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Agilent CrossLab Cartridge System (CS) Electronic Leak Detector

Easy-to-use, interchangeable cartridge gas leak detector and flow meter system

Introduction

Leak detectors are an important part of any facility that produces or uses gases. Laboratories that use expensive high-purity or hazardous gases for operation of analytical techniques such as chromatography, spectroscopy, or mass spectrometry routinely use leak detectors to monitor gases. The Agilent CrossLab Cartridge System (CS) Electronic Leak Detector tool (p/n G6693A), shown in Figure 1, will detect leaks or verify leak-free tubing and fittings for various gas types throughout the lab or site. The Electronic Leak Detector is more sensitive than using soap solutions or methanol and water. Also, these solutions can be a source of contamination and should not be used on internal instrument fittings, making the leak detector a better choice analytically.



Figure 1. The Agilent CrossLab Cartridge System (CS) Electronic Leak Detector is designed to detect leaks of noncorrosive gases, including mixtures of gases.

Easily power the leak detector

To ensure that the electronic leak detector is ready for use when needed, it can be powered by three alkaline AA batteries or charged via a USB connector. If using the USB connector with a computer, the leak detector will communicate with a connected PC via the USB port (USB cable provided) and leak detector USB driver. More information on the driver is included in the operation manual. The system does not recharge the batteries.

Keeping the firmware up to date

The USB connects to a web interface for quick and easy updates, enabling you to download new features and capabilities directly to the leak detector and upgrade the firmware when needed.

Larger OLED screen and CS body

The OLED screen (Figure 2) on the Electronic Leak Detector is larger than previous versions of the device, making it easier to read, even in low light conditions. If a gas leak is detected, an audible alarm will sound. Also, bars (with the number of bars indicating the level of the leak) and "Leak" will appear on the screen, as shown in Figure 3.

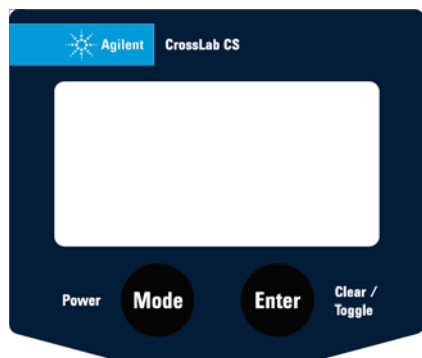


Figure 2. Face of the Agilent CrossLab CS Electronic Leak Detector.

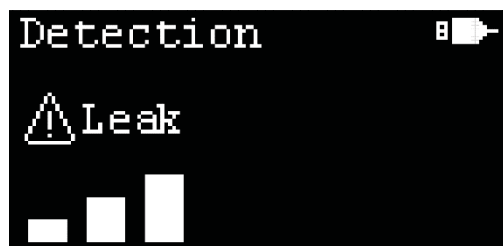


Figure 3. Example of leak identification on the OLED screen.

The body style of the CS Electronic Leak Detector is the same as the Agilent ADM Flow Meter (p/n G6691A) and includes a kick-stand for hands-free use. The leak detector cartridge (G6694A) that is supplied with the Electronic Leak Detector is also backward compatible with the ADM Flow Meter module, following a firmware update. The flow meter cartridges also fit in the CS body. This level of design flexibility means that you can switch between flow meter and leak detector using the same body or module, as shown in Figure 4.



Figure 4. Agilent CrossLab CS bundle with interchangeable leak detector and flow meter cartridges.

Quick start-up

The leak detector has a quick 50 second warm-up cycle, although this stage can be skipped by pressing the **Mode** button (Figure 5).

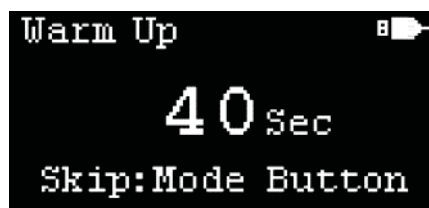


Figure 5. Agilent CrossLab CS Electronic Leak Detector warm-up screen.

Leak detector response

After the warm-up routine has completed, the Electronic Leak Detector is ready to use. When in clean ambient air, the display will show a blinking single bar. The leak detector finds leaks by comparing the thermal conductivity between the ambient atmosphere (air) and a target gas, including nitrogen and oxygen. It will not detect compressed air or “instrument air”, as these gases are equivalent to the reference gas (ambient air).

The sensitivity of the leak detector depends on the relative thermal conductivity of the target gas compared to ambient. Therefore, a greater difference in thermal conductivities results in greater sensitivity and ability to detect very small leaks.

Analytical instrumentation

Leak detectors are commonly used to detect leaks in and around various laboratory instruments. The thermal conductivities data (Table 1) and detectable leak rates (Table 2) can be used to identify which instruments can be easily checked for leaks at connection points and the level of sensitivity. Typical instruments include gas chromatographs (GC), gas chromatograph-mass spectrometers (GC/MS), inductively coupled plasma optical emission spectrometers (ICP-OES), ICP mass spectrometers (ICP-MS), liquid chromatograph-mass spectrometers (LC/MS), and microwave plasma atomic emission spectrometers (MP-AES).

Table 1. Thermal conductivities of common gases at 0 °C, 1 atm.

Gas	Thermal Conductivity (mW/m·K)
Hydrogen	168.2
Helium	142.2
Neon	46.5
Methane	30.2
Oxygen	26.7
Air*	24.1
Nitrogen	24.0
Ethane	18.0
Ethylene	16.4
Argon	16.3
Carbon Dioxide	14.5
Krypton	8.7
Xenon	5.2

* Reference gas is not detectable

Table 2. Calculated minimum detectable leak rate for selected gases and the style of bar used as a gas level indicator.

Gas	Minimum Detectable Leak Rate (mL/min)	Bar Type used as a Gas Level Indicator
Hydrogen	0.0025	Filled bar
Helium	0.003	Filled bar
Methane	0.014	Filled bar
Nitrogen	1.0	Empty bar
Argon	0.03	Empty bar
Carbon Dioxide	0.03	Empty bar

The leak detector has a high sensitivity for the typical carrier gases used for GC analysis – hydrogen and helium and can detect a minimum leak rate of approximately 3 μ L/min. Argon is commonly used in ICP-MS and ICP-OES for plasma generation, and as a carrier gas for nebulization. Argon can be detected with the leak detector to a minimum leak rate of 0.03 mL/min. Specifically, for Agilent ICP-MS, helium and hydrogen are used in the Octopole Reaction System (ORS⁴) collision/reaction cell (CRC), as collision and reaction gases, respectively. Both gases are easily detectable with the leak detector, as already stated for GC. A mixture of oxygen and argon (20:80) is commonly used for organics analyses using ICP-OES and ICP-MS, and leaks of this gas mix would also be identifiable by the Electronic Leak Detector. Methane, which is a common reagent gas for Chemical Ionization (CI) GC/MS and may be used as a CRC gas in ICP-MS, can be detected with the leak detector. However, the leak detector should not be used to check for ammonia leaks, another reagent gas for CI and an optional CRC gas used in some ICP-MS analyses. Ammonia is a corrosive gas and corrosive gases can damage the leak detector. See the operational manual for safety information.

Warning: Do not use the leak detector with corrosive gases.

Using the leak detector

To ensure accuracy and to obtain a clear baseline, simply press and release the Enter/Clear/Toggle button while the probe is held in ambient air, before probing a suspected leak area. To determine if a connection point is leaking, place the tip of the sample probe near the connection, as shown in Figure 6. Make sure that the sample probe is open and unblocked during leak detection. To protect the detector from heat or vibrations avoid placing the probe tip against the connection point. Also, avoid waving the sample probe around as rapid air movement can cause false readings.



Figure 6. Example of leak checking a valve system with the Agilent CrossLab CS Electronic Leak Detector.

The leak detector should be used on dry gas fittings only, as the leak detector will give a positive response to water vapor, such as sweat or fittings that were recently leak checked with soap or methanol/water solutions.

When a gas leak is detected, bar levels are displayed on the screen and "Leak" will also appear on the screen. The number of bar levels is proportional to the size of the leak. A maximum of eight bar levels can be displayed, indicating a large volume gas leak. When the number of bar levels is three or more, the leak alert sign will blink on the screen and the buzzer will sound to give an audible alert.

Two styles of bars are used to indicate the type of gas entering the detector, as shown in Figure 7.

- **Filled bar:** gas leak for gases with a higher thermal conductivity than air.
- **Empty bar:** gas leak for gases with a lower thermal conductivity than air.



Figure 7. Examples of gas leak for gases with higher thermal conductivity than air (A) and gas leak for gases with lower thermal conductivity than air (B).

When probing ambient air, false readings of bars may be displayed on the screen, which may be due to tip drift. To perform a reset and baseline correction, hold the probe in ambient air for two seconds, then press and release the Enter/Clear/Toggle button. After the correction, the number of bar levels is reset to zero and "Recalibrated" is displayed on the screen to indicate that the leak detector has been recalibrated.

Why is leak detection important?

Leaks are problematic for any operation that uses gas tubing and fittings. Even small gas leaks can lead to safety issues, reduced productivity, and increased costs. Depending on the gas, a leak can create an explosion hazard, a fire hazard, or result in an oxygen-deficient atmosphere. Leaks can introduce water and air into the gas flow and tubing. Universal or Gas Clean filters (or both) can help capture the contaminants. However, persistent, unidentified leaks can saturate gas filters faster than expected and cause decreased sensitivity and/or elevated baselines in instrument detectors, such as GC, GC/MS, ICP-MS, or ICP-OES. Leaks can also lead to shortened lifetimes of some consumables, especially in GC systems. Second, leaks allow the gas to flow out of the fitting and can cause loss of production and revenue, if trying to produce or collect and supply the gas. Also, if gas is being consumed at a higher rate than expected because of leakage, gas supply costs will increase.

Checking for and eliminating leaks from the gas source to the terminus can reduce safety concerns and reduce costs through decreased use of cylinders or fewer refills by the gas supply company. Regular leak checks of gas tubing fittings and regulators with the leak detector can keep leaks at a minimum and maintain optimal conditions for the laboratory or site.

How to leak check gas tubing fittings

There are many locations to check for leaks when using gases, whether in a laboratory or at other sites. It is good practice to use the leak detector to check gas cylinder regulators, gas tubing fittings between the cylinder (or gas source), and the final outlet of the gas tubing lines. Regulators are re-usable, but they can wear with age and may become prone to leaking, or a thread could be scratched or damaged, leading to leaks. When setting up new gas tubing lines and connections, it is best to leak-check the fittings after purging the lines with the chosen gas. If the gas is ambient air or a corrosive gas, use the methanol/water mixture or soap solution methods to test these lines. While these tests are not ideal, they can be used for these select gases.

In many applications that use gases, filters are installed between the gas source and outlet to remove potential contaminants, such as water, hydrocarbons, or oxygen, depending on the requirements of the user. For example, Gas Clean filter systems are used with helium and hydrogen gas tubing lines to remove hydrocarbons, oxygen, and water. These compounds need to be removed from the gas supply as they can affect the analytical performance of an instrument and reduce the lifetime of instrument consumables or detectors.

The connections to gas filters and the Gas Clean filter system can be tested using the leak detector. Before checking for leaks, be sure that the gas tubing has been purged with the desired gas, such as helium, and that gas is flowing. The leak detector can ensure that the ring on a Gas Clean unit has been sufficiently tightened, as leaks can occur if the filter is not sealed properly on the base (Figure 8).



Figure 8. Example of leak checking a Gas Clean filter unit with the Agilent CrossLab CS Electronic Leak Detector.

The terminus of the gas tubing fittings, whether at the back of an instrument (Figure 9) or in a different setting (Figure 10), should also be included in regular leak checking. Monitoring for leaks is especially important after initial installation and purging of the gas lines.



Figure 9. Example of leak checking gas fittings on the back of an Agilent 8890 GC.



Figure 10. Example of using the Agilent CrossLab CS Electronic Leak Detector to check argon gas fittings.

GC specific leak concerns

Since GC uses a carrier gas, there are several specific concerns around GC performance and leaks, beyond the gas fittings on the back of the GC. As already discussed, Gas Clean filters can trap contaminants, but unidentified and persistent leaks can shorten the lifetime of the filter, leading to more frequent replacements.

Following the sample path from vial to inlet, the first concern for leaks is at the inlet septum nut. The inlet septum nut applies pressure against the inlet septum and turn-top to create a leak-free seal. A significant septum/septum nut leak can cause an inlet pressure shutdown because the system is unable to attain the set pressure. The GC flow path includes the carrier gas fittings on the back of the GC, the column connections at the inlet, detector, or capillary flow technology devices. Any leaks in the flow path can lead to decreased column lifetime and elevated background signals, as oxygen can destroy the stationary phase of a column over time. One way to evaluate column health is by reviewing the signal background of a blank run, such as a solvent blank, and comparing the maximum value to the value on the GC column certificate of analysis, or previous solvent blanks on the same column.

Figure 11 shows an example of what can happen to the background when a leak is present. A high temperature analysis by GC-flame ionization detector (FID) was being performed and a column trim was required, but a leak was present when the column was reinstalled. Four blank runs spaced throughout a sequence of 16 runs up to 400 °C are overlaid in Figure 11. The results show a significant increase in the stationary phase bleed as more oxygen was introduced to the column, and the longer it was held above 400 °C. Eventually the bleed is greater than 150 pA, making it difficult to detect any compounds using this column.

For GC/MS systems, leaks allow water and oxygen into the analyzer chamber. This ingress can cause tune failures, increased backgrounds, shorter filament and electron multiplier lifetimes, or cause irreparable damage to the pump system.

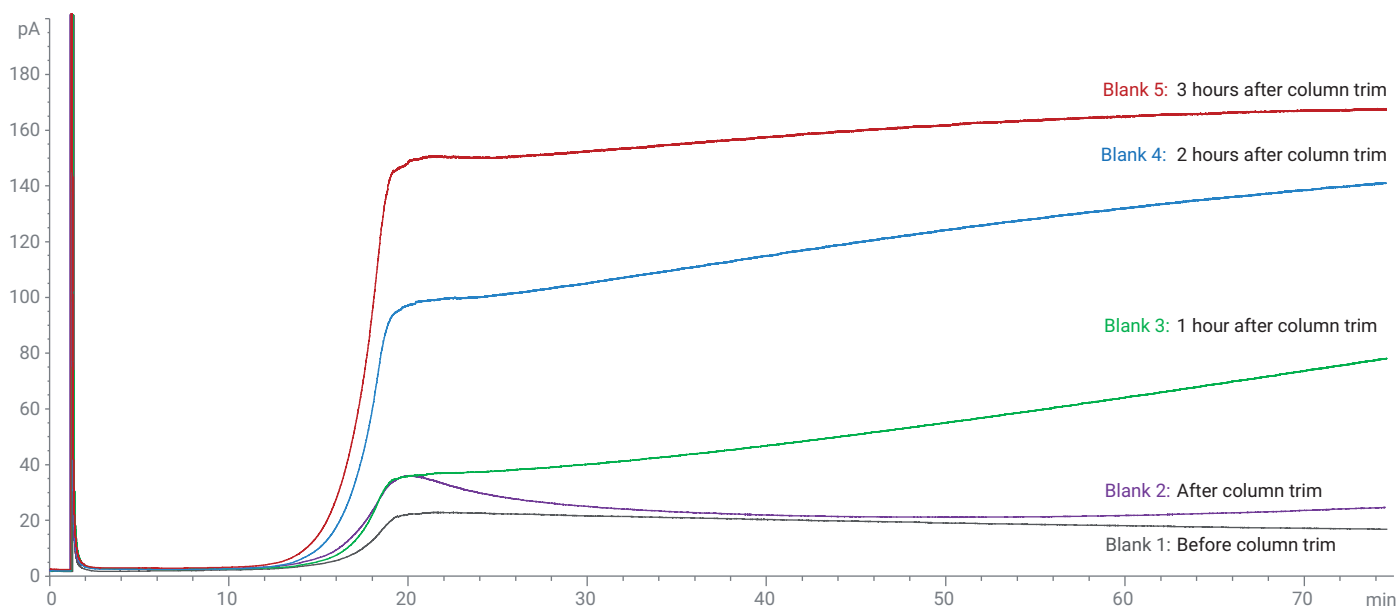


Figure 11. Comparison of solvent blank chromatograms on GC-FID when running at high temperatures.

Leak checking a GC or GC/MS

First, use the leak detector to check the gas tubing fittings on the back of the GC that connect to the various pressure modules. Remember that compressed or instrument air is the same as ambient air and cannot be checked with the leak detector. For the instrument air connections, a water/methanol mixture can be used to check for leaks. Next, leak check the inlet septum nut or nuts for leaks by holding the sample probe tip inside the stainless steel cone, as shown in Figure 12.



Figure 12. Leak checking the GC inlet septum nut with the Agilent CrossLab CS Electronic Leak Detector.

A leak at the inlet septum nut can occur from the following conditions:

- Septum nut is not tight enough.
- Septum nut has lost compression. If the septum nut is old, it may be unable to apply enough compression against the septum for a leak free seal. Be sure to replace the inlet septum nuts on a yearly basis.
- The septum is cored or split.

If both inlets are in use, such as in a dual column configuration, be sure to leak check both inlets.

Also, use the leak detector to check the base of the turn-top connection with the GC inlet weldment to verify a good seat of the turn-top. An inlet turn-top that is improperly installed or not tight enough can cause an inlet leak. Inside an air bath GC oven, check all column connections (Figure 13) that are in use:

- Inlet
- Detector
- Capillary Flow Technology (CFT) device connections

A



B



Figure 13. Checking for leaks at the GC inlet (A) and on Agilent Capillary Flow Technology (CFT) connections (B).

The Agilent Intuvo 9000 GC looks different from the traditional air bath oven GC systems, but the fittings should still be checked with a leak detector at each connection point (Figure 14). Some example connection points are as follows:

- Inlet-guard chip connection
- Guard Chip to inlet Flow Chip connection
- Column connections
- Detector tail connection

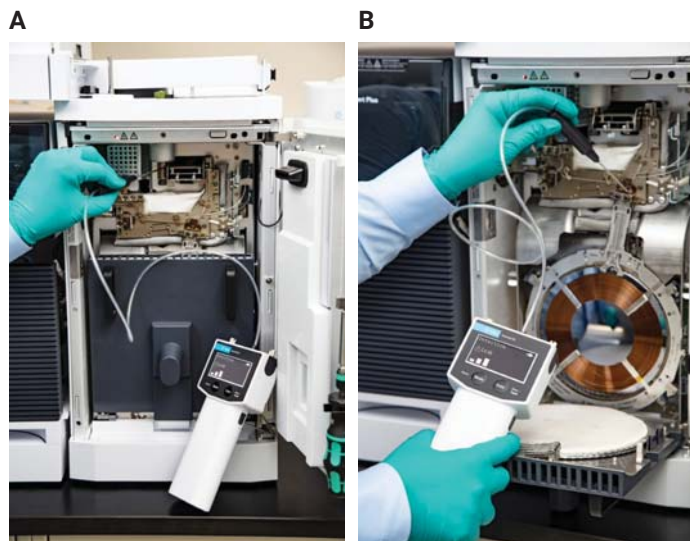


Figure 14. Checking for leaks on the Agilent Intuvo 9000 GC at the inlet-guard chip connection (A) and column connections (B).

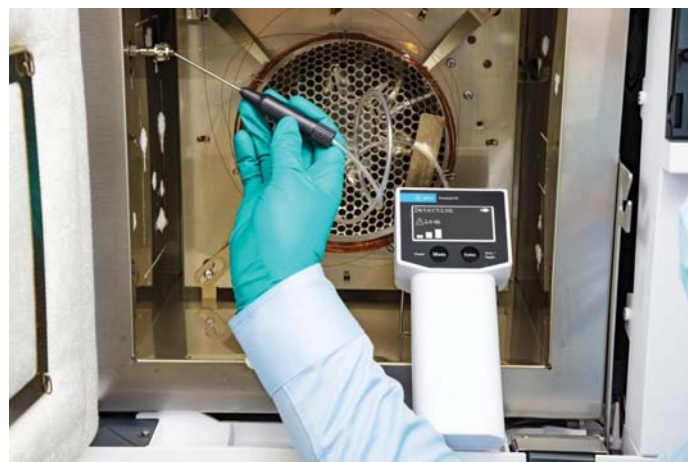
If you have a valved system on your GC, it is useful to leak check the fittings on the valves (Figure 15), even if the valves were installed in the factory. As with all leak checking of the GC system, be sure that the gas tubing is connected to the appropriate fitting, the line has been purged, and gas is currently flowing.



Figure 15. Using the Agilent CrossLab CS Electronic Leak Detector to check for leaks at connections in a valved GC system.

For a GC/MS system, use the leak detector to check the MS transfer line. Also check the MS analyzer door and vent valve for leaks. The MS transfer line, vent valve, and MS analyzer door are the most common locations for leaks on the GC/MS systems (Figure 16). For tandem quadrupole (MS/MS) systems, be aware that there are two side doors, and both should be checked with the leak detector.

A



B



Figure 16. Checking for leaks on a GC/MS system at the mass spectrometer transfer line in the GC oven (A) and at the vent valve (B) on the mass spectrometer.

Also, for MS/MS systems, there is a collision cell gas fitting on the back of the mass spectrometer. Typically there is a helium/nitrogen mix or argon gas supply connected from the collision cell electronic pressure control module (EPC). It is good practice to leak check the collision cell gas fitting.

ICP-OES and ICP-MS specific concerns

Aside from safety risks of a leak, leaks could cause problems for ICP-OES and ICP-MS instruments such as:

- Background interferences
- Low rate or unwanted reactions in the ICP-MS ORS⁴ CRC
- Introduction of air to the system

For ICP-OES and ICP-MS, argon leaks at the torch or nebulizer could cause incorrect gas flows, resulting in torch damage or low nebulizer pressure and loss of signal. Hydrogen and helium are typically passed through a Gas Clean filter, as previously mentioned for GC and GC/MS.

Where to leak check an ICP-MS

The argon, helium, and hydrogen gas inlets at the rear of the ICP-MS should be leak-checked when installed (Figure 17). If the optional gas inlet or 3rd or 4th cell gas inlets are in use, these fittings should also be leak-checked, unless a corrosive gas such as ammonia is being used.

Examples of optional gases that may be used in the 3rd or 4th cell for ICP-MS are listed in Table 3. Most are compatible with the leak detector, except the two gases shown at the bottom in italics.

Table 3. Common optional gases for ICP-MS.

Oxygen	Methane
Ethane	Propane
Fluoromethane	Tetrafluoromethane
Nitrous oxide	Carbon monoxide
Carbon dioxide	Acetylene
Propylene	Nitrogen
Neon	Xenon
Krypton	
<i>Ammonia in helium mix (Mixed gas: 10% ammonia: 90% helium)</i>	<i>Nitric oxide</i>

Warning: Do not use the leak detector with corrosive gases.

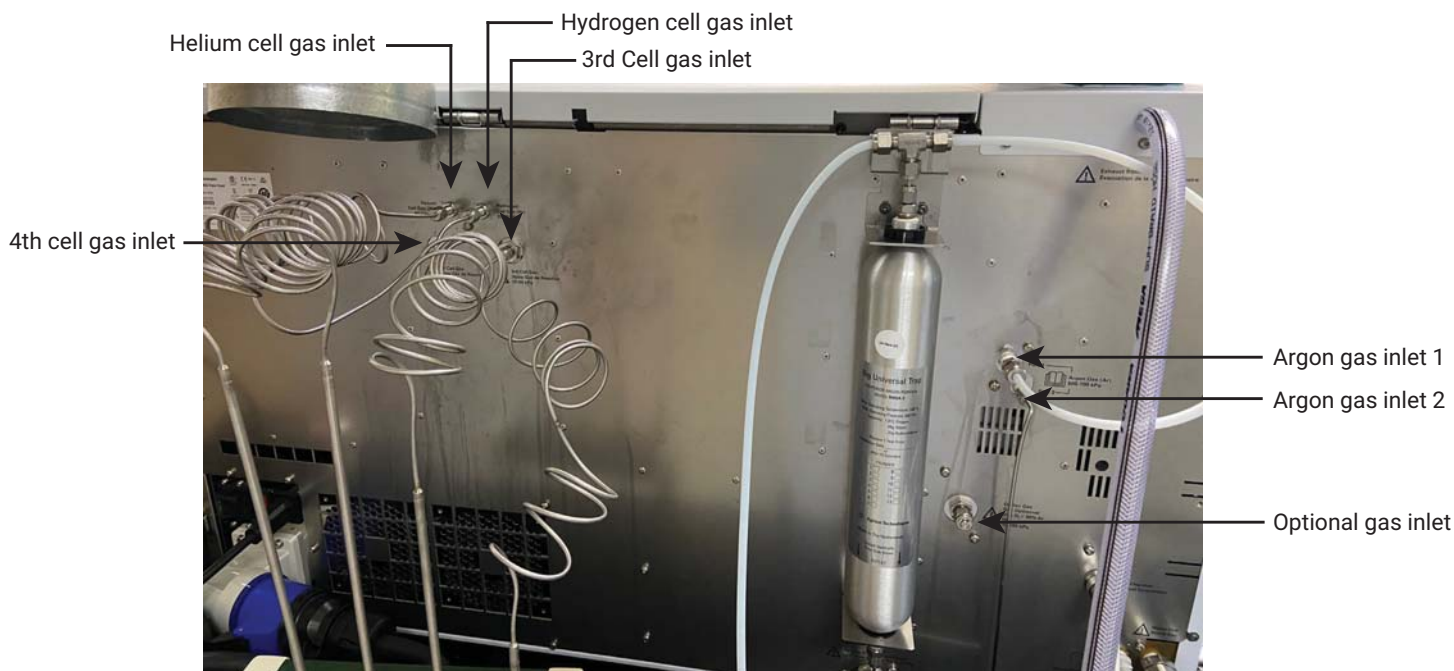


Figure 17. Rear view of an Agilent ICP-MS showing the gas inlets that should be checked with the Agilent CrossLab CS Electronic Leak Detector.

Check the ports on the left side of the ICP-MS for the option gas, make-up gas, and nebulizer gas to verify that the fittings are leak free (Figure 18). To be sure that the system is leak-free, also check the fittings near the nebulizer for the make-up gas and nebulizer gas (Figure 19).



Figure 18. Using the Agilent CrossLab CS Electronic Leak Detector to check for leaks at the option gas port on the Agilent 7900 ICP-MS.



Figure 19. Checking for leaks at the nebulizer fittings on the Agilent 7900 ICP-MS.

Troubleshooting the leak detector

False readings of leak when in ambient air or error "Need Zero"

When probing ambient air, false readings of bars may be displayed on the screen and the audible alarm may sound for a leak. These false signals may be due to tip drift. To perform a reset and baseline correction, hold the probe in ambient air for two seconds, then press and release the Enter/Clear/Toggle button. After the correction, the number of bar levels is reset to zero and "Recalibrated" is displayed on the screen to indicate that the leak detector is recalibrated.

Error "Zero Fail"

If the leak detector fails to zero after warm-up or re-zero after a reading, there is a baseline correction error, and the leak detector should be rebooted. Press and hold the Power/Mode button for three seconds to turn off the detector. Wait for 10 to 30 seconds, then briefly press and release the Power/Mode button to turn the leak detector back on. Wait for the warmup cycle to finish before using the leak detector.

Loss of detector sensitivity

In the leak detector, a filter is installed in the probe to protect against particulate contamination (Figure 20). A clogged filter may cause a decrease in the detection sensitivity of the device. If contamination is suspected, turn off the detector and back flush the mesh filter with compressed air. Or the filter can be replaced (p/n G6694-60005). If you observe the error "No Fltr Date," renew the filter with either the backflush or install a new filter and reset the new date for the filter. More details can be found in the operation manual.

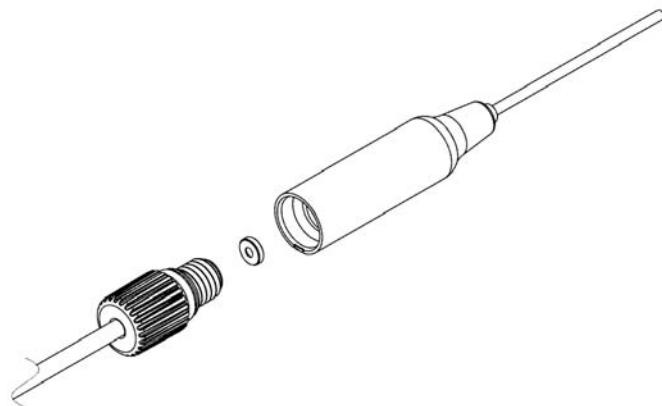


Figure 20. Exploded parts view of the sample probe, filter, and tubing of the Agilent CrossLab CS Electronic Leak Detector.

Error “I2C Fail”

This error indicates a failure to communicate with hardware and the leak detector should be rebooted, as outlined in the Zero Fail example. If problems persist, contact Agilent Technical Support.

Error “No Cart”

This error indicates that a cartridge was not detected. Check that the cartridge is fully installed into the body and that the thumbscrews are finger-tight.

Error “Ver Mismatch”

The error of “Ver mismatch” means that the firmware version does not match the cartridge version. Upgrade the firmware to the latest version via the USB connector and computer.

See the operational manual for more troubleshooting information.

Part numbers

Part numbers for the ADM Flow Meter, the CrossLab Cartridge System (CS) Electronic Leak Detector, cartridges, and the CrossLab CS bundle are given in Table 4. The CrossLab CS bundle includes one body and both the flow meter and leak detector cartridges.

Table 4. Agilent part numbers for gas monitoring meters and detectors.

Component	Agilent Part Number
ADM Flow Meter	G6691A
ADM Flow Meter Cartridge	G6692A
CrossLab Cartridge System (CS) Electronic Leak Detector	G6693A
Electronic Leak Detector Cartridge only	G6694A
CrossLab Cartridge System Bundle: One Cartridge System (CS) handheld body, ADM Flow Meter cartridge, and Electronic Leak Detector cartridge	G6699A

More information

For more information on the Agilent CrossLab CS Electronic Leak Detector, visit the website at www.agilent.com/en/product/gas-purification-gas-management/gas-management/gas-leak-detector

See the operational manual for safety information on the Electronic Leak Detector.

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