SEMTECH HI-FLOW 2

Fugitive Methane Sampler

Supplementary Manual

Document: 9510-274

Revision: 1.01

January 2025

The serial number for the HI-FLOW2 Analyzer Unit is located on the port panel on the name plate.

The serial number for the HI-FLOW 2 Handheld Unit is located on its lower side on the name plate, underneath the SEMTECH labels.

For ease of service, keep a record of the serial number and the date of first use.

Analyzer Unit Serial Number:

Handheld Unit Serial Number:

Date:

TABLE OF CONTENTS

REVISION HISTORY

Version	Date	Author	Comment
1.01	1/24/2025	Sheila Bourgoin	• Release (FLO081)

1 ABOUT THE SUPPLEMENTARY MANUAL

This document provides supplemental information for the HI-FLOW 2, including a listing of accessories, features of the host software, testing procedures, and a technical appendix. For all safety related information and performance specifications, refer to the HI-FLOW 2 User Manual (9510-239).

2 HI-FLOW 2 ACCESSORIES

2.1 ACCESSORIES (ITEMS SHOWN NOT TO RELATIVE SCALE)

The accessories shown below are not all included in the HAZLOC certification.

Included with HI-FLOW analyzer and handheld		
 Front and back		
Backpack carrier P/N: 9195-117	Umbilical harness : P/N: 9232-781	Extension nozzle P/N: 9259-184
		
HI-FLOW 2 Softcase P/N: 1408-483	Oval nozzle extension P/N: 2514-466	First use safety guide P/N: 9510-259
		
Hex driver P/N: 5403-025	9/16” Wrench P/N: 5403-024	Battery charger P/N: 6003-122
		 (For battery replacement only)
Battery P/N 9259-186	Backfeed Preventor P/N: 9292-068	T20 Torx Driver P/N: 5403-026

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Accessories not included with HI-FLOW analyzer and handheld		
		
Pelican case with foam P/N: 9296-351	6' extension hose P/N: 9296-355	Sample bag P/N: 1408-482

2.1.1 MIDI ACCESSORY

The HI-FLOW 2 MIDI accessory accurately quantifies and reports real-time, average and peak flow rates when directly coupled to the emission source, eliminating the need for an active fan which is embedded into the high-flow sampler.

The MIDI is available in multiple tube sizes to accommodate a wide range of flow rates. It is a plug and play accessory with the same accuracy as the HI-FLOW 2 handheld unit. The upper flow rate is defined in the calibration certificate (highest calibration data point) on page 48. The lowest flowrate is defined by the flow conditions in the MIDI (Reynolds number > 10,000).

Refer to the calibration certificate on page 48 for flow rate data. This accessory is not part of the HAZLOC certified product.

2.1.2 RECOMMENDED GAS BOTTLE AND REGULATOR

Sensors recommends using this compact bottle of gas and regulator with the HI-FLOW 2 calibration kit.

GASCO-2.5 Calibration Gas 50% LEL Methane (2.5% Volume) Balance Air 103 Liter Cylinder C-10 Connection, vendor part number 103L-135A-2.5, available from the Cal Gas Direct website

GASCO 70-Series Calibration Gas Regulator Fixed 4.0 LPM C-10 Connection, vendor part number 70-4.0, available from the Cal Gas Direct website). The tubing shown is included with the regulator.

It is recommended to check the gas analyzer calibration before and after any measurement campaign.

2.1.3 CALIBRATION KIT (PURCHASED FROM SENSORS SEPARATE FROM HI-FLOW 2)

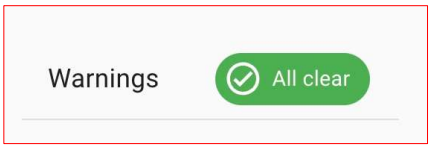
Easily perform audit checks and calibrations of the HI-FLOW 2. This kit contains a flow meter to measure gas overflow, three tubing assemblies and an adapter fitting to use on the recommended gas bottle and regulator. Contact Sensors or your local supplier.

3 COMMUNICATION AND HOST SOFTWARE

1. Click on “Network & Internet Settings” to show all wireless connections in the proximity. (Or if using a cell phone or tablet, go to “Settings>Wi-Fi)
2. Allow the wireless device to search and select the connection named “HI-FLOW-2” followed by the serial number of the unit.
3. Click on “Connect” button.

The Password for the WIFI connection is **sensors123**

4. After logging into the WIFI, open a web browser and enter in the address: **192.168.42.1:48176**
5. The main screen of the Host Software is referred to as the “Dashboard”. Enter the “Dashboard” page on a web browser and wait for the “Warming up” alert to change to “All Clear”.



By clicking on the icon located at the top left corner of the Host you can navigate between “Dashboard”, “Diagnostics”, “Recordings” “Downloads”, “Map” “Calibration”, “Settings”. The Calibration and Settings pages are password protected.

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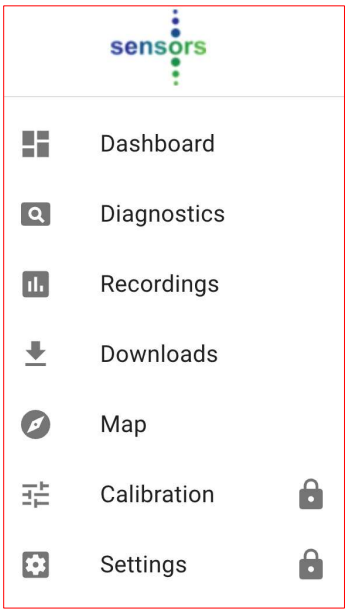

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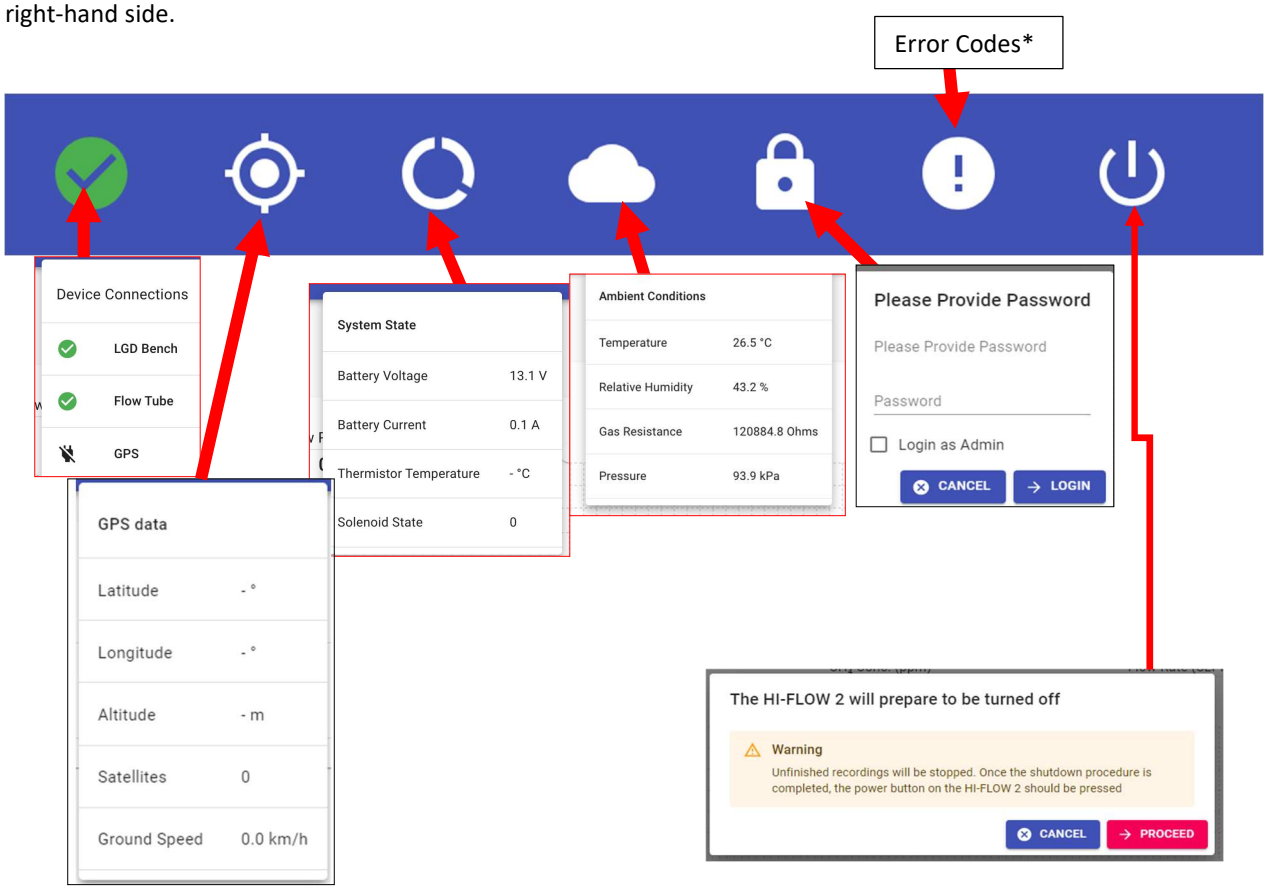
Various system parameters (e.g., Battery Voltage Fan settings) can be accessed with the two buttons on the top right-hand side.



*Error Codes are only used at the manufacturing facility.

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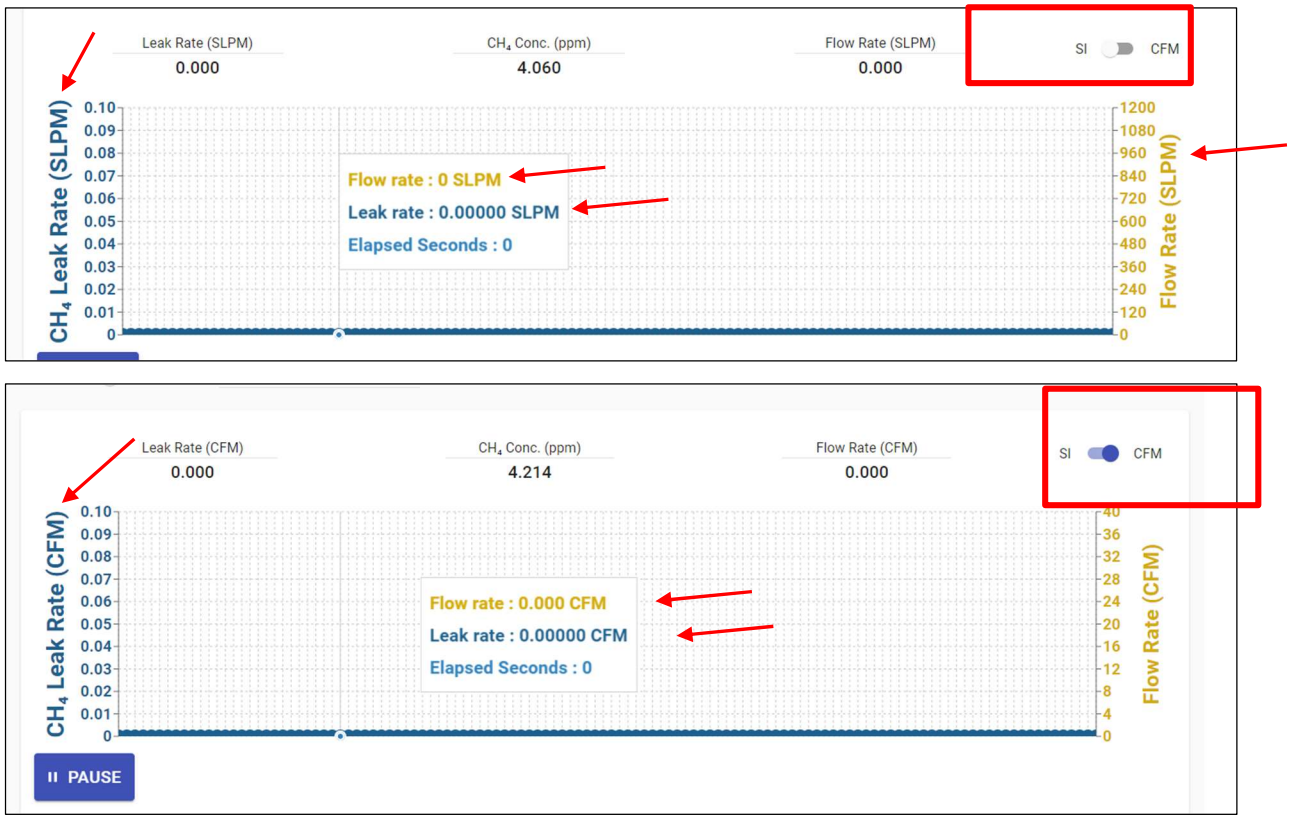
3.1 MEASURING A METHANE LEAK

3.1.1 PREPARING TO MEASURE

1. Charge the unit fully before using..
2. Turn on the power on the front panel of the gas Analyzer Unit.
3. On a Wi-Fi enabled computer or mobile device, connect to the host software via Wi-Fi.
4. Open a web browser and access the Host Software. (Section 1.6.1.1: Communication and Host Software)
5. Wait for the unit to warm up. The orange alert on the screen will change to green and will say “All Clear”.
6. Check the system for external leaks as indicated in the HI-FLOW 2 User Manual.

3.1.1.1 SELECT A FORMAT TO VIEW THE DATA

When the control is turned **off**, the flow rate and leak rate is displayed in SLPM (Standard Liters Per Minute). When the control is turned **on**, flow rate and leak rate data are displayed in CFM (Cubic Feet per Minute). This does not affect the units the data is recorded with, it only changes what is visible in the host software.



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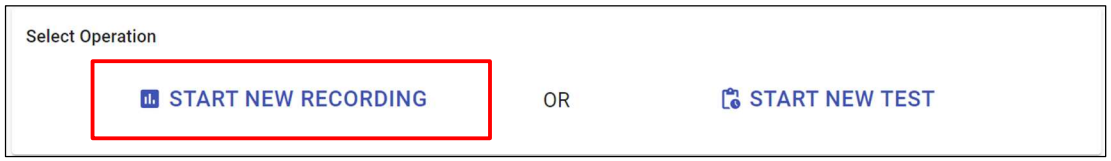
3.1.2 RECORDINGS

The Dashboard has two options for recording data. “START NEW RECORDING” records individual sessions and allows the user to select settings such as fan speeds, control modes. “START NEW TEST” is reserved for recording using preset scripts (for ACR and OOOOb specific testing, for example.)

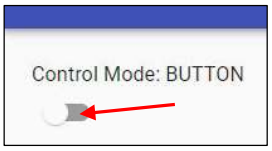
This section covers the functions available when “START NEW RECORDING” is chosen. This option permits control of the HI-FLOW 2 using the buttons on the handle or with the host software interface to change the gas path, fan speed, turn the fan off and on, control the length of the sample and the recording.



3.1.3 RECORDING CONTROL MODES

There are two control modes for testing with the HI-FLOW 2.

Control Mode: Button: This uses the buttons on the Handheld Unit to turn the fan on and off and to control the fan speed. The gas path is controlled automatically. This allows the person using the Handheld Unit to control the fan.



Control Mode: GUI: The fan is controlled from the Host Software interface. The gas path is manually controlled. This may be preferable if it is difficult to view the data on a screen and a second operator controls the fan remotely.

Leak Testing in “BUTTON” mode:

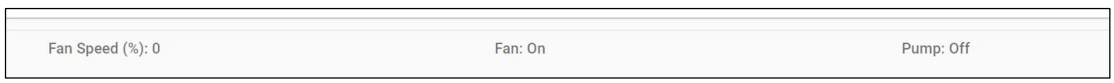
Choose a fan setting for the test. At the time of testing, a series of tests should be run to record the leak at several fan speeds, starting with a higher speed and moving to a lower speed.

- The higher fan speeds should be used for larger leaks. For instance, tests at 90%, 80%, 70% can be recorded and compared.
- Testing smaller leaks can be recorded at medium speeds, moving to lower speeds. For instance, tests at 80%, 70% and 60% can be recorded and compared.
- If the recordings at the lowest speeds are noticeably different from the higher speeds, this means the tests at the lower speed did not read the leak accurately and these tests can be deleted.

Leaks can be measured using pre-configured Fan speed settings. The default is 90%, 80%, 70% and 60%.

The Measurement ID (and fan speed) selected is identified using the LEDs on both the handheld and main module and is clearly identified on the bottom of the “DASHBOARD” page as shown below. To cycle through the settings, press and release the Measurement ID button on the top surface of the handheld Unit handle.

When the Analyzer Unit is powered on and the fan is not running, all the LED lights will glow green. Pressing the button once will switch the first LED to turn green (standby mode). Press the button again and the first LED will turn orange, and the fan will run at 90% when the fan button is pressed. The fan speed and status will be displayed in the Host Software.



When the fan is turned **on**, the selected light will turn orange for 45 seconds. This allows for a sufficient sample of gas for accurate measurement. After 45 seconds, the light turns back to green. The fan control button can be released. To cycle through all the settings, continue to press the Measurement ID button and observe the LED lights.

ID	Name	Fan Speed	LED Duration (secs) after fan control is held down.	Color
1	Standby	Off		Green
2	Fan High	90%	45	When fan control button is held down, the LED will stay gold for 45 seconds and then change to green. Allows for enough time to clear the tube of methane and sample a leak.
3	Fan Medium	80%	45	
4	Fan Low	70%	45	
5	Fan Ultra-Low	60%	45	

NOTE: These configurations can be modified through the "SETTINGS" page, which is password protected.

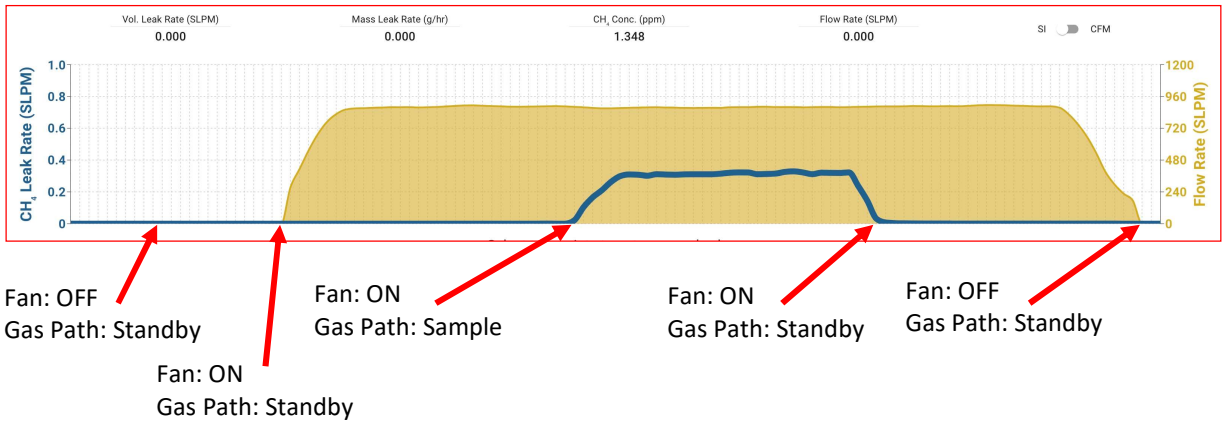
When the desired configuration has been selected (2-5 in the above table) the sampling pump and fan can be turned on using the Fan Control Button 1 This does not latch and must be depressed to keep the fan and pump active. If the button will not depress, check the manual lock button 4 is not in the on position. (This is to prevent the fan from being accidentally active when not required.) Press the Measurement ID button 2 to cycle through the IDs shown in the LED display 3.

The leak measurement procedure combines positioning at the end of the handheld tube and referring to the information from the host software.

1. If the backpack is being used, the tester should power on the Analyzer Unit and give it a several minutes to warm up. then put it on and fasten the front strap. Check the Host Software for the green "All clear" alert.
2. Decide on the desired fan speeds based on the previous section. It is recommended that the leak is measured at several fan speeds, starting from a faster one and moving to a slower one.
3. On the dashboard in the Host Software, click on the "START RECORDING" button.
4. Go through Proceed through the Zeroing steps if the unit has not previously been zeroed.

5. Enter a name for the test and select a geofence if needed. (See section 3.2 for more information about geofences.)

6. Click on START RECORDING.
7. Position the end of the hand-held unit **away** from the leak. The fan will be in standby mode. Change from standby to the desired fan speed by clicking the button on the top of the handheld mode to cycle through the speeds. When you have selected the desired speed for this test, squeeze the Fan Control Button. Observe the graph on the screen.
8. The sampled flowrate will increase within 5-10 seconds and becomes steady. The graph will fill in with a gold color, indicating that the fan is running. Continue to hold the fan control button down.
9. The CH4 concentration (blue dots / line) will be visible. When both the flow and CH4 leak rate are steady, move the end of the HI-FLOW 2 to the leak. Sample the leak for at least **20-30 seconds**.



NOTE: Clicking on the "PAUSE" button will stop the graph from drawing on the screen. This will allow the user to get data from the graph. **The graph you see may not match these examples exactly.**

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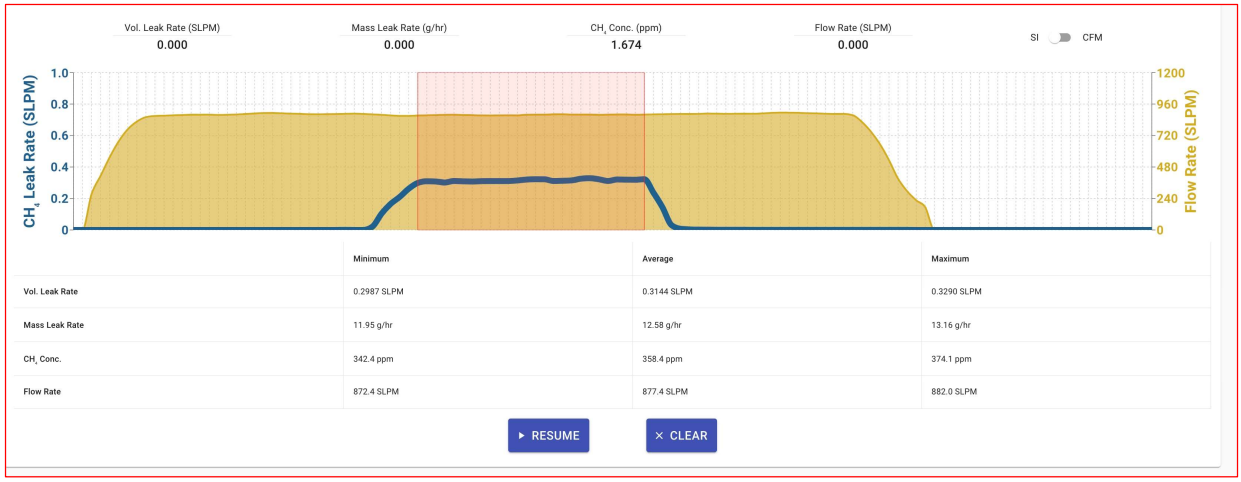
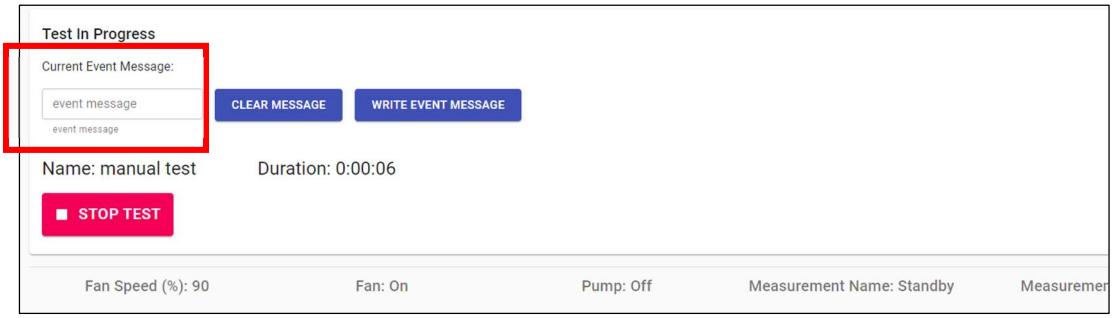
Selecting a section of the graph while paused will also show the minimum, maximum and average of the data across that section.



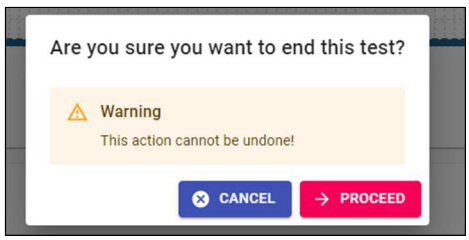
- To select a different range, click on “CLEAR”
- To return to the moving graph, click “RESUME. The blue dotted line will rise in the graph showing the methane concentration.

10. Continue to run the fan and move the end of the Handheld Unit away from the leak. This will purge out any CH4 from within the system.
11. When the CH4 concentration is back near background, release the Fan Control Button on the Handheld Unit.

NOTE: During the file recording, the user can enter “event messages” by writing an event message or clearing an old message. The Current Event Message is saved to the file at 1 Hz.



12. Click on the “STOP TEST” button on the screen to end recording data. There will be an alert on the screen asking if you want to stop the test. To confirm this, click “PROCEED”.



13. Repeat the test at decreasingly lower fan speeds.

Leak Testing in "GUI" mode:

The HI-FLOW 2 can be operated through the Wi-Fi connection using a remote device with a web browser such as a call phone, tablet, or laptop computer.

Choose a fan setting for the recording. At the time of testing, a series of tests should be run to record the leak at several fan speeds, starting with a higher speed and moving to a lower speed.

- The higher fan speeds should be used for larger leaks. For instance, tests at 90%, 80%, 70% can be recorded and compared.
- Testing smaller leaks can be recorded to medium speeds, moving to lower speeds. For instance, tests at 80%, 70% and 60% can be recorded and compared.
- If the recordings at the lowest speeds are different from the higher speeds, this means the tests at the lower speed did not read the leak accurately and can be deleted.

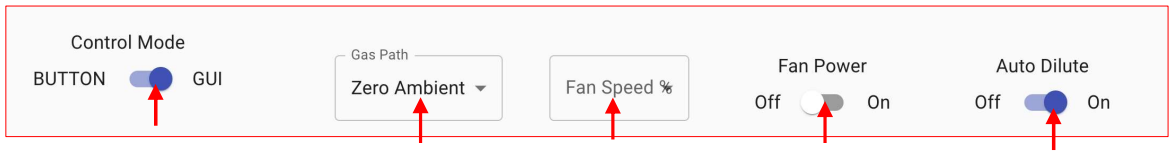
Leaks can be measured using pre-configured fan speed settings.

The GUI Control Mode controls the fan speed, turns the fan on and off, and controls the gas path manually. The LED lights will not indicate fan speeds as they do in the Button mode.

The default fan speeds are 90%, 80%, 70% and 60%.

Auto Dilute: This enables the system to automatically shift the dilution if the methane concentration goes above 8%. It is recommended to keep this setting "ON".

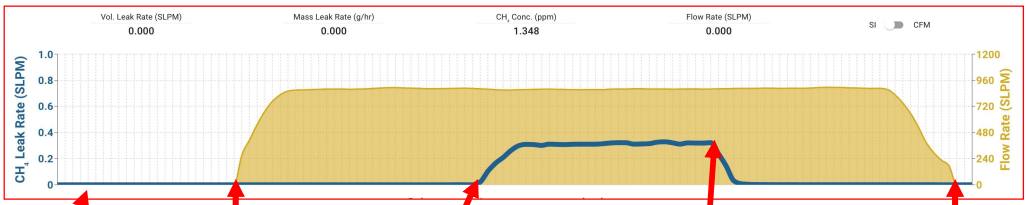
NOTE: These configurations can be modified through the "SETTINGS" page, which is password protected.



The leak measurement procedure combines positioning the end of the Handheld Unit and referring to the information from the host software.

1. Power on the Analyzer Unit and give it a several minutes to warm up. If the backpack is being used, put it on and fasten the front strap.
2. Decide on the fan speeds based on the recommendation in the previous section. Measure the leak at several fan speeds, starting from a higher percentage, and moving to a lower percentage. The default is 90% for the highest speed.
3. Start a new recording as instructed in steps 3

The graph in the host software indicates the status of the fan and the gas path.



Fan: OFF
Gas Path: Standby

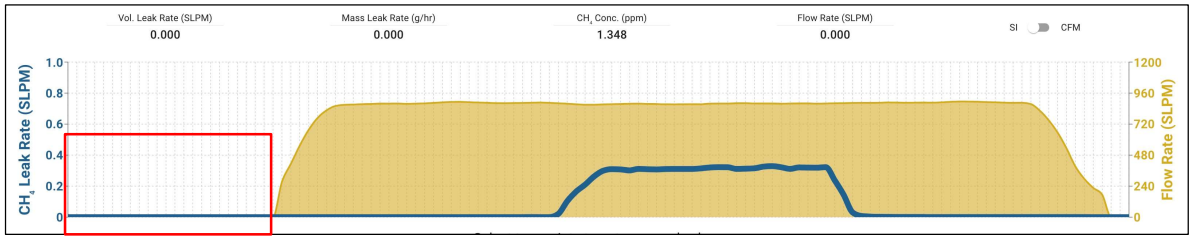
Fan: ON
Gas Path: Standby

Fan: ON
Gas Path: Sample

Fan: ON
Gas Path: Standby

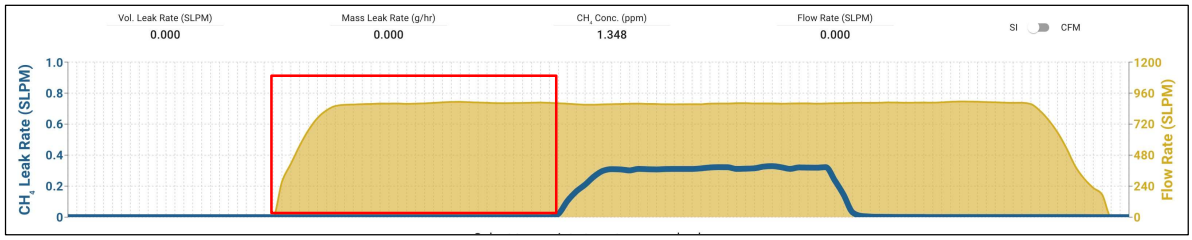
Fan: OFF
Gas Path: Standby

4. On the dashboard in the Host Software, START NEW RECORDING Enter a name for the test. If the unit has not been zeroed, follow the steps to zero the unit.

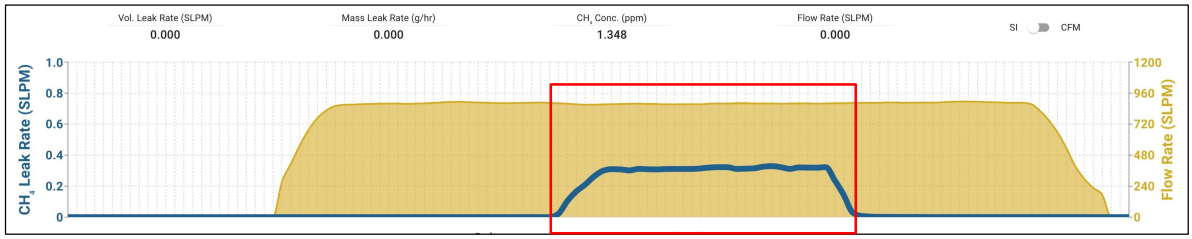


5. Position the end of the hand-held unit **away** from the leak. To start the fan, change the gas path to "Sample" change the fan speed to desired setting and turn the Fan Power to ON.

6. The sampled flowrate will increase within 5-10 seconds and becomes steady. The graph will fill in with a gold color, indicating that the fan is running.



7. The CH4 concentration (blue dots / line) will be visible. When both the flow and CH4 leak rate are steady, **move the end of the HI-FLOW 2 to the location of the leak**. Sample the leak for at least **20-30 seconds**. The blue dotted line will rise in the graph showing the methane concentration.



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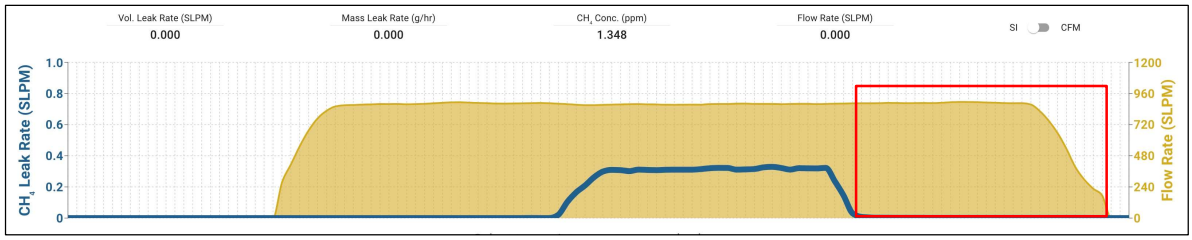
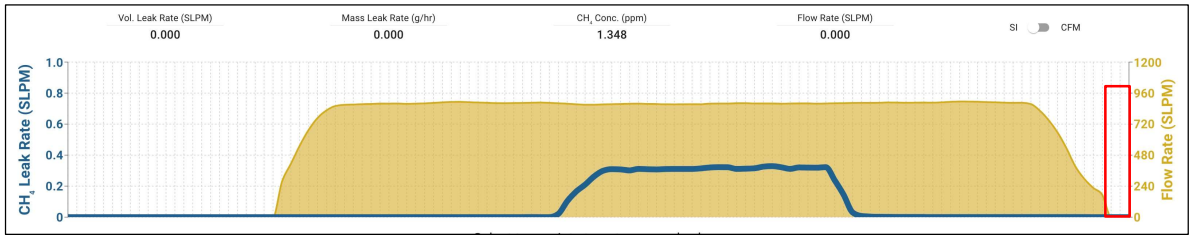
NOTE: Clicking on the "PAUSE" button will stop the graph from drawing. This will allow the user to get data from the graph. Selecting a section of the graph while paused will also show the minimum, maximum and average of the data across that section.

During the file recording, the user can enter "event messages" by writing an event message or clearing an old message. **The Current Event Message** is saved to the file at 1 Hz.

8. Move the end of the tube away from the leak.
9. Continue to run the fan. This will purge out any CH_4 from within the system.



10. When the CH_4 concentration is back near background, turn the Fan Power **Off** on the screen.



11. Click on the "STOP RECORDING" button on the screen to end recording data. There will be an alert on the screen asking if you want to stop the test. To confirm this, click "PROCEED".
12. Repeat the test at decreasingly lower fan rates.

3.1.4 RECORDING USING PRESETS (SCRIPTS)

3.1.4.1 RECORDING A TEST TO SUBMIT TO ACR

The SEMTECH HI-FLOW 2 is the only high flow methane sampler to meet the rigorous requirements outlined by ACR. ACR, (formerly American Carbon Registry) is a nonprofit enterprise of Winrock International, a leading carbon crediting program operating in global compliance and voluntary carbon markets. ACR reporting requirements are

detailed in "Methodology for the Quantification, Monitoring, Reporting and Verification of Greenhouse Gas Emissions Reductions and Removals from the Plugging of Orphaned Oil and Gas (OOG) Wells", available on the ACR website (https://acrcarbon.org/methodology/plugging-orphaned-oil-and-gas-wells/).

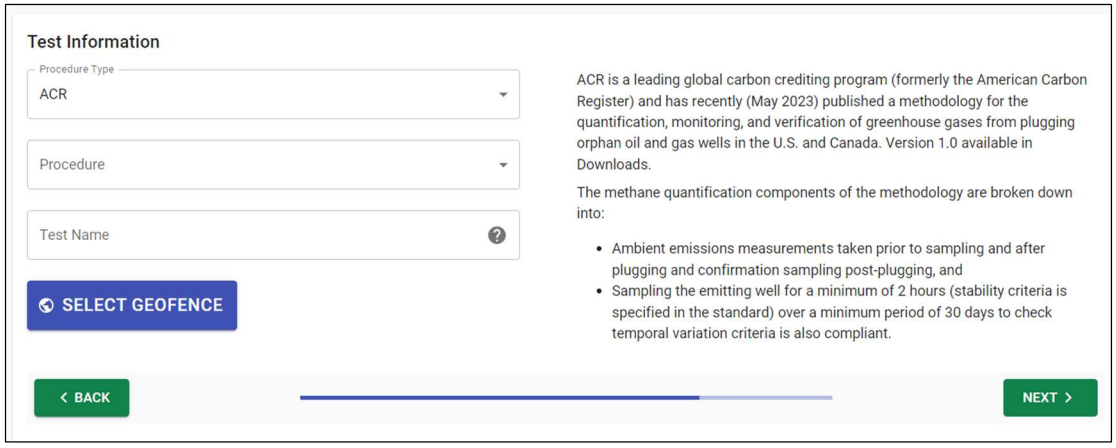
In order to generate reports aimed at meeting ACR's requirements, the HI-FLOW 2 Host Software is set up to run the test and report the results in a format that can be downloaded.

The preconfigured tests will run for the correct time automatically. During ACR testing, the buttons on the Handheld Unit and the GUI controls are disabled. The test can be halted at any time, but the test data will only be useful if the test is allowed to run completely.

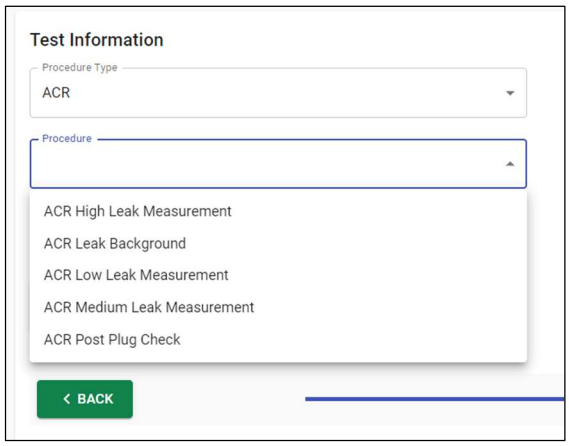
Refer to the table below for descriptions of the ACR test procedures.

Procedure	Instructions
ACR High Leak Measurement	Leak measurement should be taken at the unplugged well. This test will run for about 2 hours, sampling for 30 one-minute intervals, and requires no user input.
ACR Leak Background	Leak background should be taken upwind of the well that is being measured for this ACR test. This test will run for about 10 minutes and requires no user input.
ACR Low Leak Measurement	Leak measurement should be taken at the unplugged well. This test will run for about 2 hours, sampling for 7 ten-minute intervals, and requires no user input.
ACR Medium Leak Measurement	Leak measurement should be taken at the unplugged well. This test will run for about 2 hours, sampling for 13 five-minute intervals, and requires no user input.
ACR Post Plug Check	Post plug check should be taken within 5 cm of the ground, near the plugged well. This test will run for about 5 minutes and requires no user input.

1. Click on START A NEW TEST. If the user clicks through to the “Test Information” screen, the user will be prompted to select a procedure type select ACR”.

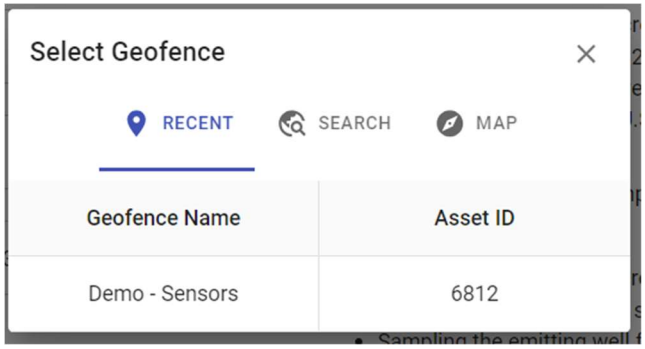


2. Select a type of test from the dropdown menu.



The test will automatically be named with the Procedure type and the date. This can be modified by the user (for example, if the user wanted to include the well number”.

A previously created geofence can be selected by selecting the geofence by name, by searching, or by selecting the geofence on the map. (For more information about geofences, refer to section 3.2.)



3. The test will finish and end recording automatically. Clicking the “Finish Test” button will cause the test to end, finishing out the current cycle. Report generation will still be guaranteed, but it may be shorter than the regulation criteria. The “Halt Test” button will end the test immediately and may prevent the report from being generated.

3.1.4.2 RECORDING A TEST USING PRESETS FOR OOOOB

The HI-FLOW 2 Host Software includes the ability automate the data collection and report generation compliant with EPA NSPS subpart OOOOb Rule (referred to here as OOOOb). This software automation greatly simplifies the tasks for the user, which would otherwise require numerous data recordings and data averaging. This version also automates the bi-annual calibration audits required for OOOOb and generates corresponding reports. The reports are stored on the HI-FLOW 2 for later retrieval. All OOOOb requirements for high flow sampling are easy to fulfill with the current HI-FLOW 2 host software.

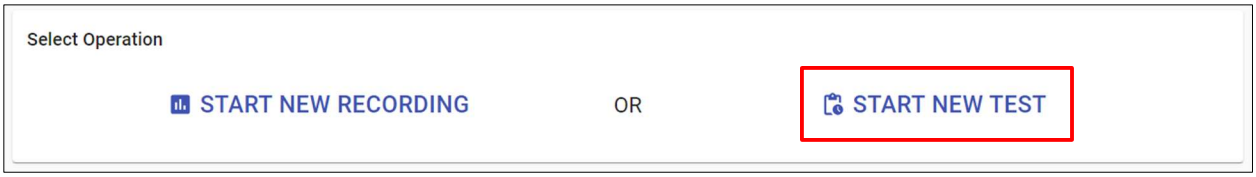
3.1.4.2.1 OOOOB TEST SEQUENCE

The OOOOb testing sequence will run automatically. It will take approximately 5 minutes, in which it will:

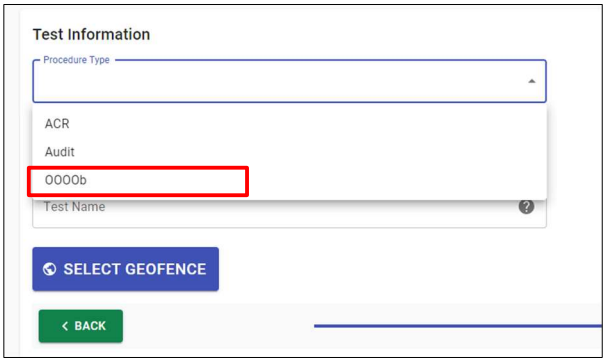
1. Test background levels for methane
2. Flush the tube
3. Sample and measure leak
4. Repeat steps 1-3 a total of 3 times
5. End the test

A report will automatically be generated upon completion of the test sequence. Each of the 3 leak measurements are graphed, adjusted for background measurements, and averaged in accordance with the OOOOb regulations. Each result is summarized in a table. The software also checks to verify that the measurements are consistent within the required tolerance, and pass/fail results are provided.

To initiate a OOOOb Compliant test sequence, start a new test:



and select OOOOb under “Procedure Type”.



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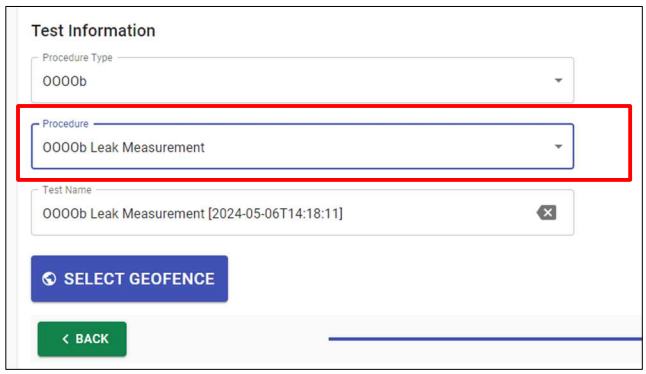
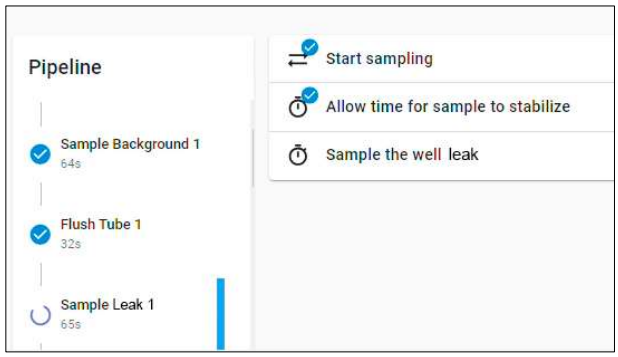
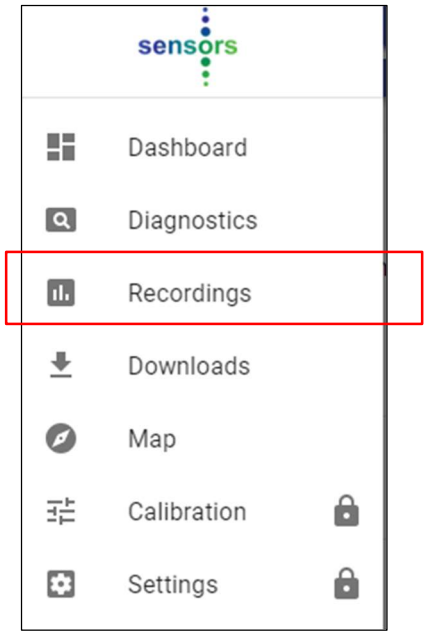
Select “OOOOb Leak Measurement” under Procedure. Once the test starts, the sequence will run automatically.



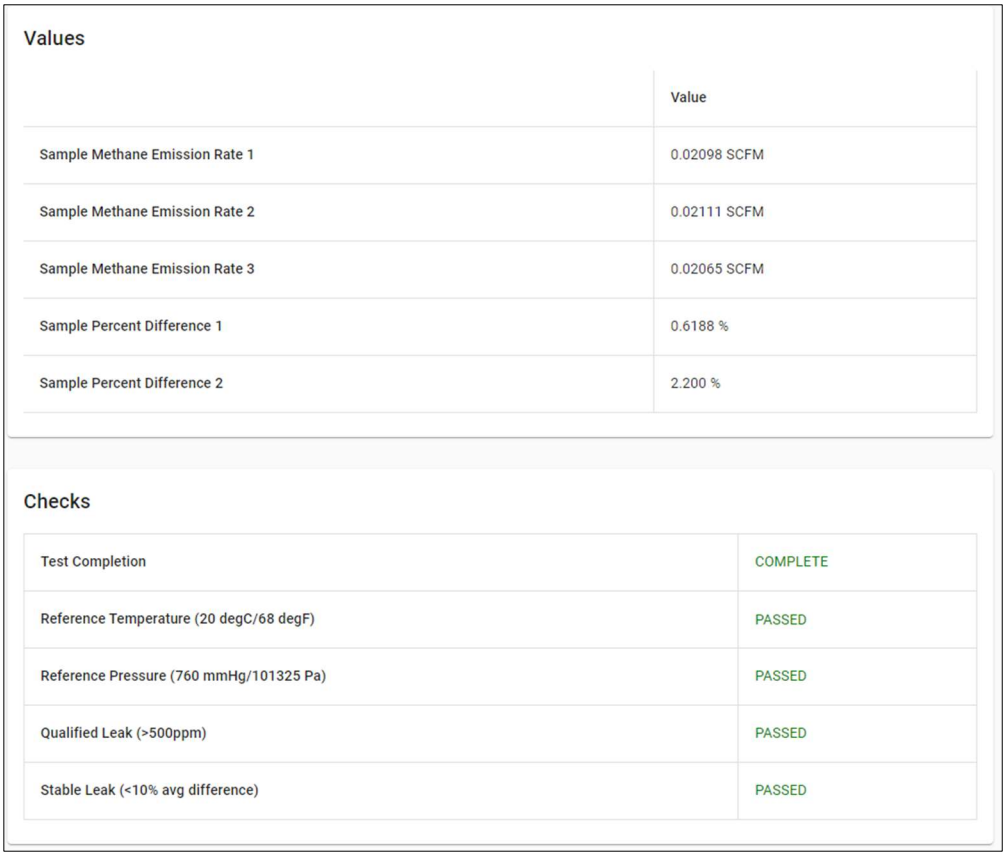
The testing sequence will end after about five minutes.



To access the report, navigate to Recordings. Reports can be downloaded or viewed in the browser as shown in the following example.



The report will include both data and PASS/FAIL for the required OOOOb requirements for high flow methane samplers.



Values

	Value
Sample Methane Emission Rate 1	0.02098 SCFM
Sample Methane Emission Rate 2	0.02111 SCFM
Sample Methane Emission Rate 3	0.02065 SCFM
Sample Percent Difference 1	0.6188 %
Sample Percent Difference 2	2.200 %

Checks

Test Completion	COMPLETE
Reference Temperature (20 degC/68 degF)	PASSED
Reference Pressure (760 mmHg/101325 Pa)	PASSED
Qualified Leak (>500ppm)	PASSED
Stable Leak (<10% avg difference)	PASSED

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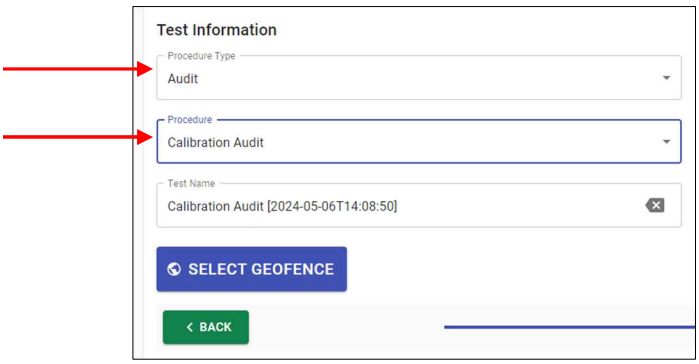
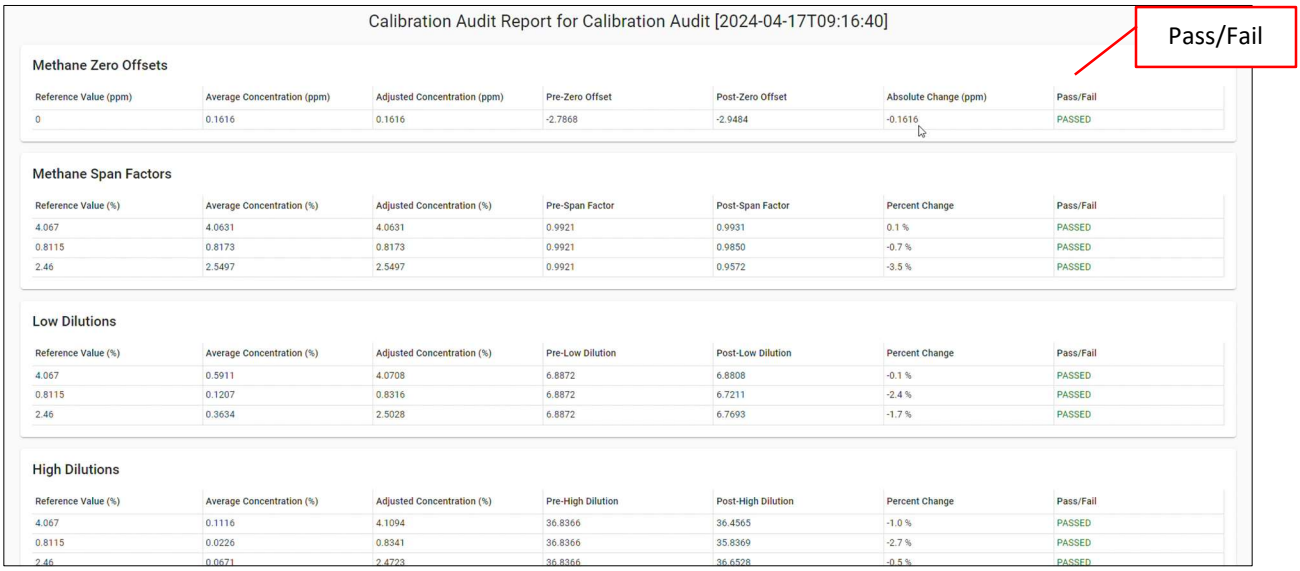
3.1.4.2.2 CALIBRATION AUDITS FOR OOOOB

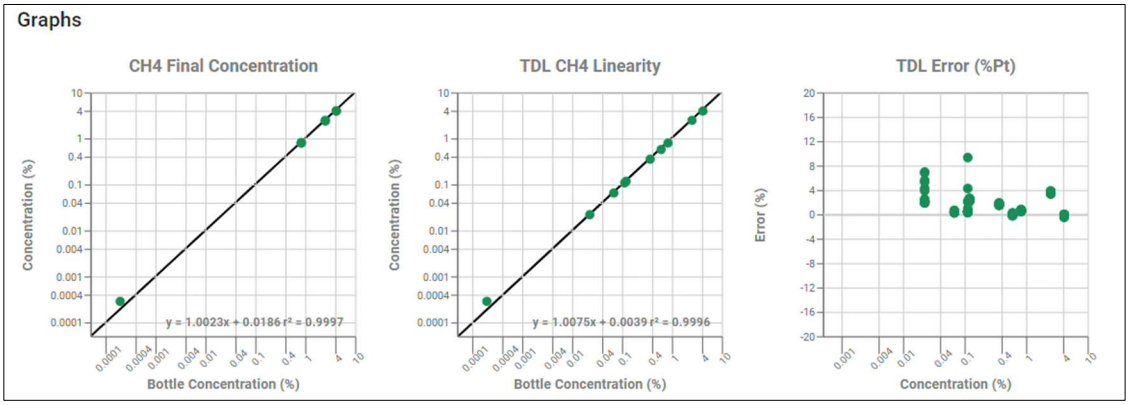
The full Calibration audit was designed with OOOOb biyearly regulations in mind, but has generalized use. The audit runs a zero, then span/low dilution/high dilution in cycle on three (configurable) different bottles. The Calibration Audit is accessed through the same steps as testing, but selecting “Audit”>”Calibration Audit”.



To locate reports, Go to “Recordings” on the side menu. Reports can be downloaded to viewed in the browser as shown in the following example.

The Calibration Audit Report provides data and Pass/Fail information.





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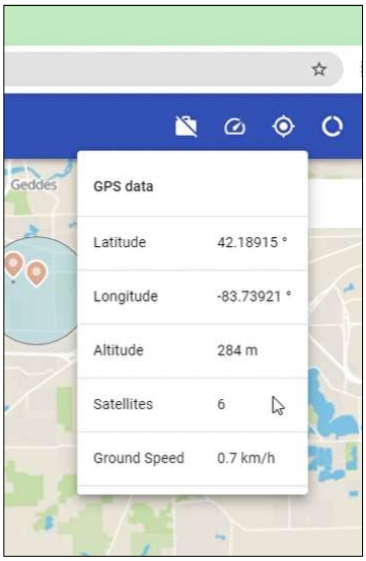
3.2 GEOFENCES AND GPS

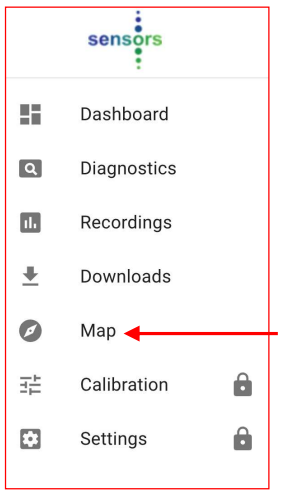
If the HI-FLOW 2 is able to detect satellites, the compass symbol will have a dot in the center and GPS data will appear in the menu.



Note that the HI-FLOW 2 will only display data in the top menu if the unit can detect satellites. This may not be possible inside a building or a vehicle. If the GPS does not detect satellites, the compass symbol will not have a dot in the center.

A geofence is a shape made of a set of points that identifies a location using latitude and longitude coordinates. Multiple HI-FLOW 2 recordings can use the same geofence. A geofence can be created without performing a test.

To access the geofence controls, select “Map” from the main menu on the upper left side of the window.



If the GPS is receiving signals from satellites, a compass icon will appear in the lower right corner. Clicking on the compass will center the map on the location of the HI-FLOW 2 and a pin with a person icon will appear on the map.

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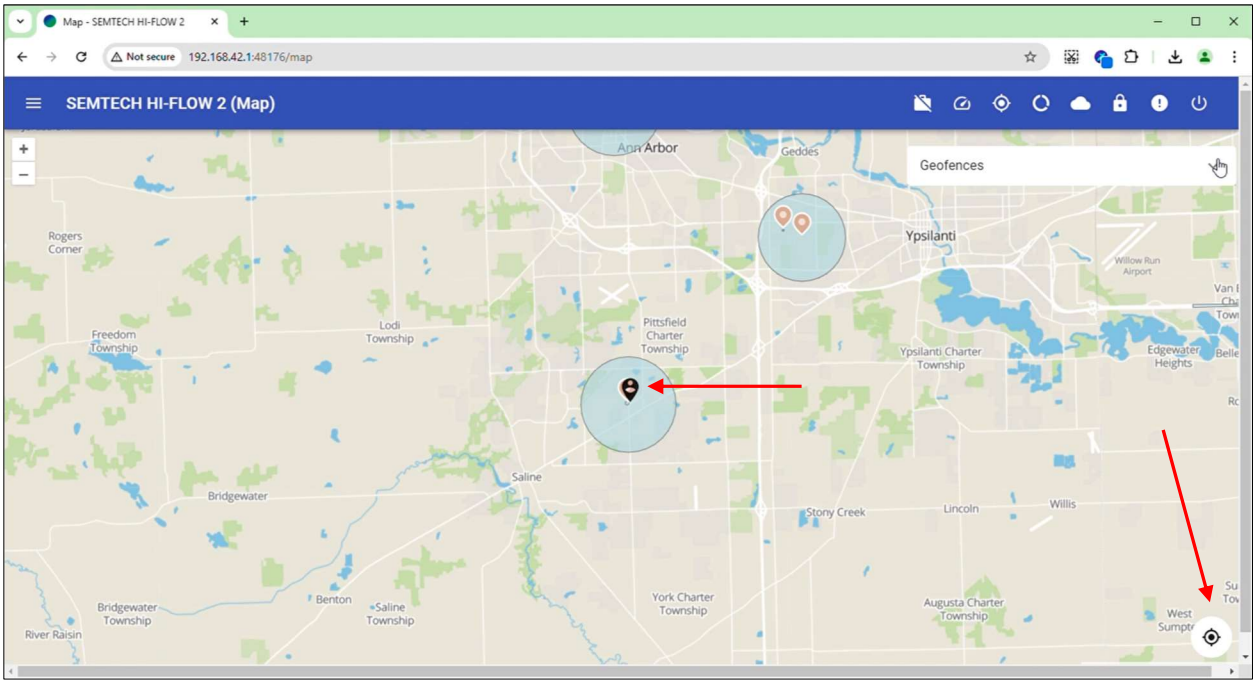

The map data is stored locally on the HI-FLOW 2. It does not depend on the GPS signal to draw geofences. The map has one display mode (basic colors with labels, no satellite view, or topographical information). The geofences that have been recorded by the unit are displayed as a list. Clicking on the name will zoom into the center of that geofence and a pin icon will be displayed with the name given to the geofence. Recorded geofences can be deleted but cannot be edited.

A new geofence can be created by clicking on the geofences button on the map page.

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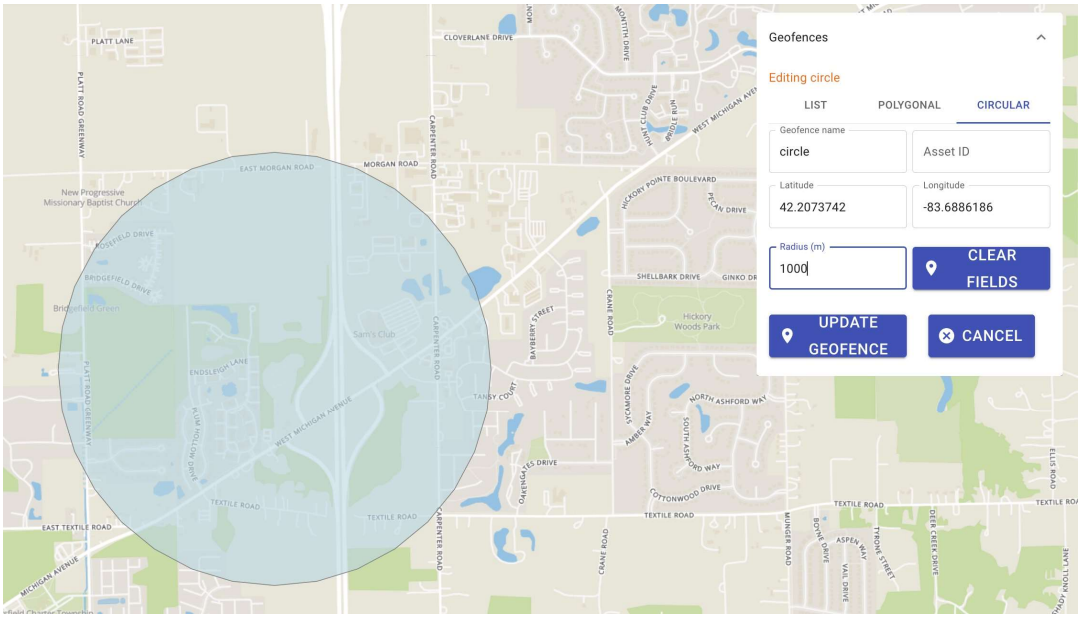
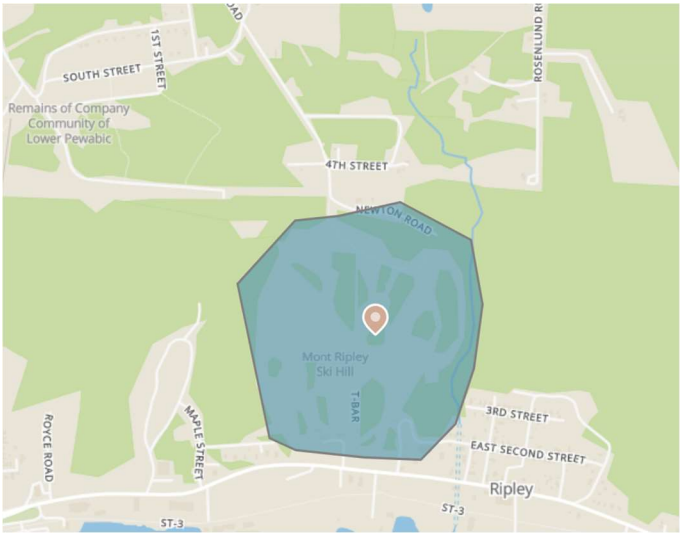
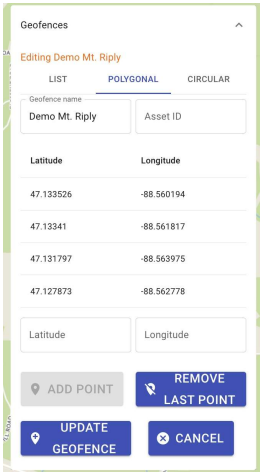
A geofence can be created as circle. Define the center point and the radius.



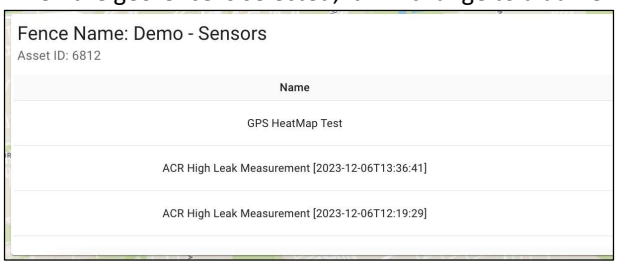
A geofence can be created as a polygon.

- Click on the Polygonal tab
- To create a polygon Geofence, click on “ADD POINT” to set the initial point and then move the cursor clockwise, click on additional points to define the shape of the polygon.
- To close the geofence, click on the circle of the pin of the first point. The pin color will shift when the cursor on the right part of the pin symbol.
- When the geofence shape is successfully closed, the “SAVE GEOFENCE” button will be activated and will change to blue.





- When the geofence is selected, it will change to a darker color. It can be deleted when it is selected.



- A Geofence can be assigned to a test. To view the tests with a specific Geofence assigned, click on the name of the test in the list on the Map page.

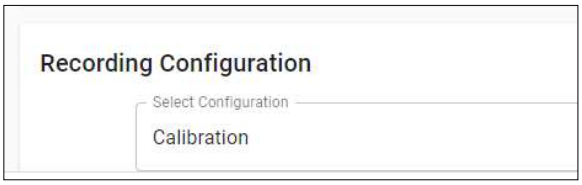
3.3 MANAGING TEST DATA

3.3.1 FILE CONFIGURATIONS

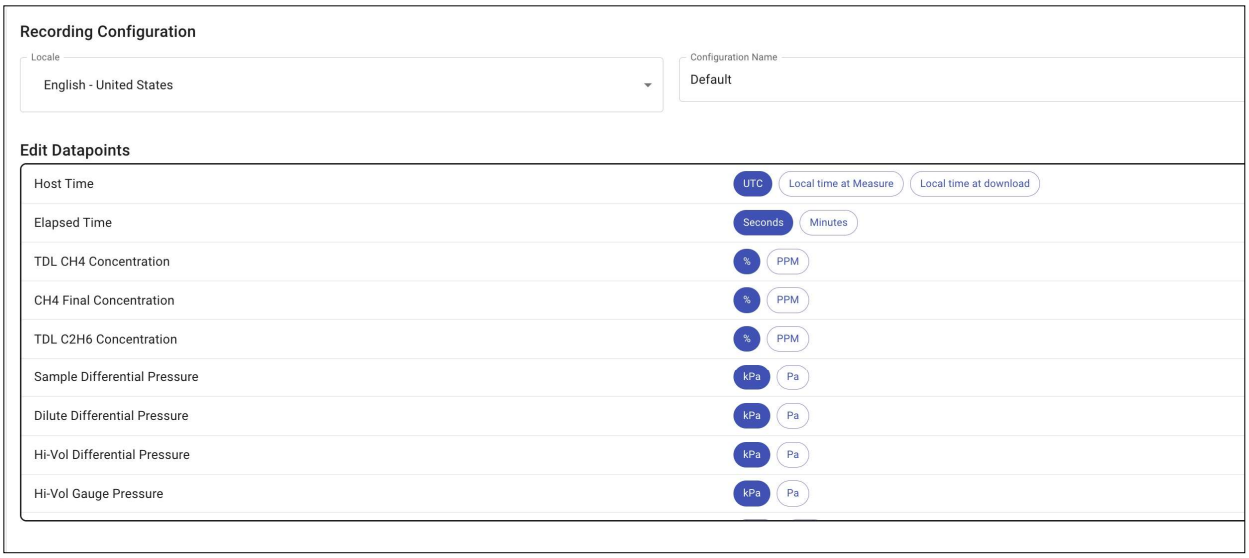
The Recording configuration file provides the ability to change the parameters and units when the file is downloaded. Navigate to the “RECORDINGS” page.

NOTE: The ability to change what parameters are downloaded with selected units (e.g., SI or imperial) is intended to provide flexibility for users in different continents and market applications.

NOTE: If the “Default” file configuration is selected the filename will be downloaded with the name displayed. However, if a custom file configuration is selected, the file name will be prefixed with the configuration name. This is illustrated below with a file named “Test-Power”. It is downloaded with two configurations: Default and Calibration.



The configuration format was created by adding a “NEW CONFIGURATION” and saving it at the bottom of the screen. In this example, the gas concentration data is selected to be downloaded in both % and ppm. The other relevant parameters are also selected with the selected units is applicable. These configurations can be edited.



NOTE: Flows reported under standard conditions are calculated using a reference temperature of 25°C and pressure of 101.325. For this testing program, the operator will need to manually select and average the methane leak rates for the tests performed.

3.3.2 MANAGING RECORDINGS

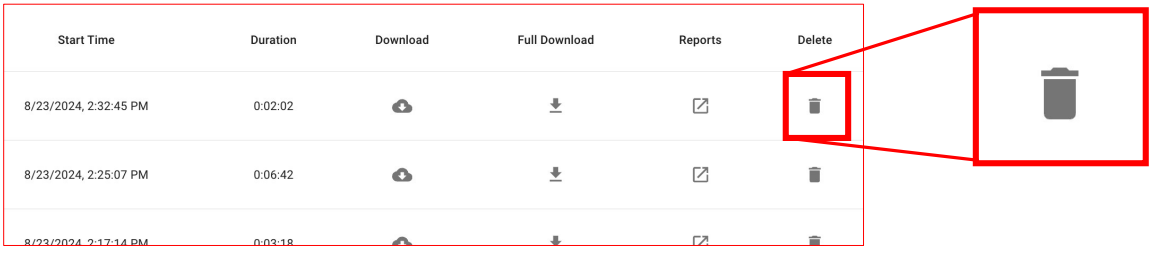
The Recordings page lists all of the recordings on the device, displaying 10 at a time. They are sorted from newest to oldest. The reports can be downloaded, deleted, and viewed through this page.

3.3.2.1 DELETING RECORDINGS

The test results can be reviewed. If tests are recorded at a very low fan speed, it may differ from tests run in the same location at higher speed.

Delete any files that are not needed in Recording History.

- To delete individual files, click on the trashcan icon in the same row as the file name.



- To delete multiple files, select the files and scroll down to the “MOVE SELECTED TO TRASH” button.

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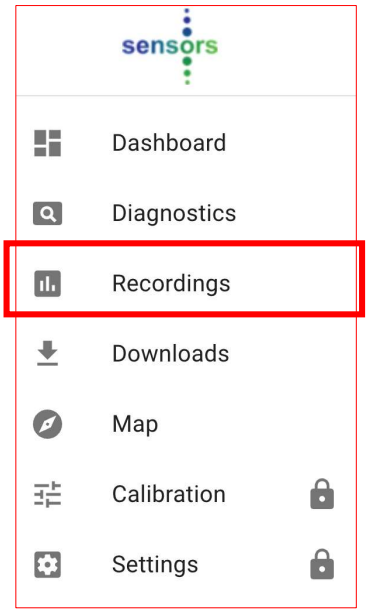
3.3.3 DOWNLOADING TEST DATA

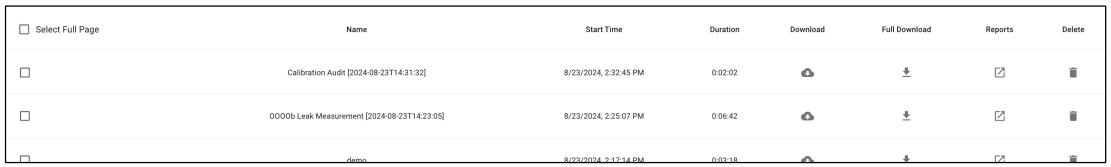
Files from testing can be downloaded.

When recording a file, the system saves the entire dataset on the internal SD Card. These files can be downloaded or deleted on the Recordings page.



NOTE: Data can be downloaded any time the HI-FLOW 2 is powered on and connected to a device through Wi-Fi.

There are two modes for downloading data. Clicking on the cloud icon in the row of a test will download **only the test data.** Clicking on the arrow icon in the row of a test will download the configuration file, along with calibration information, and the test data in a zip file.



Multiple files can be downloaded or the entire page of recordings can be downloaded. To download multiple files, click in the check box and scroll down to this section:

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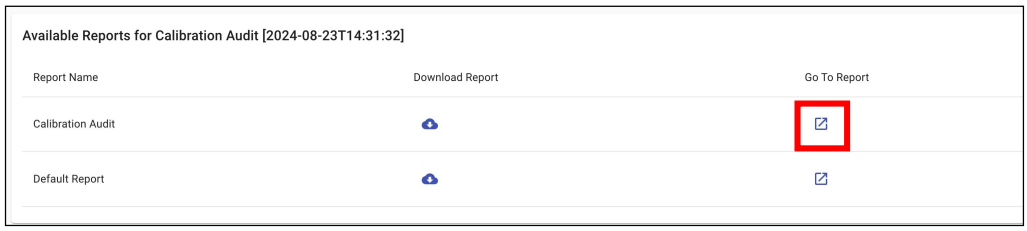
3.3.4 VIEWING A RECORDING

To view a report of a recorded test, click on the "expand" button below "Reports" on the Recordings page.



Detailed information about the csv file fields is included in the Technical Appendix Section 5.3 "Test Report Data Fields".

3.4 DIAGNOSTICS

The Diagnostics Page allows a diagnostics report to be generated which can be sent to Sensors to assess the functioning of the HI-FLOW 2.

To create a diagnostics report file:

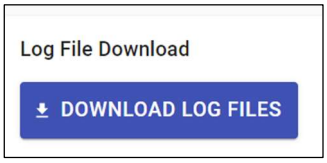
1. Go to the upper left menu and select **Diagnostics.**
2. Under **Recording** enter a test name (for example: the serial number of the unit, the date of the test). A geofence is not necessary for a diagnostics recording but may be useful to organize multiple diagnostics tests.
3. Click Start.
4. When the test recording is done, click on **Stop**, then **Proceed**.
5. To download the report, go to the menu in the upper left corner and select **Recordings**.
    a. Scroll down to the bottom of the page and select **Default** from the **Recording Configuration** menu.
    b. There are two options for downloading. The **Download** icon with the cloud will download only the test data. The **Full Download** option will create a zip file with test data and configuration/calibration files.

3.4.1.1 CALIBRATION DATA ON THE DIAGNOSTICS PAGE

Several Calibration measurements appear on the Diagnostics page. If the dates are highlighted with yellow, the machine has been calibrated more than a month earlier.

If the dates are highlighted in red, then the HI-FLOW 2 was calibrated longer than a year earlier. Contact service@sensors-inc.com for more information.

In addition to calibration files, a log file can be downloaded and sent to Sensors to assist with troubleshooting. Contact service@sensors-inc.com for more information.



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3.5 CALIBRATION

There are two levels of access for the password protected pages in the upper left menu. Logging in to the Calibration page only allows access to the Calibration page. Logging into the Settings page allows access to both Calibration and Settings.

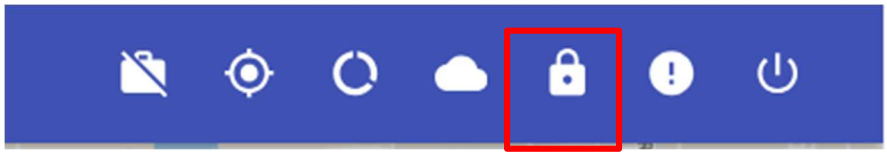
⚠ Only trained administrators of the HI-FLOW 2 should modify any settings in these pages.

- The Calibration page allows the user to calibrate and troubleshoot internal components of the Analyzer Unit.
- Go to Calibration on the menu on the upper left corner of the window.

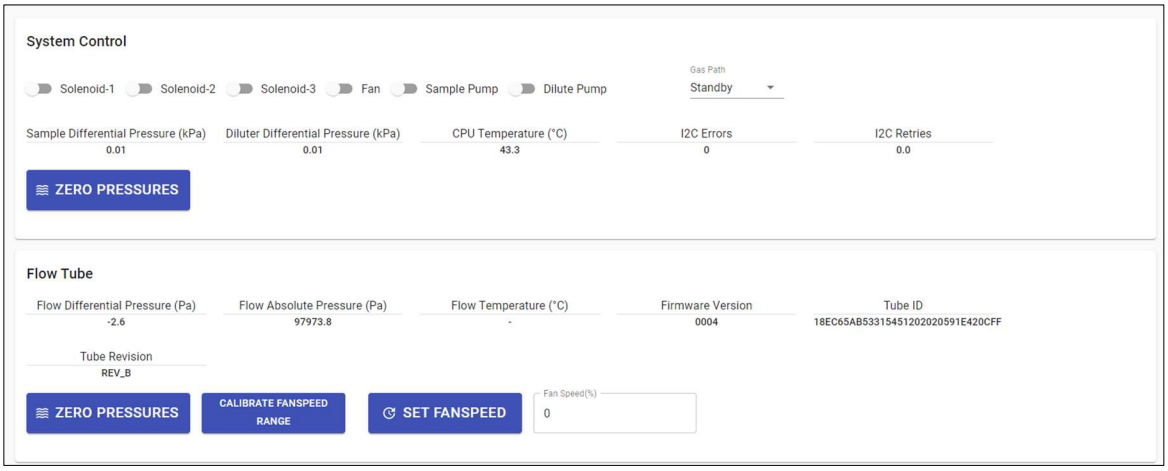
⚠ The Analyzer Unit cover should never be removed except by technicians at Sensors, Inc.

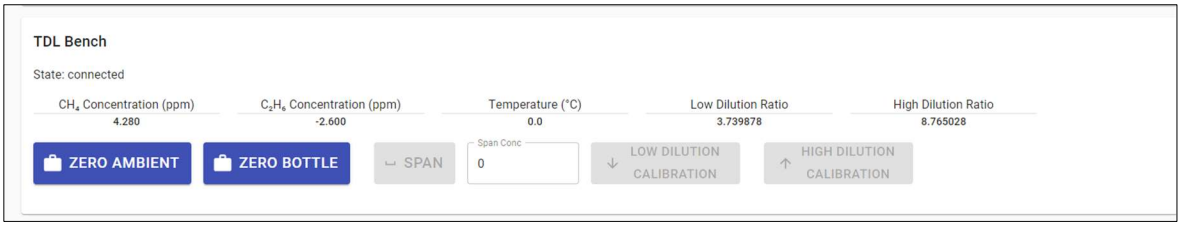
- The Calibration page is password protected. This is configurable but default is currently 1234.

When the password is entered the Calibration page is unlocked for the session. The page can be locked by clicking the lock button in the top right-hand corner of the screen.



The Calibration screen comprises 3 sections: System Control, Flow Tube and TDL Bench.





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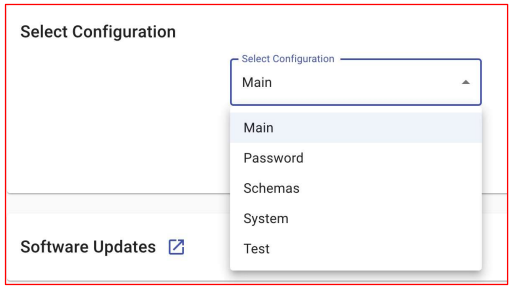
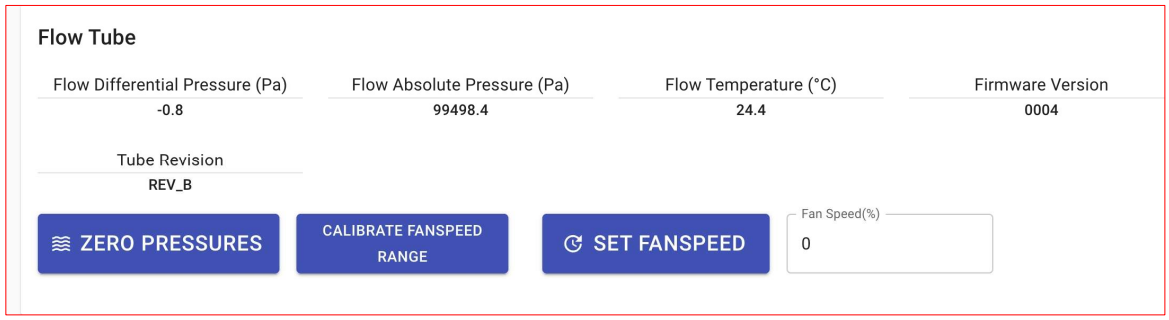
Main, Test and System configurations files can be uploaded and downloaded. Tube Config files can downloaded but not uploaded.



System Control and gas path options:

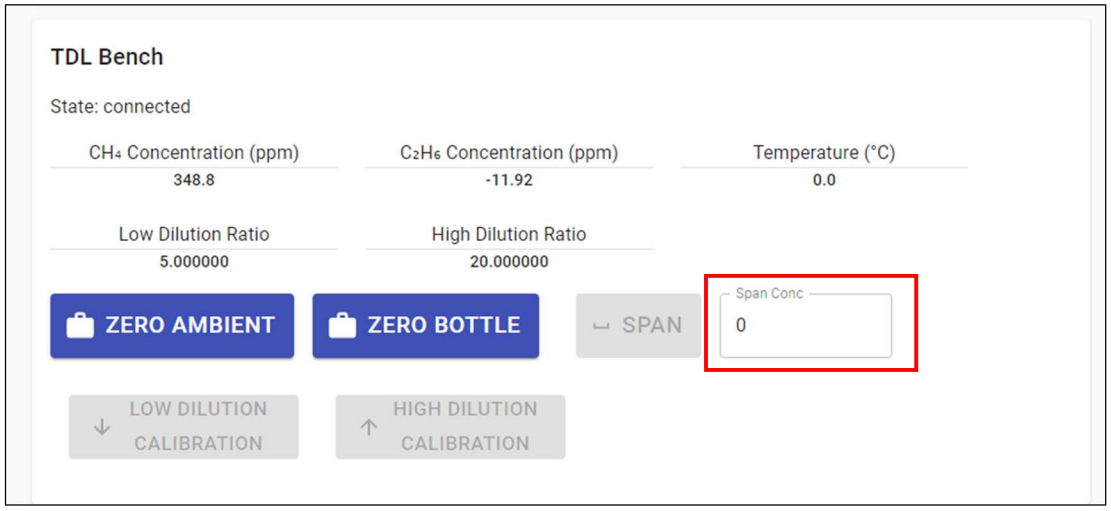
In the System Control section, the administrator can see and modify the manual configuration of the system by changing the Solenoid-1, Solenoid-2, Solenoid-3, Fan, Sample Pump and Diluter Pump status (Off or On). However, for simplicity, the **Gas Path** drop-down box can be used to select the most common configurations (Standby, Zero, Sample, Span, Low Dilution and High Dilution). The corresponding digital outputs for these are shown below.

In addition, the administrator can zero the pressure sensors used for the HI-FLOW 2 sampler and set the fan speed by entering a percentage. Note that below 40-50% the Fan speed is generally too low for the averaging Pitot to accurately measure the flowrate.



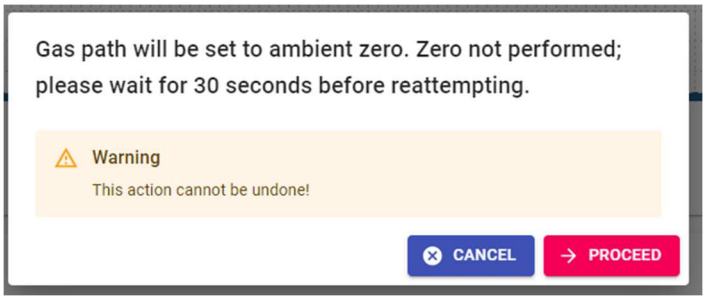
3.5.1.1 TDL BENCH

The internal methane specific tunable diode bench can be calibrated (zeroed or spanned) using the TDL Bench GUI panel located in the Calibration Screen. When you initially enter this screen, the Span, Low Dilution and High Dilution, control buttons are disabled and greyed out as shown below. To activate this button, the user MUST enter a valid span bottle concentration "Span Conc" in the input box. This should be entered in percentage NOT ppm.



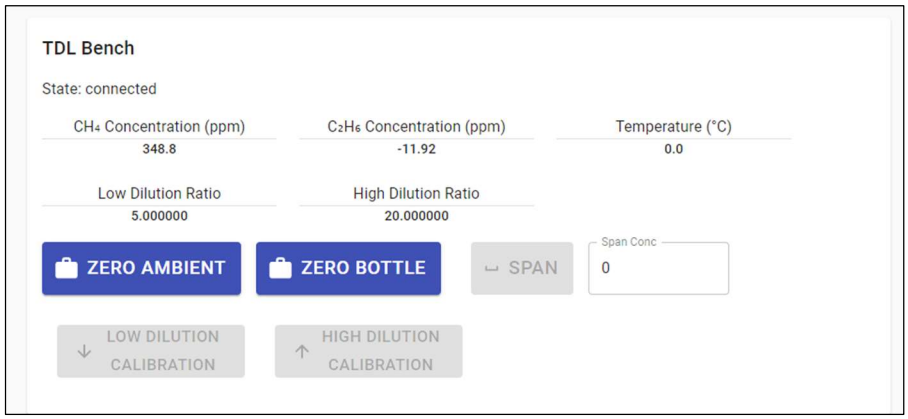
3.5.1.2 ZEROING

To perform a zero, the unit should be purged with clean air. If the user attempts to perform a zero function when the sample gas path is not set to zero, the following dialogue box will show.



Switch the gas path to zero gas and then perform a zero. The system will purge and collect data for 30 seconds and indicate a progress counter.

For most tests having a zero reading below 10ppm is sufficient to continue. Note that some testing locations may have elevated backgrounds.



Following a zero routine the unit is displaying -2ppm. DO NOT expect zero ppm to be displayed. No filtering is performed, and the numbers can be both negative or positive.

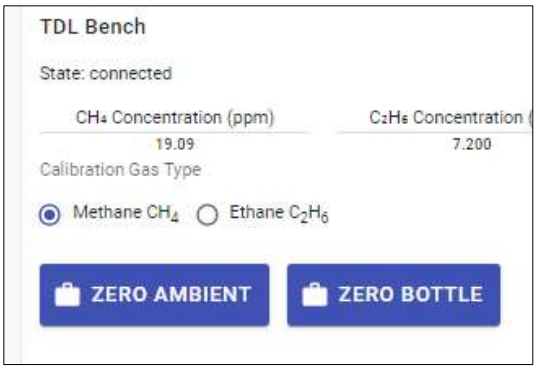
3.5.1.3 SPAN

Note: Sensors sells a calibration kit and has a recommended bottle/regulator for this step. For more information, refer to page 2.

The span operation is similar to the zero operation, but calibration gas MUST be provided to the sample inlet Swagelok fitting located on the analyzer. Note that it is preferred that a small excess flow is provided at this location and that both the excess flow and exhaust flows are vented in accordance with local safety guidelines.

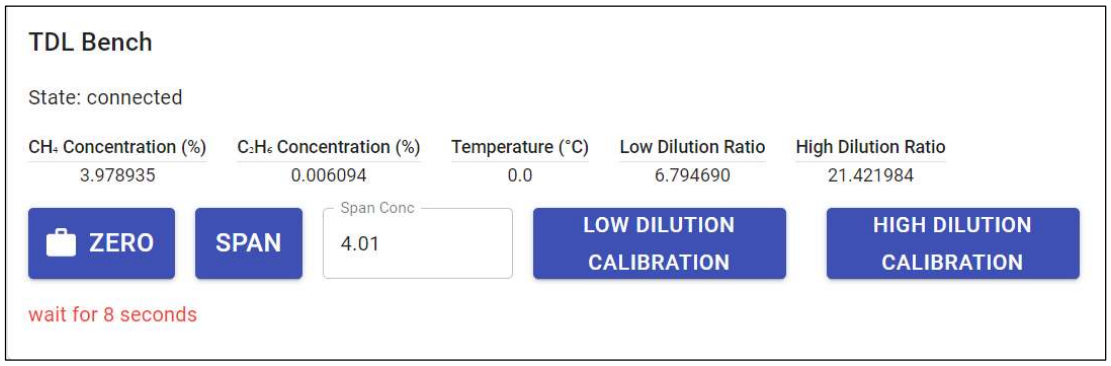
The unit is set to SPAN gas path and the reading allowed to stabilize. It is recommended to check that the reading is within 5% of the span bottle before performing the SPAN. The TDL is unlikely to require any significant adjustment and if the reading is outside this limit it is likely that the test set-up / bottle value are at fault.

1. On the calibration page, switch the calibration gas type to **Methane CH_4**.



2. Under “TDL Bench”, enter the bottle value for the methane bottle in “Span Conc (%)”. This value is the methane % value on the bottle’s label under mole %. Once entered, the LOW DILUTION CALIBRATION, HIGH DILUTION CALIBRATION, and SPAN buttons will change to blue.

3. Click on “SPAN”.



The system is configured with an internal low- and high-dilution system to facilitate the measurement of CH_4 up to 100%. The TDL upper limit is typically set in a configuration file is 8%. If the system measures a methane concentration above 8% the low-dilution configuration is turned on and the sampled gas is diluted by approximately 6:1. If the TDL still reads higher than 8% the high-dilution operation is activated (typically 10: to 20:1).

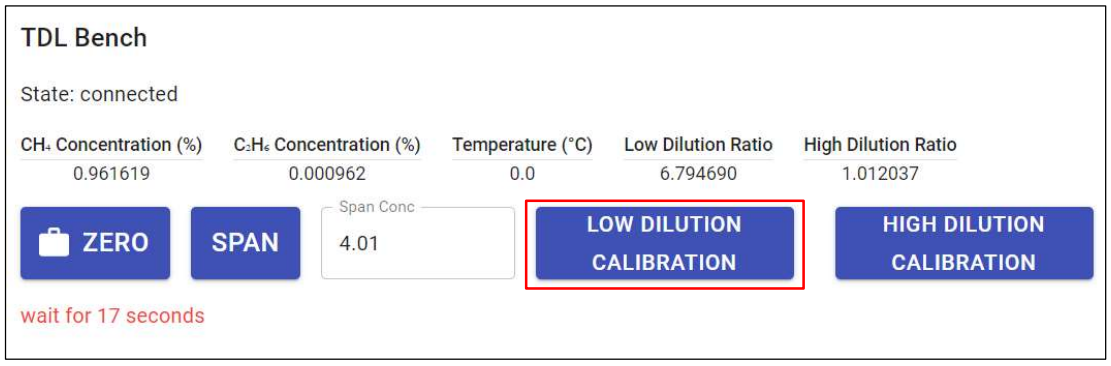
These two different dilution ratios can be calibrated using the span gas. These thresholds are controlled in the system configuration settings.

3.5.1.4 NO DILUTION

If the TDL is operating under the upper limit threshold (eg., 8%) the system operates with no additional dilution.

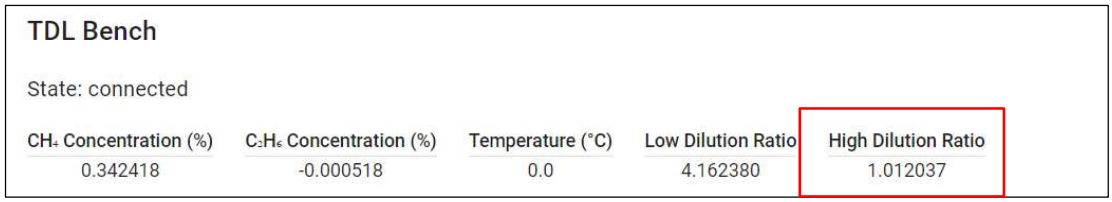
3.5.1.5 DILUTION CONTROL

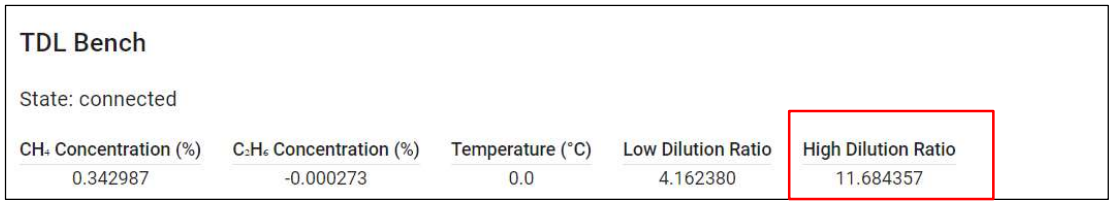
With an excess of span gas flowing at the gas inlet port, the unit is switched to Low-Dilution gas path. After the readings stabilize, click on the Low-Dilution Calibration button. The system will collect data for 30 seconds before making an adjustment to the Low-Dilution Calibration factor.



3.5.1.6 HIGH DILUTION

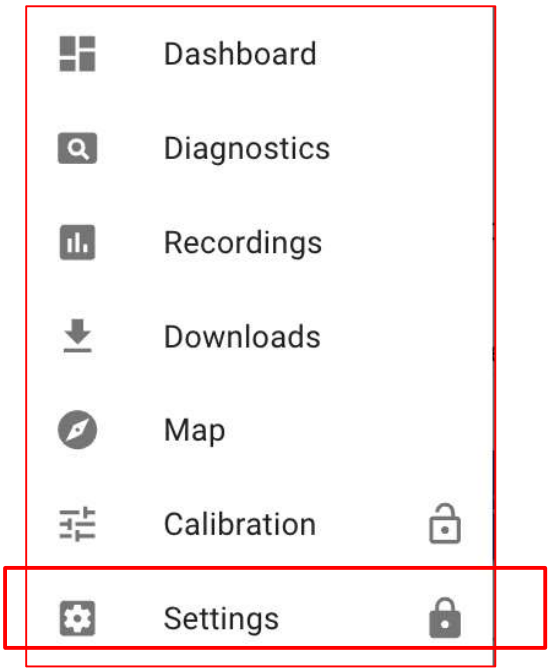
If an excess of span gas flows at the gas inlet port, the unit switches to High Dilution gas path. After the readings stabilize, and the High-Dilution Calibration button is clicked, the system will collected data for 30 seconds before making an adjustment to the calibration factor. In this example the factor is 1.01 (uncalibrated) before calibration and 11.68 after calibration.



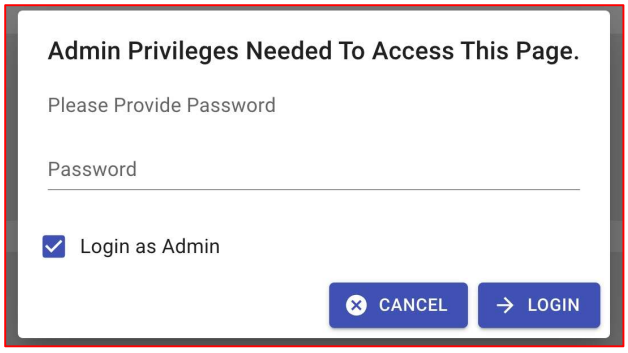


3.5.2 SETTINGS

The Settings page gives the administrator access to both the Calibrations page and the Settings page. Pull down the menu on the page to “Settings” and login. This is configurable, but default is currently 0987.



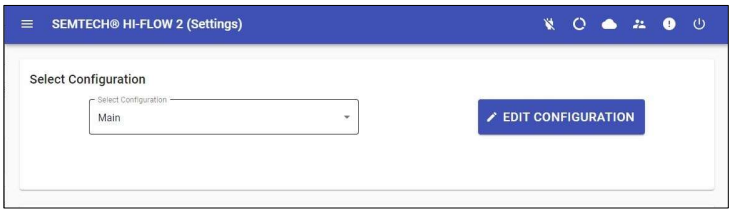
NOTE: Changing the settings away from the factory settings should only be done by trained personnel. If you have question about this, contact the distributor or the manufacturer.



The Settings page includes the following sections:

- Configurations
- Software Updates
- Database Options
- Config File Upload and Download
- Log File Download
- Time Settings
- Wifi Settings

The Settings page allows the administrator the ability to modify many of the settings of the internal components and some parts of the user interface. The edited configurations can be saved, and the unit can operate with the saved configurations.

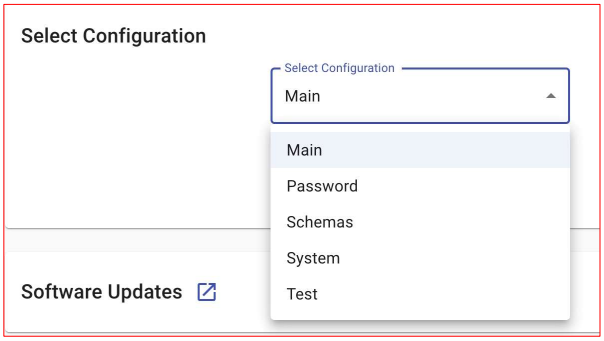


Warnings and status messages are displayed on the various pages to alert the user of any potential issues. When additional warnings are present, multiple warning boxes will appear. Many of the warnings are configurable and can be changed in the “Settings” page.

3.5.3 CONFIGURATIONS

NOTE: Changing the configurations away from the factory settings should only be done by trained personnel. If you have question about this, contact the distributor or the manufacturer.

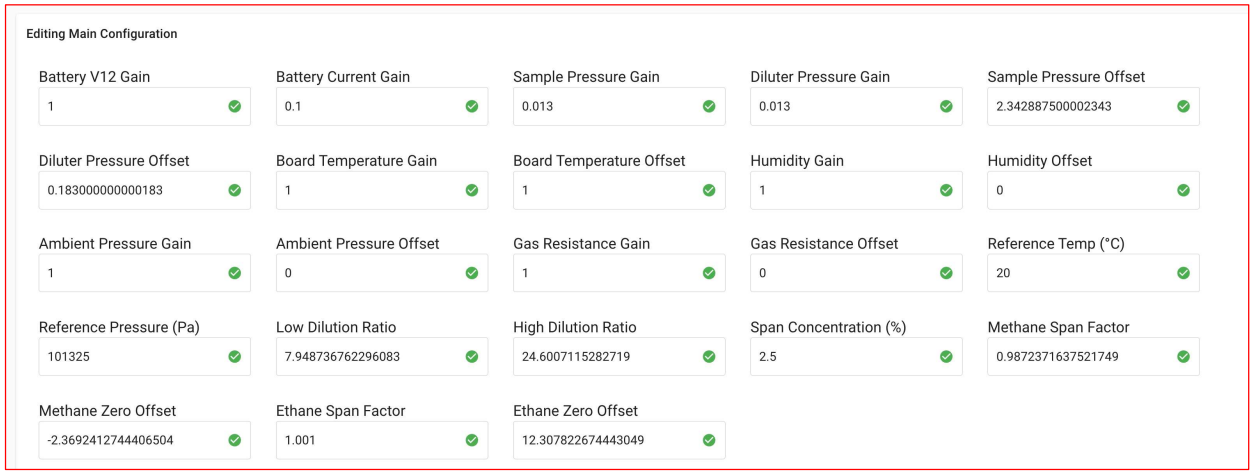
To open the configuration screens, use the drop down menu:



After viewing the individual configurations, click on “Back to Configuration Selection” below the configuration controls.

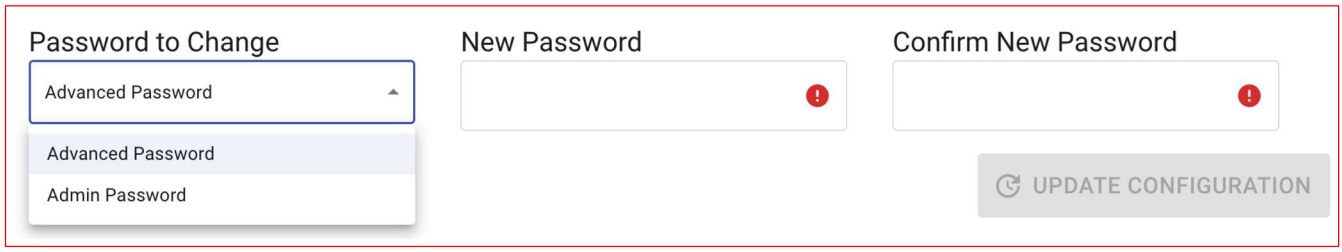
3.5.3.1 MAIN CONFIGURATION

The main configuration pertains to various hardware settings.



3.5.3.2 PASSWORD CONFIGURATION

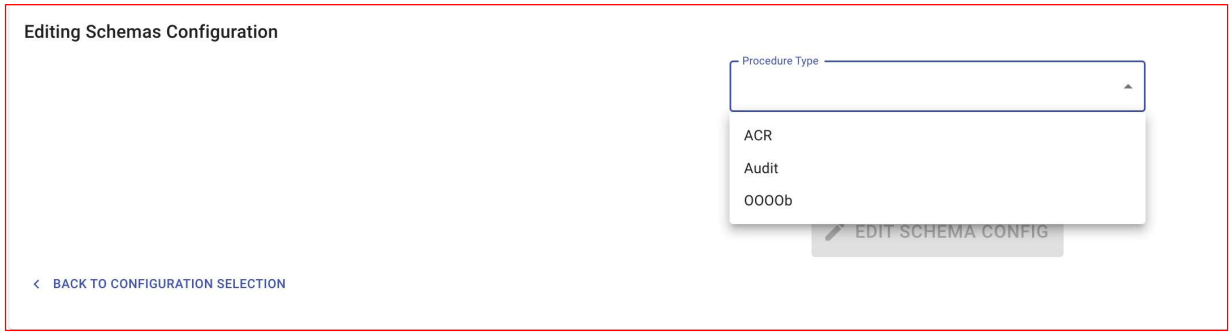
Advanced Password provides access to the options on the Calibration page. Admin Password provides access to both the calibration and the settings pages.



3.5.3.3 SCHEMAS

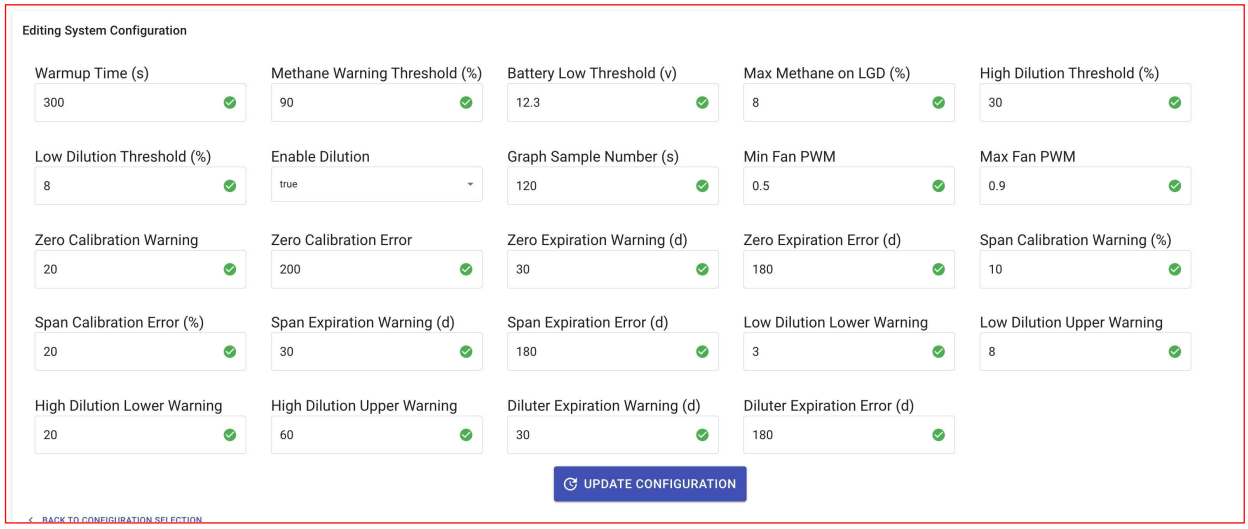
Schemas refer to the preset scripts that are available for third party testing and audits. The factory settings conform to the requirements for the required reports. Select the Procedure Type then select the appropriate option for the schema you are modifying.

NOTE: Consult with your distributor or with the manufacturer before changing any settings in this section.



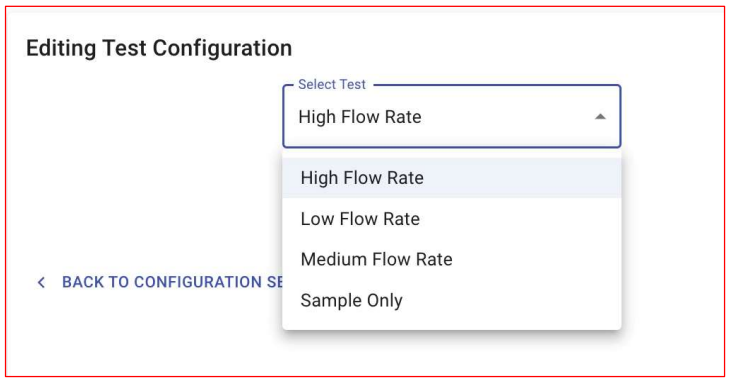
3.5.3.4 SYSTEM CONFIGURATION

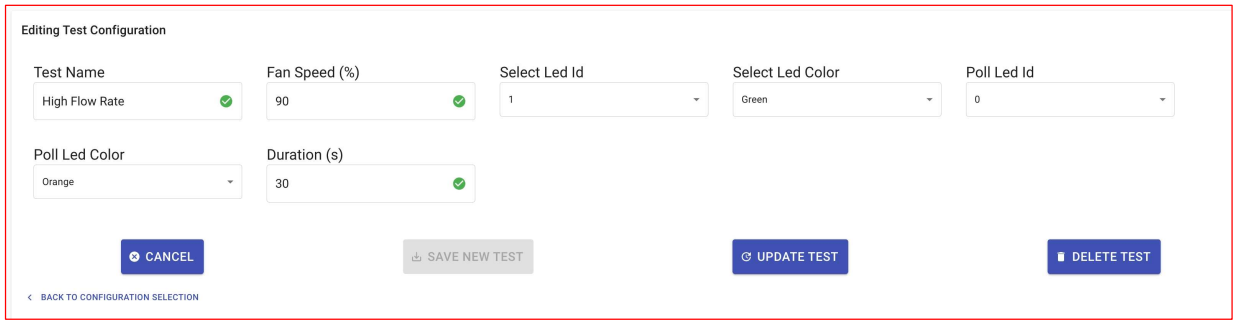
The System Configuration settings control ranges that the Host Software reports.



3.5.3.5 TEST CONFIGURATION

The Test configuration pertains to settings for the fan speeds and the settings on the handheld.





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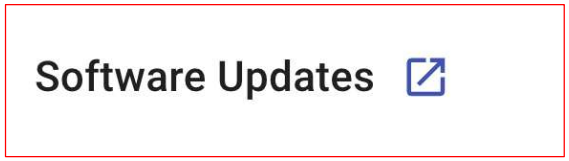
3.5.4 OTHER SETTINGS

3.5.4.1 SOFTWARE UPDATES



Software update can be emailed to customer to install onto their HI-FLOW 2. If you are sent a software update, it will be in the form of a tar file (with the extension ".tar"). Save your file on your computer. Click on the expand button shown above and follow the prompts.

3.5.4.2 LOG FILE DOWNLOAD

This option can help the service department investigate issues with the HI-FLOW 2.

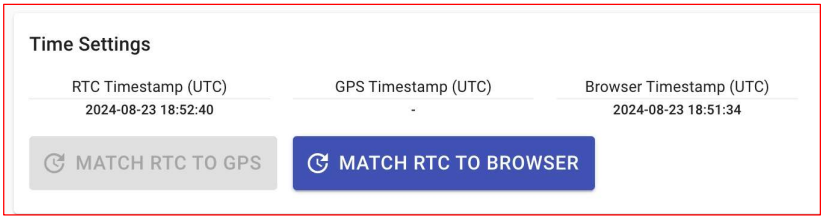
3.5.4.3 DATABASE OPTIONS

Run Data Removal is used to remove old recordings. "Download Database" is used to create a backup on a local computer. Customers will be given instructions for service if sending the unit is necessary. Do not upload any files to the database, as this can crash the system.

3.5.4.4 TIME SETTINGS

Setting the Real Time Clock: In Settings, select "**MATCH RTC TO BROWSER**".

The time will be displayed in UTC (Universal Time Coordinated). Confirm that it is correct. This website shows the current UTC https://www.utctime.net/



The Real Time Clock can be adjusted to match the time in the browser or GPS. The times may vary slightly because of the time it takes to set the time stamp in the Host Software. Set the RTC to match the browser by clicking on "MATCH RTC TO BROWSER".

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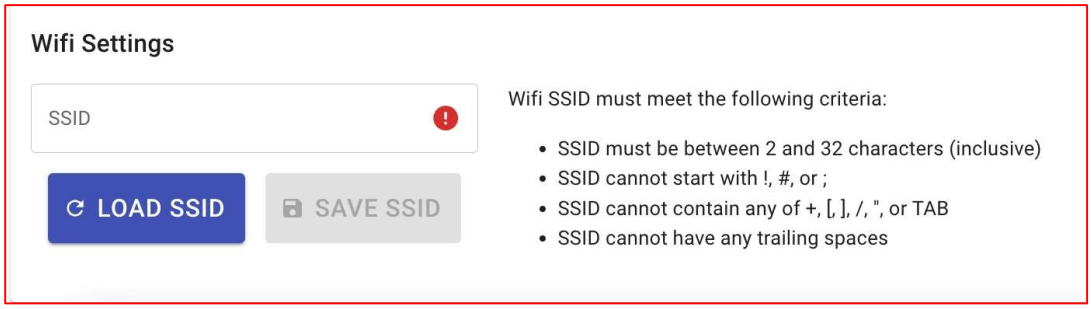
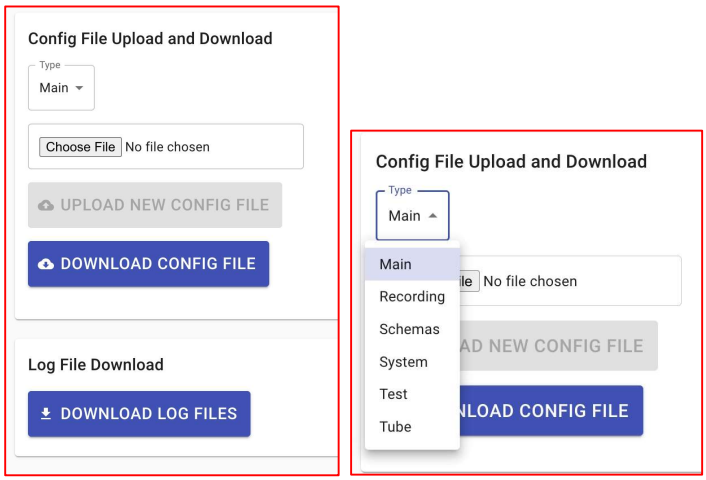
3.5.4.5 WIFI SETTINGS

The Wifi Settings can be customized. The default Wifi address is “HI-FLOW-2” followed by the serial number of the unit.



3.5.4.6 DOWNLOADING AND UPLOADING CONFIGURATIONS

Configuration files can be downloaded.



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4 DIAGNOSTICS & STORAGE

4.1 TROUBLESHOOTING

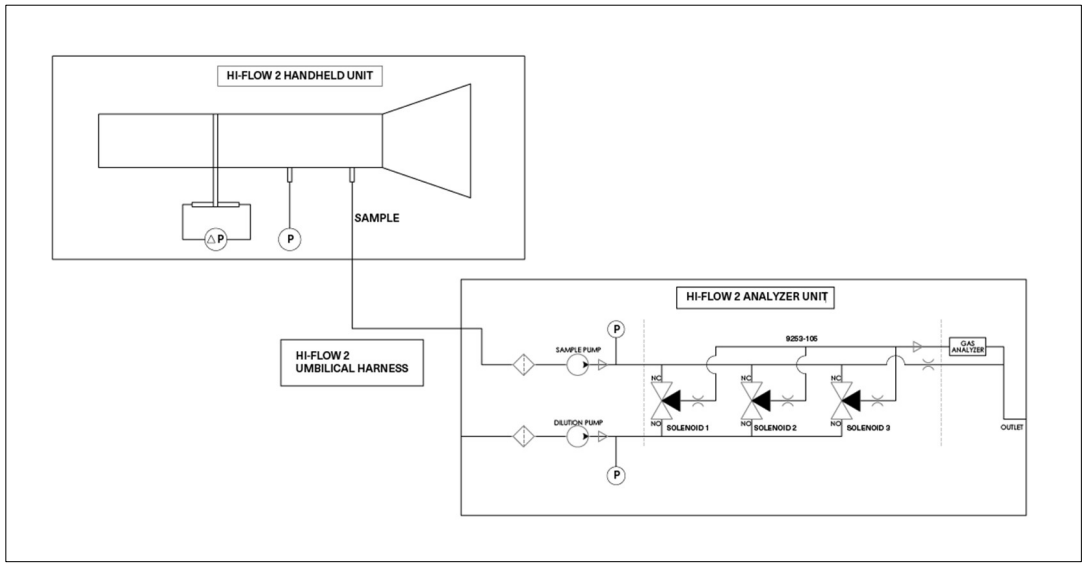
4.1.1 HOST SOFTWARE

The Host Software will display alerts if action is needed to operate the equipment. If there are repeated error codes, contact Technical Support at the end of the manual.

The Diagnostics Page (Section 3.4, page 26) may also provide information about the function of the internal components of the Analyzer Unit. **Do not open the Analyzer Unit to attempt to fix the equipment**. Always check connections and follow the operating procedures if the unit does not perform as expected.

5 TECHNICAL APPENDIX

5.1 FLOW DIAGRAM



5.2 MEASUREMENT PRINCIPLES

The fugitive volumetric leak rate can be determined by the following equation:

$$\boldsymbol{Q = V(C_{Sample} - C_{Background})}$$

Equation 1

Where Q is the leak rate (LPM), V is the total high-volume sampler flow rate (LPM), C_{Sample} is the sampled volume fraction concentration (%/100) and $C_{Background}$ is the ambient (surrounding) background concentration (%/100).

To ensure that the device is capturing all the gas that is escaping from the component, two or more measurements are often performed at different total flow rates. For example, the first measurement is taken at the highest possible flow rate, followed by a second measurement at a flow rate that is approximately 70–80% of the first. If the two calculated leak rates are within acceptable limits (e.g., 5% of each other) it can be concluded that the leak is completely captured.

Note that the surrounding air (in the close vicinity of the captured leak) MUST contain very little of the gas being investigated in order that quantification is accurate. From a practical perspective, the background concentration should be no more than 1% of the measured sample concentration or 100 ppm (vol) whichever is larger.

Thus, for fugitive methane leak quantification measurements, the internals of the HI-FLOW 2 sampler will be operated in an area in which explosive gas mixtures (predominately methane) are expected to occur in normal operation. However, the outside of the Handheld Unit and the Analyzer (which will normally be either located on the operator's back or on the ground nearby) will be in an environment where an explosive mixture is not likely to occur in normal operation.

5.2.1 METHANE CONCENTRATION MEASUREMENTS

The methane concentration is measured using a tunable diode laser spectrometer.

The volumetric concentration reported from the bench is converted to standard conditions assuming ideal gas behavior.

$$\boldsymbol{PV = nRT}$$

Equation 2

P = Pressure of sample (any units)

V = Volume of sample (any units)

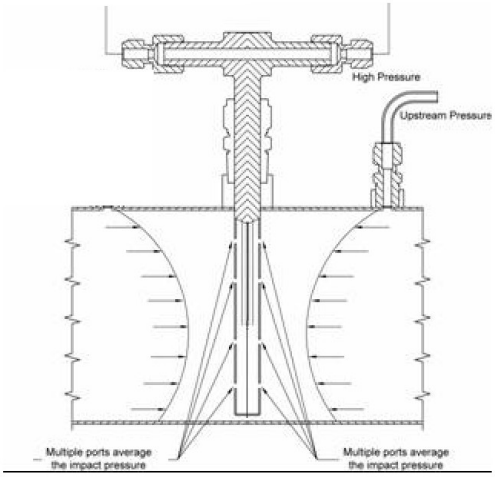
n = molar amount of sample (any units)

T = Temperature of sample (absolute units, e.g., Kelvin)

R = Ideal gas constant

5.2.2 HIGH VOLUME SAMPLER FLOWRATE DETERMINATION

- The high-volume sampler flow rate in the Handheld Unit is measured using an averaging pitot tube.
- Benefits of Pitot tube meter principle
- Low-power and safe electronics.
- Low pressure drop.
- Minimal change in gas density across meter.
- Minor influence of gas viscosity (Reynolds number discharge coefficient correction).
- Flow geometry is not changed by meter, which simplifies calculations.
- Institutional knowledge.



Averaging Pitot Cross Section

The Pitot measurement operates under Bernoulli principle and by placing a tube into the gas stream and allowing gas to flow into the tube and stop completely, generating a "total pressure" equal to the pressure of the gas in the stream (the "static pressure") plus the pressure the gas exerts when slowed to a stop. The average flow rate of the gas is then calculated as

$$\boldsymbol{Q = A\,K\sqrt{\frac{2}{\rho_s}(p_{total} - p_{static})} = A\,K\sqrt{\frac{2}{\rho_s}\Delta p}}$$

Equation 3

$Q =$ Flow rate ($m^3\ s^{-1}$)

$A =$ Cross sectional area of sample tube (m^2)

K = Pitot Discharge Coefficient (unitless)

$\rho_s =$ Density of sample ($kg\ m^{-3}$)

$p_{total} =$ Pressure at pitot tube (Pa)

$p_{static} =$ Pressure at static port (Pa)

$\Delta p =$ Measurement of differential pressure sensor (Pa)

The density of the gas sample, ρ_s , is a function of temperature, pressure, and gas composition. The effect of composition is also significant, as shown in the table – at room temperature, methane is only half the density of air. Additionally, the density of air decreases significantly with the presence of water vapor. It is expected that the gas to be sampled by SEMTECH HI-FLOW 2 sampler will contain atmospheric gases (O_2, N_2, water vapor, <1% other gases) and natural gas products (>85% methane, <5% ethane, <1% other hydrocarbons, balance N_2).

Air	1.225
Water Vapor	0.013
Methane	0.657
Ethane	1.356

Density of pure gases at room temperature, in kg m-3

Methane and water are likely to be the largest contributors to gas density variation in the measurement. The density calculation must therefore include both a water vapor measurement (via humidity sensor) and a methane measurement (via the methane gas analyzer). As ethane has a density within 10% of air and is unlikely to ever be present in quantities above 10%, it is reasonable to not measure this gas but include this potential source of error. Using these measurements of water vapor and methane, density is calculated using

$$\boldsymbol{\rho_s = \frac{P}{RT} M_s = \frac{P}{RT}(x_a M_a + x_w M_w + x_m M_m)}$$

Equation 4

$P =$ Pressure of sample at flowmeter (Pa)

$T =$ Temperature of sample at flowmeter (K)

$R =$ Ideal gas constant (m^3 Pa K^{-1} mol^{-1})

$M_s =$ Molar mass of sample (kg mol^{-1})

$x_a =$ Molar (or volumetric) fraction of dry air in sample (unitless)

$x_w =$ Molar (or volumetric) fraction of water vapor in sample (unitless)

$x_m =$ Molar (or volumetric) fraction of methane in sample (unitless)

$M_a =$ Molar mass of dry air in sample (kg mol^{-1})

$M_w =$ Molar mass of water vapor in sample (kg mol^{-1})

$M_m =$ Molar mass of methane in sample (kg mol^{-1})

Using the above equations, the rate of collection of methane into the system, $\dot{n}_{ms}$, can be evaluated.

$$\boldsymbol{\dot{n}_{ms} = x_{CH4} A_{CS} \sqrt{\frac{2P}{(1 - x_w - x_m)M_a + x_w M_w + x_m M_m)RT} \Delta p}}$$

Equation 5

$\dot{n}_{ms} =$ Molar flowrate of methane into the system (mol s^{-1})

$x_m =$ Molar fraction of methane measured by gas detector array (unitless)

$x_w =$ Molar fraction of water vapor measured by humidity sensor (unitless)

$A_{CS} =$ Cross sectional area of sample tube (m^2)

$P =$ Pressure of sample at flowmeter (Pa)

$T =$ Temperature of sample at flowmeter (K)

$R =$ Ideal gas constant (m^3 Pa K^{-1} mol^{-1})

$M_a =$ Molar mass of dry air (kg mol^{-1}) (a constant)

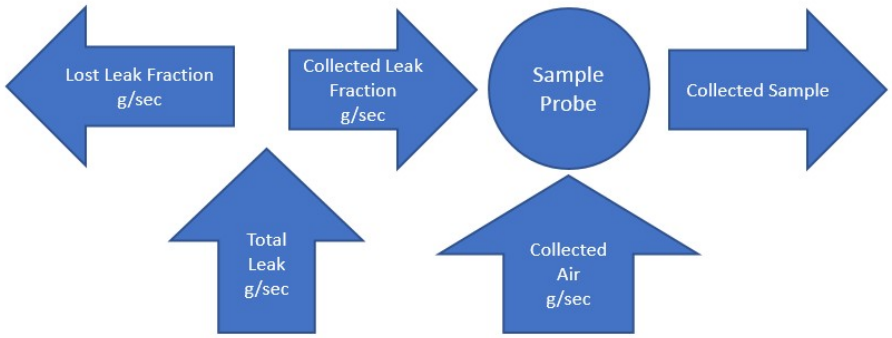
$M_w =$ Molar mass of water vapor (kg mol^{-1}) (a constant)

$M_m =$ Molar mass of methane (kg mol^{-1}) (a constant)

$\Delta p =$ Measurement of pitot-static differential pressure sensor (Pa)

5.2.3 CAPTURE EFFECTIVENESS

The flowrate of methane into the instrument is not necessarily the flowrate of the leak itself. Some fraction of the leak may be lost to air, and air collected by the probe may itself contain a small amount of ambient methane. An illustration is shown below.



Mass balance of HI-FLOW 2 Sampler

The instrument must therefore determine:

- The fraction of methane in ambient air
- The fraction of the methane leak captured

The relationship between these values and the instrument flowrate and methane concentration are defined as:

$$\dot{n}_s = \dot{n}_a + f\dot{n}_{ml}$$

Equation 6

$$\dot{n}_{ms} = \dot{n}_s x_{ms} = \dot{n}_a x_{ma} + f\dot{n}_{ml}$$

Equation 7

$\dot{n}_{ms}$ = Molar flowrate of methane in sample (mol s^{-1})

$\dot{n}_s$ = Molar flowrate of sample (mol s^{-1})

$\dot{n}_a$ = Molar flowrate of ambient air collected (mol s^{-1})

x_{ms} = Molar fraction of methane in sample (unitless)

x_{ma} = Molar fraction of methane in ambient air (unitless)

f = Fraction of leak captured (unitless, $0 \le f \le 1$)

$\dot{n}_{ml}$ = Molar flowrate of total methane leak (mol s^{-1})

Distant from the leak, the leak capture fraction $f = 0$ is zero regardless of flowrate. Therefore, $\dot{n}_s = \dot{n}_a$, and $x_{ms} = x_{ma}$. That is, the flowrate of sample and ambient are equal, and the concentration of sample and ambient are equal.

Near the leak, the leak capture fraction varies from $f = 0$ to $f = 1$. Increasing flowrate will capture greater amounts of the leak. It is important to note that the fraction of ambient air captured vs. the methane leak may either increase or decrease at $f < 1$, depending on the geometry of the leak source and the probe. That is, one cannot use the "peak" methane concentration to verify $f = 1$, as x_{ms} may reach a maximum value at conditions below $f = 1$.

The point of total leak capture can instead be found by varying the sampling rate $\dot{n}_s$ and determining how the slope of the measurement $\dot{n}_{ms}$ is affected. By taking the derivative of equation 7, we can see

$$\frac{d\dot{n}_{ms}}{d\dot{n}_s} = \frac{d\dot{n}_a}{d\dot{n}_s} x_{ma} + \frac{df}{d\dot{n}_s} \dot{n}_{ml}$$

Equation 8

When *f* = 1, further increases of sample flowrate will not increase *f*, such that $\frac{df}{d\dot{n}_s} = 0$. Furthermore, those increases in sample flowrate will be equally matched by increases in ambient flowrate, such that $\frac{d\dot{n}_a}{d\dot{n}_s} = 1$. Therefore, we know that the entire leak has been captured when $\frac{d\dot{n}_{ms}}{d\dot{n}_s} = x_{ma}$. In the trivial case of no ambient methane, total capture is confirmed when the capture rate of methane becomes constant even with increasing fan speed.

5.2.4 CAPTURE PROCEDURE

Given all the above, a measurement procedure can be developed.

The methane content of ambient air can be measured by collecting sample at a nominal fan speed, at a specified distance from the source of the leak. If the methane is ambient, it is evenly distributed in the vicinity, and the concentration will not increase or decrease when the sample flowrate is changed. Varying fan speed can verify the methane being measured is ambient and not from a point source (a leak). This generates the ambient methane concentration x_{ma} .

Once a leak is identified and the sample probe is placed to capture it, the instrument can determine leak fraction by increasing or decreasing fan speed in increments so that it identifies the region where $\frac{d\dot{n}_{ms}}{d\dot{n}_s} = x_{ma}$. At that region, all fugitive methane is being captured, and measurements of $\dot{n}_{ms}$ along that line are equal to the methane leak rate. These measurements may then be averaged together in whatever manner maximizes accuracy and precision.

5.3 TEST REPORT DATA FIELDS

The downloaded configuration data is saved in csv format and can be easily analyzed using tools like Microsoft Excel. Refer to the following table for an explanation of field data.

Field Name	Units (Selectable)	Description
Host Time	UTC	Datapoint timestamp as recorded on the SBC, in UTC
	Local time at measure	Datapoint timestamp as recorded on the SBC, adjusted to the time zone the browser used to start the recording was in
	Local time at download	Datapoint timestamp as recorded on the SBC, adjusted to the time zone the browser used to download the recording was in
Elapsed Time	Seconds, Minutes	Time since the recording was started, counted via the timestamp difference between the starting datapoint and the current datapoint
TDL CH_4 Concentration	%, PPM	CH4 concentration reported by the TLD bench
CH_4 Final Concentration	%, PPM	CH4 concentration reported by the TLD bench, adjusted by the active dilution ratio.
TDL C_2H_6 Concentration	%, PPM	C2H6 concentration reported by the TLD bench
Sample Differential Pressure	kPa, Pa	Sample differential pressure reading from the main board
Dilute Differential Pressure	kPa, Pa	Dilute differential pressure reading from the main board
Hi-Vol Differential Pressure	kPa, Pa	Sample differential pressure reading from the handheld Pitot
Hi-Vol Gauge Pressure	kPa, Pa	Gauge pressure reading from the handheld sampler (Used to determine gas density)
Hi-Vol Temperature	degC, degF	Temperature inside the handheld sampler (Used to determine gas density)
Ambient Pressure	kPa, Pa	Barometric Pressure inside the analyzer
Ambient Temperature	degC, degF	Temperature inside the analyzer
Ambient Relative Humidity	%	Relative humidity inside the analyzer
Ambient VOC Level	Ohm	Internal VOC Gas sensor (Not currently used)
Bench H2O Fraction		Water fraction in ambient air used for density calculations
Hi-Vol Density	kg/m3	Gas density in handheld sampler
Hi-Vol Flow Rate	m3/s, LPM, CFM	Volumetric Flow rate in Handheld Sampler
RE		Reynolds number
KLinear		Linear discharge coefficient
KRE Correction		Readjusted discharge coefficient
Viscosity	m2/s	Gas viscosity in Handheld Sampler
Velocity	m/s	Gas velocity in Handheld Sampler
Mass Flow Rate	kg/s	Mass flow rate in Handheld Sampler
Volume Flow	m3/s, LPM, CFM	Volume flow rate in Handheld Sampler
Standard Volume Flow	m3/s, LPM, CFM	Volume flow rate in Handheld Unit converted to Standard Conditions
CH_4 Standard Volume Leak Rate	m3/s, LPM, CFM	Volume methane leak rate converted to standard conditions
CH_4 Standard Mass Leak Rate(Actual)	g/s, g/hr, MT/year	Methane mass leak rate

CH_4 Standard Mass Leak Rate CO_2e(x25)	MT/year	Methane mass leak rate adjusted by the CO2 equivalence rate of x25
Field Name	**Units (Selectable)**	**Description**
CH4 Standard Mass Leak Rate CO_2e(x28)	MT/year	Methane mass leak rate adjusted by the CO2 equivalence rate of x28
Fan Speed	%	Duty cycle for the fan
Battery Voltage	V	Voltage read on the analyzer battery, or only battery on single battery device
Battery Current	A	Current read on the analyzer battery, or only battery on single battery device
Solenoid State		Decimal read of the bit flags that determine solenoid state. See Gas Path
I2C Communication Retries		Total number of communication retries in the I2C bus since the device was turned on
I2C Total Errors		Total number of errors in the I2C bus since the device was turned on
Measurement ID		Name of the current measurement in use on the handheld. See test-config for potential values
Location ID		
Gas Path		Gas path in use by the system. Standby, sample, Zero Ambient, Zero Bottle, Span, Low Dilution, or High Dilution
Event Message		Event message as input by the user on the dashboard during a recording
Fan Voltage	V	Voltage read on the fan battery if it exists. Can only be read accurately during fan operation
Fan Current	A	Current read on the fan battery if it exists. Can only be read accurately during fan operation
Fan State		0 if the fan is off, 1 if the fan is on
Latitude	deg	Latitude from the GPS
Longitude	deg	Longitude from the GPS
Altitude	m, ft	Altitude from the GPS
Satellites		The number of satellites the GPS receiver is currently communicating with
GPS Timestamp	UTC	Timestamp received from satellites by the GPS. May read as 2080 if the GPS has initialized but is not able to receive. a signal
Ground Speed	km/h, MPH	Movement speed of the device from the GPS
Event Marker		Used by the test procedure system to mark data. Standardly used marks are P for paused, I for awaiting input, STABLE for stable sample data, ZERO for background sample data

5.4 CALIBRATION CERTIFICATE FOR HI-FLOW MIDI

Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	**#####**
Test Date:	**December 11, 2024**
Expiration date:	**December 11, 2025**

SEMTECH HIGH-FLOW 2 CERTIFICATE OF COMPLIANCE

This document certifies that the SEMTECH HI-FLOW 2 flow module listed beow meets the compliance specifications of 40 CFR Part 60 subpart 0000b for high-volume samplers. All reference equipment are traceable to the National Institute of Standards (NIST). The device listed herein is in compliance with the regulatory requirements and manufacturerers recommendations from the issue date of this document to the indicated date for each verfication (exceptions - see note).

SEMTECH High-Flow 2 Instrument information:

Hand-held S/N:	#########
Tube Size(m):	0.0475
Linear Discharge Coefficient:	0.78

Description	Test date	Due date	Pass/Fail
Flowmeter linearity and accuracy	11-Dec-2024	initial installation or every 12 months	Pass
Temperature accuracy	11-Dec-2024	initial installation or every 12 months	Pass
Pressure accuracy	11-Dec-2024	initial installation or every 12 months	Pass

*All validation tests are required after major maintenance

Equipment Traceability

Model	S/N	Calibration Date	Calibration Due	Certificate #
EFM-CAL	H11-STF01	12/10/2024	3/10/2025	8/29/1929
EFM-CAL	H09-SF06	10/17/2024	1/17/2025	4/25/1929
Meriam Instruments Z5(	1605000085	45299	Pass	24SENI-0003
Sensors Inc.	Bar-003	3/27/2024	3/27/2025	

Q.A.:_____ Date:_____

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Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	######
Test date:	December 11, 2024
Expiration date:	December 11, 2025

Certificate of Compliance

SEMTECH High-Flow 2 Instrument information:
Hand-held S/N: ########

High-Flow 2 Flowmeter Linearity Results

Statistic	Result	Criteria	Pass/Fail
Intercept	0.524%	+/- 1% max	Pass
Slope	0.990	0.975-1.025	Pass
SEE	0.605%	+/- 1% max	Pass
R^2	1.000	≥ 0.998	Pass

High-Flow 2 Flowmeter Accuracy Results (<2.5% of pt criteria)

Reference Flow (SLPM)	Measured Flow (SLPM)	Error (SLPM)	Pass	Pass/Fail
0	0.0	0	Pass	
852	860.1	8	0.98%	Pass
1409	1431.0	22	1.53%	Pass
2002	2011.0	9	0.46%	Pass
2591	2593.0	2	0.06%	Pass
3197	3159.0	-38	-1.20%	Pass

High-Flow 2 Flowmeter Temperature Accuracy Results (<2% of pt criteria)

Reference Temp (deg C)	Measured Temp (deg C)	Error (%)	Pass/Fail
19.66	1605000085.00	548417981.73%	Pass

High-Flow 2 Flowmeter Pressure Accuracy Results (<2% of pt criteria)

Reference Press (Pa)	Measured Press (Pa)	Error (%)	Pass/Fail
98299.00	97567.00	-0.74%	Pass

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6 TECHNICAL SUPPORT

CONTACT SENSORS, INC. FOR SUPPORT

Technical Support: Sensors, Inc.'s technical staff, trained and experienced in the wide array of use of SEMTECH® products and HI-FLOW 2 systems, are available 24 hours a day at one of its locations in the Americas and Europe.

For service questions about the HI-FLOW 2, contact Sensors, Inc. at service@sensors-inc.com or contact your distributor.

Contact Sensors' Product support if you have any questions about using your equipment. In the USA, go to http://www.sensors-inc.com/About/Contact or contact us by phone (734) 429-2100.

In Europe, contact Sensors Europe GmbH by phone +49 (0)2104-14188-0 or go to http://www.sensors-inc.com/About/Contact.

Asia and Latin America, go to http://www.sensors-inc.com/About/Contact to view the complete list of support services and phone numbers.

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