MAX™

The Absolute Standard

ASC-10™

Automated Sample Console

Operating Manual

P/N: 107-0024 (March 2023)

MAX Analytical Technologies

part of Thermo Fisher Scientific

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About this Manual

This manual provides instructions for the Automated Sample Console ASC-10™ / ASC-10-ST™. Instructions are included for the safe installation, setup, and operation of the equipment. Before installing or operating the equipment, please read the entire manual and observe all hazard notices, symbols and labels on the equipment and in the manual.

Contact Information and Technical Support

Safe and reliable operation of this equipment is conditional on all installation, operation and maintenance procedures being carried out in accordance with the appropriate manuals, by personnel having appropriate qualifications, experience, and training. Failure to observe the requirements of the manual may invalidate any warranty.

For applications or technical support:

1. Dial 1-800-532-4752

2. Select “option 2” for Unity Lab Services technical support

3. For your instrument type, select “option 6” for Molecular, Vibrational Spectroscopy Based Spectrometers.

Alternatively, you can e-mail for applications or technical support to:
us.techsupport.analyze@thermofisher.com

Table of Contents

1 ASC-10 Safety

This chapter identifies potentially hazardous conditions which may be present during Installation, operation, and servicing of the equipment.

Equipment Intended Use

The equipment is intended for indoor use in an ordinary location. The equipment should be kept dry and should not be exposed to an explosive environment. See the installation section of this manual for required operating temperature, power requirements, and other specific requirements for proper installation and operation of the equipment.

Hazard Notices Used in this Manual

The equipment poses potential hazards during installation, operation, and service. In this manual you will find four levels of safety precautions and important notices that conform to ANSI Z535 and ISO 3864. These hazard notices identify the hazard, explain how to avoid the hazard, and to identify probable consequences of not avoiding the hazard. These notations are provided primarily in the procedural sections and are intended to complement the ANSI and/or ISO safety labels physically located on the equipment.

⚠DANGER

Avoid hazard. *Danger notifications indicate a hazardous situation which, if not avoided,* ***will*** *result in serious injury or death. The hazard is imminent.*

⚠WARNING

Avoid hazard*. Warning notifications indicate a hazardous situation which, if not avoided,* ***could*** *result in serious injury or death. The hazard is possible.*

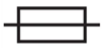
⚠CAUTION

Avoid hazard. *Caution notifications indicate a hazardous situation which, if not avoided, could result in moderate or minor injury and/or equipment damage.*

NOTICE

Notice notifications provide information to follow to avoid damaging system hardware or losing data.

Symbols Used on the Equipment

	On (Power) IEC 60417, No 5007
	Off (Supply) IEC 60417, No 5008
	Protective Earth Terminal IEC 60417, No 5019
	Fuse IEC 60417, No 5016
	General warning, refer to manual for further instructions. ISO 7010, W001
	Warning, risk of electric shock ISO 7010, W012
	Warning, hot surface. ISO 7010, W0017
	Equipment is compliant with requirements for the European Union. See Declaration of Conformity for further details on Directives and Standards used for compliance.
	Equipment is compliant with requirements for Great Britain. See Declaration of Conformity for further details on Directives and Standards used for compliance.
	The equipment should not be discarded as unsorted waste but must be sent to separate collection facilities for recovery and recycling.

General Safety Precautions

This section lists some of the hazards that could be encountered with the equipment. More specific hazards are listed throughout the manual in the relevant sections.

⚠CAUTION

Read the Manual before Operation: All operators should read and understand this manual before using the equipment. It is essential for all personnel to understand the operation procedures and how to avoid potential hazards associated with the use of the equipment.

⚠CAUTION

Only trained and experienced operators should perform maintenance and repairs. Contact Thermo Fisher Scientific for service and/or training.

⚠CAUTION

Do not substitute parts or modify equipment. Do not install substitute parts or perform any modifications to the hardware that have not been authorized by Thermo Fisher Scientific.

⚠CAUTION

Use the proper power cord. Only use a detachable power cord that is rated for the voltage and current specified on the equipment nameplate. The power cord should have a minimum cross-sectional area of 0.75 mm^2 (18AWG). The power cord should be certified by an appropriately qualified agency such as UL, VDE, or Semko.

⚠WARNING

Explosion Hazard: The equipment will expose sample gas to heated surfaces and is intended for the analysis of non- flammable gas mixtures only. The concentration of flammable gases in the source stream should be less than 25% of the lower explosive limit (LEL). Failure to comply may result in injury or death.

⚠WARNING

Inhalation Hazard: Be sure that any sample exhaust ports are properly connected to a safe vent location to prevent exposure to potentially dangerous gas mixtures. Inhalation of certain gases may cause headache, dizziness, nausea, bodily irritation, irregular heartbeat, or death.

⚠WARNING

Shock Hazard: The system enclosure contains high voltage. The system must be de-energized during all maintenance and service operations. Failure to comply could result in injury or death.

⚠CAUTION

Compressed Gas Hazard: The equipment requires compressed air for valve actuation (≥80psig) and may require calibration gas cylinders for analysis. Check for leaks before turning on any gas supply and wear safety glasses to prevent injury. Failure to comply could result in injury.

⚠CAUTION

Burn Hazard: The equipment contains heated components inside the enclosure and hot fittings on the back panel. Disconnect power and allow the equipment to cool before servicing and avoid touching the fittings on the back of the equipment. Failure to comply could result in injury.

⚠CAUTION

Equipment Damage and Ergonomic Hazard: The ASC-10 weighs approximately 95 lbs (43 kg), exceeding the recommended lifting weight (RLW) for one person. Improperly lifting the instrument may result in back injuries or the system being dropped or damaged. To avoid injury and equipment damage, exercise the proper safety precautions and always use at least two people to lift the equipment.

2 ASC-10 Overview

This chapter introduces the Automated Sample Console (ASC--10 and ASC--10-ST are used interchangeably), explains the principles of operation, and provides an overview of its components. The ASC--10 is an automated gas sampling system that includes a pump, filter, and valving to sample gas from a variety of sources for analysis by FTIR or other analyzers. The ASC--10 also includes a mass flow controller and valving to allow for automatic control of zero or calibration gases, and for spiking the sample probe (not provided by Max/Thermo Fisher) to ensure the quality of the measurement data. The system is controlled by a PLC which provides an interface to the MAX Acquisition software for automatic sequencing of measurements and analysis.

The ASC-10 is ideal for integration with the MAX-iR gas analyzer for many applications including:

- *Environmental applications*: Source testing, continuous emission monitoring and testing, and ambient air monitoring and testing
- *Vehicle and Engine applications:* Engine dynamometer testing, vehicle interior air quality (VIAQ) analysis and sealed housing evaporative determination (SHED) testing
- *Industrial applications:* Process stream monitoring and testing

Part Numbers and Power Configurations

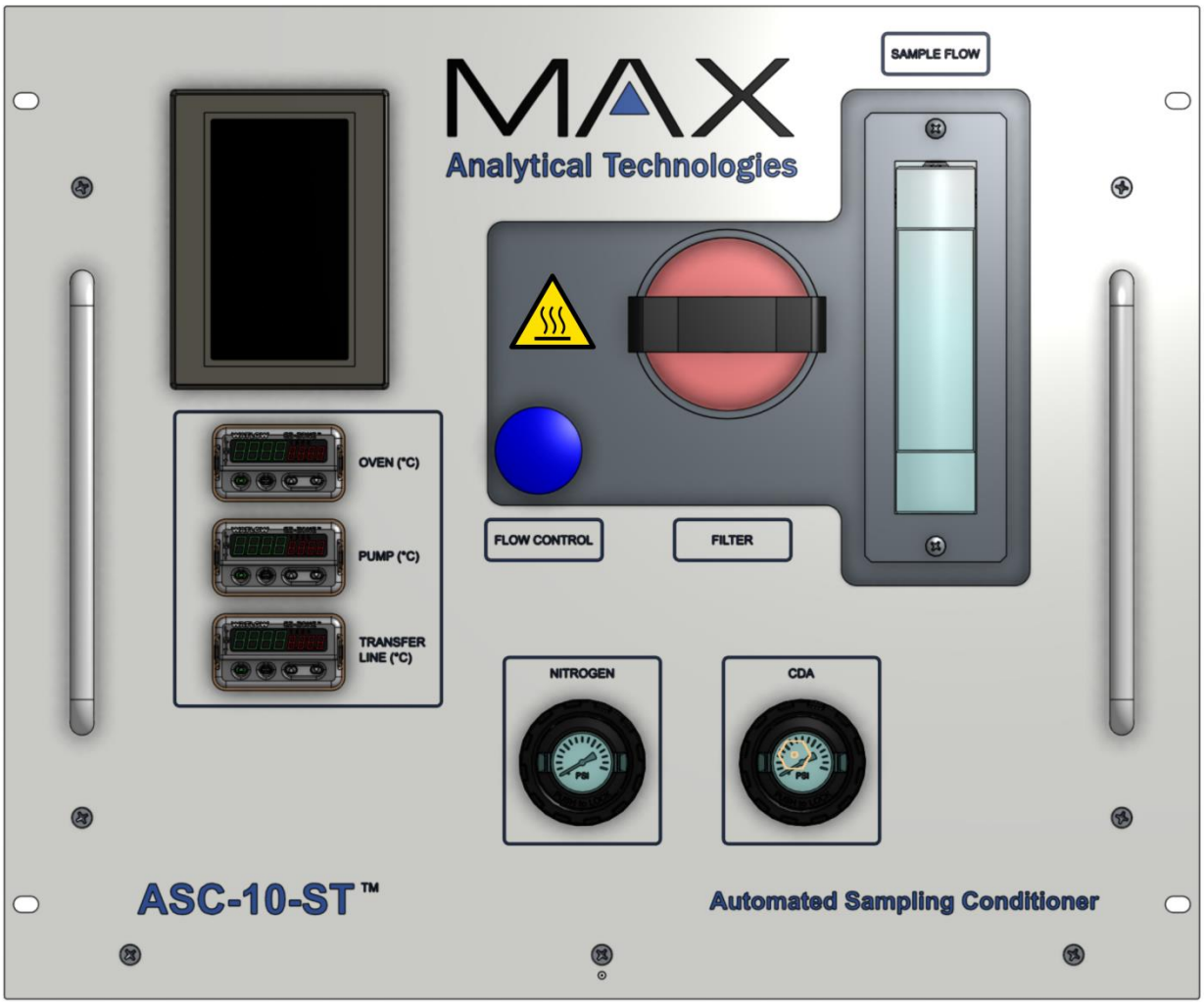
TABLE 1. ASC-10 CONFIGURATIONS

	ASC-10, 120V	ASC-10, 230V
Part Number	101-0167	101-0287
Power	120VAC, 60Hz, 5.9A	230VAC, 50Hz, 3.2A
Heated Sampling Lines	120V, 2-ft, SS, Rigid 120V, 5-ft, SS, Flex	230V, 2-ft, SS, Rigid 230V, 5-ft, SS, Flex
Accessories Kit	PN 101-0458	PN 101-0458
Power Cord	120V, North America (NEMA 5-15)	230V, EU (Euro Schuko)

Overview of Hardware

Front Panel

The front panel of the ASC-10 includes an HMI touch screen to view and control the state of the hardware and temperature controllers for the oven, pump, and transfer line heaters. Pressure regulators with gauges control the gas pressure for CDA used to actuate the pneumatic valves and Nitrogen used for purge and zero gas. A flow control valve, heated filter housing, and sample flow indicator are all part of the sample oven and are exposed through the front panel.

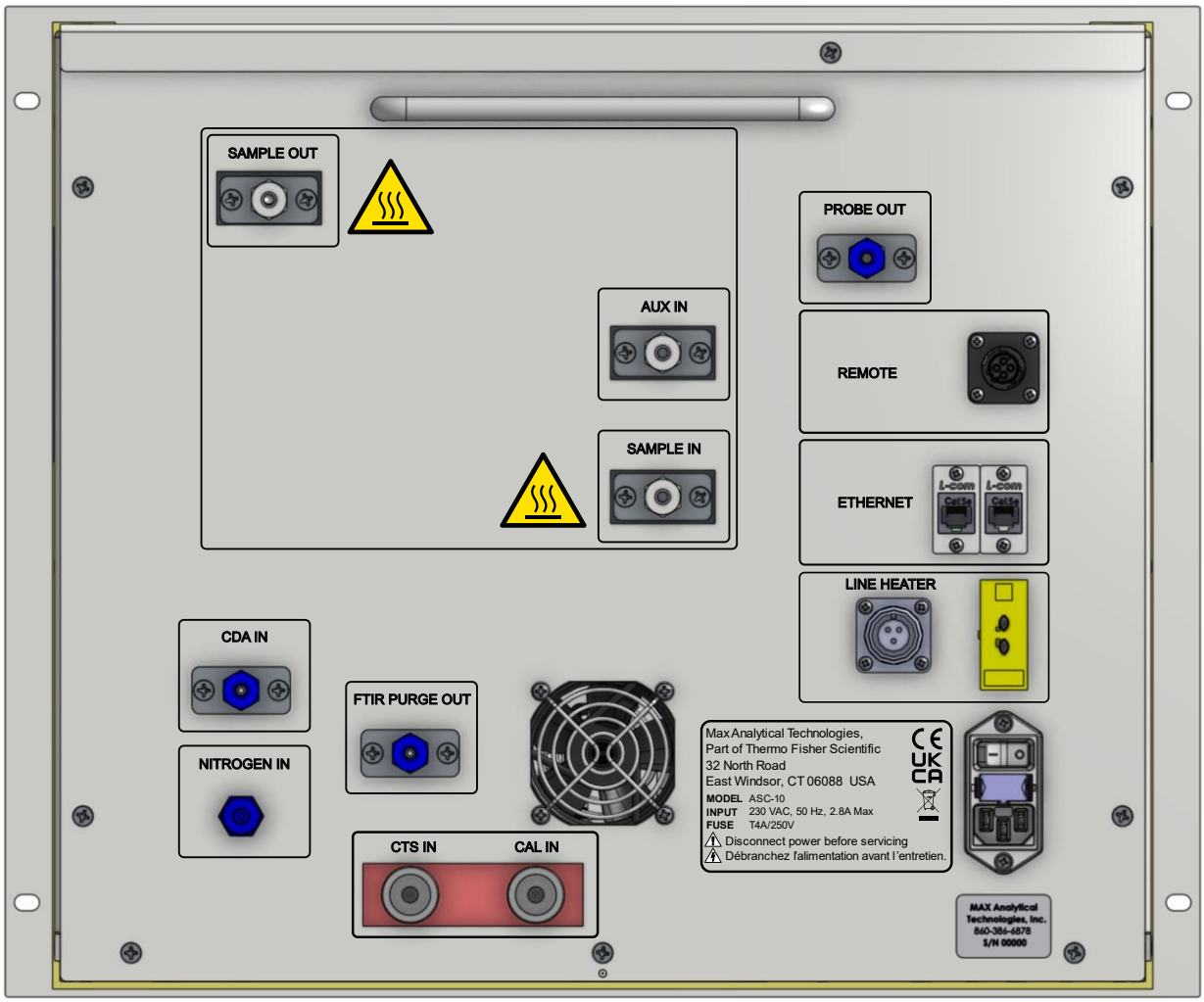


Rear Panel

The rear panel provides fittings for all gas input and output connections, and for all electrical connections. Gas inlets include sample gas streams (Sample In and AUX In), the Calibration Transfer Standard (CTS In) and Calibration (CAL In) gases, Nitrogen In (for zero and purge) and CDA (to actuate the pneumatic valves). The three gas outlets include Sample Out (to the FTIR), FTIR Purge Out, and Probe Out which is used to send a Calibration gas to the sampling probe (not included).

Electrical connections (Line Heater) are provided to control the heater power for the sample line that connects from the ASC-10 Sample Out port to the inlet of the FTIR analyzer. The controlling thermocouple input is directly next to the Line Heater power connection.

Ethernet ports are provided for connecting the ASC-10 to the system computer and the MAX-iR. The Remote connector is provided to connect an analog signal (4-20 mA) from a remote sensor (typically an Oxygen sensor) to the ASC-10 data stream. The power inlet module provides the main power switch, main fuses, and connection point for the power cord.



3 ASC-10 Installation and Setup

This chapter describes how to prepare a site for installation as well as procedures for uncrating and initial setup of the ASC-10.

Site Requirements

Environmental Requirements

TABLE 2. ASC-10 ENVIRONMENTAL REQUIREMENTS

Requirement	Description
Location	The equipment is intended for sheltered use in an ordinary location.
Ventilation	The equipment is cooled by a ventilation fan. Allow at least 6 inches clearance on all sides to ensure adequate cooling.
Ingress Protection	Designed to meet IP20.
Operating Temperature Range	10-30°C
Storage Temperature Range	5-40°C
Humidity	10-90% relative humidity, non-condensing

Facilities Requirements

TABLE 3. ASC-10 FACILITIES REQUIREMENTS

Requirement	Description
Power (US)	120 VAC, 60 Hz, 5.4 A. The power cord has a NEMA 5-15 flat blade plug.
Power (EU)	230 VAC, 50 Hz, 2.7 A. The power cord has a CEE7/7 plug (Schuko).
Overvoltage Category	Category II - Residential distribution, devices connected to standard 2 pole + earth electrical outlets.
Mains Supply Voltage Fluctuations	±5%
CDA	Instrument-grade clean dry air (CDA) or N3.0 Nitrogen gas, 80--100 psig. Use ¼" O.D. HDPE tubing and ¼" Swagelok compression fittings. -have a dewpoint of 20°C or lower.
Nitrogen	N4.0+ Nitrogen gas, 20-100 psig. Use ¼" O.D. HDPE tubing and ¼" Swagelok compression fittings to connect to the included Swagelok quick connect body (SS-QC4-B-400).

CTS	A certified gas mixture of 100 ppm Ethylene in Nitrogen balance is recommended as a Calibration Transfer Standard. Use ¼" O.D. HDPE tubing and ¼" Swagelok compression fittings to connect to the included Swagelok quick connect stem (SS-QC4-D-400). Set inlet pressure to 20 psig.
CAL	Certified gas mixtures are recommended as a Calibration Standard depending on the application. Use ¼" O.D. HDPE tubing and ¼" Swagelok compression fittings to connect to the included Swagelok quick connect stem (SS-QC4-D-400). Set inlet pressure to 20 psig.

ASC-10 Dimensions

The ASC-10 is a 9U rack-mountable system and is designed to be mounted on a shelf in a standard 19" relay rack. The system dimensions (HxWxD) are 400 x 495 x 590 mm (15.75 x 19.5 x 23.25 in.), and the weight is 43 kg (95 lbs.).

Unpacking the Equipment

If the ASC-10- is ordered as an accessory, then it will be shipped separately in its own shipping container. If it is ordered as rack-mounted, it will typically be installed in the system rack or enclosure.

When the instrument is received, inspect the packaging for any defects and check any shock and tilt indicators to be certain that damage has not occurred during shipment. If you find any damage, please notify Technical Support immediately (see Contact Information and Technical Support). You must obtain a Return Material Authorization (RMA) number from Thermo Fisher Scientific before shipping any component back to the factory. Save the original packing material as this will be required to return the system to Thermo Fisher Scientific if a return is necessary. The use of unsuitable packing material during shipping will void the instrument warranty.

⚠CAUTION

Read and understand the manual before installation.

⚠CAUTION

Equipment Damage and Ergonomic Hazard: The ASC-10 weighs approximately 95 lbs. (43 kg), exceeding the recommended lifting weight (RLW) for one person. Improperly lifting the instrument may result in back injuries or the system being dropped or damaged. To avoid injury and equipment damage, exercise the proper safety precautions and always use at least two people to lift the equipment.

⚠WARNING

Use only in non-rated locations. The equipment is not designed to operate in a location containing potentially explosive gases.

⚠CAUTION

Use correct voltage power supply to the equipment. Observe the ratings specified on the equipment nameplate.

Physical Installation

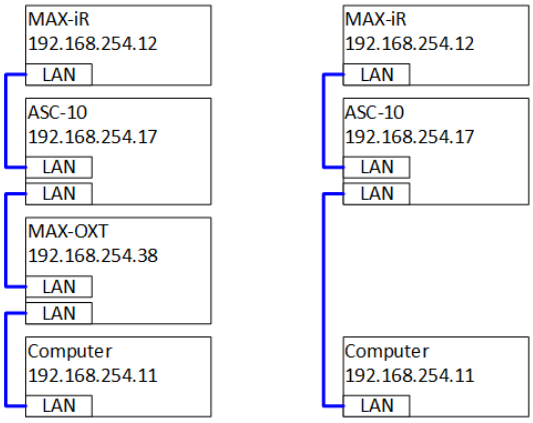
The ASC-10 is a 9U rack-mountable enclosure and weighs approximately 43 kg (95 lbs.). If mounting the equipment in a 19" rack, a shelf rated for the weight should be used to support the unit. The unit should also be secured to the rack rails using the four mounting holes in the front panel.

The ASC-10 can also be installed on a bench or cart rated for the weight. Care should be used to ensure that the unit is mounted securely.

Ethernet Connections

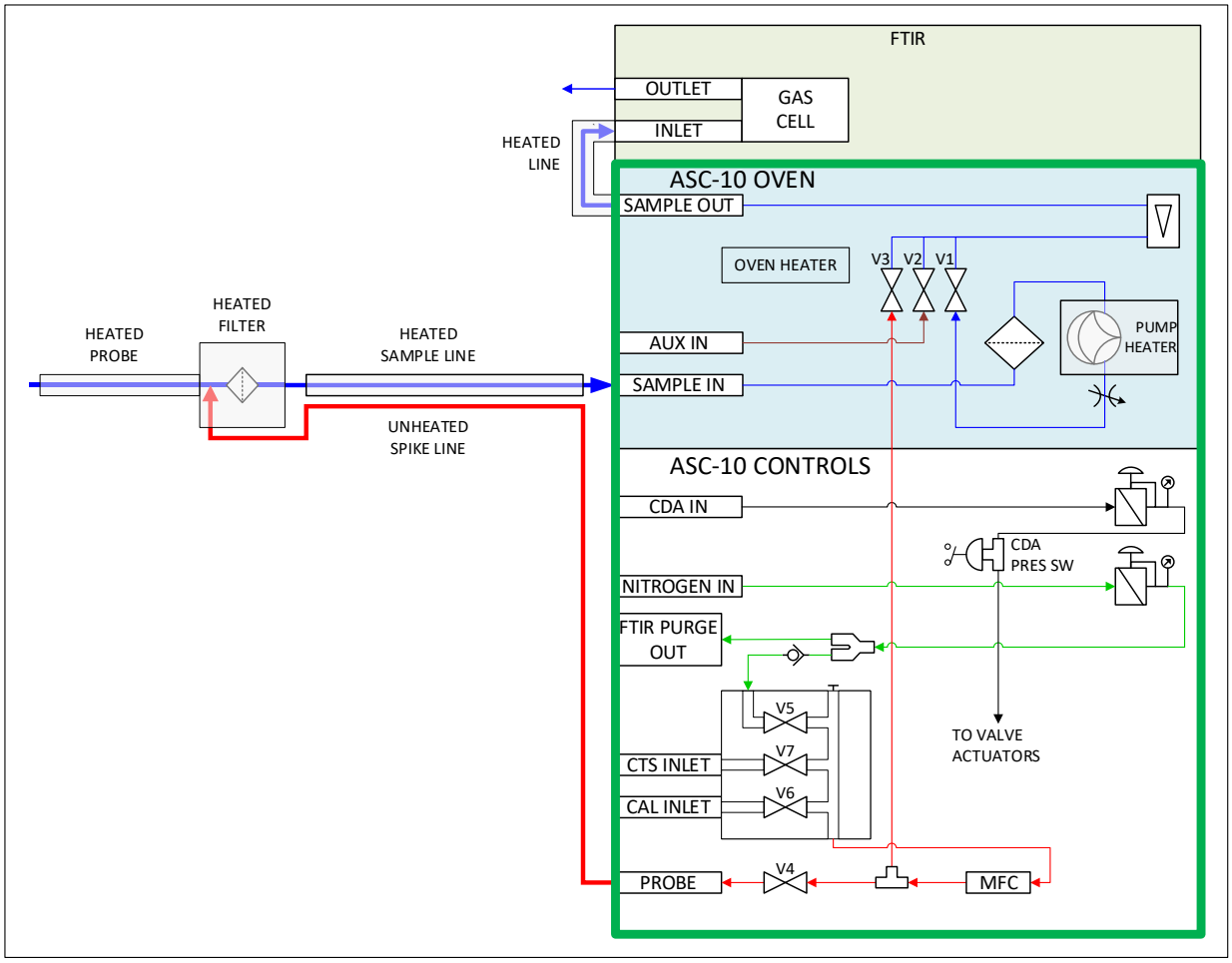
The equipment requires a dedicated ethernet port on the computer to be used with the ASC-10, although this can be shared with a MAX-iR and MAX-OXT. This equipment operates on a private subnet reserved for the equipment. If the ASC-10 is installed in a system, then the ethernet connections to the computer will already be made. The computer ethernet adapter connected to the ASC-10 should be configured with a fixed IP=192.168.254.11, subnet=255.255.255.0, gateway=192.168.254.1 (or blank).

If the system includes a MAX-iR and/or an MAX-OXT, then the connections should be made as shown in the figure below. The ASC-10 and MAX-OXT have internal ethernet switches with two external ports to allow daisy chaining the ethernet connections.



Pneumatic Connections

This section provides instructions for making the gas connections required to use the ASC-10 with a MAX-iR FTIR analyzer. Refer to the detailed diagram below to note the flow of the delineated gas streams.



CDA IN and NITROGEN IN

The ASC-10 uses CDA to actuate the pneumatic gas valves. Either CDA or Nitrogen should be connected to the CDA IN port at a pressure of 80-100 psig. The CDA regulator on the front panel of the ASC-10 is used to set the working pressure to 80 psig, and the actual pressure can be viewed on a gauge in the regulator handle.

High purity (N4.0+) Nitrogen is used as zero gas for the MAX-iR FTIR analyzer and to provide purge gas for the FTIR optics. Nitrogen should be connected to the NITROGEN IN port art 20-100 psig. The NITROGEN regulator on the front panel of the ASC-10 is used to set the working pressure to 20 psig, and the actual pressure can be viewed on a gauge in the regulator handle.

If needed, it is possible to use a single source of Nitrogen (80-100 psig) to supply both the CDA IN and NITROGEN IN (female quick connect) connections. Use a T-connection to allow a single supply line to both inlets. Detailed requirements are included in the ***Facilities Requirements*** section.

FTIR PURGE OUT

The ASC-10 includes a purge gas outlet to provide purge gas for the MAX-iR FTIR optics. Nitrogen gas at 20 psig can be connected to the FTIR, which should include a flow controller to set the desired purge flow rate. This is typically in the range of 0.1 – 1.0 LPM, but the FTIR documentation should be consulted for details. If FTIR PURGE OUT will not be used, then the fitting should be capped to prevent leakage.

CTS IN

A certified gas mixture of 100 ppm Ethylene in Nitrogen balance is recommended as a Calibration Transfer Standard. Connect the gas cylinder regulator to a Swagelok quick connect stem (male) using ¼" O.D. high purity HDPE tubing. The quick connect stem can then be connected to the CTS IN gas port on the back of the ASC-10. The gas cylinder regulator should be set to 20 psig.

CAL IN

Certified gas calibration mixtures are typically used with the ASC-10 and FTIR to verify the quality of extractive gas measurements. Connect the gas cylinder regulator to a Swagelok quick connect stem (male) using ¼" O.D. high purity HDPE tubing. The quick connect stem can then be connected to the CAL IN gas port on the back of the ASC-10. The gas cylinder regulator should be set to 20 psig.

Heated Sampling Hose and Probe

The ASC-10 is typically connected to the sample gas source using a customer-provided heated sampling hose. The sample hose typically has a 1/4" or 3/8" O.D. heated core and a 1/4" unheated spike line. The line materials can be PTFE, PFA, SS, or other materials suitable for the required temperature and gas compatibility. Heater power and control should also be provided by the customer. The heated core is used to sample gas from the source, and the unheated spike line is used to send zero, CTS, or calibration gas from the ASC-10 to the probe, and then back through the sampling train to verify sampling integrity.

⚠WARNING

The gas fittings on the back of the ASC-10 may be hot. Allow the system to cool before making sample line connections.

SAMPLE IN and PROBE OUT

The heated core of the customer-provided sampling hose should be connected to the SAMPLE IN port on the back of the ASC-10. The unheated spike line should be connected to the PROBE OUT port. At the far end of the sample hose, connections should be made to the filter box and probe as per the instructions from the probe manufacturer.

AUX IN

Although not typically used, the AUX IN port provides a means to connect a second gas source to the ASC-10. AUX IN should be capped if not used. If desired, a second gas source may be connected, but the customer must provide flow control externally. Configure the AUX gas flow to be controlled to the range of 1-9 LPM, and the pressure should not exceed 20 psig.

SAMPLE OUT

The SAMPLE OUT port is normally connected to the FTIR sample inlet using a short, heated line (2-foot rigid stainless steel or 5-foot flexible) provided with the ASC-10. Connect the ends (¼" Swagelok) to the SAMPLE OUT port on the ASC-10 and the SAMPLE IN port on the FTIR.

The ASC-10 includes a heater controller for the SAMPLE OUT heated line. Connect the heater power and thermocouple connectors to the LINE HEATER connectors on the back of the ASC-10.

⚠WARNING

The gas fittings on the back of the ASC-10 may be hot. Allow the system to cool before making sample line connections.

⚠CAUTION

Ensure that the voltage rating for the heated line matches the voltage rating listed on the nameplate for the ASC-10.

⚠CAUTION

LINE HEATER connectors are only intended for the short heated lines provided with the ASC-10. Do not connect third-party heated lines to these connectors as they may draw too much current.

Exhaust Requirements

It is important to ensure that any gas exhausted from the SAMPLE OUT port is vented to a safe location. If SAMPLE OUT is connected to an FTIR analyzer (or other analyzer), then the analyzer exhaust should be vented to a safe location. Note: The gas exiting the ASC-10 SAMPLE OUT may be hot and can potentially melt tubing. Be sure to use appropriate exhaust tubing.

⚠WARNING

Inhalation Hazard: Be sure that any sample exhaust ports are properly connected to a safe vent location to prevent exposure to potentially dangerous gas mixtures. Inhalation of certain gases may cause headache, dizziness, nausea, bodily irritation, irregular heartbeat, or death.

ASC-10 Sample Gas Filter

The ASC-10 oven includes a heated gas filter to protect the plumbing components and FTIR analyzer from particulate contamination. The filter element is mounted on a quick release handle accessible from the front of the ASC-10. It is recommended that the filter be checked for contamination periodically and replaced if necessary. See the ***Maintenance*** section of this manual for detailed instructions and precautions.

Power Connection

Once all other connections have been made, connect the system power cord to an appropriate electrical power source. Be sure to use a power source that matches the voltage rating on the equipment nameplate.

⚠CAUTION

Use the correct voltage power supply for the equipment. Observe the ratings specified on the equipment nameplate.

⚠CAUTION

Use the proper power cord. Only use a detachable power cord that is rated for the voltage and current specified on the equipment nameplate. The power cord should have a minimum cross-sectional area of 0.75 mm^2 (18AWG). The power cord should be certified by a qualified agency such as UL, VDE, or Semko.

System Fuses

The electrical system in the equipment is protected by two fuses in the power inlet module and are accessible from the back panel of the equipment. To inspect or change the system fuses, disconnect the power cord, then remove the fuse block from the power module. Insert fuses of the proper type and rating for the equipment and reinsert the fuse block before reconnecting the power cord to the equipment.

120 VAC ASC-10: Fuses = T8A/250V
230 VAC ASC-10: Fuses = T4A/250V

⚠CAUTION

Use the correct fuses for the equipment. Use fuses of the correct type and rating as indicated on the equipment nameplate and in the manual.

Cleaning

The equipment should only be cleaned by wiping with a dry cloth. Do not spray any liquids on or in the enclosure.

ASC-10 Setup and Hardware Verification

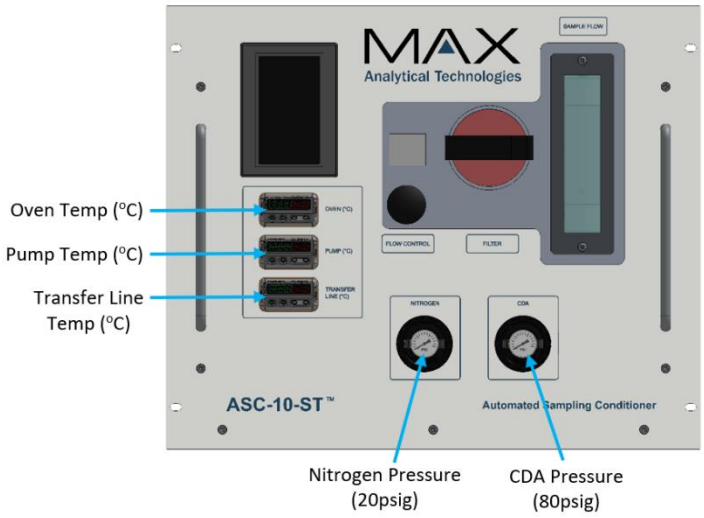
This section explains how to ensure the ASC-10 hardware is setup correctly and how to prepare the system to acquire FTIR emissions data for the first time. Verify that the ASC-10 is running properly and ready for use following the verification process below. The FTIR should be connected to the ASC-10 following the steps in the previous section, ***ASC-10 Installation and Setup***.

Verify the ASC-10 Nitrogen and CDA Pressure

1. Check the pressure of the Nitrogen and CDA on the gauges built into the handles of the regulators on the front panel. The Nitrogen pressure should be 20 psig, and the CDA pressure should be 80 psig.
2. If either value is incorrect, adjust the regulator to the correct value.
3. If the pressure is too low and can't be increased, then check that the source pressure is adequate.

Verify the ASC-10- Heater Setpoints

1. Turn on the power switch for the ASC-10. The heated zones will start warming up.
    a. Note: the temperature setpoints can be manually set or they can be controlled within the MAX-Acquisition software.
2. The three temperature controllers on the front panel will indicate the setpoint and actual temperatures for the three heated zones.
3. The Oven, Pump and Transfer Line temperatures are typically set to the same temperature as the FTIR gas cell (typically 35°C, 150°C, or 191°C) but this can vary depending on your application. To lengthen the life of the system, we recommend maintaining the oven temperature at no more than 150°C.
4. Wait for the heated zones to reach the operating temperature setpoint, which could take up to one hour.



NOTICE

If the system has been in long-term storage or undergone maintenance since its last use, the ASC-10 should be allowed to flow directly to vent before sending gas to the FTIR. Disconnect the line connecting SAMPLE OUT to the FTIR and connect an exhaust line directly to the SAMPLE OUT port before turning on the sample pump.

If Necessary, Purge the ASC-10 Sample Plumbing.

Complete this step only if the system has been in long term storage, or if the plumbing or pump has recently been serviced.

1. Be sure that the heated zones have reached the temperature setpoints before proceeding.
2. The ASC-10 sample mode should be in the "OFF" state. Press the "OFF" button on the main tab on the touchpad on the front of the ASC-10 or in the drop-down menu on the MAX-Acquisition software.
3. Disconnect the short, heated sample line from the SAMPLE OUT port on the back of the ASC-10.
4. Connect an exhaust line to the SAMPLE OUT port on the back of the ASC-10. Be sure that the exhaust line is vented to a safe area.
    a. Note: The gas exiting the ASC-10 SAMPLE OUT may be hot and can potentially melt tubing. Be sure to use appropriate exhaust tubing.
5. Switch the ASC-10 to the "SAMPLE" mode to turn on the pump and allow the system to pump gas to the exhaust line for ten minutes to purge any residual particulate material from the ASC-10 plumbing.
6. Switch the ASC-10 back to the "OFF" state.
7. Reconnect the short, heated line connecting the ASC-10 SAMPLE OUT port to the FTIR SAMPLE IN port.
8. Reconnect the exhaust line to the FTIR SAMPLE OUT port.

⚠WARNING

Avoid burn hazard. Use heat resistant gloves as the fittings and the connection on the heated lines will be hot.

⚠WARNING

Avoid FTIR Damage. Be sure the FTIR system gas cell has reached operating temperature before introducing sample gas. The gas cell should be hot to prevent condensation from occurring on the gas cell windows or mirrors.

⚠WARNING

Inhalation Hazard: Be sure that any sample exhaust ports are properly connected to a safe vent location to prevent exposure to potentially dangerous gas mixtures. Note that the gas exiting the ASC-10 SAMPLE OUT may be hot and can potentially melt tubing. Be sure to use appropriate exhaust tubing. Inhalation of certain gases may cause headache, dizziness, nausea, bodily irritation, irregular heartbeat, or death.

4 Using the Touchpad for ASC-10 Control

This chapter describes the simple operation of the ASC-10 sampling system to begin sending gas streams to the FTIR. The FTIR in this case will be the module that will acquire and store the actual data files and information. Once all the connections are made to the back of the ASC-10 and all the components are verified, the system should be ready for immediate use. The ASC-10 is fully controlled from the touchscreen on the front panel or using the MAX-Acquisition software (see ***Chapter 5***). There may also be a third-party software controller resident on the FTIR data collection computer using the remote-control inputs.

Touchscreen Panel

The ASC-10 touchscreen allows the user to select the sampling mode and to configure flow and heater parameters. There are three panels the user can access: Main, MFC, and TEMP. The MAIN page is the general usage page, where the critical parameters are displayed, and stream switching is performed. Before operating the system, the user should check the MFC and TEMP pages to confirm the MFC settings and Temperature Controller settings are correct.

If the optional Analog Input is purchased for a Remote Sensor input into the ASC-10-ST-0 version, there will be a fourth button labelled AI that will allow access to Zero and Span an external Remote Sensor.

Using the Main Touchscreen Panel

The MAIN page allows the user to select from the available sampling mode configurations and provides a quick view of critical operational parameters. When the Sample Pump is OFF the button will show up as RED and when one of the gas streams is selected, they will show up in GREEN. The table below is a summary of the main operations and settings within the MAIN page.

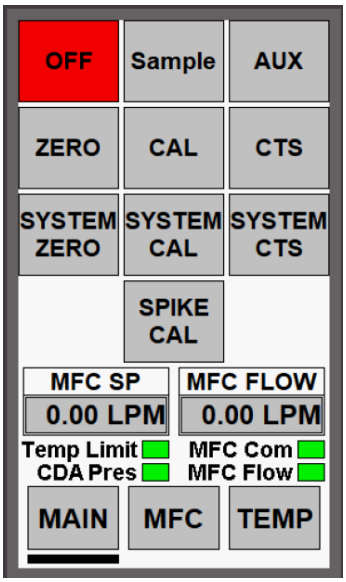


TABLE 4. TOUCHPAD MAIN TOUCHSCREEN OPERATIONS AND SETTINGS

Button	Description
OFF	Shuts off all flows to the FTIR

Sample	Turns the sample pump on and pulls the process gas stream coming from the probe at the stack or sampling point, sending it to the FTIR
AUX	Sends a second process gas stream to the FTIR (this requires an external filter and pump)
ZERO	Sends N2 gas stream directly to the FTIR (use this mode to collect a new background)
CAL	Sends the Calibration gas stream directly to the FTIR
CTS	Sends the Calibration Transfer Standard (CTS) gas stream directly to the FTIR
SYSTEM ZERO	Turns the sample pump on, sends the N2 gas stream at a high flow rate directly to the inlet port on the probe at the stack or sampling point (probe overflow), sending this sample stream to the FTIR.
SYSTEM CAL	Turns the sample pump on, sends the Calibration gas stream at a high flow rate directly to the inlet port on the probe at the stack or sampling point (probe overflow), sending this sample stream to the FTIR.
SYSTEM CTS	Turns the sample pump on, sends the CTS gas stream at a high flow rate directly to the inlet port on the probe at the stack or sampling point (probe overflow), sending this sample stream to the FTIR.
SPIKE CAL	Turns the sample pump on, sends the Calibration gas stream at a fraction of the total flow rate (initially 0.5 L/min) directly to the inlet port on the probe at the stack or sampling point (Spike recovery test), sending this sample stream to the FTIR.
MFC SP	Displays the Set Point (SP) of the Mass Flow Controller (MFC)
MFC FLOW	Displays the actual flow rate of the MFC
Temp Limit	Displays GREEN if the Temperature is within the set point range or RED if it is outside the limit.
CDA Pres	Displays GREEN if the Clean Dry Air (CDA) Pressure is within the set point range or RED if it is outside the limit.
MFC Com	Displays GREEN if the Communications are working or RED if it is not connected.
MFC Flow	Displays GREEN if the MFC Flow rate is within the set point range or RED if it is outside the limit.

Using the MFC Touchscreen Panel

The MFC page allows the user to set a single MFC for three different flow rates for the Nitrogen (ZERO), Calibration (CAL) and Calibration Transfer Standard (CTS) gas streams. The settings are stored internally and then applied when the system changes to the specified flow configuration, which are described in the table below.

NOTICE	*If you change any of the Set Points (SP) in the section, it is best practice to first turn the sample pump OFF which is done in the MAIN panel, then return to this panel to change the SP. Once you are done with the changes, return to the MAIN panel and select the stream of interest - this process will initiate the change to the new settings.*

NOTICE	*If the System Set Point (SP) is less than the Sample flow rate, then a low System Cal value will result, so it is critical to set the flow rates correctly. In general, this should be set at least 4-5 L/min above the sample system pump flow rate.*

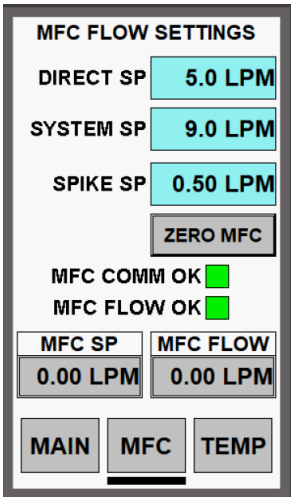


TABLE 5. TOUCHPAD MFC FLOW SETTINGS TOUCHSCREEN

Button	Description
DIRECT SP	This is the set point for all the gases (N2, Calibration, CTS) to be sent directly to the FTIR. A flow rate of 5 L/min should turn over >95% of the MAX-iR gas cell in around 30 seconds.
SYSTEM SP	This is the set point for all the gases (N2, Calibration, CTS) to be sent to the inlet on the sample probe before it is then sent to the FTIR (termed Probe Overflow). A flow rate of 9 L/min is required so that the total pump flow rate is exceeded by 4 L/min and only the gas stream sent to the probe will be observed at the FTIR.
SPIKE SP	This is the set point for the Calibration gas to be sent to be sent to the inlet on the sample probe before it is then sent to the FTIR (termed Spike Recovery). A flow rate of 0.5 L/min is initially set here but the user may need to adjust this so that this stream does not contribute more than 10% of the total Sample Gas flow rate (in this example the Sample Flow was set to 5 L/min therefore the SPIKE SP is 0.5 L/min.
ZERO MFC	This is to set the Zero Point of the MFC. Typically, flow is blocked or shut down and then the button is clicked to set zero.
MFC COMM OK	Displays GREEN if the Communications are working or RED if it is not connected.
MFC FLOW OK	Displays GREEN if the MFC Flow rate is within the set point range or RED if it is outside the limit.
MFC SP	Displays the Set Point (SP) of the Mass Flow Controller (MFC)
MFC FLOW	Displays the actual flow rate of the MFC

Using the TEMP Touchscreen Panel

The TEMP page allows the user to separately set the Heater Settings for each of the three heated zones: the Oven, Sample Pump and Sample Transfer Line. The table below provides a short description of the settings.

NOTICE	*In general, the pump and line HEATER SETTINGS should all be set to the same temperature as the gas cell temperature on the FTIR. We recommend the oven Temperature be set to 150 C.*

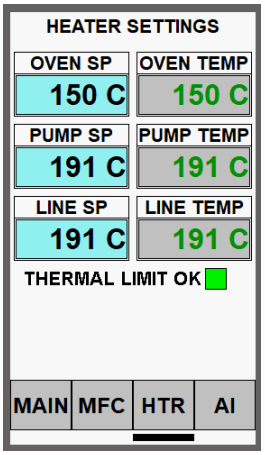


TABLE 6. TOUCHPAD TEMPERATURE CONTROL SETTINGS TOUCHSCREEN

Button	Description
OVEN SP	This is the set point for the finned strop heater within the sampling box "Oven" section which houses the sample stream switching valves and the heated filter housing. This can also be manually set using the temperature controller located on the front panel of the ASC-10.
PUMP SP	This is the set point that controls the temperature for the two cartridge heaters mounted in the pump head to maintain the pump at the correct sampling temperature. This can also be manually set using the temperature controller located on the front panel of the ASC-10.
LINE SP	This is the set point that controls the temperature on the heated gas sample transfer line between the ASC-10 Sample Out port and the FTIR Sample In port. This line should not exceed 10ft (3m) in length.
OVEN TEMP	This displays the actual temperature of the Oven, turning GREEN when the temperature nears the SP and RED when the Temperature is outside of the SP range.
PUMP TEMP	This displays the actual temperature of the Pump, turning GREEN when the temperature nears the SP and RED when the Temperature is outside of the SP range.
LINE TEMP	This displays the actual temperature of Sample Transfer Line, turning GREEN when the temperature nears the SP and RED when the Temperature is outside of the SP range.

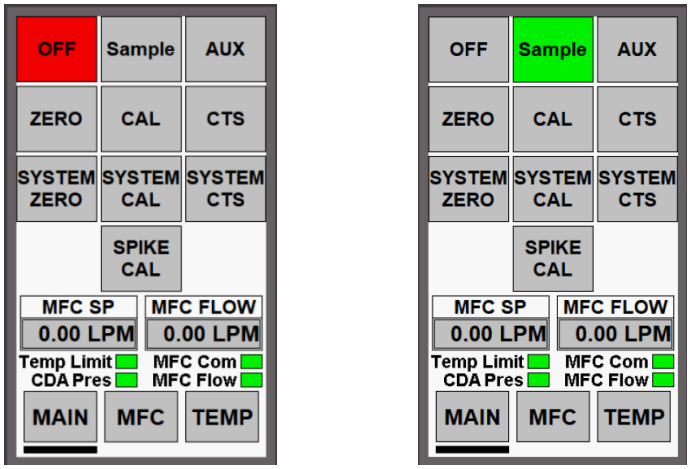
THERMAL LIMIT OK	Displays GREEN if the Thermal Limit switch has not been triggered or RED if the OVEN, PUMP or LINE thermal switches are above the limit. If above the limit, the thermal switch will activate, shutting power off to the corresponding heater.

MAIN Panel Stream Switching

Sample or Auxiliary Stream Switching

Pressing the *OFF* button will deactivate the sampling pump and stop any gas from flowing into the FTIR. Pressing the *Sample* or *AUX* button will activate the ASC-10 sampling pump or the valving controlling the flow through the auxiliary input, sending the sample gas stream to the FTIR.

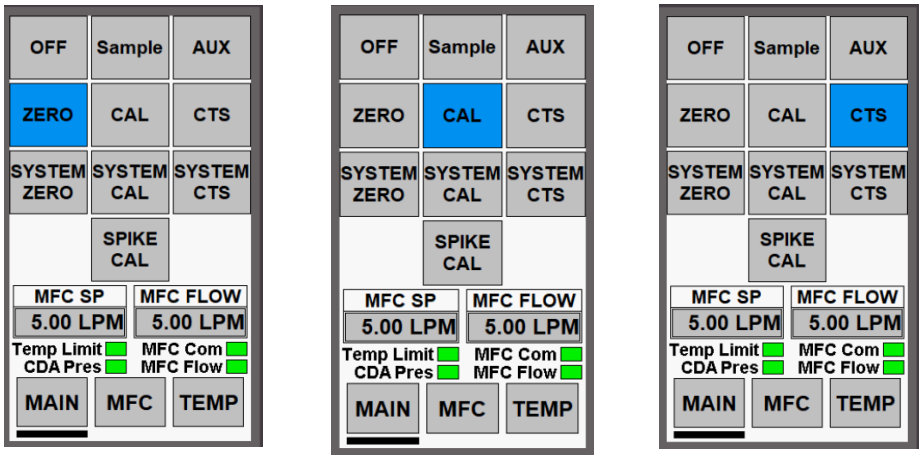
NOTICE	*The configuration shown within this section, when either the* Sample *or the* AUX *button is pressed, the MFC will not be in use.*



- When the *OFF* button is pressed it turns RED and the sample pump is stopped so that no gas stream will flow into the FTIR.
- When the *Sample* button is pressed, the internal sample pump is activated and the process gas stream coming from the probe is flowing. The MFC SP and MFC FLOW should both be reading the same amount.
- When the *AUX* button is pressed, then an external sample pump is activated and the gas stream coming from the Auxiliary port is flowing. No MFCs will be on so the MFC SP and MFC FLOW should both be reading no flow.

Direct Flow Stream Switching

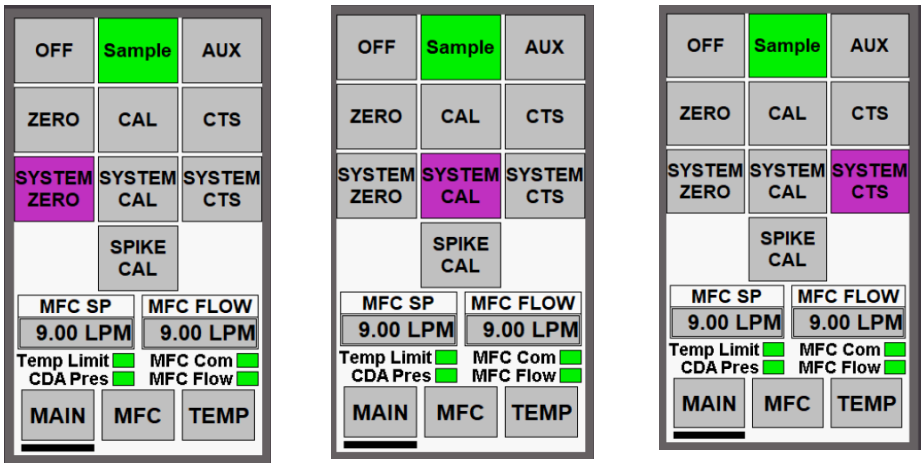
Pressing any one of the three Direct Flow stream buttons (*ZERO*, *CAL*, or *CTS*) will activate that stream sending the gas flowing through the MFC from the cylinder directly to the FTIR. The MFC flow setting was previously set by the DIRECT SP in *the MFC Panel*. When the Direct Flow stream is activated the button on the Touchscreen will turn BLUE.



- When the *ZERO* button is pressed it turns BLUE and N2 will flow directly into the FTIR through the MFC. In the example above, the flow is set at 5.00 L/min and is reporting 5.00 L/min.
- When the *CAL* button is pressed it turns BLUE and the gas from the calibration gas cylinder will flow directly into the FTIR through the MFC. In the example above the flow is set at 5.00 L/min and is reporting 5.00 L/min.
- When the *CTS* button is pressed it turns BLUE and the gas from the Calibration Transfer Standard cylinder will flow directly into the FTIR through the MFC. In the example above the flow is set at 5.00 L/min and is reporting 5.00 L/min.

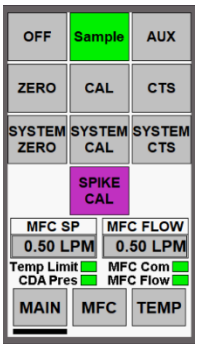
System Check Stream Switching

To perform a *System Check,* press any one of the three stream buttons (SYSTEM ZERO, SYSTEM CAL, SYSTEM CTS) which will create a process gas probe overflow situation that will be read by the FTIR. This process automatically activates the *Sample* pump (GREEN button) sending any gas coming from the probe to the FTIR at a default flow rate of 5.00 L/min. At the same time, the selected gas cylinder stream is sent through the MFC at a high flow rate, typically 9.0 L/min, up to the process gas probe inlet port, ensuring that only the selected cylinder gas (N2, CAL or CTS) will be seen by the FTIR. When the *System Check* flow stream is activated the button on the Touchscreen will turn PURPLE and the *Sample* button will turn GREEN.



- When the *SYSTEM ZERO* button is pressed it turns PURPLE and N2 will flow to the inlet port on the sample probe through the MFC at a high flow rate. It is then drawn back and sent to the FTIR through the Sample pump which is GREEN. In the example above the MFC flow is set at 9.00 L/min and is reporting 9.00 L/min.
- When the *SYSTEM CAL* button is pressed it turns PURPLE and the Calibration gas will flow to the inlet port on the sample probe through the MFC at a high flow rate. It is then drawn back and sent to the FTIR through the Sample pump which is GREEN. In the example above the MFC flow is set at 9.00 L/min and is reporting 9.00 L/min.
- When the *SYSTEM CTS* button is pressed it turns PURPLE and the Calibration Transfer Standard gas will flow to the inlet port on the sample probe through the MFC at a high flow rate. It is then drawn back and sent to the FTIR through the Sample pump which is GREEN. In the example above the MFC flow is set at 9.00 L/min and is reporting 9.00 L/min.

SPIKE CAL Check Stream Switching



To perform a Spike Recovery System Check, press the *SPIKE CAL* button. This will dilute the process gas stream up to 10% of the total flow of the sample pump and the diluted sample gas stream will be read by the FTIR.

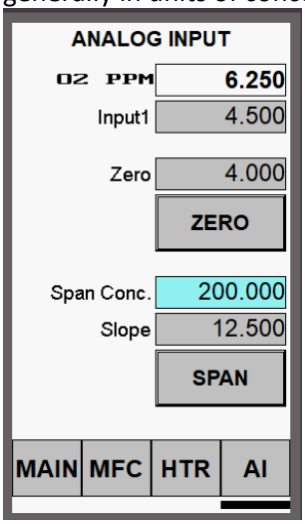
This process automatically activates the *Sample* pump (GREEN button) sending any gas coming from the probe to the FTIR at a default flow rate of 5.00 L/min. At the same time, the CAL gas cylinder stream is sent through the MFC at a low flow default rate of 0.5 L/min up to the process gas probe inlet port. This configuration is used to dilute the process gas stream that will be sent to the FTIR with up to 10% of a known concentration of the analyte of interest. When the *SPIKE CAL* flow stream is activated the button on the Touchscreen will turn PURPLE and the *Sample* button will turn GREEN.

NOTICE	*When this flow stream is first started a higher flow rate can be set on the Sample Pump using the Flow Control knob located on the Front Panel of the ASC-10, to purge the probe and sample line more quickly if needed, but then it must be reset back to the original 5.00 L/min. Flow can be monitored using the rotamer on the front panel of the ASC-10.*

Setting Up Analog Input for Remote Sensor

The optional analog input module is wired to collect the analog signal from one external sensor. See below for wiring configurations for various external analog sensors. Access to this panel is by pressing

the AI button. This panel is used to zero and span the sensor input and view the scaled information, generally in units of concentration (ppm).



External Analog Wiring Guidelines to ASC-10 Remote Port

The optional ASC-10 Analog input is only capable of supporting **one** external remote sensor which is configured on Channel 1, and the signal must not exceed 20mA on Channel 1. Use the table and figure below for guidance on wiring guidelines.

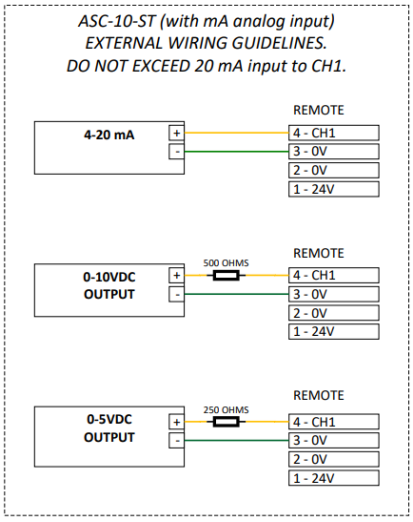


TABLE 7. ASC-10 MA INPUT WIRING GUIDELINES

Type	4 - CH1	3 – 0V	2 – 0V	1 – 24V
2 Wire Transmitter	+	-		
0 – 10VDC Output	+ *500 Ohm resistor in line*	-		

0 – 5VDC Output	+	-
	250 Ohm resistor in line	

Zero and Spanning the Analog Input

1. *Zeroing the sensor analog response.*
    - Run Zero gas (N4.0+ N2) through the sensor.
    - Press the ZERO button on the ASC-10 Touchscreen to store the *Zero* value.
2. *Span the sensor analog response.*
    - Click the BLUE “Span Conc” text box and enter the span gas concentration.
    - Run Span gas through the sensor.
    - Press the SPAN button on the ASC-10 Touchscreen to store the *Span* value (Slope).

NOTICE	*Both the Zero and Span values will be retained by the ASC-10 even if the power to the system is disrupted or turned off.*

5 Using MAX Acquisition for ASC-10 Control

This chapter describes the steps necessary to setup and operate the MAX-Acquisition software to automatically control the ASC-10 and MAX-iR FTIR within a workflow.

Max Acquisition Software

For complete automation of the ASC-10 and any additional MAX components, the MAX-Acquisition software can be used where automatic sequencing can be easily configured to streamline the workflow process with other MAX hardware. The MAX-Acquisition software and the *Acquisition Method* control all aspects of data acquisition including programmed *Work Steps*, timing, subcomponent setpoints, FTIR instrumental parameters, data saving and the MAX-iR *Quant Method*. Within the *Acquisition Method*, the *Quant Method* contains the MAX-iR calibrations and analysis parameters for all gases of interest as well as the *Modbus Map,* if this option was purchased.

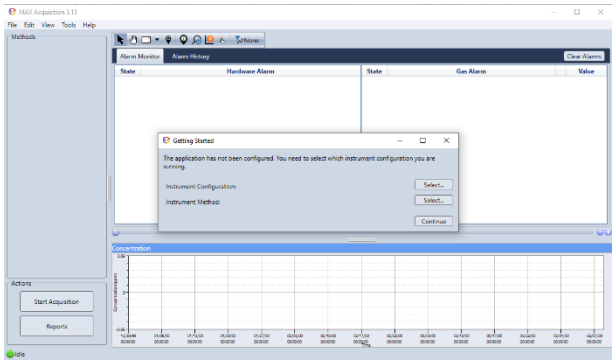
Launch the MAX-Acquisition Software

Follow the instructions in this section if this is the first time the software is used to set up the *ASC-10* with a *MAX-iR* along with the optional MAX-OXT, otherwise skip to section ***Building an Acquisition Method*** below to begin modifying an *Acquisition Method* for use with the *ASC-10* . This section assumes that the MAX-Acquisition Software program is installed on a computer that will be dedicated to controlling the operation of the MAX-iR and is not connected to the MAX-iR through a network connection see **Chapter 3** for location of the LAN line connections to the ASC-10.

NOTICE Note that *Quantification Method Development* is beyond the scope of this manual and can be found in the *MAX-iR Operating Manual*.

---

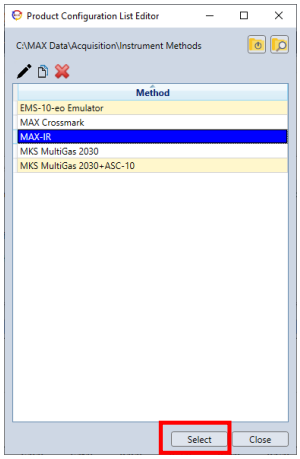
1. *Launch the MAX-Acquisition software from the desktop icon*  .

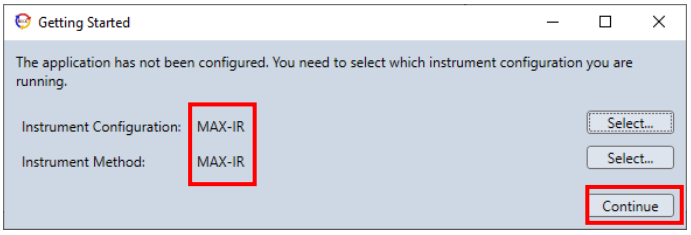


   - Press the *Select* button for the *Instrument Configuration* set up on the *Getting Started* pop up panel.

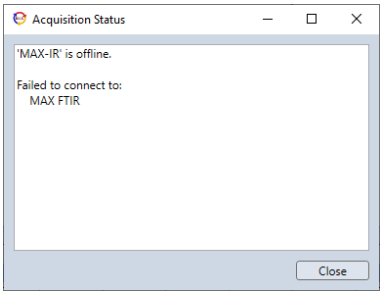
2. *Select the Instrument Configuration.*
   - Highlight *MAX-iR* and press the *Select* button at the bottom.
   - The *Getting Started* pop up should now have *MAX-iR* listed next to *Instrument Configuration* and *Acquisition Method*.

- Press *Continue*.





3. *Verify the software is connected to the hardware*.
   - A status indicator in the lower left corner of the user interface will display '🟢Connected' once the software connects to all the hardware.
   - If the software cannot connect to the hardware:
     - A pop-up will indicate that the *Acquisition Status* of the MAX-iR is offline and failed to connect.
     - The User Interface will display '🔴Offline' status in the lower left corner.
     - *Close* the pop-up panel.
     - Check that all Ethernet and USB connections from the *MAX-iR* and *ASC-10* are connected to the control computer. Also verify that the settings on the Ethernet card are correct.



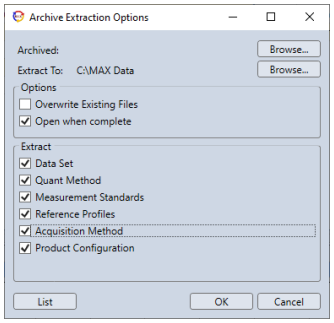
Install a New Acquisition Method

If an *Acquisition Method* was purchased from Thermo Fisher Scientific, it will contain the instrument and application specific method that controls all aspects of data acquisition including stream switching (if applicable). Pre-programmed *Work Steps* with timing, subcomponent setpoints, FTIR instrumental parameters, Modbus map (optional), and the FTIR application specific *Quant Method* are part of the *Acquisition Method*. There is a *Quantification Method* that contains the FTIR calibrations and analysis parameters for all gases of interest, however this will not be discussed in this manual.

The following steps allow the operator to upload and configure the *MAX-Acquisition* software with the new *Acquisition Method* by following these simple steps:

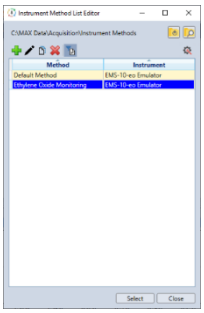
1. *Load the (*.zip) file that contains the custom method(s) or libraries provided by Thermo Fisher Scientific:*

- In the main viewing panel go to the top toolbar and select *Tools* > *Extract Archive.*
- Check / select the *Archive Extraction Options* boxes as shown in the figure on the right.
- Press the top *Browse* button to navigate to and select the zipped (not extracted) *Archived* file (*.zip).
- Then click *OK* in the *Archive Extraction Options* pop-up.
- In the next pop-up panel, select *Close* to return to the main viewing panel.



NOTICE	***Do NOT extract the Archive file*** *– leave it in the original format as a '*.zip' as the program requires this format to properly upload all the information and files. Only select 'Overwrite Existing Files' if you are updating an existing method and instructed to do so by Thermo Fisher Scientific.*

2. *If more than one* Acquisition Method *was created:*
   - In the main viewing panel go to the top toolbar and select *Edit* > *Acquisition Method* to open the *Acquisition Method List Editor*.
   - Click / highlight the appropriate *Acquisition Method* in the list.
   - Click the *Select* button at the bottom of the pop up.

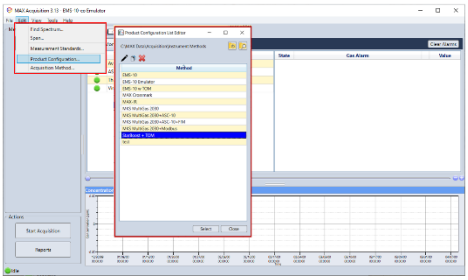


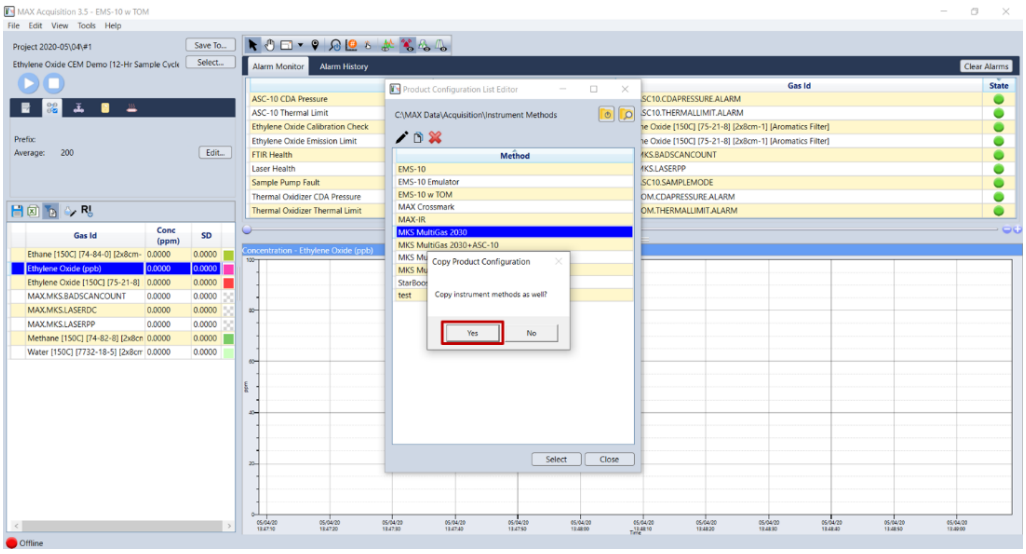
Building an Acquisition Method

The system can be configured to run continuously, executing calibrations automatically without any need for user intervention. For attended operation or source testing, a user can manually advance through pre-programmed *Work Steps*. However, be aware that if the *Work Steps* are configured to a duration, they will automatically continue to advance to the next step once the current *Work Step* finishes. Regardless of the desired level of automation, the user must set up an *Acquisition Method* to control all hardware setpoints, the *Quant Method*, and system *Workflow*.

Add the ASC-10 to Existing Product Configuration

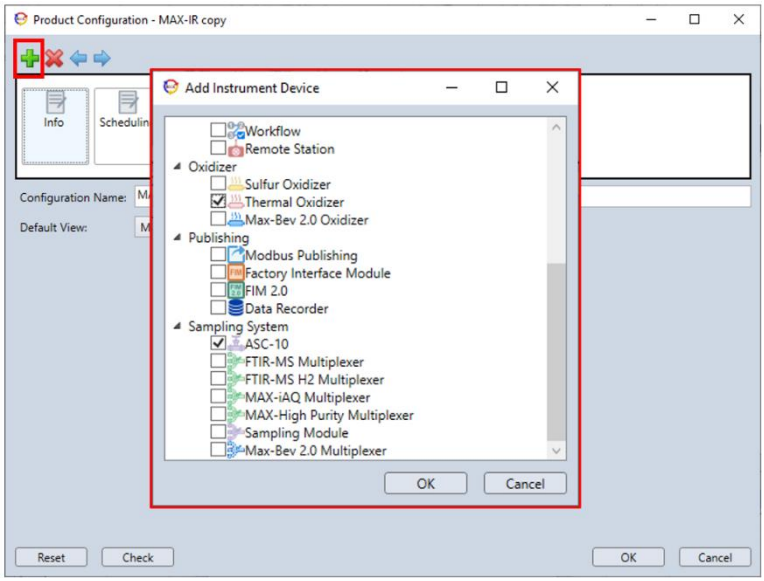
1. *Make a copy of the current Product Configuration*
   - In the main *MAX-Acquisition* software top toolbar, click *Edit* > *Product Configuration*.
   - Click / highlight the current hardware configuration, then click *Copy* ( ).
   - When prompted select *YES* to 'Copy existing Instrument Methods'.



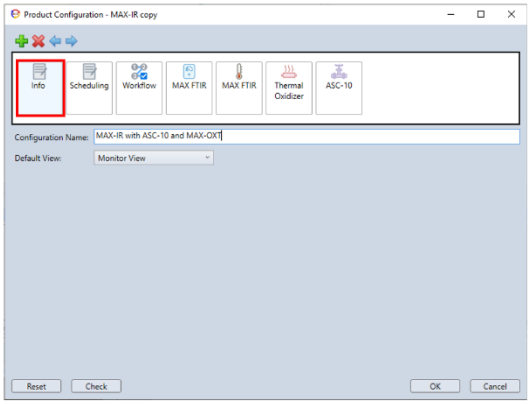


2. *Add the ASC-10 to the Copy of the Product Configuration*

- The new method will have "copy" appended to the name. Highlight this new configuration, then click *Edit* (✎) to open the *Product Configuration* Editor.
- Click Add (✚) to add the *ASC-10* to the *Product Configuration* (shown in the figure below).
- Under *Sampling System* select *ASC-10*.
- Click *OK* to return to the *Product Configuration* Editor.



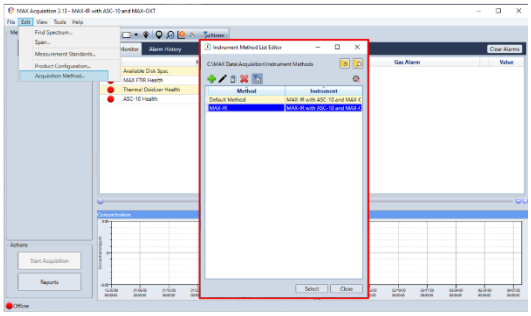
3. *Save the new Product Configuration*.
    - On the *Info* tab, type in a new *Configuration Name* in the text box.
    - Chose an appropriate name to reflect the addition of the *ASC-10 hardware*, for example, "*MAX-iR with ASC-10*".
    - Click *OK*
    - Click *Select* in the new window to load the new configuration and return the main *MAX-Acquisition* panel.



NOTICE *You should now see two new tabs at the end in the Product Configuration panel,* Thermal Oxidizer *and* ASC-10*.*

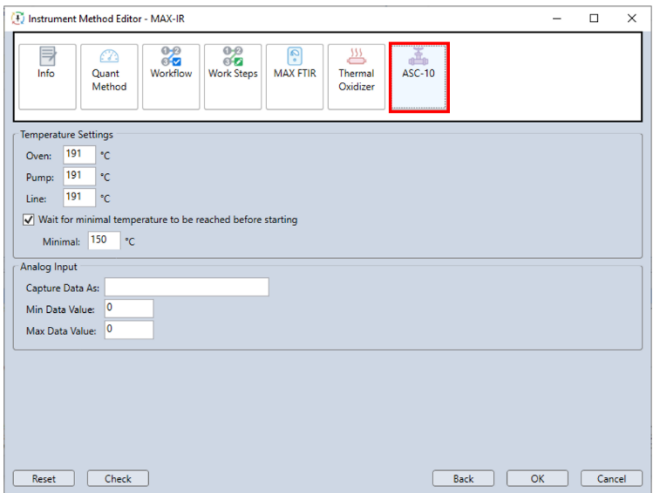
Configure the ASC-10 Settings for the Application

1. *Open the Acquisition Method Editor*
    - In the main *MAX-Acquisition* software top toolbar, click *Edit* > *Acquisition Method*.
    - Click / highlight the *Method* you wish to use with the *ASC-10* , in this case it should be the new one just created.
    - Click Edit (✎) to open the *Instrument Method Editor*.



2. *Edit the ASC-10 Settings*
    - Click *the ASC-10* tab.
    - Modify the *Temperature Settings* specifically for your application for the *Oven*, *Pump* and *Line*.
    - Check the box to "Wait for minimal temperature to be reached before starting" and set the temperature so that moisture or other components do not condense.
    - The example below is for a standard Combustion Emissions application and all temperatures are set to match the FTIR gas cell:
        - The *Oven* temperature is set to 191°C. (recommended temperature is 150°C)
        - The *Pump* temperature is set to 191°C.
        - The *Line* temperature is set to 191°C.
        - All and sample transfer lines temperatures 191°C.
        - The *ASC-10* is set to wait until it reaches 150°C before the unit will bring in any gas sample.

- If an analog input (remote sensor) has been added, then fill in a name under *Capture Data As* to store the data and add *Min Data Value* and *Max Data Value* for alarms in this section. For a standard oxygen sensor, the min value is 0% and the max value is 25%.



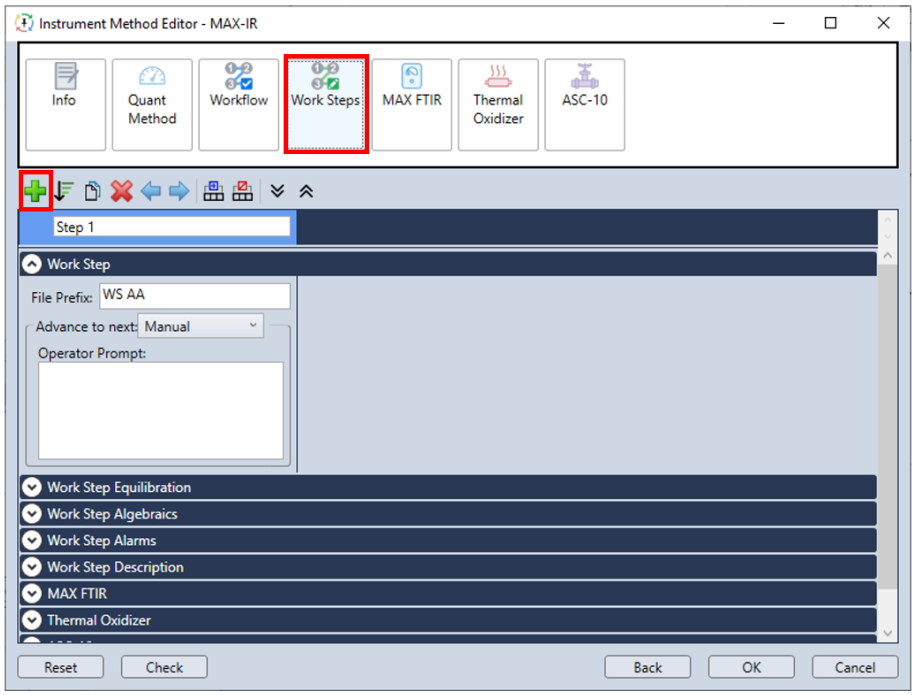
Summary Example of Some *Work Steps* Parameters for the *Workflow*

The MAX-Acquisition control software uses an application specific *Workflow* that is configured to automatically switch the various gas streams that are then sent to the FTIR for data collection. The *Workflow* is a combination of several different *Work Steps* that can be modified by the end user if needed.

In this example there are eight different components that can be added, configured, and combined for each *Work Step* depending upon the modules purchased. There is no limit on the number of *Work Steps* that can be created, and a series of *Work Steps* can be grouped to form a new *Work Step*. An example of setting up these nine configurable components is listed below along with some of the options.

To access the editor below:

- Go to the top Toolbar of the MAX-Acquisition software, press *Edit > Acquisition Method*
- *Select the <Instrument Method>* you want to modify
- Press the Edit (✎) icon
- Click on the *Work Steps* Tab
- Press the *Add* (✚) icon to include a new *Work Step*



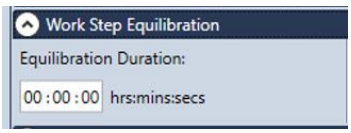
1. *Work Step Section*
    - In the text box that appears at the top of the listing, type in the NAME for the entire *Work Step* column.
        - For example, the first *Work Step* could be labelled "*Standby".*
    - Enter the desired *File Prefix* for naming all the FTIR spectra that will be generated under this step.
        - In the example above the first *Work Step* Prefix would be labelled "*Standby"* therefore all files generated during in this *Work Step* will be saved as *Standby_00000001 SPC.LAB,* etc.
    - *Advance to next* determines how and when the *Work Step* advances to the next *Work Step*:

TABLE 8. WORK STEP SECTION OPTIONS

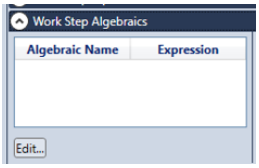
Option	Description
Manual	*Work Step* will not advance unless the User selects another *Work Step*
Duration	Moves to the next *Work Step* after a set number of hours (hrs), minutes (mins) and / or seconds (secs)
Time of Day	Moves to the next *Work Step* after a specific time in the day set as hours (hrs) and / or minutes (mins)
Spectrum #	Moves to the next *Work Step* after a set number of spectra are collected

2. *Work Step Equilibrium Section*

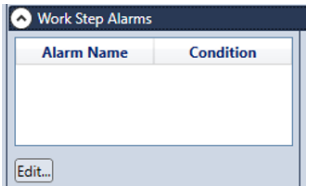
- This section is where an amount of time may be set (hrs:mins:secs) for the step to equilibrate before it begins taking data within this Work Step.



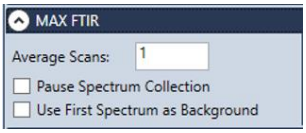
3. *Work Step Algebraics Section*
   - In this section an algebraic function can be created to be applied only to the spectra within this *Work Step,* such as applying an averaging technique to several spectra taken during that step.



4. *Work Step Alarms Section*
   - Various alarm limits can be configured including concentration High and Low on any of the gases in the method.
   - Define how the Alarm is to be cleared such as automatically clear when the condition no longer exists or manually cleared by the user.

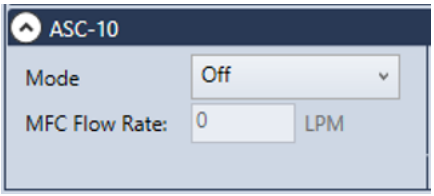


5. *Work Step Description Section*
   - A description can be added in the textbox describing the *Information* on the functions of the *Work Step*.
6. *MAX FTIR Section*
   - Set up the FTIR to average a fixed number of scans before saving the spectrum.
   - The FTIR can pause spectral data collection during the *Work Step*.
   - The *Work Step* can be configured to use the 1st spectrum collected as the background. Note: ensure the appropriate gas is flowing when taking a background.



NOTICE	*Do not use the "Use First Spectrum as Background" selection if your method is based upon the MAX StarBoost or Auto-Reference mode.*

7. *ASC-10 Section*
   - The *Mode* allows stream selection setting for the *Work Step*.
   - Modes available are: *Off, Sample, Auxiliary, Zero, CAL, CTS, System Zero, System CAL, System CTS, Spike Zero,* and *Spike Cal.*



   - Set the flow rate of the mass flow controller (MFC) for all the streams other than *Auxiliary*, and *Off* which are fixed to the internal pump settings.
8. *Optional: Modbus Publishing Section*
   - This section appears when the Modbus Communications option is purchased.
   - Here is where the user can select the calibration and other data values to be published (or not published) to Modbus by a simple check box selection.

Work Step General Guidelines and Tools

Work Step General Guidelines

The table below is a sample of some of the guideline settings to the configuration with a MAX-iR and ASC-10 sampling system.

NOTICE	*Data Acquisition Methods are developed for a particular application and/or source stream. The table below is only a guideline. For assistance in developing a Data Acquisition Method, please contact Technical Support at 1-800-532-4752. Select "option 2" for Unity Lab Services technical support. For instrument type, select "option 6" for Molecular, Vibrational Spectroscopy Based Spectrometers.*

TABLE 9. TYPICAL WORK STEP GUIDELINES

Component	Work Step Duration	Work Step Equilibration	ASC-10 Mode	How Often
FTIR Zero Spectrum	2 min	5 min	Zero	1 per test
FTIR Interference Spectrum	2 min	5 min	Sample	1 per run (3x)
FTIR Spectrum	2 min	2 min	Direct (Zero, CAL, CTS)	Each run in a compliance test
FTIR Spectrum	5 min	5 min	System (Zero, CAL, CTS), Spike (Zero, CAL)	Each run in a compliance test
FTIR Spectrum	60 min	0 min	Sample	3x in a compliance test

Work Step Icon Tools

The table below is a functional summary of the main icon / tools that are used in the *Application Method Editor* User Interface to make additions and changes to any *Work Step* within the *Workflow*.

TABLE 10. WORK STEP ICON FUNCTIONALITY

ICON	Function
	Adds a new *Work Step* to the right of the selected *Work Step*
	Generates a *Work Step* Sequence
	Copies the selected *Work Step*
	Removes the selected *Work Step*
	Moves the selected *Work Step* one spot sooner in the sequence
	Moves the selected *Work Step* one spot later in the sequence
	Groups the *Work Steps* together
	Ungroups the *Work Steps*
	Expands all the rows to show details of the *Work Steps*
	Collapses all the rows to remove the details of the *Work Steps*

6 Recommended Operating Procedures

CEM Quality Assurance Procedures

This section focuses on the use of the ASC-10 sampling system connected to a MAX-iR FTIR, used for continuous emissions monitoring (CEM) or as a third-party Reference Method for validating a CEM system in the field.

Methods and Performance Specifications

The ASC-10 with the MAX-iR quality assurance procedure is compliant with and references the following US EPA and ASTM methods:

- ***EPA PS 15*** - Performance Specification for Extractive FTIR Continuous Emission Monitoring Systems in Stationary Sources (40 CFR Part 60, Appendix B)
- ***EPA Method 301*** - Field Validation of Pollutant Measurement Methods from Various Waste Media (40 CFR Part 63, Appendix A)
- ***EPA Method 320*** – Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy (40 CFR Part 63, Appendix A)
- ***ASTM D6348*** - Determination of Gaseous Compounds by Extractive Direct Interface Fourier Transform Infrared (FTIR) Spectrometry

Initial Validation Criteria

For CEM applications, the performance of the ASC-10 with the MAX-iR should be certified upon initial installation using an analyte spiking procedure, based on *EPA Method 301 (40 CFR Part 63, Appendix A)*. The audit sample will be a known concentration of target analyte blended with a tracer in a balance of nitrogen. For some applications, a NIST traceable reference standard may not be available.

Daily Automated Calibrations

The performance of the ASC-10 with the MAX-iR CEM should be assessed daily using a series of automated Tests, according to *Section 10 Calibration and Standardization of US EPA PS-15*. These tests are outlined below:

1. *Collect FTIR Background Spectrum*
2. *Direct FTIR Calibration Transfer Standard (CTS) Check*
3. *Direct FTIR Analyte Calibration Check*
4. *System CTS Check*
5. *FTIR Signal and root mean squared noise (RMS)*
6. *FTIR Background Optical Filter Spectrum Collection*
7. *FTIR Detector Linearity*

The timing of these measurements can be scheduled by the user but must be performed daily and will take approximately 15 minutes. The ASC-10 with MAX-iR CEM can be configured using the MAX-Acquisition software to automatically execute the Checks as well as perform daily FTIR background collections. See **Chapter 5**.

Quarterly Spike Recovery and System Validation

After initial installation, the analyte spiking procedure should be repeated quarterly to validate the ASC-10 with the MAX-iR for measuring the target analyte, according to *Section 11 Analytical Procedure of US EPA PS-15*. This is a manual test that will require user interaction. If installation is purchased, training on performing analyte spiking will be provided by Thermo Fisher Scientific.

Overview of QA Requirements

The table below provides a general summary of recommended quality assurance procedures for an ASC-10 with a MAX-iR configured for use as a CEMs. QA plans vary based by application and permit requirements. Contact Technical Support (see **Contact Information and Technical Support****)** for guidance.

TABLE 11. FTIR INSTRUMENTAL CHECKS

FTIR Checks	Description	Purpose	Specification
Peak Signal Intensity	Measurement of peak intensity of single beam spectrum	Demonstrates FTIR has enough signal strength to achieve the required MDLs	>2.00V (StarBoost) >0.04V (MAX-iR)
Detector Linearity	Ratio of measurement of average detector signal at 2300-2400cm^{-1} (StarBoost) or 200-400cm-1 (MAX-iR) to peak signal intensity (expressed as %)	Demonstrates the detector response is linear with respect to changing energy intensity required for constant calibration	< 0.1% (MAX-iR)

TABLE 12. DAILY CEM SYSTEM CALIBRATION CHECKS

Daily Checks	Description	Purpose	Specification
Zero Direct	Direct FTIR measurement of N2	Observe all gases are reading near zero and not trending negative. Collect filter spectrum.	10 independent scans, determine absolute LOD (3 x StDev*)
CTS Direct	Direct FTIR measurement of CTS standard, collected pre- and post-test	Demonstrate adequate precision and that instrument is in calibration	Average of 10 independent scans, ±5% of certified value
Calibration Direct	Direct FTIR measurement of calibration standard	Demonstrate instrument is in calibration for the measured gas	Average of 10 independent scans, ±5% of certified value
CTS System	System measurement of CTS standard	Demonstrates no system leaks and to validate gas transport through sample system	Average of 10 independent scans, ±5% of direct measurement

StDev = Standard Deviation

TABLE 13. QUARTERLY OR YEARLY VALIDATION CHECKS

VAL Check	Description	Purpose	Specification
Analyte Spike Recovery (Quarterly)	Twelve independent spiked and unspiked samples. Dilution of calibration standard in stack gas not to exceed 10% of total sample flow. Spiked sample concentration approximates 2 x native concentration or 5 x LOQ.	Demonstrates accuracy and adequate sample transport of measured gas	70 – 130%
RATA* (Yearly)	Up to 12 test runs will be performed for the RATA, and each test will be approximately 21-minutes in duration. Up to three tests may be rejected, to increase the RA, with 9 or more of the test runs used to calculate the RA.	Demonstrates the relative accuracy (RA) of the FTIR CEM compared to reference method US EPA Method 320	±20%

**** RATA – Relative Accuracy Test Audit – Performed by 3rd Party***

7 ASC-10 Preventative Maintenance

This chapter provides a guide to the hardware preventative maintenance procedures for the ASC-10. Preventative maintenance is required to maintain optimal instrument performance, and these procedures should only be performed by trained and experienced personnel. While many of these items can be completed by the user, it is recommended the user take advantage of the MAX-Advantage support program. Because the ASC-10 is configured for use with a MAX-iR this section includes the standard verification practices used when the MAX-iR is part of the complete ASC-10 system configuration. For systems that also include the MAX-OXT see the MAX-OXT Operating Manual for details.

Preventative Maintenance Schedule

TABLE 24. PREVENTIVE MAINTENANCE SCHEDULE

Schedule	Procedure	Specification
Quarterly	Replace Particulate Filter Element and o-Rings	See **Replace the Particulate Filter Element**
Every 4,000 Hours	Replace Sample Pump Diaphragm	See **Replace the Pump Diaphragm**
Annually	Clean Air Filters	See **Clean the Air Filters**

Spare Parts and Consumables

The following serviceable items are consumables and are not covered under warranty. The user should maintain an on-site inventory of consumables, as shown in the table below.

TABLE 35. ASC-10 CONSUMABLES

Description	Yearly Qty	Replacement Interval
Particulate Filter Element	4	Quarterly, or as needed
Silicone o-Ring Kit	4	Replace each time the filter element is removed to prevent leaks
Pump Diaphragm Kit	2	Replace every 4,000 hrs

Thermo Fisher Scientific maintains a spare parts depot in East Windsor, CT. For critical spare parts with extended delivery times (denoted below), the user should consider maintaining spare parts on-site to minimize downtime.

TABLE 16. ASC-10 CRITICAL SPARE PARTS

Description	Yearly Qty	Replacement Interval
Bellows Valve, 1/4" Tube, Polyimide Stem Tip, NC Actuator	3	Critical Spare. Only replace if needed.

Solenoid Valve	3	Critical Spare. Only replace if needed.
Cartridge Valve	3	Critical Spare. Only replace if needed.
Regulator with Gauge	2	Critical Spare. Only replace if needed.
Push Fitting, Male Connector, Elbow, 1/8"	2	Critical Spare. Only replace if needed.
Mass Flow Controller	1	Critical Spare. Only replace if needed.
M151 Diaphragm Pump, Heated Elevated Head (120VAC Only)	1	Critical Spare. Only replace if needed.
M151 Diaphragm Pump, Heated Elevated Head (230VAC Only)	1	Critical Spare. Only replace if needed.
120VAC Fuse	2	Critical Spare. Only replace if needed.
230VAC Fuse	2	Critical Spare. Only replace if needed.

Maintenance Procedures

Prior to beginning any maintenance on the ASC-10 system, make sure that you have a recommended consumables (if available) and that the parts needed for the maintenance procedure are there.

⚠CAUTION

Burn Hazard: The equipment contains heated components inside the enclosure and hot fittings on the back panel. Disconnect power and allow the equipment to cool before servicing and avoid touching the fittings on the back of the equipment. Failure to comply could result in injury.

⚠CAUTION

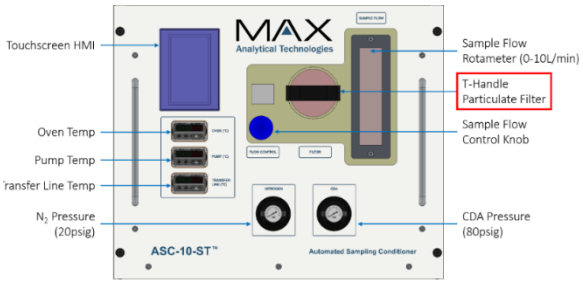
Equipment Damage and Ergonomic Hazard: The ASC-10 weighs approximately 95 lbs (43 kg), exceeding the recommended lifting weight (RLW) for one person. Improperly lifting the instrument may result in back injuries or the system being dropped or damaged. To avoid injury and equipment damage, exercise the proper safety precautions and always use at least two people to lift the equipment.

⚠WARNING

Shock Hazard: The system enclosure contains high voltage. Disconnect the power cord before all maintenance and service operations. Failure to comply could result in injury or death.

Replace the Particulate Filter Element

The ASC-10 contains a particulate filter which prevents particulate in the sample stream from contaminating the MAX-iR analyzer. It requires replacement at least quarterly as part of the routine Maintenance Schedule. This section requires one ASC-10 Filter Element and one silicone o-ring kit to complete this task.



Using the Touchscreen on the ASC-10 select the MAIN button on the bottom and then press the OFF button to stop the sample gas flow.

1. Shut the power off and let the system cool down for 4 hours before removing the filter.
2. Press the filter T-handle in and turn it about 1/8th of a turn counterclockwise.
3. Once it disengages pull the T-handle to completely remove the filter holder from the unit.
4. Unscrew the end sealing plate counterclockwise and remove the filter.
5. Remove the existing o-rings (one small one at the sealing plate end, one large one at the opposite end of the particulate filter) and replace them with new o-rings.
6. Slide the new filter element on the retaining rod and screw on the end sealing plate until finger tight. The end plate should be flush to the filter without deforming it.
7. If the new filter becomes deformed during the procedure, discard, and replace with a new filter.
8. Reinsert the filter assembly back into the ASC-10 by pushing the T handle in and turning it about 1/8th of a turn clockwise. You will feel it click into place.
9. Turn the Power back on and let the ASC-10 come to temperature before resuming sampling.

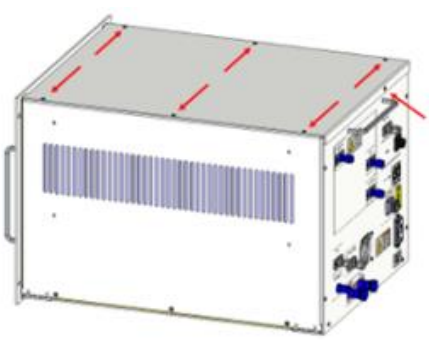
Replace the Pump Diaphragm

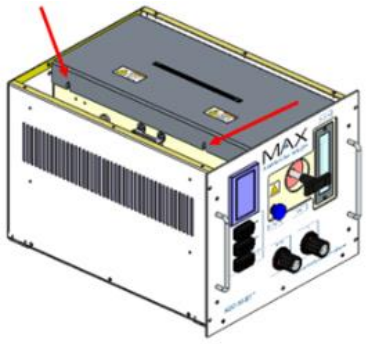
The ASC-10 pump diaphragm should be replaced 4,000 hours or every 6 months. This procedure can be completed by an experienced service technician in approximately 1 hour, excluding the time required to cool the system down. It will also require two people to move and handle the ASC-10 as it weighs approximately 95 lbs (43 kg). The following tools are required for the diaphragm replacement procedure:

TABLE 47. TOOLS REQUIRED FOR PUMP DIAPHRAGM REPLACEMENT

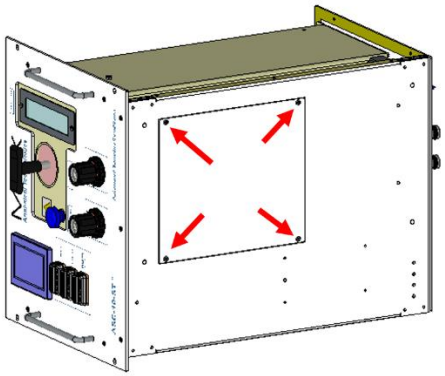
Parts / Tool	Description
Open ended wrench	9/16” (two)
Screwdriver	Phillips head
Open ended wrench, Socket or Nut Driver	5/16”
Torque wrench	5/32”, up to 110 in-lbs
Allen wrench	Full set – US dimensions
Loctite	Medium strength
Pump Diaphragm Kit	One kit

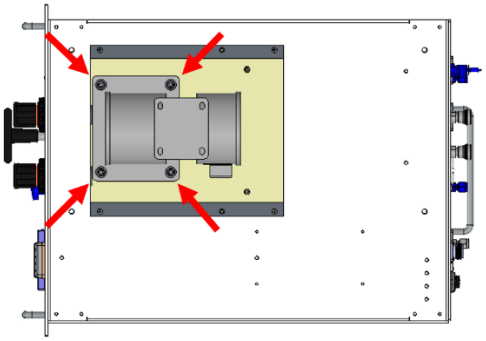
1. *Prepare the ASC-10*
    - Power down the ASC-10 and any other associated module**.**
    - Disconnect the electrical connections from the rear of the ASC-10 module.
    - Clear a work area where you'll have good access to all sides of the (unmounted) ASC-10.
    - Allow the unit to cool for at least 4 hours before disassembling.
    - Use at least two people to move the ASC-10 to the designated work area.
2. *Access the Pump in the ASC-10*
    - Remove the seven flat head screws that hold the top cover plate.
    - Loosen the four oven cover screws (two on each side) and remove the oven cover.



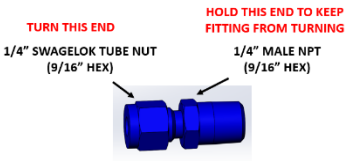


    - Using 2 people, turn the unit on its side and remove the four screws holding the pump to the bottom bracket.

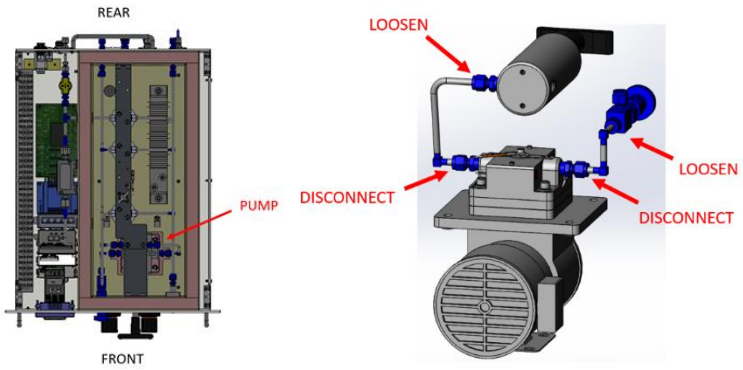




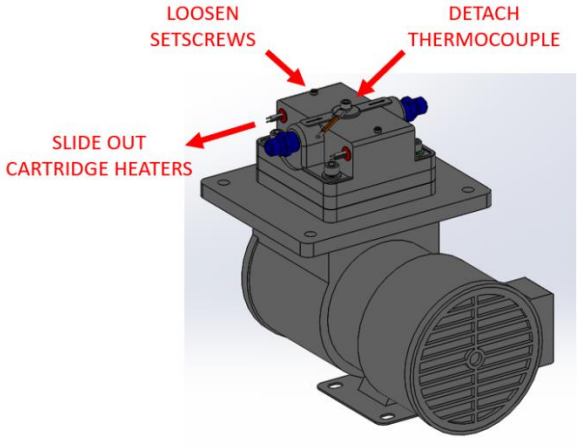
3. *Remove the Tubing Attached to the Pump*
    - Using the two 9/16" open ended wrenches, attach one wrench to the NPT fitting and use the other wrench to turn the ¼" Swagelok fitting nut. Disconnect the tubing from the pump (see the two connections below labelled "DISCONNECT").



    - Loosen the fittings at the Filter and Sample In port then move the tubing out of the way so that you will be able to pull the pump out after the electrical connections are removed (see the two connections below labelled "LOOSEN").

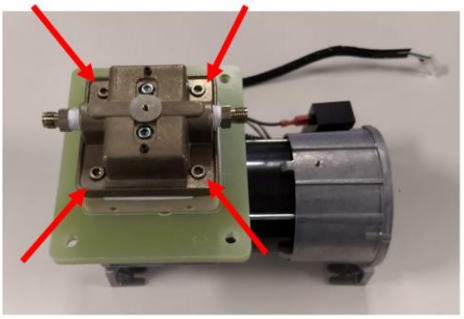


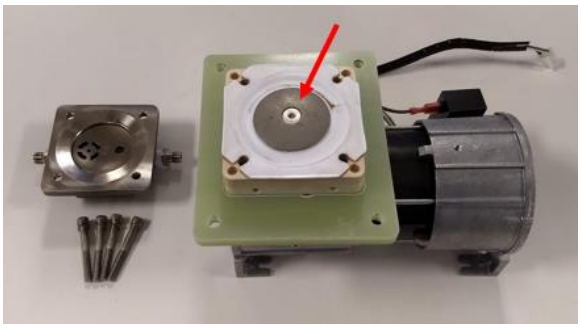
4. *Remove the Cartridge Heaters and Electrical Connections*
    - Loosen the setscrews on the pump head above the cartridge heaters (see figure below). Do not completely remove the setscrews.
    - Slide the cartridge heaters out of the pump head.
    - Detach the thermocouple from the top of the pump head.
    - Disconnect the power connector for the pump from power board.



NOTICE	*Air Dimensions, Inc. provides a useful video of Dia-Vac ® Diaphragm Repair Instructions (R-Series, M-Series) https://airdimensions.com/service/videos/.*

5. *Remove the Diaphragm on the Pump*
    - With the Allen head driver, remove the four pump head bolts and remove the head.
    - With the Allen head driver remove the diaphragm screw and lift off the diaphragm and cap.

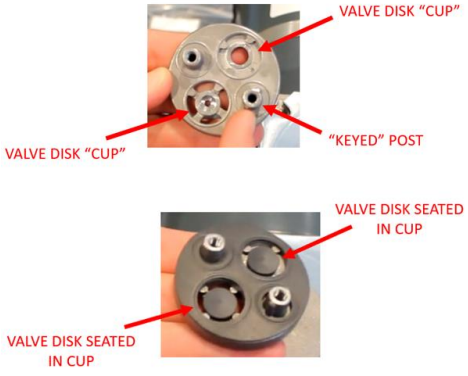




6. *Replace the Diaphragm on the Pump*
    - Take the replacement diaphragm and Teflon gasket from the Kit.
    - Replace old diaphragm with a new 2-ply diaphragm and the old Teflon gasket (see figure below).
    - The (white) diaphragm is symmetric and can be locked in placed in any orientation with respect to the screw slots.
    - Assemble the replacement pieces onto the bolt.
    - Apply one drop of medium strength Loctite to the end of the bolt.
    - Reinstall the assembly onto the pump head.
    - Use the Torque wrench and torque down to 70 in-lbs.

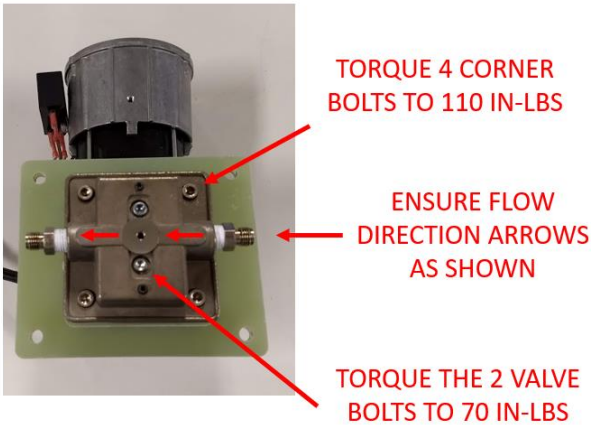
7. *Replace the Valve Head Gaskets*
    - Take the replacement gaskets and valve disks from the Kit.
    - Disassemble the valve head using the Allen head driver.
    - When removing the two bolts make sure to hold your hand under the head to catch the pieces.

- Replace the old gasket and valve disks.
- One of the posts is “keyed”. The larger gasket hole goes over that post. The keying also indicates how the valve assembly is supposed to be reassembled into the pump head. Make sure the replacement valve disks are properly seated.



NOTICE	Take care that the replacement valve disks are properly seated in their “cups”, to prevent them from getting pinched during reassembly

8. *Reassemble the Pump Head on the Pump*
   - Reassemble valve head in reverse order of disassembly.
   - Reinstall the valve head onto the pump body making sure the Flow Direction Arrows are the same as in the figure below.
   - Using the Torque wrench tighten the 4 corner bolts to 110 in-lbs.
   - Using the Torque wrench tighten two screws on the Valve Head to 70 in-lbs.



9. *Reinstall the Pump into the ACS-10*

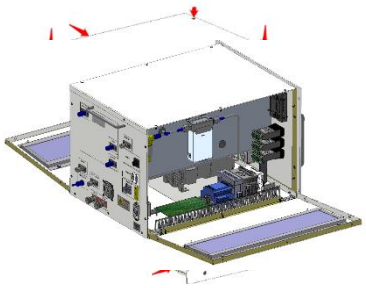
- Follow the reverse order above to put the pump back together in the ACS-10 module.
- Make sure the pump is reattached to the bottom plate and the power connection is reconnected.
- Before attaching the inlet and outlet lines, perform a leak check following the instructions in Step #10 below.

10. *Leak Test the Pump*
    - Leak test the pump before reinstalling the pump tubing.
    - Make sure you reconnect the power connection on the pump to the power board.
    - Turn the power back on to the ASC-10.
    - Attach a 1L/min or 500mL/min rotameter to the pump exhaust port and open the rotameter to the maximum setting.
    - Plug the pump inlet port with your finger or a cap.
    - Set the ASC-10 mode to sample.
    - Monitor the leak rate measurement by reading the flow rate on the meter.
        - If the leak rate exceeds 10mL/min, check and tighten all connections within pump assembly.
    - Once the leak check passes:
        - Set the ASC-10 mode to OFF.
        - Reattach all any other modules and power them back on.
    - After reassembly, perform a system check to ensure there are no additional leaks.

Clean the Air Filters

This section requires compressed air for cleaning the filter and Philips screwdriver to remove the ASC-10 panels.

1. Power down the ASC-10 and any other associated module**.**
2. Disconnect the electrical connections from the rear of the ASC-10 module.
3. Clear a work area where you'll have good access to all sides of the (unmounted) ASC-10.
4. Allow the unit to cool for at least 4 hours before disassembling.
5. Use at least two people to move the ASC-10 to the designated work area.
6. Remove all the cover screws (shown to the right).
7. Remove the top cover first, then fold down the side panels.
8. Remove the two metal air filters.
9. Clean the air filters by blowing them with compressed air.
10. Reinstall the filters, fold up the side panels, and replace the top cover. Make sure all screws are fully tightened.
11. Put the ASC-10 back into the original location and then reconnect all the plumbing and electrical.



8 Troubleshooting

This chapter provides guidelines to frequently asked questions relative to troubleshooting the ASC-10.

TABLE 18. TROUBLESHOOTING

Issue	Solution
MAX Acquisition will not connect to the ASC-10	1. Verify that the correct Product Configuration is selected. 2. Unplug the ethernet cable at the ASC-10 as well as the computer. 3. Reconnect the ethernet cable to both the ASC-10 as well as the computer. 4. If necessary, close the MAX Acquisition software package then re-open it.
Poor Spike Cal results	1. Verify that the flow rate settings are correct for the spike cal (see SPIKE CAL Check Stream Switching). 2. Verify that the calibration gas cylinder is open and set to 20psig. 3. Verify that the correct Quant Method is utilized for analysis.
Spike recovery came in low	1. Verify that the calibration gas cylinder is open and set to 20psig. 2. Verify that the CDA pressure gauge has pressure at 80psig. 3. Check that the flow rate is adequate to yield probe overflow (see Table 3). 4. Verify that the probe is not leaking. 5. Verify that the pump diaphragm is not damaged or leaking. 6. Verify that the particulate filter element is in good condition. Replace if necessary. 7. Verify that all valves are functioning as expected (see Possible leaking valve below).
Inadequate sample flow	1. Verify that the CDA pressure gauge has pressure at 80psig. 2. Verify that the particulate filter element is in good condition. Replace if necessary. 3. Verify that all valves are functioning as expected (see Possible leaking valve below).
Possible leaking valve	1. On the HMI screen, select OFF. 2. Pressurize the CDA inlet to 80psig then close the gas cylinder stem. If the CDA inlet is supplied by N2 and the line is teed to the N2 inlet, remove the N2 line from the ASC-10 at the quick connect. 3. Monitor the CDA regulator gauge on the front of the ASC-10 and use the HMI screen to select each of the different sample options. If the valve is working as expected, the CDA pressure should display a minimal change for each selection. If the CDA pressure drops to zero, the associated valve may need to be replaced.
Direct check flow is low. **No flow on system or direct.**	1. Verify that the CDA pressure gauge has pressure at 80psig. 2. Verify that 20psig of the gas is connected and open without leaks to the corresponding line quick connect (cal or CTS). 3. Switch to the corresponding system check (cal or CTS) and monitor the MFC flow rate.

	4. If the actual flow matches the MFC setpoint when running the system check, verify that the bellows valve located in the ASC-10 oven is not leaking once the oven has cooled down. Typically, a leak in a bellows valve can be heard or the flow can be felt coming from the small hole located on the side of the valve. 5. If the actual flow does not match the MFC setpoint when running the system check, verify that the cartridge vale or solenoid valve are functioning as expected. To test this, connect N2 to the corresponding quick connect (cal or CTS). Disconnect the tubing at the push fitting between the cartridge valve and the solenoid valve. Actuate the direct flow for the corresponding line and feel for pressure. If there is pressure, the solenoid valve needs to be replaced. If there is not pressure, the cartridge valve should be replaced then retested to confirm the solenoid valve does not need to be replaced as well. In most cases, the cartridge valve would not need to be replaced.
System check came in low	1. Verify that the CDA pressure gauge has pressure at 80psig. 2. Verify that there are no leaks in any of the gas lines. 3. Check the particulate filter and o-rings. Any time the particulate filter is removed, the o-rings should be replaced (even if the filter is not replaced). 4. Check the pump diaphragm for damage. Replace if necessary. 5. Verify that the bellows valve located in the ASC-10 oven is not leaking once the oven has cooled down. Typically, a leak in a bellows valve can be heard or the flow can be felt coming from the small hole located on the side of the valve.
System flow matches the setpoint on the MFC, but there is no flow on direct	1. Verify that the CDA pressure gauge has pressure at 80psig. 2. Either the solenoid valve or cartridge valve may be leaking or failing. 3. To test, disconnect the tubing at the push fitting between the cartridge valve and the solenoid valve. Actuate the direct flow for the corresponding line and feel for pressure. If there is pressure, the solenoid valve needs to be replaced. If there is not pressure, the cartridge valve should be replaced then retested to confirm the solenoid valve does not need to be replaced as well. In most cases, the cartridge valve would not need to be replaced.
Pump power is inconsistent	1. Verify that the wires and wiring harnesses coming from the pump have not been damaged or disconnected. Similarly, check the wires associated with the HMI screen as well. 2. Check that the cartridge valve and solenoid valve are functioning as expected by running a direct check.
CDA or N2 gauge won't adjust	1. Verify that the gas line is connected to the appropriate inlet port and set to the appropriate pressure. 2. To adjust the pressure on the regulator with gauge on the ASC-10, gently pull the black housing of the regulator then turn it clockwise to increase pressure or counter-clockwise to decrease the pressure.

	3. If the pressure needs to be decreased, close the corresponding CDA or N2 cylinder stem and quickly loosen the line fitting to relieve the excess pressure. Make sure to tighten the fitting then check for leaks when complete. 4. When the pressure is set appropriately, gently push the black housing of the regulator toward the ASC-10 to lock it.
Over 100psig was applied to one of the gas inlet lines	It is not recommended to apply greater than 100psig to any of the gas inlet lines. Pressure greater than 100psig applied to any of the gas inlet lines risks damage to the ASC-10. If this occurs, please contact technical support for assistance.
Filter won't go back into place	1. Verify that the filter has not been damaged or deformed and is seated in the correct location. Replace if necessary. 2. Very that the o-rings have not been damaged or deformed and are seated in the correct location. Replace if necessary.
Thermal Limit alarm activated	1. Determine which component thermal limit was triggered (pump, oven, or line). 2. Allow the component to cool to a temperature within the acceptable temperature range. 3. Verify the temperature setpoint is correct. 4. Verify that no damage has occurred to the component. Note: if the thermal limit alarm continues to occur, contact technical support for assistance.
MFC calibration in question	The ASC-10 MFC does not require calibration. To verify the flow rate, utilize a certified flow meter, such as a BIOS to confirm the flow rate.
ASC-10 is not turning on or running at reduced capacity	1. Look at the label located near the power cord on the rear of the ASC-10. 2. Verify that the power source is the same voltage as the voltage listed on the label. 3. If they match and issues persist, contact technical support for assistance.