

# G2131-*i* Analyzer User Manual

for Isotopic CO<sub>2</sub>

PICARRO



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## Revision History

This section summarizes the revision history of this document. It provides a record of updates made across versions, including the revision identifier, publication date, and a brief description of key changes.

| Revision | Date           | Notes                                                                                          |
|----------|----------------|------------------------------------------------------------------------------------------------|
| D        | September 2026 | Removed the USB backup device from the packing contents and updated the manual for Windows 11. |

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# 1 Analyzer Overview

The Picarro G2131-*i* analyzer for Isotopic CO<sub>2</sub> uses Picarro's patented Cavity Ring-Down Spectroscopy (CRDS) technology to provide precise, continuous measurements of carbon dioxide concentration and stable carbon isotope ratios for laboratory, research, and environmental monitoring applications. The system combines a laser-based spectrometer, integrated control computer, data acquisition software, and an external vacuum pump to deliver automated, real-time analysis and data storage. This manual provides information for the safe installation, operation, maintenance, calibration, and troubleshooting of the analyzer, as well as guidance on using the graphical user interface (GUI) and data management features.

## 1.1 Analyzer

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



Figure 1 - G2131-i Front/Back Panels

## 1.2 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 2 - A2000 Vacuum Pump - Side Views

## 1.3 Analyzer Specifications

Table 1 - G2131-i Specifications

| Parameter                 | Specification                                                                            |
|---------------------------|------------------------------------------------------------------------------------------|
| Measurement Technique     | Cavity Ring-Down Spectroscopy (CRDS)                                                     |
| Primary Gases Measured    | CO <sub>2</sub> isotopes                                                                 |
| Weight: Analyzer          | 20.9kg (46 lbs.) – Should be lifted by two people.                                       |
| Weight: A2000 Pump        | 6.5 kg (14.4 lbs)                                                                        |
| Dimensions - Analyzer     | Length: 43.2 cm (17.55")<br>Width: 44.6 cm (17")<br>Height: 17.8 cm (7")                 |
| Dimensions – A2000 Pump   | Length: 27.9 cm (11")<br>Width: 10.2 cm (4")<br>Height: 19.1 cm (7.5")                   |
| Clearance                 | Front: 15.3 cm (6"); Rear: 15.3 cm (6")                                                  |
| Ambient Temperature Range | Operating: 10 °C to 35 °C (50 °F to 95 °F)<br>Storage: -10 °C to 50 °C (14 °F to 122 °F) |

| Parameter                                              | Specification                                                                                                    |
|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| Ambient Humidity Range                                 | < 85% RH non-condensing                                                                                          |
| Sample Pressure                                        | 300 to 1000 Torr (40 to 133 kPa)                                                                                 |
| Sample Flow Rate                                       | <50 sccm at 760 Torr, no filtration required                                                                     |
| Maximum Altitude                                       | 3,048 m (10,000 ft – Operation)                                                                                  |
| Required Accessories                                   | Included: Pump (external),<br>Supplied by Customer: monitor                                                      |
| Operating System                                       | Windows                                                                                                          |
| Data Outputs                                           | RS-232, Ethernet, USB, analog (optional) 0–10 V                                                                  |
| Installation                                           | Benchtop or 48.3 cm (19”) rack mount                                                                             |
| Power Requirements<br>Mains Supply Voltage Fluctuation | 100–240 VAC, 47/63 Hz (auto-sensing)<br><260 W start-up (total); 125 W (analyzer)<br>80 W (pump) at steady state |
| Minimum Rated Circuit Amperage                         | 10A @ 115 VAC<br>5A @ 230 VAC                                                                                    |
| Liquid Ingress Protection                              | None                                                                                                             |

## 1.4 Acronyms

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

Table 2 - Acronyms, Formulas, Units, and Symbols

| Acronym        | Definition      |
|----------------|-----------------|
| “ (as in 1/4”) | Inches          |
| °C             | degrees Celsius |
| %              | Percentage      |
| ±              | Plus-minus sign |

| Acronym         | Definition                                            |
|-----------------|-------------------------------------------------------|
| <               | Less than                                             |
| >               | Greater than                                          |
| ≤               | Less than or equal to                                 |
| ≥               | Greater than or equal to                              |
| ‰               | per mil                                               |
| A               | Ampere                                                |
| AC              | Alternating Current                                   |
| ASCII           | American Standard Code for Information Interchange    |
| bar             | Metric unit of pressure. 1 bar = 100,000 pascals (Pa) |
| cc              | current calibration                                   |
| CH <sub>4</sub> | Methane                                               |
| cm              | centimeters                                           |
| CO <sub>2</sub> | Carbon Dioxide                                        |
| COM             | Communication Port                                    |
| CRDS            | Cavity Ring-Down Spectroscopy                         |
| CSV             | Comma Separated Values                                |
| CPU             | Central Processing Unit                               |
| DC              | Direct Current                                        |
| DIO             | Digital Input/Output                                  |
| DVI             | Digital Visual Interface                              |
| EMO             | Emergency Off                                         |
| EtO             | Ethylene Oxide                                        |
| °F              | Degrees Fahrenheit                                    |
| ft.             | Length in feet; 1 ft. = 12" or 12 inches (30.48 cm)   |

| Acronym          | Definition                                      |
|------------------|-------------------------------------------------|
| GUI              | Graphical User Interface                        |
| H <sub>2</sub> O | Water, Water Vapor                              |
| HB               | Hotbox                                          |
| HDF              | Hierarchical Data Format                        |
| HDMI             | High-Definition Multimedia Interface            |
| Hz               | Hertz                                           |
| kg               | kilograms                                       |
| kPa              | Kilopascal; unit of pressure; 1 kPa = 0.145 PSI |
| lbs              | pounds                                          |
| m                | Meters or month                                 |
| mA               | Milliampere                                     |
| max              | Maximum                                         |
| min              | Minimum                                         |
| mK               | Millikelvin                                     |
| mm               | millimeters / millimetre                        |
| NC               | Normally Closed                                 |
| NH <sub>3</sub>  | Ammonia                                         |
| NO               | Normally Open                                   |
| NTP              | Network Time Protocol                           |
| OD               | Outside Diameter                                |
| P                | Pressure                                        |
| PAIAC            | Phosphoric Acid Impregnated Activated Charcoal  |
| PC               | Personal Computer                               |
| PDF              | Portable Document Format                        |

| Acronym   | Definition                                                                                          |
|-----------|-----------------------------------------------------------------------------------------------------|
| PFA       | Perfluoroalkoxy – A chemically resistant polymer, suitable for use with sticky and aggressive gases |
| PN        | Part Number                                                                                         |
| ppb       | parts per billion                                                                                   |
| ppm       | parts per million                                                                                   |
| PS/2      | IBM Personal System/2 (6-pin mini-DIN connector)                                                    |
| PSI (psi) | Pounds per Square Inch                                                                              |
| PSIG      | Pounds per Square Gauge                                                                             |
| Pws       | Water vapor pressure                                                                                |
| QC        | Quality Control                                                                                     |
| RH        | Relative Humidity                                                                                   |
| RJ-45     | Registered Jack (physical network interface)                                                        |
| RS232     | Recommended Standard 232 (serial communication protocol)                                            |
| SCCM      | Standard cubic centimeters per minute                                                               |
| SLPM      | Standard Liters Per Minute                                                                          |
| SNTP      | Simple Network Time Protocol                                                                        |
| sec       | Seconds                                                                                             |
| SSL       | Secure Sockets Layer                                                                                |
| SS/SST    | Stainless Steel                                                                                     |
| TCP/IP    | Transmission Control Protocol/Internet Protocol                                                     |
| Torr      | Torricelli (unit of pressure equal to 1/760 atmosphere)                                             |
| UM        | User Manual                                                                                         |
| USB       | Universal Serial Bus                                                                                |
| UPS       | Uninterruptible Power Supply                                                                        |
| VAC       | Volts Alternating Current                                                                           |

| Acronym | Definition           |
|---------|----------------------|
| VDC     | Volts Direct Current |
| W       | Watts                |
| WB      | Warmbox              |
| WLM     | Wavelength Monitor   |

## 1.5 Text Conventions

The following conventions are used in the manual.

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

## 2 Safety

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

### 2.1 Warning Symbols

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

#### **DANGER**

**DANGER** indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.

#### **WARNING**

**WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or severe injury.

#### **WARNING**

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

#### **WARNING**

**HEAVY OBJECT** indicates users should use the described technique (or follow your local regulations) when lifting the analyzer.

#### **WARNING**

**LASER WARNING** alerts user of a laser danger.

#### **CAUTION**

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

 **HOT SURFACE**

HOT SURFACE alerts user to potential injury from hot surfaces.

 **NOTE**

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

 **REMINDER**

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

## 2.2 General Safety

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

### CDRH Certification

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

### CE Certification

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

 **WARNING**

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

 **WARNING**

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

 **WARNING**

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

 **CAUTION**

The analyzer contains no user serviceable components except the particulate filter, CPU fan, fan kit (hotbox and ventilation fans), and A2000 vacuum pump diaphragms and valves. To order user-replaceable parts and access video replacement instructions, see section .

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

 **CAUTION**

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

 **WARNING**

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

 **CAUTION**

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

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

 **HOT SURFACE**

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

 **CAUTION**

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

 **WARNING**

This analyzer weighs 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.

## 2.3 Laser Safety

This section describes the laser safety classification, labeling, and handling requirements for the analyzer. While the system is designated as a Class 1 laser product during normal operation, it contains an embedded higher-power laser that may present a hazard if the enclosure is opened.

Follow all safety instructions, observe all warning labels, and restrict service access to qualified personnel operating in approved laser-safe environments.

**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 3 - Laser Safety Label – Affixed to Outside Cover of Analyzer

**WARNING**

The laser is a Class3B when exposed.  
Only operate or service this device in accordance with the instructions in this guide, and only open the device in an approved laser safe service area using appropriate laser-safety glasses.

The following laser safety label is affixed to the inside of the analyzer:



Figure 4 - Laser Safety Label – Affixed to Inside of Analyzer

**WARNING**

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

 **WARNING**

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

## 3 Unpacking

This section provides instructions for inspecting and unpacking the analyzer and its associated components. Picarro products are inspected and tested prior to shipment, and the packaging is designed to protect the equipment from damage during normal transit.

Upon receipt, carefully inspect all shipping containers and contents before installation. Promptly report any damage or missing items to Picarro. Retain all original packaging materials for future transport, relocation, or service return of the analyzer.

### 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.

## 3.3 Contents

This section lists the components shipped with the analyzer. Items may be packaged in one or more shipping containers depending on the system configuration and ordered accessories.

Verify that all expected components are present and undamaged before proceeding with installation. If any items are missing or damaged, contact Picarro or your local distributor.

Table 3 - Shipping Contents

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

| Part (qty)                                                                                                           | Description                                                          |
|----------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| <br><b>Control Cable Kit (1)</b>    | For external solenoid valves.                                        |
| <br><b>Nut (1) and Ferrules (2)</b> | For connecting input line to analyzer gas input.                     |
| <br><b>Vacuum Hose (1)</b>          | Hose to connect the pump to the analyzer.                            |
| <br><b>Keyboard and Mouse (1)</b> | Monitor is not included.                                             |
| <br><b>Document Packet (1)</b>    | Includes this user manual and certificate of compliance (not shown). |

| Part (qty)                                                                                                            | Description                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p><b>A2000 Vacuum Pump (1)</b></p> | <p>Provides vacuum required for sample gas sequencing into and out of the analyzer.</p>                                                                      |
|  <p><b>AC Power Cable (1)</b></p>    | <p>A power cable with connectors appropriate to your country is provided.</p> <p><b>Note:</b> The vacuum pump voltage must be selected. See in section .</p> |
|  <p><b>Pump Manual (1)</b></p>       | <p>Detailed instructions for pump.</p>                                                                                                                       |

## 4 Hardware Setup

Read this entire section before proceeding. Refer to 4.5 in the following section for installation.

### 4.1 Required Components and Tools

- Analyzer and accessories included in shipment
- Pump and accessories included in shipment
- 9/16" open end wrench
- 11/16" open end wrench
- 5/8" open end wrench
- Phillips head screwdriver (for rack mounting)
- 2.5 mm Allen wrench (for rack mounting)
- Power cord for analyzer and pump

### 4.2 Installation Safety

The following installation safety alerts outline essential precautions for safe handling, installation, and operation of the analyzer. Review and follow these requirements carefully to prevent equipment damage and ensure safe operation.



#### WARNING

**Two-person lift required:** The analyzer weighs 20.9 kg (46 lbs). When lifting the analyzer, use the technique described General Safety (or follow your local regulations).



#### CAUTION

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



#### WARNING

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

 **WARNING**

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

 **WARNING**

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

 **WARNING**

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

 **WARNING**

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

 **WARNING**

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

 **CAUTION**

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

 **WARNING**

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

 **CAUTION**

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

 **CAUTION**

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

 **CAUTION**

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

 **CAUTION**

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

 **CAUTION**

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

 **CAUTION**

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

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

## 4.3 Analyzer Preparation

The following section provides guidance on ventilation requirements, positioning and voltage selection for the analyzer and pump.

### 4.3.1 Ventilation Considerations

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

### 4.3.2 Positioning

 **NOTE**

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

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

 **CAUTION**

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

3. Place the external vacuum pump near the analyzer in a rack, or on a cart or table.
4. Unpack the analyzer accessories (vacuum line, cable kit, manual, and certificate of compliance).

 **NOTE**

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

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

### 4.3.3 Set A2000 Pump Input Voltage

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



1 Fuse

2 Input Voltage Selector

Figure 5 - Vacuum Pump Voltage Selection

## 4.4 A2000 Pump and Gas Inlet Connections

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

### 4.4.1 Pump Connections

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

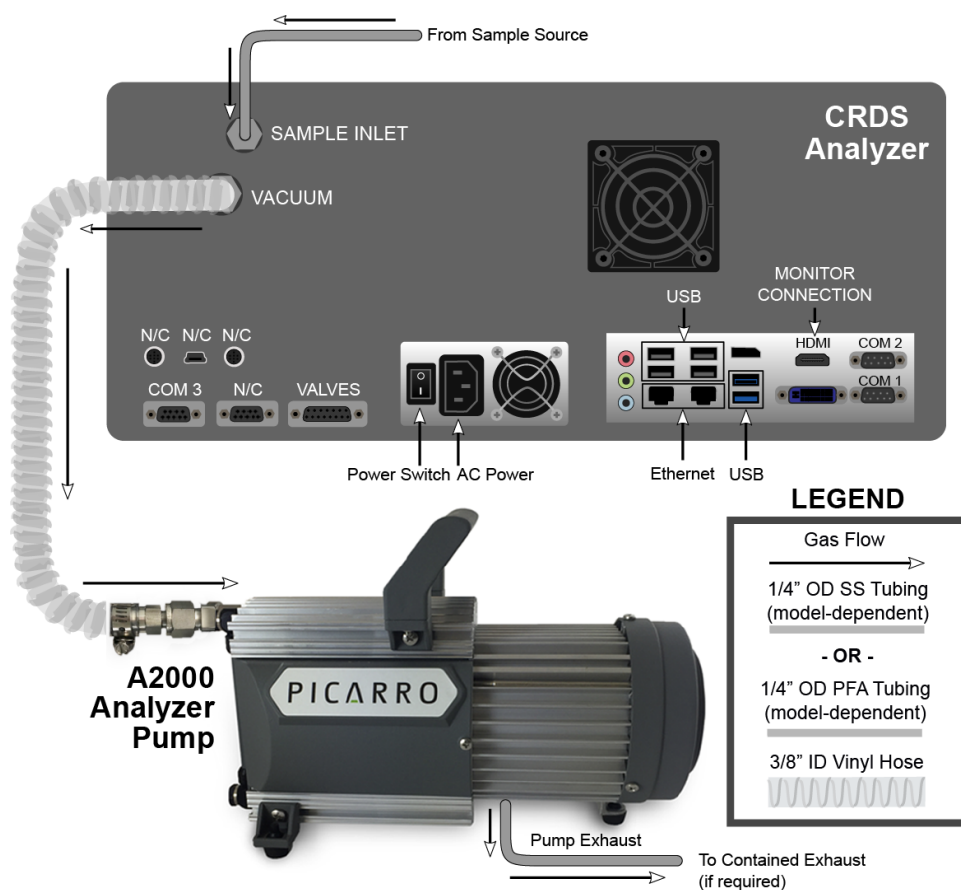


Figure 6 - Analyzer Setup with A2000 Pump

### 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)

If your analyzer is supplied with connectors for stainless steel tubing, follow these steps.

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.

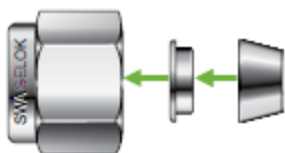


Figure 7 - Orientation of Inlet Nut and Ferrules (SST Tubing)

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

#### When reconnecting SST tubing

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

### 4.4.4 Sample Gas Inlet Connection (PFA Tubing)

#### When making a new PFA gas inlet connection:

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

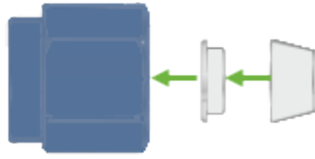


Figure 8 - Orientation of Inlet Nut and Ferrules (PFA Tubing)

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

### When reconnecting PFA tubing:

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

## 4.5 Electrical Connections

Refer to the following figure for connection points.

### NOTE

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

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

### NOTE

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

 NOTE

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

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

## 5 Analyzer Basic Operation

This section explains how to operate the analyzer using the GUI. It describes system startup, shutdown, and recovery procedures, desktop features. GUI Functions are detailed in section [Chapter 6, GUI Functions](#).

### WARNING

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

### CAUTION

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

### NOTE

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

### 5.1 Startup

Use the following procedure to turn the instrument on and launch the CRDS Data Viewer software.

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 plugged in.
5. At the analyzer back panel, press the main power switch to the **ON (I)** position.
6. If needed, press the round **Soft Power** button on the front panel. The indicator LED will illuminate green.

The software starts automatically, and the analyzer displays the CRDS Data Viewer window (Figure 9). Data Viewer features are detailed in section 6.1.

The analyzer will not begin producing data until the cavity temperature and pressure have reached their operational set points. A message will be displayed in the Status Log window (see Figure 9, bottom panel) when each set point is reached. An explanation of the most common status log messages can be found in section 6.10, Analyzer Status Log.

Data will be saved automatically once the analyzer starts to produce data. The data in the GUI is the continuous real time read out from the analyzer. User data is stored in:

C:\Userdata\DataLog\_User\YYYY\MM\DD, where Y=year, M=month, D=day. Further details can be found **section 8, File Management**.

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

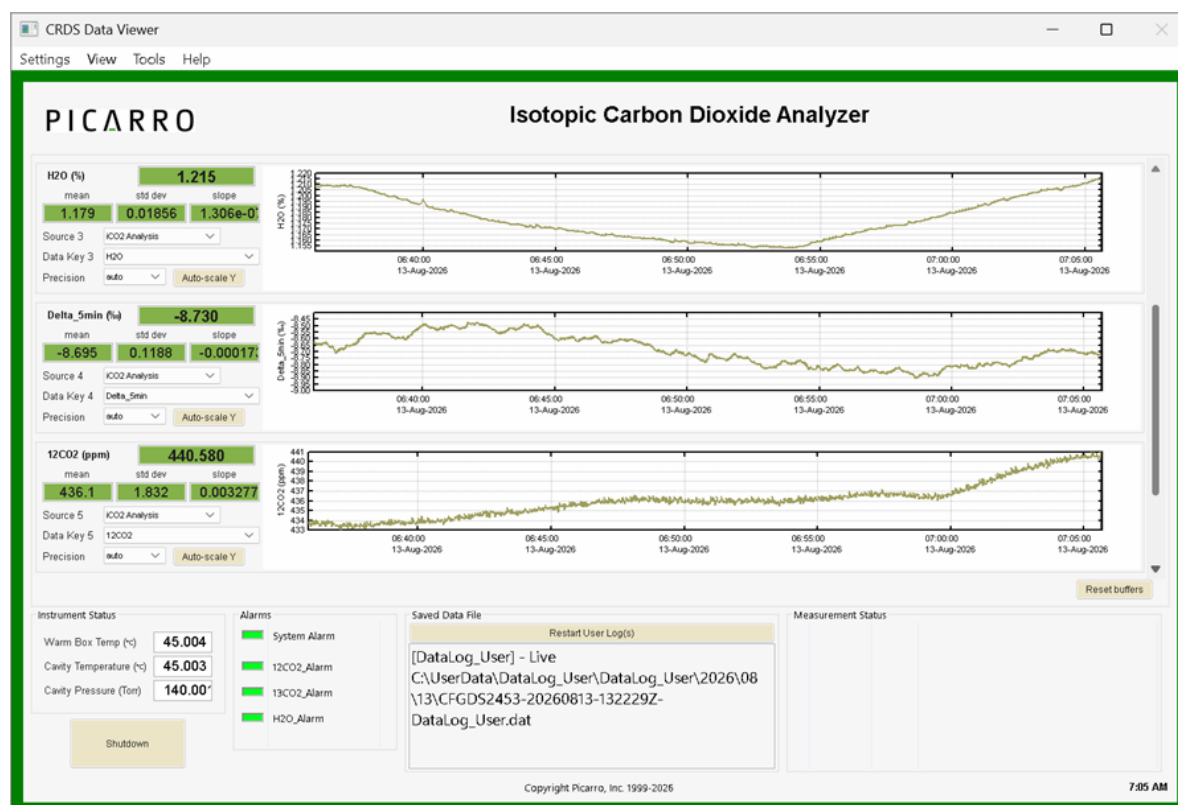


Figure 9 - CRDS Data Viewer

## 5.2 Shutdown

Use the following procedure to safely shut down the analyzer. Purging the analyzer with clean, dry gas before shutdown helps prevent moisture condensation within the measurement cavity.

### 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.

### CAUTION

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

### CAUTION

If you have trouble turning off the analyzer software, do not use the Windows Task Manager to kill the process(es). Instead, double-click on the “Stop Instrument” icon in the Diagnostics folder on your desktop and select the default option to stop the software with the drivers running. See Figure 12 below.

### 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 0.2% (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

1. Click on the **Shutdown** button located on the left side of the Data Viewer window.
2. A Shutdown Confirmation dialog box appears (see [Figure 10](#)), prompting the user to confirm the shutdown. Click **Yes** to proceed. Once confirmed, the analyzer software will begin the shutdown sequence, followed by the analyzer hardware. For older instruments that display three shutdown options, select **For Shipment**.

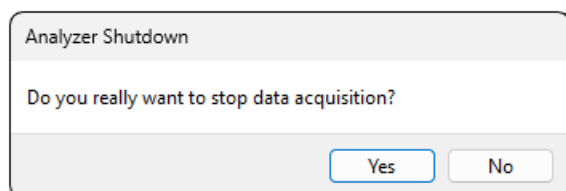


Figure 10 - Shutdown Confirmation Pop-Up Dialog

3. After confirmation, the analyzer software and then the computer operating system will shut down. This process may take several minutes to complete.

 **NOTE**

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

4. When the instrument fans audibly turn off, and when the green power button light on the front of the instrument turns is no longer illuminated, 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 Desktop Icons and Folders

This section describes the desktop icons and folders installed on the analyzer system and their functions. These shortcuts provide access to software tools used to operate the analyzer, manage sample processing, view and analyze data, and perform diagnostic and configuration tasks.

Table 4 - Desktop Icons and Folders

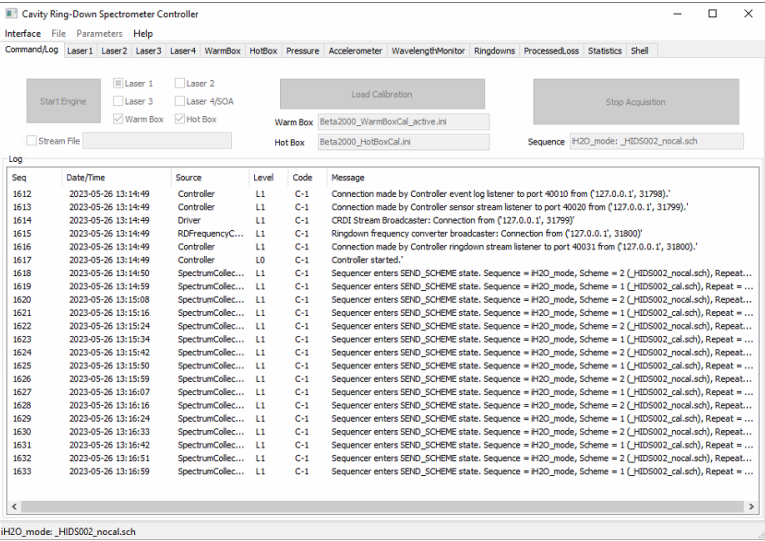
| Location                                                                                               | Icons                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br>Desktop           |    <br>Start Instrument    Coordinator Launcher    Picarro Mode Switcher    Controller |
| <br>Desktop           | <br>Picarro W11 Py3                                                                                                                                                                                                                                                                                                                          |
| <br>Picarro Utilities |   <br>Data File Viewer    Data Recal    Setup Tool                                                                                                                        |
| <br>Diagnostics     | <br>Stop Instrument                                                                                                                                                                                                                                                                                                                        |

## 5.4.1 Desktop Icons

The Desktop Icons provide quick access to the primary software tools used to operate, monitor, and manage the analyzer. These shortcuts allow the user to start and control the instrument, manage sample processing, switch measurement modes (if available), view diagnostic information, and access data visualization utilities.

Table 5 - Desktop Icon Descriptions

| Icons                                                                              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | <p><b>Start Instrument:</b> If the instrument software is already running, this restarts the software. If the instrument software has been shut down, this starts the software.</p>                                                                                                                                                                                                                                                                                                                                                                                                    |
|   | <p><b>Coordinator Launcher (not present on all configurations):</b> Clicking on this icon opens a window that allows you to choose the proper coordinator to operate peripheral modules on certain analyzers.</p>                                                                                                                                                                                                                                                                                                                                                                      |
|  | <p><b>Picarro Mode Switcher (not present on all configurations):</b> When clicked, a window opens that allows you to switch between various measurement modes. Most analyzer models are configured for one mode and may not include the Mode Switcher. If the analyzer has multiple modes, this allows the user to switch between them easily.</p> <div data-bbox="597 999 1024 1276">  </div> <p><b>Note:</b> Drop-down options varies with analyzer.</p> <p>Figure 11 - Picarro Mode Switcher</p> |

| Icons                                                                               | Description                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <p><b>Picarro Controller:</b> Opens a diagnostic interface intended for Picarro Support, providing real-time visibility into analyzer internal temperatures, pressure, and spectroscopy data. While the interface includes user-accessible functions, instrument parameter changes must only be performed under the direction of Picarro Support.</p>  |
|  | <p><b>Picarro Computer Icon:</b> The Windows Computer Icon is renamed to the analyzer serial number.</p>                                                                                                                                                                                                                                                                                                                                  |
|  | <p><b>Data file Viewer:</b> When clicked, a window opens that allows you to convert between *.dat and H5 data files and to make various graphical representations of your data over time periods longer than what is available in the software buffer. The instructions on using the Data File Viewer software are described in <a href="#">B Data File Viewer</a>.</p>                                                                   |

5.4.2 Picarro Utilities Folder

The Picarro Utilities folder provides access to tools used for data recalibration, analyzer configuration, and data file review.

Table 6 - Picarro Utilities Folder

| Icon/Folder                                                                                            | Description                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <br>Data Recal        | <b>Data Recal:</b> When clicked, a window opens that allows you to recalibrate your data based on known, certified data.                                                         |
| <br>Picarro Utilities | <b>Setup Tool:</b> When clicked, a window opens that allows you to edit various settings for your analyzer (See <a href="#">A Setup Tool and Communication</a> for information). |
| <br>Data File Viewer  | <b>Data file Viewer:</b> (see).                                                                                                                                                  |

### 5.4.3 Diagnostic Folder

The Diagnostic folder provides tools for managing analyzer operation during abnormal or emergency conditions. The **Stop Instrument** function opens the Stop CRDS Software pop-up, which allows you to shut down the analyzer in an emergency. For standard shutdown procedures, see Section [5.2 Shutdown](#).

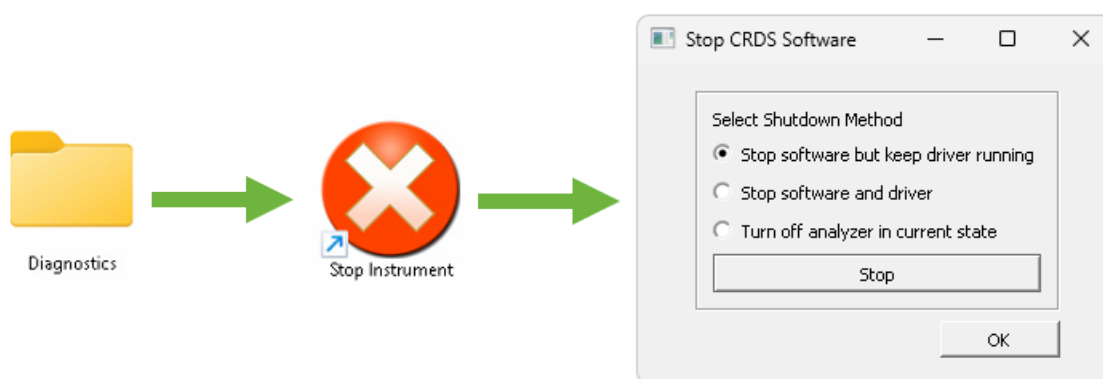


Figure 13 - Stop CRDS Software Pop-up

The Stop CRDS Software pop-up offers three shutdown methods:

- **Stop software but keep driver running:** Closes the analyzer software only. The driver continues to control cavity pressure/temperature and sample flow continues. Use this option when changing instrument settings, such as port or column configuration in the Setup Tool, or when modifying scripts.
- **Stop software and driver:** Also stops the driver, closing the valves and stopping flow; the cavity is left at low pressure. Use this option only when changing the system time by more than 30 seconds. (Routine time-server synchronization does not require this.)
- **Turn off analyzer in current state:** Immediately shuts down software and hardware, leaving the cavity at operating (low) pressure. Use only if the analyzer will be restarted soon, such as when moving it to a nearby bench or lab.

 **CAUTION**

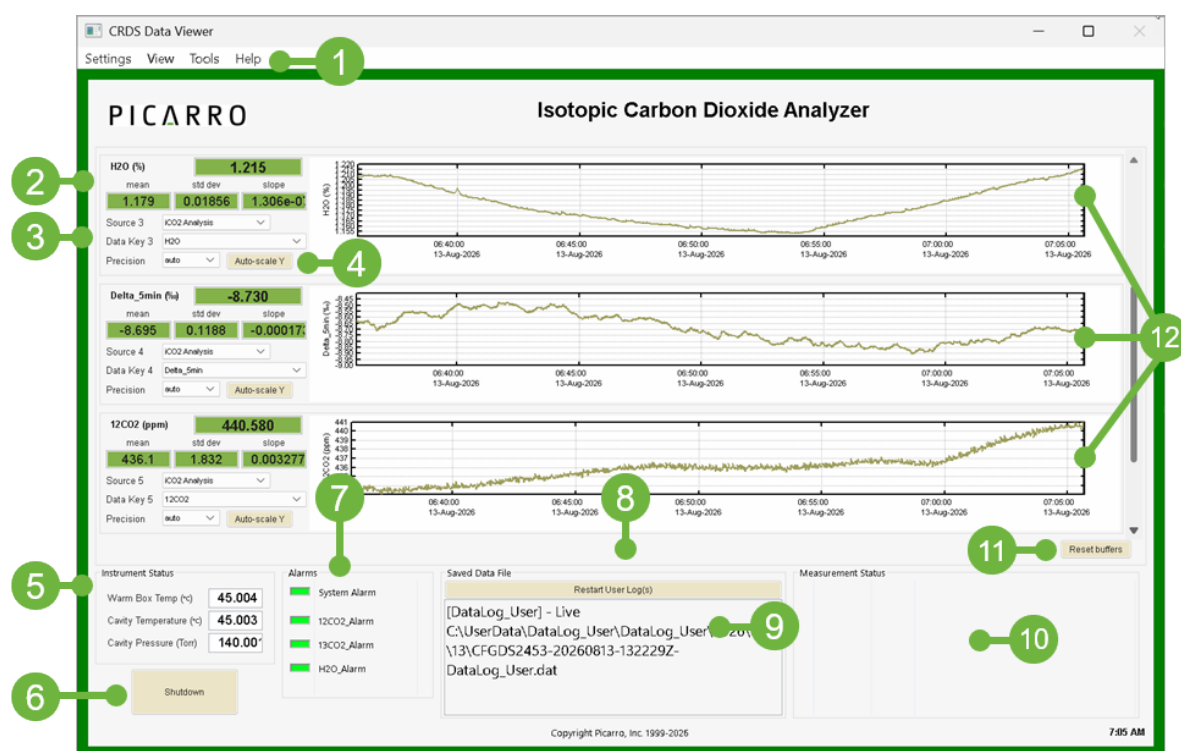
Unlike the standard shutdown procedure (Section 8.2), these emergency shutdown methods do not flush the cavity with dry gas before shutdown. Use these options only when necessary. Before the next normal shutdown or any extended power-off period, restore dry gas flow to ensure the cavity can be properly purged.

## 6 GUI Functions

The Picarro CRDS Data Viewer (GUI) serves as the primary interface for monitoring analyzer performance, viewing measurement data, and accessing operational tools. Understanding the functions available within the GUI helps users efficiently operate the analyzer, review system status, and manage data acquisition activities.

### 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.



- |                                         |                       |                                |
|-----------------------------------------|-----------------------|--------------------------------|
| 1 Settings, View, Tools, and Help menus | 4 Axis Auto Scaling   | 9 Data Log; Filename, and Path |
| 2 Digital Readouts and Statistics       | 5 Instrument Status   | 10 Status Log Window           |
| 3 Data Source, Data Key, and Precision  | 6 Shutdown button     | 11 Reset Buffers button        |
|                                         | 7 Alarm Panel         | 12 Data Windows                |
|                                         | 8 Restart Log Buttons |                                |

Figure 14 - Layout of Analyzer Data Viewer

## 6.1 Settings, View, Tools, and Help Menus

The menus in the application provide access to display controls, calibration tools, and diagnostic features. This section describes the available options in the Settings, View, Tools, and Help menus, including functions for changing GUI modes, adjusting display behavior, accessing calibration utilities, and viewing instrument version information.

### 6.1.1 Settings Menu

Left clicking on the **Settings** menu pulls down a menu that has one entry: **Change GUI Mode from Standard to Service (or Change GUI mode from Service to Standard if it is already in service mode)**.

This is the access point to a password protected service mode (default password is **picarro**) where additional operational and measurement parameters are available in the data keys. Selecting and clicking on this entry opens the Cavity Ring-Down Spectrometer Controller.

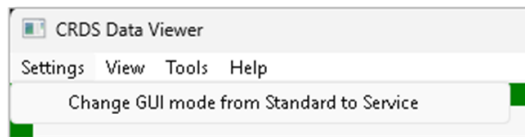


Figure 15 - CRDS Settings Menu options

### 6.1.2 View Menu

The View menu provides options for controlling the display of graphs and on-screen information:

- **Lock Time Axis When Zoomed / Unlock Time Axis:** When enabled, forces both graphs to use the same time scale during zoom operations.
- **Show/Hide Statistics:** Toggles the display of measurement statistics. See Section 6.3 [Digital Readouts](#) for more information.
- **Show/Hide Instrument Status:** Toggles the display of instrument status information. See 6.4 [Instrument Status](#) for more information.
- **Bottom Panel:** Select to show or hide the Instrument Status, Alarms, Data File, and Measurement Status panels.

#### NOTE

If the Bottom Panel is hidden, the message "Enable Bottom Panel to View Alarms" is displayed at the bottom of the CRDS Data Viewer window.

- **Graph:** Select the number of line graphs to display in the CRDS Data Viewer and specify the color for each graph.

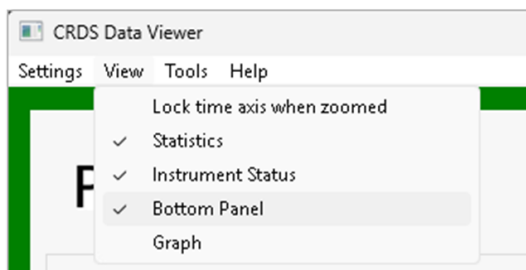


Figure 16 - CRDS View Menu Options

### 6.1.3 Tools Menu

This menu item has two entries:

1. **User Calibration:** Opens the password protected user calibration window (default password is **picarro**).  
Calibration slope and intercept can be entered, and their effects are immediately seen in the data.
2. **Show/Hide Sequencer GUI:** Toggles the display of the external valve sequencer window (user may need to hit **alt-tab** to bring it to the front).

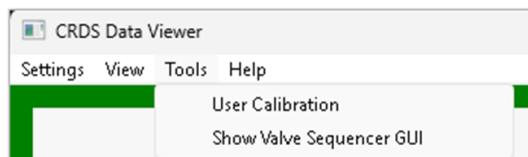


Figure 17 - CRDS Tools Menu Options

### 6.1.4 Help Menu

**About:** Displays the version number of the instrument.

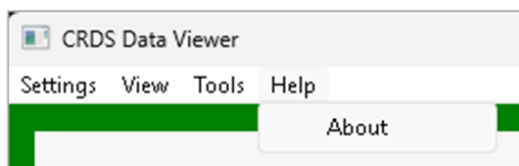


Figure 18 - CRDS Help Menu Options

## 6.2 Alarms Panel

This panel is used to monitor the status of the internal instrument alarms. These indicators are gas concentration alarms, such as “H2O 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.

**📄 NOTE**

If the Bottom Panel is hidden, the message "Enable Bottom Panel to View Alarms" is displayed at the bottom of the CRDS Data Viewer window. To display the Bottom Panel and view active alarms, select View > Bottom Panel.

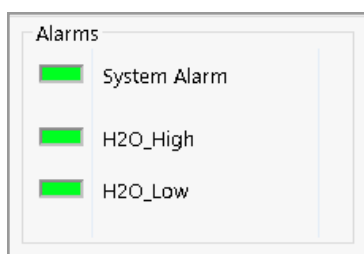
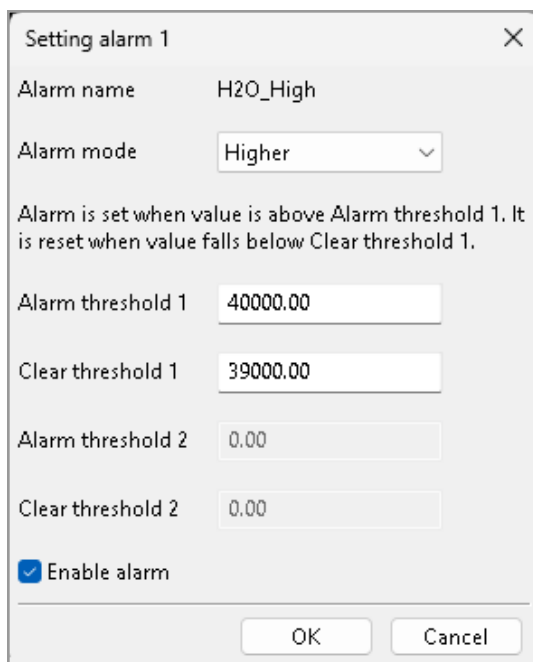


Figure 19 - Alarms Panel

To view the alarm set point, click on the **Alarm Icon** and a dialog box will appear indicating the alarm setting and allow the user to enable it or change the setpoint.



The dialog box is titled "Setting alarm 1" and has a close button (X) in the top right corner. It contains the following fields and controls:

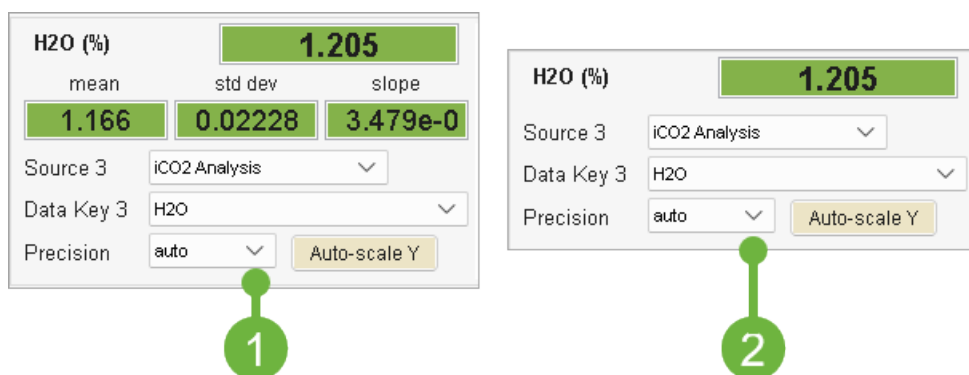
- Alarm name:** A text field containing "H2O\_High".
- Alarm mode:** A dropdown menu with "Higher" selected.
- Alarm description:** A text area containing "Alarm is set when value is above Alarm threshold 1. It is reset when value falls below Clear threshold 1."
- Alarm threshold 1:** A text field containing "40000.00".
- Clear threshold 1:** A text field containing "39000.00".
- Alarm threshold 2:** A text field containing "0.00".
- Clear threshold 2:** A text field containing "0.00".
- Enable alarm:** A checked checkbox.
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

Figure 20 - Alarm Settings Dialog Box Example

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.

## 6.3 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.



- 1 Show Statistics Enabled
- 2 Show Statistics Disabled

Figure 21 - Digital Readouts Panel

## 6.4 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 and Cavity Pressure are displayed to the left of the main trend graphs.

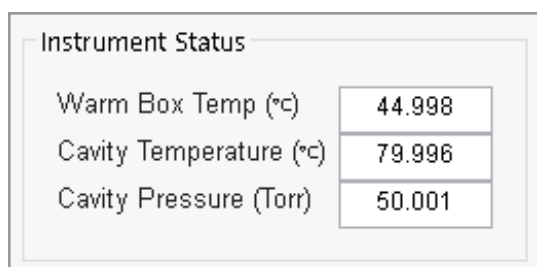


Figure 22 - Instrument Status Panel

## 6.5 Shutdown and Restart User Logs Buttons

This section describes the Shutdown and Restart User Log(s) buttons, which allow users to safely shut down the analyzer and manage instrument data logging during operation.

### 6.5.1 Shutdown Button:

Shuts down the analyzer. See section 5.2 [Shutdown](#) for more information.



Figure 23 - Shutdown Button

### 6.5.2 Restart User Log(s) Button

The analyzer automatically records all data collected on the instrument as .dat files. These are described further in [7 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.

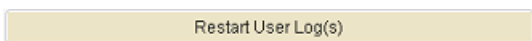


Figure 24 - Restart User Logs Button

### 6.5.3 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., “201301Z”) and subsequently at 1 hour increments (e.g., “211301Z”, “221301Z”). A new day folder (e.g., “2023\06\01”) will be generated at midnight, as will month and year folders at the appropriate times.

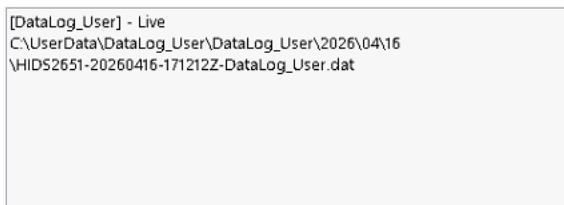


Figure 25 - Data Log File Name and Path

## 6.6 Data Window

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

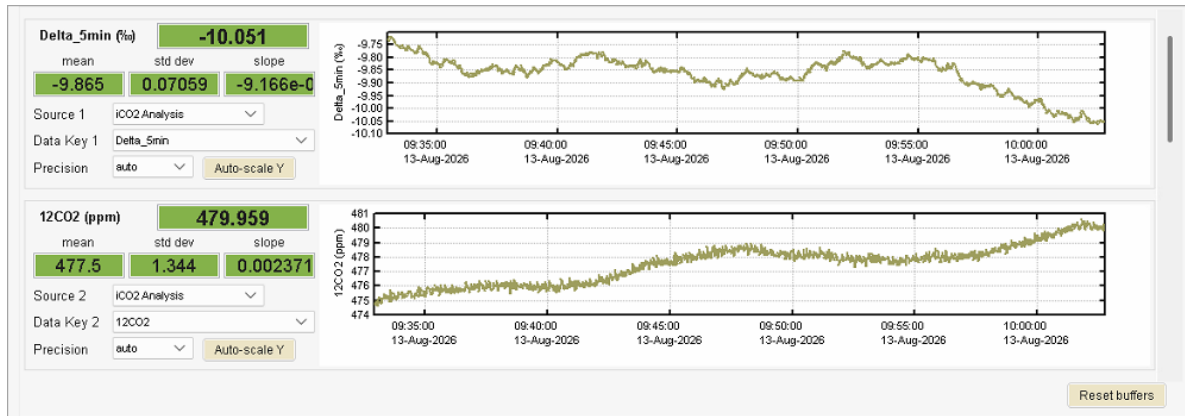


Figure 26 - Data Window Panel

## 6.7 Data Source, Data Key, and Precision Controls

The Data Source, Data Key, and Precision pull-down menus control how data is selected and displayed in the data window. Together, these controls determine which data stream is shown and how its values appear on the graph.

The **Data Source** and **Data Key** menus are used to select the type of data displayed. When Instrument Analysis (where Instrument represents the system installed) is selected, gas concentration data is shown. When Sensors is selected, the display shows system parameters such as optical cavity pressure, cavity temperature, electronics temperature (“DASTemp”), and wavelength monitor temperature (“WarmBoxTemp”).

The **Precision** pull-down menu controls the number of digits displayed on the y-axis. The default setting is Auto, which automatically selects an appropriate display precision for most applications. Users can manually select between 0 and 4 digits of precision if required. This setting affects only how data is displayed in the data window and does not affect the precision of saved data in log or results files.

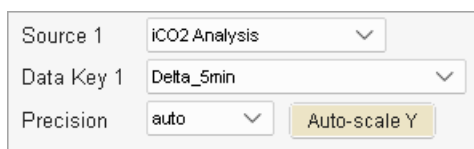


Figure 27 - Data Source, Data Key, Precision Controls

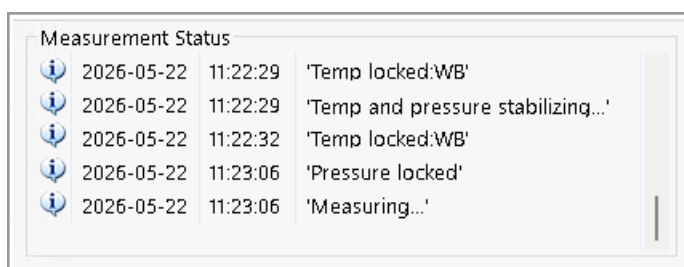
## 6.8 Analyzer Status Log

This window displays instrument status messages, in the following form:  
YYYY,MM,DDhh:mm:ss, then ‘Generic message text.’

### 6.8.1 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.



| Measurement Status |                     |                                    |
|--------------------|---------------------|------------------------------------|
|                    | 2026-05-22 11:22:29 | 'Temp locked:WB'                   |
|                    | 2026-05-22 11:22:29 | 'Temp and pressure stabilizing...' |
|                    | 2026-05-22 11:22:32 | 'Temp locked:WB'                   |
|                    | 2026-05-22 11:23:06 | 'Pressure locked'                  |
|                    | 2026-05-22 11:23:06 | 'Measuring...'                     |

Figure 28 - Analyzer Status Log

## 6.9 Reset Buffers Button

Click this 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.

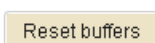


Figure 29 - Reset Buffers Button

## 6.10 Graph Zooming and Panning

The data graph provides interactive zooming and panning controls that allow users to closely inspect specific regions of interest or return to a full-data view as needed. These controls support mouse-based actions and keyboard modifiers to adjust the graph scale, navigate along the axes, and automatically rescale the display for clearer data interpretation.

### Zooming In/Out

To **zoom in** on a specific region of the graph, move the cursor to the area of interest, **click/hold** the left mouse button, **thendrag** as desired to create a box that covers the region of interest (see [Figure 30 - Data Graph Zoom Function](#)). When the box is drawn, release the

left button and the boxed area will automatically scale to fill the data window.

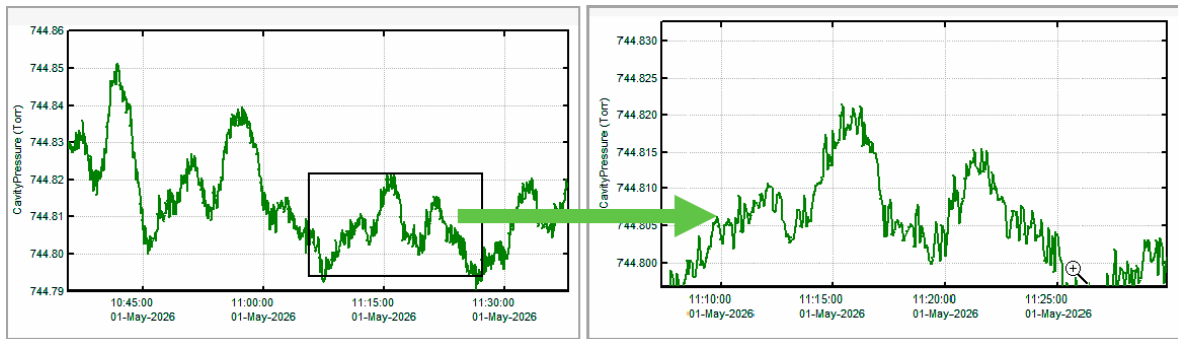


Figure 30 - Data Graph Zoom Function

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

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.

### Lock/Unlock Time Axis

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

### Panning

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

## 7 File Management

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

This section describes how data generated by the Picarro analyzer is organized, stored, and maintained on the system. The analyzer produces multiple types of output files during operation, including real-time measurement data, event logs, and diagnostic data. These files are written in standardized formats and stored in defined directory structures to support data access, review, and troubleshooting.

The following sections describe the primary data directories, file types, naming conventions, and archiving behavior used by the analyzer.

### 7.1 User Data Folder

The User Data folder is located at:

***C:\UserData\DataLog\_User - with files arranged by year\month\day\hour.***

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

Using the **Setup Tool**, the user can select and customize the data columns, file length, total storage size and folder structure for the user data logs. Setup Tool is described in more depth in [A Setup Tool and Communication](#).

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

### 7.2 Data File Name

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

CFGDS2453-20210201-224542Z-DataLog\_User.dat

Figure 31 - Example Data File Name

- **CFGDS2453** is the analyzer serial number
- **20210201** is the date, in format `yyyymmdd` (to allow chronological sorting of data files).
- **224542** is the time the file was started in the computer's Local Time as displayed in the lower right hand side of the Windows OS screen, 22:45:42, formatted as `hhmmss` using a 24-hour clock. Note that the time stamp of samples within the file is usually recorded in UTC (GMT) relative to the local time. For example, an analyzer in California will usually have a time stamp (UTC) within the file that is 8 hours ahead of the time stamp in the file name itself (UTC - 8).

## 7.3 Data Archive

The archive directory is:

***C:\Picarro\G2000\Log\Archive\***

and has subdirectories:

***DataLog\_Private, and EventLogs***

### DataLog\_Private

These data files contain a comprehensive list of system parameters such as instrument temperatures and pressure, set points and spectroscopy. This additional information is not broadly relevant to the user for day-to-day operation but can be useful for diagnostic purposes. Files are stored by the convention:

***C:\Picarro\G2000\Log\Archive\DataLog\_Private \[year]\[month]\[day]\[hour]***

The archive files are in a more efficient HDF5 format, with extension `.h5`.

### EventLogs

Event logs contain records of the operation of the instrument, the performance of the wavelength monitor and lasers, and record exceptional events like pressure or temperature instability. This is also a critical resource for Support to diagnose or troubleshoot an issue with an analyzer. Files are stored by the convention:

***C:\Picarro\G2000\Log\Archive\EventLogs\[year]\[month]\[day]\[hour]***

## 7.4 User Data Folder

The User Data folder `C:\UserData\` contains one or more subfolders associated with real-time instrument data.

### 7.4.1 DataLog\_User (all instruments)

Raw user data is contained in the `DataLog_User` folder, with format:

***C:\UserData\DataLog\_User\[year]\[month]\[day]\hour***

This is the most relevant folder for users of non-isotopic instruments, as this provides the real time data output in its most digestible form. These data files reflect the native time interval of the instrument, typically between 0.1 Hz and 10 Hz.

### 7.4.2 DataLog\_Sync

Some instruments will also contain a (*C:\UserData\DataLog\_Sync\...*) directory, which includes data that is evenly spaced in time as specified by the user in the Setup Tool, covered in [A Setup Tool and Communication](#). This format is preferred by some users who need e.g., 1 Hz data exactly, or who prefer to record smaller data files with data spaced, e.g., every 60 seconds.

### 7.4.3 DataLog\_GPS

Instruments may come with the ability to log GPS data, which can be found in this subdirectory.

### 7.4.4 DataLog\_SFP

Instruments may come with the soil flux processor software. Associated data files may be found in this subdirectory.

## 7.5 Isotopic Data

Isotopic instruments use Coordinator programs to produce discrete isotopic values for individual samples or injections. Each time a Coordinator is opened, a data file will be produced in one of two places, depending on the peripheral used, either:

*C:\IsotopeData* (sometimes called *C:\IsotopicData*)

or

*C:\Picarro\IsotopicData* (sometimes called *C:\Picarro\IsotopeData*)

While the coordinator program is running, individual sample value outputs will be populated as a new line into the coordinator window, and the respective data file.

## 7.6 File Archiving

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

*C:\Picarro\G2000\AppConfig\Config\Archiver\Archiver.ini.*

 **CAUTION**

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

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

- **Directory = C:/UserData/DataLog\_Sync**

Optionally specifies which directory to find files to archive.

- **MaxCount = -1**

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

- **MaxSize\_MB = 1500**

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

- **Compress = True/False**

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

- **AggregationCount = 0**

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

- **StorageMode = FIFO**

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

- **Quantum = 4**

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

## 8 Calibration

Periodic recalibration with standards of known concentration maintains the accuracy of your analyzer. Using the Data Recal Software Utility (described in section [Direct Calibration Through the Data Recal Tool \(Recommended\)](#)) enables the calibration constants to be tracked over time, thus enabling the user to follow system performance.

### 8.1 Slope Offset

#### NOTE

**Every Picarro analyzer ships with a default user calibration value of 1 for slope and 0 for offset. While new user calibrations will likely result in changes to both, we recommend that only offset changes are applied during more frequent calibrations.**

A rule of thumb with Picarro analyzers is that their linearity seldom drifts more than 5% in either direction over many years, so a recalibrated slope of  $<0.95$  or more than 1.05 typically reflects not instrument drift, but the uncertainty in the other components of a calibration, e.g., reference materials, gas delivery, or sample handling materials compatibility.

If during your slope calibration, a new value of 0.9 or 0.85 is suggested by the Data Recal tool, please repeat the measurements of your standards, checking for any leaks or dilution, confirming regulators are fully flushed before use, and confirming that you've taken the certified rather than target value on your calibration cylinders. In most cases, such large changes in slope are a result of these sorts of biasing effects, and do not indicate a lack of repeatability in the analyzer. If your analyzer continues to suggest a large change in slope, please consult with Picarro Support before applying a new calibration.

While the user can expect non-reactive gases (including surrogate gases which are traceable to primary standards) to be quite repeatable to better than 5% from use to use, the same is not always true of reactive gases. Gases like ammonia are typically certified with significantly larger uncertainty terms, and standards are expected to degrade, often significantly, over months or years. Accordingly, the overall health of an analyzer (e.g., laser or sensor drift) should be assessed by the non-reactive species reported when high quality reactive gas standards are not available or trusted.

#### NOTE

**If you are uncertain about the state of your current slope and offset values, they can be reset back to their user default values of 1 and 0, respectively. From the CRDS Data Viewer, navigate to Tools and User Calibration (password: picarro). Then change the slope and offset values of your parameter of interest to 1 and 0, respectively.**

## 8.2 Calibration Methodology

To perform a calibration or verification of calibration, the user simply introduces the calibration standard into the analyzer for a period long enough for the analyzer to yield a stable, typically five-minute measurement of that sample.

### WARNING

When calibrating with hazardous, corrosive, explosive, or otherwise dangerous gases, the user should follow best practices for reducing personal exposure, including locating the instrument and pump near or in a vacuum hood, and/or venting pump exhaust flow into a vacuum hood or dump line

### 8.2.1 Calibration Setup

#### Connections from the analyzer to the gas tank

- Always use a two-stage regulator capable of delivering 2-3 PSIG. Picarro recommends e.g., the Y12ASC445A590-AG stainless steel regulator from Airgas. This regulator offers a 0-30 PSIG range, which requires caution when directly connecting the instrument and cylinder, but also allows users the flexibility to use the cylinder with mass flow controllers. Always ensure the calibration pressure is set carefully before connecting to the instrument directly, and consider adding a bleed tee to avoid excess pressure buildup.
- The pressure regulator at the outlet of the gas tank protects the analyzer from over-pressurizing. The pressure should be set to about 2 – 3 PSIG (0.14 bar – 0.2 bar).
- The toggle valve allows rapid shutoff of the gas delivery.
- Tubing is connected to the male inlet bulkhead thread on the back with the analyzer.
- If the user is either moving a regulator from tank to tank, placing a regulator on a cylinder for the calibration, or calibrating for reactive gases, they should flush their regulator fully 2-3 times before use. Follow the tutorial located on the Picarro website Video Gallery. If you are viewing this manual on PDF, click [HERE](#) to go directly to the video. Otherwise, navigate to the video by following these instructions:
  - a. In your web browser, enter <https://www.picarro.com> and click the search icon (magnifying glass) from the top menu bar.
  - b. In the search box enter **Flushing Regulators** and click **Search**.
  - c. From the search results click the link for the **Flushing Regulators** video, a new page displays.
  - d. Click the **Play** button to view the video.

 **CAUTION**

Failure to flush the regulator fully will typically result in a long, slow stabilization process that may take an hour or more for values that differ greatly from ambient air, or the gas from a previous tank.

**When switching between tanks:**

1. Ensure you are in a well-ventilated setting, and that all gases are contained within a fume hood.
2. Disconnect the tubing from the instrument inlet.
3. Turn off the main cylinder valve on the current cylinder.
4. Bleed down the pressure in the regulator using best practices, typically by disconnecting the line from the regulator to the instrument, and increasing the delivery pressure until both gauges have dropped to zero.
5. Disconnect the pressure regulator from the tank.
6. Connect the pressure regulator assembly to the next gas tank,
7. Flush the regulator with the new gas, following the instructions mentioned in the previous section.
8. Set the delivery pressure back to 2-3 PSIG.

## 8.3 Direct Calibration Through the Data Recal Tool (Recommended)

Picarro recommends performing direct analyzer calibrations using the Data Recal software utility. This tool provides a guided workflow for comparing certified calibration standard values with analyzer measurements and calculating updated calibration parameters. The following sections describe the Data Recal utility, preparation of calibration standards, calibration parameter calculation, and application of new calibration values to the analyzer.

### 8.3.1 Running Calibration Standards for Direct Calibration

Before performing a direct calibration, run each calibration standard through the analyzer and record the corresponding instrument-reported values. These measured values will be compared to the certified standard concentrations in the Data Recal utility to calculate updated calibration parameters.

1. With the first standard hooked up to the inlet (typically starting with the lowest concentration), navigate to the main Picarro GUI, and watch until the calibration tank values have stabilized. Ensuring that **Show Statistics** is selected from the **View** menu, zoom in on a 5-minute stable period for a given gas species, and write down in a lab book

or new text file the reported Mean concentration value from the left side of the screen for each species being calibrated.

2. When complete for the first tank, remove the tank from the instrument inlet and close the cylinder and/or on/off toggle valve.
3. Connect up the next cylinder and repeat the above steps for the remaining cylinders.

### 8.3.2 Graphical User Interface (GUI)

The **Picarro Data Recalibration (Data Recal)** software can be found in the **Utilities** folder on the desktop. The Data Recal software utility can be launched by double-clicking on the **Data Recal** icon in the folder.

#### NOTE

The available Data Recal options, fields, and calibration parameters may vary depending on the analyzer model and gas species being calibrated. The screenshots and examples provided in this section are intended for reference only and may not exactly match the interface displayed on your instrument. Always use the options and parameters applicable to your specific analyzer configuration.



| Used for Recal           | Certified | CRDS Reported | Recalibrated |
|--------------------------|-----------|---------------|--------------|
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/> | 0.00000   | 0.00000       | 0.00000      |

**Data Options**  
Delta\_Raw

**Calibration Options**  
Offset Only

**Current Calibration**  
Offset: 0.00000  
Slope: 1.00000  
R2: 0.00000

**New Calibration**  
Offset: 0.00000  
Slope: 0.00000  
R2: 0.00000

Compute
Apply New Cal
Clear Entries
Exit

Copyright Picarro, Inc. 1999-2011

Figure 32 - Data Recal Software Utility GUI

The Data Recal Software Utility are described in the following three sections:

- Numerical Input and Selection
- Calibration Output
- Action Selection

## Numerical Input and Selection

Start with the first gas being calibrated, e.g., CO<sub>2</sub>.

1. Under **Certified** (Figure 33), enter the certified value for the tank, as characterized by the manufacturer. Importantly, ensure that you do not simply enter the target concentration requested upon purchase. While a tank can occasionally be delivered at exactly the target concentration, this is very rare. Typically, the certified value will have more significant figures, e.g., **103.1 ppm**, rather than 100 ppm. The example in the image below is notional, and thus uses round numbers.
2. Under **CRDS reported**, enter in the values noted down in a lab book/text file in the previous section corresponding to each calibration tank. Be sure to check the **Used for Recal** check box on the left so that the program knows to use the certified and CRDS reported values in the calibration curve.

| Used for Recal                      | Certified | CRDS Reported | Recalibrated |
|-------------------------------------|-----------|---------------|--------------|
| <input checked="" type="checkbox"/> | 400       | 399.6         | 0.00000      |
| <input checked="" type="checkbox"/> | 600       | 601.2         | 0.00000      |
| <input checked="" type="checkbox"/> | 800       | 804.7         | 0.00000      |
| <input type="checkbox"/>            | 0.00000   | 0.00000       | 0.00000      |
| <input type="checkbox"/>            | 0.00000   | 0.00000       | 0.00000      |

1 Change Indicator (asterisk)

Figure 33 - Data Recal Utility - Recalibration

## Calibration Output

In the **Calibration Options** drop-down menu, the user can select either an **Offset** or an **Offset + Slope**.

When using multiple standards, **Offset** and **Slope** are appropriate. Selecting **Offset** only is appropriate for single point scaling adjustments, e.g., for re-zeroing an analyzer.

Once the new calibration parameters are calculated, the Data GUI will display the new values under the **New Calibration** column. The parameters that appear here will depend on the user's initial selection. When the **Offset + Slope** option is selected, the program also calculates a goodness-of-fit correlation coefficient (R2).

| Data Options        |        | Current Calibration | New Calibration |
|---------------------|--------|---------------------|-----------------|
| CO2 ▾               | Offset | 0.00000             | 5.74780         |
| Calibration Options | Slope  | 1.00000             | 0.98740         |
| Offset + Slope ▾    | R2     |                     | 0.99999         |

Figure 34 - Data Recal Utility - Calibration Output

## Action Selection

In this section, the user can click on the **Compute** button to calculate the new calibration parameters. The compute button will be grayed out until values have been entered in the Certified and CRDS reported columns (Figure 33), and at least one pair of Certified and CRDS reported values selected for the calibration. Once these values are entered or selected, the Compute button will be active. Click **Compute** to calculate the new calibration parameters. These parameters display in the Calibration output section of the GUI, and an asterisk "\*" will be displayed at the end of the window title line (Figure 33), indicating the new change.

|                                   |               |               |      |
|-----------------------------------|---------------|---------------|------|
| Compute                           | Apply New Cal | Clear Entries | Exit |
| Copyright Picarro, Inc. 1999-2023 |               |               |      |

Figure 35 - Data Recal Utility - Action Selection

Once the calibration parameters are calculated, the user can elect to graphically display the calibration and quality control (QC) standards in a graph. To do this, click **Plot** in the upper left corner of the window, and select **Plot Linear Fitting** from the drop-down menu, as shown in the following figure.

The screenshot shows a window titled "Picarro Data Recalibration". In the top-left corner, there is a menu bar with "File" and "Plot". The "Plot" menu is open, showing a single option: "Plot Linear Fitting". The main area of the window has a green background with the text "Picarro Data Recalibration" in bold black font.

Figure 36 - Data Recal Utility - Plot Linear Fitting

The plot that the utility generates is shown in the following figure; this plot will display two graphs. The top graph presents measurements for the recalibrated standards (calibration and QC), as well as a line fitting through those points. The bottom graph shows the residuals, which shows how far each measurement is from the best-fit line.

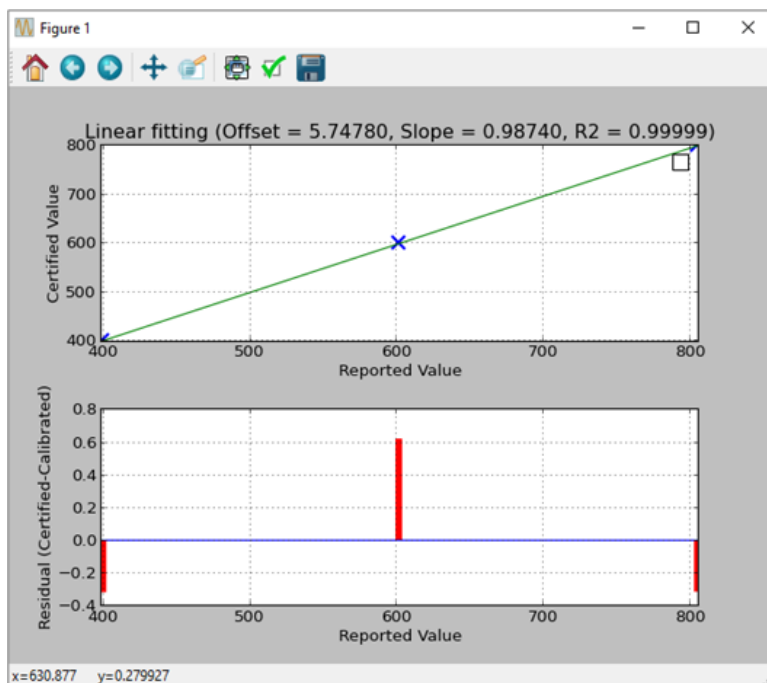


Figure 37 - Slope of Data Recalibration

If the user decides to accept the new calibration values based on this plot, they may click on the **Apply New Cal** button (Figure 43).

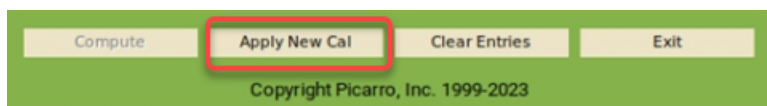


Figure 38 - Apply New Calibration Slope and Intercept

The user will then be prompted to enter a Calibration Password (Figure 44). The default Calibration Password is **picarro**, all lower case.

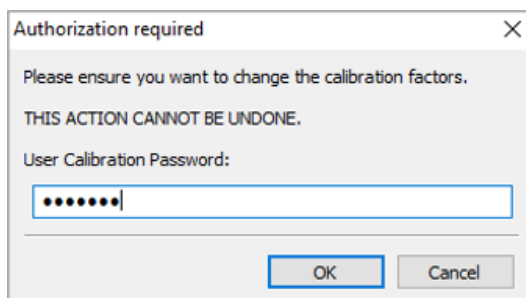


Figure 39 - User Authorization Dialog

Next, a **Recalibration Confirmation** window displays to indicate the new offset and slope (when applicable) values. This window prompts the user to confirm their choice to apply these values, to avoid any inadvertent mistakes.

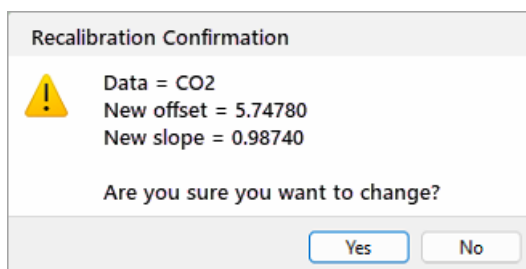


Figure 40 - Calibration Confirmation

When the user clicks the **Yes** button, the newly accepted calibration parameters will take effect immediately, without the need for the instrument main GUI to be restarted.

Once the user accepts the new calibration parameters, the **Data Recal Software Utility** automatically gives them the option to save the new recalibration file. Saving these files enables the user to track the instrument recalibration history.

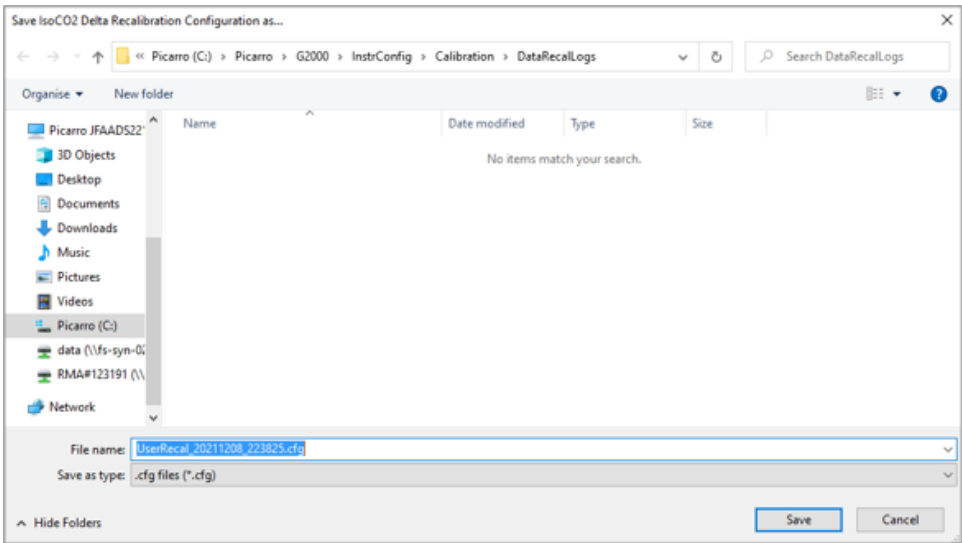


Figure 41 - Data Recalibration - Save As File Dialog

The recalibration file for this example would contain the information as shown in below.

|   |        |                |           |         |
|---|--------|----------------|-----------|---------|
| 1 | data   | CO2            |           |         |
| 2 | 400    | 399.6          | 400.31414 |         |
| 3 | 600    | 601.2          | 599.37464 |         |
| 4 | 800    | 804.7          | 800.31121 |         |
| 5 | cc     | 0.00000        | 1.00000   |         |
| 6 | nc     | 5.74780        | 0.98740   | 0.99999 |
| 7 | option | Offset + Slope |           |         |

Figure 42 - Data Recal Log File Example

- **Rows 2 – 4: Values from each standard selected for recalibration.** The first column in these rows lists the certified values, the second column lists the measured values, and the third column lists the recalibrated values. The number of rows will depend on the number of standards selected to be used for recalibration.
- **Row 5 – Current Calibration (cc) Row:** Read from left to right, lists the current offset and current slope value.
- **Row 6 – New Calibration (nc) Row:** Read from left to right, lists the new offset and new slope values. The third value in this row is the R2 value, which is only displayed if the calibration option is **Offset + Slope**.
- **Row 7 – Options Row:** The last row displays the calibration option selected.

If the user chooses to exit the Recal GUI before accepting the new recalibration values, they will be prompted to confirm their choice through a pop-up window. This window contains a warning that continuing to exit will cause the new calibration data to be lost:

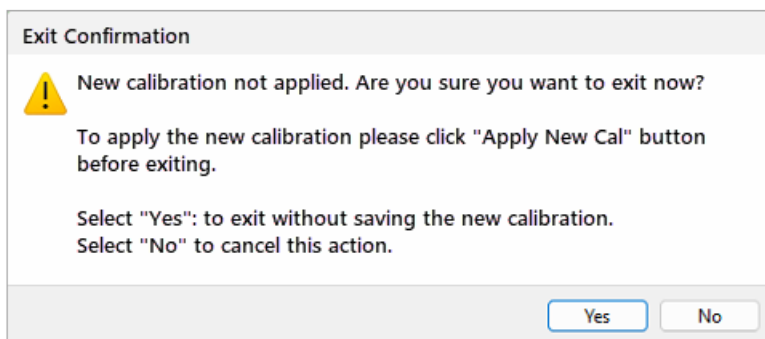


Figure 43 - Recalibration Exit Confirmation

When the user is finished with the calibration, they can either click **Clear Entries** at the bottom of the screen, and begin entering values for the next gas species, ensuring to select the right variable from the **Data Options** dropdown, or they can exit the Data Recal software utility by clicking on the **Exit** button.

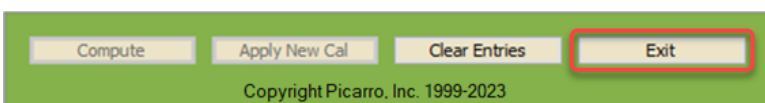


Figure 44 - Data Recal Utility - Exit

#### NOTE

The Data Recal displays an error message indicating the new slope value is not acceptable when one of the following occurs:

- At least two entries in the Certified or CRDS reported columns contain zero-value numbers.
- These entries are selected to be used for recalibration.
- The "Offset + Slope" calibration option is selected. This error occurs because the entered values will lead to an erroneous zero-slope value.

### 8.3.3 Loading a Stored Calibration

Previously saved calibration configurations are reloaded by clicking **File** in the upper left corner of the window and selecting **Load Recalibration File**.

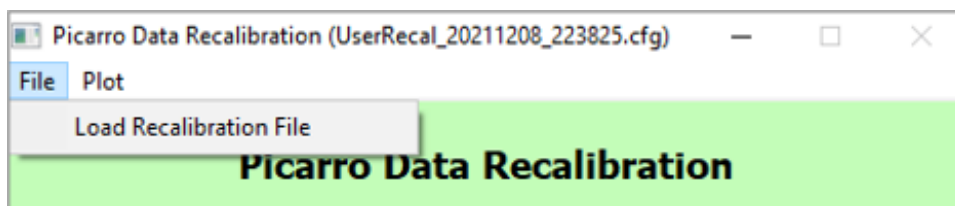


Figure 45 - Data Recalibration Load File

From the load file dialogue, the user may select and open the file they wish to load.

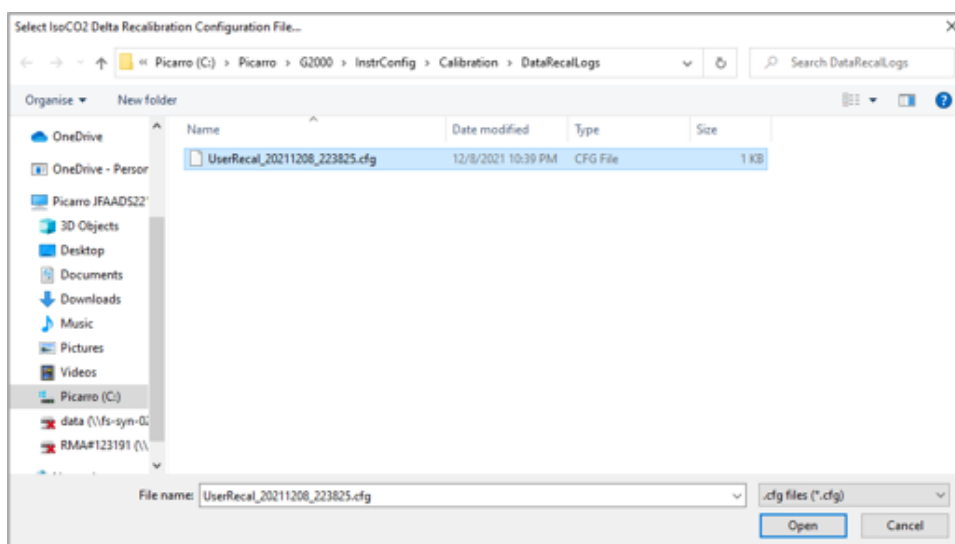


Figure 46 - Data Recalibration Load File Dialog

## 8.4 Calibration Data Processing (Less Common)

The following procedure can be used to calibrate the analyzer; however, this process is less common and not as direct as using the Data Recal Utility as described in the beginning of this chapter.

1. The user may process the calibration results from a given .dat file(s) (see File Management on Page Error! Bookmark not defined.) and calculate the average recorded value for each standard.
2. Plot these values versus the certified values from the gas supplier, and determine the linear relationship between the known calibration values and the analyzer's reported values. A linear best-fit equation can be calculated from the data.

 NOTE

It is important to plot the analyzer's reported concentration on the horizontal axis and the gas standards' stated concentrations on the vertical axis.

The slope and intercept of the best-fit line through these points are the two values that are used to calibrate the analyzer. By determining the linear relationship between the known calibration values and the analyzer's reported concentration values in this way, a calibration offset (slope and intercept) can be calculated to add a correction term to the analyzer's factory or previous calibration.

### 8.4.1 Entering the Calibration Setting

Changing the analyzer's calibration is intended to be done infrequently. Instead of recalibrating frequently to increase the accuracy of the data, users often just verify the calibration by measuring three or more gas standards and use the same regression procedure described here to calculate an offset by which to correct their data offline.

Using the following equation in the graph in Figure 52 below, this calculation would be accomplished point-by-point by calculating the corrected data "y" using the analyzer's data "x" so that:

$$\text{Data}_{\text{corrected}} = 0.9874 \times \text{Data}_{\text{raw}} + 5.7478$$

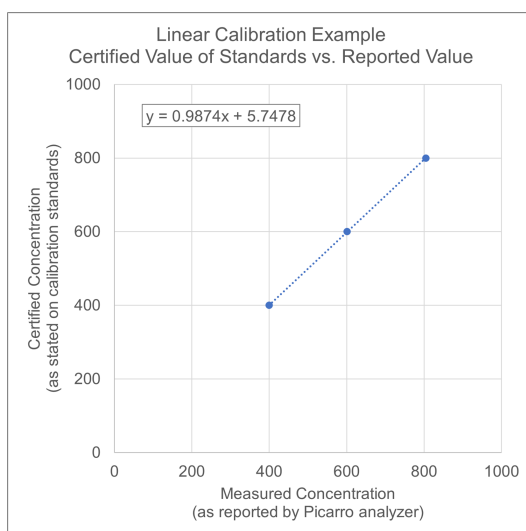


Figure 47 - Linear Calibration Example

Calibration values are input into the analyzer by selecting **Tools, User Calibration** from the CRDS Data Viewer, and then entering the slope and intercept for each species.

 NOTE

User Calibration is a password-protected form, and the default password is “picarro.” This password can be reset in the QuickGui.ini file as previously described.

The calibration will take effect immediately after clicking OK.

### 8.4.2 Returning the Instrument to its Factory Calibration

To return the instrument to its the factory calibration, within the **Calibration Tool**, simply set the slope to 1 and the intercept to 0 for the desired species. This returns the instrument to its factory settings, though this does not ensure that the system will read exactly as it did when it left the factory if a small amount of drift has accumulated over a period of time.

## 8.5 Picarro Calibration Guide

For more detailed instructions on calibrating a Picarro analyzer, refer to the [Calibration Guide for Picarro Analyzers](#). This document can be downloaded by either clicking the link below or entering the URL in a web browser.

<https://www.picarro.com/sites/default/files/Calibration-Guide-Picarro-analyzers-Rev1.pdf>

## 9 Troubleshooting

The following section describes issues that may be encountered during installation and operation of the analyzer. The accompanying troubleshooting procedures provide step-by-step instructions to resolve most problems. If the issue persists after completing the recommended procedures, contact Picarro Customer Support at +1 408 962 3939 or +31 85 888 1650, or email [support@picarro.com](mailto:support@picarro.com).

### 9.1 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.

### 9.2 User Interface Program Does Not Start

**Context:** The computer may be configured to start the instrument and the associated user interface program automatically after it completes its boot-up sequence, or the program may be launched using the **Start instrument** icon on the desktop.

Communications problems with the analyzer may occur if the analyzer fails to initialize correctly on power up. Should the analyzer initialization process not complete correctly, shut down the instrument by shutting down the Windows operating system on the control computer:

1. Using the Start menu, select the red Shut Down button and select **Shut down** in the drop-down box under “What do you want the computer to do?”  
Wait for the shutdown to complete normally and for the computer and analyzer to turn off completely.
2. After a few seconds, restart the computer by momentarily depressing the power button.

#### NOTE

Do not simply restart Windows since this does not cycle the power to the analyzer.

### 9.3 Sample Pressure Can't Be Controlled to Appropriate Value for Concentration Measurements

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

1. The **Pressure low** message indicates that there is insufficient gas available at the inlet of the analyzer. Check the inlet plumbing to the analyzer and ensure that the pressure at the inlet is within the specifications.

Check for blockages in the lines, or regulators that are turned off, especially by removing all items upstream of the inlet to see if the pressure returns to specification. If removing plumbing from upstream of the instrument inlet doesn't work, the inlet particulate filter may need to be replaced. See [Maintenance](#) for more information.

2. The **Pressure high** message indicates that gas cannot be removed from the analyzer at a sufficient rate. Check the vacuum line between the analyzer and the power vacuum unit for leaks. Failure of the vacuum pump, injecting dilution gas at excessive pressure, or excessive pressure at the inlet can also cause this problem.

### 9.4 User Interface Program Freezes / Won't Update Graphs as Data Are Collected

**Context:** The computer may become unresponsive causing the programs that control the analyzer to stop functioning. The computer and analyzer should be shut down and restarted.

1. Re-setting the computer and the instrument requires that the computer be shut down and restarted. If the computer responds to the mouse, a normal Windows shutdown may be carried out: use the Start menu, select the red Shut down button and select **Shut down** in the drop-down box under "What do you want the computer to do?"

Wait for the shutdown to complete normally and for the computer and analyzer to turn off completely. After a few seconds, restart the computer by momentarily depressing the power button.

2. If the computer does not respond to the mouse, hold down the power switch on the front panel for a few seconds until the computer and the instrument turn off. After another few seconds, restart the analyzer by momentarily depressing the power button.

## 10 Maintenance

The advanced, rugged design of Picarro analyzers provides stable, long-term operation with minimal service or maintenance. With the exception of the following items, the analyzer and pump are not user serviceable. Should either appear to malfunction, please refer to the Troubleshooting Guide or contact Picarro Customer Support.

In the following sections, 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.

### 10.1 Service Plans

Picarro offers service plans that provide additional support and maintenance benefits beyond standard telephone, email, and remote diagnostic support. Service plans may include items such as preventive maintenance kits, extended coverage, repair services, and other support benefits.

For information about available service plans, coverage options, current terms, and pricing, contact the Picarro Sales team at [sales@picarro.com](mailto:sales@picarro.com).

### 10.2 Preventative Maintenance Kits

Preventive maintenance kits can be purchased by contacting [support@picarro.com](mailto: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, PI2124
- **S3094** — Yearly Maintenance Kit for HAPs G2xxx User-Replaceable Hardware

### 10.3 User-replaceable Hardware

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

#### 10.3.1 Particulate Filter

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

### Parts

- **Stainless Steel Filter** (for all models except those that measure HF, NH<sub>3</sub>, CH<sub>2</sub>O, HCl and H<sub>2</sub>O<sub>2</sub>):  
[S1020 Particulate Filter Kit](#) – If viewing this manual as a paper hard copy, enter the following URL in your browser:  
<https://store.picarro.com/Particulate-filter-kit-all-models-except-HF-NH3>
- **Teflon Filter: For models that measure NH<sub>3</sub>, HF, CH<sub>2</sub>O, HCl and H<sub>2</sub>O<sub>2</sub>**  
[S1021 Particulate Filter Kit](#) – If viewing this manual as a paper hard copy, enter the following URL in your browser:  
[https://store.picarro.com/Particulate-filter-teflon-for-NH3-HF.\\_3](https://store.picarro.com/Particulate-filter-teflon-for-NH3-HF._3)

### Instructions

- **Video:**[Replacing Your Inlet Particulate Filter](#)  
[https://www.picarro.com/environmental/videos/replacing\\_your\\_inlet\\_particulate\\_filter](https://www.picarro.com/environmental/videos/replacing_your_inlet_particulate_filter)
- **Manual:**[Inlet Particulate Filter Maintenance Guide](#)  
[https://www.picarro.com/environmental/inlet\\_particulate\\_filter\\_maintenance\\_guide](https://www.picarro.com/environmental/inlet_particulate_filter_maintenance_guide)

## 10.3.2 CPU Fan

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

### Parts

### Instructions

- **Video:**[CPU Fan Replacement](#)  
[https://www.picarro.com/environmental/videos/cpu\\_fan\\_replacement](https://www.picarro.com/environmental/videos/cpu_fan_replacement)
- **Manual:**[CPU Fan Replacement for Picarro Analyzers](#)

## A2000 Pump Rebuild Kit

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

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

### Parts

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

**Instructions**

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

[https://www.picarro.com/environmental/a2000\\_pump\\_maintenance\\_guide](https://www.picarro.com/environmental/a2000_pump_maintenance_guide)

## 10.4 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.

## 11 Transportation and Storage

If the analyzer will be 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.

### 11.1 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 section [5.2 Shutdown](#), for specific shutdown instructions.

1. Click on the **Shutdown** button located on the left side of the Data Viewer window.
2. A window will pop-up prompting the user to confirm the shutdown. Once confirmed, the analyzer software and hardware will turn off.

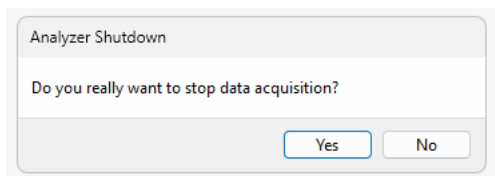


Figure 48 - Shutdown Confirmation Dialog

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

### 11.2 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 Setup Tool and Communication

The Setup Tool and Communication features provide the configuration and interface options required to manage how the analyzer records, outputs, and communicates data. The Picarro Analyzer Setup Tool enables users to customize data logging, digital communication interfaces, remote data delivery, and user interface behavior to meet specific operational and integration requirements.

In addition to local configuration, the analyzer supports multiple communication methods, including serial (RS-232), TCP/IP, and automated email delivery. These capabilities allow the analyzer to integrate with external systems, support remote monitoring, and enable automated data transfer and system time synchronization.

Before making changes using the Setup Tool, the analyzer software and drivers must be stopped to ensure that configuration settings are applied correctly. The following sections describe the Setup Tool interface, its available configuration tabs, and the communication options supported by the analyzer.

### A.1 Setup Tool

In the desktop folder called **Picarro Utilities**, the **Picarro Analyzer Setup Tool** can be launched by double clicking on its icon. This tool allows the user to configure data file saving details, including which data elements are written to data files, digital data output (via serial port or TCP/IP), remote data delivery (via email), and general GUI properties.

Seven tabs of the Setup Tool Window are explained in the next pages in brief. A more in-depth description of the material is provided in the subsequent section. If you have any questions about the Setup Tool, please contact Picarro or refer to Picarro Community for further details.

<https://www.picarro.com/support/community>

#### NOTE

**Before running the Setup Tool, the instrument software and drivers must be stopped.**

**From the desktop, open the Diagnostics folder, double-click on the Stop Instrument icon. The Stop CRDS Software window appears. Select the radio button “Stop software and driver,” then click the Stop button.**

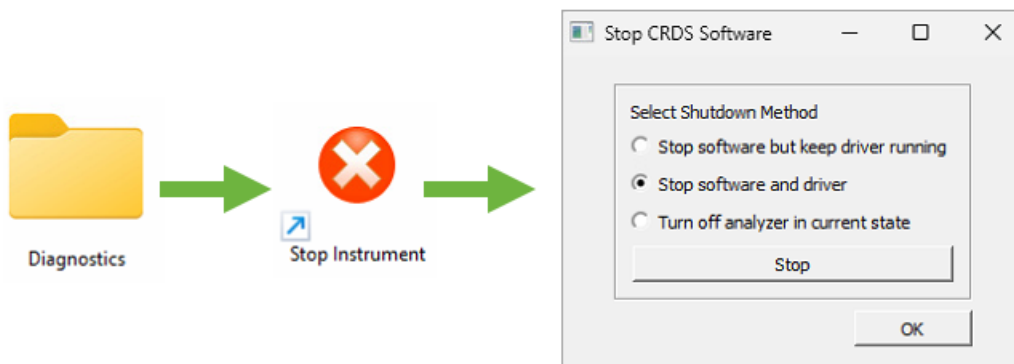


Figure 49 - Stop CRDS Software

### A.1.1 Data Logger Tab

Configuring Data File Saving Details with Data Logger

The **Data Logger** tab (Figure 50) allows the user to configure various data file saving details, including which data elements are written to data files.

- **Data Columns:** Controls which data elements are written to data files.
- **Hours of Each Log File:** Controls the size of each data document.
- **Enable Mailbox Archiving:** Enables archiving of data in the mailbox folder – C:\Picarro\G2000\Log\Archive\DataLog\_Mailbox
- **Archived Directory Structure:** Specifies part of naming convention for data documents.
- **Total User Log Storage Size (GB):** Specifies the size of storage allowed for User Data (Recent Data).
- **Mode:** Changes the way the analyzer fits and displays data in the data viewer on the basis of gas matrix, species reported, precision, and dynamic range.

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

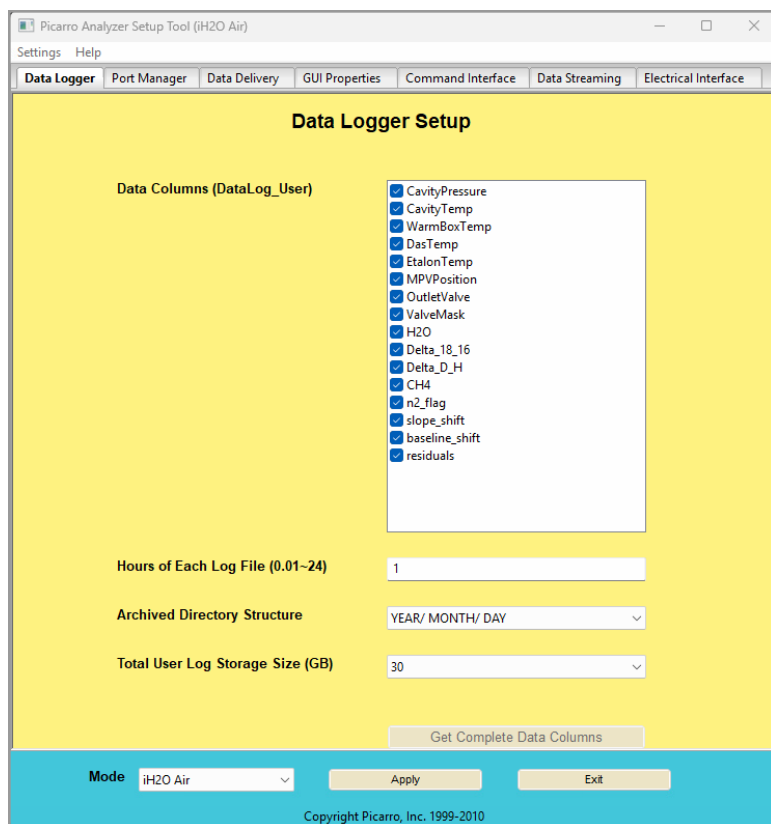


Figure 50 - Data Logger Setup Window

### A.1.2 Port Manager Tab

Managing Ports for Digital Data Output/Input and Serial Communication with Port Manager

The **Port Manager** tab (Figure 51) allows you to control digital data output/Input via serial port or TCP/IP.

On this window, you can specify:

- **Data Streaming:** The port you want your data to stream through (COM1/COM2/Off),
- **Valve SequencerMPV (Multi Position Valve):** The port you want to connect your MPV to (COM1/COM2/Off)

For more information on the configuring for external valves, contact Picarro Support.

- **Command Interface:** (COM1/COM2/TCP/Off).

Make sure there are no COM port conflicts before clicking **Apply**.

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

To learn more about Serial Communication, see [Setup Tool and Communication](#).

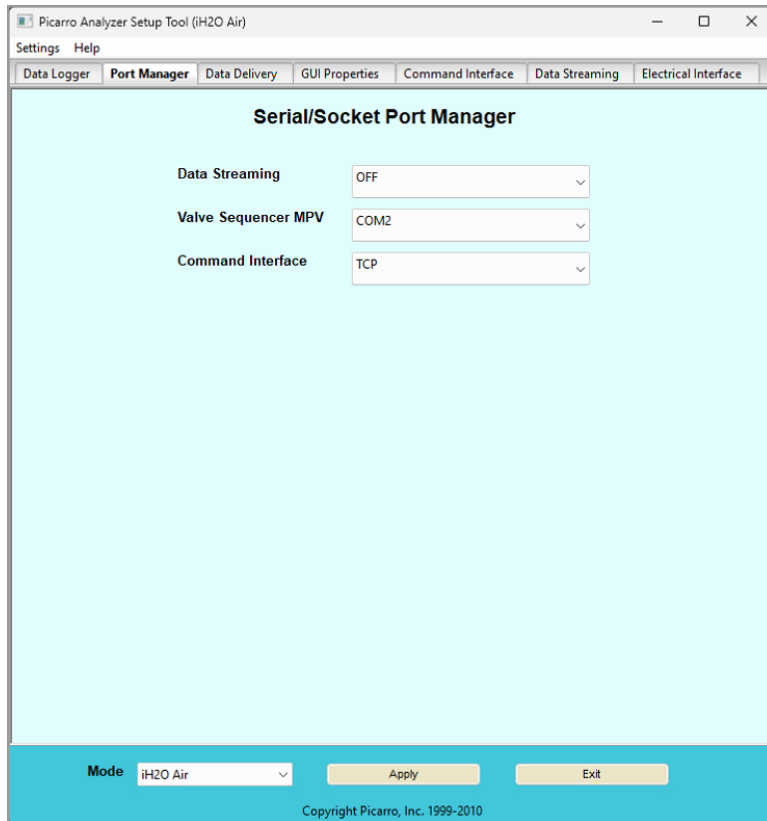


Figure 51 - Serial/Socket Port Manager Window

## A.1.3 Data Delivery Tab

The **Data Delivery** tab (Figure 52) allows the user to schedule remote data delivery (email).

- **Delivery Start Time:** Time of the day when data will be sent.
- **SSL:** Depending on the sender's email server, the sender can activate the Secure Sockets Layer (SSL).
- **Use Authentication:** Turning this on will require the receiver to provide a password and a username to access data. Set up the password and Username from this window.
- **From:** Sender's email
- **To:** Receiver's email.
- **Subject:** subject line of the email.
- **Data Directory:** Location of the data you want email.

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

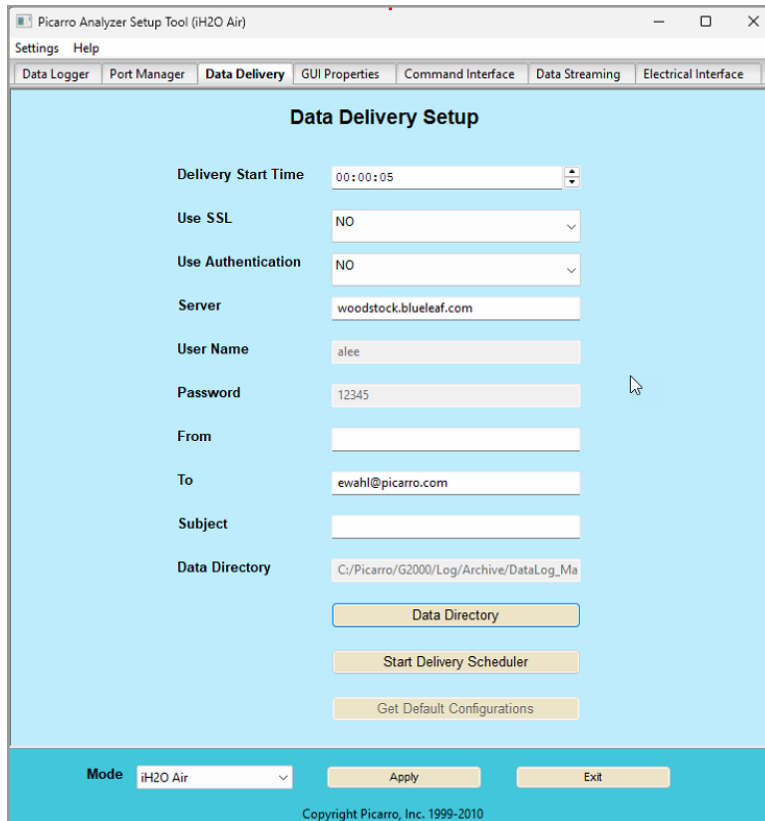


Figure 52 - Data Delivery Settings Tab

### A.1.4 GUI Properties

The **GUI Properties** tab (Figure 53) allows you to set the number of graphs displayed and to enable the control of Valve Sequencer from the main GUI.

**Number of Graphs:** Set the desired number of line graphs to be visible on the main GUI.

**Enable Control of Valve Sequencer:** To make the Valve Sequencer menu item visible under the **Tools** menu of the main GUI:

1. Click on **Settings** of the **Setup Tool** window, and then **Switch to Service** mode.
2. Choose Yes next to Enable Control Valve Sequencer drop down menu on the GUI Properties tab.
3. Click **Apply** to put changes into effect and then **Exit** to close the window.

You should now be able to access the **Show/Hide Valve Sequencer GUI** menu from the main GUI under the **Tools** menu.

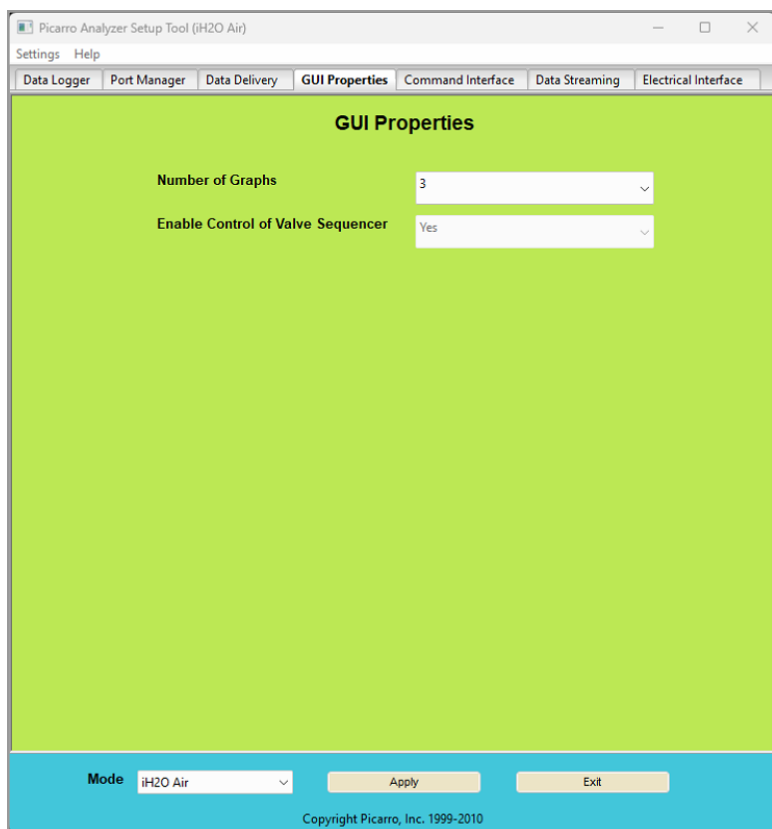


Figure 53 - GUI Properties Settings Tab

## A.1.5 Command Interface – Specifying Digital Data Output

The **Command Interface** tab allows you to specify the data elements that are sent via COM port/TCP (specified in the **PORT MANAGER** tab). Two types of data can be specified here:

### Output Data Source:

- Datalog\_User
- DataLog\_User\_Sync (Relevant only for Flux G2311-f analyzers).

### Output Data Columns:

- The data columns are output in the order they are checked, e.g., CH<sub>4</sub>, comes before CO<sub>2</sub>. Command Interface enables an external device to send a set of predetermined commands to a Picarro analyzer. The Picarro returns data or metadata on the basis of the command received.

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

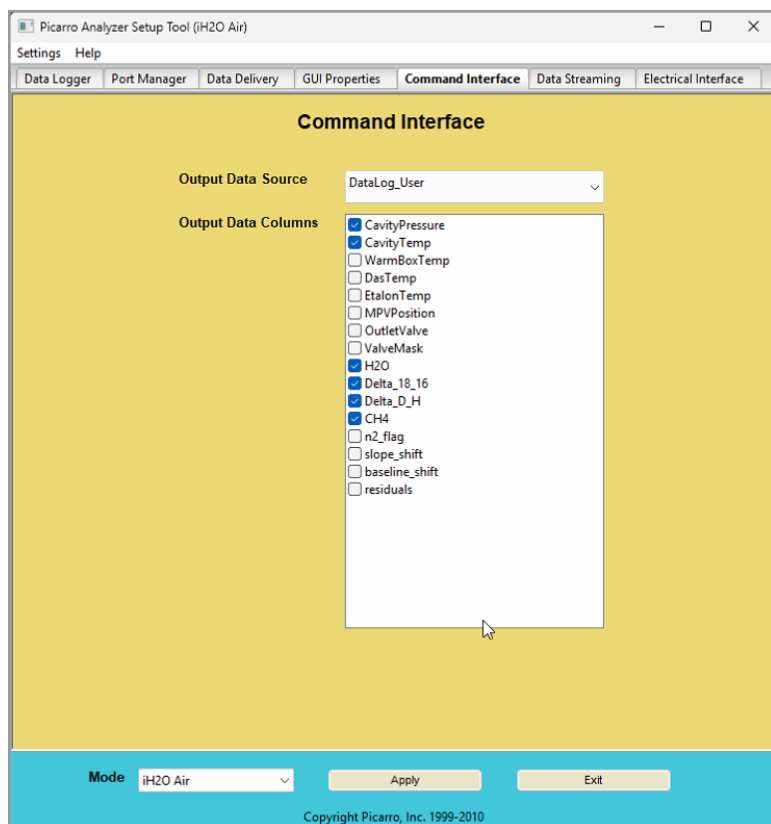


Figure 54 - Command Interface Settings Tab

### A.1.6 Data Streaming – Specifying Digital Data Output

The **Data Streaming** tab allows you to specify the data elements that you want to send via COM port (specified from the **PORT MANAGER** tab). Two types of data can be specified here:

#### Output Data Source:

- Datalog\_User
- DataLog\_User\_Sync (Relevant only for Flux G2311-f analyzers).

#### Output Data Columns:

The data columns are output in the order they are checked, e.g., CH<sub>4</sub>, comes before CO<sub>2</sub>. Command Interface enables an external device to send a set of predetermined commands to a Picarro analyzer. The Picarro returns data or metadata on the basis of the command received.

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

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

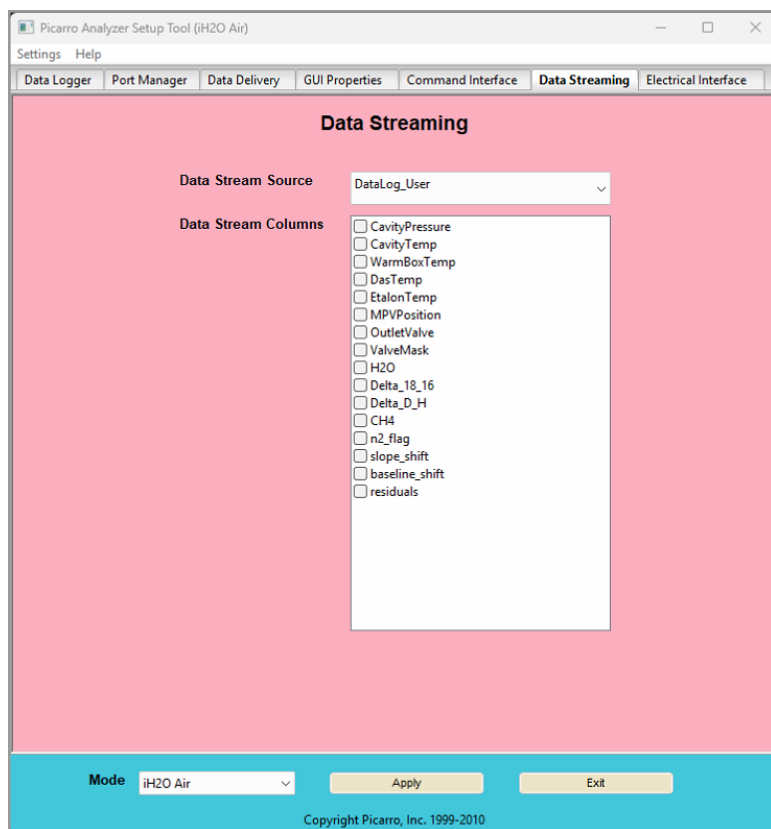


Figure 55 - Data Streaming Settings Window

### A.1.7 Electrical Interface – Customizing Analog Output Channels

The Picarro analyzer may be optionally configured with an **Electrical Interface Card (EIC)** that provides up to 8 analog signals available to the user for monitoring various measurements results and analyzer parameters.

The **Electrical Interface** tab (Figure 56) allows you to customize each analog output channel.

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

#### CAUTION

This tab will be disabled if your analyzer was not configured to work with an analog peripheral.

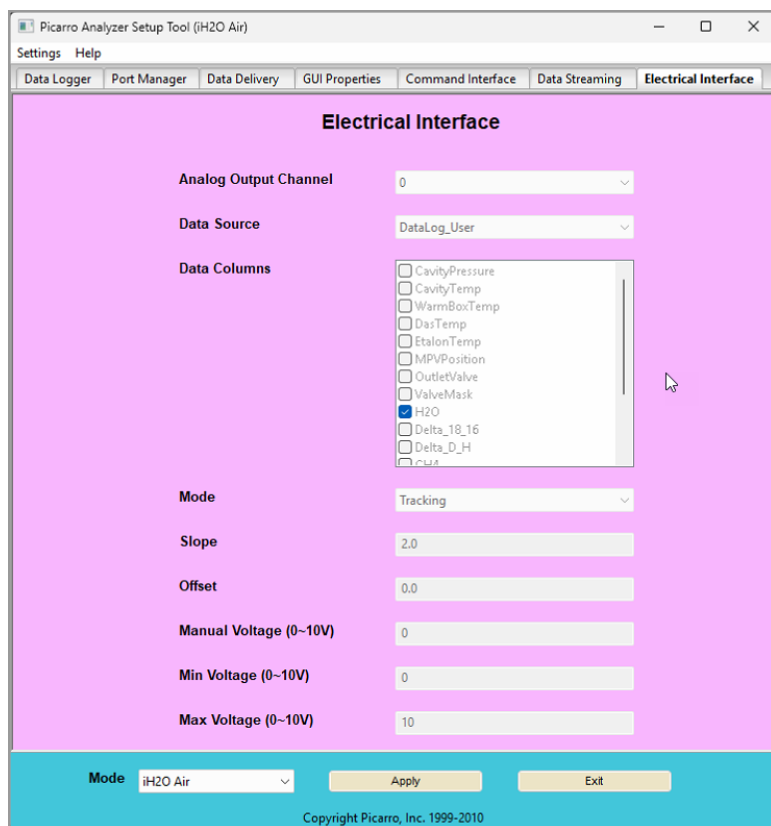


Figure 56 - Electrical Interface Settings Window

## A.2 Remote Data Access

The analyzer supports remote data access capabilities that allow users to retrieve instrument data, configure remote communications, and automate data delivery. Through the RS-232 serial interface or Ethernet connection, users can remotely control the analyzer and retrieve concentration data using Picarro's supported command set. For complete command syntax, configuration details, and supported functions, refer to the Remote Interface Programming Guide 40-0063 available through Picarro's Document Library.

In addition to direct communication, the analyzer can be configured to automatically send data files to designated email recipients and synchronize the host computer clock with internet time servers using the RemoteAccess.ini configuration file. These functions are managed through the RemoteAccess.exe utility and can be scheduled to run automatically at user-defined intervals. This section explains how to access the remote interface documentation and configure remote data transfer, email notifications, and time synchronization settings.

## A.2.1 Picarro Serial Communication

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

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

To Download:

1. Go to <https://www.picarro.com/>.
2. Under the **Support** tab (near the home page upper-right corner), select **Document Library**.
3. When the Document Library page opens, enter the search terms, “Remote Interface” in the **Search** field.
4. In the results, click on the link titled “**Remote Interface Programming Guide 40-0063**” to open the manual in your browser. From there you can also download and save it to your PC.

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

## A.2.2 Remote Data Access

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

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

The Internet connection need not be permanent and may be a dial-up connection accessible via a user-supplied USB modem. The task of sending data and/or synchronizing the clock on the analyzer is performed using the C:\Picarro\G2000\HostExe\RemoteAccess.exe program. This program can be set up to run periodically using the Windows task scheduler at a user-configurable frequency. If a dial-up connection to the Internet is employed, it is used only on demand to minimize the connection time.

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

The initialization file is:

*C:\Picarro\G2000\AppConfig\Config\UtilitiesRemoteAccess\RemoteAccess.ini*

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

### A.2.3 NTP

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

### A.2.4 Email

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

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

## B Data File Viewer

The Data File Viewer is a software tool used to visualize, analyze, and manage instrument data collected over time. This Quick Start Guide introduces a common workflow for viewing data trends by converting, concatenating, and plotting measurement files, allowing users to efficiently examine data spanning multiple hours or days. Subsequent sections describe additional features of the Data File Viewer in greater detail, including statistical analysis, data transformation, and advanced plotting options.

### B.1 Quick Start Guide

The following sections introduce the user to all functions 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.

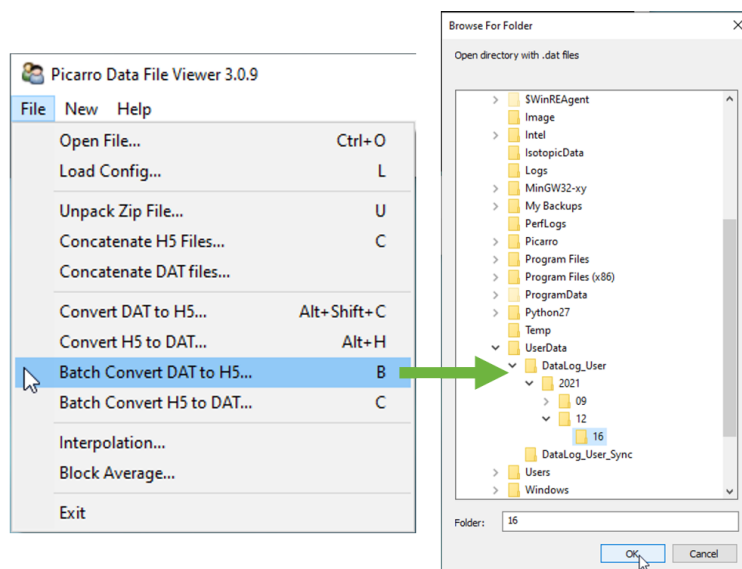


Figure 57 - Batch Convert DAT to H5 – Navigation

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 very long 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**.

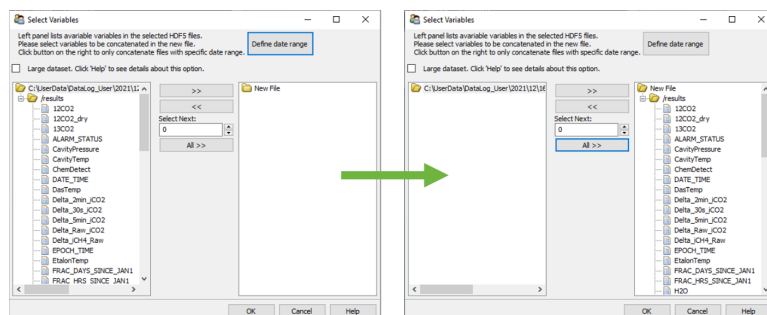


Figure 58 - Selecting Variables for Concatenation

- The user will then be asked to confirm the file name for the concatenated data. The default location will be in the parent folder for the selected day, and the filename will by default describe the time span of the measurements within. Successful concatenation will lead to the filename automatically being displayed in the main data file viewer window.

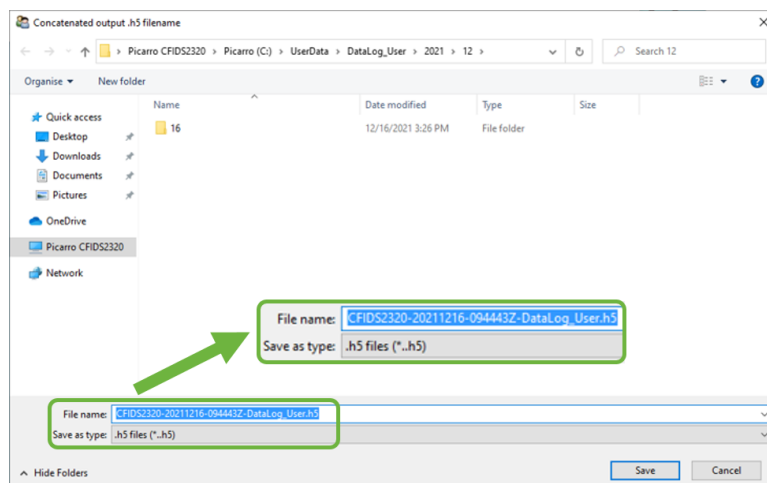


Figure 59 - Concatenated Output .h5 Filename

### NOTE

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

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

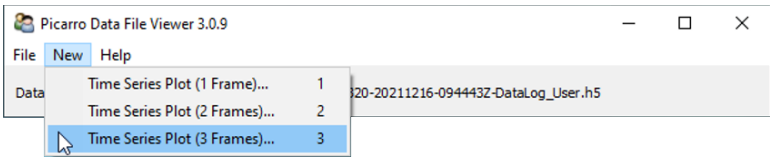


Figure 60 - Time Series Selection Options

- 7. In the new window that appears, select the variables from the **Var Name** dropdown on the right of each plot. Deselect **Autoscale y** if the data stream has a large amount of variability in the Y-axis.
- 8. Please read the following sections to learn more about features of the Data File Viewer.

B.2 Data File Viewer Overview

The Picarro Data File Viewer software is located on the desktop of the Picarro instrument. The software allows the user 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**.

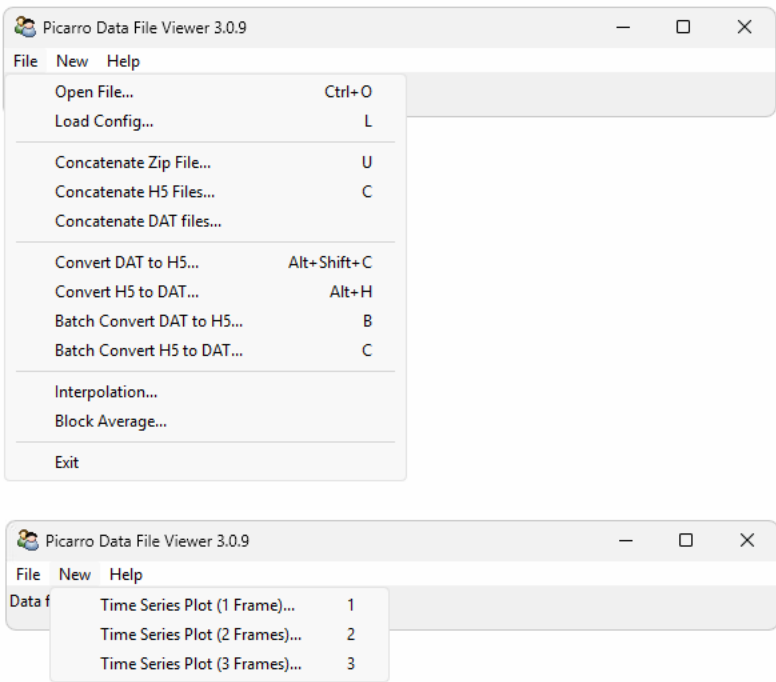


Figure 61 - Picarro Data File Viewer – File and New Menus

B.3 File Menu

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

### B.3.1 Open H5

**File > Open H5 File:** Opens a Picarro data file (HDF5 format) for data analysis and visualization. After opening the data file, you can create a new time series plot. Refer to section [B.3 File Menu](#) for more information.

### B.3.2 Load Config

**File > Load Config:** Loads a configuration file (ini format) to restore parameters of a workplace. Refer to [B.3 File Menu](#) for more information.

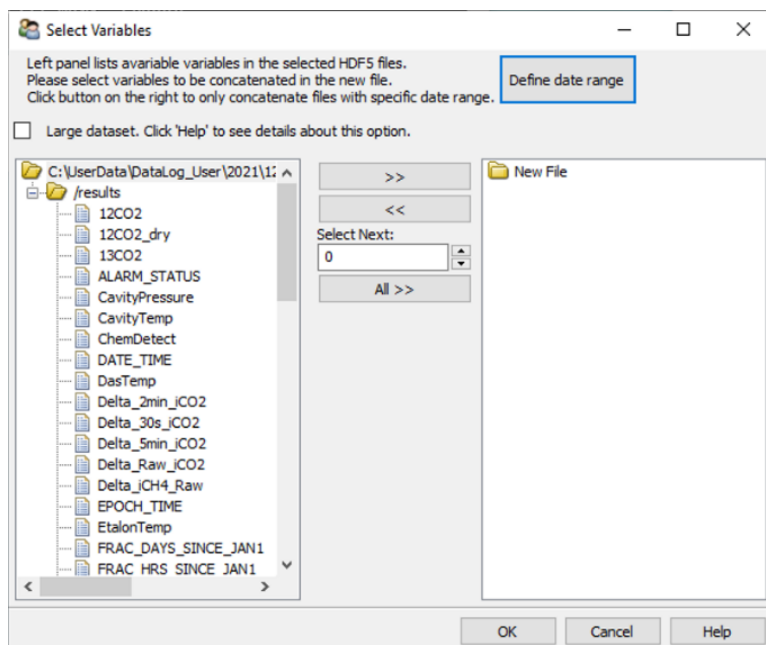
### B.3.3 Unpack Zip File

**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.

### B.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.)

After selecting the path of the data files, Data File Viewer will automatically search an H5 file in the specified zip/folder and look for all available variables in the H5 file. The variables are then listed in the **Select Variables** window in the left panel (as shown in [Figure 62 - Select Variables Form](#)), and users can use the “>>” button to move variables to the right panel for concatenation.



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

Figure 62 - Select Variables Form

### B.3.5 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 were taken.

**Select File > Concatenate H5 Files**, then click **Define Date Range** to specify the desired date range as shown in [Figure 63 - Define Date Range Dialog](#).

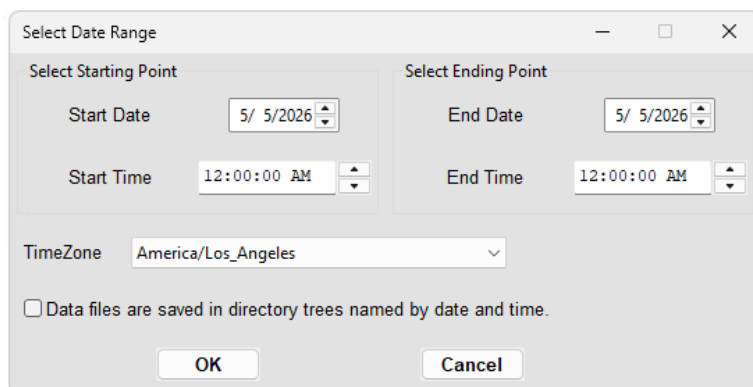


Figure 63 - Define Date Range Dialog

Data files are saved in directory trees named by date and time option.

Picarro software saves data in a directory tree that is named by the creation year, month, and day as shown in [Figure 63 - Define Date Range Dialog](#). Select this option if the target folder has this file structure. This way, Data File Viewer will only search folders within the desired date range, which can substantially reduce processing time.

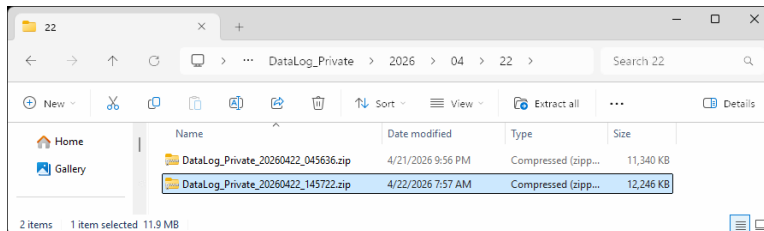


Figure 64 - File Structure of Data File Viewer

#### 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.

### B.3.6 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.

## B.3.7 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.

## B.3.8 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.

## B.3.9 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.

## B.4 Time Series Plot

You can create a time-series plots with one, two, or three frames. The additional plots display in the Time Series Viewer.

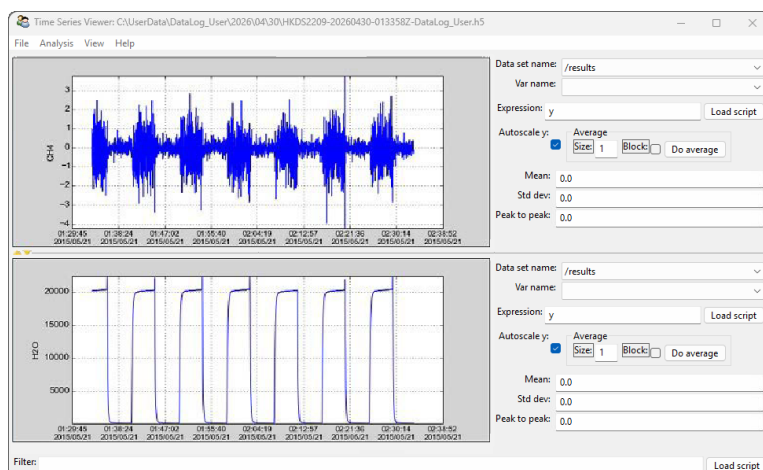


Figure 65 - Time Series Viewer

### 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 on Page 89 for more information on the Time Series Viewer UI features and options.

## B.5 Time Series Viewer Menus

The Time Series Viewer includes menu options that allow users to save display settings, export images, and manage visualization configurations. These menus provide quick access to common actions used during data review and analysis.

### B.5.1 Time Series Viewer File Menu

The File menu contains options for saving the current visualization setup and capturing images of the data display. These functions are particularly useful for preserving analysis settings and documenting results.

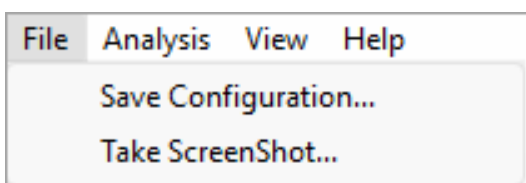


Figure 66 - Time Series Viewer – File Menu

### Save Configuration

Select **File > Save Configuration** to open the Feature Capture dialog. This dialog allows you to save the current viewer configuration, including plot properties, applied expressions, filters, axis ranges, and other display settings, into a configuration (.ini) file. This file can be reloaded later to restore the same analysis environment.

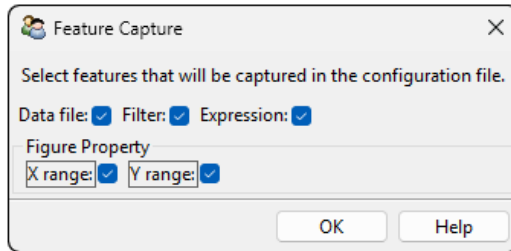


Figure 67 - Time Series Viewer – Feature Capture

#### NOTE

The options selected in the Feature Capture dialog determine which elements are saved. Any features not selected during capture will not be included when the configuration is reloaded.

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 Data file is not captured, saved parameters will be applied to the data file in memory.
- If Expression is not captured, plots will not be transformed.
- If X (Y) range is not captured, figures will be auto-scaled on the x (y) axis.

### Take Screenshot

Select **File > Take Screenshot** to capture the current Time Series Viewer display as an image file. The screenshot is saved in PNG format to a user-specified location and can be used for reporting, documentation, or sharing analysis results.

## B.5.2 Time Series Viewer Analysis Menu

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

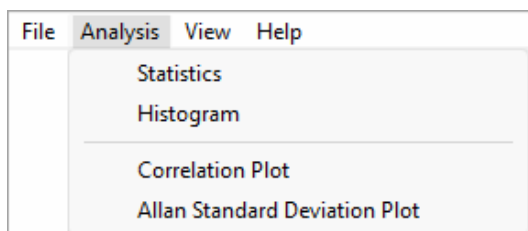


Figure 68 - Time Series Viewer – Analysis Menu

### Statistics

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

### Histogram

Use **Analysis > Histogram** to generate a histogram of data as shown in [Figure 69](#) below.

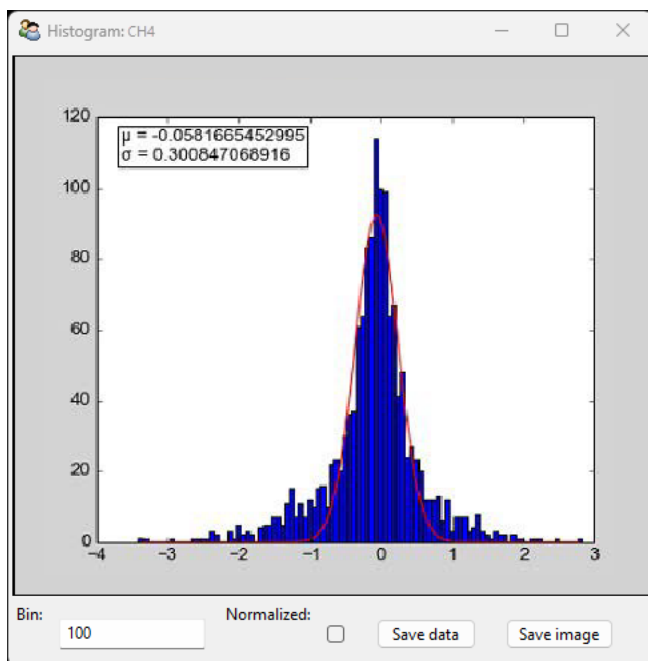


Figure 69 - Histogram Window

### Histogram Window Features

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

### Correlation Plot

Use **Analysis > Correlation Plot** to plot Y-axis data in one frame versus that in the other. This can be used when two or more frames exist in the current Time Series Plot window. See the section, [Correlation/XY Plot](#).

### 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.

## B.5.3 Time Series Viewer View Menu

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

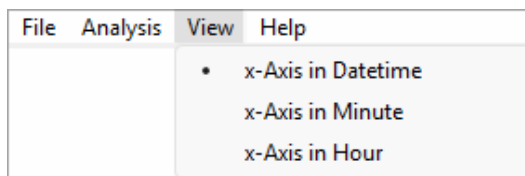


Figure 70 - Time Series Viewer – View Menu

### 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.

## B.5.4 The Time Series Viewer Canvas

The Time Series Viewer canvas ([Figure 71 - Time Series Viewer Canvas](#) below) is comprised of interactive graphs and a variety of configuration options.

## B.5.5 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.

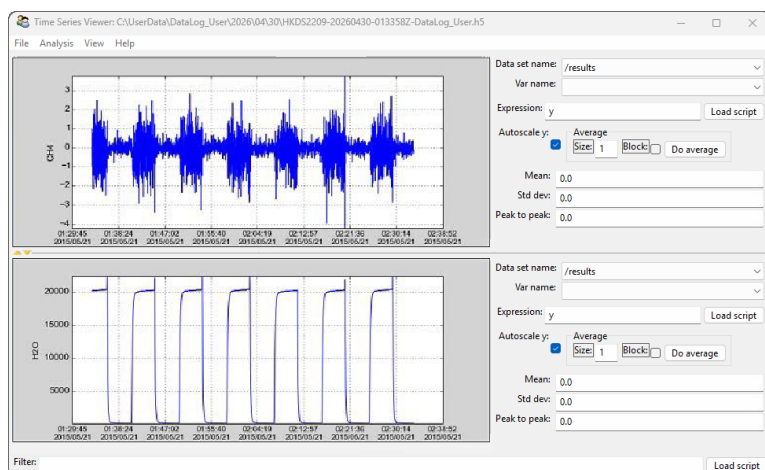


Figure 71 - Time Series Viewer Canvas

### NOTE

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

## B.5.6 Right-click Menu

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

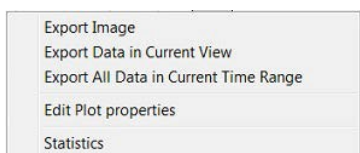


Figure 72 - Canvas Right-click Pop-up Menu

The following menu options include:

- **Export Image:** Exports the current plot as a jpeg, png, or pdf file.
- **Export Data in Current View:** Exports only date/time and the selected variable in the current view to an HDF5 or CSV file.
- **Export All Data in Current Time Range:** Exports all variable columns of the selected dataset in the current time range to an HDF5 file. Refer to Concatenate H5 Files on Page 81 for more information.

- **Edit Plot properties:** Opens the **ImageEditor** form (Figure 73 - Image Editor Form below), where the following options can be specified.

Figure 73 - 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 of 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.

### B.5.7 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 74 - Time Series Viewer Dataset Options) to select the dataset that will be 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 74 - Time Series Viewer Dataset Options

### B.5.8 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.

### B.5.9 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.

### B.5.10 Mean, Std Dev, and Peak to Peak

The **Mean**, **Std dev** (Standard deviation) and **Peak to peak** fields ([Figure 74 - Time Series Viewer Dataset Options](#)) provide all the statistical information of data in the current view.

### B.5.11 Correlation/XY Plot

The Correlation/XY Plot window ([Figure 75 - Correlation XY Plot](#)) includes two menu items: File and Analysis. For details about the File menu, see [Save Configuration](#) on page [on page 101](#).



#### REMINDER

The canvas in this plot is interactive. For details about the plot canvas, see [B.5.4 The Time Series Viewer Canvas](#) on Page [on page 103](#).

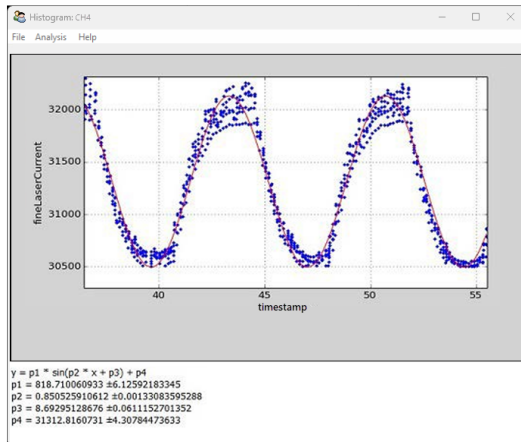


Figure 75 - Correlation XY Plot

## B.5.12 Analysis Menu

The Analysis Menu includes three options: **Fitting**, **Integration**, and **Statistics**.

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

1. **Linear fit:** Specifies to fit to linear function:  

$$y = c1x + c0$$
2. **Quadratic fit:** Specifies to fit to quadratic function:  

$$y = c2x^2 + c1x + c0$$
3. **Polynomial fit:** Specifies to fit polynomial function of degree n:  

$$y = \sum c_n x^n$$
4. **Curve fit:** Specifies to use non-linear least squares to fit an arbitrary function to data.

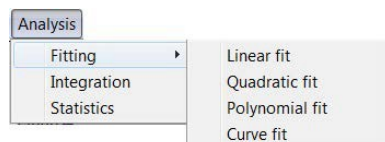


Figure 76 - Analysis Menu

**Integration** calculates area under the curve using the composite trapezoidal rule.

**Statistics** calculates mean, standard deviation, and peak to peak for data in the current view.

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

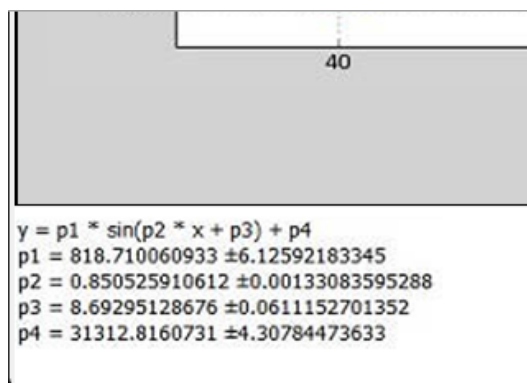


Figure 77 - Results of Quadratic Fitting

## C External Valve Sequencer

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 [C External Valve Sequencer](#)) 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.

### C.1 A0311 16-Port Distribution Manifold

The following section describes the A0311 16-port distribution manifold compatibility and functionality.

#### C.1.1 Compatibility

The A0311 ([Figure 78](#)) 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).

#### C.1.2 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 78 - A0311 – 16-port Distribution Manifold

## C.2 A0311-S 16-Port Distribution Manifold (Silco)

The following section describes the A0311-S 16-port distribution manifold compatibility and functionality.

### C.2.1 Compatibility

The A0311-S (Figure 79) 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, PI2114 and PI2124

### C.2.2 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 79 - A0311-S – 16-Port Sequencer – Fast Multiport Gas Sampler

## C.3 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**.

### CAUTION

Only use supported 12V, <500 mA, solenoids (listed above in [C.3 Valve Control Configurations](#)). Using unsupported solenoids may result in damage to the power board.

## C.4 Setting Up Solenoid Valves

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

### CAUTION

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

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

C.5 Setting up a Rotary Selector Valve

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

C.6 External Valve Sequencer Software Overview

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

C.6.1 Opening the Sequencer

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

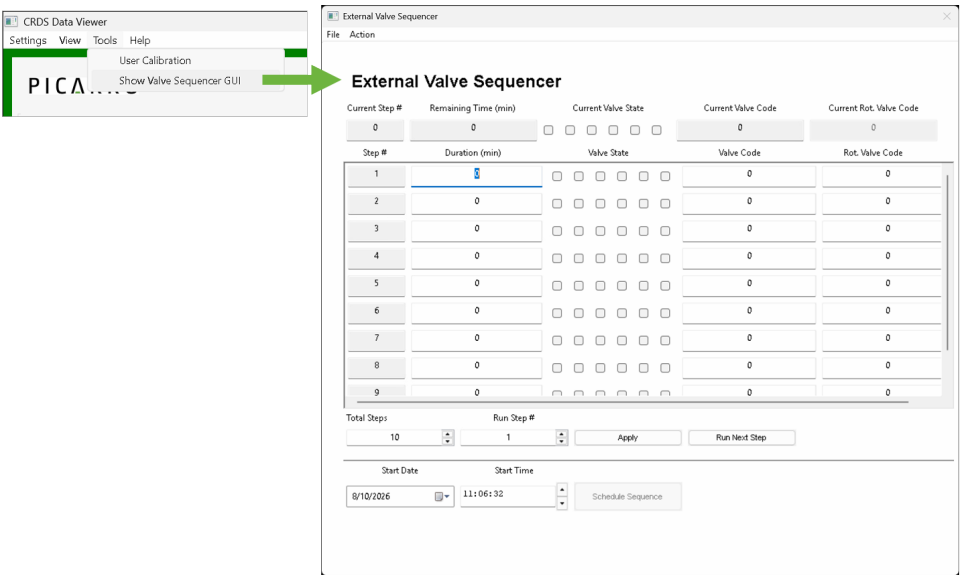


Figure 80 - Launching the Valve Sequencer GUI

C.6.2 Valve Sequencer UI Menus

The sequencer GUI provides the following dropdown menu options.

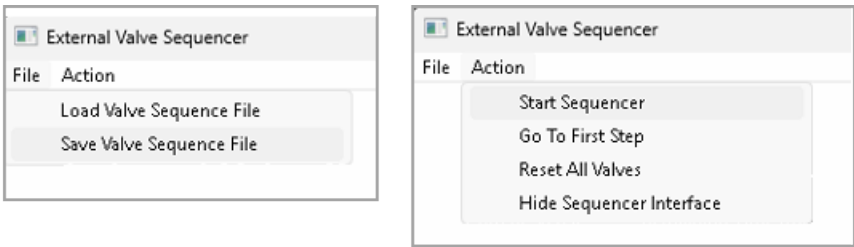
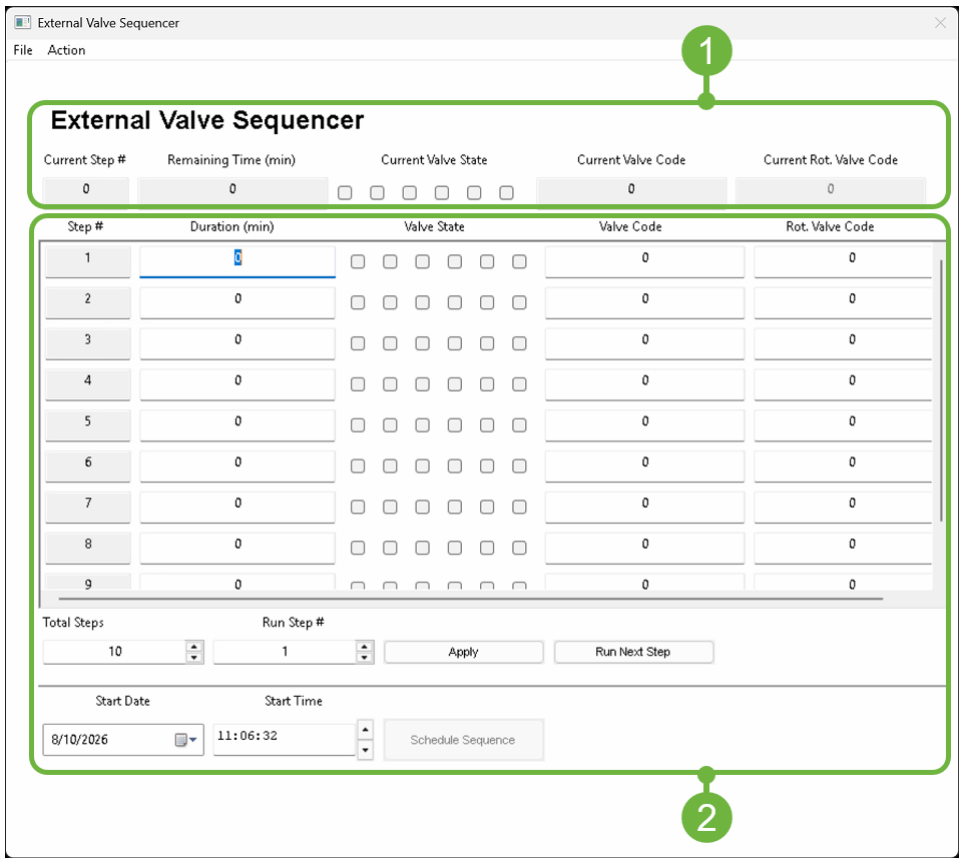


Figure 81 - Valve Sequencer UI Dropdown Menus

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 82 - 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.

## C.7 Programming and Saving a Valve Sequence

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

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

$$\text{Valve 1 Powered} = 2^{(\text{Valve number}-1)} = 2^{(1-1)} = 1$$

$$\text{Valve 2 Powered} = 2^{(\text{Valve number}-1)} = 2^{(2-1)} = 2$$

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**.

The screenshot shows the 'External Valve Sequencer' window with a menu bar (File, Action) and a title bar. The main area displays a sequence configuration table with columns: Step #, Duration (min), Valve State, Valve Code, and Rot. Valve Code. Below the table are controls for Total Steps, Run Step #, Start Date, and Start Time, along with 'Apply', 'Run Next Step', and 'Schedule Sequence' buttons.

| Current Step # | Remaining Time (min) | Current Valve State                                                                                                                                   | Current Valve Code | Current Rot. Valve Code |
|----------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------|
| 1              | 5                    | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | 4                  | 0                       |

| Step # | Duration (min) | Valve State                                                                                                                                                                 | Valve Code | Rot. Valve Code |
|--------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------|
| 1      | 5              | <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>            | 4          | 0               |
| 2      | 5              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>            | 16         | 0               |
| 3      | 5              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> | 48         | 0               |
| 4      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |
| 5      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |
| 6      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |
| 7      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |
| 8      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |
| 9      | 0              | <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>                       | 0          | 0               |

Total Steps: 3, Run Step #: 1, Apply, Run Next Step

Start Date: 8/11/2026, Start Time: 14:15:49, Schedule Sequence

Figure 83 - 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 81). The sequence may be saved with any name the user chooses.

## C.8 Loading and Running a Saved Sequence

After a valve sequence has been created and saved, it can be reloaded for future use and executed through the External Valve Sequencer software. The sequencer allows users to load predefined sampling routines, start and stop automated valve switching, advance through individual sequence steps, and return valves to a safe operating state when needed. The following sections describe how to load an existing sequence, run the sequencer, and manage sequence execution during operation.

### C.8.1 Loading a Saved Sequence

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

All the sequence files are in:

*/home/picarro/I2000/InstrConfig/ValveSequencer/Name of the Sequence File*

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

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

### C.8.2 Running a Sequence

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

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

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

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

### C.8.3 Skipping Steps or Advancing to a Particular Step

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

### C.8.4 Stopping the Sequencer

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

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

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

## C.9 Resetting Valves

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

## C.10 Valve Sequencer Data Records

For each individual measurement the analyzer makes, the valve codes and rotary valve positions corresponding to the valve state(s) at that point in time are saved alongside the concentration data as long as the variable is selected in the **User Setup utility, Data Logger tab, Data Columns** window.

If the variable is not available in that window, from the **User Setup > Settings** menu, select the service mode, password picarro, and then select the value from the variables that populate into the **Data Columns** window.

If no solenoid valves are present, the codes will be recorded regardless of whether a valve is connected.

If no steps are defined, and no sequence is active, these values will display **0**.

## C.11 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.

## D Relative Humidity Conversion

H<sub>2</sub>O 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 (P<sub>W</sub>) 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 (P<sub>WS</sub>).

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

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,  $\alpha = 4.584$  Torr,  $\beta = 17.62$  and  $\lambda = 243.12$  °C

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

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

For example, a wet concentration of 1.5% H<sub>2</sub>O 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*

## E 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.

The following sections describe the key components and functions of the analyzer system.

### E.1 Cavity Ring-Down Spectroscopy (CRDS)

Nearly every small gas-phase molecule (e.g.,  $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_2\text{S}$ ,  $\text{NH}_3$ ) and isotopologue (e.g.,  $\text{H}_2^{18}\text{O}$ ,  $^{13}\text{CO}_2$ ,  $^{15}\text{N}^{14}\text{N}^{16}\text{O}$ ) 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 84](#). 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 84](#).

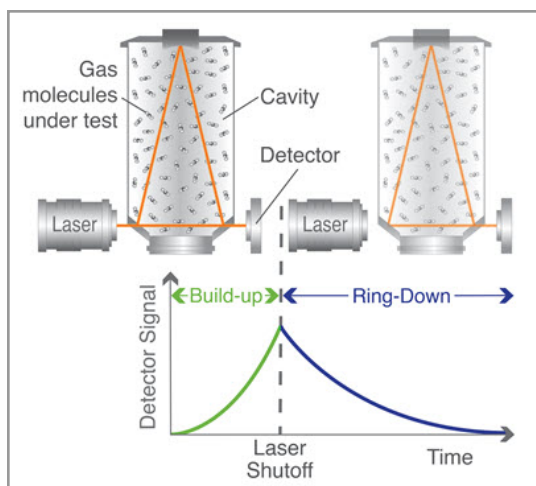


Figure 84 - Schematic of the Picarro CRDS analyzer cavity

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.

## E.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.

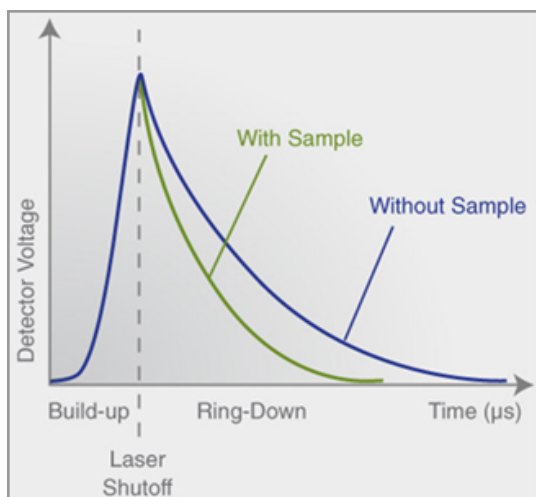


Figure 85 - Light intensity as a function of time in a CRDS system

### E.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 86 shows a plot of ideal optical spectra with a clean, uniform baseline on either side of the absorption peak.

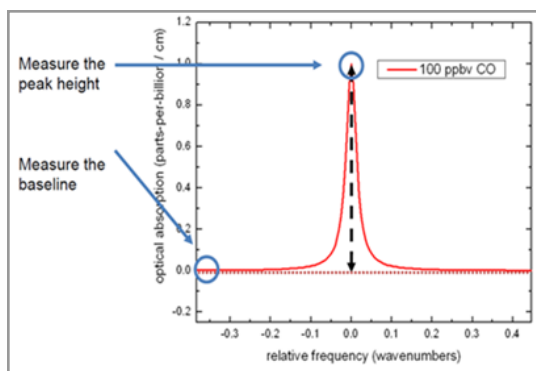


Figure 86 - Absorption Spectral Curve

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.

## E.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.

## F Limited Warranty

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

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

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

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

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

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

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

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

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

## About Picarro

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

## Product Support



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

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

[Picarro Document Library](#)

[Picarro Community \(Forums\)](#)

[Picarro Software Downloads](#)

[Picarro Literature \(Scientific Resources\)](#)

[Picarro Web Store](#)

Contact Picarro for questions regarding specific applications and additional information.

### Picarro Customer Support (USA)

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Phone: +1 408 962 3991

### Picarro Customer Support (International)

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