APEX INSTRUMENTS

XD-502G2

Operator's Manual

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Follow all relevant instructions to avoid fire, explosions, electric shocks or other hazards that may result in damage to property and/or severe or fatal injuries.

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Apex Instruments, Inc. warrants products to be free from defects in materials and workmanship for a period of one year from date of delivery. During the warranty period, we will repair or replace, at our option, any component that fails due to a defect in materials or workmanship under normal use excluding installation. Items not manufactured by Apex Instruments are subject to original manufacturer's warranty. All returns must be shipped freight prepaid at the purchaser's expense.

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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, 23, 26A, 29, 201A and 202.

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

Method 26A - Determination of Hydrogen Halide and Halogen Emissions from Stationary Sources

Method 29 - Determination of Metals Emissions from Stationary Sources

Method 201A - Determination of Pm10 and PM2.5 Emissions from Stationary Sources

Method 202 - Dry Impinger Method for Determining Condensable Particulate Emissions 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

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

WARNING

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

CAUTION

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

NOTICE

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

1.3.3 Electrical shock

CAUTION

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 22 of this manual.

1.4.4 Calibration checks

The unit is sold with a factory dry gas meter calibration at flow rates appropriate for the unit. Apex Instruments suggests performing calibration checks of the dry gas meter and other sensors 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 checks as explained in *Section 4.1 Pre-Test Calibrations* on page 43 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: 39 lbs (17.7 kg)

1.5.2 Lifting and handling

⚠ CAUTION

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 transflective 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 PM2.5 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 for consoles such as the XD-502, which 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.

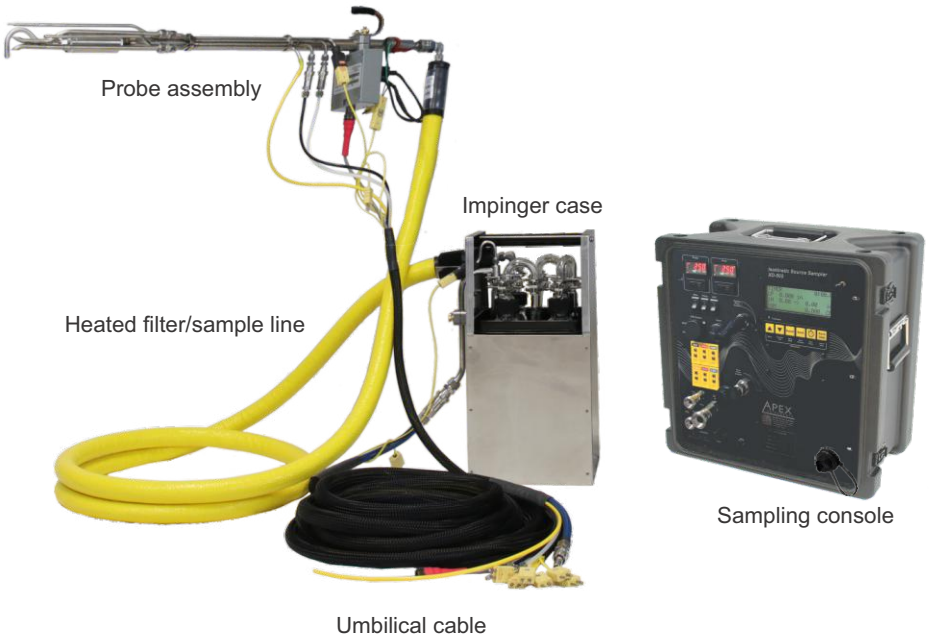


Fig. 1 Example Sampling System - *Ancillary components of the sampling system are sold separately.*

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

Buzzer
Controllable buzzer to alert operator to selective events during operation of the console.

Keypad
Display controlled by six button, long-life membrane keypad for display operation, tactile feedback keys control the timer and menu operations, quick access to console information, 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 jacks for input

Digital Pressure Transducers (Two)
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 0-30” Hg (0 to -100, kPa, 760mm Hg)

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, FILTER, EXIT

Processor
Apex Instruments PEAK32 Microcontroller Module

Firmware
Scaling factor gamma correction, input and target ΔH via K-Factor, pressure sensor damping, temperature sensor offset, user-selectable unit types (Metric, Metric Pa, Imperial)

Connectivity
USB Type B communication, wireless access point, local network, Windows 7 or higher

USB Output
USB data output port for exporting data directly to a USB drive. USB mini port for firmware updates via USB cable.

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), 39 lbs (17.7 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 53 and 54 of this manual.

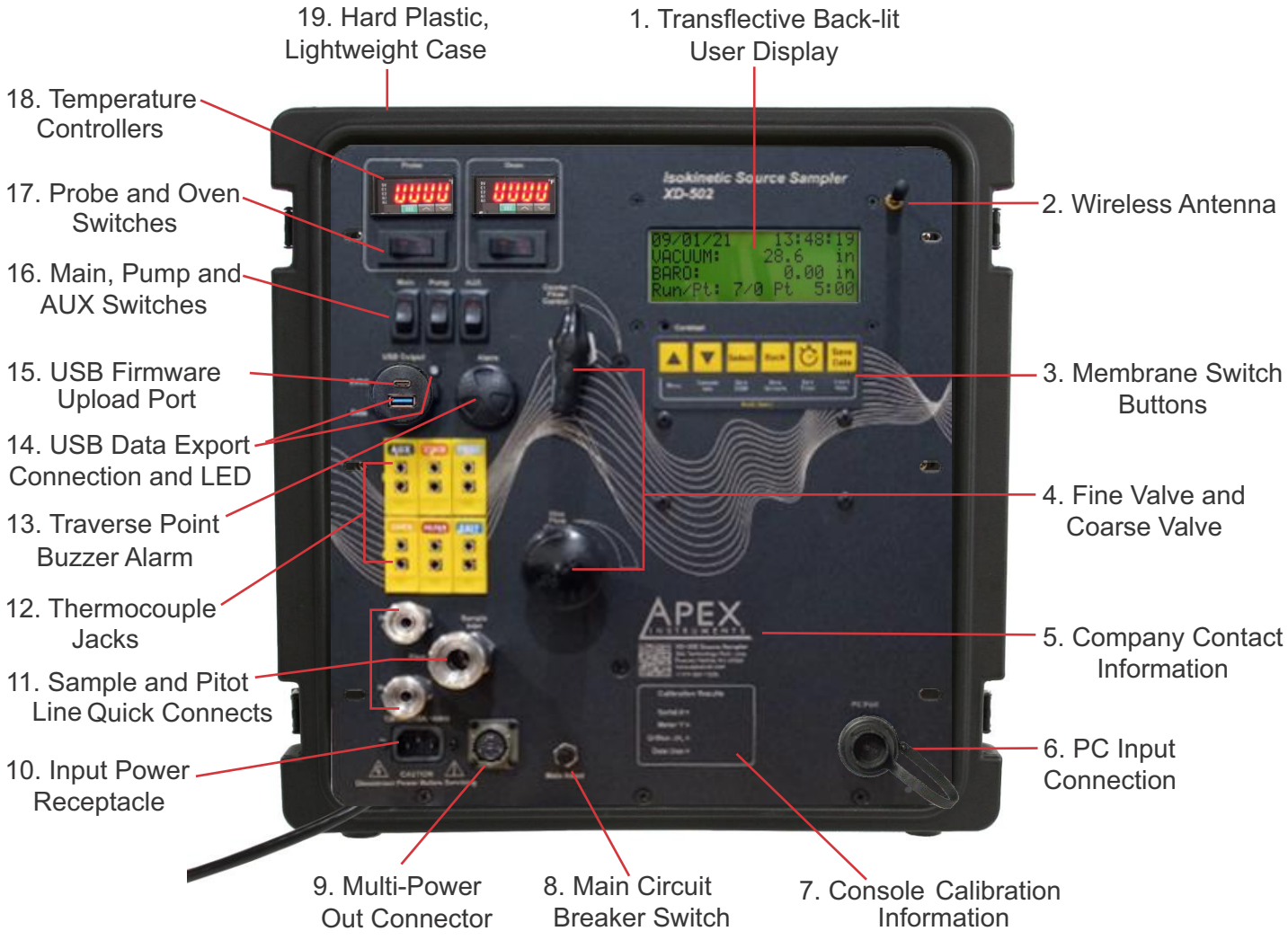


Fig. 2 Front Panel Overview - *Standard version shown, depiction of options may differ*

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.
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.
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. Target ΔH is calculated using the K-Factor and current ΔP reading.
DGM: The totalized DGM volume. This value can be reset by holding the Select button for 3 seconds.

Fig. 3 User Interface (Home Screen Shown)

Primary Screen 1

Primary Screen 2

3.1.2 Membrane switch pad buttons

▲	- Press once to go to Primary Screen 1, then again Primary Screen 2 and once more back to Home. - Press and hold for 3 seconds to enter the console's Menu (only available while on a Primary or Home) - Press once to move up or down through the Menu options (only available while in the Menu) - Press to change values, view and select options (only available while in Menu)
▼	- Press once to go to Primary Screen 2, then again Primary Screen 1 and once more back to Home.. - Press and hold for 3 seconds to enter the console's Menu (only available while on a Primary or Home) - Press once to move up or down through the Menu options (only available while in the Menu) - Press to change values, view and select options (only available while in Menu)
Select	- Press once to select and enter a Menu option (only available while in the Menu) - Press and hold for 3 seconds to zero the DGM volume (only available on the Home screen)
Back	- Press once to return to the previous screen (only available while in the Menu) - Press and hold for 3 seconds to zero all pressure transducers (only available on the Home screen)
⏱	- Press once to start or stop the console's timer (only available on the main screen) - Press and hold for 3 seconds to zero the console's timer (only available on the Home screen)
Save Data	- Press once to instantaneously save a data point to the console's storage - Press and hold for 3 seconds 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

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 Menu button (Up Arrow) for 3 seconds.

NOTICE

The menu will not scroll past the "View Wifi Info" if there is time on the Timer. Zero the Timer in order to access other Menu items.

Change K-Factor (-): Allows the user to change the K-Factor. This value is used in tandem with the ΔP reading to calculate the Target ΔH. K-Factor should be calculated before each sample run or if source conditions drastically change.

USB Drive Export (-): Use this menu to export sample run data. Insert a formatted USB drive with enough storage room available into the port labeled ***USB Output*** on the front of the console. The LED beside the Flash Drive port will flash red then turn green when a USB drive is inserted indicating it is ready to export. Choose the Run to export using the Up and Down arrows. Then press the Select button to export the run to the USB drive. While the console is writing to the flash drive, the LED will flash; it will return to stable green once the export is completed.

Damping [ΔP ΔH] (-): Damping allows the user to define the number of values in the rolling average for the ΔH readings.

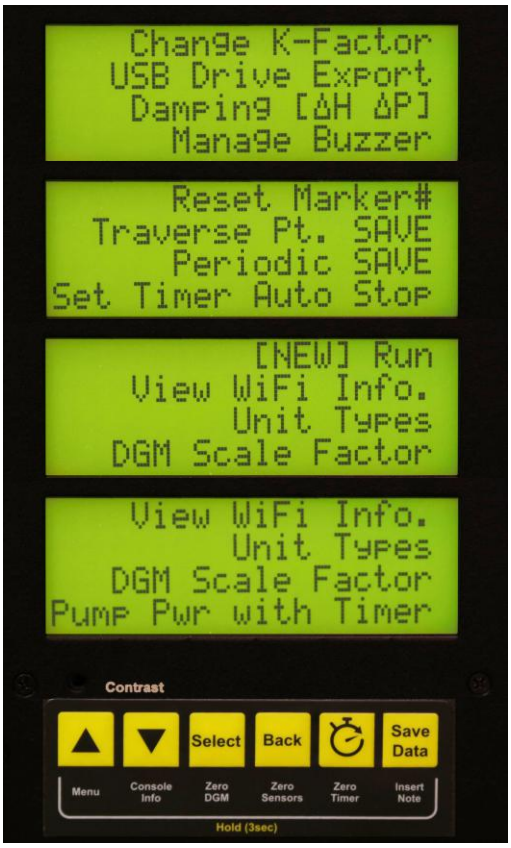


Fig. 4 Menu Overview - Exaggerated to show all menu options

ΔP and ΔH Damping Band allows the user to define a range of readings, +/- X%, which will be included in the rolling average or to initiate ("trigger") a new rolling average to begin.

"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. Damping band is a tolerance based on the full scale of the measuring transducer. The ΔH transducer used in the XD-502 sampling console has a range of 5" H_2O and the ΔP transducer has a range of 1" and 10" H_2O. To ensure the data stream displayed is smooth, the damping band should be configured to restart after an outlier is measured.

For example, ΔH values could be averaging out at 1.00" H_2O. If the damping band is set to 10% (of full scale), any reading outside of 0.95 to 1.05" H_2O would start a new average. ΔH has a Trigger Delay employed which allows the user to define a number of consecutive readings outside of the ΔH band but do not trigger the rolling average reset.

View WiFi Info. (-): Provides information regarding the wireless mode, SSID, password and IP address for connection. Settings must be configured inside of the Setup page of the software.

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

3.1 User Control Overview cont.

3.1.3 Menu overview cont.

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. Each Traverse Point saved is the average of total data accumulated between each Traverse Point.

Periodic SAVE: Saves a “snap shot” of a data point to memory between the traverse points during a sample run. These data points provide the user with more tracking data to better understand the traverse point data.

Set Timer Auto Stop: Allows the user to configure the timer to automatically stop at a set number of traverse points. Once the sample run reaches the total traverse time (e.g. 60:00 for a 5:00 time per point for 12 points), the timer will stop.

Pump Pwr with Timer: Allows the user to link the pump operation with the timer operation. If enabled, the pump will turn on and off with the timer. Otherwise it is a manual operation.

NOTICE

If the ‘Pump Pwr with Timer’ function is not enabled, the user will need to manually turn off the pump or close the coarse valve at the end of the run, even though the timer will automatically stop.

[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.

Manage Buzzer (-): Allows the user to toggle the console’s buzzer on or off. When on, the buzzer will sound for a user-configured amount of time before a traverse point change.

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

Imperial: Vol. – ft^3, Press. – Inches H_2O, Temp. – °F
Metric: Vol. – m^3, Press. – mm H_2O, Temp. – °C
Metric Pa: Vol. – m^3, Press. – Pascal, Temp. – °C

3.2 Pre-Field Test Operations

3.2.1 Console configuration

Ensure that the following console settings are configured before performing a field test: unit types, ΔH, K-Factor and ΔP damping, 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

NOTICE

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 Back 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 outlined 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 27 of this manual for instructions on how to operate the temperature controllers.

3.2 Pre-Field Test Operations cont.

3.2.5 Console leak check procedure (front side):

NOTICE

DO NOT EXCEED THE TRANSDUCER PRESSURE RATING OF 100 INCHES OF H_2O. 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 (counter-clockwise).

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.

Fig. 5 Front-Side Leak Check

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 Back 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 the run by holding the Select, or Zero DGM button, on the membrane switch pad for 3 seconds.

3.2 Pre-Field Test Operations cont.

3.2.6 Sample train leak check procedure

Navigate to the Leak Test function by pressing and holding the Insert Note button for 3 seconds and selecting Leak Test. The leak test may be performed 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 (counter-clockwise 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 overshot, 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 can be pressed and held for 3 seconds.

Fig. 6 System Leak Check

6. Press the Back 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 Select, or Zero DGM button, on the membrane switch pad for 3 seconds.

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

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 Timer, or Zero Timer, button for 3 seconds.
   - Zero the ΔH and ΔP pressure sensors by pressing and holding the Back, or Zero Sensors, button; 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. Setup the test by entering:
   - Traverse point time
   - Number of traverse points
   - Periodic save time

6. 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 Select, or Zero DGM, button on the membrane switch pad for 3 seconds.

7. 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.

8. Adjust the sample flow as closely to the target ΔH as possible. Maintain this flow rate for the duration of the first traverse point.

9. 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).

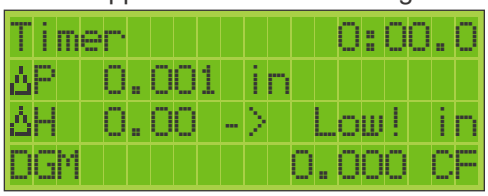
3.3 Field Test Operations cont.

3.3.1 Performing a Method 5 sampling test cont.

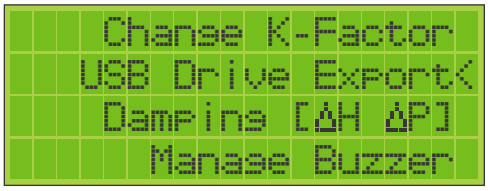
9. At the conclusion of each run, close the coarse valve and record the final readings (clock time and final DGM volume).
   - Now the pump can be turned off and the probe can be removed from the stack.
   - Once the probe has cooled down, conduct a leak check as described in *Section 3.2.6 Sample train leak check procedure on* page 23 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 flash drive
   - From the Main screen hold down the UP arrow key for about 3 seconds until the sub menu screen appears. Scroll down using the down arrow key until reaching the USB Drive Export option



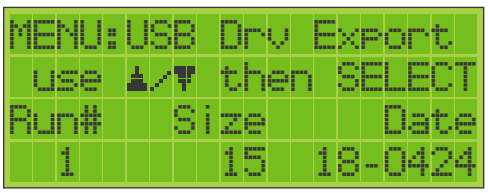
Press and hold for about 3 seconds



Press to scroll down to USB Drive Export

   - Insert a FAT32 formatted USB drive, with ample storage space, into the Data port on the USB Output port on the upper left front panel of the console.
   - Use a quality, brand name USB drive.
   - If unsure of the USB drive integrity, perform a Windows USB flash drive test.
   - The LED beside the Flash Drive port will flash red then turn solid green when USB drive is inserted.

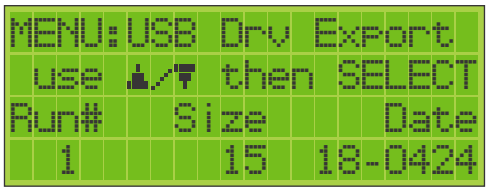
Press Select button
   - The USB drive export screen will display. Use the arrow key to scroll up/down to desired run to export.



Press Select to go to "USB Drv Export" screen

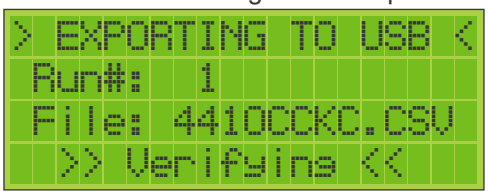
Press up/down to select desired run to export

- Press the Select key to begin data export.
- While the console is writing to the flash drive the LED will flash green and return to solid green.



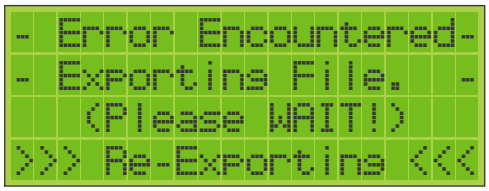
Select **Press Select to begin USB Drive Export**

- The screen will change to the export data to USB screen, assign a .csv file name while verifying the data.



Active Data Export to USB Data Screen

- After the data has exported the Export screen will display in which another run can be selected or the operator can exit out to the Sub Menu screen or Main screen by pressing the Back key. It is safe to remove the USB.



NOTICE

- If there is an error detected during the export procedure the system will display “Re-Exporting”. It will verify the exported data and return to the Sub Menu screen when done. The Re-Exporting procedure may repeat until verified data has been exported to the USB. The initial file name will be changed automatically.

12. Export the data to a PC (optional)
    - An alternative to exporting the data using the flash drive method is to use the dedicated software to export sample run data following each run.
    - Open the Storage tab and select the current run and press the Export Run button
    - Make any additional notes in the Notes 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

13. 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 ^ v 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.

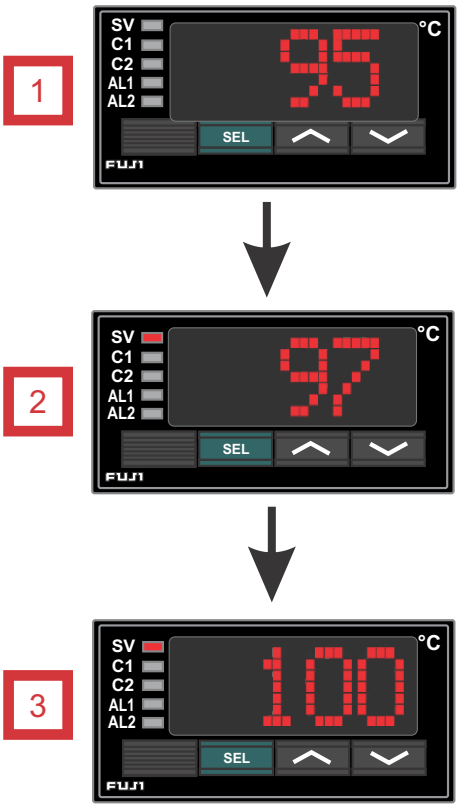


Fig. 7 Temperature Controller Configuration

3.6 Operation using software

3.6.1 Software control introduction

With the XD-502, most 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 providing extra versatility are only accessible through software control- ie. specific settings and calibrations.

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-502G2 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) 346-5754.

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-Type B cable, connect the USB-A end to the USB port on the PC and the USB-Type B end to the USB PC Port connection on bottom-right of the console's faceplate. Click the USB button, the LCD screen may flicker a few times as the connection is initialized; this is normal.

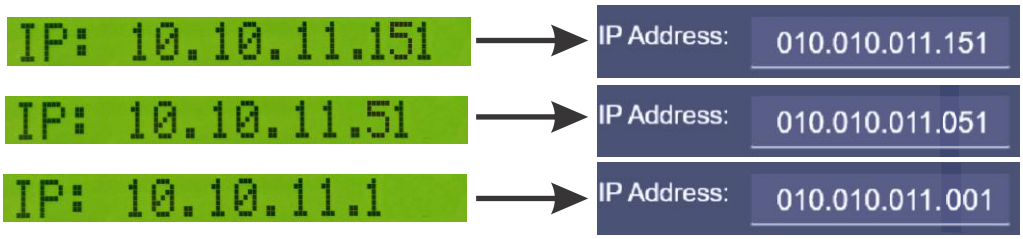
If the console does not recognize the connection, ensure that the PC has no pending Windows or driver updates. If the console still does not recognize the connection, contact our support team by email at support@apexinst.com or by phone at (919) 346-5754.

Now that the console has been connected via USB, the wireless settings can be set up in the field next to ***IP Address*** by entering the IP Address of the console. ***Reset the Timer to Zero (0) to access the IP Address.*** After resetting the Timer, hold down the "Menu Button" for 3 seconds. Use the down arrow button to scroll down through the menu items until reaching "View WiFi Info." line. Press "Select" button. The console IP Address will be displayed. See the Important NOTICE on the following page.

3.6 Operation using software cont.

NOTICE

The software requires 0 (zero) to be added in front of each 2 digit number or two 0's (zeroes) in the case of a single digit. Add the 0 (zero) to the IP Address as shown in the examples below.



Press the "Wifi" button to connect to the console.
The console can now be used without the USB cable to monitor and control the console remotely.

3.6.4 Main screen overview

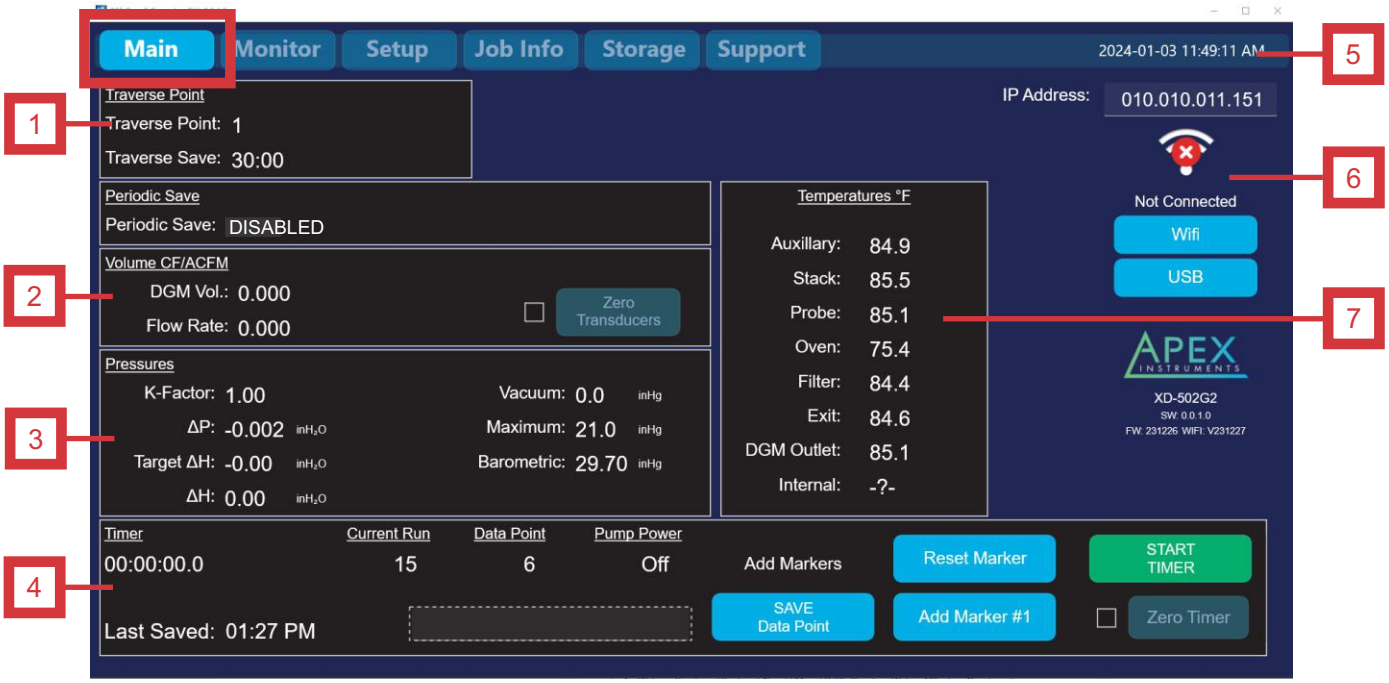


Fig. 9 Main Screen Overview

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. Traverse/Data Point section
2. Volume section
3. Pressures section
4. Data Point and Insert Note section
5. Console Time section
6. USB/WiFi Connection section
7. Temperatures section

3.6 Operation using software cont.

3.6.5 Navigation/Connection section overview

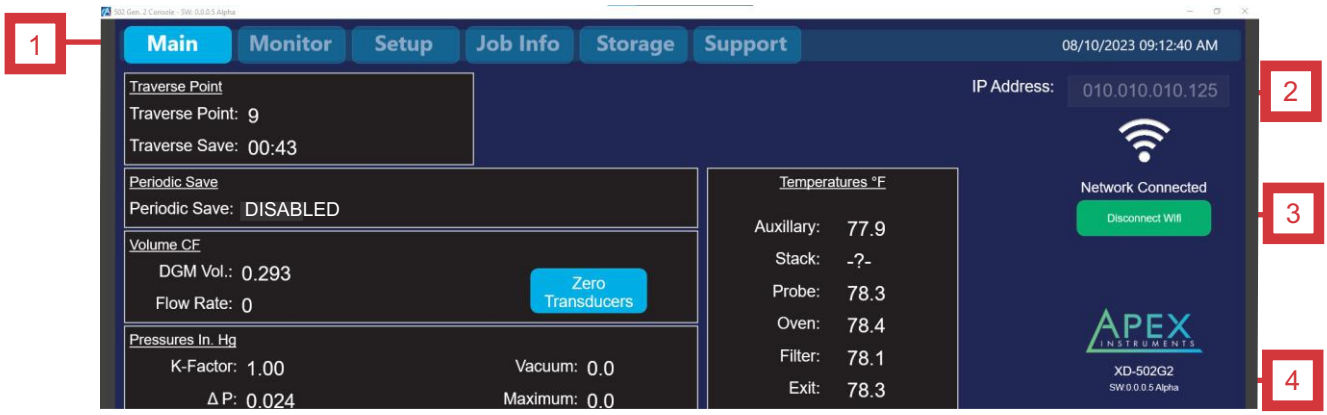


Fig. 10 Software Navigation

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. **Navigation tabs**
   Main
   - Console connection options, traverse point and timer data, sensor data

   Monitor
   - Pictorial Diagram with Volume, Flow Rate, Temperatures, Vacuum and Pressures

   Job Info
   - View and edit job information that is exported with the run data CSV file

   Storage
   - View and manage console run storage data, including exporting data and starting new runs

   Setup
   - View and manage console settings, including data saving options and other configurations

   Support
   - Access Technical Services Group, Product Manuals, SW/FW Packages and Remote Support via QR code, Phone and Email.

2. **Console USB/WiFi Connection 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
   - *COM and TCP/IP Address* | When connected, displays the current COM port or TCP/IP Address and shows “Network Connected”
   - *Disconnect Button* | When connected, this button breaks the connection

3. **Console Connect buttons**
   - *WiFi* | Connect to the console as an access point or over a local WiFi network. Settings must be configured in the Setup Configurations menu while initially connected via USB. Use the IP Address field to input the console’s broadcasted IP address.
   - *USB* | Connect to the console using a USB cable, which must be connected at this time

4. **Software, Firmware and WiFi version numbers**
   - Displays the current software and firmware version numbers. Ensure these match the latest offerings provided on our website or contact our support team to verify by email at support@apexinst.com or by phone at (919) 346-5754.

3.6 Operation using software cont.

3.6.6 Traverse Point, Data Saving and Volume section overview

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

Traverse Point
- Displays the current traverse point of the sample run (this value is iterative as the traverse save time reaches its set point)

Traverse Save
- Displays the remaining time for the current traverse point of the sample run (this value is set by the user and is equal to the amount of time to sample at each traverse point in the stack)

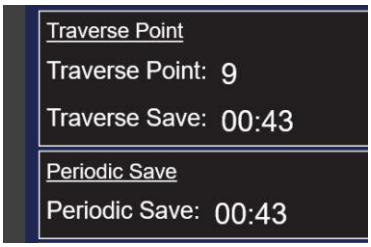


Fig. 11 Traverse Point Section

Periodic Save
- Saves a snap shot the sample data a preselected point in time between the traverse points.

Auto Pause
- Displays the amount of traverse points required for the console to automatically stop the sample timer and, if the setting is enabled, the sample pump.

DGM
- Displays the current volume of the dry gas meter. This value can be zeroed using the button in the Setup tab.

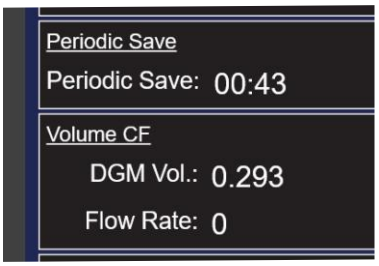


Fig. 12 Data Saving and Volume Section

Flow Rate
- Displays an estimated flow rate for the volume being sampled by the dry gas meter

3.6.7 Temperature section overview

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

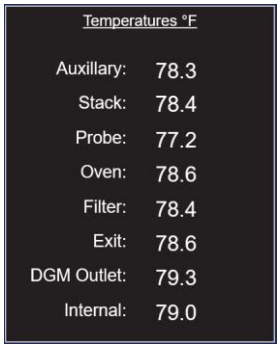


Fig. 13 Temperature Section

3.6 Operation using software cont.

3.6.8 Pressure section overview

The Pressure section of the Main screen displays the set K-Factor, live ΔP and ΔH values, calculated target ΔH, live vacuum value, maximum recorded vacuum value and the barometric pressure reading.

K-Factor
- Displays the current K-Factor set by the user in the Setup tab of the software. The K-Factor is used to calculate the target ΔH for the operator to sample at.

Del_P (ΔP)
- The console features two transducers of different ranges for the ΔP measurement, 1” and 10”. When the measured value is less than 1”, three decimal places are displayed and a (1”) symbol is shown beside of the measurement. When the measured value is above 1”, two decimal places are displayed and a (10”) symbol is shown beside of the measurement.

Del_H (ΔH) and Target (ΔH)
- The K-Factor is used in conjunction with the ΔP value to determine a target ΔH. The user should use the valves on the console to adjust the measured ΔH to match. The target ΔH is dynamic and changes with the ΔP reading.

Vacuum
- This section also displays the current, measured vacuum of the system and maximum vacuum of the current sample run for leak check reference. The user has the ability to toggle on a setting in the Setup tab to record a data point at every instance where a new maximum vacuum value is obtained.

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

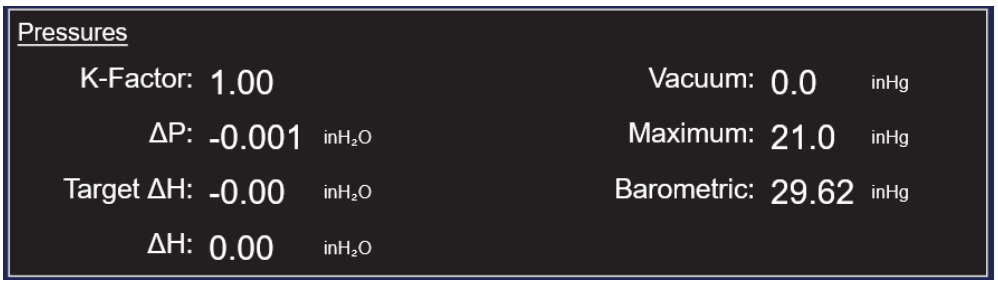


Fig. 14 Pressure Section

3.6 Operation using software cont.

3.6.9 Sample Timer and Data Point section overview

The bottom panel of the Main screen displays the run timer, Start/Stop timer button, pump control setting, current run and data point numbers and note saving functionality.

Run Timer and Start/Stop button
- Displays the sampled time for the current run. This timer can be started using the START Button and paused selecting the PAUSE TIMER Button when the pump is running. The timer can be reset to 0:00.0 by selecting the box and clicking on the Zero Timer Button. (The Zero Timer Button is directly below the START TIMER Button). A warning message will appear. Select “Yes” to continue or “No” to abort. Command Sent message will appear. Select “Ok” to continue.

Current Run and Data Point
- The current run number is displayed. Up to 15 runs, or storage slots, can be utilized on the XD-502. The current data point is also displayed here. The data point is not synonymous with the traverse points. Many actions can increase the data point count, including starting or stopping the run timer, saving a note or starting a leak test, among many others.

Reset Marker#
- This button resets the marker # back to zero

Add Marker#
- This button adds a marker to the data export to signify an important event. Markers can be accompanied by text typed in the optional notes text box. This marker is incremental.

Last Saved data point
- Shows the time of the last optional note data point save

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.

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

SAVE Data Point button
- When clicked, the software saves a data point to the storage at that time

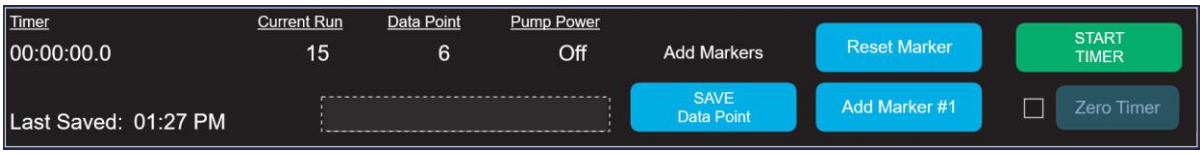


Fig. 15 Sample Timer and Data Point Sections

3.6 Operation using software cont.

3.6.10 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.

General Sampling Test Information fields
- *Client Name*
- *Plant Name*
- *Address*
- *Test Location*
- *Test Date*
- *Run Number*
- *Project Number (two different fields for entry of different sets of project number data)*
- *Notes*
- *Personnel*

Save Notes button
- Stores the information fields for the export datasheet

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

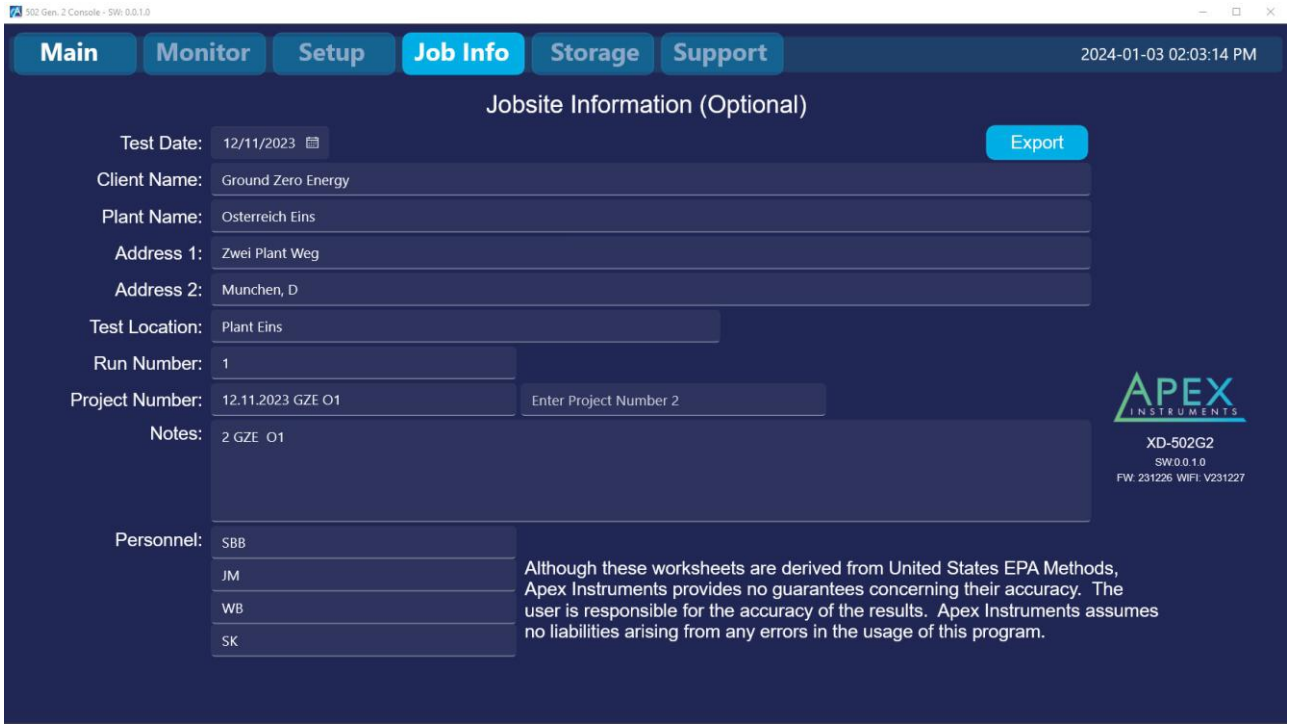


Fig. 16 Job Information Screen Overview

3.6 Operation using software cont.

3.6.11 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
- A Red “<Current>” indicates 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. New Run button
- Check the box next to the line in which you wish to save a new run. Click the “New Run” button. The “Confirm New Run” box will appear. 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. Click “Yes” to proceed.

3. 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

4. New Name window
- 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, which can also be input or reset by using the reset to calendar/time stamp button to the right of the line

5. Export Run window
- When exporting data using the software an external OS Window will pop up. Select the area where you would like to store this information by name and select “Save”.

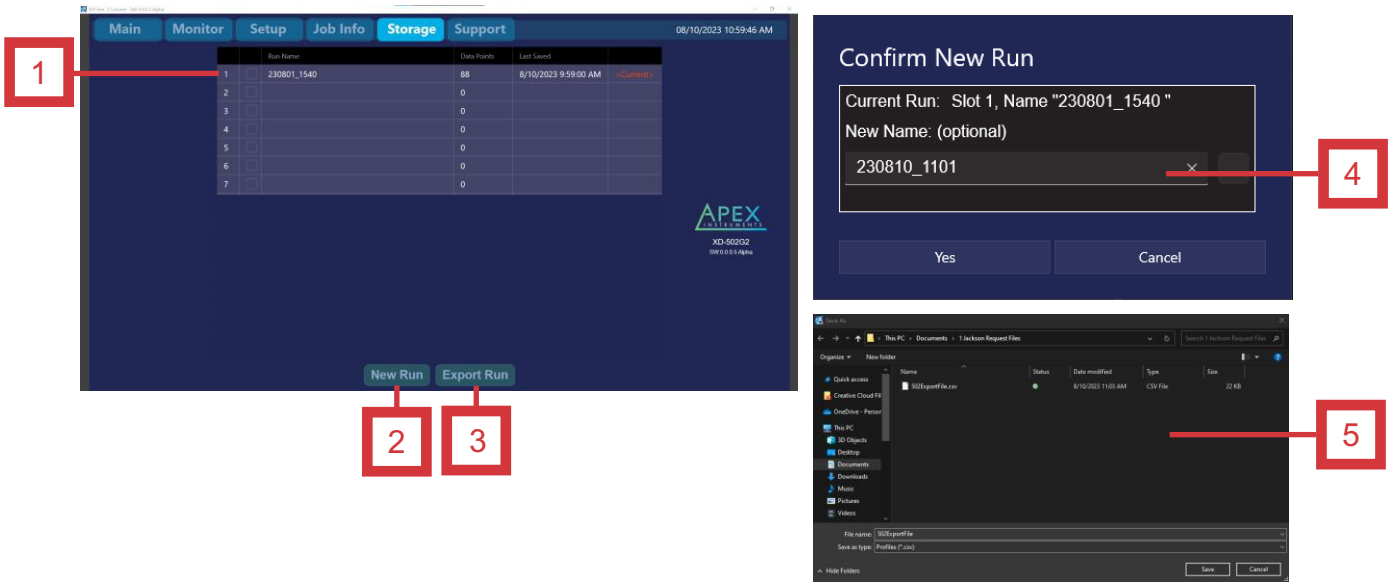


Fig. 17 Storage Screen Overview

3.6 Operation using software cont.

3.6.12 Setup Screen overview

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

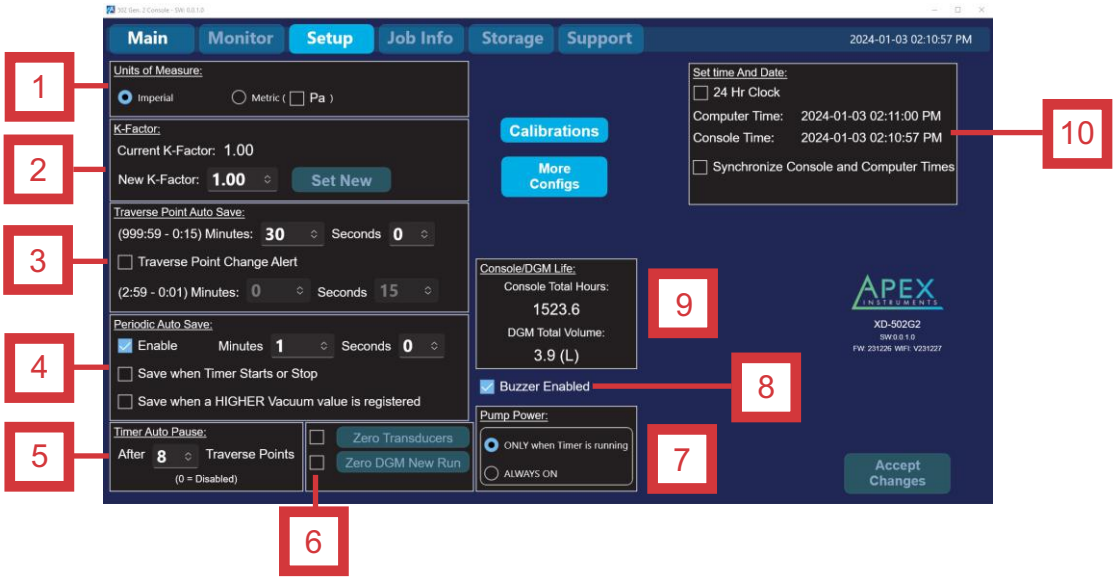


Fig. 18 Setup Screen Overview

The Setup Screen is divided into the following subsections:

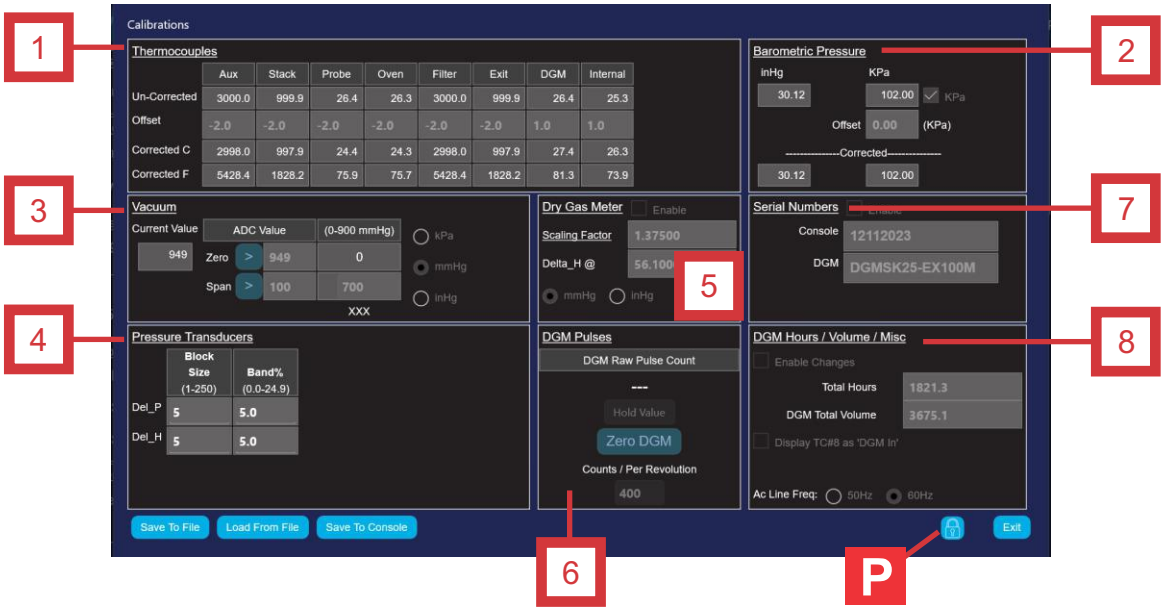
1. **Units of Measure**
   - Allows the Operator to select Imperial, Metric or Metric(Pascals) units of measure.
2. **K-Factor Value**
   - Allows the Operator to review and change K-Factor Values
3. **Traverse Point Auto Save Settings**
   - Enable checkbox: Allows the operator to enable and disable the option of traverse point change 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
4. **Periodic Auto Save settings**
   - Enable checkbox: Allows the operator to enable and disable the option of periodic auto save
   - Enable checkbox: If not enabled a “DISABLED” message is displayed on the main screen.
   - Minutes and Seconds fields: Allows the operator 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. Check boxes to save when Timer Starts or Stops and when a higher vacuum value is registered.
5. **Timer Auto Pause**
   - Allows the operator to automatically pause the timer after the entered number of Traverse Points
6. **Zero Transducer and Zero DGM New Run**
   - Select the Check Box then button to Zero the transducers and DGM before a new run
7. **Pump Power Control via Timer**
   - Select the Radio Button to enable the pump only when the timer is running or it is always on
8. **Buzzer Enabled**
   - Select the Check Box to enable the Buzzer
9. **Console and DGM Life**
   - Indicates the current Console Total Hours and the current DGM Total Volume
10. **Set Time and Date**
    - Select the Check Box to configure the 24 Hour Clock
    - Select the Check Box to Synchronize the Console and Computer Times

3.6 Operation using software cont.

3.6.12 Setup Screen overview cont.

Calibrations Window

- Click on the Calibrations Button to open the Calibrations Window.



P Password Protections

- Passwords protect different areas of the Calibrations Window against unintentional changes. Passwords are not utilized for security purposes but to maintain calibration/setting integrity. Click on the “Padlock” icon. A field will appear to the left. Type in the appropriate password to access the area. Certain areas are not available to operators and are reserved.

1. Thermocouples

- Allows the operator to correct against a NIST traceable device for temperature readings

2. Barometric Pressure

- Allows the operator to correct against a NIST traceable device for barometric pressure readings

3. Vacuum

- Allows the operator to correct against a NIST traceable device for vacuum readings

4. Pressure Transducers

- Allows the operator to modify the dampening block size and band% for Delta P and Delta H

5. Dry Gas Meter

- Allows for modification of the scaling factor and Delta H as well as changing units of measure

6. DGM Pulses

- Allows for modification of Optical Encoder Pulse Count / Per Revolution

7. Serial Numbers (*CONSOLE SERIAL NUMBER MODIFICATION IS NOT AVAILABLE TO OPERATOR*)

- Allows the operator to change the DGM Serial Number after replacement

8. DGM Hours/Volume/Misc. (*CONSOLE TOTAL HOURS MODIFICATION IS NOT AVAILABLE TO OPERATOR*)

- Allows the operator to change DGM Total Volume after replacement and to Display the TC8 as “DGM In”

3.6 Operation using software cont.

3.6.12 Setup Screen overview cont.

6. Console Connection Configurations

- Allows the operator to connect to the console wirelessly in two different manners as well as disabling the wireless connection by selecting the radio button and entering a an SSID and a password.

1. XD-502 as Access Point

- Allows the operator to connect to the console directly via SSID using a password.
- Select box to right of field to display the passord

2. Connect Console to Local Wifi

- Allows the operator to connect to the console directly via Wifi using SSID and a password.
- Select box to right of field to display the passord

3. Disable Wifi

- Allows the operator to disable connecting to the console via Wifi by selecting a radio button.

4. Get Current Settings

- Allows the operator to see the current console wireless settings

5. Accept

- The operator must select the “Accept” Button to save any changes to the wireless connections.

6. Cancel

-Aborts any changes made to wireless settings before “Accept” button is selected.

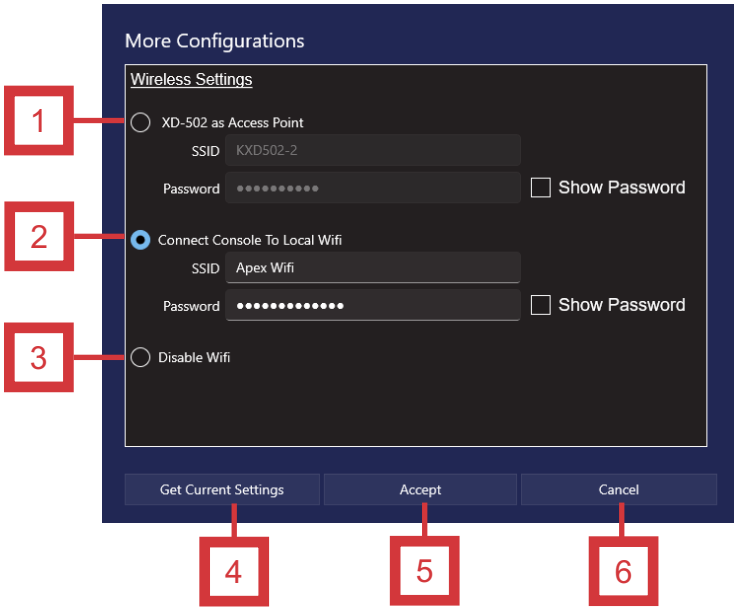


Fig. 19 Wireless Settings and Formats Panel Overview

3.6 Operation using software cont.

3.6.12 Setup screen overview cont.

6. Set Date/Time section

- Allows the user to set the console's date and time parameters to match that of the PC operating the software. This is a quick way to update the console's date and time, which can be especially important when changing time zones.

PC

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

24 Hour Clock

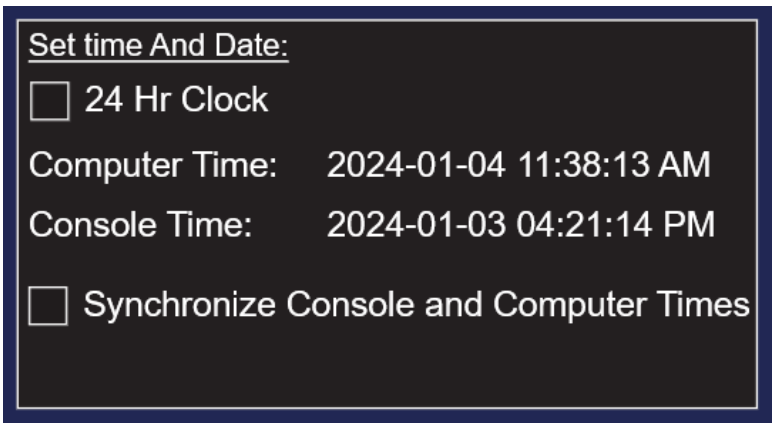
- Displays the current time in the 24 Hour format

Computer Time and Console Time

- 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

Set Time button

- If the two times (PC and Console) differ, the user must click the check box 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.



3.6 Operation using software cont.

3.6.13 Outline of Sampling Test Operations Using the Software

1. Plug in and power on the console. The console will respond with two quick chirps.

2. Double-click on the software icon to initiate the program.
   - The initial Splash Screen will appear and slowly fade to the Main Screen.

3. Attach USB cable to PC and to console or connect the PC to the console's wireless network ID.

4. Select USB or WiFi to connect to the console. The software will show the network connected icon in the upper right hand of the Main Screen.

5. Select the Job Information tab.
   - Fill in fields as necessary. When finished, navigate to the Setup tab.

6. The Setup screen provides entry for sample run setup.
   - Input values and select settings as necessary. When finished, 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 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. Leak Test
    - Perform the leak check (*refer to Section 3.2.6 Sample train leak check procedure on page 23*)

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 and 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 Operation using software cont.

3.6.13 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. Export the data to the PC
    - 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. Export the data to a flash drive (optional)
    - An alternative to exporting the data using the software is to use the USB Drive Export submenu to export sample run data following each run, if desired
    - Insert a formatted USB drive with enough storage room available into the port labeled DATA on the left side of the console
    - The LED beside of the Flash Drive port will light when the console is ready to export
    - Choose the run(s) to export using the Up and Down arrows and press the Select button to export the run(s) to the USB drive
    - While the console is writing to the flash drive, the LED will turn red; it will return to green once the export is completed
    - It is recommended to remove the flash drive while not exporting to avoid damage to the flash drive and/or the console

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

3.6 Operation using software cont.

3.6.14 Accessing console via web browser

Once the console has been set up and used wirelessly for the first time, the user is able to access the console via web browser on a mobile device or PC. This feature allows the operator or any other interested party to access the console to view live data being streamed by the sensors and even start or stop the run timer, which can also start or stop the pump if configured appropriately.

The importance to setting up the console wirelessly first is to establish a static IP address for the console. After initializing the console's wireless settings, follow the instructions below to access the console through a web browser without the need for the dedicated software.

1. Plug in and power on the console.

2. Access and record or remember the IP address displayed by the console.
   - This can be found in the console's main menu by holding the Up, or Menu, button for 3 seconds while on any of the home screens.
   - Scroll down the menu using the Down button and use the Select button to enter the View WiFi Info. submenu.
   - The first line of this submenu will display whether the console is in Local WiFi or Access Point mode.
   - Record or remember the SSID, password and IP address for the console, if applicable.

3. Connect to the console either via its access point or through your local WiFi using the steps outlined in *Section 3.6.3 on page 28* of this manual using your PC or mobile phone. The wireless initialization must be completed in order to access the console remotely.
   - The mobile device or PC may alert the user that the console has no internet connection, acknowledge this notification to stay connected to the console or local network.

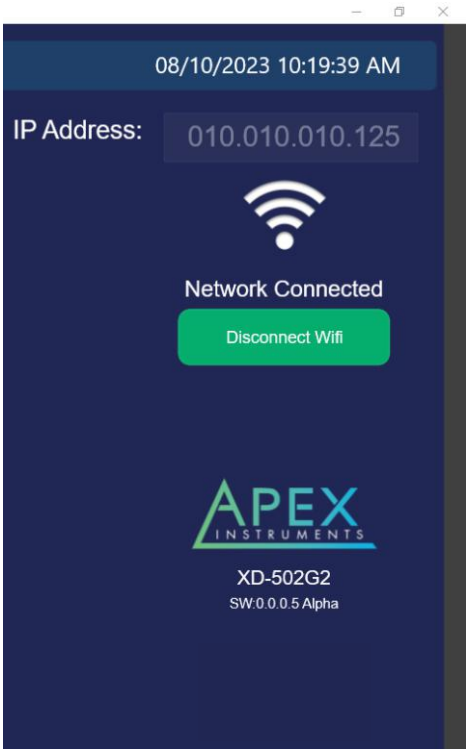


Fig. 20 Web Browser Access Interface

4. Access the console via the mobile device's web browser. **NOTE: SSID numbers are limited to 20 figures.**
   - Type in the exact IP address displayed by the console from step 2 of this procedure and press enter or click Go

5. Once connected to the console, the web browser will display numerous attributes and values from the console, including:
   - Sample, traverse point save and periodic save timers, current traverse point number
   - K-Factor, ΔP, ΔH and Target ΔH
   - Vacuum and barometric pressures
   - Thermocouple temperatures
   - DGM volume and estimated sample flow rate
   - Current run and point numbers, clock time of last saved data point
   - Sample timer Start/Stop button

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-HFM (5 Point High Flow Calibration. 10 to 30 LPM)

4.1.2 Initial end user calibration checks

Apex Instruments suggests that the end user perform calibration checks on the dry gas meter, thermocouples, and vacuum and pressure sensors before performing a field test (post-test calibrations can also fulfill this suggestion). Perform a calibration check using a critical orifice set (rated for the intended sampling flow rates) plugged in to the sample inlet on the console. Run the calibration check 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 calibration check 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 recommend that the user perform post-test calibration checks 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 calibration check 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 calibration check using the calibration check procedure outlined in *Section 3.4 Post-Field Test Operations* on page 24 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.

4.2.2 Temperature sensors

Perform calibration checks 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 calibration check the temperature sensors following the procedure outlined in *Section 4.1.2*

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 calibration checked 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 calibration checks 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
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 CALIBRATION 5PT. HIGH FLOW/10 TO 30 LPM

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

⚠ CAUTION

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

⚠ CAUTION

   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 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

⚠ CAUTION

3. Console has a leak
   Resolution - Check all fittings and tubing inside of the console for a leak, repair if necessary

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

⚠ CAUTION

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

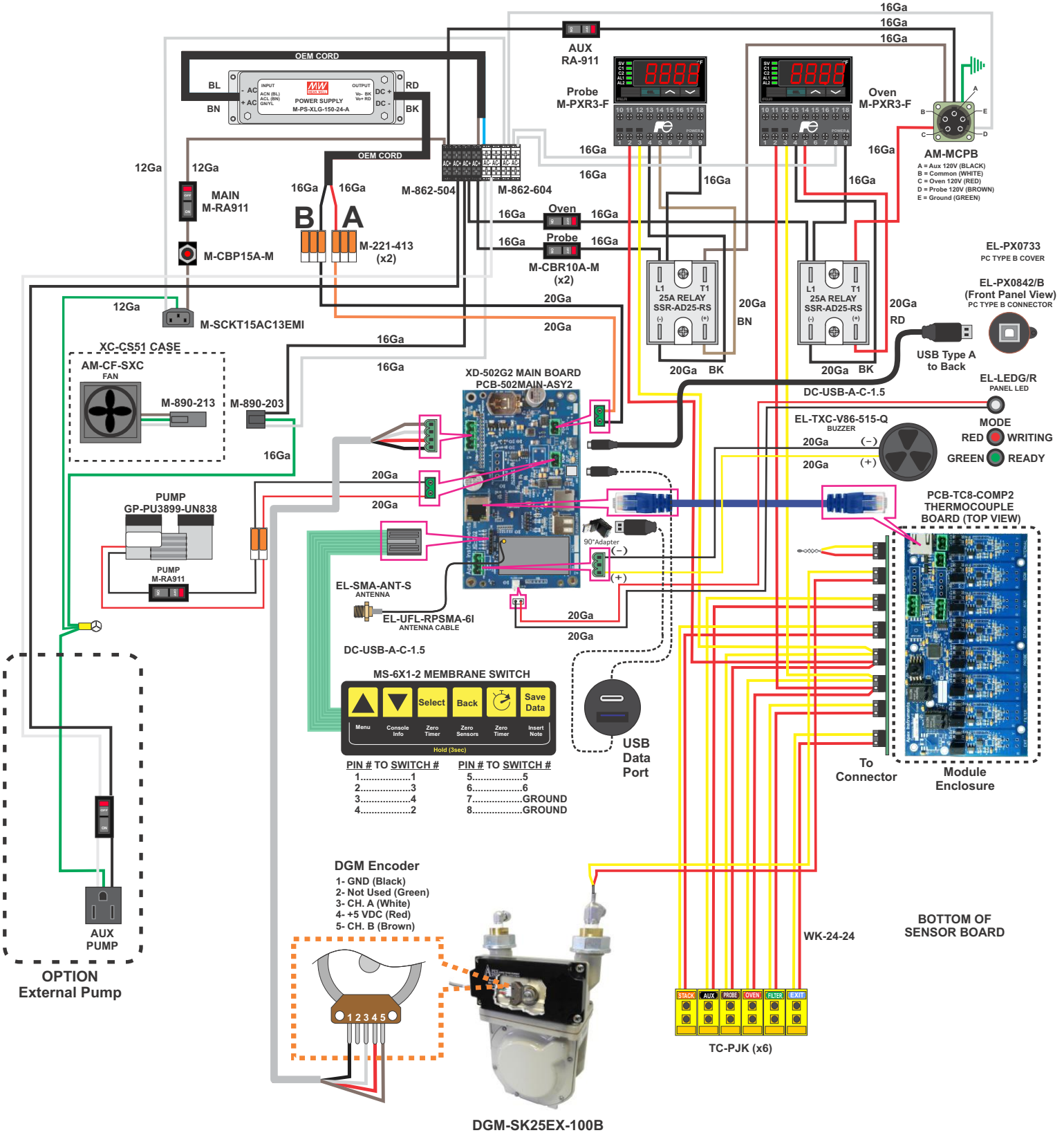
5.4 Additional Common Console Problems

⚠ CAUTION

Issue	Resolution
Maximum vacuum or flow rate decreases	- 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	- 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	- 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	- 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	- 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	- 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)



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

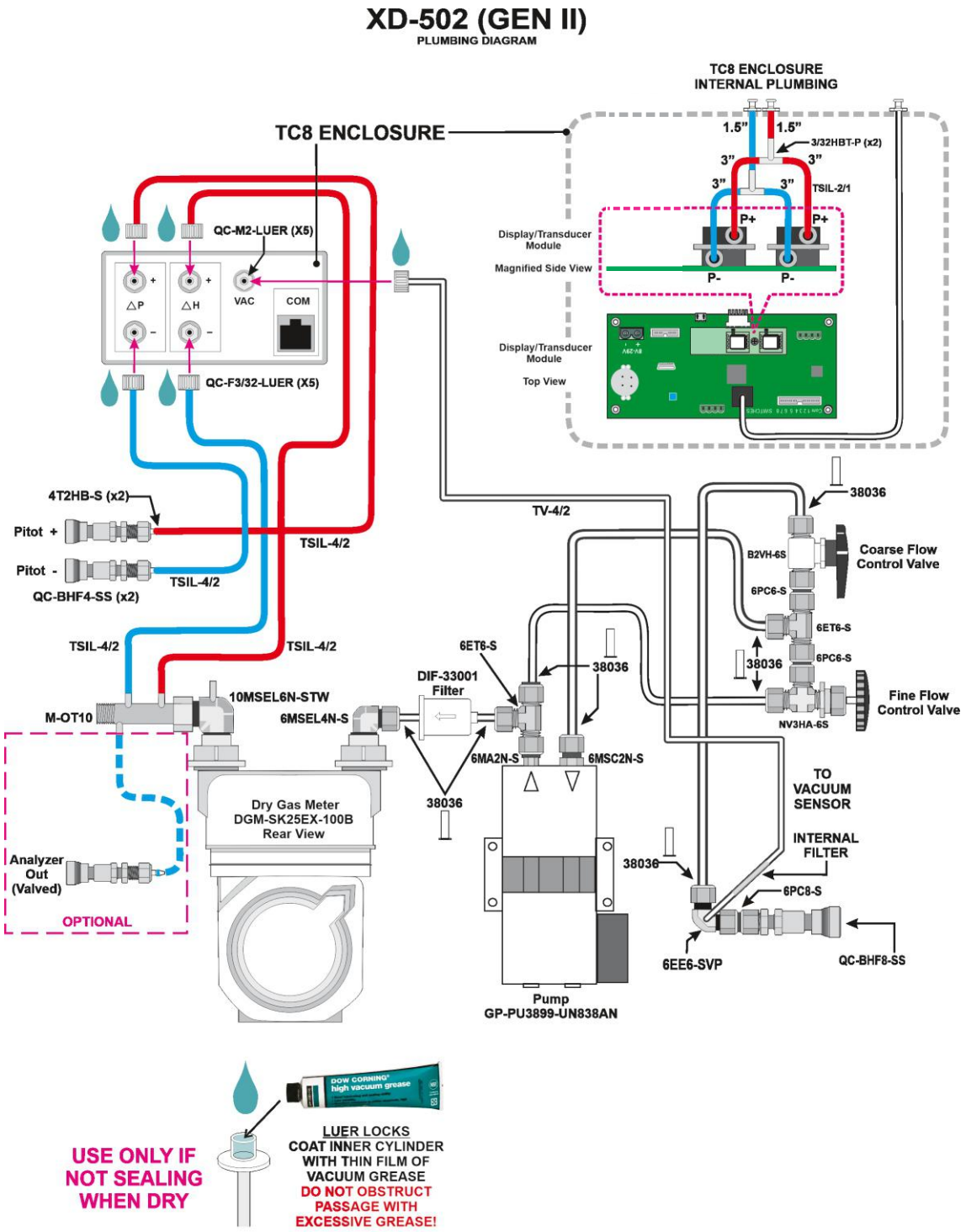


Fig. 22 Plumbing Diagram

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

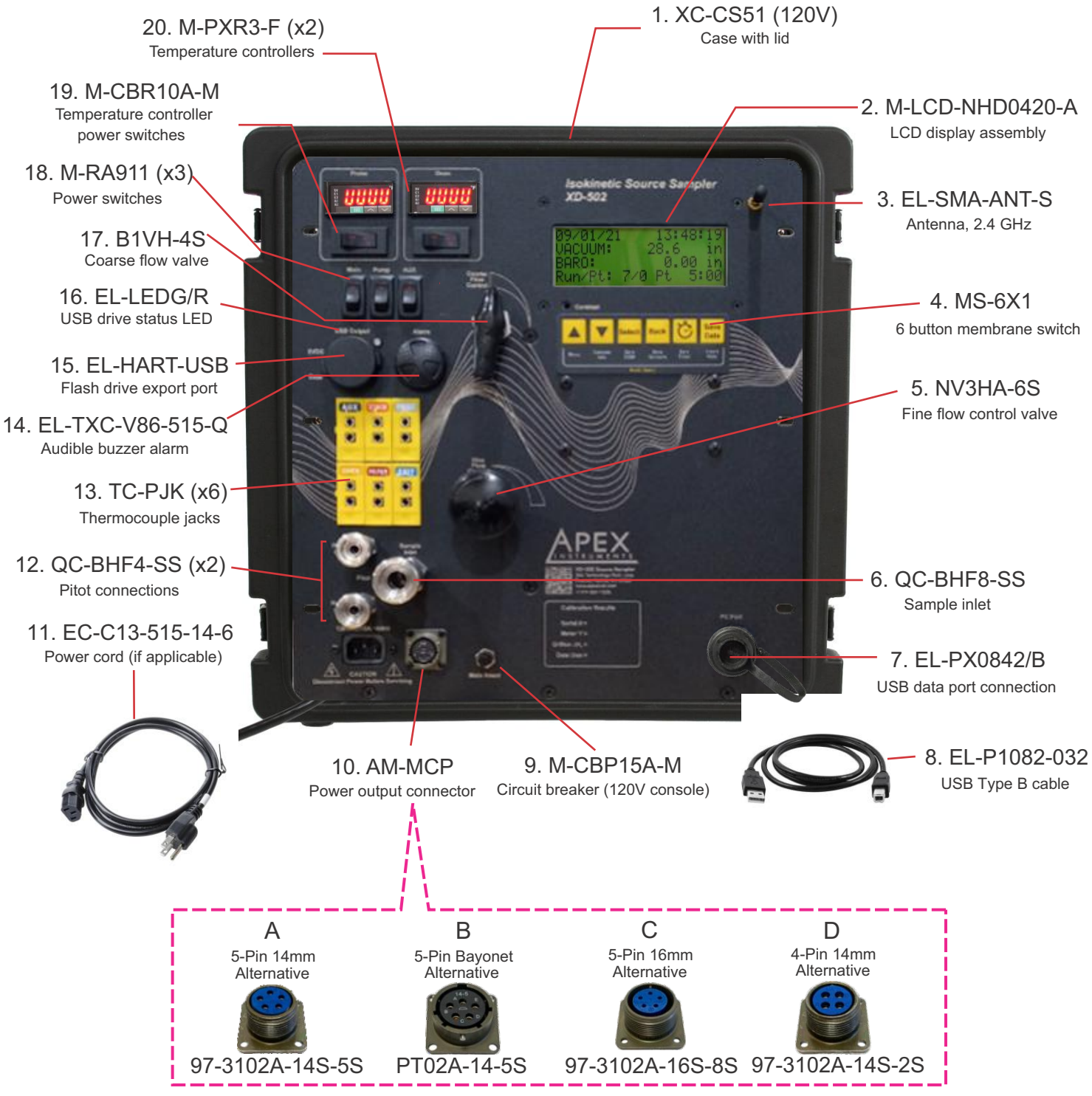


Fig. 23 Parts List (Front Panel) - *Standard version shown, depiction of options may differ*

6.4 Parts List - Interior (XD-502 120V Shown)

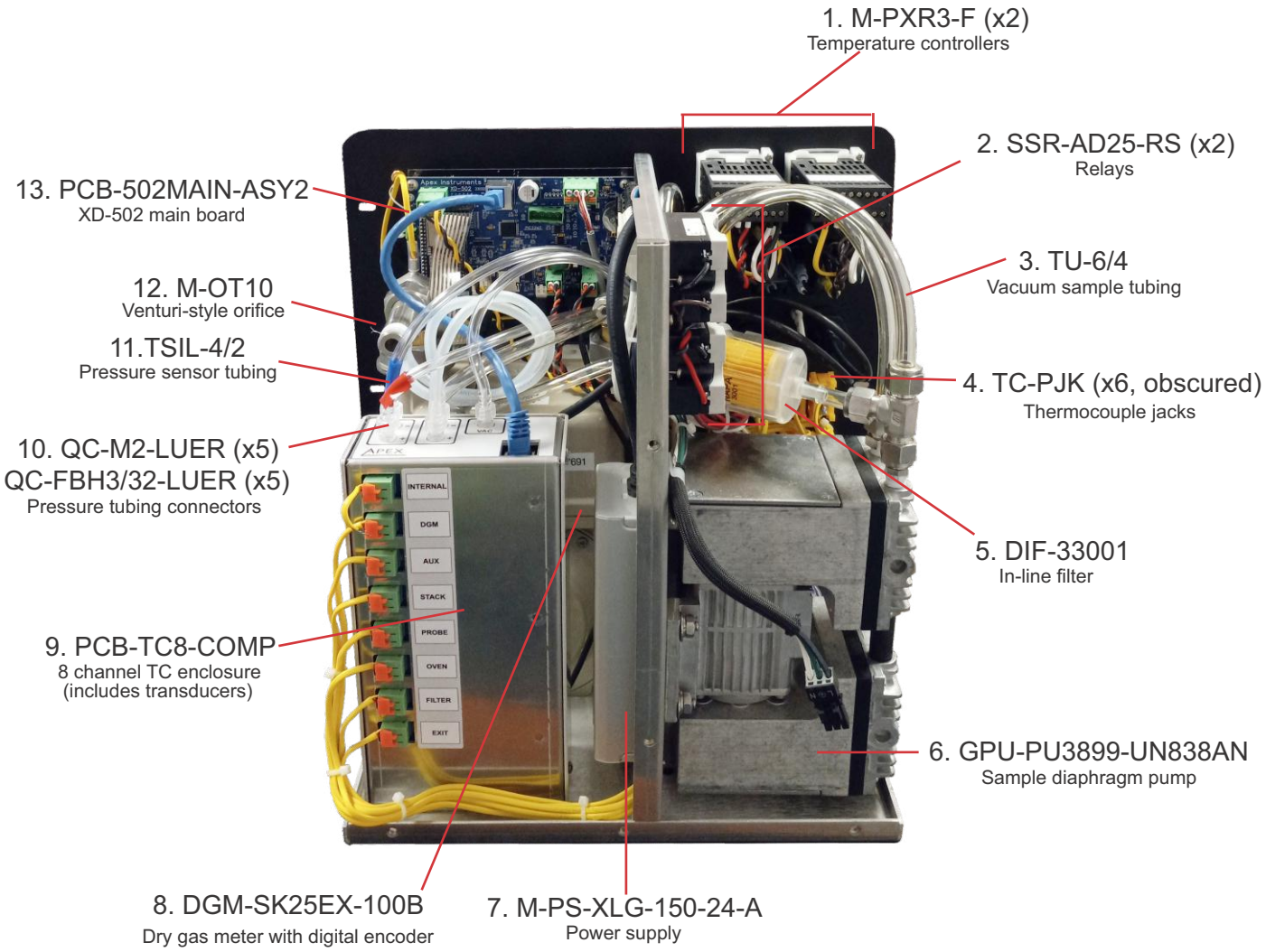


Fig. 24 Parts List (Interior) - *Standard version shown, depiction of options may differ*

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

ISOKINETIC SAMPLING DATA

Plant Name		Date	
Sampling Location		Project #	
Operator		Run #	
# of Points Across		# of Ports Used	

Ideal Nozzle Diameter and IsoKinetic Factor Setup			
Pitot Tube Coefficient	(C_p)		
Avg Stack Temp	(t_s)		°C
Avg Gas Meter Temp	(t_m)		°C
DH @ 0.75 SCFM	($\Delta H@$)		mm H_2O
Avg Pitot Tube Diff. Pressure	(Δp_{avg})		mm H_2O
Stack Moisture Content	(B_{ws})		%
Stack Dry Molecular Weight	(M_{ds})		g/g-mole
Estimated Orifice Flow Rate	(Q_m)		acmm
DP to DH Isokinetic Factor	(K)		

Sampling Equipment			
Meter #			
Meterbox Cal. Factor	(Y)		
Nozzle #			
Actual Nozzle Diameter	(D_{na})		mm
Req. Nozzle Diameter	(D_{ni})		mm
Probe # / Length			m
Liner Material			
Sample Case / Oven #			
Impinger Case #			

Pressures			
Barometric Pressure	(P_b)		mm Hg
Stack Static Pressure	(P_{static})		mm H_2O
Absolute Stack Pressure	(P_s)		mm Hg
Absolute Meter Pressure	(P_m)		mm Hg

ΔV_m	Leak Checks				
Pre		m^3/min	@		mm Hg
Mid		m^3/min	@		mm Hg
Post		m^3/min	@		mm Hg
ΔV_m <		m^3/min	☐	Leak Check OK?	
Pitot OK?	☐		Orsat OK?	☐	

Traverse Point #	Sampling Time (Θ)	Clock Time	Dry Gas Meter Reading (V_m)	Velocity Head (Δp)	Desired Orifice ΔH (ΔH)	Actual Orifice ΔH (ΔH)	Stack Temp (t_s)	Probe Temp (t_{ml})	Meter Outlet Temp (t_{mo})	Filter Temp	Impinger Exit Temp	Pump Vacuum
	min	hh:mm:ss	m^3	mm H_2O	mm H_2O	mm H_2O	°C	°C	°C	°C	°C	mm Hg
Last Pt									Maximum Vacuum			
Average Values												

APEX INSTRUMENTS SOURCE TESTING EQUIPMENT

Updated: 2020/06/11

Console Calibration

Pre-Test - 5-Point Metric Units (Critical Orifice)

Meter Console Information		Calibration Conditions		Factors/Conversions		Orifice Information	
Model #:		Bar. Press. (mm Hg):		Std. Temperature (°K):	293.15	Orifice Set ID:	
Serial #:		Relative Humidity (%):		Std. Pressure (mm Hg):	760.0	Cal. Due Date:	
DGM Model #:		Ambient Temp. (ºC):		K_1 (°K/mm Hg):	0.3857	Theoretical Critical Pressure (in. Hg)[1]:	
DGM Serial #:							

Calibration Data

Console Test Meter (DGM)							Critical Orifice				
Run Time[5]	Meter Pressure[6]	Volume			Outlet Temperature		Serial Number	Coefficient[2]	Actual Vacuum[1]	Ambient Temperature	
		Initial	Final	Total	Initial	Final				Initial	Final
Θ (minutes)	P_m (mm H_2O)	V_{mi} (m^3)	V_{mf} (m^3)	V_m (m^3)	t_{mi} (ºC)	t_{mf} (ºC)	# (ID)	K' (Metric)	P_w (mm Hg)	t_{ai} (ºC)	t_{af} (ºC)

Calibration Results

Standardized Data							Calculated Results		
Dry Gas Meter		Critical Orifice			Gamma		Flowrate	$\Delta H_@$	
Std. Volume	Std. Flow Rate	Std. Volume	Std. Flow Rate	Raw Volume	Value	Variation[3]	Std & Corr	@ 0.0212 SCMM	Variation[4]
Vm_{std} (m^3)	Qm_{std} (m^3/min)	Vcr_{std} (m^3)	Qcr_{std} (m^3/min)	V_{cr}(m^3)	Y	ΔY	$Qm_{std/corr}$ (m^3/min)	$\Delta H_@$ (mm H_2O)	$\Delta\Delta H_@$ (mm H2O)
						Y Avg.			$\Delta H_@$ Avg.

	Initial Scaling Factor
	New Scaling Factor[7]

Notes

[1] For valid test results, the Actual Vacuum during calibration should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2] The Critical Orifice Coefficient, K', must be entered in Metric units, [(m3)(°K)1/2)]/[(mm. Hg)(min)].

[3] For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.

[4] For $\Delta H_@$, orifice pressure differential that equates to 0.75cfm (0.0212m^3/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2in (5.1mm) H_2O.

[5] Recommended minimum run time per orifice is 10 minutes.

[6] Theoretical meter pressure (gauge) ΔH: 09 orifice - ~0, 40 orifice - ~7, 48 orifice - ~13.5, 55 orifice - ~27, 63 orifice - ~43, 73 orifice - ~76 (mm H2O).

[7] For a digital console calibration, enter the initial scaling factor for the console to get an updated scaling factor after the completed calibration. With the new scaling factor, the Y (Gamma) is now 1.0000.

Technician: _____ Signature: _____ Date: _____

I certify that the above Dry Gas Meter was calibrated in accordance with US EPA Methods, CFR 40 Part 60.

7.3 Equations and Nomenclature

7.3.1 Equations

- $B_{ws} = \dfrac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$
- $V_{m(std)} = \dfrac{K_1 V_m \left[P_{bar} + \left(\dfrac{\Delta H}{13.6}\right)\right]}{T_m}$
- $I = \dfrac{100 T_s \left[K_4 V_{1c} + \dfrac{(V_m Y)}{T_m}\left(P_{bar} + \dfrac{\Delta H}{13.6}\right)\right]}{60\theta v_s P_s A_n}$
- $Y = \dfrac{V_{cr(std)}}{V_{m(std)}}$
- $I = \dfrac{T_s V_{m(std)} P_{std} 100}{T_{std} v_s \theta A_n P_s 60(1 - B_{ws})} = K_5 \dfrac{T_s V_{m(std)}}{P_s v_s A_n \theta (1 - B_{ws})}$
- $V_{w(std)} = V_{1c} \dfrac{\rho_w R T_{std}}{M_w P_{std}} = K_2 V_{1c}$
- $K' = \dfrac{K_1 V_m Y \left(P_{bar} + \dfrac{\Delta H}{13.6}\right) T_{amb}{}^{1/2}}{P_{bar} T_m \theta}$
- $Y_c = \dfrac{10}{V_m}\left[\dfrac{0.0319 T_m}{P_{\boldsymbol{bar}}}\right]^{1/2}$
- $Q = K_1 \dfrac{P_{bar} V_w}{(T_w + T_{std})\theta}$
- $Y_{ds} = \dfrac{V_w (T_{ds} + T_{std}) P_{bar}}{V_{ds}(T_w + T_{std})\left(P_{bar} + \dfrac{\Delta p}{13.6}\right)}$
- $V_{cr(std)} = K' \dfrac{P_{bar}\theta}{\sqrt{T_{amb}}}$
- $Y_{qa} = \dfrac{\theta}{V_m}\sqrt{\dfrac{0.0319 T_m}{\Delta H_{@}\left(P_{bar} + \dfrac{\Delta H_{avg}}{13.6}\right)}\left(\dfrac{29}{M_d}\right)}\left(\sqrt{\Delta H}\right)_{avg}$
- $V_{m(std)} = V_m Y \dfrac{T_{std}\left(P_{bar} + \dfrac{\Delta H}{13.6}\right)}{T_m P_{std}} = K_1 V_m Y \dfrac{P_{bar} + \left(\dfrac{\Delta H}{13.6}\right)}{T_m}$
- $\Delta H_{@} = 0.0319 \Delta H \dfrac{T_m \theta^2}{(P_{bar} Y^2 V_m{}^2)}$

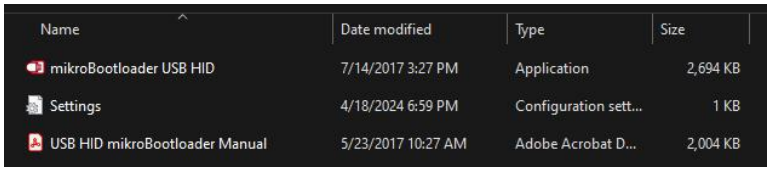
7.3 Equations and Nomenclature cont.

7.3.2 Nomenclature

acf = actual cubic feet
acfm = actual cubic feet per minute
A = effective area of flue in square feet
acm = actual cubic meters
acmm = actual cubic meters minute
A_n = inside area of sampling nozzle in square feet
B_{ws} = water vapor in gas stream, proportion by volume
%C = percent carbon by weight, dry basis
%CO = percent carbon monoxide by volume, dry basis
$\%CO_2$ = percent carbon dioxide by volume, dry basis
C_p = pitot tube coefficient
D_l = dust loading per heat input in pounds (grams) per million Btu (calories) per Fr constant
D_l^3 = dust loading per heat input in pounds (grams) per million Btu (calories) per Fr calculated
dscf = dry standard cubic feet
dscfh = dry standard cubic feet per hour
dscm = dry standard cubic meters
dscmh = dry standard cubic meters per hour
fps = feet per second
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)
gms = grams
gm-mole = gram-mole
grs = grains
ΔH = orifice pressure drop in inches water, average
%H = percent hydrogen by weight, dry basis
H_c = heat of combustion in Btu per pound, dry basis
hr = hour
%I = percent isokinetic
in. Hg = inches mercury
lbs = pounds
lbs-mole = pound-mole
%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
P_{std} = standard absolute pressure (29.92 in Hg)
P_s = absolute pressure in flue in inches (millimeters) mercury
P_f = static pressure in flue in inches water, average
ΔP = stack velocity differential pressure, as measured by pitot tube in inches water
$\sqrt{\Delta P}$ = square root of velocity head in inches water, average
%S = percent sulfur by weight, dry basis
scf = standard cubic feet
scm = standard cubic meters
TC = thermocouple; wire for temperature measurement
T_{std} = absolute temperature of air in degrees Rankine at standard conditions (528 degrees)
T_s = absolute temperature of flue gas in degrees Rankine, average
T_m = absolute temperature at meter in degrees Rankine, average
V_s = velocity of flue gas in feet (meters) per second
V_l = volume of condensate through the impingers in millimeters
V_{lc} = volume of liquid collected in condenser in millimeters plus weight of liquid absorbed in silica gel in grams indicated as milliliters
V_m = volume of metered gas corrected to dry standard conditions in cubic feet (meters)
V_{ms} = volume of metered gas measured at meter conditions in cubic feet
V_o = volume of flue gas at actual conditions in cubic feet (meters) per minute
Q_{sd} = volume of flue gas corrected to dry standard conditions in cubic feet (meters) per hour
V_t = total volume of flue gas sampled at actual conditions in cubic feet (meters)
V_w = volume of water vapor in metered gas corrected to standard conditions in cubic feet (meters)
V_{wc} = volume of water condensed in impingers corrected to standard conditions
V_{wsg} = volume of water collected in silica gel corrected to standard conditions
W_a = total weight of dust collected per unit volume in grains (grams) per actual cubic feet (meters)
W_d = total weight of dust collected per unit volume in pounds (grams) per dry standard cubic feet (meters)
W_g = total weight of dust collected in grams
W_h = total weight of dust collected per unit volume in pounds (grams) per hour, dry basis
W_p = total weight of dust collected in pounds
W_s = total weight of dust collected per unit volume in grains (grams) per dry standard cubic feet (meters)
W_{sg} = impinger silica gel weight gain in grams
Y = metered gas volume correction factor
θ = total elapsed sampling time in minutes

7.4 Firmware Upload Procedure

1. Select and open the ***mikroBootloader USB HID*** application file.



2. Turn off Console. Remove the USB connection at PC port (if used).

3. Locate a USB A / USB C cable- Plug the USB A into the computer. A C

4. Hold down the **Save Button** and power on Console. Have the USB cable ready to plug the USB C into the 5VDC Port on the USB Output Port.

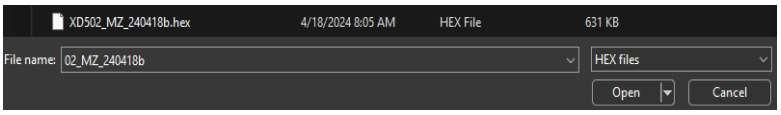
5. Plug in the USB Mini into the 5VDC Port and release the **Save Button** simultaneously.

6. The **mikroBootloader** screen will display information in the ***Device*** and ***MCU Type*** fields. ***See Screen 2.***

7. Press ***Connect*** on the **mikroBootloader** Screen

8. ***"Connected"*** will be displayed on **mikroBootloader** Screen. ***See Screen 3.***

9 Press ***"Browse for HEX"***. The SW will locate the file.



10. Select the **HEX** file and press **Open** on the Computer.

11. The SW will display "***Firmware\XD502_MZ_#####.hex***" ***See Screen 4.***

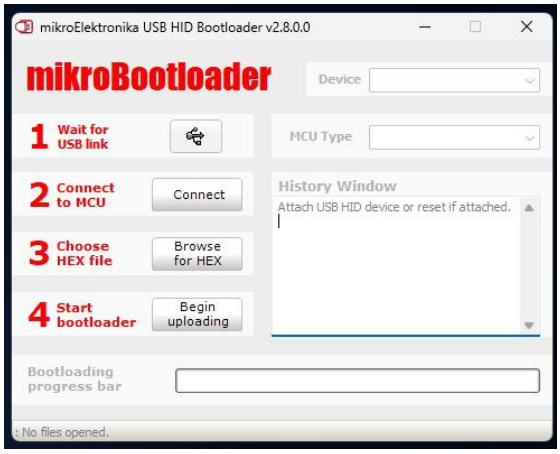
12. Press ***Begin Uploading*** on **mikroBootloader** Screen.

13. The progress screen will change to uploading mode.

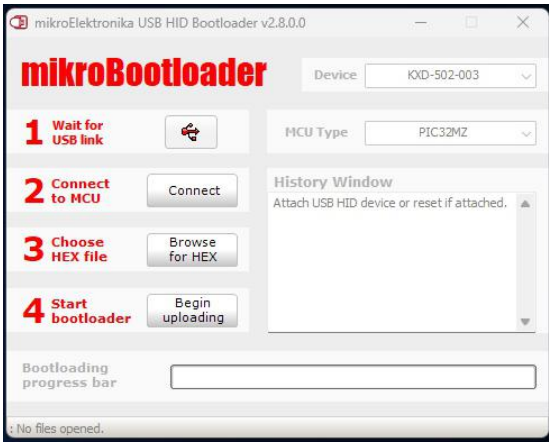
14. The Console will sound and reset after the firmware has uploaded.

15. Turn the Console off and check the display screen to ensure the displayed FW is the same as what was uploaded.

1



2



3

4