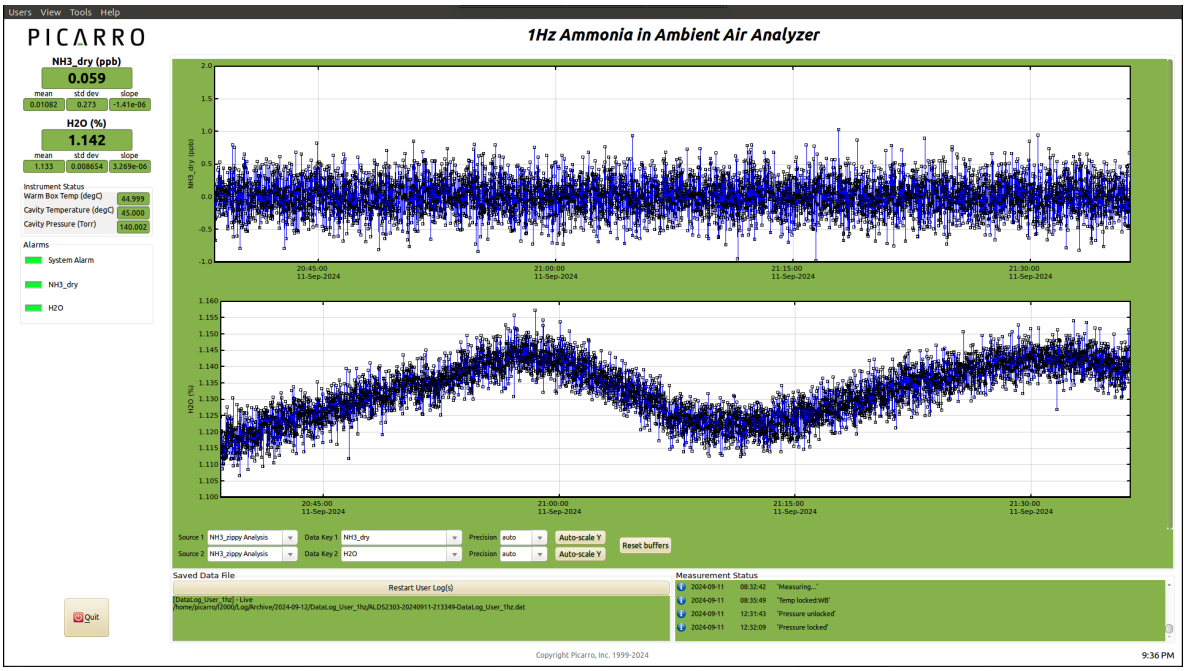


Figure 11 - CRDS Data Viewer Screen

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.

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

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).

5.2.2 Shutdown (CRDS Data Viewer)

1. Click on the **Quit** button from the botom left side of the Data Viewer window.
2. A message displays prompting the user to confirm the shutdown. Once confirmed, the analyzer software and hardware will turn off.
3. Note you must be logged in to shut down the analyzer.

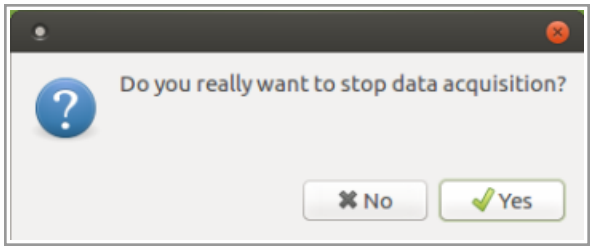


Figure 12 - Analyzer Shutdown Dialog

4. 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.

5. From the Picarro Launch Pad select **Power Off** to tun off the hardware.
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, configuration settings, and administrative controls for the instrument such as managing user accounts. This section provides an overview of the Picarro Launch Pad's key features with additional information throughout this manual.

5.4.1 Home Menu

When the analyzer is powered on the Picarro Launch Pad automatically starts and displays the Home menu as shown in Figure 13. To manually start the analyzer from the Picarro Launch Pad, single click on the **NH3** button or wait 30 seconds while the acquisition software auto starts and initializes.

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

Figure 13 - Picarro Launch Pad/Home Menu

The Home menu provides the following options:

- **NH3** — Starts the analyzer in normal operation.
- **NH3 (DCRDS)** — Started the analyzer in DCRDS operation. For more information, see , DCRDS Mode.

- **Files** — Copies data to an external device (user credentials required). See the following , File Manager for more information.
- **Power Off** — Performs a soft shutdown (user credentials required).

DCRDS Mode

The DCRDS (Differential CRDS) mode tracks variations in the baseline that are induced by changing concentrations of large molecules e.g. volatile organic compounds (VOCs) and corrects the resulting spectrum to ensure accurate and precise measurements of the targeted molecule, which is NH_3 for this analyzer. Use this mode when expecting frequent variations of VOC concentrations in the sample matrix. Please note, the measurement interval slightly increases by ~1 second when using the DCRDS mode.

File Manager

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

1. On the home page, click on **Files**.
2. Login using user credentials.
3. Plug in an external USB drive.
4. In the bottom right-hand corner, select mount and choose the desired drive. After selecting, files are populated on the right side with content from the USB drive.
5. Using the upper left-hand corner drop down menu, select the type of file: **Data**, **Screenshot**, **User History**, **Validation Report**.
6. Highlight and select the desired files.
7. Click **Copy** to copy or move to transfer file to USB drive.
8. Unmount the USB drive when file transfer/copy is complete.

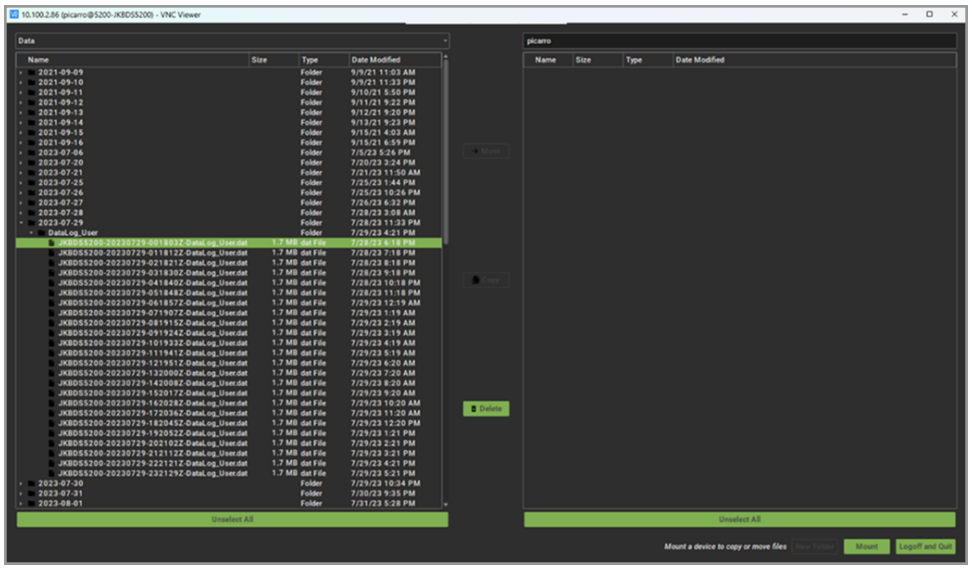


Figure 14 - Transfer Files Dialog

5.4.2 Configuration Menu

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

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

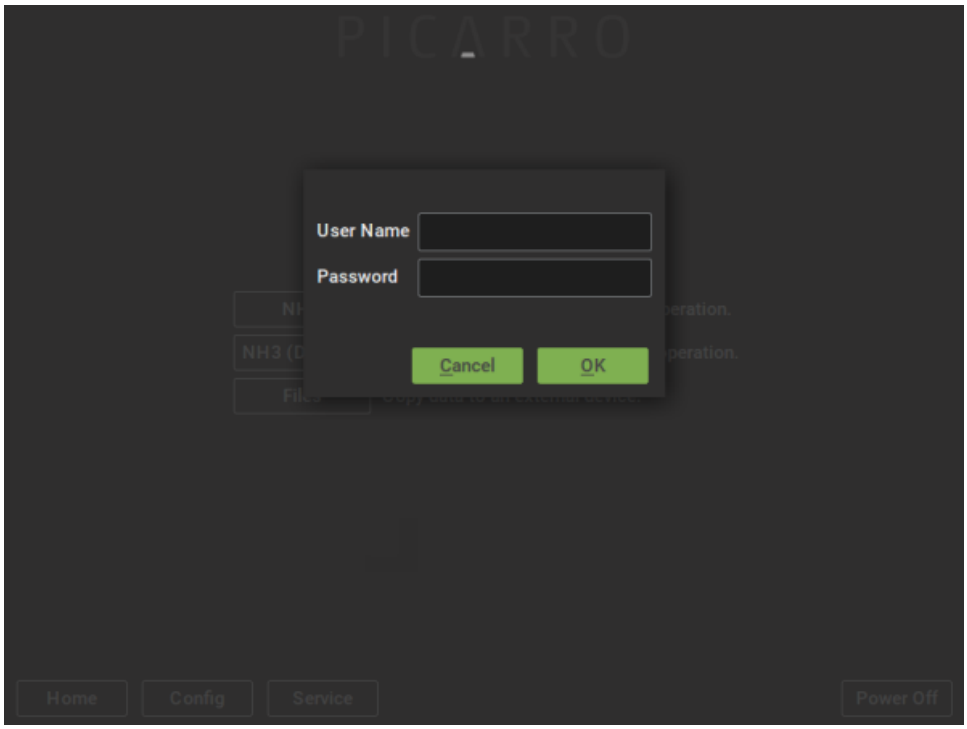


Figure 15 - The Config Login Dialog

The Configuration Menu displays.

Figure 16 - Configuration Menu

NOTE

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

Network

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

Figure 17 - Login: Network Settings Tool

The Network Settings Tool displays.

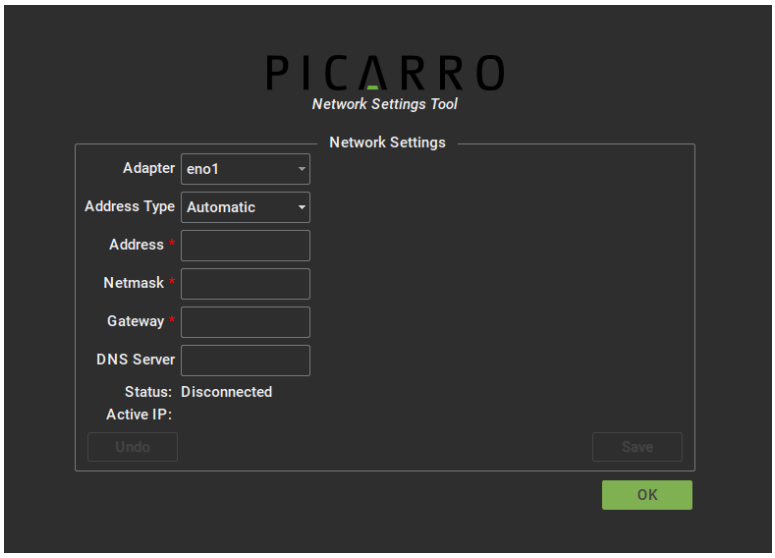


Figure 18 - Network Settings Tool

Use the Network menu to:

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

Clock

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

NOTE

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

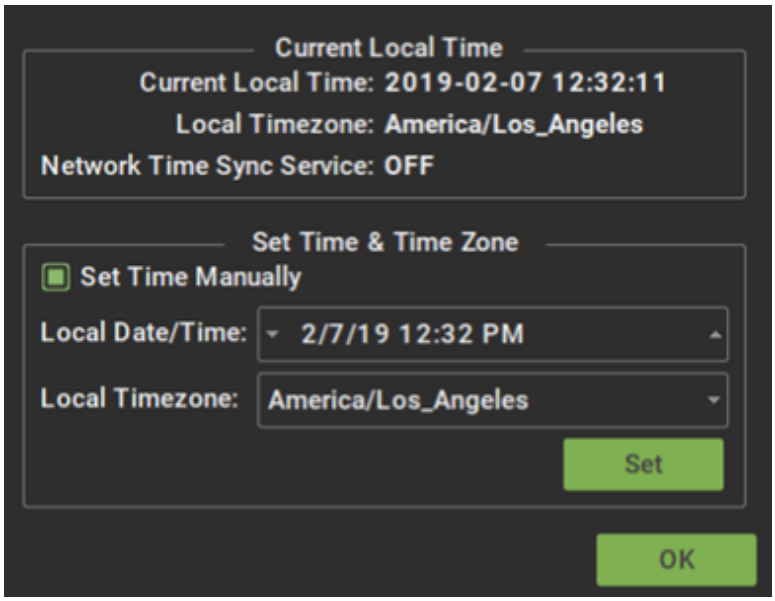


Figure 19 - Clock Set Dialog

Use the Clock dialog to:

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

Set the Local Time Zone

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

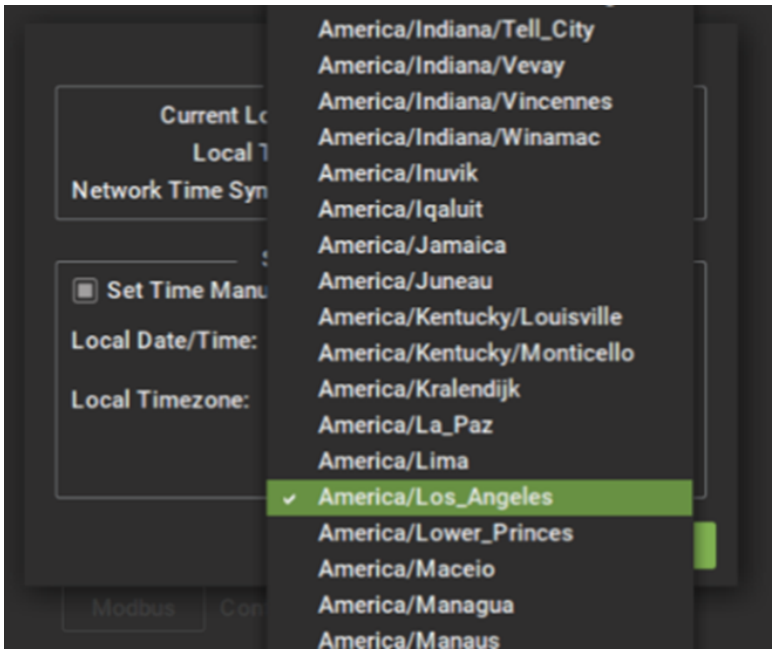


Figure 20 - Clock Set Menu

Manually Set the Time

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

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

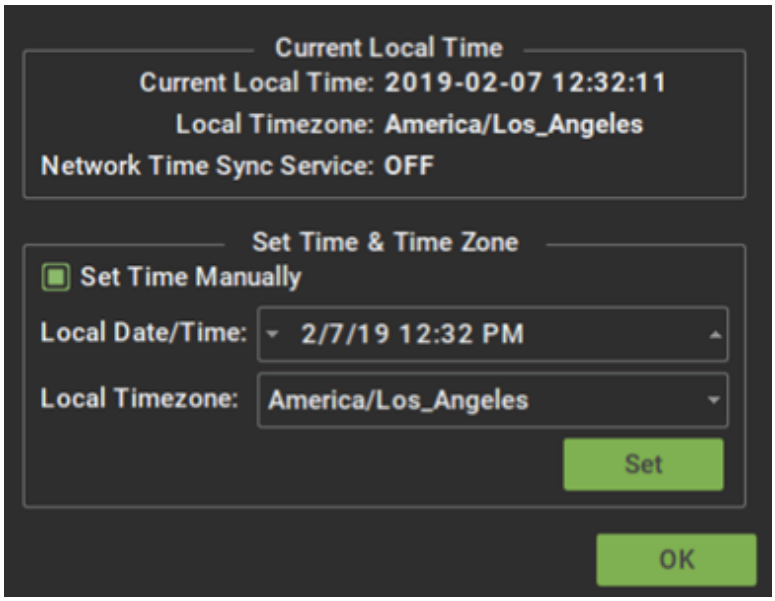


Figure 21 - Clock Set Dialog

DatViewer

The Data File Viewer software allows concatenating multiple files into one file to provide historical trends over a specified time of measurement. For more information, see Chapter A, Data File Viewer.

Serial Port

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

Users

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

Modbus

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

Backup Restore

Provides a mechanism for backing up and restoring system settings.

5.4.3 Service Menu

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

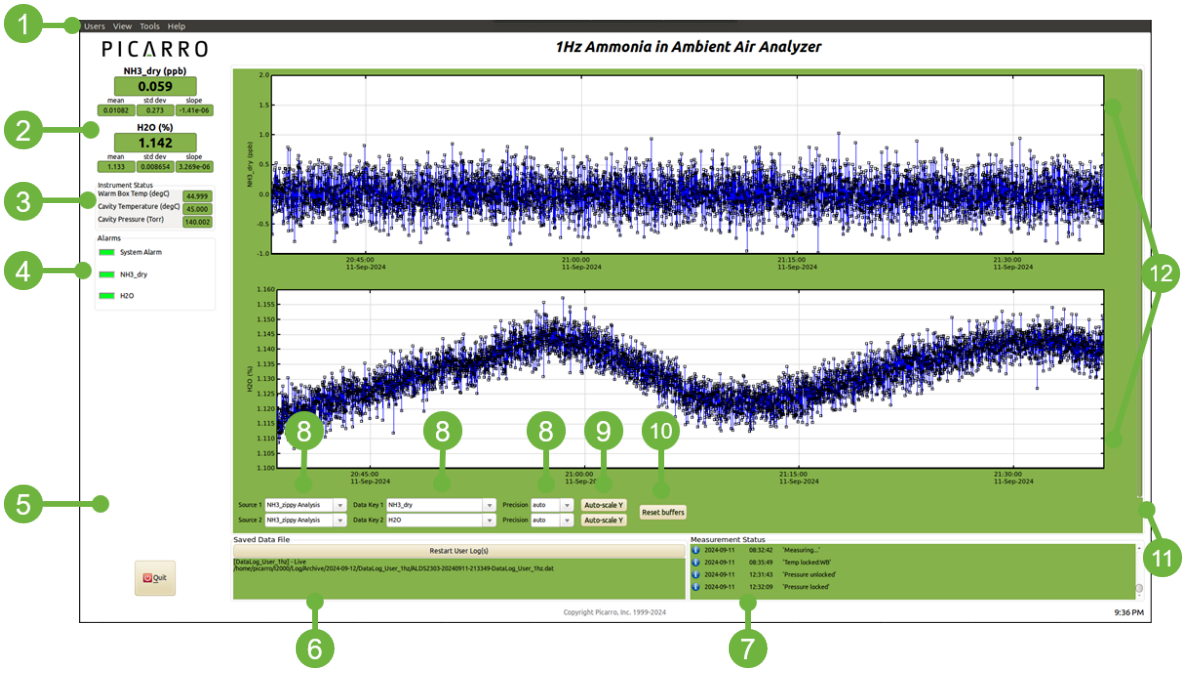
6 List of GUI Functions

NOTE

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

6.1 GUI Overview

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



1. Users, View, Tools, and Help menus
2. Digital Readouts and Statistics
3. Instrument Status (not shown)
4. Alarm Panel
5. Quit Button
6. Data Log, Filename, and Path
7. Status Log Window
8. Data Source, Data Key, and Precision pull-down menus for data window content
9. Axis Auto Scaling
10. Reset Data Buffer
11. Data Buffer Level Meter
12. Data Windows

Figure 22 - Layout of PI2103 Analyzer GUI

6.2 Users, View, Tools, and Help Menus

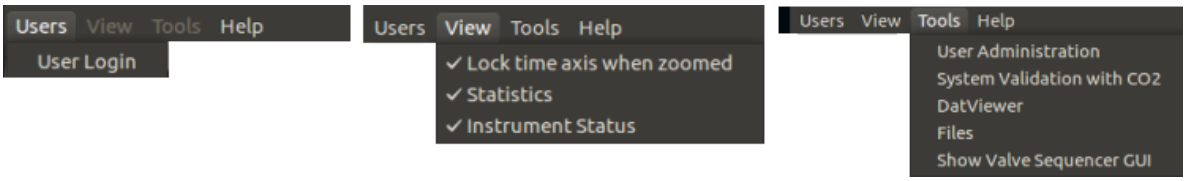


Figure 23 - CRDS Toolbar Options

6.2.1 User Menu

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

6.2.2 View Menu

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

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

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 Administration** — Provides access to User Management options for managing user accounts, policies, viewing histories and profiles.
- **System Validation with CO2** — Allows an easy and straightforward validation of the NH_3 measurement accuracy and linearity using CO_2 as a surrogate gas.
- **DatViewer** — Allows plotting of data saved in *.dat and *.h5 files.
- **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).

NOTE

More details on best practices for the surrogate gas validation and the zero-point validation are given in our technical guide titled: Rapid Analyzer Validation Using a Traceable Surrogate Gas Approach. Following is the link to the document: https://www.picarro.com/Surrogate-Gas-Validation

Also, a supplemental surrogate gas validation Excel worksheet can be used in conjunction with the above technical guide. Following is the link to the worksheet: https://www.picarro.com/Surrogate-Gas-Validation-Worksheet

The link opens the worksheet in your web browser, but the file can be saved to your PC for opening in Excel for use.

6.2.4 Help Menu

- **About** — Displays the version number of the instrument.

6.3 Alarms Panel

This panel is used to monitor the status of the internal instrument alarms. These indicators are gas concentration alarms, such as “NH3 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.

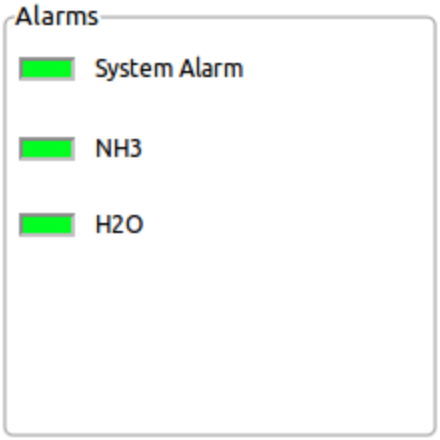


Figure 24 - Alarm Panel

Alarm Panel Indicators are colored as follows:

System Alarm:

- Green when the analyzer is measuring properly
- Flashing Yellow when the analyzer is warming up
- Yellow when not warming up properly
- Red when not operating properly

Measurement Range Alarm:

- Green when concentration is within analyzer measurement range
- Red when above analyzer measurement range

Custom Range Alarm:

- Green when within boundaries set by the user
- Red when not within boundaries set by the user
- Grey when alarm is disabled by the user (these are disabled by default)

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

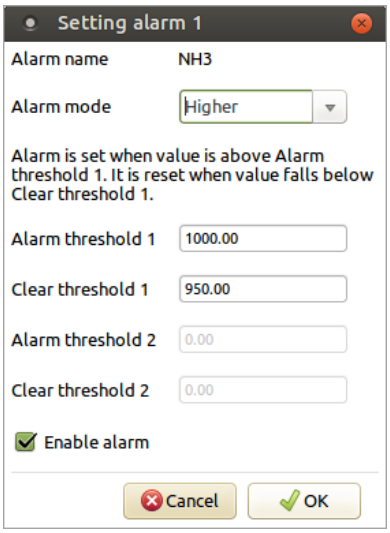


Figure 25 - Alarm Set Dialog

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 gasses are:

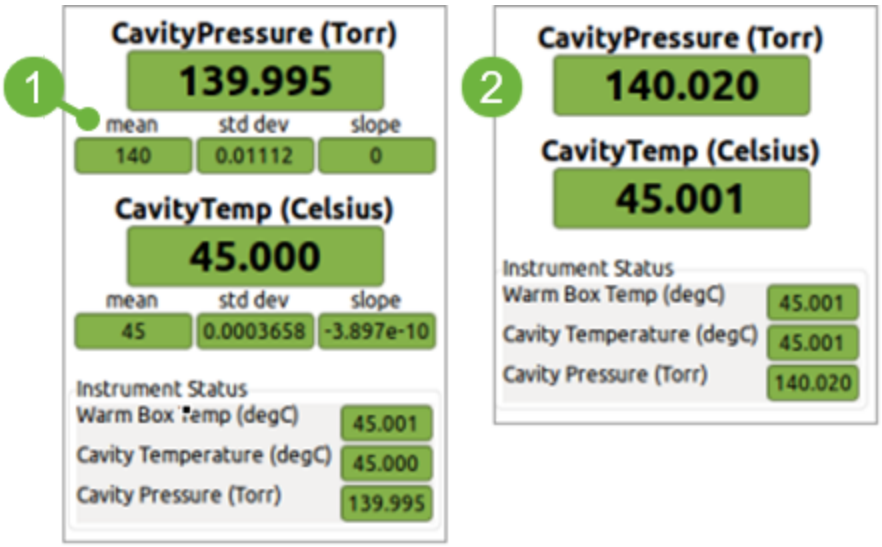
- Higher
- Lower
- Inside
- Outside

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

6.4 Digital Readouts

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

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



1 With Show Statistics

2 Show Statistics Disabled

Figure 26 - Digital Readouts Panel

6.5 Instrument Status

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

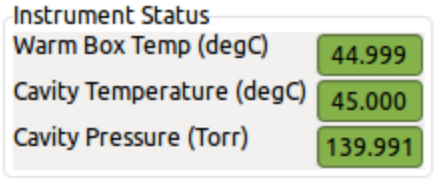


Figure 27 - Instrument Status Panel

6.6 Shutdown and Stop User Log(s) Buttons

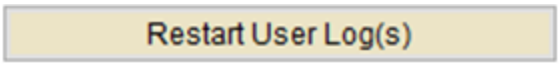


Figure 28 - Shutdown/Stop User Log

6.6.1 Quit Button:

Shuts down the analyzer. See 5.2.2, Shutdown (CRDS Data Viewer).

Figure 29 - Quit Button

6.6.2 Restart User Log(s) Button

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

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

6.6.3 Data Log Filename and Path

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

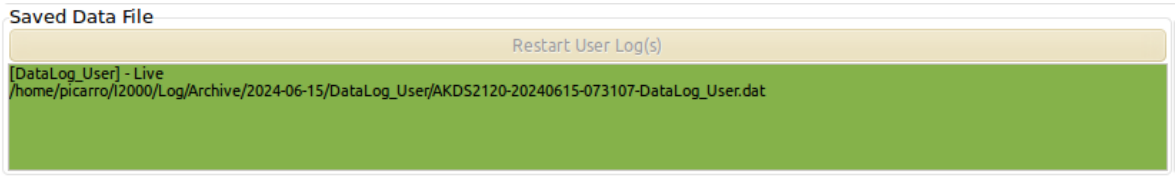
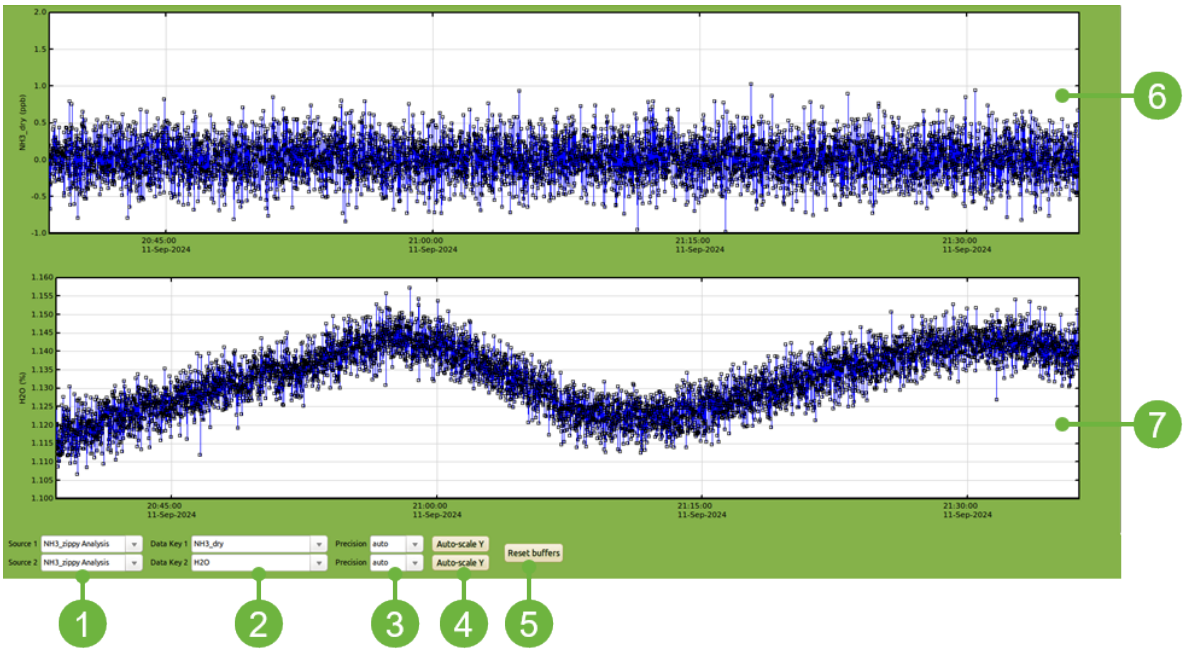


Figure 30 - Data Log Filename and Path Panel

6.7 Data Window

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



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

Figure 31 - Data Window Panel for NH_3 and H_2O

6.8 Data Source and Data Key Pull Down Menus

Data Source and Data Key menus (Figure 32) enables selection of the data stream that is viewed in the data window.

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

Figure 32 - 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.

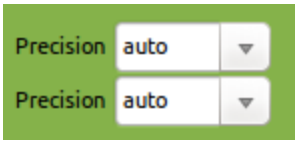


Figure 33 - Precision Pull-down Pane

6.10 Analyzer Status Log

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

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 (HB)** — When the temperatures of the warmbox (wavelength monitor) and hotbox (cavity) 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.

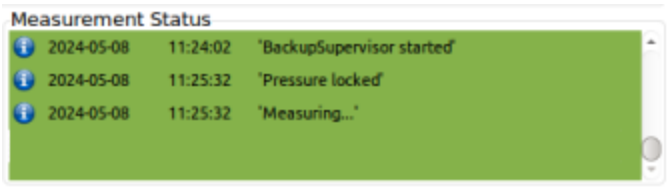


Figure 34 - Analyzer Status Log

6.11 Data Buffer Level Meter

The meter to the right of the Data Window (Figure 35) indicates how much of the internal memory of the GUI is used to retain historical data collected with the instrument. There is an internal limit of a finite number of points. Once that number of data points is collected, the buffer is full, and old data is removed from the buffer as new data is collected. This buffer affects only the data displayed in the data window, not the data stored in any files. This buffer is empty upon instrument startup and can also be emptied by pressing the **Reset buffers** button in the lower-right-hand corner of the GUI.

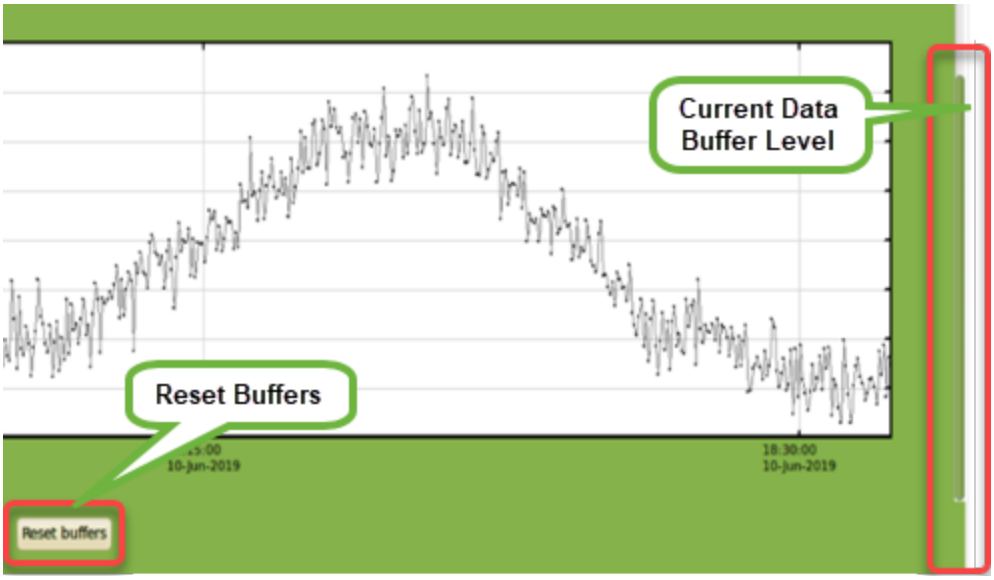


Figure 35 - Data Buffer Level Meter and Reset Buffers Button

6.12 Reset Buffers Button

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

6.13 Graph Zooming and Panning

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 (Figure 36). When the box is drawn, release the left button and the boxed area will automatically scale to fill the data window.

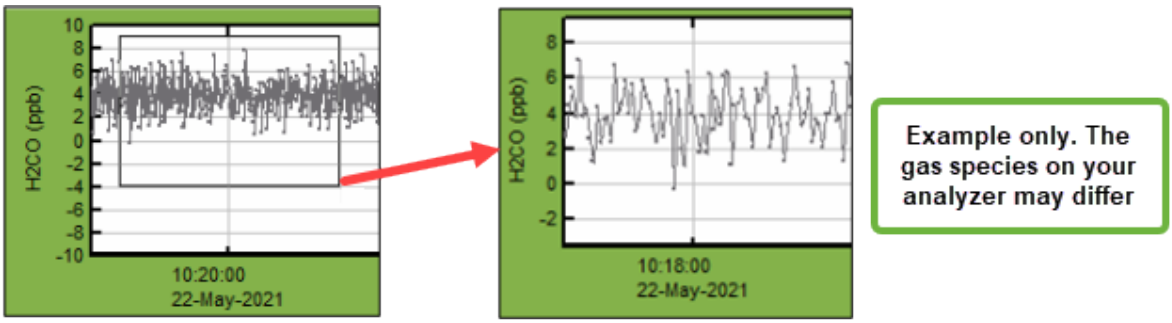
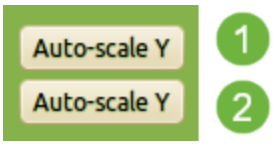


Figure 36 - Data Graph Zoom Function

- **To zoom back out to see all data in the buffer** — Use the left button and double-click within the graph display.
- **To zoom out indefinitely** — Click the right button. Right clicking multiple times zooms out further.
- **To auto scale the y-axis of either graph** — Use the Auto-Scale buttons below the graph as shown in Figure 37.
- **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



1 Top Plot

2 Bottom Plot

Figure 37 - Auto-scale Buttons

6.13.1 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**.

6.13.2 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 5 - User Accounts/Functions

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

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

From the Data Viewer:

1. From the Users menu, select **User Login**.
2. Login as an administrator (default user name is admin; default password is admin).
3. From the Tools menu, select **User Administration** to view the User Management as shown in Figure 38.

From Picarro Launch Pad:

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

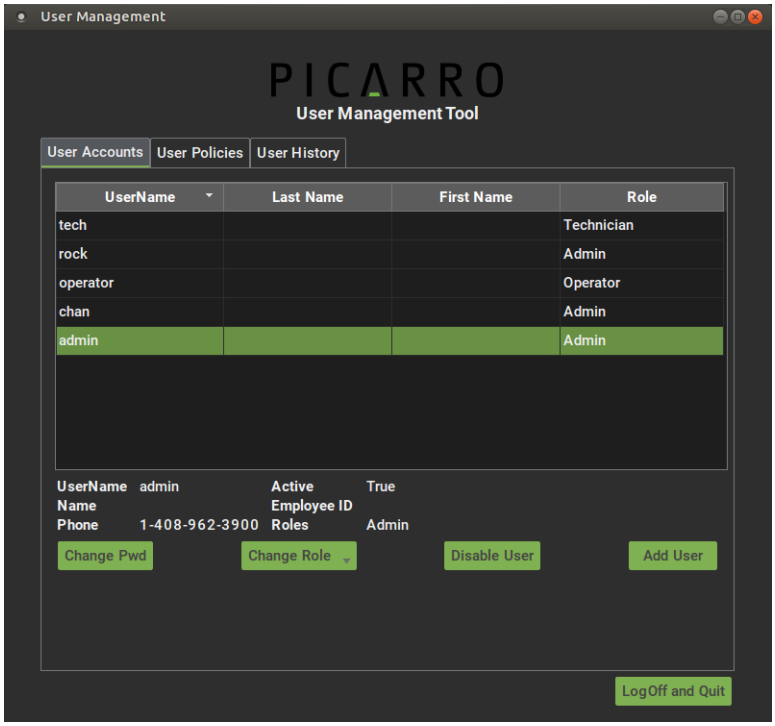


Figure 38 - User Management/User Accounts Tab

7.1 Managing User Accounts

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

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

NOTE

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

7.1.1 Changing a User Password

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

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

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

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

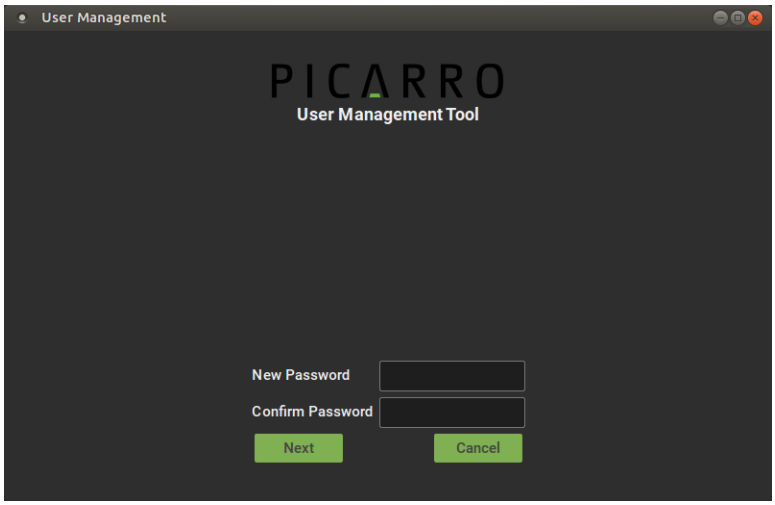


Figure 39 - Change Password

3. In the **Confirm Password** field, re-enter the password.
4. Click **Next** to save the password.

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**, click the user you want to change.
3. From the **Change Role** drop-down, select the new role and click **Ok** when prompted.

The role is now changed to the desired setting.

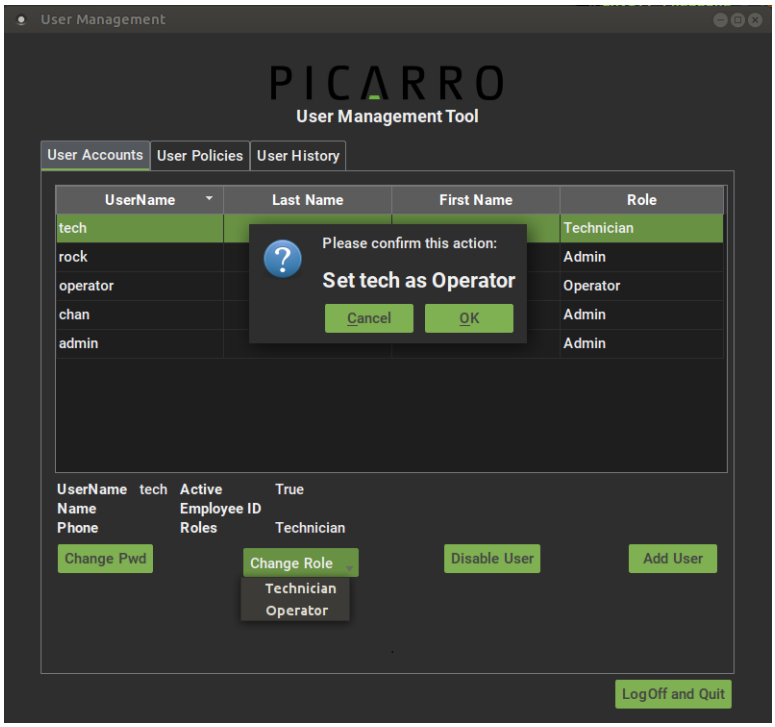


Figure 40 - Change Roles

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. See Figure 41 for more information.

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

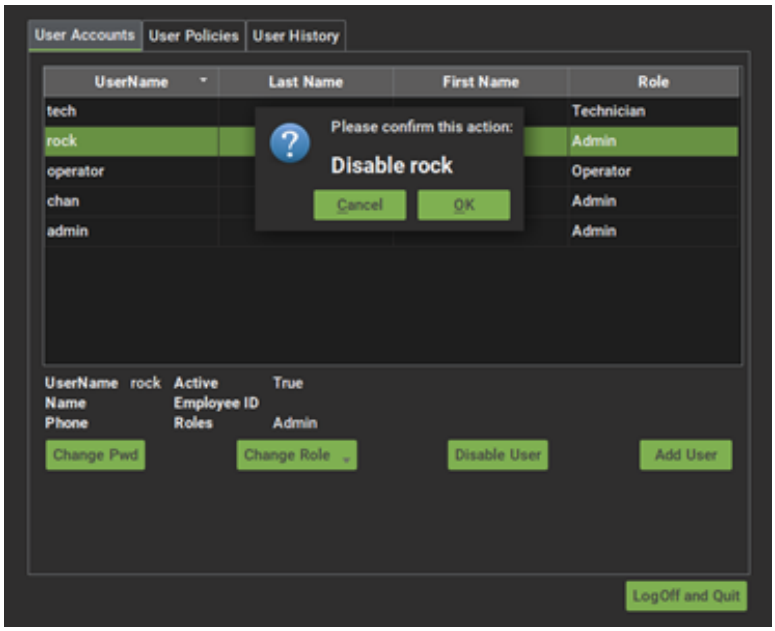


Figure 41 - Disable Users

7.1.4 Adding a User

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

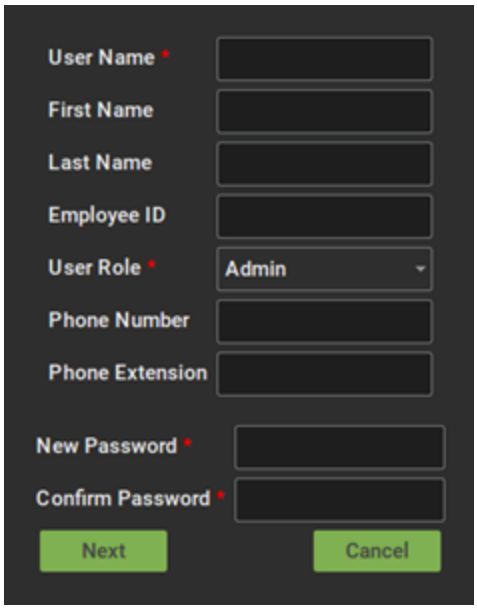


Figure 42 - Add User

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

7.2 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**.

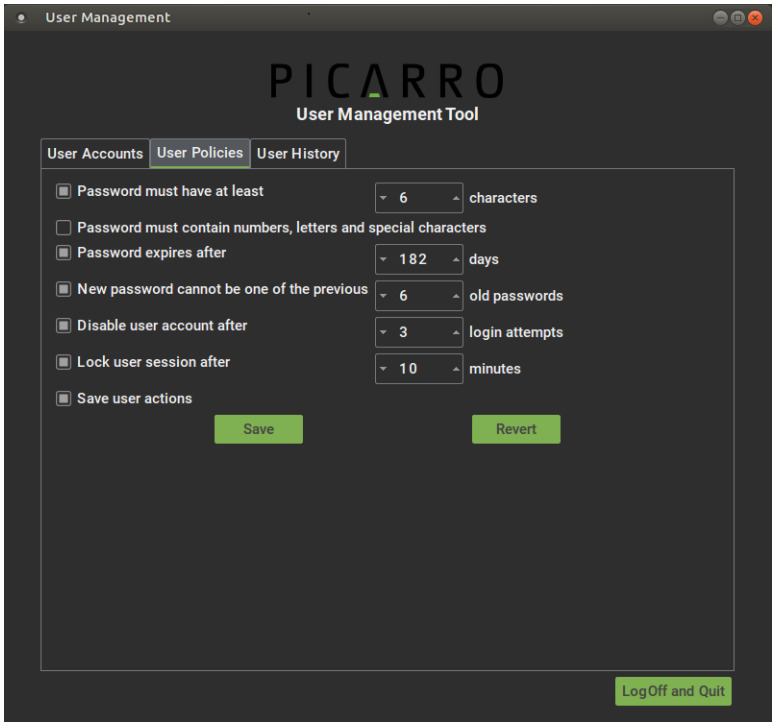


Figure 43 - User Policies Tab

7.2.1 User Policy Descriptions

The following table provides descriptions for the various user policies.

Table 6 - User Policies

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

7.3 Viewing User History

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

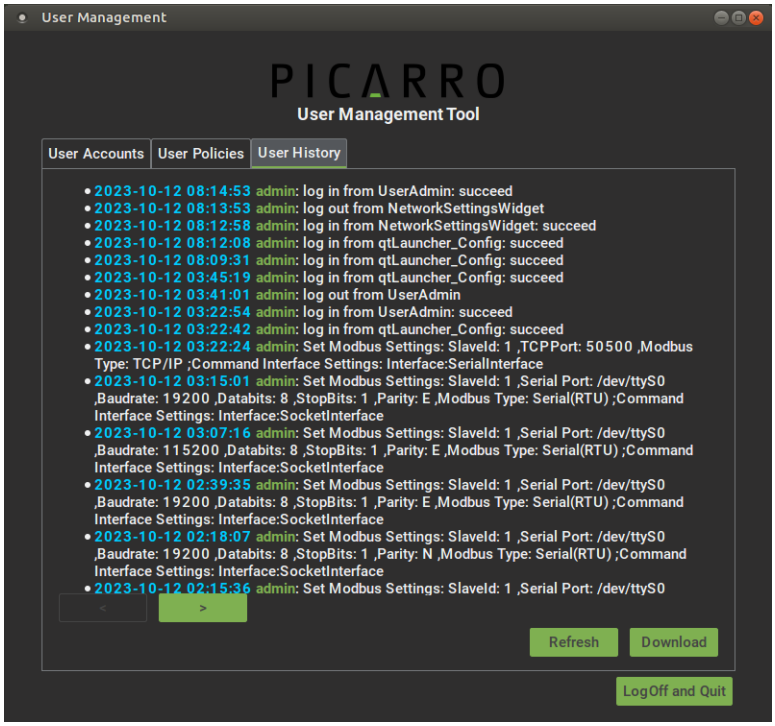


Figure 44 - User History Tab

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 laucnhes the File Manager, which will prompt to login. See File Manager on page 37 for details on copying files from the analyzer.

8 File Management

The analyzer generates ASCII-format text output files. The data files are created every 60 minutes by default.

The file name is generated from the analyzer serial number, the date, and the time when the analyzer was started. For example:

Figure 45 - Example Data File Name

SADS2001-20160127-1029-DataLog_User_Raw.dat

- **SADS2001** — The analyzer's serial number.
- **20160127** — The date, 1/27/2016, in format yyyymmdd (to allow chronological sorting of data files).
- **1029** — Time the file was started in GMT, 10:29 am, formatted as hhmm using a 24-hour clock.

The raw user data is contained in folders in the directory:

- */home/picarro/si2000/userdata/datalog_user/year/month/day/hour* for data sampled at the analyzer's native sampling rate
- */home/picarro/si2000/userdata/datalog_sync/year/month/day/hour* for data sampled at the analyzer's native sampling rate

Data files are created every 60 minutes and stored for 90 days (default for SADs analyzers) before they are automatically deleted. File deletion frequency and details can be modified in the file: */home/picarro/si2000/appconfig/config/archiver/archiver.ini*.

During data acquisition, the analyzer creates directories to store the data, filed by the date the data were acquired.

The following figure shows a partial example of a data file.

	DATE	TIME	FRAC_DAYS_SINCE_JAN1	FRAC_HRS_SINCE_JAN1	JULIAN_DAYS	EPOCH_TIME	ALARM_STATUS
2	2016-10-15	00:24:44.483	287.68384819	6904.412357	288.68384819	1476491084.484	0
3	2016-10-15	00:24:46.444	287.68387089	6904.412901	288.68387089	1476491086.445	0
4	2016-10-15	00:24:48.415	287.68389370	6904.413449	288.68389370	1476491088.416	0
5	2016-10-15	00:24:50.385	287.68391650	6904.413996	288.68391650	1476491090.386	0
6	2016-10-15	00:24:52.355	287.68393931	6904.414543	288.68393931	1476491092.356	0
7	2016-10-15	00:24:54.335	287.68396222	6904.415093	288.68396222	1476491094.336	0
8	2016-10-15	00:24:56.309	287.68398506	6904.415641	288.68398506	1476491096.309	0
9	2016-10-15	00:24:58.246	287.68400748	6904.416179	288.68400748	1476491098.246	0

Figure 46 - Data File

Datafiles are closed every 60 minutes and moved to an archive directory and a new datafile is started.

The archive directory is */home/picarro/si2000/log/archive* and has subdirectories datalog_ mailbox, datalog_private and datalog_eventlogs with files arranged by *year/month/day/hour*.

There are more complete data files which include additional information beyond the concentration data including parameters such as analyzer temperatures and pressure, setpoints and spectroscopic information. This information is generally not useful to the user but can be useful for diagnostic purposes and is store in the directory */home/picarro/si2000/log/archive/datalog_private /year/month/day/hour*.

For more information about how to include various columns of data from the datalog_private in the */home/picarro/si2000/userdata* datalog files, contact Picarro.

The currently active data file can be found in */home/picarro/si2000/log/datalogger*.

Archive directory contain subdirectories arranged by file type and internally organized by */year/month/day/hour*.

To keep the data files easy to manage and to limit the size of individual files and directories, new files are automatically generated whenever the analyzer is operating.

The software automatically generates new files each time the analyzer is powered up and also at midnight (GMT) each night. When new files are created at midnight, their file name will contain the new date and a time of 00:00.

For example, if the system was started at 10:29 am on 2/5/2016 it would create a file named *20160205/sads2001-20160205-1029-userlog.dat*. Then at midnight a new file will be created *sads2001-20160206-0000-userlog.dat*.

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.

Figure 47 - Settings/Modbus Configuration

This displays the Modbus Settings window shown in Figure 48.

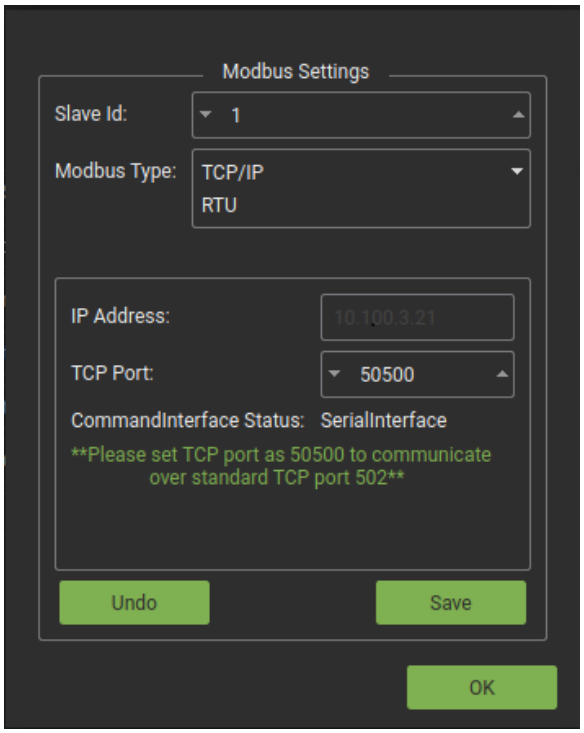


Figure 48 - Modbus Settings Window

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 Modbus Communication.
   - **TCP Port** — Designates the TCP port if TCP/IP is selected.

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

9.2 Modbus Data Registers Overview and Setup

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

Table 7 - MODBUS Register Types

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

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 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 8 - Input Registers

Address	Description	Units	Type	Comments
0-5	Time stamp		String	Long value return as 12 byte string. Date format: YYMMDDHHMMSS

Address	Description	Units	Type	Comments
6-7	Concentration of measured gas # 1, NH_3	ppb	Float	The identity of this gas varies with analyzer. However, register 6 is always gas # 1
8-9	Gas # 1 ID	Unitless	Float	Gas #1 ID = 1, NH_3
10-11	Gas #1, 30 sec trailing average	ppb	Float	
12-13	Gas #1, 2 min trailing average	ppb	Float	
14-15	Gas #1, 5 min trailing average	ppb	Float	
16-17	Gas #1, max (full scale range)	ppm	Float	
18-19	Gas #1, min (MDL)	ppm	Float	
20-21	Concentration of measured gas #2, H_2O	ppb	Float	The identity of this gas varies with analyzer, however register 20 is always gas # 2
22-23	Gas #2 ID	Unitless	Float	Gas #2 ID = 0, H_2O
24-25	Gas #2, 30 sec trailing average	ppb	Float	
26-27	Gas #2, 2 min trailing average	ppb	Float	
28-29	Gas #2, 5 min trailing average	ppb	Float	
30-31	Gas #2, max (full scale range)	ppm	Float	
32-33	Gas #2, min (MDL)	ppm	Float	
34-35	Concentration of measured gas #3, CO_2	ppb	Float	The identity of this gas varies with analyzer. However, register 34 is always gas # 3
36-37	Gas #3 ID	Unitless	Float	Gas #2 ID = 3, CO_2

Address	Description	Units	Type	Comments
38-39	Gas #3, 30 sec trailing average	ppb	Float	
40-41	Gas #3, 2 min trailing average	ppb	Float	
42-43	Gas #3, 5 min trailing average	ppb	Float	
44-45	Gas #3, max (full scale range)	ppm	Float	
46-47	Gas #3, min (MDL)	ppm	Float	
48-49	Concentration of measured gas #4, N/A	ppb	Float	The identity of this gas varies with analyzer. However, register 48 is always gas # 4
50-51	Gas #4 ID	Unitless	Float	N/A; PI2103 only reports 3 gases over MODBUS
52-53	Gas #4, 30 sec trailing average	ppb	Float	
54-55	Gas #4, 2 min trailing average	ppb	Float	
56-57	Gas #4, 5 min trailing average	ppb	Float	
58-59	Gas #4, max (full scale range)	ppm	Float	
60-61	Gas #4, min (MDL)	ppm	Float	
62-63	Concentration of measured gas #5, N/A	ppb	Float	The identity of this gas varies with analyzer. However, register 62 is always gas # 5
64-65	Gas #5 ID	Unitless	Float	N/A; PI2103 only reports 3 gases over MODBUS
66-67	Gas #5, 30 sec trailing average	ppb	Float	

Address	Description	Units	Type	Comments
68-69	Gas #5, 2 min trailing average	ppb	Float	
70-71	Gas #5, 5 min trailing average	ppb	Float	
72-73	Gas #5, max (full scale range)	ppm	Float	
74-75	Gas #5, min (MDL)	ppm	Float	
76-77	Concentration of measured gas #6, N/A	ppb	Float	The identity of this gas will vary analyzer to analyzer, but Reg 76 is always gas # 6
78-79	Gas #6 ID	Unitless	Float	N/A; PI2103 only reports 3 gases over MODBUS
80-81	Gas #6, 30 sec trailing average	ppb	Float	
82-83	Gas #6, 2 min trailing average	ppb	Float	
84-85	Gas #6, 5 min trailing average	ppb	Float	
86-87	Gas #6, max (full scale range)	ppm	Float	
88-89	Gas #6, min (MDL)	ppm	Float	
90-91	Concentration of measured gas #7, N/A	ppb	Float	The identity of this gas varies with analyzer. However, register 90 is always gas # 7
92-93	Gas #7 ID	Unitless	Float	N/A; PI2103 only reports 3 gases over MODBUS
94-95	Gas #7, 30 sec trailing average	ppb	Float	
96-97	Gas #7, 2 min trailing average	ppb	Float	

Address	Description	Units	Type	Comments
98-99	Gas #7, 5 min trailing average	ppb	Float	
100-101	Gas #7, max (full scale range)	ppm	Float	
102-103	Gas #7, min (MDL)	ppm	Float	
104-105	Concentration of measured gas #8, N/A	ppb	Float	The identity of this ga varies with analyzer. However, register 104 is always gas # 8
106-107	Gas #8 ID	Unitless	Float	N/A; PI2103 only reports 3 gases over MODBUS
108-109	Gas #8, 30 sec trailing average	ppb	Float	
110-111	Gas #8, 2 min trailing average	ppb	Float	
112-113	Gas #8, 5 min trailing average	ppb	Float	
114-115	Gas #8, max (full scale range)	ppm	Float	
	Gas #8, min (MDL)	ppm	Float	
Sections 200-298 is for public sensor data				
200-201	Cavity Pressure	Torr	Float	
202-203	Cavity Temperature	deg C	Float	
204-205	DAS Temperature	deg C	Float	
206-207	Etalon Temperature	deg C	Float	
208-209	Warm Box Temperature	deg C	Float	

Address	Description	Units	Type	Comments
210-211	Outlet Valve	dig counts	Float	
212-213	Instrument cal slope, gas #1, NH_3		Float	
214-215	Instrument cal offset, gas #1, NH_3		Float	
216-217	User cal slope, gas #1, NH_3		Float	
218-219	User cal offset, gas #1, NH_3		Float	
220-221	Instrument cal slope, gas #2, H_2O		Float	
222-223	Instrument cal offset, gas #2, H_2O		Float	
224-225	User cal slope, gas #2		Float	
226-227	User cal offset, gas #2, H_2O		Float	
228-229	Instrument cal slope, gas #3, CO_2		Float	
230-231	Instrument cal offset, gas #3, CO_2		Float	
232-233	User cal slope, gas #3, CO_2		Float	

Address	Description	Units	Type	Comments
234-235	User cal offset, gas #3, CO_2		Float	
236-237	Instrument cal slope, gas #4, N/A		Float	
238-239	Instrument cal offset, gas #4, N/A		Float	
240-241	User cal slope, gas #4, N/A		Float	
242-243	User cal offset, gas #4, N/A		Float	
244-245	Instrument cal slope, gas #5, N/A		Float	
246-247	Instrument cal offset, gas #5, N/A		Float	
248-249	User cal slope, gas #5, N/A		Float	
250-251	User cal offset, gas #5, N/A		Float	
252-253	Instrument cal slope, gas #6, N/A		Float	
254-255	Instrument cal offset, gas #6, N/A		Float	
256-257	User cal slope, gas #6, N/A		Float	
258-259	User cal offset, gas #6, N/A		Float	
260-261	Instrument cal slope, gas #7, N/A		Float	
262-263	Instrument cal offset, gas #7, N/A		Float	

Address	Description	Units	Type	Comments
264-265	User cal slope, gas #7, N/A		Float	
266-267	User cal offset, gas #7, N/A		Float	
268-269	Instrument cal slope, gas #8, N/A		Float	
270-271	Instrument cal offset, gas #8, N/A		Float	
272-273	User cal slope, gas #8, N/A		Float	
274-275	User cal offset, gas #8, N/A		Float	
386	Error code		Integer	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

Address	Description	Units	Type	Comments
387	Measurement status		Integer	ledState = **0** red, system error, gas concentration measurements invalid ledState = **1** solid yellow, need service, gas concentration. measurements might be OK ledState = **2** blinking yellow, not in reporting mode by system OK, like during warmup ledState = **3** green, system OK, gas concentration 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 9 - Discrete Input Registers

Address	Description	Units	Comments
5	Pressure locked		
6	Cavity temperature locked		
7	Warm box temperature locked		
72	Incomplete spectrum for gas #1		
73	Incomplete spectrum for gas #2		
74	Incomplete spectrum for gas #3		
75	Incomplete spectrum for gas #4		Not used
76	Incomplete spectrum for gas #5		Not used
77	Incomplete spectrum for gas #6		Not used

Address	Description	Units	Comments
78	Incomplete spectrum for gas #7		Not used
79	Incomplete spectrum for gas #8		Not used
80	Bad baseline for gas #1		
81	Bad baseline for gas #2		
82	Bad baseline for gas #3		
83	Bad baseline for gas #4		Not used
84	Bad baseline for gas #5		Not used
85	Bad baseline for gas #6		Not used
86	Bad baseline for gas #7		Not used
87	Bad baseline for gas #8		Not used
88	Degraded performance for gas #1		
89	Degraded performance for gas #2		
90	Degraded performance for gas #3		
91	Degraded performance for gas #4		Not used
92	Degraded performance for gas #5		Not used
93	Degraded performance for gas #6		Not used
94	Degraded performance for gas #7		Not used
95	Degraded performance for gas #8		Not used

9.6 Holding Register Map

The following table describes the holding registers.

Table 10 - Holding Registers

Address	Description	Type	Comments
0-3	System time	Integer	Integer representing milliseconds from 1AD January 1st to now

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

9.7 Coil Register Map

Table 11 - Coil Register Map

Address	Description	Comments
115	Quit host application	
116	Shutdown instrument	Takes approximately 2 min to shutdown
150	Get system time	After this read Sync Time holding register
153	User login	Note before executing this command, user need to set user name and user password holding register
154	Update user password	Before executing this command follow the steps 1. Login as admin using User Login functionality 2. Set user name and password by using holding register
155	User logout	
200	Get user data 1	
201	Set user data 1	
202	Get user data 2	
203	Set user data 2	
204	Get user data 3	
205	Set user data 3	
206	Get user data 4	
207	Set user data 4	
208	Get user data 5	
209	Set user data 5	
210	Get user data 6	
211	Set user data 6	
212	Get user data 7	

Address	Description	Comments
213	Set user data 7	
214	Get user data 8	
215	Set user data 8	
216	Get user data 9	
217	Set user data 9	
218	Get user data 10	
219	Set user data 10	
220	Get user data 11	
221	Set user data 11	
222	Get user data 12	
223	Set user data 12	
224	Get user data 13	
225	Set user data 13	
226	Get user data 14	
227	Set user data 14	
228	Get user data 15	
229	Set user data 15	
230	Get user data 16	
231	Set user data 16	
232	Get user data 17	
233	Set user data 17	
234	Get user data 18	
235	Set user data 18	
236	Get user data 19	

Address	Description	Comments
237	Set user data 19	
238	Get user data 20	
239	Set user data 20	

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 11, 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 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 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.

11.1 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.

11.2 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
- **S2179** — Particulate Filter Preventative Maintenance Kit, SI/PI2XXXX Analyzers

11.3 User-replaceable Hardware – Individual Components

11.3.1 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.

- **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:
  http://store.picarro.com/For — Analyzer/Parts/Particulate-filter-kit-all-models-except-HF-NH3.html
- **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:
  http://store.picarro.com/For-Analyzer/Parts/Particulate-filter-teflon-for-NH3-HF._3
- **For a video or step-by-step procedures**:
  - Replacing Your Inlet Particulate Filter (instructional video): or visit:
    https://www.picarro.com/videos/replacing_your_inlet_particulate_filter
  - Inlet Particulate Filter Replacement (maintenance Guide): or visit:
    https://www.picarro.com/support/documents/inlet_particulate_filter_maintenance_guide

11.3.2 CPU Fan

The analyzer CPU fan is user-replaceable and is available per the following service kit:

CPU Fan for MI990 Motherboards

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

11.3.3 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.

- **Pump Rebuild Kit: Used with SI2xxx, G2xxx analyzers (except Flight and Flux analyzers)**
  S2009 Rebuild Kit for A2000 Vacuum Pump – If viewing this manual as a paper hard copy, enter the following URL in your browser: http://store.picarro.com/For-Analyzer/Pump/Rebuild-kit-for-Picarro-A2000-vacuum-pump.html

11.3.4 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.

11.4 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.

12 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.

12.1 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.

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

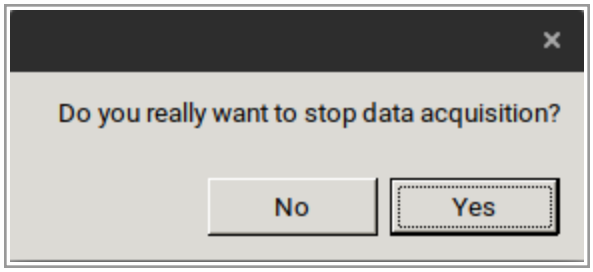


Figure 49 - Stop Data Acquisition/Shutdown

3. 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.

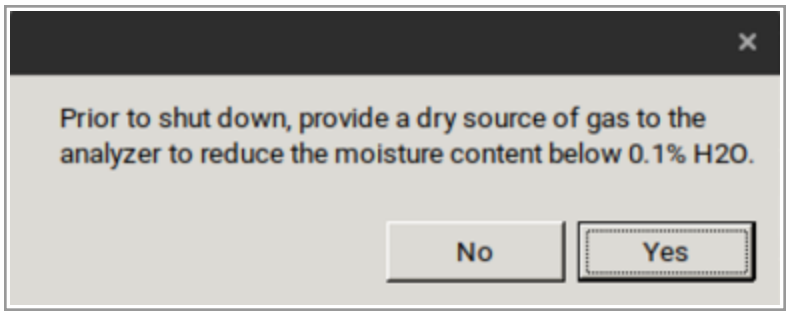


Figure 50 - Reduce Moisture Content/Shutdown

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

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

12.2 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 Data File Viewer

A.1 Quick Start Guide

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

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

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

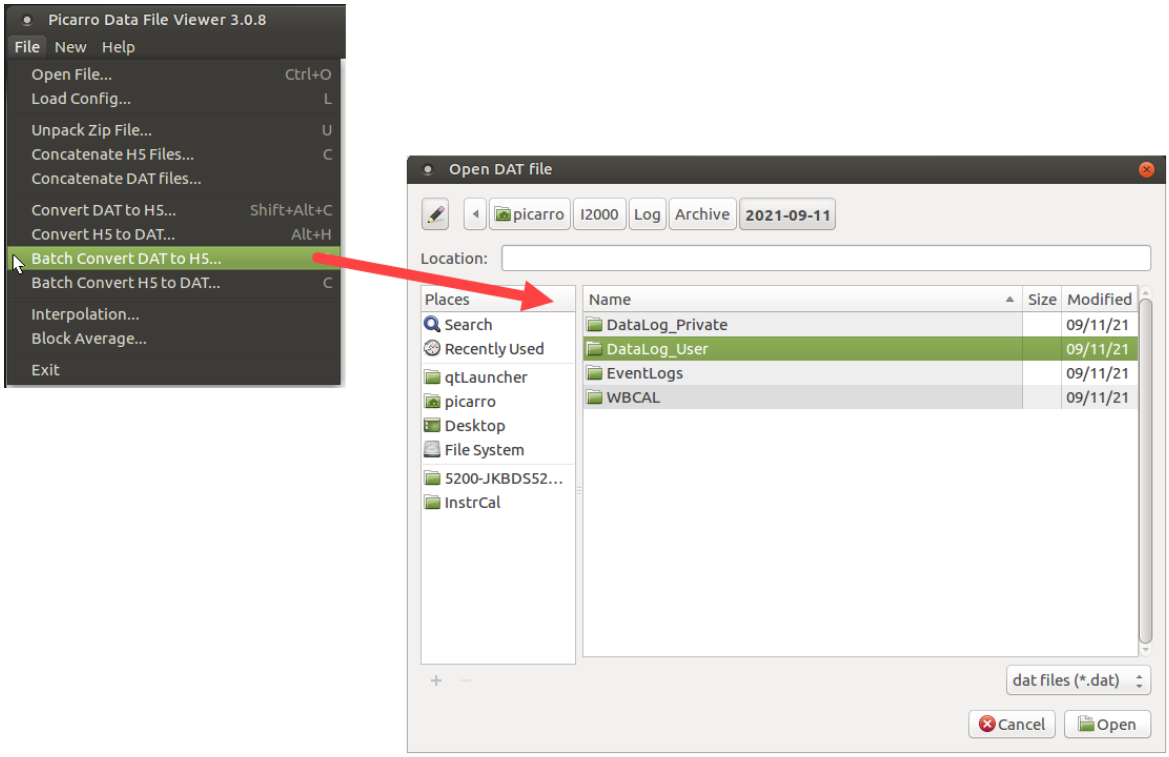


Figure 51 - Batch Convert DAT to H5 – Navigation

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**.

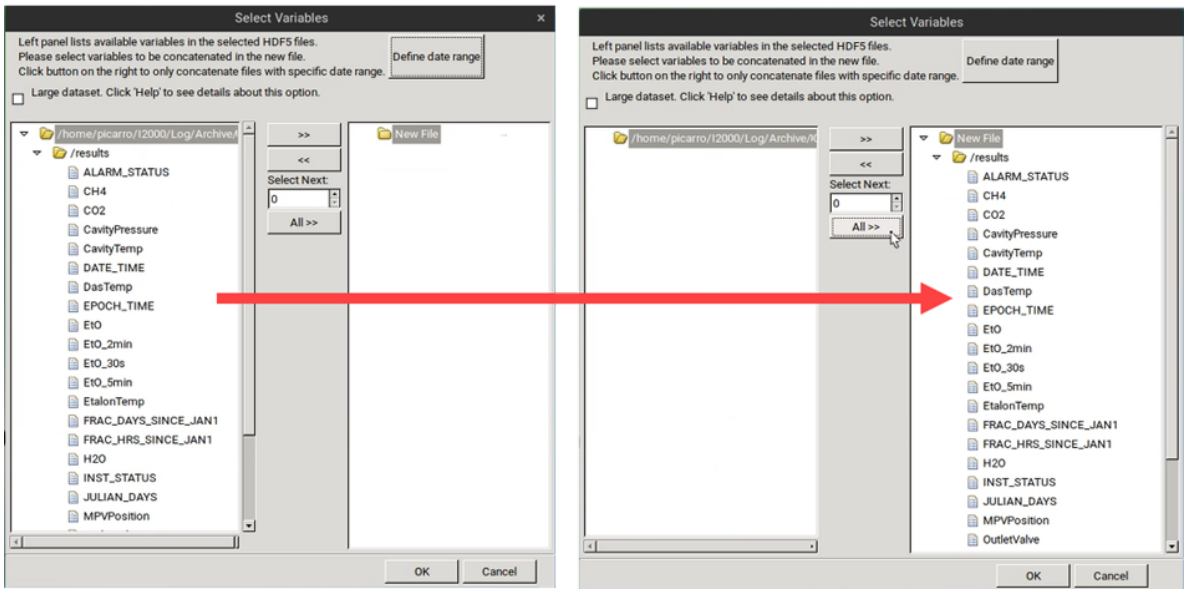


Figure 52 - Selecting Variables for Concatenation

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 below.

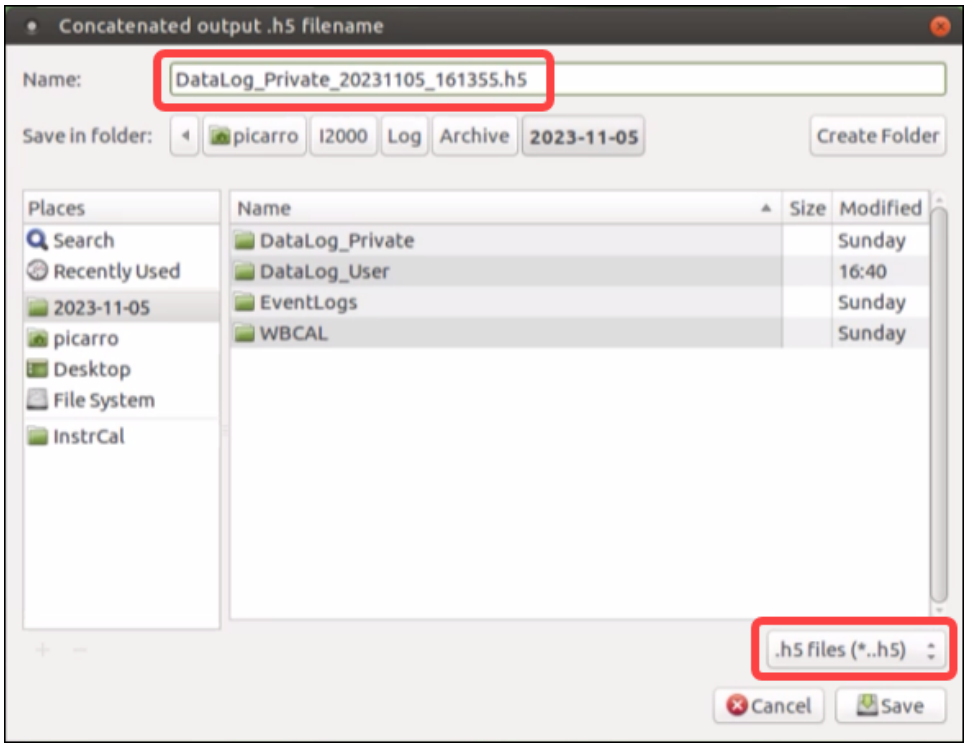


Figure 53 - Concatenated Output .h5 Filename

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 one time.

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

Figure 54 - Time Series Selection Options

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

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

A.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 55, Figure 56).

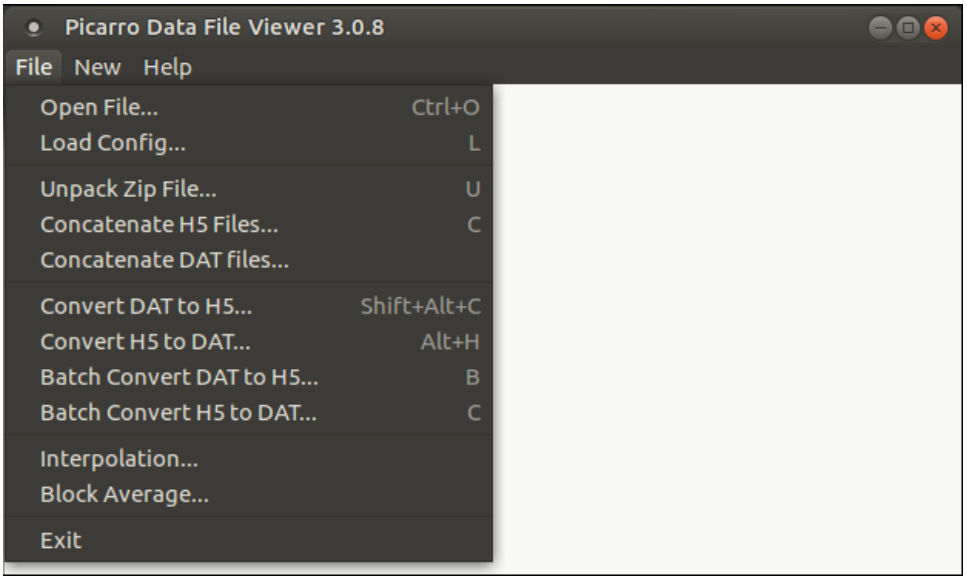


Figure 55 - Picarro Data File Viewer – File Menu

A.3 File Menu

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

A.3.1 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 A.5, New – Time Series Plot for more information.

A.3.2 Load Config

File > Load Config — Loads a configuration file (.ini format) to restore parameters of a workplace. Refer to A.6.2, Save Configuration for more information.

A.3.3 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.

A.3.4 Concatenate H5 Files

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

After selecting the path of the data files, Data File Viewer will automatically search an H5 file in the specified zip/folder and look for all available variables in the H5 file. The variables are then listed in the **Select Variables** window in the left panel (Figure 57), and users can use the **>>** button to move variables to the right panel for concatenation.

A.4 New Menu

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

Figure 56 - Picarro Data File Viewer – New Menu

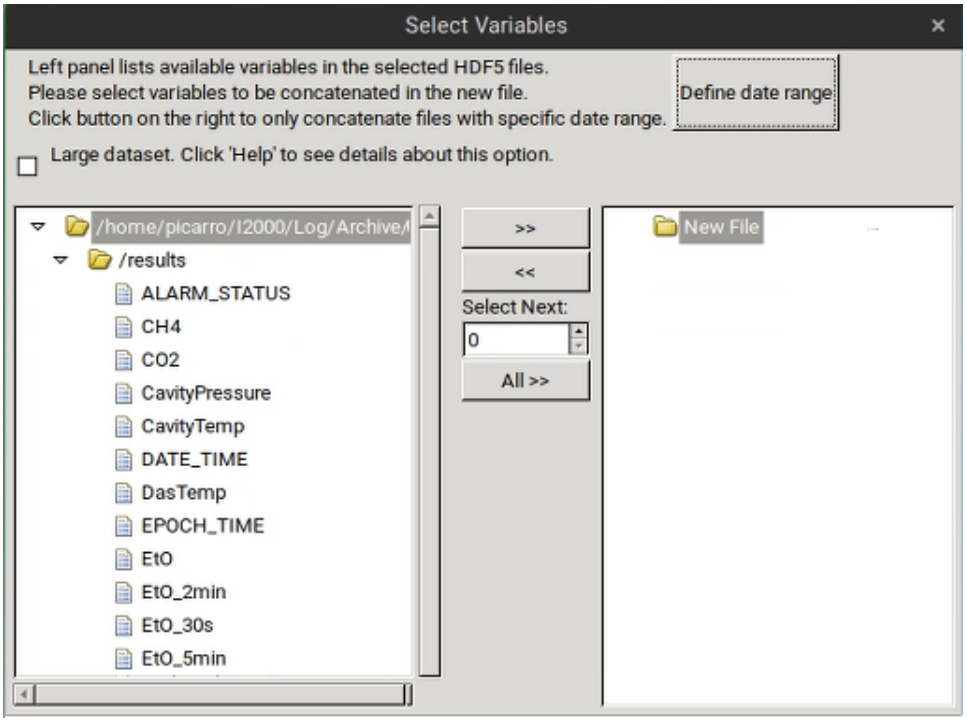


Figure 57 - Select Variables Form

NOTE

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

A.4.1 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.

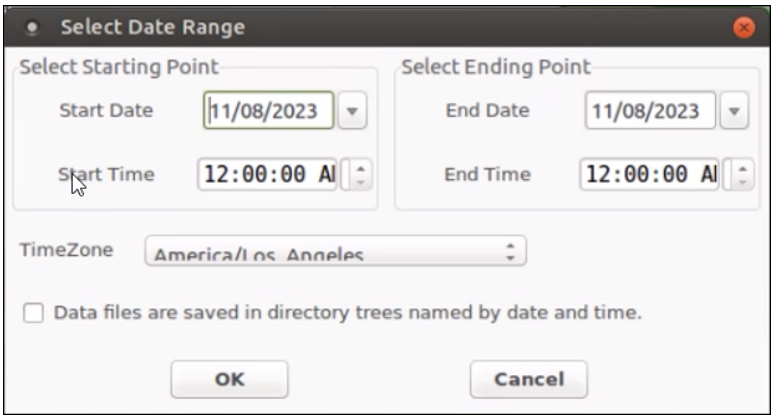


Figure 58 - Define Date Range Dialog

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

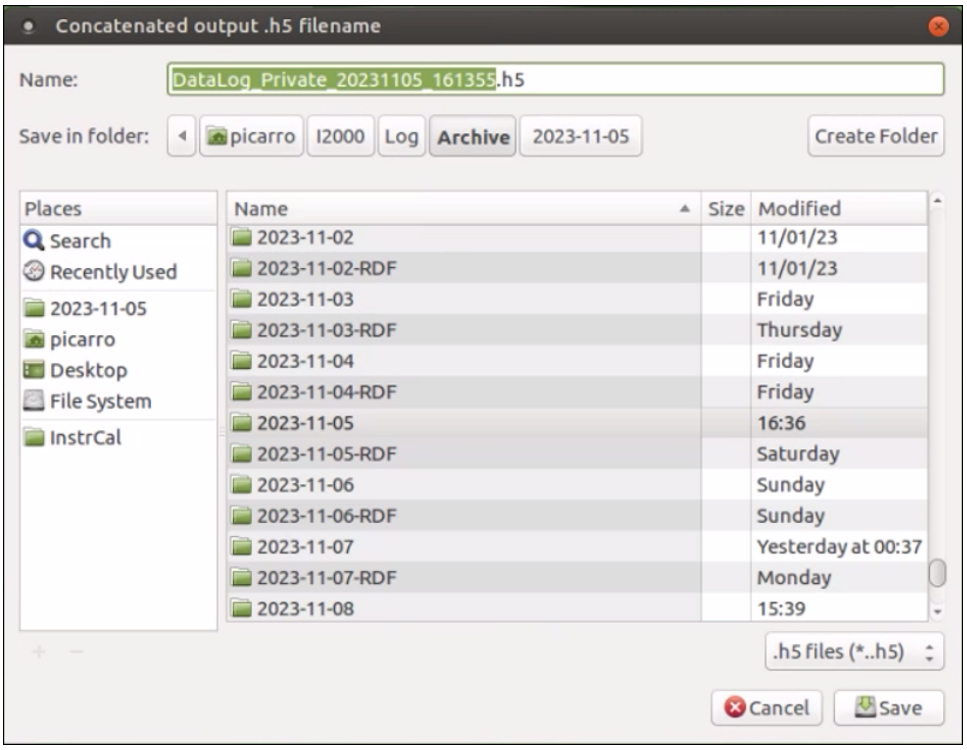


Figure 59 - File Structure of Data File Viewer

NOTE

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

CAUTION

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

NOTE

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

A.4.2 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.

A.4.3 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.

A.4.4 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.

A.4.5 Block Average

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

NOTE

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

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

A.5 New – Time Series Plot

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

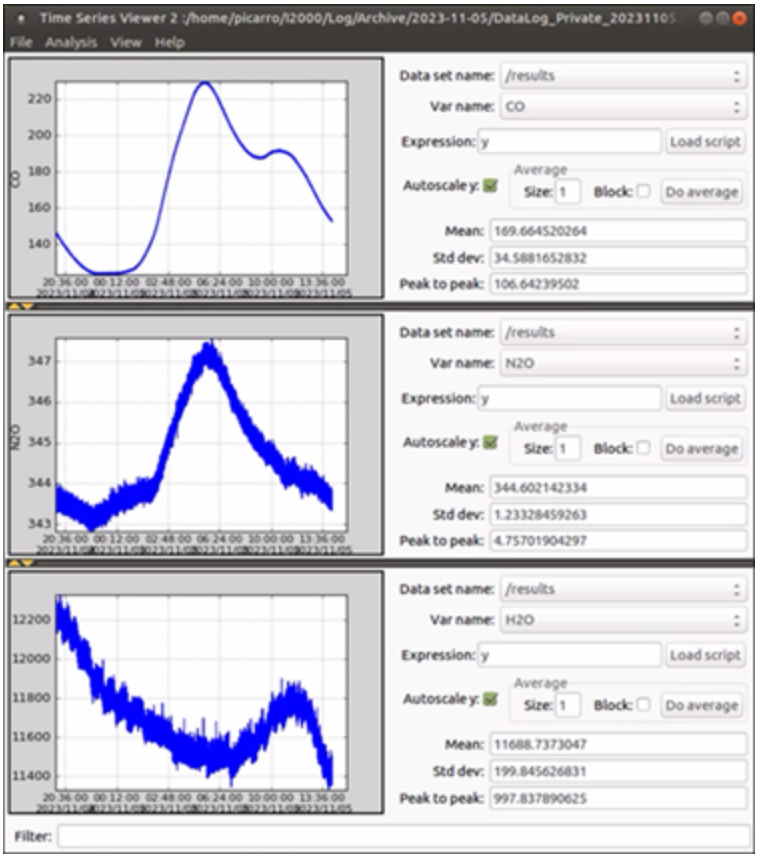


Figure 60 - Time Series Viewer

NOTE

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

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.

A.6 Time Series Viewer Menus

This section describes the Time Series Viewer menu options.

A.6.1 Time Series Viewer File Menu

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

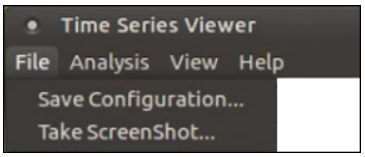


Figure 61 - Time Series Viewer – File Menu

A.6.2 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.

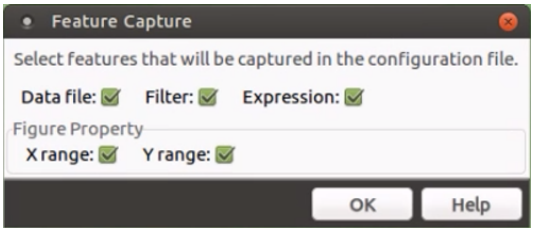


Figure 62 - Time Series Viewer – Feature Capture

⚠ 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.

A.6.3 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.

A.6.4 Time Series Viewer Analysis Menu

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

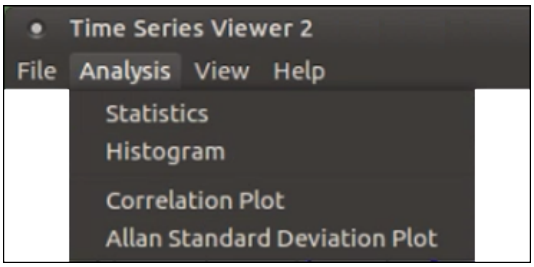


Figure 63 - Time Series Viewer – Analysis Menu

A.6.5 Statistics

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

A.6.6 Histogram

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

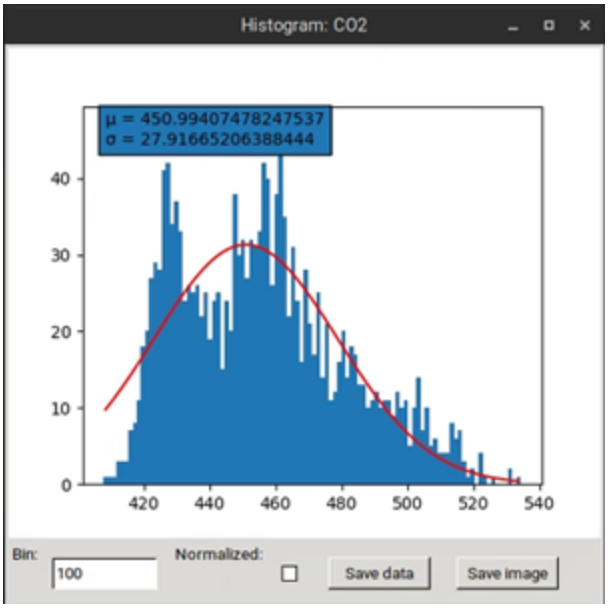


Figure 64 - Histogram Window – CO_2

Histogram Window Features:

- **Red Line** — A Gaussian function fitted to the histogram. Fitting results of μ and σ are shown in the top-left corner of the plot.
- **Bin** — Specifies the number of intervals that the range of values is divided into.
- **Normalized** — When selected, the sum of the histograms is normalized to 1.
- **Save data** — Saves histogram data to a CSV file.
- **Save image** — Saves the histogram image as a JPEG, PNG, or PDF file.

A.6.7 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.

A.6.8 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.

A.6.9 Time Series Viewer View Menu

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

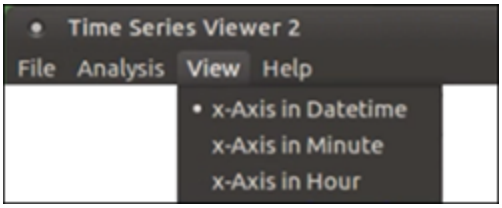


Figure 65 - Time Series Viewer – View Menu

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.

A.6.10 The Time Series Viewer Canvas

The Time Series Viewer canvas (Figure 66) is comprised of interactive graphs and a variety of configuration options.

A.6.11 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.

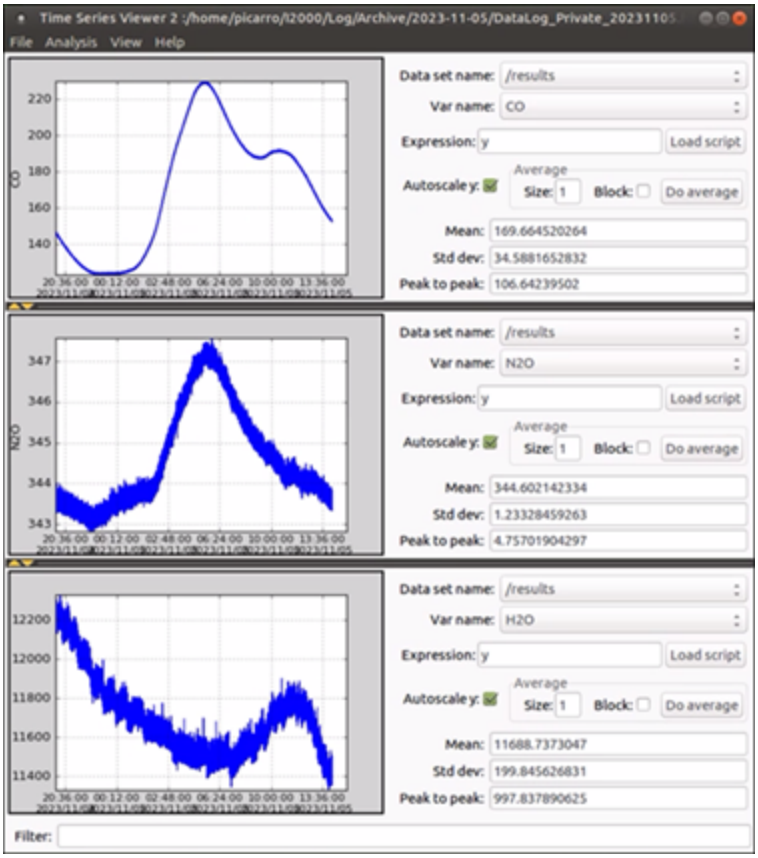


Figure 66 - Time Series Viewer Canvas

NOTE

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

A.6.12 Right-click Menu

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

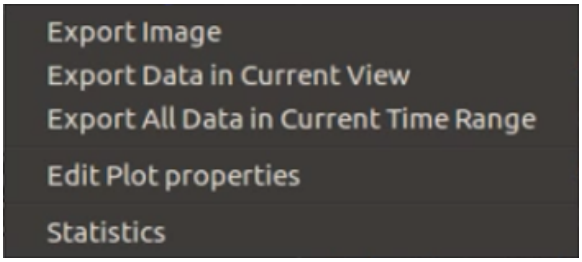


Figure 67 - Canvas Right-click Pop-up Menu

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

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

Export All Data in Current Time Range — Exports all variable columns of the selected dataset in the current time range to an HDF5 file. Refer to A.3.4, Concatenate H5 Files for more information.

Edit Plot properties — Opens the Image Editor form (Figure 68), where the following options can be specified.

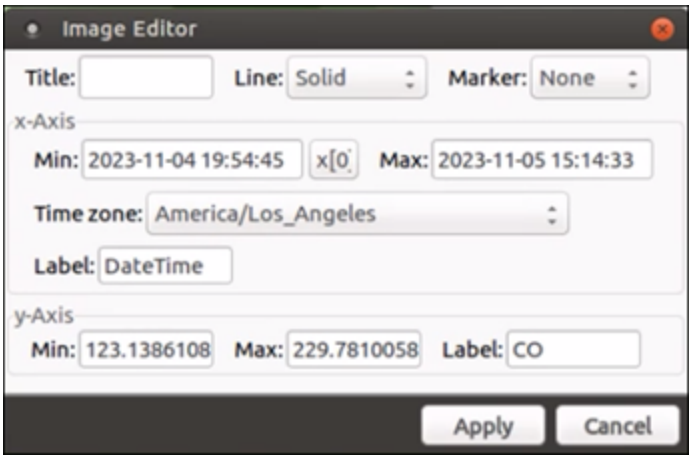


Figure 68 - Image Editor Form

Image Editor Form Options:

- **Title** — Edits the title of the plot.
- **Line** — Specifies the line pattern of the plot. If None is selected, the data points will be plotted without connecting lines.

- **Marker** — Specifies the marker type to indicate data points. If None is selected, data points will not be shown.
- **x-Axis** — Min and Max: Specifies the minimum and maximum date range for the X-axis.
- **x[0]** — Sets the earliest time of the dataset as the minimum of the X-axis.
- **Time zone** — Sets the time zone for date/time variables. This defaults to the local time zone.
- **Label** — Specify labels for the X-axis and the Y-axis.
- **y-Axis** — Min and Max: Specifies the minimum and maximum of data displayed on the Y-axis.

A.6.13 Dataset Name and Var Name

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

Use the **Dataset name** drop down (Figure 69) 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.

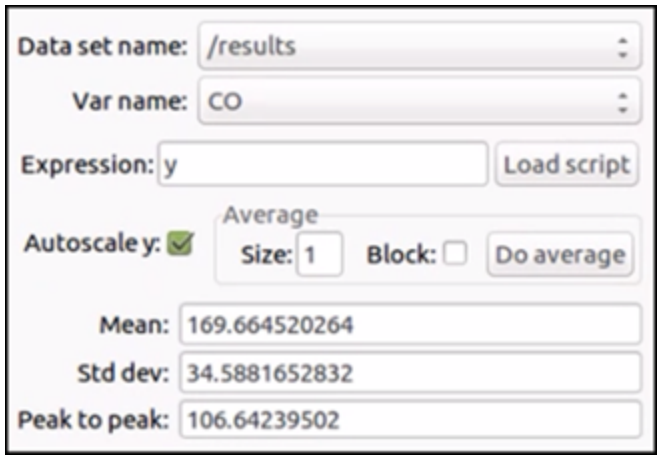


Figure 69 - Time Series Viewer Dataset Options

A.6.14 Autoscale Y

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

A.6.15 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.

A.6.16 Mean, Std Dev, and Peak to Peak

The Mean, Std dev (Standard deviation) and Peak to peak fields (Figure 69) provide all the statistical information of data in the current view.

A.6.17 Correlation/XY Plot

The Correlation/XY Plot window (Figure 70) includes two menu items: File and Analysis. For details about the File menu, see A.6.2, Save Configuration.

REMINDER

The canvas in this plot is interactive. For details about the plot canvas, see A.6.10, The Time Series Viewer Canvas.

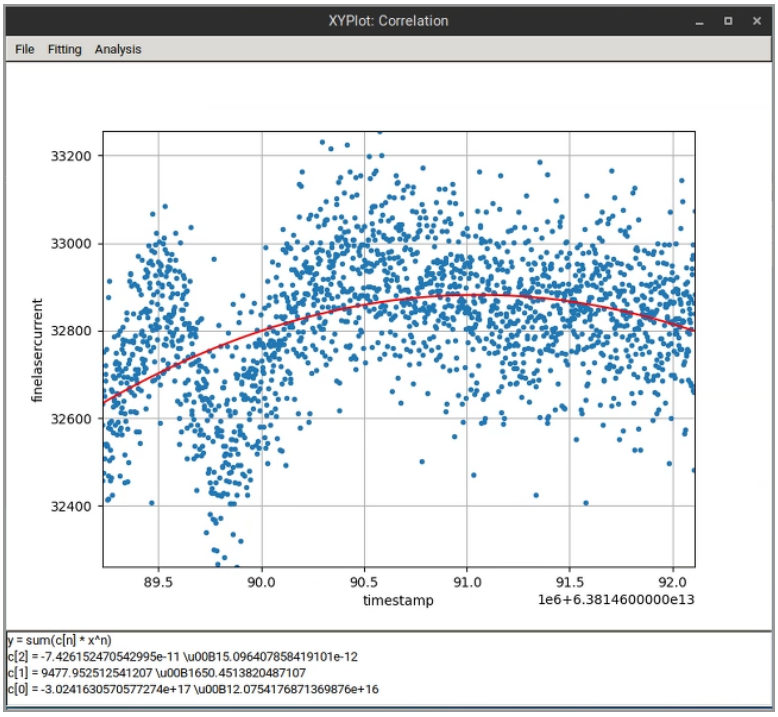


Figure 70 - Correlation XY Plot

A.6.18 Fitting Menu

The Fitting menu includes the four options that are described below.

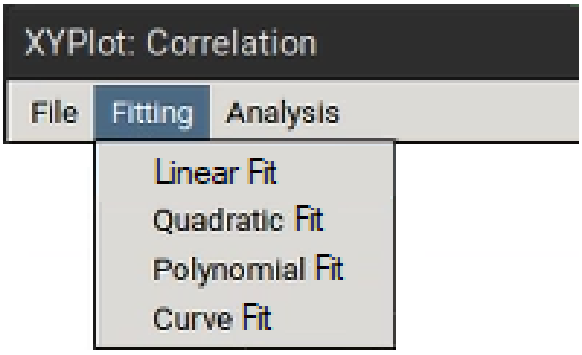


Figure 71 - Fitting Menu

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.

A.6.19 Analysis Menu

The Analysis menu has two options: Integration and Statistics.

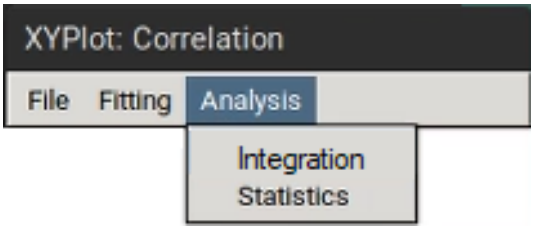


Figure 72 - Analysis Menu

1. Integration – Calculates area under the curve using the composite trapezoidal rule.
2. 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 73).

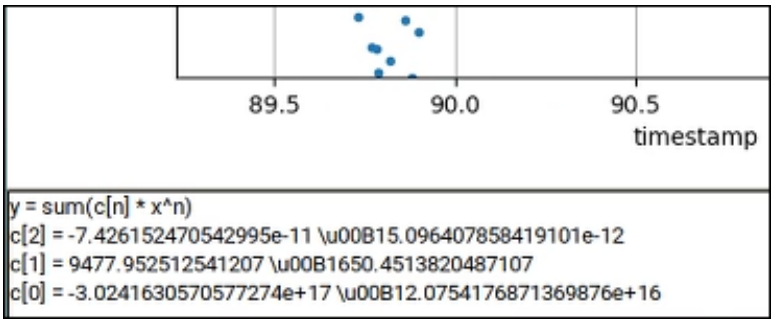


Figure 73 - Results of Quadratic Fitting

B 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

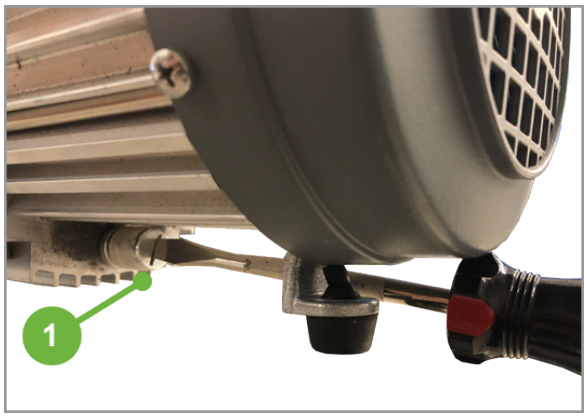
Figure 74 - A2000 Pump Vacuum and Exhaust Ports

B.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

B.2 Directions

1. Remove the noise dampener fitting from the bottom of the pump using a long flathead screwdriver (Figure 75).

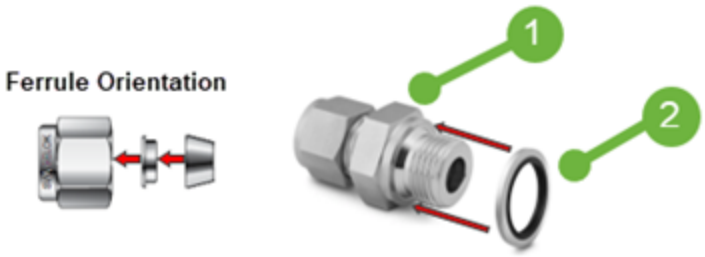


1 Noise Dampener

Figure 75 - Pump Noise Dampener Removal

2. Slide the adapter gasket PN 22929 onto the adapter fitting PN 22928 (Figure 76), screw it into the pump exhaust port, and then tighten it 1/4 turn using a 9/16” wrench.
3. Remove the Swagelok nut and ferules from the adapter fitting to ensure their orientation is as shown below, then loosely reattach to the adapter.
4. Slide the 1/4” exhaust tubing into the Swagelok nut and ferules until the tubing is fully seated, then using a 9/16" wrench, tighten the nut approximately seven flats (420 degrees).

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



1 Adapter Fitting PN 22928

2 Adapter Gasket PN 22929

Figure 76 - 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)

C Analog Signal Output

This analyzer is configured with an optional Electrical Interface Card (EIC) that provides four 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.

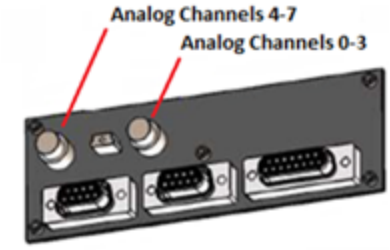


Figure 77 - Analog Channel Connectors

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 12 - 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

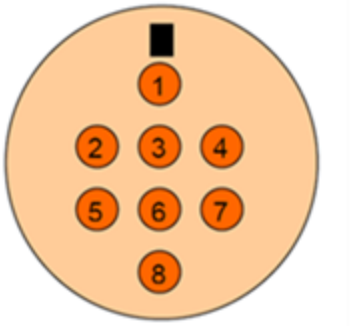


Figure 78 - Analog Pin Map

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 13 - 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	NH_3 concentration	0-10V	10 ppb/V	0 to 90 ppb
1	NH_3 concentration	0-10V	100 ppb/V	0 to 0.9 ppm
2	NH_3 concentration	0-10V	2 ppm/V	0 to 18 ppm
3	H_20 concentration	0-10V	2%/V	0 to 18 ppm
4	DAS Temp	0-10V	10^{o} C/V	0 to 90^{o}C
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.

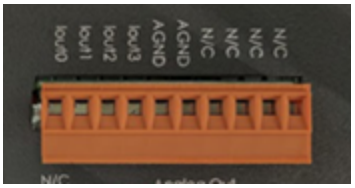


Figure 79 - 4–20 mA Output with Terminal Connector

By default, the settings for the four channels are as follows:

Table 14 - Signal Output Settings

	Iout0	Iout1	Iout2	Iout3
Monitoring	NH_3	H_2O	DAS Temperature	Cavity Pressure
Units	ppb	%	Degrees C	Torr
Min	0.0	0.0	0.0	0.0
Max	1000.0	20.0	100.0	1000.0

- **NH_3** — Displays the NH_3 concentration reading in parts per billion (ppb)
- **H_2O** — Displays H_2O in percent (%)
- **DasTemperature** — 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 80 - Removing the Terminal Connector

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

Figure 81 - 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.

E Serial Communication Protocols

The Serial Port Menu is accessible from the Config Menu and displays the configurations of COM1 (used for Command Interface) and COM3 (used for Data Out). The COM1 port is preconfigured, and its settings cannot be changed. The COM3 port can be enabled or disabled, and the following settings can be configured:

- **Baud rate** — The number of bit transfers per second.
- **Data Bits** — The number of data bits in a communication packet, or a single byte transfer.
- **Stop Bits** — The number of bits used to signal the end of a communication packet.
- **Parity** — Sets the parity bit to Even, Odd, Mark, Space, or None.

After making any changes, select Save to apply the changes or Undo to revert to the previous configuration.

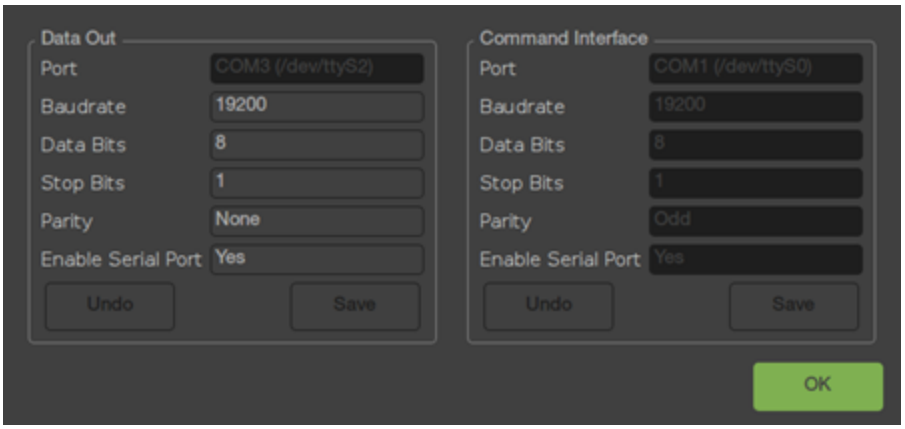


Figure 82 - Default Serial Port Configuration

E.1 COM1 (Command Interface) Protocol

The headers below correspond to each column of data and are not included in the output:

CavityPressure, CavityTemp, DasTemp, EtalonTemp, WarmBoxTemp, species, MPVPosition, OutletValve, solenoid_valves, NH3, H2O, NH3_Raw, NH3_sigma, NH3_tau, nh3_base_11, ymd, hms

Output Frequency:

Data will output when command is sent to COM1 via RS232.

E.2 COM3 (Streaming) Protocol

The column headings for the streaming interface are as follows:

Column	Description
Column0	Timestamp
Column1	CavityPressure
Column2	CavityTemp
Column3	DasTemp
Column4	EtalonTemp
Column5	WarmBoxTemp
Column6	species
Column7	MPVPosition
Column8	OutletValve
Column9	solenoid_valves
Column10	NH3
Column11	H2O
Column12	NH3_Raw
Column13	NH3_sigma
Column14	NH3_tau
Column15	nh3_base_11
Column16	ymd
Column17	hms

NOTE

The data in columns 12-17 are reserved for diagnostic use by Picarro authorized technicians.

E.2.1 Output Frequency:

The data outputs automatically in real time similar to the GUI display.

F External Valve Sequencer

F.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 F.7, External Valve Sequencer Software Overview) which is available from the **Tools** menu on the GUI.

Picarro offers two rotary valve and two solenoid valve solutions:

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

F.2 A0311 16-Port Distribution Manifold

F.2.1 Compatibility

The A0311 (Figure 83) 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).

F.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 83 - A0311 – 16-port Distribution Manifold

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

F.3.1 Compatibility

The A0311-S (Figure 84) 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

F.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 84 - A0311-S – 16-Port Sequencer – Fast Multiport Gas Sampler

F.4 Valve Control Configurations

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

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

⚠ CAUTION

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

F.5 Setting Up Solenoid Valves

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

⚠ CAUTION

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

The valve connector cable should be connected to the 15-pin connector at the lower left corner of the analyzer. There are six pairs of wires with connectors labeled V1, V2, … V6 with 2-pin female Molex connectors (Molex #43020-0200) for connection to the solenoid valves. For valves wired with matching Molex connectors, connect V1 to the solenoid valve 1, V2 to solenoid valve 2, etc. Do not connect the solenoid valve to the analyzer ground – use only the provided electrical connectors.

F.6 Setting up a Rotary Selector Valve

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

F.7 External Valve Sequencer Software Overview

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

F.7.1 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.

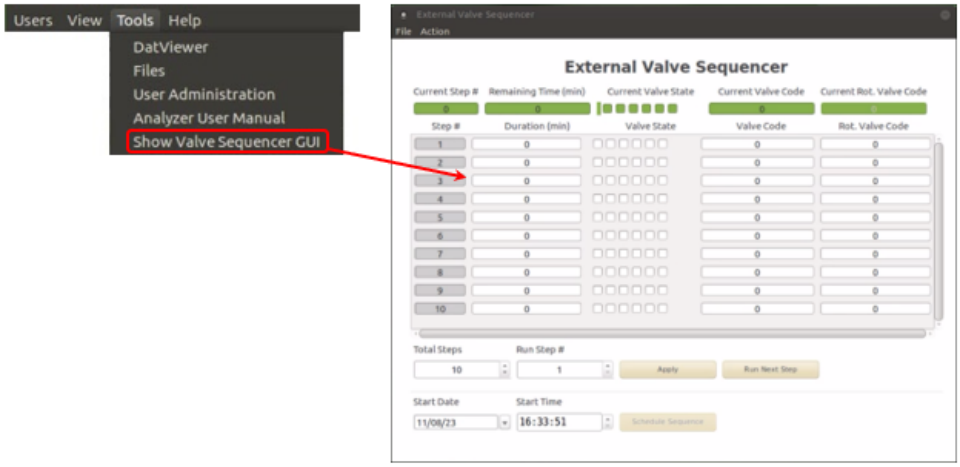


Figure 85 - Launching the Valve Sequencer GUI

F.7.2 Valve Sequencer UI Menus

The sequencer GUI provides the following dropdown menu options.

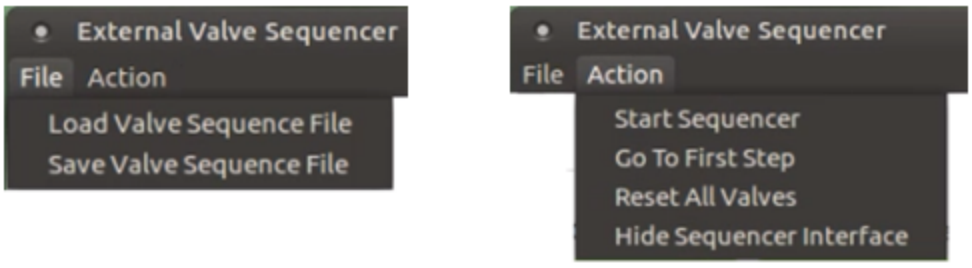


Figure 86 - Valve Sequencer UI Dropdown Menus

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 87 - 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.

F.8 Programming and Saving a Valve Sequence

Each "step" in the sequence can be used to set the rotary valve to a given position or activate selected solenoid 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**.

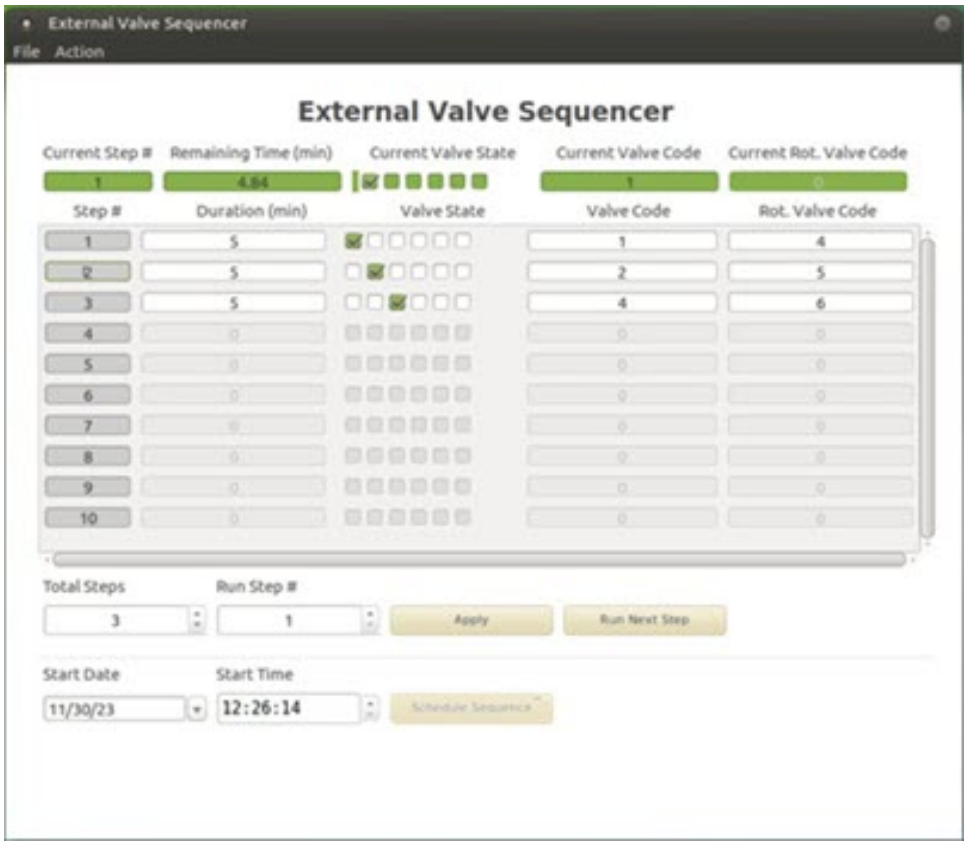


Figure 88 - Example 15 Minute Sequence

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 86). The sequence may be saved with any name the user chooses.

F.9 Loading and Running a Saved Sequence

F.9.1 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**.

F.9.2 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.

F.9.3 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**.

F.9.4 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.

F.9.5 Resetting Valves

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

F.10 Scheduling a Sequence

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

G Relative Humidity Conversion

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

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

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

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

The two concentration definitions can be related by

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

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

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

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

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

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

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

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

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

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

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

H 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.

H.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.

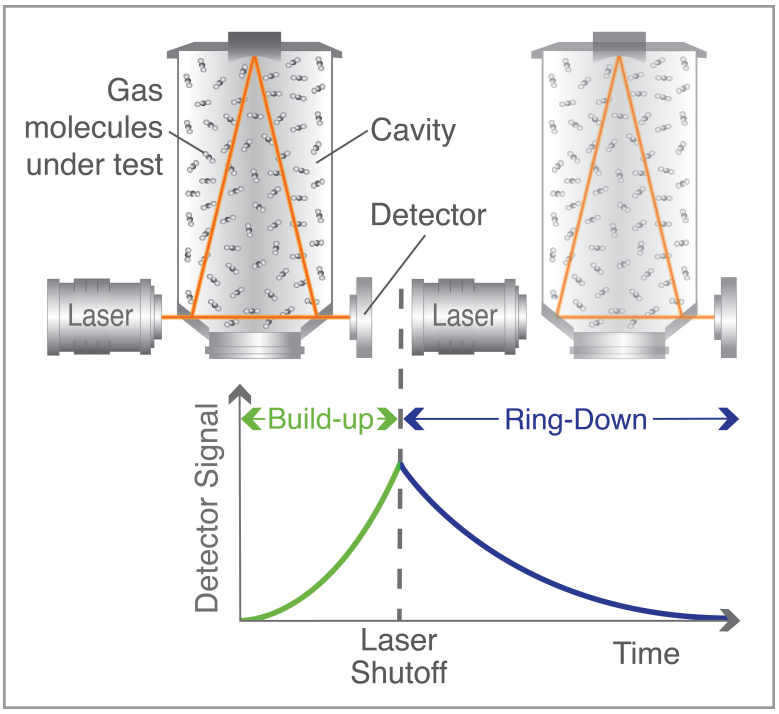


Figure 89 - Schematic of the Picarro CRDS analyzer cavity

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.

H.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.

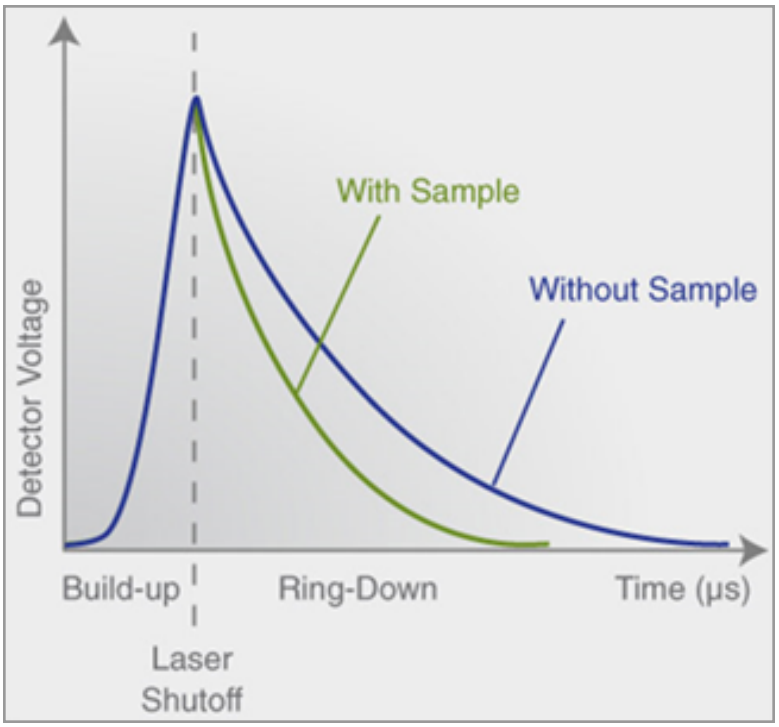


Figure 90 - Light intensity as a function of time in a CRDS system

H.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 91 shows a plot of ideal optical spectra with a clean, uniform baseline on either side of the absorption peak.

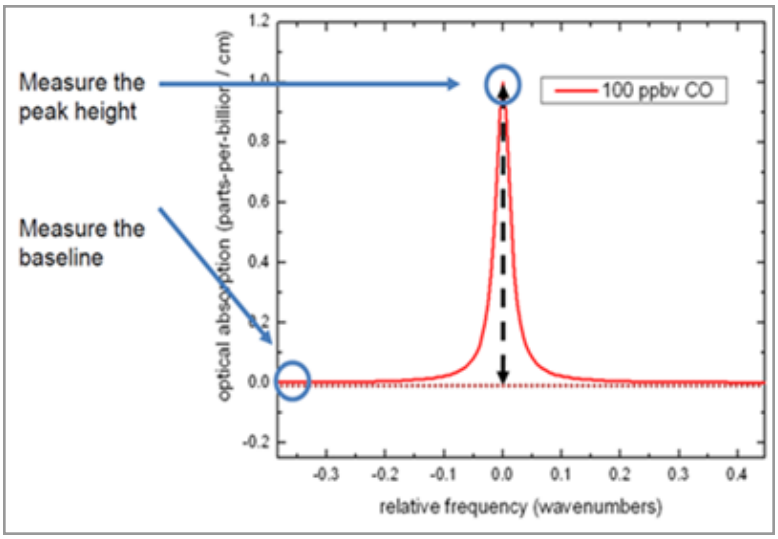


Figure 91 - Absorption Spectral Curve

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.

H.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.

I Limited Warranty

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

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

NOTE

DISCLAIMER

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

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

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

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

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

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

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

DAMAGE IN SHIPMENT — Your analyzer should be inspected and tested as soon as it is received. The product is packaged for safe delivery. If the product is damaged in any way, you should immediately file a claim with the carrier or, if insured separately, with the insurance company. Picarro, Inc. will not be responsible for damage sustained in shipment. All Picarro products are F.O.B. origin, shipped from the Picarro factory or Picarro distributor. The price of all Products, unless otherwise specifically stated, is Ex- Works, Sunnyvale, CA as defined by Incoterms, 2001. The cost of normal packaging for shipment is included in the invoiced price. Where Buyer specifies special packaging, a charge will be made to cover any extra expense.

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

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

About Picarro

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

Product Support

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