



XD-502

Operator's Manual

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1 Preface

1.1 Product Introduction

The XD-502 Source Sampler from Apex Instruments is designed for manual, isokinetic sampling of gaseous pollutants from stationary sources, e.g. stacks, flues, vents or pipes. The console is most commonly used for EPA Methods 5, 17 and 23.

The Source Sampler is easily adapted to test for a wide range of pollutants from stationary sources, such as particulate matter including PM 2.5 and PM10 fractions, metals, polychlorinated biphenyls (PCBs), dioxins/furans, polycyclic aromatic hydrocarbons (PAHs) and many more pollutants with adaptations of the basic isokinetic test method.

1.2 Purpose of this manual

The purpose of this manual is to provide a basic understanding of the Apex Instruments XD-502 source sampling console. The XD-502 is applicable for use with a variety of US EPA sampling methods and other isokinetic sampling procedures.

Additionally, this manual provides the users with a reasonable amount of reference information on system configuration, calibration procedures, maintenance and troubleshooting as it applies to the specific product and the US EPA Regulations.

1.2.1 Relevant US EPA method descriptions

Method 5 - Determination of Particulate Matter Emissions From Stationary Sources

Method 17 - Determination of Particulate Matter Emissions From Stationary Sources

Method 23 - Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans From Stationary Sources

Detailed information on method sampling may be found through the US EPA website - please visit <https://www.epa.gov/emc/emc-promulgated-test-methods> for complete method descriptions

1.3 Safety Instructions

1.3.1 Safety information related to the intended use

Source sampling is intended to be performed by technicians who have been trained in source sampling methods. Personnel conducting source sampling are expected to understand basic gas laws and chemistry.

In addition, all technicians should have adequate general safety training to identify, abate and prevent job-related hazards including site-specific training.

Please visit the following link for more information on Stack Sampling Safety Procedures and Protocols:
<http://www.sesnews.org/>

1.3.2 Explanation of safety warnings



“DANGER” indicates a hazard with high level of risk which, if not avoided, will result in death or serious injury.



“WARNING” indicates a hazard with medium level of risk which, if not avoided, could result in death or serious injury.



“CAUTION” indicates a hazard with low level of risk which, if not avoided, could result in minor or moderate injury.



“NOTICE” Indicates information considered important, but not hazard-related.

1.3.3 Electrical shock



Use and maintenance of the source sampling console presents potential electrical hazards.

Ensure that the console is protected from wet conditions such as rain or process emissions. If the console is wet, do not continue to operate the console until it has been adequately dried.

Do not perform maintenance on this console when it is still plugged into a power source and the main power switch is turned on.

Do not continue to use the console if wires are exposed or loose from their connectors.

1.3 Safety Instructions cont.

1.3.4 Weight



Although the unit is compact and lighter than previous versions, the unit itself can present risks due to its weight. When carrying the unit, make sure to use proper form to lift using your legs. Lift and carry the unit using the provided handles or by holding the entire unit close to the body. If a user is not comfortable carrying the unit, a partner may provide the necessary assistance in moving the unit around.

1.3.5 Elevated surfaces



Use of the unit on elevated surfaces also poses risks that range from minor to fatal. Be sure to operate the unit on a level, stationary surface. If necessary, secure the unit using straps or braces to ensure that vibration or accidental contact does not knock the unit off of its surface.

1.4 What To Do When the Unit Arrives

1.4.1 Unpack and inspect

Unpack the unit from its shipping container. Inspect the exterior of the unit for visible damage or missing components. Remove the lid by using the four butterfly latches and visually inspect the front of the unit.

NOTICE

Do not tamper with the internal components unless otherwise recommended.

Check the packing list to ensure that everything has arrived. The console comes with a pre-test calibration certificate for the dry gas meter and temperature sensors. A power cord will also be included for any units that use 120V supplied power.

1.4.2 Become familiar with console operations

Perform mock sample runs to ensure operation of console follows proposed test plan and EPA Method procedures.

1.4.3 Leak checks

Perform the console leak checks as explained in *Section 3.2.5 Console Leak Check Procedure* on page 21 of this manual.

1.4.4 Calibration audits

The unit is sold with a factory dry gas meter calibration at flow rates appropriate for the unit. Apex Instruments suggests performing audits of the dry gas meter before and after each testing period and performing a full calibration on the dry gas meter, sensors and thermocouples annually. Ensure that you verify calibration standards with your local administrator.

Perform the unit calibration audits as explained in *Section 4.1 Pre-Test Calibrations* on page 45 of this manual.

1.4.5 Test plan and methods

Begin the sampling operation procedures as directed by the applicable EPA Method and local compliance regulations.

1.5 How To Transport and Store the Unit

1.5.1 Dimensions

Case: Mini 8U
Height: 17" (43 cm)
Width: 17" (43 cm)
Depth: 12" (30.5 cm)
Weight: 37.5 lbs (17 kg)

1.5.2 Lifting and handling



Avoid dropping the unit and other forms of collision during transport. When lifting, make sure to use the handles on the sides to lift. Do not try to lift the unit by anything other than the handles or the carrying strap.

1.5.3 Storage

Store upright, if possible, in a controlled environment on a shelf off of the ground. The unit should be stored in the case with the lid attached and disconnected from power.

1.5.4 Shipping

While the unit features a rugged design, the components and integrity of the build are delicate; the unit should be treated as a lab instrument when considering transport. Sudden jarring movements or drops could damage the internal components or cause faults within the electrical subsystem and various sensors.

The unit should not be shipped independently. Ensure proper shipment of the unit by packing it in a foam-lined box or an appropriate shipping container that provides adequate protection.

2.0 Description of the Product

2.1 Intended Use and Reasonably Foreseeable Misuse

2.1.1 Source sampling

The sampling console is the operator's control station. The XD-502 sampling console includes a precision dry gas meter fitted with a high-resolution rotary encoder, a leak-free pump, a digital vacuum gauge, flow control valves and a venturi-style orifice tube for monitoring the gas flow rate. A 32-bit microcontroller converts the sensor inputs and displays the totalized sample volume, temperatures and pressures into user-selectable units. The transfective LCD display is sunlight readable and backlit so it can be seen in the dark. Two advanced, self-tuning 1/32 DIN temperature controllers with individual solid-state relays are used for controlling heaters for the probe and oven (filter).

The digital LCD screen displays the elapsed time, the dry gas meter pressure differential (ΔH), pitot tube differential pressure (ΔP) and the totalized, corrected dry gas meter volume. Coarse and fine valves are used to control the sample flow rate and for adjusting the vacuum during leak checks. A female sample inlet and pitot tube quick connects provide convenient connections for the sample vacuum and pitot lines.

2.1.2 Versatile use

The XD-502 console can be easily adapted to various gaseous sampling train systems. Using different configurations of sampling trains, the XD-502 console can be used to test for PM_{2.5} and PM₁₀ fractions, metals, polychlorinated biphenyls (PCBs), dioxins/furans, polycyclic aromatic hydrocarbons (PAHs) and many more pollutants with adaptations of the standard particulate, isokinetic test method.

2.2 Product Compliance

This product complies with all relevant US EPA sampling regulations and was designed based on the schematics and sampling practices established by the EPA in the Code of Federal Regulations.

2.3 System Overview

NOTICE

This manual covers the sampling console part of the train. The rest of the sampling train is sold separately.

The first step to effective sampling is to become familiarized with the standard equipment. To illustrate the necessary components of source sampling, we've included an overview of the five main components of the Apex Instruments Source Sampling Train. The main components of a Source Sampling system are: probe assembly, heated filter, glassware case, umbilical cable and the console with an internal or external sampling pump.

2.3.1 Sampling Console (XD-502)

The sampling console houses the dry gas meter, internal sampling pump (standard, optionally without), temperature controllers, PIC32 microcontroller module (MCM), vacuum gauge, flow adjustment valves and a user interface display.

Some sampling trains use an external pump assembly to pull the sample; an external pump is not necessary when a console, such as the XD-502, uses an internal sampling pump to extract the sample gas.

Sample gas enters the console from the umbilical and then through the pump and dry gas meter.

The console is housed in a strong and durable polyethylene case with a carrying strap on top.

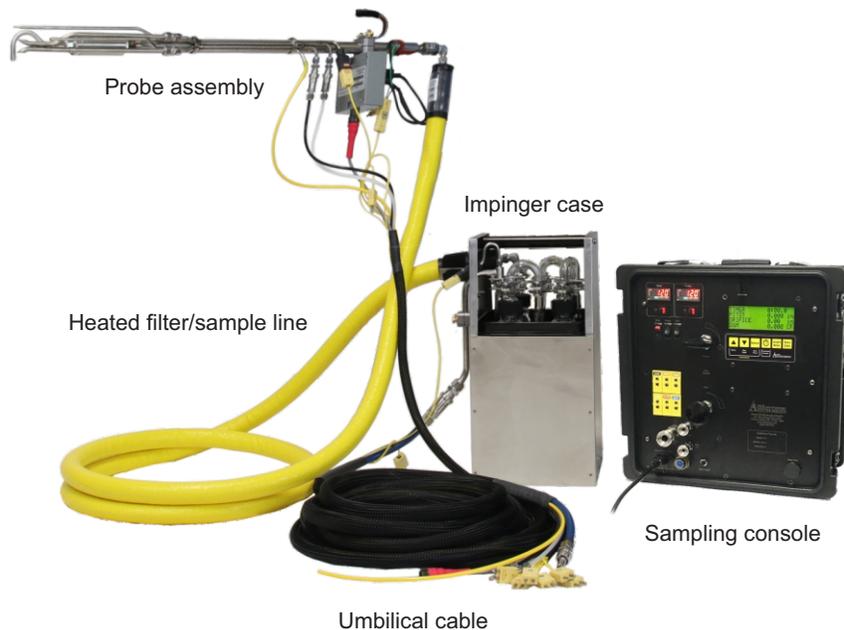


Fig. 1 Example Sampling System: Ancillary components of the sampling system are sold separately.

2.4 Technical Specifications

Dry Gas Meter

Model SK25EX-100 multi-chamber positive displacement meter fitted with a quadrature encoder. Q_{max} for air 41 LPM at 150 Pa, Q_{min} 0.26 LPM, Resolution 0.002 Liter, cyclic volume 0.7 Liter, 400 pulses/revolution, accuracy 1.5% at volumes greater than 10 Liters. Type K thermocouple for meter exit temperature (optional Type K thermocouple for meter inlet temperature)

Internal Sample Pump (Standard, Optional Without)

Dual head diaphragm, 70 LPM free flow, 21 LPM @ -50 kPa, max vacuum 27" Hg (-85 kPa), 24 VDC brushless motor

Display

4x20 character backlit transfective liquid crystal display, 160x96 dot matrix, viewing area 74 mm x 45 mm, operating temperature -20 to 70 °C (-4 to 158 °F)

Keypad

Display controlled by six button, long-life membrane keypad for display operation, tactile feedback keys control the timer and menu operations, ability to zero the meter pressure differential (ΔH) and pitot tube pressure (ΔP) transducers, DGM volume and reset the timer

Temperature Measurement

Cold junction compensated Type K thermocouple-to-digital converter °C/°F selectable, -200 to 1372 °C range (-328 and 2502 °F), up to 6 additional Type K thermocouple inputs, standard size jacks

Temperature Controllers

Probe and Oven. Fuji PXR3 compact, 1/32 DIN self-tuning PID temperature controller with 3 button keypad, SSR driver for 25A solid state relay, Type K thermocouple jack for input

Digital Pressure Transducers

High resolution, digital, factory calibrated and temperature compensated -20 to 70 °C, proof pressure 49 kPa
 ΔP Low +/- 1.0" (+/-249 Pa) range bi-directional with 0.001" (0.1 Pa) resolution
 ΔP High +/- 10.0" (+/-2491 Pa) range bi-directional with 0.01" (1 Pa) resolution
 ΔH 5.0" (1245 Pa) range with 0.01" (1 Pa) resolution

Vacuum Measurement

PCB-mounted sensor, 0 to -30" Hg (0 to -100 kPa)

Umbilical Connection

Electrical multi-conductor circular connector, instrumental grade stainless steel quick connects
Sample inlet - 1/2", pitot connections - 1/4", Type K thermocouple plugs - AUX, STACK, PROBE, OVEN, EXIT

Processor

Apex Instruments PIC32 Microcontroller Module

Firmware

Scaling factor gamma correction input, pressure sensor damping, temperature sensor offset, user-selectable unit types (Metric, Metric Pa, Imperial)

Power

Supply 120VAC/60Hz 15 amps max. or 240VAC/50Hz 10 amps max., IEC C-14 Inlet

Dimensions and Weight:

H17" x W17" x D12" (43 cm x 43 cm x 30.5 cm), 37.5 lbs (17 kg) base configuration

2.5 Faceplate Components

Reference the image below for an introduction to the essential components of the XD-502 Source Sampling console.

For specific part numbers and a detailed look at the internal components, go to *Sections 6.3 and 6.4* on pages 55 and 56 of this manual.

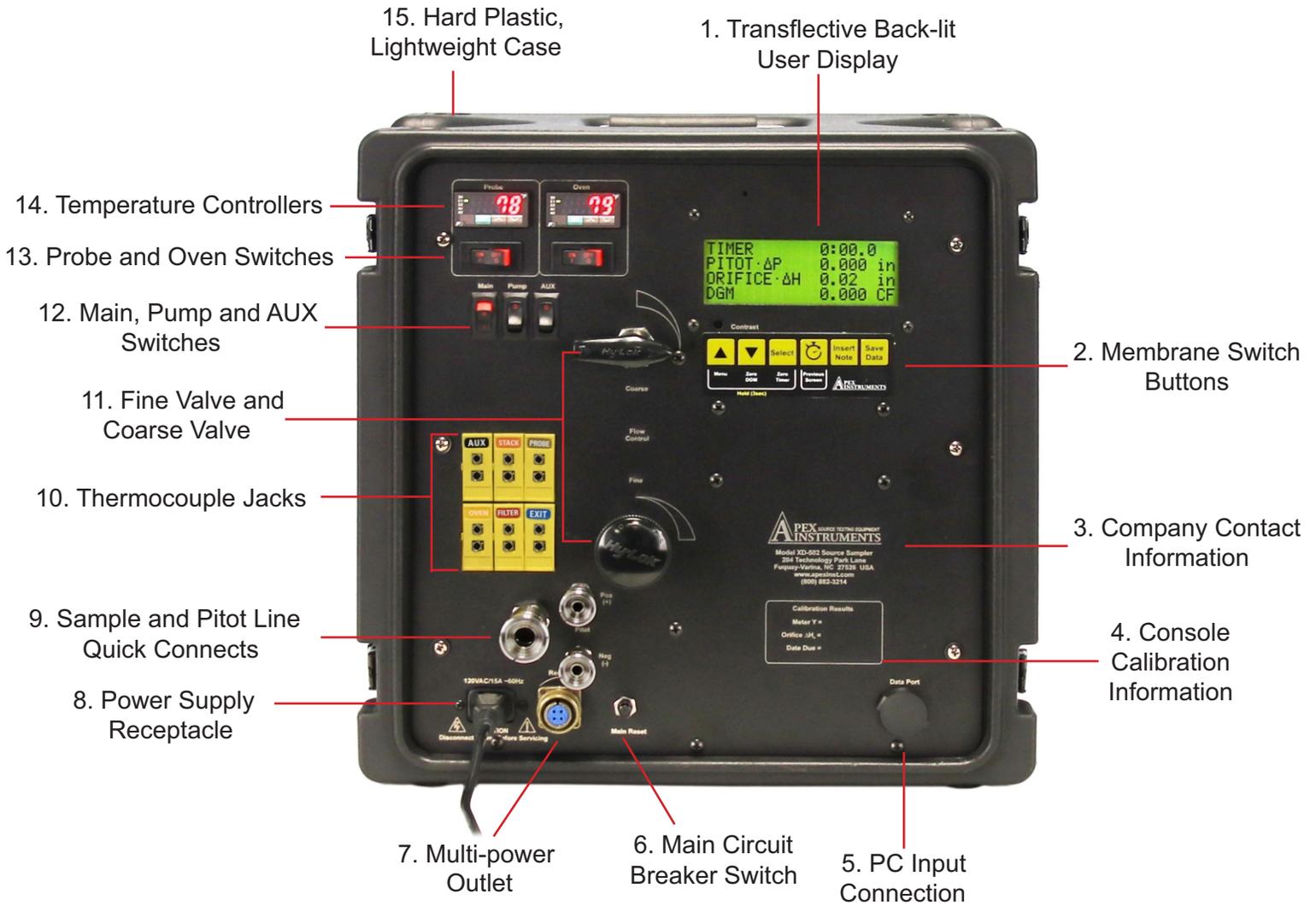


Fig. 2 Front Panel Overview: Standard version shown, depiction of options may differ.

3.0 Console Operation

3.1 User Control Overview

3.1.1 Home screen overview

The home screen on the XD-502 console allows the operator to view and manage run data.

Timer: Run time displayed in MM:SS.ms format and can be started, stopped and reset using the membrane switch pad buttons.

Pitot-ΔP: The current ΔP pitot tube differential pressure is displayed for the pitot. The averaging (or damping) of this value can be adjusted in the console menu.

Orifice-ΔH: The current dry gas meter ΔH, orifice pressure differential, measured by the venturi-style orifice tube fitted at the exit of the DGM. The averaging (or damping) of this value can be adjusted in the console menu.

DGM: The totalized DGM volume. This value can be reset by holding the Down button for 3 seconds.

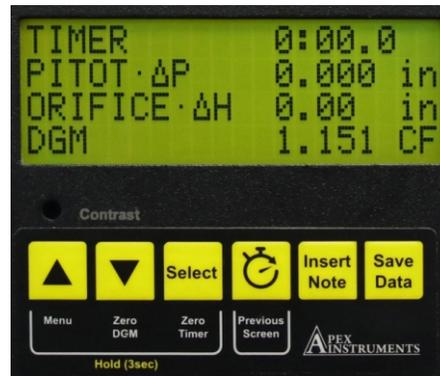


Fig. 3 User Interface

3.1.2 Membrane switch pad buttons

	<ul style="list-style-type: none"> - Press once to move upward through home screens - Press once to move upward through menu options (only available while in the Menu) - Press and hold for 3 seconds to enter the console's Menu (only available while on the main screen)
	<ul style="list-style-type: none"> - Press once to move downward through home screens - Press once to move downward through menu options (only available while in the Menu) - Press and hold for 3 seconds to reset the digital DGM reading to zero (only available on the main screen)
Select	<ul style="list-style-type: none"> - Press once to select and enter a menu option (only available while in the Menu) - Press and hold for 3 seconds to zero the timer to 0:00.0 (only available on the main screen) <p>***To enable K-Factor/Delta H Target Feature See NOTE Below</p>
	<ul style="list-style-type: none"> - Press once to start or stop the timer (only available while on the main screen) - Press once to return to the previous screen (only available while in the Menu) <p>***To enable K-Factor/Delta H Target Feature See NOTE Below</p>
Insert Note	<ul style="list-style-type: none"> - Press once to enter the Note menu which allows the user to start a leak test or insert a marker that serves as a note for a particular event
Save Data	<ul style="list-style-type: none"> - Press once to instantaneously save a data point to the console's storage

*****NOTE:** To enable or disable the K-Factor/Delta H target feature:
 -Power off console
 -Press and hold the center 2 buttons ([Select] & [Previous Screen]) while you power up the console
 -Repeat to toggle the feature on or off

3.1 User Control Overview cont.

3.1.3 Menu overview

The menu on the XD-502 console allows the operator to set data averaging values, change units and provide TC offsets. The menu can be accessed by pressing and holding the Previous Screen (Menu) button for 3 seconds.

NOTICE

An abbreviated menu will appear if the run timer is not at 0:00.

Pitot- Δ P and Orifice- Δ H Damping: “Block size” is the averaging rate of the transducer readings. Each “block” is equal to a sample every 1/4 second. Four damping “blocks” would be a 1 second averaging period.

Δ P and Δ H Damping Band: A tolerance based on the full scale of the measuring transducer. The Δ H transducer used in the XD-502 sampling console has a range of 5” H₂O and the Δ P transducers have a range of 1” and 10” H₂O. To ensure that the data stream displayed is smooth, the damping band should be configured to restart after an outlier is measured. For example, Δ H values could be averaging out at 1.00” H₂O. If the damping band is set to 10% (of full scale), any reading outside of 0.95 to 1.05” H₂O would start a new average.

Reset Marker#: Resets the marker number back to 0.

ZERO Sensors: Resets the zero point for all transducers, Δ P and Δ H. Ensure that no pressure is being applied to the sensors.

Traverse Pt. SAVE: Sets a timer for the console to save a data point to memory in sync with traverse points in the sample run. This time should be set up to match the sample traverse point time at each point.

Periodic SAVE: Sets a timer for the console to save a data point to memory in sync with traverse points in the sample run. This time should be set up to match the sample traverse point time at each point.

[NEW] Run: Allows the user to start a new run from a fresh data slot. The user is prompted to choose the data slot and if the data slot has data in it already, will be prompted to confirm the overwrite.

Unit Types: Allows the user to change unit types displayed on the console. There are 3 options included:

- Imperial:* Vol. – ft³, Press. – Inches H₂O, Temp. – °F
- Metric:* Vol. – m³, Press. – mm H₂O, Temp. – °C
- Metric Pa:* Vol. – m³, Press. – Pascal, Temp. – °C



Fig. 4 Menu Overview

3.2 Pre-Field Test Operations

3.2.1 Console configuration

Ensure that the following console settings are configured in the lab before performing a field test: unit types, ΔH and ΔP damping and time and data saving settings.

To access each of these settings on the console, enter the Menu by pressing and holding the Up arrow button for 3 seconds (timer must be at or reset to 0:00 to access full menu).

Use the Up and Down buttons to scroll to a menu option with the indicated < ("less-than") symbol. Press the Select button to enter a menu option. Use the Up and Down buttons to adjust values, press the Select button to confirm changes, and press the Previous Screen button to exit submenus and again to return to the home screen.

3.2.2 Moisture determination (if applicable)

At the sampling location, prior to testing, determine the percent moisture of the stack gas using the wet and dry bulb temperatures or, if appropriate, a relative humidity meter. Another option is a moisture approximation through procedures outline in EPA Method 4.

3.2.3 Preparation of impinger train

Follow procedures outlined in an applicable EPA Method to prepare the impinger train.

3.2.4 Preparation of sampling train

Assemble the sampling train as shown in the applicable EPA Method. Adjust the probe and oven/filter heaters to a temperature warm enough to prevent water condensation or as dictated in the sampling method using the respective temperature controller on the left side of the console faceplate; keep in mind the previously determined moisture content of the gas stream. Place crushed ice and water around the impingers in the sample case.

Refer to *Section 3.5 Setting the Temperature Controller* on page 26 of this manual for instructions on how to operate the temperature controllers.

3.2.5 Console leak check procedure (front side):

NOTICE

DO NOT EXCEED THE TRANSDUCER PRESSURE RATING OF 100 INCHES OF H₂O. DOING SO MAY RESULT IN OPERATIONAL SENSOR FAILURE.

Navigate to the Leak Test function by pressing the Insert Note button and selecting Leak Test or perform the leak test from the main screen.

1. Position the valves

- a. Close the coarse valve by turning the handle clockwise to the horizontal position ("3:00").
- b. Decrease the fine tune knob fully by turning all the way to the left (counterclockwise).

2. Block airflow of sample inlet

- a. Insert a capped quick connect into the 1/2" sample inlet.

3. Initiate flow

- a. Turn on the pump and open the coarse valve all the way counterclockwise to the vertical position ("12:00").

4. Adjust vacuum (if necessary)

- a. If the Vac value displayed on the LCD screen is below 10 inches Hg (250 mm Hg), slowly turn the fine tune knob clockwise until the vacuum is at least 10 inches Hg.

5. Monitor the console leak rate

- a. Start the timer using the Start/Stop button on the membrane switch keypad and monitor the DGM value on the LCD screen for 1 minute. If the flow through the DGM exceeds 2% of the average sample rate (e.g. 0.02 L/min for a 1.00 L/min target sample rate), the leaks must be found and corrected.

6. Complete the console leak check procedure

- a. Remove the plug from the sample inlet and turn off the pump. Be sure to return the valves to a lower flow starting position. Press the Save Data button to save and exit the leak test menu. The DGM reading can remain at the current value or can be zeroed before the run by holding the Down, or Zero DGM button, on the membrane switch pad for 3 seconds.

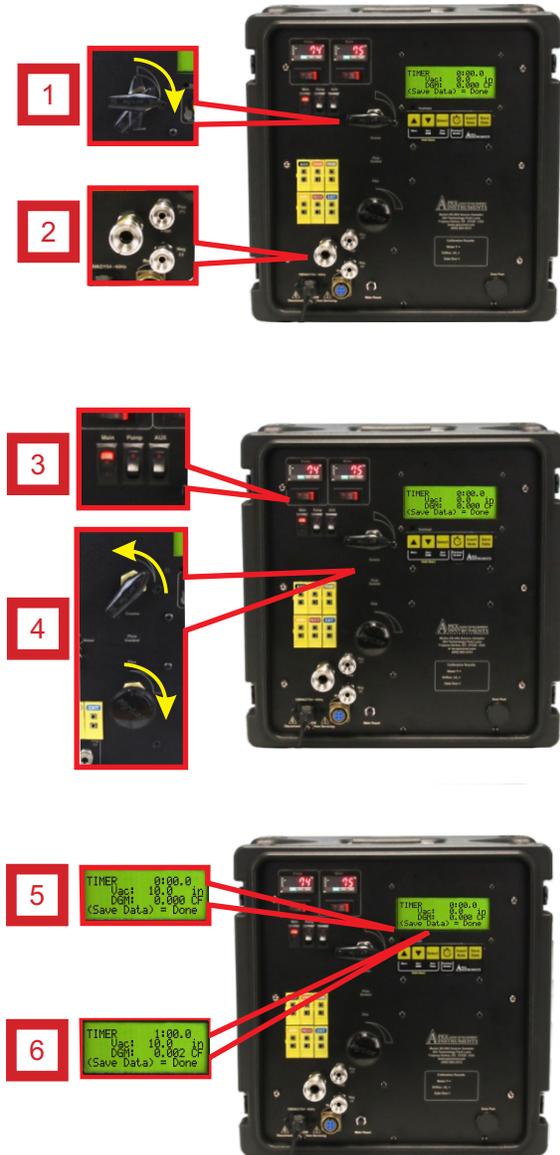


Fig. 5 Front-Side Leak Check

3.2.6 Sample train leak check procedure

Navigate to the Leak Test function by pressing the Insert Note button and selecting Leak Test or perform the leak test from the main screen.

A leak check before the sampling run is recommended, but not required. The leak check procedure includes the following steps:

1. Close the coarse valve by rotating the handle 1/4 turn right (clockwise) until it is horizontal or the arrow is pointing to “3:00.” Decrease the fine tune knob by rotating all the way to the left (counterclockwise).
2. Plug the probe inlet or nozzle tip using a clean finger or a clean cap.
3. Turn the pump on using the switch in the upper-left corner of the console and open the coarse valve fully by turning to the left (counterclockwise until it is pointing straight up).
4. Adjust the fine valve by rotating it clockwise to pull a vacuum of at least 10 inches Hg (250 mm Hg), which can be observed by the vacuum value on the LCD screen.
 - a. If this vacuum level is overshoot, either complete the leak check at this value or slowly release the cap from the probe or nozzle and close the coarse valve.
 - b. Adjust the fine valve by rotating it counter-clockwise and then repeat the leak check process.
5. Observe the leak rate as indicated by the DGM volume on the LCD screen for one minute and ensure that the volume is not increasing during this time. A leakage rate in excess of 2 percent of the target average sample rate is not acceptable (e.g. 0.02 L/min for a 1.00 L/min target sample rate).

The operator can use the timer to track and quantify leak rates. The timer can be started or stopped by pressing the Start/Stop button once. If the timer needs to be reset, the Zero Timer button (Select) can be pressed and held for 3 seconds.

6. Press the Save Data button to save and exit the leak test menu. The DGM reading can remain at the current value or can be zeroed before the run by holding the Down, or Zero DGM button, on the membrane switch pad for 3 seconds.

NOTICE

Slowly release the probe inlet plug before closing the coarse valve.



Fig. 6 System Leak Check

3.3 Field Test Operations

3.3.1 Performing a Method 5 sampling test

This operation guide is written based on US EPA Method 5 sampling. Ensure that you follow the appropriate procedures outlined in the applicable isokinetic method to be performed. EPA Methods 1, 2, and 4 should already be performed and an approximation of Method 3 should be made or measured.

1. Use pre-test conditions to calculate a K-Factor that will be used to determine the operational ΔH for each traverse point.
 - The K-Factor should not change unless source conditions change drastically from pre-test conditions when the initial calculation was made.
 - Input the K-Factor into the console using the Change K-Factor submenu found in the main menu.
2. The sample impingers should be charged and the volume or weight should be measured before use. Record these values on the field data sheet or laboratory recovery log.
 - Set up the impinger train in the sample case and add ice and water.
 - Connect all of the equipment, including the nozzle, probe, filter, impinger train, umbilical, console, and any other applicable sample lines or connections.
3. Ensure probe and heated oven or filter, as applicable, have reached the set point.
 - If either has not reached the suggested temperature, turn the heaters on using the appropriate switch in the upper-left corner of the console and/or allow time to reach the set point.
4. Ensure that the timer and sensors are zeroed/reset.
 - If it is not, press and hold the Select, or Zero Timer, button for 3 seconds.
 - Zero the ΔH and ΔP pressure sensors by opening the user menu using by holding the Up button for 3 seconds and navigating to Zero Sensors; ensure that no pressure is being applied to the sensors and conditions are ambient.
 - With the coarse valve closed, start the pump using the switch in the upper-left corner of the console.
5. Record all applicable site data such as plant name, location, date, personnel, etc.
 - Record the initial DGM reading displayed on the console LCD screen and barometric pressure, which is found on the third home screen of the LCD display (use the Up and Down buttons to change screens). The DGM reading can begin at the current value or can be zeroed before the run by pressing and holding the Down, or Zero DGM, button on the membrane switch pad for 3 seconds.
6. To begin sampling, position the tip of the probe and nozzle at the first traverse point.
 - Note the clock time and then open the coarse valve and turn on the timer by pressing the Timer button.
7. Adjust the sample flow as closely to the target ΔH as possible. Maintain this flow rate for the duration of the first traverse point.
8. Take readings (clock time, DGM volume, ΔH flow rate, ΔP reading, vacuum, all applicable equipment temperatures) at least every 5 minutes or at the change of a traverse point.
 - Recalculate the target ΔH , or follow the calculation provided by the console, at each traverse point; adjust the flow rate appropriately using the fine valve.
 - Add more ice or a fresh ice pack to the impinger train during the run to keep the temperature of the gases leaving the last impinger between 0°C (32°F) and 20°C (68°F).

3.3 Field Test Operations cont.

3.3.1 Performing a Method 5 sampling test cont.

9. At the conclusion of each run, close the coarse valve and record the final readings (clock time and final DGM volume).
 - Now the pump can be turned off and the probe can be removed from the stack.
 - Once the probe has cooled down, conduct a leak check as described in *Section 3.2.6 Sample train leak check procedure* on page 22 of this manual or Section 8.4.4 of EPA Method 5 (this check is mandatory). If a leak is detected, void the test run or use procedures acceptable by the administrator to adjust the sample volume for the leakage.

10. Begin the sample train recovery.
 - Drain the ice bath.
 - The nozzle, sample probe and front half of the filter holder (if applicable) should be rinsed into an appropriate container using the applicable solvents.
 - The filter media should be stored safely inside of its own container.
 - The sample impingers may need to be recovered, but the weights or volumes should be measured first.
 - Follow the applicable EPA method for the remaining post-run sample recovery procedures.

11. Export the data to a PC (optional)
 - Use the dedicated software to export sample run data following each run, if desired
 - Open the Storage tab and select the current run and press the Export Run button
 - Make any additional notes in the window that pops up and select the Go! button
 - Select the Done! button
 - Select a place to save the data to on the PC
 - Open the file in a notepad application to view data in a .CSV format or in a spreadsheet application to view the data in a formatted layout

12. Perform all additional post-test procedures as indicated in the sampling method

3.4 Post-Field Test Operations

3.4.1 Post-test calibration check

After each field test series, conduct a calibration check using the procedures outlined in EPA Method 5, Section 10.3.2 (or Section 16.3), noting that three calibration runs at a single, intermediate orifice setting (based on the previous field test) with the vacuum set at the maximum value reached during the test series should be performed.

The console should be confirmed to be leak-free prior to performing this calibration. Calculate the average value of the DGM calibration factor (EPA Method 5, Section 10.3.2). If the value has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings as detailed in EPA Method 5, Section 10.3.1

If the post-test calibration indicates that the metering system is unacceptable for use, either void the test run or use methods, subject to the approval of the Administrator, to determine an acceptable value for the collected sample volume. (EPA Method 5, Section 10.3.3)

3.5 Setting the Temperature Controller

3.5.1 Set value setting

1. The current temperature of the equipment is shown on the Fuji controller. To change the set value (SV) press **SEL** once.

2. Current value is displayed and SV is lit. Press the **▲** **▼** to increase or decrease the displayed value (set value).

3. After the new setting is entered, press **SEL** to lock in the value and return to the C1 (control 1) display.

Repeat procedure to check value if necessary.

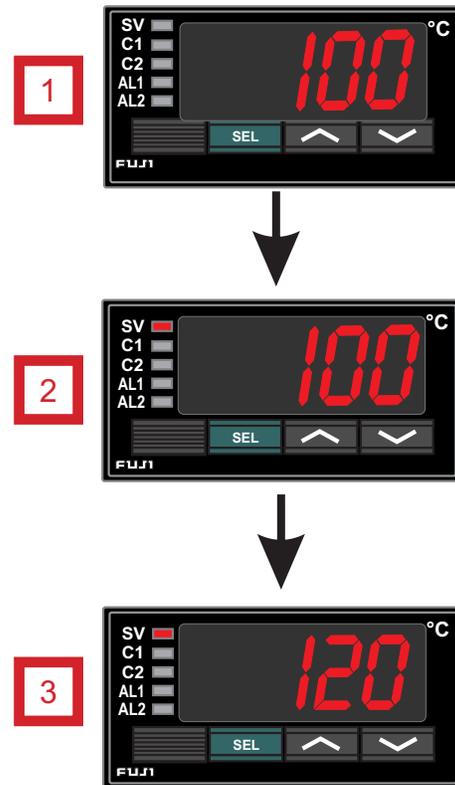


Fig. 7 Temperature Controller Configuration

3.6 Operation using software

3.6.1 Software control introduction

With the XD-502, all functions can be controlled on the console itself using the membrane switch buttons or by using the included software on a compatible computer.

After the software is installed on a Windows operating system device and the device is connected to the console, the user is able to perform sampling operations and monitor all critical information using the software.

Certain settings and features that provide extra versatility are only accessible through software control.



Fig. 8 PC to Console Connection

3.6.2 Downloading the software

Navigate to <https://www.apexinst.com/resources/software> and click on the link for the XD-502, which should be labeled as *XD-502 Software and Firmware Package*. This will take you to a cloud storage location that will always contain the latest software and firmware for the console. Download the zip file and extract it somewhere accessible on the PC.

Inside of this folder is the firmware uploader tool and relevant files, installation instructions, software EXE application and firmware HEX file. Double click on the software application icon to open the software and run it. Double check that the firmware version in the download matches the version on the boot screen on the console. If it does not, follow the instructions in the E-170 Electronics Package Console Firmware Installation.txt file. If any issues are experienced, contact our support team by email at support@apexinst.com or by phone at (919) 345-5754.

3.6.3 Connecting laptop to software

Plug in and turn the console on using the switch in the upper-left corner of the console's faceplate. Using the provided USB-A to USB-A cable, connect one end to a USB port on the PC and the other end to the USB Data Port connection on bottom-right of the console's faceplate. The LCD screen may flicker a few times as the connection is initialized; this is normal.

If the console does not recognize the connection, ensure that the PC has no pending Windows or driver updates. If the console still does not recognize the connection, contact our support team by email at support@apexinst.com or by phone at (919) 346-5754.

3.6.4 Main screen overview



Fig. 9 Main Screen Overview

The Main screen of the software is where the user can monitor all of the necessary information for a sampling operation.

The Main screen is divided into the following subsections:

1. Navigation/Connection section
2. Traverse Point and Periodic Save section
3. Volume and Flow Rate section
4. Temperatures section
5. Pressures section
6. Data Point and Insert Note section
7. Console Time section

3.6.5 Navigation/Connection section overview



Fig. 10 Software Navigation

The Navigation section of the Main screen allows the user to control the connection of the console and switch between the software screens/tabs.

The Navigation section features the following buttons/tabs:

1. USB Connect button (opens Console Connect window - see Fig. 10 below)

- Click the USB Connect button to establish communication with the console. Ensure that you are connected with the provided USB-A to USB-A cable between the front of the console and your device.

Console Connect window

- 1a. USB button
 - Connects the Software via USB cable
- 1b. WiFi button and IP Address field
 - Connects to the software via WiFi or Access Point
- 1c. Cancel button
 - Closes the window



Fig. 11 Console Connect Window

2. Console Status

- *Not Connected* | Console is not currently connected to the PC software
- *Connecting* | PC software is in the process of connecting to the console (this alert should not appear for more than five seconds)
- *Console Not Found!* | An attempt was made to connect the PC software and the console; this attempt was unsuccessful and adjustments must be made before attempting to connect again
- *TCP/IP Address* | When connected, displays the current TCP/IP Address
- *Disconnect Button* | When connected, this button breaks the connection

3. Software and firmware version number

- Displays the current software and firmware version numbers. Ensure these match the latest offerings that we provide on our website or contact your salesman or our support team to verify.

3.6.6 Traverse Point section overview

The Traverse Point section of the Main screen allows the user to control the timer on the console.

The Traverse Point section features the following buttons/tabs:

1. Start/Stop Timer button

- Starts and stops the timer (a data point can optionally be saved using this button)

2. Timer Reset button and checkbox

- Resets the main run timer

3. Sample Timer

- Displays current elapsed time for a run or leak test

4. Time

- Displays a countdown timer until the next traverse point

5. Current

- Displays current traverse point

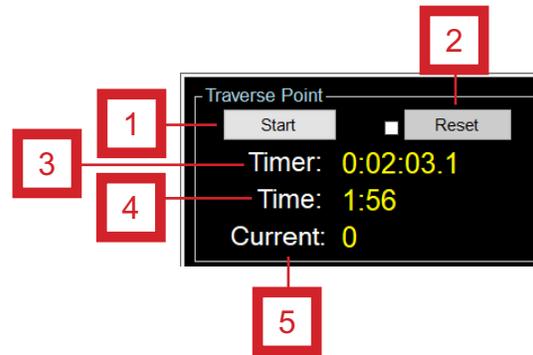


Fig. 12 Traverse Point Section

3.6.7 Periodic Save and Auto Stop section overviews

The Periodic Save and Auto Stop sections allow the user to view data and time settings at a glance.

The Periodic Save and Auto Stop sections feature the following information:

1. Periodic Save Timer Countdown

- Shows time until the next periodic data save is performed in the background (configured under Traverse Point menu)

2. Auto Stop Status

- *Disabled* | Indicates that the timer must be manually operated
- *Enabled* | Indicates that the timer will stop after the designated number of traverse points



Fig. 13 Periodic Save and Auto Stop Sections

3.6.8 Volume/Temperature section overviews

Volume section

The Volume section of the Main screen allows the user to view volume and flow data and set the zero point for the pressure transducers.

The Volume section features the following information and control:

1. DGM Volume

- Displays the current DGM volume that has been metered

2. Flow Rate

- Displays the current flow rate being metered by the console

3. Zero Transducers button (only available when the timer is at 0:00)

- Zeroes all pressure transducers

NOTICE

Ensure that no pressure is being generated from the system when performing this action

Temperature section

The Temperature section of the Main screen allows the user to view temperatures from the various TC channels on the console at one time.

The Temperature section features the following information:

4. Thermocouple readouts

- Displays a countdown timer until the next traverse point

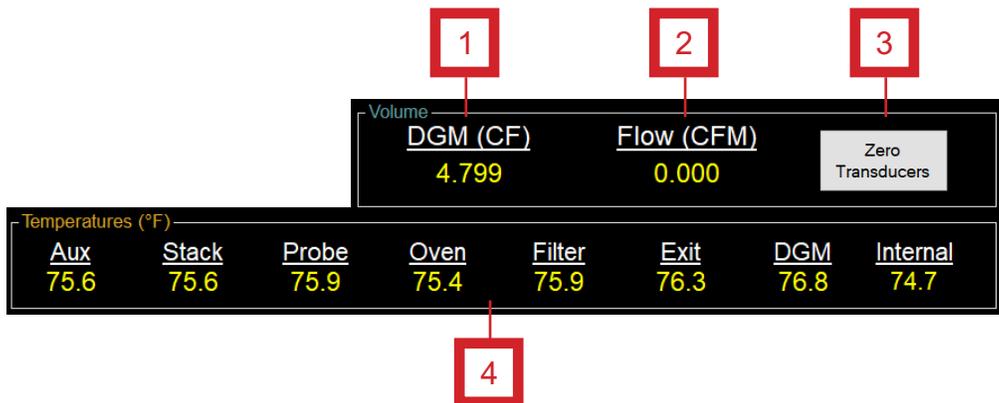


Fig. 14 Volume and Temperature Sections

3.6.9 Pressure/Console Time section overviews

Pressure section

The Pressure section of the Main screen allows the user to view pressures measured by the various pressure transducers and barometric and vacuum sensors. The user can also start a leak test from this section.

The Pressure section features the following information and control:

1. Flow readouts

- Displays the current ΔP and ΔH values from the pitot tube and console respectively. Also displays the current vacuum of the system and maximum vacuum of the current sample run for leak check reference.

2. Barometric readout

- Displays the current, ambient barometric pressure as measured by the board-level sensor inside of the console

3. Perform a Leak Test checkbox and button

- Allows the user to perform a leak test of the sampling train. Must check the box to the left before clicking this button. Will bring up a separate menu to display the leak test data.

Console Time section

The Console Time of the Main screen allows the user to view the current clock time for the console as set by the user based off of the PC operating the software.

The Console Time section features the following information:

4. Console date and time

- When connected to the console, this area displays the current date and time that was last set on the console. If the console and PC connection becomes severed, a line will cross through the date and time and the time stamp will indicate when the devices were disconnected.

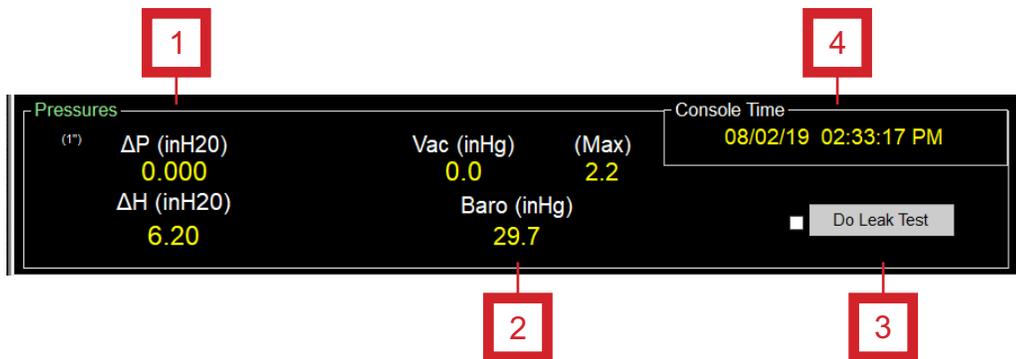


Fig. 17 Pressure and Console Time Sections

3.6.10 Data Point and Note Saving menu section overview

The Data Point and Note Saving menu is the section of the software where the user can save data points manually and insert notes for reference. This section of the software is available at the bottom of the window from any of the software screens.

Data Point and Note Saving menu section

1. Last Saved data point

- Displays date and time of the last data point save

2. Optional Notes text box

- The user can type a quick, or elaborative, note in this box to attach to the next saved data point
- The note will accompany that data point save in the exported spreadsheet

3. Previous Optional Note

- Below the optional notes box, a text field displays previous optional notes that were saved manually

4. SAVE Data Point button

- When clicked, the software saves a data point to storage at that time

5. Current Run number

- Displays the current run number (1-16)

6. Data Point number

- Displays the current data point number for the run

7. Marker Note button

- When clicked, the software saves a data point at that time with an iterative number to be used as a marker. The user would keep track of what each marker number was for during the run.

8. Reset Marker # checkbox and button

- Resets the marker number back to 0. Must check the box to the left before clicking the button.

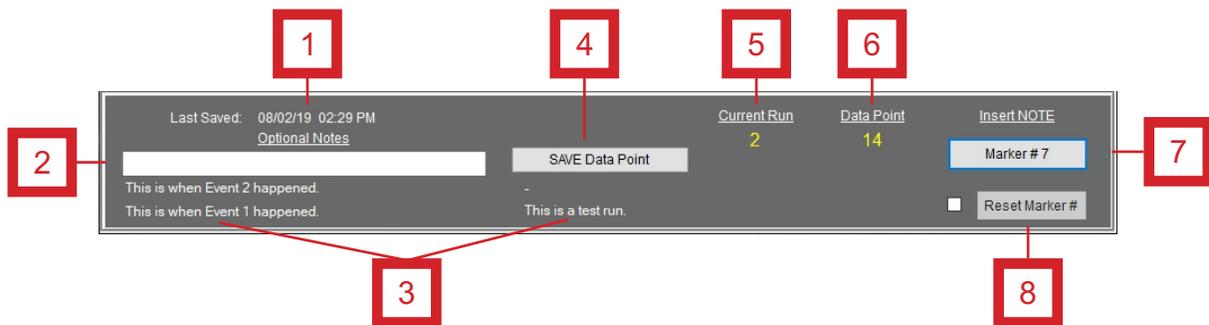


Fig. 15 Data Point and Note Saving Menu

3.6.11 Job Information screen overview

The Job Information screen allows the user to input general test information that will be added to the data export spreadsheet.

1. General Sampling Test Information fields

- Client Name
- Plant Name
- Address
- Test Location
- Test Date
- Run Number
- Personnel
- Project Number (three different fields for entry of different sets of project number data)

2. Save Notes button

- Stores the information fields for the export datasheet

3. Additional Notes field

- Allows the user to include additional information to be exported with the sampling datasheet

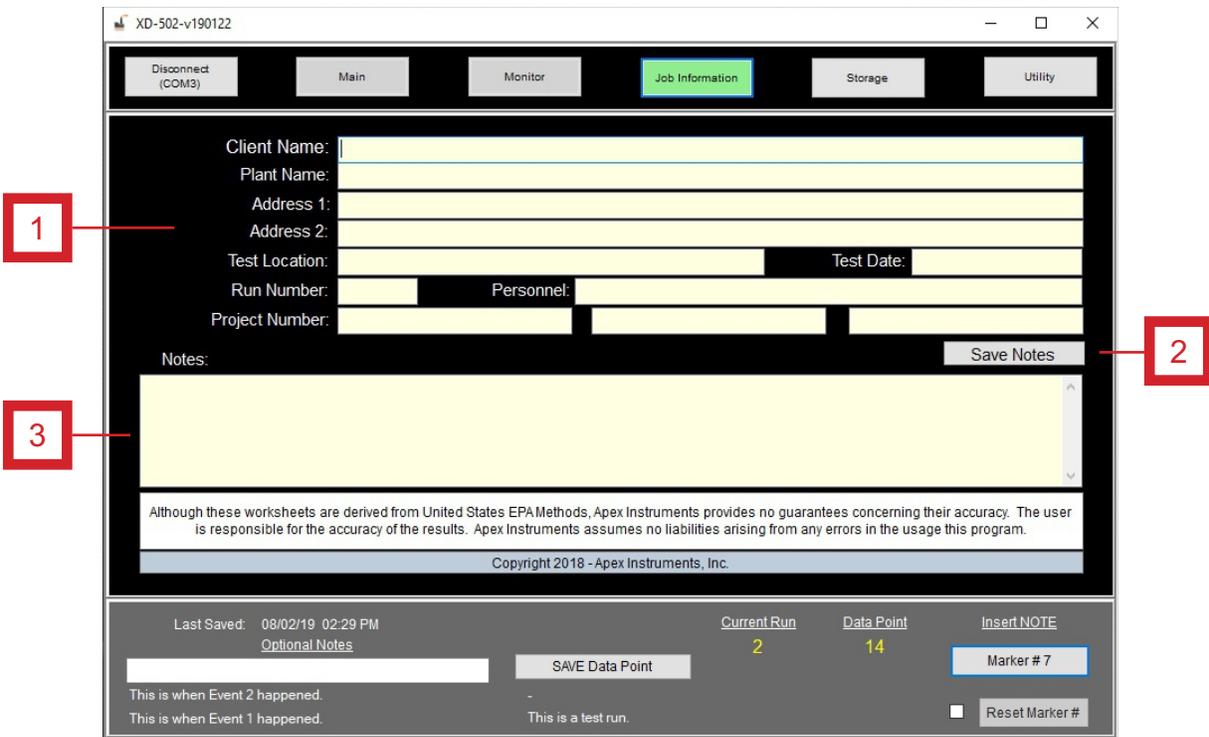


Fig. 16 Job Information Screen Overview

3.6.13 Storage screen overview

The Storage screen displays a list of runs, and their associated data, as well as buttons to export run data.

1. Run Name list

- The green arrows indicate which run is currently being used (a different run may be highlighted for exporting)
- List of all current run names in the list
- The amount of data points in each run is displayed
- The date and time of the last data point save for the run

2. Start a New Run button

- When clicked, a small window will appear allowing the user to start a new run (open a new, dedicated storage group). The user will be alerted if that storage group already contains a run. If this is the case, the user can export, cancel or simply overwrite the previous run. The user can also specify a name for the run at this point or simply refer to the default of the current time and date stamp.

3. New Name text box

- The user can optionally input a name here before clicking the YES button to create a new storage group where data will be contained for a new run
- The default run name is a date/time stamp

4. Export Run button

- When clicked, this button allows the user to export all of the data contained in a selected storage group (run) and save it locally on their PC as a .CSV file (comma separated values) that can be viewed in Excel or compatible spreadsheet program

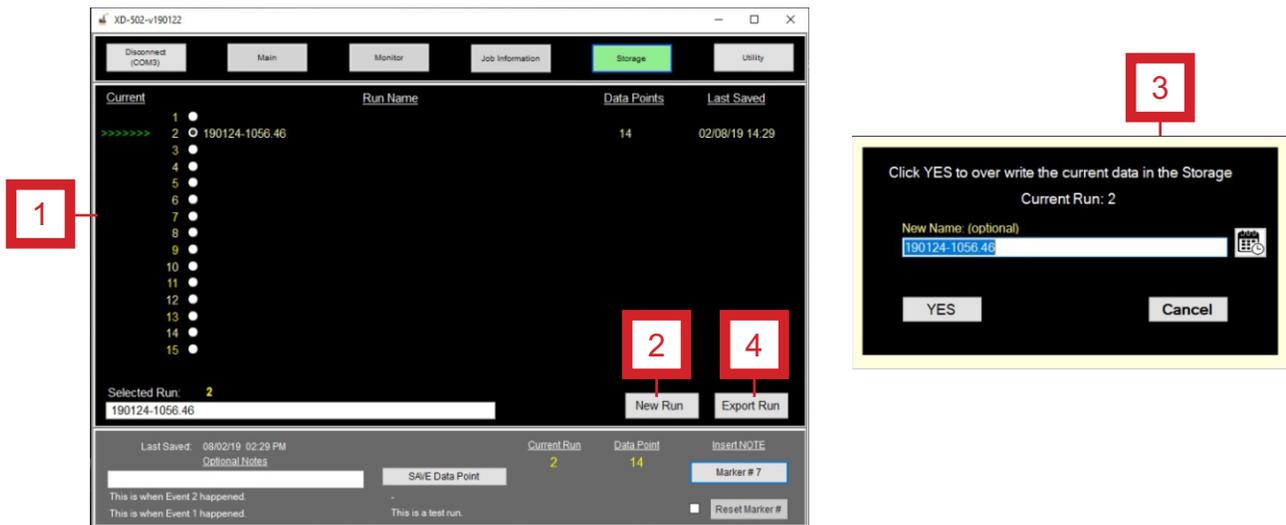


Fig. 18 Storage Screen Overview

3.6.12 Monitor screen overview

The Monitor screen displays a graphical form of the sampling train with real-time values and data (temperatures, flows, volumes and time).

1. AutoStop status

2. Timer data (see the Main screen overview for descriptions of functions in this section)

- Timer
- Traverse Point Save
- Periodic Save
- Start button
- Reset button and checkbox

3. Impinger Out/Exit temperature

4. ΔH reading/setting

5. ΔP reading

6. Calculated Flow Rate

7. Dry Gas Meter Out temperature

8. Dry Gas Meter Volume

9. Barometric Pressure reading

10. Zero Transducers button

11. Sample Vacuum reading

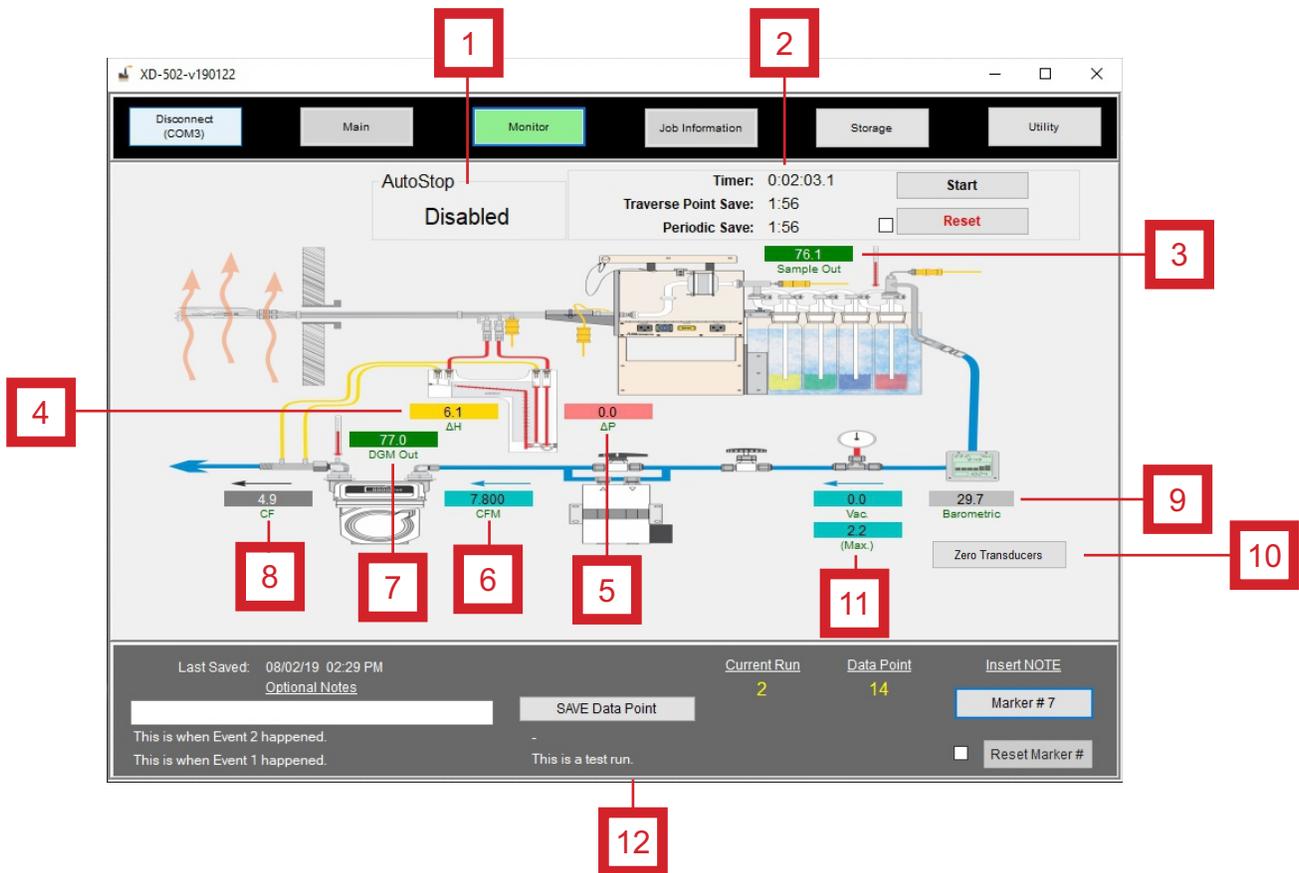


Fig. 19 Monitor Screen Overview

3.6.14 Utility screen overview

The Utility screen is where the user can view and update the settings for the console and software.

The Utility Screen is divided into the following subsections:

1. **Wireless Settings section**
2. **Timers section**
3. **Set Date/Time section**
4. **Formats section**
5. **DGM section**

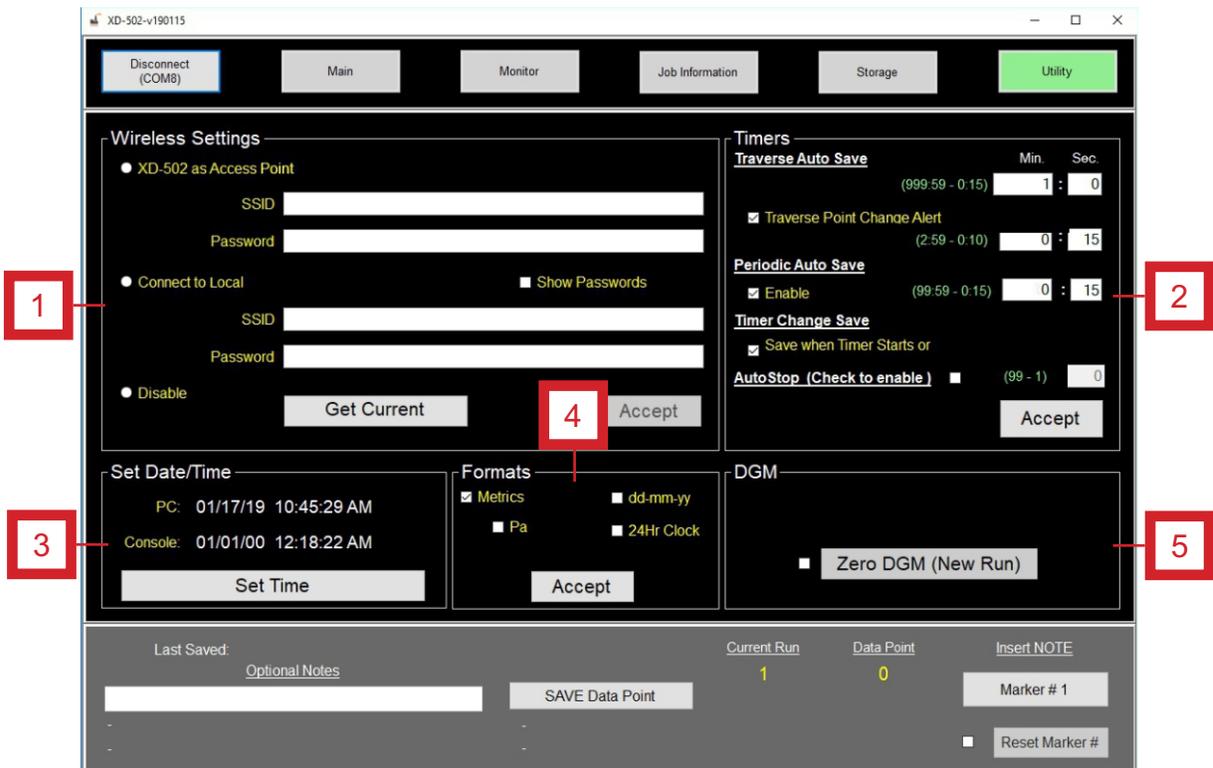


Fig. 20 Utility Screen Overview

3.6.14 Utility screen overview cont.

Wireless Settings section - The Wireless Settings section of the Utility screen allows the user to modify and update settings related to the console connectivity.

1. XD-502 as Access Point

- Allows the console to function as a router and connect to software wirelessly
- SSID: Name of the wireless channel created by the console
- Password: User-generated password for wireless software access

2. Connect to Local

- Allows the user to connect to an existing WiFi network
- SSID: Input field for the name of the WiFi network
- Password: Input field for the password of the WiFi network

3. Disable

- Allows the user to turn off the wireless functionality

4. Get Current button

- Displays the current connection settings

5. Accept button

- Confirms and updates the wireless connection settings of the console

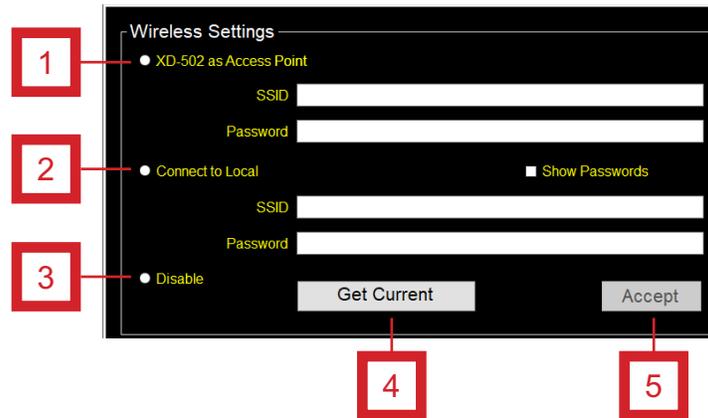


Fig. 21 Wireless Settings Panel Overview

3.6.14 Utility screen overview cont.

Timers section - The Timers section of the Utility screen allows the user to modify and update settings related to time-based data point saving.

1. Traverse Auto Save settings

- Minutes and Seconds fields: Allows the user to specify the amount of time of traverse points in minutes. This will allow the console to save at each new traverse point after a point change and will be clarified in the final data.

2. Traverse Point Change Alert settings

- Enable checkbox: Allows the user to enable and disable the option of traverse point change alert to flash the timer in the software to alert the user of an upcoming point change (also flashes the LCD screen on the console)
 - Minutes and Seconds fields: Allows the user to specify the amount of time in seconds before each traverse point change

3. Periodic Auto Save settings

- Enable checkbox: Allows the user to enable and disable the option of periodic auto save
 - Minutes and Seconds fields: Allows the user to specify the timer increments in which background data is saved during the run. This data can be collected every so often (i.e. 30 seconds) to collect more data than single traverse point readings and is done in the background with no alerts

4. Timer Change Save settings

- Save when Timer Starts or Stops checkbox: Allows the user to enable/disable the option. When this option is enabled, the system will save a data point each time that the timer is started or stopped by the user.

5. AutoStop (Check to enable) settings

- Enable checkbox: When enabled, the timer will stop after the designated number of traverse points. When disabled, the timer must be manually operated.
 - Value field: Allows the user to designate the number of traverse points

6. Accept button

- All changes in the Timer Settings box are not saved until this Accept button is clicked. If the user does not click this button, all previous settings are still in effect.

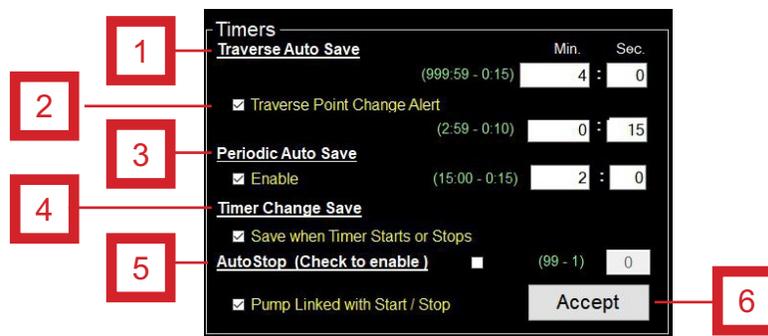


Fig. 22 Timers Settings Panel Overview

3.6.14 Utility screen overview cont.

Set Date/Time section - The Timers section of the Utility screen allows the user to modify and update settings related to time-based data point saving.

1. PC

- Displays the current date and time of the user's PC

2. Console

- Displays the current date and time on the console
- By default, the time is set to the Eastern Standard Time Zone
- Note: When console is disconnected from the software device, this time does not stop

3. Set Time button

- If the two times (PC and Console) differ, the user must click this button in order to sync the console time to the PC time. This should be checked each time the software is opened and a connection between the two devices is made.

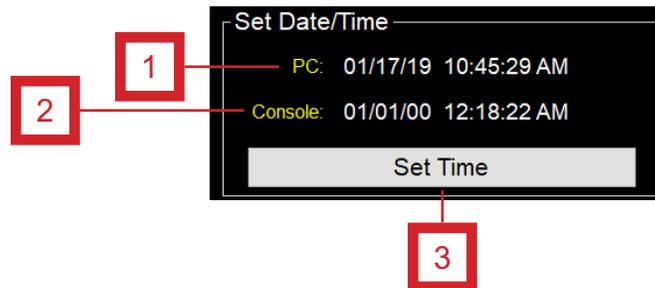


Fig. 23 Set Date/Time Panel Overview

3.6.14 Utility screen overview cont.

Formats section - The Formats section allows the user to modify and update settings related to measurement units.

1. Metrics checkbox

- Clicking this checkbox will change all units to metric in both the software and on the console. If this box is unchecked, all units will be imperial.

2. Pa checkbox

- Clicking this checkbox will change pressure to Pascals (Pa or kPa)

3. dd-mm-yy checkbox

- Clicking this checkbox will change the date used in both the software and firmware to the dd-mm-yy format. If this box is unchecked, all dates will be displayed in the mm-dd-yy format instead.

4. 24Hr Clock checkbox

- Clicking this checkbox will change all times used in both the software and firmware to the 24 hour clock format (e.g. 7:00PM will display as 19:00). If this box is unchecked, times will be displayed in the 12 hour format.

5. Accept button

- Saves and stores all of the Formats settings. If not pressed, the console reverts to previously set settings.

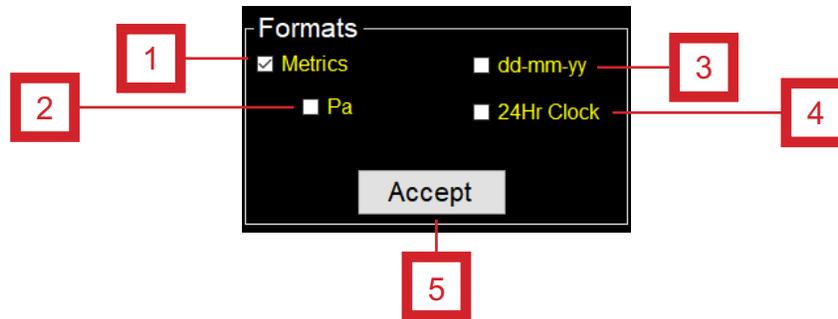


Fig. 24 Formats Panel Overview

3.6.14 Utility screen overview cont.

DGM section - The DGM section allows the user to zero the dry gas meter reading and also access the Calibration menu.

1. Zero DGM (New Run) button

- Allows the user to zero the DGM volume
- The checkbox must be checked first to perform this action

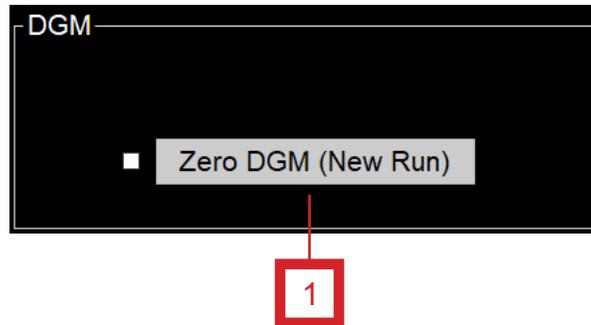


Fig. 25 DGM Panel Overview

3.6.15 Outline of Sampling Test Operations Using the Software

1. Plug in and power on the console.
2. Attach USB cable to PC and to console. The console screen will flicker on and off indicating it has recognized the USB cable connection.
3. Double-click on the software icon to initiate the program.
 - A window may pop up with the following message: "Microsoft Defender SmartScreen prevented an unrecognized app from starting. Running this app might put your PC at risk." Click the More Info text, confirm the software app and then click the Run anyway button.
4. Select USB to connect to the console. Sensor data is displayed and the Navigation menu is unlocked after connection is made with the console.
5. Select the Job Information tab.
 - Fill in fields as necessary. When finished, navigate to the Utility tab.
6. The Utilities screen provides entry for sample run setup.
 - Input values and select settings as necessary and click the appropriate Accept button. When finished, navigate to the Storage tab.
7. Select the New Run button and name the run. When finished, navigate to the Monitor tab.
8. Verify operation of the following components and/or perform the following actions:
 - Sample pump
 - Pressure sensors
 - Thermocouples
 - Vacuum sensor
 - Barometer
 - DGM flow and volume
 - Reset the Marker number, if necessary
 - Make any Optional Notes and save
9. Perform all pre-sampling procedures per the EPA or regulatory method. When finished, navigate to the Main tab.
 - Consult APTD-0576 or other EPA literature
10. Select the Do Leak Test button
 - Perform the leak check (refer to *Section 3.2.6 Sample train leak check procedure* on page 22)
11. Record all necessary initial data on a sample data sheet
 - Open the Monitor screen and record the DGM reading and observe other sample values
12. Starting the sample run
 - Ensure the timer is set to zero
 - Remove the cover from the nozzle tip, place the pitot tube and nozzle at the first sampling point, and add ice to the impinger train
 - Record the clock time
 - Turn on the pump and set the ΔH by opening the coarse flow valve first and then fine tuning with the fine flow valve

3.6.15 Outline of Sampling Test Operations Using the Software cont.

13. During the sample run, the probe is moved from point to point without turning off the pump or closing the flow valve (except when changing ports).
 - The ΔP reading should be monitored and adjustments should be made to the ΔH as necessary
 - Record regular time interval recordings. A set of readings should be recorded when the ΔP changes by more than 20 percent.

14. After the last data point has been sampled and testing is complete, take a final set of readings by pressing the SAVE Data Point button.
 - Turn off the oven and probe heater switches. Remove the probe from the sampling port.
 - Cover the nozzle tip as soon as it has cooled down to avoid contamination or loss of sample
 - Go to the Main tab and perform the post-test leak check

15. Open the Storage tab and select the current run and press the Export Run button
 - Make any additional notes in the window that pops up and select the Go! button
 - Select the Done! button
 - Select a place to save the data to on the PC
 - Open the file in a notepad application to view data in a .CSV format or in a spreadsheet application to view the data in a formatted layout

16. Perform all additional post-test procedures as indicated in the sampling method

4.0 Maintenance

4.1 Pre-Test Calibrations

4.1.1 Factory meter calibration

Apex Instruments performs an initial 5-point calibration following the procedures outlined in EPA Method 5. The result of the calibration is an average calibration factor Y_i (V_w / V_m , adjusted to the same reference temperature and pressure) that is used as the calibration factor for subsequent test runs. Calibration flow rates are performed at 5 points using the calibration part number below:

DGMC-5A-HF

4.1.2 Initial end user calibration checks

Apex Instruments suggests that the end user perform calibration checks on the dry gas meter, thermocouples, vacuum gauge and pressure sensors before performing a field test (post-test calibrations fulfill this suggestion). Perform an audit using a critical orifice set (rated for the intended sampling flow rates) plugged in to the sample inlet on the console. Run the audit at 1-2 in. Hg (25-50 mm Hg) above the calculated critical vacuum. Calculate the Y (Gamma) using the standardized orifice's flow rate and compare this value to the standardized flow rate metered by the dry gas meter after a minimum of 10 minutes using this formula: $(Q_{cr(std)} / Q_{m(std)}) * 100$.

If these values differ by more than 5%, check the integrity of the console before beginning sampling.

To audit the thermocouples, use a calibrated temperature simulator (NIST-traceable preferred) to simulate a known temperature and compare the value on the simulator to the console's displayed value by plugging in directly to one of the thermocouple jacks on the front of the console. If the displayed value on the console does not match the simulator, use the console's menu to offset the displayed value to match the simulator's value.

Another quick check is done by taking the TC out of the dry gas meter outlet and dipping it in an ice bath that also has a calibrated thermometer dipped inside. Ensure the dry gas meter thermocouple channel reading matches the calibrated thermometer at or near freezing, 32 °F (0 °C). If it is not, adjust the console reading to match the ice bath's thermometer.

4.2 Post-Test Calibrations

4.2.1 Dry gas meter

Apex Instruments and the EPA recommends that the user perform post-test audits following a field test series using the procedures outlined in EPA Method 5, Section 10.3.2 Calibration After Use. This procedure closely mirrors the pre-test calibration, except only three runs need to be made that are at or near the sample rate metered and at or higher than the vacuum observed during the test.

The average of the post-test audit factors, Y , is not allowed to deviate more than 5% from the pre-test calibration factor Y_i . If this deviation is greater than 5%, a post-test calibration factor needs to be redetermined using the Pre-Test Calibration procedure. This new post-test calibration factor is then compared to the post-test audit factor and whichever is smaller is accepted as the DGM calibration factor.

Conduct a post-test audit using the audit procedure outlined in *Section 3.4 Post-Field Test Operations* on page 25 of this manual. If the $Q_{m(std)}$ obtained before and after the test differ by more than 5%, void the test run; if not, calculate the volume of the gas measured with the critical orifice.

If recalibration indicates that the metering system is unacceptable for use, void the test results or use approved methods by the administrator to determine an acceptable value for the collected sample.

4.2.2 Temperature sensors

Audit against mercury-in-glass thermometers. An alternative thermometer may be used if the thermometer is, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application (EPA Method 5, Section 10.5).

The user can also audit the temperature sensors following the procedure outlined in *Section 4.1.2 Initial end user audits* on page 45 of this manual.

4.3 Post-Test Maintenance

4.3.1 Purging

At the conclusion of a test series, it is highly recommended to “purge” the console plumbing by drawing in clean, ambient air for 10 minutes or greater. This process will extend the life of the internal tubing, fittings and dry gas meter. The purge can be conducted by turning the sample pump (internal or external for certain options) on and opening the valves to draw air through the inlet of the sample port on the front of the console when it is not connected to other equipment or a sample train.

4.3.2 Cleaning

Maintaining the cleanliness of the console will also extend the life of its components. The outside of the case and console can be cleaned with a non-abrasive, weak degreaser or soapy water. Ensure that exposed electrical components are not sprayed during this process.



Never clean the console while it is connected to power or powered on.

4.3.3 Inspections



Periodically inspect components of the console to ensure everything is in working order and nothing is exhibiting a sign of future issues. Check for things such as exposed or frayed wires, melted or damaged electrical components, discolored or cloudy tubing, and any sign of oil or moisture. The console can be safely vacuumed out while disconnected from power in a dry location. Vacuuming the internals of the console will remove any dust or particulate buildup that could cause issues in the long term. Any signs of damage to the internal or external components of the console should be replaced immediately.

4.4 Semi-Annual Maintenance

All components of the console should be audited and evaluated on a semi-annual schedule (once a quarter or every six months). This comprehensive procedure should include audits of the dry gas meter thermocouples and electrical components. Post-test calibrations and audits satisfy this suggestion.

4.5 Annual Maintenance

Apex Instruments highly recommends that the console be returned to Apex Instruments on an annual basis. The Technical Services Group will perform an evaluation of all components of the system including functionality and build-integrity checks. All sensors and the dry gas meter can also be calibrated at this time.

4.6 Manufacturer Support for the Product

4.6.1 Technical services

Our knowledgeable service staff includes skilled industry professionals, stack testers and technicians ready to help with specific service needs. From basic troubleshooting to full equipment overhauls and repairs, our technical service team can help.

Phone: (919) 346-5754, Toll Free (877) 726-3919

Email: support@apexinst.com

4.6.2 Calibration services

Apex Instruments offers dedicated, climate-controlled precision calibration services for a variety of measuring instruments to help keep all equipment up to date and within US EPA calibration requirements. Calibration services are available for consoles, reference meters, critical orifice, orifice sets, pitot tubes (geometric and wind tunnel) and thermocouple simulators.

Please contact the service department or a sales representative for more details on our calibration services. Certification of calibration available upon request. The part number for the annual calibration is as follows:

DGMC-5A-HFM

4.6.3 Obtaining documentation and information

Internet

Detailed product information, firmware and/or software, stack sampling guides and EPA regulation references are available on our website: <https://www.apexinst.com>

Support and service

Any requests for field data sheets, calibration spreadsheets, diagrams or component supporting documentation, please reach out to our Technical Services Group for assistance.

5.0 Troubleshooting

5.1 LCD Screen

5.1.1 No power to LCD screen



1. Connector in the bottom-right corner of the board is not secure
Resolution - Ensure that all wires are firmly clamped inside of the connector and that the connector is plugged into the board
2. Console main power switch is not turned on
Resolution - Turn on the main power switch
3. Console is not plugged in to a working power outlet
Resolution - Find an appropriate power source with the correct voltage output and plug the power cord in to the outlet
4. Main circuit breaker on the front of the console is extended out showing red shank
Resolution - Push in the main circuit breaker. If this is happening repeatedly, turn the console off immediately, disconnect power and remove from service until the console is inspected and repaired.

5.1.2 Screen contrast too dim or bright, cannot read characters on screen

1. Console is not plugged into a working power outlet of the correct voltage
Resolution - Find an appropriate power source with the correct voltage output and plug the power cord into the outlet
2. Console contrast needs to be adjusted
Resolution - Use the screw-through access hold on the front of the faceplate just under the LCD screen. Using a Phillips head screwdriver, making small turns counter-clockwise to decrease contrast or clockwise to increase contrast.

5.2 Pressures

5.2.1 Vacuum transducer non-zero



1. Vacuum transducer reads a non-zero value with no flow going through the system
 - Resolution - Recalibrate the vacuum sensor using a NIST-traceable reference vacuum gauge
 - Resolution - Check the tubing connections between the inlet to the console and the vacuum gauge
 - Resolution - Replace Main board

5.2.2 ΔH reading is changing quickly and is difficult to read

1. ΔH reading is too sporadic
 - Resolution - Adjust ΔH damping settings in the console menu. If the value is jumping large amounts, increase the damping band. If the value jumping small amounts, increase the damping block size.

5.2.3 Pump motor running abnormally

1. Console is not plugged into a working outlet of the correct voltage
 - Resolution - Ensure the console is powered off and then plug into a working outlet of the correct voltage

5.2.4 DGM volume not increasing

1. Console is not being operated upright
 - Resolution - Reposition the console to be standing upright



2. Console has a leak
 - Resolution - Check all fittings and tubing inside of the console for a leak, repair if necessary
3. Console scaling factor is not correct or is set at 0.0000 or 1.0000
 - Resolution - Find the scaling factor on the most recent full calibration and input this value into the settings through the console menu option

5.3 Temperatures

5.3.1 TC displayed values are changing too quickly to read

1. TC values are too sporadic
Resolution - Adjust TC damping settings in the console menu. If the value is jumping large amounts, increase the damping band. If the value is jumping small amounts, increase the damping block size.

5.3.2 TCs reading inaccurately (or not reading at all)

1. TC channels reading inaccurately
Resolution - Adjust TC offset in the console menu using calibrated temperature simulator



2. TC channels not reading
Resolution - Ensure all TC wires are connected at the rear of the TC jacks inside of the console
Resolution - Ensure all TC wires are in good condition and are in their plugs on the umbilical and other sampling equipment

5.3.3 Probe, oven or AUX not heating or receiving power

1. Temperature controller or power switch for appropriate equipment is not turned on
Resolution - Turn on the switch for the appropriate temperature controller
2. Power output is not connected or secure on the console and the umbilical power adapter
Resolution - Make sure the power output is connected securely on the console faceplate and the umbilical cable
3. Temperature controller is not setup properly
Resolution - Verify that the Fuji controller settings are correct and adjusted to the correct set point

5.4 Additional Common Console Problems



Issue	Resolution
Maximum vacuum or flow rate decreases	<ul style="list-style-type: none"> - Filters are dirty and need to be replaced - Obstruction in sample flow path - Blockage or kinks in plumbing - Leak in console plumbing or sample train
Pump motor fails to start or hums	<ul style="list-style-type: none"> - Check for correct current (5 to 6 Amperes) - Check to see if fuse is blown - Unit has frozen due to ambient temperature, move pump to a warmer environment to “heat” it up and then return to the sampling location - Unit has overheated - Console is connected to incorrect voltage power source (240V console powered by 120V power source, for example)
Probe doesn’t heat or heats slowly	<ul style="list-style-type: none"> - Verify that the correct thermocouple is plugged in - Verify that the Fuji controller settings are correct and adjusted to the correct set point - Auto-tune the temperature controller - Check all connections for probe power (output on console end, output on oven end, power plug from probe to oven, and TCs)
Oven doesn’t heat or heats slowly	<ul style="list-style-type: none"> - Verify that the correct thermocouple is plugged in - Verify that the Fuji temperature controller settings are correct and adjusted to the correct set point - Check all connections for the oven power (output on console end, output on sample case end, and TCs)
User display doesn’t power on	<ul style="list-style-type: none"> - Check connections on the board for proper power input - Ensure console is being used in operational range of -13 to 158 °F (-25 to 70 °C)
Console doesn’t power on	<ul style="list-style-type: none"> - Check the position of the circuit breaker switch, if pop-out switch is popped out and red is showing, push it back in - Check to make sure the console is plugged in to a working power source

6.0 Diagrams and Schematics

6.1 Electrical Diagram (XD-502, 120V Shown)

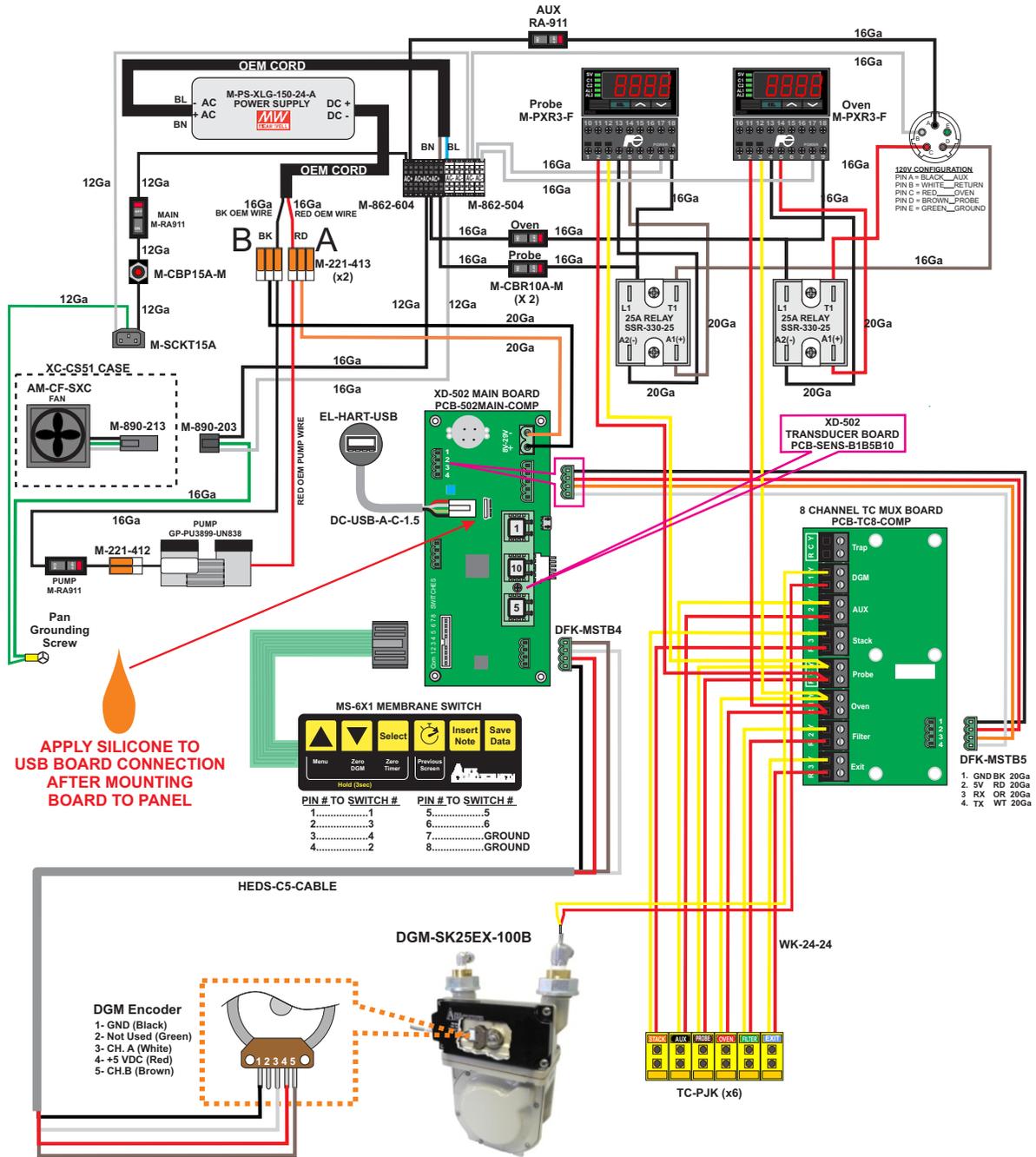


Fig. 9 Electrical Diagram

6.2 Plumbing Diagram (XD-502, 120V Shown)

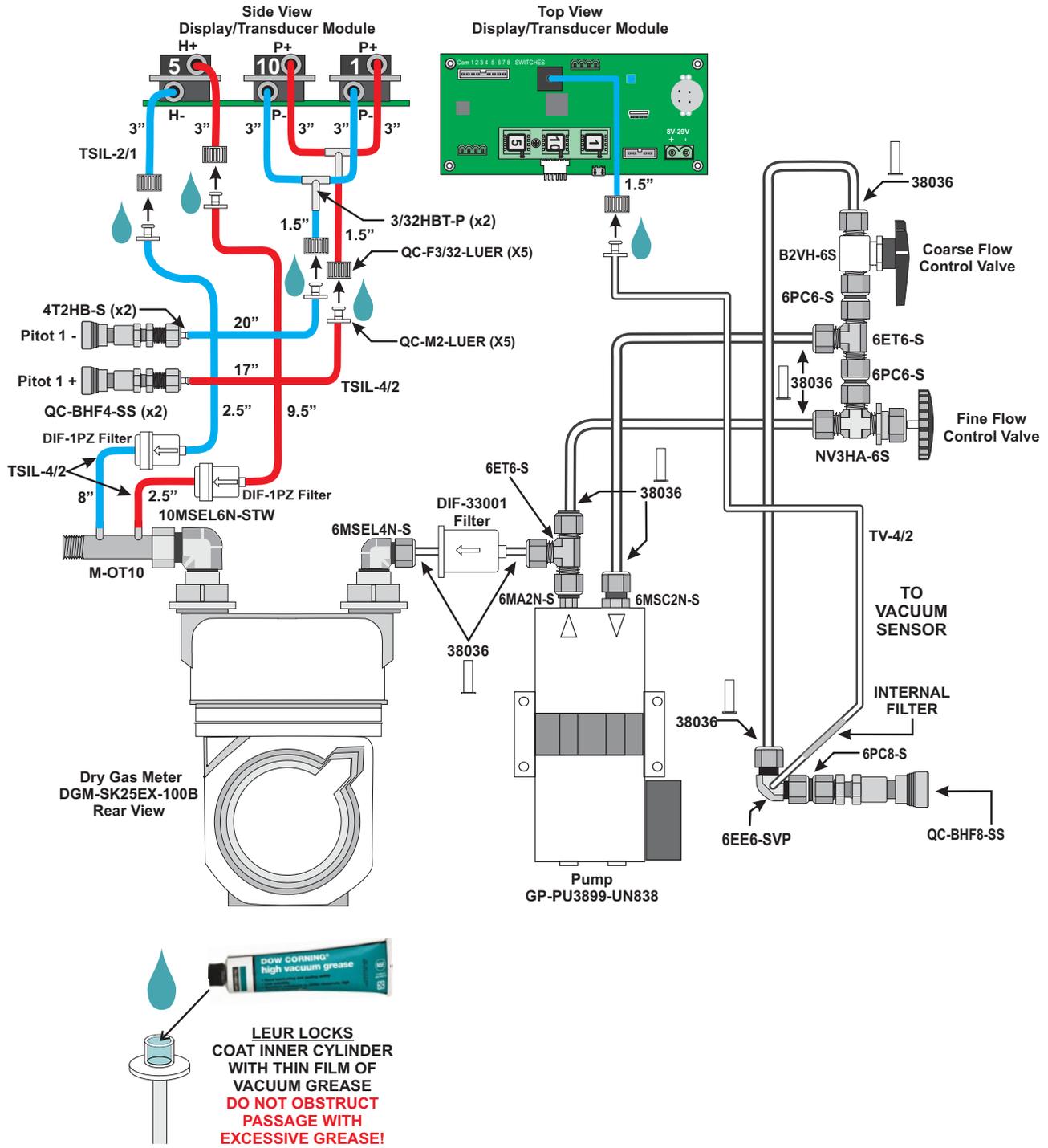


Fig. 10 Plumbing Diagram

6.3 Parts List - Front Panel (XD-502, 120V Shown)

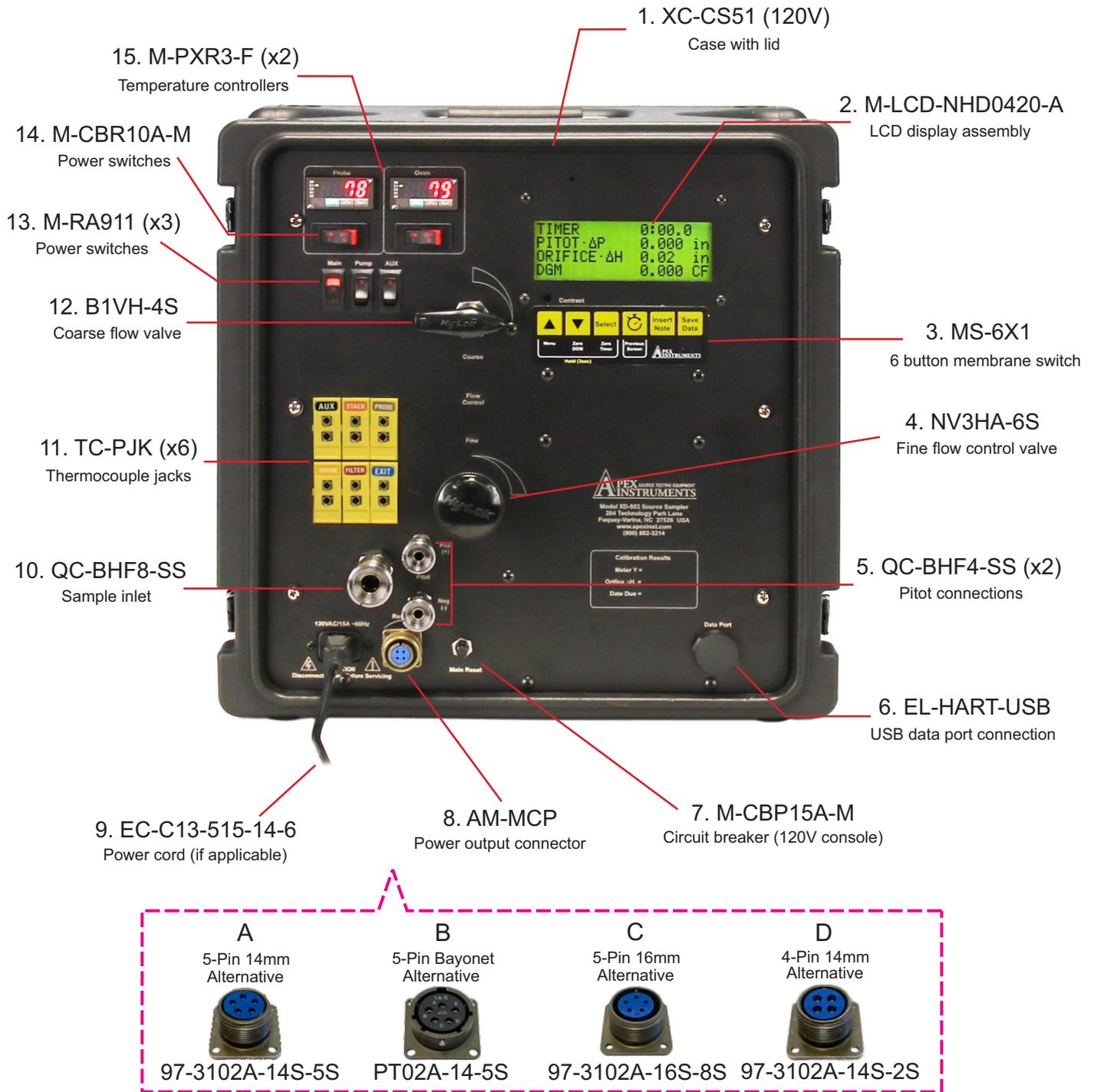


Fig. 11 Parts List - Front Panel: *Standard version shown, depiction of options may differ*

6.4 Parts List - Interior (XC-53B-MV 240V Shown)

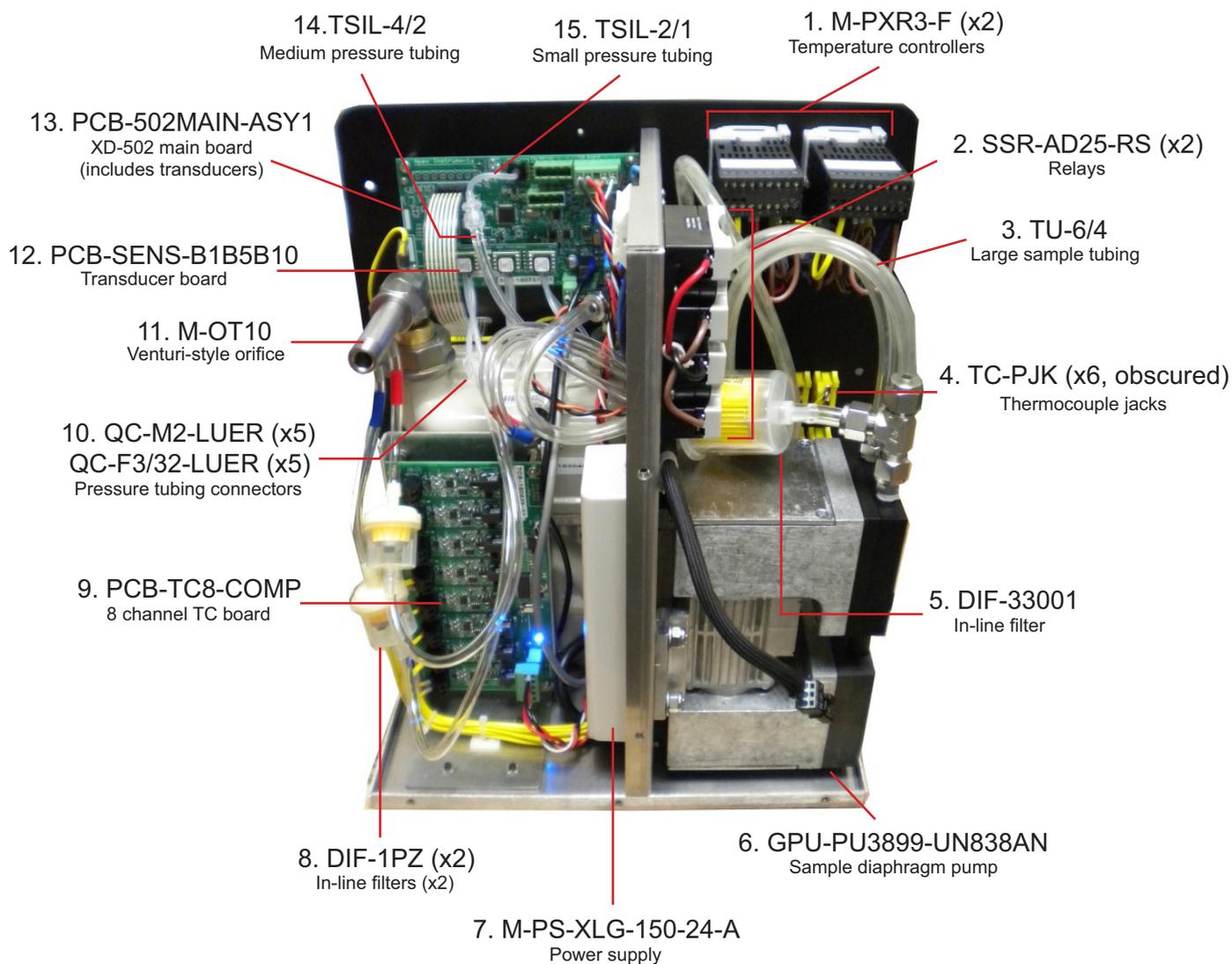


Fig. 12 Parts List - Interior: *Standard version shown, depiction of options may differ*

7.0 References and Related Documentation

7.1 References

7.1.1 EPA and CFR

EPA EMC Promulgated Test Methods

Method 1

Method 2

Method 3

Method 4

Method 5

Method 17

Method 23

Method 26A

Method 29

Method 201A

Method 202

Code of Federal Regulations (CFR) 40 Part 60

7.2 Related Documentation

7.2.1 Apex Instruments documentation

Apex Instruments Isokinetic Sampling Handbook

7.3 Equations and Nomenclature

7.3.1 Equations

$$\bullet B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

$$\bullet V_{m(std)} = \frac{K_1 V_m \left[P_{bar} + \left(\frac{\Delta H}{13.6} \right) \right]}{T_m}$$

$$\bullet I = \frac{100 T_s \left[K_4 V_{1c} + \frac{(V_m Y)}{T_m} \left(P_{bar} + \frac{\Delta H}{13.6} \right) \right]}{60 \theta v_s P_s A_n}$$

$$\bullet Y = \frac{V_{cr(std)}}{V_{m(std)}}$$

$$\bullet I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std} v_s \theta A_n P_s 60 (1 - B_{ws})}$$

$$\bullet V_{w(std)} = V_{1c} \frac{\rho_w R T_{std}}{M_w P_{std}}$$

$$= K_5 \frac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$$

$$= K_2 V_{1c}$$

$$\bullet K' = \frac{K_1 V_m Y \left(P_{bar} + \frac{\Delta H}{13.6} \right) T_{amb}^{1/2}}{P_{bar} T_m \theta}$$

$$\bullet Y_c = \frac{10 \left[\frac{0.0319 T_m}{P_{bar}} \right]^{1/2}}{V_m}$$

$$\bullet Q = K_1 \frac{P_{bar} V_w}{(T_w + T_{std}) \theta}$$

$$\bullet Y_{ds} = \frac{V_w (T_{ds} + T_{std}) P_{bar}}{V_{ds} (T_w + T_{std}) \left(P_{bar} + \frac{\Delta p}{13.6} \right)}$$

$$\bullet V_{cr(std)} = K' \frac{P_{bar} \theta}{\sqrt{T_{amb}}}$$

$$\bullet Y_{qa} = \frac{\theta}{V_m} \sqrt{\frac{0.0319 T_m}{\Delta H_{@} \left(P_{bar} + \frac{\Delta H_{avg}}{13.6} \right)} \left(\frac{29}{M_d} \right) (\sqrt{\Delta H})_{avg}}$$

$$\bullet V_{m(std)} = V_m Y \frac{T_{std} \left(P_{bar} + \frac{\Delta H}{13.6} \right)}{T_m P_{std}}$$

$$\bullet \Delta H_{@} = 0.0319 \Delta H \frac{T_m \theta^2}{(P_{bar} Y^2 V_m^2)}$$

$$= K_1 V_m Y \frac{P_{bar} + \left(\frac{\Delta H}{13.6} \right)}{T_m}$$

7.3.2 Nomenclature

acf	= actual cubic feet	P_{std}	= standard absolute pressure (29.92 in Hg)
acfm	= actual cubic feet per minute	P_s	= absolute pressure in flue in inches (millimeters) mercury
A	= effective area of flue in square feet	P_r	= static pressure in flue in inches water, average
acm	= actual cubic meters	$\sqrt{\Delta P}$	= square root of velocity head in inches water, average
acmm	= actual cubic meters minute	%S	= percent sulfur by weight, dry basis
A_n	= inside area of sampling nozzle in square feet	scf	= standard cubic feet
B_{ws}	= water vapor in gas stream, proportion by volume	scm	= standard cubic meters
%C	= percent carbon by weight, dry basis	T_{std}	= absolute temperature of air in degrees Rankine at standard conditions (528 degrees)
%CO	= percent carbon monoxide by volume, dry basis	T_s	= absolute temperature of flue gas in degrees Rankine, average
%CO ₂	= percent carbon dioxide by volume, dry basis	T_m	= absolute temperature at meter in degrees Rankine, average
C_p	= pitot tube coefficient	V_s	= velocity of flue gas in feet (meters) per second
D_l	= dust loading per heat input in pounds (grams) per million Btu (calories) per Fr constant	V_l	= volume of condensate through the impingers in millimeters
D_l^3	= dust loading per heat input in pounds (grams) per million Btu (calories) per Fr calculated	V_{lc}	= volume of liquid collected in condenser in millimeters plus weight of liquid absorbed in silica gel in grams indicated as milliliters
dscf	= dry standard cubic feet	V_m	= volume of metered gas corrected to dry standard conditions in cubic feet (meters)
dscfh	= dry standard cubic feet per hour	V_{ms}	= volume of metered gas measured at meter conditions in cubic feet
dscm	= dry standard cubic meters	V_o	= volume of flue gas at actual conditions in cubic feet (meters) per minute
dscmh	= dry standard cubic meters per hour	Q_{sd}	= volume of flue gas corrected to dry standard conditions in cubic feet (meters) per hour
fps	= feet per second	V_t	= total volume of flue gas sampled at actual conditions in cubic feet (meters)
F_r	= ratio factor of dry flue gas volume to heat value of combusted fuel in dry standard cubic feet (meters) per million Btu (calories)	V_w	= volume of water vapor in metered gas corrected to standard conditions in cubic feet (meters)
gms	= grams	V_{wc}	= volume of water condensed in impingers corrected to standard conditions
gm-mole	= gram-mole	V_{wsg}	= volume of water collected in silica gel corrected to standard conditions
grs	= grains	W_a	= total weight of dust collected per unit volume in grains (grams) per actual cubic feet (meters)
ΔH	= orifice pressure drop in inches water, average	W_d	= total weight of dust collected per unit volume in pounds (grams) per dry standard cubic feet (meters)
%H	= percent hydrogen by weight, dry basis	W_g	= total weight of dust collected in grams
H_c	= heat of combustion in Btu per pound, dry basis	W_h	= total weight of dust collected per unit volume in pounds (grams) per hour, dry basis
hr	= hour	W_p	= total weight of dust collected in pounds
%I	= percent isokinetic	W_s	= total weight of dust collected per unit volume in grains (grams) per dry standard cubic feet (meters)
in. Hg	= inches mercury	W_{sg}	= impinger silica gel weight gain in grams
lbs	= pounds	Y	= metered gas volume correction factor
lbs-mole	= pound-mole	θ	= total elapsed sampling time in minutes
%M	= percent moisture by volume		
mmBtu	= million Btu		
mmcal	= million calories		
mm Hg	= millimeters mercury		
mps	= meters per second		
M_s	= molecular weight in pound (gram) per pound (gram) mole (wet basis)		
%N	= percent nitrogen by weight, dry basis		
%N ₂	= percent nitrogen by difference, dry basis		
%O	= percent oxygen by difference, dry basis		
%O ₂	= percent oxygen by volume, dry basis		
P_b	= barometric pressure in inches mercury		

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