Service Manual

Agilent G2350A Atomic Emission Detector

Part No. G2350-90157

First edition, MAY 2000

Replaces Part No. G2350-80170 and G2350-90150.

Printed in USA

Safety/Regulatory Information

The G2350A Atomic Emission Detector (AED) meets the following IEC (International Electrotechnical Commission) classifications: Safety Class 1, Transient Overvoltage Category II, and Pollution Degree 2.

This unit has been designed and tested in accordance with recognized safety standards and designed for use indoors. If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired. Whenever the safety protection of the G2350A AED has been compromised, disconnect the unit from all power sources and secure the unit against unintended operation.

Refer servicing to qualified service personnel. Substituting parts or performing any unauthorized modification to the instrument may result in a safety hazard. Disconnect the AC power cord before removing the top cover. The customer should not attempt to replace the fuses in this instrument. The customer should not open the top rear cover, which is secured by screws.

Notice

Warnings in this manual or on the instrument must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions violates safety standards of design and the intended use of this instrument.

Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

Safety Symbols used in this manual:

WARNING

A warning calls attention to a condition or possible situation **that could cause injury to the user**.

CAUTION

A caution calls attention to a condition or possible situation **that could damage or destroy the product or the user's work**.

Safety Symbols marked on the instrument:

⚠ Caution. Refer to accompanying instructions.

⚠ Indicates a hot surface.

⚠ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

⏽ On

◯ Off

Sound Emission Certification for Federal Republic of Germany

Sound pressure LP
< 49.1 dB
During normal operation
At the operator position
According to ISO 7779
(Type Test)

Schallemission
Schalldruckpegel
LP< 49.1 dB

Am Arbeitsplatz
Normaler Betrieb
Nach EN27779
(Typprüfung)

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1 Installation

Introduction

This Installation section repeats information included in the *Setting Up and Maintaining the Agilent G2350A AED* manual included in the shipping box with your G2350A Atomic Emission Detector. It also describes how to prepare your Atomic Emission Detector (AED) for use, and how to test the instrument to make sure that it is functioning properly.

Installing your Atomic Emission Detector (AED)

Your G2350A AED is designed to operate in conjunction with a Gas Chromatograph (GC) and a computer running Microsoft© Windows ™ NT 4.0, and the G2070AA ChemStation application with the G2360AA GC-AED software option. If these systems are not installed yet, refer to each system's instructions to install and learn how to operate them properly. First set up your Gas Chromatograph then your computer and ChemStation application, before installing your AED.

To unpack, install, and learn how to operate your new G2350A AED, perform the following:

1. Prepare your work station. See *Preparing your work station* on page 12.
2. Prepare your gas sources and lines. See *Preparing your gas sources* on page 19.
3. Install and learn how to use your GC-AED ChemStation software as described in the instructions included with the ChemStation. See *Installing your ChemStation software* on page 20.
4. Install your G2350A Hardware Installation CD-ROM software. See the CD-ROM cover/insert instructions.
5. Uncrate your AED. See *Uncrating your AED* on page 21.
6. Connect the control cables between all components. See *Connecting control cables* on page 28.
7. Connect the AED to the appropriate gas sources and the gas chromatograph. See *Connecting gas piping* on page 30.
8. Install the transfer line between your AED and 6890 gas chromatograph. See *Installing your transfer line* on page 33.
9. Fill the AED water reservoir with water. See *Water filling* on page 37.
10. Connect the AED to electrical power. See *First start-up* on page 41.
11. Install the column in the transfer line. See *First start-up* on page 41.

12. Turn on the GC-AED ChemStation, adjust flow systems, and run preliminary checks. See *First start-up* on page 41.
13. Run verification tests on the samples provided to verify your new G2350A AED is working properly. See *Verifying performance* on page 47.

For a general description of how to operate the AED, see:

Basic operation of your AED on page 39

Setting Up and Maintaining the G2350A AED

For a detailed listing of the G2350A AED performance specifications, see *Specifications* on page 50.

Preparing your work station

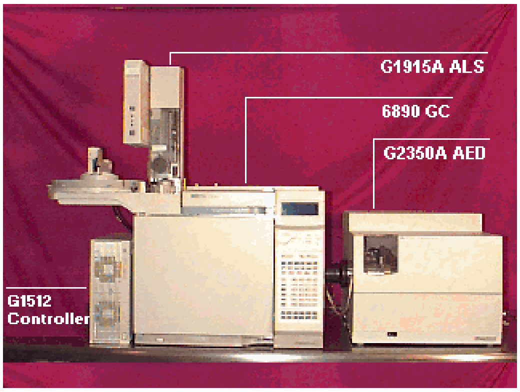

Figure 1. A typical GC-AED installation

A typical AED installation requires space, power, gases, and physical support as listed below. In addition, the amount of heat generated by the typical components is also listed. If any of your components are different than those below, make sure that enough room is allocated for proper AED installation.

A complete GC-AED ChemStation system typically consists of:

- G2350A Atomic Emission Detector
- 6890 Gas Chromatograph (with split/splitless inlet and GC-AED interface)
- G1915A or G1916A ALS (with a G1512 Controller), or 7683 ALS
- GC-AED ChemStation (a Pentium TM processor based computer running the GC-AED ChemStation under Windows NT 4.0)
- HP DeskJet or LaserJet printer

Note that the AED must be installed to the **right** of the GC.

Table 1. Physical Dimensions and Power Requirements

G2350A AED	
H x W x D:	41 x 52 x 57 cm (16 x 21 x 23 inch)
Power:	1100 VA max
	120 Vac at 20 amps, or
	100 Vac at 20 amps, or
	220 Vac at 15 amps, or
	240 Vac at 15 amps
Outlets:	One outlet on individual circuit
Heat:	3952 kJ, or 3750 BTU/hr
Weight:	37 kg (80 lbs)
Required clearance: (for maintenance)	Above: 41 cm (16 inch)
	Right: 25 cm (10 inch)
	Left: 5 cm (2 inch)
	Front: 18-36 cm (7-14 inch)
	Behind: 29 cm (11 inch)
6890 GC	
H x W x D:	50 x 68 x 50 cm (20 x 26.7 x 21 inch)
Power:	2250 VA
Outlets:	One outlet on individual circuit
Heat:	8,100 kJ, or 7,681 BTU/hr
Weight:	56.8 kg (125 lbs.)
Required clearance:	Above: 44 cm (17 inch) for Injector
	Left: 31 cm (9 inch) for Tray
	Behind: 13 cm (5 inch)

G1519A Automatic Liquid Sampler (ALS)	
G1512A Controller	
H x W x D:	10 x 33 x 31 cm (4 x 13 x 12 inch)
Power:	150 VA max
	120 Vac at 2.5 amps
Outlets:	1
Heat:	545 kJ, or 515 BTU/hr
Weight:	7.3 kg (16 lbs.)
Required clearance*:	Behind:13 cm (5 inch)
* The controller may be placed on its side to the left of the 6890 GC without requiring further table space than used by the 6890 with a Tray attached.	
18593 Injector	
H x W x D:	44 cm (17 inch) above the GC
Power:	200 Vac at 1.25 amps
Weight:	3.6 kg (7.2 lbs.)
18596B Tray	
H x W x D:	31 cm (9 inch) left of the GC
Power:	220 Vac at 1.25 amps
Weight:	1.8 kg (4 lbs)
G2613A Injector	
H x W x D:	44 cm (17 inch) above the GC
Weight:	3 kg (6.6 lbs.)
G2614A Tray	
H x W x D:	31 cm (9 inch) left of GC
Weight:	3 kg (6.6 lbs.)

Computer with monitor (example only)	
H x W x D:	40 x 42 x 51 cm (20 x 17 x 16 inch), with monitor
Power:	N/A
Outlets:	2
Heat:	N/A
Weight:	N/A
Required clearance:	Behind: 29 cm (11 inch) for Injector
	1 side: 25 cm (10 inch) for Tray
	Front: see keyboard
Computer keyboard (example only)	
H x W x D:	5 x 46 x 18 cm (2 x 18 x 7 inch), with monitor
Laser printer	
H x W x D:	30 x 42 x 41 cm 12 x 17 x 16 inch)
Power:	300 Vac max
Heat:	N/A
Outlets:	1
Weight:	16.8 kg (37 lbs)
Required clearance:	Behind:15 cm (5 inch)

Table 2. Overall GC-AED ChemStation Space Requirements

Space:	1 m high x 3.4 m wide x 87 cm deep (37 inch x 11 ft. x 34 inch)
Weight capacity:	123.3 kg (271.3 lbs), plus computer and keyboard.

Other space requirements: The AED requires the use of four to six gas cylinders for the makeup and reagent gases, as well as a space for a nitrogen purge supply (dewar or generator) and a helium getter (required).

Table 3. G2350A AED Environmental Conditions

Condition	Operating Range
Temperature:	10°C to 40°C*
Relative Humidity:	80% max. for temperatures up to 31°C, decreasing linearly to 50% at 40°C.
Altitude:	up to 2000 m
Main voltage fluctuations	not to exceed ±10% of nominal voltage

* Recommended ambient temperature is 15°C to 35°C.

Table 4. Electrical Supply Summary

	Circuits	Outlets
GC	1 dedicated	1
AED	1 dedicated	1
Sampler	_____	_____
Computer/monitor	Shared	2
Printer	Shared	1
Getter	Shared	1

Gas sources

The AED requires the pure gases listed below.

Table 5. Pure Gases

Gas	Function	Purity (%)
Helium	GC carrier gas and AED plasma	99.9999
Hydrogen	AED reagent gas	99.997
Oxygen	AED reagent gas	99.997
Nitrogen	Spectrometer purge	99.99
Auxiliary Gas (10% ± 1% CH_4/90% N_2)**	AED reagent gas	99.99*
Methane**	AED reagent gas	99.99

*The purity requirement is on original gases for the reagent gas.

**The G2350A AED can only be plumbed for three reagent gases. The user must decide whether to plumb for 10%CH_4/90%N_2 (to detect oxygen 171) or for methane (to detect nitrogen 388 mm line and nitrogen –15 isotope). The performance verification checkout procedure described in this manual requires 10% CH_4/90%N_2.

Agilent Technologies requires six 9's (99.9999%) gas for helium. An optional method of obtaining that level of purity is with the use of five 9's gas and a helium getter. A helium getter is recommended to help ensure helium gas purity. Do not use filters on the helium line.

For nitrogen (spectrometer purge), the user is advised to provide a moisture trap (part no. 5060-9084) and a hydrocarbon trap (part no. 5060-9096) to prevent condensation on the optics.

See also *Helium Getter Suppliers* on page 17.

Suppliers of helium getters and nitrogen generators

Listed below are suppliers of helium getters and nitrogen generators:

Table 6. Helium Getter Suppliers

SAES Pure Gas Inc.	Valco Instruments Co. Inc.
4175 Santa Fe Road	P.O. Box 55603
San Luis Obispo, CA 93401, USA	Houston, TX 77255, USA
Phone: (805) 541-9299	Phone: (713) 688-9345
Fax: (805) 541-9399	Sales: 800 367-8424
	Fax: (713) 688-8106
SAES Getters, Japan Co., Ltd.	
No. 2 Gotandafujikoshi Bldg.	Valco Europe
5-23-1 Higashi-Gotanda	Unterannberg 7 CH-6214
Shinagawa-Ku, Tokyo 141	Schenkon, Switzerland
Phone: +81.3.5420.0435	Phone: (045) 21 68 68
Fax: +81.3.5420.0439	Fax: (045) 21 30 20
	Telex: 868342
SAES Getters (Deutschland) GmbH	
Gerolsteiner Stassel	
5000 Koln 41	
Phone: +49.221.44.30 86	
Fax: +49.221.44 10 95	
Telex: 887700	

Table 7. Nitrogen Generator Suppliers

Whatman Inc.	Whatman SARL
260 Neck Road, Box 8223	BP 255, 4 Av de la Creativite
Havenhill, MA 01835-0723	59665 Villeneuve D'Ascq Cedex
800-343-4048 or 508-374-7400	France
Fax: 508-374-7070	Phone: 30-47-30-48
	Telex: 136268
Whatman Canada Ltd.	Fax: 30-47-30-48
2495 Haines Road	
Mississauga	Whatman Japan Limited
Ontario L4Y 1Y7	6th and 7th floor
800-667-2917 or 905-272-1516	Akihabara MF Bldg
Fax: 905-272-7074	No. 28
	14-9 Soto-Kanda 6-chrome
Whatman International Limited	Chiyoda-Ku
Whatman House	Tokyo, 101
St. Leonard's Road	Japan
20/20 Maidstone	Phone: 81-3-3832-6412
Kent ME16 OLS	Fax: 81-3-3832-6452
England	
Phone: (01622)676670	Whatman Asia Pacific Pte Ltd
Fax: (01622)677011	171 Chin Swee Road
	#08-01 San Centre
Whatman GmbH	Singapore 0316
Auf der Krautweide 32	Phone: 65-534-0183
6232 Bad Soden/Ts.	Fax: 65-534-5627
Germany	
Phone: 0 61 96/64 30 26	
Fax: 0 61 96/2 22 53	

Preparing your gas sources

In order to minimize AED installation time, first install all the gas tanks and check that all other required equipment, including regulators, purifiers, filters, and tubing, is available.

Gas system considerations

The configuration of the gas system can effect AED performance and safety. Note the following as you set up your gas system:

- Use only regulators having dual stainless steel diaphragms with 1/8 inch swage fitting connections.
- If you wish to use GC inlet pressures > 80 psi, you must use a helium regulator with an outlet **pressure** of at least 110 psi.
- Make all gas connections with Vespel ferrules when possible. Brass ferrules are not recommended. When connecting helium lines to the getter, use stainless steel ferrules. The getter produces high temperatures that can melt plastic ferrules.
- Avoid sharing the AED's gas system with other instruments. The gas system should be dedicated to the AED. Fewer connections, unions, and tees, and shorter supply tubing provides better performance.
- Use a gas getter to ensure the purity of the helium gas.

Gas system set-up

1. Install a moisture trap (part no. 5060-9084) and a hydrocarbon trap (part no. 5060-9096) on the nitrogen gas line that will feed the spectrometer purge.
2. Set up the gas cylinders/sources for the purities and pressures listed below.

Table 8. Gas Cylinders/Sources Setup

Gas	Purity (%)	Flow Rate (mL/min) (Approx. Consumption)	Supply Pressure (psi)
Helium	99.9999	200	80-100
Hydrogen	99.997	20	60
Oxygen	99.997	20	60
Auxiliary Gas (10% ± 1% CH_4/90% N_2)	99.99*	20	60
Methane	99.99	20	70-90
Nitrogen	99.99	400	40

*The purity requirement is on original gases for the reagent gas.

Installing your ChemStation software

The G2350A AED requires ChemStation GC-AED software for operation. If you already have a computer set up to run the proper version of the ChemStation software and know how to use it, move on to *Uncrating Your AED*. If the GC-AED ChemStation software must be installed, or if you are not familiar with it, take time now to install it and learn to use it. It is important that you understand how to use this software to effectively operate the G2350A.

To install and learn how to use the ChemStation software, please refer to the *Installing and Understanding Your GC-AED ChemStation* booklet which was provided with the ChemStation. (Note that if you purchased a complete GC-AED ChemStation system from Agilent Technologies, the proper ChemStation software was loaded onto the computer at the factory.)

Uncrating your AED

Figure 2. G2350A AED shipping crate

Tools needed

Flat head screwdriver

Long-necked posi-drive

7 mm wrench or socket driver

7/16 inch open-end wrench

9/16 inch open-end wrench

Uncrating

Uncrate the G2350A AED as follows:

1. Make sure enough bench space is clear for the AED. You will need at least 41 x 52 x 57 cm (16 x 21 x 23 inch), plus room to make the gas piping and electrical connections. Leave at least 13 cm (5 inch) to the right and rear of the AED if possible.
2. Cut the packing straps and open the top portion of the box.
3. Remove contents list, ship kit, transfer line, GPIB cable, learning products, envelope, power cable, and checkout sample(s). See the contents list below.

Figure 3. Hardware, and learning products

4. Remove the main carton from around the AED. Remove the packing foam.

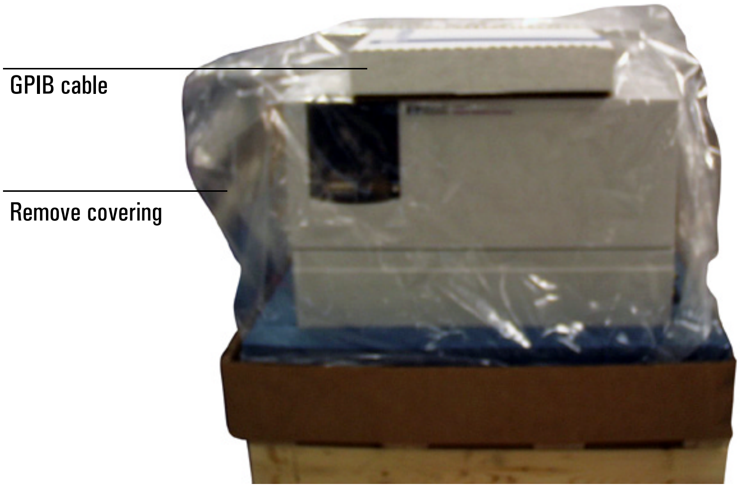

Figure 4. Location of GPIB cable

Remove the GPIB cable, packing foam, and the plastic bag covering the instrument.

Caution The AED weighs 37 kg (80 lbs).

5. Remove the G2350A AED from the box. Use the hand holds in the AED frame while moving and lifting the AED.
6. Place the AED on the work bench (or other sturdy work surface) and arrange as desired. Be sure to leave room for connections to the gas cylinders, the nitrogen dewar, the GC, and the ChemStation.
7. Lift the front lid of the AED enclosure until the retaining arm on the right hand side of the enclosure clicks into place. If desired, remove the front

lid. Lower the front facing.

8. Remove the four screws in the top lid and remove the top.
9. Set the voltage selection switches on the AC board to the proper setting for your line voltage. See *Voltage selection switches* on page 73.
10. Remove the foam packing from the top of the spectrometer and remove the tape holding the spectrometer cable onto the spectrometer.

Figure 5. Unpacking the spectrometer

11. Using a long-necked posi-drive, remove the four mounting screws on the spectrometer shipping bracket and remove the bracket. Re-install the two spectrometer screws and lockwashers in the spectrometer.
12. Pull the two foam supports from under the front of the spectrometer.
13. Attach the spectrometer cable to the spectrometer. Attach the nitrogen purge line to the spectrometer using 7/16 inch and 9/16 inch open end wrenches.
14. Use a 7 mm wrench or socket driver to loosen the two nuts securing the firewall behind the spectrometer and emission source. Then remove the firewall.
15. Remove the foam from behind the emission source lock. Remove the two rear cushions from beneath the spectrometer.

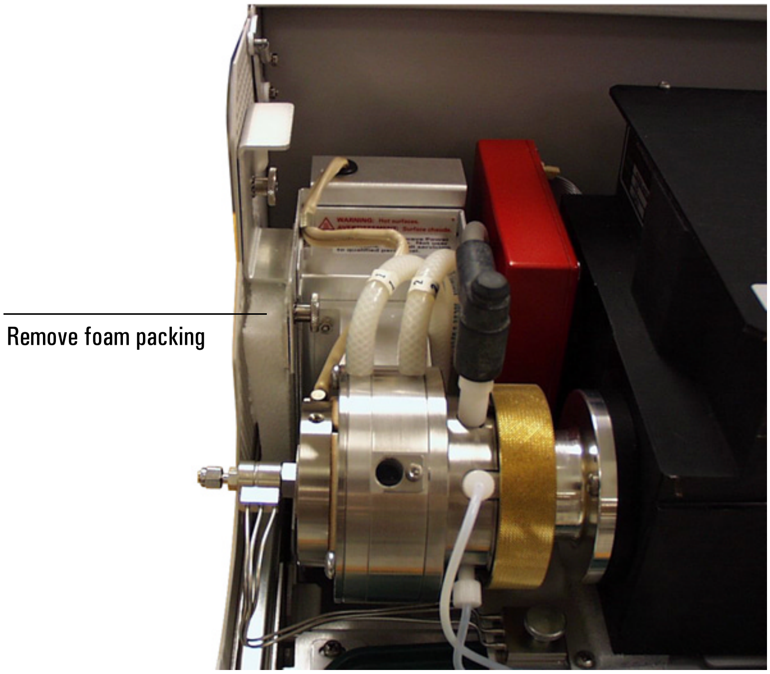

Figure 6. Remove foam packing

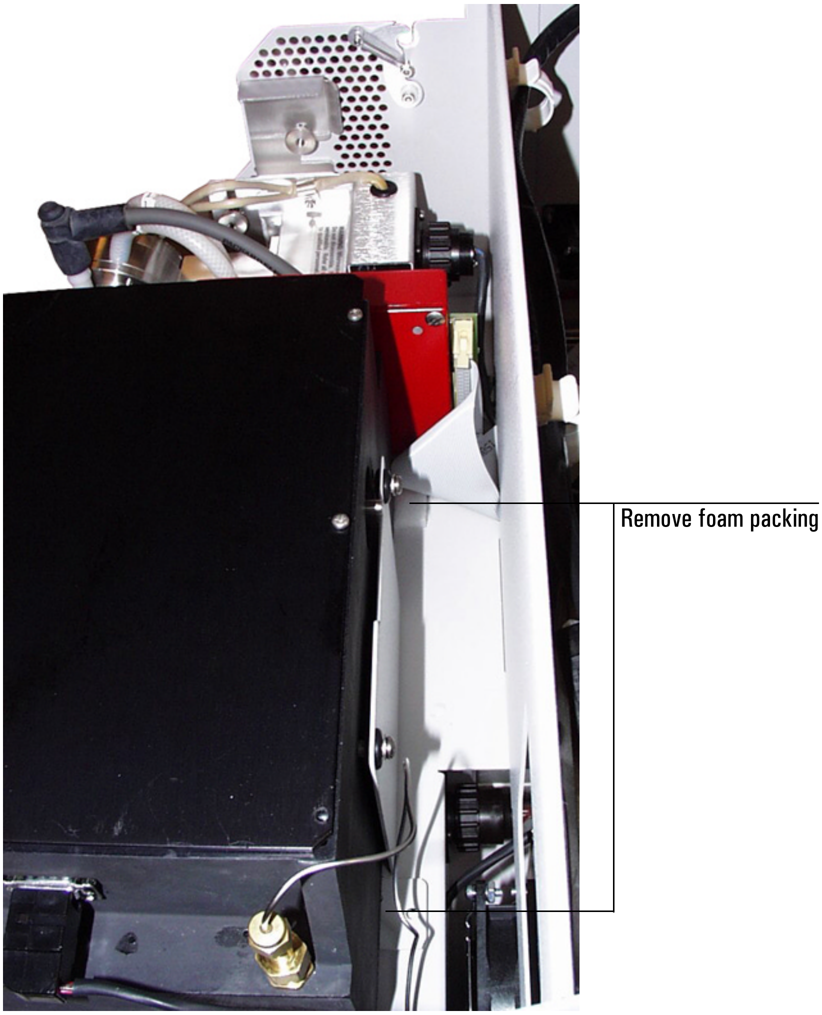

Figure 7. Remove foam packing

16. Slide the water drawer out. Remove the block and cushion from between the water drawer and the cavity assembly. Replace the water drawer.

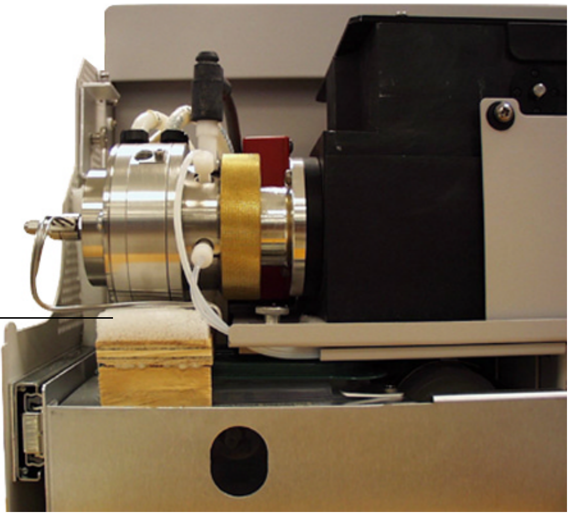

Figure 8. Remove emission source packing

17. Remove the lockwashers from beneath the emission source lock thumbnuts. Re-install the thumbnuts.

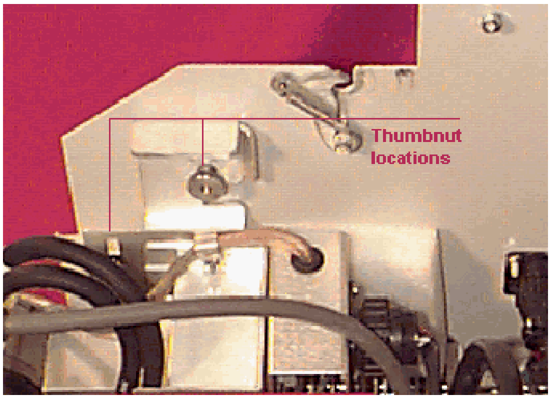

Figure 9. Remove lockwashers and re-install the thumbnuts

18. Optionally, remove the bracket from the top of the high voltage power supply.
19. Reinstall the firewall and the top lid. Route the PDA cable, ground wire, and sparker wire through the cutout in the bottom of the firewall to avoid crimping.
20. Install the front lid, and lift it slightly to remove it from the retaining arm, lightly press the arm inward, and close the lid. Close the front facing.
21. Make sure you have removed all parts and paperwork from the shipping box before storing or discarding it.

Contents list

Figure 10. Parts shipped

You should have received the following parts and manuals in the AED shipping box:

Table 9. Contents List

Part Number	Description	UM	Qty
0100-0053	1/16 inch gas union SS tubing nut	EA	1
0100-0090	Tee-union brass	EA	2
0100-1326	Ferrule, 1/16 inch graphite 10/pk	PK	1
0100-1328	Ferrule, 1/8 inch Vespel 10/pk	PK	1
0100-1329	1/16 inch Vespel ferrule 10/pk	PK	1
0905-1293	Lens O-ring	EA	1
0905-1099	Lens keeper O-ring	EA	1
0905-1159	GC side cavity O-ring	EA	1
0905-1160	Optical side cavity O-ring	EA	1
0905-1162	O-ring	EA	3
0905-1451	Lens mount liner O-ring	EA	2
3150-0417	Filter tube, flyash	EA	1
5080-8853	Transfer line graphite ferrule, 0.5 mm 10/pk	PK	1
5180-4103	Nut, 1/8 inch brass 10/pk	PK	1
5181-8830	Column nut 2/pk	PK	1
8120-3446	GPIB cable 2m	EA	1
various	Power cord	EA	1

Part Number	Description	UM	Qty
8500-5067	Performance sample (box)	EA	1
8710-0510	Open end wrench 1/4 inch & 5/16 inch	EA	2
878-2360	Hex key 2.5 mm	EA	1
8710-0803	Open end wrench 7/16 inch & 9/16 inch	EA	1
8710-0972	Open end wrench 7/16 inch and 3/8 inch	EA	1
8710-1876	Sm cavity twisted wire brush	EA	2
8710-1938	Large cavity brush	EA	1
8710-2358	Nut driver 5.5 mm	EA	1
8710-2359	Wrench 1/2 and 3/8 inch	EA	1
G2350-80610	Column setting tool (plastic tube)	EA	1
G2350-80350	Hardware information CD-ROM	EA	1
G2350-61090	Discharge tube kit	EA	3
G2350-61300	Heated transfer line	EA	1
G2350-90200	Contents list	EA	1
G2350A	Atomic Emission Detector II	EA	1
G2350-90110	Setting Up and Maintaining manual	EA	1
—	Declaration of conformity	EA	1

Also included with the AED is a Customer Information Sheet listing the step-up conditions which optimized performance during testing at Agilent Technologies. This data will be used to set up and test your unit.

Connecting control cables

The G2350A AED comes with two control cables:

- GPIB cable
- Remote start cable

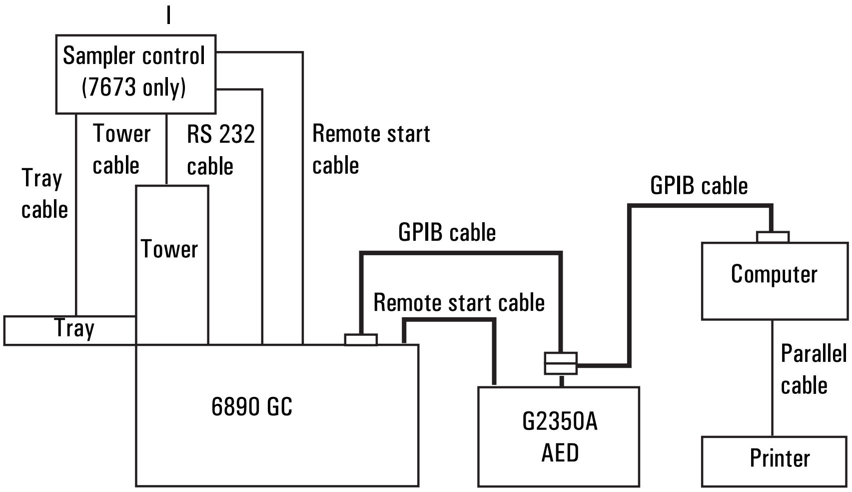

Figure 11. GC-AED ChemStation cabling diagram

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

GPIB cable

Connect one end of the GPIB cable to the GPIB port on the AED. Connect the other end to the GPIB port on the ChemStation. Leave enough room behind the AED so that the cable is not bent excessively at the connector. Bending may decrease connector life. See Figure 12.

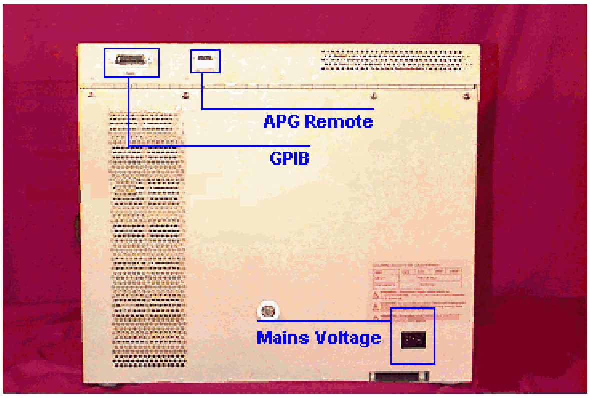

Figure 12. Connecting cables to the G2350A AED

Remote start cable

Connect the remote start cable to the remote start cable connector on the back of the AED, and also to the back of the 6890 GC.

GC, injector, tray, and controller (if present)

Connect the autosampler, tray and controller (if present) to the GC as described in the Installation Manuals. Set the DIP switches on the controller (if present) to the settings appropriate for the configuration purchased.

Connecting gas piping

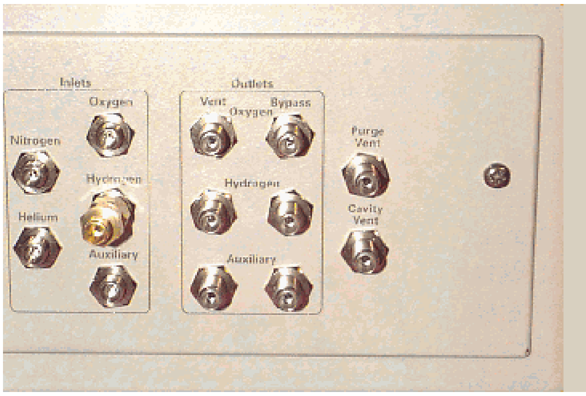

Figure 13. Gas inlets and outlets

The AED requires constant supplies of helium and nitrogen, and often requires reagent gases. For a listing of the gases and purities required, see *Preparing your work station* on page 12 and *Preparing your gas sources* on page 19. In general, the flow rates are not adjusted after set-up unless required by a certain recipe. For information on how to set-up the flow rates, see *First start-up* on page 41.

Connecting the nitrogen purge

1. Using a 7/16 inch open end wrench, connect the nitrogen purge line to the Nitrogen Purge line on the side of the AED. See Figure 14.
2. Set the nitrogen pressure to 40 psi at the source.

Caution The AED uses a fixed restrictor to control the purge flow rate. Tank pressures above 40 psi may cause higher flow rates that can damage the AED. Tank pressure below 40 psi may not yield optimal purging.

It may take several hours before the AED will reach its maximum sensitivity in the UV range due to light adsorption by O_2 and water inside the spectrometer. However, initial set-up tests can be performed right away.

Connecting other gas lines

Warning Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that hydrogen gas is only connected to the gas inlet on the side panel labeled "HYDROGEN."

Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that the hydrogen gas flow is turned off at the source and in the AED before starting this procedure.

Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, turn off all reagent gas flows and the column flow before starting this procedure.

For GCs without Electronic Pressure Control (EPC), connect the gas source directly to the AED using ferrules and two 7/16 inch wrenches. Set the source pressures to the levels listed in the Customer Information Sheet provided with your AED. If the data is not available, set the pressures to the approximate values given below.

Table 10. Gas Pressures and Purities

Gas	Purity (%)	Flow Rate (mL/min) (Approx. Consumption)	Supply Pressure (psi)
Helium	99.9999	200	80-100
Hydrogen	99.997	20	60
Oxygen	99.997	20	60
Auxiliary Gas* (10% ± 1% CH_4/90% N_2)	99.99**	20	60
Methane	99.99	20	70-90
Nitrogen	99.99	400	40

* Required for the performance verification procedure.

**The purity requirement is on component gases of the mixture.

It is important to set the source pressures properly. The AED uses fixed restrictors to regulate the flow rates of the gases. Information is provided with the AED with the reagent gas pressure settings that provide optimum performance. Set the gas cylinder regulators to this pressure.

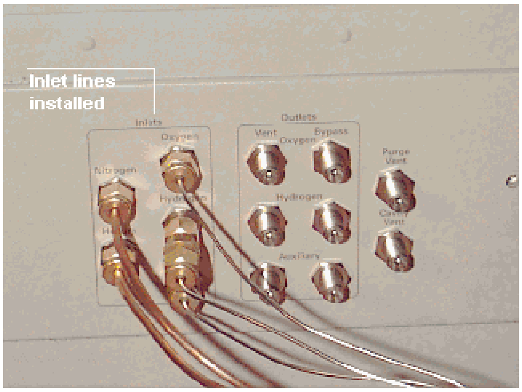

Figure 14. Properly connected gas lines

For GCs with EPC (option 308):

1. Replace the frits in the EPC auxiliary manifold with FID air restrictors (part no. 19231-60610). These frits are required for proper flow of gases in the AED. Use the Viton O-rings (part no. 5180-4182, 12pk) provided in the EPC manifold ship kit.
2. Connect the three reagent gas lines to the auxiliary manifold of the GC EPC as shown below. See *Figure 15*.

Aux 3	O_2
Aux 4	H_2
Aux 5	CH_4/N_2 or CH_4

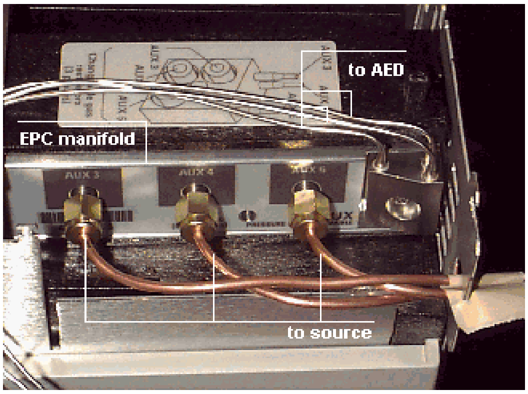

Figure 15. Gas lines connected to the EPC

3. Connect the three stainless steel lines from the EPC outlet to the corresponding inlets on the AED side panel.
4. Set the EPC gas pressures to the values listed in the Customer Information Sheet provided with your AED. If the data is not available, set the pressures to the values given in the table above.

Installing your transfer line

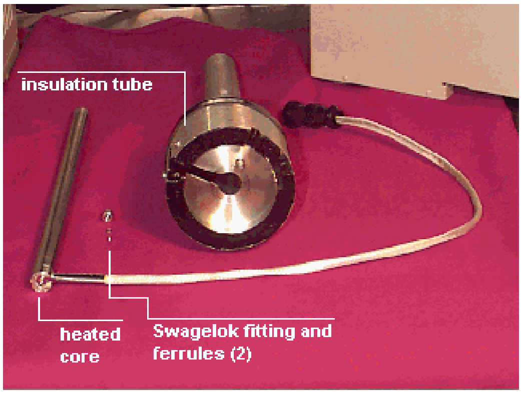

Figure 16. Transfer line

Note: To modify existing GCs, you must order G2350A option 320, which includes the oven modification kit, the instructions, and the tools required to modify the GC oven for AED use.

Install your transfer line in your 6890 GC as follows:

1. If the right cover panel on your 6890 GC was pre-drilled at the factory, remove the panel and remove the plastic bag which covers the opening. Re-install the cover panel. If your 6890 GC contains a round knock-out on the right panel for the transfer line, remove the knock-out.

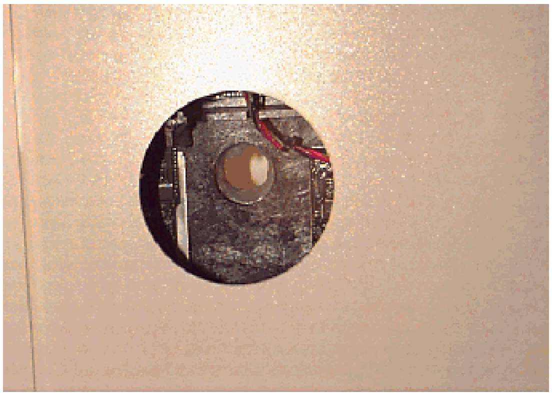

Figure 17. Removing the knock-out

2. Ensure oven insulation has been removed from the transfer line through holes in the GC, and that the mounting bracket is installed in the GC oven. See Figure 18.

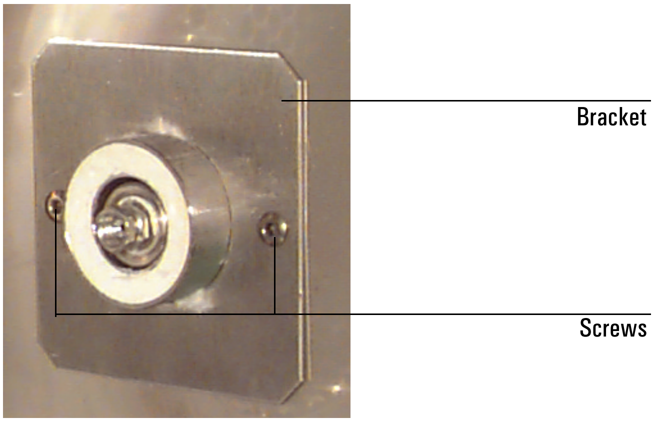

Figure 18. Mounting bracket installed in oven (transfer line shown installed in bracket)

3. Remove the heated core from the insulation tube.
4. Using two 5/16 inch wrenches, remove the plug from the left end of the gas union.
5. Install a 1/16 inch stainless steel nut (part no. 0100-0053) and a 1/16 inch graphite ferrule (part no. 0100-1326, 10/pk) onto the heated core at the gas union side. (Note that the pictures in this documentation show stainless steel ferrules for visibility.)

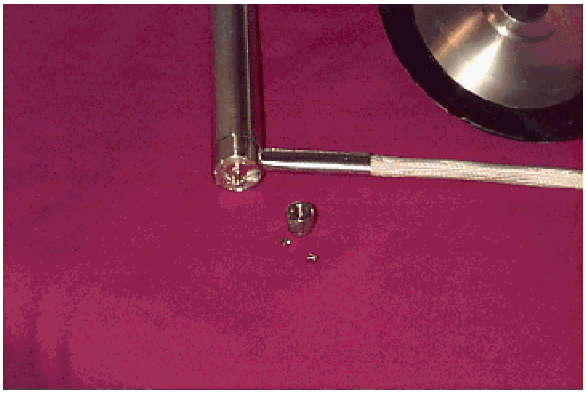

Figure 19. Ferrule and nut

6. Slide the heated core into the insulation tube.
7. Slide the heated transfer line assembly through the GC outer wall and into the GC oven.

Figure 20. Installing transfer line assembly

8. Orient the AED so that:
   - The centerline of the gas union fitting is precisely aligned with the centerline of the hole through the GC.
   - The heated transfer line will protrude at least 1 inch (2.5 cm) into the GC oven after it is installed onto the AED.
   - Leave as much of the transfer line outside the GC as possible to make maintenance easier. See Figure 22 below.

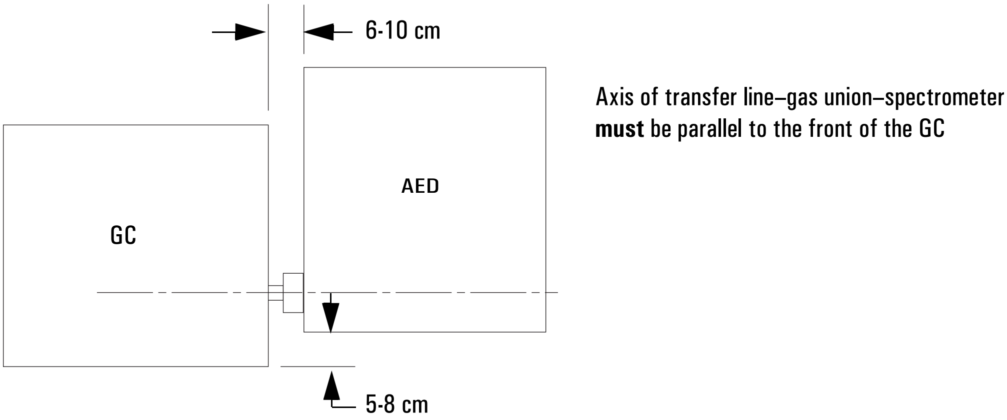

Figure 21. GC-AED alignment

9. Using two 5/16 inch wrenches, install the heated core onto the gas union.

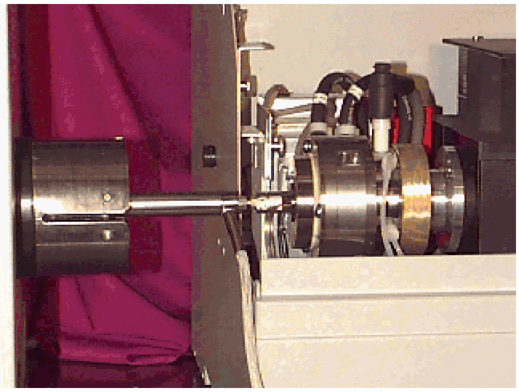

Figure 22. Installing the heated core onto the gas union

10. Slide the insulation tube onto the heated cavity block and secure with the set screw. Do **not** over tighten.

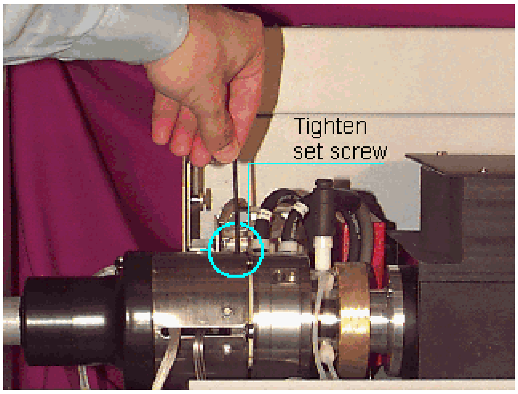

Figure 23. Installing the insulation tube

11. Readjust the spacing between the GC and AED as necessary to keep approximately 1 inch of the transfer line inside the GC oven. Make sure the GC-AED alignment is correct per Figure 21.

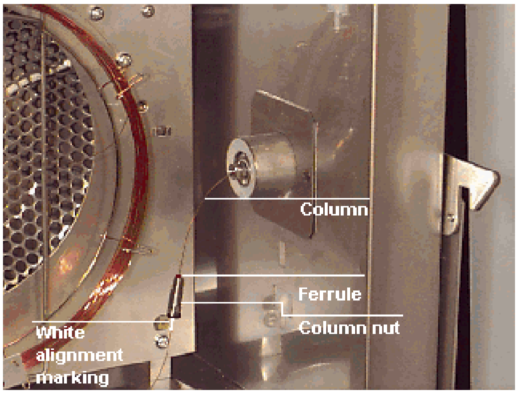

Figure 24. Adjusting the space between the GC and AED

Water filling

The AED requires a flow rate of 370 mL/min to 430 mL/min of distilled water for cooling the discharge tube during operation. Before using the AED for the first time, fill the water reservoir as follows:

Warning Do not operate the AED with the water drawer open.

Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

1. Lift the emission source lock to release the water drawer.
2. Open the lower front panel and slide the water drawer out.
3. Open the water reservoir and fill to just **above** the upper fitting with distilled water.

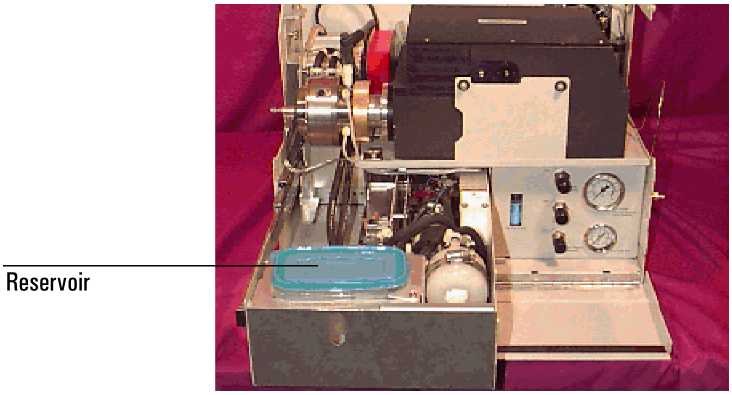

Figure 25. Filling water reservoir

4. Close the reservoir lid.
5. Close the water drawer.

After starting the AED for the first time, you may need to refill the reservoir.

Caution

Do not use de-ionized water. De-ionized water attacks the system and causes deposits to build up, shortening instrument life.

Distilled water will keep the system sufficiently clean. Do not add algal inhibitors.

Keep the reservoir lid closed to avoid shock hazard and prevent water loss through evaporation.

Check the water level daily.

Add distilled water to the reservoir to maintain the level near the top. If the water level drops too low, the plasma will shut off.

Do not put objects in the reservoir, as they will contaminate the system.

If the system is to be shut down for any length of time, drain the water reservoir to prevent algal growth

Charge the water in the reservoir every time the discharge tube is changed during the first 3 months of use.

Basic operation of your AED

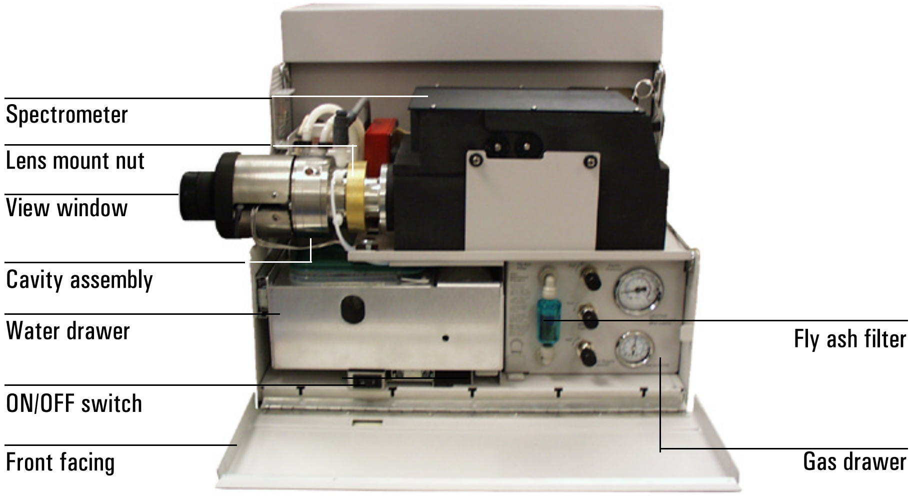

Figure 26. Front view of the G2350A AED

G2350A AED control

The G2350 Atomic Emission Detector is controlled through the GC-AED ChemStation computer software. Only the main power and certain gas pressures are manually controlled.

Creating and running methods

To learn how to run methods and sequences to analyze samples, refer to the extensive online help files available in the GC-AED ChemStation and the *Understanding Your ChemStation* manual.

ON/OFF switch

The ON/OFF switch is located in the front of the AED in lower left corner.

View window

On the front of the AED in the upper left corner is a tinted view window which allows you to look into the cavity while the AED is running. During operation, a bright glow from the plasma should be seen.

Adjusting gas flows

The makeup gas flow is controlled using two flow controllers located on the gas drawer front panel. Other gas flows are set from the ChemStation or fixed at the factory.

Adjusting the water flow

The water (coolant) flow rate is set automatically by the G2350A.

Checking the water level

The water level can be checked by lowering the front face of the AED. A slit in the water drawer shows the water level in the reservoir. Check the water level daily when the AED is in use.

Order of GC-AED system start up

In most cases, start your GC and your G2350A AED before starting the ChemStation software.

When starting the system for the first time, see *First start-up* on page 41.

Important operating tips

Below is a summary of important operating tips.

- Do not attempt to analyze for O_2 if the AED is plumbed for pure methane. Use of pure methane when searching for oxygen can damage the instrument with excessive carbon buildup.
- To measure the N 388, you must use pure methane.
- Once the helium supply pressure is set at 30 psi, do not adjust it further. The AED uses a system of fixed restrictions to control gas flows. If the helium supply pressure is not 30 psi, the reagent, purge, and carrier flow rates will vary by unknown amounts.
- Use only distilled water in the water reservoir.

First start-up

In order to verify that the AED performance meets the specifications as tested at Agilent Technologies, install the checkout column and set the gas flow rates to factory standard as described below.

Once check-out performance is verified, vary the gas flow rates, oven temperature program, or columns to optimize results for the compounds being analyzed.

Install the column in the GC

Install the AED checkout column (25m x 0.32 mm ID x 0.17 mm film thickness, HP-1, part number 19091Z-012) as follows:

1. Install column nuts and ferrules onto the column and trim the column to the proper length as described in *Column installation/changing columns* on page 112.
2. For best results, install the checkout column in the GC and purge for 20 to 30 minutes with helium before conditioning. Set the GC column inlet pressure inlet press change to 20 psi.
3. Begin conditioning the column at 250°C for 1 to 2 hours.

Turn the AED ON and set the initial gas flow rates

Warning Microwaves! When turning the instrument on for the first time after receipt, check for microwave leakage immediately after the plasma ignites.

If stray microwave emission is above 5 mW/cm^2 at a distance of 5 cm, shut down the instrument immediately and call the Agilent Technologies Service Department for service.

1. Slide the conditioned column into the transfer line and tighten the column nut into the fitting. Make sure that the white correction fluid mark is still visible. See *Column installation/changing columns* on page 112.
2. Plug the AED into the proper outlet. See the label near the power cord receptacle on the back panel of the AED.
3. Lower the front facing.
4. Turn ON the supply and reagent gases at their sources. (Your source pressure must be set as shown in Table 6 on page 17 and Table 7 on page 18.
5. Allow time for the gas flow system to purge.

6. Check the cavity pressure and the helium supply pressure on the gas drawer front panel. The cavity pressure should read 1.5 psig and the helium supply pressure should read 30 psig. Adjust the pressures as required.
7. Turn ON the ChemStation components in the order specified below:
    - ALS
    - GC
    - AED
    - The computer running the GC-AED ChemStation
    - peripherals (e.g., printer)

The status of each instrument will appear in the Workstation.

8. Wait for the self-test to finish and the AED water system to start. The plasma should light.
9. **As soon as the plasma is lit, immediately check for microwave leakage.** See *Testing for Microwave Leakage*. If the stray microwave reading is above 5 mW/cm^2 at a distance of 5 cm, turn OFF the instrument **immediately**.
10. Carefully slide out the water drawer. (The emission source must be locked to the enclosure, not to the drawer.)
11. Check for water leaks. If a leak is found, turn OFF the AED. Check that the discharge tube is not broken and that all fittings are tight. See *Water leaks* on page 204.
12. Check that the water level in the reservoir is just above the upper fitting. Add distilled water if necessary.
13. Slide the water drawer in fully.
14. Open the ChemStation software. From the Start menu, select the ChemStation folder, then the appropriate Instrument Online icon. This will start the ChemStation. Once the ChemStation is running, it will load the last method used and the AED Real-Time Spectral plot should be displayed. If the AED Real-Time Spectral Plot window is not displayed, it can be brought up by selecting `View/AED Real-Time Spectral Plot on/off`. Once the spectral plot is displayed, the AED status can be checked from the ChemStation.

15. Load method CKO_TIME.M. Select `Method/Load Method/CKO_TIME.M.` The following parameters will be automatically loaded:

Table 11. Checkout Parameters

GC Parameters	
Oven Initial Temperature	60°C
Initial Time	0
Rate	30°C/min
Final Temperature	180°C
Final Time	0
Inlet Temperature	250°C
AED Parameters	
Transfer line temperature	250°C
Cavity Temperature	250°C
Solvent Vent Time	On at 0.75 min
	Off at 0.90 min
ALS Parameters	
Sample 1	Position 1
Sample 2	Position 2
Injection volume	1 μL
Sample pre wash	4
Solvent A wash	4
Sample pumps	6

16. For GCs without Electronic Pressure Control (EPC), also set the following GC parameters:

Inlet liner type	split (part no. 5183-4647)
Split vent setting	7.5 ± 10
Septum purge	2.5 ± .5
Split ratio	17.5 ± 2

17. Turn OFF all reagent gases using the ChemStation. (Note: Verify the column inlet pressure is set at 20 psi or at the value saved during a previous performance verification.) Adjust the pressure if needed.

18. Connect a flow meter to the purge vent. Measure the flow rate and record. Turn off the makeup flow. The cavity pressure should drop but should not reach zero. Re-measure the purge flow rate. The flow rate should be from 30 to 35 mL/min. If necessary, adjust the cavity pressure until the flow rate is between 30 to 35 mL/min.

19. Move the flow meter to the cavity vent. Adjust the makeup flow until a flow rate of 60 to 70 mL/min is obtained.
20. Re-measure the purge vent flow rate. (The flow rate should be approximately 40 to 45 mL/min).
21. The cavity vent flow rate should equal:
    [the purge vent flow rate + 30] mL/min ± 5 mL/min. If necessary, adjust the cavity pressure until the cavity vent flow is within the acceptable range.
22. Cycle the reagent solenoid valves ON and OFF while monitoring the purge vent flow rate. The flow rate should remain relatively constant.

After the initial flow rates are established, you will need to verify spectrometer performance and correct the reagent gas flow rates obtain optimal (default) sensitivity for performance verification. Refer to *Adjust EPC-controlled reagent gas flow rates (6890 only)* on page 44 and/or *Adjust manually controlled reagent gas flow rates* on page 45 below to adjust any EPC-controlled and/or manually controlled reagent gas flow rates.

Adjust EPC-controlled reagent gas flow rates (6890 only)

If you have any reagent gas flows controlled using EPC, you can check and correct their flow rates automatically using a macro described below.

- If the macro cannot determine an acceptable flow rate, try to adjust the pressures manually as described in *Adjust manually controlled reagent gas flow rates* on page 45.
- If small manual adjustments to the flow rates of the reagent gases still cannot solve a problem found during this procedure, contact your Agilent service representative.

To adjust the reagent gas flow rates, follow the instructions below.

1. Display the Method and Run Control View. If full menus are not displayed, select `View/Full menu`. Then, display the AED spectral plot by selecting `View AED Spectral Plot On/Off`.
2. Realign the instrument by selecting the `Realign bar` on the spectral plot screen.
3. When alignment finishes (after approximately 5 min.), enter `725 nm` as the wave length and select the `Go To bar`.
4. When the spectrometer arrives at 725 nm, turn the oxygen `ON`.
5. Select `Instrument/AED Utilities/Auto-set reagent gases`. A macro will begin and will automatically set your EPC reagent gas pressure(s) to the optimum values for default performance.

6. Save the EPC settings in the CKO_TIME.M method. Select `Method/Save Method`. Overwrite the earlier version.

These pressure setpoint values are a starting point for measurement and for performance verification as described in *Verifying performance* on page 47, and may require additional adjustment after running the AED Checkout sample.

Adjust manually controlled reagent gas flow rates

If any of your reagent gas flow rates are controlled manually, or if you are using an 5890 GC, you must adjust them as described in this section.

If small adjustments to the flow rates of the reagent gases still cannot solve a problem found during this procedure, contact your Agilent service representative.

To adjust the reagent gas flow rates, follow the instructions below.

Prepare to set the gas flow rates

1. Display the Method and Run Control View. Then, display the AED spectral plot by selecting `View AED Spectral Plot On/Off`.
2. Realign the instrument by selecting the `Realign bar` on the spectral plot screen.
3. When alignment finishes (after approximately 5 min.), enter `725 nm` as the wave length and select the `Go To bar`.
4. When the spectrometer arrives at 725 nm, turn the oxygen *ON* from the ChemStation.

Set the oxygen pressure

5. Measure the area of the oxygen 725 line by placing the mouse cursor over the peak and pressing the left mouse button. Record the value for use in step 7.
6. Select the helium 728 line and determine its area. Record the value for use in step 7.
7. The ratio of the oxygen 725 to helium 728 line areas should be 0.12 ± 0.01. If the ratio is greater than 0.13, decrease the oxygen pressure at the oxygen regulator. If the ratio is less than 0.11, increase the oxygen pressure.
8. Perform steps 5 through 7 until the ratio is correct.
9. Turn the oxygen *OFF* from the ChemStation.

Set the hydrogen pressure

10. Enter 486 nm as the wavelength and select the `Go To` bar.
11. When the spectrometer arrives at 486 nm, turn *ON* the hydrogen from the ChemStation.
12. Measure the area of the hydrogen 486 line and record the value for use in step 14.
13. Select the helium 492 line and measure its area. Record the value for use in step 14.
14. The ratio of the hydrogen 486 to helium 492 line areas should be 10 ± 1. If the ratio is greater than 11, decrease the hydrogen pressure at the hydrogen regulator.
15. Perform steps 12 through 14 until the ratio is correct.
16. Turn the hydrogen *OFF* from the ChemStation.

Set the auxiliary gas (CH_4/N_2) pressure

17. Set the AED auxiliary gas (methane/nitrogen or methane) pressure to 30 psig.
18. Turn *ON* the oxygen reagent gas from the ChemStation.
19. Measure and record the area count value of the helium 492 line.
20. Turn *ON* the AED auxiliary gas from the ChemStation.
21. Measure and record the area count value of the hydrogen 486 line.
22. The ratio of the hydrogen 486 to helium 492 line areas should be 3.3 ± 0.2. Adjust the AED auxiliary gas pressure at the regulator until the hydrogen 486 to helium 492 area count ratio is correct. Remeasure both area counts after each adjustment.

Prepare for performance verification

23. Turn *OFF* the reagent gases from the ChemStation.

These pressure setpoint values are a starting point for measurement and for performance verification as described below, and may require additional adjustment after running the AED Checkout sample.

Verify initial spectrometer purge

Allow the AED to purge for two hours to reach optimal spectrometer sensitivity in the UV range. After sufficient purge time has passed, check the spectrometer purge flow as follows:

1. Enter 165 nm as the wavelength and select the `Go To` bar.
2. When the spectrometer reaches 165 nm, select the `carbon 165` line.
3. Measure the area and record the area count value.
4. Enter 193 nm as the wave length.
5. When the spectrometer reaches 193 nm, select the `carbon 193` line.
6. Measure the area and record the area count value.
7. Calculate the area ratio of the carbon 193 to carbon 165 lines. The ratio should be 4 or less. If the ratio is greater than 4, wait at least 15 minutes, then remeasure the carbon 165 and 193 lines and recalculate the ratio. If the ratio still is greater than 4:
   - If the spectrometer purge is controlled through an EPC, slightly increase the nitrogen flow rate. Wait at least 15 minutes, then re-test.
   - Check the quality (purity) of the nitrogen purge gas.
   - Check the system for gas leaks. See *Finding Gas Leaks*.

When the ratio is acceptable, the AED is ready for performance verification.

Verifying performance

Once all the GC-AED ChemStation components are set-up and ready to operate, the AED must be tested to verify its performance. Agilent Technologies provides test samples and pre-programmed recipes for this purpose. Also verify performance after significant repair has been performed.

Agilent Technologies provides 3 ChemStation methods (and 1 sequence) which are used to verify performance. Method CKO_TIME.M checks the retention time. Sequence CKO_TST.S runs methods CKO_RUN1.M and CKO_RUN2.M, which check if the instrument is operating within specification.

Procedure

1. Install the standard (checkout) column (part number 19091Z-012) in the GC and condition it as described in *First start-up* on page 41.
2. Set-up the gas flows to the original factory conditions as described in *First start-up* on page 41.
3. Place a vial of AED checkout sample #1 (part number 8500-5067) in position 1 of the auto injector or tray, and place a vial of AED checkout sample #2 (part number 8500-5067) in position 2.

4. Display the AED Spectral Plot on the ChemStation (`View/AED spectral plot on/off`).
5. From the Instrument menu, display the main AED screen.
6. After the checkout column in the GC is conditioned and all hardware is connected, load method CKO_TIME.M. Select Method/Load Method/ CKO_TIME.M. The method should include any changes to the default settings made during *First start-up* on page 41.
7. Run the method. Select `Run Control/Run Method`. For the performance calculations to work correctly, the retention time of the t-butyldisulfide must be between 2.115 and 2.150 minutes. If the retention time of the peak is in the correct range, the message "retention time of sulfur peak OK" is printed. If the retention time is outside the required window, the message "Suggested pressure change (psi) = X.XX" is printed, where X.XX is the amount by which the column inlet pressure should be changed to bring the peak into the window. Adjust the column inlet pressure.
8. Repeat step 7 until the retention time for the sulfur peak is between 2.115 to 2.150 minutes.
9. Save the modified method. Select `Method/Save Method`. Overwrite the earlier version.
10. Print the method parameters. Select `Method/Print Method`. The parameters will be used to modify methods CKO_RUN1.M and CKO_RUN2.M.
11. Load method CKO_RUN1.M. Select `Method/Load Method/ CKO_RUN1.M`.
12. Modify the default settings listed in the method for the oxygen, hydrogen, auxiliary gas, and/or column inlet pressures as needed to match the printout of method CKO_TIME.M.
    - Select `Instrument/Edit Parameters`.
    - Click on the `Aux` icon. Select the appropriate reagent gas and modify the settings.
    - Click on the `Inlets` icon. Modify the inlet pressure as required.
    - Save the new settings. Select `Method/Save Method`. Overwrite the earlier version.
13. Load method CKO_RUN2.M. Select `Method/Load Method/ CKO_RUN2.M`.
14. Modify the default settings listed in the method for the oxygen, hydrogen, auxiliary gas, and/or column inlet pressures as needed to match the printout of method CKO_TIME.M. See step 12 above. Save the new settings.

Select `Method/Save Method`. Overwrite the earlier version.

15. Load sequence CKO_TST.S. Select `Sequence/Load Sequence/ CKO_TST.S`.
16. Run sequence CKO_TST.S. `Select Run Control/Run Sequence`. The sequence takes about 1 hour to run. When finished, a report is printed which shows the detection limit, noise, selectivity, and back amount for each of the test elements. See the sample data and sample chromatograms below.
17. Compare the printed **Psel** values to the **selectivity** limits of the specification, and compare the printed **MDL** values to the **MDL** specification. If the results are acceptable, the unit is ready for use. If the results are unacceptable, adjust the reagent flow rate(s), troubleshoot the unit, and retest (see step 16) until the AED output is within specification.
18. At the end of the sequence, you will be asked if you want to save the measured back amounts for the tested elements.
    - If the test results look acceptable, click `OK` to save the Back Amount if desired.
    - If the test results were unacceptable, click `Cancel`.
19. If any changes were made to the EPC settings or the column inlet pressure after running the CKO_TST.S sequence, modify the three methods (CKO_TIME.M, CKO_RUN1.M, CKO_RUN2.M) and save the changes. Print each method for future reference. The new settings can be used as a starting point for any new methods which are created.

Specifications

The AED results must meet the specifications listed in *Specifications* on page 50.

Specifications

Figure 27. G2350A AED

When set-up and tested as described in *First start-up* on page 41 and in *Verifying performance* on page 47, the G2350A AED performance must meet the specifications listed below.

Table 12. Performance Specifications

Emission Line	MDL* (pg/sec)	Selectivity over Carbon
C193	1	
Cl 479	30	3000
H 486	4	
N 174	30	2500
O 171	150	5000
P 178	2	5000
S 181	2	10000

* Minimum Detectable Level

Sample chromatograms and tabulated data

The sequence's printed output should be similar to the samples below. The chromatograms and data are provided for reference, and are not part of the G2350A specifications.

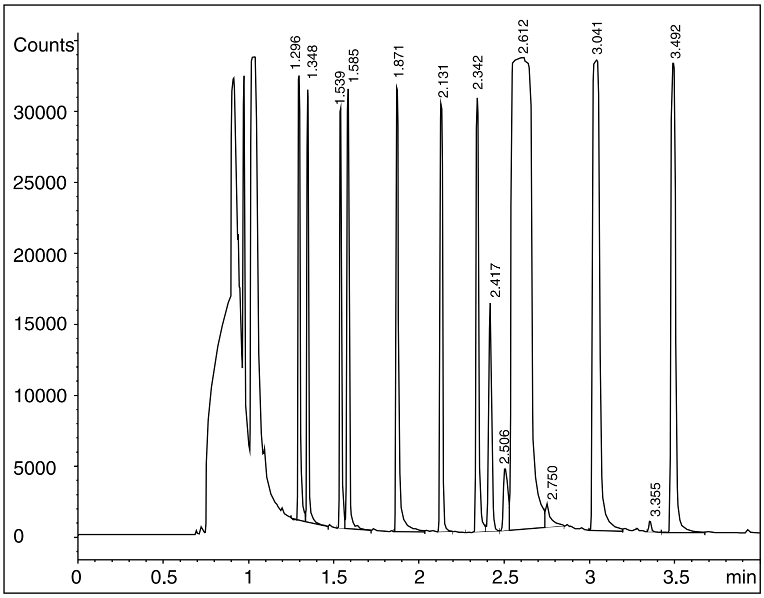

Figure 28. Carbon 193

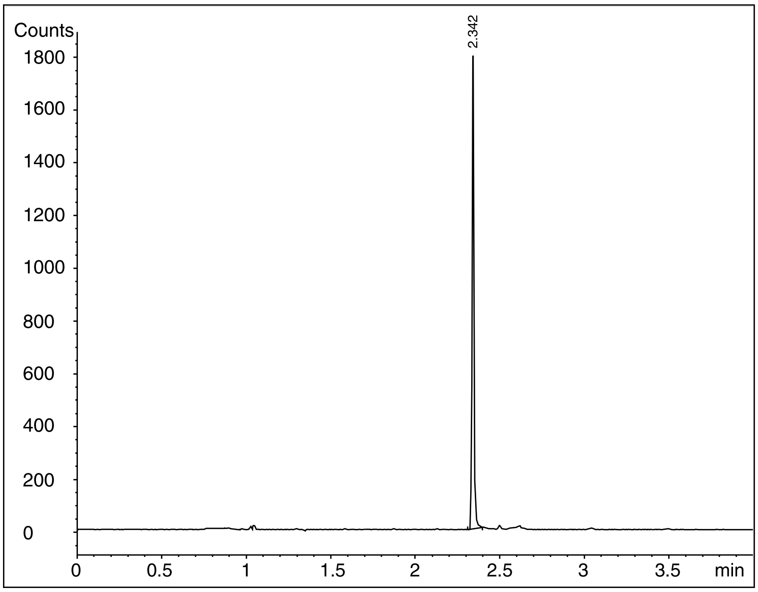

Figure 29. Chlorine 479

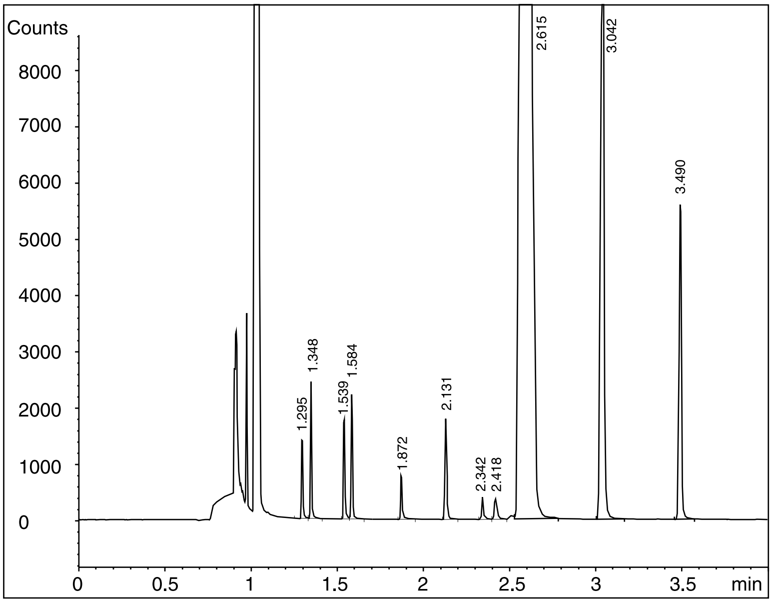

Figure 30. Hydrogen 486

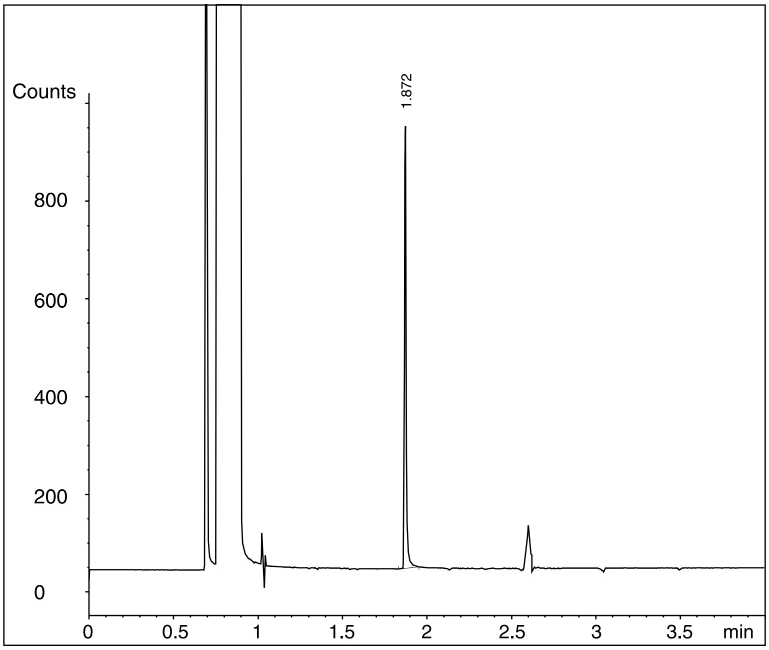

Figure 31. Nitrogen 174

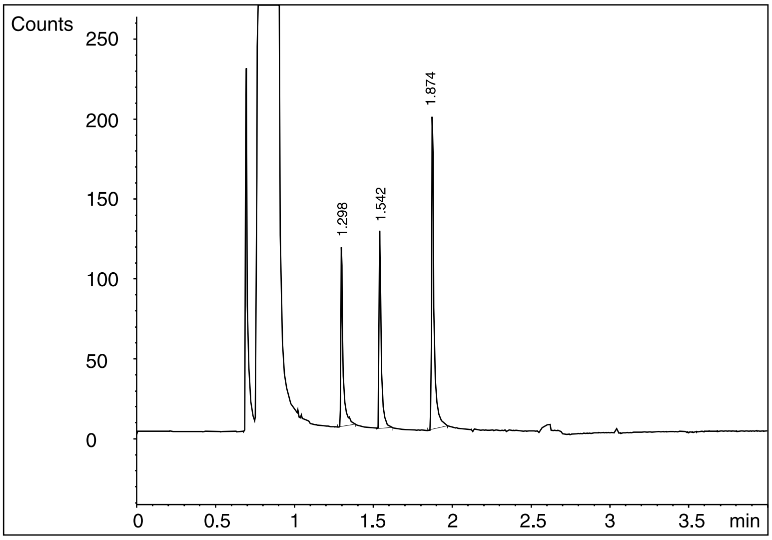

Figure 32. Oxygen 171

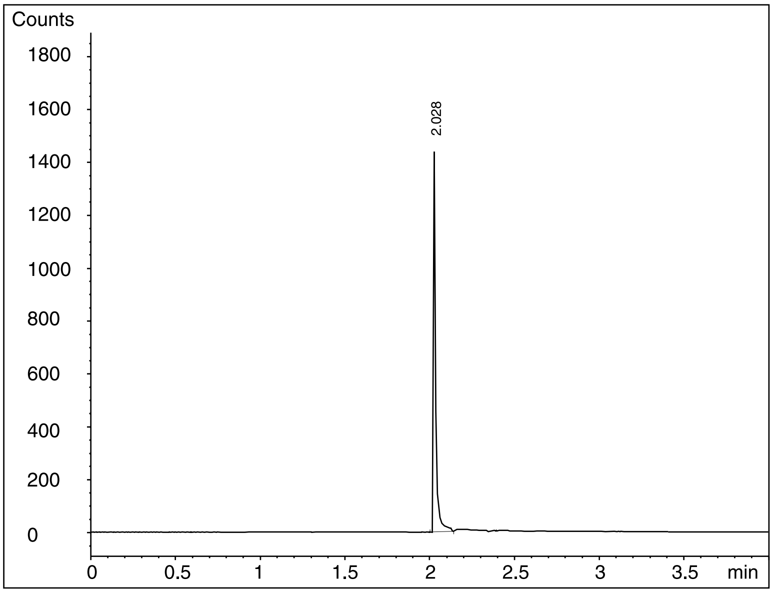

Figure 33. Phosphorus 178

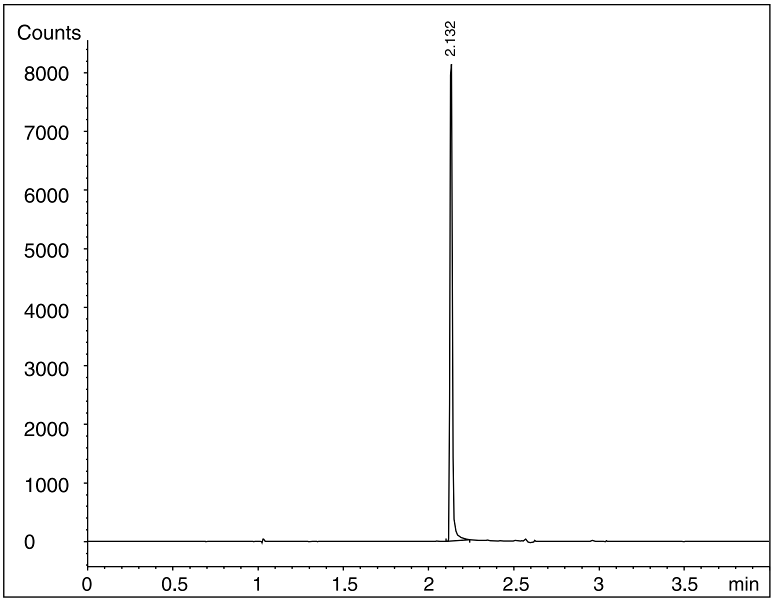

Figure 34. Sulfur 181

Table 13. Sample Printout of Results

	mdl pg/sec	noise	Msel	supamt	Psel	Area
C 193 nm	0.46	0.896	----	----	----	31719.9
Cl 479 nm	9.58	0.647	2609	0.9987	12183	1624.1
H 486 nm	0.75	0.689	----	----	----	1304.8
N 174 nm	4.12	0.729	3431	0.9452	5463	690.6
O 171 nm	32.46	0.543	6215	1.004	16845	224.7
P 178 nm	1.05	0.275	4205	0.8036	17315	924.2
S 181 nm	0.41	0.322	9007	0.9857	24749	7751.5

Checkout sample composition

Part Number: 8500-5067

Checkout Sample #1 Composition: Mixture of the following on (w/w) basis:

0.07% Nitrobenzene ($C_6H_5NO_2$)
0.043% b-Tridecane ($C_{13}H_{28}$)
0.07% 4-Fluoroanisole (C_7H_7FO)
0.05% tert-Butyl Disulfide ($C_8H_{18}S_2$)
0.08% 1,2,4-Trichlorobenzene ($C_6H_3C_{l3}$)
0.05% Tetraethyl orthosilicate ($C_8H_{20}SiO_4$)
0.05% n-Decane [perdeuterated] ($C_{10}D_{22}$)
4.3% n-Dodecane ($C_{12}H_{26}$)
0.13% n-Tetradecane ($C_{14}H_{30}$)
0.07% 1-Bromohexane ($C_6H_{13}Br$)
4.04% n-Octane (C_8H_{18})
In Isooctane (C_8H_{18}) as solvent

Checkout Sample #2 Composition: Same as Sample 1, with the addition of 0.06% Triethyl Phosphate ($C_6H_{15}PO_4$).

2 Maintenance

General

Intended use

The maintenance section of this documentation is intended for use primarily by the Agilent Customer Engineer. While some of the procedures described can be performed as part of regular maintenance and upkeep, other procedures are to be performed only by qualified personnel. Please reference the *Setting Up and Maintaining the G2350A AED* manual for routine maintenance procedures.

General maintenance procedures

When performing any maintenance on the G2350A AED, observe the following rules:

- Adding distilled water to the reservoir when the water level is low is the only procedure which can be performed while the AED is running. Never perform any other maintenance procedure while the AED is running.
- Allow the cavity and heated zones to cool down before performing maintenance on them.

AED shutdown

If it becomes necessary to shut down your unit for one day or more, follow the procedures below:

1. Turn the AED power off.
2. Turn off all gases except the nitrogen purge to the spectrometer.
3. Allow the water to cool to ambient temperature.
4. Drain all water from the system.
5. Purge all water lines in the AED with helium or nitrogen gas to dry them off.

Hazard awareness

This manual contains safety information that should be followed to ensure safe operation. There are seven potential safety hazards which the user should be aware of when using the AED. These are described as follows:

1. High temperature
2. High voltage
3. Microwaves
4. Ultraviolet light
5. Effluent venting
6. Hydrogen gas
7. Insulation

High temperature

Warning Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat-resistant gloves.

High-temperature heated zones in the G2350A AED include the column transfer line, cavity assembly, and the water bath.

The column transfer line is surrounded by an insulated sleeve enclosed in a metal tube. Although the tube surface of the transfer line can get hot, it is safely contained within the GC except for a few inches between the GC and AED, which are surrounded by rigid protective insulation. The transfer line does not present a burn hazard as long as this rigid insulation is in place.

The cavity assembly hardware is located under a hinged safety cover to prevent burns. **Keep this cover closed** until the cavity has reached ambient temperature before performing maintenance procedures, such as changing a column or replacing a discharge tube.

The water reservoir and water lines can reach high temperatures and can be accessed easily. Be sure to turn OFF the AED and let the water cool before draining the system.

High voltage

Warning To reduce risk of electric shock, always disconnect the power cord when changing the fuse on the AED.

To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the wave guide when the AED is in operation.

High voltage hazards include:

- The high voltage supply to the magnetron, which delivers a current of 8 A at 2.2 V to the magnetron filament and 60 mA at 2340 V to the magnetron high voltage circuit.
- The 120/220 V supplies connected to the column transfer line heater, the emission source heater, the water bath heater, and the 115/120 V circuits at the primary instrument supply.

Microwaves

Warning Microwave radiation

Never remove the screws attaching the cavity to the wave guide or the screws which fasten the cavity halves together.

Never operate the G2350A AED when the cavity, magnetron, or wave guide are disassembled or mechanically loose.

If stray microwave emission is suspected and/or measured above 5 mW/cm^2 at a distance of 5 cm, shut down the instrument **immediately** and call the Agilent Service Department for service.

[**Note**: 5 mW/cm^2 at a distance of 5 cm is the amount of microwave leakage allowed from microwave ovens by the International Electrotechnical Commission (IEC) and the United States Food and Drug Administration (FDA). This standard is published in IEC Publication 519-6-1982 and in the Radiation Control for Health and Safety Act of 1968 (PL90-602, section 358.)]

Ultraviolet light

Warning To reduce risk of eye damage, **never** operate the G2350A without the glass filter in the view port of the cavity. Never view the plasma by looking directly into the open end of the discharge tube while the plasma is lit.

The AED emits ultraviolet light that can damage the eyes if stared at for long periods of time. The view port in the cavity has a glass filter that prevents ultraviolet light (light of wavelengths shorter than 360 nm) from passing through to the viewer's eyes.

Effluent gases

Warning To reduce risk of breathing ozone and other harmful gases produced by the plasma, vent G2350A AED effluents from the side panel to a fume hood.

The effluent gases may contain ozone or other harmful gases produced by the plasma. Oxygen, hydrogen, and methane present an explosion hazard. Vent the gases to a fume hood. Ideally, each gas should be vented to a separate hood.

Hydrogen gas

Warning To reduce risk of explosion, fire, and injury, ensure that hydrogen gas is only connected to the gas inlet on the side panel labeled "HYDROGEN."

Hydrogen gas presents an explosion hazard. Vent hydrogen gas to a fume hood. Ensure that hydrogen is plumbed only to the hydrogen inlet.

Insulation

Warning If the insulation is flaky/crumbly, replace or seal the insulation. Wear protective clothing, eye wear, and a dust respirator until the insulation is either sealed or replaced.

The AED end of the heated transfer line is insulated with a material consisting of lime, silica, and reinforcing fibers that can cause irritation to the skin, eyes, and mucous membranes. Wear gloves when touching the bare insulation. Replace any part with exposed insulation.

Optical Assembly

The PDA and preamp board, the spectrometer, and the PDA ribbon cable are designed to be easily replaceable as units. Therefore, no maintenance is performed on these units. If a problem is detected within the Spectrometer, cable, PDA, or the PDA preamp, the assembly is replaced.

Replaceable components

PDA assembly

PDA to main PCB cable assembly

Spectrometer

Spectrometer assembly

Lens mount assembly, including:

- Lens
- Lens keeper
- Lens keeper O-ring
- Lens mount cone
- Lens mount liner
- Lens mount liner O-ring
- Lens O-ring

Tools needed

Two 5/16 inch open end wrenches

7/16 inch open end wrench

9/16 inch open end wrench

Posi-drive

PDA

Replace the PDA (and PDA preamplifier board) as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

1. Turn off the AED.
2. Lower the AED front facing and open the front lid.
3. Turn off the spectrometer purge (nitrogen) at the source.
4. Move the cavity to the service position. See *Moving the cavity assembly to the service position* on page 91.
5. Use a 9/16 inch and 7/16 inch wrench to remove the spectrometer purge line.
6. Remove the spectrometer cable, the lens purge and cavity vent tubing, and the spark plug and wire.
7. Remove the spectrometer and lens mount assembly from the enclosure by sliding it all the way to the left and then lifting.
8. Stand the spectrometer on its end so that the PDA faces up.

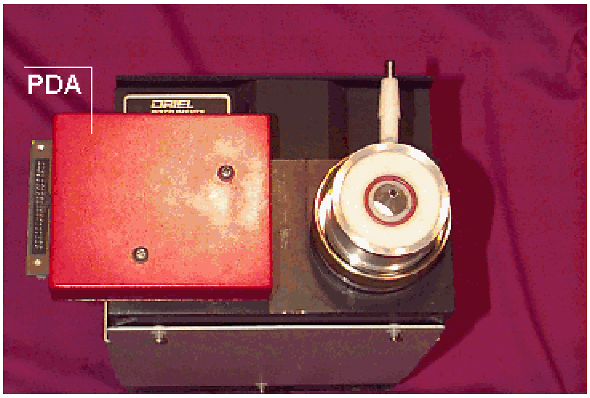

Figure 35. PDA and spectrometer assemblies (top view)

9. Remove the two screws holding the PDA in the spectrometer.

10. Remove the PDA.

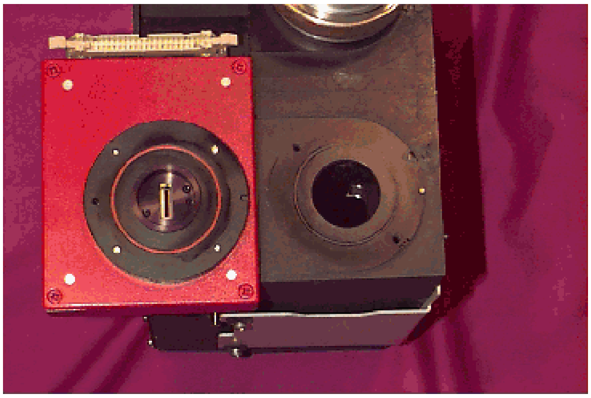

Figure 36. PDA removed

11. Ensure the O-ring is properly seated, then install the new PDA using the two mounting screws.
12. Re-assemble in reverse order.

See also *PDA* on page 145.

Spectrometer

Replace the spectrometer, as described below, when problems with the optics are suspected and all other causes have been ruled out:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

1. Turn off the AED.
2. Slide out the cavity assembly and water drawer as described in *Moving the cavity assembly to the service position* on page 91.

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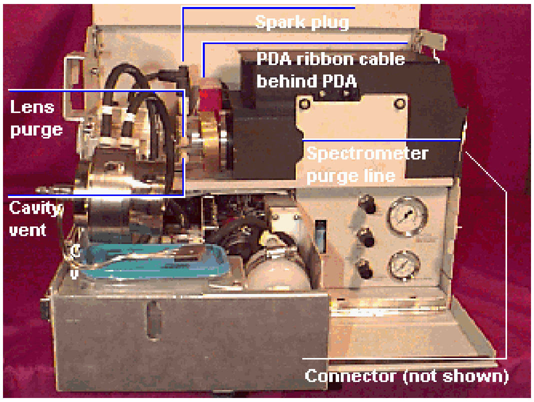


Figure 37. Spectrometer detached from cavity assembly

3. Disconnect the PDA ribbon cable from the PDA.
4. Disconnect the spark plug wire and unscrew the spark plug and remove.
5. Disconnect the lens purge and cavity vent lines.
6. Unplug the connector at the rear of the spectrometer.
7. Turn OFF the nitrogen purge at the source.
8. Disconnect the spectrometer purge line using a 9/16 inch and a 7/16 inch wrench. Plug the line and the spectrometer inlet.
9. Take the spectrometer and cradle out of the AED and place them on a bench.
10. Place the spectrometer so that it stands with the slit and PDA on top.

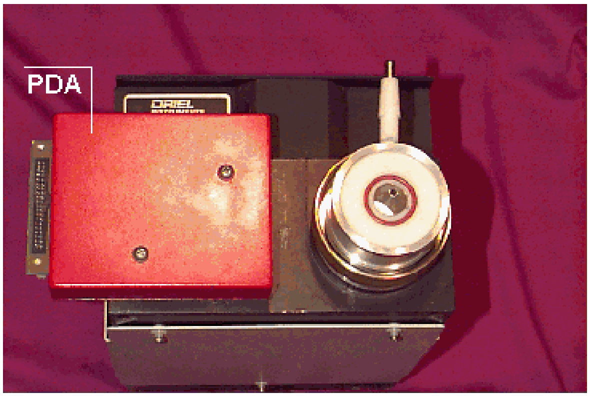


Figure 38. Spectrometer on end

11. Remove the two screws in the PDA, and remove the PDA. Clean the threads and mounting surfaces with clean air spray.

12. Cover the opening.
13. Remove the lens mount liner assembly (O-ring, lens mount cone, and lens mount liner) from the lens mount top. Be careful not to lose the three O-rings in the lens mount liner. See Figure 39.

Figure 39. Lens mount liner removed

14. Remove the three screws in the lens keeper and remove the lens keeper assembly. See Figure 40.

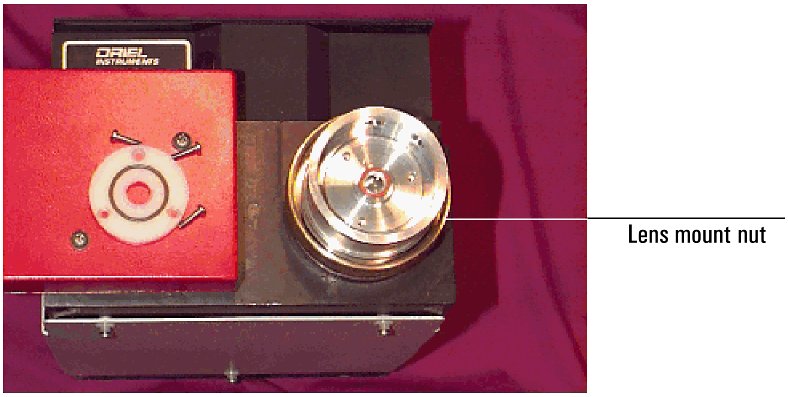


Figure 40. Lens keeper assembly removed

15. Remove the lens mount top and lens mount nut. Cover to keep clean.
16. Inspect the lens. Replace (or clean) as required. See *Spectrometer lens* on page 67.
17. Unscrew the 2 screws in the lens mount bottom and remove. Clean the threads and mounting surfaces with clean air spray. See Figure 41.

Figure 41. Lens mount bottom removed

18. Install plastic slit cover and tape cover in place.
19. Remove the four mounting screws and remove the spectrometer from the cradle. Set the cradle aside.
20. Place new spectrometer upright, with the PDA window and slit facing up.
21. Remove the tape and cover from the new spectrometer.
22. Install the lens mount bottom. The screw near the small through hole should be at the top of the assembly. (1 o'clock position.)
23. Place the lens mount nut over the lens mount bottom with the threads facing out. Install the lens mount top so that the pin in the lens mount bottom fits in the hole in the lens mount top.
24. Install the lens in the lens keeper assembly, then install the lens keeper using three screws. Be sure the O-ring is secure and undamaged. Tighten the screws a little at a time until all are tight, and follow a circular tightening pattern. **The tightening pattern is important for sealing.**
25. Remove the two mounting screws in the PDA window cover and remove the cover.
26. Install the PDA onto the spectrometer, making sure the alignment slot is aligned.
27. Install the spectrometer into the cradle with four screws.
28. Install into AED and slide back.
29. Install the lens mount liner assembly and the spark plug to keep the assembly in place and to ensure proper alignment of the through holes in the liner with the cutouts in the water chamber. See Figure 38 on page 64.
30. Put a light coat of Hi-Vac grease or equivalent lubricant on the bottom interior flange of the lens mount nut.

31. Slide the water drawer back into the AED and lock the emission source to the enclosure.
32. Install the spectrometer assembly onto the optical side water chamber and hand tighten the lens mount nut onto the threads.
33. Reinstall the spectrometer purge, the cavity vent, the lens purge, and the spectrometer cable.
34. Reinstall the transfer line and column.
35. When complete, the pressure gauge on the panel should read 1.5 psi for the spectrometer lens purge. If it does not, there is a leak at one of the gas ports, at the spark plug, or at the O-ring seal. Tighten the spark plug, gas lines, or the lens mount nut as required.

See also *Spectrometer* on page 144.

Spectrometer assembly

To replace the spectrometer assembly (spectrometer, cradle assembly, PDA, and lens mount assembly):

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

1. Turn off the AED.
2. Disconnect the PDA to Main PCB cable from the main board.
3. Remove the spectrometer assembly from the AED as described in *Spectrometer* on page 63.
4. Replace the spectrometer assembly.

Spectrometer lens

It is most convenient to replace or clean the lens when the discharge tube is being replaced.

Note: While a dirty lens can be cleaned, it is recommended that a dirty lens always be replaced.

Removing the lens

To remove the lens, follow the procedure described below:

1. Shut down the AED.
2. Move the cavity to the service position.
3. Remove the spark plug wire, spectrometer lens purge inlet, and cavity vent lines from the lens mount liner. Cap off the lens purge inlet.
4. Remove the lens mount cone, lens mount liner, and lens mount liner O-ring. Be careful not to lose the O-rings in the lens mount liner.
5. Inspect the lens mount liner for deterioration. If the central area of the lens mount liner is greatly discolored, or if the lens mount cone is loose and cannot be tightened, replace the lens mount liner.

Warning Dirt or scratches on the lens decrease AED performance. Avoid scratching the lens. Never touch the lens with bare fingers. Always wear clean latex (or similar) gloves to handle the lens.

6. Unscrew the three mounting screws in the lens keeper and carefully remove it and the lens.
7. Replace or clean the lens as needed.

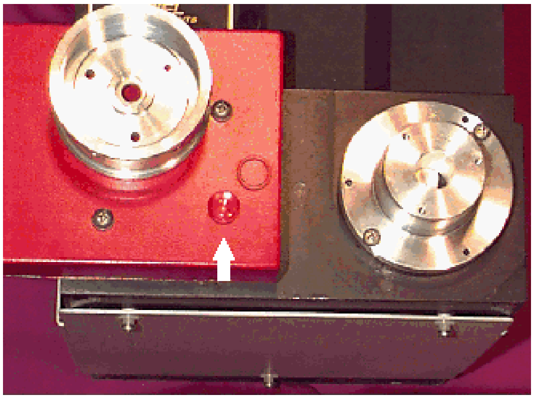


Figure 42. Lens keeper removed

8. Reassemble the lens and lens keeper in reverse order. Be sure the O-ring is secure and undamaged. Tighten the screws a little at a time until all are tight, following a circular tightening pattern.
9. Place the lens mount nut over the lens mount bottom, threads facing out. Install the lens mount liner with the through holes at the 12 o’clock, 1 o’clock, and 4 o’clock position. See Figure 43.

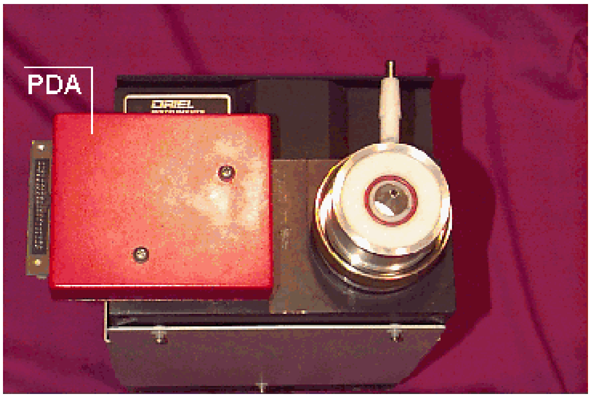


Figure 43. Lens mount liner orientation

10. Reassemble the rest of the parts in reverse order.

Cleaning the lens

1. Remove the lens as described above in *Removing the lens* on page 68.
2. Wipe the lens with clean methanol and lab tissue. (Do not attempt to clean the lens when it is inside the receiver since the O-rings holding it in place will absorb the methanol.)
3. Hold the lens up to the light and make sure there are no fingerprints, dirt, or discolored areas.
4. If the center is a different color or if the lens shows any damage, discard it and replace it with a new lens.

Lens mount assembly

For instructions on how to remove the lens mount assembly and related hardware (listed below) for replacement, see *Spectrometer* on page 63.

Lens mount assembly, including:

- Lens keeper
- Lens keeper O-ring
- Lens mount cone
- Lens mount liner
- Lens mount liner O-ring

Electronics

The AC board, sparker board, and power supply are easily replaced. In general, no repairs are made to them in the field. The main board can be upgraded in the field by the Customer Engineer, but again it is replaced rather than repaired once it is determined to be defective.

Replaceable components

Main board assembly

- ROM (upgrades only, Agilent Customer Engineer only)
- Fuses (Agilent Customer Engineer only)

AC board assembly

- Fuses (Agilent Customer Engineer only)

Sparker assembly

- Sparker PCB assembly
- Sparker assembly cable
- Spark top brazement
- Ignition module
- Ignition coil
- 8 mm ignition wire

Power transformer assembly

Power supply

Water board (see *Water Flow System* on page 122)

AC input cable

AC input wiring assembly

Heater/sensor cable assembly

Main harness cable assembly

PDA to main cable assembly

Remote rocker switch

Tools needed

Posi-drive

5 mm nut driver

7 mm nut driver

Chip puller

Flat head screwdriver

Two 9/16 inch open-end wrenches

Connector pin punch

Connector pin installer

Grounded wrist strap (part number 9300-0969, large, or 9300-0970, small)

Grounded work mat

AC board

Replacing the AC board

Replace the AC board as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Turn off the AED and unplug from main power.
2. Open the top cover and remove the front lid.
3. Remove the two wires leading to the power switch.

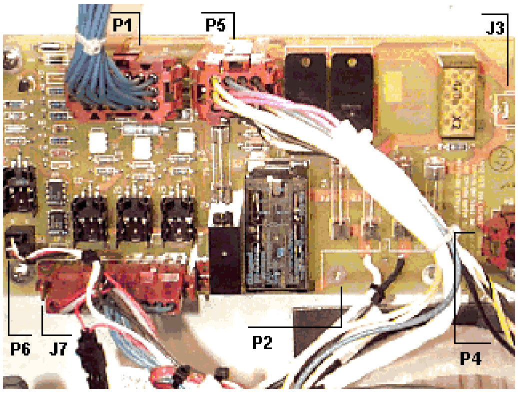


Figure 44. **Removing connectors from AC board**

4. Remove connectors J7, P6, P1, P5, and the two leads from P2 to the remote rocker switch.
5. Remove the four mounting screws using a posi-drive.
6. Lift the board out of the AED and set aside.
7. Check the voltage selection switches on the new board and reset, if applicable. (See Table 14 below.)
8. Install the new board.

See also:

AC board on page 147

AED does not turn ON on page 182

Troubleshooting the AC board on page 183

AC board, part no. G2350-60057 on page 212

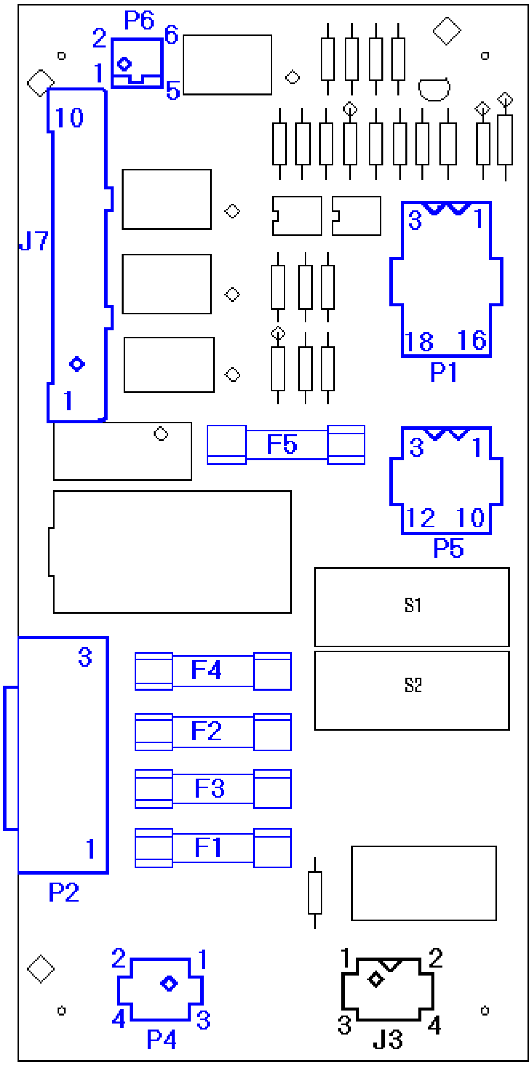


Figure 45. AC board connectors

Voltage selection switches

When a new AC board is installed, the voltage selection switches may need to be properly set before use. Set the switches as follows:

Table 14. Voltage Selection Switch Settings

Country	VAC	S1 Setting	S2 Setting
Japan	100	down	up
USA	120	down	down
Europe	220/230	up	up
USA	240	up	down

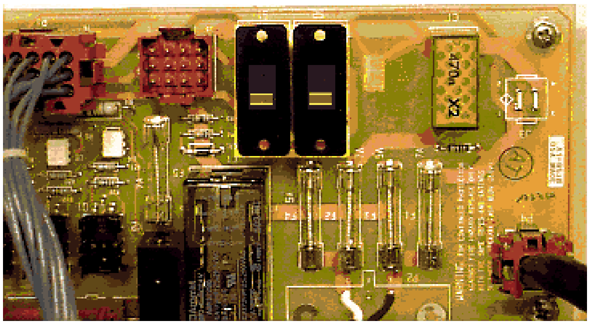


Figure 46. Switch settings for USA, 120V, AC board shown installed

Note: The AC board is installed upside down. The switch settings above are given for the **installed** orientation. “Up” is toward the main board, and “Down” is toward the bench top, **as installed in the AED**.

Fuses

Always try to determine the possible cause for a blown fuse before replacing the fuse.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Shut down the AED if still running.
2. Unplug the power cord.
3. Open the main cover.
4. Always replace fuses F1/F2 and F3/F4 in pairs.

See also *Troubleshooting the AC board* on page 183 and *AED does not turn ON* on page 182.

High voltage power supply

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

To replace the high voltage power supply:

Always disconnect the power cord when changing the power supply on the AED.

1. Turn off the AED and **unplug the power cord**.
2. If the shipping bracket is still installed, remove its two mounting fasteners and remove the bracket.
3. Attach the emission source to the water drawer and slide the drawer out as described in Moving the Cavity Assembly to the Source Position.
4. Disconnect the power supply connector and ground wire from the emission source assembly, and slide the drawer back into the AED.
5. Remove the power supply cable from P4 on the AC board.
6. Use a posi-drive to remove the power supply mounting screw.

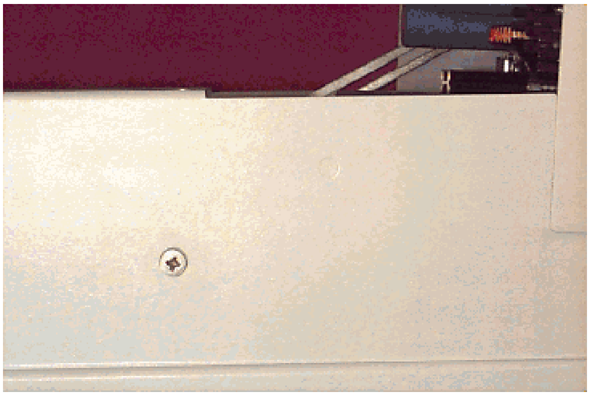


Figure 47. Removing power supply

7. Loosen (do not remove) the two 7 mm nuts which secure the fire wall, and remove the fire wall.
8. Lift the power supply up and out of the AED.
9. Install a new power supply. Make sure that the tab in the power supply aligns with the slot in the enclosure bottom.
10. Reconnect the power supply to the emission source. Re-attach the ground strap.

Warning High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the wave guide when the AED is in operation.

11. Reinstall the fire wall. Make sure that the cables will feed through the fire wall without excessive stress.

See also *Troubleshooting the high voltage power supply* on page 184 and *Power supply* on page 151.

Service display board

The service display board is an optional diagnostic tool available only to the Agilent Customer Engineer. To install the board:

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

1. Open the AED top cover.
2. Attach the ribbon cable from the service display board to the P101 connector on the main board. See Figure 48.

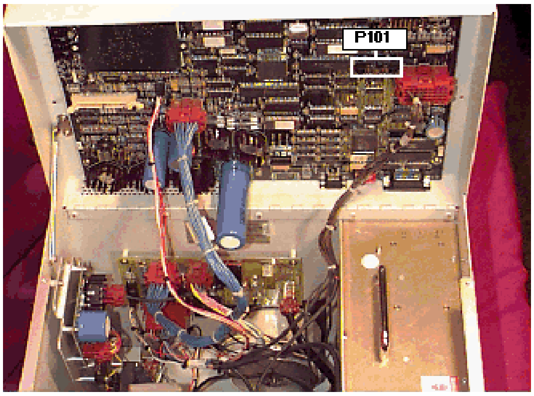


Figure 48. Installing the service display board

Main board

Replacing the main board

Replace the main board as described below.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Turn OFF the AED and unplug from main power.
2. Open the top cover.
3. Remove the connectors at:

   J100
   J102
   J252
   P101
   P100
   P500
   J251

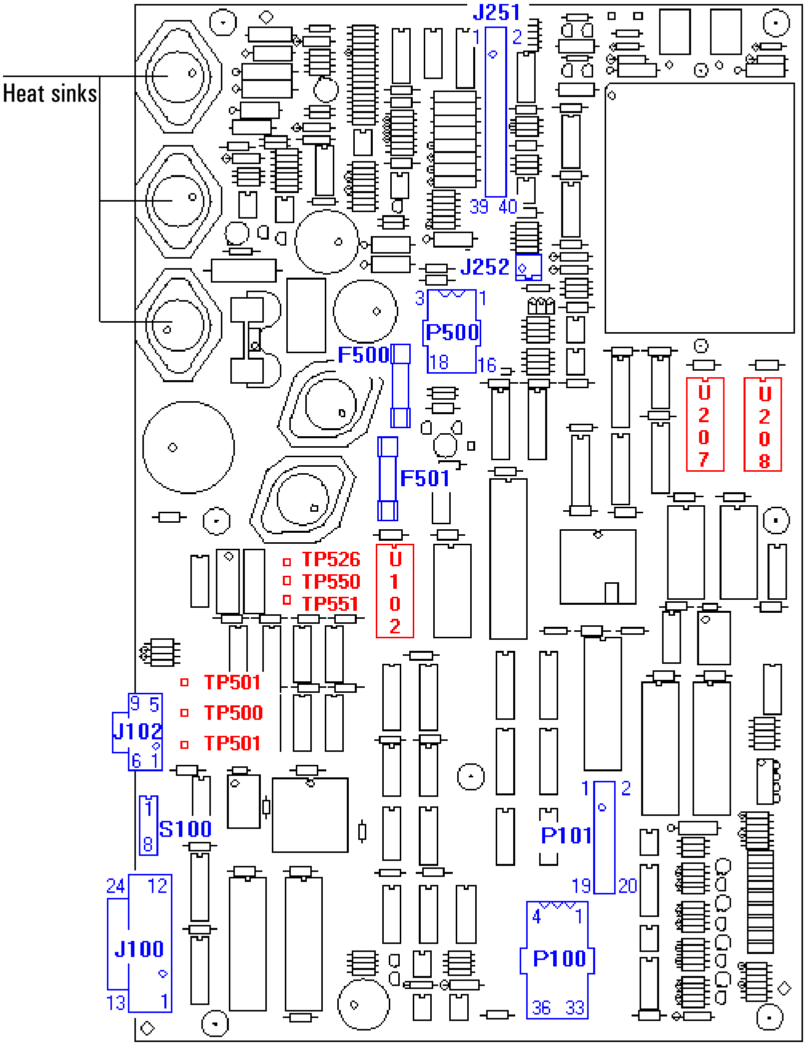


Figure 49. Main board test points connectors

4. Remove the eight board mounting screws using a posi-drive.
5. Lift the board out of the AED and set aside.
6. Verify the GPIB address on the new board is set to the default setting (15) or the setting configured by the user. See *GPIB address* on page 79 below.
7. Install a new board. Make sure that the heat sinks shown in Figure 49 do not short to any cover.

See also *Main board* on page 150 and *Troubleshooting the main board* on page 183.

GPIB address

The GPIB controller can be set to a different address as described below.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Turn OFF the AED.
2. Open the top cover.
3. If desired remove the main board. See *Replacing the main board* on page 77.
4. Set or reset the pins on the GPIB controller to match the proper GPIB configuration. For installed systems, reference the ChemStation Configuration Editor for each instrument's current GPIB address.

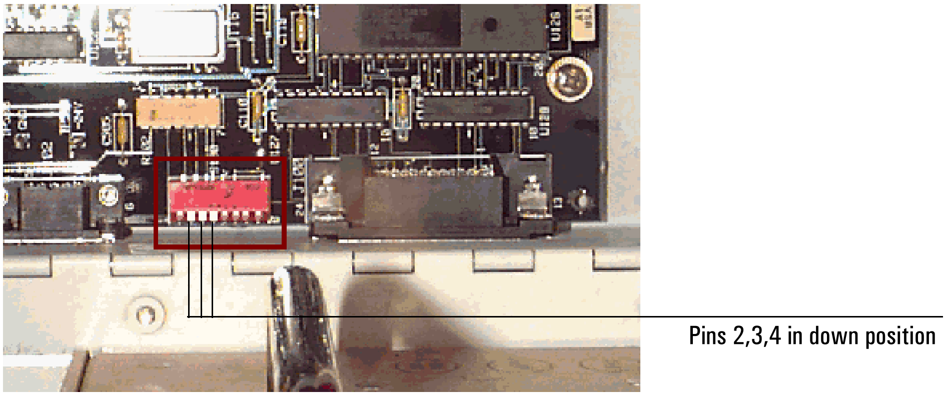


Figure 50. GPIB, default setting (15)

An address of 15 is set as follows:

Table 15. Default Settings

Switch	Setting
1	up
2	down
3	down
4	down
5 to 8	up

ROM

Three ROMs on the main board are replaceable for possible future firmware upgrades. These ROMs are U102, U207, and U208. Replace a ROM as described below.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Turn off the AED.
2. Open the cover.
3. Using a chip remover, firmly but gently grab the ROM and pull it straight out from its socket.
4. Install the new chip.

Sparker board

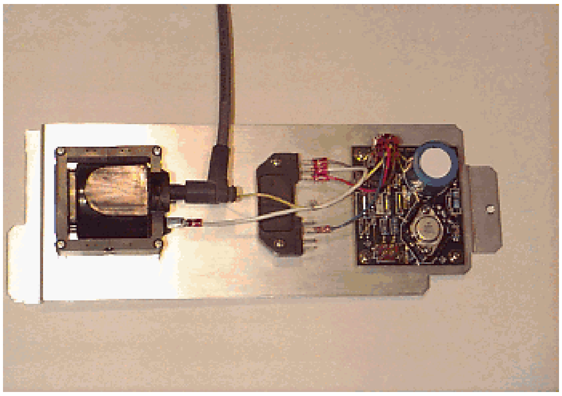


Figure 51. Sparker assembly

Sparker assembly

Replace the entire sparker assembly (PCB, coil, and module) as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Warning High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the wave guide when the AED is in operation.

1. Turn off the AED and unplug the power cord.
2. Remove the connector at J1.
3. Remove the spark plug wire at the spark plug.
4. Remove the mounting screw that secures the sparker assembly to the AED enclosure using a posi-drive.

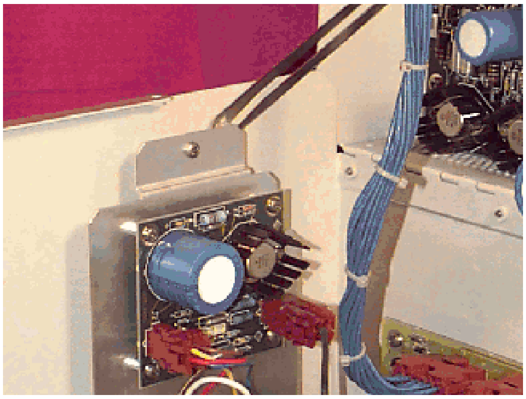


Figure 52. Remove the mounting screw to sparker assembly

5. Lift the sparker assembly out of the two slots in the enclosure and remove.
6. Replace and reassemble in reverse order.

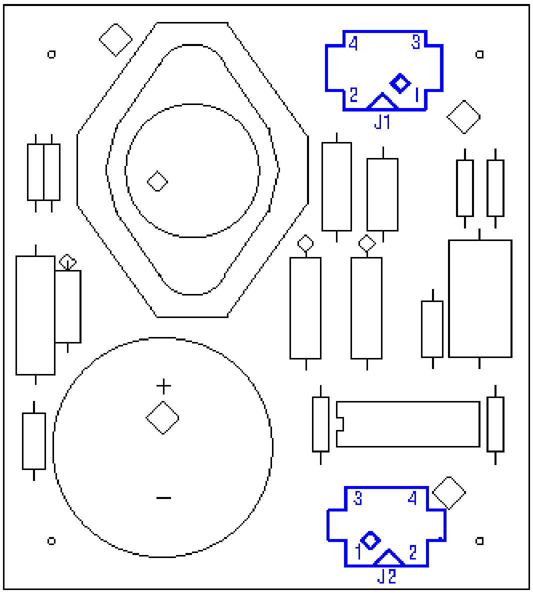


Figure 53. Sparker board

See also *Sparker board* on page 152 and *Sparker board, part no. 05921-60030* on page 236.

Sparker PCB assembly

Replace the sparker board as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the waveguide when the AED is in operation.

1. Turn off the AED and unplug the power cord.
2. Open the top cover.
3. Remove the connectors at J1 and J2.
4. Remove the four M4 mounting screws using a posi-drive.
5. Install a new board.

Ignition module

Replace the ignition module as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the waveguide when the AED is in operation.

1. Turn off the AED and unplug the power cord.
2. Open the top cover.
3. Remove the four blade connectors.
4. Remove the two M4 mounting screws using a posi-drive.
5. Install a new ignition module.

Ignition coil

Replace the ignition coil as described below:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the waveguide when the AED is in operation.

1. Turn off the AED and unplug the power cord.
2. Open the top cover.
3. Remove the two blade connectors and the spark plug wire.
4. Remove the four M4 mounting screws using a posi-drive.
5. Install a new ignition coil.

Transformer

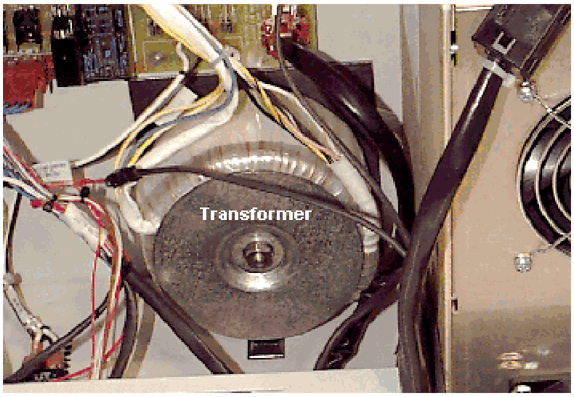


Figure 54. Transformer

To replace the transformer:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Turn the AED OFF and **unplug the power cord**.
2. Remove the front lid, lower the front facing, and open the top cover.
3. Slide the water drawer out.
4. Remove the transformer connector on the AC board at P5.
5. Using two 9/16 inch wrenches, remove the nut and bolt in the center of the transformer and remove the transformer.
6. Install a new transformer so that the wires are as shown in the picture. Note that the lead from the transformer with the white-wrapped bundle is on the left, and both leads exit the coil on vertical tangents. Installing the transformer in a different orientation may cause interference with the water drawer.
7. Connect the new transformer to the AC board. Use a tie wrap around the wiring if needed to keep the wires from interfering with other cables.

Emission Source

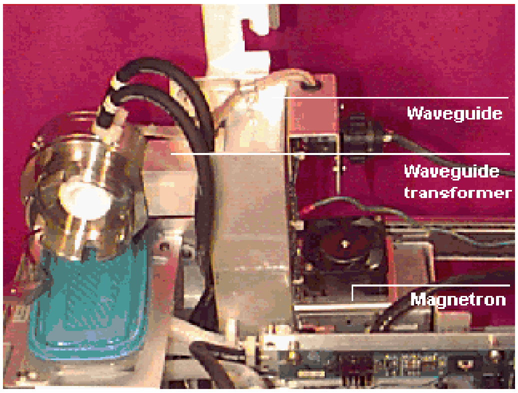


Figure 55. Emission source, waveguide, and waveguide transformer

The microwave emission source, waveguide, and waveguide transformer are all replaced as an assembly. Other components are replaced individually as part of routine and unscheduled maintenance.

Replaceable components

Emission source assembly (emission source, waveguide, and waveguide transformer)

Cavity heater/PRT assembly

Exit chamber

Optical side water chamber

Heater block

Discharge tube kit, including:

- Discharge tube
- O-ring
- Ferrule

Gas union assembly

GC side water chamber

Gas union

Normally, the gas union is replaced as a whole unit, and is not disassembled. However, if for any reason it is disassembled, it is important that the four-bellville washers are installed correctly. While holding the GC half of the gas union facing up, install two washers so that their conical surface faces up. Install the last two washers with their conical surfaces facing down. Re-assemble the gas union halves.

Tools needed

Posi-drive

Flat head screwdriver

5 mm nut driver

7 mm nut driver

1/2 inch open end wrench

Two 5/16 inch open end wrenches

7/16 inch open end wrench

Small nylon screw or equivalent

Agilent-supplied nylon screw (or equivalent)

Correction fluid

Column trimming tool (part no. G2350-80610)

Needle nosed pliers

Cavity brushes (part no. 8710-1876 and 8710-1938)

2.5 mm hex key

Special handling notes and cautions

Check the unit for microwave leakage whenever any portion of the magnetron, waveguide, or cavity to waveguide interface has been loosened or disassembled and reassembled. See *Testing for microwave leakage* on page 180.

Cleaning the cavity

After removing a broken discharge tube, you will need to clean the cavity assembly to prevent small particles of glass from lodging in the water flow paths. Such debris will shorten discharge tube life and can damage other parts of the flow system. Clean the cavity as described below.

Warning Wear safety glasses when performing this procedure.

Ultraviolet Light! To reduce risk of eye damage, never operate the G2350A without the glass filter in the view port of the cavity. Never view the plasma by looking directly into the open end of the discharge tube while the plasma is lit.

1. Move the cavity into the service position.
2. If you haven't already done so, remove the white exit chamber and gas union from the cavity. See *Discharge tube* on page 98.
3. Remove the water lines from the cavity by pulling them off the fittings. You do not have to remove the hose clamps to do this.

Caution Do not spill the water from the lines onto the water drawer electronics.

4. Run the large brush through the cavity water fittings to remove any debris.
5. While supporting the GC and optical side water chambers, remove the three screws that secure the chambers to the cavity assembly. Remove the cavity heater/PRT assembly to avoid straining the wires.
6. Lift the GC side water chamber from the cavity assembly.

Caution Do not use solvents to clean the O-rings. Residual solvents may contaminate your test results or degrade O-ring life.

7. Use clean compressed air to blow any water off of the conical surface on the water chamber. Carefully remove the O-ring from its seat. Inspect for glass particles and clean any particles from the chamber using clean compressed air. If necessary, use a Kimwipe to remove glass particles stuck to the chamber surface. See Figure 56.

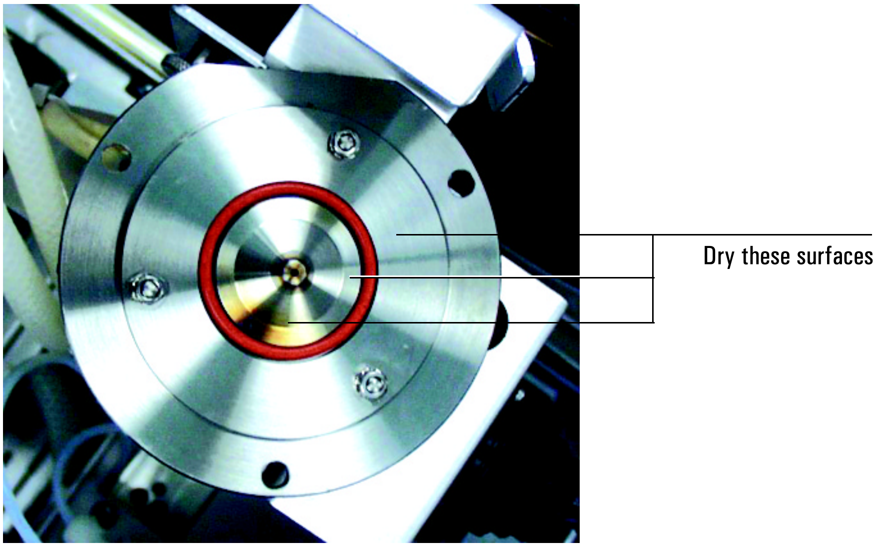


Figure 56. Drying the GC side water chamber

8. Using the small brush, clean the through hole in the GC side water chamber. Use clean compressed air to dry the O-ring seat and clean out the discharge tube through hole.
9. Re-install the O-ring. If the O-ring is damaged, replace it.
10. Remove the optical side water chamber from the cavity. Remove the old discharge tube O-ring from the tip of the exit cone in the chamber.
11. Use clean compressed air to blow any water and particles out of the O-ring groove and off of the faces of the chamber. Do **not** remove the O-ring set inside the optical side water chamber. If necessary, use a Kimwipe to remove glass particles stuck to the surface.
12. Using the small brush, clean the through hole in the chamber. Use clean compressed air to dry the chamber and clean out the discharge tube through hole in the water jacket.
13. Clean the discharge tube through hole in the cavity using the small cleaning brush. Use clean compressed air to blow any particles of debris from the through hole.

14. Reassemble the cavity. Hold the GC side- and optical side water chambers in place, then install the topmost screw to hold them together. Install the other two screws. Alternately tighten each screw until snug.
15. Inspect the fly ash filter for water contamination. If there is water in the filter, you will need to inspect the spectrometer lens for contamination. Clean any water or debris from the lens as described in *Spectrometer lens* on page 67.

Caution Blowing air through the lower fitting on the fly ash filter will damage the cavity pressure gauge. Allow water below the filter to dry out through normal use.

16. If there is water in the fly ash filter, remove the filter as described in *Fly ash filter* on page 116. Leave it disconnected for now. Connect clean compressed air to the lens purge tubing at the lens mount liner fitting and blow any water through the tubing and out of the upper fly ash filter fitting.
17. Replace the fly ash filter and reassemble
18. Inspect the lens mount liner for deterioration. If the central area of the lens mount liner is greatly discolored, or if the lens mount cone is loose and cannot be tightened, replace the lens mount liner.
19. Reinstall the spectrometer lens, lens purge lines, sparker and sparker wire, and lens mount liner as described in *Spectrometer lens* on page 67.
20. Reconnect the water tubes to the cavity fittings:

	Fittings	Tube no.	Flow direction
•	Left side:	1	Flow out from cavity
•	Right side:	2	Flow in to cavity

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

Continue with discharge tube replacement, or reassemble the cavity.

Moving the cavity assembly to the service position

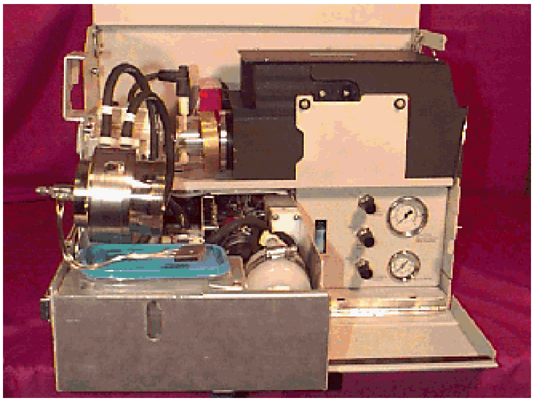


Figure 57. Cavity assembly

In order to perform certain routine maintenance procedures, it is necessary to safely move the cavity into the service position. To move the cavity into the service position, perform the following:

Warning Wear safety glasses when performing this procedure.

High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Using the ChemStation software, disable the heated zones in the AED and the GC.
2. Allow the GC, cavity, and heated transfer line to cool down to 35°C or less.
3. Turn off the AED and the GC.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

4. Turn off the reagent gases (oxygen, hydrogen, and methane/nitrogen), but leave the helium and nitrogen on to continue to purge air out of the system.
5. Open the GC oven.
6. Use two wrenches to loosen the column nut inside the GC. Slide the nut away from the fitting.
7. Pull the column back a minimum of 45 mm into the GC.

8. Lower the front face and open the front lid.

Warning Do not cut or abrade insulated surfaces. If the insulation is flaky/crumbly, replace or seal the insulation. Wear protective clothing, eye wear and a dust respirator until the insulation is either sealed or replaced.

9. Using a 2.5 mm hex key, loosen the set screw in the top of the insulation tube over the cavity until the insulation tube moves freely. Do **not** remove the screw. It is not easy to reinstall.

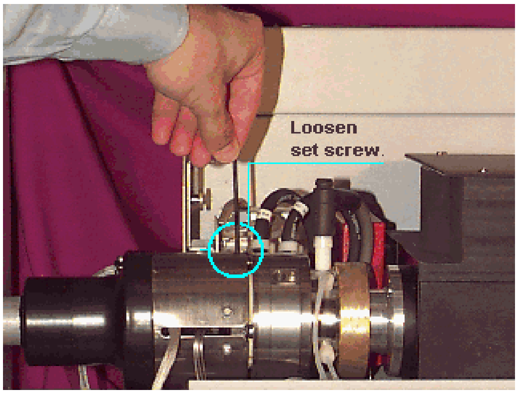


Figure 58. Loosening the insulation tube set screw

Caution Be careful not to move the AED or GC. You must keep the sides of the AED and GC parallel to each other so that the transfer line and gas union mate properly.

10. Carefully push the insulation tube off the heater block and into the GC oven until the gas union and heated core are exposed. If necessary, gently wiggle or twist the tube until it moves easily.
11. Using two 5/16 inch wrenches, loosen the Swagelok nut that holds the heated core onto the gas union. Push the heated core into the insulation until clear of the gas union. Be careful not to disturb the nut and ferrule in the end of the heated core.

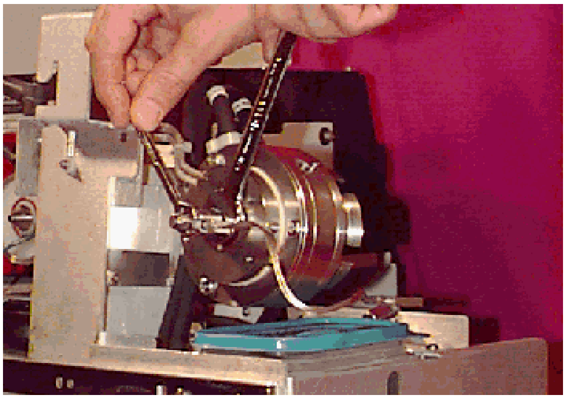


Figure 59. Gas union disassembly

12. Loosen the lens mount nut and slide it away from the cavity.
13. Slide the spectrometer and lens mount assemblies to the right until clear of the cavity. Be careful not to damage the nitrogen purge line or crimp the spectrometer cable. See Figure 60 below. You will need to lift the right edge of the spectrometer over the lip on the sheet metal.

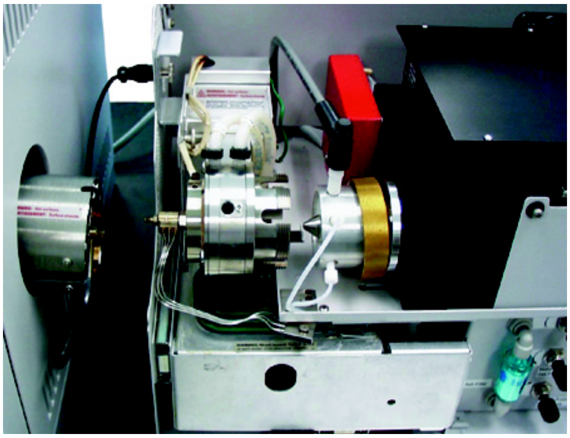


Figure 60. Emission source disassembled from spectrometer assembly

14. Remove the thumbscrew in the disconnect block. Lift the top of the block off so that the metal tubing from the gas union is free. Gently move the block around the lens purge tubing so it won't entangled when you pull the drawer out. See Figure 60.
15. Loosen the two thumb nuts on the emission source lock. Lift the lock.

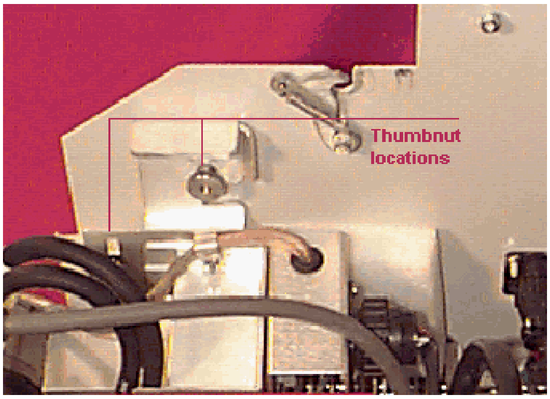


Figure 61. Thumbnuts on the emission source lock

16. Slide the water drawer, cavity, and emission source assemblies out from the AED until there is enough space to perform the maintenance.

Replacing other emission source assembly hardware

To remove the following parts/assemblies for replacement, see the instructions in the sections listed below:

Table 16. Parts/Assemblies for Replacement

Topic	See
Exit Chamber	*Discharge tube* on page 98
Optical Side Water Chamber	*Cleaning the cavity* on page 87
GC Side Water Chamber	*Cleaning the cavity* on page 87
Gas Union	*Discharge tube* on page 98

Cavity heater/PRT assembly

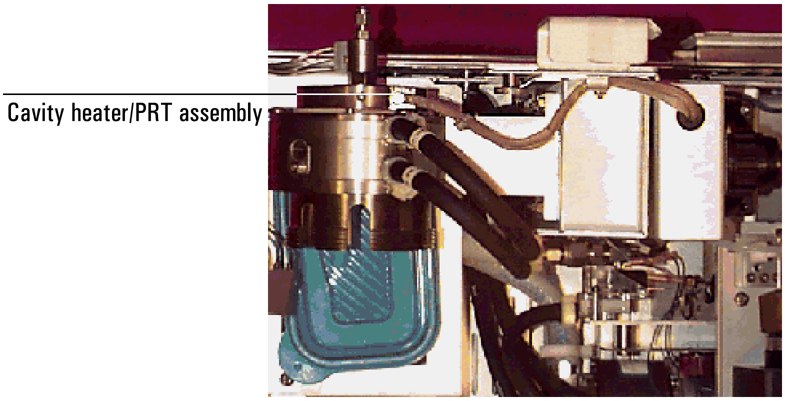


Figure 62. Cavity heater/PRT assembly

To replace the cavity heater/PRT assembly:

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Using the ChemStation software, turn off the plasma and disable the heated zones in the AED.
2. Allow the cavity and heated transfer line to cool down to 35°C or less.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

3. Turn off the AED and remove the power cord.
4. Open the front lid.

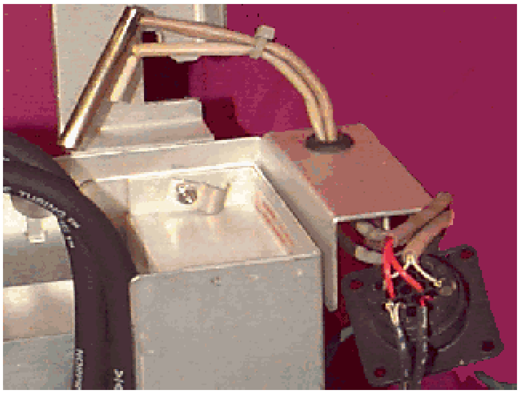


Figure 63. Disassembly

Warning Microwaves! Never remove the screws attaching the cavity to the waveguide or the screws which fasten the cavity halves together.

Never operate the G2350A AED when the cavity, magnetron, or waveguide are disassembled or mechanically loose.

If stray microwave emission is suspected and/or is measured above 5 mW/cm^2 at a distance of 5 cm, shut down the instrument immediately and call the Agilent Service Department for service.

5. Unplug the heater/sensor cable from the connector at the back of the emission source assembly.
6. Loosen the wire guide bracket on the heater PRT wires and free the wires.
7. Pull the heater/PRT assembly out of the cavity.
8. Cut the wires.
9. Loosen the two screws that secure the connector in the emission source assembly and remove the connector.
10. Punch the old heater and PRT pins from the connector with an AMP pin extractor.

11. Install the wires into the connector according to the pin chart below:

Table 17. Pin Chart

Connector Pin No.	Wire
1 – 5	Not used
6	PRT sensor
7	PRT sensor
8	Cavity heater
9	Not used
10	Cavity heater
11	Fan, red
12	Fan, black
13	Magnetron sensor
14	Magnetron sensor

12. Push the heater through the grommet, then push the PRT through it.
13. Install the heater and PRT in the cavity, and install the connector in the emission source assembly. Secure the wires with the guide bracket.

See also *PRT resistance vs. temperature* on page 179.

Discharge tube

Replace the discharge tube as described below:

Figure 64. Tools for replacing the discharge tube

Warning Wear safety glasses when performing this procedure.

1. Move the cavity into the service position. See *Moving the cavity assembly to the service position* on page 91.
2. Often the lens mount liner O-ring becomes stuck to the exit cone. Gently remove the O-ring. Inspect the O-ring for damage. Use a new O-ring if needed. Replace it into its seat in the lens mount liner.

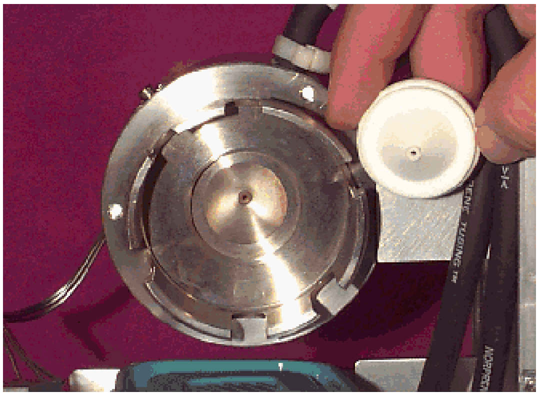


Figure 65. Exit chamber

Warning The edges of the exit cone may be sharp.

3. Using lab tissue to cover the sharp exposed edge of the exit cone, unscrew the exit cone from the cavity assembly and remove.
4. Using a 5/16 inch wrench and the 1/2 inch wrench supplied in the Agilent ship kit, loosen the gas union from the cavity.

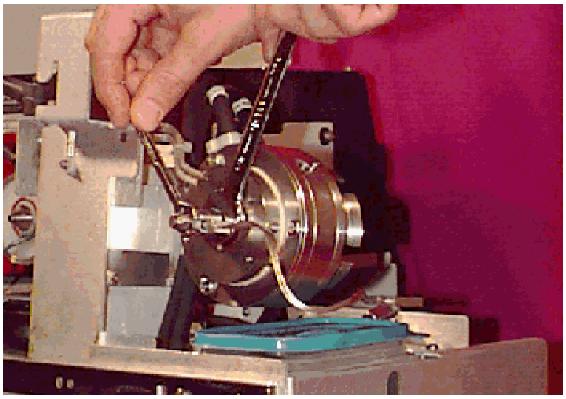


Figure 66. Removing the gas union

5. The discharge tube extends into the gas union but rests in the cavity assembly. Gently pull the gas union straight back away from the cavity until the discharge tube is completely clear. If you angle the gas union while pulling it out, you will break off the discharge tube in the cavity.
6. Using needle nose pliers, gently rotate the discharge tube ferrule enough to break the seal between the tube and the gas union, then remove the discharge tube from the gas union. See Figure 67.

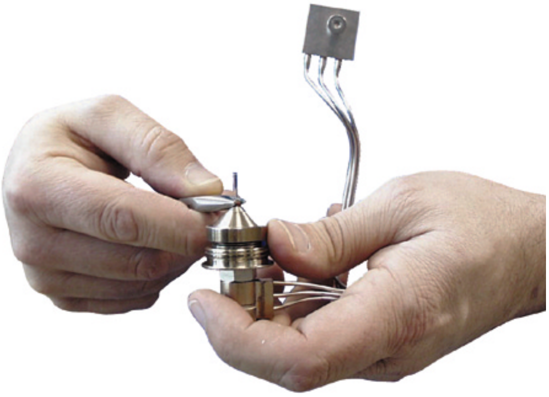


Figure 67. Removing the discharge tube

7. Dry the cavity using clean compressed air. Then clean the discharge tube through hole in the cavity using the small cleaning brush supplied by Agilent Technologies in the ship kit. Use clean compressed air to blow any particles of debris from the through hole.
8. Use clean compressed air to clean the gas union. First blow air through the column side so that any particles are blown out the discharge tube seat. Then, blow air up from the gas union disconnect block through each of the three tubes to the gas union.

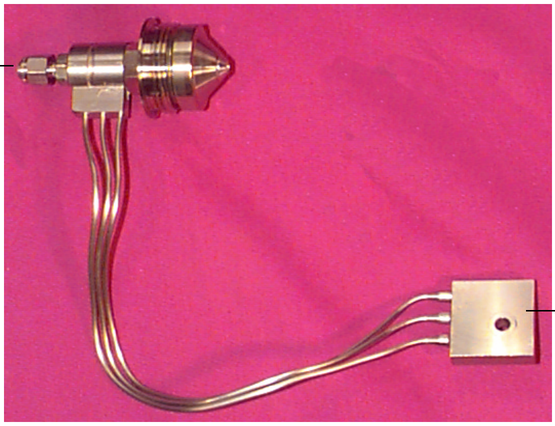


Figure 68. Cleaning the gas union

9. If the discharge tube has broken, clean the cavity, fly ash filter, and lens as described in *Cleaning the cavity* on page 87.
10. Inspect the lens mount liner for deterioration. If the central area of the lens mount liner is greatly discolored, or if the lens mount cone is loose and cannot be tightened, replace the lens mount liner.

Caution Do not touch the clear portions of the discharge tube with bare fingers.

11. Rinse the inside of the discharge tube with alcohol. Dry with clean compressed air.
12. Install the ferrule onto the discharge tube. Install the end with the short taper to the right. See Figure 69 below.

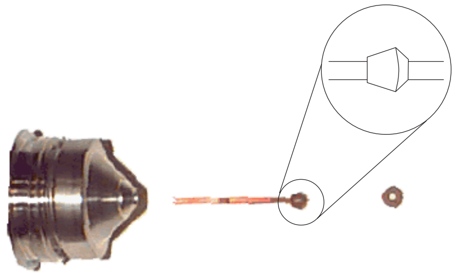


Figure 69. Ferrule orientation

13. Gently slide the discharge tube into the cavity until it protrudes approximately 1 cm past the O-ring seat on the far side. Gently rotate if necessary.
14. Place a new discharge tube O-ring over the end of the tube on the optical side. Avoid excessive pressure on the tube. Slide the O-ring a few millimeters down the tube.

Caution To avoid breaking the discharge tube, make sure the gas union is exactly perpendicular to the face of the cavity during installation.

15. With the forefinger of your right hand, hold the O-ring in place while using your left hand to carefully slide the gas union over the discharge tube and into place in the heater block. Hand tighten the gas union nut until the ferrule begins to grip the discharge tube. The tube should slightly resist movement. Do not fully tighten. The tube should move if pushed gently.
16. Align the gas union to the cavity as shown in Figure 70 below. Use a wrench to tighten the gas union nut 1/8th of a turn. Do not fully tighten. The tube should move if pushed gently.

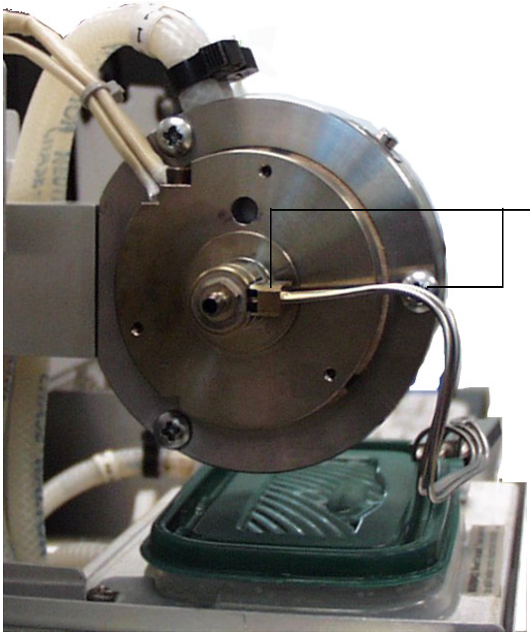


Figure 70. Gas union orientation

17. Using the small nylon screw provided in your ship kit, gently push the discharge tube and O-ring inward until the O-ring seats in its recess and is flush with the discharge tube end.
18. Using lab tissue to cover the sharp edge of the exit chamber, install the exit chamber and hand tighten.
19. Use two wrenches to tighten the gas union 1/8th of a turn. Use the 5/16 inch wrench to maintain orientation as shown in Figure 70.
20. Look through the cavity window to make sure the tube is still intact.
21. If you removed the cavity water lines while cleaning the cavity, you may wish to perform a gross leak test now. See checking the *Cavity gross leak test* on page 104. This is a recommended good practice.
22. Slide the water drawer back into the AED.
23. Reattach the spectrometer assembly to the cavity. Make sure the lens mount nut is tight.

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

24. Re-start the AED.

Caution If there is a water leak, quickly shut off the AED to avoid spilling water within the enclosure.

25. Check for water leaks. Check for leaks at the three gas tubes leading from the gas union, at the exit chamber, at the tubing connections, and where the gas union connects to the water chamber. If there is a leak at the gas union, check that the gas union nut has been sufficiently tightened with a 1/2 inch wrench, and tighten the exit chamber again. Correct other leaks as required. Shut down the AED and reassemble if required.
26. When all leaks are fixed, shut off the AED.
27. Examine the disconnect block. Make sure that the three O-rings are in place for the gas tubes and that the bottom interface is clean. Attach the top half of the disconnect block using the thumbscrew.
28. Cover the open end of the gas union with a spare septum. If the cavity pressure gauge reads above 0, there are no gross leaks.
29. Loosen the thumb nut near the cavity, lower the emission source lock, and tighten the two thumb nuts in the lock so that the cavity is attached to the enclosure.
30. Re-attach the transfer line to the gas union.

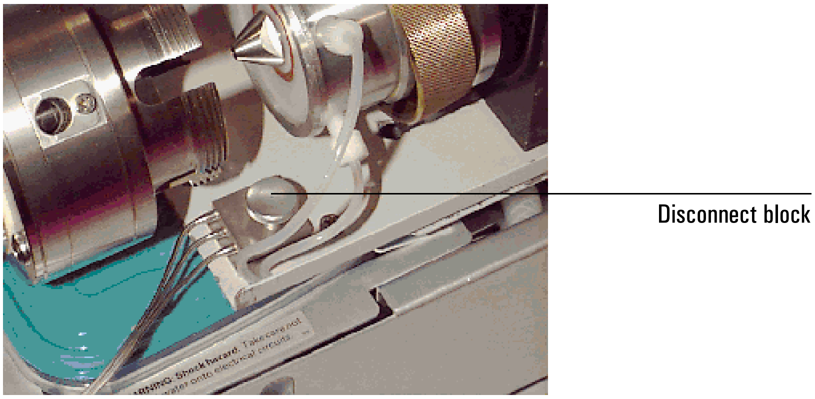


Figure 71. Disconnect block

31. Start the AED.
32. The cavity pressure should read 1.5 psi. If the pressure is too low or too high, check for gas leaks or obstructions.

Verifying discharge tube installation

After discharge tube installation, perform a quick check to verify that the installation will not leak.

This test requires that the discharge tube, gas union, and exit chamber are installed, as well as the following equipment:

- Tubing
- Gas-tight syringe
- Pressure gauge
- Tee union
- Surgical forceps or similar clamp

1. Connect a clean air source to one of the water chamber fittings at the top of the cavity.
2. Attach a pressure gauge to the other fitting (may require a plug with a gauge installed). See Figure 72 below.

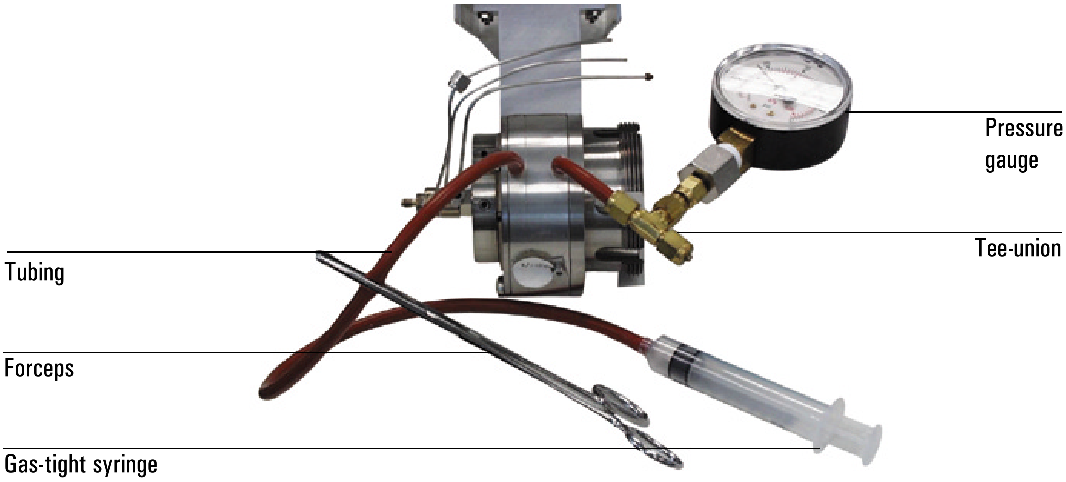


Figure 72. Cavity gross leak test

3. Briefly pressurize the water chamber to 40 psig. If the pressure rapidly drops, there is a problem in the discharge tube installation. If the pressure drop is less than 1 psi/5 min, the tube is correctly installed. A leak rate of 1 psi/min or greater indicates a leak.

Emission source assembly

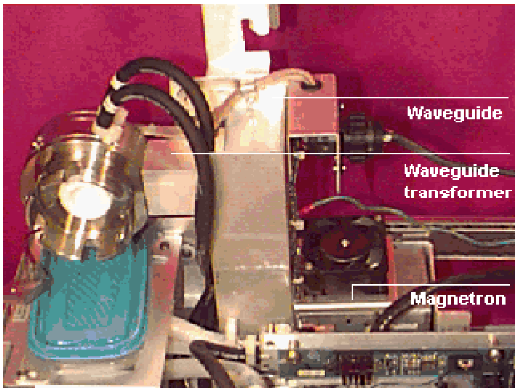


Figure 73. Emission source assembly

Replace the emission source assembly as follows:

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Using the ChemStation software, disable the heated zones in the AED.
2. Allow the cavity and heated transfer line to cool down to 35°C or less.
3. Turn off the AED.

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

4. Disconnect the heated transfer line and heated core, and slide the spectrometer back as described in *Moving the cavity assembly to the service position* on page 91.
5. Pull the water inlet and outlet hoses from the cavity assembly.
6. Slide the water drawer out. See *Water drawer* on page 133.
7. Loosen the two thumbnuts in the emission source lock and lift the lock.
8. Slide the emission source assembly out until the power supply cable is accessible.

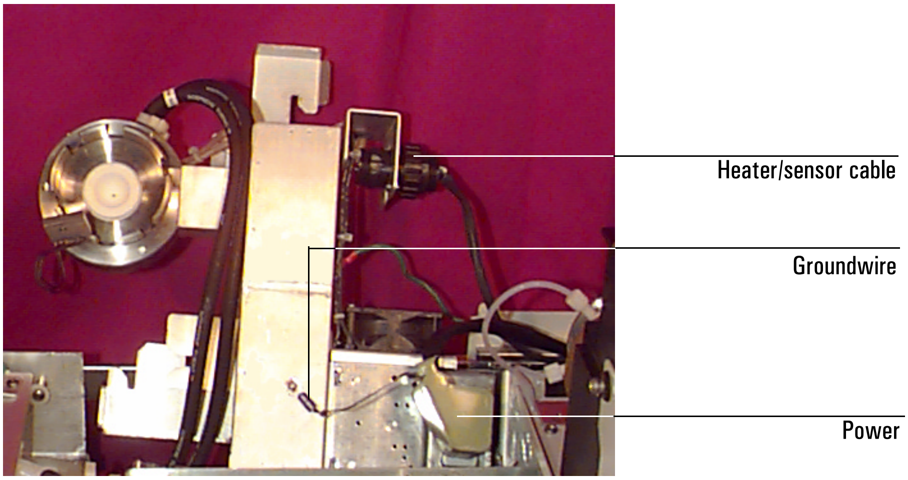


Figure 74. Emission source connections

9. Disconnect the ground wire from the enclosure.
10. Remove the cable and ground wire.
11. Remove the heater/sensor cable.

Warning Microwaves! Never remove the screws attaching the cavity to the waveguide or the screws which fasten the cavity halves together.

Never operate the G2350A AED when the cavity, magnetron, or waveguide are disassembled or mechanically loose.

If stray microwave emission is suspected and/or is measured above 5 mW/cm^2 at a distance of 5 cm, shut down the instrument immediately and call the Agilent Service Department for service.

12. Remove the emission source assembly.

Warning Be sure to reconnect the ground strap to the high voltage power source. Lethal voltage could be present on the case if it is not reconnected.

13. Re-assemble in reverse order.

Warning Check the unit for microwave leakage whenever any portion of the magnetron, waveguide, or cavity to waveguide interface has been loosened or disassembled and reassembled.

- Install the new emission source assembly into the AED with the lock UP. After the emission source is seated, push the lock DOWN to secure it to the AED. Slide the water drawer in and check for clearance between the drawer, cabling, and emission source assembly.

- Align the tab on the emission source lock with the slot in the enclosure. Drop the lock into the slot and secure the thumbscrews.
- Ensure that the emission source assembly engages the interconnect switch.
- Make sure the power supply cable is out of the way of the water drawer.
- Check the clearance between the drawer and cabling. Make sure the emission source lock functions properly.
- Reconnect the water tubes as follows:

Fittings	**Tube No.**	**Flow direction**
Left side fitting:	1	Flow out from cavity
Right side fitting:	2	Flow in to cavity

14. Check for interference between the hardware at:
    - The lock and the water drawer track
    - The white washer on the lock and the drawer. The washer should fit inside the square notch in the drawer so that the lock will fully engage the drawer.
    - The emission source support clip (located near the door open switch) and the drawer.

See also *Emission Source* on page 156.

Gas Flow System

Replaceable components

Ash filter assembly
Back pressure regulator
Cavity pressure gauge
Filter tube, fly ash
Fitting–bushing
Forward pressure regulator
Gas drawer
Helium pressure gauge
Mass flow assembly
Solenoid assembly

Column adapter brazement
Heated core assembly
Heated transfer line
Insulation jacket assembly

Tools needed

Two 5/16 inch open end wrenches

Two 7/16 inch open end wrenches

9/16 inch open end wrench

Posi-drive

Gas flow meter

Accessing the gas drawer

Figure 75. Gas drawer (version with exterior fly ash filter shown)

There are two versions of the gas drawer in service. For AEDs with serial number < 03000208, the fly ash filter is mounted on the inside wall of the drawer front panel. All newer AEDs have an externally-mounted fly ash filter as shown in Figure 75.

To access the Gas Drawer for maintenance or troubleshooting:

Warning Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that the hydrogen gas flow is turned off at the source and in the AED before starting this procedure.

Warning Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, vent G2350A AED effluents from the side panel to a fume hood.

1. Turn off the AED.
2. Turn off the column flow. Reduce the GC oven temperature to less than

40°C. Turn off all reagent flows at the AED and the source.

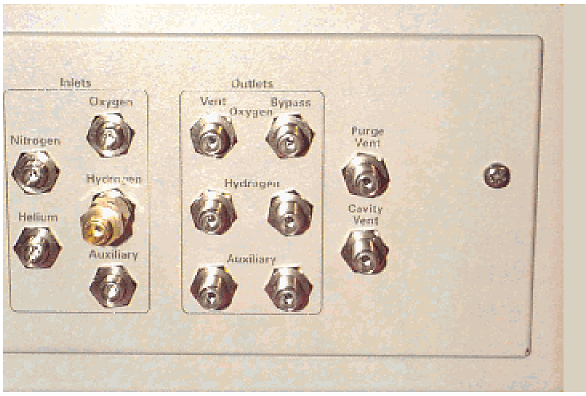


Figure 76. Screw location

3. Remove the mounting screw in the enclosure at the lower left foot of the drawer. Remove the mounting screw on the right side of the drawer, and just past the gas ports.
4. Slide the drawer partially out. If needed, slide the tubing from the gas union disconnect block out of the guide channel.
5. Label the five gas lines leading into the drawer, and label the corresponding connections inside the drawer.
6. Use two 5/16 inch open end wrenches to disconnect the Swagelok fittings from the disconnect block tubing.

If necessary, remove the drawer fully:

1. Turn off the helium and nitrogen flows at the source, label all inlet and outlet lines, and then remove the lines. Plug the inlet lines from the sources to prevent contamination.
2. Use a 9/16 inch and a 7/16 inch wrench to remove the spectrometer purge line from the spectrometer. Plug the spectrometer's inlet.
3. Disconnect the three stainless steel lines to the gas drawer.
4. Disconnect the two teflon purge lines from the gas drawer.
5. If needed, the drawer frame can be disassembled into two parts, although the gas lines will still hold the halves together. To disassemble the drawer, remove the seven mounting screws which hold the drawer halves together. Five screws are located on the bottom of the drawer, and two are along the side. This will allow more working room within the drawer. Be careful not to stretch the gas lines too far.

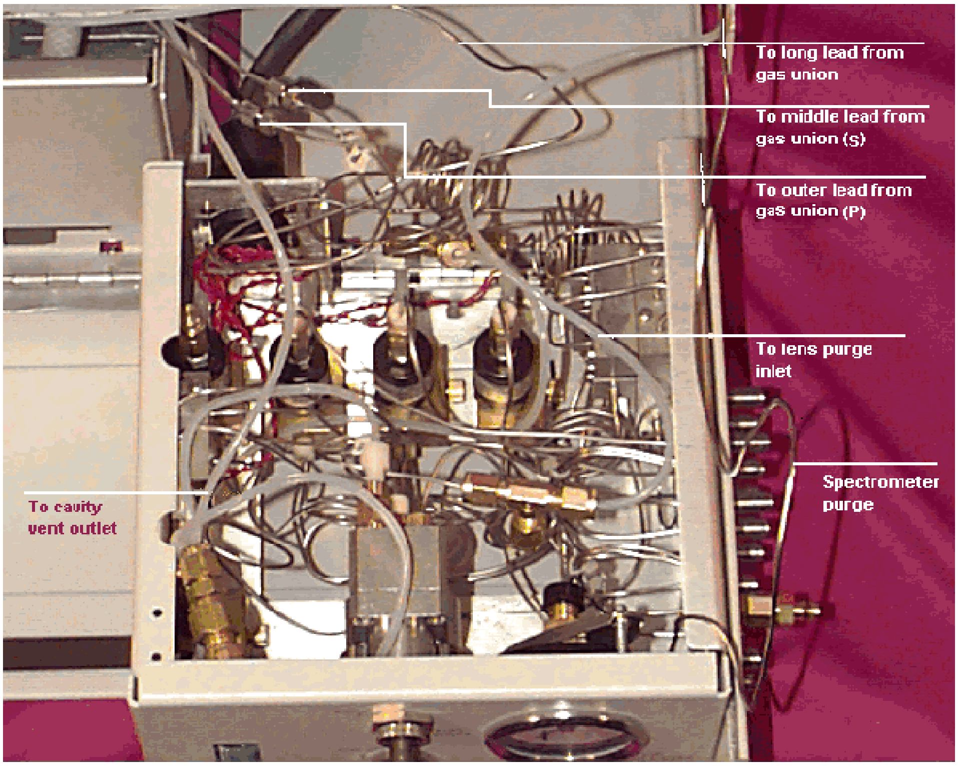


Figure 77. Pneumatic connections

Changing gas cylinders

Gas purity is most likely compromised when gas cylinders are being changed. Follow the procedure below for changing the gas cylinder to ensure gas purity:

Warning Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that hydrogen gas is only connected to the gas inlet on the side panel labeled "HYDROGEN."

Warning Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that the hydrogen gas flow is turned off at the source and in the AED before starting this procedure.

1. If using a getter, cool it to room temperature. The getter must be at room temperature so that it will not react with the air when the gas line is opened.
2. Ensure that the inside of the valve for the new tank is clean. Remove any debris which can cause restrictions in the flow system.

3. Disconnect the old cylinder and connect the new cylinder.
4. Open and close the tank valve; then bleed the pressure out of the regulator. Repeat this five times. Open the inlet fitting at the AED to bleed the gas through the line. Filling the line with gas a little bit at a time and bleeding the air out ensures that air will not diffuse back into the tank.
5. Turn the gas cylinder on and use a thermal conductivity leak detector (never use a water-based soap solution such as snoop) to check the tank fitting and the fitting retightened at the AED. Dirty valves can be a source of leaks. Debris can clog restrictors in the flow system. If a leak exists, a water-based leak detector will create high hydrogen backgrounds.

Column installation/changing columns

To change the column in the GC-AED, follow the steps below:

Warning Wear safety glasses when performing this procedure.

Do not cut or abrade insulated surfaces. If the insulation is flaky/crumbly, replace or seal the insulation. Wear protective clothing, eye wear and a dust respirator until the insulation is either sealed or replaced.

High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Use two wrenches to loosen the column nut, then remove the column from the transfer line.

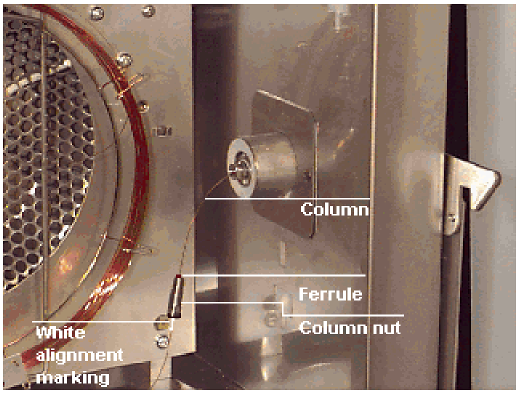


Figure 78. Removing column from transfer line

2. If the column appears damaged at the end, resulting in broken column pieces in the cavity, clean the cavity as described in *Cleaning the cavity* on page 87.
3. Disconnect the column from the GC inlet and remove it from the GC oven in accordance with the *6890 GC Service Manual*.
4. Slide a column nut and graphite ferrule over one end of the new column and install in the injector.
5. Slide a column nut and graphite ferrule over the other column end.
6. Insert the column into the fitting end of the column sizing tool and slide it through until it protrudes from the open end of the tool. (Note that the version of this tool, shown below, is equivalent to the newer version delivered in the skip kit.)

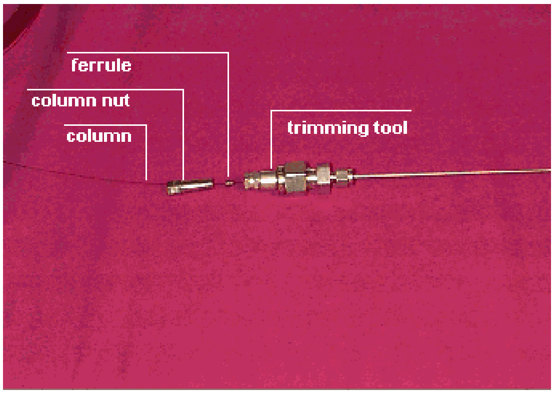


Figure 79. Column installed in tool, column nut side

Figure 80. Column installed in tool, before trimming

7. Tighten the column nut into the fitting on the tool. This properly swages the ferrule onto the column. Use white correction fluid to mark the column just behind the nut. If the column slides in the nut, the mark will move, showing the problem.

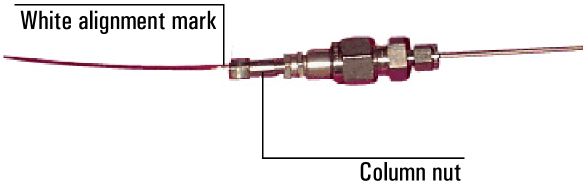


Figure 81. Swage the ferrule onto the column

8. Use a column cutter to score the column and cut it flush to the end of the tool.
9. Remove the column from the tool.
10. Install the column in the GC injector in accordance with the *6890 GC Service Manual*. Condition at about 20 to 30 degrees above the highest operating temperature for one hour.
11. Slide the column into the transfer line and tighten the column nut into the fitting. Make sure that the white correction fluid mark is still visible and properly positioned.
12. Close the GC oven.

Solenoid valve assembly

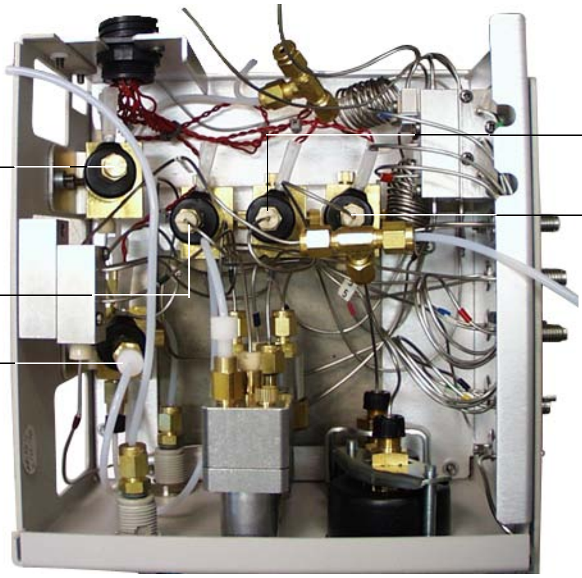


Figure 82. Solenoid valve assemblies

To replace a solenoid valve assembly:

Warning Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that hydrogen gas is only connected to the gas inlet on the side panel labeled "HYDROGEN."

Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that the hydrogen gas flow is turned off at the source and in the AED before starting this procedure.

Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, turn off all reagent gas flows and the column flow before starting this procedure.

1. Turn OFF the AED.
2. Remove the gas drawer. See *Accessing the gas drawer* on page 109.
3. Split the drawer.
4. Remove connecting lines.
5. Remove the wires from the connector.
6. Remove the solenoid assembly mounting screws.

7. Replace the solenoid and reassemble the gas drawer.

See also *Solenoid will not operate* on page 196 and *Finding gas leaks* on page 192.

Replacing related components

Other gas drawer components are replaceable by the Agilent CE.

To replace the components listed below, see *Accessing the gas drawer* on page 109.

- Back pressure regulator
- Cavity pressure gauge
- Column adapter brazement
- Fitting–bushing
- Forward pressure regulator
- Helium pressure gauge
- Mass flow assembly

See also *Gas Flow System* on page 188, *Adjusting gas flow rates* on page 188, and *Finding gas leaks* on page 192.

Unless otherwise noted, these components should be hand-tightened and then given an additional 1/4 turn.

Caution Do not use brass fittings. Use only graphite or vespel ferrules.

Fly ash filter

The fly ash filter is in the blue-green plastic cylinder located in the gas drawer and is visible from the front of the AED. The filter keeps dirt from getting into the back pressure regulator. Replace the fly ash filter or filter tube as follows:

If your AED serial number is ≥ US 03000208

Warning Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, turn off all reagent gas flows and the column flow before starting this procedure.

1. Turn off the AED.

2. Using the pliers supplied by Agilent Technologies in your ship kit, carefully press the gray capture ring on the upper fitting inward while pulling outward on the filter tube fitting. Avoid scratching the connecting tube. Loosen the lower fitting in the same manner. Repeat for each fitting until the filter tube and fittings are released from the front panel of the gas drawer. See Figure 83 below.

Figure 83. Replacing the fly ash filter

3. Remove an elbow fitting from the filter housing.
4. Replace the filter. be sure to install the new filter so that the arrow points **UP**, against the direction of the flow.
5. Reassemble.
6. When the gas flows are resumed, the cavity pressure gage reading should be the same as it was before filter replacement (usually approximately 1.5 psi).

If your AED serial number is < US03000208

Warning Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, turn off all reagent gas flows and the column flow before starting this procedure.

1. Turn off the AED.
2. Pull the gas drawer out far enough to reach the filter. See *Accessing the gas drawer* on page 109.

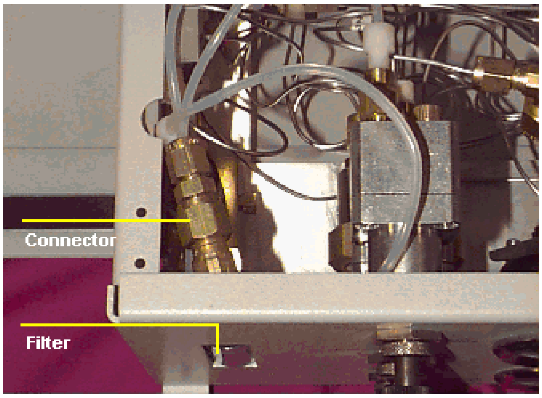


Figure 84. Replacing the fly ash filter

3. Remove teflon line to the cavity and to the solenoid valve.
4. Replace the filter in its holder and connect the teflon lines to the cavity and solenoid valve. Check that the arrow on the filter is **against** the direction of the flow. Installing the filter backwards allows the user to easily see when the filter needs to be replaced.
5. Turn on the AED and check for gas leaks. The cavity pressure gauge should read 1.5 psi.

Gas drawer

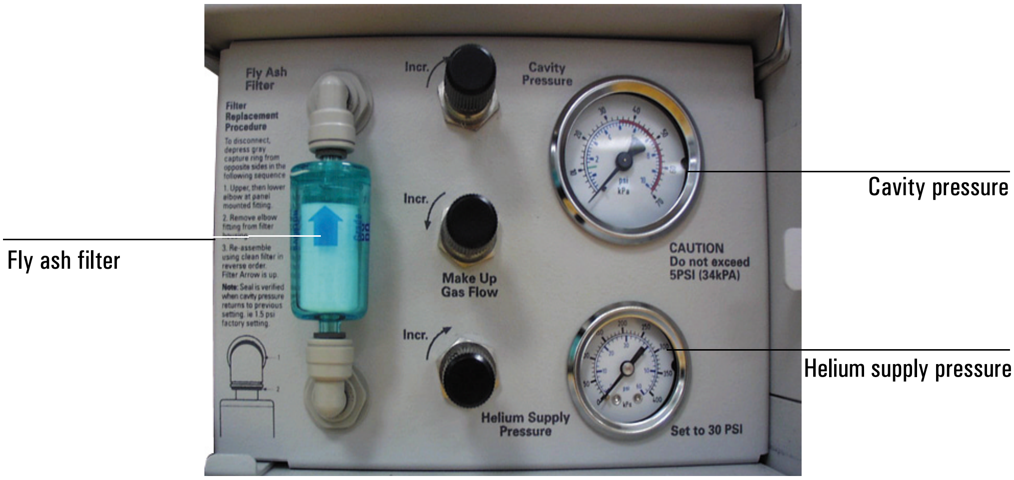


Figure 85. Gas drawer

To replace the gas drawer as a module:

Warning Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, turn off all reagent gas flows and the column flow before starting this procedure.

Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that hydrogen gas is only connected to the gas inlet on the side panel labeled "HYDROGEN."

Hydrogen Gas! To reduce risk of explosion, fire, and injury, ensure that the hydrogen gas flow is turned off at the source and in the AED before starting this procedure.

1. Turn off the AED.
2. Turn off the column flow. Set the GC oven temperature to less than 40°C. Turn off all gas flows at the AED and the source.

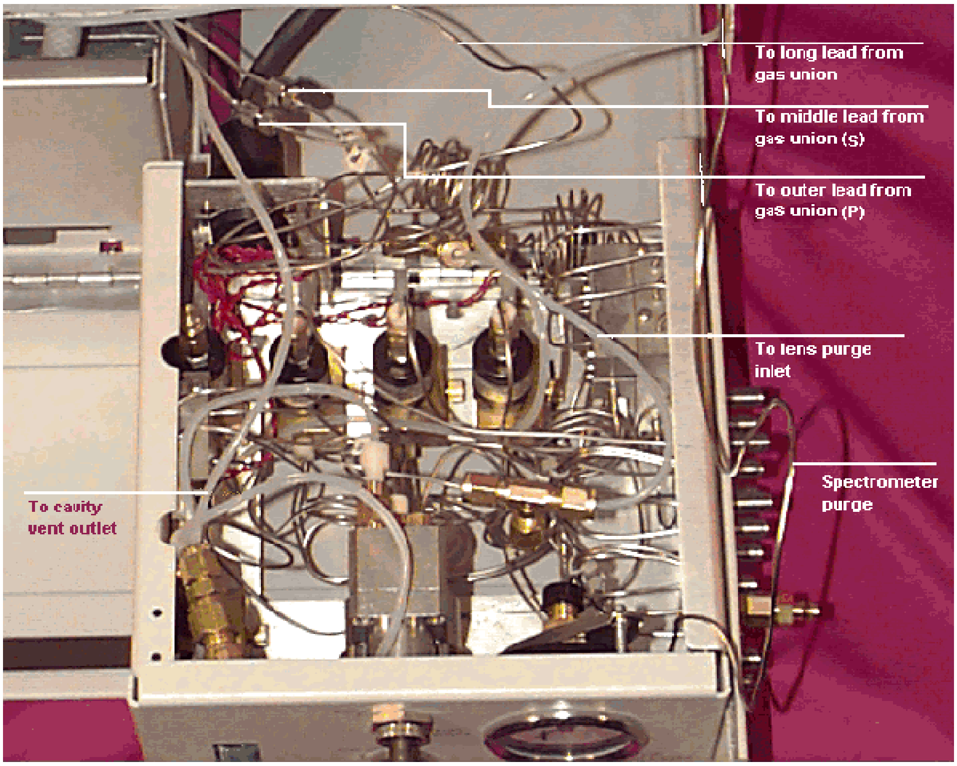


Figure 86. Pneumatic connections

3. Label all input and outlet gas lines from the side of the gas drawer as required, including the lines from the gas union and cavity. Label the connections inside the gas drawer.

4. Use a 7/16 inch wrench to remove the input line.
5. Remove the exhaust lines.
6. Use a 9/16 inch and a 7/16 inch wrench to remove the spectrometer purge line from the spectrometer. Plug the spectrometer's inlet.
7. Remove the mounting screw in the enclosure at the lower left foot of the drawer. Remove the mounting screw on the right side of the drawer, just past the gas ports.

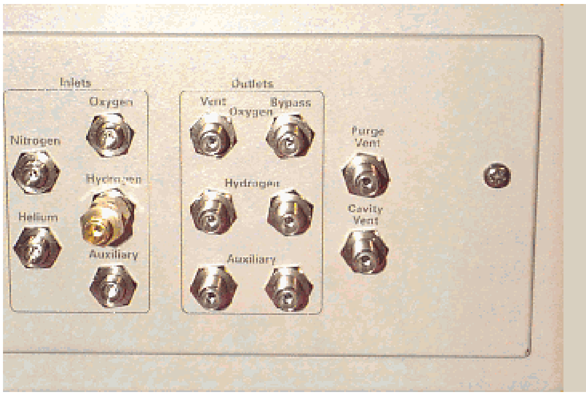


Figure 87. Removing mounting screw

8. Slide the drawer partially out. If needed, slide the tubing from the gas union disconnect block out of the guide channel.
9. Label the lines from the gas union and label the connecting lines inside the gas drawer.
10. Use two 5/16 inch open end wrenches to disconnect the Swagelok fittings from the disconnect block tubing. Use a 7/16 inch open end wrench to remove the tubing from the T union in the back of the drawer.
11. Unplug the cable connector at the back of the drawer.
12. Remove the gas drawer from the AED.
13. Install a new drawer in reverse order.

See also *Finding gas leaks* on page 192, *Gas Flow System* on page 188, *Solenoid will not operate* on page 196, and *Gas Flow System* on page 157.

Insulated jacket assembly and heated core

To replace the Insulated Jacket Assembly and/or Heated Core (transfer line heater and PRT assembly):

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Effluent Gases! To reduce risk of breathing ozone and other harmful gases produced by the plasma, vent G2350A AED effluents from the side panel to a fume hood.

1. Turn OFF the heated zones (including the GC oven) and allow them to cool to ambient temperature. Turn OFF the AED.
2. Remove the column and disconnect the transfer line (heated core and insulated jacket assembly) from the gas union as described in *Moving the cavity assembly to the service position* on page 91.

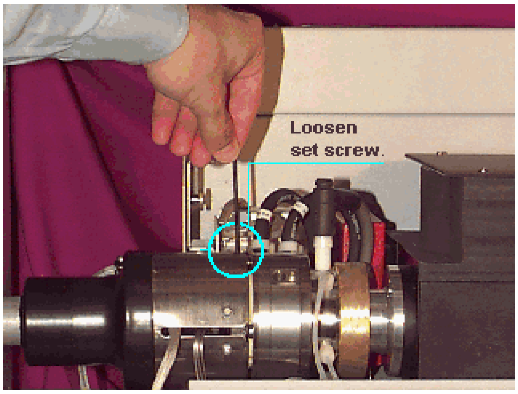


Figure 88. Loosening the transfer line

3. Loosen the nut that secures the column to the GC oven and slide the column out of the heated core.
4. Slide the heated core out of the insulated jacket assembly. Replace the heated core if required.
5. Slide the insulated jacket out of the GC. Replace the insulated jacket if required.

Water Flow System

While working on the water drawer, it is usually most convenient to couple the cavity assembly to the AED enclosure so the drawer can be removed separately.

Replaceable Components

5 µm water filter element
Hose clamps
Modified water board assembly
Pressure switch (AED serial number < US01000166)
Pump
Tubing
Water drawer control cable assembly
Flow Sensor (AED serial number < US01000166)

Tools needed

Posi-drive

Small flat head screwdriver (to adjust the water flow sensor, AED serial number < US01000166)

Keeping clean water in the system

Fill the reservoir to within 1 inch of the top with **distilled water**. Distilled water will keep the system clean. **Do not add algal inhibitors**. **Do not use de-ionized water**. De-ionized water damages the tubing and fittings and reduces instrument performance and life.

- Check the water level daily at the reservoir in the AED.
- Add distilled water to the reservoir to maintain the level at just above the upper fitting. If the water level drops too low, the plasma will shut off.
- Keep the lid on the water reservoir. This avoids burn hazards and prevents water loss through evaporation.
- Do not put rust-prone objects in the reservoir, as rust will contaminate the system.

- If the system is to be shut down for any length of time, drain the water system to prevent algae growth.

Pressure switch

If your AED serial number is < US01000166

To replace the pressure switch:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Do not operate the AED with the water drawer open.

High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Power down the AED.
2. Remove power cord in the rear of the instrument.
3. Remove the water drawer. See *Water drawer* on page 133.
4. Remove the water board panel and switch assembly from the drawer. See *Water board* on page 130.

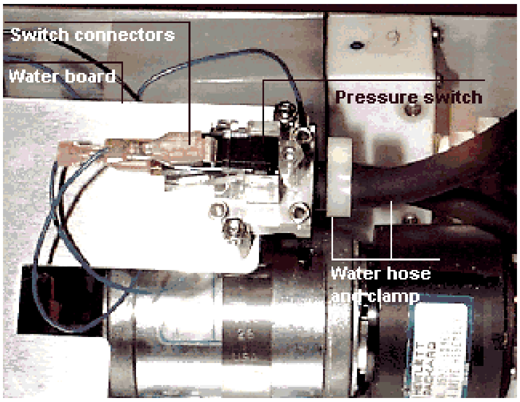


Figure 89. Replacing pressure switch

5. Remove the switch connectors from the switch.
6. Remove the two mounting screws holding the pressure switch in place. Remove the water hose and clamp.
7. Remove and replace the switch.

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

8. Re-assemble in reverse order.

See also *Water Flow System* on page 170.

If your AED serial number is ≥ US01000166

You cannot replace the pressure switch alone. If the pressure switch fails, replace the water board. See *Water board* on page 130.

See also *Water Flow System* on page 170.

Water Pump

These instructions describe how to install a replacement water pump into a G2350A Atomic Emission Detector.

Figure 90. Water pump assembly, part no. G2350-61445

Prepare for service

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Do not operate the AED with the water drawer open.

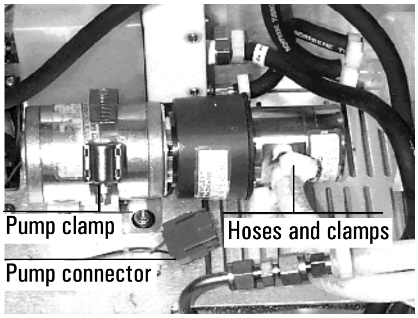
High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Power down the AED and remove the power cord.
2. Remove/pull out the water drawer.

Replace the water pump

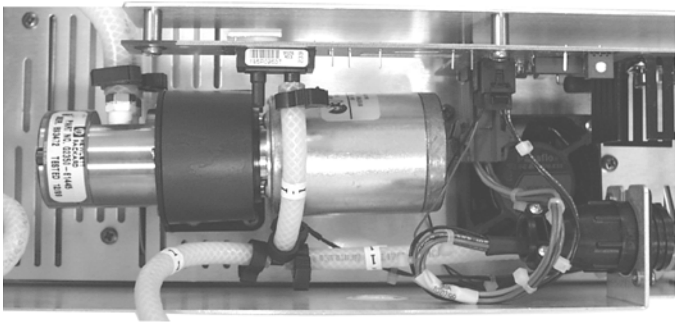
There are three types of water pump installations, as shown in Figure 91 below. Follow the instructions for the type of installation you have.

Installation Type	See Page
Type 1	126
Type 2	128
Type 3	129



Type 1 – Hose clamp on water drawer base
AED serial number < US01000166

Type 2 – Bracket on side of water drawer
AED serial number between
US01000166 and US03000388



Type 3 – Bracket on water drawer base
AED serial number ≥ US03000388

Figure 91. Water pump installation types

See your Service Manual for details on general procedures, such as how to remove and reinstall your water drawer.

Installing the water pump in a Type 1 water drawer

For this type of installation, you will remove the bracket from the new pump and install it in the existing mounting clamp.

1. Remove the water board panel and water board.

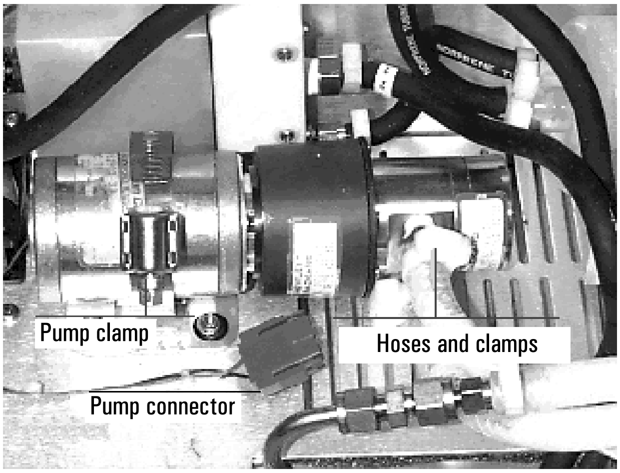


Figure 92. Removing the Type 1 water pump

Caution When removing the fittings from the pump head, hold the assembly by the **pump head**.

2. Remove the pump connector from the water board, then remove the hoses, clamps, and hose barbs from the old pump.
3. Unfasten the clamp around the pump and remove the old pump.
4. Remove the mounting bracket from the new pump by removing the four screws that hold it onto the coupling. Reinstall the mounting screws into the coupling.

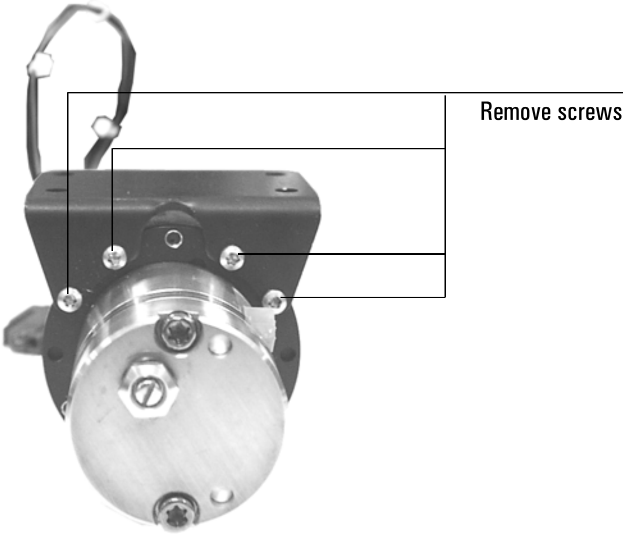


Figure 93. Removing the mounting bracket

5. Install the new pump into the hose clamp and reconnect all fittings.

Installing the water pump in a Type 2 water drawer

For this type of installation, you will rearrange the mounting bracket on the new pump and use it to install the pump onto the side of the water drawer.

Caution When removing the fittings from the pump head, hold the assembly by the **pump head**.

1. Remove the pump connector from the water board, then remove the hoses, clamps, and hose barbs from the old pump.
2. Remove the old pump.
3. Remove the mounting bracket from the coupling by removing the four mounting screws. See Figure 94.

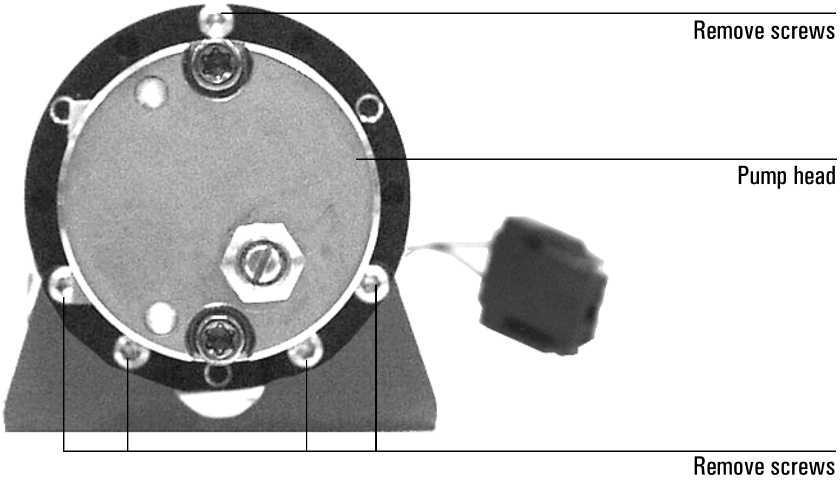


Figure 94. Remove the mounting bracket and loosen the coupling

4. Remove the remaining screw securing the coupling to the pump motor. See Figure 94.
   The coupling and pump head will now rotate on the pump motor. Magnetic attraction helps keep the parts together.
5. Holding the pump motor steady, rotate the pump head approximately 30° counterclockwise. See Figure 95.
6. Install the mounting bracket directly across from the pump IN and OUT connections.

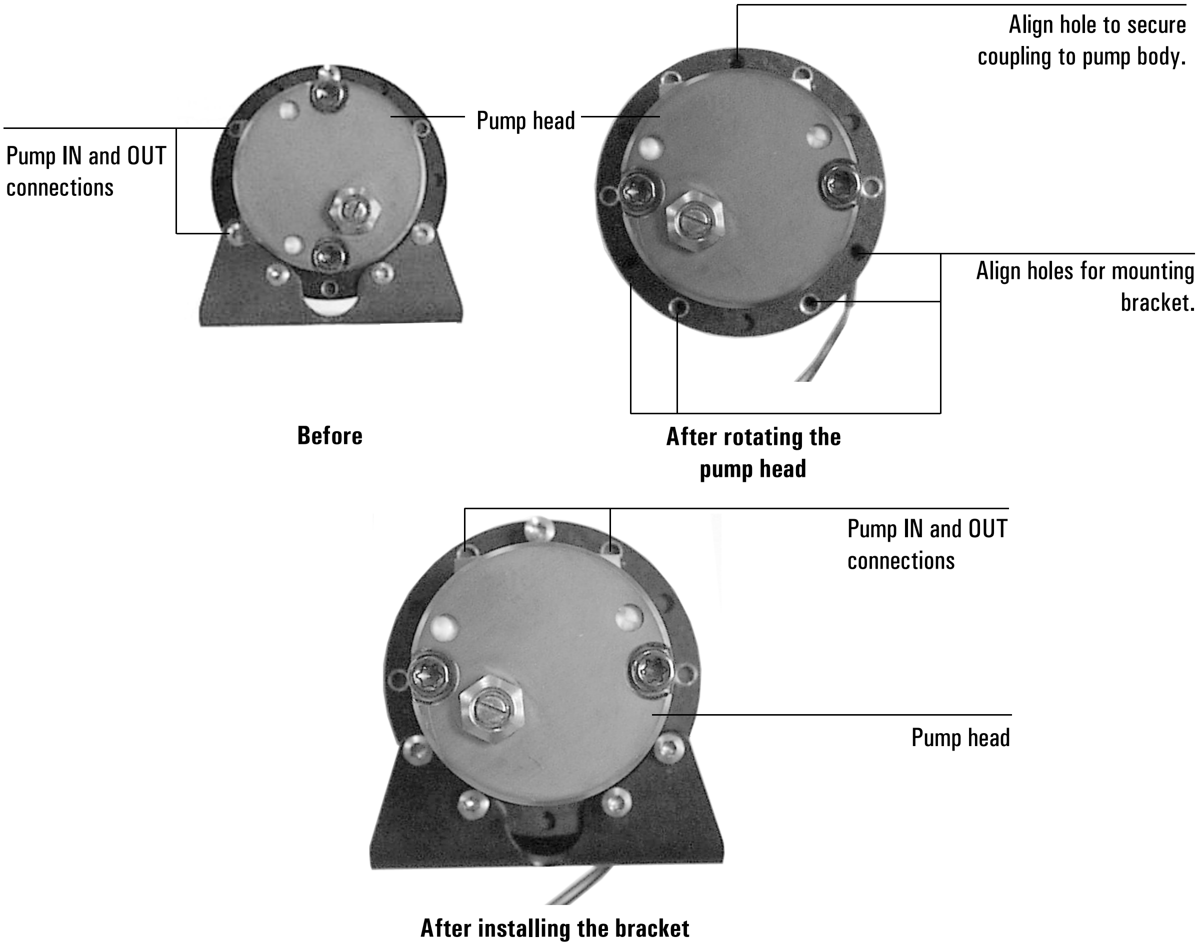


Figure 95. Installing the bracket on the pump motor

7. Install the remaining screw.
8. Install the pump onto the side of the water drawer and reconnect all fittings and tubing.

Installing the water pump in a Type 3 water drawer

1. Remove the pump connector from the water board.

Caution When removing the fittings from the pump head, hold the assembly by the **pump head**.

2. Remove the hoses, clamps, and hose barbs from the old pump, then remove it from the bottom of the water drawer.

Complete the installation

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

1. Close the water drawer and connect to power.
2. Check for water leaks.

Water board

If your AED serial number is < US01000166

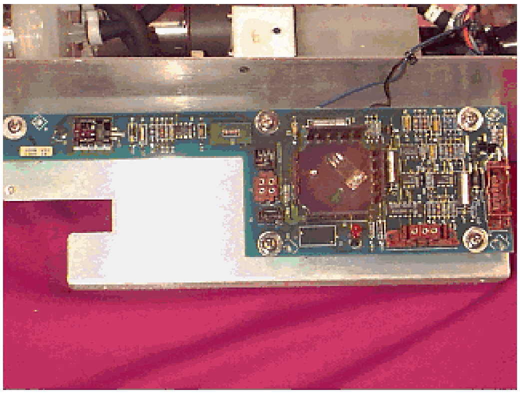


Figure 96. Water board assembly

To replace the water board assembly:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Power down the AED.
2. Remove the power cord in rear of instrument.
3. Lower the front facing and remove the water drawer. See *Water drawer* on page 133.
4. Label the wires leading to the pump, fan, and water flow sensor, if needed.
5. Remove the connectors from the board.
6. Using a posi-drive, remove the two mounting screws which secure the water board panel in the drawer, and remove the board and panel.

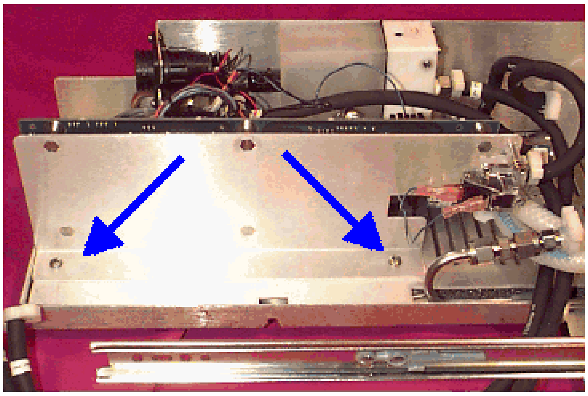


Figure 97. Board panel removal

7. Remove the five board mounting screws and remove the board from the panel.

Warning Do not operate the AED with the water drawer open.

8. Replace and reassemble in reverse order.

See also:

Water board on page 153

Water Flow System on page 170

Water board, part no. G2350-60080 on page 237

Water board, part no. G2350-60085 on page 239

If your AED serial number is ≥ US01000166

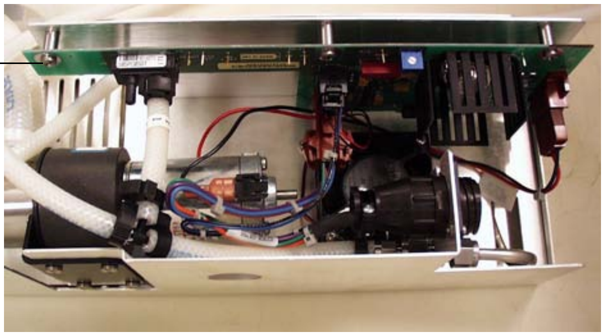


Figure 98. Water board assembly

To replace the water board assembly:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

Caution The following steps require protection from electrostatic discharge (ESD). Use a grounded wrist strap (part no. 9300-0969 - large, or 9300-0970 - small) connected to a suitable ground. Failure to use a wrist strap may result in damage to the AED electronics.

1. Power down the AED.
2. Remove the power cord in rear of instrument.
3. Lower the front facing and remove the water drawer. See *Water drawer* on page 133.
4. Label the wires leading to the pump, fan, and water drawer control cable, if desired.
5. Remove the wires from the board.
6. Using a posi-drive, remove the two mounting screws which secure the water board panel in the drawer, and remove the board and panel.

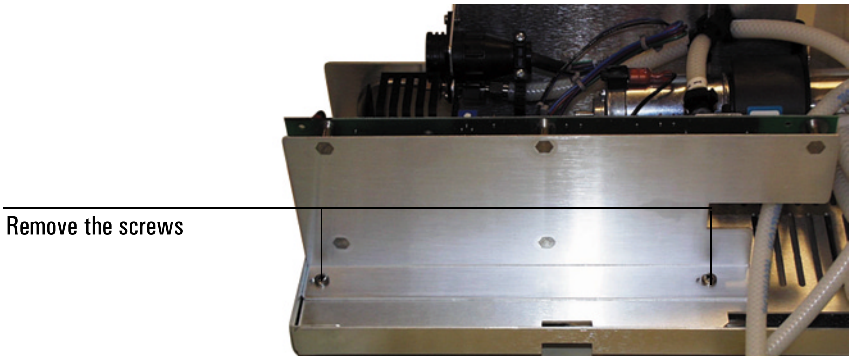


Figure 99. Board panel removal

7. Remove the five board mounting screws and remove the board from the panel.

Warning Do not operate the AED with the water drawer open.

See also *Water board* on page 153, *Water Flow System* on page 170, *Water board, part no. G2350-60080* on page 237 *Water board, part no. G2350-60085* on page 239

Water drawer

To replace the water drawer:

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

1. Power down the AED, and allow the water to cool.
2. Pull the lower AED door down, and open the front lid.
3. Disconnect the inlet and outlet tubing at the cavity. Connect the ends together, or plug them to avoid leaks. Leave the tubing connected at the water module.
4. Slide the water drawer out.

5. Disconnect the heater/sensor cable assembly.

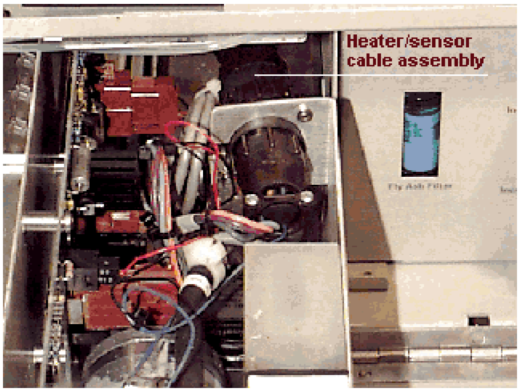


Figure 100. Heater/sensor cable assembly (serial number < US01000166 drawer shown)

6. Push the tabs in the slide and on the bottom of the water drawer slides, and remove the drawer from the rails.

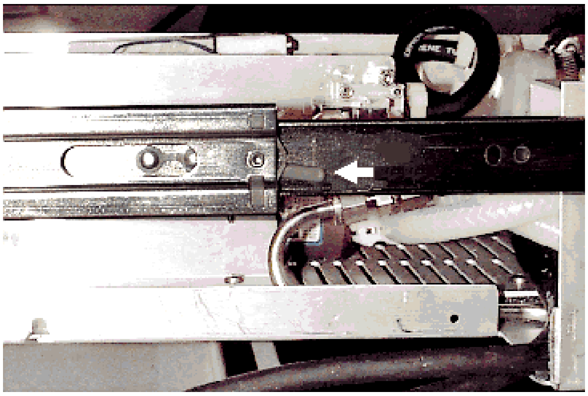


Figure 101. Water drawer locking tabs

7. Install a new water drawer into the slides.
8. Check for clearance/interference at:
   - The high voltage power supply connector on the emission source assembly
   - The emission source support clip
   - The tubing in the drawer
   - The cables at the rear of the drawer
   - The transformer

Also verify that:

- The white roller on the emission source assembly lock cleanly engages in the square cutout in the drawer
- The emission source lock locks in both positions
- The tab on the left water drawer slide is flush with the guide rail

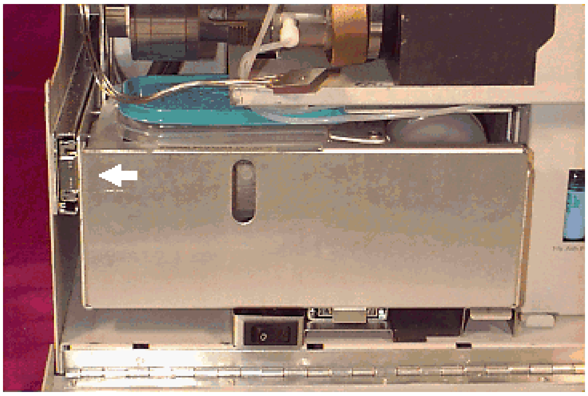


Figure 102. Drawer tab

9. Fill the new system with distilled water. See *Water filling* on page 37.

Warning Do not operate the AED with the water drawer open.

Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

10. Drain the water from the old drawer.

Water filter

If your AED serial number is < US01000166

To replace the water filter:

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Turn off the instrument. Allow the water to cool.

2. Slide the water drawer out.
3. Remove the three clamps and hoses leading into the water filter.
4. Note the orientation of the outlet connectors on the filter. Unscrew the water filter hose clamp and remove the water filter.

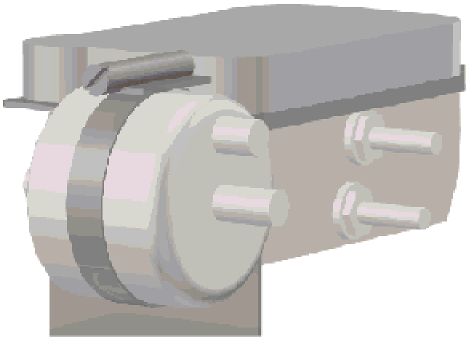


Figure 103. Removing water filter

5. Replace the water filter in the hose clamp and orient the outlet connectors to exactly the same position as noted earlier.

Caution The water filter must be oriented so that the outermost outlet fitting is at the vertical or topmost position.

6. Retighten the hose clamp.
7. Replace the three hoses onto the water filter and tighten the three clamps.

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

8. Turn on the AED.
9. Observe the water flow, making sure there are no leaks. Correct any leaks.

Caution If there is a water leak, quickly shut off the AED to avoid spilling water within the enclosure.

10. Refill the reservoir with distilled water to just above the upper fitting.

See also *Pump cycles very fast, then slow* on page 203.

If your AED serial number is ≥ US01000166

To replace the water filter:

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Turn off the instrument. Allow the water to cool.
2. Slide the water drawer out.
3. Remove the two clamps and hoses leading into the water filter. See Figure 104.
4. Note the orientation of the outlet connectors on the filter. Unscrew the water filter hose clamp and remove the water filter.

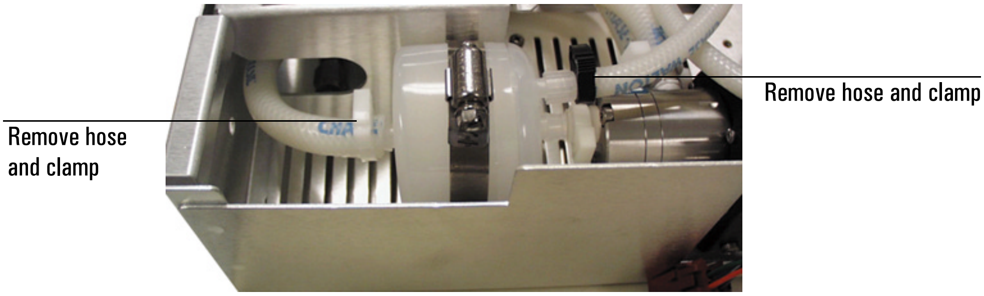


Figure 104. Removing the water filter

5. Replace the water filter in the hose clamp and orient the outlet connectors as shown in Figure 104.

Caution The water filter must be oriented so that the outermost outlet fitting is at the vertical or topmost position.

6. Retighten the hose clamp.
7. Replace the hoses onto the water filter and tighten the clamps.

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

8. Turn on the AED.
9. Observe the water flow, making sure there are no leaks. Correct any leaks.

Caution If there is a water leak, quickly shut off the AED to avoid spilling water within the enclosure.

10. Refill the reservoir with distilled water to just above the upper fitting.

See also *Pump cycles very fast, then slow* on page 203.

Flow sensor

If your AED serial number is < US01000166 (only)

To replace the water flow sensor:

Warning High Temperature! Before touching the GC-AED column transfer line, cavity assembly, or water reservoir, turn off the instrument. Allow it to cool to ambient temperature or wear heat resistant gloves.

1. Turn off the AED and allow the water to cool.
2. Lower the front facing.
3. Remove the water drawer. See *Water drawer* on page 133.
4. Remove the water board panel and switch assembly from the drawer. See *Water board* on page 130.
5. Loosen the water pump clamp and move the pump aside. See *Water Pump* on page 124.

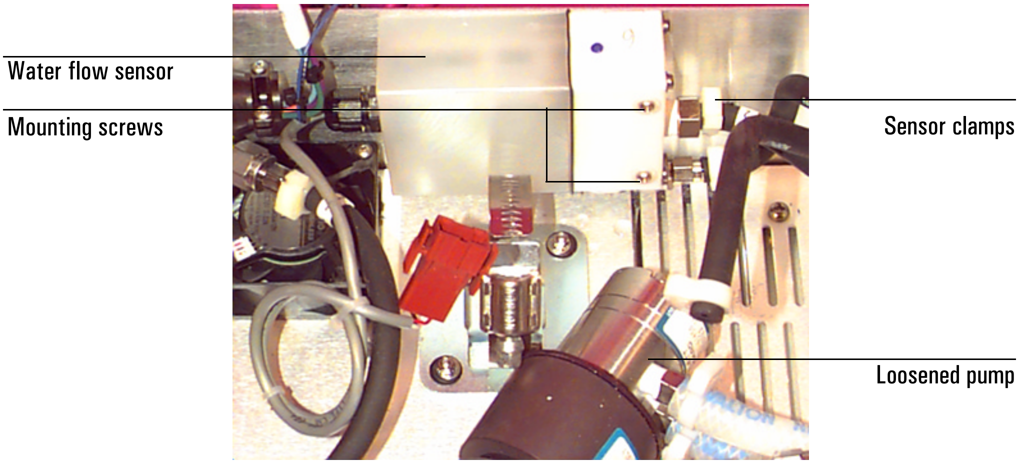


Figure 105. Replacing the flow sensor

6. Remove the connector from the sensor.
7. Remove the two hoses, clamps, and hose barbs from the sensor.
8. Remove the two mounting screws from the sensor.
9. Replace.
10. Install in reverse order.

Warning Before re-starting the AED, make sure there is no water on the AED electronics. Remove water puddles and allow electronic surfaces to dry thoroughly. Make sure no water is inside the cavity or purge vent tubing, or the ash filter. To avoid electrical shock, make sure the spark plug wire is attached to the spark plug before starting the AED.

Do not operate the AED with the water drawer open.

11. Turn on the AED.
12. Observe the water flow, making sure there are no leaks. Correct any leaks.

Caution If there is a water leak, quickly shut off the AED to avoid spilling water within the enclosure.

13. Refill the reservoir with distilled water to just above the upper fitting.

The new flow sensor switch may require adjustment. To adjust the new flow sensor, turn the adjusting screw fully clockwise, then back it off until the flow LED goes off. (Turning the screw **clockwise decreases** the flow rate and turning it **counterclockwise increases** the flow rate.)

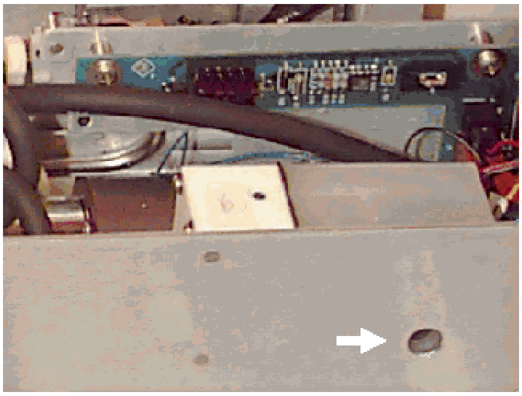


Figure 106. Potentiometer

3 Theory of Operation

Overview

The AED is an analytical device which uses the characteristic energy emitted by atoms in a plasma state to identify the substances present in an input gas flow. Input gas from the GC is fed through a transfer line and into the AED. It is joined by a stream of makeup gas containing additional reagents, and flows through a cavity where the gases are ionized into plasma by electrical and microwave energy. Because of the high energy state in the plasma, the substances are broken down into atoms, ions, or free radicals. As they return to ground state, they emit radiation (light) in characteristic bandwidths. This radiation travels through a lens and into a spectrometer. The gases are vented.

The light entering the spectrometer passes through a narrow slit and is reflected by a mirror onto a reflective holographic grating. The grating breaks the light into discrete bandwidths and disperses the light along a flat focal plane. See Figure 107 below. A motor rotates the grating to reflect the desired range of wavelengths onto a second mirror and then onto a photo-diode array (PDA). The PDA determines the specific characteristic wavelengths present and transmits this data to the AED main board and the ChemStation software. The data is analyzed and the composition of the input gas is determined.

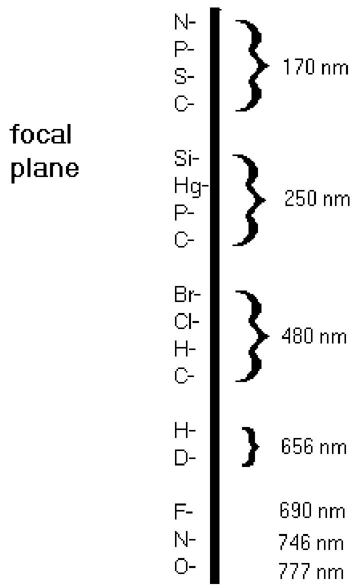


Figure 107. Focal plane diagram with common emission regions

The element characteristic wavelengths detectable using the G2350A AED are given in Table 18 below.

Table 18. Table of Spectral Lines

B	**F**	**N**	**S**
249.773*	685.602*	174.272*	180.734*
182.587	690.246	746.831	182.036*
(same as S)		744.230	182.626
Br(II)	**H**	**O**	**S(II)**
481.670	656.285*	170 (CO band)*	545.388
470.485	486.133*	777.539	
478.550*	434.047	777.194	
	410.174	777.417	
C	**He**	**P**	**Se**
193.090*	471.338	253.561	203.985
247.856*	706.519	255.325	196.090
495.724 (2nd)*		253.561	
		253.399	**Si**
Cd	**Hg**	255.490	251.611*
228.802	253.652	178.287*	
326.105	184.950	178.768*	**Sn**
		255.490	283.999
Cl(II)	**I**	213.547	286.332
479.454*	206.238	213.618	303*
481.006*	206.163	214.914	271*
481.946*	180*	186*	
542.325			
725.665	**I (II)**	**Pb**	
837.597	466.648	217.558	
	516.120	283.307*	
	533.822	405.782*	
	562.569		

*Line used in the G2350A AED

Optical Assembly

The optical assembly consists of a spectrometer (including a grating, mirror, and grating motor), PDA, and preamplifier assembly. These components break down the emitted energy and sort it for analysis by the ChemStation. The optical assembly components are briefly described below.

Spectrometer

The spectrometer focuses emitted light and directs it onto the PDA for detection. The light emitted by the excited atoms passes through a fused silica lens and through a slit in the spectrometer. The lens prevents cavity gases from entering the spectrometer. A constant helium purge on the cavity side keeps the lens clean and free of contamination.

Inside the spectrometer, the light is reflected off two fixed mirrors and a moveable holographic grating. The holographic grating disperses the light into discrete vertical bands and focuses them in a horizontal plane. These characteristic bands are ordered by wavelength, from 160 nm on the left to 800 nm on the right. Since the PDA is not wide enough to measure all of the bandwidth at the same time, a motor is used to rotate the grating so that only a 20 to 26 nm bandwidth is reflected onto the PDA at any one time. The grating rotates through about 5 nm per second, so that about two minutes are required to move from 160 nm to 800 nm. See Figure 108 below.

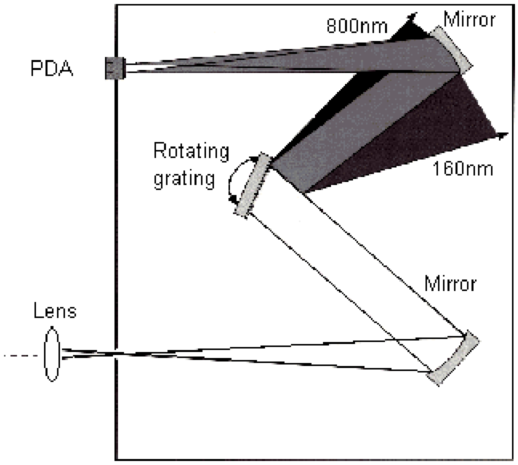


Figure 108. Light path

Moisture and oxygen in the spectrometer cause a loss of sensitivity, particularly in the UV range. To prevent this, the unit is purged with 400 mL/min of nitrogen. A short tube acts as a restrictor to maintain an internal back pressure of 0.5 psi. A fixed restrictor in the spectrometer inlet controls the purge flow rate when the nitrogen pressure is set at 40 psi at the tank.

A switch is mounted on the grating motor assembly in the spectrometer to monitor the motor function. It is in series with the cavity PRT circuit. If the grating moves too far, the switch opens and the high voltage to the emission source is stopped. Similarly, if the switch fails (open), or if the spectrometer cable is not fully connected, the high voltage is stopped and will not start. See also Figure 107 and *Plasma shut off circuits*, on page 177.

PDA

The PDA consists of 512 photo-sensitive diodes which register the intensity of light directed at their surface. As the light from the mirror is splayed across the PDA surface, diodes receiving light from atomic lines send out a voltage which is relayed to the PDA preamplifier board. The intensity of light determines the voltage transmitted by the diodes. The PDA uses four to five pixels per nanometer. The PDA preamplifier board amplifies the analog output signals from the 512 diodes and transmits them to the A/D converter on the main board for processing. In this way, the characteristic atomic lines of each element present can be isolated and the composition of the compound determined.

Since the output voltage from a diode depends on the quantity of photons striking its surface, PDA function is affected by the following spectrometer and assembly conditions:

- Contamination in the optical assembly, whether gaseous or deposited
- Mirror alignment
- Grating alignment
- Mounting of the PDA to the spectrometer

See Table 18 for a listing of spectral lines.

Electronics

AED electronics

The AED electronics consist of four printed circuit boards (PCB's), the power supply, and associated cables and wires. The four boards are the AC board, the main board, the sparker board, and the water board. A fifth board, the service display board, is a diagnostic device sometimes used by the Agilent Customer Engineer.

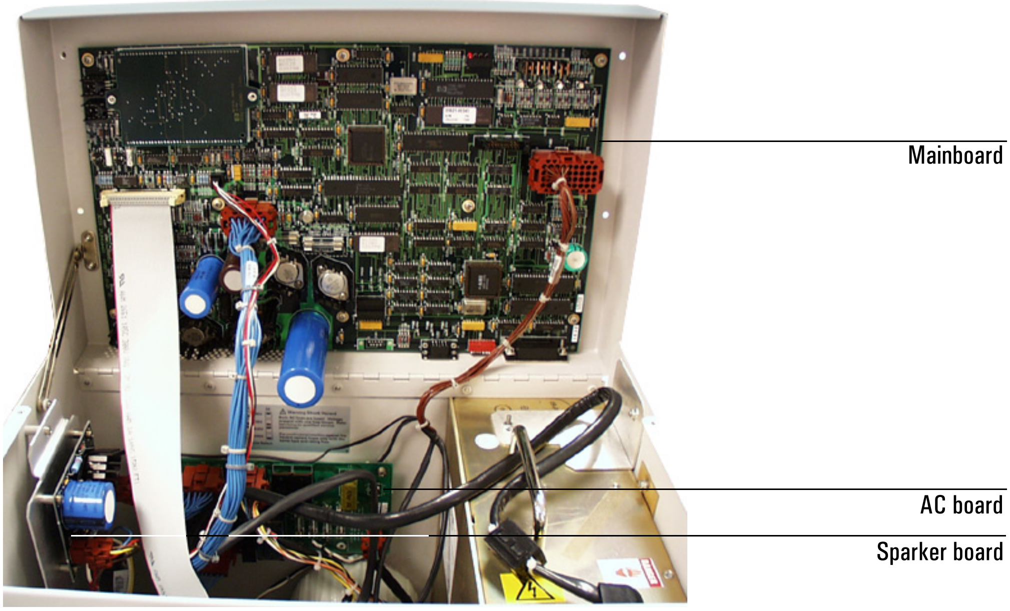


Figure 109. AED electronics

AC board

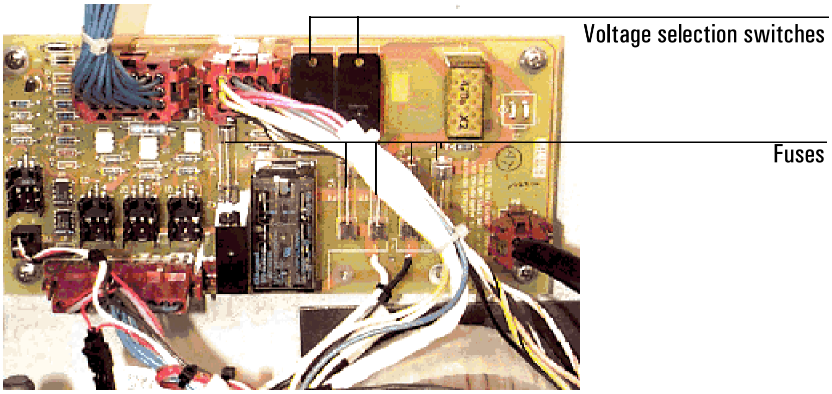


Figure 110. AC board

The AC board works in conjunction with the transformer to condition and supply power to all AED components. Specifically, the AC board:

- Transforms incoming AC voltage (100 V, 120 V, 220/230 V, or 240 V) into 40 V AC for the main board fused DC power supply and into 120 V AC for the heated zones using fused contactor K2.
- Provides primary power to the 2340 V DC magnetron through fused contactor K1.
- Provides zero crossing line sense signals for AC heater control.
- Controls the magnetron temperature.
- Provides line voltage selection.
- Provides line filtering.
- Specific board elements are described below.

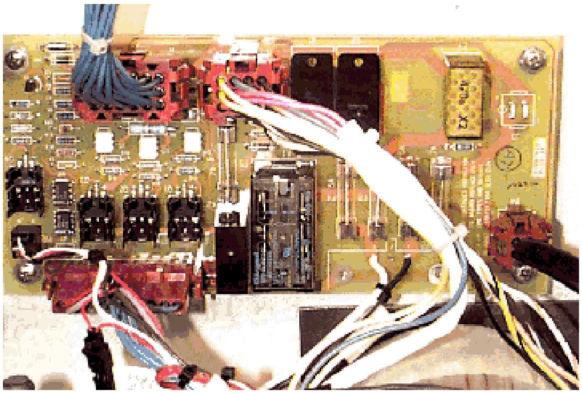


Figure 111. Board elements

Input voltages (listed by country)

The AED can operate using any one of the following voltages:

Table 19. Input Voltages

V AC	Country
100 V	Japan
120 V	USA
220/230 V	Europe
240 V	USA

Voltage selection settings

Two switches, S1 and S2, are factory preset to select the incoming line voltage according to country of use. Refer to the following chart for voltage selection settings according to country:

Table 20. Voltage Selection Settings

Country	V AC	S1 Setting	S2 Setting
Japan	100	up	down
USA	120	up	up
Europe	220/230	down	down
USA	240	down	up

See also *Voltage Selection Switch Settings*, on page 74.

Heated zones

There are two zones in the AED which require heating in order to operate properly:

- The transfer line (Q1)
- The cavity (Q2)

The temperature of these two heated zones is controlled by the main board using a relay and opto-isolators on the AC board. The main board uses thermal sensor data to determine whether to turn the heating ON or OFF. The board can control a third heated zone, Q3, but this zone is not used on the G2350A.

See also Table 23 in chapter 4, *Diagnostics*.

Opto-isolator

The AC board uses three opto-isolators to control the power to the heaters. The opto-isolators isolate 120 V AC and deliver it to the triacs controlling the heaters (Q1, Q2, Q3) when activated by the main board.

Magnetron temperature control circuit

The magnetron operates most efficiently at 94°C and is cooled by a variable speed fan to maintain that temperature. The control circuit on the AC board operates the fan as follows:

- Below 94°C, the fan does not run.
- At 94°C, the fan starts.
- If the temperature increases while above 94°C, the fan speed increases.
- If the temperature decreases while above 94°C, the fan speed decreases.
- If the temperature goes above 175°C, there is a temperature runaway problem. The fan runs at full speed and the power to the magnetron is shut down.

The PRT reads 147 ohms at 94°C. The AC board compares the actual PRT resistance to a set point of 147 ohms and adjusts the variable speed fan accordingly.

See also *PRT resistance vs. temperature*, on page 179.

Contactors

The AC board uses two contactor switches to deliver power on command. The first, K1, enables 120 V to get to the heated zone circuitry. Contactor K2 provides low voltage power to the high voltage power supply when all components of the instrument are ready for plasma ignition.

High voltage enable

The high voltage enable circuit uses a wire running from the AC board to the high voltage power supply. At a signal from the main board, the voltage in this wire drops to 0.2–0.3 V and the power supply delivers 2340 V to the magnetron. A relay controls primary power to the high voltage power supply.

Main board

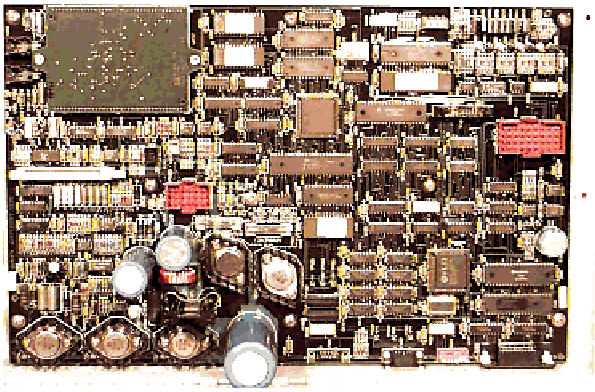


Figure 112. Main board

The main board provides most of the control logic for AED operation, including the switching functions of the AC board. The board receives the input data from the ChemStation and translates them into the specific tasks required to run the AED. The following is a summary list of tasks:

- Monitors and controls temperature in the cavity, microwave emission source, and transfer line.
- Monitors the water board operation.
- Monitors the status of the other internal components (verifies plasma shutoff circuits).
- Controls the ignition spark, the microwave emission source, the high voltage power supply, the optical assembly, and all the gas flows.
- Communicates with the ChemStation.

The main board can be divided into six functional parts:

- Power supply
- Processor (CPU, RAM, and ROM)
- I/O control (GPIB communications control)
- Motor control
- PDA control
- Solenoid control

Power supply

Input power of 40 V AC enters the main board (at P500) and goes through two fuses (F501 and F500). If one of these fuses is blown, a capacitor holds up the voltage. The 40 V AC is first converted to unregulated 24 V DC, which is then regulated by a +5 V DC regulator and a ±15 V DC regulator. The +5 V DC is used by the processors on the main board, and the ±15 V DC is used on the sparker board, the AC board, other sections of the main board, and the PDA.

Processor (CPU, RAM, and ROM)

The main processor of the AED is a Motorola 6809E microprocessor. It talks to ROM, power-fail protected static RAM (a capacitor is used to maintain RAM settings during a power-failure), a dual-port RAM shared with the A/D processor, and a dynamic RAM buffer. The I/O system includes a front panel display, GPIB, valve drivers, three motors, remote start/stop, three heated zones, and various on/off controls for microwaves, lamps, and water cooling.

I/O control (GPIB communications control)

A GPIB address is factory set for proper parallel communication between the AED I/O bus and the ChemStation. The address is set by manual switches and is not software selectable.

Motor control

The main board controls the stepper motor which focuses the mirror reflecting emitted light onto the PDA assembly. Control logic automatically aligns the system to correspond with the detection bandwidth input by the user.

PDA control

The main board receives the raw analog data coming from the PDA preamplifier, converts it to digital data, and routes it through the I/O Bus to the GC-AED ChemStation.

Solenoid control

The main board controls the five gas flow solenoids based on reagent makeup selection and total gas flow requirements input by the user. Drive transistors activate the triacs which send the control voltage to each solenoid.

This section of the main board also controls the three sets of opto-isolators and triacs which control the heated zones. Zone Q1 is the transfer line, zone Q2 is the cavity, and zone Q3 is not used.

See also Table 23 in chapter 4 *Troubleshooting*, on page 175.

Sparker board

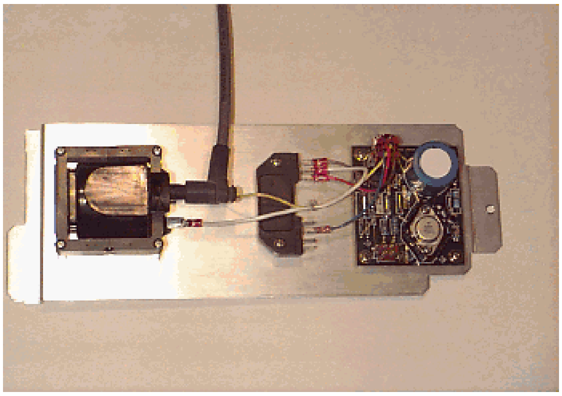


Figure 113. Sparker board

The sparker board generates the electrical pulse which, along with the microwave energy, converts the gases in the cavity into plasma. The main board controls the sparker board.

The sparker board consists of the following three parts:

- Regulator board
- Ignition module
- Ignition coil

Regulator board

The regulator board receives power inputs of 24 V and 5 V DC. The 24 V input is filtered and regulated to charge a capacitor to 13.6 V DC. The 5 V input is filtered and sent to power the board circuitry.

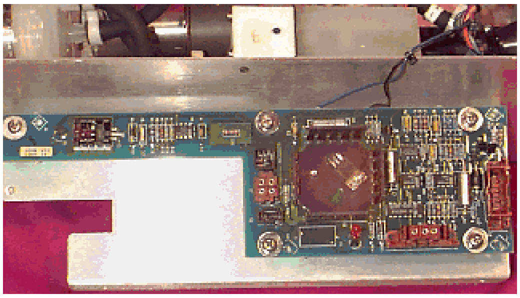
Ignition module

The main board instructs the ignition module to trigger. The ignition module gives off a spark which interrupts the flow of the 13.6 V DC supply through the primary. At this instant, 20 kV travels out of the sparker on the ignition module/ coil, down the spark plug wire, and directly down the discharge tube through microwave energy. As long as conditions in the cavity are acceptable, the plasma is ignited or “triggered” as the spark travels through the microwave energy.

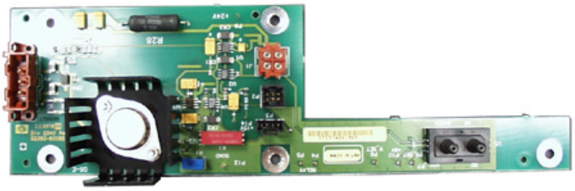
Ignition coil

The ignition coil increases the initial ignition pulse from 13.6 V up to 20 kV.

Water board



G2350–60080



G2350–60085

Figure 114. Water boards

G2350-60080

The water board regulates the discharge tube temperature while the AED is on and controls the AED cooling fan. It monitors a water flow sensor and contains a pressure switch to confirm coolant flow. The water board also compares the flow sensor information to set points to determine the appropriate coolant flow rate. The board then varies the water pump speed accordingly. The pressure switch and a relay attached to the flow sensor are connected in series to connector J252 on the main board. If the either switch or the relay opens, the main board stops the 24 V power to the water board and the power to the magnetron to prevent plasma ignition. The main board notifies the user of the potential problem. The relay opens when the output from the flow sensors is less than 2.5 V. During start-up, the main board allows for a delay of approximately 30 seconds for the water pump to pressurize the system.

The water drawer cooling fan runs at a constant rate while the AED is ON.

A diagnostic LED on the water board flashes when the measured flow rate drops below 375 mL/min. The light continues to flash even when the flow rate drops below 250 mL/min and the pump stops.

G2350-60085

The water board regulates the discharge tube temperature while the AED is on and controls the AED cooling fan. It monitors a water flow sensor and contains a pressure sensor to confirm coolant flow. The board then varies the water pump speed accordingly. The pressure switch is connected in series to connector J252 on the main board. If the switch opens, the main board stops the 24 V power to the water board and the power to the magnetron to prevent plasma ignition. The main board notifies the user of the potential problem.

The water drawer cooling fan runs at a constant rate while the AED is ON.

Power supply

The high voltage power supply delivers both the filament current of 8 A at 2 V, and the magnetron current of 60 mA at 2340 V. The power supply has two connectors, one running to the AC board and the other to the magnetron. It is attached to the AC board by four wires: hot, neutral, ground, and high voltage enable. When the AED is first powered on, AC voltage runs to the auto-sensing power supply at standard house voltage. Power is immediately supplied to the main board. When settling time has passed, the main board enables the contactor to close the circuit to the power supply, starting the low voltage power flow to the filament. The low power meter on the power supply should read about 8 A (4 A × 2 for scale). When the main board verifies that all conditions are acceptable (water flow, water temperature, heated zone temperatures, interlocks, etc.), the voltage in the high voltage enable wire drops to about 0.2–0.3 V, and 60 mA at 2340 V AC flows from the power supply to the magnetron.

The high voltage circuit is a “latched” circuit. If the circuit is ever over-energized, it must bleed off before the power supply will function properly. This may take several minutes to several hours.

Service display board

The service display board is an optional diagnostic tool available only to the Agilent Customer Engineer. It can be plugged into P101 on the main board as a troubleshooting tool if the computer is either down or is not registering the AED self diagnostics at start-up. If the AED is operational, the display board will show the results of the self-diagnostics as it starts up.

Emission Source

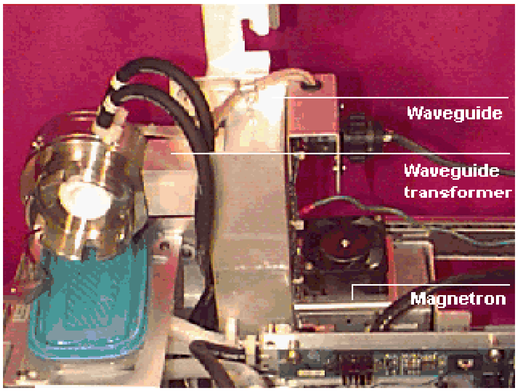


Figure 115. Emission source

Emission source assembly

The AED magnetron generates an intense microwave field which is directed toward the cavity by the wave guide. The microwave radiation is impedance matched by the wave guide transformer and focused on the discharge tube by the cavity chamber. As the spark generated by the ignition module travels through the microwave energy, the microwave energy ionizes the gases in the discharge tube and the plasma is formed. The magnetron is controlled by the main board through the high voltage power supply, and is cooled by a variable speed fan.

Emission source safety switch

A safety switch is located on the enclosure wall behind the emission source and the water drawer. This switch is in series with the switch on the spectrometer grating motor and with the cavity PRT so that when it opens, the main board assumes the cavity is too hot and prevents high voltage from reaching the magnetron. This feature ensures that the AED magnetron shuts down if the water drawer is opened while the cavity and emission source assembly are attached to it. See also *Plasma shut off circuits*, on page 177.

Gas Flow System

Overview

The gas flow system in the AED controls the flow of five gases which are used to generate plasma, increase test sensitivity, and purge sensitive items of contamination. Sample gases flow from the column into the transfer tube where they are merged with makeup and reagent gases before entering the discharge tube. Gases exiting the discharge tube are vented to the front of the gas drawer. Purge gases flow over the spectrometer lens and the spectrometer to keeping them clean and dry. The purge gases are then vented.

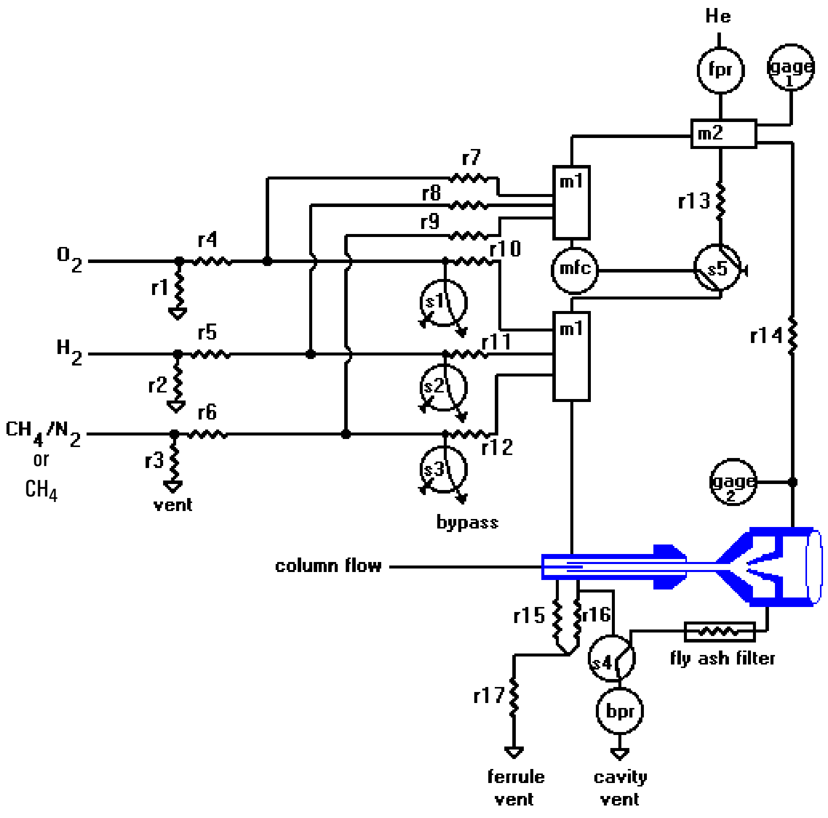


Figure 116. Gas flow system

The AED uses the following gases:

Table 21. Gases Used in AED

Gas	Use
Helium	Added to the sample gas flow from the column to achieve a sufficient flow through the AED cavity. Makes the plasma. Spectrometer lens purge
Nitrogen	Spectrometer purge only
Oxygen	A reagent gas. Increases sensitivity to certain elements
Hydrogen	A reagent gas. Increases sensitivity to certain elements
CH_4/N_2	A reagent gas. Increases sensitivity to certain elements
Methane	A reagent gas. Increases sensitivity to certain elements

Flow modes

By varying the composition of the gas mixture and the overall amount of gas, the AED operates in one of five primary and three secondary flow modes. These flow modes are:

- Standby
- Basic operation
- High flow
- Solvent vent
- Calibration
- +Reagent gas

The mode in use depends on the current analysis being run or the operational state of the instrument. The flow modes are created when the main board energizes different combinations of the five solenoid valves controlling the gas flows through the manifolds, tubing, restrictors, and cavity.

The flow modes are described below. The flow rates given are measurable at the cavity purge outlet when:

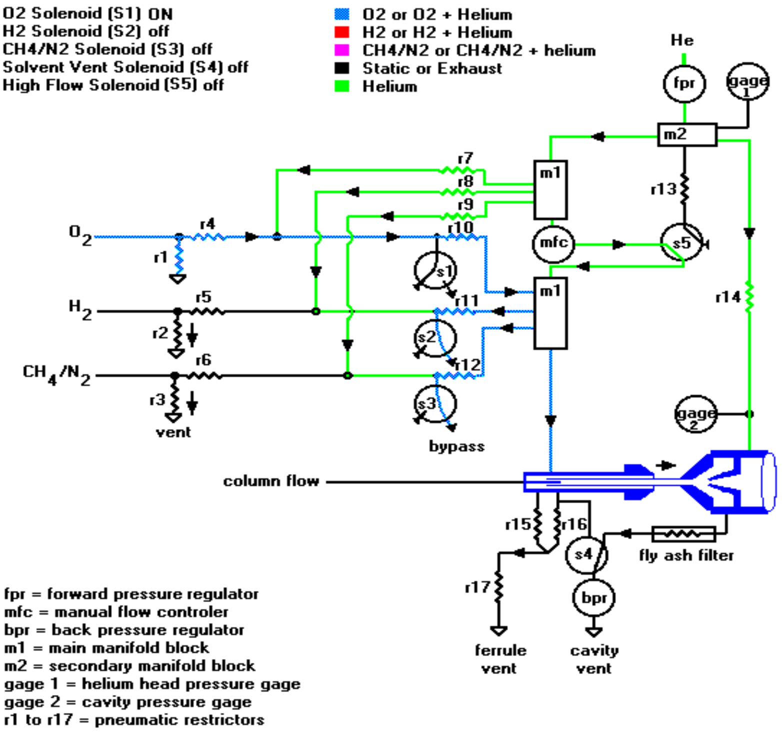
- The ferrule vent is closed.
- The cavity pressure is set at 1.5 psi.
- The cylinder head pressures are set according to the procedures listed under *Connecting gas piping*, on page 30.

Note that the spectrometer lens purge is fixed at 25 mL/min, and the sample flow from the GC is not included in the total.

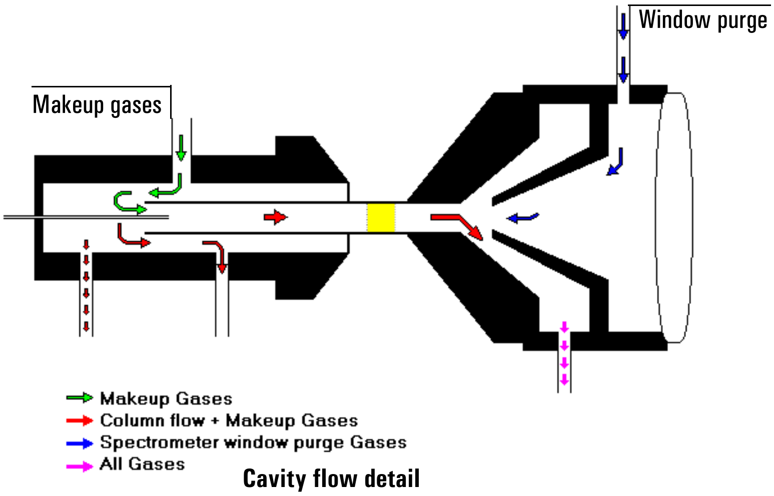
Standby

Description: Spectrometer lens purge flow (He), standard helium flow through the discharge tube, oxygen flow turned on.

- Solenoid(s) energized: O_2
- Total flow rate: 85^+ mL/min



Gas flow system



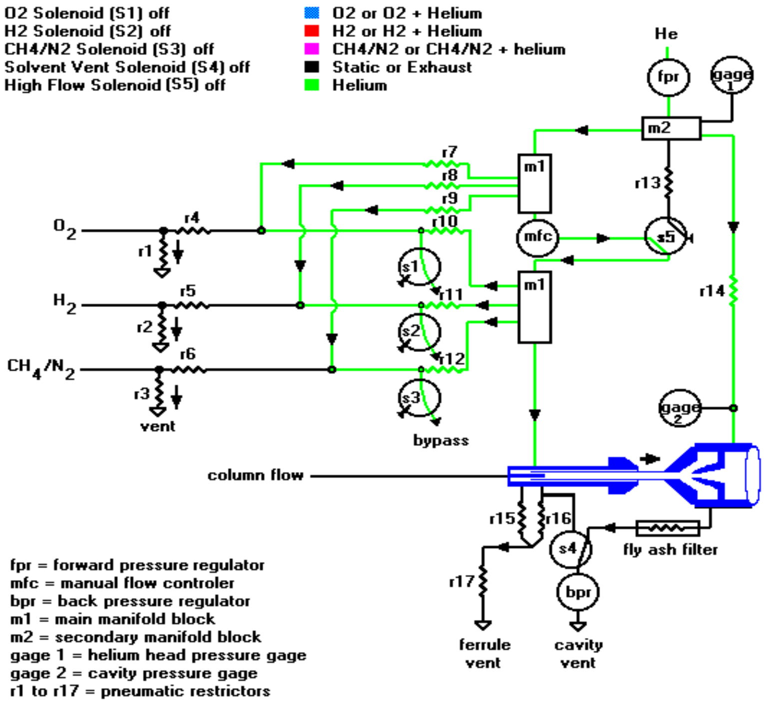
Cavity flow detail

Figure 117. Gas flow system in standby mode

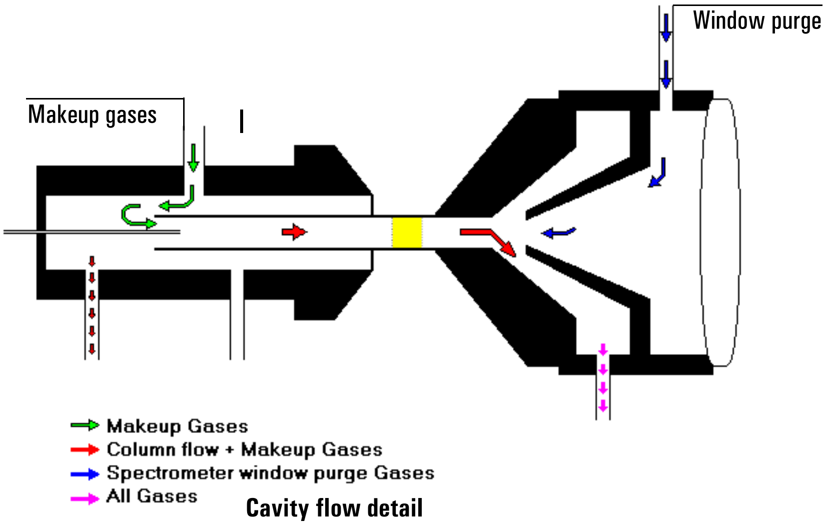
Basic operation

Description: Spectrometer lens purge flow (He), standard helium flow through the discharge tube, plus any desired reagents.

- Solenoid(s) energized: Any reagent (O_2, H_2, CH_4/N_2)
- Total flow rate: 80^+ mL/min +5 mL/min per reagent



Gas flow system



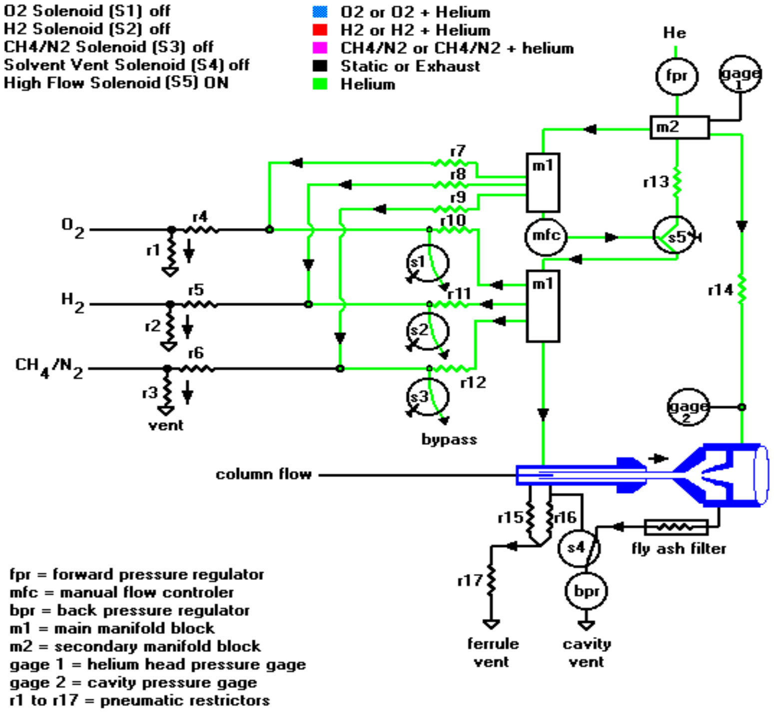
Cavity flow detail

Figure 118. Gas flow system in basic operation flow mode

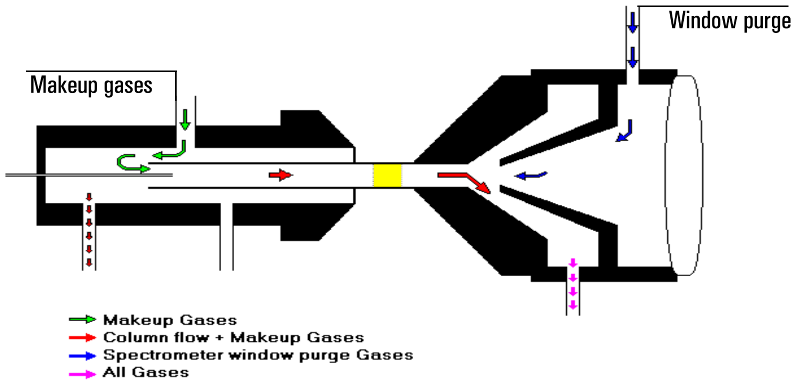
High flow

Description: An additional 120 mL/min of helium increases the flow through the discharge tube to boost sensitivity and to prevent the GC gases from reacting with the discharge tube.

- Solenoid(s) energized: High flow, any Reagent (O_2, H_2, CH_4/N_2)
- Total flow rate: 150 to 300 mL/min



Gas flow system



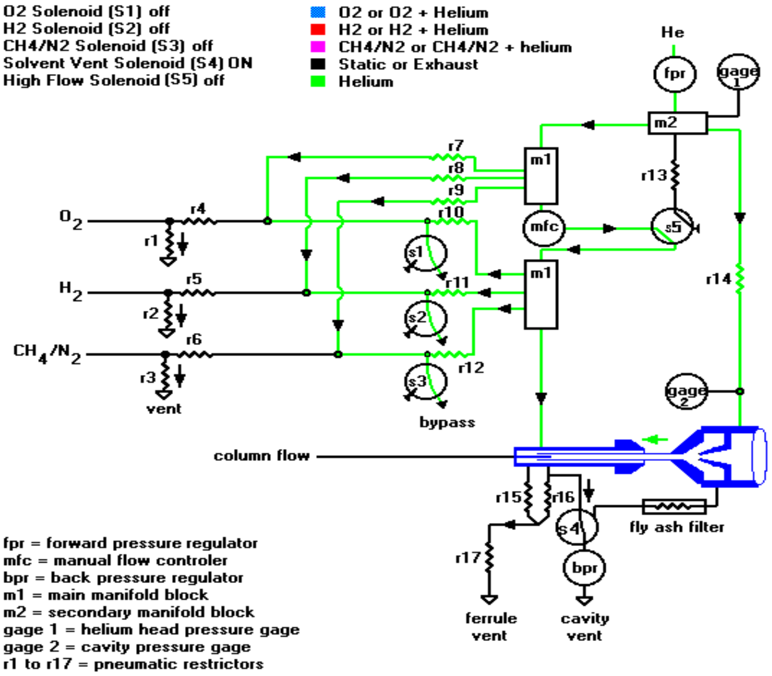
Cavity flow detail

Figure 119. Gas flow system in high flow mode

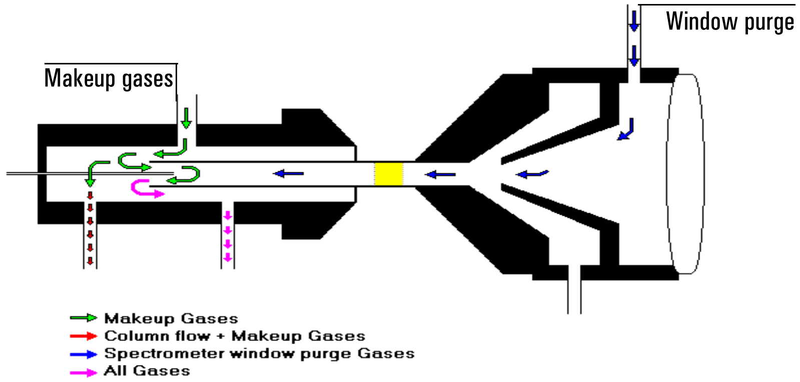
Solvent vent

Description: With the vent closed, the lens purged flow is forced to back-flow through the discharge tube to prevent solvent spike contamination. The gases flow through the solvent vent solenoid and out to waste for a time set using the ChemStation.

- Solenoid(s) energized: Solvent vent
- Total flow rate: 80^{+} mL/min



Gas flow system



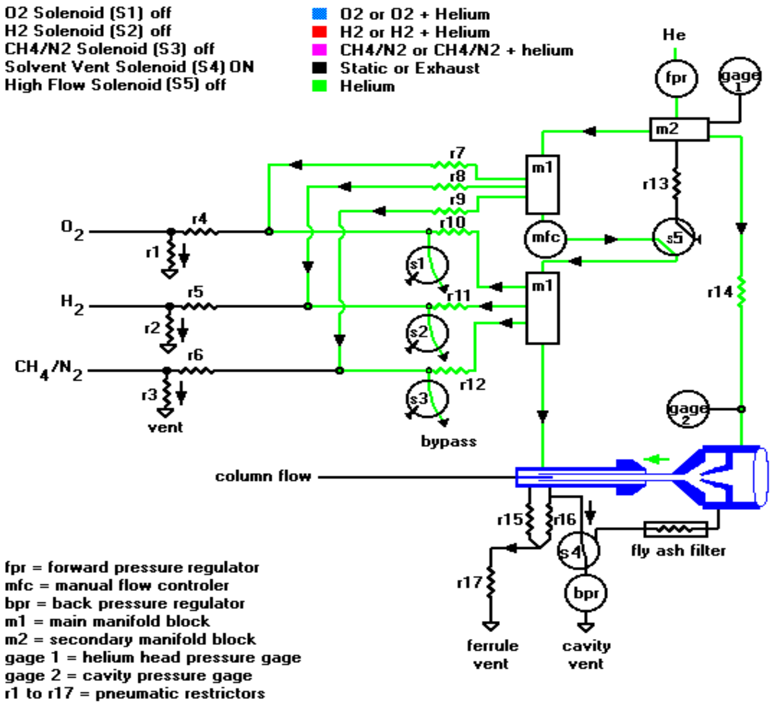
Cavity flow detail, solvent vent ON

Figure 120. Gas flow system, in solvent vent mode

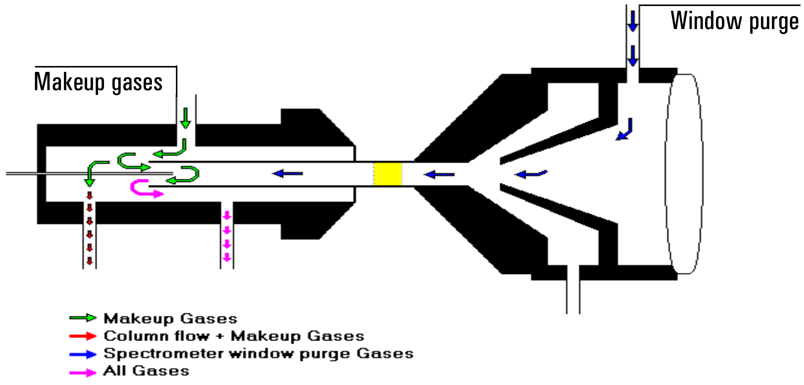
Calibration mode (N_2 and O_2 lines)

Description: Helium lens purge gas is routed through the spectrometer side of the cavity to back-flow through the discharge tube. N_2 and O_2 leech through the bypass tube, reach the plasma, and register at the PDA for calibration.

- Solenoid(s) energized: Solvent vent
- Total flow rate: 25 mL/min



Gas flow system



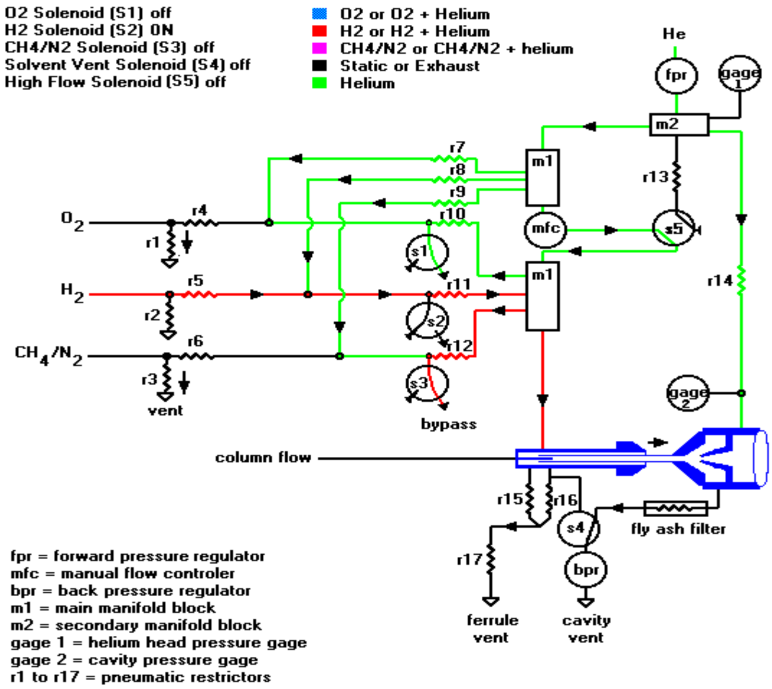
Cavity flow detail, solvent vent ON

Figure 121. Gas flow system in calibration mode

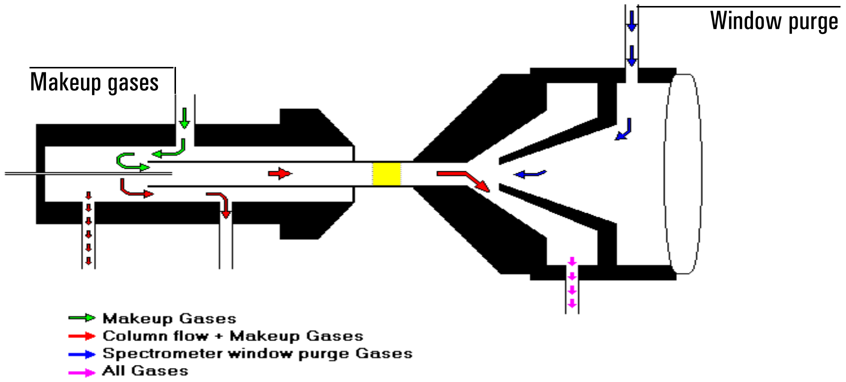
+Reagent mode (three reagents)

Description: A small flow of reagent gas adds to the overall flow to the cavity.

- Solenoid(s) energized: as described above plus any reagent(s) (O_2, H_2, CH_4/N_2)
- Total flow rate: +5 to 10 mL/min each



Gas flow



Cavity flow detail

Figure 122. Gas flow system in + reagent mode

Note that under normal operating conditions, approximately 20 mL/min flows out the ferrule vent.

Components

The system consists of the following components:

- Gas drawer (which houses most of the system)
- Two manifolds
- Five solenoids
- Tubing and fittings

Gas drawer

All of the AED gas system components (except some tubing and fittings) are contained in the gas drawer assembly. The gas drawer contains:

- Five inlet and eight outlet ports
- Five solenoids
- Manifolds
- One manual flow controller
- Two pressure regulators
- Fly ash filter

Inlets and outlets

There are four sets of inlet and exhaust connections on the side of the gas drawer:

Inlets:	He, N_2, O_2, H_2, CH_4/N_2 (Aux)
Inlet vents:	O_2, H_2, CH_4/N_2 (Aux)
Bypasses:	O_2, H_2, CH_4/N_2 (Aux)
Exhaust vents:	ferrule vent, cavity vent

Flow control

Flow control is provided by the forward and back pressure regulators, one manual flow controller, five solenoids, manifolds, and 17 fixed pneumatic restrictors.

Manifold 2

Distributes incoming helium to manifold 1, the high flow solenoid, and the spectrometer lens purge. The manifold is gauged to show incoming pressure [30 psi (207 kPa)].

Manifold 1

- Distributes helium to the incoming reagent gas lines and the manual flow controller.
- Receives incoming reagent gases and any helium from the high flow solenoid and distributes the reagent/helium mixture to the reagent solenoids while exhausting excess reagent flow to vent.
- Receives incoming reagent gases from the solenoids, combines them with the main helium flow, and directs the combined flow to the cavity.
- Uses restrictors one through six to vent approximately 20 mL/min of each reagent through to vent, and allows approximately 0.1 mL/min each to flow through to the reagent solenoids.
- Uses restrictors seven through nine to allow 4 mL/min of helium to merge with the reagent gases and augment their flow and delivery times.
- Uses restrictors 10 through 12 to regulate the flow rate out of the reagent solenoids.

Solenoids

The solenoids are controlled by the main board through the main harness cable assembly at P100. The solenoids set the flow mode (see *Gas Flow System*, on page 157 and *Solenoids*, on page 167).

Forward pressure regulator

The forward pressure regulator is used to manually adjust the flow rate of incoming helium. The inlet pressure in manifold 2 registers on a pressure gauge on the front panel and is always set to 30 psi.

Back pressure regulator

The back pressure regulator controls the flow exiting through the cavity vent and is normally set to 1.5 psi. The pressure gauge is on the front panel.

Example of reagent and helium flow

When oxygen is selected during basic operational flow mode, about 20 mL/min flows from the cylinder regulator to the restrictors R1 and R4. Most of the gas flows out R1 to the O_2 vent on the gas drawer front panel, and approximately 0.1 mL/min flows through R4. A flow of approximately 4 mL/min of helium exits through manifold 1, passing through R7, and merges with the oxygen to help carry it more quickly. This mixture flows through R10 at about 4 mL/min and joins the main gas flow in the lower portion of manifold 1. The majority of the mixture flows into the cavity, and small amounts flow out through R11, R12, and to the bypass vent. The total makeup and reagent flow is about 50 mL/min. A flow of 20 mL/min is used to purge the column ferrule, giving an actual makeup flow into the plasma of approximately 30 mL/min.

If two reagents are turned on, the total flow is approximately 60 mL/min, and the actual makeup flow into the plasma is approximately 40 mL/min.

Spectrometer lens purge

A flow of 25 mL/min of helium passes a pressure gauge and over the spectrometer lens to keep it clean and dry. This flow is never turned off under normal conditions.

Solenoids

The main board controls five solenoids which direct the flow of gases within the gas flow system. Each solenoid is triggered by a 24 V signal from the main board. The solenoids are normally in the closed (de-energized) position, which puts the AED into the basic run flow mode. The five solenoids are:

- High flow (helium), s5
- Auxiliary, s3
- Oxygen, s1
- Hydrogen, s2
- Solvent vent, s4

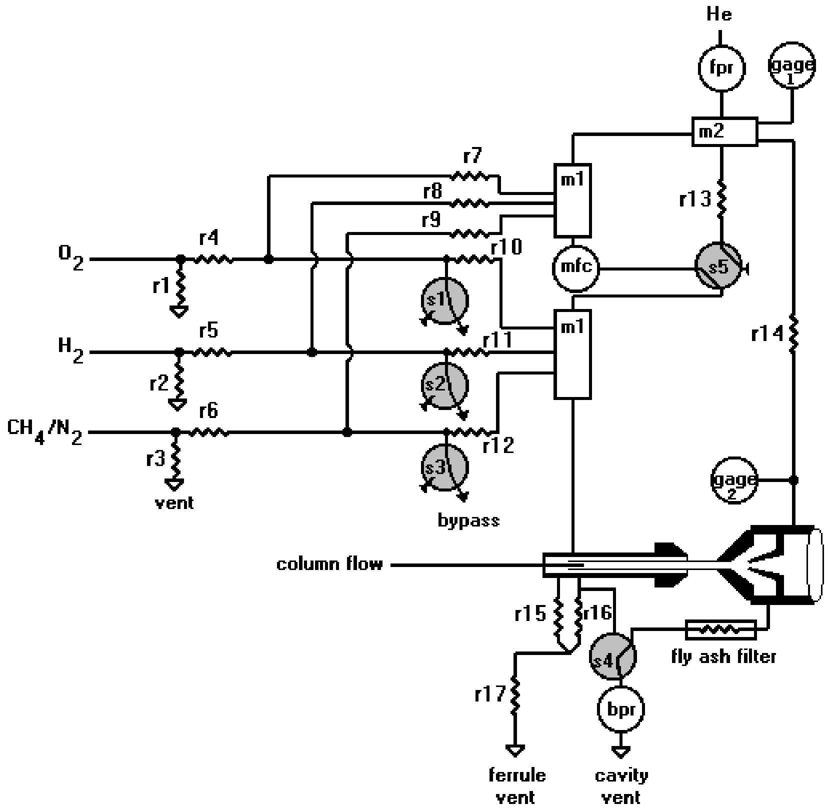


Figure 123. Solenoids (in de-energized state)

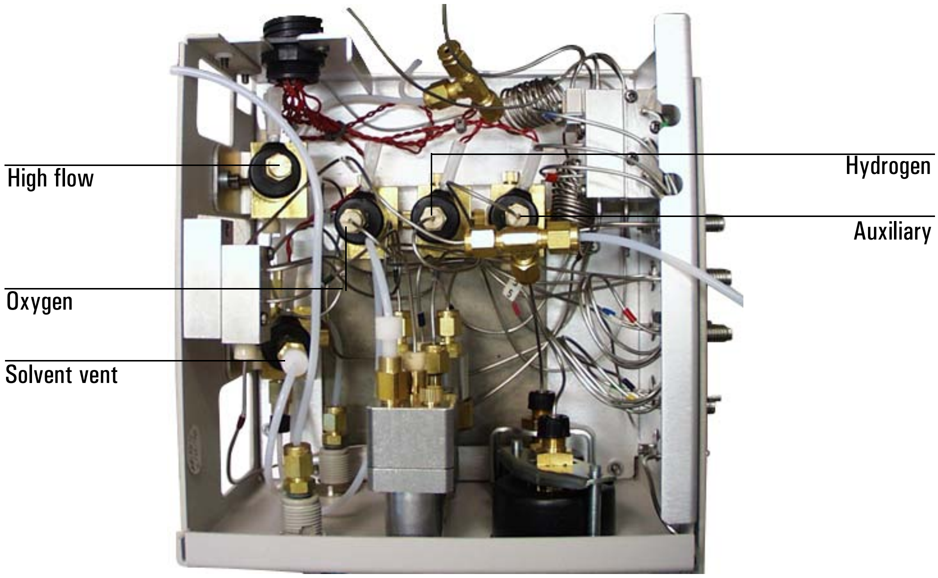


Figure 124. Solenoid locations

The reagent and auxiliary gas solenoids direct flow into either manifold 1 or a bypass outlet on the side of the gas drawer, depending on whether each reagent gas is required.

Water Flow System

Water drawers using a flow sensor

Some G2350A water drawers use a flow sensor. If your water drawer looks like Figure 125, it is described below.

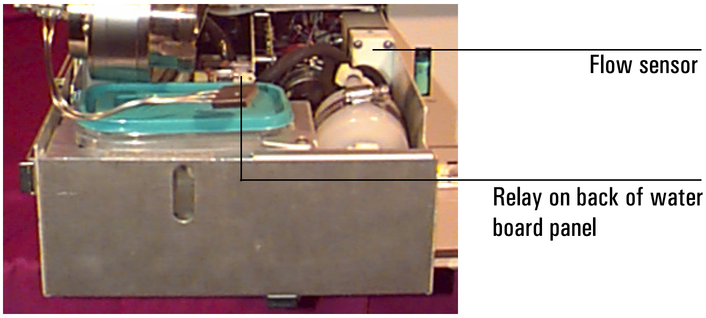


Figure 125. Water drawer with flow sensor

The water flow system pumps distilled water over the discharge tube to maintain a safe operating temperature in the tube. The system is controlled by the water board. A 9 to 21 V DC variable-speed pump with a magnetically coupled head circulates 370 to 430 mL/minute through the instrument for cooling. A Hall Effect rotometer measures the flow rate with 1 volt output equal to 100 mL linear. If the water flow drops below 250 mL/minute, the high voltage to the magnetron is stopped and plasma ignition is prevented. The water passes through a 5 micron, 70 mL capacity filter to clean any particles which have generated or degenerated from the gear pump head.

Water flow path

Water flows from the lower port on the reservoir into the pump, which pumps it through the filter. The central outlet from the filter ends at the pressure switch, while the other outlet carries the flow through the water flow sensor and into the cavity. The water flows across the discharge tube, out the cavity, and into the heat exchanger.

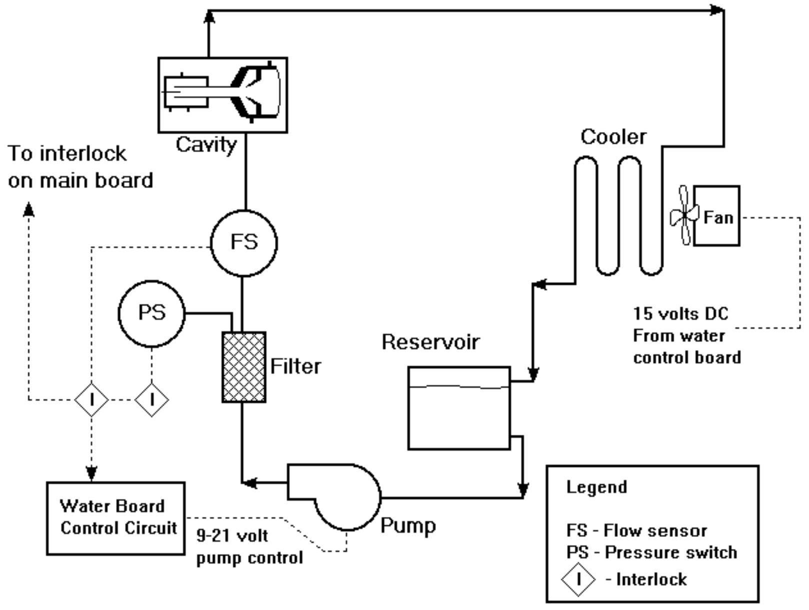


Figure 126. Water flow path diagram

Water pump control

At start-up, the main board waits approximately 30 seconds for the water pump to establish the correct flow rate. During operation, about 9 to 12 V is used to drive the pump at a flow rate of 400 mL/min. If the pump head is worn or if there is a restriction in the system, the voltage will be increased to gain the same flow rate.

The high flow solenoid is normally off (with flow blocked), but in high flow mode it directs 120 mL/min of helium into the main manifold to augment the makeup flow for a total flow rate between 150 mL/min and 300 mL/min.

The solvent vent solenoid 1 closes the exhaust path for gases exiting the discharge tube. This forces the window purge to back-flow through the discharge tube, preventing the makeup and column flows from entering. Instead they are routed to bypass through the solvent vent solenoid and out to vent.

Water drawers without a flow sensor

Some G2350A water drawers use only a pressure sensor to monitor flow. If your water drawer looks like Figure 127, it is described below.

Figure 127. Water drawer with pressure sensor only

The water flow system pumps distilled water over the discharge tube to maintain a safe operating temperature in the tube. The system is controlled by the water board. A 9 to 21 V DC variable-speed pump with a magnetically coupled head circulates 370 to 430 mL/minute of water through the instrument for cooling. If the water pressure drops too low, the high voltage to the magnetron is stopped and plasma ignition is prevented. The water passes through a 5 micron, 70 mL capacity filter to clean any particles which have generated or degenerated from the gear pump head.

Water flow path

Water flows from the lower port on the reservoir into the pump, which pumps it through the filter. The other filter outlet carries the flow into the cavity, across the discharge tube, out the cavity, through a tee-union to the pressure sensor, and into the heat exchanger. See Figure 128.

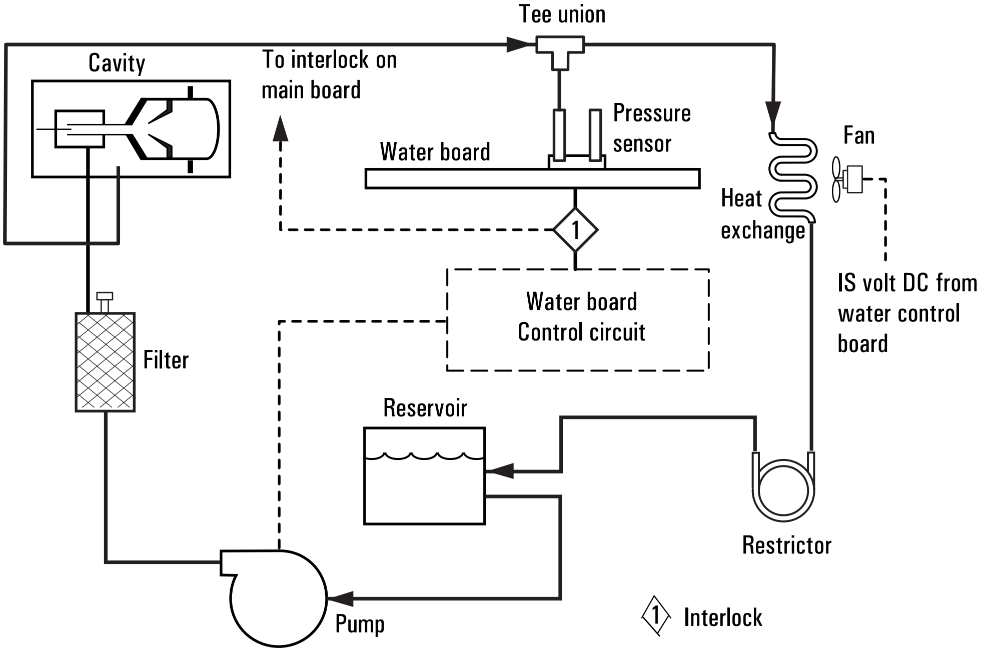


Figure 128. Water flow path diagram

Water pump control

At start-up, the main board waits approximately 30 seconds for the water pump to establish the correct flow rate. During operation, about 9 to 12 V is used to drive the pump at a flow rate of 400 mL/min. If the pump head is worn or if there is a restriction in the system, the voltage will be increased to gain the same flow rate.

The high flow solenoid is normally off (with flow blocked), but in high flow mode it directs 120 mL/min of helium into the main manifold to augment the makeup flow for a total flow rate between 150 mL/min and 300 mL/min.

The solvent vent solenoid 1 closes the exhaust path for gases exiting the discharge tube. This forces the window purge to back-flow through the discharge tube, preventing the makeup and column flows from entering. Instead they are routed to bypass through the solvent vent solenoid and out to vent.

Water drawer sensors, switches, and connections

Water board connections

Connector J1 is the power input from the AC board, and carries a 24 V enable signal in pin 4 while the pump is operating. Output from the flow sensor (if equipped) enters the water board at J2. The P1 connector carries 9 to 21 V DC to the pump. The P2 connector powers the fan with 15 V DC. The P3 connector is part of a series loop to turn off water board, emission source, and heated zone power if there is a problem. The pressure switch is in the water control drawer assembly cable, which connects to the water board at P3 and is in series with the flow sensor relay (if equipped), the cavity PRT (temperature) circuit, and the main board. If water pressure is too low, the main board stops power to the water, emission, and heating systems.

For information on water board pinouts, see:

Water board, part no. G2350-60080, on page 237 or

Water board, part no. G2350-60085, on page 239.

Pressure switch

When the water flow through the system is above 250 mL/min, the water pressure is sufficient and the pressure switch remains closed. If the water pressure drops too low, the pressure switch opens, the heated zones are turned off, and power to the emission source is stopped.

Relay switch (AED serial number < US 01000166)

When the water flow through the system is 400 mL/min ± 30 mL/min, the relay switch is closed. If the water flow drops below 250 mL/minute or the 2.5 volt equivalent, the relay switch on the back of the water board opens and the heated zones are turned off. The emission source is powered down.

Diagnostic LED (AED serial number < US 01000166)

The diagnostic LED on the water board flashes when the flow rate is 370 mL/min or less.

4 Troubleshooting

General Procedures

Tips

The following tips and techniques are designed to help diagnose AED problems.

Diagnostic descriptions in this manual cover the symptoms and corrective actions for the most common AED technical problems. If a problem cannot be isolated or resolved using the actions described, contact Agilent Service Personnel.

- In general, before working on a gas flow problem, reset the flow rates to standard whenever possible. By setting the flow back to standard, troubleshooting flow rates and leak rates becomes easier.
- Because the spectrometer is highly sensitive to moisture and contamination, check the following before performing detailed diagnostics on the optical assemblies:
  a. The spectrometer lens. Replace it as required.
  b. The nitrogen used to purge the spectrometer. The purge gas must be sufficiently clean (99.99% pure).
- To access the water board more easily, loosen the two screws holding it to its palette and let the board incline at an angle.

Plasma shut off circuits

At start-up and during operation, the AED main board and the AC board check the voltages of certain inputs to verify it is safe for plasma ignition. If any part is not operating correctly, or if one of the monitored circuits is open, then the main board will not enable the magnetron power, will cut off power to the heated zones, and prevent plasma ignition.

These circuits are listed in Table 22 below.

Table 22. AED Plasma Shutoff Circuits

Circuit	Acceptable condition	Measured input	Power cut:
Cavity temperature	See (1) below	See (1) below	High voltage, heated zones
Heated transfer line temperature	See (1) below	See (1) below	High voltage, heated zones
Emission source temperature	See (1) below	See (1) below	High voltage, heated zones
Switch on the spectrometer grating motor	Closed	Closed (0 V)	High voltage, heated zones
Emission source safety switch (2)	Emission source in enclosure when water drawer open	Closed (0 V)	High voltage, heated zones
Pressure switch in water drawer (2)	Water flow > 250 mL/min	Closed	High voltage, heated zones, water board
Relay switch on water board (3)	> 250 mL/min flow	Closed	High voltage, heated zones, water board

(1) The main board will assume there is a temperature runaway problem and turn off the plasma if any PRT reads above 460°C, or if a PRT significantly exceeds the temperature set point.

(2) The water drawer circuit is a safety circuit controlled by the main board as if it were a PRT. A resistor in the water drawer control cable provides a 110 W impedance in the circuit, which the main board interprets as ambient temperature. If a switch opens, the main board sees an infinite resistance and the plasma is shut off/prevented as if there were a temperature runaway problem.

(3) Only used in AEDs with serial number < 1000166. See *Flow sensor,* on page 138 for a photograph.

For example, high voltage to the plasma will be shut off if any of the following occur:

- The resistor in the water drawer control cable fails or the resistance drifts out of range
- The cavity PRT fails or is disconnected
- The water drawer is pulled out from the AED with the cavity attached
- The emission source sense cable is disconnected
- The spectrometer grating motor travels too far
- The main harness cable is loose at the spectrometer

Refer to Figure 129 below for a general diagram of the shut off circuits.

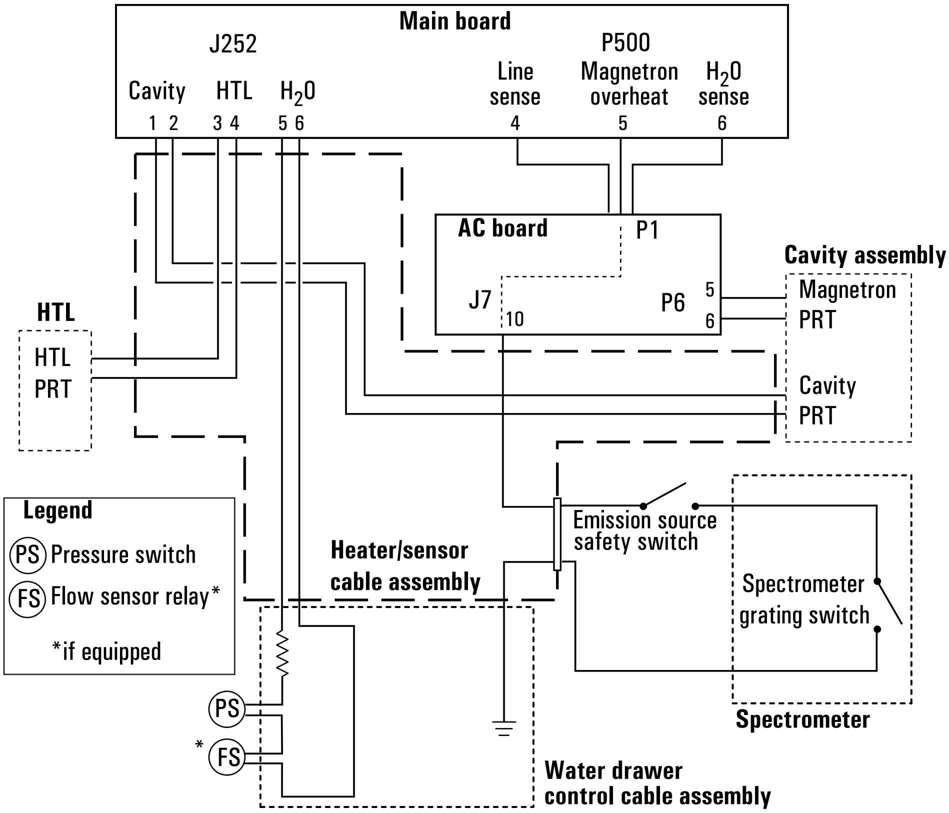


Figure 129. Plasma shutoff circuits and cabling

PRT resistance vs. temperature

The main board will assume there is a temperature runaway problem and turn off the plasma if any PRT reads above 460°C, or if a PRT significantly exceeds the temperature set point. The resistance of the PRTs used varies with temperature according to the following approximate equation:

$R = 100 \text{ ohms} + (0.36 \times T)$

Alternately, look up the approximate resistance from Table 23 below.

Table 23. Approximate PRT Resistance (ohms) vs. Temperature (°C)

°C	0	100	200	300	400
0	100.00	138.50	175.84	212.03	247.06
+10	103.90	142.28	179.51	215.58	250.50
+20	107.79	146.06	183.17	219.13	253.34
+30	111.67	149.82	186.82	222.66	257.34
+40	115.54	153.57	190.46	226.18	260.75
+50	119.40	157.32	194.08	229.69	264.14
+60	123.24	161.04	197.70	233.19	267.52
+70	127.07	164.76	201.30	236.67	270.89
+80	130.89	168.47	204.88	240.15	274.25
+90	134.70	172.16	208.46	243.61	277.60

Testing for microwave leakage

A Holaday Microwave Survey Meter Model 1510A is required. Before turning on the AED, visually examine the waveguide, waveguide transformer, magnetron, and all other parts of the emission source assembly to make sure there are no gross defects, such as any cracks, gaps, or obvious damage.

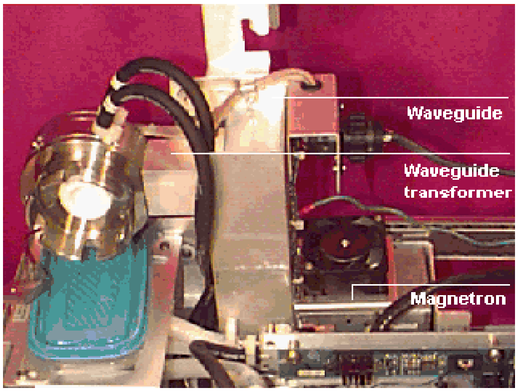


Figure 130. Emission source assembly

To test for microwave leakage:

1. Turn off the AED.
2. Verify that the microwave survey meter is functioning.
   - Check the battery. Turn the function switch to `"BATT. TEST"` and confirm that the needle indicates `"BATTERY OK."`
   - Test the leak detector probe. Turn the selection switch to `"PROBE TEST."` The display should read `"OK PROBE TEST."`
   - Turn the function switch to the most sensitive scale: `"2 mW."`
   - Set the response switch to `"FAST."`
   - Zero the meter with the knob labeled: `"ZERO ADJ."`
3. Turn on the AED.
4. Activate the magnetron power supply by issuing the IGN command.
5. With the 5 cm spacer installed on the probe, slowly pass it as close as possible to all areas around the emission source. Pay special attention to the joints between the cavity and the waveguide.
6. Record the results of the test. A reading of > 5 mW/cm^2 is outside the specification and must be corrected.

Warning A sizable leak is indicated by the meter beeping during testing. **Immediately** shut off the AED and inspect the hardware for possible assembly failures.

Using the service display board

To use the service display board (if available) for troubleshooting, plug the ribbon cable into the P101 connector on the main board. The service display board displays the same AED diagnostic messages and codes sent to the computer. Remove the board when finished.

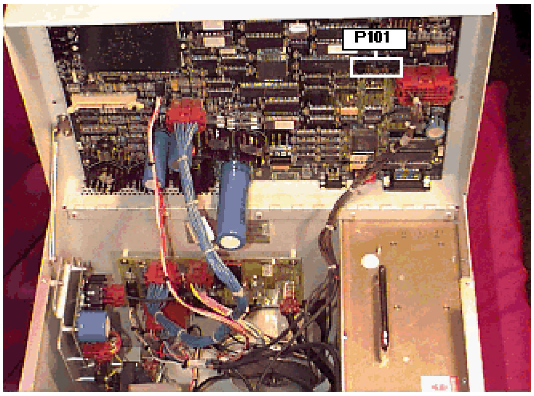


Figure 131. P101 connector location

Electronics

AED does not turn ON

Problem	Possible cause	Suggested actions
AED does not turn on (nothing happens)	AC board not providing power to main board or high voltage power supply	Check the fuses on the AC board. Replace if needed. See *Troubleshooting the AC board,* on page 183, and Figure 132 AC board.
	Main board not powering up or not transmitting start-up	Check main board fuses at F500 and F501. Replace if needed.
		Check test points on main board: +5 V ± 2%; +15 V, -15 V, +24 V, GND, -24 V. Replace the main board. See Figure 133 Main board.
	Bad cabling: power cord, jumpers from AC board, jumpers from main board, jumpers from high voltage power supply	Check cable continuity. Replace if necessary. See Figure 139 G2350A internal cabling diagram.

Troubleshooting the AC board

Once a problem has been isolated to the AC board, replace the board and re-test.

To troubleshoot the AC board:

1. Check the fuses:

*F1/F2:	Transformer
*F3/F4:	High voltage power supply
F5:	Heaters

*Replace fuses F1/F2 and F3/F4 in pairs

2. If all heated zones are out, the problem is either a cable or the AC board. Verify that the heaters and the PRTs are operating properly. See also *Zone is not heating*, on page 187. If the heaters are not shorted out, replace the AC board.
3. If fuses F1/F2 and F5 have blown, replace them and check the heaters to verify they are not damaged or shorted.

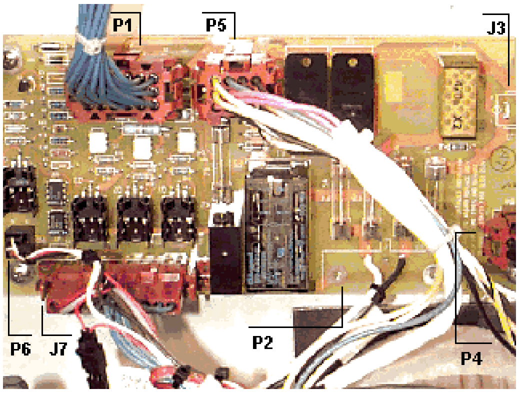


Figure 132. AC board

Troubleshooting the main board

1. Check the fuses on the main board.

F500	40 VAC
F501	40 VAC

2. For potential communications (GPIB) problems, verify the GPIB address is set correctly on the board. If the problem persists, troubleshoot the GP-IB by switching the main board.

Once a problem has been isolated to the main board, replace the board and re-test.

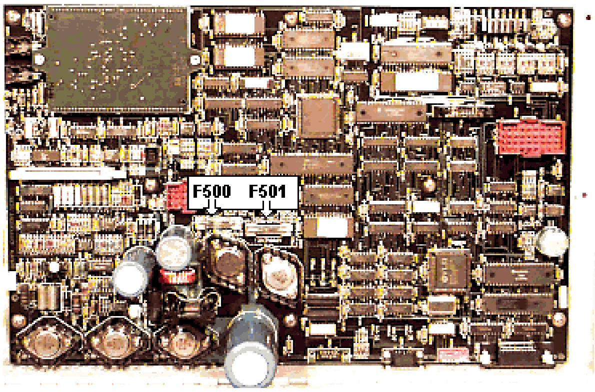


Figure 133. Main board

See also Figure 139 G2350A internal cabling diagram.

Troubleshooting the high voltage power supply

Warning High Voltage! To reduce risk of electric shock, disconnect the power cord from the AED.

Warning High Voltage! To reduce risk of electric shock, the ground strap for the magnetron power supply must always be connected to the waveguide when the AED is in operation.

Voltage problems

Problem	Possible cause	Suggested actions
No low voltage (no filament current)	Bad cabling, connections, or main board	Check the gauges. The amp meter gauge should read 8 A. If it does, check the cabling and the main board. If it does not read 8 A, then check the AC board. See Figure 132 AC board.
	No power from AC board	Check the fuses on the AC board. Check the output at connectors P1–P4. Check the triacs. See Figure 132 AC board.
	Main board contactor K2 not working	Check the output from the contactor. If there is no output from the contactor, troubleshoot the main board or replace it. See Figure 133 Main board.
	High voltage power supply.	Replace the high voltage power supply.
No high voltage to magnetron (no plasma)	Bad cabling, connections, or main board	Check the gauges. The high voltage gauge should read 22 KV. If it does, check the cabling and the main board. If it does not read 22 KV, then continue with the actions below.
		Power cycle the AED and watch the gauges on the power supply. When the AED is first turned ON, the filament current reading should go full scale, then settle at approximately 8A (4A ¥ 2 for scale). If there is no filament current, then there is a problem at either the connection between the power supply and the magnetron, or the power supply is bad, or the magnetron is bad.
	A zone temperature or the water flow rate reading is not correct	Verify that the PRTs and heaters are working properly, the water pump system is delivering proper flow, and that the microwave is at temperature. See *Plasma shut off circuits,* on page 177 and also *PRT resistance vs. temperature,* on page 179.
	No signal from main board	Check the voltage in the high voltage enable circuit (Pin 4 of the supply cable). If the voltage is near 0 (enabled), replace the power supply. If not, check the cabling. See Figure 139 G2350A internal cabling diagram

General troubleshooting

1. Enable the high voltage using the ChemStation.
2. Check pin 3 of P500 on the main board. It should read 0.2 – 0.3 V (approximately 0 V) to ground. If it reads 5 V, the main board has not enabled the high voltage.
3. With the high voltage enabled, the power supply's fan should be running. If the fan is off, the power supply is not delivering power to the fan, and there should be no dial readings on either the filament or the high voltage dials. Check the connection to the AC board and check that the AC board is delivering power. Pin 1 of connector P4 on the AC board should be carrying primary line voltage to the power supply.
4. Turn the AED OFF, then turn it back ON. When the AED is first turned ON, the filament current reading should go full scale, then settle at approximately 8A (4A × 2 for scale). If there is no filament current, then one of the following problems exists:
    - Faulty connection between the power supply and the magnetron
    - Power supply is bad
    - Magnetron is bad.

Comments

- If the connection between the magnetron and power supply was bad or broken for any reason, turn the AED OFF, reconnect, and wait approximately 1 minute before turning the AED ON again.
- The AC board-high voltage power supply circuit is a latched circuit. If the filament current ever reaches 10A and stays at 10A, an overvoltage protection engages. The circuit will not activate again until it sufficiently de-energizes. It will take three minutes minimum for the circuit to de-energize, and may take significantly longer (an hour or more).
- Note the two dials on the left cover of the power supply. If the plasma will not light, power cycle the AED and watch the dial readings per step 4 above.

Zone is not heating

Problem	Possible cause	Suggested actions
One or more zones are not heating	The PRT wiring is bad	Check the temperature reading on the ChemStation. A bad PRT will give incorrect readings, perhaps very low or very high as its lead wires are shorted. If the zone is too cold and the reading agrees, check the heater or the AC board. See *PRT resistance vs. temperature,* on page 179 and Figure 132 AC board. **If the PRT reads below room temperature, it is not working. Replace the PRT/heater assembly.**
	The heater wiring is bad	If there is power, check the pinouts on the AC board to verify power is going to the heated zone. If the zone has power, replace the heater. Alternately, examine the wires for the heater and PRT. If the insulation is frayed, check the resistance/voltage of the PRT and heater. See Figure 132 AC board.
	The AC board relay is bad	If there is power, check the pinouts on the AC board to verify power is going to the heated zones. If there is no power, the relay is bad. Replace the AC board. See Figure 132 AC board.
	The main board control transistor is not developing the gate pulse	See *Troubleshooting the main board,* on page 183.
No zones are heating	AC board fuse F5 is blown	Check the fuse and replace if necessary. Check the transfer line, magnetron, and cavity heaters to verify they are not damaged before restarting the AED. If the fuse is intact, replace the AC board. See Figure 139 G2350A internal cabling diagram.

Gas Flow System

Adjusting gas flow rates

Follow the steps below to adjust the gas flow rates. When practical, set the flow rates to the values given on the factory Customer Information Sheet provided with the AED. Otherwise, adjust the flow rates as described in *First start-up*, on page 41. Refer to Figure 135 for a gas flow system schematic.

(During this procedure, no column should be installed.)

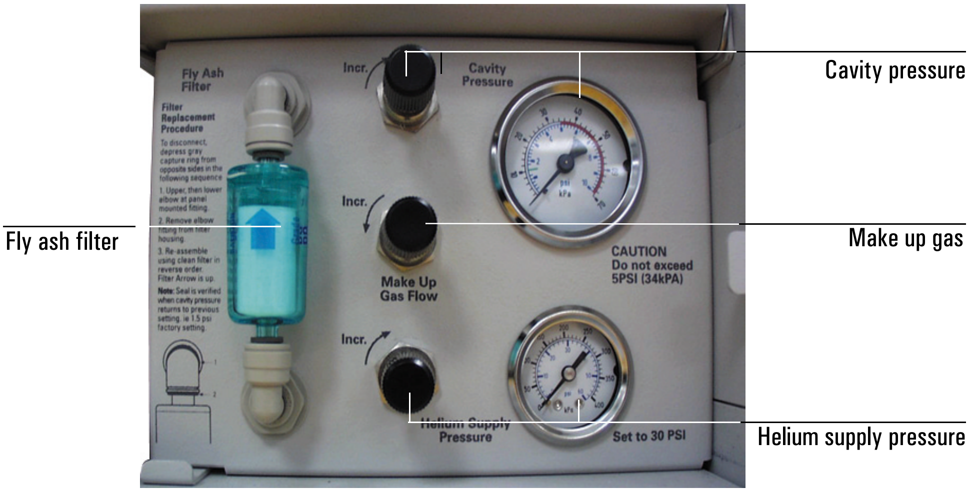


Figure 134. Gas drawer

Helium

1. Check the supply gas conditions.

Source gas	Expected condition
Helium source pressure	60 psi
Oxygen	30 psi
Hydrogen	15 psi
Nitrogen/methane	25–35 psi

2. Turn off all reagents and the solvent vent and high flow valves.

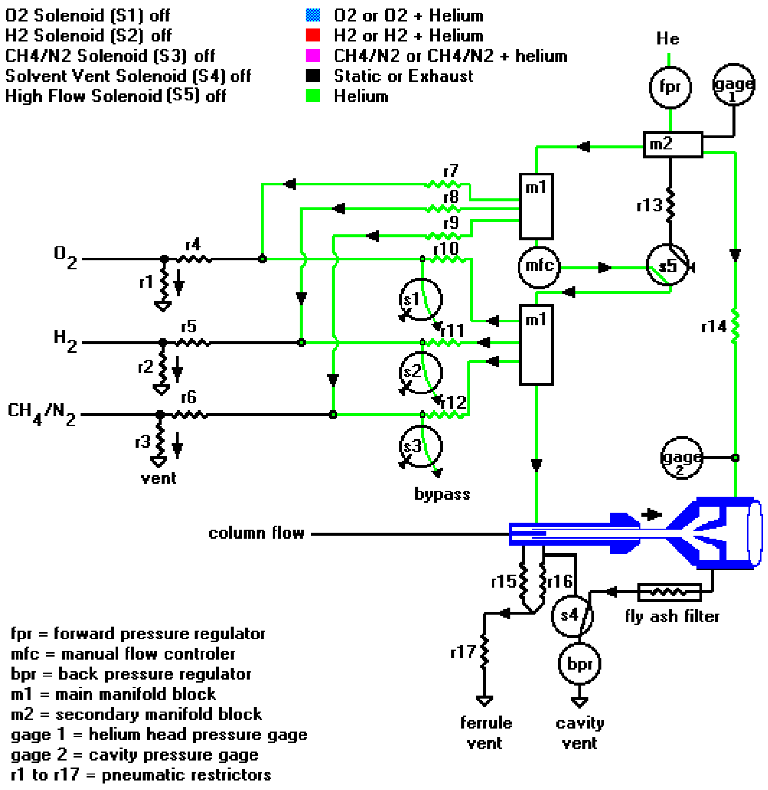
Source gas	Expected condition
Helium source pressure	60 psi
Oxygen	30 psi
Hydrogen	60 psi
Nitrogen/methane	70–90 psi

3. Check the helium supply pressure on the front panel. Adjust it to 30 psig using the helium regulator.
4. Check the cavity pressure on the front panel. Adjust the cavity pressure 1.5 psig.
5. Open the ChemStation software. The ChemStation can be started by clicking on the ChemStation Group icon on the Program Manager screen. When the ChemStation window appears, double click on the Instrument 1 On Line icon. This will start the ChemStation. Once the ChemStation is running, it will load the last method used and the AED Real-Time Spectral plot should be displayed. If the AED Real-Time Spectral Plot window is not displayed, it can be brought up by selecting View/AED Real-Time Spectral Plot on/off. Once the spectral plot is displayed, the AED status can be checked from the ChemStation.
6. Connect a flow meter to the purge vent. Measure the flow rate and record. Adjust the back pressure regulator (cavity pressure) until the head pressure is 0. Re-measure the purge flow and record.
7. Move the flow meter to the cavity vent. Adjust the mass flow controller (makeup gas) until a flow rate of 60 to 70 mL/min is obtained.
8. Re-measure the purge vent flow rate and record it.
9. Next, measure the cavity vent flow rate. The flow rate should be equal to the purge flow rate + 25 mL/min, ± 5 mL/min. Adjust the flow rate, if necessary, by changing the helium supply pressure.
10. Return the flow meter to the purge vent. Cycle the reagent solenoid valves ON and OFF while monitoring the flow rate. The flow rate should remain relatively constant. Record the flow rate with each solenoid turned ON.

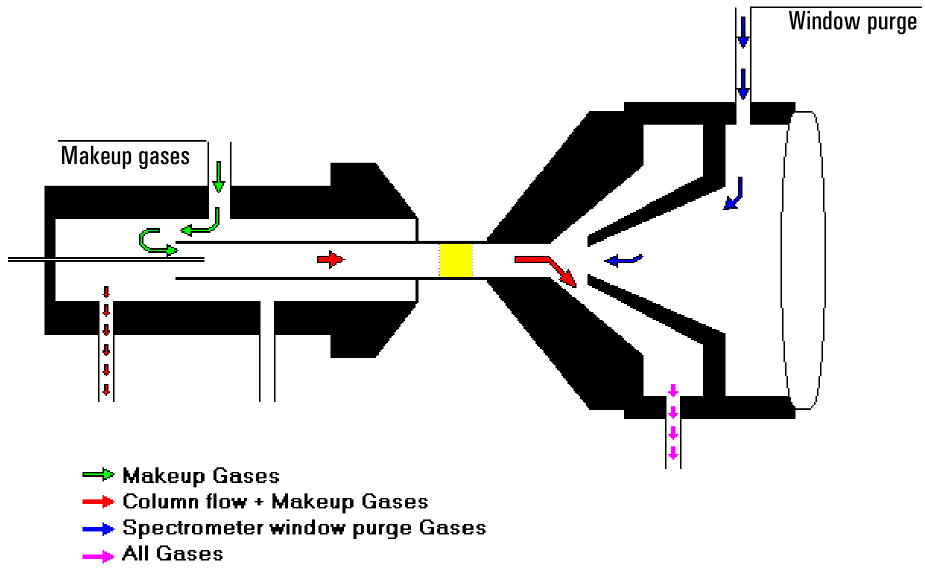
    Note that each reagent on adds approximately 5 mL/min to the total flow rate.

Reagent and spectrometer purge gases

Follow the steps described under *Initial Tests* and *Initial Spectrometer Purge* in *First start-up*, on page 41 to set the flow rates for the reagent gases and the nitrogen purge gas.



Gas flow systems



Detail of cavity flows

Figure 135. Gas flow systems in basic operation flow mode

Discharge tube breaks frequently

Problem	Possible cause	Suggested actions
Discharge tube breaks frequently and with shorter than expected mean time to failure	Low water flow.	Use a graduated cylinder to verify that the water flow is 400 mL/min. See *Verifying the actual water flow rate,* on page 203.
	Pieces of a broken discharge tube are lodged between the discharge tube and water jacket.	Measure the pump voltage (the voltage across P1(1) and P1(3) on the water board). Normal voltage ranges between 9–12 V. A voltage of 20 V indicates a restriction or pump problem. Clean the cavity and blow out the cavity and water lines with high pressure air. If the problem persists, troubleshoot the water drawer to verify that the pump, flow sensor, and board are operating correctly.
	Coating on outside of discharge tube restricts water flow.	Clean/replace discharge tube. Use only distilled water. Check the water to make sure it is distilled and not deionized. De-ionized water corrodes the tubing, which causes deposits to form on the discharge tube.
	Connections are too tight, causing stress on the discharge tube.	Check that the gas union and exit chamber seals have not been over-tightened.
	GC side water chamber, GC side brazement, and/or optical side water chamber not aligned properly.	Disassemble and reassemble. Check for water leaks, which may indicate misalignment. Check the O-rings for damage and proper seating. If the GC side water chamber, GC side brazement, and/or optical side water chamber show signs of damage, replace them.

Finding gas leaks

Gas leaks often show up as pronounced nitrogen lines in the background as air gets into the GC or AED system. See also Figure 135 for a diagram of the gas flows in the AED.

First, determine where to look for the leak:

1. Let the column cool to a temperature of less than 50°C.
2. Turn off the column flow by removing the septum. Watch the nitrogen 174 line. If the nitrogen peak diminishes, the leak is in the GC. If there is no change, the leak is either not in the GC or is common to both systems.

Alternately:

1. Disconnect the GC from the AED, plug the open end of the gas union, and check the N 174, C 193, H 486, and O 170 lines as appropriate. If the lines still read excessively high (see below), the leak is in the AED.
2. Vary the carrier gas flow rate into the plasma and monitor the N 174, C 193, H 486, or O 170 lines. If the area counts increase with increasing carrier flow, the leak is in the GC.

Element line	Expected value
N 174	< 130
C 193	< 520
H 486	< 520
O 170	< 104

If the leak is in the GC:

1. Check the liner and verify that the liner seal is *not* graphite. Graphite line seals can leak. Make sure the septum is not leaking.
2. Inspect the flow controller tubing: Adjust the M8 fittings to determine if they change the nitrogen line. Spray an aerosol duster at the fittings while inspecting the carbon line. If there is a leak, the carbon in the Freon will increase the carbon line.

If the leak is **not** in the GC:

1. Perform a gross leak test by placing your thumbs over the ferrule purge and the cavity vents. This should cause the cavity pressure gauge to rapidly rise in value. If the gauge rises slowly and does not reach 5 psi, then there is a leak in the AED.
2. Monitor the background as you turn reagent gases ON and OFF. If it moves up and down, check the reagent gas system for leaks.
3. Increase the makeup gas flow and monitor the nitrogen 174 line. If it decreases, there is a leak in the AED.
4. Remove the lens purge line from the cavity and plug with your finger. If the helium pressure quickly rises, the problem is in the cavity assembly, the exit lines, the fly ash filter, or the gauge. If the pressure does not rise quickly, the problem is in the gas drawer.
5. Use a leak hunter to leak check fittings at tanks, unions, etc. (Butane may take two or three minutes to show up on the carbon line.)
6. Leak check around any gas getter in the system.
7. Remake the column at the detector end and use a new ferrule.

No plasma

Problem	Possible cause	Suggested actions
There is no plasma	No high voltage from power supply	See *Troubleshooting the high voltage power supply,* on page 184.
	No spark from sparker board	Replace the sparker board. Check for carbon build-up (track) on the O-rings in the lens mount liner (carbon track indicates a short). Replace the O-rings. See Figure 151 Sparker board.
	Low water flow or pressure	Check the flow sensor and pump. See *Flow rate too low/high,* on page 202. Replace the water filter. Troubleshoot and, if necessary, replace the water board.
	No helium	Check for 30 psig at the helium pressure gauge on the gas drawer front panel. Check for leaks at the gas union. Replace the O-rings in the disconnect block. Check for leaks in the gas drawer. See *Finding gas leaks,* on page 192.
	Cavity, emission source (magnetron), or transfer line heater or PRT faulty	Check the heaters and PRTs for open or shorted circuits or obvious damage. See Table 23 on page 179. Replace the heater/PRT assembly or heated core.
	Emission source assembly not closed against the door open switch, or the door closed switch is faulty	Verify the emission source assembly is attached to the enclosure and is fully against the switch. Short the pins of the switch. If the plasma lights, replace the switch. See Figure 139 G2350A internal cabling diagram.
	Spectrometer grating motor is stuck or the switch is faulty	Check the resistance of pins 2 and 3 on the spectrometer. If the pins read open, the switch is faulty. Replace the spectrometer.
	Faulty cable or poor connection	Check that the cables are properly connected and that there is no contamination on the pins. Replace cables as required. See Figure 139 G2350A internal cabling diagram.
	Pressure switch is faulty	Short the pins across the switch. If the pump starts and the plasma re-ignites, replace the switch.
	Emission source (magnetron) is not functioning	Replace the emission source.

No pressure at the cavity pressure gauge

Problem	Possible cause	Suggested action
There is no pressure at the cavity pressure gauge, and there is gas available at the source.	Gross leak in the cavity assembly, lens mount assembly, or gas drawer	Tighten the lens mount nut firmly until the lens mount liner cannot be moved by wiggling the spark plug.
		Remove the lens purge line from the cavity and plug with your finger. If the helium pressure quickly rises, there is a leak in the cavity assembly, the exit lines, the fly ash filter, or the gauge. If the pressure does not rise quickly, there is a leak in the gas drawer.
		Check the placement and condition of the O-rings in the lens mount liner beneath the purge inlet, cavity vent, and spark plug. Check for a ferrule under the purge and cavity vent lines. Install/replace the O-rings or ferrule as needed.
		Check the cavity and ferrule purge lines for leaks. Check the fly ash filter.
		Check that the gas union is tight. If the leak persists, remove the transfer line and plug the open gas union end. Disassemble the cavity assembly, remove the discharge tube, and check all O-rings for placement and damage. Replace O-rings as needed and reassemble. If the leak persists, disassemble the lens mount assembly, check the O-rings, and reassemble. If the leak persists, check the pressure gauge. See also: Figure 135 Gas flow systems in basic operation flow mode.

Plasma glows brown

Problem	Possible cause	Suggested actions
Plasma glows brown, not white.	Dirt on the outside of the discharge tube due to: Residual cutting solution from machining; Use of de-ionized water	Empty all the water from the AED and replace with fresh distilled water. Clean the cavity and replace the discharge tube. Make sure that the cooling water is distilled and pure.

Plasma glows red

Problem	Possible cause	Suggested actions
Plasma glows red, not white.	Hydrogen gas is turned on.	Check if hydrogen is turned on.
	After changing the discharge tube, there is residual water in the tube.	Wait approximately 20 minutes. If the problem persists, investigate the other possible causes below.
	Discharge tube is cracked (water leak).	Inspect the discharge tube and replace if necessary.
	Discharge tube O-ring is missing or damaged (water leak).	Replace the O-ring.

Solenoid will not operate

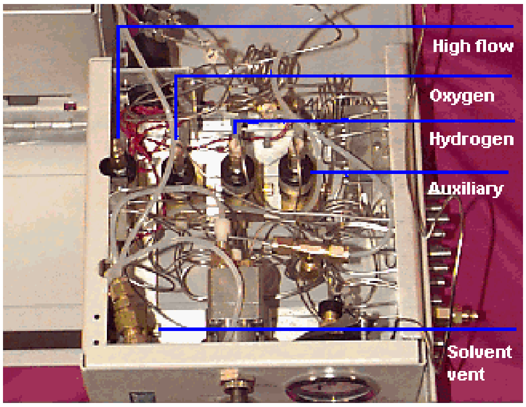


Figure 136. Solenoid locations

Problem	Possible cause	Suggested action
Reagent gas or high flow will not operate (the gas sources are working)	Solenoid	Set the ChemStation to monitor the appropriate line for the solenoid (N 174, C 193, H 486, or O 777). Toggle the solenoid ON and OFF and check for a significant change in the area counts. See also *First start-up,* on page 41, for information on the proper area counts for each element Solenoid — Monitor element line: Hydrogen — H 486 Oxygen — O 777 Auxiliary — C 193 Makeup/High — N 174 Solvent vent — any of the above Turn valve on/off and check for a 24 V reading at the solenoid input. If there is no signal, check the wiring and the main board. If there is a signal but the solenoid does not switch, replace it.
	Clogged or blocked line after the solenoid.	Set the flow rates to standard (see *First start-up,* on page 41), and check for flow at the end of the line. Replace the line if clogged

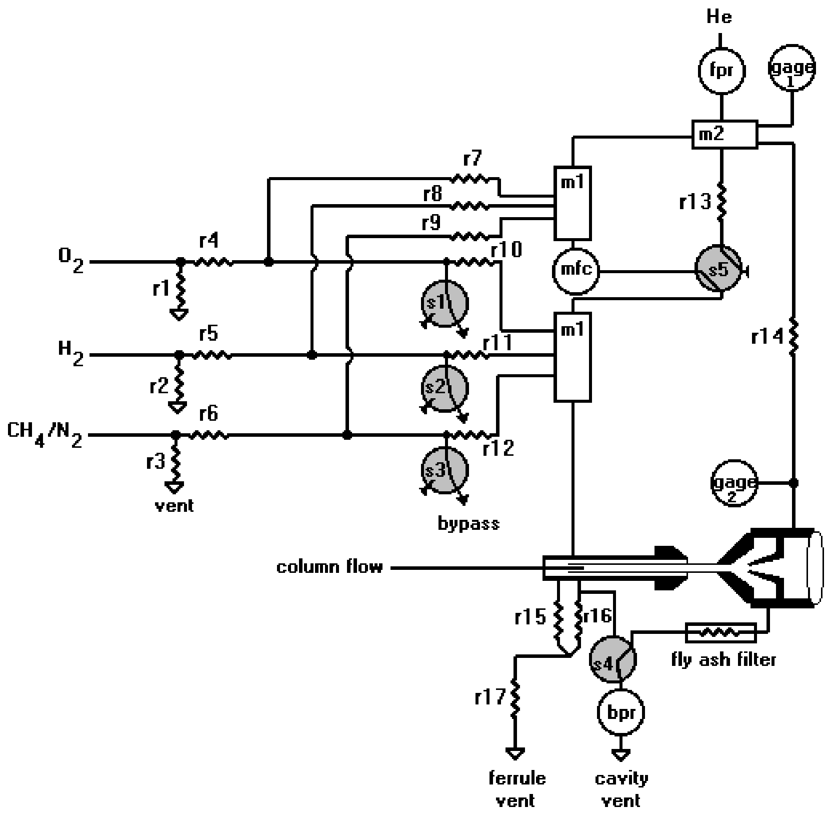


Figure 137. Solenoids in de-energized state

Troubleshooting the gas drawer

Problem	Possible cause	Suggested actions
0-60 psi gauge pinned, 0-10 psi gauge working, cavity vent flow is high	Tubing to the forward pressure regulator is misplumbed	Replace the gas drawer
The mass flow controller (MFC) does not work but the lens purge flow is acceptable	Tubing to the (MFC) is misplumbed	Replace the gas drawer
There is a loud hiss if the nitrogen flow is On, there are no flows and no pressure readings	The nitrogen source is connected to the helium inlet, or the internal plumbing leading from the helium and nitrogen inlets are swapped	Replace the gas drawer
	The nitrogen gauge is misplumbed (probably to the forward pressure regulator or to the 0–60 psi pressure gauge)	Replace the gas drawer
There is no cavity pressure, the MFC has no effect, but the lens purge is acceptable	The MFC and nitrogen lines are swapped	Check the Out and the In lines to the MFC. Reconnect them if they are not correctly installed
		Replace the gas drawer
There is no lens purge flow, there is no cavity pressure, and the helium supply pressure is acceptable	Solvent vent solenoid plumbing incorrect	Check the plumbing to the solvent vent solenoid valve
	Solvent vent solenoid valve defective.	Replace the valve
The 0–60 psi gauge works properly but the 0–10 psi gauge will not set	There is a leak in the cavity or in the cavity fittings	See *Finding gas leaks,* on page 192
	There is a leak in the back pressure regulator fittings or in the back pressure regulator	Isolate the source of the leak. See *Finding gas leaks,* on page 192. If the fittings are leaking, tighten them. If the leak persists, or if the back pressure regulator is leaking, replace the back pressure regulator
The 0–60 psi gauge works properly but the 0–10 psi gauge will not set	There is a leak in the 0–10 psi gauge	Isolate the source of the leak. See *Finding gas leaks,* on page 192. If the gauge is leaking, try tightening the fittings first. If the leak persists, replace the gauge.

Spectrometer and Chromatography

Chromatographic peaks not sharp

Problem	Possible cause	Suggested actions
Chromatographic peaks are not sharp.	Contamination in the GC.	Check for column damage, injection port leaks, sample contamination of injection port or column. Clean and replace contaminated part.
	Chromatography techniques: AED and/or GC gas flows are inappropriate.	Check the flow settings in the AED and the GC. Reset the flows. Different flow settings may yield better results.
	Contamination in the AED.	Check the gas purity and the cleanliness of the plumbing. Replace as required.
	Transfer line temperature not hot enough, not controlled to temperature set point, or heater is defective.	Check transfer line setpoint and reported temperatures. Check the transfer line heater/sensor for damage. Adjust the setpoint or replace the heater/sensor.
	SiO_2 buildup in the discharge tube.	Replace the discharge tube.

Loss of UV sensitivity

Problem	Possible cause	Suggested actions
Loss of sensitivity in the UV region. Area ratio of the carbon 193 and 165 lines is greater than 1:2.	Purity of spectrometer purge gas is too low.	Verify nitrogen purge gas is of acceptable purity. If the gas is apparently pure at the source, check the spectrometer lens for cleanliness. If the lens is clean, change gas cylinders and inspect the lines or change them to make sure no contaminants are within the purge system.
	Seals at spectrometer connections are loose and/or leaking.	Verify that the inlet and outlet purge lines are secure and non-leaking. Check that the PDA is not loose, and that the optical side chamber and lens assemblies are properly attached to the spectrometer housing.
	Spectrometer lens is dirty.	Replace (or clean) the lens.

PDA output not registering

Problem	Possible cause	Suggested actions
PDA output not registering at the main board.	Loose connection at the PDA or main board.	Check the cable. Reconnect it. See Figure 139 G2350A internal cabling diagram
	PDA or PDA preamplifier not functioning properly.	Change the PDA and re-test at the PDA connector and at J251 on the main board. If the problem persists, see *Troubleshooting the main board,* on page 183.
	PDA cable is damaged.	Check connectors for cleanliness and clean if necessary. Replace the cable and re-test. See Figure 139 G2350A internal cabling diagram

Sensitivity is poor

Problem	Possible cause	Suggested action
Sensitivity is poor or molecular lines have sections missing.	PDA is damaged.	Run the test to verify PDA performance. See *Verifying PDA performance,* on page 201. Replace the PDA if necessary.

UV wavelengths missing

Problem	Possible cause	Suggested action
UV wavelengths are not being registered by the PDA.	PDA is defective.	Replace and re-test the PDA. See also *Loss of UV sensitivity,* on page 200.

Verifying PDA performance

To verify PDA performance, replace it and compare the old and new performance.

Water Flow System

Flow rate too low/high

Problem	Possible cause	Suggested actions
Water flow rate too low or too high, SPECTR/NO WATER message, and frequent discharge tube breakage.	Flow restriction or worn pump.	Check the voltage across pins P1(1) and P1(3) on the water board. Normal voltage is 9–12 V. A reading of 20 V indicates a restriction or pump problem. Replace the water filter, clean the cavity, and blow pressurized air through the cavity and hoses to remove any debris which may be lodged inside. Average pump life is 18–24 months of constant use. Replace the entire pump if the voltage remains high after cleaning. See Figure 139 G2350A internal cabling diagram and Figure 153 Water board, revision 2.
	Water flow sensor (if used) is defective.	If the flow oscillates between high and low, and the water filter is properly installed so that the outlet fitting is in the topmost position, replace the flow sensor. See Figure 152 Water board assembly, revision 1.
		If the pump is 1 year old or less, check the pump drive voltage. If the voltage is approximately 24 V or approximately 6 V, replace the sensor.
	Water board is defective.	Replace and re-test.

Pump cycles very fast, then slow

Problem	Possible cause	Suggested actions
Air is trapped in the water system.	Misaligned water filter. The water filter must have the outlet fitting at the topmost, vertical position in order to let air escape the system.	Loosen the water filter and rotate it until the outlet fitting is at the top.
	Damaged flow sensor.	If the water filter is correctly installed (see above), replace the flow sensor.

Verifying the actual water flow rate

To verify the actual water flow rate, follow the steps below. Note that it is best to verify the water flow rate before troubleshooting on any potential flow rate problem.

1. Power down the AED.
2. Attach a rubber tube to the return nozzle of the water reservoir.
3. Place the end of the rubber tube in a graduated cylinder.
4. Turn on the AED but do **not** start the plasma.
5. Measure the water flow and the time to check the flow rate.
6. Add distilled water, if necessary, to the bath to keep the AED running while measuring.
7. Power down the AED.
8. Disconnect the rubber tube from the water return nozzle.

Water board LED diagnostics (G2350-60080 only)

- If the LED is flashing, the flow rate is less than 370 mL/min.
- If the pump is running, the flow is above 250 mL/min and the problem may be a worn pump head or a restriction.
- If the pump is off, check for a leak or blockage, and make sure the flow sensor and pressure switch are operating normally.

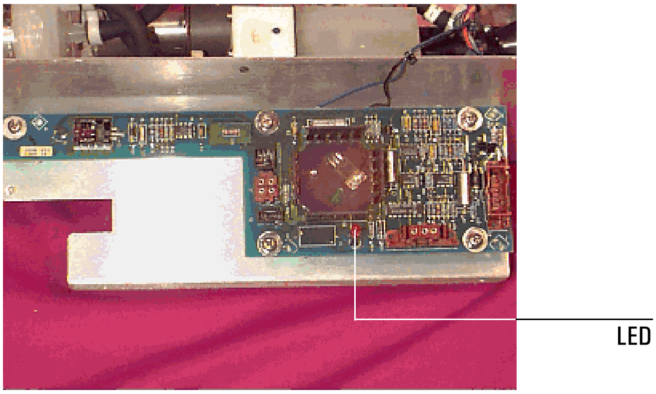


Figure 138. Waterboard LED location

Water leaks

Problem	Possible cause	Suggested actions
Water leaks.	Poor seal at fittings.	Wrap the fitting with Teflon tape. Replace the hose/clamp if still leaking. If still leaking after replacing the hose/clamp, replace the part with the fittings.
	Loose clamp.	Tighten/replace hose and clamp.
	Discharge tube ferrule and O-ring need replacement.	Replace the discharge tube, ferrule, and O-ring if worn or damaged.
	Discharge tube is cracked.	Replace discharge tube, ferrule, and O-ring.
	GC Side Water Chamber, GC Side Brazement, and/or Optical Side Water Chamber not aligned properly.	Disassemble and reassemble. Check the O-rings for damage and proper seating. If the GC Side Water Chamber, GC Side Brazement, and/or Optical Side Water Chamber show signs of damage, replace them.

5 Error messages

Error messages

A/D and DRAM messages

The ChemStation displays the following messages when a problem is detected in the A/D converter or PDA board.

A/D RAM FAILED

Meaning: Fatal error in the main board RAM.

Possible cause: Faulty main board. Replace the board and re-test.

BAD DRAM BUFFER

Meaning: Fatal error in the main board DRAM buffer.

Possible cause: Faulty main board. Replace the board and re-test.

A/D CPU FAILED

Meaning: Fatal error in the main board A/D converter CPU.

Possible cause: Faulty main board. Replace the board and re-test. If the problem persists, replace the PDA and retest.

A/D SW MISMATCH

Meaning: Fatal error.

Possible cause: Faulty main board. Replace the board and re-test.

A/D FAULT

Meaning: Fatal error in the main board A/D converter in the PDA control subsystem.

Possible cause: Faulty main board. Replace the board and re-test.

BAD CAVITY READING/BAD XFR LN RDG

Meaning: The signal from the cavity PRT or heater transfer line PRT is below -100C or above 460C.

Possible cause: Faulty PRT. Faulty heater. Faulty AC board. Faulty main board.

`CAVITY OVERHEAT/XFER LN OVERHEAT`

Meaning: The signal from the cavity PRT or heater transfer line PRT is above 460°C, or has significantly exceeded the setpoint.

Possible cause: Faulty PRT. Faulty heater. Faulty AC board. Faulty main board.

`CAVITY NOT HEATING/XFER NOT HEATING`

Meaning: The signal from the cavity or heated transfer line PRT indicates that the heated zone has not begun to increase in temperature within 3 minutes after its heater was turned on.

Possible cause: Faulty PRT. Faulty heater. Faulty AC board. Faulty main board.

`CAVITY TEMP/XFER LINE TEMP`

Meaning: Zone temperature errors are shown whenever the cavity assembly PRT or the heated transfer line PRT reads a temperature outside of the acceptable setpoint range. For example, the messages are displayed at start-up until the zones heat to setpoint temperature.

`HIGH VOLTAGE OFF`

Meaning: The main board has not yet sent the high voltage enable signal to the power supply to ignite the plasma. This message is displayed while the AED is warming up and while the heated zones are not yet up to temperature.

Possible cause: See *No plasma*, on page 194.

`NO CAVITY SENSOR/NO TRANSFER LINE`

Meaning: The main board does not detect the presence of the cavity PRT or the heated transfer line PRT.

Possible cause: Part not installed. PRT faulty. Loose connection. Open safety switch.

SPECTR/NO WATER

Meaning: The SPECTR/NO WATER error message is displayed whenever the pump is disabled for any reason. On the main board, pin 1 of connector P500 will read 0 V to ground, instead of the 24 V to ground which enables the water pump.

Possible cause: Any one of the following parts/problems:

- Spectrometer cable
- Spectrometer (open internal switch on the grating motor)
- 2 pin jumper cable running into the heater/sensor cable
- Heater/sensor cable
- Emission source sensor cable
- Emission source sensor switch
- Water board cable
- Bad flow sensor or flow sensor relay on the water board
- AC board (J7, P1)
- Main board [P500, J252 (pins 5, 6)]
- Water flow obstruction
- No water pressure (leak, no water, or water pump bad)

See also: Figure 133 Main board
Figure 132 AC board
Figure 139 G2350A internal cabling diagram.

TRIAC INTERRUPT

Meaning: The triac controlling a heated zone has not detected a "zero-crossing" in the line voltage, and is not turning its heater on/off.

Possible cause: Faulty AC board.

6 Cabling Diagrams and Pinouts

Internal cabling diagram

Figure 139 below is a simplified wiring diagram showing all of the wires and harnesses used in the G2350A AED. Following it are pinouts listings for each of the cables or wires. All AED board pinouts are listed after the pinouts for the cables.

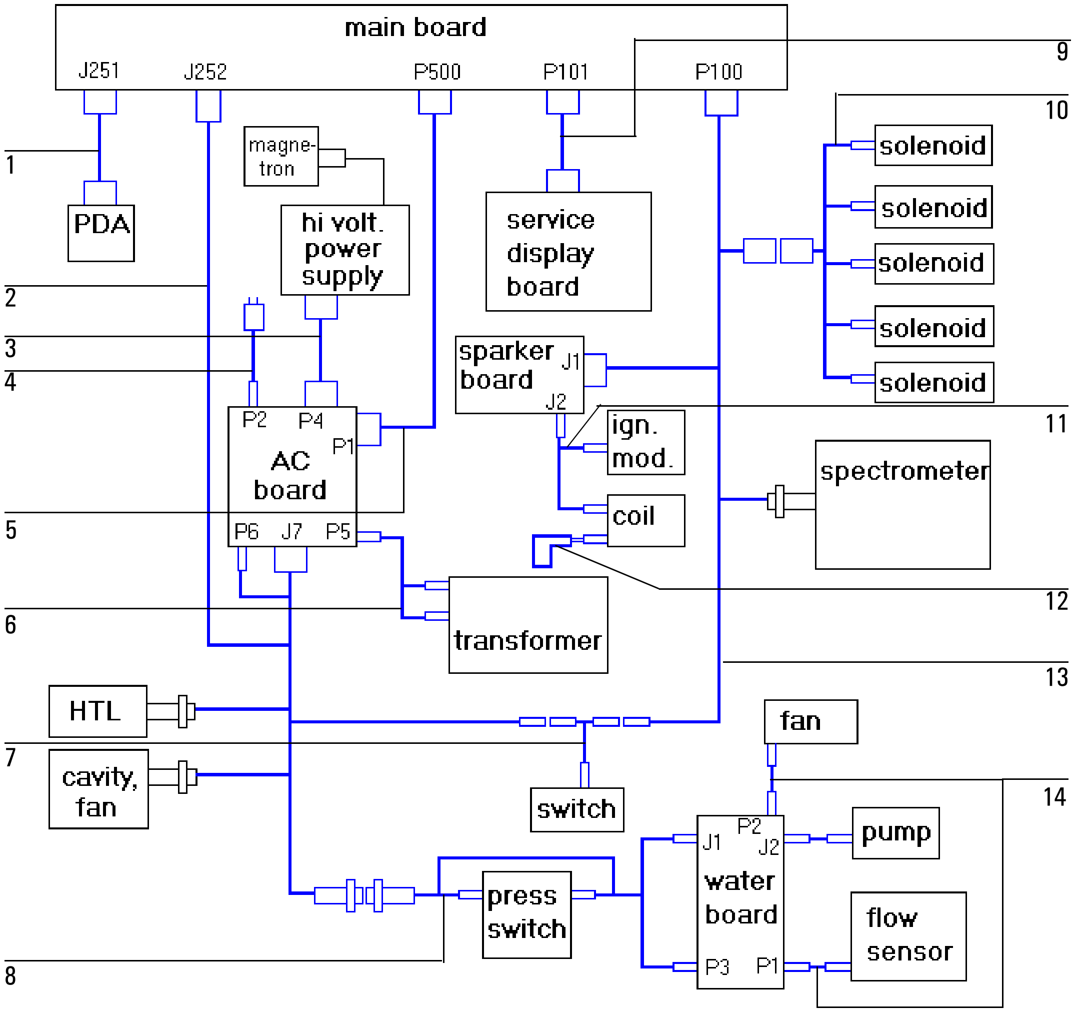


Figure 139. G2350A internal cabling diagram

Table 24. AED Cables

No	Description	part no.
1	PDA to main PCB cable assembly	G2350-60860
2	Heater/sensor cable assembly	G2350-61310
3	High voltage power supply	G2350-80075
4	AC input cable assembly	G2350-60500
5	AC-main cable assembly	G2350-60690
6	Transformer leads	
7	Emission source sense cable assembly	G2350-60510
8	Water drawer control cable assembly	G2350-60750
9	Service display board cable	05921-60710
10	Gas flow system connector	
11	Sparker assembly cable	05921-61000
12	8 mm Ignition wire, 18.5 inch long	8120-5473
13	Main harness cable assembly	G2350-60680
14	Wires, water board to flow sensor and pump	

AC board, part no. G2350-60057

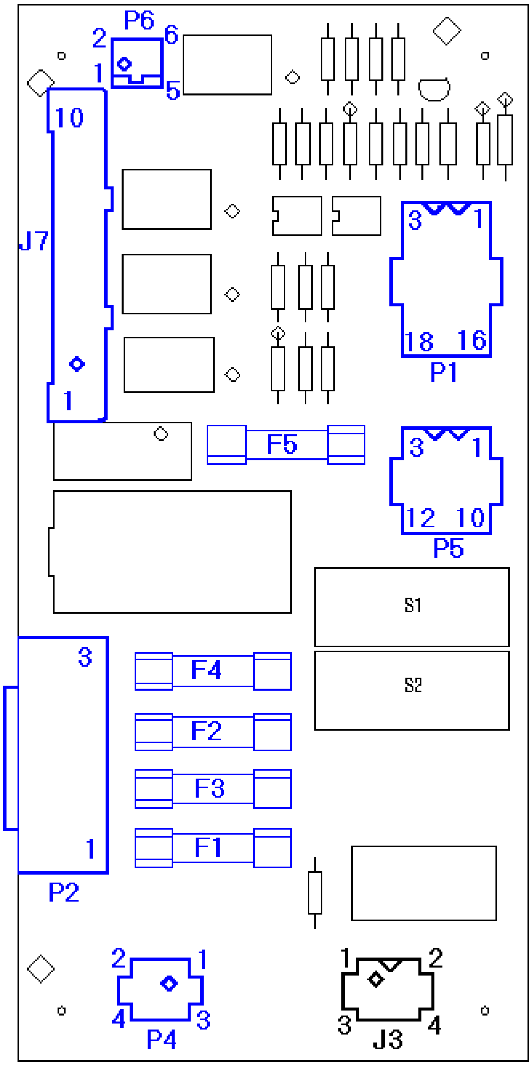


Figure 140. AC board

Connector P1 (to main board P500)

Pin	Function	Pin	Function
1	Line sense	10	High voltage primary
2	24 V DC from main board	11	Main relay heated zone
3	High V on/off	12	REF. GND (main board)
4	Water pump control	13	DC GND
5	Magnetron overheat	14	DC GND
6	24 V DC (water pump)	15	REF. GND (main board)
7	AUX3	16	20 VAC
8	Cavity gate	17	20 VAC C.T.
9	HTL gate	18	20 VAC

Connector P2 (AC power cord)

Pin	Function
1	Mains AC voltage
3	Mains AC voltage

Connector P4 (high voltage power supply)

Pin	Function
1	Hot
2	Neutral
3	GND
4	HV enable (0 V when HVPS is on to 5 V if off)

Connector P5 (transformer)

Pin	Function
1	20 VAC
2	20 VAC
3	120 VAC
4	CT
5	GND
6	Line voltage
7	Neutral
8	Shield
9	Line voltage
10	Line voltage
11	Not used
12	Neutral

Connector P6 (magnetron fan)

Pin	Function
1	Mag. fan
2	Mag. fan –
3	Mag. PRT
4	Mag. PRT
5	Mag. fan
6	Mag. fan –

Connector J7

Pin	Function
1	Transfer line heat
2	Transfer line heat return
3	Cavity heat
4	Cavity heat return
5	120 VAC
6	120 VAC back
7	Pump GND
8	24 V (pump enable)
9	24 V DC
10	H_2O sense A (senses open ckt in wiring)

AC board fuses

Fuse	Type	part no.	Circuit
F1	7A/250 V	2100-0614	Main
F2	7A/250 V	2100-0614	Main
F3	5A/250 V	2110-0010	High voltage power supply
F4	5A/250 V	2110-0010	High voltage power supply
F5	7A/250 V	2100-0614	Heated zones

AC input cable assembly, part no. G2350-60500

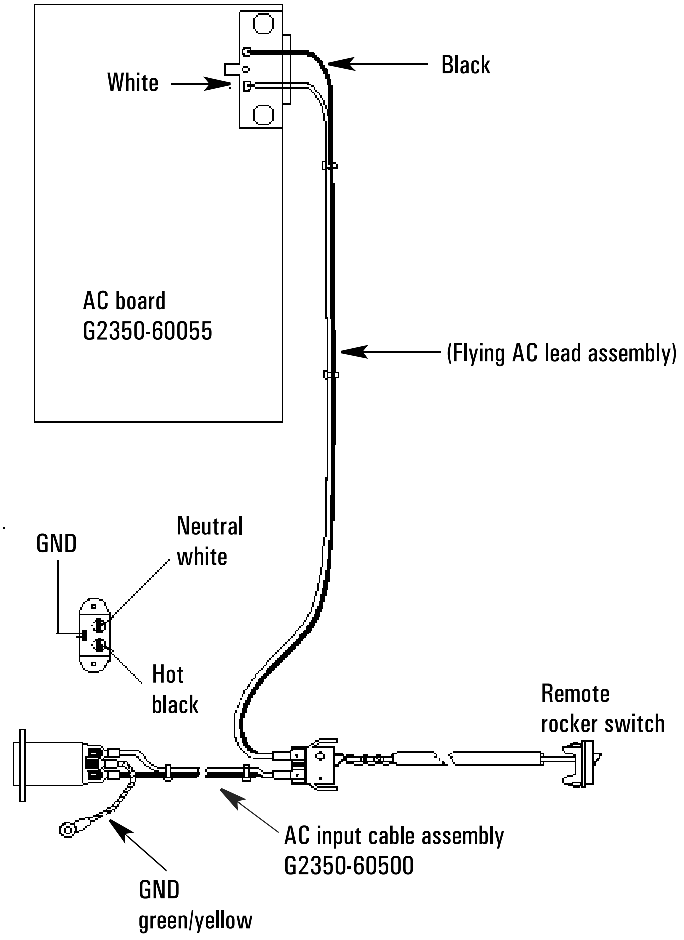


Figure 141. AC input cable assembly

AC-main cable assembly, part no. G2350-60690

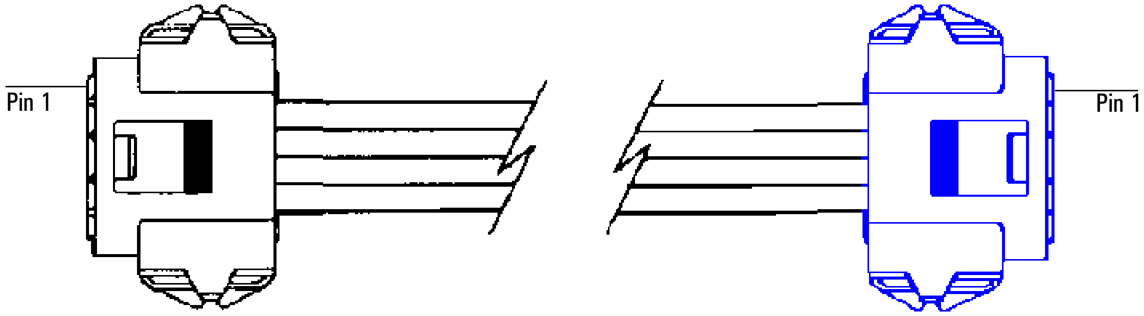


Figure 142. AC-main cable assembly

Connector pinouts

Pin	Function
1	Line sense
2	24 V unreg
3	High V. ON/OFF
4	Water pump control
5	Magnetron overheat
6	H_20 sense
7	AUX3
8	AUX2
9	AUX1
10	High V. primary
11	Main relay
12	Reference GND
13	DC ground
14	DC ground
15	Reference GND
16	20 VAC
17	20 VAC C.T.
18	20 VAC

Emission source sense cable assembly, part no. G2350-60510

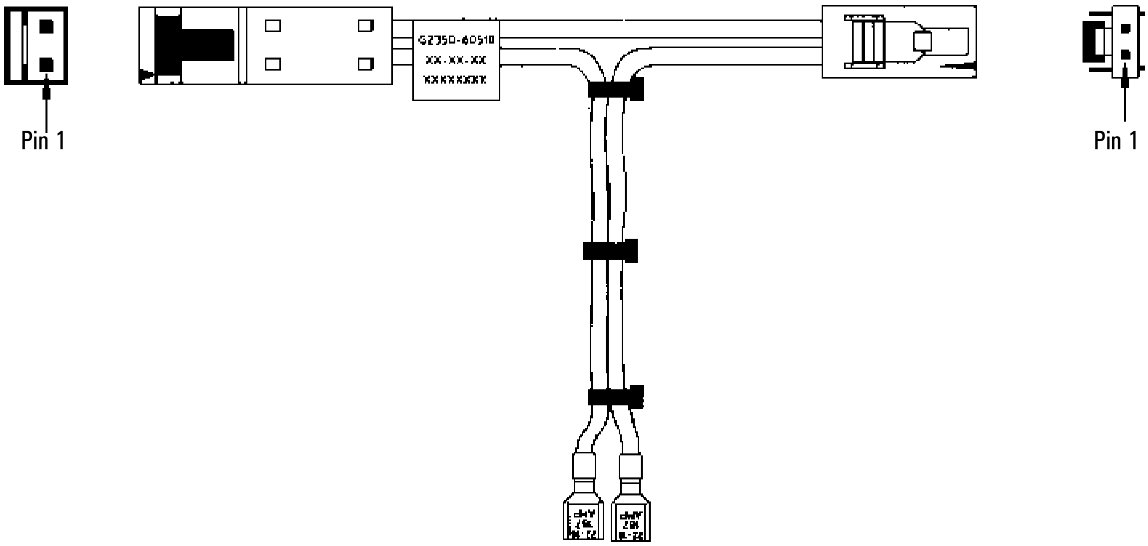


Figure 143. Emission source sense cable assembly

Connector pinouts

Pin	Function
1	PRT/safety circuit (normally not open)
2	PRT/safety circuit (normally not open)

Gas flow system connector

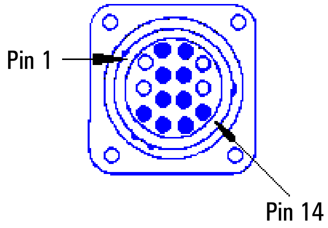


Figure 144. Gas flow system connector

Connector to main harness

Pin	Function
1-2	Not used
3, 14	High flow solenoid
4, 8	Solvent vent solenoid
5, 9	Oxygen solenoid
6, 10	Hydrogen solenoid
7, 11	Auxiliary solenoid

Voltage across the pins of a solenoid is 0 V normally, 24 V when energized.

Heater/sensor cable assembly, part no. G2350-61310

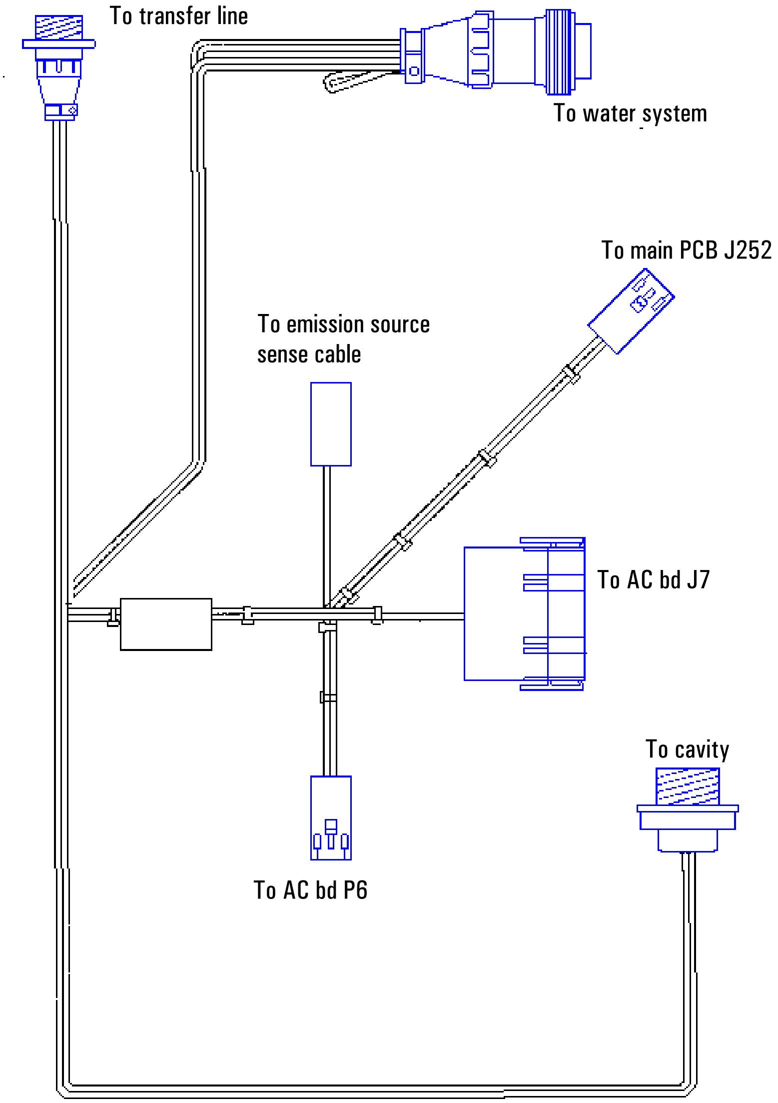


Figure 145. Heater/sensor cable assembly

Connector to main board J252 (PRT circuit)

Pin	Function
J252(1)	Cavity PRT
J252(2)	Cavity PRT GND (s)
J252(3)	Transfer line PRT
J252(4)	Transfer line GND (s)
J252(5)	Emission source safety switch
J252(6)	Emission source safety switch GND

Connector to AC board J7

Pin	Function
1	Transfer line heat
2	Transfer line heat return
3	Cavity heat
4	Cavity heat return
5	120 VAC
6	120 VAC back
7	Pump GND
8	24 V (pump enable)
9	24 V DC
10	H_2O sense A (senses open circuit in wiring)

Connector to AC board P6

Pin	Function
1	Transfer line heat, fan red
2	Transfer line heat return, fan black
3	Magnetron source
4	Magnetron source

Connector to cavity assembly

Pin	Function
1-5	Not used
6	Cavity PRT
7	Cavity PRT
8	Cavity heater, 120 VAC
9	Not used
10	Cavity heater, 120 VAC
11	Fan, red
12	Fan, black
13	Magnetron PRT
14	Magnetron PRT

Connector to water board control cable

Pin	Function
5	NC
6	NC
7	GND
8	24 V enable
9	24 V
10	GND (for cabling circuit closed sensor)

Connector to heated transfer line pinouts

Pin	Function
1	Transfer line heater, 120 VAC
2	Transfer line heater, 120 VAC
3	Transfer line PRT
4	Transfer line PRT

Connector to emission source sense cable

Pin	Function
1	PRT/safety circuit (normally not open)
2	PRT/safety circuit (normally not open)

High voltage power supply, part no. G2350-80075

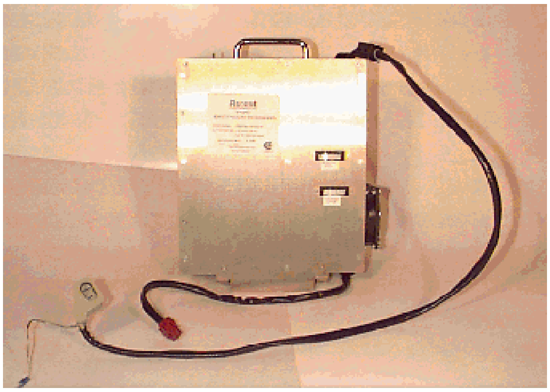


Figure 146. High voltage power supply

Connector to the AC board

Pin	Function
1	Hot
2	Neutral
3	GND
4	HV enable (0.2-0.3 V when high voltage is enabled; 5 V if off)

Main board, part no. G2350-60015

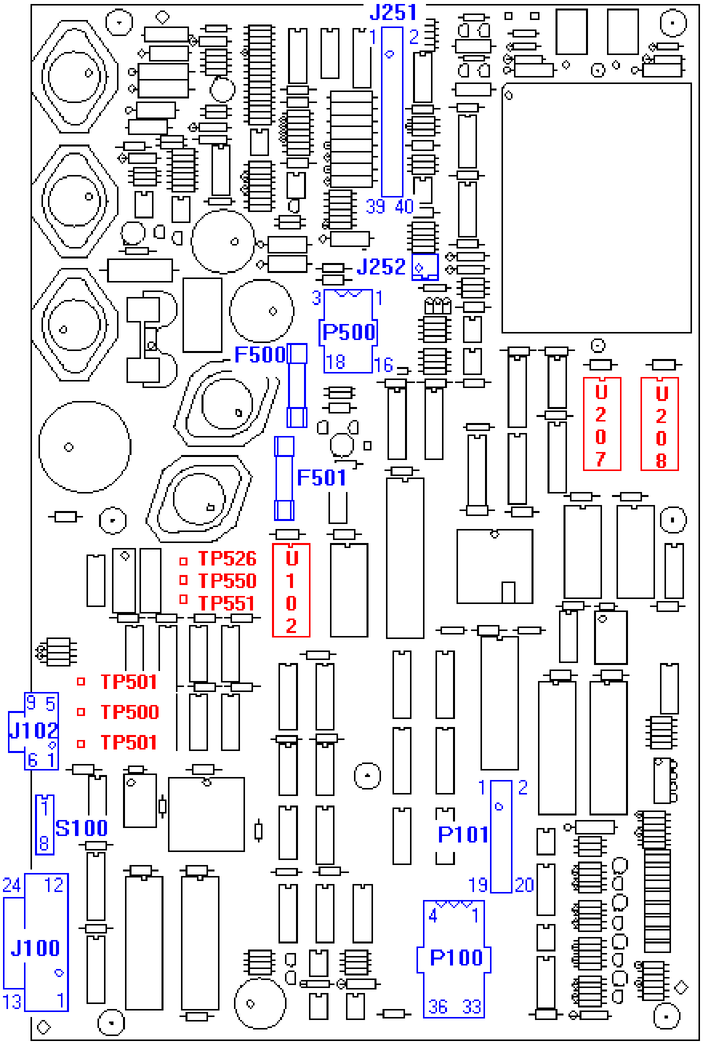


Figure 147. Main board

Connector J251 (main board to PDA)

Pin	Function	Pin	Function	Pin	Function
1	GND	15	CAL2	29	PH2
2	PGA OUT	16	GND	30	GND
3	GND	17	CAL1	31	PH1
4	GND	18	GND	32	GND
5	CAL REF	19	CAL0	33	ASUB
6	*–15	20	GND	34	GND
7	*15	21	GAIN2	35	RES0
8	*–15	22	GND	36	GND
9	*15	23	GAIN1	37	RESF
10	*–15	24	GND	38	GND
11	*15	25	GAIN0	39	HBW
12	GND	26	GND	40	GND
13	CALEN	27	STRT		
14	GND	28	GND		

Connector J252 (PRT circuit)

Pin	Function
J252(1)	Cavity PRT
J252(2)	Cavity PRT GND (S)
J252(3)	Transfer line PRT
J252(4)	Transfer line GND (S)
J252(5)	Water bath PRT
J252(6)	Water bath GND (S)

Connector P500 (AC board)

Pin	Function	Pin	Function
1	Line sense	10	High V primary
2	24 V enrage	11	Main relay
3	High V ON/OFF	12	Reference GND
4	Water pump control	13	DC ground
5	Mignonette overheat	14	DC ground
6	H_2O sense	15	Reference GND
7	AUX3	16	20 VAC
8	AUX2	17	20 VAC C.T.
9	AUX1	18	20 VAC

Connector P101 (service display board)

Pin	Function	Pin	Function
1	BA0	11	BD6
2	BA1	12	GND (D)
3	BA2	13	GND (D)
4	BA4	14	GND (D)
5	BD0	15	5 V
6	BD1	16	5 V
7	BD2	17	*FPST
8	BD3	18	*BWR
9	BD4	19	*DISP0
10	BD5	20	*DISP1

Connector P100 (main harness cable assembly)

Pin	Function	Pin	Function	Pin	Function
1	Stepper motor	13	Stepper motor	25	Slit motor blue lead
2	Spark (sparker)	14	24 V (sparker)	26	BX (slit encoder)
3	24 V	15	24 V	27	5 V (slit encoder)
4	Solvent dump	16	Aux reagent	28	5 V (unassigned)
5	Stepper motor	17	24 V (stepper motor)	29	Array motor red lead
6	5 V (sparker)	18	24 V (stepper motor)	30	AY (array encoder)
7	24 V	19	24 V	31	GND (D) (array encoder)
8	O_2 reagent	20	Unassigned	32	GND (D) (unassigned)
9	Stepper motor	21	Slit motor red lead	33	Array motor blue lead
10	GND (D) (sparker)	22	AX (slit encoder)	34	By (array encoder)
11	24 V	23	GND (D) (slit encoder)	35	5 V (array encoder)
12	H_2 reagent	24	Slit motor shield	36	Array motor shield

Connector J102 (APG remote)

Pin	Function
J102(1)	GND (D)
J102(2)	
J102(3)	*START
J102(4)	
J102(5)	
J102(6)	PWRON
J102(7)	READY
J102(8)	*STOP
J102(9)	

S100 (GPIB address)

When set for GPIB address 15 (the default), the switches are set as shown below.

Switch	Function	Setting
S100(1)	Test	Down
S100(2)	SRQ	Down
S100(3)	Not used	Down
S100(4)	ADDR 16	Down
S100(5)	ADDR 8	Up
S100(6)	ADDR 4	Up
S100(7)	ADDR 2	Up
S100(8)	ADDR 1	Up

See the instructions for installing the ChemStation software for other address settings.

Connector J100 (GPIB communications)

Pin	Function	Pin	Function
1	DI01	13	DI05
2	DI02	14	DI06
3	DI03	15	DI07
4	DI04	16	DI08
5	EOI	17	REN
6	DAV	18	DCOM
7	NRFD	19	DCOM
8	NDAC	20	DCOM
9	IFC	21	DCOM
10	SRQ	22	DCOM
11	ATN	23	DCOM
12	SHLD ((GND (D))	24	LOGIC

Main board test points

Test point	Reading
TP500:	GND
TP501:	–24 V
TP502:	24 V
TP526:	5 V
TP550:	15 V
TP551:	–15 V

Main board fuses

Fuse	Type	part no.
F500	5A, 250 V fast acting	2100-0010
F501	5A, 250 V fast acting	2100-0010

Main harness cable assembly, part no. G2350-60680

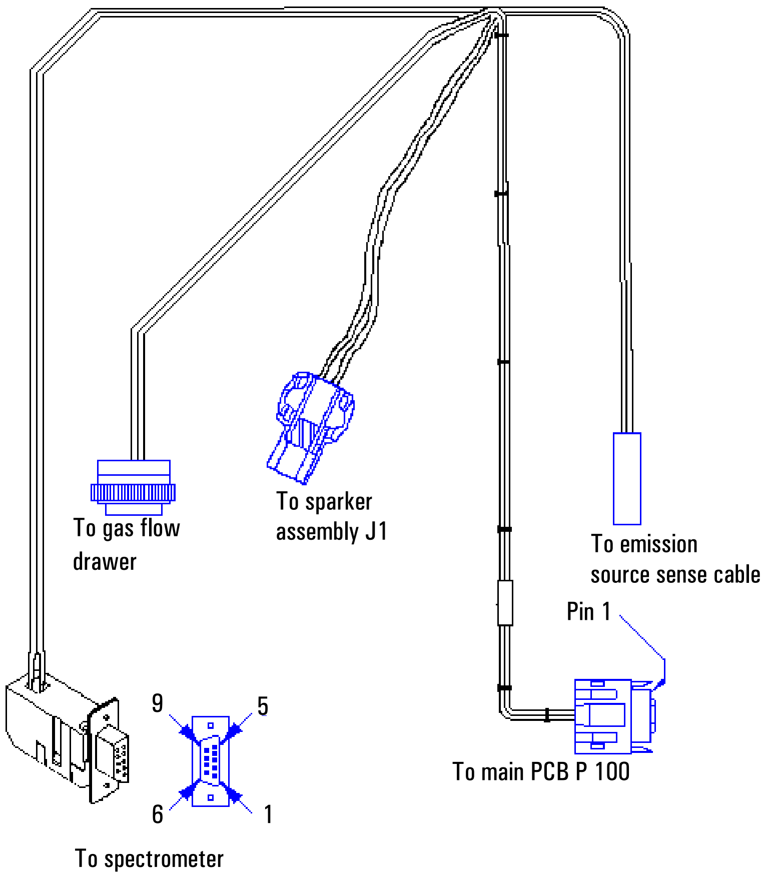


Figure 148. Main harness cable assembly

Connector to sparker board J1

Pin	Function
1	5 V in
2	24 V in
3	Trigger
4	GND

Connector to spectrometer

Pin	Function	Color
1	Stepper motor	Black
2	Switch closed	Black
3	Switch normally closed	Black
4	Stepper motor	Yellow
5	Stepper motor	Orange
6	24 V stepper motor	Red
7	Not used	
8	24 V stepper motor	Red
9	Stepper motor	Brown

Connector to gas flow system

Pin	Function
1-2	Not used
3	High flow solenoid
4	Solvent vent solenoid
5	Oxygen solenoid
6	Hydrogen solenoid
7	Auxiliary solenoid
8	Solvent vent solenoid
9	Oxygen solenoid
10	Hydrogen solenoid
11	Auxiliary solenoid
12-13	Not used
14	High flow solenoid

Connector to main board P100

Pin	Function	Pin	Function	Pin	Function
1	Stepper motor	13	Stepper motor	25	Slit motor blue lead
2	Spark (sparker)	14	24 V (sparker)	26	BX (slit encoder)
3	24 V	15	24 V	27	5 V (slit encoder)
4	Solvent dump	16	Aux reagent	28	5 V (unassigned)
5	Stepper motor	17	24 V (stepper motor)	29	Array motor red lead
6	5 V (sparker)	18	24 V (stepper motor)	30	AY (array encoder)
7	24 V	19	24 V	31	GND (D) (array encoder)
8	O_2 reagent	20	Unassigned	32	GND (D) (unassigned)
9	Stepper motor	21	Slit motor red lead	33	Array motor blue lead
10	GND (D) (sparker)	22	AX (slit encoder)	34	By (array encoder)
11	24 V	23	GND (D) (slit encoder)	35	5 V (array encoder)
12	H_2 reagent	24	Slit motor shield	36	Array motor shield

Connector to emission source sense cable

Pin	Function
1	PRT/safety circuit (normally not open)
2	PRT/safety circuit (normally not open)

PDA to main PCB cable assembly, part no. G2350-60860

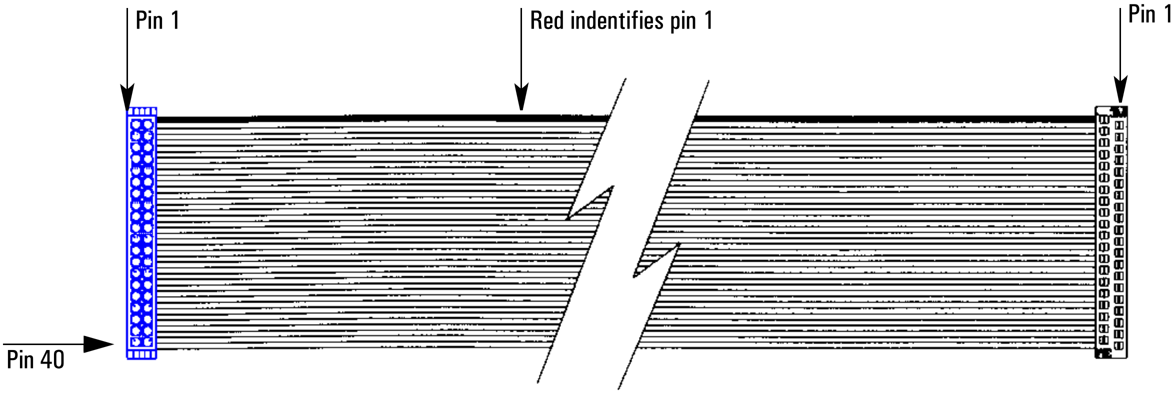


Figure 149. PDA to main PCB cable assembly

Connector J151 (PDA to main board)

Pin	Function	Pin	Function	Pin	Function
1	GND	15	CAL2	29	PH2
2	PGA OUT	16	GND	30	GND
3	GND	17	CAL1	31	PH1
4	GND	18	GND	32	GND
5	CAL REF	19	CAL0	33	ASUB
6	*–15	20	GND	34	GND
7	*15	21	GAIN2	35	RES0
8	*–15	22	GND	36	GND
9	*15	23	GAIN1	37	RESF
10	*–15	24	GND	38	GND
11	*15	25	GAIN0	39	HBW
12	GND	26	GND	40	GND
13	CALEN	27	STRT		
14	GND	28	GND		

Service display board cable, part no. 05921-60710

Connects to P101 on the main board and to the display LED PC board assembly, part no. 05921-60020.

Sparker assembly cable, part no. 05921-61000

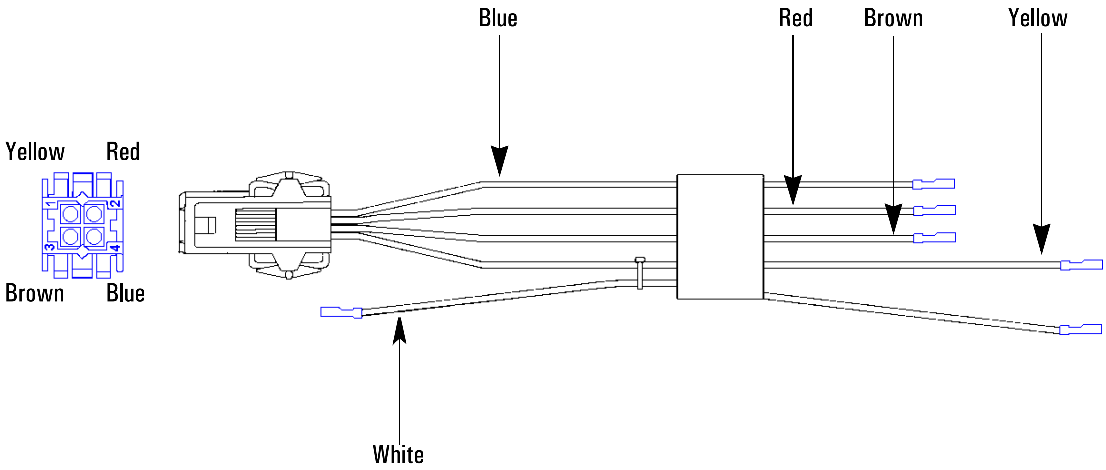


Figure 150. Sparker assembly cable

Connector to J2

Pin	Function
1	13.6 V (coil)
2	13.6 V (module)
3	5 V (module)
4	Trigger (module)

Wiring

Wire	Function
Blue	Trigger (module)
Brown	5 V (module)
Red	13.6 V (module)
White	GND (coil to module)
Yellow	13.6 V (coil)

Transformer leads

Pin	Function	Stage
1	20 VAC (yellow)	Secondary
2	20 VAC (yellow)	Secondary
3	120 VAC (red)	Secondary
4	CT (blue)	Secondary
5	GND (red)	Secondary
6	Line (black/green)	Primary
7	Neutral (black/red)	Primary
8	Shield (green/yellow)	Secondary
9	Line (black/orange)	Primary
10	Line (black)	Primary
11	Not used	
12	Neutral (black/yellow)	Primary

Sparker board, part no. 05921-60030

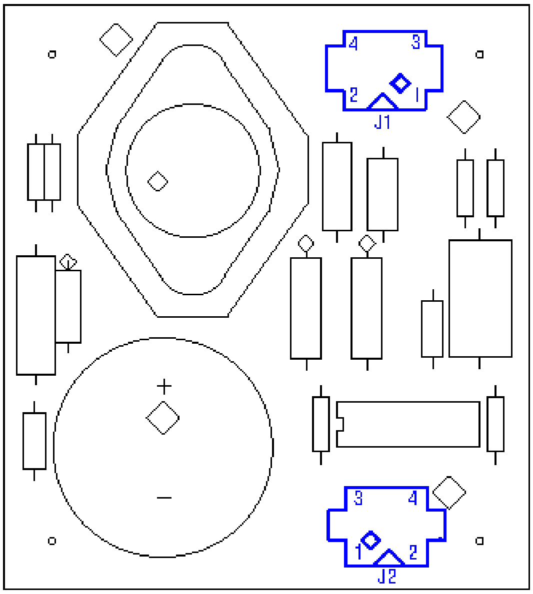


Figure 151. Sparker board

Connector J2

Pin	Function
1	13.6 V
2	13.6 V to module
3	5 V to module
4	Trigger (module)

Connector J1

Pin	Function
1	5 V in
2	24 V in
3	Trigger
4	GND

Water board, part no. G2350-60080

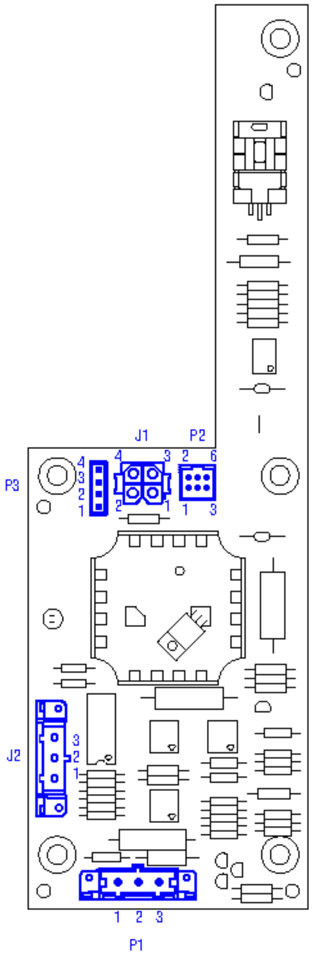


Figure 152. Water board assembly, revision 1

Connector J1

Pin	Function
1	Enable (24 V when pump and fan are running)
2	GND
3	GND
4	+24 V

J1 on the water board connects to the water drawer control cable, G2350-60750.

Connector J2

Pin	Function
1	+15 V
2	Flow sensor input, normally 3.75 to 4.30 V
3	GND

J2 on the water board connects to the flow sensor.

Connector P1

Pin	Function
1	Red
2	NC
3	Black

P1 on the water board connects to the pump.

Voltage across 1-3 is 9 to 21 V DC (9-12 V nominal).

Connector P2

Pin	Function
1	+15 V fan
2	GND
3	NC
4	NC
5	GND
6	+15 V fan

P2 on the water board connects to the fan.

Connector P3

Pin	Function
1	NC
2	NC
3	PRT
4	PRT shutdown

P3 on the water board connects to the water drawer control cable, G2350-60750.

Water board, part no. G2350-60085

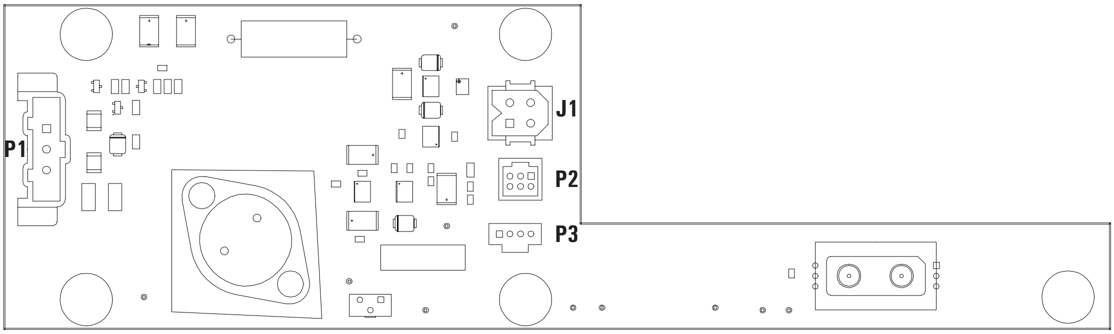


Figure 153. Water board, revision 2

Connector J1

Pin	Function
1	Enable (24 V when pump and fan are running)
2	GND
3	GND
4	+24 V

J1 on the water board connects to the water drawer control cable, G2350-60755.

Connector P1

Pin	Function
1	Red
2	NC
3	Black

P1 on the water board connects to the pump.

Voltage across 1-3 is 9 to 21 V DC (9-12 V nominal).

Connector P2

Pin	Function
1	+15 V fan
2	GND
3	NC
4	NC
5	GND
6	+15 V fan

P2 on the water board connects to the fan.

Connector P3

Pin	Function
1	NC
2	NC
3	PRT
4	PRT shutdown

P3 on the water board connects to the water drawer control cable, G2350-60755.

Water drawer control cable assembly, part no. G2350-60750

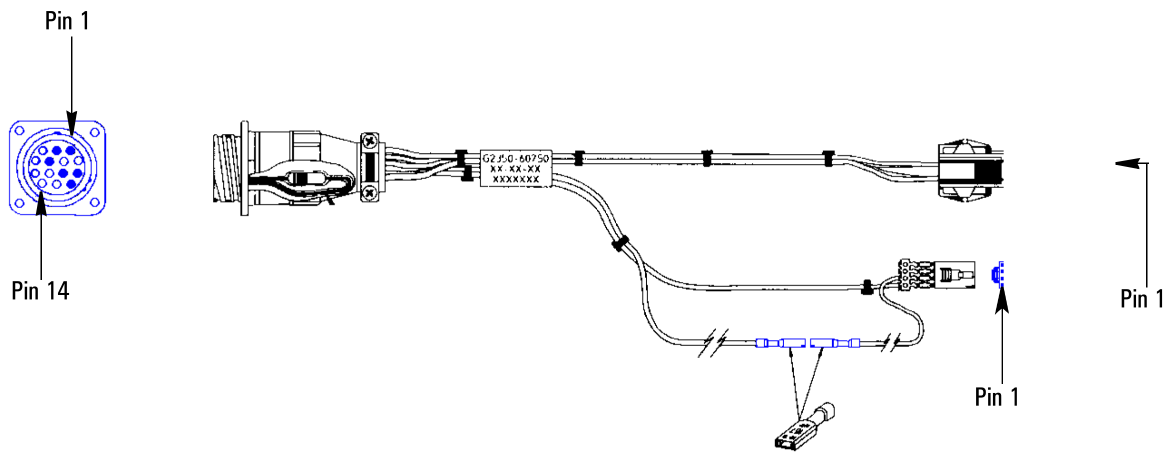


Figure 154. Water drawer control cable assembly

Connector to heater/sensor cable pinouts

Pin	Function
1	NC
2	NC
3	GND (for cabling ckt closed sensor)
4	24 V
7	24 V enable
10	Shorted to 13
11	PRT ckt (to pressure switch and flow sensor)
13	J252(5) from main board (PRT ckt). Shorted to 10. 110 ohms.
14	J252(6) from main board (PRT ckt)

Connector to pressure switch

Should read 110 ohms nominal, or open when system is down.

Connector to water board J1

Pin	Function
1	Enable (24 V when pump and fan are running)
2	GND
3	GND
4	24 V

Water drawer control cable assembly, part no. G2350-60755

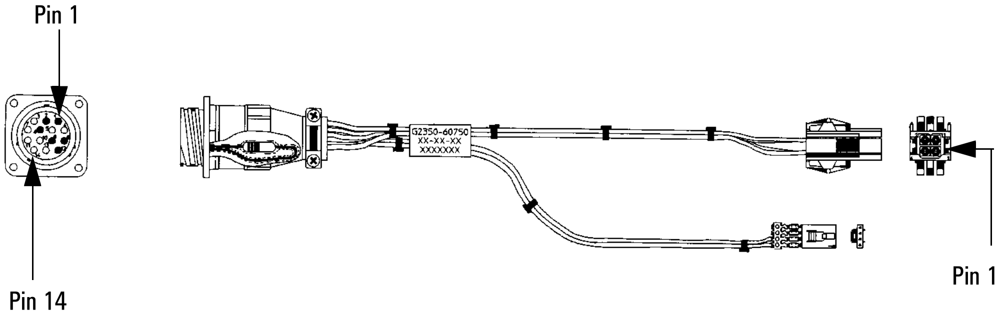


Figure 155. Water drawer control cable assembly

Connector to heater/sensor cable pinouts

Pin	Function
1	NC
2	NC
3	GND (for cabling ckt closed sensor)
4	24 V
7	24 V enable
10	Shorted to 13
11	PRT ckt (to pressure switch and flow sensor)
13	J252(5) from main board (PRT ckt). Shorted to 10. 110 ohms
14	J252(6) from main board (PRT ckt)

Connector to pressure switch

Should read 110 ohms nominal, or open when system is down.

Connector to water board J1

Pin	Function
1	Enable (24 V when pump and fan are running)
2	GND
3	GND
4	24 V

Wires, water board to flow sensor and pump

Pump

Pin	Function
1	Red
2	NC
3	Black

Voltage across 1-3 varies from 9-21 V (9-12 V nominal when new).

Fan

Pin	Function
1	15 V
2	GND
3	NC
4	NC
5	NC
6	NC

Flow sensor (if used)

Pin	Function
1	15 V
2	Output (normally 3.75-4.25 V)
3	GND

7 Replacement Parts

Introduction

This chapter lists the part numbers for all replaceable parts. Please note **not all parts in the list are user replaceable**. In addition, some parts are replaceable only as part of larger assemblies. To replace one of these parts, order the **assembly**.

Gas drawer changes

Beginning with AED serial number 3000208, all gas drawers use an externally accessible filter. Aside from the filter mounting hardware, the earlier gas drawers are identical to the newer version.

Water drawer change

Beginning with AED serial number 1000166, the water drawer uses different flow monitoring electronics. If desired, you may upgrade the water drawer to the current configuration. See *Water drawer*, *AED serial no. < 1000166* on page 261.

Electrical components

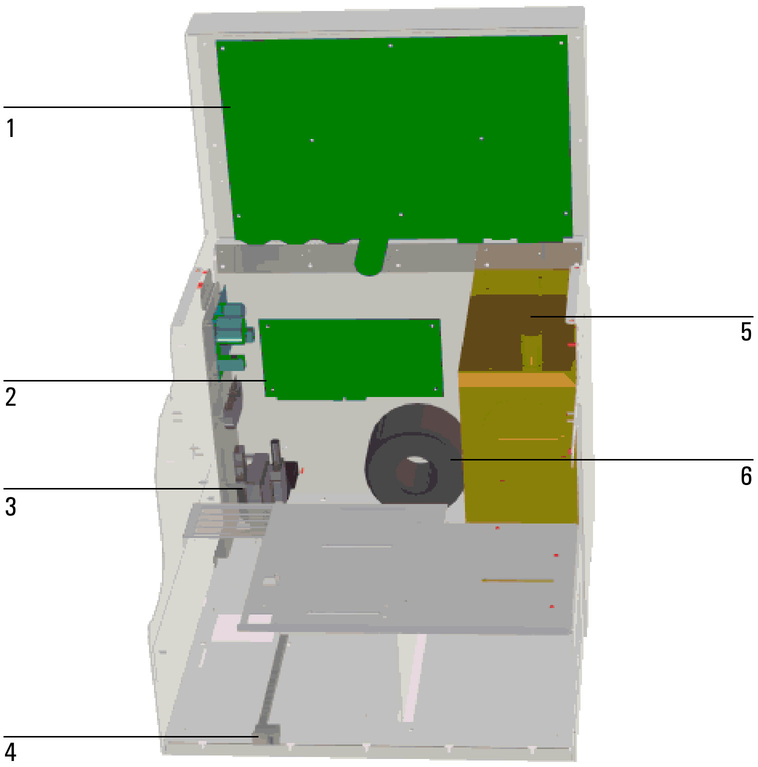


Figure 156. Electrical components

Number	Description	Part number	Qty/Assy
1	Main board assembly	G2350-60015	1
2	AC board assembly	G2350-60055	1
3	Sparker assembly	G2350-60550	1
4	Remote rocker switch	3101-3444	1
5	Power supply	G2350-80075	1
6	Power transformer assembly	G2350-60660	1

Emission source assembly

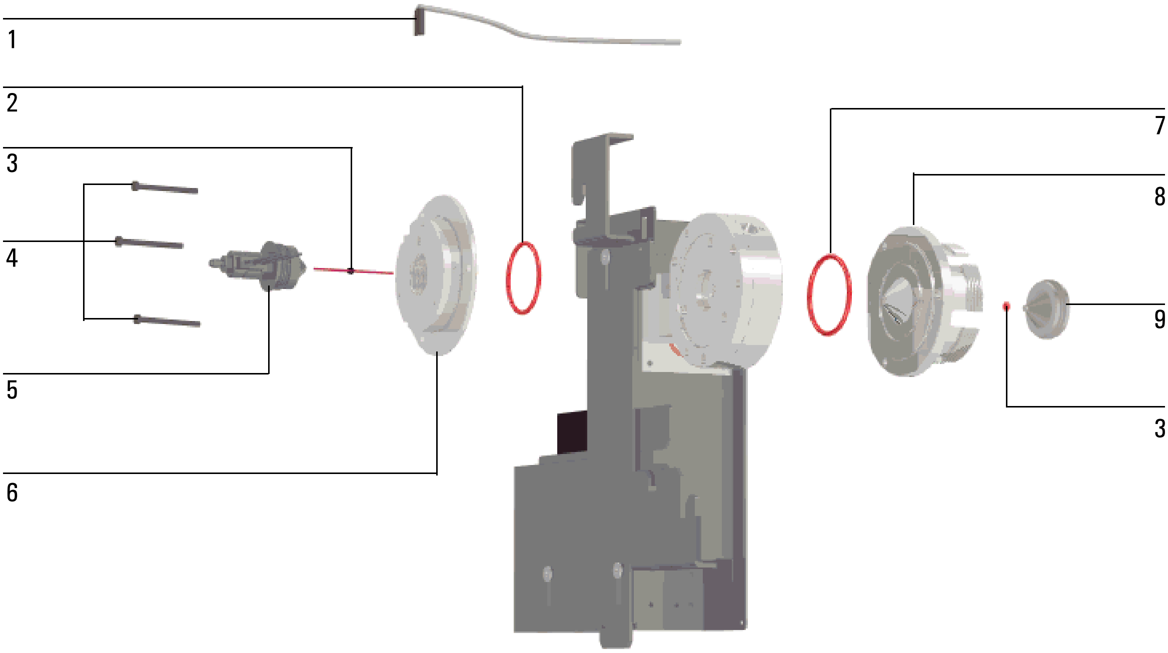


Figure 157. Emission source assembly, part no. G2350-60560

Number	Description	Part number	Qty/Assy
	Emission source assembly	G2350-60560	–
	RP-emission source assembly	G2350-60900	–
1	Cavity heater/PRT assembly	G2350-60930	1
2	GC chamber O-ring	0905-1159	1
3	Discharge tube kit	G2350-61090	1
4	RP-MS M5×3.80 35mm	0515-0110	3
5	Gas union assembly	G2350-61190	1
6	RP-heater chamber assembly	G2350-60190	1
7	Optical side water chamber O-ring	0905-1160	1
8	Optical side water chamber	G2350-20520	1
9	Exit chamber	05921-22240	1
NS	Belleville washers	3050-1907	4
NS	Set screw	0515-2432	

Front assemblies

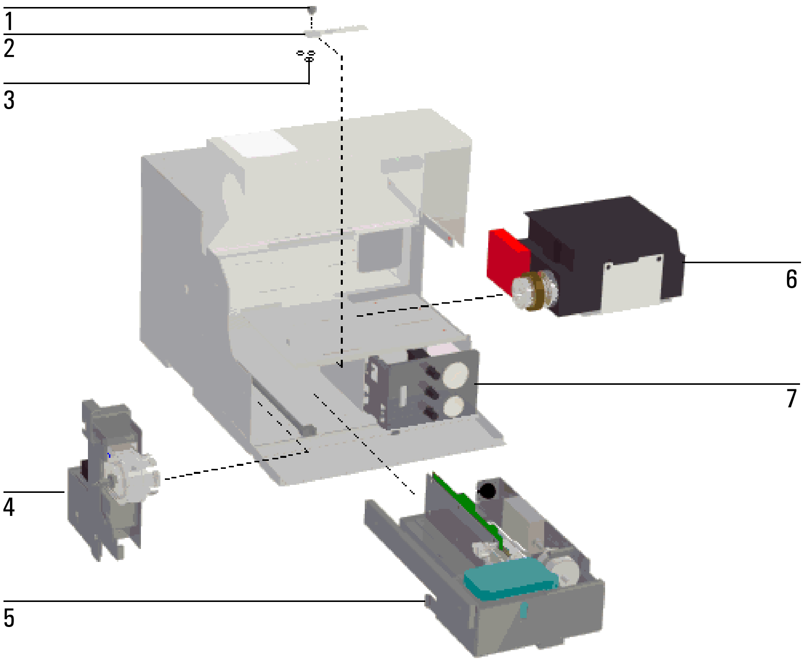


Figure 158. Front assemblies

Number	Description	Part number	Qty/Assy
1	Thumb nut	0535-0165	1
2	Gas drawer disconnect brazement	G2350-80680	1
3	O-ring	0905-1162	3
4	Emission source assembly	G2350-60560	1
5	Water drawer	G2350-61250	1
6	Spectrometer assembly	G2350-61170	1
7	Gas drawer	G2350-60530	1
NS	Ship kit	G2350-60800	–
NS	AED II Packaging assembly	G2350-61140	–

Gas drawer

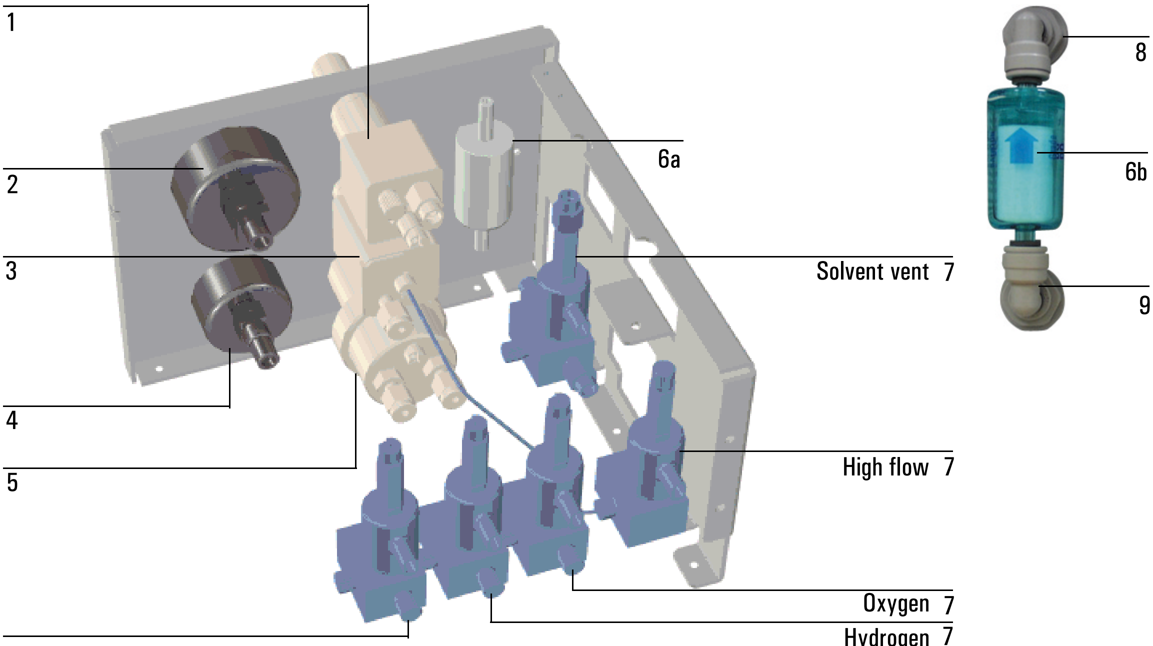


Figure 159. Gas drawer regulators, solenoids, and gauges (tubing not shown)

Number	Description	Part number	Qty/Assy
	Gas drawer	G2350-60530	–
1	Regulator, 0-15 psi back pressure	19246-60560	1
2	Gauge, 10psi	G2350-60590	1
3	AED mass flow assembly	05921-61210	1
	Mass flow controller, 400 cc/min	19362-60575	1
	Nut, 1/8" tubing, brass ferrule, O-ring (M8)		
4	60 psi pressure gauge	19363-60505	1
5	0-60 psi forward pressure regulator	19246-60540	1
6a	Ash filter assembly	G2350-60990	1
6b	Filter tube fly ash	3150-0417	1
7	AED solenoid assembly	05921-61200	5
	Cap. solenoid valve	G1544-60560	–
8	Bulkhead union	0100-1698	2
9	Plug-in elbow	0100-1699	2

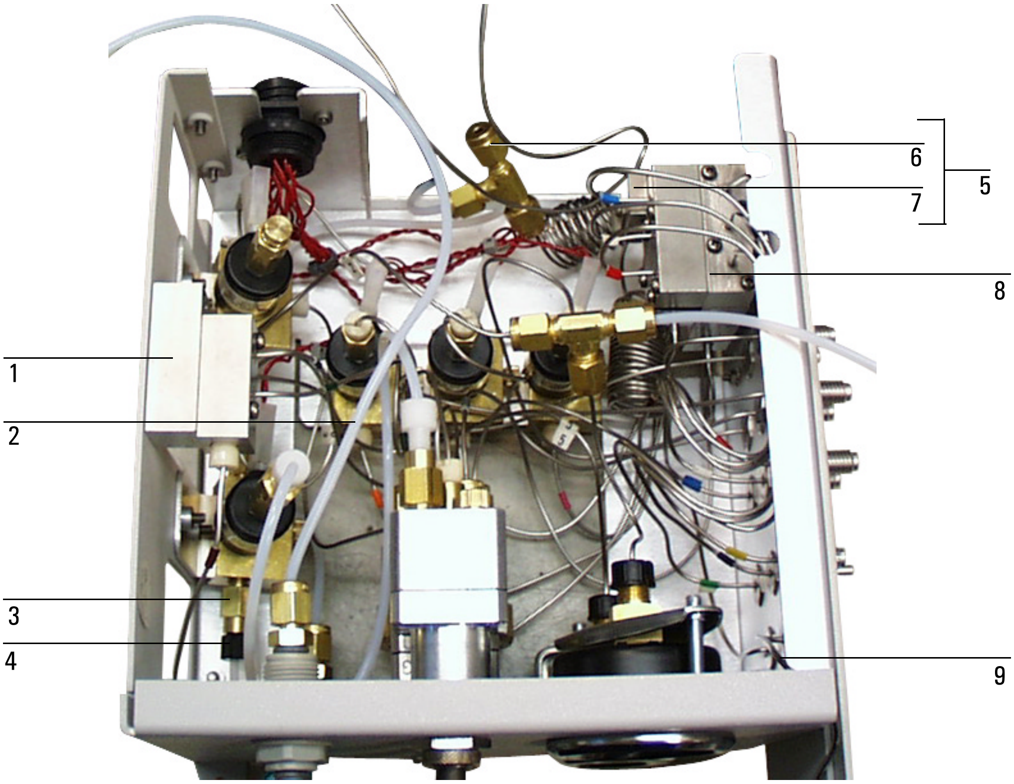


Figure 160. Gas drawer manifolds and weldments

Number	Description	Part number	Qty/assy
1	Make up manifold assembly	G2350-61192	1
2	1/8 inch teflon tubing	0890-0746	48 inches
3	Union	05921-21370	4
4	Flange free fitting	0100-1877	1
	Bushing	0100-1504	1
5	Purge manifold assembly	G2350-61390	1
6	1/8 inch tee union	0100-0053	1
7	Purge brazement 1/8 inch	G2350-81090	
8	Manifold assembly	G2350-60540	1
9	Jumper brazement (N_2 purge)	G2350-80670	1
NS	Inlet weldment	05921-80730	1
NS	Jumper weldment, 8 inch	19243-80560	
NS	H_2 fitting nut	05921-22110	1

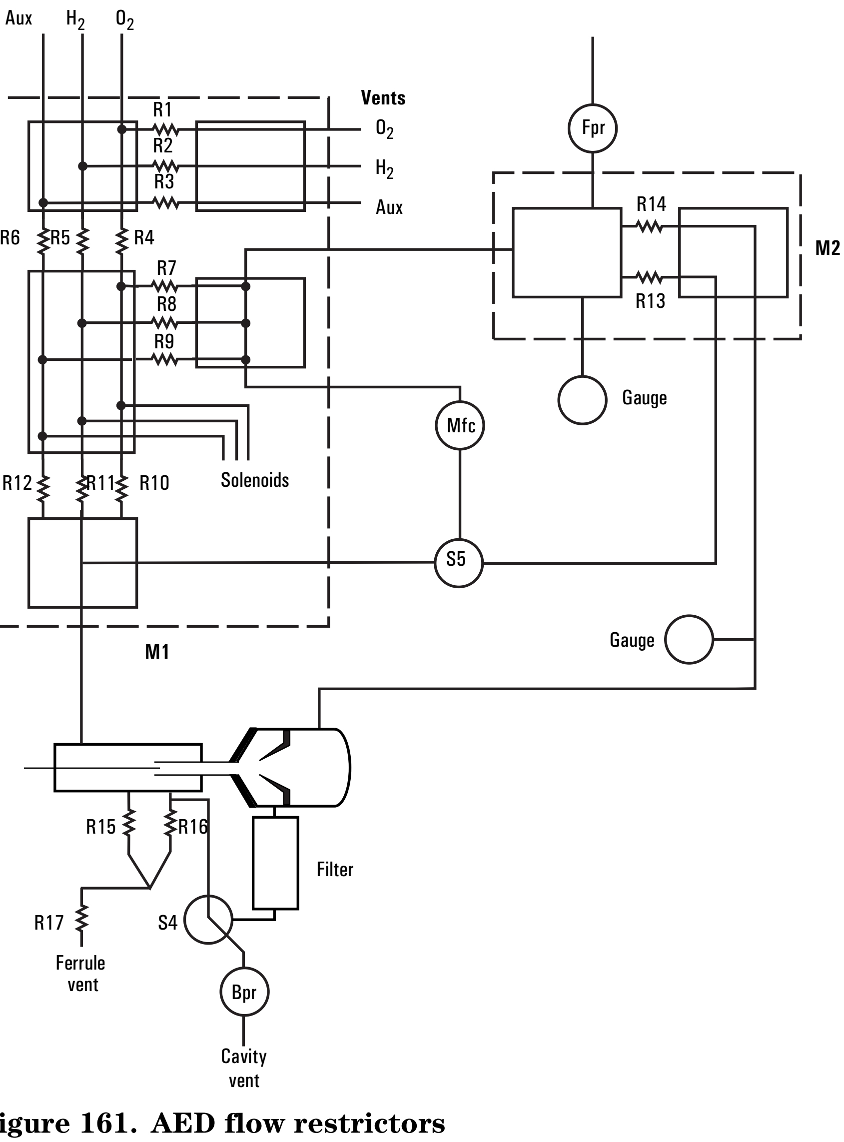


Figure 161. AED flow restrictors

AED Flow Restrictors (see Figure 161).

Number	Description	Part number	Qty/assy
R1	FID H2 restrictor	19231-60770	1
R2	NPD H2 restrictor	19234-60660	1
R3	NPD H2 restrictor	19234-60660	1
R4	Rz restrictor	0100-1473	1
R5	Rz restrictor	0100-1473	1
R6	Rz restrictor	0100-1473	1
R7	NPD H2 restrictor	19234-60660	1
R8	NPD H2 restrictor	19234-60660	1
R9	NPD H2 restrictor	19234-60660	1
R10	NPD H2 restrictor	19234-60660	1
R11	NPD H2 restrictor	19234-60660	1
R12	NPD H2 restrictor	19234-60660	1
R13	AED makeup restrictor	0100-1521	1
R14	FID H2 restrictor	19231-60770	1
R15	1/16 inch tubing restriction		1
R16	1/16 inch tubing restriction		1
R17	1/16 inch tubing restriction		1

Heated transfer line

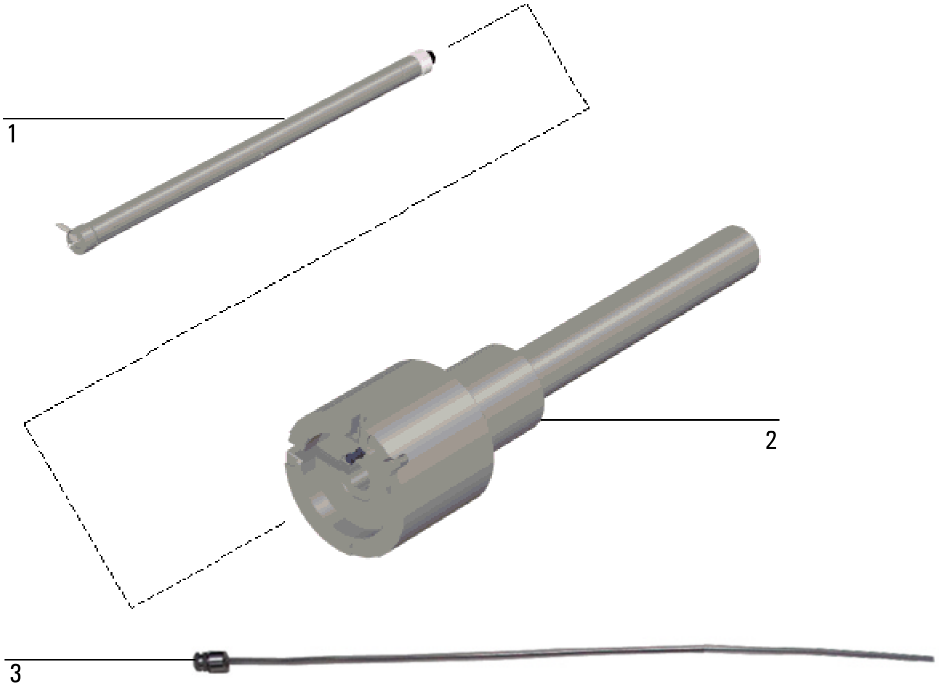


Figure 162. Heated transfer line

Number	Description	Part number	Qty/Assy
	Heated transfer line	G2350-61300	–
1	Heated core assembly	G2350-80780	1
	1/16 inch graphite ferrule (10 pk)	0100-1326	
	1/16 inch gas union SS tubing nut (each)	0100-0053	
2	Insulation jacket assembly	G2350-61240	1
3	Column setting tool	G2350-80610	–

Lens mount assembly

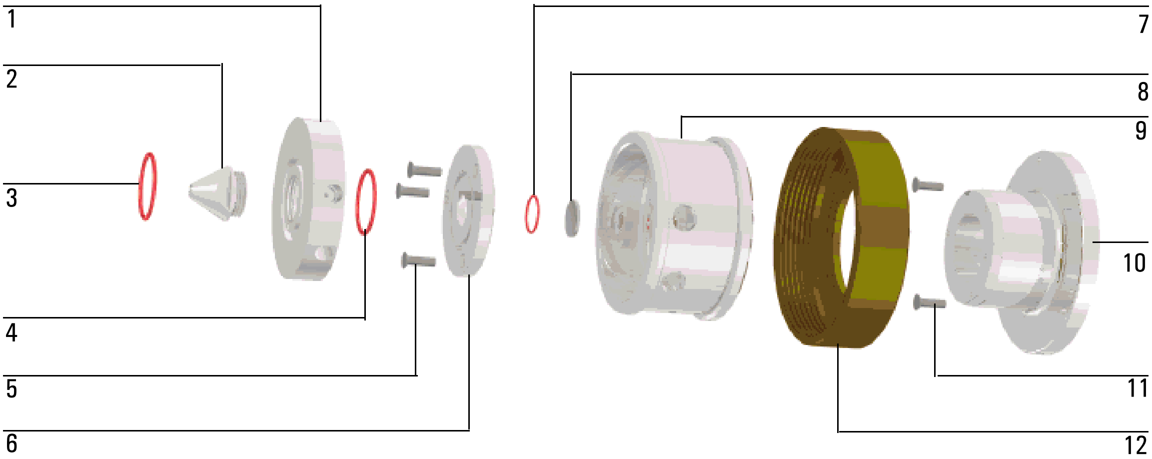


Figure 163. Lens mount assembly, part no. G2350-60740

Number	Description	Part number	Qty/Assy
	Lens mount assembly	G2350-60740	
1	Lens mount liner	G2350-22230	1
2	Lens mount cone	G2350-22220	1
3	Lens mount liner O-ring	0905-1451	1
4	Lens keeper O-ring	0905-1099	1
5	SCR-MACH M3×0.5×12mm LG	0515-0911	3
6	Lens keeper	G2350-22240	1
7	Lens O-ring	0905-1293	1
8	Lens	G2350-80360	1
9	Lens mount top	G2350-20910	1
10	Lens mount bottom	G2350-21320	1
11	Screw M4×20	0515-0982	2
12	Lens mount nut	G2350-20980	1
NS	Lens mount liner interior O-ring	0905-1162	3
NS	Lens mount liner ferrule (bushing)	0100-1504	1
NS	Lens mount liner fitting (nut)	0100-1505	1

Sparker assembly

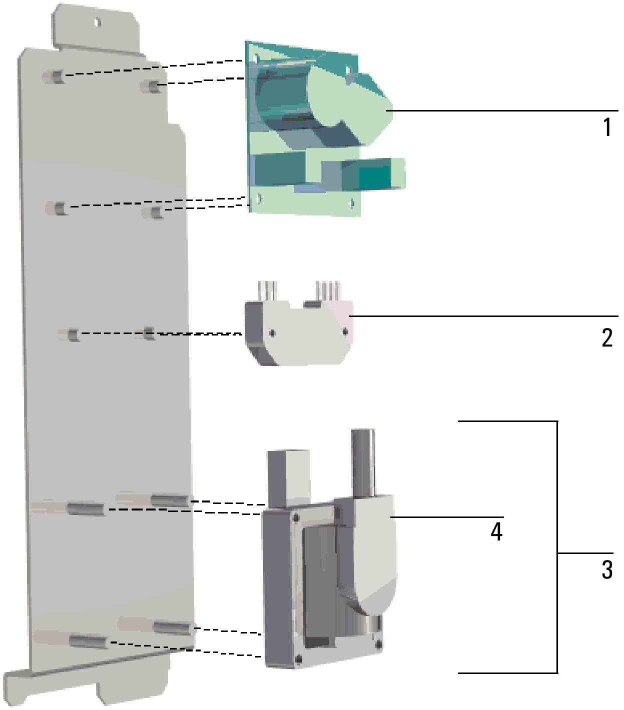


Figure 164. Sparker assembly, part no. G2350-60550

Number	Description	Part number	Qty/Assy
	Sparker assembly	G2350-60550	–
1	Sparker PCB assembly	05921-60030	1
2	Ignition module	0960-0826	1
3	Ignition coil	9140-1516	1
4	Spark top brazement	05921-80880	1
NS	8 mm ignition wire	8120-5473	1
NS	Sparker assembly cable	05921-61000	1
NS	Spark fitting	05921-22056	1

Spectrometer assembly

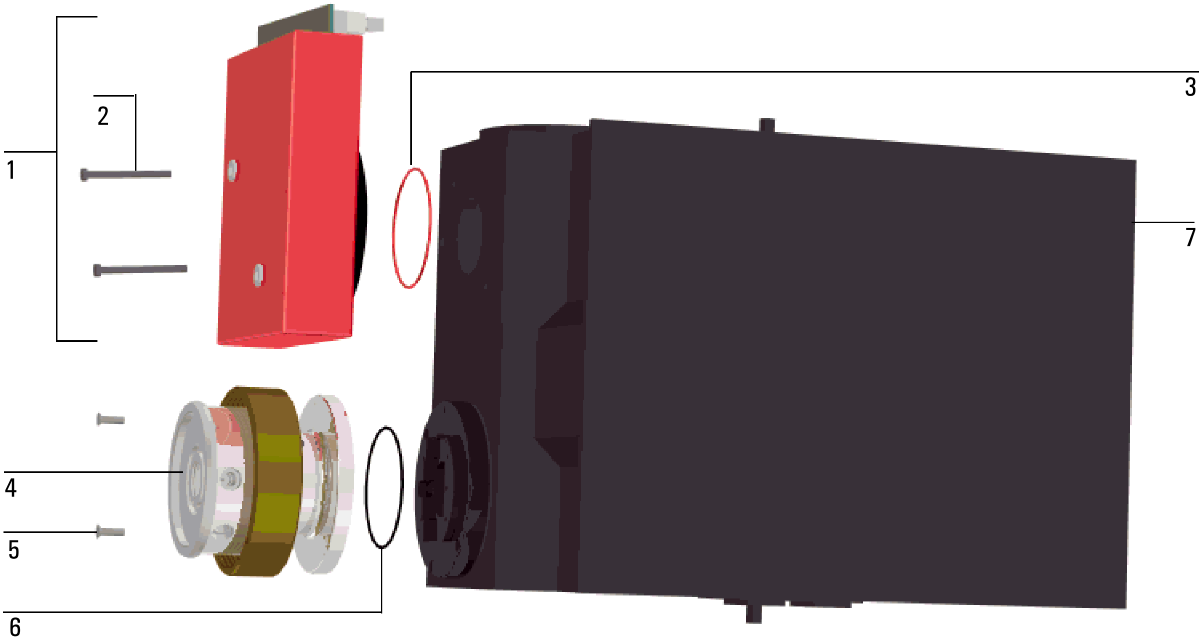


Figure 165. Spectrometer assembly, part no. G2350-61170

Number	Description	Part number	Qty/Assy
	Spectrometer assembly	G2350-61170	–
1	PDA assembly	G2350-60630	1
2	Mounting screw	G2350-20700	2
3	O-ring	0905-1433	1
4	Lens mount assembly	G2350-60740	1
5	Mounting screw	0515-0982	2
6	O-ring	0905-1435	1
7	Spectrometer	G2350-60720	1

Water drawer, AED serial no. > 1000166

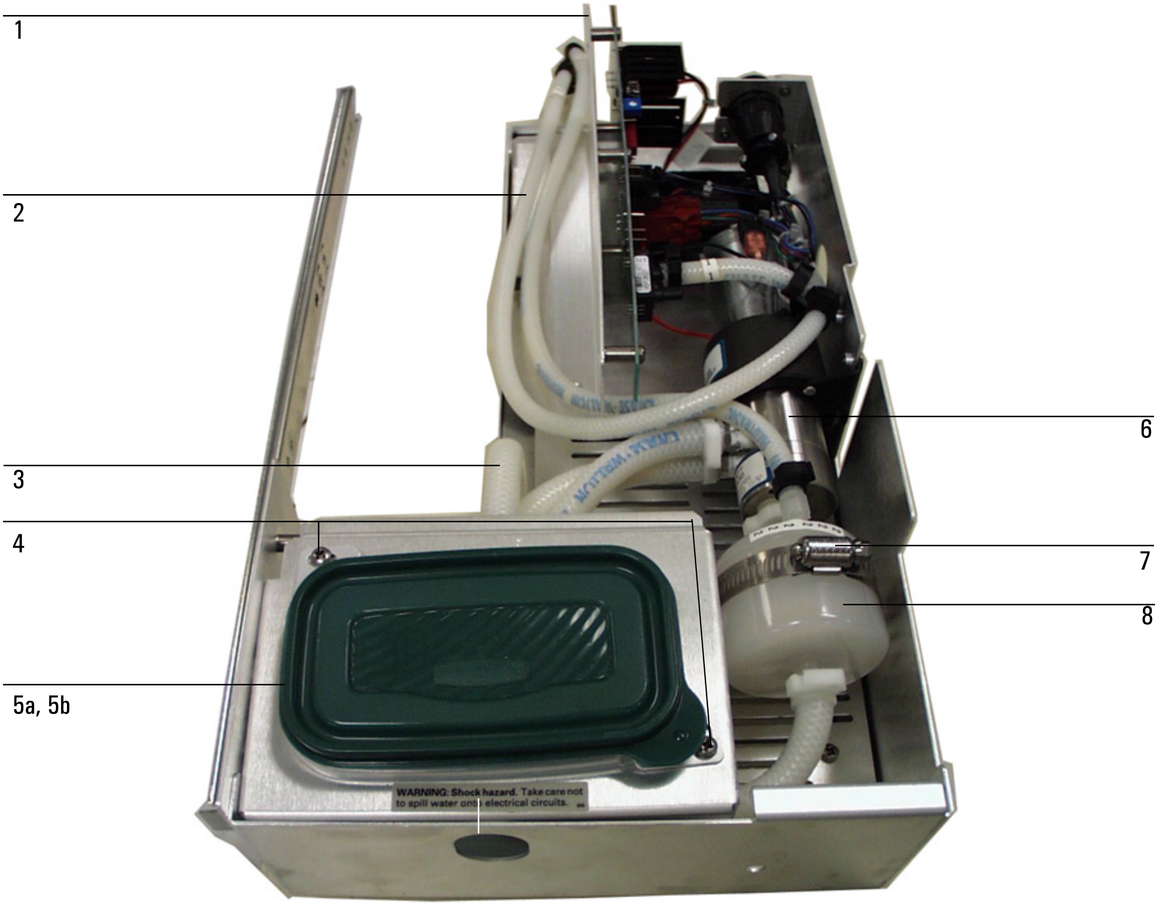


Figure 166. Water drawer, AED serial no. 1000166 to 03000388. (Water drawer for AED serial no. > 03000388 is similar.)

See Figure 166 for an illustration of the water drawer.

Number	Description	Part number	Qty
	Water drawer	G2350-61250	–
1	Water board panel	G2350-00470	1
2	Rubber tubing	0890-2104	154 cm
3	Tubing, per.cured si rubber	0890-1831	57 cm
4	Reservoir clip	G2350-00480	2
5a	RP-reservoir assembly	G2350-60710	1
5b	Reservoir	1540-1724	1
6	Water pump assembly	G2350-61445	1
7	Plastic clamp (on filter deadend)	1400-1660	1
8	0.5 μm water filter element	G2350-80300	1
NS	1/8×1/4 SS reducing union	0100-0121	2
NS	Adapter tube SS 1/8 inch hose–1/4 inch	0100-1464	1
NS	1/4 inch barb to 1/8 inch male, SS	0100-1608	2
NS	1/4 inch barb to 1/4 inch tube	0100-1609	1
NS	Plastic fitting (luer tube fitting)	0100-1869	1
NS	Luer lock ring (on filter)	0100-1874	1
NS	Nut-hex w/lkwr	0535-0031	5
NS	Gasket	0905-1440	68
NS	Washer-flat	3050-0307	4
NS	Washer-flat	3050-0891	4
NS	Washer-flat	3050-0893	4
NS	Washer-fl nm 6.0	3050-1202	1
NS	Washer-nylon	3050-1414	2

See Figure 169 for a plumbing diagram.

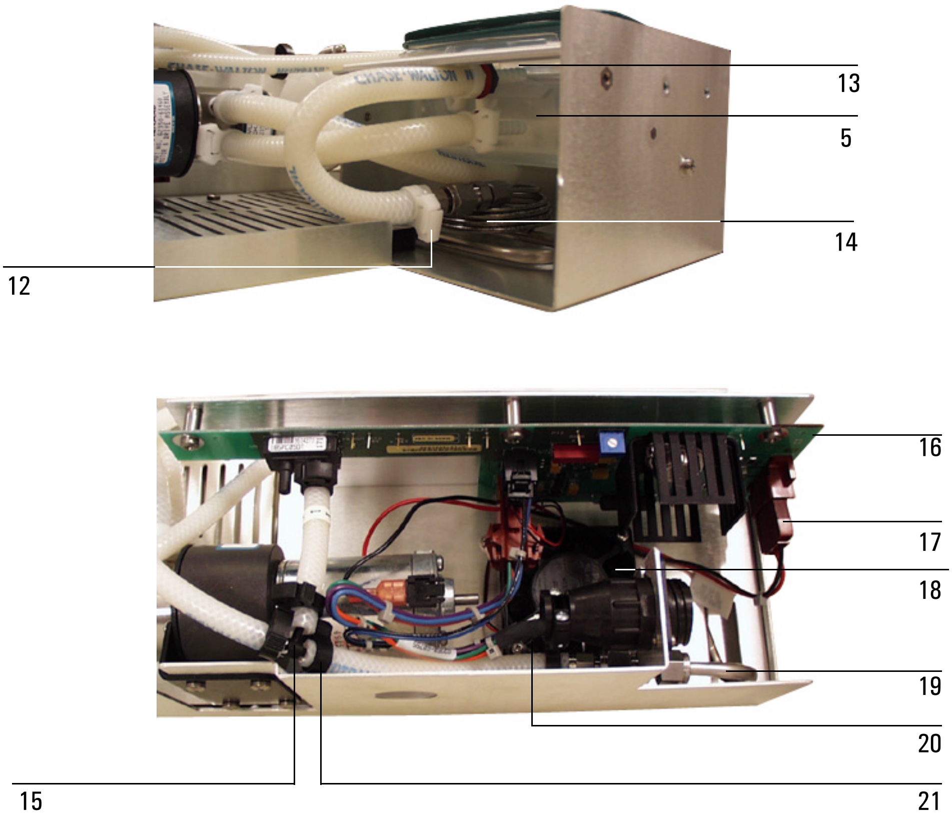


Figure 167. Water drawer parts

Number	Description	Part number	Qty/Assy
5	RP-reservoir assembly	G2350-60710	1
12	Hose clamp (pump and reservoir)	1400-2152	6
13	Fitting, barbed bulkhead	0100-1680	1
14	Restrictor, 1/8 inch SS tube coil	G2350-20890	1
15	Fitting ("tee"), 1/8 inch barbed	0100-1869	1
16	Water control PCB	G2350-60085	1
17	AED II pump cable	G2350-60810	1
18	Water drawer fan assembly	G2350-61070	1
19	Heat exchanger	G2350-20905	1
20	Water drawer cable	G2350-60755	1
21	Hose clamp SNP-2-HSO	1400-1569	8

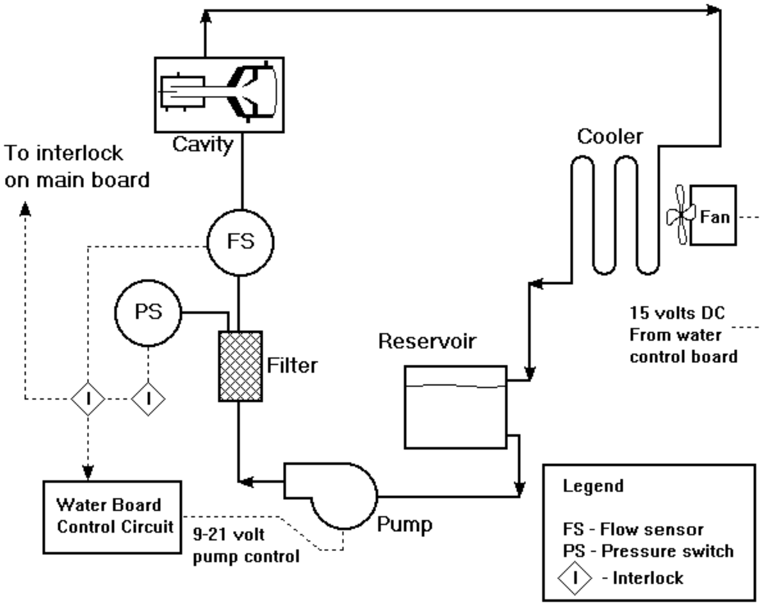


Figure 168. Water flow path diagram, version 1

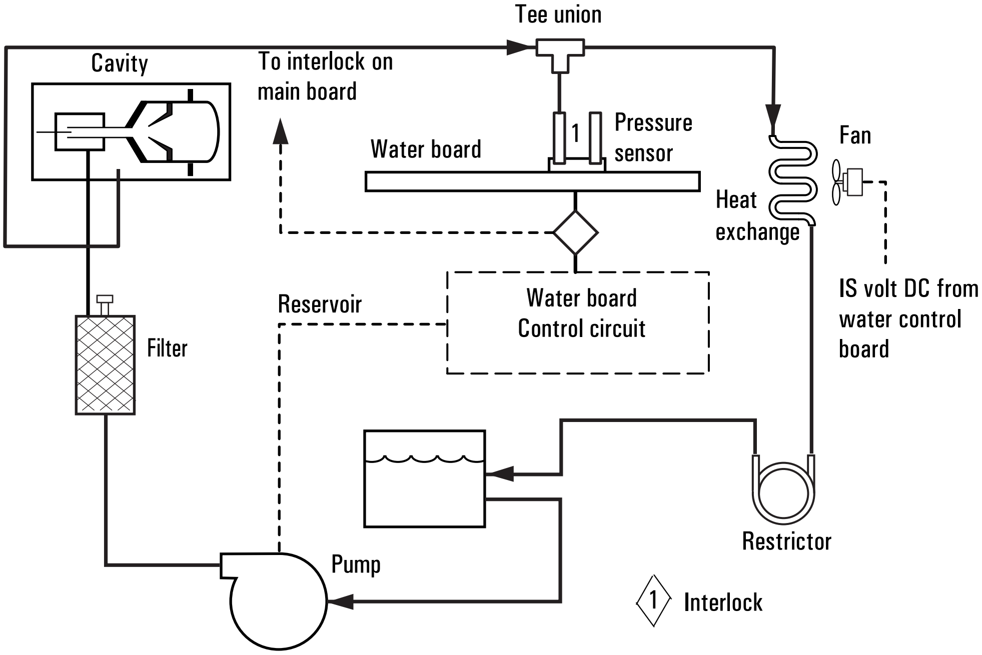


Figure 169. Water flow path diagram, version 2

Water drawer, AED serial no. < 1000166

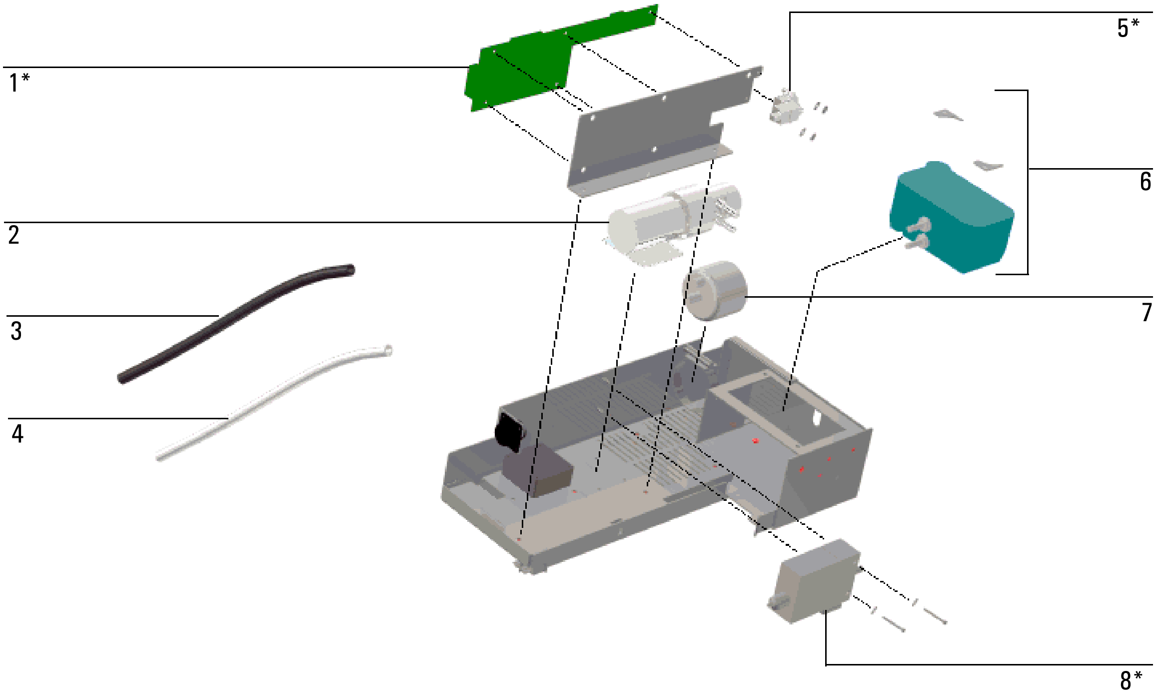


Figure 170. Water drawer for AED serial no. < 1000166

See Figure 170 for an illustration of the water drawer.

Number	Description	Part number	Qty/Assy
	Water drawer	G2350-61250	–
1	Modified water board assembly*	G2350-60080	N/A
2	Water pump assembly	G2350-61445	1
3	1/8 in ID×1/8 in wall neoprene tubing	0890-1745	N/A
4	Tubing per cured Si rubber	0890-1831	N/A
5	Switch, pressure*	115226	N/A
	Nuts		
	Washers		
6	RP-reservoir assembly	G2350-60710	1
	Reservoir clips		2
7	0.5 μm water filter element	G2350-80300	1
8	Flow sensor*	0960-0877	N/A
	Elbow mounting screws		
	Washers		
NS	Water drawer control cable assy*	G2350-60750	N/A

*To upgrade your water drawer, order the following parts:

Description	Part number	Qty
Tee fitting	0100-1685	1
Water control board	G2350-60085	1
Water drawer cable	G2350-60755	1
Clamp	1400-1569	2
Restrictor	G2350-20890	1
Reducer fitting	0100-0121	1

See Figure 168 for a plumbing diagram.

See *Water drawer, AED serial no. > 1000166* on page 257 for additional replacement parts.