PICARRO

PI2114 Analyzer for H_2O_2
User Manual

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Picarro Analyzer User Manual

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

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

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

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1. INTRODUCTION TO TECHNOLOGY

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

The Picarro analyzer is comprised of two modules:

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

1.1 Cavity Ring-Down Spectroscopy (CRDS)

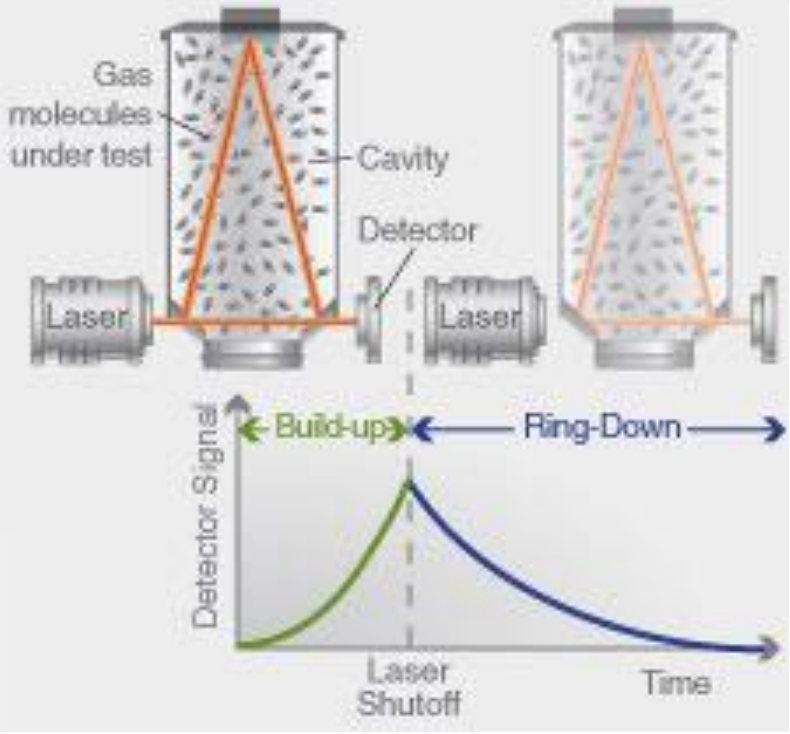
Nearly every small gas-phase molecule (e.g., CO_2, H_2O, H_2S, NH_3) and isotopologue (e.g., $H_2{}^{18}O$, $^{13}CO_2$, $^{15}N^{14}N^{16}O$) uniquely absorb specific wavelengths of near-infrared light. The strength of the light absorption is related to the concentration of a molecule in a sample and the distance that light travels through the sample, called the path length.

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

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

In Picarro analyzers, light from a single-frequency laser enters a cavity where three mirrors reflect the laser light as seen in Figure 1. The light enters through the mirror closest to the laser, bounces off the angled mirror in the lower right corner of the cavity, travels to the hemispherical mirror at the top of the cavity, bounces toward the mirror in the lower left corner of the cavity, and then returns to the first mirror. This motion becomes a continuous traveling light wave, which is represented by the dark orange path in Figure 1.

Figure 1
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.

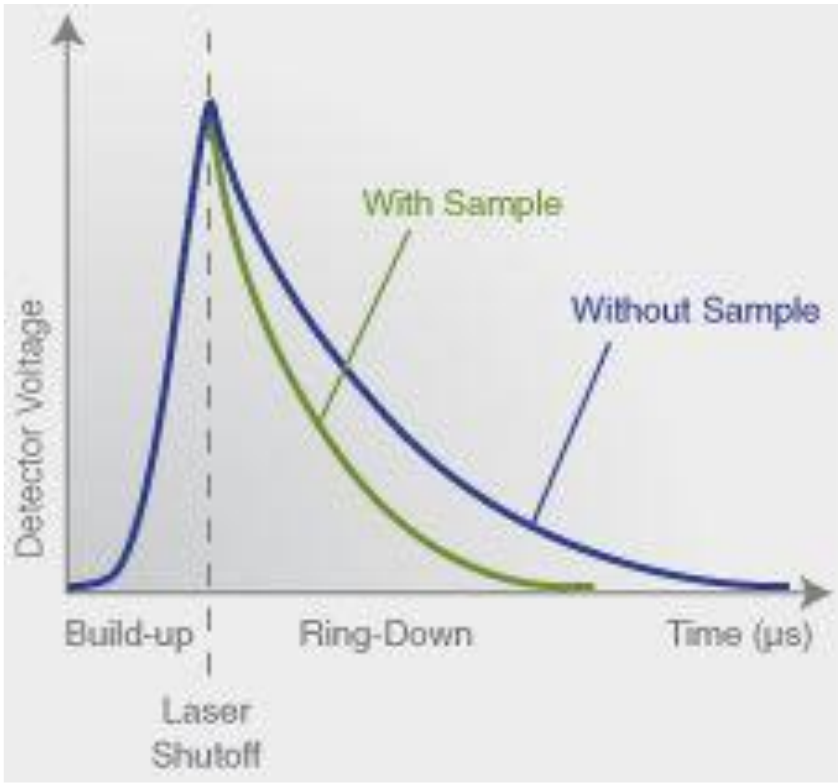
1.2 Relating ring-down time to absorption intensity

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 1: Light intensity as a function of time in a CRDS system

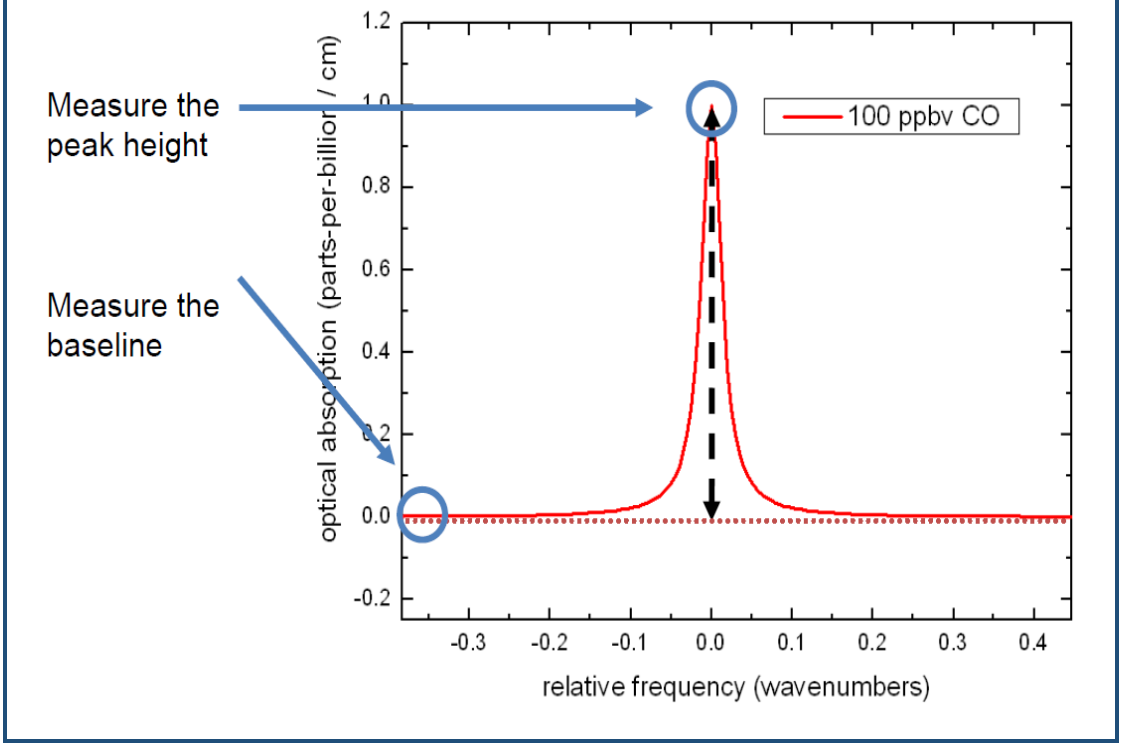


1.3 Converting absorption intensity to concentration

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

Figure 2: 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.

1.4 Spectral precision and high sensitivity measurements

Picarro analyzers contain two features that provide high spectral precision:

- A proprietary **wavelength monitor (WLM)** that measures the absolute laser wavelength to a precision that is a few orders of magnitude narrower than the spectral linewidth: Picarro's patented WLM measures absolute laser wavelength to a precision more than 1,000 times narrower than the observed Doppler-broadened linewidth for small gas-phase molecules. The instruments lock the laser to the WLM, and then the monitor tunes to wavelengths known to be maximally and minimally absorbed by the target molecule. The result is closely clustered absorption intensities, measured at wavelengths just before peak absorption, at peak absorption, and just after peak absorption, as the absorbance returns to the baseline.

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

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

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

2. CONVENTIONS

The following icons are used throughout this manual to emphasize important information in the text. These icons indicate dangers to either the operator or to the analyzer, and other important information.

	Consult the user's manual for important information (When you see this symbol placed at hazard points on equipment, consult the user manual).
	**NOTE** is important information that you should be aware of before proceeding.
 WARNING	**LASER WARNING** alerts you of a laser danger.
 CAUTION	**CAUTION** alerts you of a potential danger to equipment or to the user.
 WARNING	**WARNING** indicates an imminent danger to the user.
 **REMINDER**	**REMINDER** is a helpful hint to procedures listed in the text.

3. ACRONYMS

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

Table 1: Acronyms

Acronym	Definition
” (as in 1/4”)	Inches
°C	degrees Celsius
‰	per mil
cm	centimeters
CRDS	Cavity Ring-Down Spectroscopy
GUI	Graphical User Interface
H_2O	Water
H_2O_2	Hydrogen Peroxide
HB	Hotbox
mm	millimeters
ppb	Parts Per Billion
ppm	Parts Per Million
RTU	Remote Terminal Unit (Modbus)
WB	Warm box

4. SAFETY

4.1 General Safety

CDRH Certification

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

CE Certification

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

WARNING

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

WARNING

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

WARNING

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

CAUTION

The analyzer contains no user serviceable components except the particulate filter, fans, and the vacuum pump. Do not attempt repairs; instead, report all problems to Picarro Customer Service or your local distributor. Please contact Picarro if you have any questions regarding the safe operation of this equipment.

WARNING

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

WARNING

This analyzer weighs 47.0 lbs. (21.3 kg). Use the technique described below when lifting the analyzer.

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

4.2 Laser Safety

WARNING

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

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

WARNING

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

The following **Laser Safety Labels** are affixed to the inside of the analyzer:

Figure 4: Laser Safety Label

WARNING

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

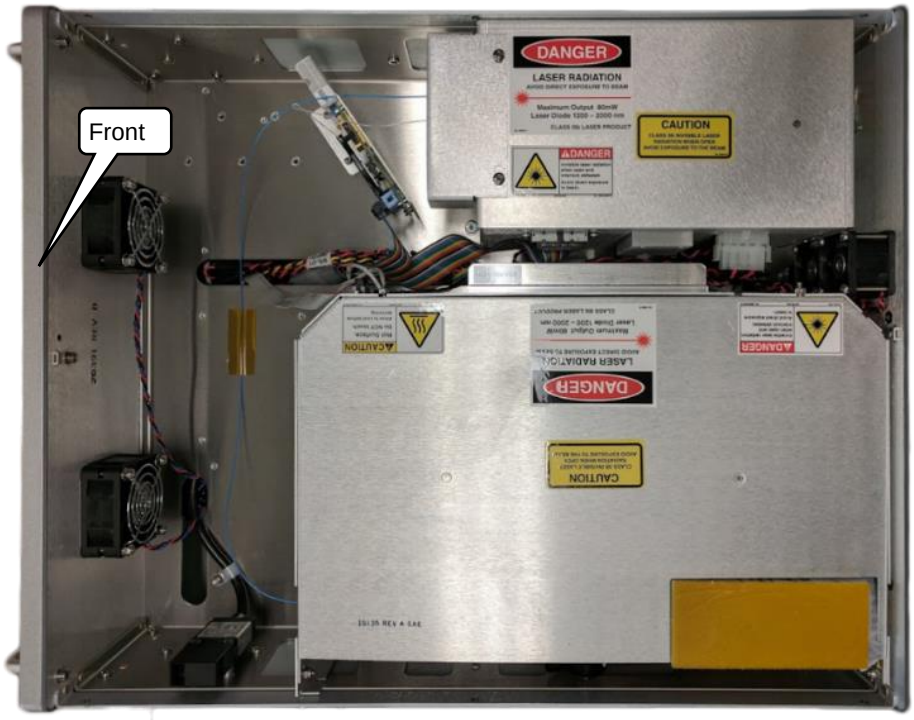
4.3 Warning Label Locations

The warning labels are located in the following positions.

Figure 3: Warning-labels on top

Figure 4: Warning labels on rear panel

Figure 5: Warning labels inside



The inside of the analyzer should not be accessed under normal operation. Only remove the top cover when replacing the filter (see Section 13.2, Filter Replacement).

5. UNPACKING THE ANALYZER

5.1 Inspect the Shipping Boxes

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

Inspect the condition of the 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 is cushioned enough that it will protect the instrument under most circumstances.

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

5.2 Unpack the Shipping Boxes

This section describes the contents of the shipping boxes:

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

WARNING

This analyzer weighs 47.0 lbs. (21.3 kg). Use the technique outlined in the General Safety section on Page 15 when lifting or moving the analyzer.

Table 2: Box One: Analyzer and Accessories

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

Item (qty)	Description
Keyboard (1)	USB keyboard
Mouse (1)	USB mouse
Control Cable (1)	For External Solenoid Valves
Nut (1) and Ferrules (2)	For connecting input line to analyzer INPUT
Document Packet (1)	Includes this manual, PI2114 Service Manual, PI2114 Installation Qualification/Operational Qualification Protocols and Instructions, and Certificate of Compliance.

Table 3: Box Two: Vacuum Pump and Accessories

Item (qty)	Description
Pump (1)	Provides vacuum required for sample gas sequencing into and out of the analyzer.
A/C Power Cable (1)	A power cable with connectors appropriate to your country is provided. The pump automatically adjusts to local voltage.
Vacuum Hose (1)	Hose to connect the pump to the analyzer.
Pump Manual (1)	Detailed instructions for pump.

6. ANALYZER OVERVIEW

6.1 Intended Use

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

6.2 Analyzer Front-Panel

Figure 6: Front Panel

Feature	Description
Status Indicator LED	There are five states of the status indicator: Off: System is off or has no power. Yellow (flashing): Warming up. Green: Operating correctly. Yellow (steady): not operating correctly. Red: Not measuring.
USB Port	For transferring files to a flash drive.

CAUTION

Only use the USB ports to connect to flash drives, mice, or keyboards. Do not connect hubs or other types of devices.

6.3 Analyzer Back Panel

Figure 7: Back Panel

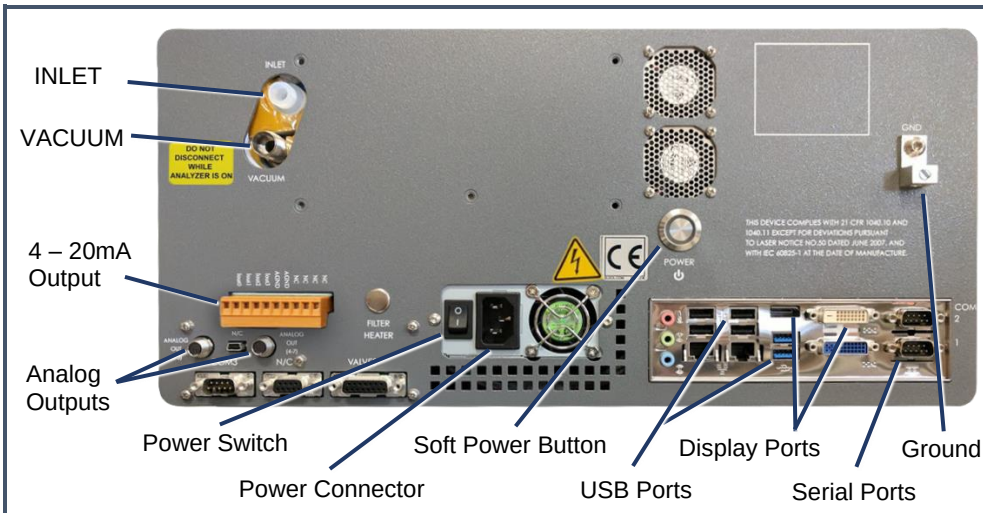


Table 4: Back Panel Features

Feature	Description
INLET	Connect to gases to be sampled.
VACUUM	Connect to external vacuum pump.
4–20 mA Output	Output terminal for monitoring the analyzer's 4–20mA signal output.
Power Switch	Control power to the analyzer.
Power Connector	Connect to AC power.
Soft Power Button	On/off button (Main Power Switch must be on).
USB Ports	Connect the mouse and keyboard USB flash-memory drive (optional).
Display Ports	Connect your video monitor (not included) to one of these three display ports. Three different types of connector are available: DVI-I, DVI-D, and DisplayPort.
Ground	Ground lug (if needed).
Serial Port	Connect for digital data streaming. See Service Manual for configuration instructions.
Analog Outputs	Connect for analog signal streaming. See Service Manual for configuration instructions.

NOTE

The analyzer's universal power supply automatically adjusts to power sources ranging from 100-240 VAC, 50/60 Hz, 250 W max.

CAUTION

Only use the USB ports to connect to flash drives, mice, or keyboards. Do not connect hubs or other types of devices.

6.4 External Vacuum Pump

The external 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 8: External vacuum pump

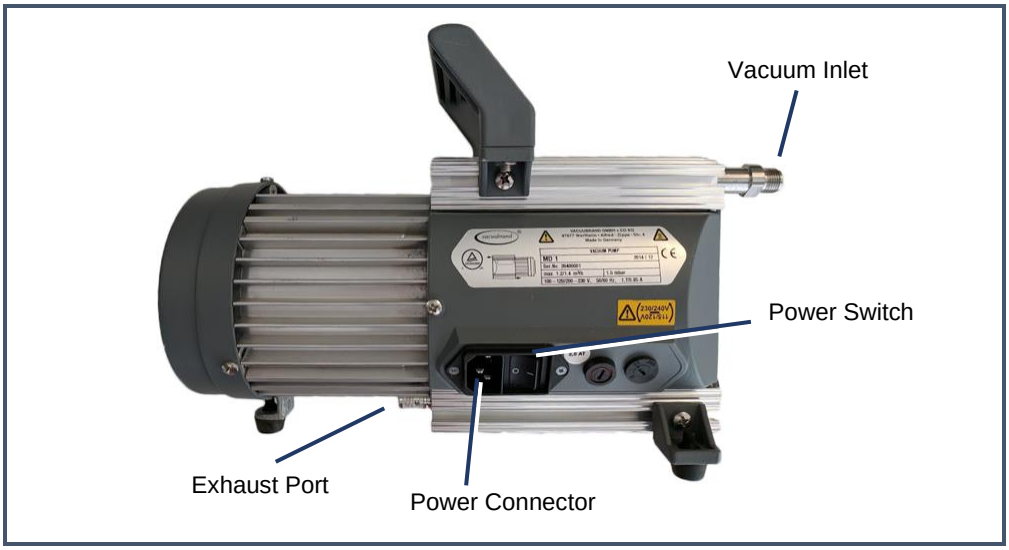


Table 5: Vacuum Pump Features

Feature	Description
Vacuum Inlet	Connect to the vacuum port on the analyzer.
Exhaust Port	Pump output (see pump manual).
Power Switch	On/Off switch for the pump.
Power Connector	Connect to AC power.

6.5 Analyzer Specifications

Table 6: Analyzer Specifications

Parameter	Specification
Weight Total Analyzer Pump	61.9 lbs. (28.1 kg), including external pump and vacuum tubing 47.0 lbs. (21.3 kg) 14.9 lbs. (6.8 kg)
Dimensions	Length: 24.38 in. (61.9 cm) Width: 17.5 in (44.5 cm); (17.75 in. with rails) Height: 7.88 in. (20.1 cm), (8.38 in. [21.3 cm] with feet)
Temperature Range	Storage: –10 °C to 50 °C Operating: 10 °C to 35 °C
Ambient Humidity Range	< 99% R.H. non-condensing
Maximum Altitude	10,000 ft. (3048 m), (operation)
Clearance Requirements	Front: 6 in. (15.2 cm) Rear: 6 in. (15.2 cm)
Power Requirements	100–240 VAC, 47–63 Hz (auto-sensing), < 260 W start up (total): 110 W (analyzer), 35 W (pump) at steady state
Minimum Rated Circuit Amperage	10A @115VAC 5A @230VAC
Liquid Ingress Protection	None

7. INSTALLATION

This section describes the setup and installation of the Picarro Analyzer. Please read and understand this section thoroughly before proceeding.

NOTE

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

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

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

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

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.

CAUTION

Picarro sells USB enabled devices, such as GPS, which is approved for use. Please do not connect USB hubs or unapproved USB devices, other than flash drives to the computer because they can interfere with the operation of the analyzer.

CAUTION

If rack mounted, the Analyzer cannot support itself using a front rack mount kit alone. The instrument *must* be supported by a shelf or additional rails attached to the rack.

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

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.

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.

CAUTION

During installation and operation, do not position the analyzer so that it is difficult to operate the disconnecting device.

NOTE

Take care to ensure that warm air is exhausted from an enclosure in which the analyzer is mounted.

CAUTION

It is imperative that the analyzer have adequate ventilation and/or cooling to maintain the ambient temperature below 35 °C when operating. 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” (15.2 cm) of clearance in the front and back of the analyzer.

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

WARNING

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

7.1 Install the Analyzer and Vacuum Pump

1. Place the analyzer on a sturdy, level, cart, or table. (A 19" rack-mounting kit is available separately if preferred.)

WARNING

This analyzer weighs 47.0 lbs. (21.3 kg). Use the technique outlined in the General Safety section on page 15 when lifting or moving the analyzer.

NOTE

Placing the analyzer where it may be exposed to RF radiation in the 80 MHz to 1 GHz range at field strengths over 10 V/m per IEC 61326-1-2013 may degrade performance.

2. Place the external vacuum pump near the analyzer on a cart or table.

Remove the caps from the analyzer's INLET and VACUUM connection ports. Save the caps; you should reinstall them when the analyzer is stored, moved, or shipped.

3. Remove the cap from vacuum pump's inlet. Save the cap for later use. Reinstall the caps when the pump is stored, moved, or shipped.
4. Connect one end of the vacuum hose to the pump: hand tighten the nut and then use an 11/16" wrench (not included) to make an additional turn of one flat (about 60 degrees).
5. Connect the other end of the vacuum hose to the VACUUM connector on the back of the analyzer: hand tighten the nut and then use the 11/16" wrench to make an additional turn of one flat (about 60 degrees).
6. Connect the analyzer to a power source using one of the supplied AC power cables.

CAUTION

Use only 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

When working with hazardous gases, make sure to provide proper ventilation or direct the exhaust with a hose to a safe place for venting. Consult the pump's manual for details.

7. Connect the external vacuum pump to a power source using the remaining AC power cable.

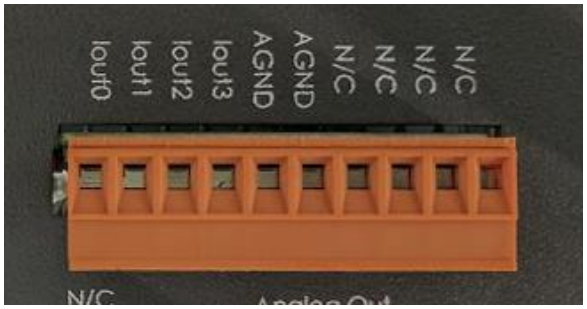
Select the appropriate voltage, 110V or 220V, for the External Vacuum Pump using the Power Switch located on the pump.

Connect the External Vacuum Pump to a power source using the other AC power cable.

7.2 Connect the 4–20mA Signal Output

Four channels of output are available on the back of the analyzer.

Figure 9: 4–20mA output with terminal connector in place



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

Table 7: Signal Output Settings

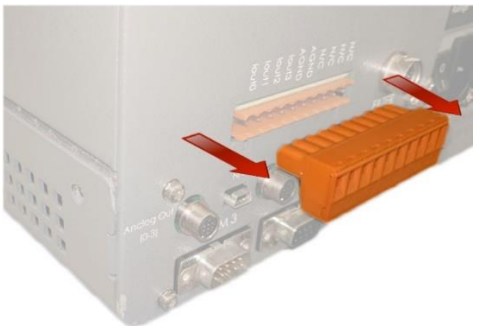
	Iout0	Iout1	Iout2	Iout3
Monitoring	H_2O_2	Cavity Temperature	DAS Temperature	Cavity Pressure
Units	ppb	Degrees C	Degrees C	Torr
Min	0.0	0.0	0.0	0.0
Max	1000.0	100.0	100.0	1000.0

To change this configuration, or to use one of the other outputs, see the *PI2114 Service Manual*.

To connect to the output:

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

Figure 10: Removing the terminal connector



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

Figure 11: Retaining screws at the bottom of the terminal connector

3. Insert the stripped end of the wire into the terminal.
4. Tighten the retaining screw.
5. Repeat for each desired terminal.
6. Slide the terminal connector back onto the analyzer with the retaining screws facing down; there should be a soft click when the connector is set into its proper position.

NOTE

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

7.3 Connecting to the Analyzer Inlet

Connect to the inlet of the analyzer using ¼" OD PTFE or PFA tubing using the supplied plastic ¼" PFA inlet nut and ferrules.

WARNING

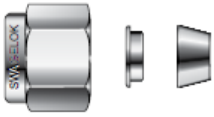
When using compressed gases, follow all appropriate safety conventions, including use of eye protection, physical restraint of cylinders, etc.

Making a new connection:

When using new tubing, follow these steps.

1. Place the two ferrules inside the nut as shown.

Figure 12: Orientation of ferrules and nut



2. Loosely connect the nut to the INLET on the back panel of the analyzer about a full turn, being careful not to let the ferrules fall out.
3. Insert the tubing into the back of the nut, feeding it in as far as possible without deforming the tubing.
4. Hand tighten the nut.
5. Using a 5/8" wrench (not included), tighten the nut approximately seven flats (420 degrees).

Replacing a connection

When reattaching tubing that already has a nut connected:

1. Inspect 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's INLET.
3. Using a 5/8" wrench (not included), tighten the nut approximately one flat (60 degrees).

7.4 Setting Up a Monitor, Keyboard and Mouse

A video monitor (not included), keyboard, and mouse are required for monitoring device operations, viewing, or changing settings (including setting user permissions), or validating device performance.

NOTE

This device will operate under its default settings without any direct control of the internal software.

1. Connect a keyboard to one of the available USB ports.
2. Connect a mouse to one of the available USB ports.
3. Connect a monitor to one of the monitor ports. The analyzer will detect the connection and adjust the resolution to match the monitor.

4. Connect the monitor to a power source.
5. Turn on power to the monitor.

8. OPERATE THE ANALYZER

8.1 Startup Procedure

This section describes the steps to power on the system. These steps are sufficient for operating the instrument at the default values.

1. Switch on the external vacuum pump.

CAUTION

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

2. Switch on the main power to the analyzer.
3. Press the soft power button.
4. Wait approximately 45 minutes for the system to power up, initialize, and stabilize.

   The status indicator on the front panel will flash yellow during initialization. Once the cavity pressure and operating temperature are at their proper values and stable, the indicator will turn to green.
5. To assign user roles, manage password requirements, or perform other administrative tasks, refer to “USER MANAGEMENT” on page 41
6. To run the validation procedure to check the operation of the instrument, refer to “INSTRUMENT VALIDATION” on page 55.

8.2 Using the GUI

Operating the system through the graphical user interface (GUI) requires a monitor, keyboard, and mouse (see page 29).

When the device is first powered on, the analyzer first displays the Home Screen.

Figure 13: Home Screen

The Home Screen will be available for 30 seconds before the device initializes and begins normal operation. While on the home screen, choose another action or click anywhere to stop the timer.

Use the buttons on the Home Screen to select a task:

Table 8: Home Screen Button Functions

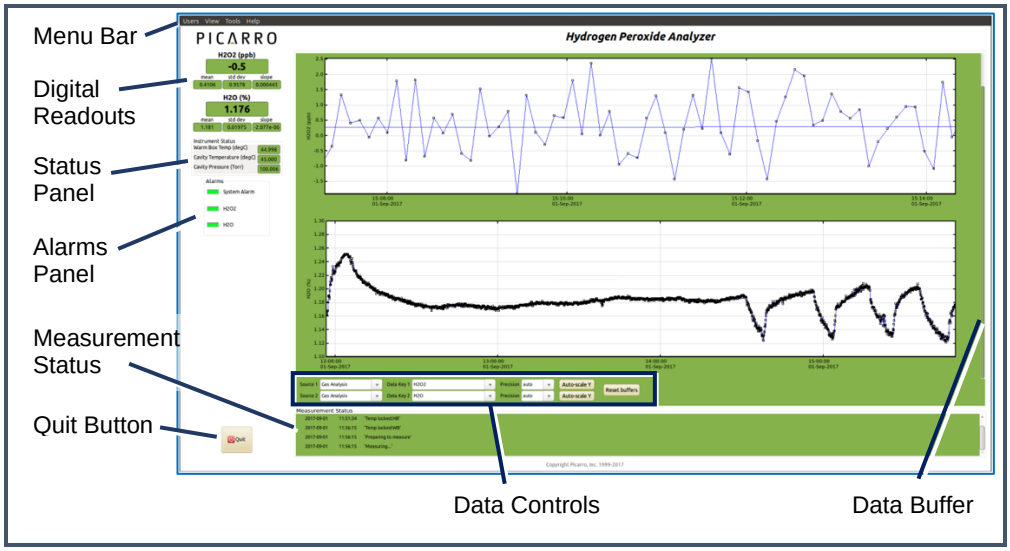
Button	Function
H_2O_2	Begin normal operation.
Files	Copy validation reports or user history to a USB drive.
Config	Perform configuration tasks (see Service Manual).
Service	Perform service tasks (for trained personnel only).
Power Off	Shutdown and power off the analyzer (user name and password required).

8.3 The Data Viewer (Main Screen)

From the Home Screen, click **H_2O_2** and wait while the instrument initializes. Once initialization is complete, the analyzer will display the Data Viewer.

This is the analyzer main screen. By default, the data viewer plots the detected H_2O_2 and H_2O in real time.

Figure 14: Data Viewer



Menu Bar

The menu bar gives access to the following features:

Table 9: Menu Bar Features

Menu	Selection	Description
Users	User Login/Logout	Sign in or out of the device.
View[1]	Lock/Unlock Time Access When Zoomed	When locked, forces the two data plots to use the same time scale.
View[1]	Show/Hide Statistics	Toggles the measurement statistics in the Digital Readouts panel.
View[1]	Show/Hide Instrument Status	Toggles the Status Panel.
Tools[2]	User Administration[2]	Manage user accounts, set user policies, and view user history. (See "USER MANAGEMENT" on page 41.)
Tools[3]	H_2O_2 Validation[3]	Validate the analyzer's performance by measuring methane as a reference gas. (See "INSTRUMENT VALIDATION" on page 55.)
Help	About	Display the software version running on the analyzer.

[1] Requires Login. [2] Requires admin login. [3] Requires technician or admin login.

Digital Readouts

During initialization, these readouts show status of the instrument.

During normal operation, they show the latest values for the selected data key for each data stream. Additionally, if *Show Statistics* is enabled in the *View* menu, statistical data based on the graphs is calculated and displayed.

Status Panel

The Status Panel displays the following parameters:

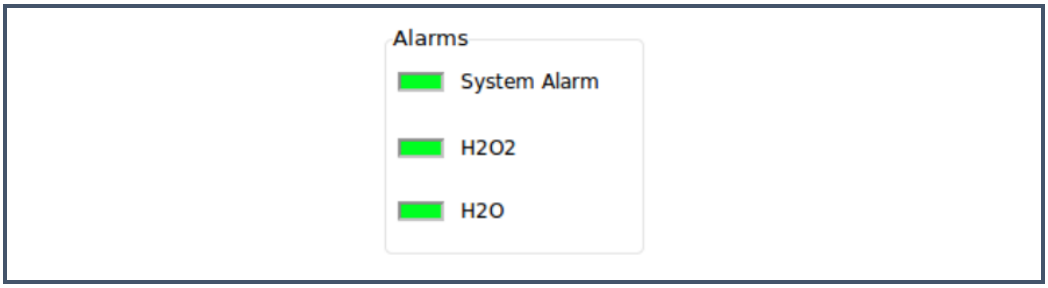
- Warm-box (wavelength-monitor) temperature in ^{0}C
- Cavity temperature in ^{0}C
- Cavity pressure in torr

If you are signed in, you can show or hide this panel using the **View** menu.

Alarms Panel

Monitor the status of the internal alarms:

Figure 15: Close-up of the Alarms panel



The *System Alarm* monitors the current pressure, temperature, and measurement status. The *H_2O_2* and *H_2O* alarms monitor gas concentration.

Table 10: System Alarm Descriptions

Item	Description
System Alarm	There are three states for the system alarm: Yellow (flashing): Warming up. **Green:** Operating correctly. **Yellow (steady):** Not operating correctly.
H_2O_2 H_2O	There are 3 states for the gas alarms: **Off:** Not measuring (system warm up). **Green:** Within thresholds. **Red:** Reached alarm thresholds (not cleared).

To view or change the H_2O_2 or H_2O alarm set points:

1. Click on the colored indicator next to the gas name to display the Setting Alarm dialog.

Figure 16: Setting Alarms

With the settings shown above, the indicator turns red when the concentration goes above 50 and clears (returns to green) when it returns below 45.

2. Choose the alarm mode. There are four alarm modes: *higher*, *lower*, *inside*, and *outside*.
3. Enter your desired threshold values.
4. Select **Enable Alarm**.
5. Click **OK**.

Data Controls

Source Keys

The Source Keys allow you to select the data source for each data stream displayed in the *Data Window.* There are three keys to choose from:

- **Gas Analysis** shows gas concentrations.
- **Sensors** displays data from the analyzer's sensors.

NOTE

Changing a source key will only change the Digital Readout displayed on this screen; it will not affect the output of the device.

Data Keys

The Data Keys allow you to choose what data to plot for the selected source.

The Data Keys available depend on your login role: technicians and operators have fewer options than administrators. (If you are not logged in, you will not be able to change the data key.)

Precision

Control the precision displayed on the y-axis of each of the plots in the data window, between 0 and 4 digits of precision or *auto*. This affects *only* the data plot displayed in the Data Viewer, not the signal output of the analyzer.

Reset Buffers

Clear the internal data buffer of the analyzer (this clears the current data traces from the graphs). Resetting the buffer has no effect on the output signal from the analyzer.

Data Buffer Level Meter

The green bar on the right edge of the *Data Window* shows the amount of buffer memory used for the displayed data streams. When the buffer is full, old data is removed from the buffer as new data is collected. This affects *only* the data displayed in the Data Viewer.

The buffer automatically resets when the analyzer starts and can be emptied at any time by clicking the **Reset Buffers** button in the lower-right-hand corner of the Data Window.

Zoom in a Data Stream

Zoom in on a section of a data stream to get a detailed view of the graph:

1. Move the cursor over the graph you want to magnify.
2. Click and drag the cursor over the section you want to zoom (hold down the left mouse button as you move the cursor).
3. Release the mouse button and the selected area will automatically scale to fill the data window.
    - To auto-scale the y-axis of either graph, use the **Auto-scale Y** buttons below the graphs.
    - To lock or unlock the time axes of the graphs during zooming, select that menu item in the **View** menu (you must be logged in).

Measurement Status

The Measurement Status box displays all the analyzer status messages.

Typical messages are as follows:

Table 11: Measurement Status Messages

Message	Description
Temperature Locked: HB	The temperature of the “hot box” (HB – the chamber containing the analyzer’s optical cavity and gas handling system) is stable. Achieving stability is typically the longest step in the startup sequence. It may take from 5 to 60 minutes to lock, depending on the ambient temperature and how much time has elapsed since the unit was shut down.
Temperature Locked: WB	The temperature of the “warm box” (WB – the chamber containing the electronics and wavelength monitor) is stable.
Preparing to Measure	Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds.
Pressure stabilizing	The valve control system is allowing flow through the analyzer and is stabilizing the pressure inside the cavity.
Pressure Locked	The valve control system has stabilized the pressure inside the cavity.
Measuring	This is the normal mode of operation. The analyzer will scan and report concentration measurements until it is shutdown.

For a list of all messages, see MEASUREMENT STATUS MESSAGES on page 73.

Quit Measuring

To quit measuring and return to the Home Screen, click the **Quit** button (you must be logged in to quit measuring).

8.4 Shutdown Procedure

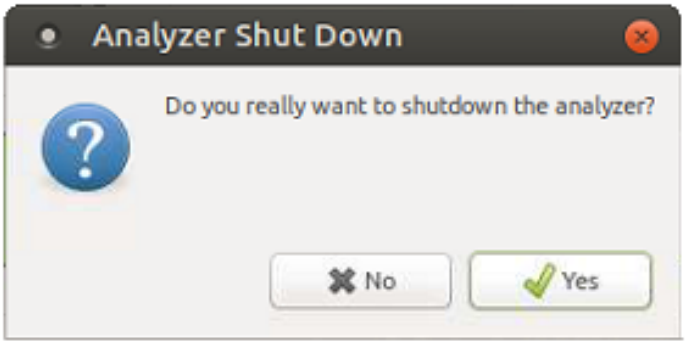
To shut down the analyzer using the GUI:

1. From the **Users** menu, choose User Login.
2. Enter your Username and password and click **OK**.

All roles—operator, technician, and administrator—are authorized to shut down the analyzer.

3. Click **Quit** in the lower-left corner of the Data Viewer. The analyzer will display the Analyzer Shut Down dialog.

Figure 17: Quit measuring



4. Click **Yes** to end measuring. The analyzer will step through the following sequence of events and may take a few minutes:

Fill cavity with gas from the inlet until it reaches near-atmospheric pressure.

Close proportional valves.

Display the Home Screen.

In the lower-right corner of the Home Screen, click **Power Off**. This will prompt for a username and password.

Enter the username and password and click **OK**.

Turn off the pump.

CAUTION

Do not turn off the pump while the analyzer is operating. This could damage the instrument.

To shut down the analyzer without the GUI:

1. Press and release the soft power button on the back of the analyzer.
2. Wait until the status indicator on the front of the analyzer turns off.
3. Turn off the pump.

CAUTION

Do not turn off the pump while the analyzer is operating. This could damage the instrument.

8.5 Recovery from Power Outages

When the power returns after an unplanned outage, the analyzer will restart automatically.

If short power outages will be a routine operating environment, Picarro recommends using power conditioning or an uninterrupted power supply to help prevent damaging to the operating system or other software corruption that may occur with repeated crashes.

9. USER MANAGEMENT

9.1 Overview

User management includes:

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

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

Table 12: User Roles

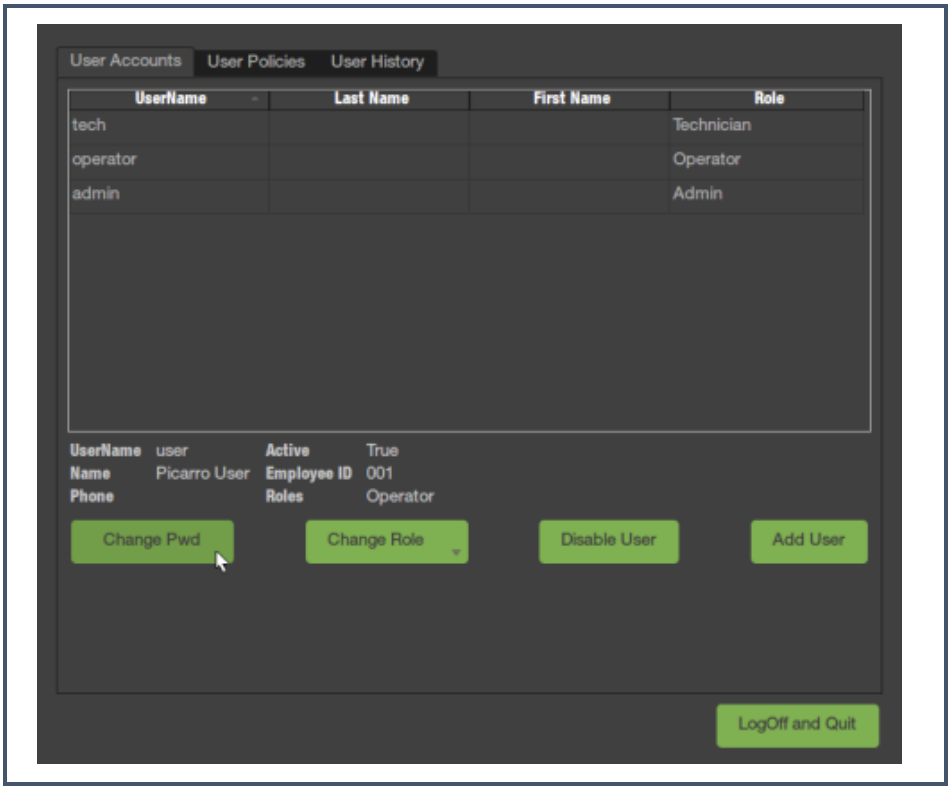
Function	Not Signed In	Operator	Technician	Administrator
View Data Viewer	•	•	•	•
Set Alarms		•	•	•
Configure Data Viewer (partial)		•	•	•
Quit Measuring		•	•	•
Shut Down (software shutdown)		•	•	•
H_2O_2 Validation			•	•
Configure Data Viewer (full access)				•
User Management				•

User management settings are available from the **Tools** menu in the Data Viewer:

1. In the Data Viewer, from the **Users** menu, select **User Login**.
2. Login as an administrator (default user name is *admin*; default password is *admin*).

3. From the **Tools** menu, select **User Administration** to view the User Management window.

Figure 18: User Management Window



The User Management window has three tabbed states: User Accounts, User Policies, and User History.

4. Make any desired changes and click **LogOff and Quit** to return to the Data Viewer.

9.2 Manage User Accounts

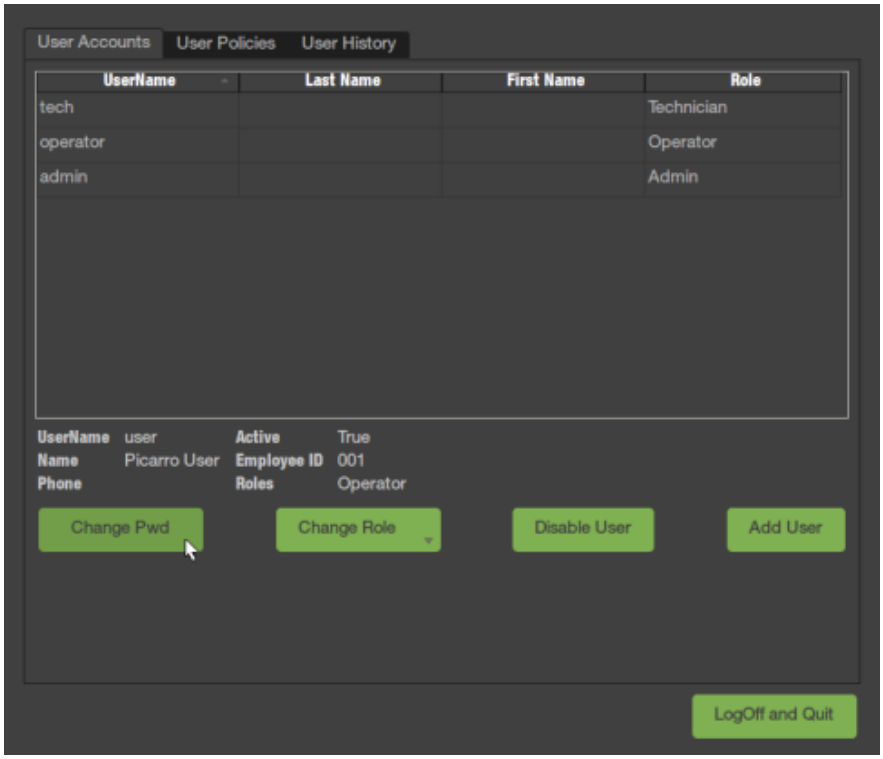
From the User Accounts tab, perform any of the following tasks:

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

NOTE

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

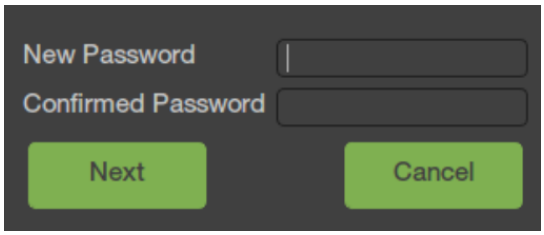
Figure 19: User Accounts Tab



To change a password:

1. In the User Management window, click the **User Accounts** tab.
2. From the list of users, click the user you want to change.
3. Click **Change Pwd** to prompt for a new password.

Figure 20: Change Password



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

   Passwords are case sensitive. Additional rules for passwords can be set in the User Policies tab (see page 45).
5. In the **Confirm Password** field, re-enter the password.
6. Click **Next** to save the password.

To Change a User's Role:

1. In the User Management window, click the **User Accounts** tab.
2. From the list of users, click the user you want to change.
3. Click **Change Role** to see a menu of available roles.

Figure 21: Change Roles

4. Click the new role; this will prompt you to confirm the change.
5. In the Confirm Action dialog, click **OK** to confirm the changed role.

To Disable a User Account:

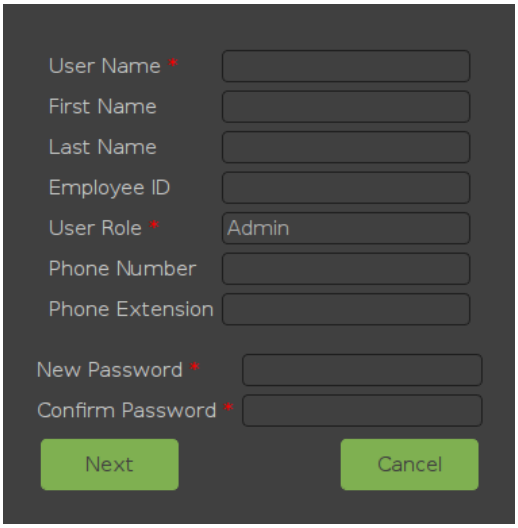
Users cannot be deleted from the system, but they can be disabled so they will not have access to the software.

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

To Add a User:

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

Figure 22: Add User

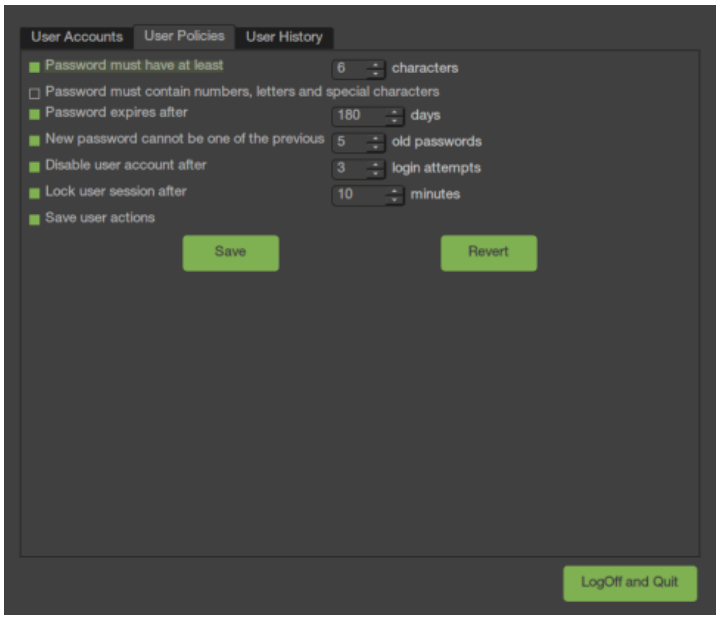


3. Fill in the fields in the Add User window.
4. Click **Next** to open the New User Account dialog.
5. Review the user information and click **OK** to accept or **Cancel** to go back and edit the information.

9.3 Set User Policies

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

Figure 23: User Policies Tab



2. Make the changes you want:

Table 13: User Policy Descriptions

Policy	Description
Password length	Specify that the length of passwords (6–15 characters) or turn off the length requirement.
Password complexity	When selected, all *new* passwords must have at least one number, one letter, and one special character. This will not impact existing passwords.
Password expiration	When selected, any passwords that reach the selected maturity will expire. Any user signing in with an expired password will be required to create a new password.

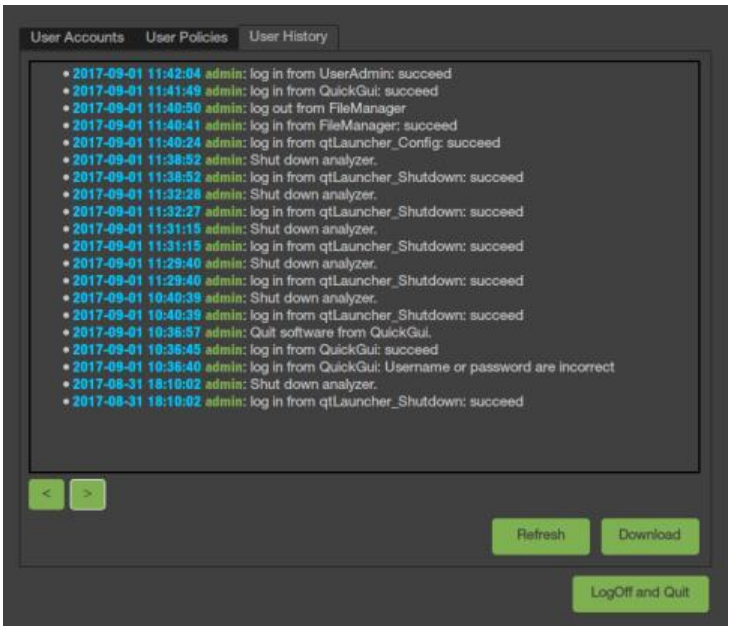
Policy	Description
Previous passwords	When set, prevents a user from reusing a recent password. The system can remember up to 10 old passwords.
Limit login attempts	Tell the system to disable a user account after a set number of failed password attempts. The failed attempts are counted until the user successfully logs in. Once disabled, an admin will have to enable the account.
Lock session	When set, the system will automatically logoff any user after a set period of inactivity, requiring the user to sign in again.
Save user actions	When enabled, user actions (such as logging in) will be saved in the User History.

3. Click **Save**. If you typed in a bad value and want to undo any changes and revert back to the last saved configuration, click **Revert**.

9.4 View User History

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

Figure 24: User History Tab



2. Click the **<** and **>** buttons to navigate through the history (if the button is grayed out, then there are no additional pages).

3. To make sure the content is up to date, click **Refresh**.
4. To copy the user history onto a USB drive, click **Download**. This will direct you to the File Manager, which will prompt you to login again. See page 48 for details on copying files from the analyzer.

10. FILE MANAGER

10.1 Overview

The File Manager allows you to copy the User History logs or H_2O_2 Validation reports from the analyzer onto a USB flash-memory drive.

10.2 Accessing the File Manager

The File Manager is accessible from three places:

- The User History tab of the User Management window (see page 46).
- At the end of the analyzer validation process (see page 55).
- From the Home screen, by clicking the **Files** button (see page 31).

Regardless of your starting point, the File Manager will prompt you for your user name and password. You must have Technician or Administrator privileges to access the File Manager.

Once you are signed in, the File Manager will look something like this:

Figure 25: File Manager

Above the left column, the label will read either User History or Validation Report; Click this label to switch to the other type of file.

10.3 Mounting a USB Flash Memory Drive

NOTE

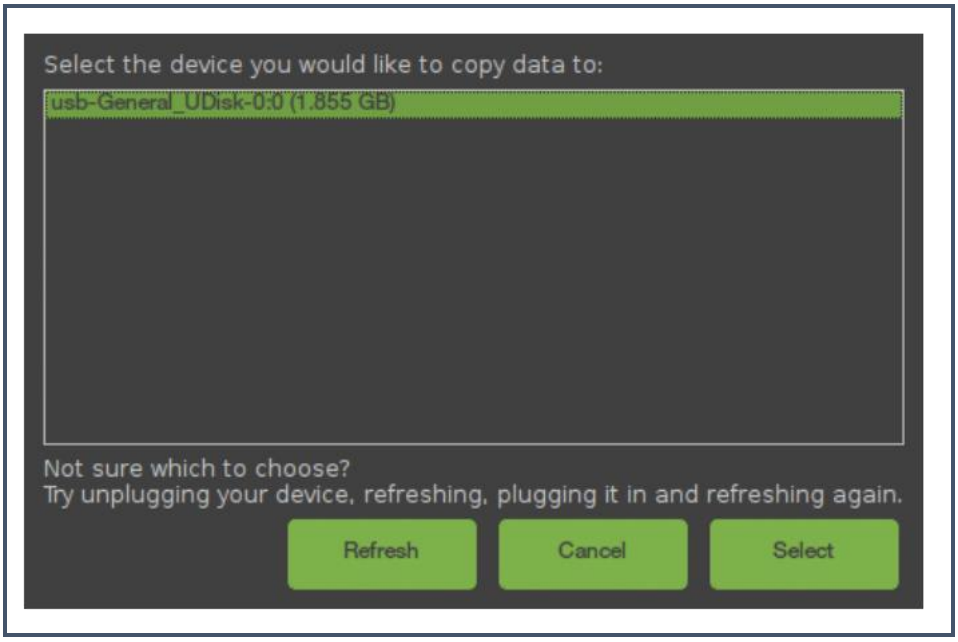
Some users may wish to extract instrument data to a password-protected thumb drive. While the PI2114's Linux system does not support the functionality to enter in a thumb drive's password on the computer itself, it does support the use of thumb drives with external pin pads on them. Operators may use devices like the Kingston DataTraveler 2000 or equivalent thumb drive if such protection is required.

To copy user histories or validation reports from the analyzer to a USB flash memory drive, use the following steps:

1. If a password-protected USB flash memory drive is required (see above note), prior to inserting it into a USB port on the analyzer, unlock the drive by entering the access code on its keypad. Use the manufacturer's unlocking instructions provided with the drive. If not using a password-protected drive, skip to Step 2.
2. Insert the flash-memory drive into one of the USB ports on the analyzer.
3. In the File Manager, click **Mount** to see the list of connected drives.

   If the drive is not listed, click **Refresh**. If the device still is not showing in the list, try inserting it into a different port or try a different memory stick.

Figure 26: Mounting a flash-memory drive



4. Click on a device to highlight it.
5. Click **Select** to return to the File Manager. The contents of the drive will be listed in the right-hand column.

10.4 Copying a File

1. In the upper left corner of the File Manager, use the dropdown to select the type of file you want: User History or Validation Report.
2. In the column on the left, click on the file you want to copy.

   Hold down SHIFT on the keyboard and click again to select multiple files.
3. Click **Copy**. A progress bar should briefly appear.
4. When you are done copying files, click **Unmount** to unmount the USB drive.
5. Remove the USB drive from the device.
6. If using a password-protected USB flash memory drive, follow the manufacturer's instructions to lock the drive.

11. TROUBLESHOOTING

11.1 Overview

This section lists problems that may occur during installation and operation of the analyzer, and step-by-step procedures that will provide resolution in most cases. If these instructions do not solve the problem, contact Picarro Technical Support. *(Please see Page 3 for Contact Information.)*

11.2 Analyzer Will not Turn On

The Status Indicator on the front panel of the analyzer should be lit whenever the analyzer is on.

Figure 27: Status Indicator on Front Panel

If pressing the soft power button on the back of the analyzer does not switch the analyzer on, perform following steps:

1. Check that the AC power cord is attached to the instrument and plugged into a working outlet.
2. Check that the rear ON-OFF switch near the AC power cord on the rear panel is in the ON position.
3. Press and hold the soft-power button on the rear panel for 5 seconds (the analyzer may not respond to a quick press).

11.3 Cavity Pressure Unlocked

The cavity pressure should automatically adjust to the correct value during normal operation. The “Pressure Locked” message in the Measurement Status panel of the Data Viewer indicates that the cavity pressure is within operating parameters.

If the cavity pressure is out of operating specification, the Measurement Status in the Data Viewer will display a “Pressure Unlocked” message.

The first step in troubleshooting will be determining if the cavity pressure is too high or too low:

1. From the **Users** menu, click **User Login**.
2. Login to the analyzer and click **OK**.
3. From the **Source 1** dropdown, select **Sensors**.
4. From the **Data Key 1** dropdown, select **CavityPressure**.
5. Look at the top data plot:
    - If the pressure is less than 99.85 Torr, the pressure is too low.
    - If the pressure is greater than 100.15 Torr, the pressure is too high.

Troubleshooting Low Pressure

If there is insufficient flow through the cavity:

- Ensure the inlet plumbing to the analyzer is not clogged.
- Ensure that the vacuum pump is turned on and running.
- Ensure that the plumbing between the analyzer VACUUM port and the pump is clear. Avoid accidentally loosening the connections on either end of the vacuum hose as this can create a backdraft of unfiltered air into the analyzer cavity.
- When connected to a gas cylinder or bottle, ensure the regulator pressure is set between 2–3 psi (0.1–0.2 bar) and the valve is open.
- If the pressure continues to be low, the filter may be clogged and need replacement. See (see Section 13.2, Filter Replacement)..

Troubleshooting High Pressure

If gas cannot exhaust from the analyzer at a sufficient rate:

- Check for leaks in the vacuum line between the analyzer and the pump.
- Ensure that the vacuum pump is turned on and running.
- When measuring flow from a gas cylinder or bottle, ensure the regulator is set to the proper pressure (2–3 psi).

11.4 GUI Does Not Update Graphs During Operation

In the event the GUI becomes unresponsive during operation, it may be necessary to restart the instrument.


NOTE

The device may still be sending data even if the GUI is unresponsive. You may wish to finish your measurements before restarting.

If the computer responds to the mouse:

1. Follow the shutdown procedure on page 38.
2. Wait until the analyzer is completely shut down.
3. After a few seconds, restart the analyzer by pressing the soft power button on the back panel.

If the computer does not respond to the mouse:

1. Press and release the soft-power button on the rear panel.
2. Wait for the instrument to turn off (the status indicator on the front panel will turn off).
3. Press the soft power button to restart the analyzer.

11.5 Liquid in the Inlet

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

Some symptoms of a clogged filter are:

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

If you observed or suspect liquid in the inlet:

1. Do NOT turn off the analyzer or try to replace a wet filter. Liquid in the filter can cause condensation on the optics if the analyzer is allowed to cool when the filter is still wet.
2. Dry the filter by running Clean Dry Air (CDA) through the analyzer.

If the analyzer functions normally after drying, a filter replacement is not necessary. If drying the filter does not fix the problem, replace the filter. See (see Section 13.2, Filter Replacement).

11.6 Unusual Measurements or Slow Response Time

Filters can become clogged with continual use. Some symptoms of a clogged filter are:

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

CAUTION

If you suspect liquid may have been sucked into the inlet line, do NOT turn off the analyzer. Follow the steps above to try and let the water evaporate.

If you suspect a clogged filter is to blame, and you do not think there is liquid in the inlet, then you may need to replace the filter. See (see Section 13.2, Filter Replacement).

11.7 Long Measurement Intervals or Excessive Noise

Exposure to RF radiation between the frequencies of 80MHz to 1GHz with field strength above 10V/m (per IEC 61326-1-2013) may degrade the performance of the analyzer below its normal operating specifications.

If possible, relocate the instrument or take measurements when the interfering equipment is not in use.

12. INSTRUMENT VALIDATION

12.1 Validation Overview

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

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

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

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

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

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

12.2 Required Supplies

Instrument validation requires the following:

- **Four cylinders of input gases:**
  - **One cylinder of zero air** (dry synthetic hydrocarbon-free air).
  - **Three methane standard cylinders**. Three cylinders of methane, each with a different concentration, certified within +/- 2% composition uncertainty. We recommend concentrations of 7, 50, and 100 ppm.
- **Four regulators** (one for each cylinder being used). Each regulator should be capable of accurately delivering 2–3 psi (0.1–0.2 bar) of line pressure.
- **Sufficient tubing to connect the regulator(s) to the instrument.** We recommend using ¼" OD PTFE or PFA tubing when working with

hydrogen peroxide. While not required for work with methane, we recommend using the same material in this procedure to avoid inadvertent use of inappropriate tubing in later work with hydrogen peroxide.

- Suitable adjustable or fixed wrenches for making gas-line connections.

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

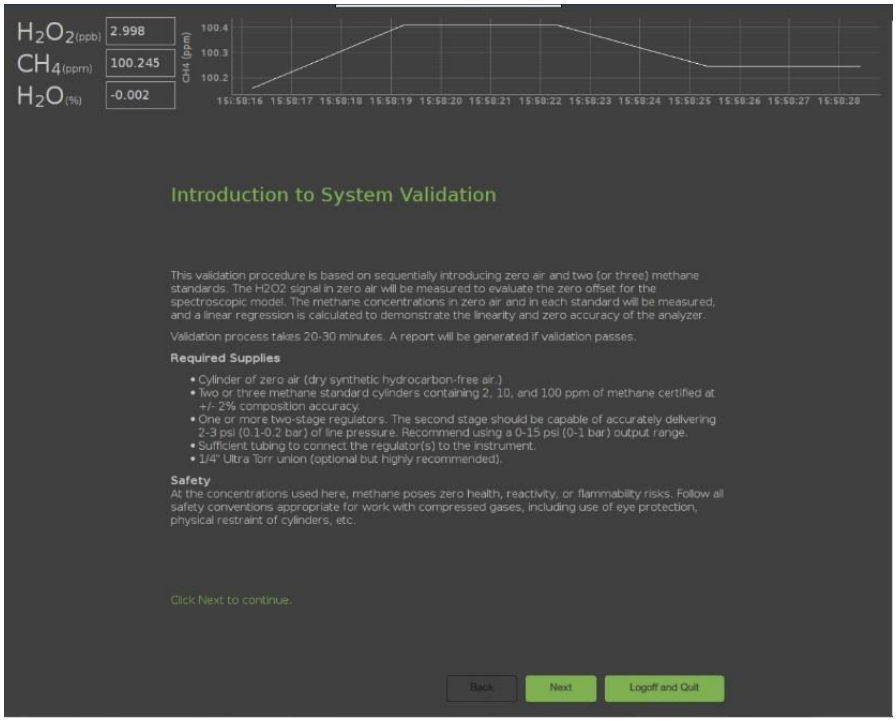
12.3 Safety

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

12.4 Validation Procedure

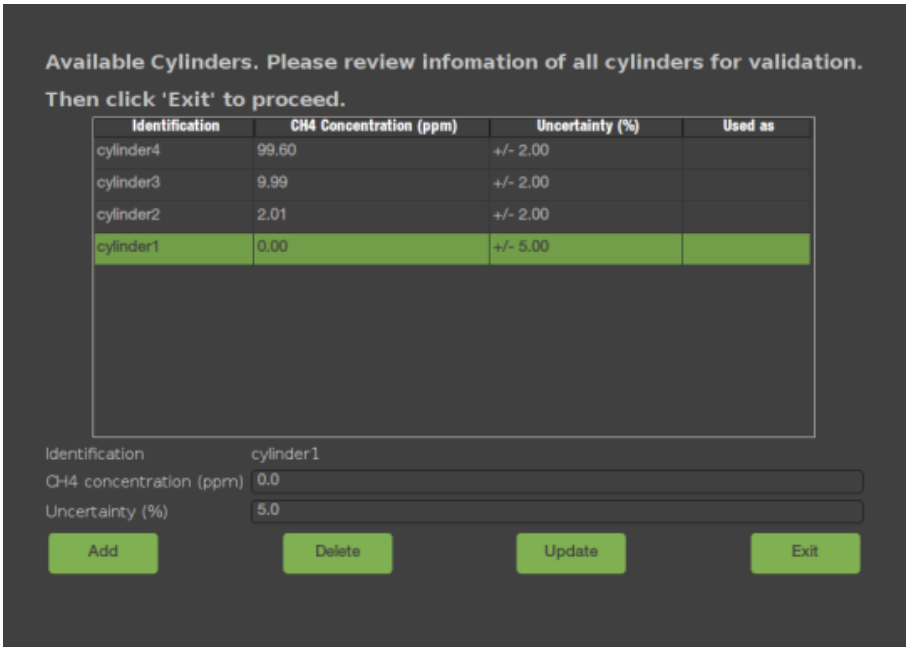
1. Allow the system to reach operating temperature and pressure settings. (See Section 8.1, Startup Procedure).
2. Attach regulators to the gas sources and adjust their output line pressures so they are within the range of 2–3 psi (0.1–0.2 bar).
3. From the **Users** menu, select **User Login** and sign in (requires technician or administrator privileges).
4. From the **Tools** menu, select **H_2O_2 Validation** to open the first step, Introduction to System Validation window.

Figure 28: Beginning System Validation



5. Click **Next**. The first-time validation is run, this will display the Edit Cylinders page. Use this page to specify the concentrations and uncertainties of the cylinders being used in this procedure. On subsequent uses, the system will remember the saved values and skip directly to the Zero-Air Measurement step.

Figure 29: Edit Cylinders



6. If this is the first-time performing system validation, enter the information for each of the cylinders you are going to use. Note that the uncertainty value is typically provided by the supplier for each cylinder.

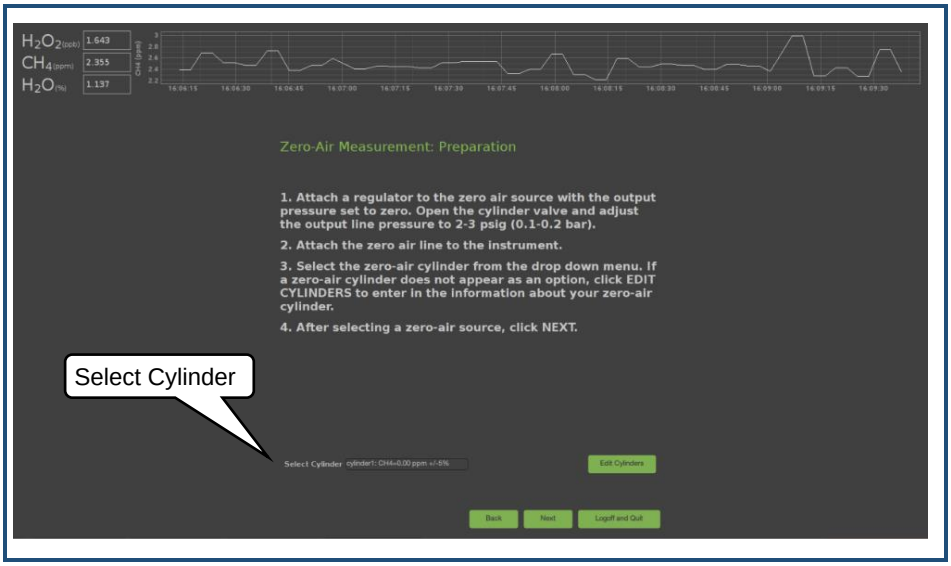
   If validation has been run before, use this window to verify that the concentrations match the cylinders to be used and make any necessary updates.

Table 14: Cylinder Button Functions

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

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

Figure 30: Zero Air Measurement Preparation

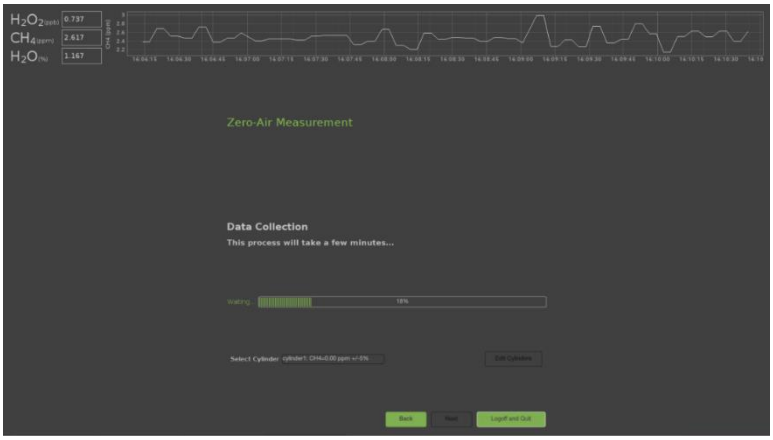


8. If this is not the first-time running validation on this system, click **Edit Cylinder** and verify the settings for the cylinders being used in this procedure (see steps 5–7).
9. Select the zero-air cylinder from the **Select Cylinder** list.
10. Open the valve on the zero-air cylinder.

11. Connect the zero-air cylinder to **INLET** on the back of the analyzer. (See “Connecting to the Analyzer Inlet” on page 28).

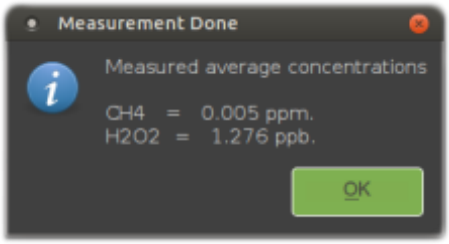
12. Click **Next** to begin measurement. This will take several minutes. Once it has finished with measuring the cylinder, it will show a confirmation dialog that measurement is complete.

Figure 31: Zero-Air Measurement



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

Figure 32: Measurement Done dialog

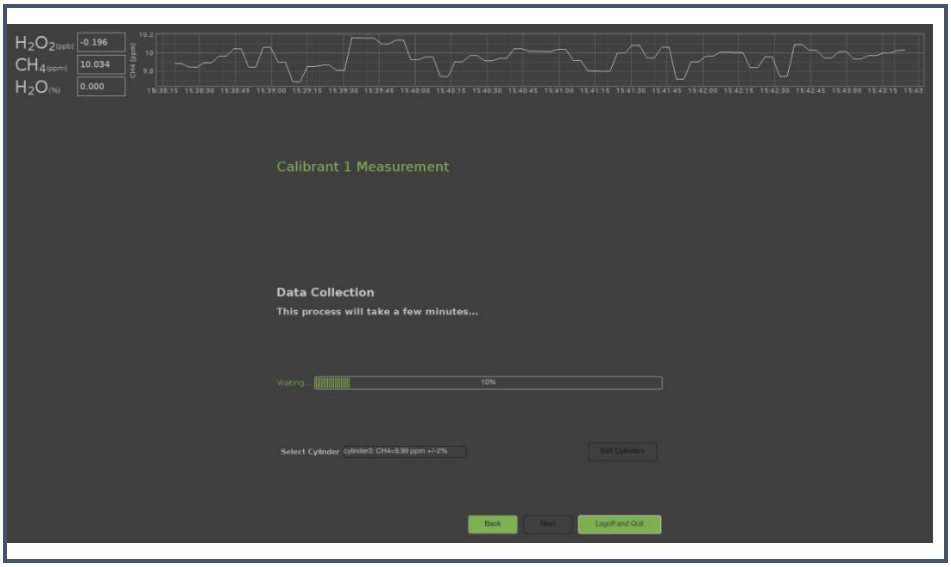


13. Click **OK** to proceed to the next step, Calibrant 1 Preparation.

Figure 33: Calibrant 1 Preparation

14. Disconnect the zero-air cylinder from the analyzer INLET.
15. Close the valve on the zero-air cylinder.
16. Open the valve on the first methane cylinder (the regulator should already be set to 2–3 psi).
17. Connect the cylinder to the analyzer INLET.
18. Select the cylinder from the **Select Cylinder** list.
19. Click **Next** to begin measuring the first cylinder.

Figure 34: Calibrant 1 Measurement



20. Follow the prompts to finish measuring the first methane cylinder and to prepare and measure the next two methane cylinders.

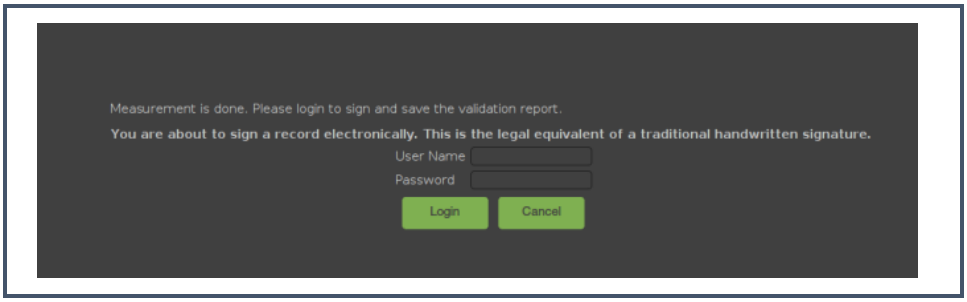
CAUTION

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

- Do not turn off the gas valve before disconnecting the cylinder from the analyzer.
- Before connecting the next cylinder, make sure its regulator is set to 2–3 psi (0.1–0.2 bar) and open the regulator valve before connecting it to the analyzer INLET.
- Refer to Section 7.3 for information on connecting to the INLET.

After the last cylinder has been measured, the system will prompt you to sign in again as a digital signature.

Figure 35: Digital signature is required after all cylinders have been measured

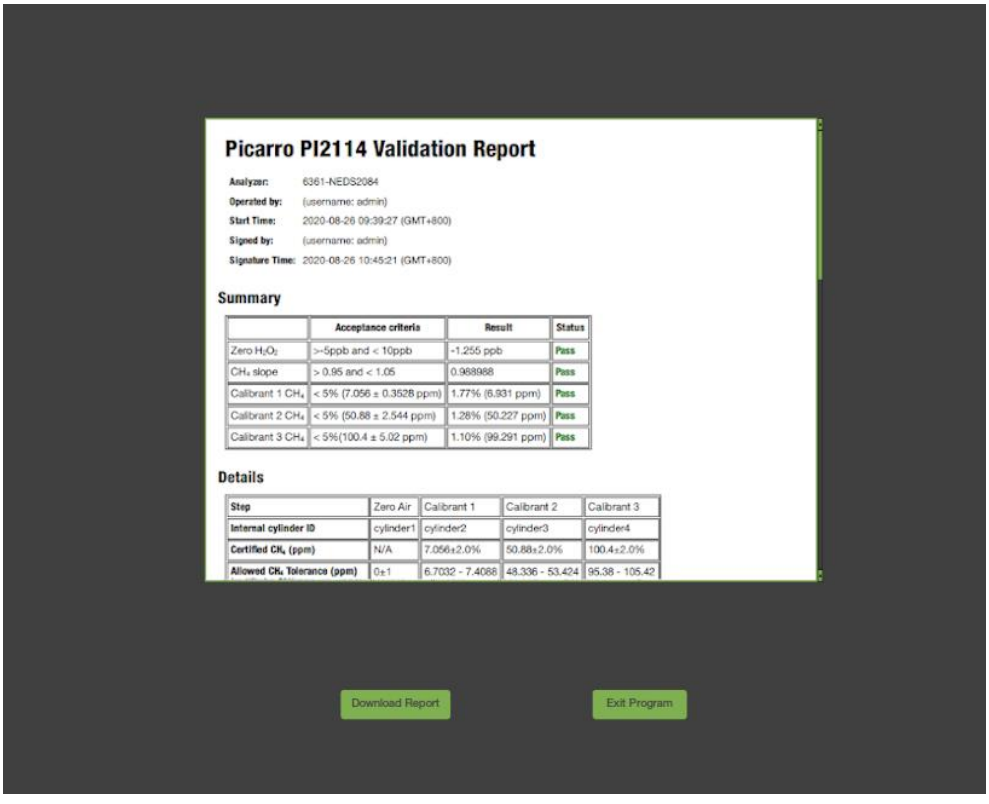


21. Enter your user name and password (must have technician or administrator privileges) and click **Login** to display the validation results.

Figure 36: Validation Results

22. Click **OK** to clear the dialog and view a preview of the Validation Report.

Figure 37: Validation Report



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

    Downloading the report will prompt you to sign in to the File Manager, which you can use to copy the report to a USB drive. See “FILE MANAGER” on page 48.

24. To return to the Data Viewer, click **Exit Program**.

25. Disconnect the last methane cylinder, making sure to disconnect it before closing the cylinder’s valve.

12.5 Example of Results from Validation

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

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

Figure 38: Validation Report, page 1

Picarro PI2114 Validation Report

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

Summary

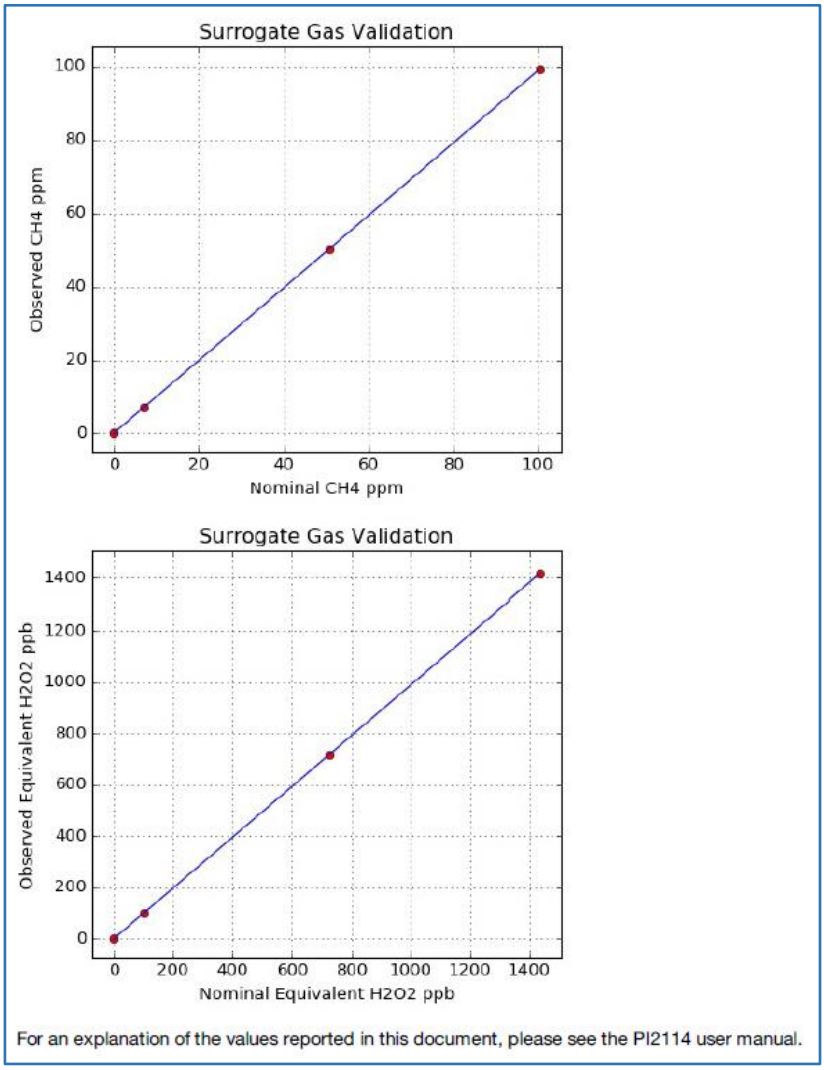
	Acceptance criteria	Result	Status
Zero H_2O_2	>-5ppb and < 10ppb	-1.255 ppb	Pass
CH_4 slope	> 0.95 and < 1.05	0.988988	Pass
Calibrant 1 CH_4	< 5% (7.056 ± 0.3528 ppm)	1.77% (6.931 ppm)	Pass
Calibrant 2 CH_4	< 5% (50.88 ± 2.544 ppm)	1.28% (50.227 ppm)	Pass
Calibrant 3 CH_4	< 5%(100.4 ± 5.02 ppm)	1.10%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

Details

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

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

Figure 39: Validation Report, page 2



12.6 If the Analyzer Does Not Pass

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

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

If the analyzer did not pass and there is no discrepancy between the nominal values of the calibrants in the report and the values of the cylinders used during validation, contact Picarro. *(Please see Contact Information on Page 3.)*

13. MAINTENANCE

13.1 Overview

Picarro analyzers require minimal service or maintenance. Except for changing a particulate filter and cleaning, the analyzer is not user serviceable.

13.2 Filter Replacement

Gasses are filtered by two in-line, sub-micron particulate filters before reaching the measurement cavity. Only one of these filters, the outer filter, is user-serviceable. Contact Picarro to obtain a replacement filter.

CAUTION

The inner filter is inside the analyzer's internal hot box and is NOT user replaceable. Do NOT open the hot box. If you suspect the inner filter is clogged, contact Picarro for replacement by a Picarro-certified technician. USER REPLACEMENT OF THE INNER FILTER OR BREAKING THE ANTI-TAMPER TAPE ON THE INNER FILTER VOIDS THE WARRANTY.

Symptoms of a Clogged Filter

Filters can become clogged with continual use.

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

Some symptoms of a clogged filter are:

- The analyzer pressure is low.
- Unusual measurements.
- Response time is slower than usual.

If You Suspect a Wet Filter

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

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

Required Tools

Make sure you have these tools before starting the filter replacement:

- $^{7}/_{8}$" open-end wrench
- $^{9}/_{16}$" open-end wrench
- Needle-nosed pliers
- 2 mm hex wrench

Safety Requirements

Follow the safety precautions as described in chapter 1, “User Safety.”

Remove the Old Particulate Filter

1. Shut down the analyzer (see page 38).
2. Wait for the indicator on the front panel to turn off.
3. Turn off the vacuum pump.
4. Disconnect the pump and any input gases.
5. Disconnect the AC power cable from the back of the instrument.
6. Disconnect any monitor, keyboard, or mouse that may be connected.
7. If necessary, move the analyzer to a clean work environment.

WARNING

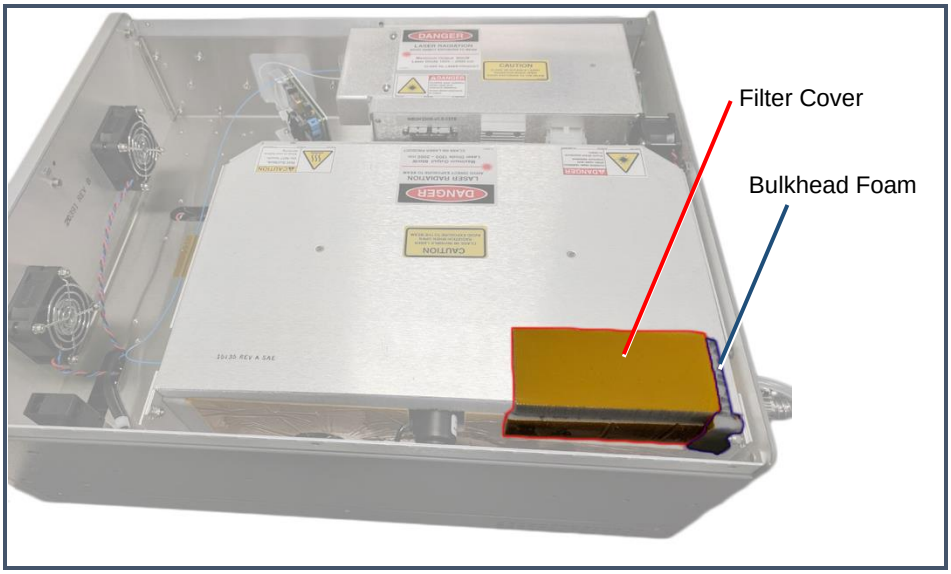
This analyzer weighs 48 lbs. Lifting it is a two-person job. Use the technique outlined in the General Safety section on page 15 when lifting or moving the analyzer.

8. Use a 2mm hex wrench to remove the top lid’s six M3 x 6mm socket flathead screws (three screws per side).

Figure 40: Lid Screws (right side)

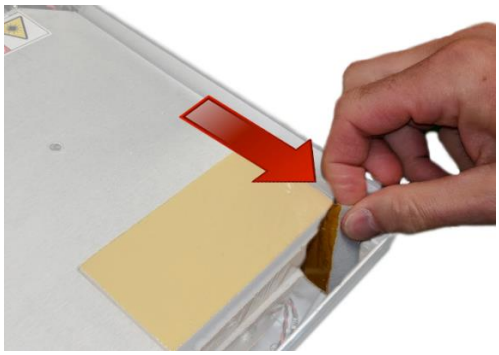
9. Lift the top cover off the analyzer. This will reveal the bulkhead foam and filter cover.

Figure 41: Filter Cover and Bulkhead Foam



10. Carefully slide the bulkhead foam to the side of the analyzer, and then lift it up and out. This will reveal the *Jam Nut*.

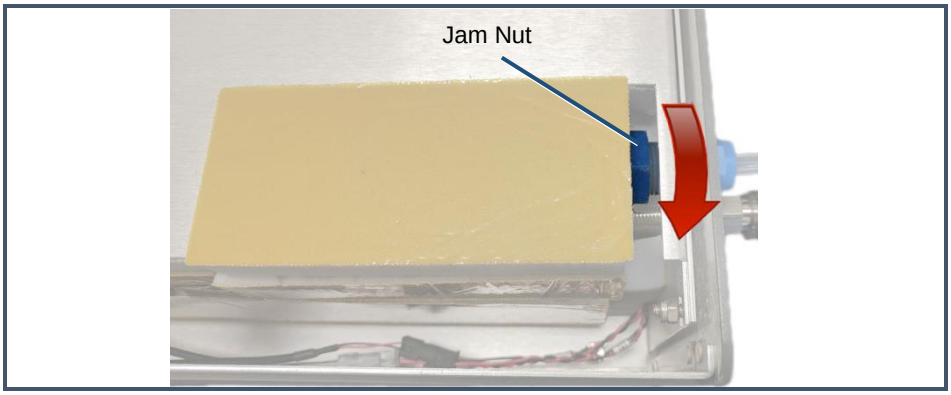
Figure 42: Removing the Bulkhead Foam



Be careful not to tear the foam when sliding it to the side and lifting it out of the analyzer.

11. Use the $^{7}/_{8}$" wrench to loosen the jam nut enough that the filter cover can slide free (about 1 full turn should be enough).

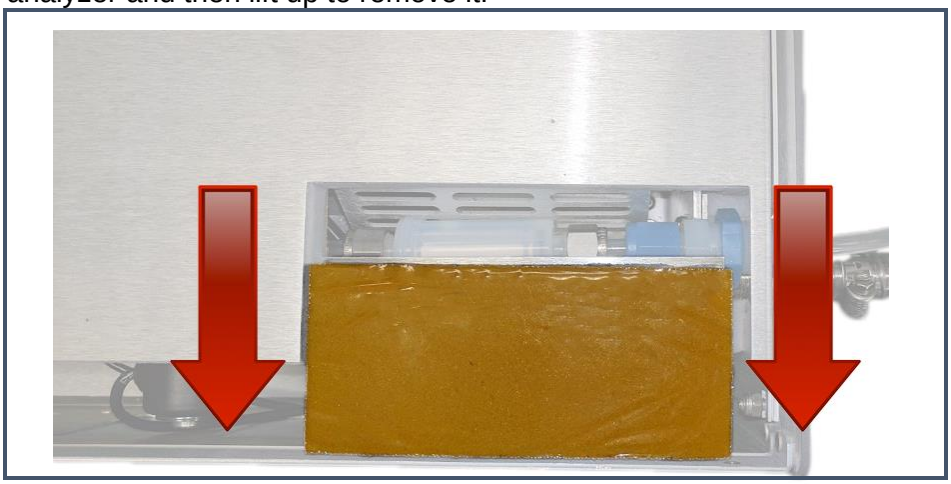
Figure 43: Loosening the Jam Nut



Removing the Bulkhead Foam provides access to the Jam Nut. Loosen the nut about one full turn to allow removal of the Filter Cover.

12. With the jam nut loose, slide the filter cover towards the side of the analyzer and then lift up to remove it.

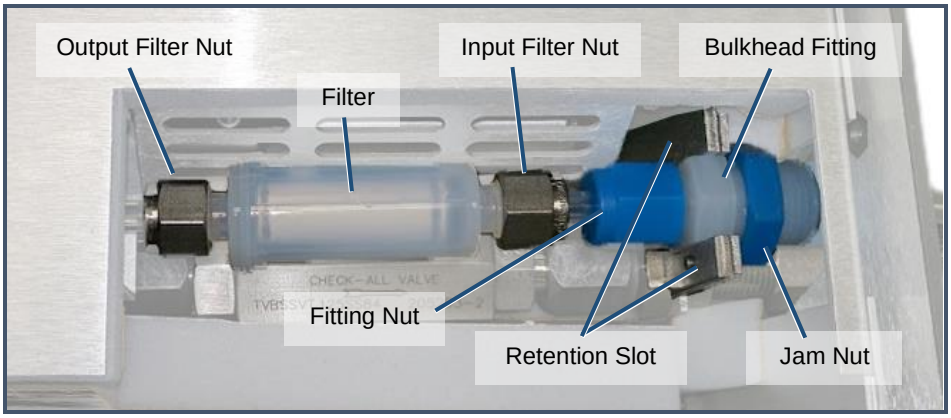
Figure 44: Removing the filter cover



Slide the filter cover towards the side, then lift out.

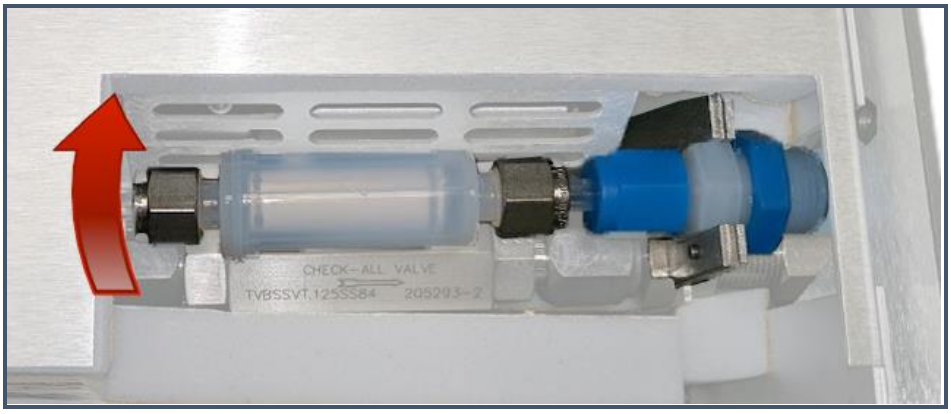
Removing the filter cover will reveal the filter assembly:

Figure 45: Filter assembly



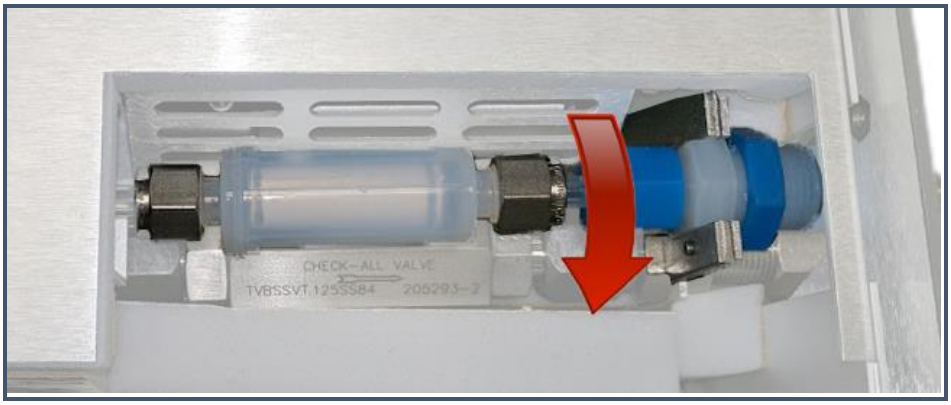
13. Use the needle nose pliers to hold the filter while using the $^{9}/_{16}$" wrench to unscrew the Output Filter Nut. (Once loosened with the wrench, it may be easier to unscrew the nut by hand.)

Figure 46: Loosen the Output Filter Nut



14. Use the needle nose pliers to hold the filter while using the $^{9}/_{16}$" wrench to unscrew the Input Filter Nut. (Once loosened with the wrench, it may be easier to unscrew the nut by hand.)

Figure 47: Loosen the Input Filter Nut



15. Shift the filter assembly towards the back of the analyzer until there is enough room to pull the filter out. (The Fitting Nut will fit through the Retention Slot, although it may require a little twist to get it oriented correctly.)
16. Pull the filter out and dispose of it appropriately.
17. Inspect the ferrules in both the input and output nuts. If they show signs of wear, they should be replaced before installing the new filter.

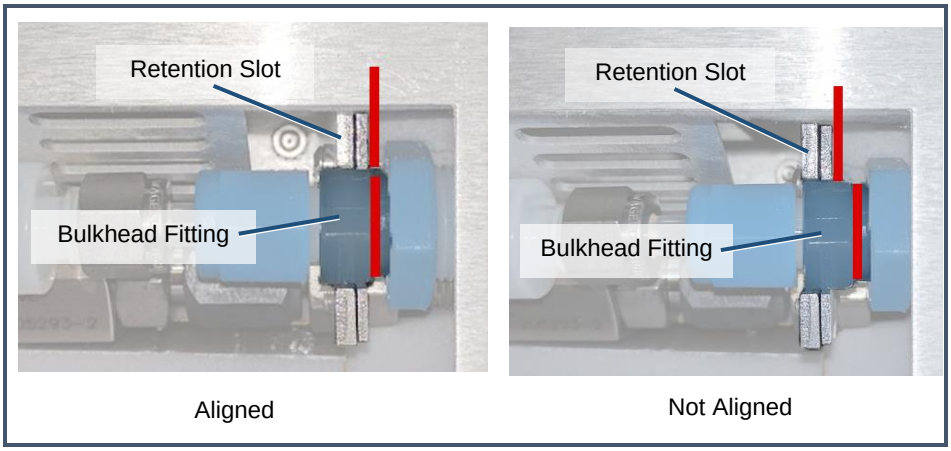
Install the New Filter

18. Remove the new filter from its packaging.
19. Thread the output end of the new filter (the end with the wide flange) into the Output Filter Nut until finger tight. Be careful to avoid cross-threading.

Figure 48: Filter orientation

20. Shift the Bulkhead fitting towards the filter and thread the Input Filter Nut onto the input end of the filter until finger tight. Be careful to avoid cross-threading.
21. Use the needle nose pliers to hold the filter while using the $^{9}/_{16}$" wrench to tighten the Input Filter Nut about one flat (60 degrees).
22. Use the needle nose pliers to hold the filter while using the $^{9}/_{16}$" wrench to tighten the Output Filter Nut about one flat (60 degrees).
23. Shift the filter assembly so that the Bulkhead Fitting is approximately flush with the back of the Retention Slot:

Figure 49: Aligning the filter assembly



24. Reposition the filter cover over the filter assembly.
25. Use the $^{7}/_{8}$" wrench to retighten the Jam Nut.
26. Reposition the Bulkhead Foam around the Bulkhead Fitting.
27. Replace the lid on top of the analyzer.
28. Use the 2mm hex driver to fasten the lid to the analyzer with the six lid screws (three on each side).

13.3 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.

14. LIMITED WARRANTY

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

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

DISCLAIMER

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

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

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

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

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

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

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

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

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

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

APPENDIX A – MEASUREMENT STATUS MESSAGES

Table 15: Measurement Status Messages

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

Message	Description
Putting Data Manager in warming mode	Exiting measuring state.
Reset	
Restart Measuring	This is the normal mode of operation. The analyzer will scan and report concentration measurements until it is shutdown.
Sample prepare complete	
Shutdown	
Starting	
Temp and Pressure Stabilizing	Entering warming state.
Temperature Locked: HB	The temperature of the “hot box” (HB – the chamber containing the analyzer’s optical cavity and gas handling system) is stable. Achieving stability is typically the longest step in the startup sequence. It may take from 5 to 60 minutes to lock, depending on the ambient temperature and how much time has elapsed since the unit was shut down.
Temperature Locked: WB	The temperature of the “warm box” (WB – the chamber containing the electronics and wavelength monitor) is stable.
Temperature Unlocked: HB	
Temperature Unlocked: WB	
Uploading warmbox cal to DAS…	Entering warming state.
Warming…	

APPENDIX B – MODBUS COMMUNICATION

B.1 Configuring for Modbus Communication

1. Click the **Config** button (Figure 50).

   The analyzer configuration screen shown in Figure 51 appears.

Figure 50: Home Screen

NOTE

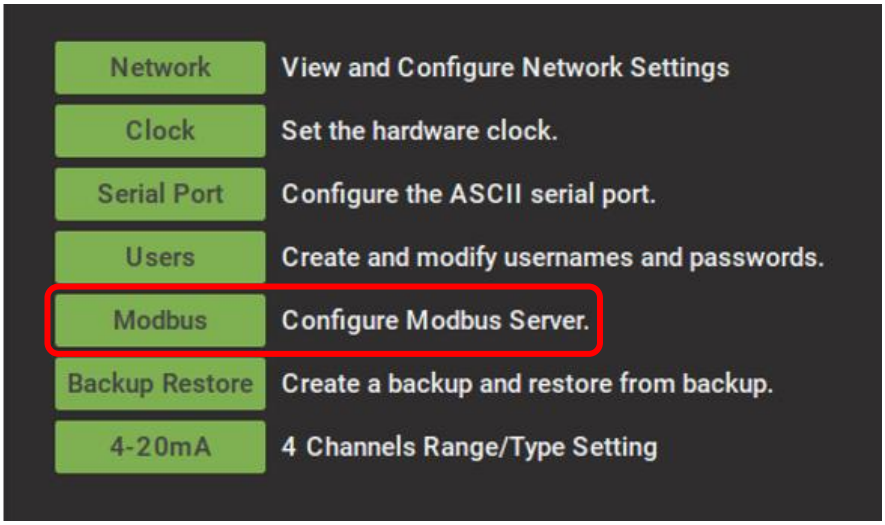
If a Modbus button does not appear in the Configuration menu, then Modbus communications must be enabled before Modbus can be configured. Please contact Picarro Technical Support for assistance in enabling this feature. (See Contact Information on Page 3.)

2. Click on the **Modbus** button.

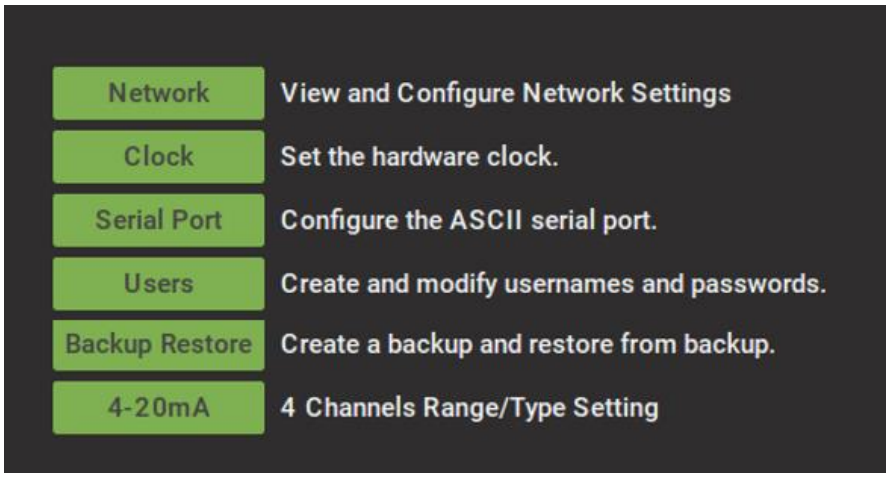
   This will open the *Modbus Settings* window shown in Figure 52.

Figure 51: Analyzer Configuration Screen for Modbus Access

Modbus Enabled on Configuration Screen



Modbus Disabled on Configuration Screen



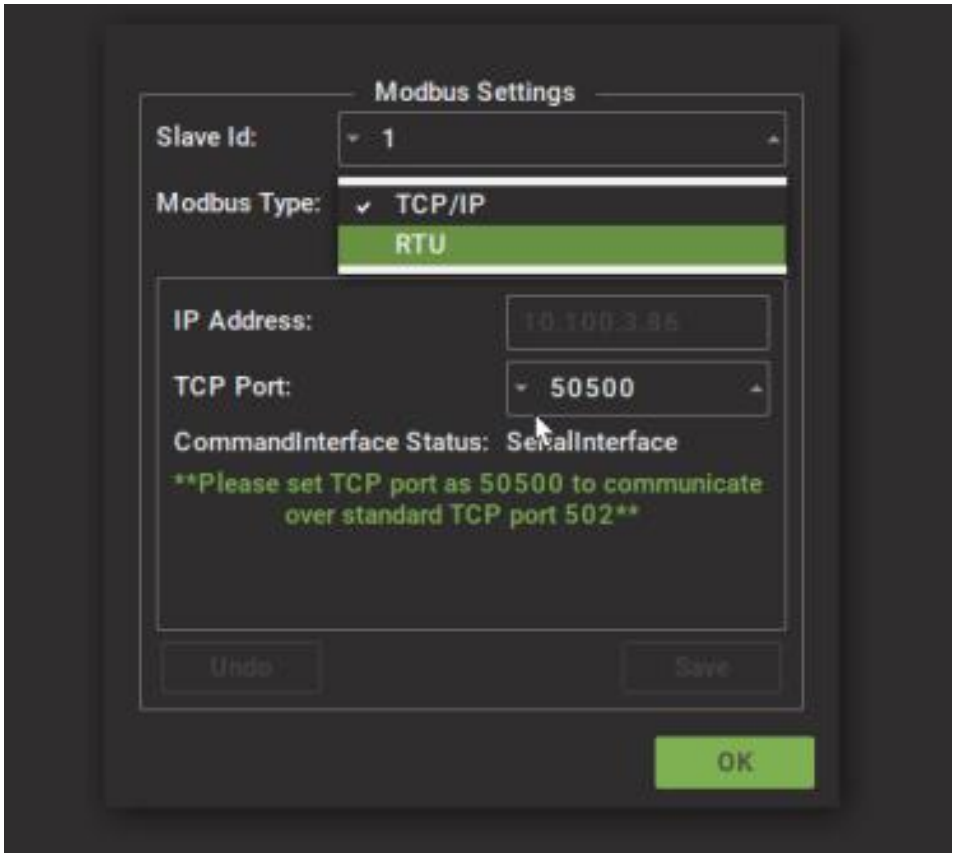
**If the Modbus button does not appear on the configuration screen, it means that feature has not been enabled. Contact Picarro Technical Support for assistance in enabling Modbus.*

3. From the Modbus Settings window (Figure 52), you can configure:

- The analyzer's Slave ID
- Modbus Communication Protocol: TCP/IP or RTU (For more information and notes, see *Section B.2, Modbus Data Registers Overview and Setup.*)
- TCP Port designation (if TCP/IP is selected)

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

Figure 52: Modbus Settings Window



B.2 Modbus Data Registers Overview and Setup

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

Table 16: MODBUS Register Types

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

Setup Notes for Modbus TCP

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

Setup Notes for Modbus RTU

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

B.3 Modbus Register Maps Overview

- Data returned is in big endian format if it utilizes more than one Modbus register.
- If input register functionality is not available for a given analyzer type, the instrument will return value as "NaN" for float values and "False" for 1-bit registers.
- Memory map is continuous memory. If a user tries to read a register address for which functionality is not available, it will return "0". For example, reading address 0 for coil registers will return "0" since the address does not exist.
- If a user tries to read a register address outside of maximum register memory map, the request will return an exception. For example, reading address 156 for coil register will return exception code "0x02" (Illegal address).
- System time is in "milliseconds Since 0001-01-01 AD".

B.4 Input Register Map

Most of the readings in Picarro analyzer are the float type and need 32-bit data. Each parameter utilizes 2 registers, out of which the first one will be storing MSB and the second one will be storing the LSB of the float number.

NOTE

All entries are floats unless otherwise noted.

Table 17: Input Registers

Address	Description	Units	Type	Comments
1-6	Time stamp		String	Long value return as 12byte string. Date will be in format YYMMDDHHMMSS
7-8	H_2O_2 Concentration	ppb	float	
9-10	H_2O_2_ID	unitless	float	Gas ID code 14 identifies gas at register 7 as H_2O_2
11-12	H_2O_2, 30sec trailing average	ppb	float	
13-14	H_2O_2, 2min trailing average	ppb	float	
15-16	H_2O_2, 5min trailing average	ppb	float	
17-18	H_2O_2, max (full scale range)	ppb	float	Value is 100,000 ppb or 100 ppm
19-20	H_2O_2, min	ppb	float	Value set to 0
21-22	Concentration of H_2O	%	float	Water is measured in absolute %, not to be confused with relative humidity
23-24	H_2O_ID	unitless	float	Gas ID code 00 identifies gas at register 20 as H_2O

Address	Description	Units	Type	Comments
25-26	H_2O, 30sec trailing average	ppm	float	
27-28	H_2O, 2min trailing average	ppm	float	
29-30	H_2O, 5min trailing average	%	float	
31-32	H_2O, max (full scale range)	ppm	float	Value is 50,000 (5%)
33-34	H_2O, min	ppm	float	Value is set to 0
35-36	Concentration of CH_4	ppb	float	
37-38	CH_4_ID	unitless	float	Gas ID code 04 identifies gas at register 34 as CH_4
39-40	CH_4, 30sec trailing average	ppb	float	
41-42	CH_4, 2min trailing average	ppb	float	
43-44	CH_4, 5min trailing average	ppb	float	
45-46	CH_4, max (full scale range)	ppm	float	Value is set at 200 ppm
47-48	CH_4, min	ppm	float	Value is set at 0
49-50	Reserved			
51-52	Reserved			
53-54	Reserved			
55-56	Reserved			
57-58	Reserved			

Address	Description	Units	Type	Comments
59-60	Reserved			
61-62	Reserved			
63-64	Reserved			
65-66	Reserved			
67-68	Reserved			
69-70	Reserved			
71-72	Reserved			
73-74	Reserved			
75-76	Reserved			
77-78	Reserved			
79-80	Reserved			
81-82	Reserved			
83-84	Reserved			
85-86	Reserved			
87-88	Reserved			
89-90	Reserved			
91-92	Reserved			
93-94	Reserved			
95-96	Reserved			
97-98	Reserved			
99-100	Reserved			
101-102	Reserved			
103-104	Reserved			

Address	Description	Units	Type	Comments
105-106	Reserved			
107-108	Reserved			
109-110	Reserved			
111-112	Reserved			
113-114	Reserved			
115+116	Reserved			
117-118	Reserved			
201-202	Cavity Pressure	Torr	float	
203-204	Cavity Temperature	deg C	float	
206-207	DAS Temperature	deg C	float	
207-208	Etalon Temperature	deg C	float	
209-210	Warm Box Temperature	deg C	float	
211-212	Outlet Valve	dig counts	float	
213-214	Instrument cal slope, H_2O_2		float	
215-216	Instrument cal offset, H_2O_2		float	
217-218	User cal slope, H_2O_2		float	
219-220	User cal offset, H_2O_2		float	
221-222	Instrument cal slope, H_2O		float	

Address	Description	Units	Type	Comments
223-224	Instrument cal offset, H_2O		float	
225-226	User cal slope, H_2O		float	
227-228	User cal offset, H_2O		float	
229-230	Instrument cal slope, CH_4		float	
231-232	Instrument cal offset, CH_4		float	
233-234	User cal slope, CH_4		float	
235-236	User cal offset, CH_4		float	
237-238	Reserved			
239-240	Reserved			
241-242	Reserved			
243-244	Reserved			
245-246	Reserved			
247-248	Reserved			
249-250	Reserved			
251-252	Reserved			
253-254	Reserved			
255-256	Reserved			
257-258	Reserved			
259-260	Reserved			

Address	Description	Units	Type	Comments
261-262	Reserved			
263-264	Reserved			
265-266	Reserved			
267-268	Reserved			
269-270	Reserved			
271-272	Reserved			
273-274	Reserved			
275-276	Reserved			

Address	Description	Type	Comments
387	Error Code	int	Error for each control command of COIL • NO_ERROR = 0 • ERROR_HANDLER_ERROR = 1 • ERROR = 2 • NO_SUDO_USER_PRIVILEGE = 3 • NO_USER_EXIST = 7 • USERNAME_PASSWORD_INCORRECT = 9 • USER_DISABLED = 10 • ADMIN_RIGHT_REQUIRES = 11 • PASSWORD_LENGTH_ERROR = 12 • PASSWORD_FORMATE_ERROR = 13 • PASSWORD_REUSE_ERROR = 14

Address	Description	Type	Comments
388	Measurement Status	int	ledState = 0 red, system error, gas conc. measurements invalid ledState = 1 solid yellow, need service, gas conc. measurements might be ok ledState = 2 blinking yellow, not in reporting mode by system ok, like during warmup ledState = 3 green, system ok, gas conc. measurements accurate

B.5 Discrete Input Register Map

NOTE

All entries are floats unless otherwise noted.

Table 18: Discrete Input Registers

Address	Description
6	Pressure locked
7	Cavity temperature locked
8	Warm box temperature locked
73	Reserved
74	Reserved
75	Reserved
76	Reserved
77	Reserved
78	Reserved
79	Reserved

Address	Description
80	Reserved
81	Reserved
82	Reserved
83	Reserved
84	Reserved
85	Reserved
86	Reserved
87	Reserved
88	Reserved
89	Reserved
90	Reserved
91	Reserved
92	Reserved
93	Reserved
94	Reserved
95	Reserved
96	Reserved

B.6 Holding Register Map

Table 19: Holding Registers

Address	Description	Units	Type	Comments
1-4	System time		int	Integer representing milliseconds from 1AD January 1st to now
5-8	User Name		String	
9-12	Password		String	
201-202	User data 1		Float	
203-204	User data 2		Float	
205-206	User data 3		Float	
207-208	User data 4		Float	
209-210	User data 5		Float	
211-212	User data 6		Float	
213-214	User data 7		Float	
215-216	User data 8		Float	
217-218	User data 9		Float	
219-220	User data 10		Float	
221-222	User data 11		Float	
223-224	User data 12		Float	
225-226	User data 13		Float	
227-228	User data 14		Float	
229-230	User data 15		Float	
231-232	User data 16		Float	
233-234	User data 17		Float	

Address	Description	Units	Type	Comments
235-236	User data 18		Float	
237-238	User data 19		Float	
239-240	User data 20		Float	

B.7 Coil Register Map

Table 20: Coil Registers

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

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

Address	Description	Units	Comments
227	Get User data 14		
228	Set User data 14		
229	Get User data 15		
230	Set User data 15		
231	Get User data 16		
232	Set User data 16		
233	Get User data 17		
234	Set User data 17		
235	Get User data 18		
236	Set User data 18		
237	Get User data 19		
238	Set User data 19		
239	Get User data 20		
240	Set User data 20		

NOTE

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

B.8 Gas ID Map

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

Table 21: Gas ID Map

Address	Species	Description
00	H_2O	Water
01	NH_3	Ammonia
02	H_2S	Hydrogen sulfide
03	CO_2	Carbon dioxide
04	CH_4	Methane
05	CO	Carbon monoxide
06	C_2H_2	Acetylene
07	C_2H_4	Ethylene
08	N_2O	Nitrous oxide
09	CH_2O	Formaldehyde
10	HF	Hydrogen fluoride
11	O_2	Oxygen
12	HCl	Hydrogen chloride
13	C_2H_6	Ethane
14	H_2O_2	Hydrogen peroxide