

eosAC-T/O and eosMX-16

User Manual

Auto-chambers,
Recirculating Multiplexers,
and Related Software



This guide is distributed by EOSENSE INC ("Eosense") for users of the eosAC-T/O auto-chamber and eosMX-16 multiplexer instruments, in conjunction with the eosLink-MX and eosAnalyze-AC software. Eosense is not liable for special, indirect, incidental, or consequential damages. Eosense's obligation under this warranty is limited to repairing or replacing (at Eosense's discretion) defective products within one (1) year from date of delivery to the customer. The customer shall assume all costs of removing, reinstalling, and shipping defective products to Eosense where applicable. Eosense will return said products by surface carrier prepaid. This warranty is in lieu of all other warranties, expressed or implied.

**WARNING: CRUSH HAZARD**

This symbol indicates that a crush hazard is present. Keep hands and all other objects clear of the bottom lip of the chamber during operation. Never attempt to prevent the chamber from opening or closing.

**WARNING: PINCH HAZARD**

This symbol indicates that a pinch hazard is present. Keep hands and all other objects clear of the chamber arm during operation. Never attempt to prevent the chamber from opening or closing.



These products comply with the following directives for CE Marking:

2006/42/EC (Machinery)
2011/65/EU (RoHS2)
2004/108/EC (Electromagnetic compatibility)

For more information, contact support@eosense.com

Version: 0.1
Revised: April 2024



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1 Summary

This manual is intended to help end-users of the Eosense eosAC-T/O autochamber and eosMX-16 multiplexer chamber system, in conjunction with an external gas analyzer, measure a variety of soil flux and gas concentration data. The information provided is intended for first time users of the eosAC-T/O and eosMX-16, and assumes a working knowledge of the gas analyzer in question. We highly recommend that you read the document thoroughly before using the eosAC-T/O or eosMX-16, as each of the hardware and software features are explained in detail.

This manual is intended to be used in conjunction with the eosLink-MX v2.0.X and eosAnalyze-AC 4.0.X software packages. Please check the [Eosense website](#) or contact support@eosense.com for the most up-to-date manuals and software.

If you have any specific questions or require additional guidance or information, please contact Eosense Technical Support through our website, by phone or by email:

support@eosense.com

888.352.8313

<https://eosense.com/contact-support/>

- Make sure your system is ready to go: [Section 2 \(Quick Start Checklist\)](#) lists everything you need to get your system up and running. Make sure to read the relevant sections of the manual for more information on each step!
- Want to jump right into collecting flux measurements? [Section 6 \(eosLink-MX Scheduling Software\)](#) tells you all you need to know to start out. For best results, we do recommend you read this complete user manual for both the eosAC-T/O and the eosMX-16 multiplexer!
- Ready to start viewing and analyzing your flux data? [Section 7 \(eosAnalyze-AC Analysis Software\)](#) explains how the software allows you to import, view and quality check your measurements, before exporting the data.
- Please visit the [Resources](#) section of our website to review the Application Notes relevant to your system's setup.



2 Quick Start Checklist

- ☐ **Review Documentation**
 - ☐ User Manual for the analyzer being used in your system
 - ☐ eosAC-T/O / eosMX-16 User Manual
 - ☐ Relevant Application Notes for your study, found here: <https://eosense.com/resources/>
- ☐ **Analyzer Setup**
 - ☐ **Picarro Users**
 - ☐ Install the Virtual COM Port (VCP) [USB-Serial driver](#) on your analyzer
 - ☐ Download and extract the Eosense software folder to the analyzer desktop
 - ☐ Locate the eosLink-MX and eosAnalyze executable files in the root directory of the Eosense software folder and create a desktop shortcut for each application
 - ☐ Note: eosAnalyze can be used directly on your Picarro analyzer or data can be transferred for processing on a separate PC or laptop. Refer to [Section 7](#) for additional information
 - ☐ **Gasmet Users**
 - ☐ Install the Virtual COM Port (VCP) [USB-Serial driver](#) on the Gasmet supplied tablet or laptop
 - ☐ Download and extract the Eosense software folder to the device's desktop
 - ☐ Locate the eosLink-MX and eosAnalyze executable files in the root directory of the Eosense software folder and create a desktop shortcut for the application
 - ☐ Note: eosAnalyze is not designed for extensive use on tablet devices. To process data collected using eosLink-MX, data should be transferred to a separate PC or laptop. Refer to [Section 7](#) for additional information
 - ☐ **All Other Users**
 - ☐ Please contact support@eosense.com for assistance installing the Eosense software on your analyzer
 - ☐ Eosense will supply a software package customized for your system and provide further instruction for installation
- ☐ **eosAC-T/O / eosMX-16 Hardware Setup**
 - ☐ Insert the eosAC-T/O collars as per the instructions detailed in section [3.3 Deploying eosAC-T/O in the Field](#)
 - ☐ Connect the eosMX-16 Multiplexer to power using the supplied power cable and switch it on
 - ☐ Connect gas tubing between the eosMX-16 and your analyzer
 - ☐ Connect the USB cable from the eosMX-16 to your analyzer
 - ☐ Connect each eosAC-T/O to the eosMX-16 using the combined power/data cable
 - ☐ Connect gas tubing between each eosAC-T/O and the eosMX-16



3 eosAC-T/O Transparent/Opaque Automated Chambers

3.1 Hardware Overview

The eosAC-T/O automated flux chamber is field-ready, compact, and ideal for long-term deployment in a wide variety of applications. The chamber's design incorporates scientific best practices and features swappable components that allow for hassle-free repairs in the field. Seamless integration with leading gas analyzers and included flux analysis software enable robust measurements of trace gas fluxes for a variety of biogeochemical applications. The eosAC-T/O is built of aluminum with either a transparent acrylic (-T) or opaque ABS (-O) dome and has several main components which are outlined in **Figure 1**. The dome should be handled with care as it can be damaged and may crack or break with blunt impact. Do not use any cleaning products that will dissolve or damage acrylic or ABS (e.g. acetone, isopropyl). The feet can be adjusted to ensure the chamber is stable once installed on the soil collar.

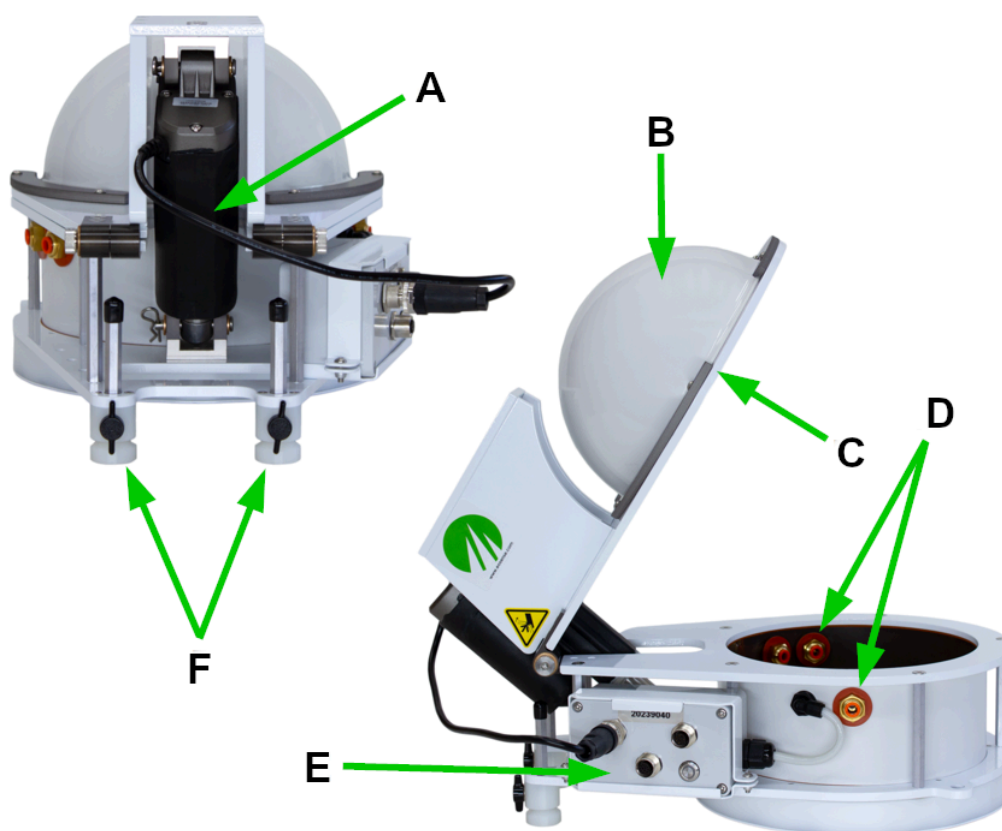


Figure 1. eosAC-T/O main components: (A) chamber actuator, (B) transparent acrylic or opaque ABS dome, (C) chamber lip with gasket seal, (D) push-connect gas tubing connections, (E) control box, including COMM port for power/data cable, and (F) height-adjustable feet.

3.2 eosAC-T/O Sensors and Auxiliary Ports

The eosAC-T/O is equipped with temperature and pressure sensors, as well as an AUX connection port for one exterior sensor (see **Figure 2**). Data from this auxiliary port is read whenever a measurement is made, allowing auxiliary fields such as soil temperature/moisture or PAR to be integrated with the soil flux data. The data can be analog (voltage or converted current) or digital (SDI-12). Please contact Eosense support (support@eosense.com) for assistance setting up your auxiliary sensors.



Figure 2. eosAC-T/O sensors: (A) temperature sensor, (B) exterior auxiliary port.

**Ambient pressure is measured by a sensor located in the chamber control box*

3.3 Deploying eosAC-T/O in the Field

Before deploying the eosAC-T/O, clear any large debris from the soil surface and insert the collar into the soil. Collar installation should happen at least 48 hours in advance, though 1-2 weeks is recommended. The conditions of the field site will dictate how long the soil will take to recover from disturbances caused by collar insertion. For example, tilled agricultural soil may only require a few hours to a few days while dense forested areas with high root density will require much longer.

When additional force is required to insert the collar to an appropriate depth, ensure force is applied evenly across the top. This can be accomplished with a hammer and a small section of wood, for example (See **Figure 3**). Depending on the density of the soil you may also need to pre-cut a circle for collar insertion.

When installed and resting on a collar, the chamber should sit flush with the ground. Use the chamber's adjustable feet to ensure it is resting in a stable position. While the eosAC-T/O is water resistant, avoid situating the chamber in areas of standing water or hollows where flooding is a possibility. For best results choose a flat, clear soil surface to deploy the chamber.



Figure 3. (left) Collar insertion into soil, applying force evenly using a hammer and wood, (right) chamber installation after collar insertion

The eosAC-T/O comes with a tube stem polypropylene gas muffler (see **Figure 4**) which helps prevent any large particles or liquid water from entering the eosMX-16. The muffler attachment should be installed inside the eosAC-T/O on the gas port being used as the Inlet. Either port can be used as an inlet or outlet, however the supplied length of vent tubing should be installed on the port positioned furthest back on the dome, on the side opposite of the chamber's control box.

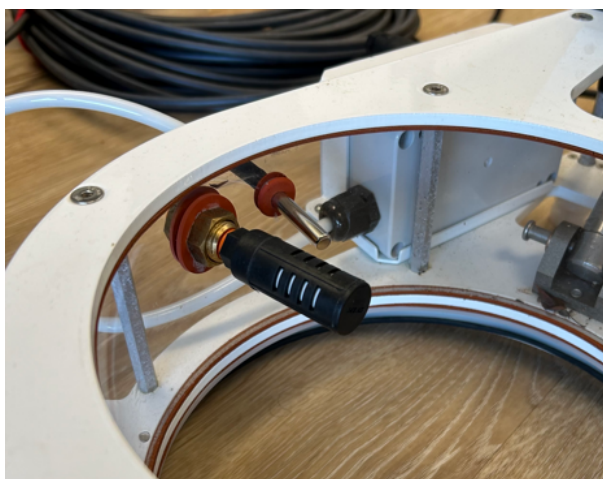


Figure 4. Gas muffler installed on Inlet

When collecting chambers from your field site, ensure they are in a closed position by using the 'Close all eosAC-Ts' option on the main window of the eosLink-MX software. Alternatively, individual chambers can be opened and closed manually by pressing and holding the circular button found in the top left corner of the device's control box until the chamber begins to close. **Only operate a single chamber at a time in this fashion, and only when there is no active measurement cycle.** Disconnect the power/data cable then remove the chamber from its collar, disturbing the soil as little as possible.

Note: Depending on the environment in which the analyzer and eosAC-T/O are deployed, steps to protect the power/data and gas tubing from rodents and other wildlife may be recommended.

4 eosMX-16 Recirculating Gas Multiplexers

4.1 Hardware Overview

The eosMX-16 (see **Figure 5**) is a recirculating multiplexer for gas analyzers that schedules chamber flux measurements using eosAC-T/O autochambers. Although the outer case is weather resistant, the inside panel and interior components can be damaged if left exposed to the elements.



Figure 5. eosMX-16

On the eosMX-16, the chamber tubing Inlet, Outlet and Data ports are located on either side of the outer case (see **Figure 6**). The On/Off switch, gas analyzer tubing Inlet and Outlets, power cable, USB and auxiliary ports are located on the front (see **Figure 7**). An LED indicating if the multiplexer is powered on can be found on the front of the case encircling the On/Off switch.

The eosMX-16 can be powered directly by a 12 VDC power source, but may also come with a wall adapter. The USB cable should be connected to the computer that will be operating eosLink-MX, the chamber scheduling software, and storing measurement logs. This is typically the gas analyzer itself.



Figure 6. The eosMX-16 side panels, showing chamber tubing Inlet/Outlets and Data ports 1 through 8 (left) and 9 through 16 (right)

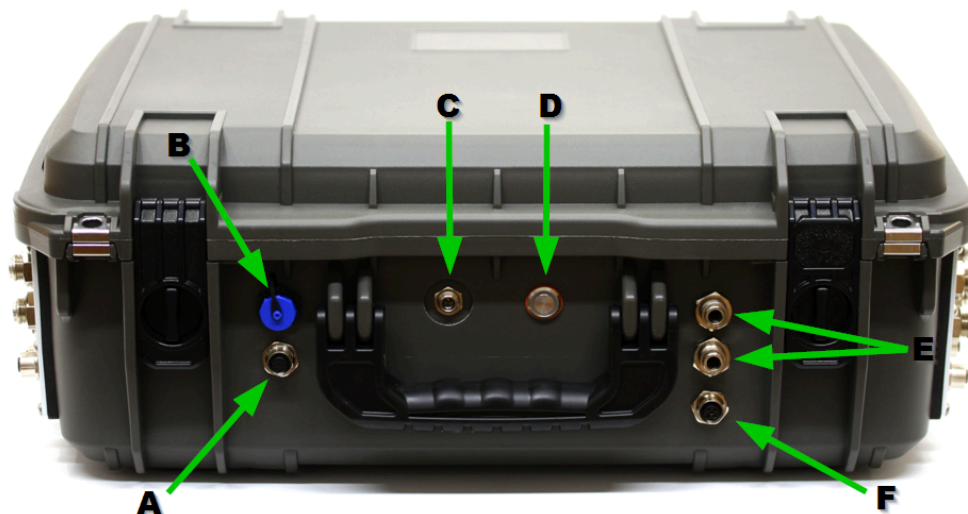


Figure 7. The front of the eosMX, showing (A) 8-pin serial input for control by data logger, (B) USB port, (C) power cable port, (D) On/Off switch, (E) gas analyzer inlet & outlet, (F) 5-pin auxiliary port

4.2 Connecting eosAC-T/O Automated Chambers to the eosMX-16

The eosMX-16 has connections for up to sixteen Eosense eosAC-T/O autochambers, which include a combined power/data port and two push-connect gas fittings for transporting gasses to and from the analyzer. Each connected eosAC-T/O will require a power/data cable and two lengths of tubing, with a maximum length of 30 m (see **Figure 8**).

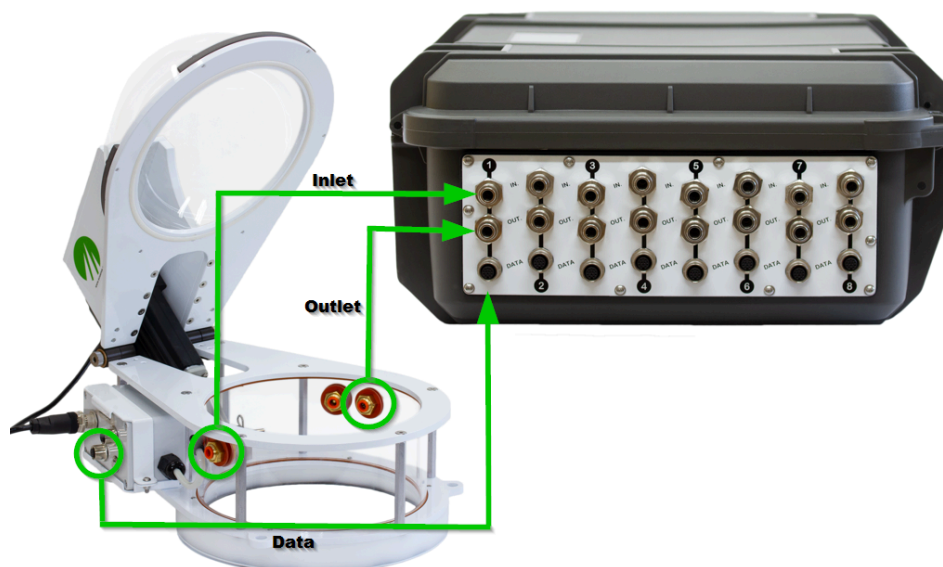


Figure 8. eosAC-T/O gas inlet connects to the IN port, gas outlet connects to the OUT port; and the combined power/data cable connects to the Data port on eosMX-16.

Attach one length of tubing to the port being used as the inlet on one side of the eosAC-T/O by pushing the tubing into the push-connect port until held securely. Connect the other end of the tubing to an IN port on the eosMX-16 using the

push-connect fitting. Repeat this process with the other length of tubing for the port being used as the outlet on the eosAC-T/O and corresponding OUT port on the eosMX-16. Please note, either port on the eosAC-T/O can be used as the inlet or outlet, but the tube stem polypropylene gas muffler should be installed on the inlet port. To remove tubing from a push-connect fitting first push in on the fitting collar, applying pressure parallel to the tubing toward the MX-16, and pull the tubing away from the port.

Attach the eosAC-T/O power/data cable to the control box of the eosAC-T/O, ensuring that it is connected to the middle port, labeled Data. Connect the other end of the cable to the corresponding Data port on the eosMX-16. Each eosAC-T/O must be connected to a Data port and the matching IN/OUT ports. For example, the first eosAC-T/O would connect to Data 1, Inlet 1 and Outlet 1, while the next would connect to Data 2, Inlet 2, Outlet 2 and so on. Connecting the power/data cable or tubing to the wrong ports will result in failed measurements and other issues.

4.3 Relief Valve - Port 16

When not drawing from an active port, the eosMX-16 defaults to directing the Inlet/Outlet lines of port 16 to the analyzer Input/Exhaust lines. As a result, systems with less than 16 chambers often draw in small portions of air from right beside the eosMX-16 while between chamber measurements.

Depending on the layout of equipment and proximity to people, this can result in noticeably different CO₂ concentration and moisture data during these periods, which often manifests as “spikes” in the real-time data displayed by the analyzer. To remove this bias, we recommend running a length of tube from the 16th eosMX-16 Inlet to a distance of 10 m from the eosMX-16 to an area of “fresh air” (away from other equipment and people). Use of a filter on the end of this tubing length is also recommended.

Port 16 is also sampled during an "Idle/Delay" step (see [Section 6: eosLink-MX Scheduling Software](#) for more details). Additionally, anytime the eosMX-16 is powered on but not running a cycle (e.g. after a non-looped cycle finishes), Port 16 remains open to act as a relief valve for the entire system.

5 Connecting Gas Analyzers

The following sections will outline how to connect your eosMX-16 to three common analyzer brands. These sections are meant to supplement documentation provided by the analyzer manufacturer and server as a quick reference when connecting your equipment. Please review any available analyzer manuals prior to setup.

5.1 Connecting Picarro Gas Analyzers to the eosMX-16

The eosMX-16 allows the user to coordinate Picarro gas analyzer samples from up to sixteen eosAC-T/O autochambers (sequentially). The analyzer, multiplexer and external pump should be connected in a continuous loop, as shown in **Figure 9**.



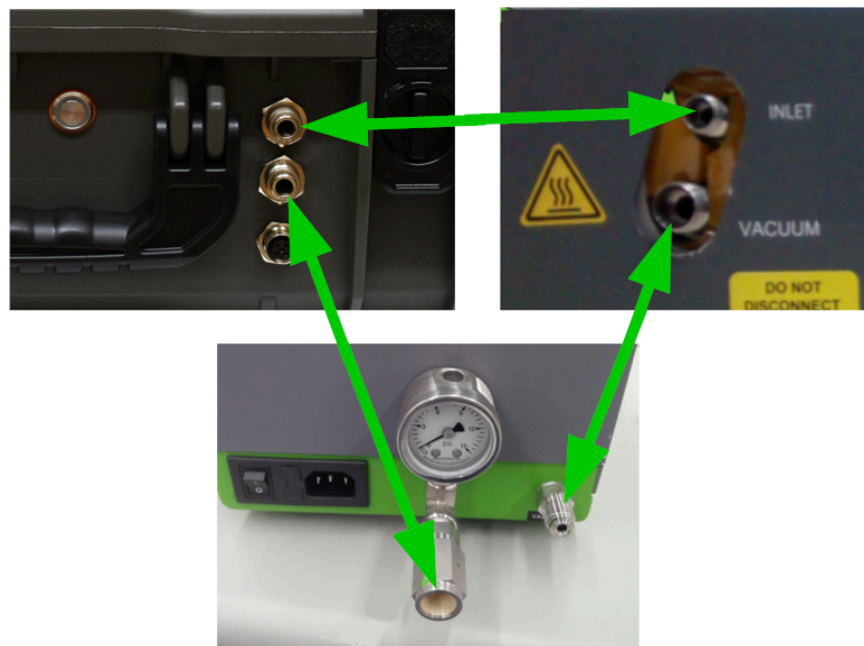


Figure 9. Gas tubing connections between the eosMX-16 (top-left), Picarro analyzer (top-right), and external pump (bottom)

In order to create this loop, a number of components are required (see **Figure 10**):

- Picarro Analyzer (e.g. G2508)
- Recirculation Pump (A0702)
- Eosense eosMX-16 Multiplexer
- (A) Convoluted Metal Hose (VCR)
- (B) VCR Coupling (SS-4-VCR-CG)
- (C) VCR →Swagelok Fitting (SS-4-VCR-6-400)
- (D) 1/4 Ferrule x2 (SS-403-1, SS-404-1)
- (E) 1/4 Swagelok Nut x2 (SS-402-1)
- (F) Vacuum VCR Connection
- (G) VCR Metal Gasket x3 (SS-4-VCR-2)

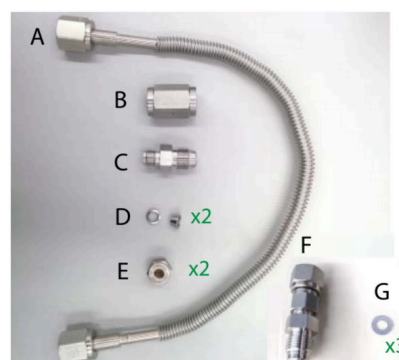


Figure 10. Components A-G (left).

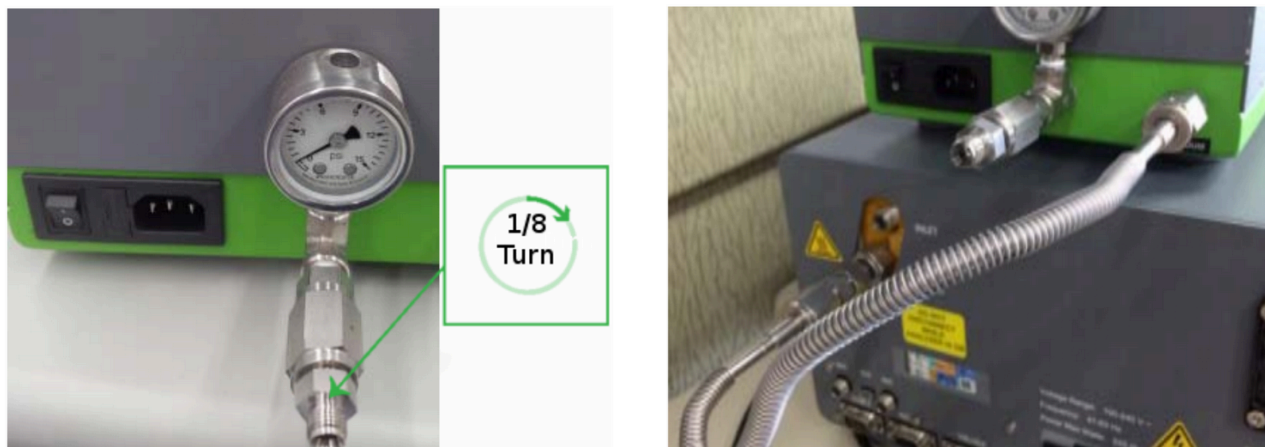


Figure 11. External recirculating pump with VCR coupling and Swagelok fitting attached.

Carefully set the analyzer, eosMX-16 and external pump on a flat surface and remove the caps from the analyzer (Vacuum and Input) and pump (Vacuum and Exhaust), if still present. There are two ports on the back of the recirculating pump: one provides vacuum to the Picarro analyzer, which is necessary for its operation, while the other port acts as the gas exhaust for the system. To connect the external recirculating pump into the gas sampling loop (see **Figures 9** and **11**):

1. Attach the VCR coupling (B) to the outlet port of the pump;
2. Insert the VCR Metal Gasket (G) into the coupling and attach the VCR to Swagelok fitting (C);
3. Once the VCR to Swagelok fitting (C) is finger tight, turn the fitting an additional 1/8th turn to compress the gasket;
4. Attach the Vacuum VCR Connection (F) to the Vacuum port of the gas analyzer;
5. Connect the pump and analyzer vacuum ports using the convoluted metal hose (A); and
6. Ensure that each connection receives a VCR Metal Gasket (G) and is tightened 1/8th of a turn past finger tight.

Before attaching the tubing between the analyzer and the eosMX-16, ensure that the unit's main power is turned on so that the pressure relief valve is active. Depending on application, the tubing lengths for the eosMX-16 setup may vary. Two lengths of pre-Swagelok fitted tubing approximately 60 cm long are included with your eosMX-16 equipment. Using one of these pieces, attach one end to the gas analyzer Inlet on the Picarro, hand tightening and then turning an extra 1/4 turn with a wrench, and the other to the Analyzer Inlet port on the eosMX-16. Using the other piece, repeat this process between the external pump Swagelok fitting (C) and the eosMX-16 Analyzer Outlet port.

5.2 Connecting ABB-LGR Gas Analyzers to the eosMX-16

Up to sixteen eosAC-T/O autochambers can be linked to an ABB-LGR analyzer (such as the U-GGA-915) through the eosMX-16. Connecting the U-GGA to the eosMX-16 is accomplished through two pieces of tubing and a USB cable.

With the U-GGA powered off and using one piece of the provided tubing, connect one end to the Analyzer Inlet push-connect port on the eosMX-16 and insert the other end into the Inlet push-connect port on the U-GGA, making sure it is firmly seated. Using the other piece of tubing, connect one end to the Analyzer Outlet push-connect port on the eosMX-16, and plug the other end into the Waste push-connect port on the UGGA, making sure it is firmly seated (see **Figure 12**). If using a microportable greenhouse gas analyzer (M-GGA-918), use its quick-connect fittings to secure the tubing into the appropriate ports.



Figure 12. Left: Inlet and Waste push-connect ports on the U-GGA.
 Right: Inlet (top) and outlet (bottom) ports on the eosMX-16.

Connect the USB from the eosMX-16, to the ABB-LGR analyzer. To access the eosLink-MX software when connected to the U-GGA-915 or M-GGA-918, switch to the second Desktop (default shortcut: <Ctrl> + <Alt> + <Right Arrow>) and launch the software from the shortcut. After a short warm up period, custom measurement cycles can be created and started.

5.3 Connecting Gasmet Gas Analyzers to the eosMX-16

Up to sixteen eosAC-T/O automated chambers can be linked to a Gasmet analyzer (such as the DX4015) through the eosMX-16. Two lengths of $\frac{1}{4}$ " outer diameter (OD) tubing are included with your eosMX-16 equipment. The bare ends of this tubing are fitted with $\frac{1}{4}$ " to 6 mm tubing adapters. Two lengths of 6 mm OD tubing should be connected to the provided adapters. Gasmet ports are most often metric (though some analyzers can be special-ordered with imperial $\frac{1}{4}$ " push-connect ports). Please note the 6 mm OD tubing (and Swagelok fittings for the DX4015) are not included and should be provided by the customer.

With the Gasmet analyzer powered off, connect the bare ends of the provided tubing to the Analyzer Inlet and Outlet ports on the eosMX-16. Connect the other 6 mm lengths of tubing to the Sample port of the DX4015 (Sample In port in the DX4040) and the Out port of the DX4015 (Sample Out port in the DX4040), respectively. When using the DX4015, hand tighten the Swagelok nuts and then turn a further $\frac{1}{4}$ " turn to secure using a wrench (see **Figure 13**). If connecting to a DX4040, use its quick-connect fittings and snap into the corresponding front panel port.

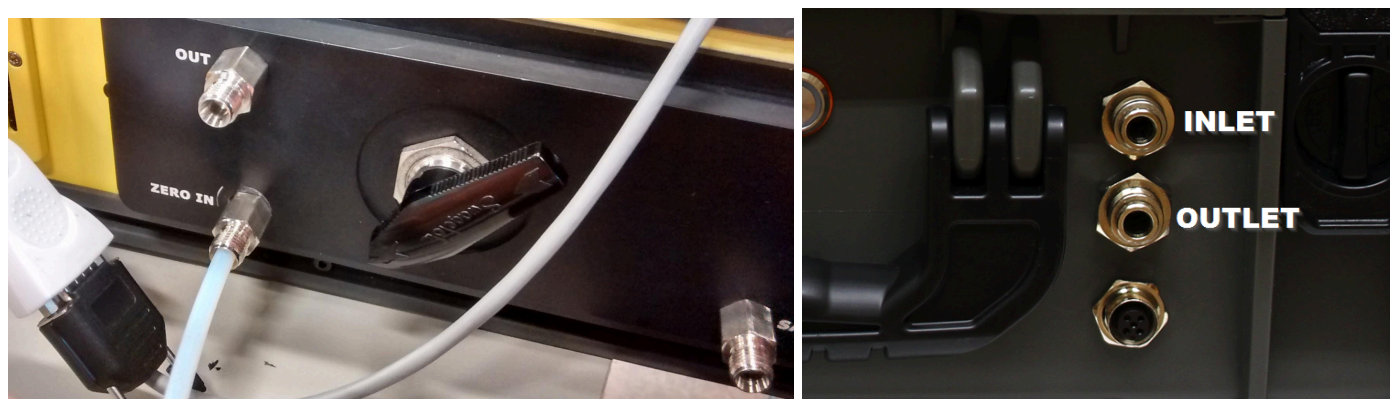


Figure 13. Left: Out, Zero In and Sample ports on the DX4015. .
 Right: Inlet (top) and outlet (bottom) ports on the eosMX-16.

Connect the USB from the eosMX-16 to the desktop PC that will be running the Calcmeter Pro software and check the following (see [AN0016](#) for more information):

1. Check that the chemical formula (e.g. CO₂ for carbon dioxide) is present in the species name.
2. For the best balance of data density and analytical accuracy, navigate to Options > Measuring Times and set the Measuring interval to 20 s and the Sampling time to 18 s.
3. Ensure the Calcmeter software is logging data in a format expected by the eosAnalyze-AC software. Under Options > Autosave Results, Create Result Files by Date, and Save residuals to results file should be checked. Change the default Save To File (.TXT) filename to "DATA".

6 eosLink-MX Scheduling Software

6.1 Overview

The eosLink-MX software logs temperature, pressure and peripheral data from up to sixteen connected eosAC-T/Os, while also serving as the control panel for the eosMX-16 multiplexer. The application comes as part of the Eosense software package and can run immediately after it is uncompressed.

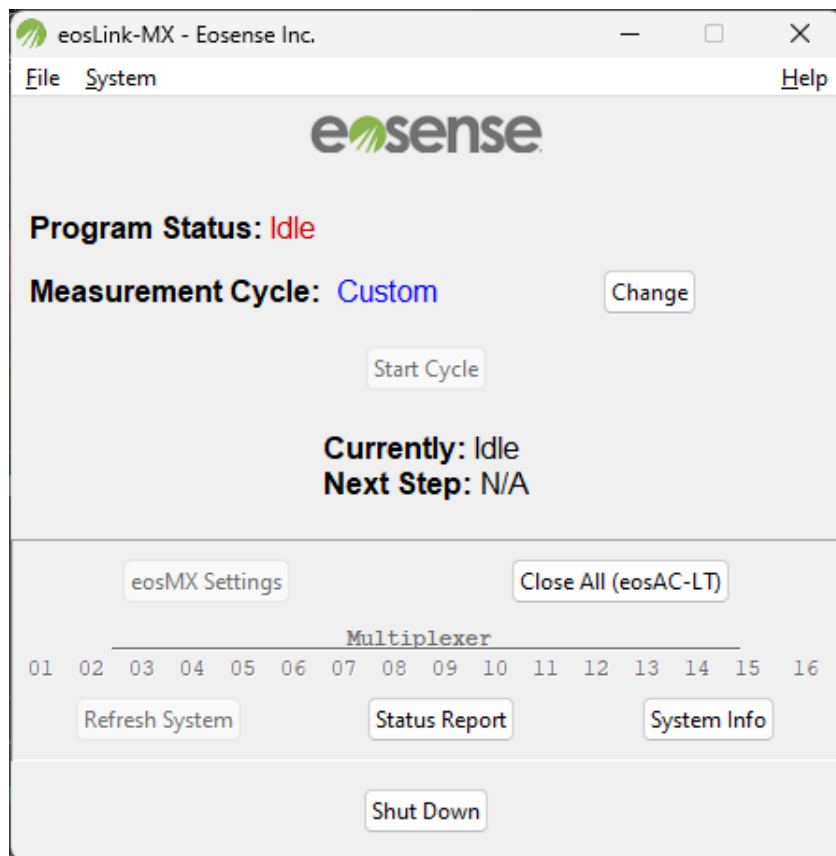


Figure 14. eosLink-MX main window.

The main software window shows the current connection status (Idle, Searching, or Measuring), the type of Measurement Cycle (Default or Custom), the current and next steps in the cycle, and the eosMX-16 ports with detected eosAC-T/Os (see **Figure 14**). Once a Measurement Cycle is configured, clicking the **Start** button will begin the cycle, with a new option appearing to stop the cycle.

As each step in the cycle completes, the main window will be updated to show the new current step (with time remaining) and the next step in the cycle (with duration). The numbers underneath the “Multiplexer” heading will also update, with unused multiplexer ports grayed out, and currently closed chambers in bolded **green text**. If the cycle is set to loop, it will continue until manually stopped, otherwise the program will return to an idle status when the cycle is complete.

The current cycle should always be stopped using the **Stop Cycle** button and the software should be closed using the **Shut Down** button. In older versions of the software, if eosLink-MX is closed by clicking the “X” at the top-right of the screen, the software will minimize and continue to run in the computer’s System Tray.

The **eosMX Settings** button is not available at this time. The **Close All (AC-LT)** button can be used to control all connected eosAC-T/Os when collecting the chambers from the field. The **Refresh System** button will scan all 16 eosMX-16 ports again, updating the chamber IDs associated with each port. The **System Info** button will be covered in [Section 6.3](#).

6.2 Measurement Cycle

From the main eosLink-MX window, the measurement cycle can be configured by clicking the **Change** button. This brings up the **Create Measurement Cycle** window that allows the user to choose the number and type of measurement steps, as well as **Save** or **Load** custom cycles (see **Figure 15**). Checking the **Use Default** box will reset the measurement cycle to a loop through each detected eosAC-T/O using 10 minute measurements.

As the **Number of Measurements** is increased, steps will be added to the scrolling window, to a maximum of 50. To access the **Edit Measurement** window, click on one of the steps in the measurement cycle. The **Measurement Type** can be set to one of 16 eosMX-16 ports (Chambers 1-16) or an Idle/Delay period (see **Figure 16**). During an idle measurement, samples are taken from the multiplexer’s relief valve (see [section 4.3](#) for more information). The duration of either choice is displayed in seconds. The Idle/Delay option can also be set to wait until the next hour according to the current system time.

The **Treat as Calibration Standard** button must be checked for non Eosense chamber sampling (see **Figure 16**). Checking this box creates a placeholder event in the Chamber Data file so non chamber measurements can be processed in eosAnalyze-AC analysis software.

Checking **Loop Cycle** will cause the specified measurement cycle to begin from the first step each time the cycle completes. Checking **Randomize Chamber Measurements** instructs the software to randomly sample from each step in the measurement cycle.

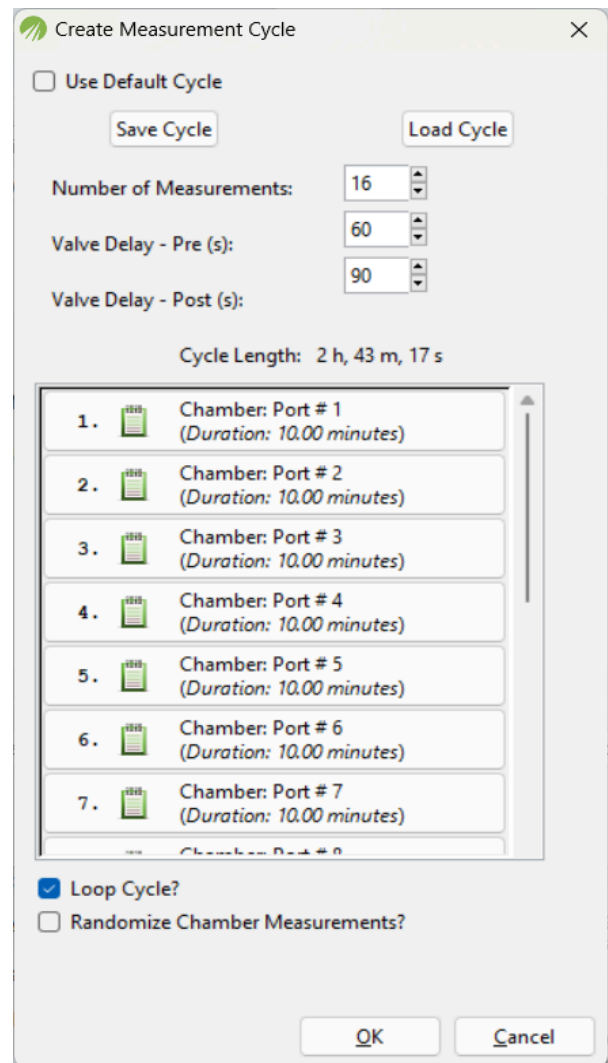


Figure 15. The Create Measurement Cycle window.

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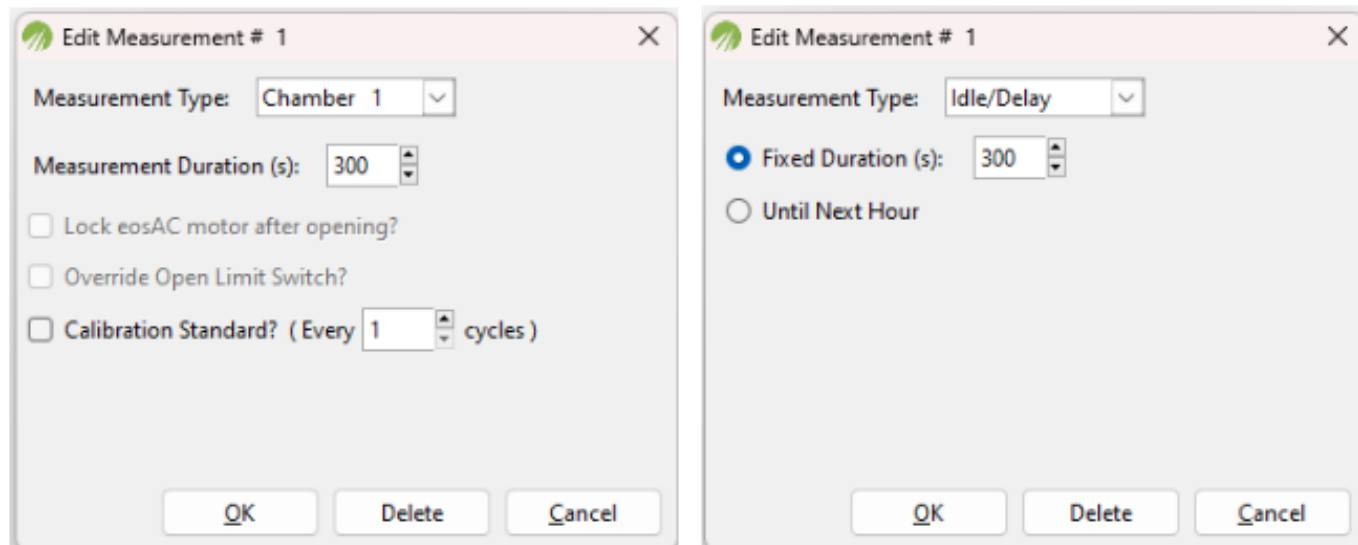


Figure 16. Edit Measurement window - the Measurement Type can be set to Chamber 1 through 16 (left) or an Idle/Delay period (right). The first two checkboxes are for eosACs only and are not applicable to eosAC-T/Os

The **Valve Delay** options in the Create Measurement Cycle window specify the amount of time to wait between starting to draw gas from the chamber and the chamber closing (“**Pre**”) and the length of time to wait between the chamber opening and the end of gas being drawn from this chamber (“**Post**”). The optimal setting for these delays varies depending on a number of factors - increasing with tubing length and other factors that increase the total system volume, and decreasing with increased flow rate. We recommend setting these Pre and Post values to **at least 45 and 90 seconds, respectively**, but **strongly recommend you review these settings after collecting representative field measurements** in order to prevent data issues. Please see [AN0011](#) for more information about setting valve delays and data deadbands.

6.3 System Info and Chamber Settings

A number of chamber specific notifications can be viewed by clicking on the **System Info** button (see **Figure 17**). This window contains a tab for each of the sixteen possible eosAC-T/Os, showing the most recently collected temperature, pressure and relative humidity data, as well as the current status of the chamber and any related warnings / errors. If eosAC-T/Os are experiencing issues, this is the first place to look for diagnostic and troubleshooting purposes.

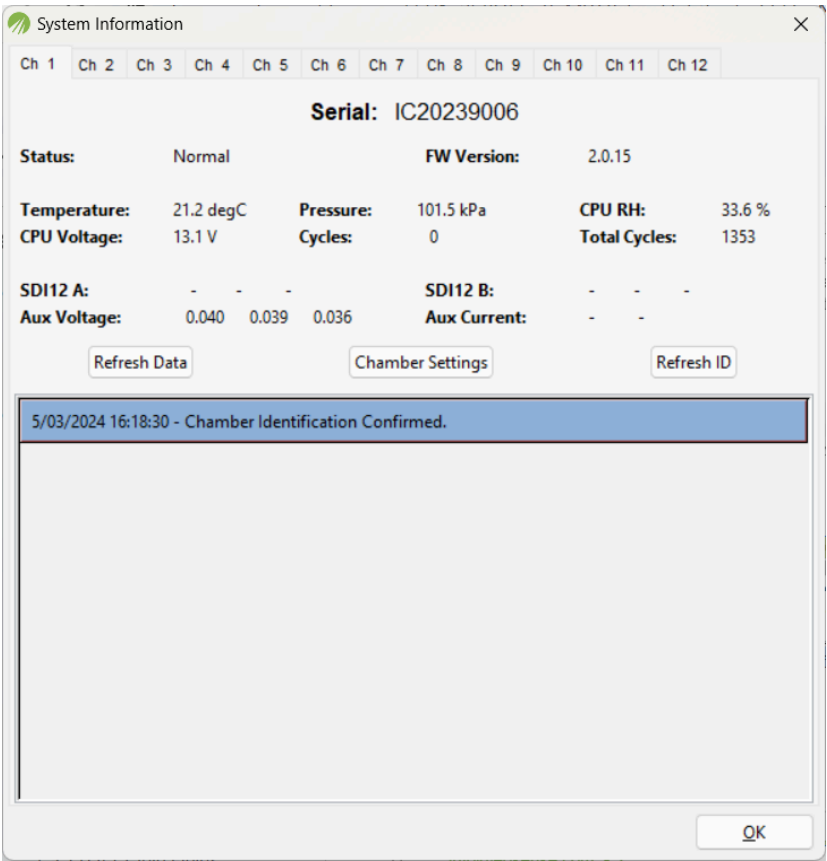


Figure 17. System Information window

The **Refresh Data** button will update the displayed chamber data and the **Refresh ID** will re-initialize and update the current chamber connected to that eosMX-16 port. A number of chamber parameters can be accessed through the **Chamber Settings** button (see **Figure 18**), including several options to modify how the chamber opens or closes.

Note: Please do not change any settings until given instructions from Eosense Support.

Note that the chamber will be instructed to open when this window is launched, and some settings may not be accessible depending on the type (eosAC-T/O or eosAC-LT/LO) and current firmware version of the chamber. The top of the screen shows the current eosMX-16 port, Chamber ID and Serial Number of the connected chamber.

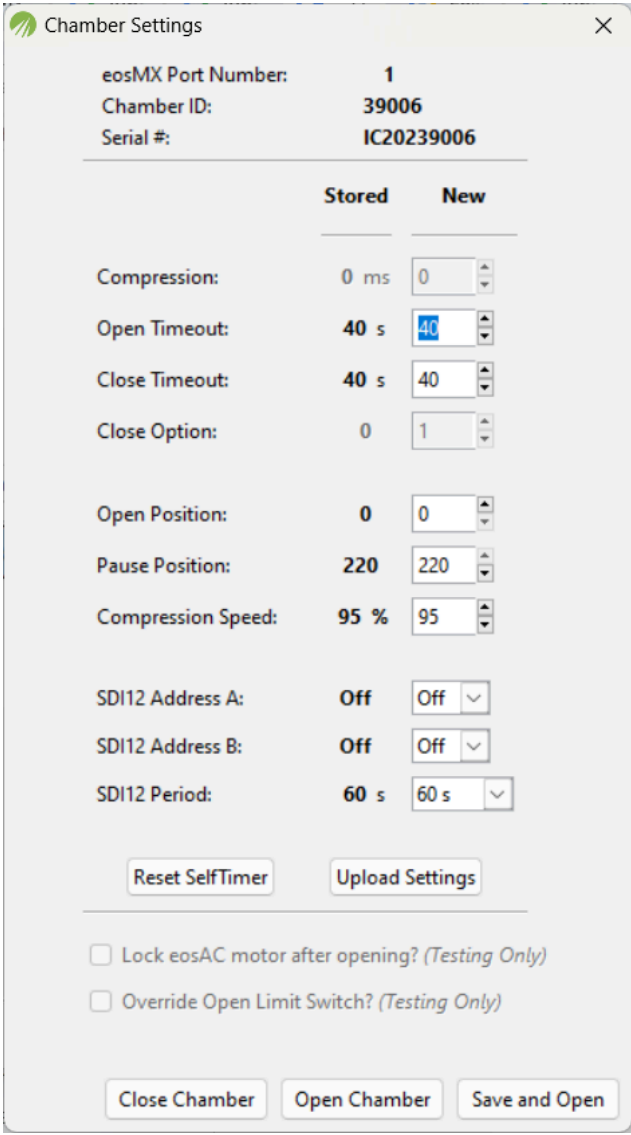


The **Open and Close Timeout** lengths govern how long the chamber will attempt to open or close (i.e. drive the actuator) before giving up and recording a timeout error.

The **Open Position** controls the angle at which the chamber will remain open between measurements. An Open Position of “0” is fully open; increasing this value will instruct the actuator to move the chamber dome down closer to the lip of the chamber.

The **Pause Position** controls where the chamber will pause when closing in order to minimize the induced pressure differential. The minimum setting of “150” will instruct the actuator to pause the chamber dome well above the chamber lip. As with the Open Position, increasing this value will tell the actuator to move the chamber dome closer to the bottom of the chamber.

The eosAC-T/O uses a dynamic closing speed to minimize pressure effects and reduce power consumption when closing the chamber. The chamber gradually decreases its speed from 95% to 30% of full speed when closing between the set Open and Pause Positions (see **Figure 19**).



	Stored	New
Compression:	0 ms	0
Open Timeout:	40 s	40
Close Timeout:	40 s	40
Close Option:	0	1
Open Position:	0	0
Pause Position:	220	220
Compression Speed:	95 %	95

SDI12 Address A: Off Off

SDI12 Address B: Off Off

SDI12 Period: 60 s 60 s

Reset SelfTimer Upload Settings

☐ Lock eosAC motor after opening? (Testing Only)

☐ Override Open Limit Switch? (Testing Only)

Close Chamber Open Chamber Save and Open

Figure 18. The Chamber Settings window.

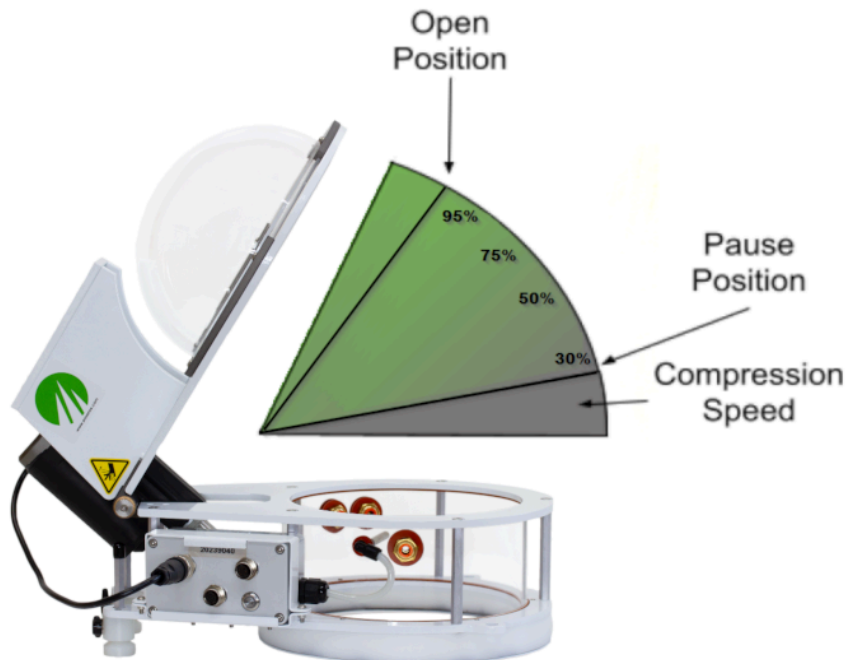


Figure 19. Dynamic closure of the eosAC-T/O.

The **Compression Speed** controls the speed of chamber movement between the set Pause Position and fully closed. **Figure 19** shows the location of the Open and Pause Positions, as well as where the Compression Speed set by the user in the Chamber Settings window will take effect. In cold or adverse weather conditions, users may need to increase Compression Speed if they find that they are getting Timeout Close errors; however, this setting should not be altered unless advised by Eosense Support.

The **SDI12 Address A & B**, and **SDI12 Period** should not be changed unless done so by Eosense Support. The default values for these settings should be Off and 60 seconds as shown in **Figure 18**. For more information about configuring peripheral sensors please contact support@eosense.com.

All of the settings above are shown as Stored values (i.e. what the chamber is currently set to) and New values (the custom value that a user can upload). Once the desired New settings are chosen, click **Upload Settings** to confirm the new values to be used by the chamber. You should then see the Stored settings change to reflect this update. The Close and Open Chamber buttons at the bottom of the screen can be used to test the new settings. Finally, the **Save and Open** button in the bottom right confirms any uploaded settings and returns to the main software window.

Note: The Compression setting at the top of the Chamber Settings window and the checkboxes at the bottom of the Chamber Settings window (“Lock eosAC motor after opening?” and “Override Open Limit Switch”) are for eosACs only, so will be disabled and are not covered in this manual. Additionally, the **Reset SelfTimer** button is not applicable at this time.

7 eosAnalyze-AC Analysis Software

7.1 Setup

The **eosAnalyze-AC** software requires no installation on the part of the user. Simply copy the zipped Eosense software folder to a suitable directory on the PC in question, unzip it and locate the 'eosAnalyze-AC_v4.0.0X.exe' executable file. None of the files in this folder should be removed or changed in any way. If this occurs, simply delete the entire folder from your PC and re-extract from the zip file to recreate the folder.

Creating a shortcut to the eosAnalyze-AC executable file on the Desktop is recommended. Double clicking this file or a Desktop Shortcut will launch the software. Please note that the data collected by the companion program **eosLink-MX** is required in order to import flux measurements, as this data records chamber events and metadata. [Section 6](#) provides more information on how to use this program.

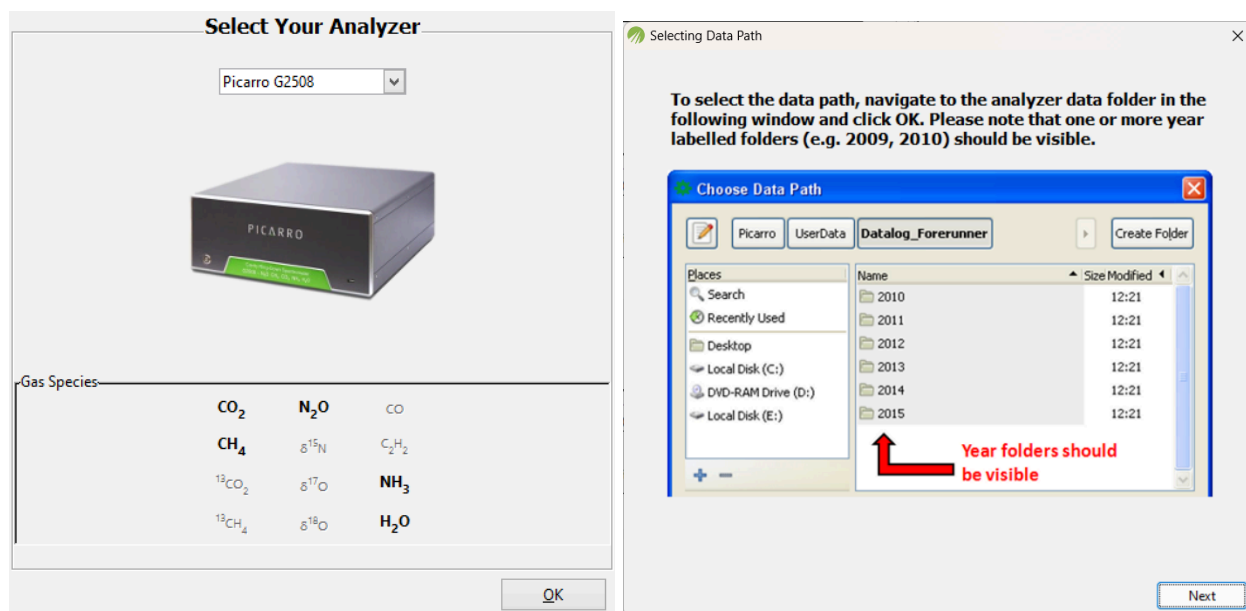


Figure 20. Select Analyzer (left) and Select Data Path (right).

The first time eosAnalyze-AC is run, the Analyzer Type, Analyzer Data Path, and Chamber Data Source need to be selected, and the user will be prompted to choose these options sequentially. The **Select Your Analyzer** window has a drop-down menu for selecting the gas analyzer used to collect data (see [Figure 20](#)). The **Choose Data Path** window will also pop-up and ask you to select the folder where the analyzer data is located. The **Chamber Data Source** window prompts users to choose one of four options. For most applications, this should be set to Session Log Files (.USF) ([see section 7.3 for more details](#)).

These choices will be saved and loaded on each subsequent use of the eosAnalyze-AC software. If required, these settings can be changed from the **Options⇒Equipment** menu (Analyzer Type and Data Source) or **Data⇒Analyzer Data Path** or **Chamber Data Path**. Please note that incorrect measurement data or processing issues may occur if these options are set incorrectly. The currently selected Analyzer and Chamber Data Source will be displayed in the software's title bar.

7.2 User Interface

Once the program is running, the main viewing window will appear. This window consists of two main areas: the Plotting section and the Measurements section. Both sections will be empty until data has been imported (see **Figure 21**).

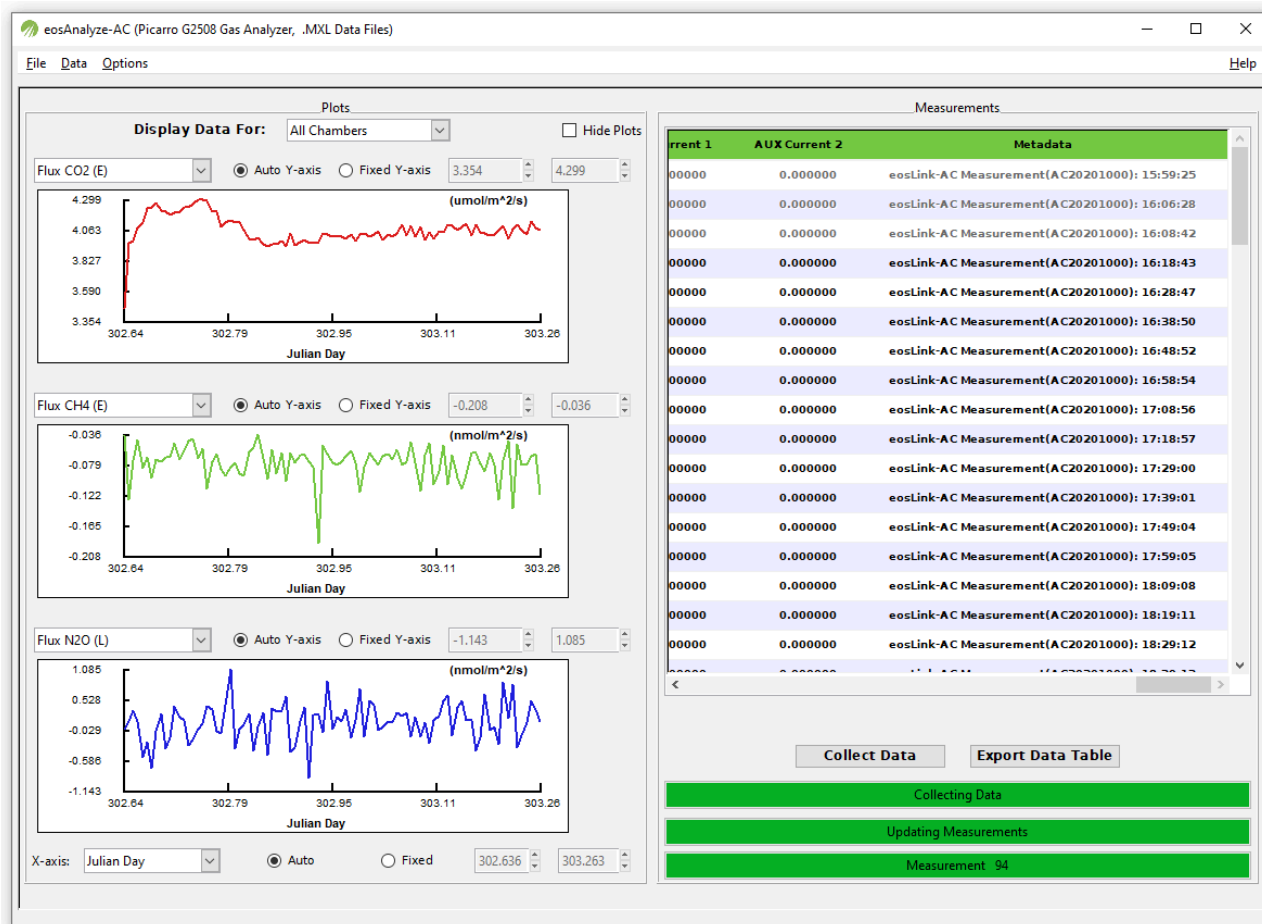


Figure 21. eosAnalyze main viewing window with Plotting section (left) and Measurements section (right).

The **Plotting** section on the left-hand side of the main window allows the user to quickly inspect up to three different time-series plots at a time from the chamber measurements collected. The **Display Data For** drop-down menu can be set to All Chambers or a specific Chamber number. Each of the three plots can be changed using the drop-down menus in the upper left of their areas, and the Y-axis behavior can be toggled between Automatic and Fixed scaling. The X-axis type and scaling for all three plots can be changed using the buttons at the bottom of the plotting area.

The two buttons underneath the **Measurements** section on the right-hand side of the main window allow the user to **Collect Data** and then **Export Data Table**. Chamber measurements detected by the program will populate a list in the Measurements area to the right of the main window. This scrolled window allows the user to view a customized table of data from the analyzer and chamber, as well as modify individual measurement parameters such as the deadband range or chamber offset. In addition to these two main sections, a number of options are available from the menu toolbar at the very top of the screen (**File, Data, Options, Help**).

7.3 Analyzer and Chamber Data Paths

The **Analyzer Data Path** corresponds to the location of stored analyzer data files on the computer. This option should be set after the first start-up of the eosAnalyze-AC software, but can always be changed by selecting **Analyzer Data Path** from the **Data** menu at the top of the screen. This will prompt the user to specify a data path using the **Choose Data Path** popup window. This screen will also provide instructions based on the analyzer selected at first setup or through the **Options⇒Equipment** menu at the top of the screen.

Note: The correct folder is selected by navigating to the root level of the data folder (see **Figure 22**). In the case of Picarro analyzers, this is the folder containing annual folders such as “2019”. For ABB-LGR analyzers, this can be any folder of unzipped analyzer files. For Gasmeter analyzers, this is typically the /CalcmeterResults folder. Once you have navigated to the correct location, click **OK** to set the path.

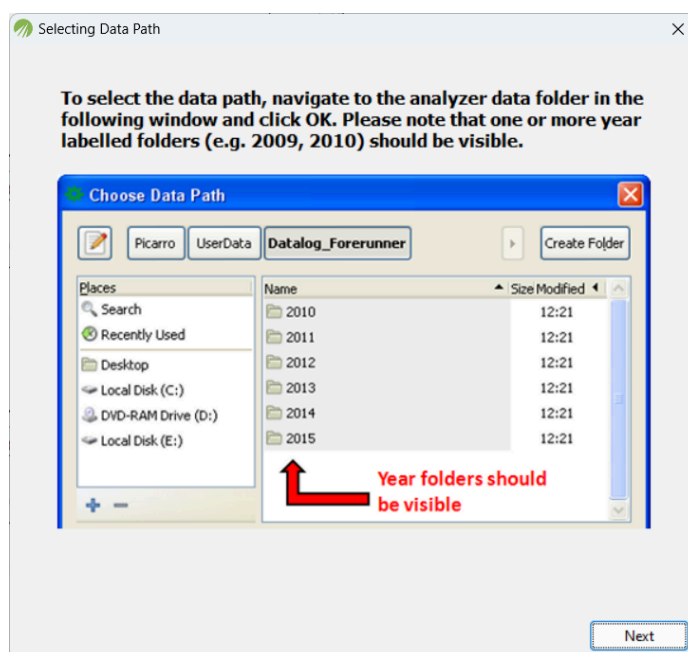


Figure 22. Analyzer Data Path location example for a Picarro analyzer.

The **Chamber Data Path** option specifies where the eosLink-MX chamber event log files are stored. This option should also be set after first start-up of the eosAnalyze-AC software, but can always be changed by selecting **Chamber Data Path** from the **Data** menu at the top of the screen. Most users will select “Session Files (.USF)” for Chamber Data Source, so the Chamber Data Path should be set to the main Eosense software folder where these files are located (see **Figure 23**).

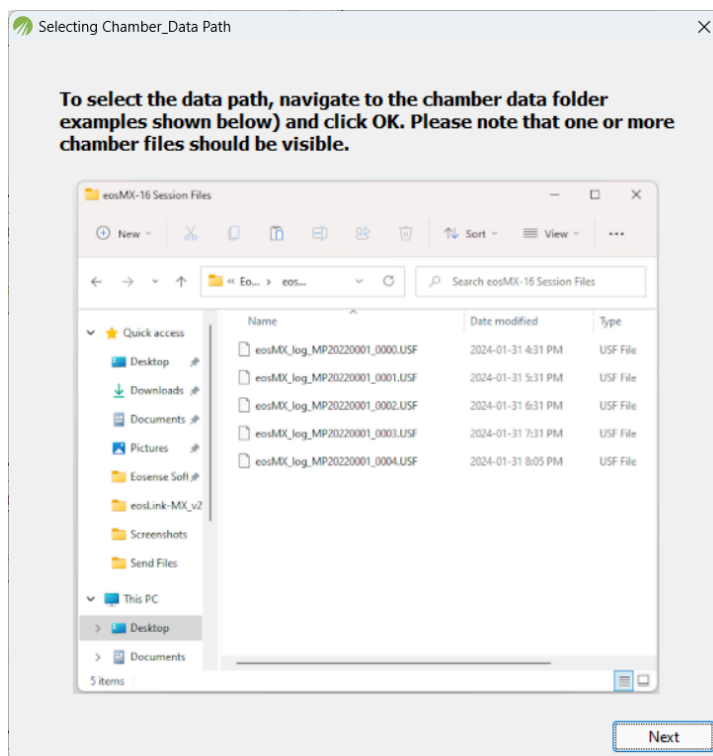
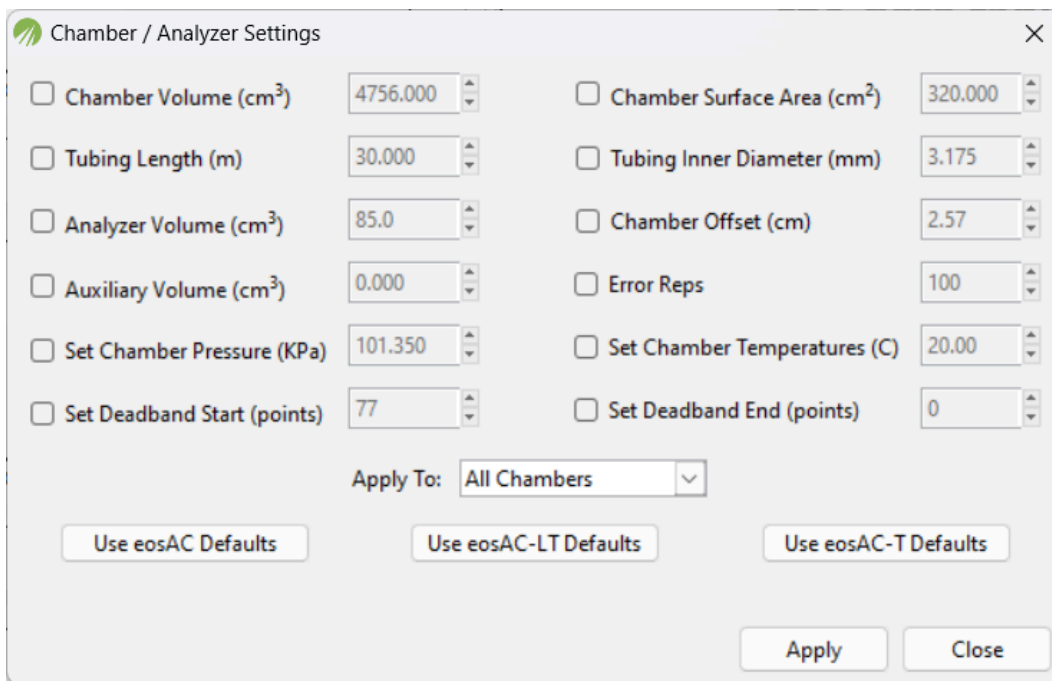


Figure 23. Chamber Data Path set to the main Eosense software folder where eosMX_log files are stored.

NOTE: Analyzer Data Path, Chamber Data Path, Chamber Data Source are viewable and changeable from the Choose Data Interval window (please see [Section 7.5.1](#) for more information).

7.4 Chamber and Analyzer Settings

The **Chamber and Analyzer Settings** window can be found under the **Options⇒Equipment** menu at the top of the screen, and allows the user to modify a number of chamber and analyzer specific settings (see **Figure 24**). The majority of these settings are related to the total volume occupied by the chamber, the analyzer cavity and the tubing connecting the two. These settings can be changed after data has been imported; however, this will require reprocessing of all of the flux data, so configuring these values before collecting data is recommended. The **Apply To** drop-down menu at the bottom of the window specifies which set of chamber measurements to modify.



Chamber / Analyzer Settings

☐ Chamber Volume (cm ³)	4756.000	☐ Chamber Surface Area (cm ²)	320.000
☐ Tubing Length (m)	30.000	☐ Tubing Inner Diameter (mm)	3.175
☐ Analyzer Volume (cm ³)	85.0	☐ Chamber Offset (cm)	2.57
☐ Auxiliary Volume (cm ³)	0.000	☐ Error Reps	100
☐ Set Chamber Pressure (KPa)	101.350	☐ Set Chamber Temperatures (C)	20.00
☐ Set Deadband Start (points)	77	☐ Set Deadband End (points)	0

Apply To: All Chambers

Use eosAC Defaults Use eosAC-LT Defaults Use eosAC-T Defaults

Apply Close

Figure 24. Chamber and Analyzer Settings in eosAnalyze-AC.

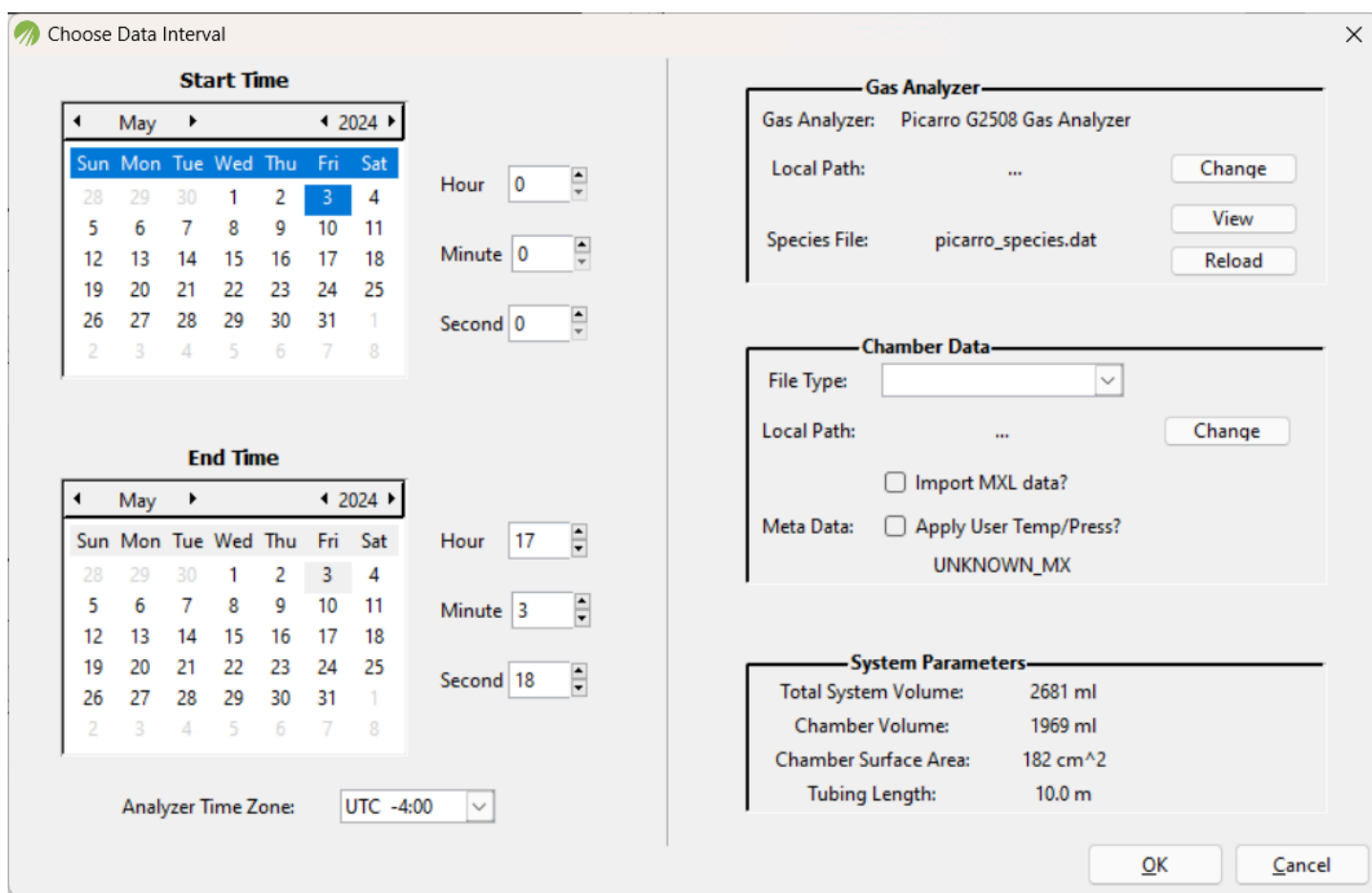
The tubing volume is expressed via the length (m) and inner diameter (mm) for convenience. The chamber and analyzer volumes should remain unchanged under normal operation, as the **Auxiliary Volume** and **Chamber Surface Area** options allow the user to include any aftermarket modifications they may have made to the system (with the latter corresponding to the total surface area exposed to the soil). The final volume-related setting is **Chamber Offset**. This value represents the distance between the top of the soil collar and the soil surface, with the minimum value being 2.57 cm. This offset is then transformed into an additional volume by assuming that the soil surface area within the collar is equal to the chamber's surface area.

The **Error Reps** setting dictates how many fitting iterations will be used to estimate the parameter error for the linear and exponential flux/Keeling intercept values. For demonstration purposes, this value defaults to 3. Note that changing this value can dramatically increase processing time, depending on the amount of data collected. A more in-depth explanation of this error estimation is available upon request. Finally, a global temperature and pressure can be applied to all chamber measurements using the **Set Chamber Pressure** and **Set Chamber Temperature** options. These temperature and pressure values will override those reported by the eosAC-T/O chambers, and should only be applied in the event of chamber data loss or malfunction.

7.5 Chamber Measurements

7.5.1 Importing Data

Analyzer data can be imported by clicking the **Collect Data** button below the Measurements window. This will prompt the user to select a time and date range in which to search for chamber measurements (see **Figure 25**). This data interval does not need to be exact; however, only chamber measurements falling within this range will be processed. The **Analyzer Local Time** option at the bottom is used to correct for any UTC offsets that may exist: this value should be set to correspond with the analyzer's local clock *at the time the chamber data was measured*.



Choose Data Interval

Start Time

May 2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

Hour: 0
Minute: 0
Second: 0

End Time

May 2024

Sun	Mon	Tue	Wed	Thu	Fri	Sat
28	29	30	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

Hour: 17
Minute: 3
Second: 18

Analyzer Time Zone: UTC -4:00

Gas Analyzer

Gas Analyzer: Picarro G2508 Gas Analyzer

Local Path: ... Change

Species File: picarro_species.dat View Reload

Chamber Data

File Type: ...

Local Path: ... Change

☐ Import MXL data?

Meta Data: ☐ Apply User Temp/Press?
UNKNOWN_MX

System Parameters

Total System Volume: 2681 ml
Chamber Volume: 1969 ml
Chamber Surface Area: 182 cm²
Tubing Length: 10.0 m

OK Cancel

Figure 25. The Choose Data Interval window. Note the Analyzer TimeZone drop-down menu at the bottom of the window.

The right-hand side of the **Choose Data Interval** window displays the current settings for the software, including information about the Gas Analyzer (Analyzer Type and the Analyzer Data Path, the Chamber Data (File Type and Chamber Data Path), and some common System Parameters. The Analyzer Data Path and Chamber Data Paths can be changed from this window by clicking the **Change** button next to **Local Path** under the Gas Analyzer or Chamber Data sections, respectively. The Chamber Data File Type can also be changed using the corresponding drop-down menu.

Note: The Analyzer Type (under Gas Analyzer section) and the System Parameters (i.e. Chamber and Analyzer Settings) section can only be changed by navigating to the **Options⇒Equipment** menu.

Once the data interval has been set by clicking **OK**, the program will begin searching through the chamber data (.USF files) or to find chamber events, and will then match these events to the corresponding analyzer data files to produce a set of flux estimates. During this process many Graphic User Interface (GUI) elements will be disabled as the Measurement and Plotting sections are updated. Progress bars indicating the status of the data search and measurement processing can be found in the area directly below the **Collect Data** and **Export Data Table** buttons (see **Figure 26**).

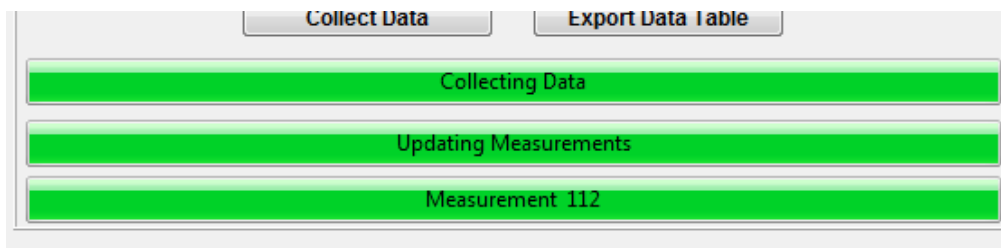


Figure 26. Progress bars indicating status of data search and measurement processing.

As new measurements are found, they will be used to populate the Measurement and Plotting sections of the main window. Once the entire data interval has been searched and all fitting is complete, normal GUI interaction will be restored. Additional measurements can be added to the same data table by clicking the **Collect Data** button again, and by specifying a new data interval. Any measurements that have already been added to the Data Table will be ignored on subsequent searches.

7.5.2 Data Table Fields

Once analyzer data has been parsed for the eosAC-T/O measurements, a number of data fields will be displayed in the Data Table (see **Figure 27**). These default parameters are analyzer specific, but generally include gas flux, gas concentration, and analyzer diagnostics information. Fields that are not currently displayed can be added by clicking on the Data Table header (or from **Data⇒Customize Data Table**), and customizing the table using the pop-up window (see **Figure 28**). From this window the number of columns can be adjusted, as well as what parameter will be displayed in each column.

Measurements						
#	Chamber	Julian Day	Duration	Mean CO2	Mean CH4 (HP)	Mean CH4 (HR)
1	12	138.99	0:21:51	437.953483	1.921688	1.884723
2	1	139.01	0:21:56	437.499731	1.927777	1.891095
3	2	139.03	0:21:53	437.810043	1.931128	1.894530
4	3	139.05	0:21:55	435.524115	1.944864	1.910288
5	4	139.07	0:21:52	447.609674	1.920039	1.886054
6	5	139.10	0:22:18	436.970618	1.948540	1.914508
7	6	139.12	0:22:04	439.525089	1.945779	1.908958

Figure 27. Examples of parameters included in the Data Table and chamber errors flagged by red numbers on measurements 3 and 6.

If any chamber errors are detected while importing data, the software will flag this with a “Chamber Errors Detected” warning. Chambers with errors are identified with a **red** measurement number (please see **Figure 27**). Mousing over the red number will indicate the type of error. Please contact Eosense Support for more information about these errors.

In addition, the timestamp used for each line of the Data Table can be changed to one of three options:

- **Julian Day** - Fractional days elapsed since January 1 of respective year
- **Date/Time** - Timestamp using MM/DD/YYYY HH:MM:SS format
- **Hours Elapsed** - Hours elapsed since start of first measurement

Note: The number/order of columns and the chosen timestamp will be reflected in any exported data. You may need to scroll the Data Table in order to view all columns.

The flux estimates for each chamber measurement will default to a unit generally appropriate for the gas in question ($\mu\text{mol}/\text{m}^2/\text{s}$ for CO_2 and NH_3 , $\text{nmol}/\text{m}^2/\text{s}$ for CH_4 and N_2O). These can be changed from the Data menu under Flux Units, either prior to or after data collection. This window allows the flux units to be specified arbitrarily from various mass, area and measurement time settings, such as $\text{kg}/\text{km}^2/\text{year}$ or $\text{nmol}/\text{ha}/\text{hour}$ (see **Figure 29**).

Note: Some combinations of units may be rejected if they would typically produce extremely large (e.g. $\text{nmol}/\text{km}^2/\text{yr}$ for CO_2 flux) or extremely small values (e.g. $\text{kg}/\text{m}^2/\text{s}$ for CH_4 flux).

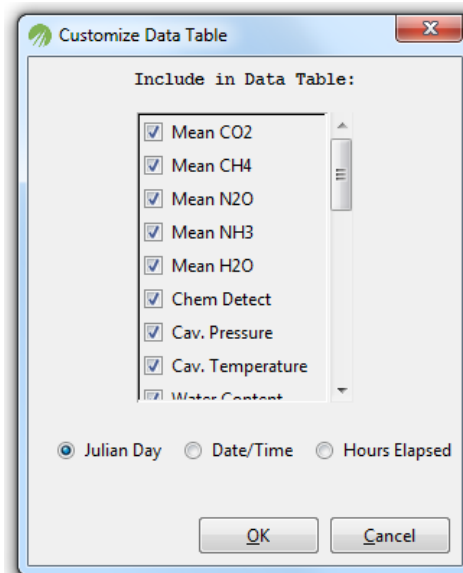


Figure 28. Customize Data Table window.

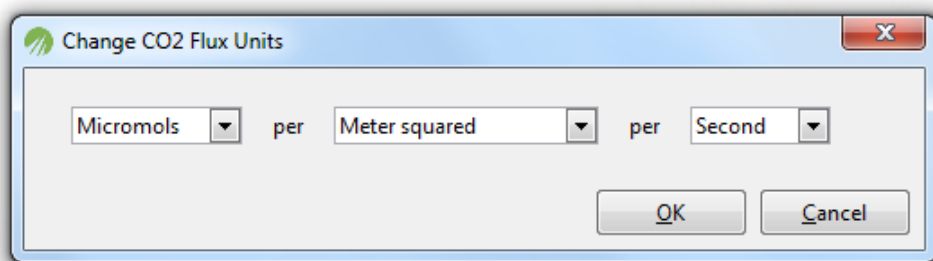


Figure 29. Change flux Unit Window.

7.6 Data Processing

Individual measurements can be viewed in greater detail by clicking on them in either the Data Table or one of the main plots, which brings up the **Measurement Settings** window (see **Figure 30**).

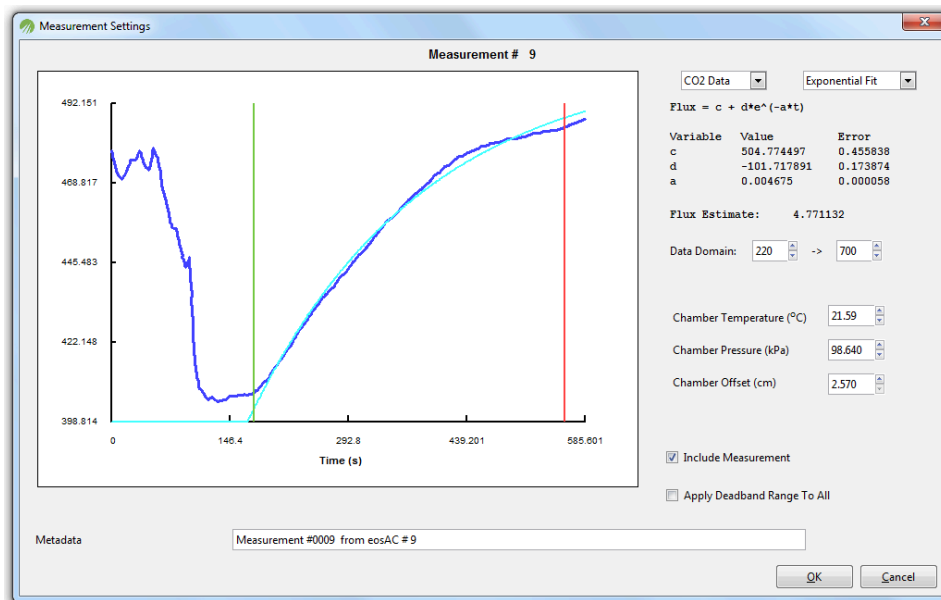


Figure 30. Measurement Settings window.

The flux fits and Keeling plot intercepts (isotopic analyzers only) for any relevant gasses can be viewed using the drop down menus in the top-right of the window. Directly below these buttons are the specific parameter estimates for the shown fit, followed by the current deadband settings. Data from the beginning or end of the timeseries can be omitted by changing these settings using the **Data Domain** spin buttons. Note that changing these options will result in a brief updating period while the fits are recalculated once the Measurement Settings window is closed. The **Apply Deadband Range To All** check box can be checked to apply the deadband setting to all current data table measurements. Please see [AN0011](#) for more information about adjusting data deadbands.

The chamber temperature, chamber pressure and chamber offset (distance between bottom of chamber and soil due to collar) can be modified from their default values as well. The **Use Measurement** check box can be unchecked to exclude the displayed measurement from both the (exported) data table and the main window plots. **Note:** Adjust deadbands before deciding to exclude any measurements, as the Apply Deadband Range To All button will re-select all measurements.

The user can enter a metadata string directly below the Measurement Settings plot. This string can be up to 200 characters long, and is used to make any notes about the measurement/environment or other important details. Holding shift while clicking the plot provides an option to export the current data as a PNG or JPEG image.

7.6.2 Viewing Data

Along with the Data Table, chamber data can be viewed via three plots on the left of the main window (see **Figure 31**). Each plot can be customized using the drop down data selector, the Y-axis settings and the X-axis settings, and all three can be hidden using the **Hide Plots** checkbox. The style of all three plots can also be modified from the **Plotting Options** window (see **Figure 32**), found under the **Options** menu. Note that if both Lines and Symbols are turned off, nothing will be shown in the plots.

The Y-axis is automatically scaled by default. As long as this option is left unchanged, the (unused) Fixed Y-axis settings will be updated to reflect the current plot zoom. Once the **Fixed Y-axis** is selected for the first time, this relationship will be broken, in order to prevent loss of user-specified axis settings.

The X-axis type can be selected at the bottom of the Plotting section, and can be set to Julian Day (since January 1 of that year), Hours Elapsed (since start time) and Measurements (sequential numbering). Unlike the Y-axis settings, switching back to Automatic X-axis scaling will always result in the Fixed X-axis settings being changed along with the plot, to allow for the inclusion of new data. Mousing over a plot will display the X/Y coordinates at that location and holding shift while clicking will save the current plot as an image.

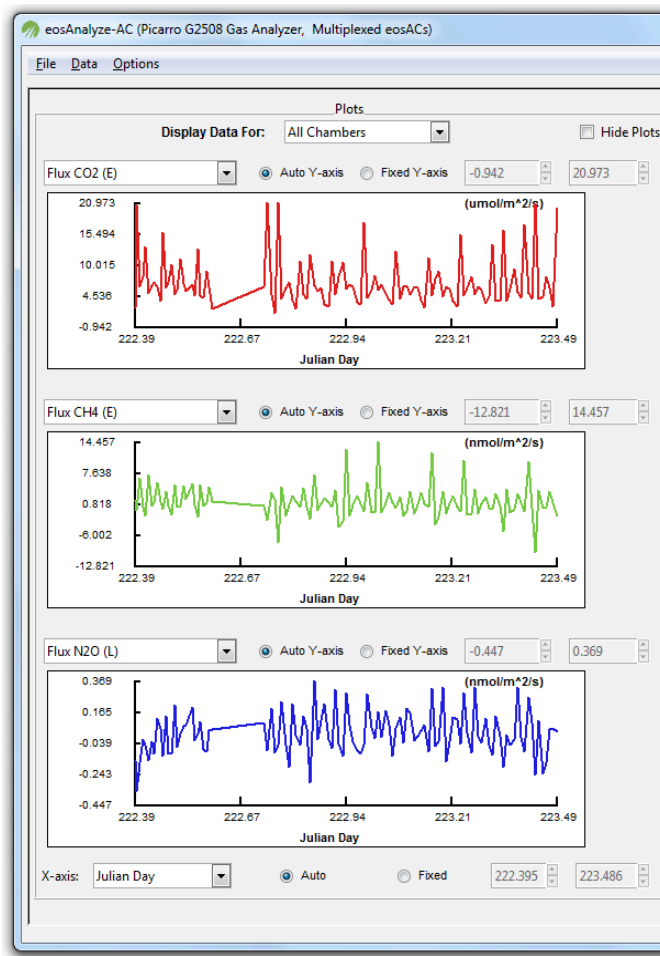


Figure 31. Plotting windows in eosAnalyze-AC.

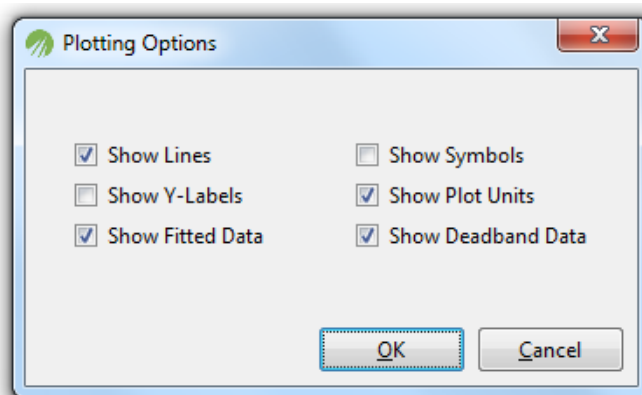


Figure 32. Plotting Options window.

7.6.3 Exporting Data

Once all the chamber data has been collected and fine-tuned, the user can export the Data table as either a .csv or .dat file using the **Export Data Table** button at the bottom left of the screen (see **Figure 33**). This prompts the user for a formatting type, followed by a pop-up window to choose the save location.

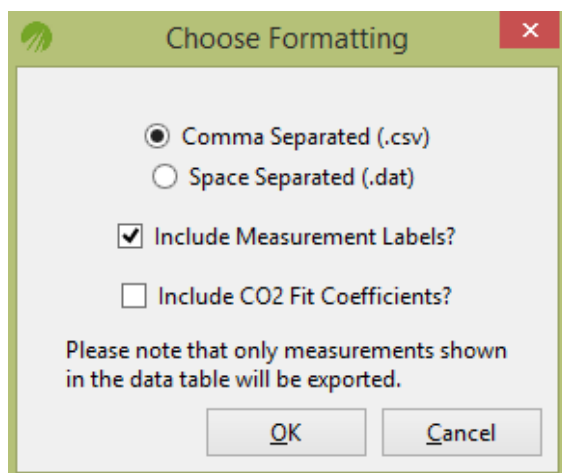
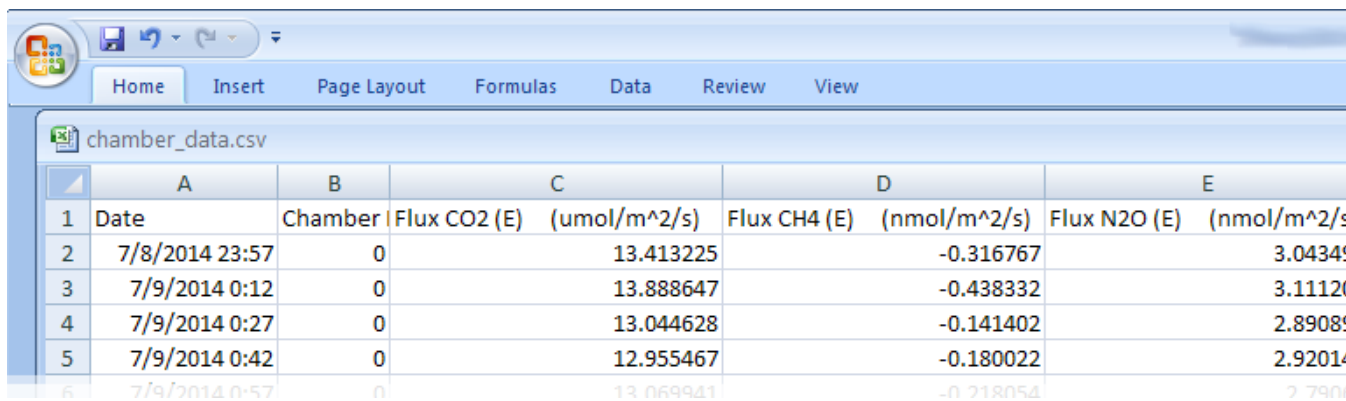


Figure 33. Choose format for exporting data.

Note: Data fields present in the table will be present in this exported file, and that measurements that have been deselected (appearing grayed out) will be excluded. This data can then either be used directly, or easily imported into a spreadsheet for further analysis (see **Figure 34**).



	A	B	C	D	E
	Date	Chamber	Flux CO2 (E) (umol/m ² /s)	Flux CH4 (E) (nmol/m ² /s)	Flux N2O (E) (nmol/m ² /s)
1	7/8/2014 23:57	0	13.413225	-0.316767	3.04349
2	7/9/2014 0:12	0	13.888647	-0.438332	3.11120
3	7/9/2014 0:27	0	13.044628	-0.141402	2.89089
4	7/9/2014 0:42	0	12.955467	-0.180022	2.92014
5	7/9/2014 0:57	0	13.069941	-0.218054	2.79014

Figure 34. eosAnalyze-AC data exported to Microsoft Excel.

8 Troubleshooting for eosAC-T/O and eosMX-16

8.1 Health Check

If you're experiencing issues with your Eosense Multiplexer and/or chambers, a good first step is to run a system health check (See **Figure 35**). The health check option can be accessed from the main eosLink-MX window under **Help > Perform System Health Check**. Under the eosMX Port(s) dropdown, choose a specific eosMX port to check, or select **All Ports** to run a check on the entire system. When the **Begin Check** button is clicked the software will run a series of tests on the ports selected and any chambers connected to those ports.

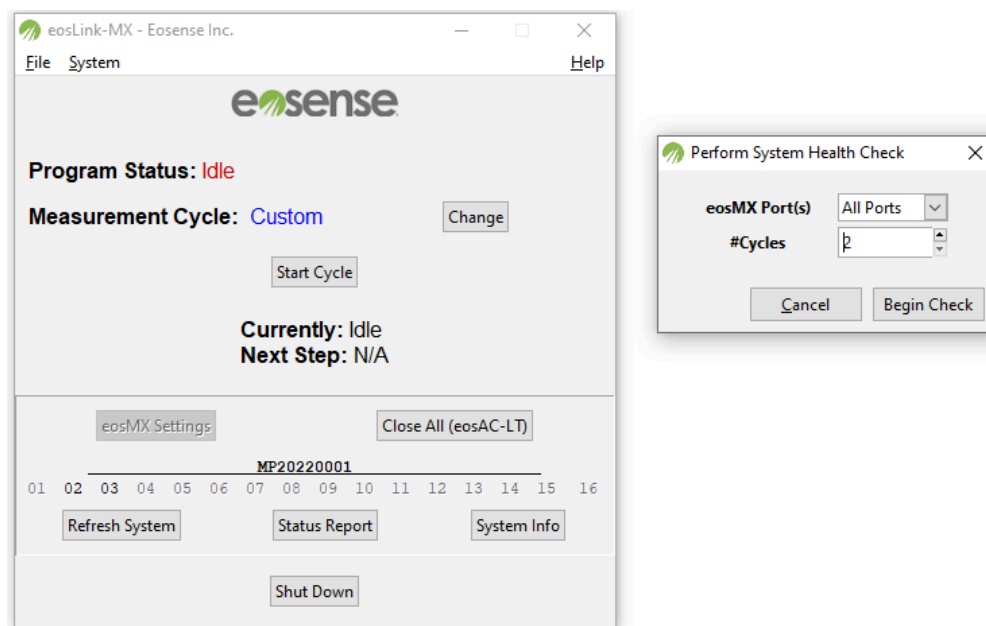


Figure 35: System Health Check Window

When the health check is finished, the software will produce a new window with the results of the health check. A copy of the results will also be saved in the software main folder labeled *eosMX_All_Ports_DATE.csv*. If you're experiencing issues with your Eosense equipment, please send a copy of the health check file to support@eosense.com for review.

8.2 eosAC-T/O Communication issues

There are several reasons why an eosAC-T/O may not be recognized in eosLink-MX. If possible, contact support@eosense.com with the serial number and port number of the chamber that is not responding. Some of the diagnostic tests that support may ask to run include:

8.2.1 Unidentified Chamber Test

The **Unidentified Chamber Test** can be accessed from the main window in eosLink-MX by clicking on **Help > Unidentified Chamber Test** as shown in **Figure 36**. There is an option to select between smart search, which searches for chambers with a serial number within 10 of any of the identified chambers connected to the system, or a specific serial number (**Figure 37**).

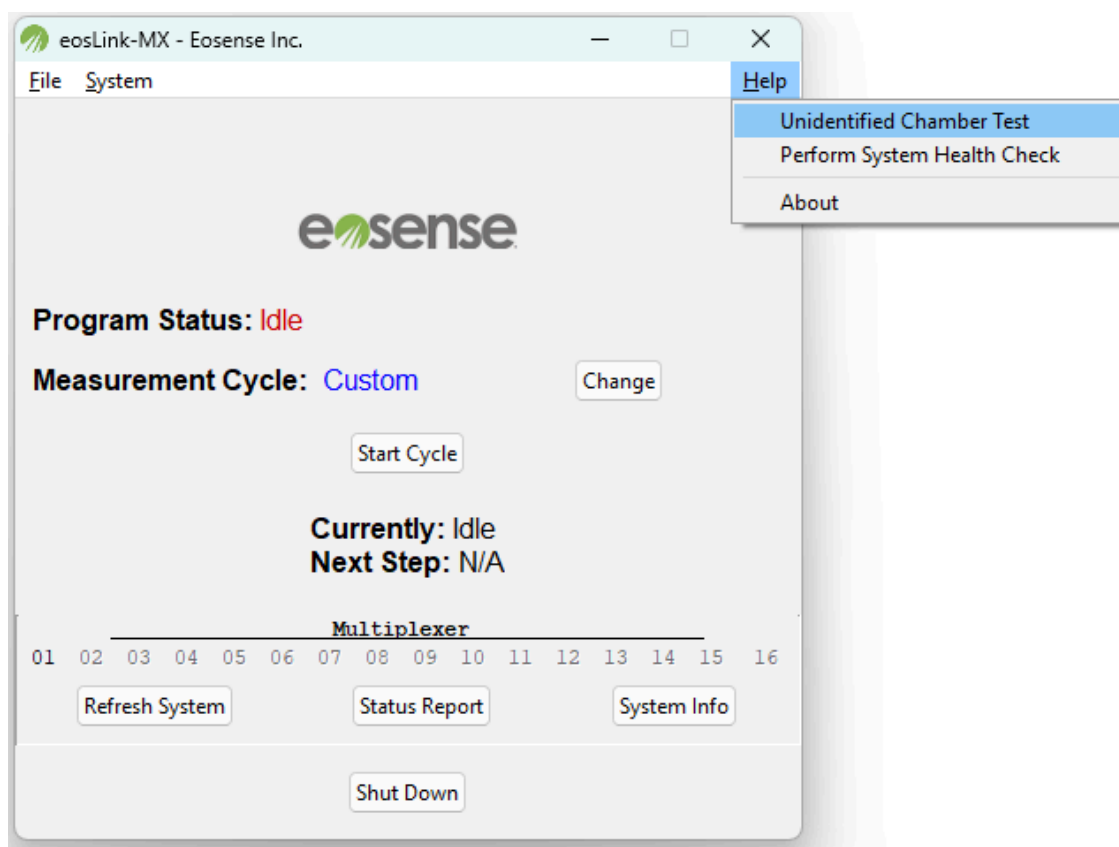


Figure 36: Accessing the Unidentified Chamber test from the main eosLink-MX window

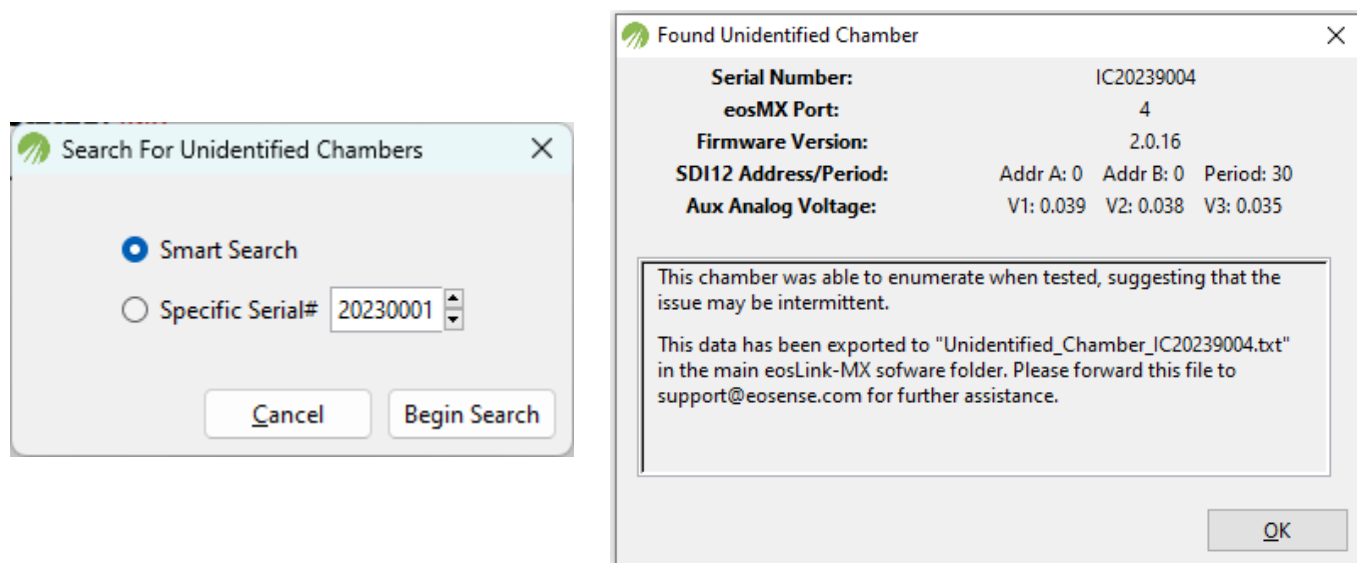


Figure 37: Unidentified Chamber Test Window

If an unidentified chamber is found, a new window with a summary of chamber details and the suspected issue will appear. The summary will also be added to Unidentified_Chamber_SerialNumber.txt in the main eosLink-MX software folder. The text file can be sent to Eosense Support for further assessment.

8.2.2 Coolterm Test

Typically chamber commands are handled through Eosense software. However, when troubleshooting it is sometimes useful to by-pass the software and communicate directly with the chambers. The use of a terminal program (such as [CoolTerm](#)) allows the user to communicate directly with a chamber. This is most conveniently done through command files - which are text files containing the hex characters that make up different chamber commands. For example, the "! AC - Chamber Close.txt" file, when sent to a listening eosAC-T/O chamber, instructs the chamber to close (see **Figure 38**).

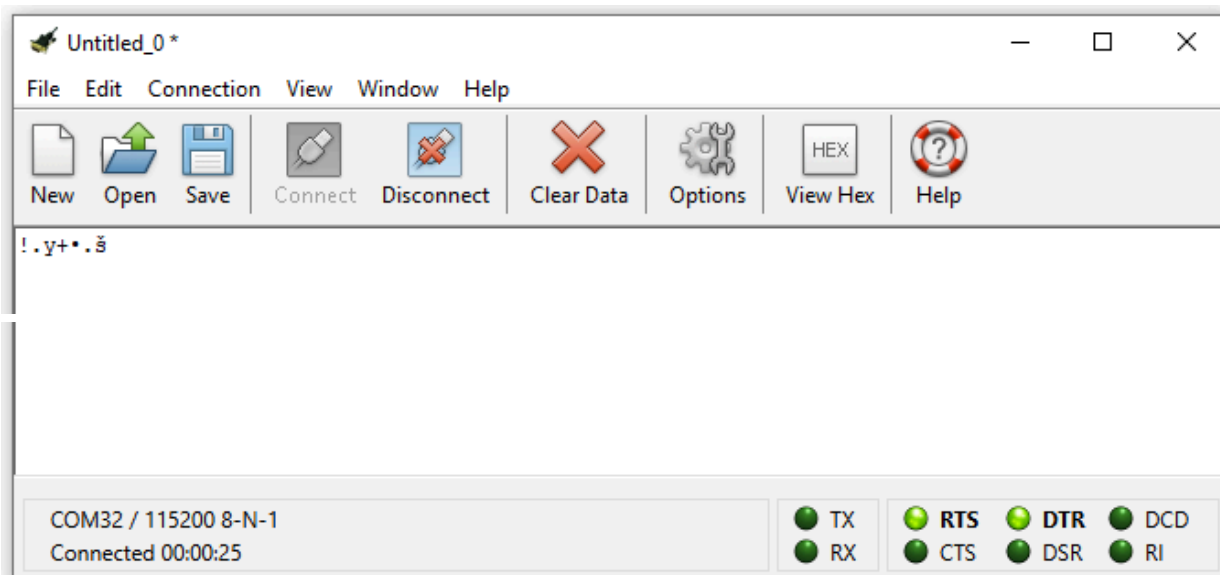


Figure 38. Example response from an eosAC-LT/LO. Responses always start with '!' and are typically 6-9 characters long

Example: Closing an eosAC-LT/LO Chamber

This example walks through the process of using CoolTerm to send a command file to a connected eosAC-T/O that will instruct the chamber to close. This could be used to test chamber functionality outside of the typical eosLink-MX software.

1. Connect the eosAC-T/O to your PC (via USB) and a stable 12 VDC power source using the provided power/data cable.
2. Extract the downloaded .zip file containing the [CoolTerm](#) terminal program and the command files provided by Eosense Support. Be sure to save these files in an accessible folder (we recommend saving both to your computer's desktop).
3. Click the Options button from the CoolTerm main window (also found under Connection in the top menu). Click the **Re-Scan Serial Ports** button at the bottom of the **Serial Port** tab, and ensure that the Baudrate is set to 115200, Data Bits are 8, Parity is none, and Stop Bits are 1 (see **Figure 39**).

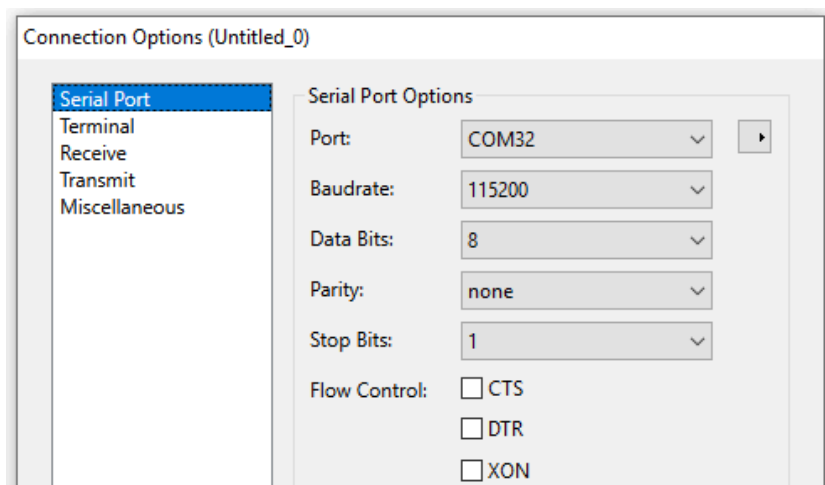


Figure 39. Serial Port Options in CoolTerm

4. Choose a port from the Port drop down menu ("COM32" is selected in the example above). What ports are available depends on your system - for example, some analyzers will have their own devices on COM1 and/or COM2, so try higher ports to start. The use of Windows Device Manager is recommended for determining the correct COM Port.
5. Click **OK** to return to the main CoolTerm window, and then click the **Connect** button.
6. If the port connects successfully, click the Connection menu and choose "**Send Textfile...**". Navigate to the folder created in step 1 and select the "**! AC - CloseChamber.txt**" file to send. The listening eosAC-LT/LO chamber should respond - this will appear as a series of ASCII characters in the CoolTerm window (see **Figure 38**), followed by the chamber closing.

Other command files can ask the chamber for temperature/pressure data, change the unit's serial number, or place the eosAC-LT/LO in an automatic open/close loop.

8.2.3 Single Chamber Software Test

To help isolate the issue, eosLink-AC can be a useful tool that allows for control of the eosAC-T/O without the multiplexer. Please contact [Eosense support](mailto:info@eosense.com) for assistance installing the eosLink-AC on your Windows device.

