PICARRO

16-Port Manifold
User Manual
Including A0311, A0311-S, A0310

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Notices

Thank you for purchasing a Picarro product. It has been designed and manufactured to provide reliable performance.

This manual is an important part of your purchase as it will help familiarize you with the product and explain the features that have been designed into it. Please read this manual thoroughly before using it.

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

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1. Introduction

This manual is written for operators, service technicians and maintenance technicians who install, operate, and maintain the A0311 distribution manifold, the A0311-S Silconert high-flow distribution manifold, and the A0310 recirculation package (2x A0311 with splitter cable, requiring the A0702 recirculation pump).

Material in this manual will be marked with a combination of the following three icons indicating whether the material is relevant to one, two, or all three of these peripherals or configurations.

A0310 A0311 A0311-S

We strongly encourage users to use these labels, and section names, to guide their use of this manual, as integration instructions for one product (e.g., A0310 recirculation) differ significantly from those for another (e.g., A0311-S for pharmaceutical isolators).

For repairs or service other than those mentioned in this manual, contact Picarro Technical Support or your local Picarro-authorized and certified technicians.

These Picarro products comply with all required CE specifications.

1.1 Intended Use

A0311 The **A0311** 16-Port Distribution Manifold samples up to 16 gas sources in any order specified by the user. During operation, the selected line is routed through the valve into the analyzer. The 15 lines that are not selected terminate in the valve.

A0311-S The **A0311-S** 16-Port Distribution Manifold samples up to 16 gas sources in any order specified by the user. During operation, the selected line is routed through the valve into the analyzer. The 15 lines that are not selected flow through the manifold to a high flow pump to keep the lines primed with fresh sample air.

A0310 The **A0310** recirculation package uses two A0311 manifolds to allow recirculation for up to 16 sample positions, typically associated with parallel soil incubations, and must be operated with the A0702 recirculation pump (sold separately).

1.2 General Descriptions

Refer to Figure 1 and Figure 2 below for of the front and back panel views of each manifold model.

A0311 A0311 16-Port Distribution Manifold

- 16 port valve, tubing, and fittings are all stainless steel. All valve connections are 1/8 Swagelok.
- Is configured and controlled using Picarro's Valve Sequencer software (included).
- Can be controlled using a manual hand-pad (included).
- Can be programmed to select one of 16 gas streams.
- Unselected gas streams terminate at the valve.
- Broadly compatible with all Picarro analyzers with the exception of those with known surface and chemical compatibility issues (such as the G2103, G2108, G2204, G2205, G2307, and PI2114).

A0311-S A0311-S 16-Port Distribution Manifold

- Uses a 16-port valve, PFA tubing, and SilcoNert coated stainless steel fittings. The sample line and analyzer fittings are 1/4" Swagelok. The vacuum fitting is 3/8" Swagelok.
- Is configured and controlled using Picarro's Valve Sequencer software (included).
- Can be controlled using a manual hand-pad (included).
- Can be programmed to select one of 16 gas streams.
- The unselected 15 lines that are not selected flow through the manifold to a high flow pump to keep the lines primed with fresh sample air.
- Purged lines lead to significantly faster response times.
- Broadly compatible with all Picarro analyzers. Optimized for use with sticky and reactive gases on the following platforms:

  G2103, G2108, G2204, G2205, G2307, and PI2114

A0310 A0310 Recirculation Configuration

- Consists of two A0311 manifolds and a splitter serial cable.
- 16 port valve, common lengths of tubing, and fittings are all stainless steel. All external connections on manifolds are 1/8" Swagelok. Tubing to individual sample vessels is provided by user, typically 1/8" OD Tygon or similar, with 1/4" OD recommended for distances over a few feet.
- Both valves are configured and controlled in parallel using Picarro's Valve Sequencer software (included). Each can only move to the same position (e.g., 1 and 1; 16 and 16)

- Can each be controlled separately using a manual hand-pad (included) as needed.
- Can be programmed to select one of 16 recirculating gas streams, though 14 or 15 is recommended to allow purging of previous gas from the instrument between samples (see *section* ***9.1, Reducing Position-to-Position Carryover***).
- Chiefly intended for isotopic carbon and G2308/G2508 analyzers, which are equipped with internal hardware to retain leak-tightness.
- Must be used with the A0702 Recirculation pump, and the relevant instrument must be configured with the A0701 sample handling materials upgrade. This is configured by default on G2308, G2508 and G2201-i instruments and can be added to many other instruments. The user should check with their sales representative before purchasing the A0310 kit to request this configuration upgrade, and confirm it is compatible with the instrument they have chosen.

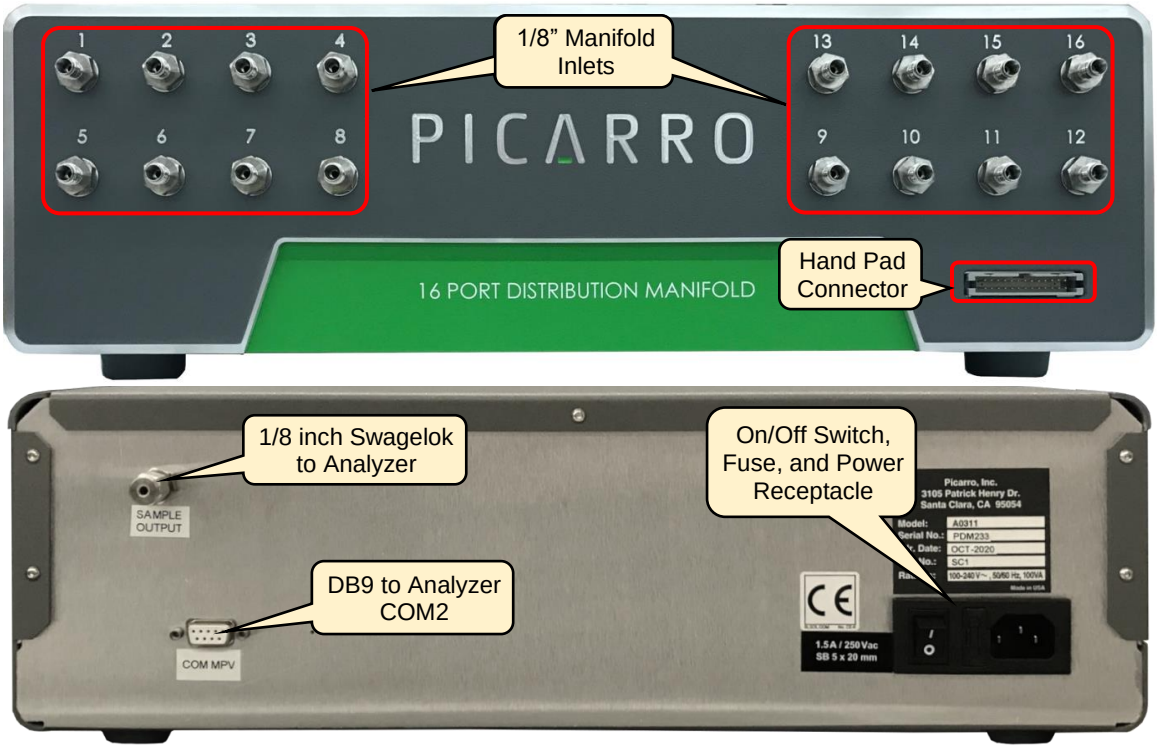


Figure 1: A0311 Front and Back Panels (Two A0311 Used for A0310)

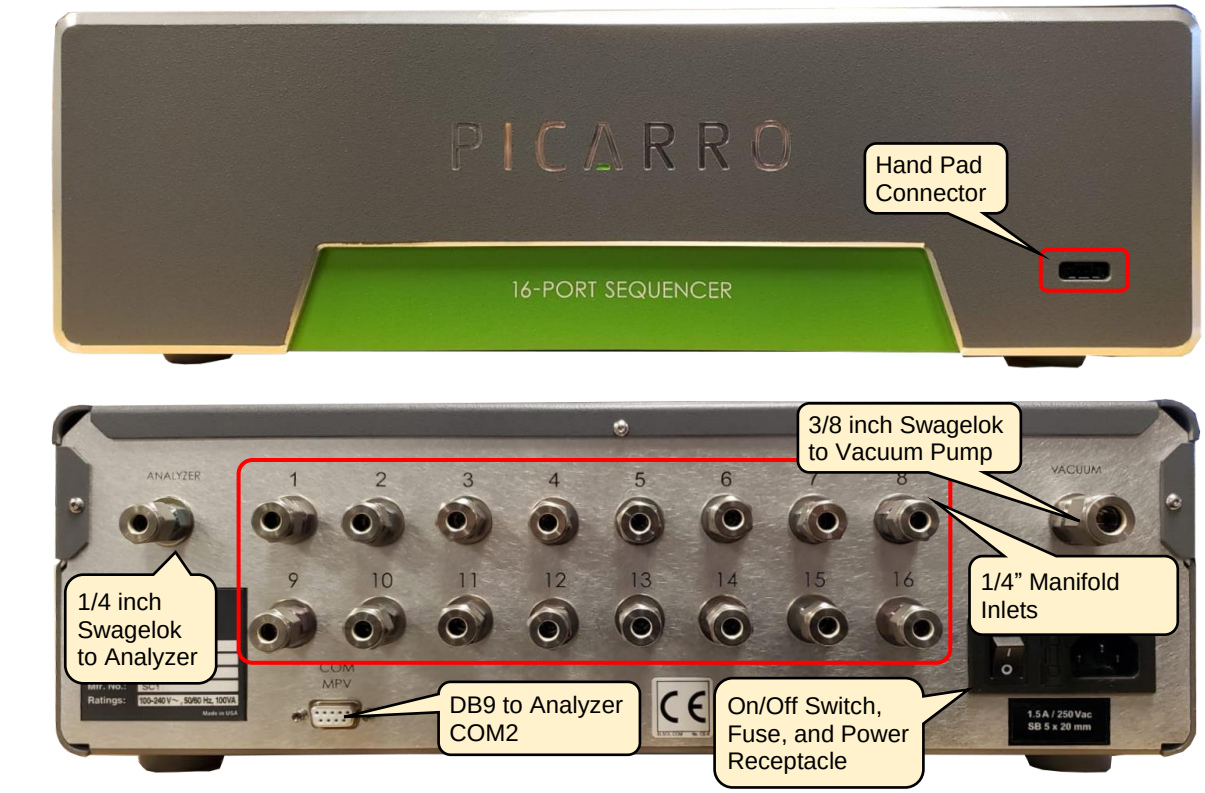


Figure 2: A0311-S Front and Back Panels

1.3 A0311 and A0310 Specifications

A0311
A0310

Table 1: A0311 and A0310 Specifications

Parameter	Specification
Number of Gas Inlets	16
Sample Handling Materials	Stainless Steel
Temperature Range	Storage: 0 °C to 70 °C (32 °F to 158 °F) Operation: 0 °C to 35 °C (32 °F to 95 °F)
Ambient Humidity Range	< 85% R.H. non-condensing
Maximum Altitude (During operation)	3050 m (10,000 ft)
Clearance Needed for Front Connectors	20 cm (8 in.)
Clearance Needed for Rear Connectors	15 cm (6 in.)
Installation Options	Benchtop or Rack Mount
Gas Connections	1/8” in Swagelok
Control Connections	Null modem DB9 serial cable for connection to Analyzer Valve Sequencer Control Software Hand Pad Connector for Manual Control Pad Splitter cable (A0310 only)
Dimensions	Width: 48.3 cm (17 in.) Length: 43.8 cm (17.25 in.) Height: 13.3 cm (5.25 in.)
Weight	7.3 kg (16.1 lbs) No special lifting precautions are required. One person may lift the manifold.
Power Requirements	100 - 240 VAC, 50 - 60 Hz, 100 VA max.
Power Supply Voltage Fluctuation	± 10% of nominal voltage
Fuse Ratings	1.5 A at 250 VAC, slow blow 5 mm x 20 mm (0.196 in. x 0.78 in.)
Software	Controlled by Picarro Analyzer Software Valve Sequencer Interface.
Liquid Ingress Protection	None
Number of Manifolds	A0311: 1; A0310: 2

1.4 A0311-S Specifications

A0311-S *Table 2: A0311-S Specifications*

Parameter	Specification
Number of Gas Inlets	16
Sample Handling Materials	Valve and Fittings: Stainless Steel with SilcoNert 2000 coating Tubing: PFA between manifold and instrument. Coil-reinforced Vinyl between manifold and pump.
Temperature Range	Storage: 0 °C to 70 °C (32 °F to 158 °F) Operation: 0 °C to 35 °C (32 °F to 95 °F)
Ambient Humidity Range	< 85% R.H. non-condensing
Maximum Altitude (During operation)	3050 m (10,000 ft)
Clearance Needed for Front Connectors	20 cm (8 in.)
Clearance Needed for Rear Connectors	15. cm (6 in.)
Installation Options	Benchtop or Rack Mount
Gas Connections	1/4 in. Swagelok at Inlets and Outlet, 3/8 in. to pump
Control Connections	Null modem DB9 serial cable for connection to Analyzer Valve Sequencer Control Software Hand Pad Connector for Manual Control Pad
Dimensions	Width: 48.3 cm (17 in.) Length: 43.8 cm (17.25 in.) Height: 13.3 cm (5.25 in.)
Weight	Manifold: 7.2 kg (15.8 lbs) A2000 pump: 6.5 kg (14.4 lbs)
Power Requirements	100 to 240 VAC, 50 - 60 Hz, 100 VA max
Power Supply Voltage Fluctuation	± 10% of nominal voltage
Fuse Ratings	1.5 A at 250 VAC, slow blow 5 mm x 20 mm (0.196 in. x 0.78 in.)
Software	Controlled by Picarro Analyzer Software Valve Sequencer Interface.
Liquid Ingress Protection	None

1.5 Acronyms

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

Table 3: Acronyms, Formulas, Units, and Symbols

Acronym	Definition
CRDS	Cavity Ring-Down Spectroscopy
GUI	Graphical User Interface
cm	centimeters
mm	millimeters
” (as in 1/4”)	Inches
H_2O	Water
ppm	Parts Per Million
ppb	Parts Per Billion
UM	User Manual
‰	per mil
°C	Degrees Celsius

1.6 Text Conventions

The following conventions are used in the manual.

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

2. Safety

2.1 Warning Symbols

Icon notes and warnings are used in Picarro manuals. The purpose of these icons is to provide a visual convention to alert you of important information. They indicate dangers to either the operator or to the analyzer, and other important information.

Table 4: Warning/Information Icon Types

Icon	Description
 NOTE	**NOTE** is important information that you should be aware of before proceeding.
 DANGER	**DANGER** indicates an imminently hazardous situation that, if not avoided, will result in death or severe injury.
 WARNING	**WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death or severe injury.
 CAUTION	**CAUTION** alerts user of a potential danger to equipment or to the user.
 WARNING	**HAZARDOUS VOLTAGE** alerts user to areas that may expose a user to electrical energy that is high enough to cause injury or death.
 CAUTION	**HOT SURFACE** alerts user to potential injury from hot surfaces.
 REMINDER	R**EMINDER** is a helpful hint for procedures listed in the text.

2.2 General Safety

CE Certification

This Picarro product 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 a Picarro manifold in a manner not specified by Picarro may result in damage to the unit and render it unsafe to operate.

WARNING

Picarro manifolds are for indoor use only and have an ingress protection rating of IPx-0. They are 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

Picarro manifolds contain no user serviceable components except the fuse. Do not attempt any repairs other than those mentioned in this manual. 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

Only authorized persons may open a Picarro manifold cover or perform internal maintenance. Contact Picarro for maintenance instructions and maintenance kits. Unplug the manifold before working with the internal components. Failure to do so may result in electric shock or electrocution or can damage the manifold.

CAUTION

The inlet gas connector on the back panel of the associated analyzer and its immediate vicinity runs hot during operation of the analyzer. Use caution when connecting the gas line from the manifold or when working at the rear of the analyzer. Wear protective gloves or avoid contact with these surfaces.

3. Unpacking

3.1 Shipping, Handling and Storage

- Picarro equipment may be transported in non-pressurized aircraft.
- Do not store boxes outside in the rain or in extreme heat or cold.
- Handle Picarro equipment with care. Do not drop or shake boxes.
- Do not stack boxes more than five high.

3.2 Inspect the Shipping Box

Picarro products are inspected and tested before leaving the factory. The shipping boxes provide proven safety from most dropping, crushing or spiking events.

If the equipment arrives damaged, photograph the damage and contact Picarro (email pictures if possible) for consultation on best course of action.

NOTE

Save the original shipping materials for re-use when storing or shipping the unit.

3.3 Unpack the A0311 or A0310 Shipping Boxes

A0311

A0310

Unpack the shipping box. It contains:

- A 16-port Gas Manifold
- A stainless-steel tube that connects the manifold output port (1/8” Swagelok nut) to the input port on the analyzer (1/4” Swagelok nut)
- An accessories bag (Figure 3) containing:
  - A manual valve control hand-pad and ribbon cable.
  - An RS232 connection cable (to connect Gas Manifold to analyzer).
  - Swagelok nuts and ferrules.
  - A power cable for the Gas Manifold with a plug applicable to your country (not shown). Always use either the provided power cable or a cable that meets or exceeds the rating on the provided power cable.

NOTE

The Gas Manifold has a universal power supply that accepts a power source range from 100-240 VAC, 50/60 Hz, 100 VA max.

Figure 3 shows the accessories kit minus the power cable.

Figure 3: A0311 or A0310 Accessory Kit

A0310

Users who purchase an A0310 dual manifold kit will also receive a splitter cable (Figure 4) for the analyzer that allows the user to control both manifolds directly from the same communications port on the analyzer.

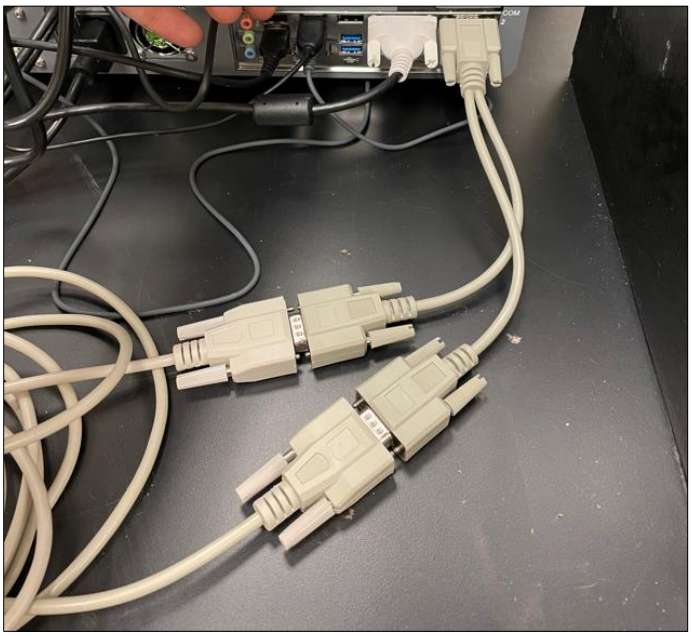


Figure 4: Splitter Cable

3.4 Unpack the A0311-S Shipping Box

A0311-S

Unpack the shipping box. The manifold box contains:

- A0311-S 16-port Distribution Manifold
- An accessories bag (Figure 5) containing:
  - A manual valve control hand-pad.
  - An RS-232 connection cable (to connect Distribution Manifold to analyzer).
  - Swagelok nuts and ferrules.
  - A power cable for the Distribution Manifold with a plug applicable to your country (not shown). Always use either the provided power cable or a cable that meets or exceeds the rating on the provided power cable.
  - A pair of adjustable slides and hardware for rack-mounting the 16-port Distribution Manifold.

CAUTION

Caps should be added for safety on unused ports when working with hazardous gases. These can be purchased from Swagelok using PN SS-400-P. (See warning in section *4.1, Installation Safety*).
https://www.swagelok.com/en/catalog/Product/Detail?part=SS-400-P

NOTE

The A0311-S contains a universal power supply that accepts a power source range from 100-240 VAC, 50/60 Hz, 100 VA max.

Figure 5 shows the accessories kit minus the power cable.

A0311-S

Figure 5: A0311-S Accessory Kit

While most Picarro instruments will run with one A2000 pump on the downstream side of the instrument (exception for this manual: A0310 configurations), the A0311-S kit comes with a second A2000 pump which should be connected to the A0311-S itself, following guidance in section ***4.4, Connection Procedure A0311-S***. Figure ***6*** shows this vacuum pump. See the vendor's manuals (included with the pump) for pump safety, installation, and operation. See ***APPENDIX A – Setting up Contained Pump Exhaust Flow*** for instructions on how to install exhaust lines on the A2000 pump.

A0311-S

Figure** 6**: A2000 Vacuum Pump

3.5 Recirculation Pump

A0310

A0702 Recirculating Vacuum Pump

NOTE

The recirculation pump for use for an A0310 must be purchased separately. For A0702 setup and configuration details, see the *A0702 User Manual*, Picarro PN 40-0050.

The A0702 Pump can be used with A0310 setup to measure gas concentrations in a recirculating closed system with extremely low leak rates and well-controlled pump materials compatibility. This makes it ideal for monitoring gas evolution from soils, vegetation, or living organisms. (Picarro has not tested ammonia measurement accuracy using the A0702 recirculation pump.)

A0310

Figure 7: A0702 Recirculating Vacuum Pump

4. Installation

4.1 Installation Safety

WARNING

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

CAUTION

When the analyzer and manifold 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 manifold and analyzer so that it is difficult to operate the disconnecting device.

WARNING

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

If the A0311-S is mounted separately, it can be mounted using a front rack mount kit alone without additional support.

CAUTION

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

WARNING

Picarro manifolds are for indoor use only and have an ingress protection rating of IPx-0. They are NOT protected against exposure to water including dripping, spraying, splashing or immersion.

CAUTION

Use the AC power cable supplied with the manifold 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.

WARNING

PERSONAL INJURY: When using the A0311-S with hazardous gases, cap all unused ports. In the event of a failure of the A0311-S vacuum pump, or if the user fails to turn on the pump, gas flowing from active ports could flow out of the unused/uncapped positions. This could expose the operator to high levels of hazardous sample gas.

CAUTION

Take care to ensure that warm air is exhausted from an enclosure in which the analyzer and A0311 are mounted.

CAUTION

All active sampling lines on the A0311 or A0311-S should be equipped with a low pressure-drop ~3-micron filter upstream of each valve bulkhead position. This is required to ensure that coarse particulates don't cause the valve rotor to seize or leak after extended use. Relevant filters can be found on scientific supply websites, and should match the tubing diameter being used, either 1/8" or 1/4".

4.2 Confirm Manifold Receives Line Power

A0311 A0311-S A0310

Before connecting the manifold to the Picarro analyzer, perform the following steps to confirm it is receiving power from the line power source.

1. Connect the power cable from the back of the box to line power source.
2. Turn the rocker switch on the back of the manifold to on (|).
3. On the A0311, connect the hand pad via the ribbon cable to the front right of the manifold (Figure 10).
4. On the A0311-S, connect the hand pad via the black communication cable to the front right of the manifold (Figure 13).
5. The hand pad should receive power and display a position reading. If it does not, follow the troubleshooting steps in section ***12, Troubleshooting***.

4.3 Connection Procedure: A0311

A0311

A schematic for A0311 connections and gas flows is shown below in Figure 8.

To connect a Picarro analyzer to the A0311 16-Port Distribution Manifold:

1. With A0311 and analyzer turned off, Attach the RS-232 cable from the A0311 ***COM MPV*** port (the DB9 connector on the back panel shown in Figure 9) to the analyzer's serial port (***COM 2*** port).

CAUTION

When applicable, use two wrenches when connecting or disconnecting Swagelok fittings. One wrench to turn the fitting nut, and the second wrench on the fitting body to prevent rotation.

2. Connect the 1/8” Swagelok nut end of the steel tube (the tubing assembly shown in Figure 3) to the **SAMPLE OUTPUT** port on the manifold (Figure 8), then connect the 1/4” Swagelok nut end of the tube to the analyzer **Inlet** port. **Leave all A0311 inlet positions 1 through 16 unconnected and uncapped**.
3. Connect the A0311 power cable to line power.
4. Turn the manifold **ON** using the On/Off switch on the A0311 back panel.
5. With A0311 powered on, start the pump and then analyzer. This lets the analyzer recognize the newly installed hardware.

CAUTION

Leave enough free space for easy connections. Leave about 8 inches of free space at the rear and front of the manifold.

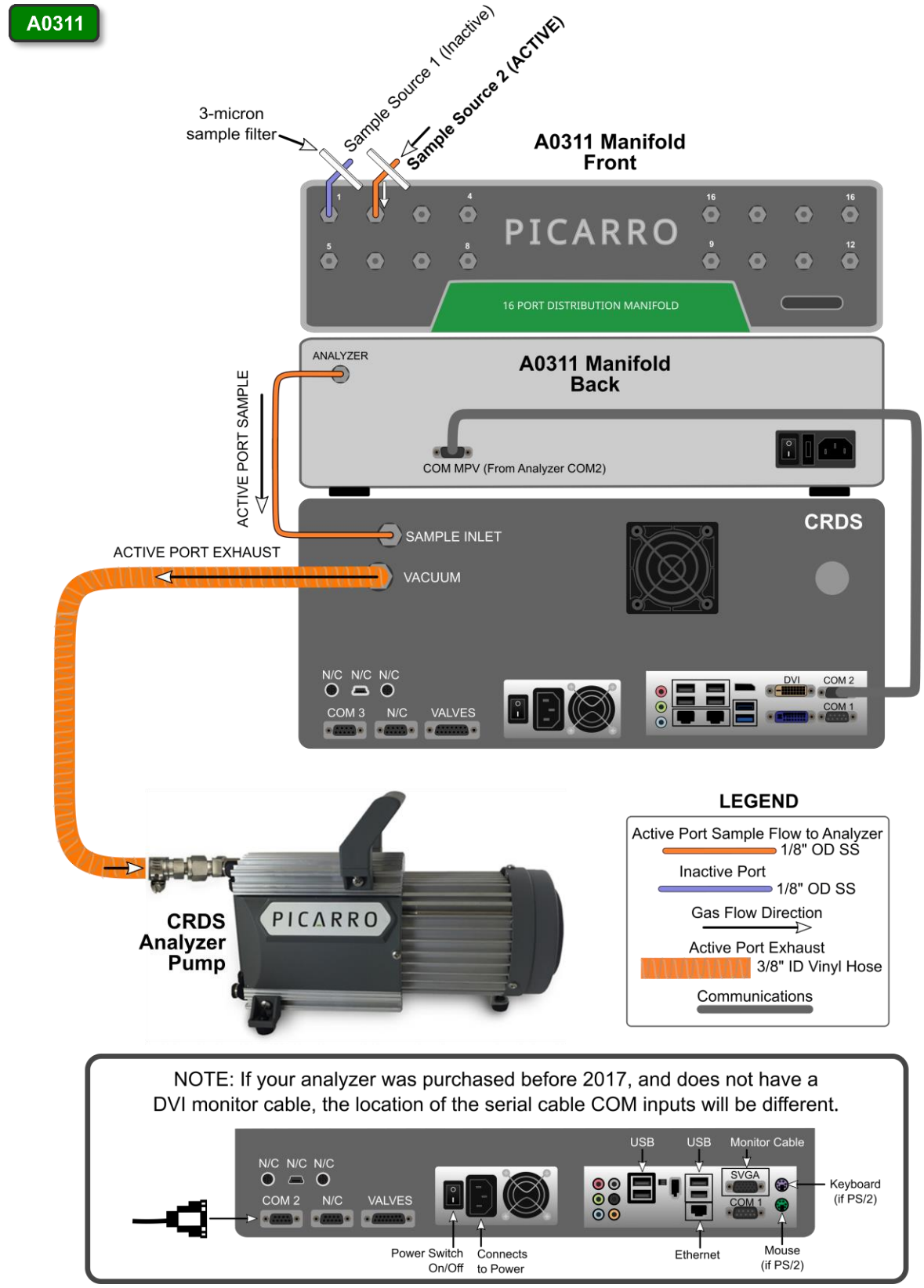


Figure 8: A0311 Setup Schematic

Figure 9: A0311 or A0310 Back Panel Connections

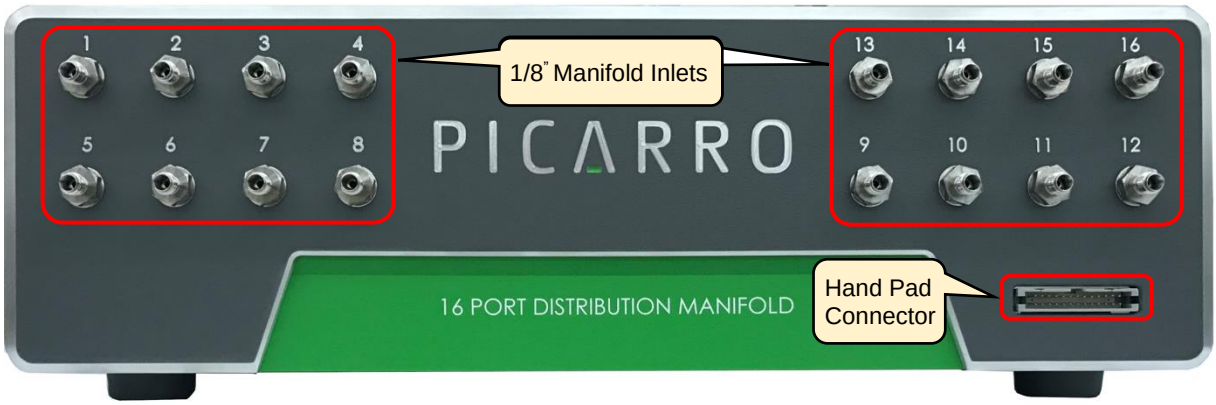


Figure 10: Hand Pad Connector Port on A0311 Front Panel

6. Next, follow the steps outlined in section ***5, Initialize the Sequencer (Windows)*** or section ***6, Initialize the Sequencer (Linux)***, as appropriate for your operating system.

4.4 Connection Procedure A0311-S

A0311-S A schematic for A0311-S connections and gas flows is shown below.

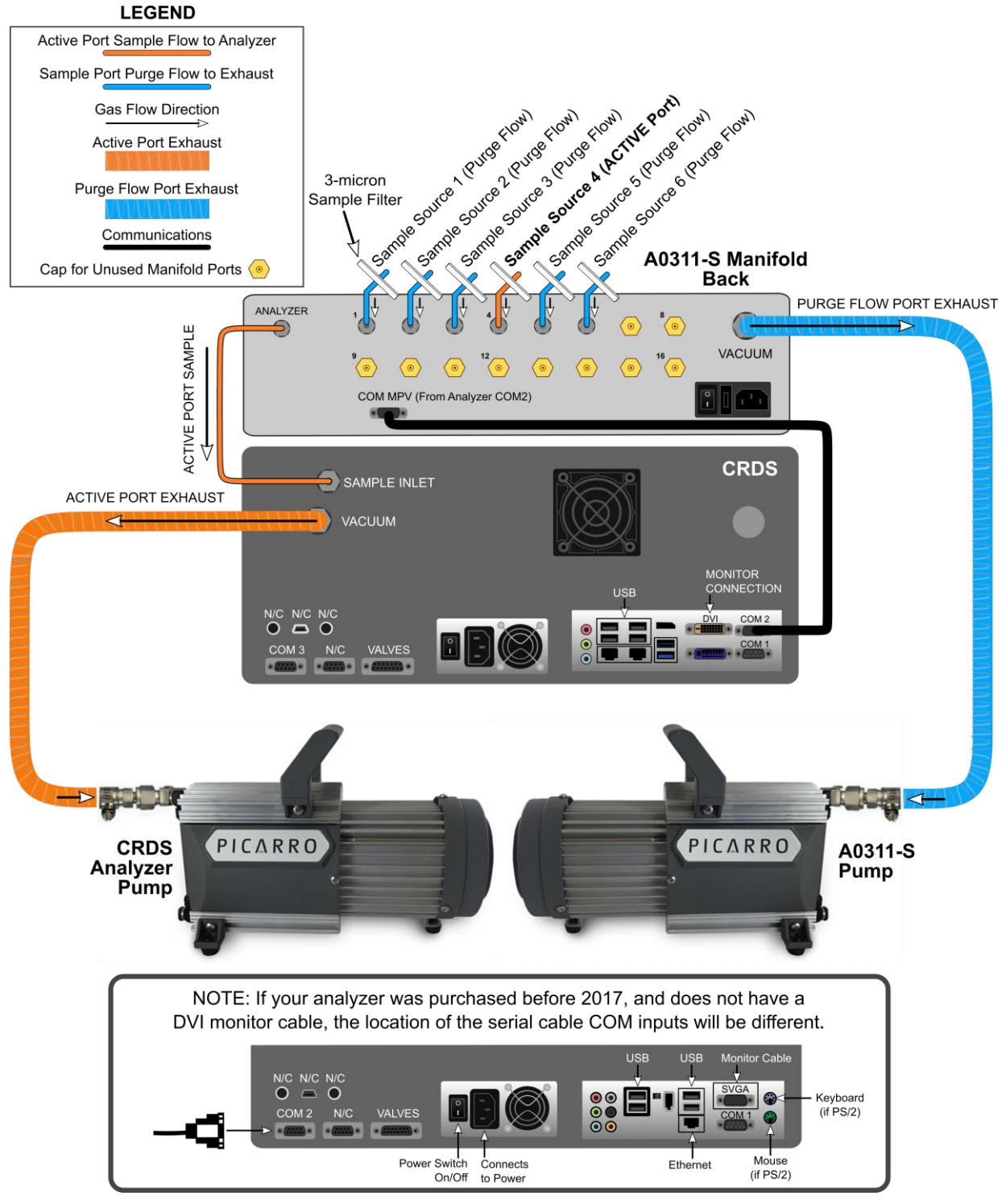


Figure 11: A0311-S Setup Schematic

Using the steps below, connect a Picarro analyzer to the A0311-S 16-port manifold. See Figure 12 for the manifold back panel connectors.

1. With A0311-S and analyzer turned off, attach the RS-232 cable from the A0311-S **COM MPV** port (the DB9 connector on the back panel) to the analyzer serial port (**COM2** port). **Remove any/all caps from the lines.**
2. Connect the A0311-S power cable to line power.
3. Turn the Distribution Manifold on using the On/Off switch on the Distribution Manifold's back panel.
4. With A0311 powered on, start the pump and then analyzer. This lets the analyzer recognize the newly installed hardware.
5. Next, follow the steps outlined in section ***5, Initialize the Sequencer (Windows)*** or section ***6, Initialize the Sequencer (Linux)***, as appropriate for your operating system

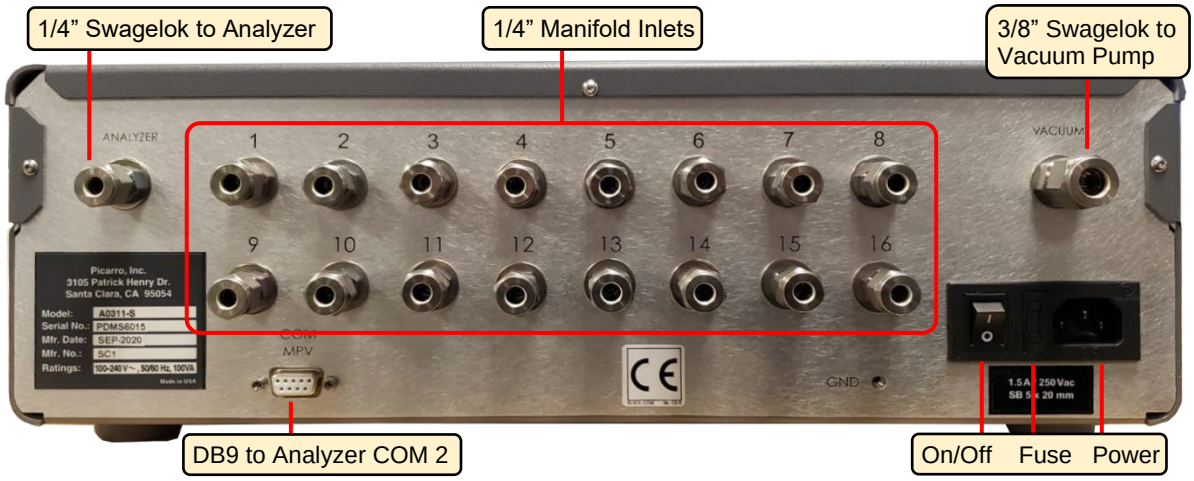


Figure 12 A0311-S Manifold Rear Panel Connections

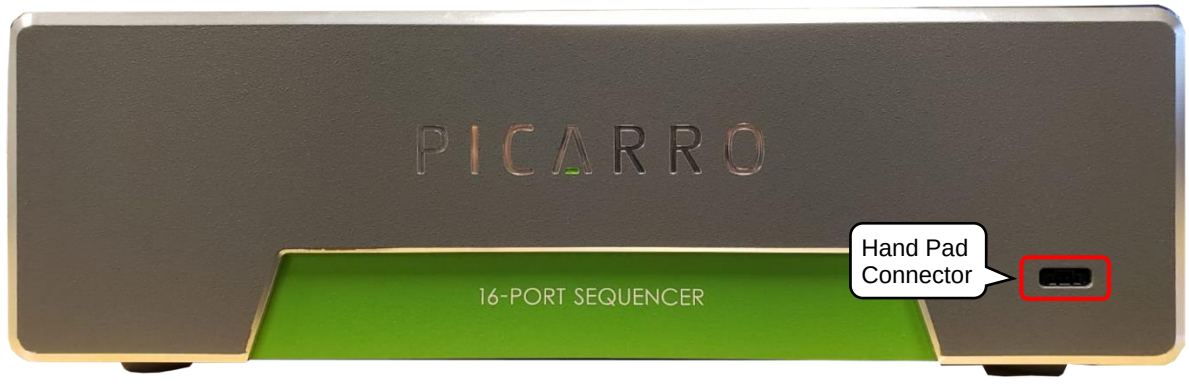


Figure 13: Hand Pad Connection

4.5 Connection Procedure A0310

A0310

A schematic for A0310 connections and gas flows is shown below. A Picarro A0702 Recirculation Pump is used with this setup. Refer to the *A0702 User Manual* (Picarro PN 40050) for detailed instructions on setup and use of this pump. ***Note that the diagram below recommends 1/8" Tygon lines between manifolds and chambers. Some customers prefer to size up to ¼" lines if tubing lengths exceed roughly six feet to reduce sample pressure drop.***

A0310

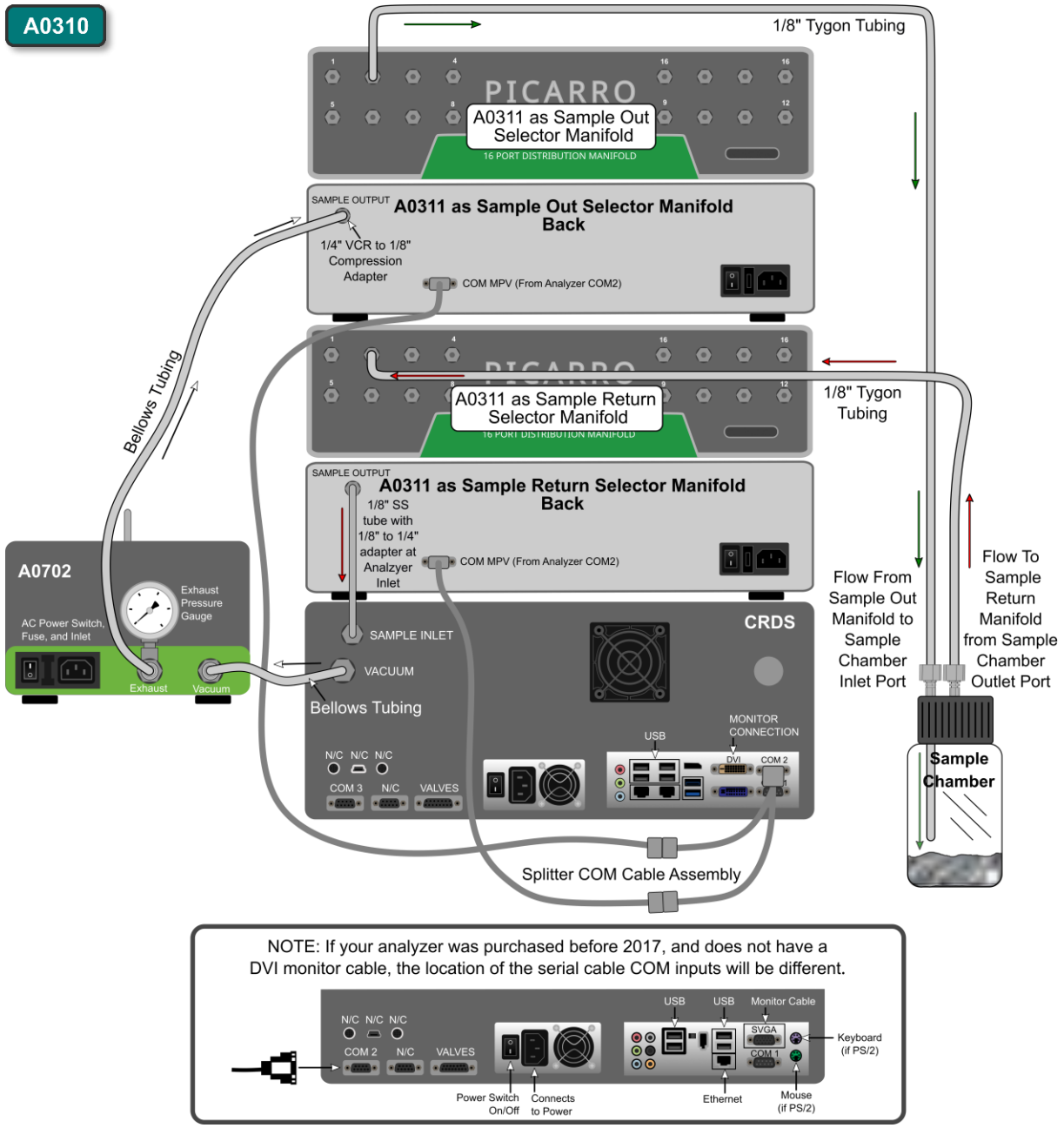


Figure 14: A0310 Recirculation Setup Schematic

CAUTION

Users of the recirculation system should be aware that pressure can build in sample jars and manifolds if both manifolds are not pointing to the same position, or if sample or common lines are not correctly plumbed. Picarro recommends that users perform all modifications to the sample flow path for recirculation with the instrument off and manifolds in Position 1, with the relevant fittings on the manifolds open to room air. Likewise, Picarro recommends that users trace all IN and OUT sample lines carefully to their respective sample containers before beginning any valve sequences.

A0310 To connect a Picarro analyzer to the A0310 recirculation manifold kit:

1. With A0311 and analyzer turned off, stack the two A0311s on top of each other, on top of the analyzer (Figure 15). The upper manifold is the **Sample Out Selector Manifold**, while the bottom is the **Sample Return Selector Manifold.**
2. Remove all caps from the front of the manifolds, carefully placing the black cap, nut, front ferrule, and back ferrule into a bag. **Leave all lines disconnected from the sample positions.**

A0310

Figure 15: A0310 Recirculation Setup, Front View

3. With A0311 and analyzer turned off, first connect the two serial cables to the split ends of the splitter cable (Figure 16).

4. Connect the splitter cable common port to **COM2** on the back of the Picarro analyzer.

5. Attach **one** of the two serial cables to the lower manifold **only** at the *COM MPV* port (the DB9 connector on the back panel shown in Figure 20). Leave the cable going to the top manifold disconnected for now. ***Connecting both cables for initializing the pairing can lead to communications errors.***

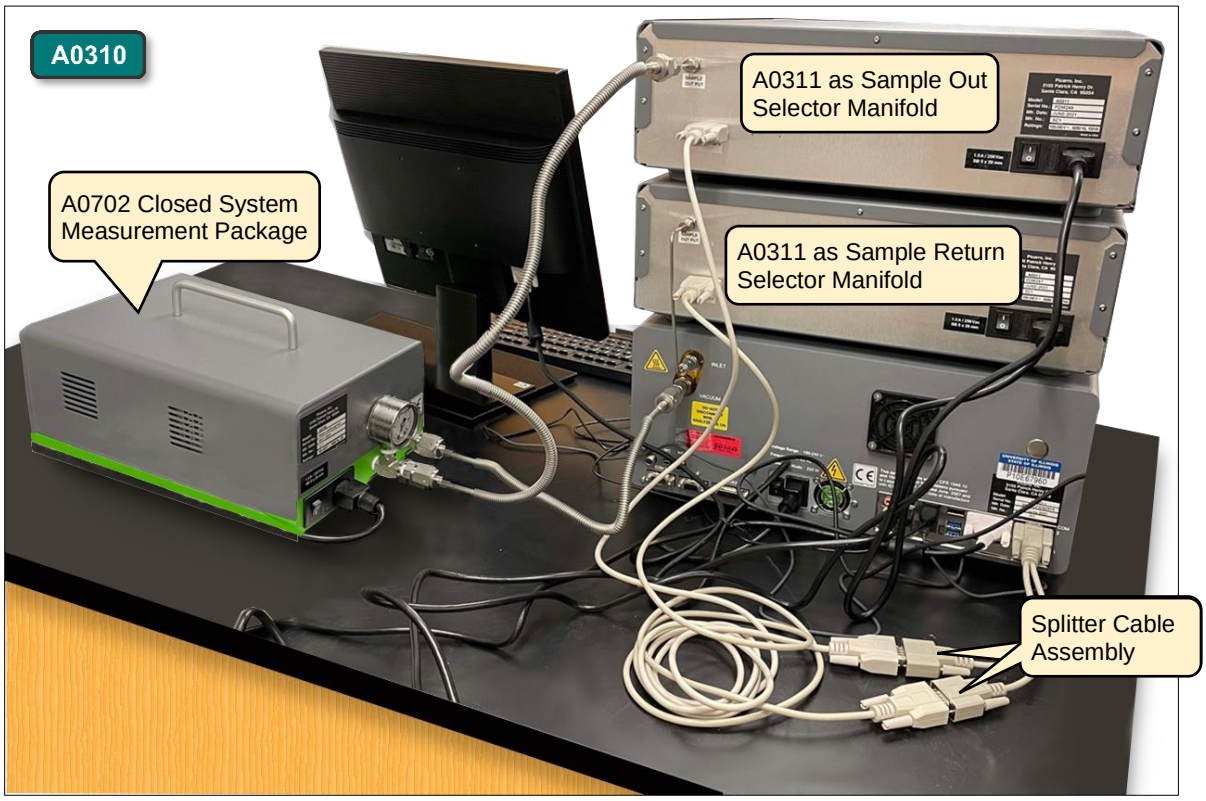


Figure 16: A0310 Recirculation Setup, Rear View

CAUTION

When appropriate, use two wrenches when connecting or disconnecting Swagelok fittings; one wrench to turn the fitting nut, and the second wrench on the fitting body to prevent rotation.

6. From the lower manifold, connect the 1/8” Swagelok nut end of the steel tube (the tubing assembly is shown in Figure 3) to the **SAMPLE OUTPUT** port on the manifold (Figure 20), then connect the 1/4” Swagelok nut end of the tube to the analyzer **Inlet** port. ***Leave all A0311 inlet positions 1 through 16 unconnected and uncapped.***

7. Connect the recirculation pump to the vacuum line on the instrument following the steps below. Customers may also want to consult the A0702 manual (Picarro PN 40050) for further guidance. *It is very*

important to follow these instructions carefully to ensure the system is leak-tight to avoid damaging fittings and sample containers.

8. The vacuum adapter fittings should come connected, but not tightened together. Tighten the 1/4” nut onto the 1/4” tube-to-1/4” VCR union (Figure 17). *Skipping this step is the most common cause of vaccum leak issues.*

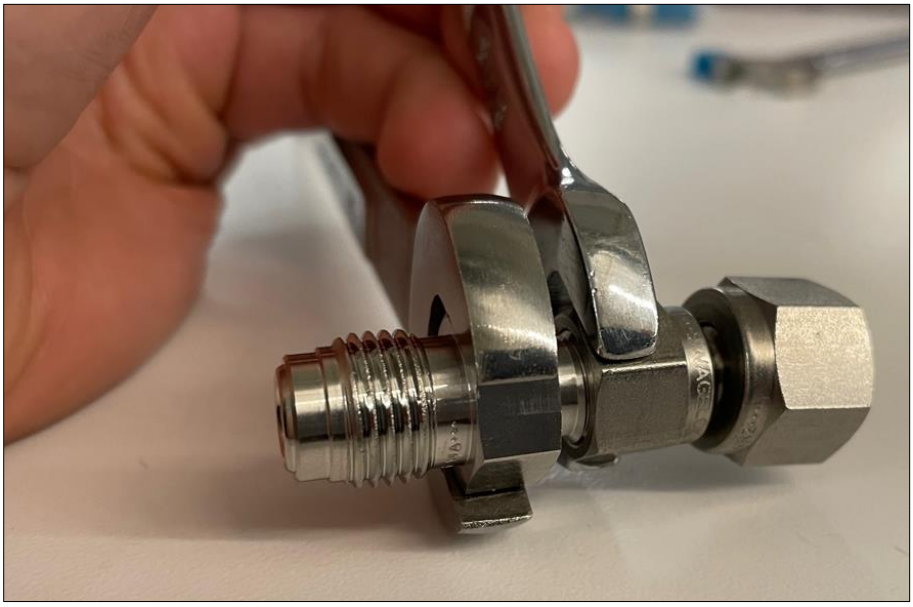


Figure 17: Tightening Vacuum Adapter Fitting

9. Attach the 1/4" VCR to 3/8” tube adapter to the analyzer VACUUM port bulkhead fitting and finger-tighten (red box in left pane of Figure 18). Using the 11/16” wrench, tighten 1/4” to 1/2” turn.

When connecting the vacuum line 3/8” nut to the vacuum port on the Picarro analyzer, ensure that the adaptor union sits straight when tightened in place. See* Figure 18 *(left and middle panes) for a reference for a correct fitting alignment and see* Figure 18 *(right pane) for an example of a poor alignment.

When the fitting is aligned incorrectly, the vacuum line will leak significantly, adding pressure to the sample lines. The user may see a “pressure unlocked” error in the host software GUI that indicates this issue if the leak is large enough, but if the leak is small and the vacuum pump is able to stabilize the cavity pressure, this error may not show up. The procedure in Leak Check section of the A0702 user manual (PN 40050) will reveal this leak, however installing the fitting correctly the first time will avoid potential for damaging the fitting (through cross-threading) and sample vessels (through over-pressurization).

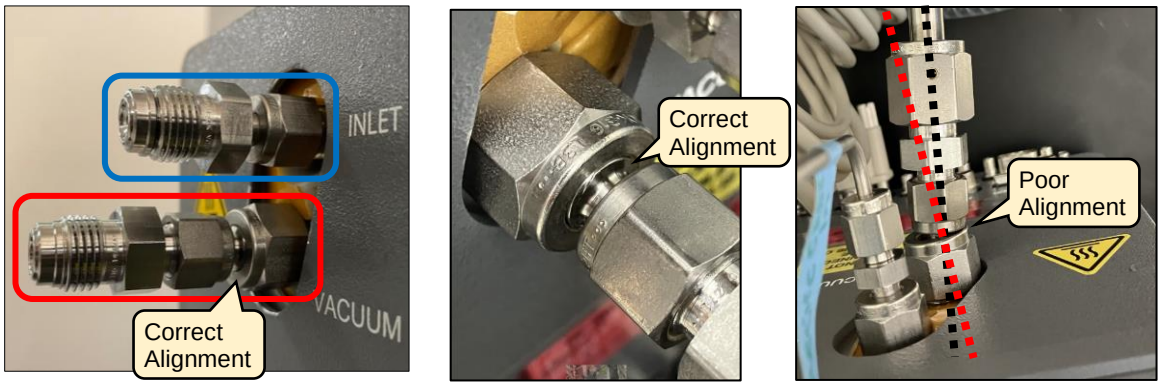


Figure 18: VCR to Analyzer Adapters – Ensure Proper Alignment and Tightness

10. Connect the 12” flexible stainless steel line between the analyzer **Vacuum** port and the A0702 **Vacuum** port. Ensure a new VCR gasket is inserted into each VCR female fitting following the steps below.

WARNING

Accidentally connecting the vacuum line from the instrument to the exhaust port on the pump can cause back-pressurization of the cavity and serious damage to the analyzer. Ensure you are connecting to the vacuum port on the pump, which should be on the right, and does NOT have a gauge above it. Refer to Figure 14.

VCR Adapter Installation and Tightening:

11. As each VCR tubing connection is made, insert a new 1/4” Ni/Ag gasket (Swagelok NI-4-VCR-2) into the VCR nut (Figure 19).

12. To ensure a good seal when connecting the following VCR fittings:

a. Turn the nut until finger-tight.

b. Use a 3/4” wrench (backed with a 5/8” wrench) to tighten the nut an additional 1/8 turn.

CAUTION

Always use a new gasket when reconnecting VCR fittings. A used gasket can be identified by a circular depression on the surface:

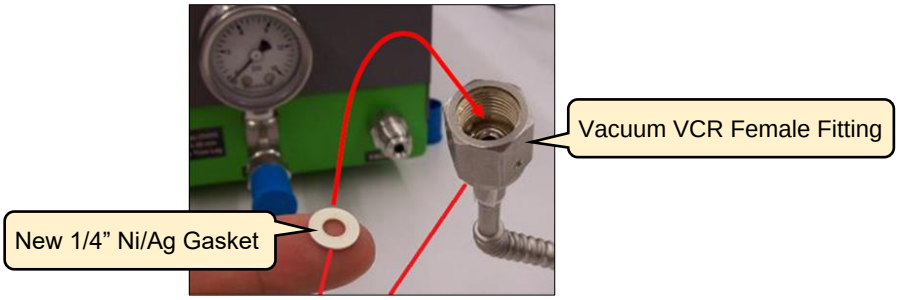


Figure 19: Inserting New Gasket into VCR Female Fitting

13. Connect the exhaust flow from the pump to the common port on the back of the upper manifold using the 1/4” VCR to 1/4” compression fitting provided in the A0702 kit.[1]
14. Connect the A0311 power cable to line power.
15. Turn the manifold **ON** using the On/Off switch on the manifold’s back panel.

Figure 20: A0311 Back Panel Connections

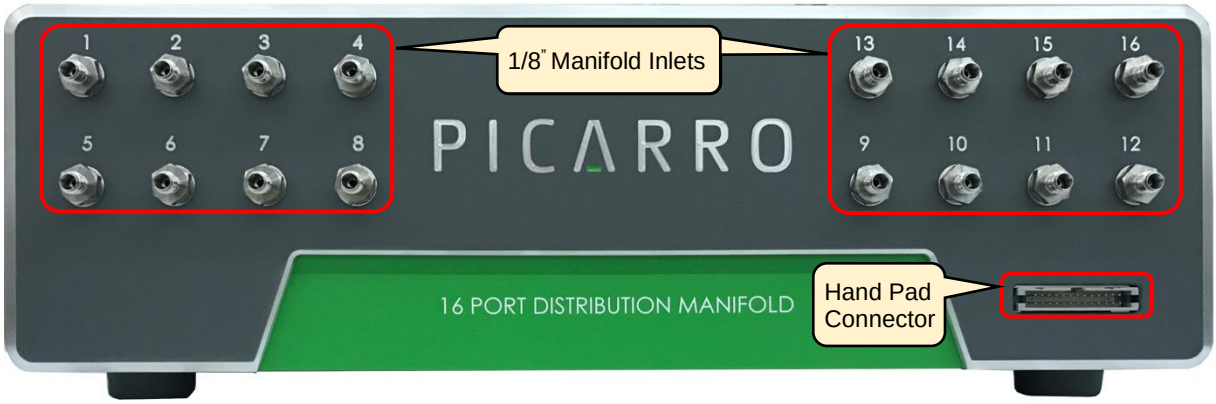


Figure 21: Hand Pad Connector Port on A0311 Front Panel

CAUTION

Leave enough free space for easy connections. Picarro recommends 8 inches of free space at the rear and front of the manifold.

[1] Users who purchased their A0310 kit prior to mid-2022 will need to source an adaptor to connect the 1/4” fitting on the adaptor to the 1/8” fitting on the manifold, as Picarro did not provide this piece until recently. The relevant part numbers for this adapter are: Swagelok SS-400-R-2 (SS tube reducing fitting), and SS-200-NFSET (a single 1/8” SS nut set).

16. If not already done, use the provided hand pad (refer to Figure 27) and ribbon cable to connect into the front of the manifolds one by one (Figure 21), and check the current position. Both manifolds should show the position clearly with a red number on the hand pad display. If either is not at Position 1, hit the “Home” button to send it there. The valve should move audibly, and the value on the hand pad should change to “1”. If the hand pad doesn’t iluminate, or if the valve doesn’t turn, refer to section ***12, Troubleshooting***.
17. With both A0311 powered on, but only the bottom manifold connected to the instrument COM port, start the pump and then analyzer. This lets the analyzer recognize the newly installed hardware. Follow the steps outlined in section ***5, Initialize the Sequencer (Windows)*** for initialization, and then return to this section. If the analyzer does not recognize the hardware, refer to ***APPENDIX B – Steps if Analyzer Can’t Recognize Valve***.
18. At this point, if not already done, connect the second serial cable to the back of the upper manifold.
19. With the recirculation pump and tubing connected to the back of the two manifolds, gas should enter the system through Position 1 on the lower manifold (Sample Return) and exit in Position 1 on the upper manifold (Sample Out). At this point, the customer may carefully set up Sample In/Out connections to all sample containers.
20. With samples in place, follow the instructions in section ***7.4, Set Up a Sequence Using the Valve Sequencer Window*** to program in a sequence. Follow the instructions in section ***9.1, Reducing Position-to-Position Carryover*** if the customer wishes to purge out the contents of the cavity and common tubing in between each position to reduce concentration and isotopic carryover from one position to the next.

5. Initialize the Sequencer (Windows)

5.1 Verify Analyzer Recognized Valve Automatically

1. With the instrument measuring, a manifold connected and turned on, navigate to the Picarro host software.
2. Click on the **Tools** menu, and select **Show/Hide Valve Sequencer** (Figure 22).

   This should open the valve sequencer interface in the background.

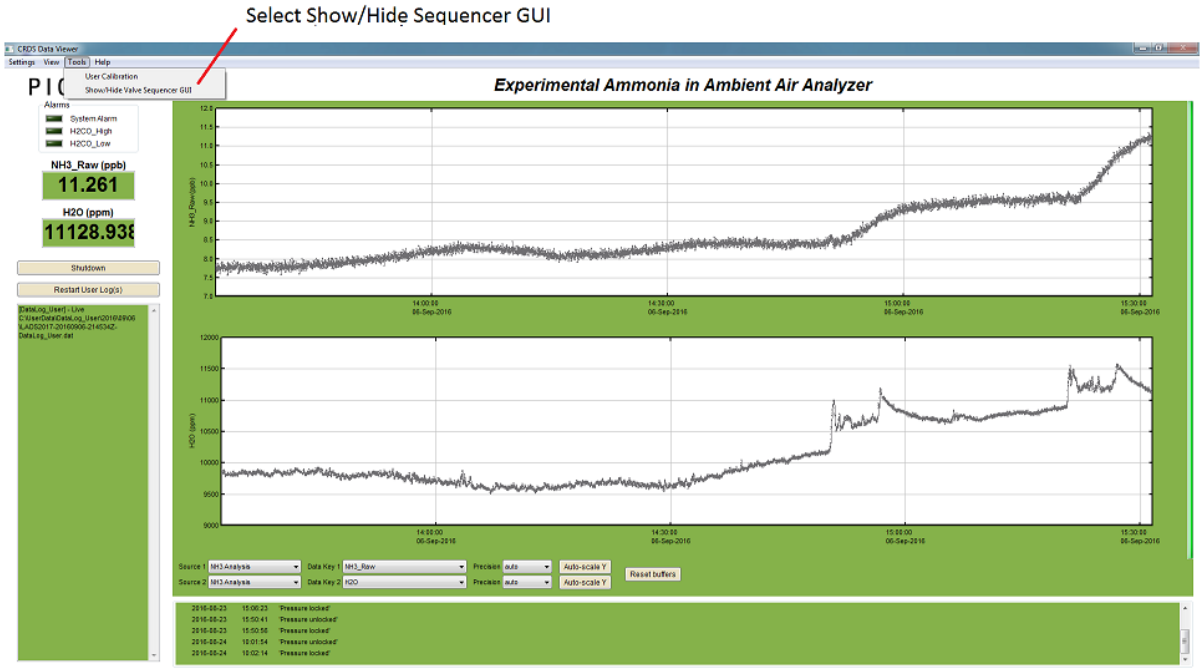


Figure 22: Show/Hide Sequencer under Tools Drop Down Menu

3. To see the valve sequencer, press **Alt+Tab** or click on the small generic rectangular icon that appears in the Windows task bar (Figure 23).
4. Look to see whether the top right box labeled **Current Rot. Valve Code** is shaded green. If it is, the manifold is successfully connected and communicating with the analyzer.

   If is not shaded green, this means that automatic valve recognition has failed. In this case see ***APPENDIX B – Steps if Analyzer Can't Recognize Valve.***

A0310

5. ***A0310 users***: if communcation was successful, you may now connect the serial cable into the COM port on the second manifold and return to *section* ***4.5, Connection Procedure A0310*** to finish setup.

A0311-S A0311 **6.** ***A0311 and A0311***-S users may now proceed to section ***7, External Valve Sequencer Window***.

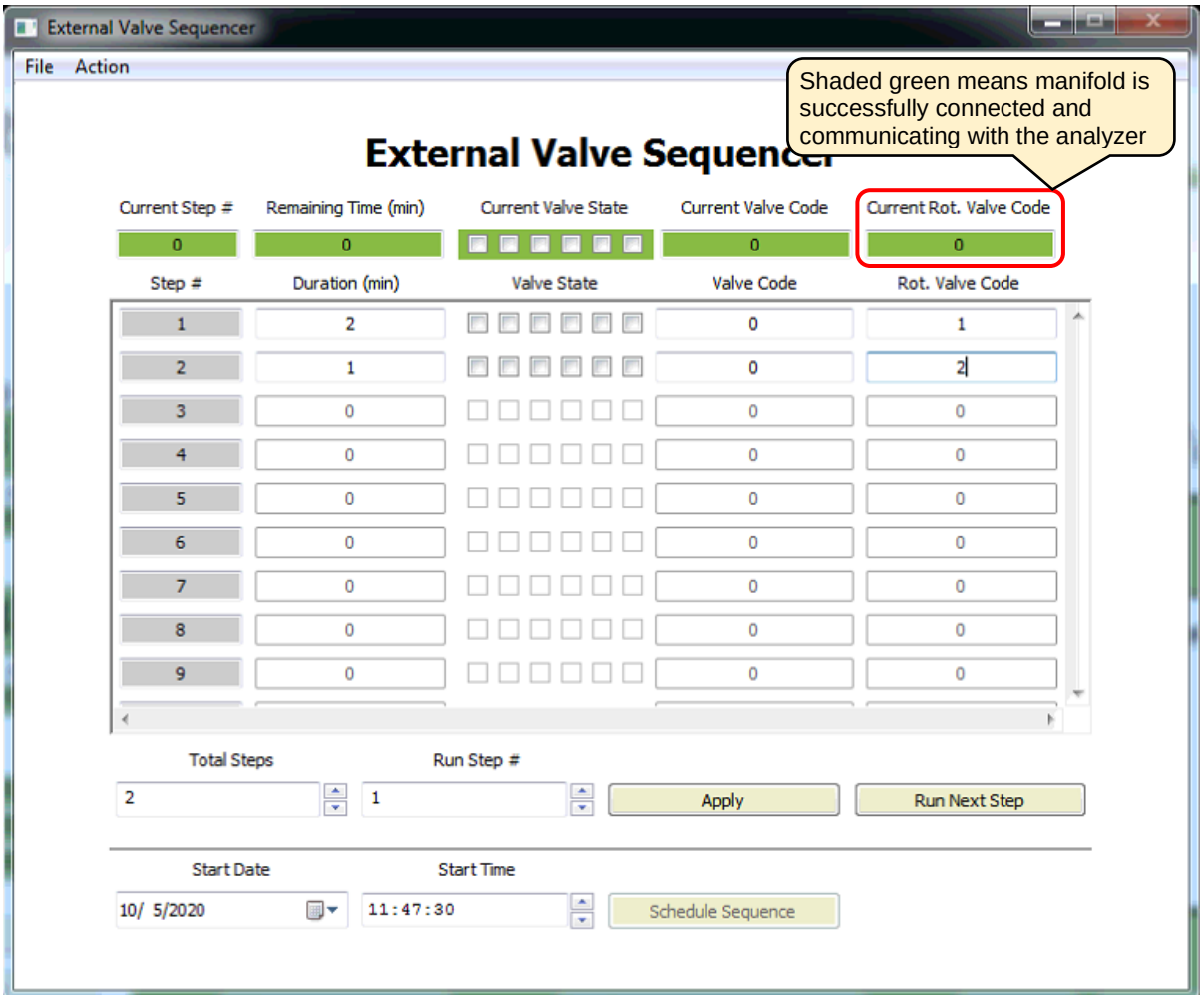


Figure 23: External Valve Sequencer Window

6. Initialize the Sequencer (Linux)

To initialize the Distribution Manifold for analyzers using Linux:

1. On the CRDS Data Viewer (Figure 24), click **Quit**.

   The Analyzer Shut Down pop-up displays.

2. Click **Yes** to shut down the analyzer.

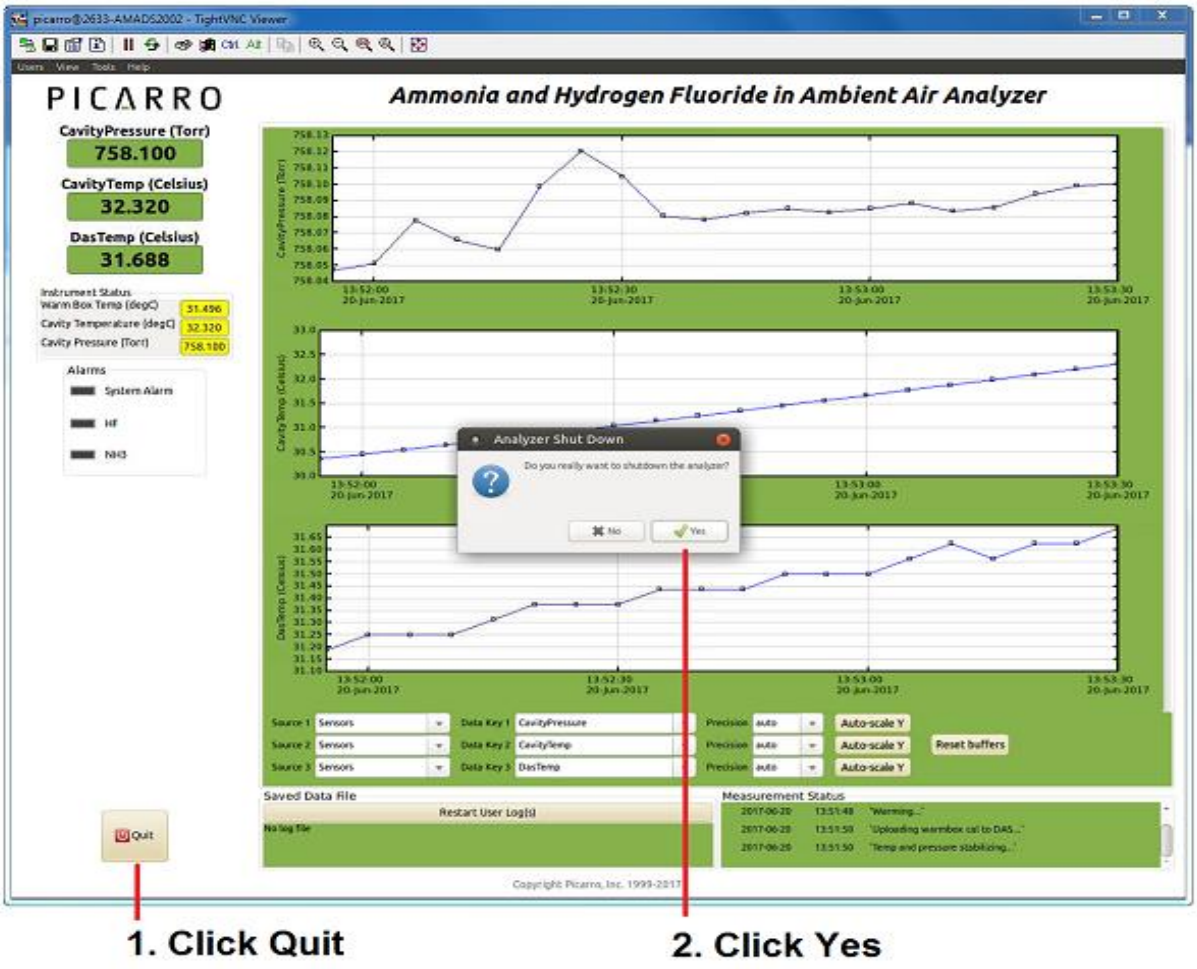


Figure 24: CRDS Data Viewer

3. Confirm the valve is connected into COM2 on the back of the analyzer, and then restart the analyzer.
4. The Distribution Manifold should now be initialized.
5. A0311 and A0311-S users may now proceed to *section* ***7, External Valve Sequencer Window***.

A0311

A0311-S

7. External Valve Sequencer Window

A0311

A0311-S

A0310

The 16 Port Distribution Manifold can be controlled using either:

- The hand-pad channel selector, or
- Picarro's **External Valve Sequencer** window

The External Valve Sequencer window serves a triple purpose. It can be used for the rotary (also known as multiport or multiposition) valve covered in this document; for controlling up to six valves in front ends like the Picarro A0314 Small Sample Introduction Module (SSIM) for leak testing; or for controlling additional 12V valves, typically 3-way solenoids for switching between gas sources.

It is important to understand that the check boxes in the **Current Valve State** column do not need to be selected when the valve sequencer is communicating with/controlling the MPV. Nor will the **Current Valve Code** number be relevant. Only the **Current Rot. Valve Code** is relevant to the functioning of the MPV.

If **Current Rot. Valve Code** doesn't show up with a green box beneath it (shown as green in Figure 25 below) the instrument doesn't recognize the MPV or MPVs. In this case, ensure the valve or valves are turned on, connected correctly per the setup diagrams, that **COM2** is selected for Valve Sequencer MPV in the Setup Tool, and that instrument restart has been executed. See ***APPENDIX B – Steps if Analyzer Can't Recognize Valve*** for help.

Figure 25 shows the External Valve Sequencer window status bar menu items and actions (which are described below). Figure 26 shows and describes the External Valve Sequencer field descriptions.

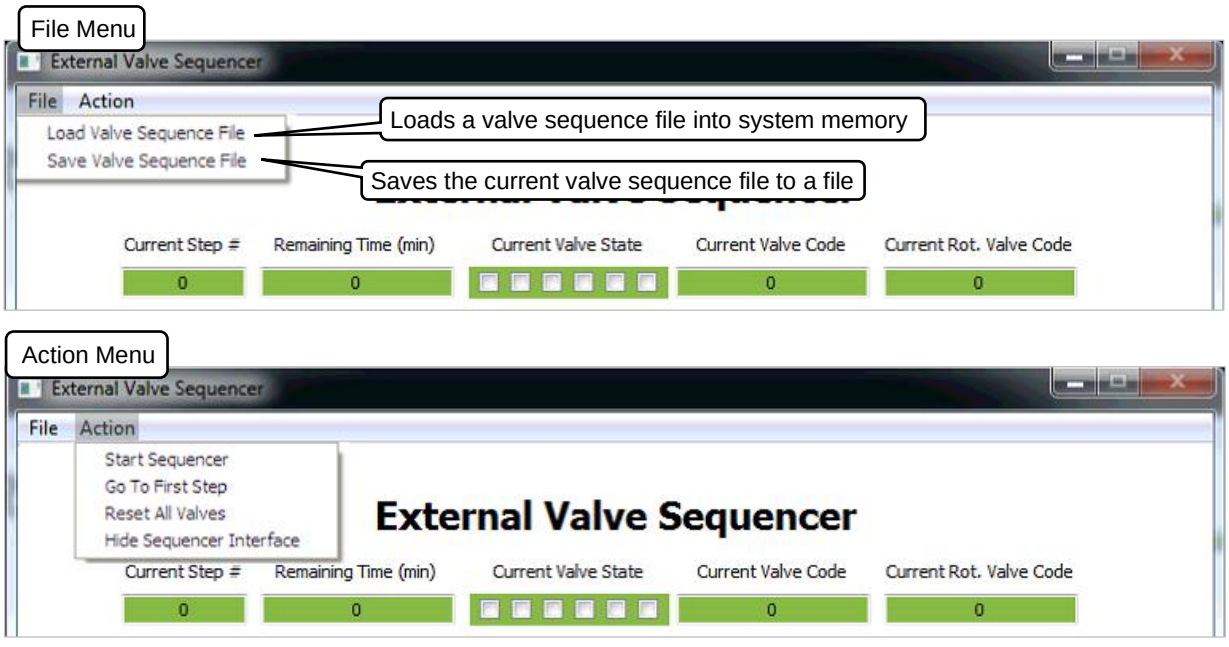


Figure 25: External Valve Sequencer File and Action Menu Selections.

7.1 File Menu

Refer to Figure 25.

Load a Valve Sequence File

Click here to load saved files.

For Windows OS, the sequence files are in:
C:\Picarro\G2000\InstrConfig\ValveSequencer\name of sequence file

For Linux OS, the sequence files are in:
/home/picaro/SI2000/InstrConfig/ValveSequencer/name of sequence file

Save a Valve Sequence File

Click **Action** | **Save Valve Sequence File**

7.2 Action Menu

Refer to Figure 25.

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). Will only act if valve sequence is already started.

Reset All Values

Click here to change all the *Rot. Valve Code* fields to zero.

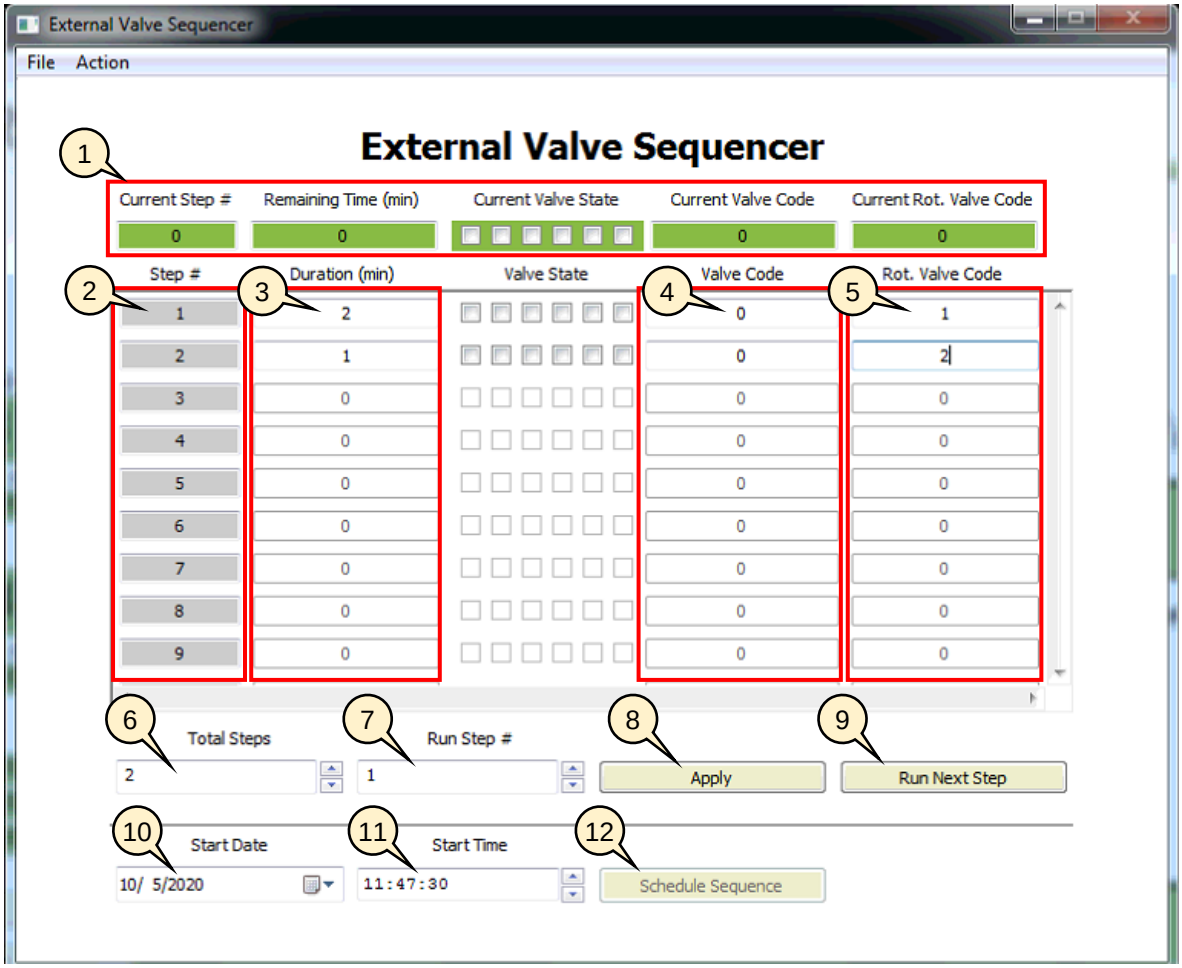
Hide Sequencer Interface

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

7.3 External Valve Sequencer Window Features

Figure 26 describes the External Valve Sequencer window features. They are described in more detail after the figure.

A0311-S A0311 A0310



1. Current status fields
2. Step number displays in this column
3. Set the duration of each step in this column
4. Valve code column reflects the bitmask value of the combined solenoid valve states. This is not related to the the multiposition valves, but can be combined with them to provide more fleixibility for multiplexing.
5. Use the Rot. Valve Code column to define the steps of a run.
6. Sets the total number of steps available.
7. Choose a step number to run
8. Apply changes
9. Manually move to the next step'
10. Sets the start date
11. Sets the start time
12. Click here to start the test at the defined date and time.

Figure 26: External Valve Sequencer Field Descriptions

Current Status Fields

The top row on the menu (Figure 26) gives the 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:** The Valve State value is not related to the multiplexer valves. It relates instead to the on or off state of independently powered 12V solenoid valves, which can be controlled by the Picarro analyzer. Selecting the check boxes for a given step will turn on such valves if present. From left to right, the conventional names for these external valves are V1, V2, … V6. These valves are powered from relays on the instrument power board and are controlled using the gray valve cable provided with Picarro analyzers. This cable comes with six Molex connectors labeled V1-V6, and with equivalent connectors and pins for the mating fittings on solenoid valve cables. Picarro is able to quote and provide 3-way solenoid valves with either 1/4” fittings (S3112) or 1/8” fittings (S3136), and users may use their own solenoid valves (on/off, 4-way, etc.) as long as they meet the criteria that they pull <0.5 Amps current at 12V.
- **Current Valve Code:** This field is not used when an analyzer is connected to a manifold. It reflects the bitmask value of the Valve State described in the previous section. For valves V1 – V6, a value of 0 is added to the total bitmask if the valve is off, and a value of 2^(n-1) is added if a valve is on, where n = the valve number, 1-6. When valves 1 and 4 are turned on, and all others are off, the Current Valve Code will display 2^(1-1) + 2^(4-1) = 1 + 8 = 9. All valve code bitmasks are uniquely determined. The purpose of this value is to provide a single field, typically referred to either as “solenoid_valves” or “ValveMask”, to the UserData files that tells the user the state of all 6 solenoid valves at a given time.
- **Current Rot. Valve Code:** Indicates which port is being sampled from the manifold. This value is recorded to the UserData files as “MPVPosition”.

Step Sequencing Fields

Use the step sequencing 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:** Enter the rotation valve code. For example, to sample port 1, enter valve code 1.

NOTE

The *Valve State* and *Valve Code* fields are not relevant to the multiport manifold, though they can sometimes be used in conjunction with other valves.

Window Bottom Section Fields

Use the bottom section of the window (Figure 26) 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 the step currently running. If a different step is desired, enter that step number and click on **Apply** (Figure 26).
- **Apply:** Click here to apply changes made using the *External Valve Sequencer* window.
- **Run Next Step:** Forces the sequencer to 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.

7.4 Set Up a Sequence Using the Valve Sequencer Window

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

To set up a sampling sequence:

1. On the Picarro analyzer GUI, go to:
   - **Tools**
   - **Show/Hide Valve Sequencer**

The External Valve Sequencer window displays (Figure 26).

2. Use the *Rot. Valve Code* column to set the position of the rotary selector valve.
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 1 on the rotary 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 (Windows)

   /home/picaro/SI2000/InstrConfig/ValveSequencer/name of the sequence file (Linux)
6. Start sequence by hitting **Apply**, and then **Start Sequence** from the **Action** menu. Ensure the sequence is starting from the first step, and if not, select **Go to the First Step** from the **Action** menu.

7.5 Load and/or Run a Saved Sequence

1. Load saved sequence files by clicking **File | Load Valve Sequence** (Figure 25). All the sequence files are in:
   - C:\Picarro\G2000\InstrConfig\ValveSequencer\Name of the Sequence File (Windows).
   - /home/picaro/SI2000/InstrConfig/ValveSequencer/name of the sequence file (Linux).
2. Click **Apply** to run the sequence.

   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 (Figure 25).
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 sequencer 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).

7.6 Using the Channel Selector Hand-Pad – A0311

A0311

A0310

The channel selector hand-pad shown in Figure 27 overrides the GUI set valve sequence.

If an *up* or *down* channel selection is made on the hand-pad during a sample run, the valve will switch, without regard for the GUI-set valve sequence. The list below describes the hand-pad controls.

1. Display screen
2. The **STEP** button moves the actuator up to the next position.
3. The **HOME** button moves the actuator to position 1.
4. Pressing the **STEP** and **HOME** buttons at the same time moves the actuator to the previous position.

A0311

A0310

Figure 27: Hand-Pad Channel Selector – A0311 or A0310

7.7 Using the Channel Selector Hand-Pad – A0311-S

A0311-S

The channel selector hand-pad shown in Figure 28 overrides the GUI set valve sequence.

If an **Up** or **Down** channel selection is made on the hand-pad during a sample run, the valve will switch, without regard for the GUI-set valve sequence. The list below describes the hand-pad control functions.

1. Display screen.
2. The up arrow button (moves the actuator up to the next position).
3. The down arrow button (moves the actuator down to the next position).
4. The home/setup button (moves the actuator to position 1).

A0311-S

Figure 28: Hand-Pad Channel Selector – A0311-S

8. Calibration, Flow Pathways

8.1 Calibration

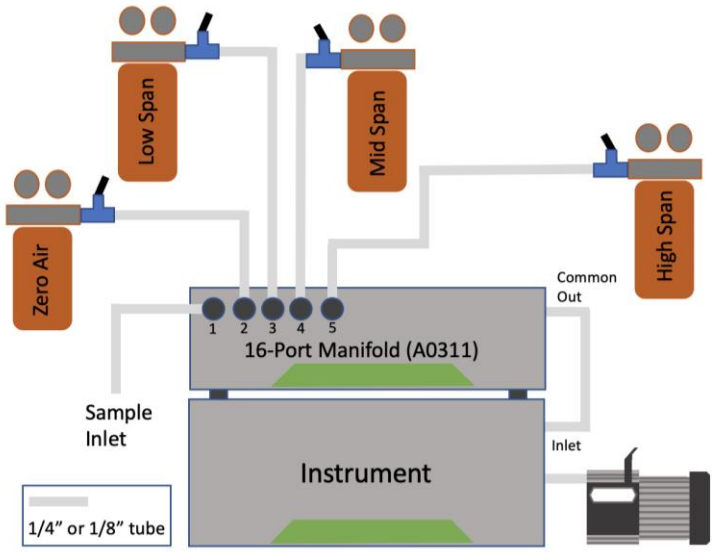
A0311

The flow path for the A0311-S manifold differs significantly from that for the A0311. On the A0311, a single position is selected at a time (Figure 8), and all other positions dead-end in the valve. In the A0311-S (Figure 11), a single position is selected to go to the instrument, and is pulled in by the instrument pump, while all other 15 positions are flushed continuously by a second pump connected to the back of the A0311-S manifold box.

Because the A0311-S is constantly flushed, it is typically a poor choice as a tool for enabling calibration checks. Connecting up calibration tanks to, e.g., positions 2-5 would cause those tanks to be drawn down in pressure significantly in a very short amount of time. Similarly, if a closed regulator was upstream, a negative pressure draw from the A2000 pump could potentially damage the regulator's internal gasket seals.

The A0311, however, is a good choice for calibration checks (Figure 29), as positions e.g., 2-5 dead-end while position 1 is chosen. In this configuration, calibration gas is saved, ***as long as all fittings upstream of the valve are leak tight***.

To set up a calibration check with a consistent cadence, follow the steps below. Durations used are nominal but typical and will depend on the user needs. Instruments with high gas flow rates may use shorter calibration check periods, while instruments with slow flow rates, or where memory effect can be challenging (e.g., isotopic carbon instruments), may wish to extend their calibration periods.



This shows a simplified calibration check setup for the A0311 using zero air and three span gases.

Figure 29: Simplified Calibration Check Setup for A0311

1. Select **Show/Hide Valve Sequencer GUI**. If the valve sequencer doesn't show up immediately, hit **Alt+Tab** keys to bring it to the foreground.

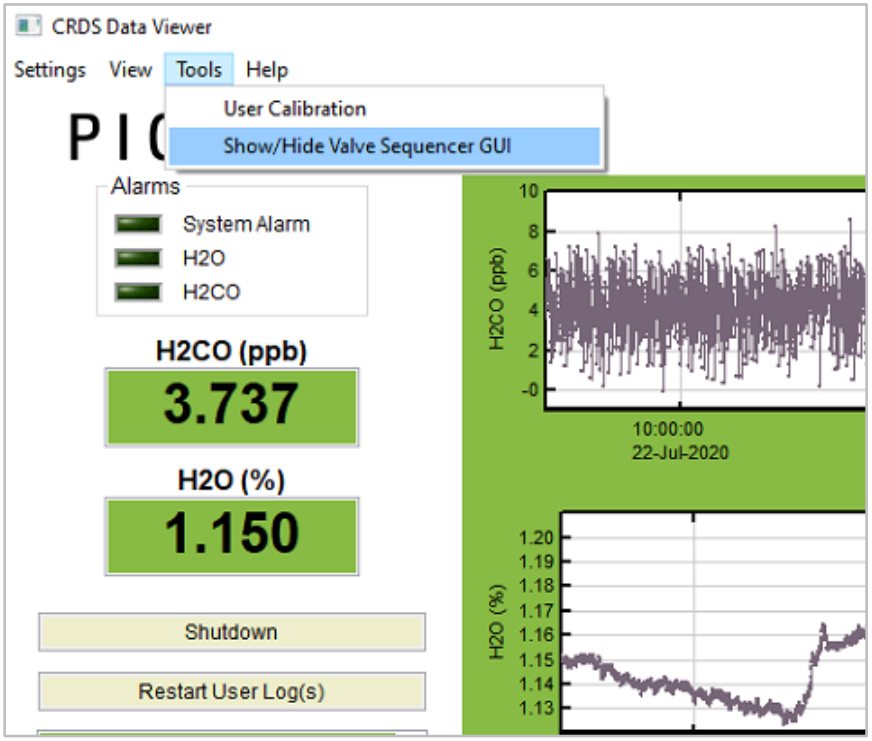


Figure 30: Showing Valve Sequencer Window

2. In Valve Sequencer, set the manifold to run the validation procedure itself with 10-minute periods for each cylinder:

Table 5: Valve Sequencer Validation Steps

Sequence:		
***Step 1*: Duration:** 10 minutes	**Rot Valve Code:** 2	**Desc:** Run first cylinder
***Step 2*: Duration:** 10 minutes	**Rot Valve Code:** 3	**Desc:** Run second cylinder
***Step 3*: Duration:** 10 minutes	**Rot Valve Code:** 4	**Desc:** Run third cylinder
***Step 4*: Duration:** 10 minutes	**Rot Valve Code:** 5	**Desc:** Run fourth cylinder
***Step 5*: Duration:** 1400 minutes (daily) 10040 (weekly)	**Rot Valve Code:** 2	**Desc:** Sampling

3. Confirm that "Valve Code" is set to 0 for all steps.
4. Under the **Action** menu, select **Start Sequencer**, and confirm that the valve audibly switches to position 2, and that the **Remaining Time (min)** entry begins counting down from 10 minutes. If the sequencer does not start, consult section ***12, Troubleshooting*** in this manual, especially regarding com ports.

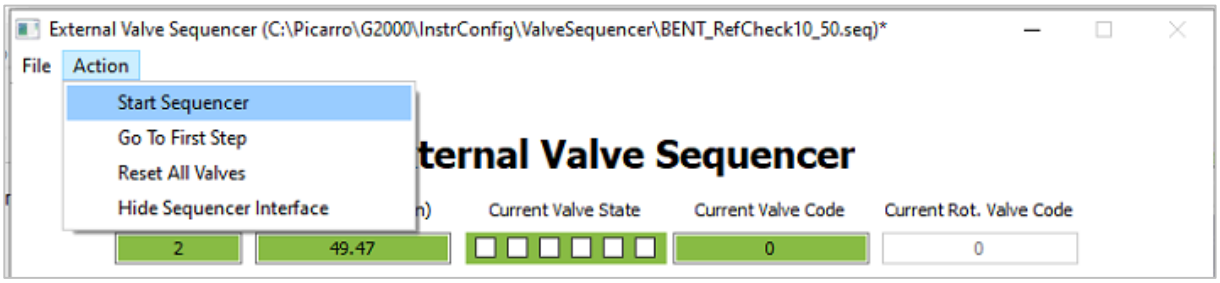


Figure 31: Starting Valve Sequencer from Action Menu.

5. To instead begin the sequence at midnight, with the sequencer not actively counting down, and with the valve in position 1, adjust **Start Date** to tomorrow's date, and **Start Time** to **00:00:00**, and click **Schedule Sequence**. If Schedule Sequence shows up as grayed out, check that you are selecting tomorrow's date using the system clock time, which is hours ahead of local time for US customers.

NOTE

Sequences started at midnight will not stay perfectly aligned with midnight as the sequence progresses, with timing procession on order a few seconds to a few minutes per day.

8.2 Single-port Operation

A0311
A0311-S

Some operators may wish to keep the manifold in place on top of the instrument and connected to the inlet, but only sample from a single position consistently. To ensure that the valve sequencer won't move during operation, follow these steps:

5. Ensure the analyzer is off.
6. With A0311 connected and turned on from the rear pannel, use the hand pad to send the valve to **Position 1**.
7. Start the pump and then the instrument.
8. From the Picarro software **Tools** menu, select **Show/Hide Valve Sequencer** (Alt+Tab to bring to front).
9. Confirm that the sequencer is not actively running either by noting that **Remaining Time (min)** is not changing or by confirming that **Start Sequencer** (not **Stop Sequencer**) is visible in the Action menu.
10. At this point, unless changed, the Picarro instrument will pull gas from the 1st port on the A0311 or A0311-S manifold only.

9. Recirculation with the A0310

A0310

The A0310 manifold pairing for recirculation is provided with the goal that customers will likely use this hardware as the basis of a more sophisticated recirculation system, depending on the nature of their needs. For example, in soil incubations focusing on isotopic carbon signatures with rapid CO2 fluxes into a small headspace, it may be challenging to run a sequence for a long enough period before the concentration of CO2 exceeds the range for Picarro's instruments.

We provide here some broad guidance on best practices for recirculation, including some suggestions about purging common lines with dry gas, sweeping out headspace, and how to set up valve sequences to accommodate differing use cases. Because the details of these configurations are complex, Picarro cannot guarantee that a configuration will work for a given use case and encourages users to explore any additional system elements that may be needed.

9.1 Reducing Position-to-Position Carryover

Refer to Figure 32 *below while following these instructions.*

When a user moves from one sample container to the next, it is often desirable to sweep out all gas from the shared sample lines and instrument cavity before proceeding to the subsequent position, to ensure that gas from the first chamber doesn't contaminate the next. To reduce this carryover effect, the user may designate a single position on the lower "Sample Return" selector manifold as a "Purge Position". For the purposes of illustration in this section, we will recommend using Position 1 as an Ambient Air/Default position, and Position 2 as this dry gas "Purge Position".

For an Ambient Air/Default position, leave Position 1 on both the "Sample Return" and "Sample Out" selector manifolds disconnected.

For a Purge Position, choose a dry gas delivered reliably at the lowest possible pressure (1PSIG recommended) which is consistent with the sample matrix (zero air if aerobic, N_2 if anaerobic). Connect this gas line to position 2 on the lower "Sample Return" manifold and leave Position 2 on the "Sample Out" selector manifold disconnected and venting to room.

In this configuration, when the user/Valve Sequencer moves to Position 1, ambient air will flush through the instrument from the Sample Return manifold to the instrument to the Sample Out manifold, giving the user a safe location where no consumable gas is expended, and where test configurations can be hooked up. When the user/Valve Sequencer moves to Position 2, the chosen dry gas will sweep through the common line of the Sample Return manifold, the instrument, the recirculation pump, and the Sample Out manifolds, and then vent to air, at the native flowrate of the instrument. When any other position is selected, the Purge gas will terminate at the Sample Return manifold and will not flow.

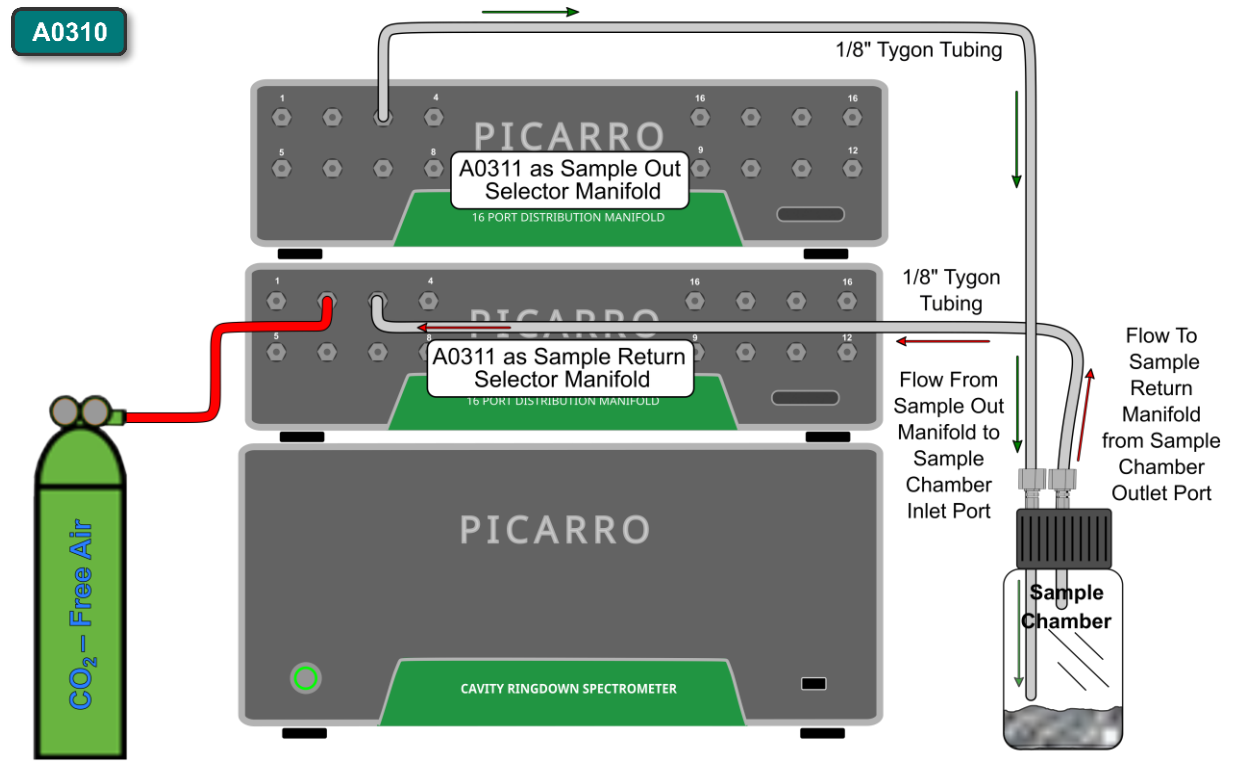


Figure 32: Setup for Eliminating Position-to-Position Carryover

A typical sequence to perform headspace characterization might look like the following:

During setup:

Move valves to Rot Valve Code 1, ambient air, with sequence stopped, until all sample jars are prepped and connected.

Table 6: Valve Sequencer Setup for Headspace Characterization

Sequence:		
***Step 1*: Duration:** 2 minutes	**Rot Valve Code:** 2	**Desc:** Purge common lines
***Step 2*: Duration:** 10 minutes	**Rot Valve Code:** 3	**Desc:** Run first sample
***Step 3*: Duration:** 2 minutes	**Rot Valve Code:** 2	**Desc:** Purge common lines
***Step 4*: Duration:** 10 minutes	**Rot Valve Code:** 4	**Desc:** Run second sample
***Step 5*: Duration:** 2 minutes	**Rot Valve Code:** 2	**Desc:** Purge common lines
***Step 6*: Duration:** 10 minutes	**Rot Valve Code:** 5	**Desc:** Run third sample
… Etc., until the user reaches Valve Position 16.		
***Step n*: Duration:** 100 minutes	**Rot Valve Code:** 1	**Desc:** Return to ambient

The user should determine the appropriate length for the Purge steps. Above, we suggest a notional choice of 2 minutes based on experience that this is adequate for bringing the sample measurement to <1 ppm CO2 even on slower flow systems like the G2201-i. Users may find that 1 minute or even 30 seconds is adequate for the G2508/G2308 and other instruments. The user must make their own determination about an acceptable baseline concentration value between samples. For some, a baseline of <10 ppm CO2 may be acceptable, while for others a baseline of <10 ppb N2O or Ethylene may be necessary depending on the size of the flux produced in the chambers.

The user should also determine the appropriate time for the sample steps given the signals to be observed, the expected flux, and the speed of the biological, chemical, or physical process.

CAUTION

As gases, typically CO_2, accumulate in the headspace of a sample jar over hours, they may eventually exceed the operating concentration range of the instrument for a given gas. Consult your data sheet, and limit runs without headspace purging to ensure headspace gas build-up does not lead to data quality issues through ringdown timeouts or interference. If sweepout is desired, consider the approach recommended in the next section.

9.2 Sweeping Out Headspace

A0310

Sweeping out the headspace of each chamber before analysis cannot be achieved with the A0310 alone, and it is challenging to do even in the way described below for low-flow instruments, as the sweep-out rate is limited to the flow rate of the analyzer. The suggestions in this section have not been tested by Picarro, but broadly they could be put to use if an appropriate 4-way valve with low pressure drop is chosen.

CAUTION

This should only be attempted by customers comfortable with and knowledgeable about electrical wiring and pneumatic systems. Picarro Support cannot be responsible for assisting with setting up such a system. The methods recommended below are notional only, provided as guides for customers who engineer their own solutions, and do not constitute a Picarro-approved complete solution.

NOTE

Picarro is able to quote and provide 3-way solenoid valves with either 1/4" fittings (S3112) or 1/8" fittings (S3136) but is not currently able to quote 4-way or on/off solenoids. For the time being we do not have specific recommendations on suitable products, though Humphrey (e.g., P/N 1943712VDC) and Mettle Air have historically provided high quality 12V solenoids. The user must ensure that the solenoid is 12VDC drawing 0.5A (total 6W) or less. Valves that draw more current than this may blow the relays on the Picarro analyzer power board. Ideal valves have a flow CV value of 0.47 or greater, typical with ¼" fittings. 1/8" fittings may lead to pressure drop and instability.

Figure 33 below gives some notional sense for one way that sweep out of headspace might be achieved. In this diagram, a 4-way valve (with a 4/2 flow pathway) is powered from the V1 position on the Picarro Valves cable, while a second on/off solenoid is powered from the V2 position. The 4-way is connected up such that the normally open pathway (blue lines) allows normal operation of the recirculation system, while the normally closed (green dots) a.k.a. energized state allow purging from CO2-free air (either zero air or N2). During the normally closed state of V1, V2 is energized to allow air to flow from the tank, while during the normally open state of V1, V2 is closed to preserve gas. Below is an example of how this might be set configured in the Valve Sequencer program. Unlike in the prior example, this example uses ambient air in position 1, and doesn't have a dedicated Purge Gas port, as the purge gas is incorporated via the 4-way valve. In this example, Valve Code refers to the binary code for the V1 and V2 positions. Here, when V1 and V2 are both *not* energized, it produces a value of 0 + 0, and when V1 and V2 are both energized it produces a value of 1 + 2. See ***Current Status Fields*** in section ***7.3*** for more details.

In the example below, 10 minutes is chosen for the purge step. Choose an appropriate duration based on your instrument flow rate (Isocarbon: ~40 sccm; G2308/G2508 ~230 sccm), headspace volume, and baseline concentration value requirements.

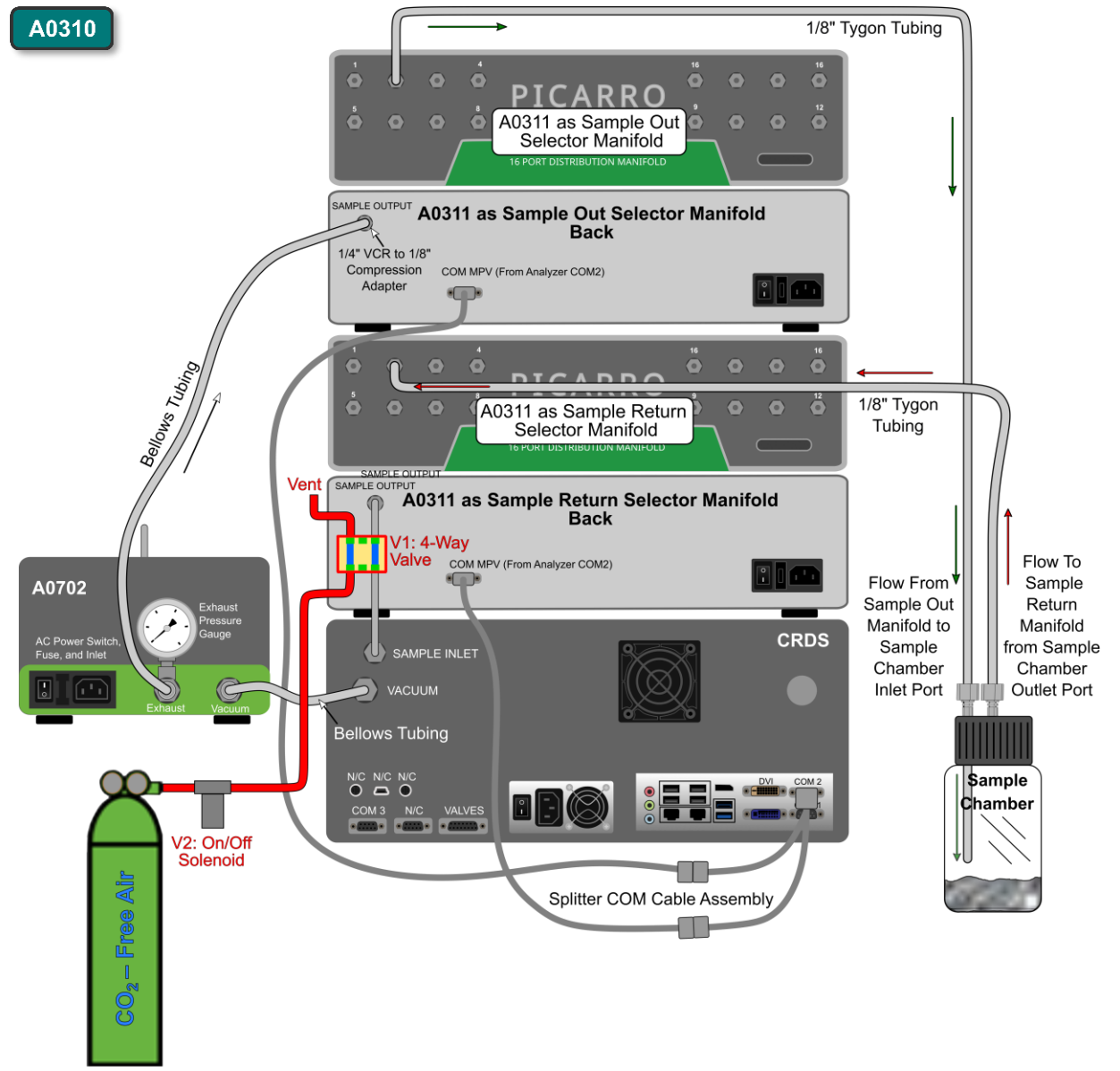


Figure 33: Notional Configuration for Sweep-Out of Chamber Headspace

During setup:

Move valves to Rot Valve Code 1, ambient air, with sequence stopped, until all sample jars are prepped and connected.

Table 7: Valve Sequencer Setup for Sweep-out of Chamber Headspace

Sequence:			
***Step 1*: Duration:** 10 min	**Valve Code: 3**	**Rot Valve Code:** 2	**Desc:** Purge
***Step 2*: Duration:** 10 min	Valve Code: 0	**Rot Valve Code:** 2	**Desc:** Samp 1
***Step 3*: Duration:** 10 min	**Valve Code: 3**	**Rot Valve Code:** 3	**Desc:** Purge
***Step 4*: Duration:** 10 min	Valve Code: 0	**Rot Valve Code:** 3	**Desc**: Samp 2
***Step 5*: Duration:** 10 min	**Valve Code: 3**	**Rot Valve Code:** 4	**Desc**: Purge
***Step 6*: Duration:** 10 min	Valve Code: 0	**Rot Valve Code:** 4	**Desc:** Samp 3
… Etc. until the user reaches Valve Pos 16. ***…***			
Step n: Duration: 10,000 min	Valve Code: 0	**Rot Valve Code**: 1	**Desc**: Return to ambient

Here, **Valve Code 3** signifies V1 (4-way solenoid) being energized into the purge position (blue lines in the figure above), V2 (on/off solenoid) being energized to allow dry gas flow. **Valve Code 0** refers to V1 (4-way) being in its normal position allowing recirculation flow, and V2 (on/off) being off so that gas isn't purged and wasted from the tank. See section ***7.3*** above for more descriptions of Valve Codes, and other parameters in the Valve Sequencer software.

9.3 Additional best practices

A0310

Because the A0310 configuration is not a complete solution for flux measurements, we encourage customers to supplement the A0310 with additional sensors or devices as needed to fit their application. Some considerations include:

1. **Providing leak-tight fittings for sample jars or other containers.** Picarro provides two possible fittings in the A0702 fittings kit that adapt VCR 1/4" to 1/8" Male NPT that can be used for single container purposes. However, for Ball Jars, we typically recommend slightly different bulkhead fittings. Examples include:
    a. **(Inexpensive)** Bulkhead push-connect fittings like those from Legris (Figure 34). These fittings can be found at Grainger.com. For 1/4", search **PN 1PFC6**, Manufacturer **PN 3116 56 00**, and for 1/8", search **PN 1PFT9**, Manufacturer **PN 3116 53 00**. These can be sealed to the jar lid with either a grommet or silicone sealant, and if desired, a small section of tubing can be

connected to the lower fitting on the inlet side of the container to ensure the in and out tubes don't sample/return from the same level in the headspace (see ***Figure 14***).

Figure 34: Bulkhead Push-Connect Fitting

b. **(Expensive)** Quick connect or standard Swagelok stainless steel bulkhead fittings (search Swagelok.com for "bulkhead quick connect" to see options. One such fitting is shown on the left in Figure 35, PN SS-QC4-B1-400, which would mate to a SS-QC4-D1-400 to its right.

Figure 35: Swagelok Quick Connects

2. **Circulating headspace with a fan.** Especially with large headspaces and low flow instruments, headspaces can stratify, concentrating flux signals near the surface of the soil. Adding a small computer fan to each jar's headspace can address this effect significantly, improving stabilization time between samples. Such a fan can be routed through a small bulkhead grommet in a Ball jar lid and powered from a small battery or computer board.
3. **Providing temperature or pressure sensors for headspace.** Users may want to monitor temperature and pressure in the headspace of jars to correct for any small dilution effects from purge gases, or temp/pressure related mass conservation terms. These can also be installed through a grommet in the Ball Jar lid.

9.4 Interpreting results of recirculation work

Headspace work is inevitably challenging from a mass conservation perspective. Using a syringe to removing headspace aliquots at set time intervals may reduce carryover concerns but decreases the headspace pressure (potentially changing system dynamics), which can lead to inward leaks, and eventually challenges

pulling adequate sample volume for later sample aliquots. Conversely, using a multiplexing recirculation system like the A0310 can lead to some carryover, dilution, or over-concentration effects discussed in the previous sections if not adequately controlled for by the setup. Using a purge gas between samples helps reduce carryover but may lead to a slight increase in sample pressure and volume with time as the delivery pressure of the gas increases the pressure in all positions. This effect is small but real and can be corrected for if a pressure gauge is used on the jars in question.

Some amount of equilibration should be expected at each new position as the sampling lines carry sample from the sample container to the analyzer, so users should attempt to control for this by estimating this equilibration time, based on their setup. In the example below, each position on an isotopic carbon analyzer shows some equilibration period before a general upward or downward trend dominates, showing the expected system behavior or respiration or photosynthesis. In the figure below an equilibration time of about 4 minutes appears adequate. The user would want to flag the first four minutes of data on a given position (using the MPVPosition variable) before using the remaining data to calculate an average value or a flux trend.

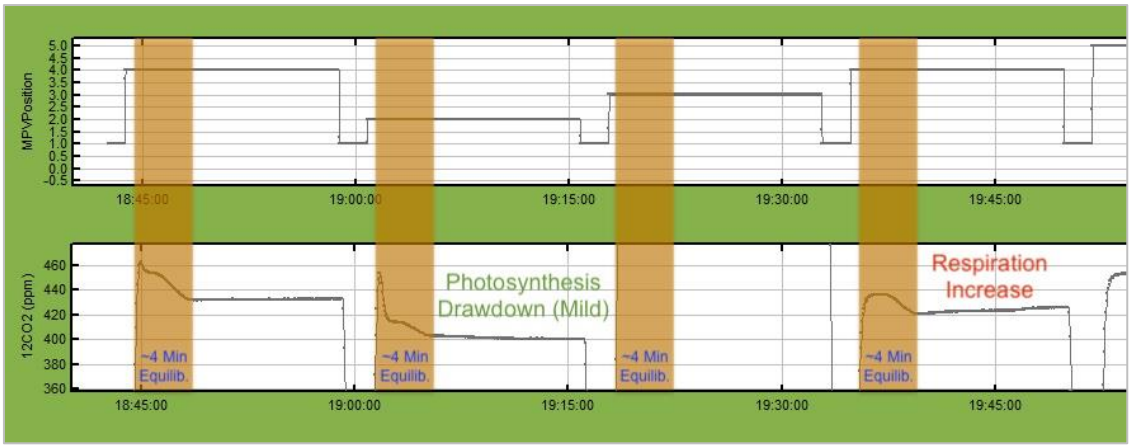


Figure 36: A0310 Valve Sequence Showing Equilibration Periods

Given the challenges of movement from position to position, users may prefer to set up their experiments to follow each position for a longer period of time (say, 1 hour) to quantify a flux as it evolves clearly over a single period of time, rather than from one sampling time period A to some later time period B.

There are no discrete sample values by position provided by the A0310 configuration, unlike with some Picarro peripherals controlled by coordinators (e.g. SSIM A0314, Water Autosampler A0325). Data produced with the A0310 is saved to the UserLog data files, found under C:/Picarro/UserData/datalog_user/YYYY/MM/DD. Position can be determined by the MPVPosition (multiplexer valve position) variable column. Fluxes can be computed position by position in Excel using appropriate formulas, or can be automated with software like Python, R, or Matlab based on the MPVPosition and other variable cues.

10. Pharmaceutical Use (PI2114 + A0311-S)

A0311-S
PI2114

Pharmaceutical customers wishing to multiplex vapor-phase hydrogen peroxide (VHP, or VPHP) sampling will want to use the A0311-S manifold, as it contains compatible sample handling materials, and keeps all lines constantly refreshed to reduce position-to-position memory effects. Though this manifold is an excellent choice for this application, there are some important caveats about its use, which we outline here.

1. The A0311-S and PI2114 pairing is suited for research applications only at this time for the following reasons:
    a. The A0311-S is only enabled in the PI2114 software on instruments in “Research Mode”, and not for those in “Compliance Mode".
    b. The A0311-S pulls from all positions simultaneously, which may cause some isolator pressure integrity checks to fail before a decontamination step. Accordingly, users may wish to turn the A0311-S pump off during this stage of the overall fill cycle. This can be done easily for research applications, but becomes more challenging for day-to-day operations.
2. The A0311-S significantly increases the removal of H2O2-rich air from an isolator (by a factor of 10-20) which can increase the ambient H2O2 concentrations around the operators in the room. Users with a A0311-S should consider equipping their A2000 pump(s) with an appropriately-chosen exhaust line vented to the vent plenum of the isolator, or to an appropriate activated carbon scrubbing vessel if they are concerned about increases in ambient H2O2. See **APPENDIX A – Setting up Contained Pump Exhaust Flow**) for instructions.

NOTE

Users should speak with a Picarro application scientist before purchase to scope whether an A0311-S is appropriate for their application.

11. Maintenance

11.1 Fuse Replacement

Fuse replacement is the only maintenance that should be performed by uncertified persons. Follow this procedure to replace a fuse. Figure 37 shows the fused power connector on the rear panel of the unit.

Figure 37: Fused Power Connector

WARNING

When replacing the fuse, ensure the new fuse has the same rating as the original.

WARNING

Before replacing a fuse, make sure that the power switch is in the OFF position (Figure 37) and that the power cord is disconnected.

1. Insert a screwdriver flat head under the tab on the fuse housing (see Figure 38).
2. Carefully push the screwdriver handle away from you to extract the fuse housing out of the back panel.
3. Remove the fuse from the fuse housing. Figure 38 shows these steps.
4. Put a new fuse (1.5 A/250 VAC, SB 5 x 20 mm) in the fuse holder.
5. Push the fuse holder into the rear panel. You will hear a click when it is fully inserted.

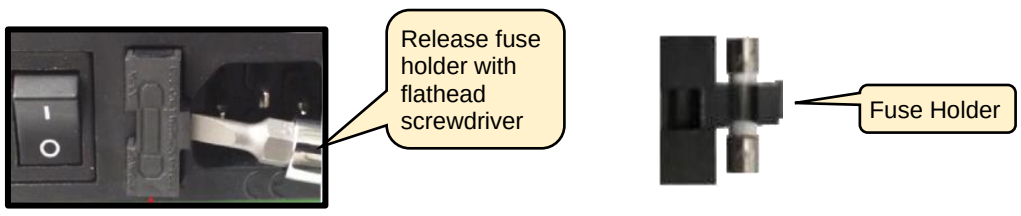


Figure 38: Replacing the Fuse

1.1 Cleaning

Clean the outside of the A0311 or A0311-S with a clean dry cloth. Only certified service technicians should access or clean the inside of the A0311 unless otherwise instructed.

12. Troubleshooting

12.1 Valves Not Turning On

My valve(s) is/are plugged in and connected. Why won't the valve sequencer recognize them?

Occasionally, if the user changes a system parameter in *Setup Tool*, the system may subsequently fail to communicate with the manifold valves. This typically does not happen during a run, but in preparatory stages.

Try first rebooting the software from the **Stop Software** red icon in *Diagnostics* and then double clicking **Start Instrument** on the desktop. If this does not sort the issue out, turn off the analyzer, unplug the serial cable at the back of the instrument, plug it back in, and restart the analyzer.

If this is unsuccessful, when the system boots up, from *Picarro Diagnostics* folder, select **Stop Instrument**, keep driver running. From *Picarro Utilities*, select **Setup Tool**, navigate to *Port Manager* and under *Valve Sequencer MPV* select **Off**, click **Apply**, select **COM2**, **Apply**, and then **Exit**. Restart the instrument.

12.2 Hand Pad Not Operating

The Hand Pad on my manifold won't show a position or otherwise indicate it has power when the manifold is plugged into line power and turned on.

Occasionally A0311 or A0311-S builds from before mid-2022 have experienced power cables coming loose inside the box. Builds after mid-2022 contain standoffs designed to prevent this from occurring. If your hand pad will not power up, you will need to remove the lid of the A0311 or A0311-S box to reconnect the power supply cable.

WARNING

Hazardous Voltage: Ensure the manifold is turned off and the power plug removed. Removing the cover without unplugging may expose user to hazardous voltages.

1. Turn of the power switch at the back panel of the manifold and remove the power plug.
2. Remove the 2 mm screws from the back and sides of the manifold box and set them aside safely in a container (Figure 39).

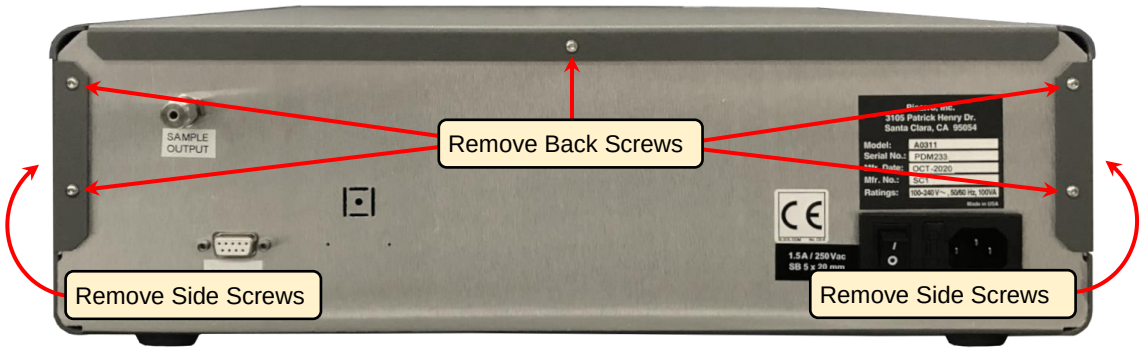


Figure 39: Remove 2 mm Screws (Back And Sides)

3. Remove the lid and set aside, and inspect the power suppy area.
4. If the power cable is disconnected, as seen on the left in Figure ***40***, reconnect it to the power supply brick.
5. Install the manifold box cover and secure it with the 2 mm screws.

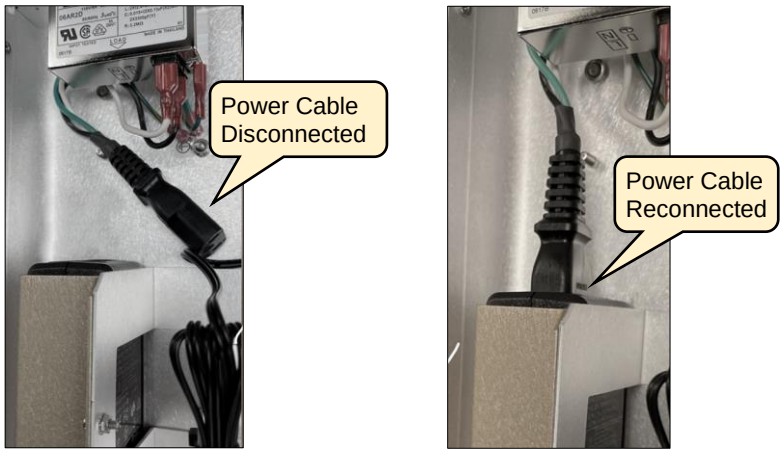


Figure** 40**: Inside Manifold Box – Disconnected and Reconnected Power Cable

12.3 "Pressure Unlocked" errors

If the Picarro data viewer software shows "Pressure unlocked" errors, check the following:

1. That the position(s) of the manifold(s), is as expected, and/or consistent if the A0310 is being used.
2. Confirm that the manifold(s) are turned on and confirm position with the hand pad.
3. Confirm that the manifold(s) is/are communicating by checking the Current Rot Valve Code window in the upper right of the Valve Sequencer is green, indicating communications are successful.

4. Confirm that pumps are turned on, and that flow or recirculation pathway is correct.
5. Check lines for any impediments, especially inlets that may have accumulated condensed water.
6. Check relevant tanks to ensure that the cylinder valve, pressure delivery knob and on/off valve (if present) are all open or at their set points.

12.4 Sampling Port Does Not Change

The sampling port doesn't change after commanding the software to do so. I have directed the A0311/A0311-S to sample from another port, but I'm still measuring what I have connected to the previous port. Why doesn't the valve change position?

1. Check that the cables, especially the cable connecting the MPV to the Analyzer's COM ports is still connected and seated snugly. If the cable is loose, damaged, or has otherwise failed, it might need to be addressed first before performing further troubleshooting.
2. Reattach any loose cables as written in section ***4.3, Connection Procedure: A0311*** or section ***4.4, Connection Procedure A0311-S Connection Procedure***, and then power down and start the A0311/A0311-S and Picarro Analyzer in the proper startup order.
3. If problems persist, connect the hand pad to the A0311/A0311-S and change the position of the valve manually.

   You should hear the motor faintly make a sound as it attempts to change the valve head. If the hand pad does indicate the position has changed, but the input sampling port appears to remain unchanged, report the results of this test to support@picarro.com for further instructions.

12.5 Sample Vessel Pressure is Increasing with A0310

The pressure in my sample vessels is increasing with time. Why is this happening?

This may occur for a few reasons:

1. Pressure of purge gas regulator is too high (>2 psig) and increasing system pressure slowly with time.
2. A fitting on the vacuum portion of the recirculation system is leaking inward. Check section ***4.5, Connection Procedure A0310*** for images of the two most likely leak points on the 1/4” to 3/8" adaptor.

12.6 Dilution Using Purge Gas on A0310

When I use the purge gas approach in section ***9.1 Reducing Position-to-Position Carryover*** I find a small dilution of the concentration values of my sample vessel with time. Why is this happening?

The purging approach removes sample gas from the common lines in the analyzer and manifolds to prevent a memory effect (especially isotopic) on the subsequent sample position. This common sample pathway contains roughly 105 SCCs of gas. When this is swept out with zero air, the zero air will slightly dilute the concentration of the headspace in the subsequent sample. We encourage users to favor a method of longer sampling time on each position (e.g., 20-30 mins) to observe fluxes in real time. The alternative approach—revisiting the same sample many times to calculate flux over several hours—will be biased by this dilution effect.

If the alternative approach is preferred, however, users may quantify the dilution effect using an empty jar with a known concentration of gas (e.g., 1000 ppm CO2) in it, and observing the dilution effect with each purging and sampling iteration on that position (e.g., 3-5 repeats of the following steps: 2 mins purge step, 10 mins Position 3 with the empty sample jar). The decrease in the stable concentration value as a fraction of the previous value will give the dilution factor. E.g., 1000→900→810→729 would suggest a consistent 10% dilution effect.

APPENDIX A – Setting up Contained Pump Exhaust Flow

A.1 Introduction

The A2000 vacuum pump is shipped with a noise dampener attached to the exhaust port. When a hazardous gas exhaust line from the pump is needed, it requires replacing the noise dampener with an adapter that allows a 1/4” OD exhaust tubing connection. Use the following instructions if installing a pump exhaust line.

Figure 41: A2000 Pump Vacuum and Exhaust Ports

A.2 Tools and Parts Required

- Long flathead screwdriver (6” x 5/16” recommended)
- 9/16” open end wrench
- Swagelok ISO parallel thread adapter 1/4"-1/8” SS-400-1-2RS (Picarro PN 22928)
- Swagelok gasket SS-2-RS-2V (Picarro PN 22929)
- 1/4" tubing and stainless-steel ferrule set
- Snoop leak-detection fluid or similar soap solution

A.3 Directions

1. If your Picarro Analyzer is running, power down by clicking the **Shutdown** button on the main screen. Picarro recommends following the Shutdown section located in your analyzer User Manual. Once powered down, turn off the analyzer pump using the switch on the side and unplug the power cable.
2. Remove the noise dampener fitting from the bottom of the pump using a long flathead screwdriver (Figure 42). Note that due to close the proximity of the pump foot, it may be difficult to remove the dampener using the screwdriver. As an alternative, use adjustable locking type pliers to remove the dampener.

Figure 42: Pump Noise Dampener Removal

3. Slide the adapter gasket PN 22929 onto the adapter fitting PN 22928 (Figure 43), screw it into the pump exhaust port, and then tighten it 1/4 turn using a 9/16” wrench (Figure 44).
4. Remove the Swagelok nut and ferrules from the adapter fitting to ensure their orientation is as shown below, then loosely reattach to the adapter.
5. Slide the 1/4” OD ventilation exhaust tubing into the Swagelok nut and ferrules until the tubing is fully seated, tighten the nut finger tight, then using a 9/16" wrench, tighten the nut approximately seven flats (420 degrees).

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

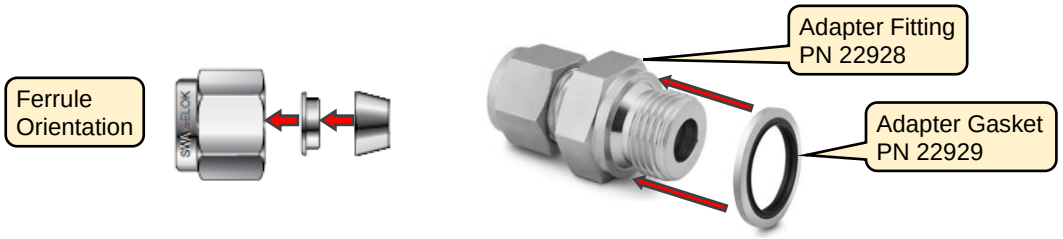


Figure 43: Pump Exhaust Line Adapter Fittings

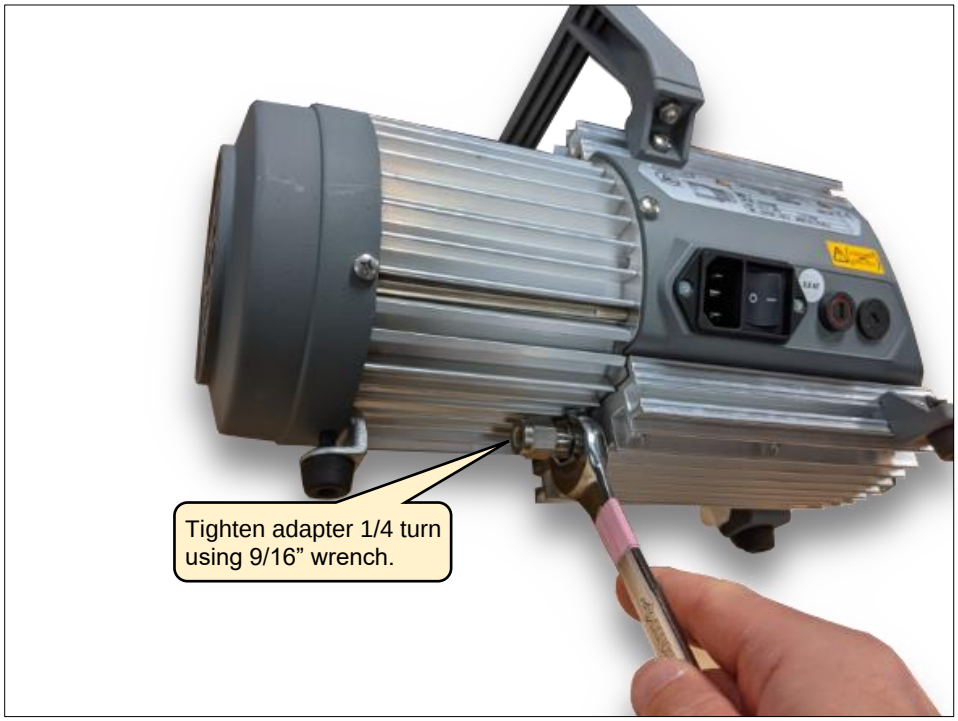


Figure 44: Exhaust Adapter Fitting Installation

6. With the pump running on room air, apply Snoop leak detection fluid to the installed exhaust components to confirm that the system is leak tight. Instructions for leak testing using Snoop can be found in this video:

   https://vimeo.com/375518688 (go to time 5:20 minutes in the video)

7. Reconnect the pump power line, turn on the switch, and power on your analyzer.

NOTE

Ventilation exhaust tubing should be 1/4" or larger to avoid back pressure build-up in the analyzer pump. If the vent line is more than a few feet long, it must be sized up to 3/8” or 1/2”.

APPENDIX B – Steps if Analyzer Can't Recognize Valve

If the analyzer does not automatically recognize the multi position valve, follow the steps below.

Run the Stop CRDS Software Executable

1. If your analyzer uses the Windows Operating System, go to the Picarro Utilities folder on the Desktop, and run the Stop CRDS Software and Serial/Socket Port Manager executable.

   The Stop CRDS Software Popup appears (Figure 45).

NOTE

On older systems, if this shortcut is not included in the folder, the user may navigate to find it at C:\Picarro\G2000\HostExe\StopSupervisor.exe.

2. Select the default *Stop software but keep driver running* radio button.
3. Click on **Stop** to stop the analyzer.

Figure 45: Show/Hide Sequencer Drop Down

Select the COM Port

4. In the *Picarro Utilities* folder on the desktop, double-click **Setup Tool** (Figure 46).

   The Picarro Analyzer Setup Tool displays. (Figure 47).

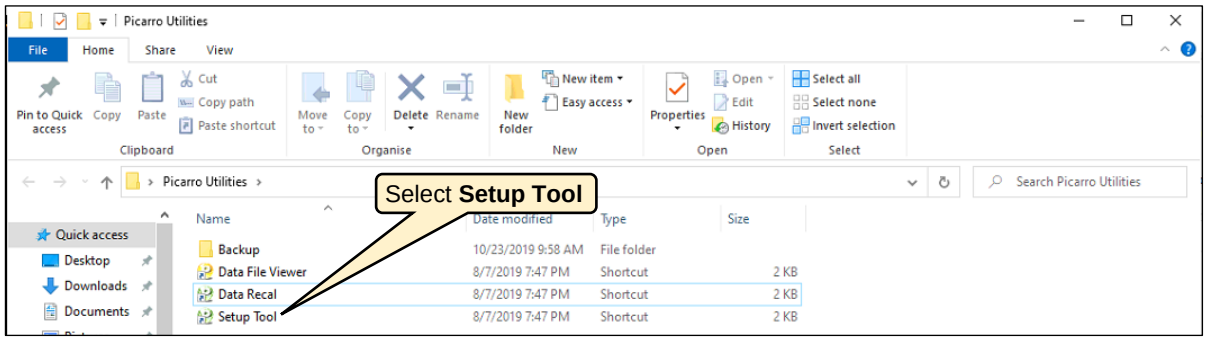


Figure 46: Setup Tool Selection

5. Click on **Settings**.
6. Click on the **Port Manager** tab.

   The Serial/Socket Port Manager dialog appears.
7. In the *Valve Sequencer MPV* drop-down choose **COM2**. Confirm that this doesn't conflict with any other communications, and if it does, change the port assignment on the other entries, being aware that this will change communications for other active connections.
8. Confirm that the **Mode** dropdown states the Picarro mode being used.
9. Click **Apply** to save the changes, and then **Exit**.
10. Restart the software from the **Start Instrument** icon on the desktop.
11. From the Picarro software **Tools** menu, select **Show/Hide Valve Sequencer,** (Alt+tab to bring sequencer to front).
12. Confirm that the **Current Rot. Valve Code** box is green (Figure 49).

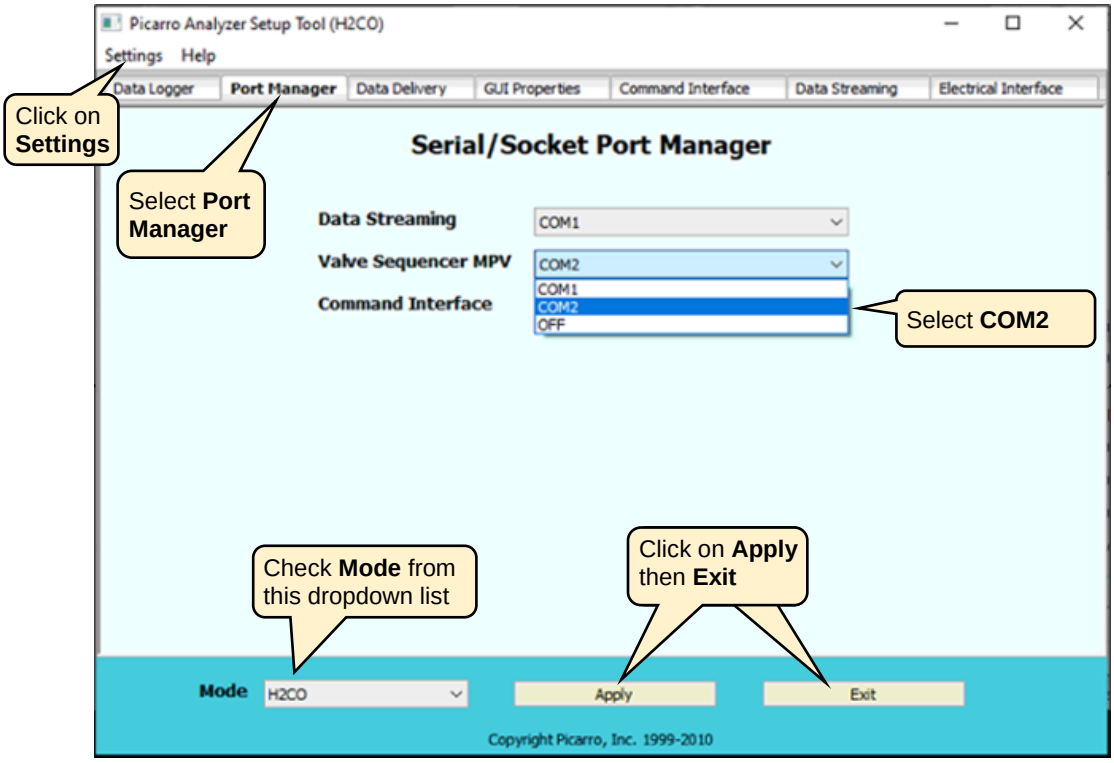


Figure 47: Picarro Analyzer Setup Tool – Port Manager

Display Valve Sequencer GUI

Though it is possible the instrument will recognize the MP valve(s) when the user restarts the software, it is often necessary to restart the computer first.

1. Ensuring that the MP valve(s) is (are) turned on, and that the COM cable is connected to **COM 2** on the back of the analyzer, restart the computer by clicking **Shutdown** in the main host software. Once the instrument boots up, the host software will restart itself.
2. In the **Tools** menu of the analyzer **Data Viewer** screen, select **Show/Hide Valve Sequencer GUI** (Figure 48).

   The External Valve Sequencer GUI displays (Figure 49). Alt+Tab the window to the front if needed. Refer to section ***7, External Valve Sequencer Window*** for operation instructions.

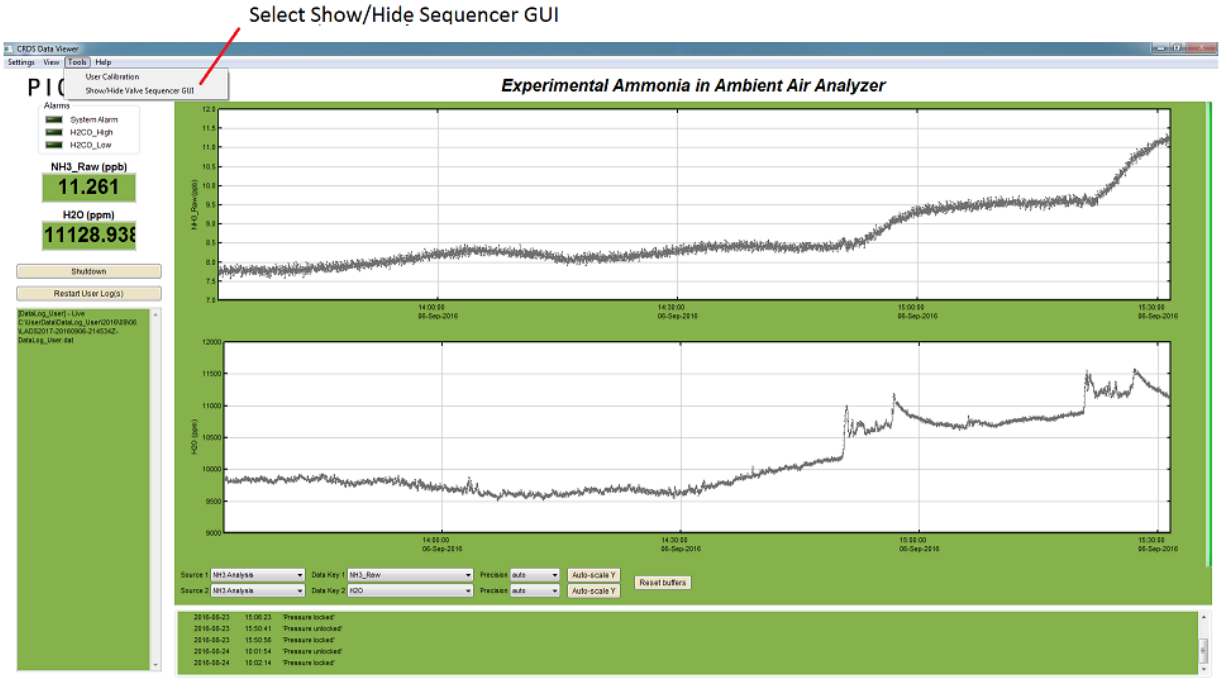


Figure 48: Show/Hide Sequencer under Tools Drop Down Menu

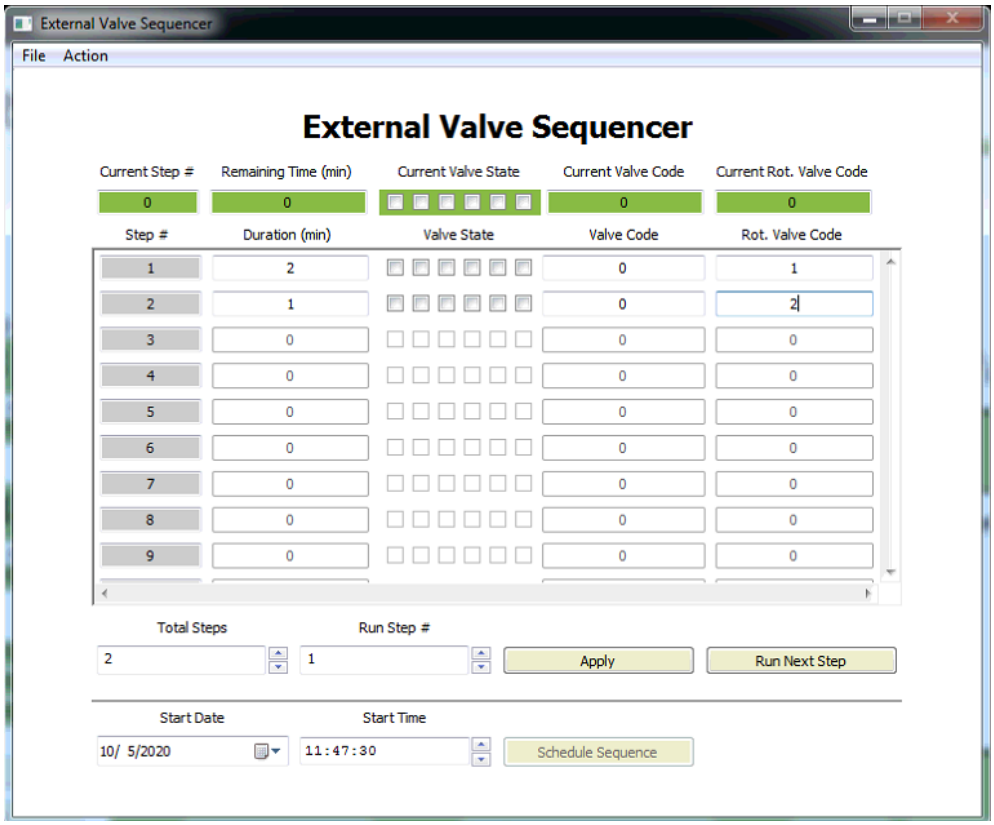


Figure 49: External Valve Sequencer Window

APPENDIX C – Third Party Fittings and Parts

This section provides a central location for listing various recommended third party parts that may be used with A031x setups for different circumstances.

Table 8:Third Party Fittings and Parts

Fitting Description	Application	Picarro PN	MFG/PN	Purchase Source and PN
Swagelok ISO parallel thread adapter 1/4"-1/8” 	Contained Pump Exhaust See ***APPENDIX A – Setting up Contained Pump Exhaust Flow***	22928	Swagelok SS-400-1-2RS	Swagelok SS-400-1-2RS
Swagelok adapter gasket 	Contained Pump Exhaust See ***APPENDIX A – Setting up Contained Pump Exhaust Flow***	22929	Swagelok SS-2-RS-2V	Swagelok SS-2-RS-2V
1/4” tube OD x 1/8” SS tube reducer fitting 	A0310 Pre to Mid 2022 See section ***4.5, Connection Procedure A0310***	NA	Swagelok SS-400-R-2	Swagelok SS-400-R-2
Single SS nut and ferrule set 	A0310 Pre to Mid 2022 See section ***4.5, Connection Procedure A0310***	NA	Swagelok SS-200-NFSET	Swagelok SS-200-NFSET
Sample Jar 1/4” bulkhead push to connect fitting 	A0310 See section ***9, Recirculation with the A0310***	NA	Legris PN 3116 56 00	Grainger PN 1PFC6

Fitting Description	Application	Picarro PN	MFG/PN	Purchase Source and PN
Sample Jar 1/8" bulkhead push to connect fitting 	A0310 See section ***9, Recirculation with the A0310***	NA	Legris PN 3116 53 00	Grainger PN 1PFT9
Sample Jar Quick Connect Set 	A0310 Recirculation See section ***9, Recirculation with the A0310***	NA	Swagelok PN SS-QC4-B1-400 PN SS-QC4-D1-400	Swagelok PN SS-QC4-B1-400 PN SS-QC4-D1-400
4-Way Solenoid Valve 	A0310 See section ***9.2, Sweeping Out Headspace***	NA	Humphrey PN 1943712VDC	Multiple sources (Humphrey website provides distributor search)
3-Way Solenoid Valve 1/4" fittings 	Various – Determined by user	S3112	NA	NA
3-Way Solenoid Valve 1/8" fittings 	Various – Determined by user	S3136	NA	NA