PICARRO

G5131-*i* Analyzer for Isotopic N_2O (^{18}O and ^{15}N) User Manual

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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.

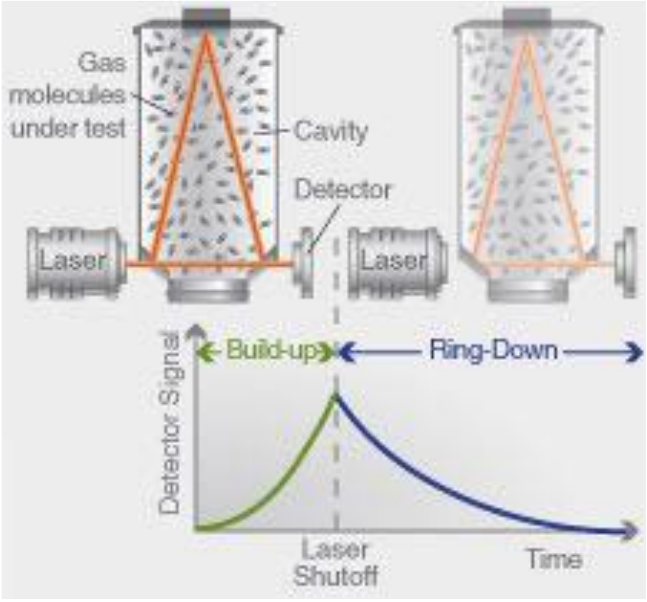


Figure 1: Schematic of the Picarro CRDS analyzer cavity

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.

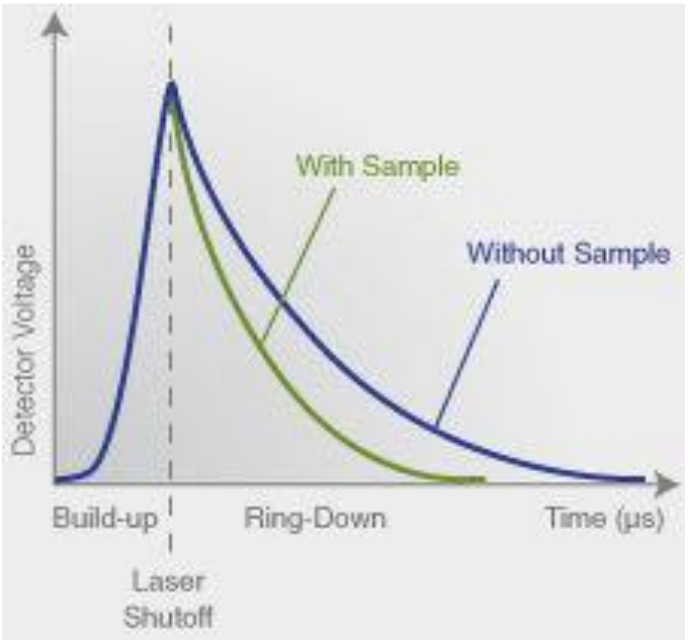
1.2 Relating ring-down time to absorption intensity

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



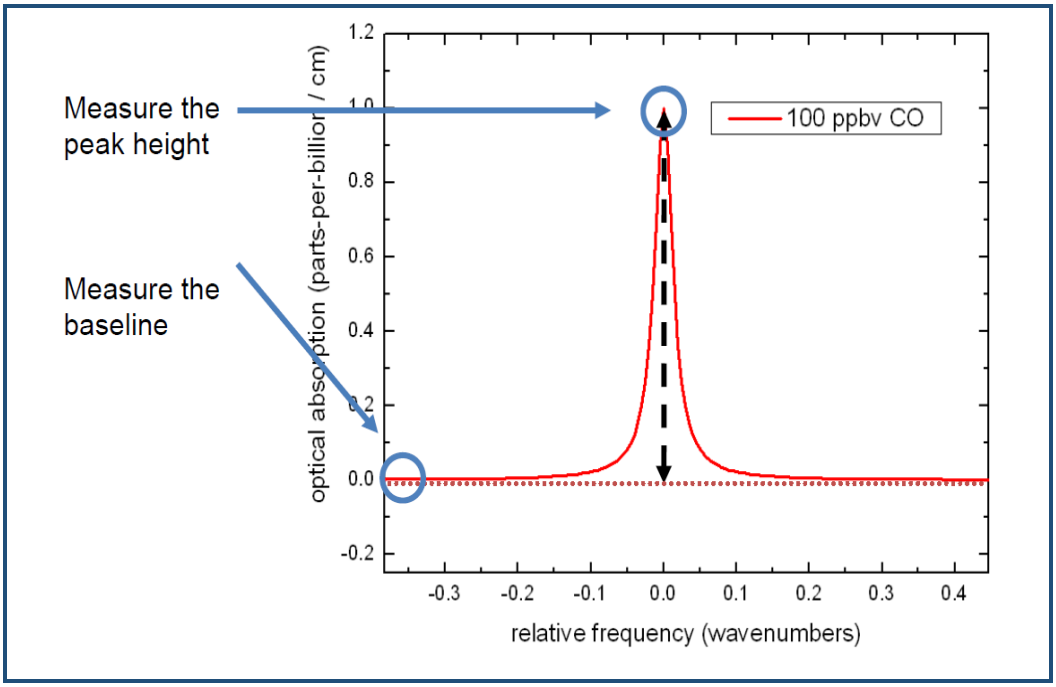
1.3 Converting absorption intensity to concentration

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 3: 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:

Acronym	Definition
CRDS	Cavity Ring-Down Spectroscopy
DAS	Data Acquisition System (the Analyzer)
PPU	Pump Power Unit
GUI	Graphical User Interface
cm	centimeters
mm	millimeters
” (as in 1/4”)	Inches
N_2O	Nitrous Oxide
CO	Carbon Monoxide
H_2O	Water
HB	Hotbox
WB	Warm box
ppm	Parts Per Million
ppb	Parts Per Billion
‰	per mil
°C	degrees Celsius

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

is 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, fuse, and laser chiller. 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 67 lbs. (30.4 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 guide, and only open the device in an approved laser safe service area using appropriate laser-safety glasses.

The following **Laser Safety Label** is affixed to the inside of the analyzer:

Figure 4: Laser Safety Label

WARNING

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

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 system is delivered in a shipping crate divided into two sections: if the outer box shows damage, the inner area holding the analyzer is cushioned enough that it will protect the instrument under most circumstances.

NOTE

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

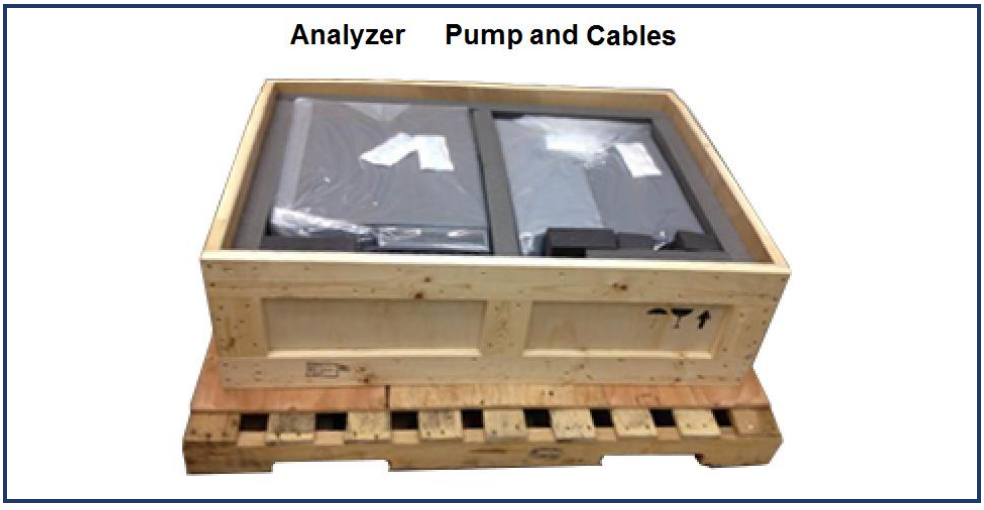
The analyzer section contains:

- Analyzer
- Keyboard
- Mouse

The pump section contains:

- Vacuum pump
- Cables and hoses needed to connect and power the analyzer and pump

Figure 4: Shipping Crate and Contents



5.2 Unpack the Shipping Crate

This section describes the contents of the shipping crate:

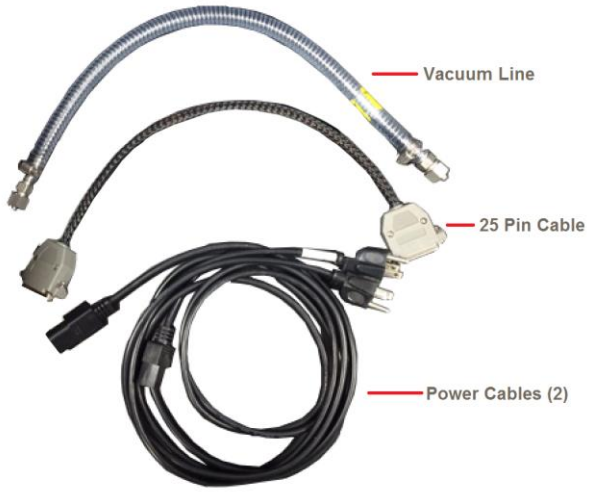
- Inspect each item to ensure it is not damaged.
- If items are missing, contact Picarro.
- Keep the shipping crate and all packaging to reuse when transporting the analyzer.
- Contact Picarro for options on transporting systems to remote labs.

WARNING

This analyzer weighs 67 lbs. (30.4 kg). Use the technique outlined in the General Safety section on page 15 when lifting or moving the analyzer.

Figure 5: Analyzer and Pump Components

Figure 6: Connection Componentts



Analyzer, Pump, and Connection Components

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.
Pump (1)	Provides vacuum required for sample gas sequencing into and out of the analyzer.
Vacuum Hose (1)	Hose to connect the pump to the analyzer.
A/C Power Cables (2)	A power cable with connectors appropriate to your region is provided. The analyzer automatically adjusts to local voltage.
Keyboard (1)	USB keyboard
Mouse (1)	USB mouse
Multi-Pin Control Cable (1)	For External Solenoid Valves Electronic cable (25-pin)
Nut (1) and Ferrules (2)	For connecting input line to analyzer INPUT
Document Packet (1)	Includes this manual, certificate of compliance, and Windows License.
USB Flash Drive	Contains backup software.

Unpacking the Pump Unit

1. Unpack the pump unit from the crate and plastic bag and place it on a tabletop.
2. Remove the two screws from the black plate on the base of the PPU and remove the plate. This plate keeps the rubber feet on the pump (inside the PPU enclosure) from shearing off. Removing the screws releases the pump inside the PPU, allowing it to vibrate freely. See Figure 8.

Figure 7: Removing the Pump Securing Screws

NOTE

Save the plate with the packing materials (crate, shipping foam, plastic bags and desiccation pouches). Re-attach the plate before packing and shipping the unit.

3. Unpack the analyzer and remove it from its plastic bag.
4. Carefully set the analyzer atop the PPU to prepare for setup of connections at the back. Figure 6 above shows the analzyer positioned correctly on the PPU.

CAUTION

Leave enough free space for ease in making connections. Leave 6” free space at the rear of the analyzer and 6” free space at the front of the analyzer.

6. ANALYZER OVERVIEW

6.1 Intended Use

The G5131-*i* analyzer measures concentrations of Isotopic N_2O (^{18}O and ^{15}N) using Picarro's patented Cavity Ring-Down Spectroscopy (CRDS). The analyzer can be deployed for air monitoring applications in a lab or in the field, allowing in-situ analysis of trace and ambient amounts of Isotopic N_2O.

6.2 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.

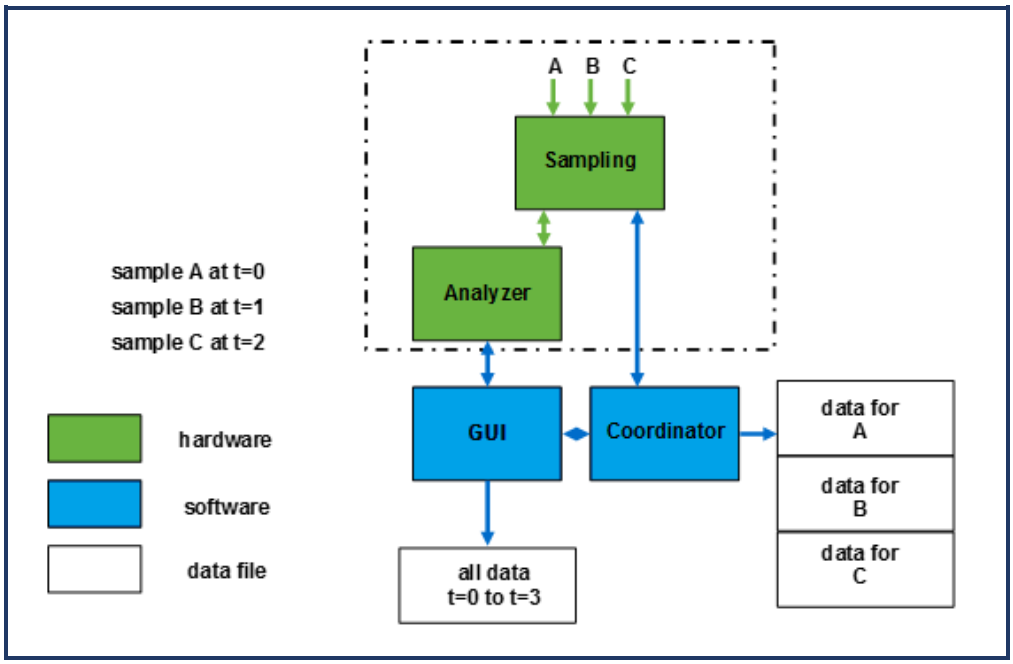
6.3 Analyzer Specifications

Weight (Total) **Analyzer** **Pump**	87 lbs. (39.5 kg), Including external pump 67 lbs. (30.4 kg) 20 lbs. (9.1 kg)
Analyzer Dimensions	17" W x 12" H x 27" D (43 x 32 x 69 cm)
Temperature Range	15 to 35°C (operating) -10 °C to 50 °C (storage)
Sample Pressure	300 to 1000 Torr (40 to 133 kPa)
Sample Flow Rate	< 50 sccm at 760 Torr (101 kPa)
Ambient Humidity Range	< 85% R.H. non-condensing
Maximum Altitude	10,000 ft. (operation)
Clearance	Front: 6" (15.3 cm); Rear: 6" (15.3 cm)
Power Requirements **Startup Power** **Steady-state Power** **Mains Supply Voltage Fluctuation**	100 to 240 VAC; 47 to 63 Hz (auto-sensing) <375 W at start-up (Analyzer and Pump) 120 W (Analyzer), 150 W (Pump) Steady-state operation ±10% of the nominal voltage
Minimum Rated Circuit Amperage	10 A @115 VAC, 5 A @230 VAC
Liquid Ingress Protection	None

6.4 Analyzer Operation Flow Diagram

To measure discrete samples (such as individual gas bags) or from multiple locations (when switching valves draw in ambient air from different heights), a separate software window (coordinator) is used to control the sample source and match the corresponding real time read out with the sample source. Depending on system configuration, coordinator programs may not be included. Figure 9 shows analyzer operation as a flow diagram.

Figure 8: Analyzer Operation Flow Diagram



1. The samples A, B, and C are introduced into the analyzer sequentially.
2. The timing of sample introduction is controlled by coordinator or valve sequencer software.
3. The analyzer measures samples continuously and reports the data to the GUI.
4. The GUI saves a single file where all data is reported as a function of time. The coordinator gets data from the GUI and creates a single file, the data is reported as a function of sample.
5. Before shutdown, Picarro recommends flowing clean dry air (CDA) through the analyzer for several minutes. This prevents moist gas in the cavity from condensing on the optics as the analyzer cools.

7. INSTALLATION

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

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

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

WARNING

Picarro sells 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.

WARNING

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.

WARNING

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. Do not operate or store the unit outside or exposed to the elements.

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 4” (10cm) 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)

7.1 Analyzer and Vacuum Positioning

1. Remove the Analyzer and Vacuum Pump from the shipping container. This requires two persons for lifting the hardware.

WARNING

This analyzer weighs 67 lbs. (30.4 kg). Use the technique outlined in the General Safety section on page 15 when lifting or moving the analyzer.

2. Place the Pump unit on a bench top or flat surface. Place the analyzer on top of the pump. Don't push the analyzer/pump into position yet; there are cables to be installed on the back panel.

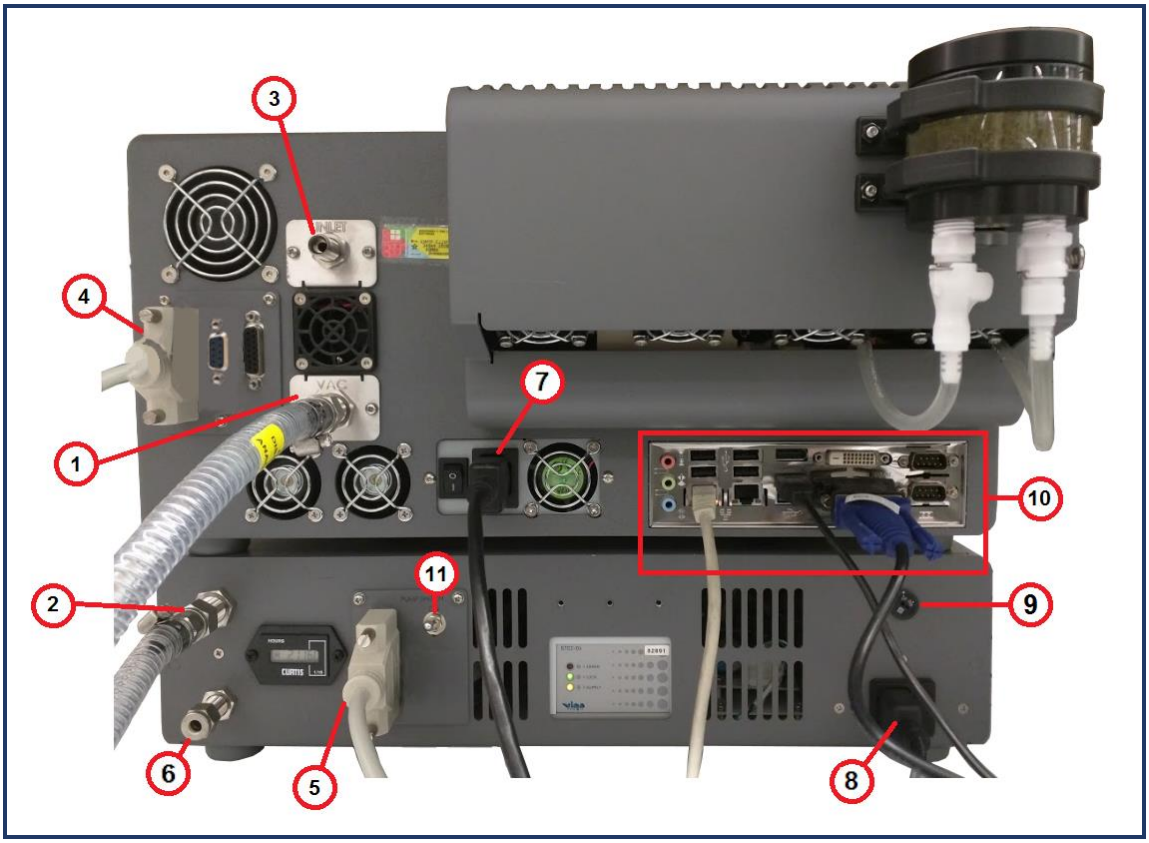
Figure 9: Analyzer and Pump Placement

3. Unpack the analyzer connection accessories. The Certificate of Compliance and USB drive should be stored in a safe place and may be required if you contact Picarro with questions about the analyzer.

7.2 Connections

Figure 11 shows the analyzer rear panel with the connections labeled. The numbered steps in below correspond to the numbered list below.

Figure 10: Rear panel connections



1. Connect the vacuum hose to the top box.
2. Connect the free end of the vacuum hose to the bottom box.

WARNING

<u>Equipment Damage</u>: Never disconnect the vacuum hose unless the pump and analyzer are OFF, otherwise the system may be damaged.

3. Connect the inlet from the analyzer to the sample line.
4. Connect the 25-pin cable to the analyzer.
5. Connect the 25-pin cable to the bottom box.
6. Leave the exhaust port open to the atmosphere.

CAUTION

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

CAUTION

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

7. Connect power cord to the top box.
8. Connect the power cord to the bottom box.
9. Make sure the 110/220 SELECT switch on the bottom box is configured properly for your region.
10. Connect a keyboard (included), mouse (included), and monitor (not included) to the computer connectors on the top box.

NOTE

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

11. This switch is used for customers who may want to use external pumps.

    When the switch is in the ON position, the internal vacuum pump activated.

    When the switch is in the OFF position, the internal vacuum pump will remain off even when the analyzer is turned on.

NOTE

The software to operate the instrument will start automatically after the operating system has loaded. The user interface will appear a few seconds after the instrument software starts. See "Startup Procedure" in Section 8.1.

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

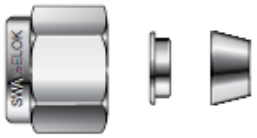
When using compressed gases, follow all appropriate safety conventions, including use of eye protection, physical restraint of cylinders, etc.

Making a New Connection:

When using new tubing, follow these steps.

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

Figure 11: 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

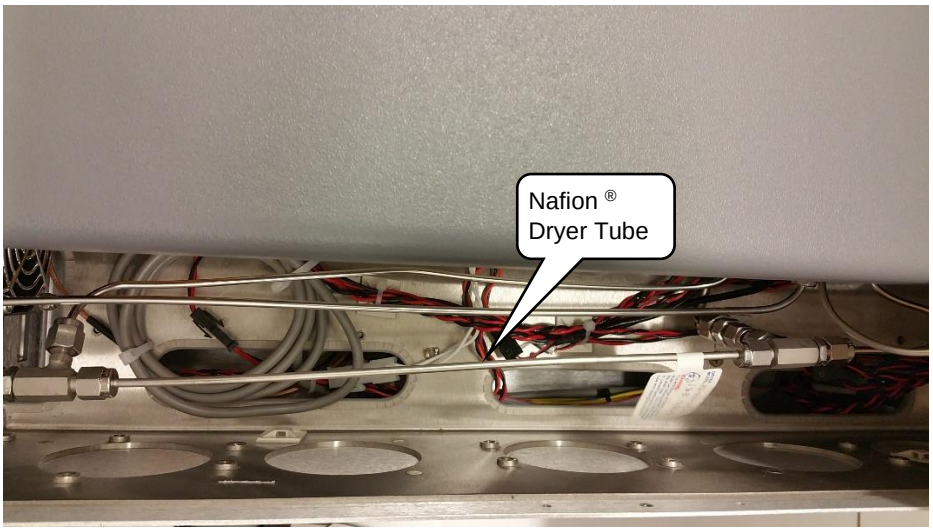
When reattaching tubing that already has a nut connected:

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 Water Removal from the Gas Stream

The G5131-i analyzer requires water removal from the gas stream prior to its admission to the analyzer. In order to achieve this purpose, Picarro has embedded a Nafion® dryer tube inline of the analyzer inlet stream. The dryer uses part of the pump exhaust as a counter-current gas in order to drive off the water from outer walls of the Nafion® dryer in order to regenerate its drying capacity.

Figure 12: Dryer Tube



8. ANALYZER BASIC OPERATION

8.1 Startup Procedure

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

1. Switch on the main power to the analyzer at the rear panel.

Figure 13: Main Power Switch

2. Press the soft power button located on the front panel. The software will start automatically, and the analyzer will display the CRDS Data Viewer window. Data Viewer features are detailed in Section 9.
3. Wait approximately 45 minutes for the system to power, initialize, and stabilize.
4. Once the cavity pressure and operating temperature are at their proper setpoints and stable, the analyzer will start measuring.

NOTE

As the instrument is starting up, it is normal for there to be a delay in reporting data. This can take several minutes depending on how long it takes for the internal temperature and pressure to reach their operating points, and it is normal during this time for some concentration readings to be negative or constant.

The data selection pull-down menus will not be populated with the appropriate items until actual data is being reported in the graph. This is typically less than 30 minutes, but depending on ambient temperature, the analyzer can take up to 1 hour to stabilize.

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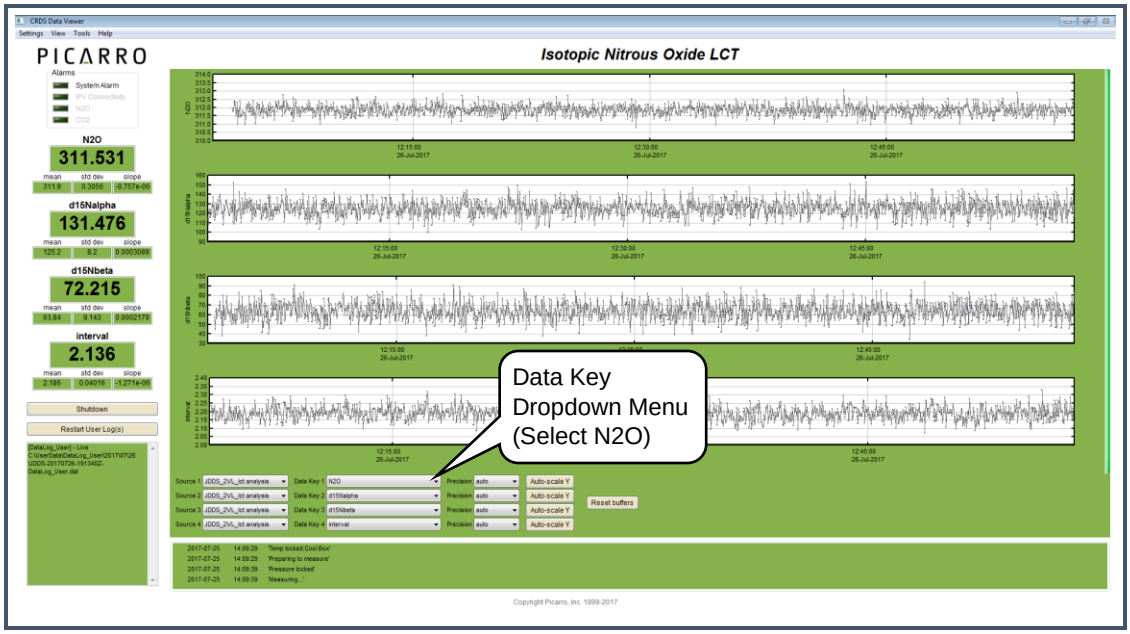
5. Select **N2O** from the *Data Key* dropdown menu in the *CRDS Data Viewer screen*. Figure 14.
6. Restart the analyzer: double-click the **Picarro Mode Switcher** icon on the desktop and select **Isotopic N2O.**

   If you get logged off of Windows at some point, the username you log into is **Picarro** and Password: **Extreme_Science!**

Figure 14: Picarro Analyzer GUI



8.2 Desktop Icons and Folders

On the Windows™ desktop, there will be the following icons and folders:

1. **Start Instrument:** When clicked, the analyzer will start measuring in the configuration that it was in when the software/analyzer was shut down.
2. **Coordinator Launcher:** Depending on the system's configuration, the coordinator program may not be included. Clicking on this icon will lead you to a window that will allow you to choose the proper coordinator to operate the peripheral module that came with your analyzer.
3. **Picarro Mode Switcher:** When clicked, you will be led to a window that will allow you to switch between various measurement modes. Most analyzer models are configured for one mode and may not include the Mode Switcher. If the analyzer has multiple modes, this allows the user to switch between them easily.

Figure 15: Picarro Mode Switcher

4. **Picarro Controller:** When clicked, you will be led to a useful diagnostic panel allowing the user to see the analyzer's internal temperatures, pressure, and spectroscopy in real time. This program has user-accessible functions, but it cannot change anything related to analyzer functionality. It is intended for diagnostic purposes only.
5. Picarro Utilities Folders:
    a) **Data file Viewer:** When clicked, you will be led to a window that will allow you to convert between *.dat and H5 data files and to make various graphical representations of the data. The instructions on using the Data File Viewer software are described in the Appendix B
    b) **Data Recal:** When clicked, you will be led to a window that will allow you to recalibrate the data based on known, certified data.
    c) **Setup Tools:** When clicked, you will be led to a window that will allow you to edit various settings for the analyzer (See the Setup Tool section of this manual for information about these settings).
6. Diagnostic Folder
    a) **Stop Instrument:** When clicked, you will be led to a window that will allow you to turn off the analyzer in an emergency event. Upon clicking on this icon, the following window will pop up. Please see **Shutdown Procedure** on page 33 of this manual to shut down the analyzer in normal circumstances.

Figure 16: Stop CRDS Software

CAUTION

EXCEEDING GAS INLET PRESSURE OR TEMPERATURE SPECIFICATIONS COULD RESULT IN DAMAGE TO THE INSTRUMENT. In the case of higher input pressure or flow, configuring a sampling bypass manifold system is recommended.

Use a 'tee' at the gas inlet and either return the remainder to the main gas stream or exhaust appropriately.

CAUTION

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

CAUTION

Analyzers which include the external valve control option are provided with a cable consisting of five electrical connections intended for controlling solenoid valves (typically 12VDC <1A max).

It is important to electrically isolate the solenoid valves from the analyzer's ground to avoid electrical interference which could compromise the analyzer's accuracy.

8.3 Shutdown Procedure

CAUTION

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

To shut down the analyzer using the GUI:

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

   The analyzer shuts down:
3. Cavity fills with gas from the inlet until it reaches near atmospheric pressure.
4. Status log shows the pressure as the cavity is filled.
5. Proportional valves close.
6. Software shuts down.
7. Analyzer powers off.
8. When the soft shutdown is completed, shut off the main power using the power switch on the back panel.

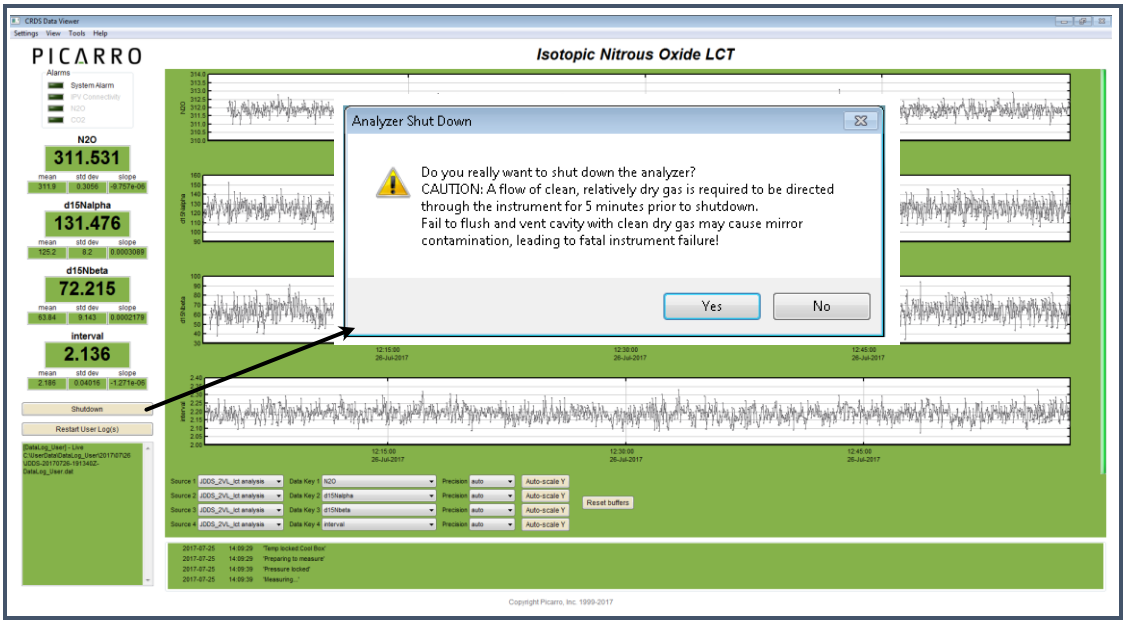
CAUTION

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

CAUTION

FOR G2xxxx ANALYZERS: If you have trouble turning off the analyzer software, do not kill the process(es) in the task manager; rather, double-click on the "Stop Instrument" icon in the Diagnostics folder on the desktop.

Figure 17: Shutdown Window



8.4 Recovery from Electrical Power Outage

When the power returns after an unplanned outage, the analyzer restarts automatically. The Picarro software:

- Closes files that were interrupted by the power outage.
- Opens new files for data collection.
- Data, analyzer diagnostics and other parameters recorded up to the time of power outage are retained.

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

9. LIST OF GUI FUNCTIONS

9.1 GUI Overview

The features of the Picarro analyzer GUI are identified in Figure 18 and described in the following sections.

NOTE

Note that the types of data shown in the following illustrations may differ from this model. This section generally shows the available features common to most models.

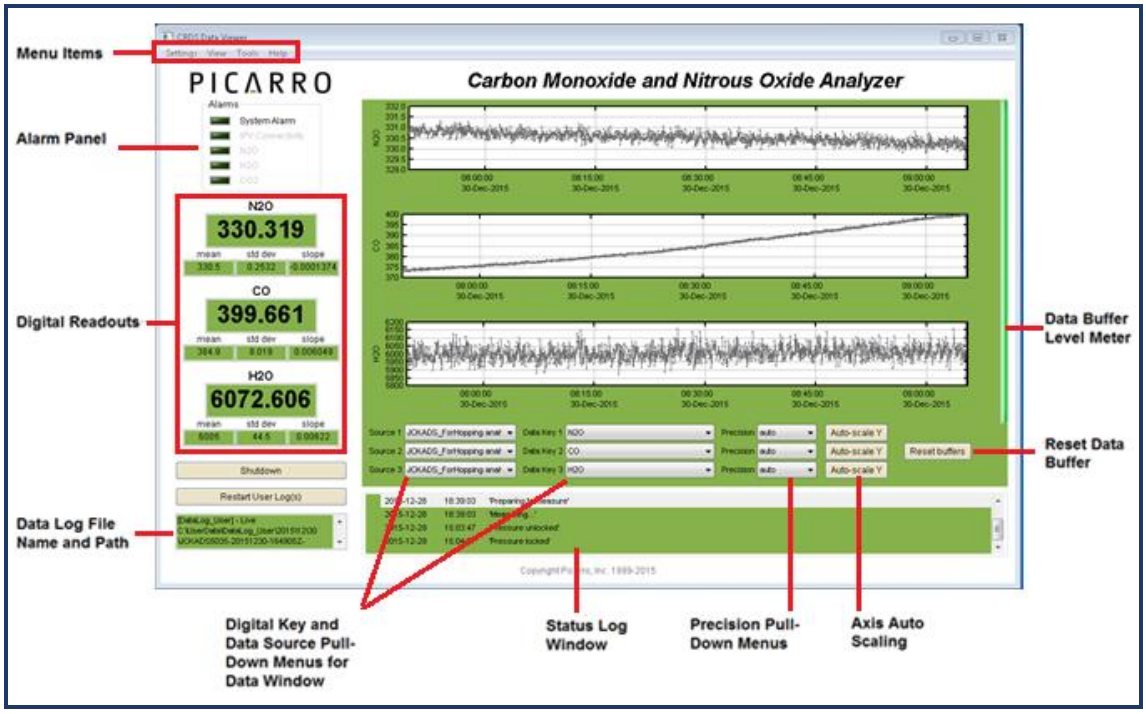


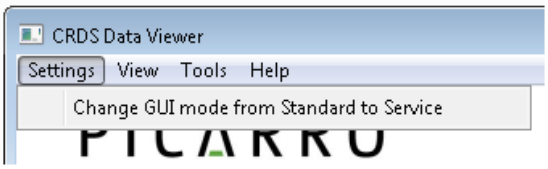
Figure 18: G5131-I GUI Data Viewer

9.2 Settings, Tools, and Help Menus

Settings Menu

Left clicking on the Settings menu pulls down a menu that has one entry 'Change GUI Mode from Standard to Service.' This is the access point to a password protected service mode where additional operational and measurement parameters are displayed. Selecting and clicking on this entry opens the Cavity Ring-Down Spectrometer Controller. This is reserved for Picarro service operators only.

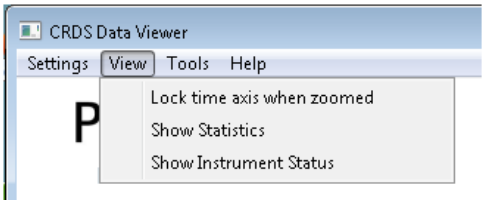
Figure 19: Settings Menu



View Menu

This menu item has three entries:

Figure 20: View Menu

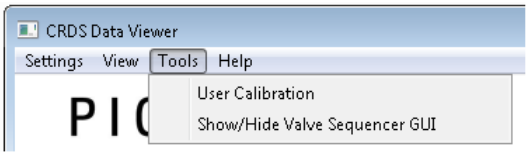


1. Lock/Unlock time axis when zoomed: When locked, forces the two graphs to display the same time scale during zoom.
2. Show/hide statistics: Toggles the measurement statistics display, see **Digital Readouts** section on page **42** below.
3. Show/hide instrument status: Toggles the status of the instrument display.

Tools Menu

This menu item has two entries:

Figure 21: Tools Menu



1. **User Calibration:** Opens the user calibration window (default password is “picarro”). The password can be reset in the QuickGui.ini file in the instrument directory: “C:\Picarro\G2000\AppConfig \Config\QuickGUI\” under the section: [Authorization] UserCalPassword = Picarro Show/Hide Valve
2. **Show/Hide Sequencer GUI:** Toggles the display of the external valve sequencer window.

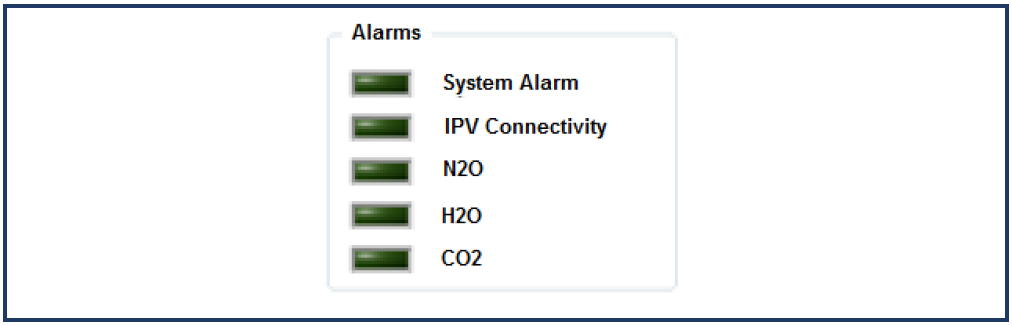
   The calibration slope and intercept can be entered, and their effects immediately were seen in the data. Please refer to the Calibration Section on page 64.

Help Menu

About: Displays the version number of the instrument.

9.3 Alarms Panel

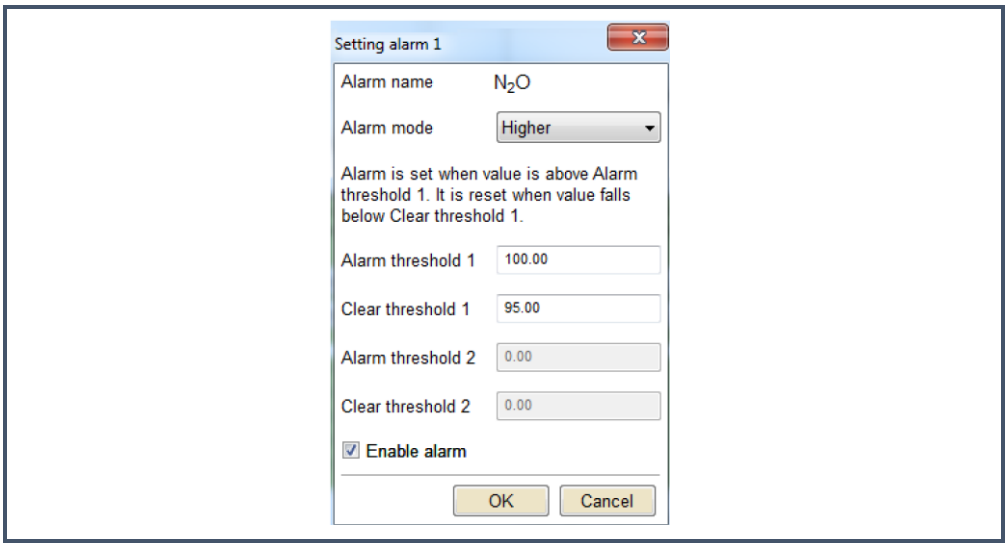
Figure 22: Alarms Panel



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

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

Figure 23: Alarm Setting Window

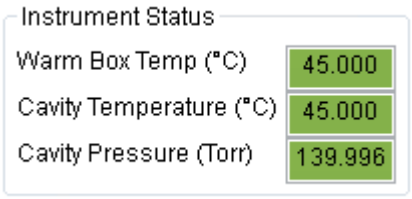


Type the value you wish to set the alarm to and press the “OK” button, or press “Cancel” if you do not wish to change the alarm value. If you do nothing, the dialog box will disappear, and the alarm value will remain unchanged.

9.4 Instrument status

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

Figure 24: Instrument Status



9.5 Data Log Filename and Path

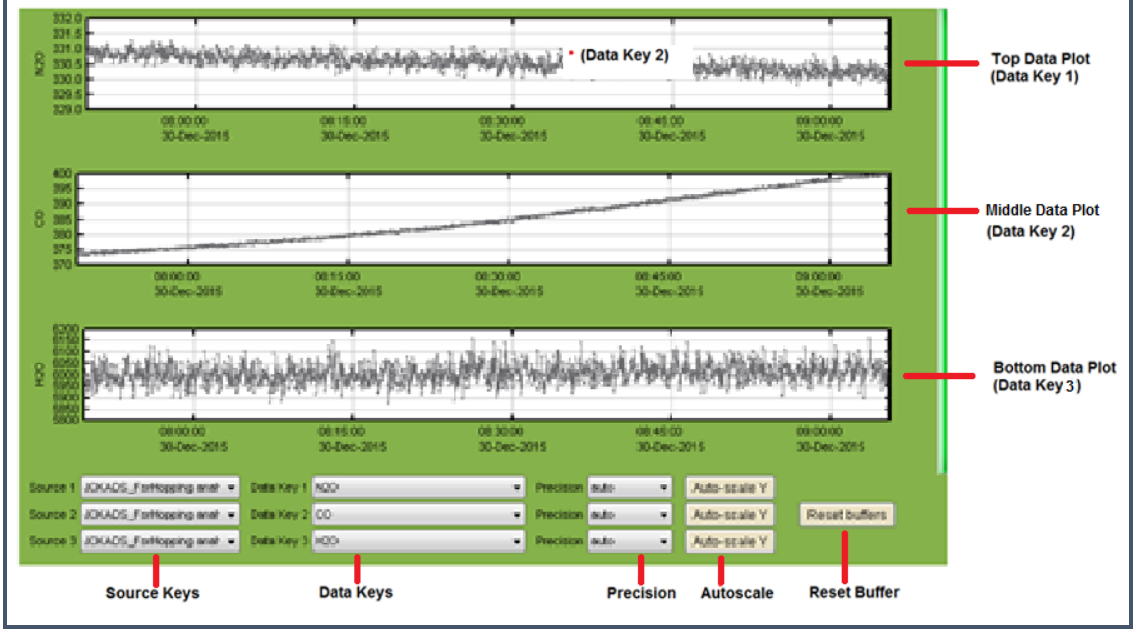
The filename and path of the active data log are displayed in this pan. The indicator is grayed-out if there is no active data log (i.e., if a new data log has not been started using the *Start /Stop New Data Log Button*). A new file will be generated at midnight, which will be saved to the same location as the original log file.

Figure 25: Data Log Filename

9.6 Data Window

The data window displays a graph of any stream of data vs. system time, with a format of hh: mm: ss. The user can select which data stream is displayed using combinations from the Data Source and Data Key pull-down menus. The precision displayed can be adjusted using the “Precision” menu and Auto-scaling of the ‘Y’ axis is also available.

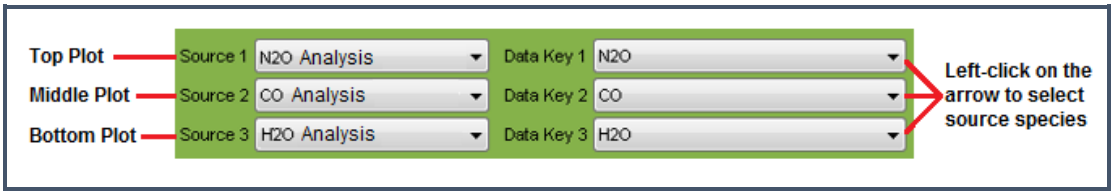
Figure 26: Data Window



Data Source and Data Key Pull Down Menus

These two menus enable selection of the data stream that is viewed in the *data window*. Data streams available on the GUI are gas concentrations, if '*instrument* Analysis' (where *instrument* represents the system installed) is selected, or if "sensors" is selected, the analyzer's optical cavity pressure or temperature can be viewed as well as the nominal ambient temperature of the analyzer ("DAS temp") and the temperature of the analyzer's electronics chamber, indicated as "warm chamber temp."

Figure 27: Source and Data Key Pull-Down Menus



Precision Pulldown Menu

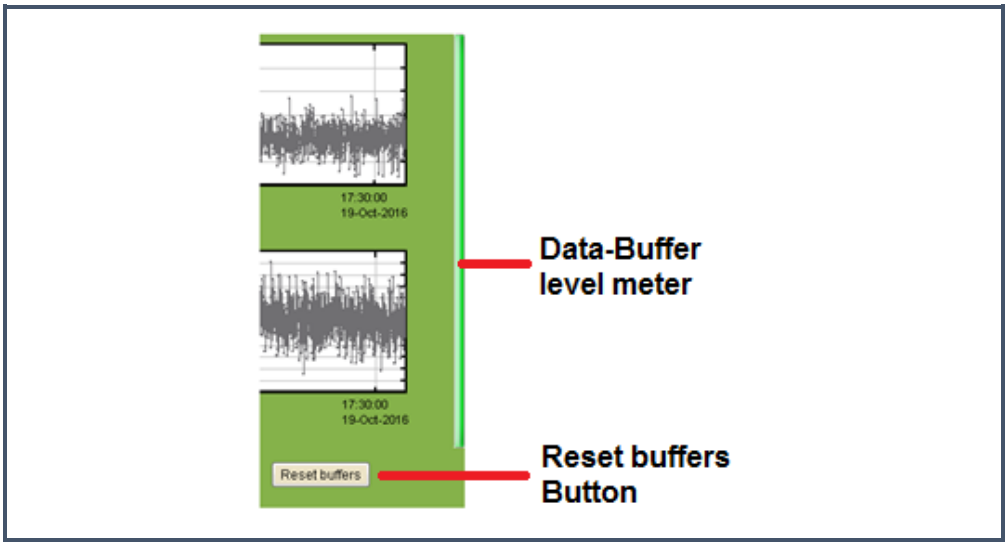
Click on this icon to select the precision displayed on the y-axis, between 0 and 4 digits of precision or "auto." The currently selected precision is displayed during operation. This does not affect the precision of the saved data in the data log files or results files.

Figure 28: Precision Pulldown

Data Buffer Level Meter

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

Figure 29: Data Buffer and Reset Buffer



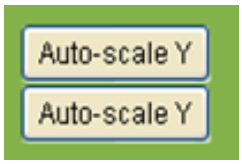
Reset Data Buffer Button

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

Graph Zooming

To zoom the graph, simply drag the magnifying glass over the section to be zoomed and click and hold the left mouse button. While holding down the left button, move the mouse to create a box that covers the region of interest. When the box is properly drawn, release the left button and boxed area will automatically scale to fill the data window. To zoom back out, double-click on the left button. To auto scale, the y-axis of either graph, use the auto-scale buttons below the graph. To lock or unlock the time axis of each graph during zooming, select that menu item in the ‘View’ menu.

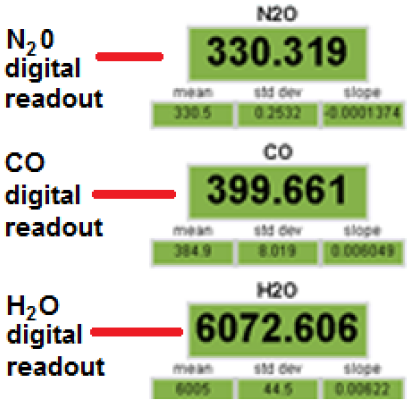
Figure 30: Graph Zooming



Digital Readouts

Displays the latest value recorded for the selected Data Key for each Data Window. Changing the Data Key modifies the Digital Readout as well as the Data Window view. If the 'Show Statistics' entry is enabled in the 'View' menu, the mean, standard deviation and slope of the data in the graph are dynamically calculated and indicated below the digital concentration readout. These numbers change to reflect statistics of whatever data is in the data window.

Figure 31: Digital Readout



Start / Stop Data Log Button

The Analyzer automatically records all data collected on the instrument and saves it for later analysis. These files are called Data.dat files, which are described below in the section called **File Management**. In addition, the user can record a separate data log file. Press this button if you would like the instrument to start recording a separate data file. A dialog box will appear prompting you for a filename and location. Press this button again to stop recording the data file.

9.8 Status Log Window

This window displays instrument status messages, in the following form: “MM/DD/YYYY hh: mm: ss generic message text.” These messages include all messages sent to the DAS front panel display. The common status log messages are:

3. Temperature Locked: WB (HB)

   The system waits for the warm box (“WB” – the temperature-controlled electronics and wavelength monitor chamber) to reach operating temperature. Similarly, the temperature of the hot box (“HB” – the temperature-controlled chamber containing the analyzer’s optical cavity and gas handling system) is stabilized. This is typically the longest step in the startup sequence. The duration of this step can range from 5 to 60 minutes, depending on the ambient temperature and how much time has elapsed since the last startup.

4. Entering Measurement

   Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds. The instrument will continue to scan and report concentration measurements until the instrument is shut down using the procedure below.

5. Pressure Stabilizing/Locked

   The valve control system begins to allow flow through the analyzer and stabilizes the pressure inside the cavity.

6. Measuring

   This is the normal mode of operation after startup has completed.

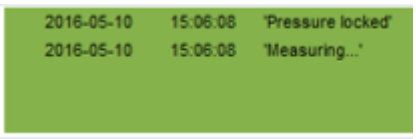


Figure 32: Status Log Window

10. MAINTENANCE

Picarro analyzers require minimal service or maintenance. With the exception of the particulate filter, and refilling the chiller, and replacing fuses, the analyzer is not user serviceable.

Before performing any maintenance shut down the analyzer.

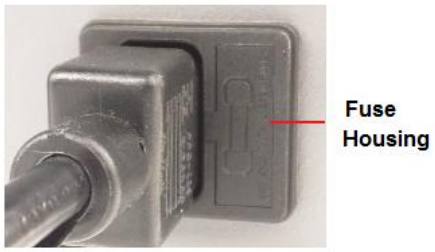
10.1 Cleaning

Clean the outside of the analyzer with a clean dry cloth. Users should never access or clean the inside of a Picarro analyzer.

10.2 Fuse Replacement Procedure

Fuse replacement can be performed by users. The analyzer uses a 1.5A at 250 VAC, 5mm x 20mm, slow blow fuse. Follow this procedure to replace a fuse. Figure 33 shows the fused power connector on the lower right corner of the PPU rear panel (Figure 33).

Figure 33: Analyzer Fuse Location

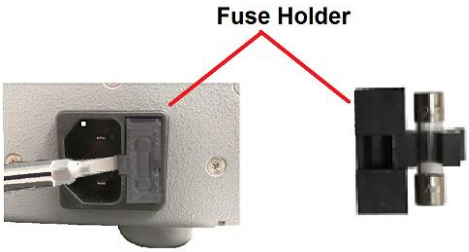


WARNING

Before replacing a fuse, make sure that the analyzer power is off and that the power cord is disconnected.

1. Insert a screw driver flat head under the tab on the fuse housing.
2. Carefully push the screw driver handle away from you to lever the fuse housing out of the analyzer back panel.
3. Remove the fuse from the fuse housing as shown in Figure 34.

Figure 34: Fuse Replacement



4. Put a new fuse in the fuse holder.
5. Push the fuse holder into the rear panel. You will hear a click when it is fully inserted.

10.3 Particulate Filter Replacement

Gasses are filtered by two in-line, sub-micron particulate filters before the reaching the measurement cavity. The outer filter is user-replaceable. Replacement filters can be purchased from Picarro and installed by users. This section describes outer filter replacement.

WARNING

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

Symptoms of a Clogged Filter

Filters can become clogged with continual use.

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

Some symptoms of a clogged filer are:

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

Solutions

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

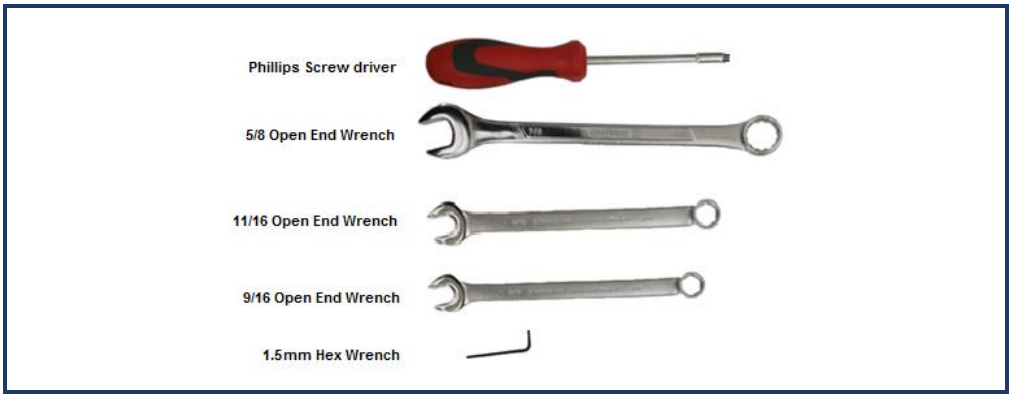
- Dry the filter by running Clean Dry Air (CDA) through the analyzer. If the analyzer functions normally after drying, a filter replacement is not necessary.
- If drying the filter does not fix the problem, replace the filter.

Tools Required

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

- $^{9}/_{32}$ nut driver
- $^{7}/_{8}$" open-end wrench
- $^{9}/_{16}$" open-end wrench
- Needle-nosed pliers
- 1.5 mm hex wrench

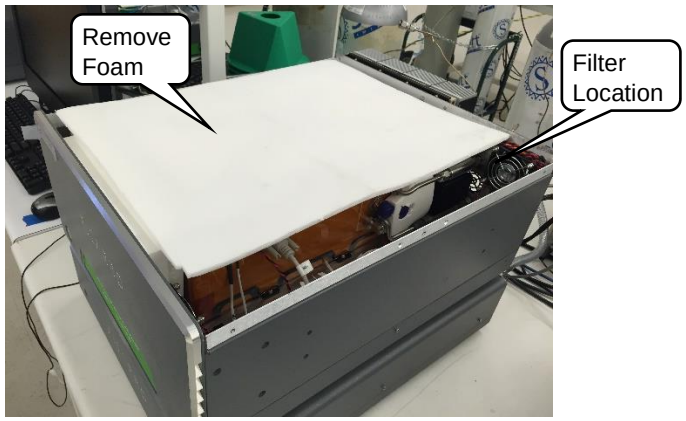
Figure 35: Tools Required



Particulate Filter Removal

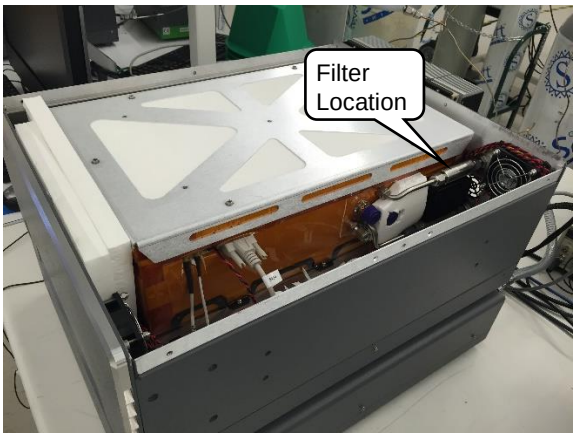
1. Move the analyzer to a clean environment.
2. Using the 2mm hex driver, remove analyzer top lid by removing six (3 per side) M3 x 6mm socket flathead screws.
3. Lift the top cover off of the analyzer.

Figure 36: Foam Removal



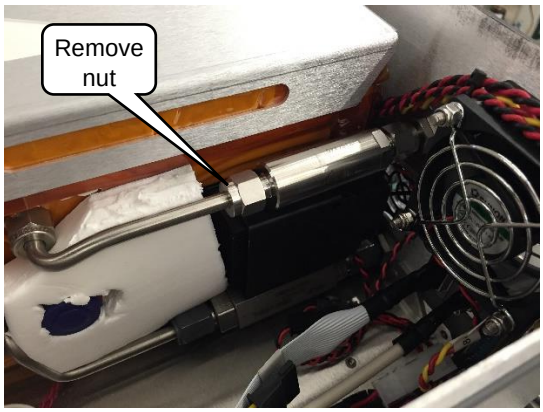
4. Remove the foam sheet from the top of the analzyer.

Figure 37: Filter Exposed



5. Loosen the filter output nut. (Fig 37)

Figure 38: Filter Outlet Nut



7. Remove the two screws that secure the inlet bulkhead (Fig 39).
8. Pull out the Inlet bulkhead with filter still attached.

Figure 39: Remove Bulkhead Screws

9. Remove the filter from the inlet bulkhead by loosening the attaching nut.
10. Attach new filter in the correct orientation (observe flow arrow direction). Installation is the reverse of removal.

10.4 Laser Chiller Service

The analyzer is equipped with a chiller (40ml water buffer tank) for laser cooling. Figure 40 shows the buffer tank.

- The recommended coolant is from Koolance, PN # LIQ-702. It is a solution of distilled water and propylene glycol.
- The buffer tank is filled with coolant when shipped. Refill or add for cases when empty or at a low-level.
- Make sure there aren't any kinks / twists in the exposed coolant tubes, especially during an analyzer's installation or after a relocation.
- Instrument must be powered off before connecting coolant tubes and the initial fill or drain of buffer tank. One may leave the analyzer on when refilling a tank with low coolant using the two ports on top of the tank's lid.
- Picarro recommends inspecting the coolant level in the buffer tank and adding or refreshing in case of coolant loss or contamination.
- Coolant consumption is dependent on many factors. Recording the frequency for coolant maintenance can be helpful.

Buffer Tank Initial Coolant Fill

Following is a procedure for the initial fill of the buffer tank:

1. Seat the analyzer's main box and PPU on a table.
2. Inspect buffer tank for possible crack and/or external tube breakage. Repair before filling.

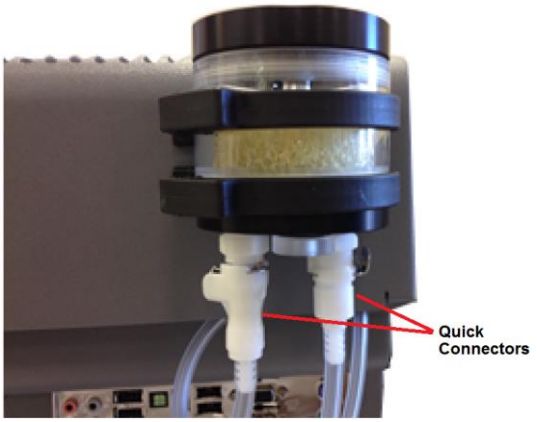
Figure 40: Chiller Buffer Tank

3. The black top lid of the buffer tank should sit slightly higher than the top of main box. Adjust tank level, if necessary.
4. Remove the black top lid by turning counter-clockwise. Fill the buffer tank with coolant until full; secure top lid to seal the tank. On top of the lid, are two ports, which can also be used to fill and refill tank.

Figure 41: Filling the Buffer Tank

5. Disconnect the quick connectors from each other, as they are shipped plugged into each other. Then plug them into the two quick adaptors at the bottom of the buffer tank, as shown in Figure 42.

Figure 42: Buffer Tank Connections



6. Power on the analyzer to check the coolant flow. In a normal operating condition, coolant will be visible inside the tank. If necessary, add more coolant to buffer tank.

Refilling the Chiller

In the event coolant level is below the minimum level marker on the tank, a refill is necessary.

1. Analyzer can be ON or OFF for this operation.
2. Perform Step 4 of initial coolant fill.
3. Turn on analyzer to circulate coolant in tank for 5-10 minutes.
4. Check level and flow. Add more coolant if necessary.
5. If coolant is contaminated, turn off analyzer, drain buffer tank, and reconnect the tubes, before performing Steps 2 - 4.

11. TROUBLESHOOTING

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.

11.1 Power LED on Analyzer Does Not Illuminate

Pressing the front panel ON button does not start the analyzer. The green power LED is normally illuminated when the analyzer is on.

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

11.2 GUI Does Not Display at Start-Up

The computer may be configured to either:

- Automatically start the analyzer and GUI after it completes its boot-up sequence
- Launch the GUI using the *Start Analyzer* icon on the desktop

To configure the computer:

1. Shut down the analyzer by shutting down Windows on the on-board computer.
2. Wait for the shutdown to complete normally and for the computer and analyzer to turn off completely.
3. After a few seconds, restart the computer by momentarily pressing the power button on the front panel. See Figure 6 for the location of the front panel power button.

CAUTION

Do not restart windows without cycling the power to the analyzer. Restarting windows will not fix this problem.

11.3 Cavity Pressure Cannot be Adjusted for Concentration Measurements

The cavity pressure is automatically locked to the correct value during normal operation.

The *Pressure Locked* message on the on the lower left corner of the GUI indicates that the cavity pressure is within operating parameters. See Figure 43.

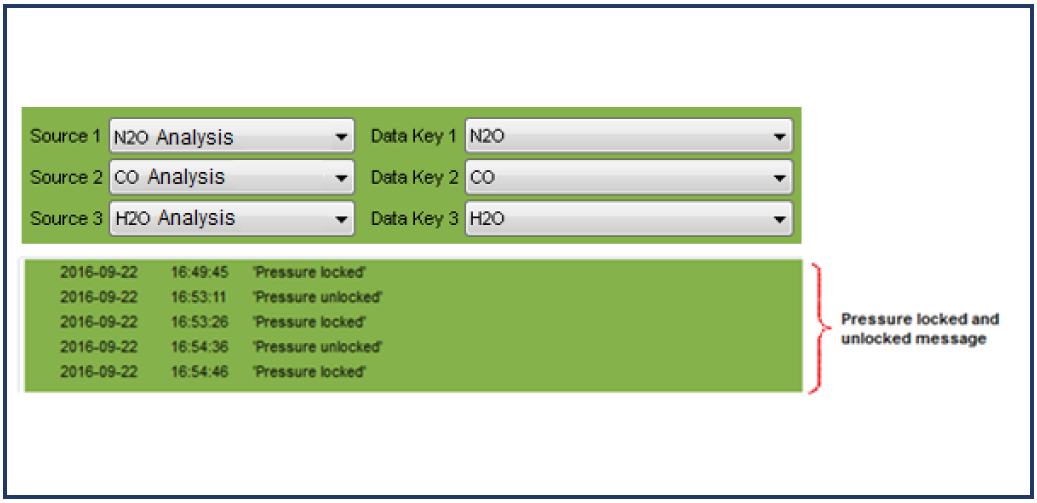


Figure 43: Status Log for New Filter

If the cavity pressure is out of operating specification the GUI displays a *Pressure high* or *Pressure Low* message.

1. The *Pressure Low* message on the GUI indicates that there is insufficient gas available at the analyzer gas inlet.
    a. Check the inlet plumbing to the analyzer.
    b. Ensure that the pressure at the inlet is within specifications.
2. The *Pressure High* message on the GUI indicates that gas cannot exhaust from the analyzer at a sufficient rate.
    a. Check the vacuum line between the analyzer and the power vacuum unit for leaks.
    b. Check the vacuum pump. Make sure it is functioning correctly.
    c. Check the gas pressure inlet for excessive pressure.

11.4 User Interface Program Does Not Update Graphs as Data is Collected

The computer may become unresponsive causing the programs that control the analyzer to stop functioning. If this happens:

Shut Down the Computer

If the computer responds to the mouse, do a normal Windows shutdown from the Windows start menu:

1. Wait until the computer is completely shut down.
2. After a few seconds, start the computer using the power button.

If the computer does not respond to the mouse:

1. Hold down the power switch on the front panel for a few seconds until the computer and the analyzer turn off.
2. After another few seconds, restart the analyzer using the power button.

12. FILE MANAGEMENT

The analyzer generates ASCII-format text output files. Data files are created every 15 minutes by default.

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

JKADS2001-20160127-1029-DataLog_User_Raw.dat

JKADS2001 is the analyzer serial number

20160127 is the date, 1/27/2016, in format yyyymmdd (to allow chronological sorting of data files).

1029 is the time the file was started in GMT, 10:29 am, formatted as hhmm using a 24 hour clock.

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

- C:\UserData \DataLog_User\year\month\day\hour. (for data that has been sampled at the analyzers native sampling rate).
- C:\UserData\DataLog_Sync\ month\day\hour (for data that has been sampled at a constant rate.

Data files are created every 60 minutes and stored for 90 days (default for SADs analyzers) before they are automatically deleted. File deletion frequency and details can be modified in the file: C:\Picarro\SI2000\AppConfig\Config\Archiver\Archiver.ini. See *File Archival and Automatic Deletion of Old Files*.

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

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

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

Datafiles are closed every 15 minutes and moved to an archive directory and a new datafile is started.

The archive directory is C:\Picarro\ G5000\Log\Archive\ and has subdirectories DataLog_Mailbox, DataLog_Private and DataLog_EventLogs with files arranged by year\month\day\hour.

There are more complete data files which include additional information beyond the concentration data including parameters such as analyzer temperatures and pressure, setpoints and spectroscopic information. This information is generally not useful to the user, but can be useful for diagnostic purposes and is store in the directory *C:\Picarro\ G5000\Log\Archive\DataLog_Private \year\month\day\hour*.

For more information about how to include various columns of data from the DataLog_Private in the C:\UserData DataLog files, contact Picarro.

The currently active data file can be found in C:\Picarro\ G5000\Log\DataLogger\.

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

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

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

For example, if the system was started at 10:29 am on 2/5/2016 it would create a file named 20160205\S

JKADS5310-20160205-1029-UserLog.dat. Then at midnight a new file will be created -20160206-0000-UserLog.dat.

12.1 File Archival and Automatic Deletion of Old Files

The analyzer can automatically compress (zip) and archive old files as mentioned above. This operation is controlled by the ini file: C:\Picarro\G5131-I\AppConfig\Config\Archiver\Archiver.ini.

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

Directory = C:/UserData/DataLog_Sync

Optionally specifies which directory to find files to archive.

MaxCount = -1

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

MaxSize_MB = 1500

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

Compress = True/False

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

AggregationCount = 0

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

StorageMode = FIFO

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

Quantum = 4

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

In addition to the automatic file and directory management described above, the analyzer also automatically deletes various files specified in C:\Picarro\ SI2000\AppConfig\Config\FileEraser\FileEraser.ini. There are various settings, as described below:

runtime_interval_hrs = 0.5

Specifies how often (in hours) to run the file eraser.

path = ../../../Log/Archive/DataLog_Private

Specifies which directory to look in for files to delete.

extension = dat

Specifies which files having what extension are to be deleted. If empty, it deletes all files.

delete_time_hrs = 48

Specifies how long to keep files prior to deletion.

12.2 Setup Tool

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

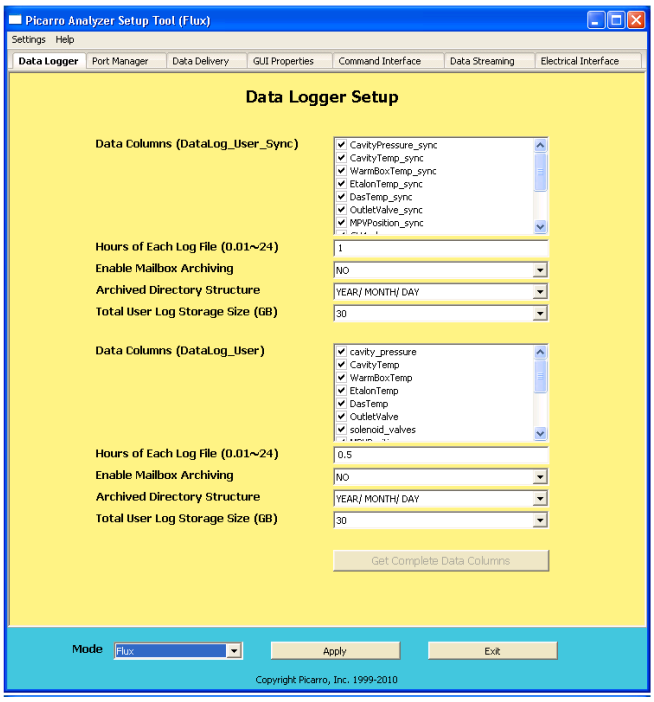
Data Logger

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

- **Data Columns**: Controls which data elements are written to data files.
- **Hours of Each Log File:** Controls the size of each data document.
- **Enable Mailbox Archiving:** Enables archiving of data in the mailbox folder: *C:\Picarro\G2000\Log\Archive\DataLog_Mailbox*
- **Archived Directory Structure:** Specifies part of naming convention for data documents.
- **Total User Log Storage Size (GB):** Specifies the size of storage allowed for User Data (Recent Data).

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

Figure 44: Data Logger Setup Window



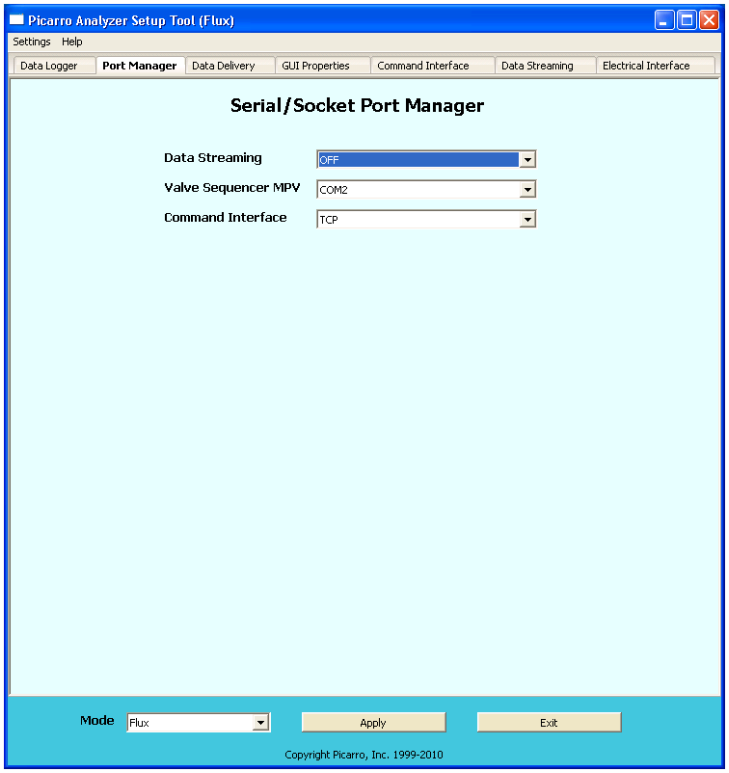
Serial/Socket Port Manager

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

- **Data Streaming:** specify the port for data streaming (COM1/COM2/Off)
- **Valve Sequencer MPV:** specify the port for connecting to Valve Sequencer (COM1/COM2/Off)
- **Command Interface:** specify the port for Command Interface (COM1/COM2/ TCP/Off).

Make sure there are no COM port conflicts before clicking “Apply.” After making the appropriate edits, click “Apply” to put changes into effect and then “Exit” to close the window.

Figure 45: Serial/Socket Port Setup Window



Data Delivery Setup

The **Data Delivery** tab allows the user to schedule remote data delivery via email.

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

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

Figure 46: Data Delivery Setup Window

Editing Main GUI Properties

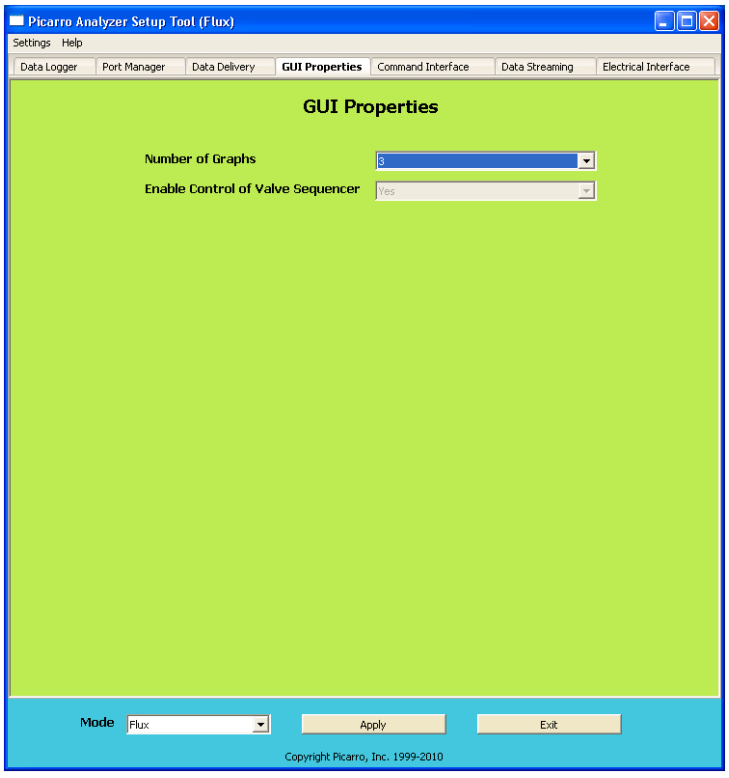
The **GUI Properties** tab allows you to set the number of line graphs visible on the main GUI.

In this tab, you can enable control of a connected Valve Sequencer from the main GUI:

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

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

Figure 47: GUI Properties Window

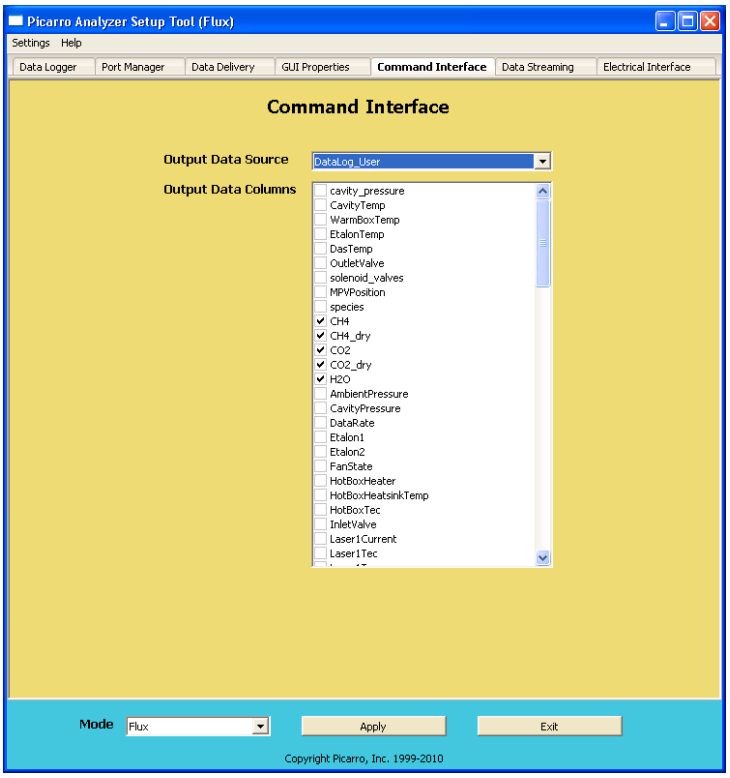


Specifying Digital Data Output for Command Interface

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

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

Figure 48: Command Interface Window



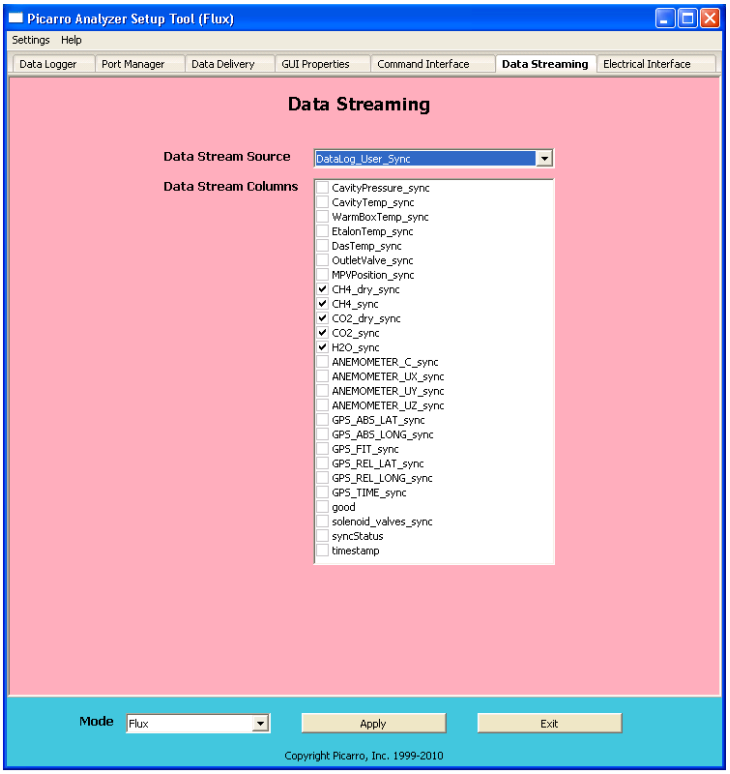
Specifying Digital Data Output for Data Streaming

The **Data Streaming** tab allows you to specify the data elements that you want to send via COM port (specified in the Port Manager tab). Two types of data can be specified here: *Datalog_User* and *DataLog_User_Sync*.

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

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

Figure 49: Data Streaming Window



Customizing Analog Output Channels

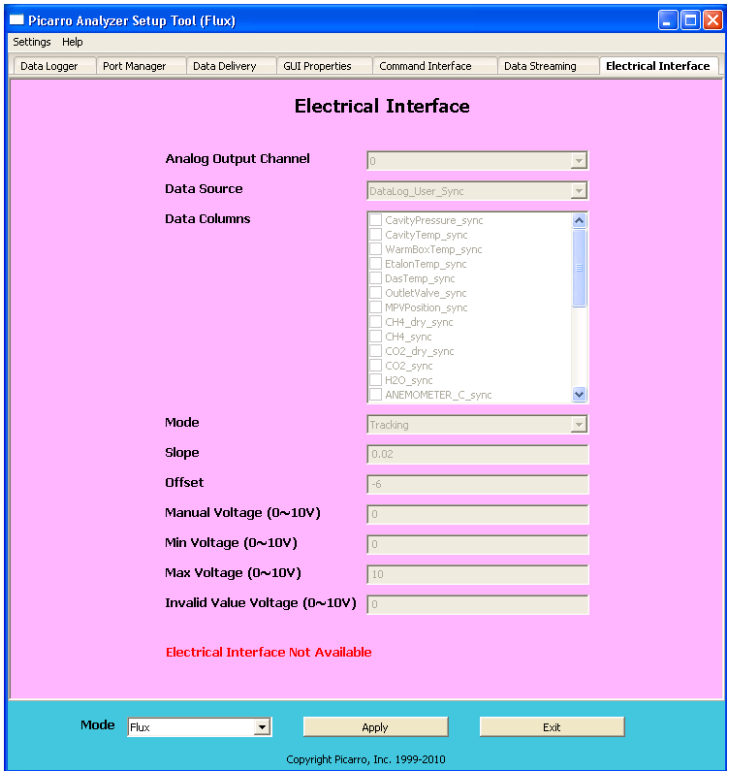
The Picarro analyzer may be optionally configured with an Electrical Interface Card (EIC) that provides up to 8 analog signals available to the user for monitoring various measurements results and analyzer parameters.

Electrical Interface

The **Electrical Interface** tab allows you to customize each analog output channel. This tab will be disabled if the analyzer was not configured to work with an analog peripheral.

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

Figure 50: Electrical Interface Window



13. CALIBRATION

The two primary analytical measurements of the instrument are the concentration of $^{12}CH_4$ and $\delta^{13}C\text{-}CH_4$. Periodic recalibration with standards of known concentration maintains the accuracy of these quantities. Using the Data Recal Software Utility (See instructions in Section 13.3: Calibration Software Utility Tools) enables the calibration constants to be tracked over time, thus enabling the user to follow system performance.

13.1 Slope and Offset

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

If a new slope calibration is to be applied, the user must be mindful of their experimental uncertainty. For example, a change in the slope calibration from 1 to 0.95 may not represent a change in the system's linearity but may simply reflect the experimental uncertainty. If during the slope calibration, a new value of 0.9 or 0.85 is suggested by the Data Recal tool, please repeat the measurements of the standards. In most cases, such large changes in slope are a result of uncertainty and do not indicate a bad nonlinearity of the analyzer. If the analyzer continues to suggest a large change in slope, please consults with Picarro Support before applying a new calibration.

NOTE

If you are uncertain about the state of the current slope and offset values, they can be reset back to their user default values of 1 and 0, respectively. In the Picarro GUI, navigate to "Tools -> User Calibration -> (password: picarro) ->" Then change the slope and offset values of the parameter of interest to 1 and 0, respectively.

13.2 Calibration Methodology

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

Calibration Setup

This section describes the connections from the analyzer to the gas tank.

- The pressure regulator at the outlet of the gas tank protects the analyzer from over-pressurizing. The pressure should be set to about 1 - 3 psi.
- The toggle valve allows rapid shutoff of the gas delivery.
- Tubing is connected to the male quick-disconnect connector provided with the analyzer.
- The male connector is inserted into the inlet port of the analyzer.

To replace the gas tank:

6. Turn off the main valve on the gas tank.
7. Disconnect the pressure regulator assembly from the tank.
8. Connect the pressure regulator assembly to the next gas tank.

Measurement Time for Each Standard

The measurement period for a calibration standard is dependent upon the recorded precision of the standard gas and performance characteristics of the analyzer, using the Allan standard deviation plot.

Measuring Multiple Gas Standards

When measuring multiple gas standards, the order of the gas standard is not important. However, make sure that you measure the gas standard slightly longer than the time you determined in the previous section because the usable/effective data set will be trimmed down.

Calibration Data Processing

1. Process the calibration results from the .dat file (see *File Management* on page 54) and calculate the average recorded value for each standard.
2. Plot these values versus the certified values from the gas supplier and determine the linear relationship between the known calibration values and the analyzer's reported values. A linear best-fit equation can be calculated from the data.

NOTE

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

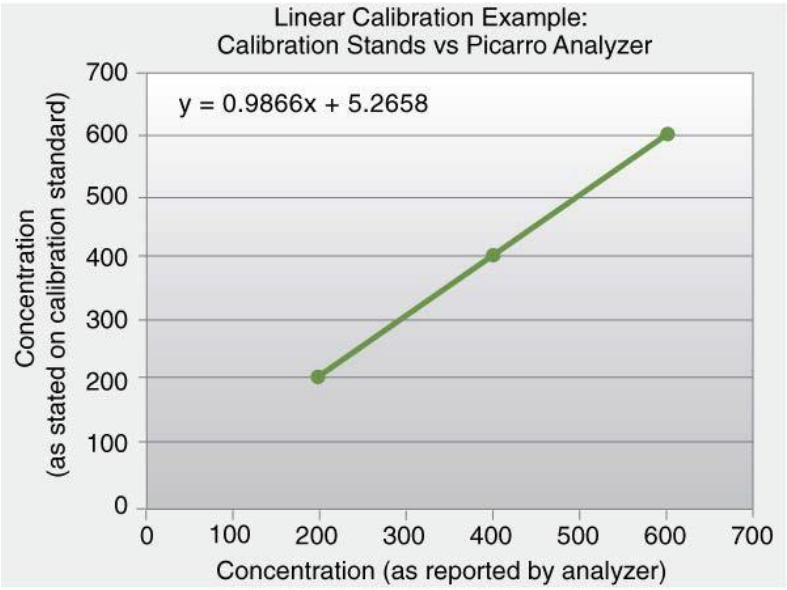
The slope and intercept of the best-fit line through these points are the two values that are used to calibrate the analyzer. By determining the linear relationship between the known calibration values and the analyzer's reported concentration values in this way, a calibration offset (slope and intercept)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

Entering the Calibration Setting

Changing the analyzer's calibration is intended to be done infrequently. Instead of recalibrating frequently to increase the accuracy of the data, users often just verify the calibration by measuring three or more gas standards and use the same regression procedure described here to calculate an offset by which to correct their data offline. Using the following equation in the graph below, this calculation would be accomplished point-by-point by calculating the corrected data "y" using the analyzer's data "x" so that:

Data corrected = 0.9866•Dataraw+5.268

Figure 51: Linear Calibration Example



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

NOTE

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

The calibration will take effect immediately after clicking **OK**. To return to the factory calibration, simply set the slope to 1 and the intercept to 0 for each species.

13.3 Calibration Software Utility tools

Data Recal

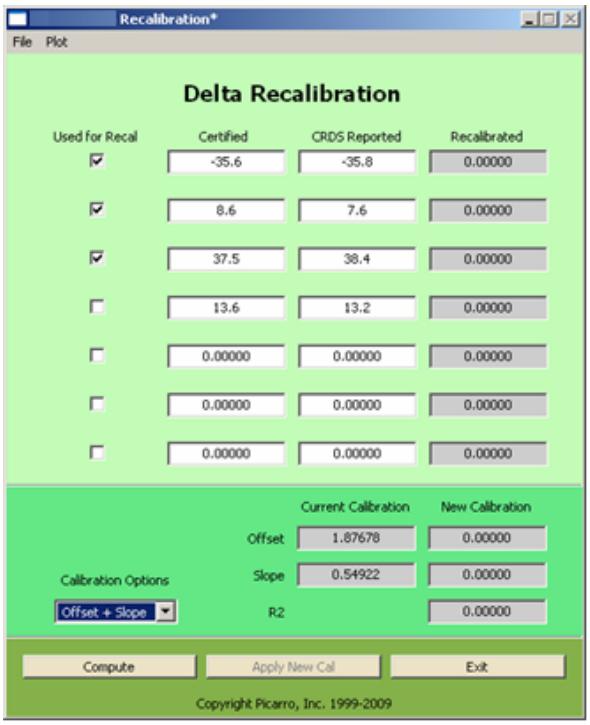
The Data Recal software utility is designed to enable users to perform a routine concentrate calibration or calibration verification of Picarro’s gas concentration Analyzer via a user-friendly interface.

Data Recal allows the input of ten calibration points. Some of these points can be used for recalibration, while the remaining points can be used as quality control calibrants. In an ideal situation, three concentration certified standards should be analyzed on the system to generate CRDS-reported values for concentration. The standards with isotopic values spanning and encompassing the intended sample analysis should then be used to build a standard calibration curve. Parameters of this curve will then be used to correct the instrument readings so that they match standard values. The other standards will be simultaneously used for quality control, to verify other recalibrated delta values against their certified delta values.

Graphical User Interface (GUI)

The Picarro Data Recalibration (“Data Recal”) software can be found in the “Picarro Utilities” folder on the desktop. The Data Recal software utility can be launched by double-clicking on the Data Recal Icon in the folder. Shown below is a screenshot of the window that will open.

Figure 52: Data Recal Software Utility GUI

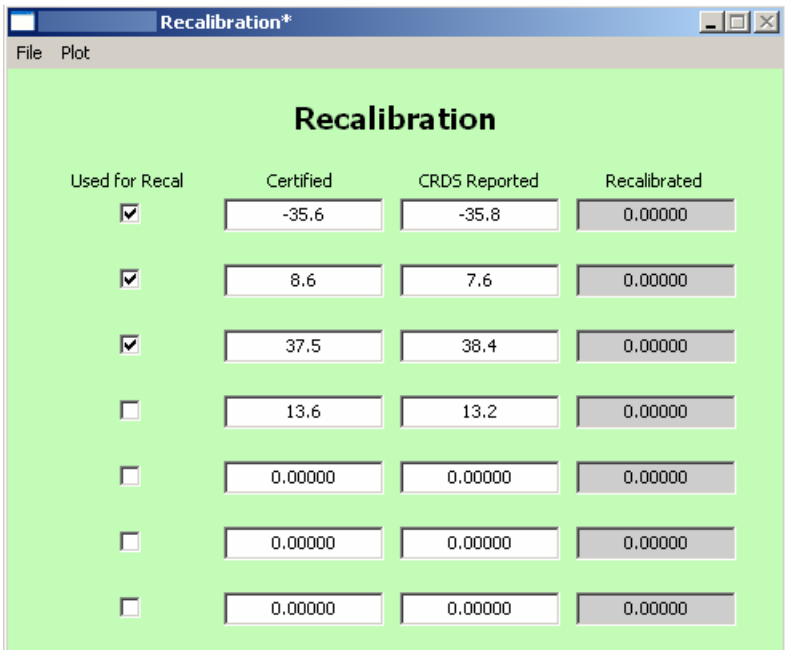


The Delta Recal Software Utility comprises three sections:

1. A numerical input and selection section (shown below):

   Certified and **CRDS reported** values are entered in the white boxes. Standards that will be used for instrument recalibration are then selected by checking the corresponding box in the first column, labeled “Used for Recal.”

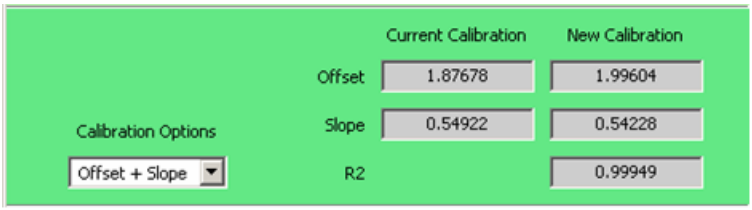
Figure 53: Recalibration section of Data Recal Software Utility GUI



2. Calibration output section (shown below):

In the "Calibration Options" drop-down menu, you can select either an "offset" or an "offset + slope." Once the new calibration parameters are calculated, the Data GUI will display the new values under the "New Calibration" column. The parameters that appear here will depend on your initial selection. When the Offset + Slope option is selected, the program also calculates a goodness-of-fit correlation coefficient (R^2).

Figure 54: Calibration output section of Data Recal Software Utility GUI

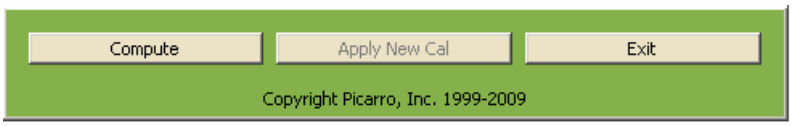


3. Action selection section (shown below):

In this section, the user can click on the compute button to calculate the new calibration parameter(s). The compute button will be grayed out until values have been entered in the **Certified** and **CRDS reported** columns, and at least one pair of **Certified** and **CRDS reported** values selected for the calibration. Once these values are entered or selected, the "Compute" button will be active. Click "Compute" to calculate the new calibration parameters. These parameters will appear in the Calibration output section of the GUI,

and an asterisk "*" will be displayed at the end of the window title line, indicating the new change.

Figure 55: Action selection section of the Data Recal Software Utility GUI

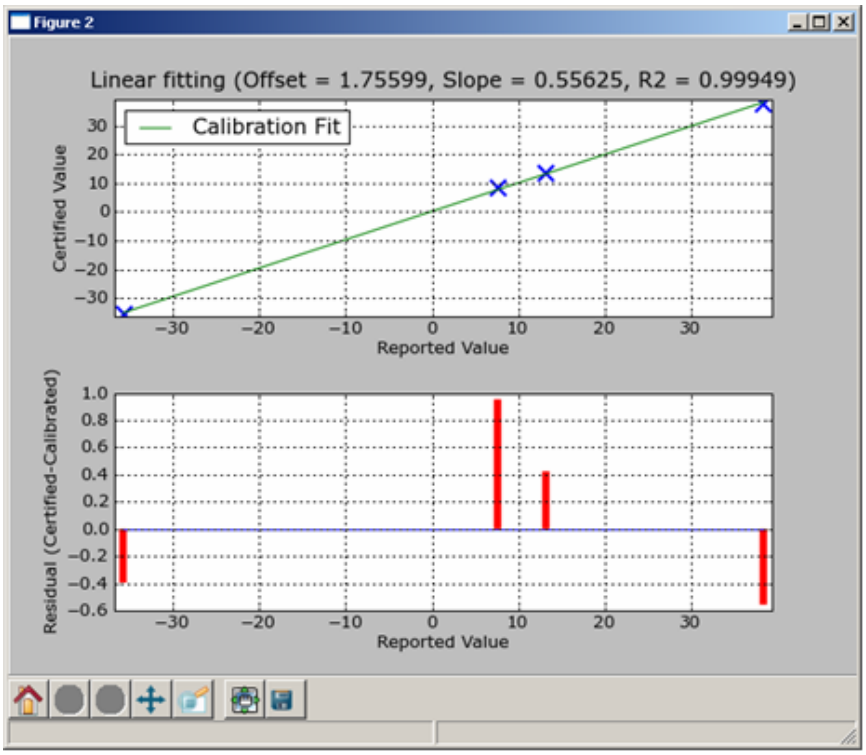


Once the calibration parameters are calculated, you can elect to graphically display the calibration and quality control (QC) standards in a graph. To do this, click "Plot" in the upper left corner of the window, and select "Plot Linear Fitting" from the drop-down menu, as shown below.

Figure 56: Delta Recalibration

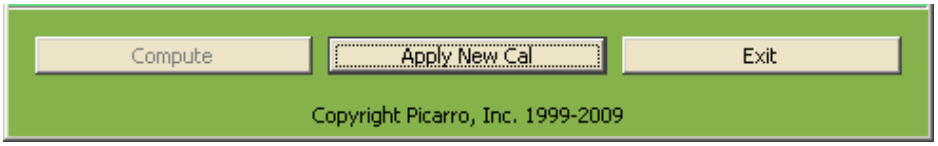
The plot that the utility will generate is shown below; this plot will display two graphs. The top graph presents measurements for the recalibrated standards (calibration and QC), as well as a line fit through those points. The bottom graph shows the residuals, which shows how far each measurement is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

Figure 57: Slope of Delta Recalibration



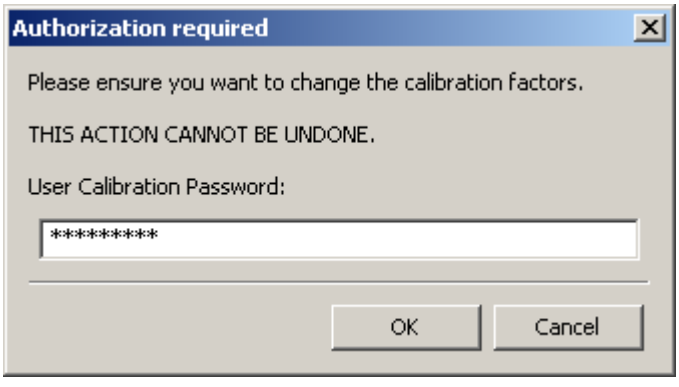
If you decide to accept the new calibration values based on this plot, click on the “Apply New Cal” button.

Figure 58: Apply new calibration slope and intercept



Then you will be prompted to enter a Calibration Password. **The default Calibration Password is PICARRO.**

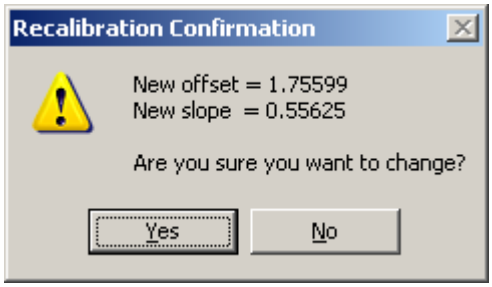
Figure 59: User Authorization Dialog box



Next, a “Recalibration Confirmation” pop-up window will appear, displaying the new offset and slope (when applicable) values. This window will prompt

you to confirm your choice to apply these values, to avoid any inadvertent mistakes.

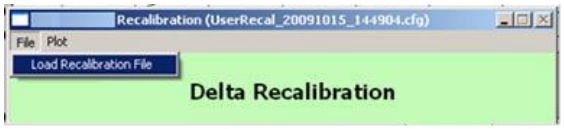
Figure 60: Calibration Confirmation Dialog box



Please note that when you press the “Yes” button, the newly accepted calibration parameters will take effect immediately, without the need for the instrument main GUI to be restarted.

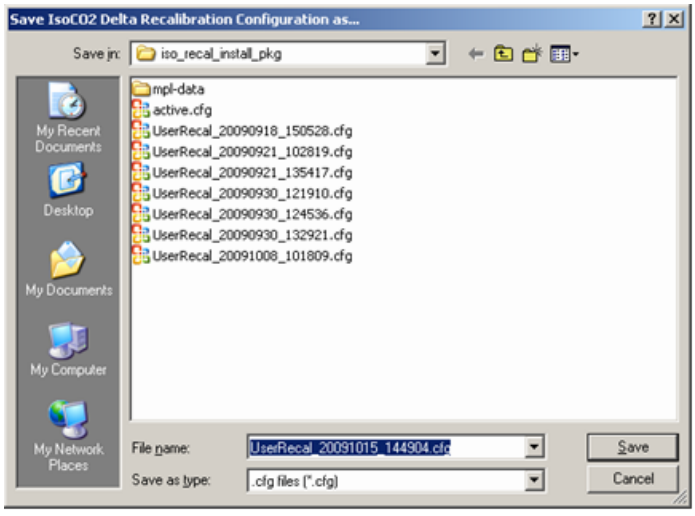
Once you accept the new calibration parameters, the Data Recal Software Utility automatically gives you the option to save the new recalibration file. Saving these files enables you to track the instrument recalibration history. Saved files can be reloaded by clicking “File” in the upper left corner of the window and selecting “Load Recalibration File.”

Figure 61: Delta Recalibration Load File



Next, select the file that you want to load.

Figure 62: File Browser Delta Recal File Option



The recalibration file for this example will contain the following information:

Figure 63: Delta Recal Log File

Row Number	Certified Values	Measured Values	Recalibrated Values
1	-35.6	-35.8	-35.20437
2	8.6	7.6	7.64690
3	37.5	38.4	38.05748
4	cc	1.75599	0.55625
5	nc	1.87678	0.54922 0.99949
6	Option	Offset + Slope	

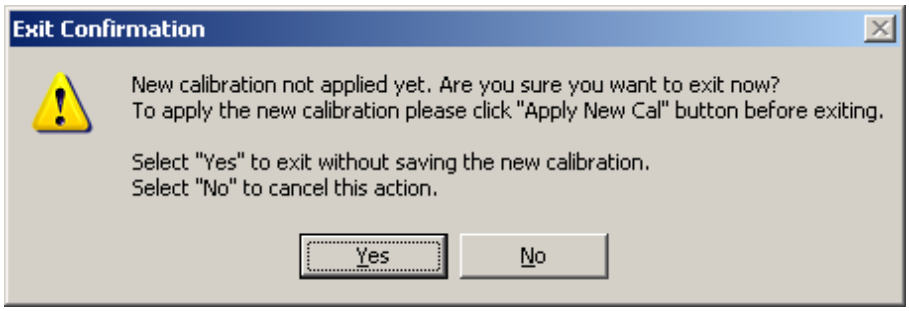
Rows 1 – 3: values from each standard selected for recalibration. The first column in these rows lists the certified values, the second column lists the measured values, and the third column lists the recalibrated values. The number of rows will depend on the number of standards selected to be used for recalibration.

Row 4: Current Calibration (cc) Row: read from left to right, list the current offset and current slope value.

Row 5: New Calibration (nc) Row: read from left to right, lists the new offset and new slope values. The third value in this row is the R^2 value, which is only displayed if the calibration option is “offset + slope.”

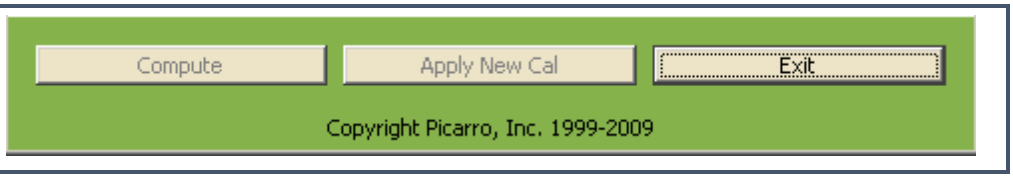
Row 6: Options Row: The last row displays the calibration option selected. If you choose to exit the Recal GUI before accepting the new recalibration values, you will be prompted to confirm your choice through a pop-up window. This window contains a warning that continuing to exit will cause the new calibration data to be lost.

Figure 64: Recalibration Exit Confirmation



When you are finished with the calibration, you can exit the Delta Recal software utility by clicking on the “Exit” button at the bottom part of the Recal GUI.

Figure 65: Calibration Exit Button



NOTE

The Recal GUI displays an error saying the new slope value is not acceptable when (1) at least two entries in the Certified or CRDS reported columns contain zero-value numbers, or (2) these entries are selected to be used for recalibration, or (3) the "offset + slope" calibration option is selected. This error occurs because the entered values will lead to an erroneous zero-slope value.

Figure 66: Invalid New Slope Entry

14. STATUS LOG MESSAGES

14.1 Normal Startup Messages

Temperature Locked: WB

The system waits for the warm box (WB – the temperature-controlled electronics and wavelength monitor chamber) to reach operating temperature.

Temperature Locked: HB

The system waits for the hot box (HB – the temperature-controlled chamber containing the analyzer's optical cavity and gas handling system) is stabilized.

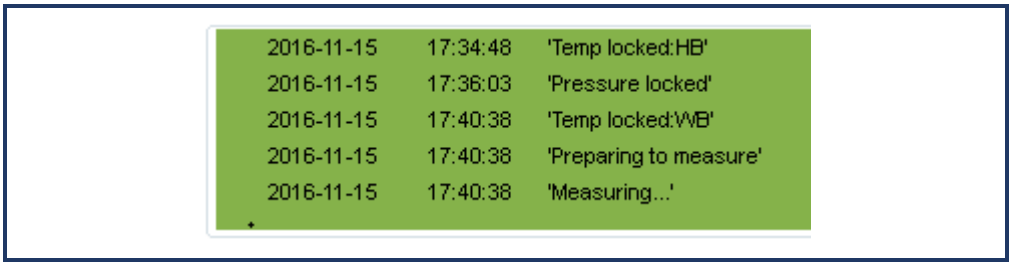
This is typically the longest step in the startup sequence. The duration of this step can range from 5 to 60 minutes, depending on the ambient temperature and how much time has elapsed since the last startup.

Preparing to Measure

Spectral scanning has started. Concentration measurements will be available in approximately 30 seconds. The analyzer continues to scan and report concentration measurements until the analyzer is shutdown using the procedure below.

Figure 67 shows an example of the status log messages for startup.

Figure 67: Sample Status Log Messages for Startup



Pressure Stabilizing/Locked

The valve control system begins to allow flow through the analyzer and stabilizes the pressure inside the cavity.

Measuring

This is the normal mode of operation after startup has completed.

15. CONTROLLING EXTERNAL VALVES

This section explains how to control external valves using the built-in External Valve Sequencer GUI.

If you are using the optional Picarro 16 Port Distribution Manifold with the analyzer, see the *16 Port Distribution Manual User Guide* for instructions on using the External Valve Sequencer GUI.

15.1 Display the Show/Hide Valve Sequencer GUI

1. Start the analyzer by double-clicking the **Start Analyzer** shortcut on the desktop.
2. Wait for the analyzer to begin measuring.
3. On the status bar menu of the analyzer *Data Viewer* screen, select **Show/Hide Valve Sequencer GUI** dropdown (Figure 68).

   The External Valve Sequencer GUI displays (Figure 69).

Figure 68: Show/Hide Valve Sequencer GUI

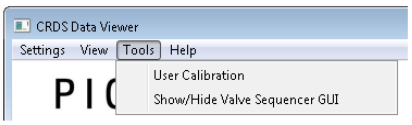
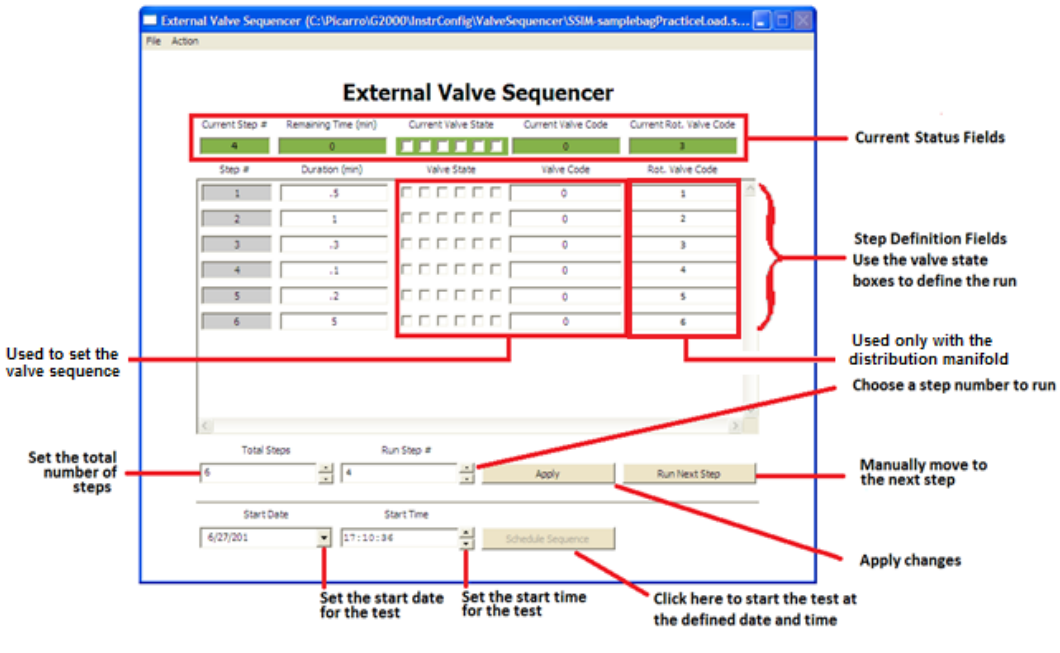


Figure 69: External Valve Sequencer GUI



15.2 The External Valve Sequencer Window

This section describes the External Valve Sequencer window.

15.3 File Menu

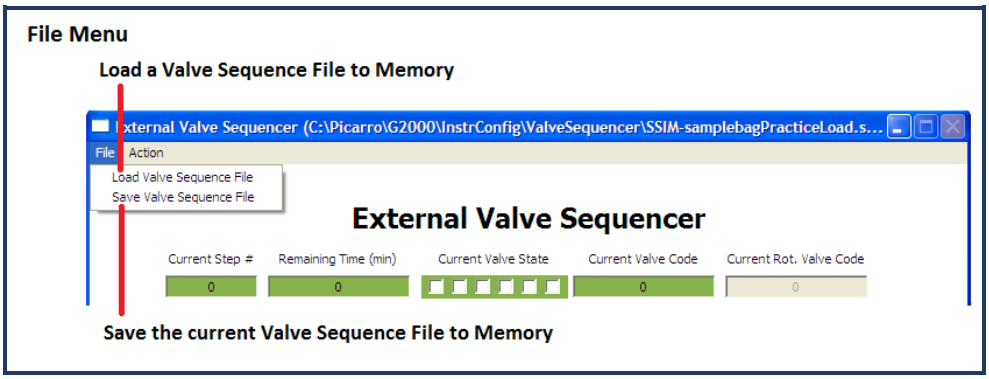
Load a Valve Sequence File

Click here to load saved files. Sequence Files are in: C:\Picarro\G2000\InstrConfig\ValveSequencer\Name of the Sequence File

Save a Valve Sequence File

Click **Action/Save Valve Sequence File** to save a valve sequence file.

Figure 70: Valve Sequencer File Menu



15.4 Action Menu

See Figure 71 below.

Start Sequencer

Click here to start a sequence.

Go to First Step

Click here to run step one (automatically resets to 1 from whatever step is currently being sampled).

Reset All Valves

Click here to change current valve states to *All off*.

Hide Sequencer Interface

This toggle shows or hides the *Sequencer Interface* window. To reveal the window click on the **Show Sequencer Interface**.

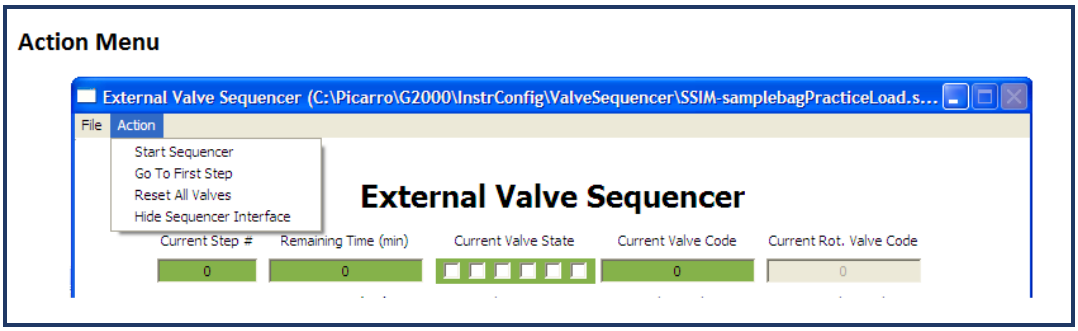


Figure 71: Valve Sequencer Action Menu

15.5 Current Status Fields

The top row on the menu (Figure 69) gives the current status of the current step.

Current Step

Gives the number of the current step as defined by the setup

Remaining Time (min)

Time remaining on the current step

Current Valve State

Check boxes indicate which valves are energized

Current Valve Code

Binary code representing which valves are energized

Current Rot. Valve Code

Used only with gas distribution manifold

15.6 Step Definition Fields

Use the step definition fields to define the test sequence.

Step

Enter the step number.

Duration (min)

Enter how long you want the step to last.

Rot. Valve Code

Used only with the gas distribution manifold

15.7 Bottom Panel

Use the bottom section of the window (Figure 69) to configure the sample.

Total Steps

Use this field to enter the total number of steps in the test. When the last step is finished, the sequencer loops back to the first step.

Run Step

Shows the number of step currently running. If a different step is desired, enter that step number and click on Apply (Figure 43).

Apply

Click here to apply changes made using the *External Valve Sequencer* window.

Run Next Step

Forces the next step in the sequence.

Start Date

Use this field to enter the date to start the test.

Start Time

Use this field to enter the time to start the test.

Schedule Sequence

Click this button to have the sequence start automatically at the date and time specified in the *Start Date* and *Start Time* fields.

15.8 Set Up a Test Sequence Using the Valve Sequencer Window

A variety of sequences can be created and saved *External Valve Sequencer* window. This section explains how to set up a test sequence using the *External Valve Sequencer* window.

To set up a sampling sequence:

1. On the Picarro analyzer GUI, go to:
    a. Tools
    b. Show/hide valve sequencer
    c. The External Valve Sequencer window displays. See Figure 69.
2. Use the *Rot. Valve Code* column to set the rotary selector valve position.
3. Enter the number (1-16) that corresponds to the desired valve position.

    A value of 1 in the *Rot Valve* Code field corresponds to position 2 on the valve. Only one rotary position can be selected per step.
4. Enter the Step duration in the *Duration (min)* field, where the duration of the step is in minutes. If duration values are set to less than 0.1 minutes they may not be carried out correctly.
5. Save the valve sequence as:

    C:\Picarro\G2000\InstrConfig\ValveSequencer\Name of the Sequence File.

15.9 Load and Run a Saved Sequence

Load saved sequence files by clicking File/Load Valve Sequence. All the Sequence Files are in *C:\Picarro\G2000\InstrConfig\ValveSequencer\Name of the Sequence File.*

1. Click **Apply** to run the sequence.
2. To skip the next step click **Run Next Step** (even while in middle of running a step):
3. Click on the *Action* scroll-down menu.
4. Reset all Valves by changing all the *Rot. Valve Code* fields to Zero.
5. Click on **Go to the First Step** (Whatever the step the user is at, step 1 will be played).

6. Click on **Start/Stop Sequencer** (while the sequence is running, it will read *Stop Sequencer*).
7. Click on **Hide Sequencer Interface** (which will hide the *External Valve Sequencer* window).

16. 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 – REMOTE DATA ACCESS

A.1 Picarro Serial Communication

The analyzer supports an RS-232 physical command interface, which can be used to control the instrument and to retrieve concentration data. Not all features of the instrument are available on the serial interface. For details on how to use the serial command interface, please see the Programming Guide (included in pdf format on the installation CD). This command set may also be used across a TCP/IP interface through an Ethernet connection. Please contact Picarro for further details.

A.2 Remote Data Access

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

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

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

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

The initialization file is:

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

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

NTP

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

Email

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

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

Dial-up

The DIALUP section is used if a dial-up connection to the Internet needs to be established when the program runs. If the section does not exist, a permanent connection is assumed to be available for carrying out the other tasks specified in the initialization file. The connection name key specifies the name of the dial-up connection to use, as listed under Network Connections in the Control Panel. The values of the keys Username, Password and Number are used to make the connection.

Examples of "RemoteAccess.ini" File

[LOGGING]	Logfile=c:/temp/RemoteAccessLog
[NTP]	Server1=time-a.nist.gov Server2=time-b.nist.gov Server3=time-a.timefreq.bldrdoc.gov Server4=time-b.timefreq.bldrdoc.gov Server5=time-c.timefreq.bldrdoc.gov Server6=time.nist.gov Server7=time-nw.nist.gov UpdateClock=1
[DIALUP]	ConnectionName=Picarro Dialup Access Username=user Password=password Number=14085551212
[EMAIL]	Server=smtp.servername.org Directory=c:/picarro/mailbox From=instrument@picarro.com To1=recipient1@site1.com To2=recipient2@site2.com Subject=CRDS data from Silverstone instrument UseAuthentication=0

APPENDIX B – THE DATA FILE VIEWER

B.1 Introduction

The Picarro Data File Viewer software is located in the Picarro Utilities folder on the desktop. The software allows the user to graph and to conduct statistical analysis of the raw data. Additional functions include Allan Variance plot and quadratic or polynomial fittings.

The Picarro Data File Viewer includes two main menus: **File** and **New.**

Figure 72: File Menu

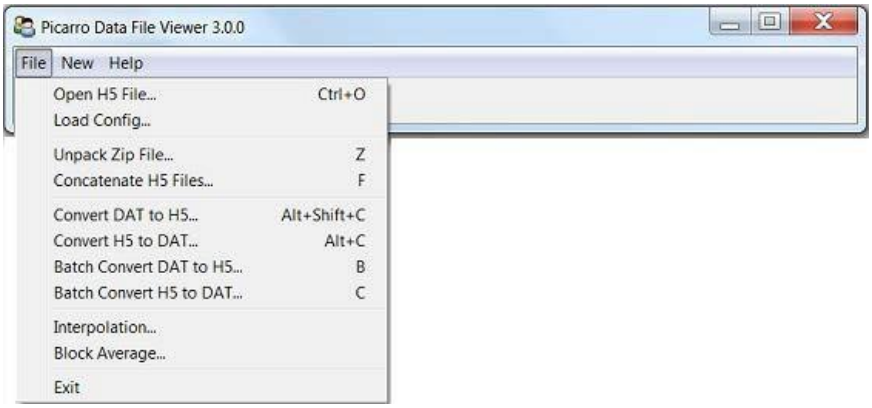
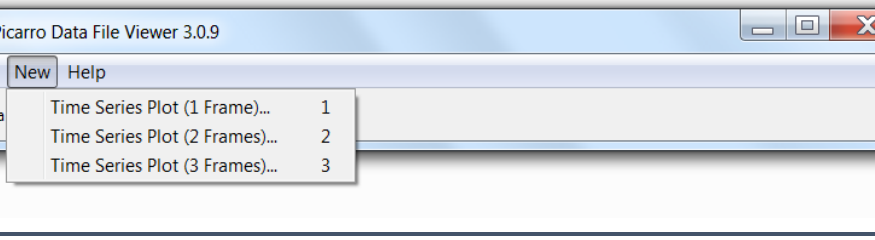


Figure 73: New Menu



B.2 The File Menu

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

Open H5

File > Open H5 opens a Picarro data file (HDF5 format) for data analysis and visualization. After opening the data file, you can create a new time series plot. Refer to *New Time Series Plot* for more information.

Load Config

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

Unpack Zip File

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

Concatenate H5 Files

Use **File > Concatenate H5 files** to concatenate multiple files and zip archives of H5 files into a single H5 file. Navigate to the desired folder or use the **Define date range** button to specify a date range of files to concatenate. (See next section.)

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

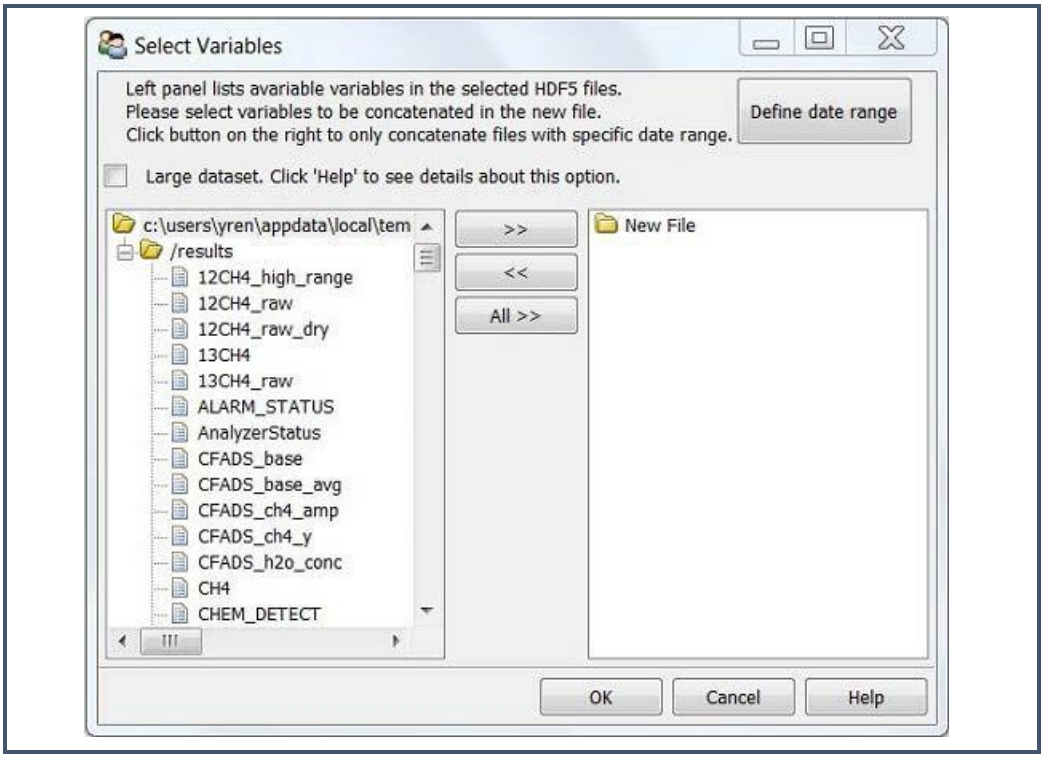


Figure 74: Select Variables Form

Define Date Range

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

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

Select File > Concatenate H5 files, then click Define date range to specify the desired date range.

Figure 75: Defining Date Range

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

Picarro software saves data in a directory tree that is named by the creation year, month, and day. (See example directory tree in the following image.) Select this option if the target folder has this file structure. This way, Data File Viewer will only search folders within the desired date range, which can substantially reduce processing time.

Figure 76: File Structure of Data File Viewer

NOTE

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

CAUTION

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

NOTE

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

Convert DAT to H5

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

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

Convert H5 to DAT

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

NOTE

Data File Viewer does not concatenate data files exactly within the defined time range. This is because the time extracted from file name is different from the data acquisition time. To not miss data points, Data File Viewer expands the specified time, column name "fineLaser-Current_1_controlOn" will be replaced with "fineLaserCurr_1_ctrlOn".

Interpolation

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

Block Average

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

NOTE

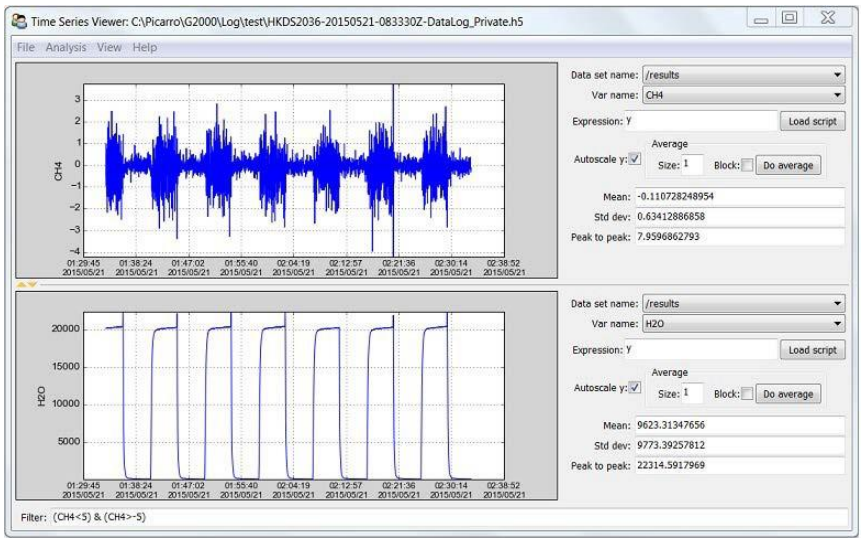
The specified block size must be greater than the average data interval.

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

B.3 New – Time Series Plot

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

Figure 77: Time Series Viewer

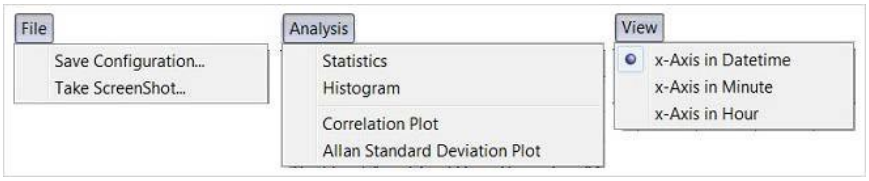


The next section describes the options available on the Time Series Viewer menu bar. Refer to *Time Series Viewer Canvas* on page 96 for information the Time Series Viewer UI features and options.

B.4 Time Series Viewer Menus

The Time Series Viewer form includes the following menus:

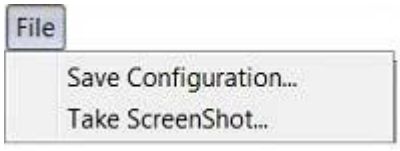
Figure 78: Time Series Viewer Menus



Time Series Viewer File Menu

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

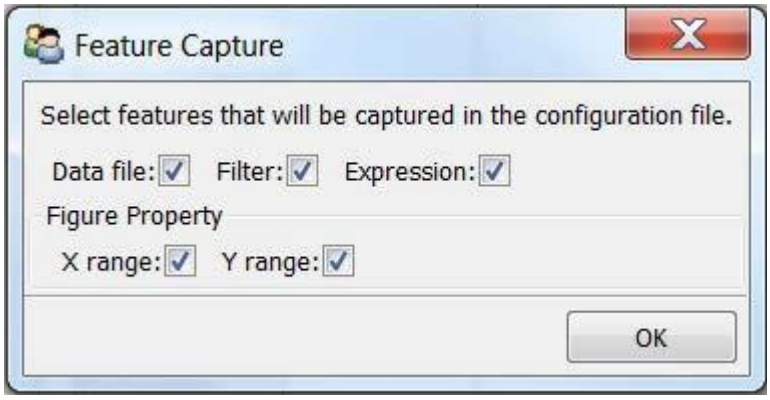
Figure 79: Time Series Viewer – File Menu



Save Configuration

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

Figure 80: Time Series Viewer – Feature Capture



CAUTION

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

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

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

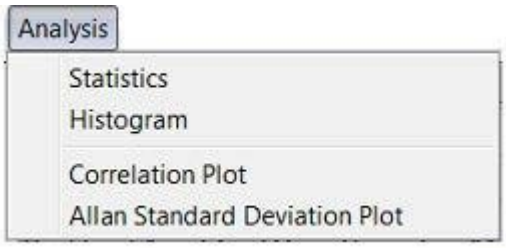
Take ScreenShot

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

Time Series Viewer Analysis Menu

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

Figure 81: Time Series Viewer – Analysis Menu



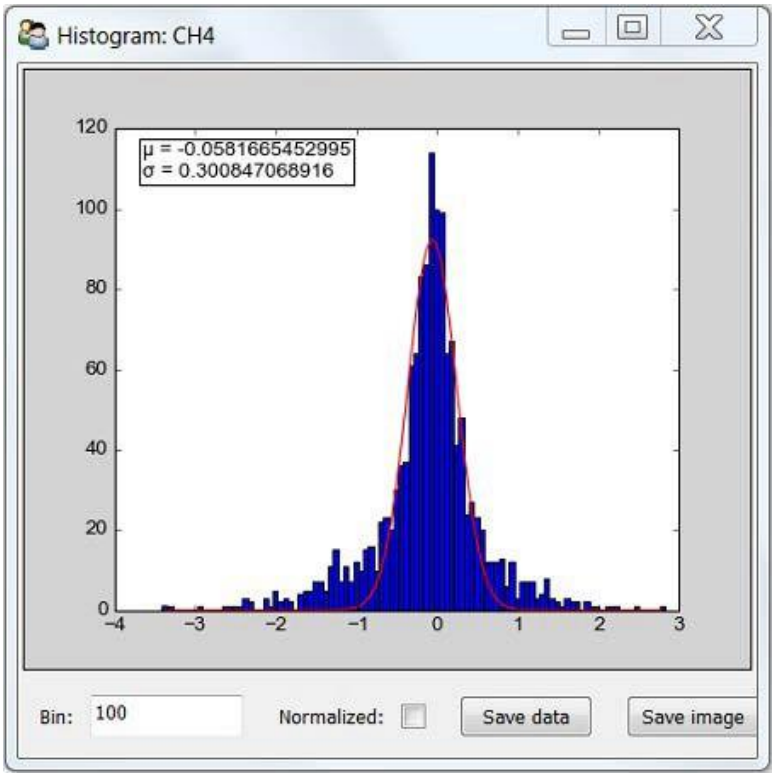
Statistics

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

Histogram

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

Figure 82: Histogram Window



- **Red Line**: A Gaussian function fitted to the histogram. Fitting results of μ and σ are shown in the top-left corner of the plot.
- **Bin**: Specifies the number of intervals that the range of values is divided into.

- **Normalized**: When selected, the sum of the histograms is normalized to 1.
- **Save data**: Saves histogram data to a CSV file.
- **Save image**: Saves the histogram image as a JPEG/PNG/PDF file.

Correlation Plot

Use Analysis > Correlation Plot to plot Y-axis data in one frame versus that in the other. This can be used when two or more frames exist in the current Time Series Plot window. See Correlation/XY Plot on Page 98 for details.

Allan Standard Deviation Plot

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

Time Series Viewer View Menu

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

Figure 83: Time Series Viewer – View Menu

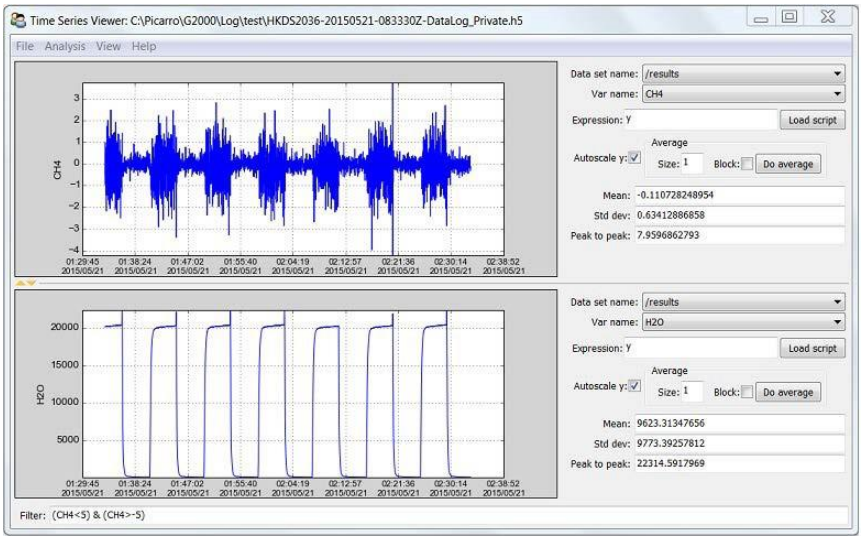
NOTE

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

The Time Series Viewer Canvas

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

Figure 84: Time Series Viewer Canvas



Mouse Options and Graph Transform

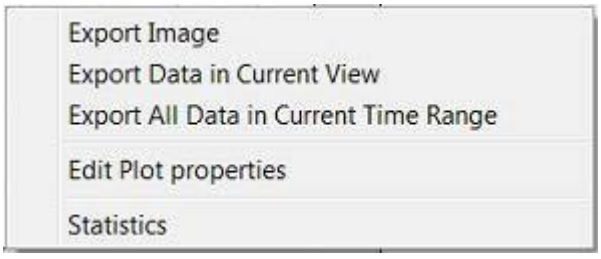
The following mouse actions can be used in the canvas graphs:

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

Right-click Menu

Right-clicking on the canvas provides opens a pop-up menu.

Figure 85: Canvas Right-click Menu



Export Image: Exports the current plot as a jpeg, png, or pdf file.

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

Export All Data in Current Time Range: Exports all variable columns of the selected dataset in the current time range to an HDF5 file. Refer to *Concatenate H5 Files* on page 88 for more information.

Edit Plot properties: Opens the Image Editor form, where the following options can be specified:

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

Figure 86: Image Editor Form

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

Dataset Name and Var Name

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

Use the **Dataset name** drop down to select the dataset that will be used for this time series graph. Use the **Var name** drop down to select the column in the dataset to use in the graph.

Autoscale Y

When the Autoscale Y option is selected, the Time Series Viewer will autoscale on the Y-axis to make sure that all data within the range of the X-axis is displayed.

Average

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

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

REMINDER

Averaging is performed after the Filter and Expression are performed.

Mean, Std Dev, and Peak to Peak

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

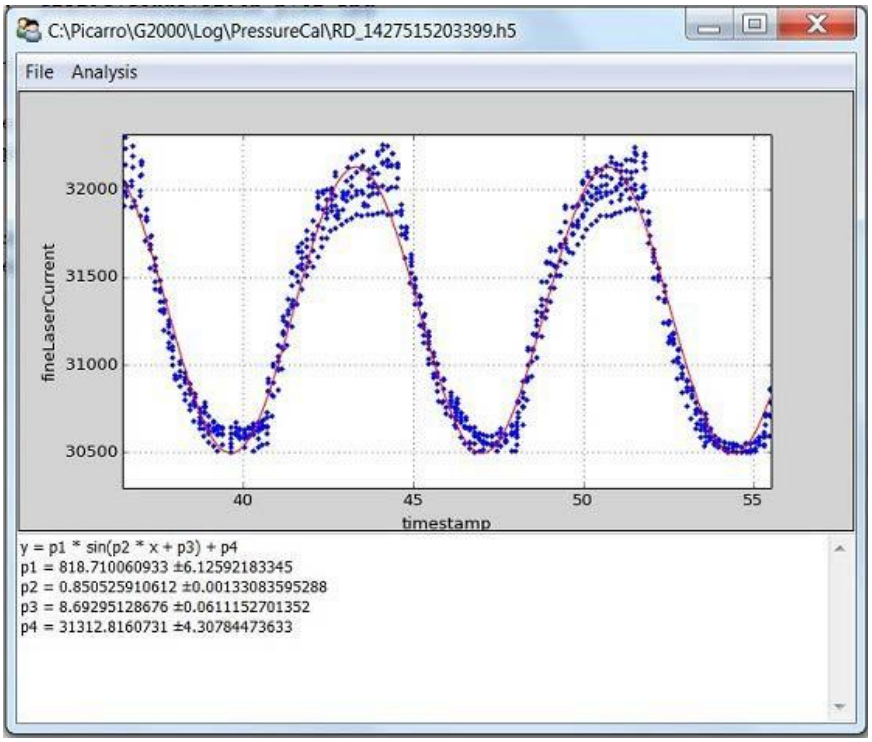
Correlation/XY Plot

The Correlation/XY Plot window includes two menu items: **File** and **Analysis**. For details about the File menu, see *Save Configuration* on page 93.

REMINDER

The canvas in this plot is interactive. For details about the plot canvas, see *The Time Series Viewer Canvas* on Page 96.

Figure 87: Correlation/XY Plot

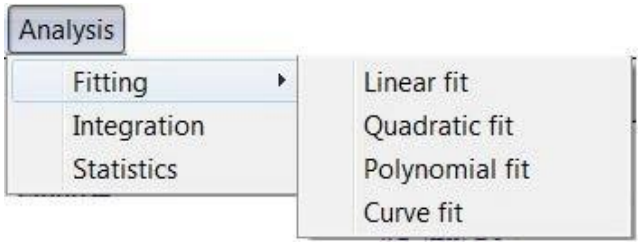


Analysis Menu

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

- **Fitting** allows you to specify one of four fitting methods to include in the Correlation/XY plot:
  - **i. Linear fit:** Specifies to fit to linear function $y = c_1x + c_0$
  - **ii. Quadratic fit:** Specifies to fit to quadratic function $y = c_2x^2 + c_1x + c_0$
  - **iii. Polynomial fit:** Specifies to fit polynomial function of degree n: $y = \Sigma c_n x^n$
  - **iv. Curve fit:** Specifies to use non-linear least squares to fit an arbitrary function to data.

Figure 88: Analysis Menu



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

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

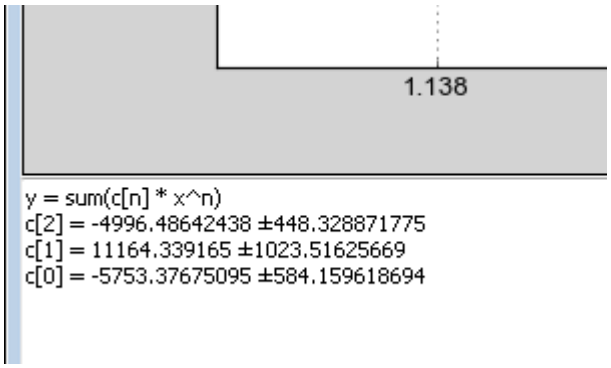


Figure 89: Results of Quadratic Fitting

APPENDIX C – LIST OF PARAMETERS

These parameters can be toggled on the GUI. See the section Setup Tool for how to access this stored information.

Be aware that the parameters are alphabetized by parameters starting with capital letters first before parameters starting with lowercase letters.

List of Parameters	Unit	Explanation
CavityPressure	Torr	Reading of cavity pressure. Operating pressure is 75 Torr
CavityTemp	Celsius	Average temperature reading of 4 thermistors along the cavity. Operating cavity temperature is very close to 40 Celsius
ChillerTemp	Celsius	Temperature reading of liquid in the chiller. The chiller is used to remove heat from laser and keep laser baseplate temperature constant
CoolBoxAuxTec	digiU	Digital reading of auxiliary CoolBox TEC current. Above 32000 means that TEC is heating; below 32000 means that TEC is cooling
CoolBoxHeatsink1Temp	Celsius	Temperature reading of the other TEC used to keep CoolBox temperature constant. Operating temperature is about 42 Celsius
CoolBoxHeatsink2Temp	Celcius	Temperature reading of the other TEC used to keep CoolBox temperature constant. Operating temperature is about 42 Celsius
CoolBoxPriTec	Celsius	Digital reading of CoolBox TEC current. Above 32000 means that TEC is heating; below 32000 means that TEC is cooling
CoolBoxTec	Celsius	Digital reading of CoolBox TEC current. Above 32000 means that TEC is heating; below 32000 means that TEC is cooling
DasTemp	Celsius	Temperature reading of Logic board. Usually close 7^{o}C above ambient
Etalon1	AU	Mean digital readout of Etalon1 transmission over scan
Etalon2	AU	Mean digital readout of Etalon2 transmission over scan
EtalonTemp	Celsius	Temperature of Etalon in the Wavelength monitor
FRAC_DAYS_SINCE_JAN1	Days	Time since January 1, 1970
FRAC_HRS_SINCE_JAN1	Hours	Time since January 1, 1970
HotBoxHeater	AU	Digital reading of heater current. The heater is underneath the CoolBox. It is used to heat the CoolBox. For this unit, the heater is not used

List of Parameters	Unit	Explanation
INST_STATUS	Bit	Bit mask for instrument Status, nominally 163
InletValve	AU	Digital reading of Inlet Valve Voltage. Default setting is 50000
JULIAN_DAYS	Days	Days since January 1, 1970
Laser1Current	Celsius	Average laser current setpoint for entire scan
Laser1Tec	AU	Average laser current for entire scan
Laser1Temp	Celsius	Average temperature reading for laser for entire scan
LaserBaseplateTec	AU	Current setpoint for the TEC controlling the Laser Baseplate
LaserBaseplateTemp	Celsius	Temperature reading of Laser Baseplate. nominal baseplate temperature is set to 27 Celsius
MPVPosition	AU	Valve position for attached rotary valve
N2O	ppb	N2O concentration
N2O_100s	ppb	Running average of N2O concentration for previous 100 seconds
OutletValve	AU	Outet Valve voltage
P2Temp	Celsius	Temperature reading of one thermistor along the cavity. This thermistor is located close to front mirrors
P3Temp	Celsius	Temperature reading of second thermistor along the cavity. This thermistor is located close to Wavelength Monitor.
P4Temp	Celsius	Temperature reading of third thermistor along the cavity. This thermistor is located close to Ringdown Detector
P9Temp	Celsius	Temperature reading of fourth thermistor along the cavity. This thermistor is located close to rear mirror
Ratio1	AU	Average Ratio of Etalon 1 to Reference 1 over a scan
Ratio2	AU	Average Ratio of Etalon 2 to Reference 2 over a scan
RecalibrateFlag		Number of times PZT has jumped causing a shift in the offset of isotopic calibration. Recalibrate instrument after incremented. Analyzer always restarts with 0.

List of Parameters	Unit	Explanation
Reference1	AU	Optical signal of Reference 1 in the wavelength monitor
Reference2	AU	Optical signal of Reference 2 in the wavelength monitor
ValveMask	AU	Binary addition of current valve state
WlmTemp	Celsius	Controlled Temperature of Wavelength Monitor
adjust1	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 1 after each spectral scan
adjust2	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 2 after each spectral scan
base1a	ppb/cm	Baseline level for N2O peak fit for virtual laser 1
base1b	ppb/cm	Baseline level for N2O peak fit for virtual laser 2
co2_corr	ppm	CO2 concentration after corrections
co2_raw	ppm	Raw CO2 concentration from spline fit
d15N	permil	Isotopic ratio/Delta for N isotopes of N2O
d15Nalpha	permil	Isotopic ratio/Delta for alpha isotope of N2O
d15Nalpha_100s	permil	Running average of Delta for N2O alpha isotope of last 100 seconds
d15Nbeta	permil	Isotopic ratio/Delta for beta isotope of N2O
d15Nbeta_100s	permil	Running average of Delta for N2O beta isotope of last 100 seconds
d18O	permil	Isotopic ratio/Delta for 18O isotope of N2O
d18O_100s	permil	Running average of Delta for N2O 18O isotope of last 100 seconds
dm_latency	seconds	Datamanager processing duration
fitBackground	AU	Digital background of ringdown signal
fit_time	Seconds	Duration of time to fit data

List of Parameters	Unit	Explanation
fsr_base1	ppb/cm	Baseline loss level for $^{14}N2O$ final peak fit
fsr_base4	ppb/cm	Baseline loss level for alpha isotopomer
fsr_base5	ppb/cm	Baseline loss level for beta isotopomer
fsr_base6	ppb/cm	Baseline loss level for O18 isotopologue
fsr_peak1	ppb/cm	Peak loss for $^{14}N2O$ absorption feature
fsr_peak1_spec	ppb/cm	Corrected peak loss for $^{14}N2O$
fsr_peak4	ppb/cm	Raw peak corresponding to Alpha isotope of N2O
fsr_peak4_spec	ppb/cm	Peak corresponding to Alpha isotope of N2O with corrections
fsr_peak5	ppb/cm	Raw peak corresponding to Beta isotope of N2O
fsr_peak5_spec	ppb/cm	Peak corresponding to Beta isotope of N2O with corrections
fsr_peak6	ppb/cm	Raw peak corresponding to oxygen isotope of N2O
fsr_peak6_spec	ppb/cm	Peak corresponding to oxygen isotope of N2O with corrections
fsr_residuals1	ppb/cm	RMS loss residual of N2O fit
fsr_residualsN	ppb/cm	RMS loss residual of virtual laser 1 scan
fsr_residualsO	ppb/cm	RMS loss residual of virtual laser 2 scan
fsr_shiftN	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 1 after each spectral scan
fsr_shiftO	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 2 after each spectral scan
fsr_str1	ppb	Fitted strength of $^{14}N2O$ absorption feature
fsr_str4	ppb	Fitted strength of alpha $^{15}N2O$ absorption feature
fsr_str5	ppb	Fitted strength of alpha $^{15}N2O$ absorption feature

List of Parameters	Unit	Explanation
fsr_str6	ppb	Fitted strength of 18O isotopologue N2O absorption feature
fsr_y1	AU	Fitted width of ^{14}N2O absorption feature
interval	seconds	time period of each measurement
max_fitter_latency	seconds	Fitter processing duration
n2o_conc_raw	ppb	Raw N2O concentration
ngroups1	AU	Number of ringdown clusters in virtual laser 1 scan
ngroups2	AU	Number of ringdown clusters in virtual laser 2 scan
numpoints	number	Number of total RingDowns per spectral scan
peak1a	ppb/cm	Peak loss for ^{14}N2O absorption feature
peak1b	ppb/cm	Peak loss for ^{14}N2O absorption feature
pzt1_adjust	AU	Amount PZT voltage is off in order to center peak
pzt1_delta	AU	Amount PZT voltage has changed from precious scan
pzt1_offset	AU	PZT voltage setpoint for virtual laser 1
pzt2_adjust	AU	Amount PZT voltage is off in order to center peak
pzt2_delta	AU	Amount PZT voltage has changed from precious scan
pzt2_offset	AU	PZT voltage setpoint for virtual laser 1
pzt_per_fsr	AU	Amount PZT must move to jump to next FSR point. The distance moved when Recalibrate flag is incremented
shift1	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 1 after each spectral scan
shift2	cm^{-1}	The amount of Wavelength Monitor (WLM) offset change for virtual laser 2 after each spectral scan

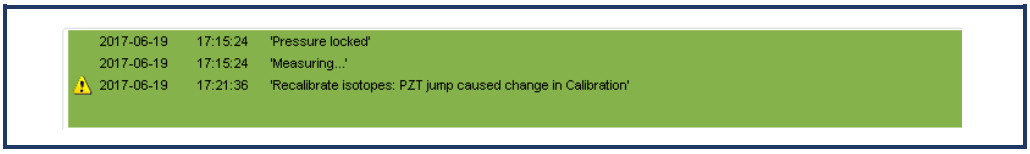
List of Parameters	Unit	Explanation
spect_duration	seconds	Time to collect spectral scan
spect_latency	seconds	Time to process spectrum
str1a	ppb	Fitted strength of $^{14}N2O$ absorption feature for virtual laser 1
str1b	ppb	Fitted strength of $^{14}N2O$ absorption feature for virtual laser 2
timestamp	Seconds	Time in seconds since 0
vy1a	AU	Fitted width of $^{14}N2O$ absorption feature for virtual laser 1
vy1b	AU	Fitted width of $^{14}N2O$ absorption feature for virtual laser 2
wlm1_offset	cm^{-1}	Current frequency offset of for virtual laser 1
wlm2_offset	cm^{-1}	Current frequency offset of for virtual laser 2

APPENDIX D – RECALIBRATION FLAG

The Recalibration Flag is data column in the Datalogs, as well as a warning message in the status log window of the GUI that informs the user that the calibration has changed due to a discontinuous jump in the way the instrument tunes. It was put in place along with a new method of tuning called Laser Current Tuning (LCT) that maintains the PZT at a constant position. Over time the PZT voltage changes slowly to maintain ringdowns at specific desired frequencies; however, if the voltage ever reaches an extremum (about 57000 or 12000), the PZT discontinuously jumps to its next resonance position which is exactly one half wavelength of light away. This jump in position can cause a change in the calibration offsets for isotopes by as much as 6‰. These events are expected to occur infrequently, once every 4-8 weeks. Because there are specific conditions in which this event occurs, the user can monitor the PZT voltage while in use to estimate the next occurrence. (i.e. “pzt1_offset” or “pzt2_offset” near 12000 or 57000).

The events associated with the jump in PZT voltages are tracked enumerated in a Recalibration_flag data column located in the user data file. A warning message on the instrument GUI is also displayed to alert the user what time this occurred. For diagnostic purposes this message is also logged in the Event Logs, which are found in the C:\Picarro\G2000]Log\Archive\EventLogs folder. A picture of the event message is shown below.

Figure 90: Event Log



When this happens to an analyzer, it is recommended that the isotope measurements be recalibrated before any more data is to be taken. If the analyzer is kept measuring after a calibration is done, the Recalibration_flag will be maintained at 1 until this event occurs again, in which it will be incremented to 2. Whenever the instrument is restarted this flag will be initialized to 0. This means that there is no memory of the last time this event occurred. It is solely the responsibility of the user to maintain proper calibration of the instrument for measurements, specifically when these events occur.

For more information, contact support@picarro.com

APPENDIX E – ANALOG SIGNAL OUTPUT

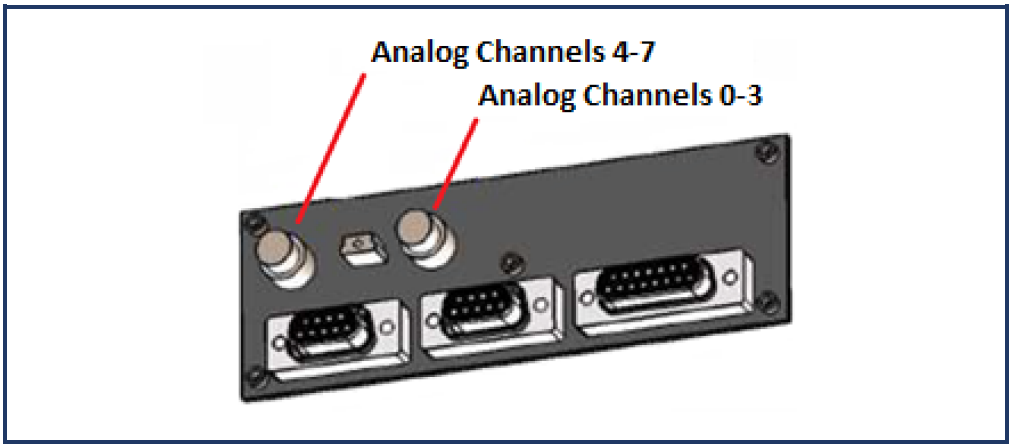
E.1 Overview

This section is provided if the G5131-*i* is configured with an optional Electrical Interface Card (EIC). It provides 4 analog signals for monitoring various measurement results and analyzer parameters.

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

Figure 90 shows the analog channel connectors on the back of the analyzer.

Figure 91: Analog Channel Connectors



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

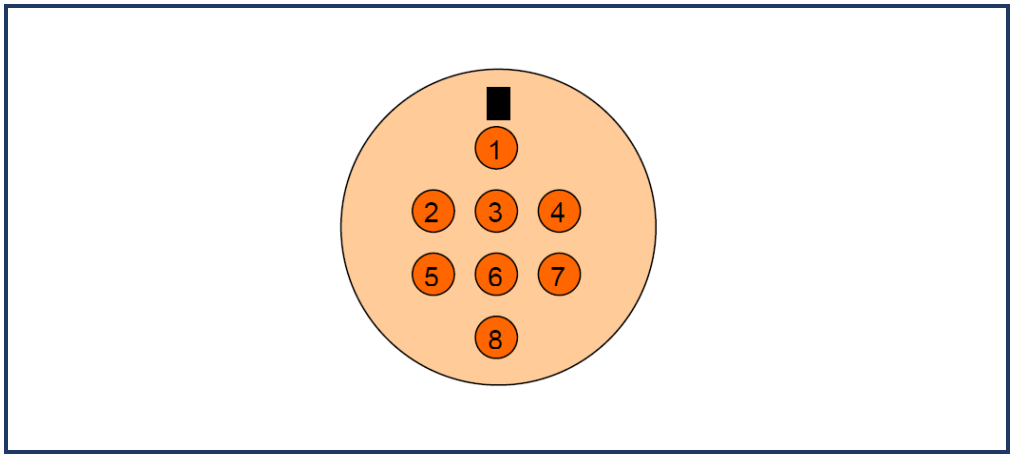
E.2 Analog Signal Pin Mapping

The table below lists the analog pinouts and Figure 91 shows the analog pinout map.

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

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

Figure 92: Analog Pin Map



E.3 Configuration

The default configuration is set at the factory and is listed in the table below. It can be modified by editing the electricalInterface.ini file located in the *C:\Picarro\G2000\AppConfig\ElectricalInterface* directory.

E.4 Analog Output Configuration

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

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

Analog Configuration Master Table				
Channel	Parameter	Output Scale (<1V indicates error)	Conversion All channels have a +1V offset (+1V=0)	Indicating Range 1V to 10V or 0 to 90 ppb
0		0-10V	10 ppb/V	0 to 90 ppb
1		0-10V	100 ppb/V	0 to 0.9 ppm
2		0-10V	2%/V	0 to 18%
3	DAS temp	0-10V	10º C/V	0 to 90 º C
4	None	NA	NA	NA
5	None	NA	NA	NA
6	None	NA	NA	NA
7	None	NA	NA	NA

APPENDIX F – PACKING AND SHIPPING

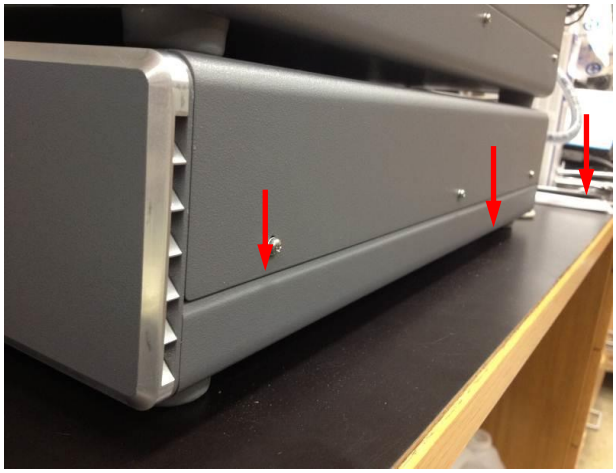
The following describes how to prepare the G5131-*i* for shipment. Shown here is a step by step procedure which, if followed correctly, will help ensure the safe delivery of the system. Please follow the instructions carefully.

1. Ensure the analyzer has been fully powered down following the previous instructions.
2. Disconnect all electronic cables and the vacuum line from the rear of the analyzer.

Figure 93: Disconnect

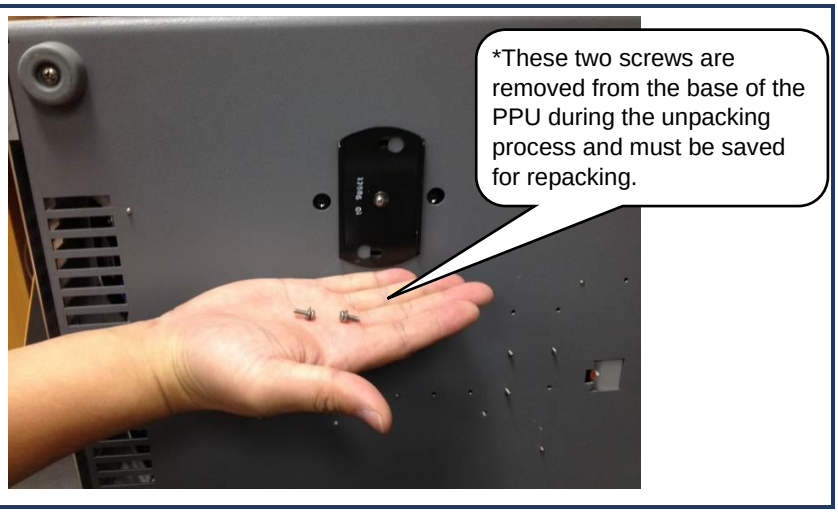
3. Place the two power lines, two electronic cables and one vacuum line into a plastic bag.
4. Remove the lid of the PPU by removing the six screws which are used to attach the lid of the PPU to the main PPU assembly. These screws are located on upper sides of the PPU. There are three screws on each side.

Figure 94: Remove Six Screws from Side Panel



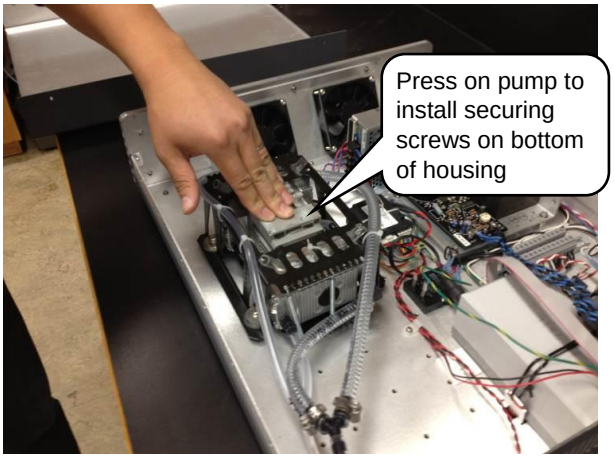
5. The next step is to secure the pump in the PPU for shipping by attaching the two screws* through the bottom of the PPU to the pump mounting bracket.

Figure 95: Secure Pump



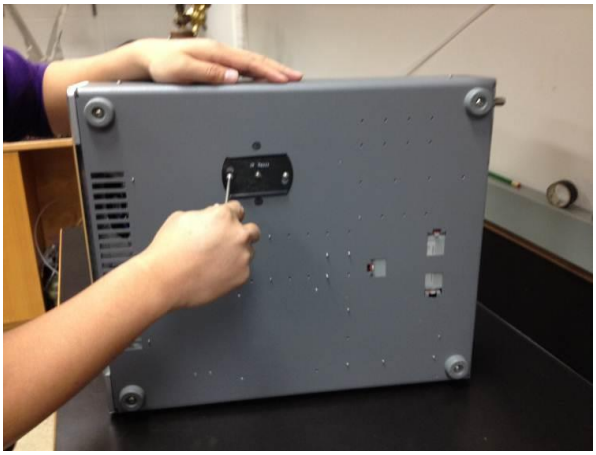
6. Press the pump towards the PPU base (see figure below) and insert the two screws into the holes at the bottom of the PPU and tighten two screws. This step is easier with the PPU on its side.

Figure 96: Securing Pump for Shipment



7. Secure the pump by rotating the black cover plate so that the screw holes in the black plate line up with the through holes in the bottle of the PPU cover and tightening the screws. The proper orientation is shown below.

Figure 97: Securing Pump Shipment Screws



8. Place the lid back on top of the PPU, close the lid of the PPU and re-attach the six screws which are used to secure the lid of the PPU to the main PPU assembly. Place the PPU in its plastic bag with two desiccant pouches as shown in the two figures below. Ensure that the bag remain closed by sealing with 2” wide packing tape.

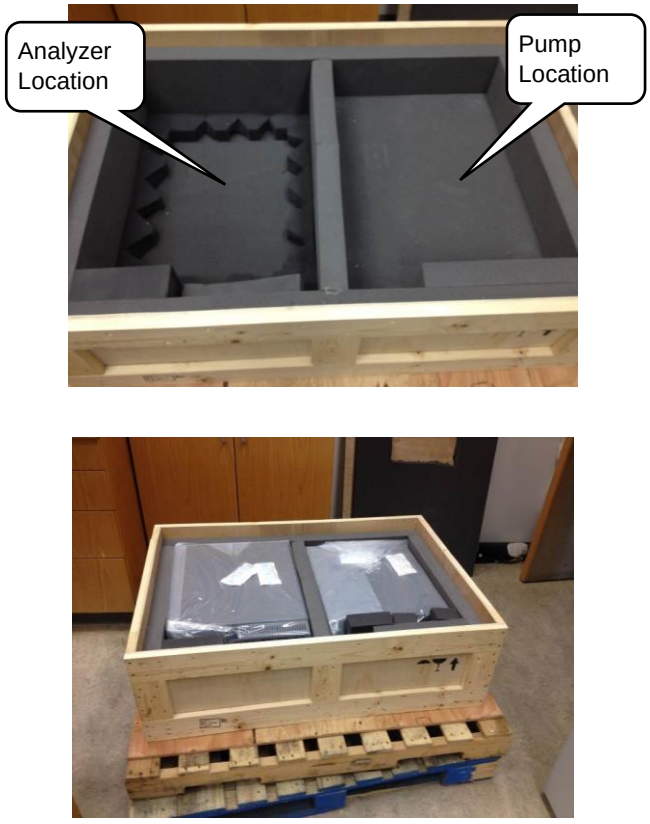
Figure 98: Bagging the PPU

9. Place the analyzer in its plastic bag with two desiccant pouches as shown below. Again, ensure that the bag remains closed by sealing with 2” wide packing tape.

Figure 99: Bagging the Analyzer

10. Place Analyzer into the side of the wood shipping crate containing the saw toothed shaped packing foam. Placing the analyzer in the correct area is extremely important. Make sure analyzer is placed in this area such that it fits completely inside the packing foam (see figure below).

Figure 100: Unit Packing Locations



12. Place PPU into the other side of the wood shipping crate. Placing the PPU and analyzer in their correct respective areas is extremely important. Make sure PPU is placed in this area such that it fits completely inside the packing foam (see figures below). Once the PPU is in position, place the remaining small pieces of packing material at the back of the PPU as shown in the figures below.

Figure 101: Pack Remaining Foam Around PPU

13. Place the plastic bag containing the two power lines, two electronic cables and one vacuum line on top of the PPU as shown in the figure below.

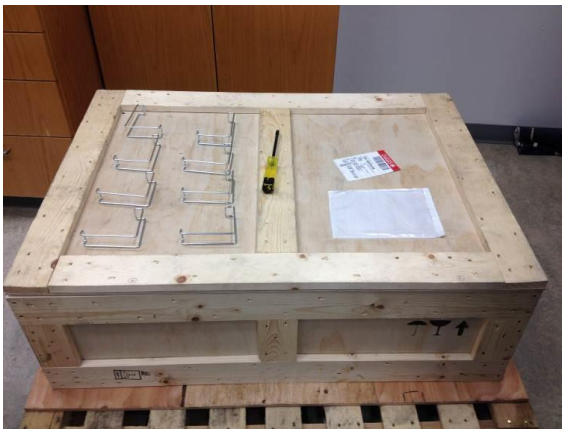
Figure 102: Add Cable Bag and Foam Top Piece

15. Place the large foam insulation piece on top of the analyzer and PPU as shown in the figure below. The plastic bag containing the two power lines, two electronic cables and one vacuum line will sit in the rectangular hole in the foam lid.

Figure 103: Ready for Top Cover

16. Place the lid on the wooden crate as shown in the figure below. The metal clamps shown in the figure are used to secure the lid to the wooden crate.

Figure 104: Ready For Clamps



18. Secure the lid by pressing down on the clamps as shown in the figure below. There should be eight clamps in all.

Figure 105: Attaching Clamps

19. When completely assembled, the packing crate should look like the system shown in the figure below.

Figure 106: Ready to Ship

20. To finish, remove any old shipping labels from the crate and attach new labels as appropriate.