Hardware Manual for the DAWN® EOS™ Light Scattering Instrument

Wyatt Technology Corporation

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M2100 Rev. B

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1 Introduction

When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science.

—Lord Kelvin

William Thomson Kelvin, the 19th century physicist and mathematician who wrote that paragraph, would have been very comfortable with the DAWN® EOS (Enhanced Optical System) laser photometer and software. The DAWN systems, measuring scattered light at 18 different angles simultaneously, can determine the molar masses of polymers and biopolymers from a thousand to hundreds of millions of daltons. Certain options permit temperature control of the flow cell, the use of different lasers, and connection to an autocorrelator. The flexibility, versatility and built-in redundancy of the DAWN instruments make them exceptional measuring systems.

Read on to learn more about the DAWN EOS.

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Overview

The Instrument

The DAWN EOS combines the proven features of photometers, nephelometers, turbidimeters and "goniometers" into a single light scattering instrument. It can be used as a detector for continuous-flow (GPC/SEC/HPSEC) detection or as a stand-alone unit in a batch or micro-batch mode.

The read head and the laser tube of the DAWN anchor to the base plate, and the flow cell and manifolds bolt directly into the read head to provide a single, stable optical bench.

The laser beam is aimed into the flow cell, and passes in the same direction as the flowing stream. The windows that let light pass through the flow cell are recessed in the manifolds, minimizing sample volumes and stray light. The 18 discrete photodetectors spaced around the flow cell enable simultaneous measurements over a range of angles (typically 15°—160°, depending on solvent/glass refractive indices).

Each photodetector has its own DSP (Digital Signal Processor) chip for processing the analog signal. In addition, two auxiliary analog inputs (with their own DSP chips) enable interfacing to external detectors such as differential refractive index and ultra-violet detectors or differential viscometers. A six-pole Gaussian filter in the DSP chip processes each light scattering and auxiliary signal for the greatest possible noise rejection without peak distortion. Since the analog-to-digital conversion is performed onboard the DAWN, low light scattering signals are not prone to environmental "noise" or pickup. The digital output transmits to your computer through its RS-232 serial port.

Instrument Options

The DAWN is available with the following heating and cooling options:

- **Ambient:** Operates at room temperature only. This is the base model described in Chapters 1 through 4.
- **Ultra-High Temperature:** The read head may be heated from approximately 10° above ambient temperature to 210 °C. Temperature can be controlled to within 0.1 °C and is accurate to ±1 °C. This option is described in Appendix A.
- **Peltier Heated/Cooled:** The read head may be cooled down to -30°C or heated up to 150°C. Temperature can be controlled to within 0.1 °C and is accurate to ±1 °C. This option is described in Appendix B.

DAWN EOS vs. DAWN DSP

The GaAs laser in the DAWN EOS is more powerful and more tightly focused than the laser used in the older DAWN DSP. As a result, the data collected has higher signal to noise ratios. In addition, the laser no longer requires an alignment step.

A nitrogen purge valve is included on all models of the DAWN EOS. In addition to preventing condensation in a cooled instrument's read head, the nitrogen purge keeps the flow cell and read head cleaner at all temperatures.

The connectors, controllers, jumpers, switches, and cables have been redesigned to increase ease of use. For example, the sample input and output connectors are more easily accessible. Separate connectors and cables are provided for various auxiliary devices. On temperature-controlled models, the Watlow temperature controllers let you precisely control the temperature ramp rate and view the percentage of active heating time.

The Software

Wyatt Technology offers the ASTRA® for Windows software package for collecting and analyzing data from the DAWN instrument:

ASTRA for Windows collects and processes chromatography data from dilute polymer solutions. From polymers fractionated by size or molecular weight, ASTRA calculates the molecular weight moments (number, weight and z-average) along with the rms radius moments of the molecules in solution. From unfractionated polymers, ASTRA displays Zimm, Debye or Berry plots.

About This Manual

The *DAWN EOS Hardware Manual* describes how to set up and use the DAWN EOS laser photometer. Because the DAWN software is used for stand-alone applications and ASTRA primarily for HPLC, you need to consult their respective user's manuals for guidelines in sample preparation and auxiliary hardware setup.

Manual Conventions

We will refer to the DAWN EOS simply as the *DAWN*.

Whenever we point out internal components, your orientation is from the front of the instrument.

The IUPAC Definition Committee specifies the term *molar mass* for the sum of the atomic weights of all atoms in a mole of molecules. The term *molecular weight* means the same thing. You will see both terms used in this manual.

How the Manual Is Organized

The chapters and appendices in this manual are organized as follows:

Chapter 1—Introduction introduces the DAWN and this manual, and describes the support options available from Wyatt Technology.

Chapter 2—Setup takes you through the necessary first steps for unpacking, connecting and testing the DAWN.

Chapter 3—DAWN Components takes you on a guided tour of the DAWN.

Chapter 4—Maintenance has procedures for keeping the DAWN in good working order, and includes flow cell cleaning.

Appendix A—Ultra-High Temperature Option describes the Ultra-High Temperature version of the DAWN and its operation.

Appendix B—Peltier Heated/Cooled Option describes the Heated/Cooled version of the DAWN and its operation.

Appendix C—Polarization Option tells about the installation and use of polarization filters.

Appendix D—Interference Filters describes the use of interference filters for keeping non-laser wavelengths from reaching the photodiodes.

Appendix E—Laser Specifications supplies the electrical, optical and environmental specifications for the GaAs laser head.

Appendix F—Flow Cell Properties lists thermal and chemical properties, refractive indices, and scattering angles of solvents for the K5 and F2 flow cells.

Appendix G—Data Rate, Baud Rate, DSP Filter Settings describes these transmission settings and how to change them.

How to Contact Wyatt Technology Corporation

If you have a question about your DAWN, first look in this manual or consult the online help that comes with ASTRA for Windows. If you cannot find an answer, please contact Wyatt Technology Technical Support.

Corporate Headquarters

Wyatt Technology Corporation
30 South La Patera Lane, B-7
Santa Barbara, CA 93117
USA

Sales Department

Wyatt Technology Corporation Sales Hours are 8:30 A.M. to 5:00 P.M. Pacific Time.

Sales Phone:	(805) 681-9009
Sales Fax:	(805) 681-0123

Technical Support

Wyatt Technology Corporation offers a variety of support options to help you get the most from your DAWN.

You can also contact the Wyatt Technology Distributor in the country where you bought your product.

Before contacting technical support, try to resolve any problems through the ASTRA for Windows on-line help system and this manual.

Internet

You can use the Internet to ask questions and receive answers via e-mail, as well as visit Wyatt Technology's world-wide-web site.

World-Wide-Web URL:	http://www.wyatt.com
Electronic mail address:	support@wyatt.com

FAX

Please fill in a copy of the problem report form at the end of this chapter, then fax it. You can fax your questions or comments to us at any time.

Wyatt Technology Corporation Technical Support Fax: (805) 681-0123

Mail

Please fill in a copy of the problem report form at the end of this chapter, then mail it to our corporate headquarters.

Telephone

You can reach the voice mail for Wyatt Technology Corporation Technical Support at any time. To speak to our support personnel directly, please call between 8:30 A.M. and 5:00 P.M. Pacific Time, Monday through Friday. When you call you should be at your instrument and have the documentation at hand. Please be prepared to provide the following information:

- DAWN instrument serial number (located on the back panel).
- If the problem is software related: Microsoft Windows version number; ASTRA version number; exact wording of any messages that appear on your computer screen. The software version number is located on the original distribution diskette(s), or you can view it by selecting About from the Help menu.
- The type of computer hardware you are using.
- What you were doing when the problem occurred.
- How you tried to solve the problem.

Wyatt Technology Corporation Technical Support Phone Number:

(805) 681-9009

Where to Go from Here

Continue now to Chapter 2 to check out your shipment and make some necessary initial checks and adjustments.

If you have purchased special options, such as the Peltier Heated/Cooled version of the DAWN, you will also want to read the appropriate appendix for a description and instructions for setting up and working with the option.

2 Installing the DAWN

This chapter helps you get the DAWN unpacked, tested and connected. You will also make some first time adjustments.

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Unpacking the Instrument

This section lists accessories and spare parts shipped with the instrument. Please read this list and check that everything arrived in good condition.

1. Carefully examine the shipping container. If it has been mishandled, CONTACT THE SHIPPING CARRIER IMMEDIATELY.
2. Unpack the instrument.
3. Place the DAWN on a level surface and inspect the cabinet for damage. If you see any damage, CONTACT THE SHIPPING CARRIER IMMEDIATELY.
4. Check that the boxes contain the following items in addition to the instrument (the packing slip sent with the instrument contains an up-to-date list):

Table 2-1: Part Lists

	Ambient	**Heated/ Cooled**	**Ultra-High Temperature**
Batch Mode:			
1 Conversion kit	Ambient Batch: 200630	Heated Batch: 200631	Heated Batch: 200631
100 20 mL Scintillation vials	P8403-01	P8403-01	P8403-01
100 Scintillation vial caps	P8403-9	High Temp: P8403-0	High Temp: P8403-0
Documentation:			
1 Hardware manual			
Software			
Cables:			
1 Interface cable adapter	P3796-0925	P3796-0925	P3796-0925
1 RS-232 interface cable	P4045-03	P4045-03	P4045-03
1 Macintosh interface cable	200105	200105	200105
1 Power cable, 120 V	P4100-120	P4100-120	P4100-120
or 1 Power cable (European), 220 V	P4100-220	P4100-220	P4100-220
3 Cable assemblies, 4 Cond, 22 AWG, 2M, EOS	P4045-05	P4045-05	P4045-05
Fuses:			
2 Power module fuses	1 Amp: S3616-01000	4 Amps: S3616-04000	4 Amps: S3616-04000
or 2 Power module fuses (European)	0.5 Amps: S3616-00500	2 Amps: S3616-02000	2 Amps: S3616-02000
1 Electronics power fuse	0.5 Amps: S3616-00500	1 Amp: S3616-01000	1 Amp: S3616-01000
or 2 Electronics power fuses (European)	0.25 Amps: S3616-00250	0.5 Amps: S3616-00500	0.5 Amps: S3616-00500

Table 2-1: Part Lists

	Ambient	**Heated/ Cooled**	**Ultra-High Temperature**
Misc. Electrical:			
20 Jumper pins	S3799-02	S3799-02	S3799-02
1 Set heated lines (optional)	—	211003-X	211003-X
1 Water pump, 120 V	—	P8320-115	—
or 1 Water pump (European), 220 V	—	P8320-230	—
Fluid Fittings and Tubing:			
3 Hose clamp, snappers, 3/8”	—	P6636-06	—
2 Female barb hose fittings	—	P6701-04	—
1 90 degree fitting (for nitrogen purge line)	P6703-02	P6703-02	P6703-02
1 Polyethylene tubing, ¼” OD x 10’ (for nitrogen purge line)	S6607-04	S6607-04	S6607-04
1 Tygon tubing (12’)	—	P6609-05	—
8 Stainless steel ferrules	P6455-12	P6455-12	P6455-12
8 Stainless steel fittings	P6405-310	P6405-310	P6405-310
1 Brass barbed hose fitting (for water pump)	—	P6701-03	—
2 6 mm Kalrez O-rings (for flow cell)	P6504-2006	P6504-2006	P6504-2006
2 9 mm Kalrez O-rings (for flow cell)	—	P6504-2009	P6504-2009
2 Backing rings (for flow cell)	200609	200609	200609
2 Window O-rings	P6504-2004	P6504-2004	P6504-2004
2 Flow cell windows	116007-002	116007-002	116007-002
1 Precut stainless steel tubing, 0.005" ID x 3" (white insulation)	212053-0539	212053-0539	212053-0539
1 Precut stainless steel tubing, 0.010" ID x 7" (white insulation)	212053-1079	212053-1079	212053-1079
1 Precut stainless steel tubing, 0.010" ID x 3" (blue insulation)	212053-1036	212053-1036	212053-1036
1 Precut stainless steel tubing, 0.010" ID x 7" (blue insulation)	212053-1076	212053-1076	212053-1076
1 Precut stainless steel tubing, 0.005” ID x 10” (white insulation)	212053-0519	212053-0519	212053-0519
1 Precut stainless steel tubing, 0.010” ID x 10” (blue insulation)	212053-1016	212053-1016	212053-1016
Tools:			
1 1.5 mm Ball driver	P9004	P9004	P9004
1 2.0 mm Ball driver	P9015	P9015	P9015
1 2.5 mm Ball driver	P9005	P9005	P9005
1 4 mm Ball driver	P9008	P9008	P9008
1 Flat-bladed screwdriver, 3/16"	P9016	P9016	P9016
2 Crescent wrenches, ¼"	P9018	P9018	P9018

Table 2-1: Part Lists

	Ambient	**Heated/ Cooled**	**Ultra-High Temperature**
1 Jeweler's loupe	P8404	P8404	P8404
1 Disposable wrist strap	P9012	P9012	P9012
1 Box, 13”, Trans Poly	P9328-013	P9328-013	P9328-013
1 Shipping box label	P8016	P8016	P8016
Optional Standards Kits:			
1 Organic standards kit	P8402	P8402	P8402
or 1 Aqueous standards kit	P8401	P8401	P8401

You may have additional items if you ordered optional features such as the Autocorrelator, Polarization, or Interference Filter options.

Installing the Instrument

The installation procedure for the DAWN EOS involves some initial tests to see that everything is working properly.

To install the DAWN, do the following:

1. Place the DAWN on a flat, clean surface, standing on its feet and positioned to allow air convection through the back of the instrument to keep its electronics cool. (See Chapter 4 for more information about the DAWN environment and how to keep it in peak condition.)
2. Check that the voltage setting on the back panel is correct. The voltage has already been set at the factory. Should you ever need to change it, see the instructions in Chapter 3.
3. Plug the power cord into its connector on the back panel. Plug the other end into an AC outlet.
4. Connect one end of the RS-232 interface cable to its port on the instrument's back panel. Plug the other end into the computer's serial port.

   This 9-pin interface cable connects the SERIAL connector on the back panel of the DAWN to a serial port on the back panel of your computer. We recommend COM2 for most systems.

Note: If you use an interface cable other than the one supplied by WTC, it must be a "9-pin RS-232 serial cable with all 9 wires wired straight through".

5. Switch on the instrument and let it warm up for 30 minutes before continuing to step 7. The power switch is on the rear panel.
6. If you have the Nitrogen Purge option for Peltier cooled instruments (this step is not necessary for ambient or heated instruments): While the instrument is warming up, attach a filtered dry air or chromatographic grade nitrogen line to the Nitrogen Purge connector on the back of the DAWN. Use the 90 degree fitting and the 10' Polyethylene tubing provided. The dry gas will flow into the cell cavity and will minimize the amount of dust in the cell cavity. The pressure in the dry air or nitrogen line should be 20 psi or less. (If you are using a Peltier Heated/Cooled DAWN and operating below ambient temperature, it is particularly important to use the nitrogen purge line to prevent condensation. At ambient or high temperatures, the air source excludes dust from the instrument by creating positive pressure inside the cell.)
7. After the instrument has warmed up for 30 minutes, press the up or down button to switch the channel displayed on the front panel. Con-

firm that the channel values agree with the dark offsets in the DAWN EOS Certificate of Performance.

Channel Setting	**Value Displayed**
L	Rear laser monitor voltage
1–18	Detector 1 through 18 voltage
A1, A2	Auxiliary 1, 2 voltage
F	Forward laser monitor voltage
P1	+5 volt power supply voltage
P2	+15 volt power supply voltage
P3	-15 volt power supply voltage
LC	Laser drive current

If the readings for detectors 1–18 are different from those on the Certificate of Performance, check your laboratory temperature. The dark offsets for the detectors may differ from the Certificate of Performance by as much as 10 mV per °C. For example, if your laboratory temperature is 20 °C and the QC laboratory temperature was at 23 °C, your current dark offsets may be 30 mV different. If you see a greater difference, monitor the dark offsets for a few days to see if they remain stable at this voltage. If they do not, contact Wyatt Technology Technical Support.

The rear and forward laser monitors are set to 5 volts at the factory and should be within ±0.1 volts DC.

8. Using the supplied WTC software (ASTRA), perform the appropriate steps to configure the instrument to communicate with the software. Establishing communications with the software causes the laser to turn on. (See the software user's guide for instructions on configuring communication with the instrument.)
9. After establishing communications, wait at least 30 minutes for the laser to warm up and stabilize.

Note: The laser in the DAWN EOS is software-controlled and will not be turned on until communications have been established between the software and the instrument.

10. View the numeric real-time channel values. (See the software user's guide for instructions on viewing real-time channel values.)
11. Compare the channel values with the solvent offsets on the Certificate of Performance.

Before shipment, the solvent offsets were measured with toluene and the flow cell was filled with toluene and capped, so the solvent offsets you see should be very close to those on the Certificate of Performance. More than 20 mV difference between your values and those on the Certificate of Performance may indicate air bubbles in the manifolds, in which case you will need to flush the cell with filtered toluene and recheck the solvent offsets. If your dark offsets differed from the Certificate of Performance in step 7, the solvent offsets should differ by the same amount.

Tip: You can use the ASTRA software to view all channel voltages at once (except channel F), as opposed to the single value shown on the front panel.

12. Calibrate the DAWN using the ASTRA software.

See the software user's guide for instructions to configure communication with the instrument and perform the calibration measurement.

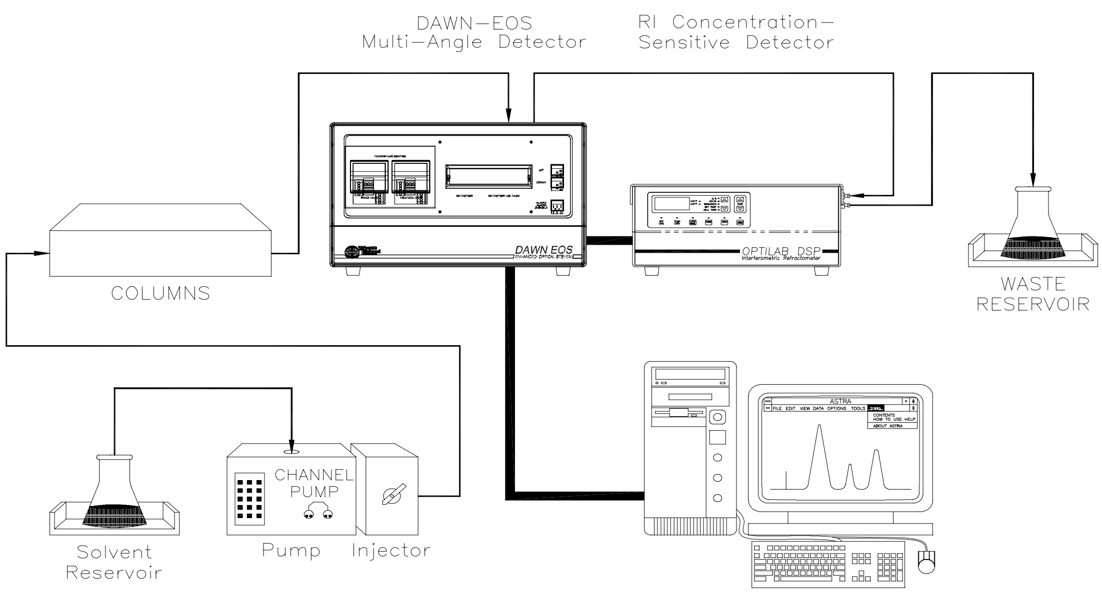
13. Compare your calibration result with the value from the Certificate of Performance.

Your calibration result should be within 5% of the value on the Certificate of Performance.

14. When you have confirmed that the instrument is in good working order, connect the DAWN to any other devices for your application. (Auxiliary cable connection is described in the next section.)

The *ASTRA for Windows User's Guide* describes how to connect the DAWN to your chromatography system.

Figure 2-1: The DAWN in-line with a chromatography system



This configuration requires the ASTRA software.

Note: The cover has an opening above the read head. You can remove the black section of the cover (the bib) by rotating it to release the magnets that hold it in place. You may want to use this opening to connect the inlet and outlet lines directly to the flow cell. Minimizing the amount of connecting tubing in this way reduces the dead volume of the system.

Connecting Auxiliary Devices

You can connect the DAWN to various other devices using the connectors on the back panel. Three cables are provided for such connections. These cables have a DAWN connector on one end and four wires on the other end. Because devices have a variety of connector types, you will need to attach these wires to the connector used by your devices.

The auxiliary device connectors on the back of the DAWN are:

- AUX 1 and AUX 2: You can connect the DAWN to one or two concentration-sensitive detectors (DRI, UV, DAD, etc.).
- AUTO INJECT: You can use this connector to sense an injection from an auto injector. This signal is then monitored by the ASTRA software.
- 90° DET: You can use this connector to send the 90° output signal to your existing data collection system or to a chart recorder.
- VAPOR INTERLOCK: You can use this connector to detect any solvent leaks and to shut down an external device, such as a pump, if a leak is detected.
- CORR. OUT: Connection for the WyattQELS instrument.

Attaching Auxiliary Device Connectors

To attach an Auxiliary connector, do the following:

1. Attach a cable to the appropriate port on the rear panel of the DAWN.
2. Connect the wires of the cable to your other device as shown in this table:

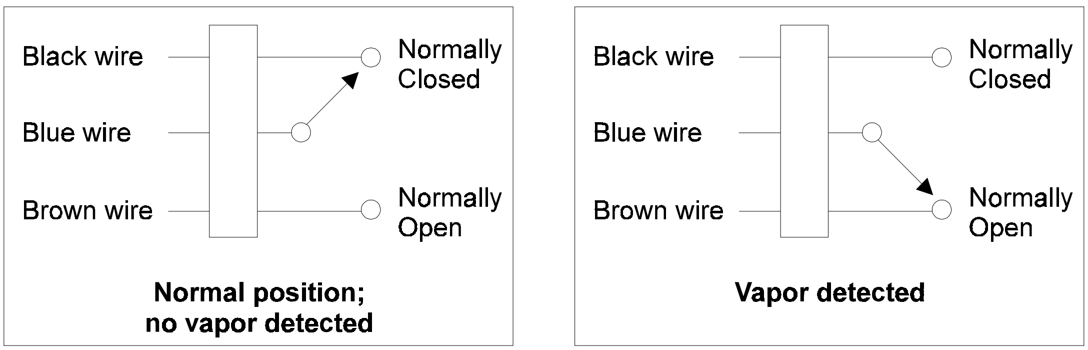
Table 2-2: Auxiliary Connector Wires

	Brown Wire	Blue Wire	Bare Wire (shield)	Black Wire
Aux 1	positive terminal	negative terminal	chassis ground	signal ground
Aux 2	positive terminal	negative terminal	chassis ground	signal ground
Auto Inject	input	return	chassis ground	not used
90° Det	output	return	signal ground on A/D board	not used
Vapor Interlock	normally open	common	chassis ground	normally closed

3. You may need to connect the wires to a connector provided with your device or to the device directly. The following list contains additional information for various auxiliary connectors:
   - AUX1 or AUX2: It is not usually necessary to connect the ground and shield wires. However, if you experience electronic drift or noise, try connecting the ground wire and/or the shield wire to the RI detector's chassis ground.

- AUTO INJECT: Some injectors require programming in order for the closure to happen. Make sure that an injection closes the circuit.
- VAPOR INTERLOCK: Two relay contacts are provided, one Normally Open (NO) and one Normally Closed (NC). When vapor is detected, the NO contact closes and the NC contact opens. For example, you might want to connect the system so that power to the pump shuts off (blue and black wires) and power to an alarm turns on (blue and brown wires) when vapor is detected. The relay can handle a maximum of 250 V at 2.0 A. The circuit diagram is shown in Figure 2-2.

Figure 2-2: Vapor interlock circuit in normal and vapor present modes



Adjusting the Auxiliary Gain

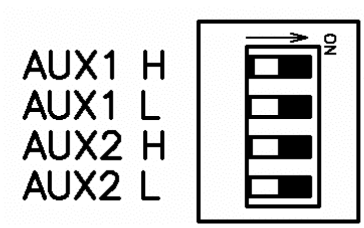
The DAWN is shipped with an AUX gain setting of 1x, which can be adjusted via the DIP switch on the amplifier booster board. (See the section on "Printed Circuit Boards" in Chapter 3.)

To adjust the gain settings, do the following:

1. Disconnect the power cord.
2. Remove the Amplifier Booster board cover from the left side of the chassis.
3. Locate the DIP switch at the lower-left corner of the booster board.

   You will see that the switch settings are all ON for a 1x gain.

Figure 2-3: AUX Gain switch on Amplifier Booster board



4. Set the switch according to the table shown below and on the board.

The gain adjustments for AUX1 and AUX2 are independent of one another, so, for example, you could set the gain at 1000 for AUX1 and at 10 for AUX2.

Table 2-3: AUX gain settings

	AUX1	
GAIN	**AUX1 H**	**AUX1 L**
1	ON	ON
10	ON	OFF
100	OFF	ON
1000	OFF	OFF

	AUX2	
GAIN	**AUX2 H**	**AUX2 L**
1	ON	ON
10	ON	OFF
100	OFF	ON
1000	OFF	OFF

3 DAWN Components

This chapter gives you a guided tour of the DAWN components, starting with the front panel and ending with the printed circuit boards.

The instrument was shipped in perfect condition and should be received that way. If you have just installed the DAWN, read this chapter to complete your inspection and to familiarize yourself with the various instrument parts and their functions before making any measurements.

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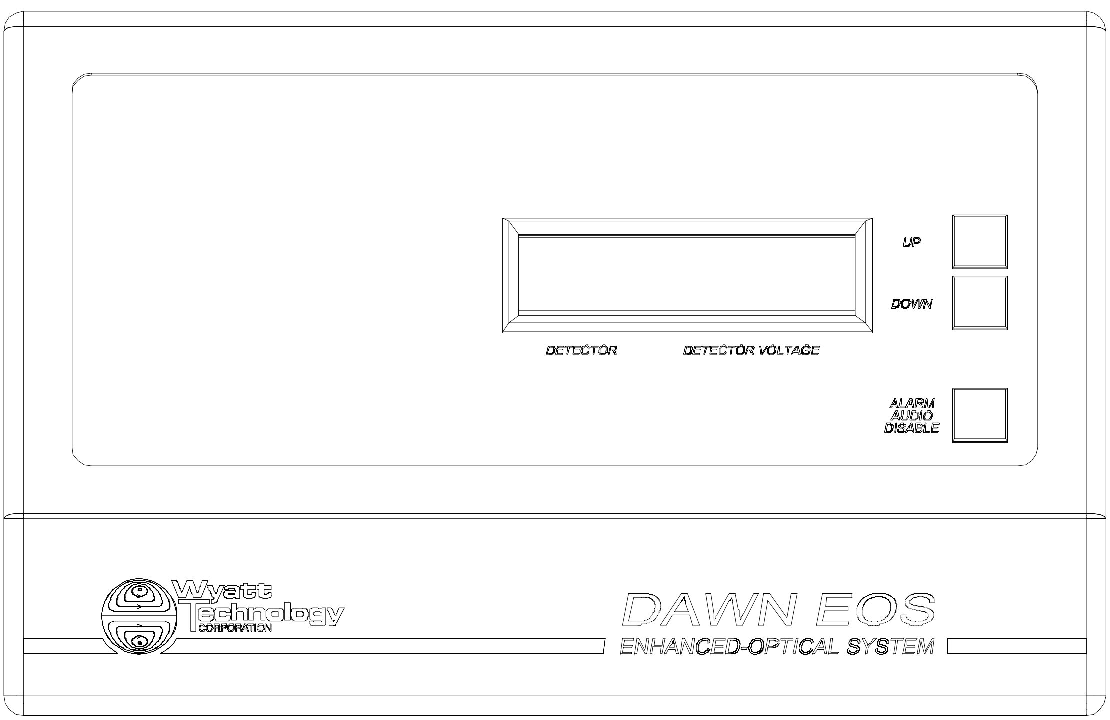
Front Panel View

On the front panel of the DAWN you will find the channel display, the channel selection UP and DOWN buttons, and an ALARM AUDIO DISABLE switch. The selected channel and its voltage are shown on the LED display.

Table 3-1: Channel settings available on the LED display

Channel setting	Value displayed
L	Rear laser monitor voltage
1–18	Detector 1 through 18 voltage
A1, A2	Auxiliary 1, 2 voltage
F	Forward laser monitor voltage
P1	+5 volt power supply voltage
P2	+15 volt power supply voltage
P3	-15 volt power supply voltage
LC	Laser drive current

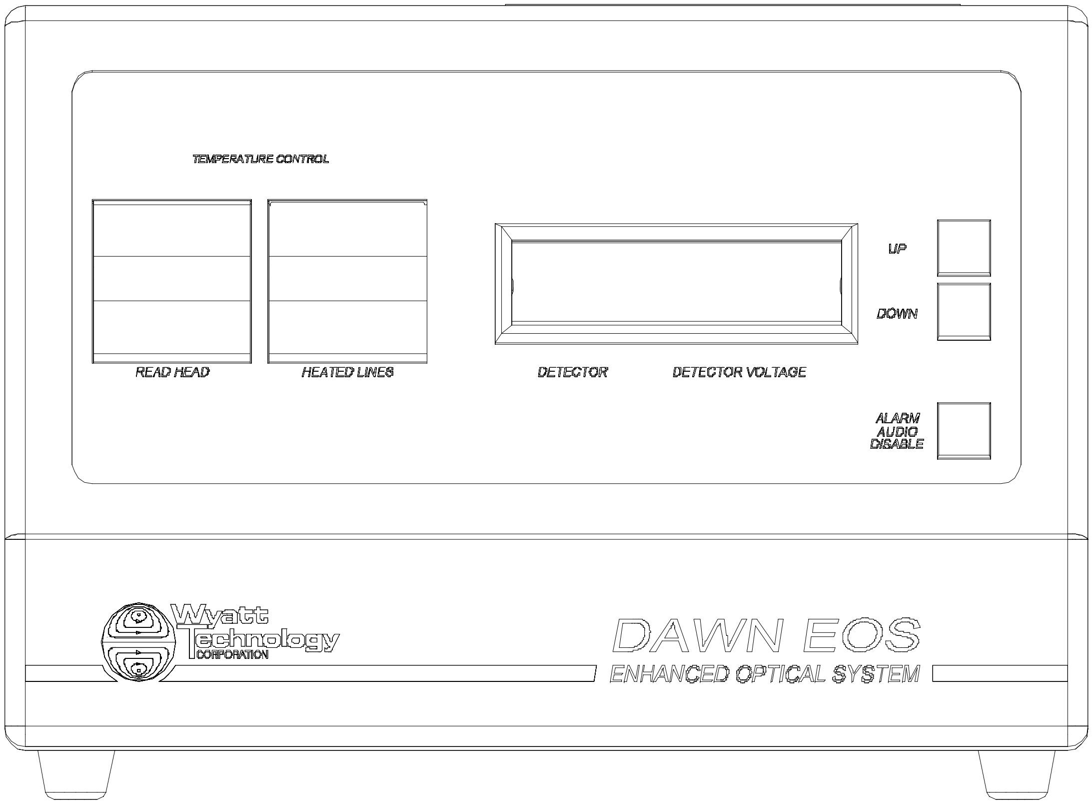
Figure 3-1: Ambient front panel



With the Ultra-High Temperature or Peltier Heated/Cooled option, the front panel has a read head temperature controller.

If you purchased an optional heated line, the front panel also has a temperature controller for the heated line. If you purchase a heated line at a later time, you will receive a second controller to add to the front panel. These controllers are described in Appendix A.

Figure 3-2: Temperature-controlled front panel (with optional heated line controller)

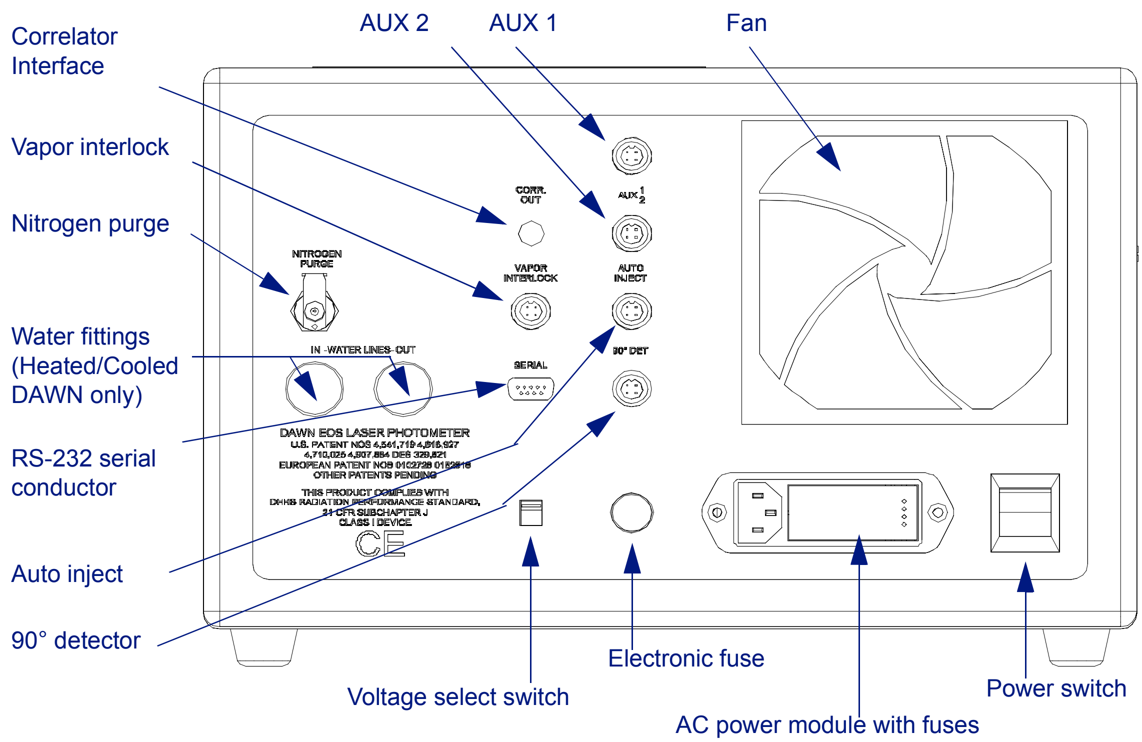


Back Panel View

The back panel contains the main power switch, AC power module, auxiliary and serial connectors, nitrogen purge connector, and cooling fan. The electronic fuse is also located on the back panel; the main power fuses are located in the AC power module and are described below.

With the Peltier Heated/Cooled option, which is described in Appendix B, the back panel also includes an inlet and outlet for water circulation.

Figure 3-3: Back panel



Changing the Voltage

The DAWN is configured for the AC power listed on the instrument identification label, and may be reconfigured for use anywhere in the world.

What you need to change the voltage:

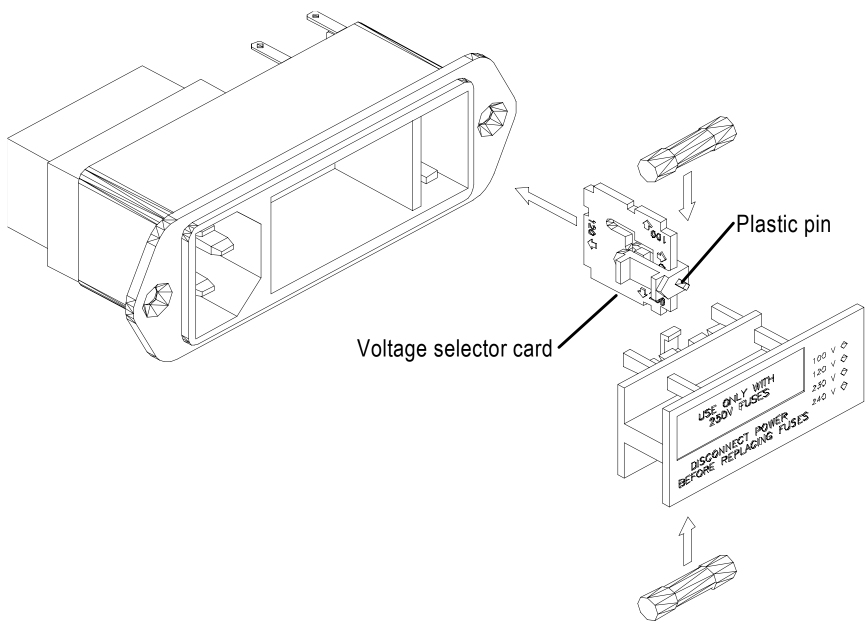
- Tool to pry off AC Power module cover, such as a small-bladed screwdriver.
- Fuses for the new voltage from set of spares supplied in the accessory kit.

To change the selected voltage, do the following:

1. Disconnect the power cord.
2. Pry open the cover of the AC Power module using a screwdriver with a small blade or a similar tool.

3. Set aside the cover/fuse block assembly and pull the voltage selector card straight out of its housing (Figure 3-4).

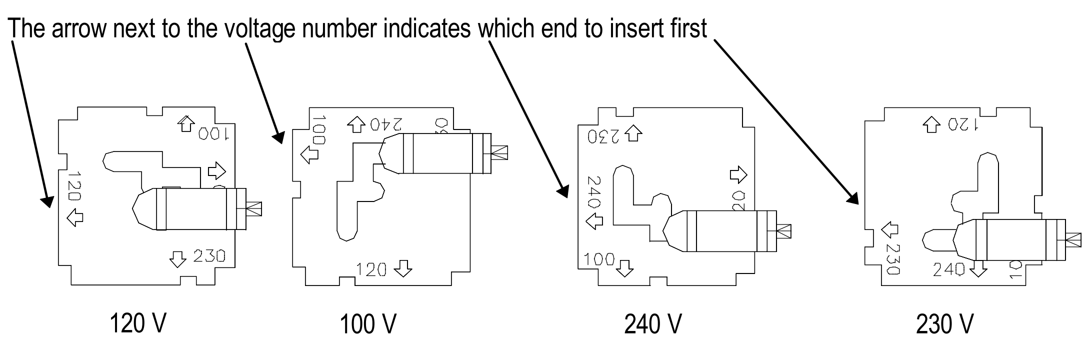
Figure 3-4: Fuse/AC power module assembly



The plastic pin points in the opposite direction to the arrow for the selected voltage.

4. Orient the selector card and plastic pin so that the selected voltage is readable at the left side of the card, and the plastic pin points to the right side of the card (Figure 3-5).

Figure 3-5: AC voltage selector card orientation



You can slide the pin around to each side of the card.

5. Insert the selector card into the housing so that the printed side of the card is facing towards the power socket.

6. Replace the old fuses with new ones according to the chart below:

DAWN type	Voltage	Amperes	Speed
Ambient	100/120	1.0	slow
	220/240	0.5	slow
Ultra High Temp.	100/120	4.0	slow
	220/240	2.0	slow
Heated/Cooled	100/120	4.0	slow
	220/240	2.0	slow

7. Replace the electronic fuse according to the chart below:

DAWN type	Voltage	Amperes	Speed
Ambient	100/120	0.5	slow
	220/240	0.25	slow
Ultra High Temp.	100/120	1.0	slow
	220/240	0.5	slow
Heated/Cooled	100/120	1.0	slow
	220/240	0.5	slow

8. Set the Voltage Select switch to the desired voltage, making sure it matches what you set on the selector card in Step 4.
9. Replace the cover and verify that the indicator pin shows the desired voltage.
10. Connect the power cord.

Changing a Fuse

What you need to change a fuse:

- Tool for prying the AC Power module cover off, such as a small-bladed screwdriver.
- Fuses from the spares supplied in the accessory kit.

To replace a Main Power Fuse, do the following:

1. Disconnect the power cord.
2. Open the cover of the AC Power module using a small blade screw-driver or similar tool.
3. Replace the old fuses with new ones according to the chart in step 6 of "Changing the Voltage," above.

   Be sure to use the correct fuse for the voltage.
4. Replace the cover of the AC Power module and reconnect the power cord.

To replace an Electronic Fuse, do the following:

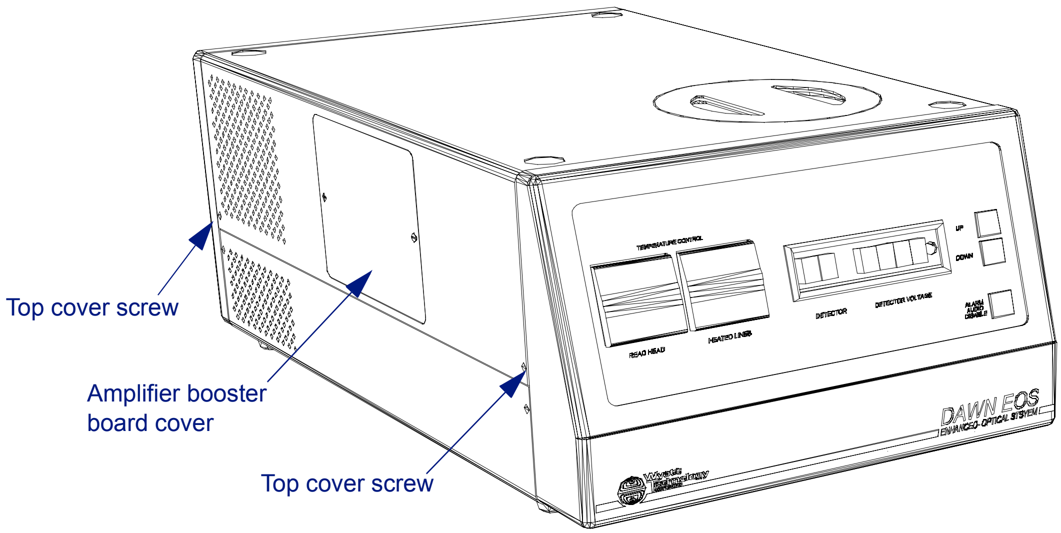
1. Disconnect the power cord.
2. Remove the electronic fuse by turning its holder counter clock-wise half a turn and pulling it towards you.

3. Replace the old fuse in the holder with a new one according to the chart in step 7 of "Changing the Voltage," above.
4. Be sure to use the correct fuse for the voltage.
5. Replace the fuse holder by pushing it into its receptacle and turning it clock-wise half a turn, then reconnect the power cord.

Side Panel Views

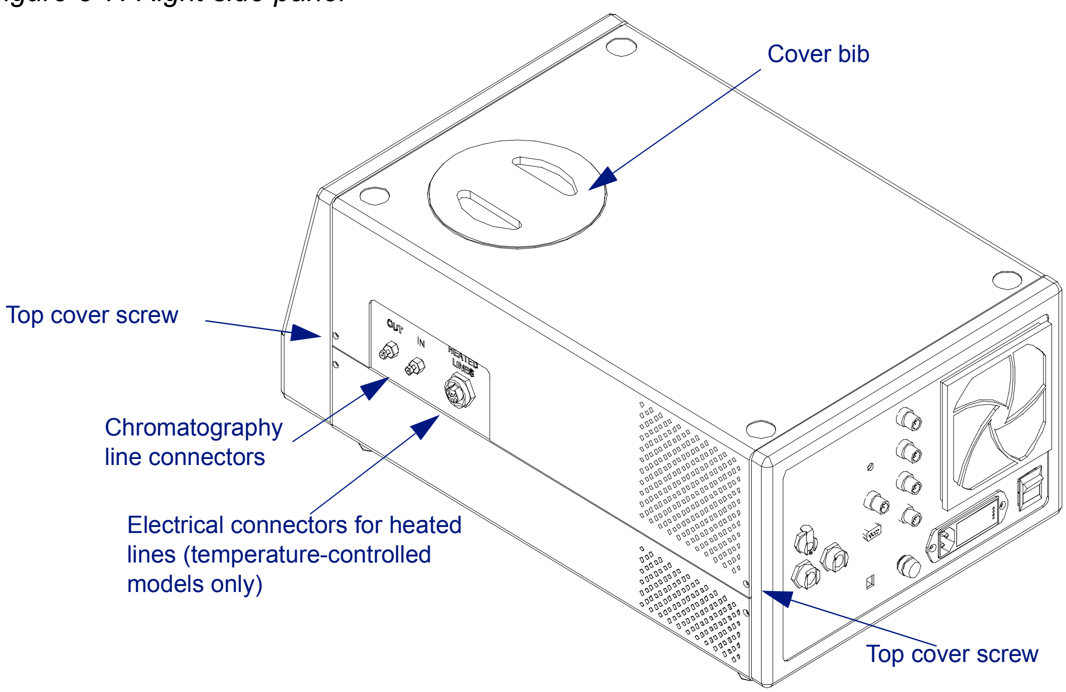
The left side panel has a cover for the Amplifier Booster board. You can remove this cover with a flat-bladed screwdriver. See “Amplifier Booster Board” on page 3-21 for information about changing the amplification.

Figure 3-6: Left side panel.



The right side panel has IN and OUT fittings for chromatography line connections. The Ultra-High Temperature and Peltier Heated/Cooled models also have an electrical connector for the heated lines on the right side panel (see Appendix A).

Figure 3-7: Right side panel



DANGER: The HEATED LINE fitting contains live 120 V pins. Keep the dust cap on this connector whenever the heated lines are not connected.

Top Cover

The cover has an opening above the read head. You can remove the black section of the cover (the bib) by rotating it to release the magnets that hold it in place. The bib is shown in Figure 3-7.

Removing the Cover

The DAWN has access covers for the flow cell, AC power module, and Amplifier Booster board. For normal operation and maintenance, you should not need to open the top cover. If you do need to open the top cover, follow these instructions.

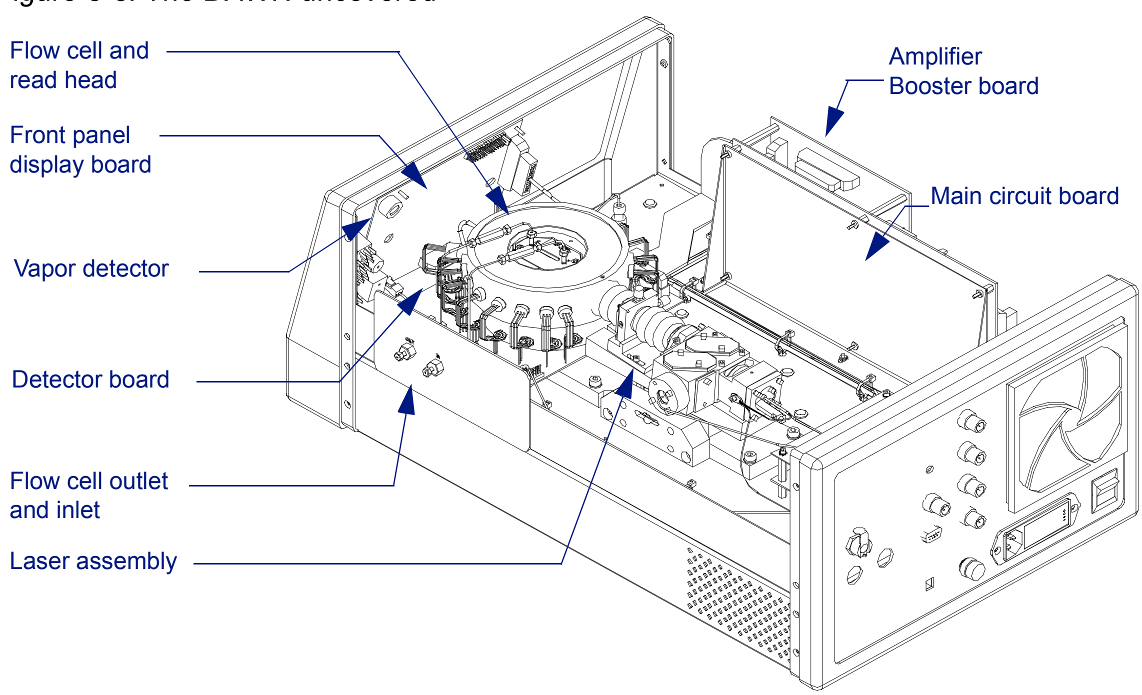
What you need to remove the cover:

- 2.0 mm Ball driver

To remove the cover, do the following:

1. Make sure the DAWN has enough space above it to lift up the cover.
2. Disconnect the power cord.
3. Remove the four screws that fasten the top cover to the instrument using the 2.0 mm Ball driver. The screws are shown in Figure 3-6 and Figure 3-7.
4. Slide the cover up to remove it. You can now see the DAWN components.

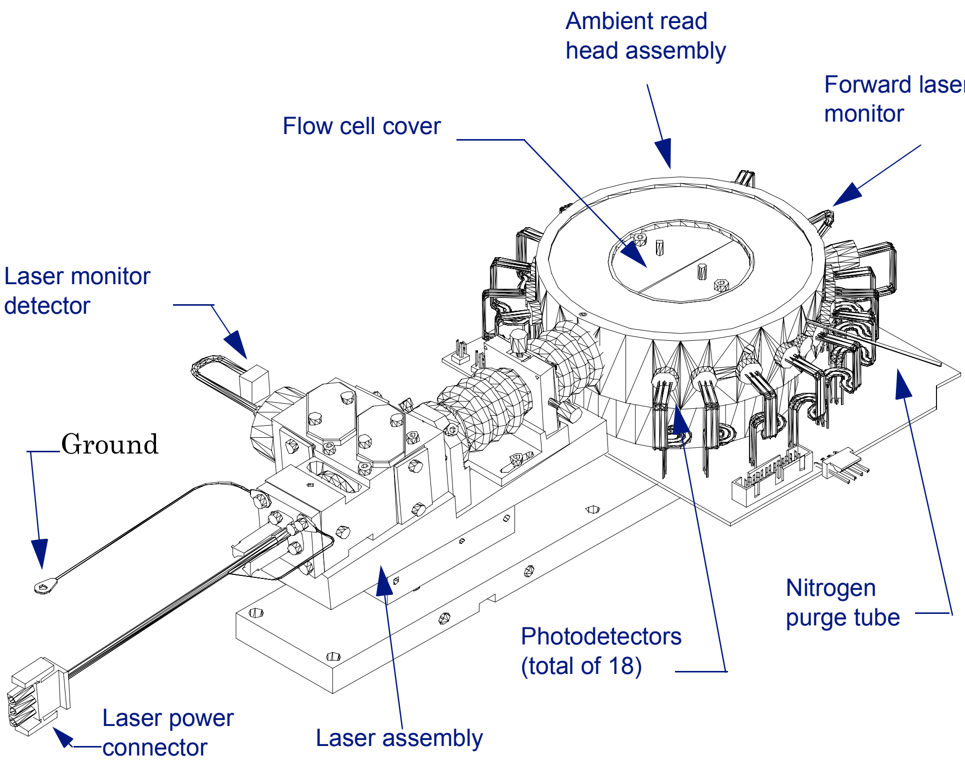
Figure 3-8: The DAWN uncovered



Laser

The 30 mW linearly polarized GaAs (gallium arsenide) laser provides the exceptional light source for the system. The special laser system provides very high power density at the illuminated sample by means of a special, narrow beam diameter (the $1/e^2$ diameter of the Gaussian beam profile is 0.2 mm). This small beam diameter also helps reduce the noise contributions of larger particulate contaminants (such as dust). The laser is positioned so that the incident beam is vertically polarized. A beam monitor (rear laser monitor) is incorporated in the laser assembly. The output of this monitor is displayed on `CHANNEL L` of the channel display.

Figure 3-9: Read head and laser assemblies



Laser Beam Warning

It is good laboratory practice with any laser source, irrespective of its power, to <u>AVOID LOOKING INTO THE BEAM</u>. Figure 3-10 shows the warning label affixed to the read head. Appendix E gives the laser specifications.

Figure 3-10: Laser beam warning label

DANGER

LASER RADIATION WHEN OPEN
AVOID DIRECT EXPOSURE TO BEAM.

Laser Monitors

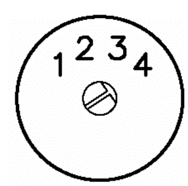
The software uses the rear laser monitor signal, Channel L, to normalize the scattering signals relative to incident laser beam power. The method involves splitting the beam at its source and dividing background corrected values by the split signal. The normalization factor I_0—the incident intensity, is proportional to the beam emitted from the front of the laser and is obtained from the beam splitter on the laser assembly.

- CHANNEL L is adjusted to about 5 volts before the instrument is shipped. If, over time, the rear laser monitor value begins to drop below 4.9 volts, contact Wyatt Technical Support. The laser may have reached the end of its useful lifetime. You can view the rear laser monitor voltage on the front panel or in the software (see the respective software User's Guide "Collect Menu" section).
- CHANNEL F, the forward laser monitor, enables the DAWN to measure transmitted light through the flow cell and sample. (The software does not use this value.) It is useful for detecting flow path obstructions, such as air bubbles or large particles, which reduce the transmitted signal intensity to near zero volts.
- CHANNEL LC, the laser current monitor, is used for diagnostic purposes by Wyatt Technology.

You can send either the forward laser monitor signal or the laser current monitor signal to an auxiliary device by turning the laser monitor rotary switch on the Amplifier Booster board (shown in Figure 3-18). Use a small screwdriver to turn the selector in the center of the dial to position 1, 2, 3, or 4.

Figure 3-11: Laser monitor rotary switch

SW POS	FUNCTION
1	F —> AUX3
2	F —> AUX2
3	L_{CUR} —> AUX2
4	OFF



Note: Position 4 is the default setting. Before you change the setting, disconnect any device connected to the AUX2 connector and monitor the AUX2 input using the ASTRA software. Return this switch to position 4 before connecting a device to the AUX 2 connector.

The numbered switch settings are as follows:

1. F -> AUX3: This setting is reserved for future use.
2. F -> AUX2: This setting causes the forward laser monitor signal to be sent to the AUX2 input. It is possible to use the forward laser monitor signal to measure the transmitted light intensity at the center of the cell when the laser is passing through a light-absorbing sample.

3. L_{cur} -> AUX2: This setting causes the laser current signal to be sent to the AUX2 input. This setting can be used for diagnostic purposes to detect laser instability due to temperature fluctuations or the power supply.
4. OFF: This is the default setting. This setting allows the signal from a concentration detector to be received by the AUX2 connector. This data is then passed to the software along with the data collected by the DAWN.

Read Head and Detectors

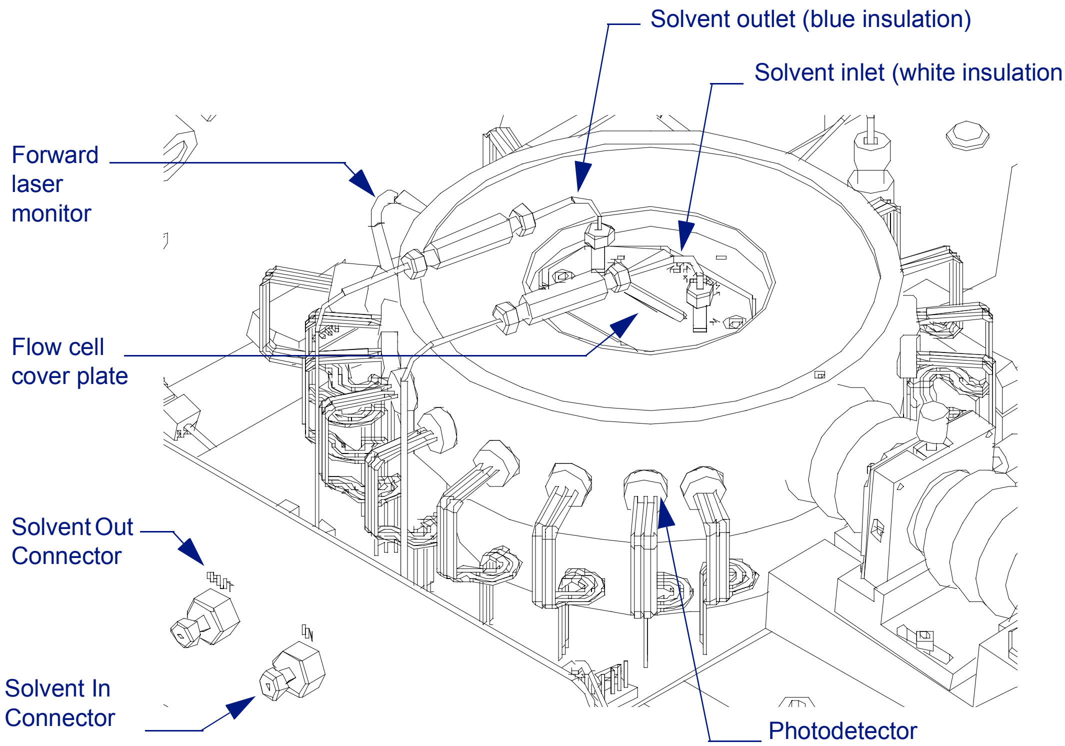
The next major assembly is the read head (Figure 3-12 and Figure 3-13). Here, the sample cell is held precisely, scattered light is collimated, and the detectors are aligned in their proper angular positions.

Read Head Structure

The read head structure holds the 18 hybrid transimpedance photodetectors, limits the sample field of view at each detector, and minimizes stray light effects by means of its special structure. Since each detector's field of view is limited by its own collimator, only the center of the illuminated sample scatters light into a given detector. A heavy aluminum mounting plate supports both the laser and the read head and is attached to the instrument sub-chassis, providing a single, stable optical bench structure.

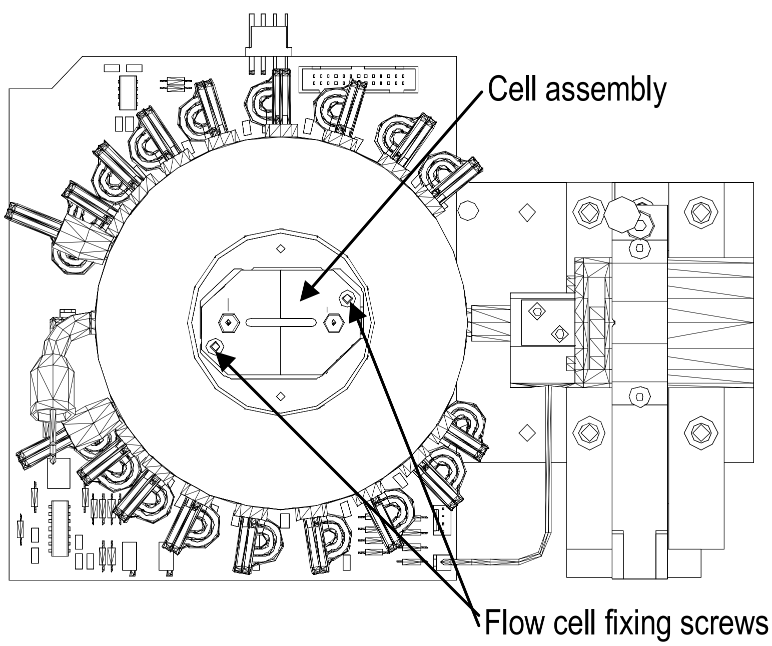
The optics have been aligned at the factory and should need no adjustment. If you are examining the instrument for the first time, check for any obvious damage, broken wires, loose screws, etc. Note that the instrument's major components are mounted on the steel sub-chassis, which also contains all power supplies (laser, meters, electronics) and fan assembly.

Figure 3-12: Ambient read head



In Figure 3-13 the two halves of the read head cover plate have been removed to reveal the flow cell assembly. You can view the cell bore through an opening in the cell manifolds.

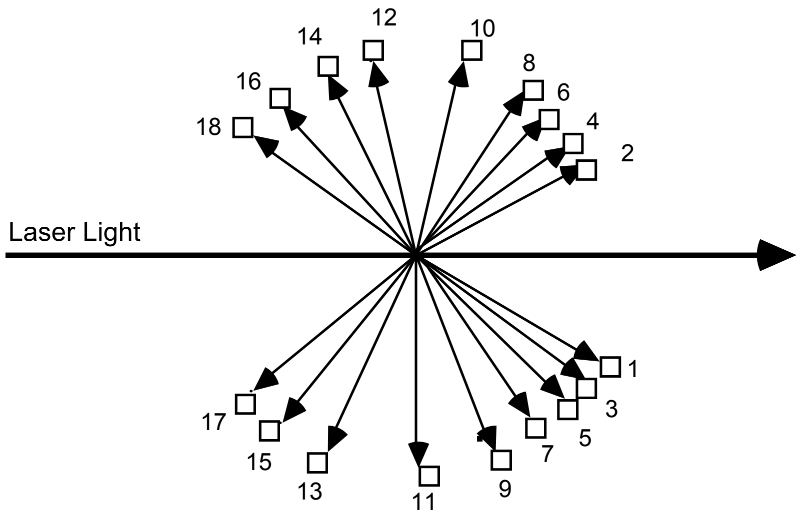
Figure 3-13: Read head, top view, open



Detector Placement

The 18 detectors are placed as shown in Figure 3-14. Channel #1 is available only during Batch measurements (using scintillation vials).

Figure 3-14: Detector locations



The angles are measured with respect to the direction of the laser beam. Since the observed angle changes with solvent refractive index, small scattering angle measurements are possible. To include at least some small scattering angles for all solvents, we have chosen the set of fixed detector angles, θ'. (See "“Flow Cell” on page 3-16" in this chapter.)

Table 3-2: Positions of the 18 detectors relative to the incident laser beam

Channel #	(fixed detector angles)
1	22.5°
2	28.0°
3	32.0°
4	38.0°
5	44.0°
6	50.0°
7	57.0°
8	64.0°
9	72.0°
10	81.0°
11	90.0°
12	99.0°
13	108.0°
14	117.0°
15	126.0°
16	134.0°
17	141.0°
18	147.0°

Masking a Detector

Should you ever wish to mask a detector to decrease its field of view and reduce signal levels you can do so quite easily.

What you will need to mask a detector:

- Anti-static wrist strap
- Tweezers
- Small mask

To mask a detector, do the following:

1. Put on the anti-static wrist strap.
2. Switch off the power to the instrument and laser, then remove the top cover.
3. Ground yourself to the chassis and gently remove a photodiode from the read head using a pair of tweezers.

   Be careful not to stress the solder connection of the lead to the PCB. Also, make sure the leads do not touch one another to cause a short circuit.
4. Insert a small mask into the collimated hole.
5. Remove the black O-ring from the photodiode and push it into the shoulder of the collimated hole.

   This holds the mask in place.
6. Moisten the O-ring, then push the detector through the O-ring, against the mask, and into its collimated hole.

   By moistening the O-ring you ensure that the detector slides easily into place.
7. Replace the cover and switch the instrument and laser back on.
8. Repeat normalization and, for Batch mode, solvent offset measurements.

Detector Gain

The amplification on all the detectors is set to 101.0 at the factory, but can be changed via the Amplifier Booster Board for your application. See “Amplifier Booster Board” on page 3-21 in this chapter for details.

Flow Cell

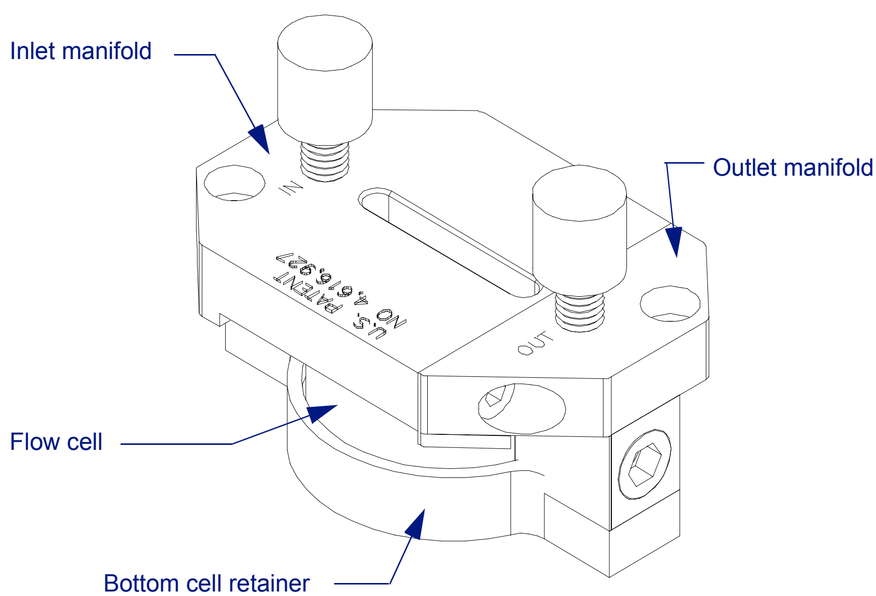
Flow Cell Design

The patented flow cell is at the heart of the DAWN, and is critical to the instrument’s unique measuring capabilities.

In many applications, such as chromatography, the ability to measure small samples is crucial, so cell volumes must be minimal. The total volume of the cell from the manifold inlet to the manifold outlet is about 70 μL. The actual scattering volume—the illuminated part of the sample that is viewed by the detectors—is less than 1 μL.

In other light scattering instruments, the cell walls are so close to the detected sample that the light scattered from the cell walls often overwhelms the small scattering signals from the sample. The DAWN’s flow cell design resolves this dilemma. Because the windows are recessed in the manifolds, away from the scattering volume, any stray light from the air/glass/solvent interfaces is not seen by the detectors. As a result, the detectors measure scattering only from the sample and not from the cell.

Figure 3-15: Flow cell assembly



Laser Beam Orientation

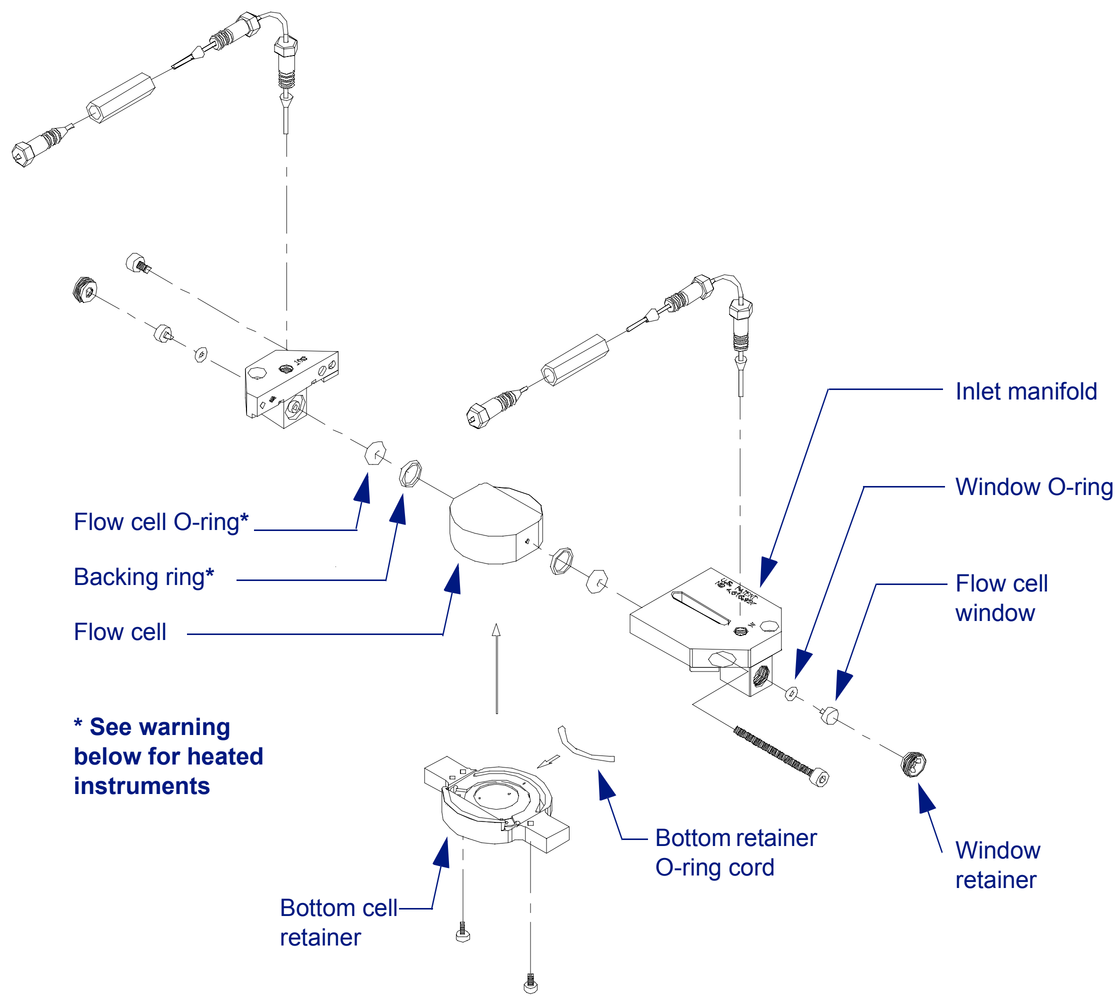
Another critical element of the DAWN flow cell is the laser beam’s unconventional orientation: The laser passes in the same direction as the flowing stream. This helps to minimize beam/cell interface problems by keeping the cell and its interfaces clean of precipitates.

Cell Windows

The cell's windows protrude into the flowing stream at the entrance and exit manifolds. These miniature rods of glass are designed to minimize debris buildup on their flat ends, and, for the same reason, have no recessed rims or edges.

Note: The large surface facing out from the cell has been coated to minimize reflections (shown in Figure 4-5). Be careful not to scratch the coating during cleaning and do not use acids.

Figure 3-16: Exploded view of the flow cell assembly (–30 °C to +80 °C configuration)

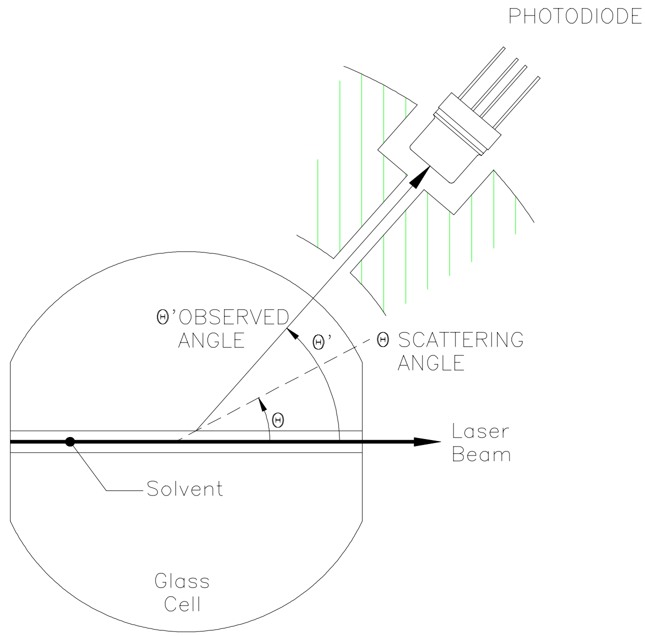


Warning: If you intend to operate your instrument above 80 °C, the flow cell must use the 9 mm O-rings instead of the 6 mm O-ring and backing ring combination used at lower temperature. The instrument is initially configured for the temperature you indicated during the purchasing process. If your instrument is configured for temperatures below 80 °C and you decide to operate at temperatures above 80 °C, you must change the O-ring configuration. Failure to do so may cause the flow cell glass to crack.

Refractive Index Differences—Liquid vs. Glass

The difference in refractive index between the solvent and the surrounding glass cell results in some of the most important features of the flow cell design. As long as the refractive index of the solvent is less than that of the cell glass, it will be possible to obtain measurements of light scattered at relatively small angles, with minimized background contributions. Figure 3-17 shows a detail of the liquid/glass interface and rays scattering from the laser-illuminated sample.

Figure 3-17: Flow cell refractions



Applying Snell's Law, the refraction of a ray scattering at angle θ may be determined from

$$n_{liquid}\sin(\pi/2-\theta)=n_{glass}\sin(\pi/2-\theta')$$

(1)

where the angle of incidence is $\pi/2-\theta$ and the angle of refraction is $\pi/2-\theta'$. Expanding the sine functions in Equation (1) results in

$$n_{liquid}\cos(\theta)=n_{glass}\cos(\theta')$$

(2)

The detectors are set to detect light at an angle θ, collimated to be centered in the cell. As a result of refraction, the light detected is the light scattered at an angle θ. In this way a greater angular range of scattered light can be detected. Table F-3 in Appendix F lists the flow cell scattering angles.

Accessible Available Detectors

Because of the refraction of scattered light passing from the solvent into the glass cell, some fixed detector angles are inaccessible. Consider water, for example. With a refractive index of 1.330 and the K5 cell refractive index of 1.51876 (at 690 nm), the smallest scattering angle must be $\theta = 0°$. Substituting into Snell's Law Equation (2) we find the smallest fixed detector angle, viz.

$$1.332\cos(0°) = 1.52064\cos(\theta')$$

$$\therefore \theta' = \cos^{-1}(1.332/1.52064) = 28.8°$$

We see that for water the first accessible detector is the third, corresponding to $\theta' = 32.0°$. Since this is the lowest detector for a water solvent system, theoretically no scattered light should enter Channels 1 and 2 (note that Channel 1 is actually blocked by the flow cell). Although there may be signals on these channels, their source is not light scattered from the sample, but rather stray light outside the range of the experiment. The ASTRA software will select the appropriate detectors based on these considerations. See Table F-3 in Appendix F for more examples.

Vapor Alarm

The DAWN has a vapor detector alarm to aid in safe operation of the instrument, especially at high temperatures. The vapor detector is not intended as a protection device but as a convenience to alert the operator to the possibility of flammable liquid or vapor inside the DAWN.

The alarm activates within 15 to 30 seconds after vapor is present. The alarm should reset within 30 seconds after all solvent disappears from the flow cell cavity. The sensitivity of the vapor sensing device is different for each solvent. The detector is set to a sensitivity level that works for both toluene and tetrahydrofuran.

You can use the VAPOR INTERLOCK connector to shut down the pump system or activate an external alarm if a leak is detected. See “Attaching Auxiliary Device Connectors” on page 8.

Turning Off the Alarm

When vapor is detected, there is an audible alarm and the ALARM AUTO DISABLE button on the front panel flashes on and off. When this occurs, you can turn off the audible alarm, but not the flashing indicator.

To turn off the audible alarm, do the following:

- Press the ALARM AUTO DISABLE button down.

To enable the audible alarm, do the following:

- Press the ALARM AUTO DISABLE button once more to return it to the up position and enable the audible alarm. If you leave the button in the depressed position, the button will be lit constantly (not flashing) to indicate that the audio alarm is disabled.

Printed Circuit Boards

The DAWN has five internal printed circuit boards (PCBs):

- Front Panel Display board
- Detector board
- Main Circuit board
- Laser Driver board
- Amplifier Booster board

You may at some time need to access one of them. Here is a description of each board and what you can change on them to affect operations. You can see some of the PCBs in Figure 3-8.

Front Panel Display Board

The Front Panel Display board is affixed to the inside of the front panel for controlling front panel operations. The vapor detector described in this chapter is also located on the Front Panel Display Board.

Detector Board

The detectors all connect to the Detector board, which sits under the read head assembly. This PCB sends signals from the detectors to the Amplifier Booster board and controls the gain on the front and rear monitors.

Main Circuit Board

The Main circuit board is shown in Figure G-1. It is mounted vertically to the left of the laser. This PCB controls the analog to digital conversion of data. The Main circuit board also contains the J5 jumper block for setting baud rate, data rate, and roll-off frequency. You must remove the top cover of the instrument in order to access this jumper block. See Appendix G for jumper settings.

Laser Driver Board

The Laser Driver board provides the precision current source needed to operate the solid-state GaAs laser. It incorporates numerous protection circuits to safeguard the sensitive laser from power line noise.

Amplifier Booster Board

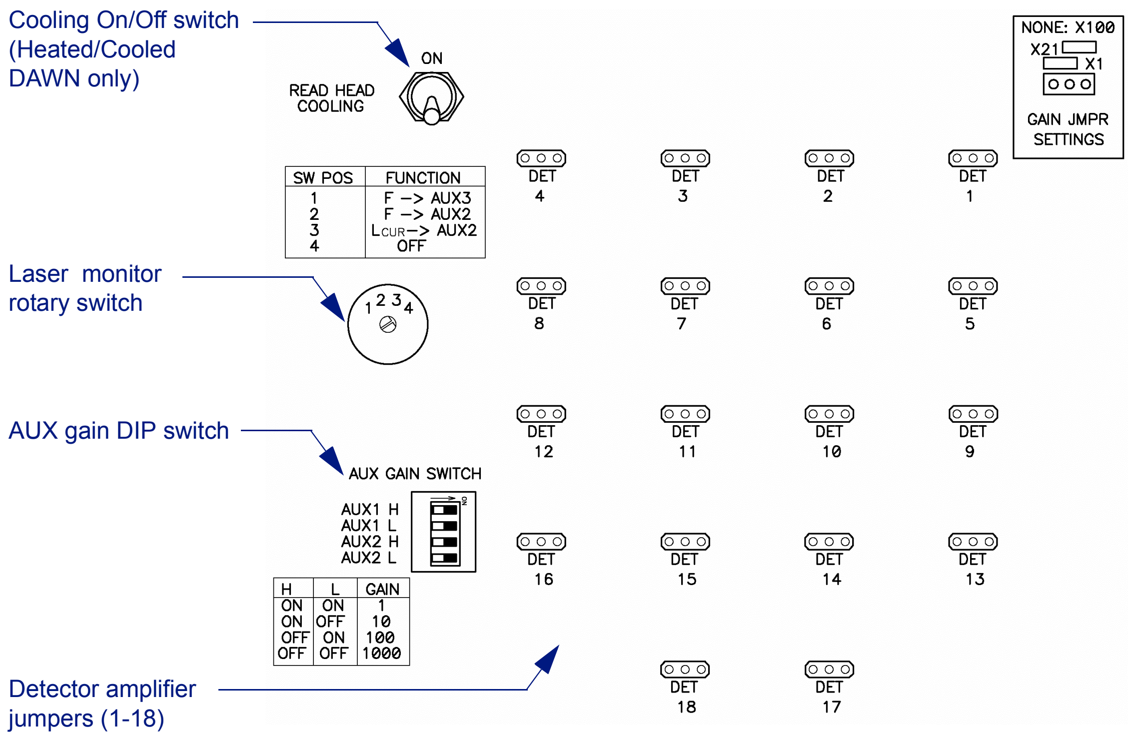
The Amplifier Booster board is mounted vertically behind the Amplifier Booster board cover (see Figure 3-8). The Amplifier Booster Board contains the following switches and jumpers, which you can use to adjust gains and other settings.

- Detector amplifier jumpers. There is one jumper for each of the 18 detectors. See the following section for jumper settings.

- Cooling ON/OFF switch. This switch is available on Peltier Heated/ Cooled models only. See Appendix B for details about this switch.
- AUX1 and AUX2 gain DIP switch (SW1). See “Attaching Auxiliary Device Connectors” on page 2-8 in Chapter 2 for switch settings.
- Laser monitor rotary switch (SW2). See “Laser Monitors” on page 3-11 for switch settings.

The Amplifier Booster board gives the photodiodes sensitivity comparable to photo multipliers for classical light scattering experiments. As well, it provides excellent signal-to-noise processing and resolution.

Figure 3-18: Amplifier Booster PC Board



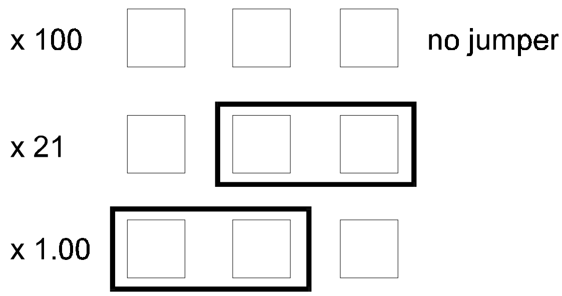
Amplifying Detector Signals

The Amplifier Booster Board enables you to amplify the output of the photodiodes by 1, 21 or 100 times the original signal. The default setting for the detectors is 100 times the original signal. Each detector may be set individually.

Each amplifier has three pins:

- With the jumper removed the gain is 100.
- With the jumper on pins 2 and 3, the gain is 21.
- With the jumper on pins 1 and 2, the gain is 1.

Figure 3-19: Jumper settings for a gain of 1, 21 or 100



Using the x100 gain mode enables you to operate at extremely low concentrations. The signal resolution also increases since each mV change at the detector corresponds to 100 mV before Analog–to–Digital conversion.

You can also take advantage of the high precision of the amplifiers. When using a gain of 1 (for instance for particle measurements), normalization can still be made at a gain of 100. This option allows you to measure the normalization coefficients at a high signal-to-noise ratio; the error due to the amplification will be less than 0.1%.

You might want to lower the gain for detectors that get the highest signal values to prevent detector saturation when using batch mode.

If you are calibrating the DAWN EOS with Magic Glass, you will need to lower the detector gain for the 90° detector (detector 11) to 21. Otherwise, the detector signals will saturate.

The maximum value that can be shown for a detector (that is, the saturation point) in ASTRA is 10 volts. However, the front panel channel monitor can show detector values up to 14 volts before saturating.

Renormalizing and Recalibrating After Changing Jumpers

Changes to the jumper settings on the Amplifier Booster board affect the software settings listed in Table 3-3. The affected software settings must be remeasured or recalculated following a jumper change (see the formula given below.)

Table 3-3: Software settings affected by changes in amplification

Detectors Affected	**ASTRA for Windows**
Detector 11 only	Calibration constant Normalization coefficients
Individual detectors other than 11	Normalization coefficients

As an alternative to taking new measurements after changing amplification, and as long as the gain is not changed, you can recalculate any of the values. In calculations, use the following amplification coefficients: 1.0, 21.0 and 100.0.

$$N_{new} = N_{old}\left(\frac{GAIN_{old}}{GAIN_{new}}\right) \times \left(\frac{detector\ 11\ GAIN_{new}}{detector\ 11\ GAIN_{old}}\right)$$

where N is the normalization coefficient for the detector. As an example, consider an amplification gain on detector 3. The original normalization coefficient was 2.8000 and the gain was boosted from 1.0 to 21.0, so the new normalization coefficient would be:

$$0.1340 = 2.8 \times (1.0/20.9)$$

If you change the jumpers universally (for all detectors) from one setting to another, you do not need to renormalize because the gain is proportionally the same for all detectors. But you do need to change the calibration constant.

Note that the normalization coefficient of detector 11 never changes (it is always 1.0) but, if the gain is changed for detector 11, normalization coefficients for all other detectors will change.

4

DAWN Maintenance

The DAWN photometer requires little maintenance. When you remove parts for cleaning (or convert between flow and batch modes), you will find they are easy to access and disassemble. This chapter gives guidelines for keeping the instrument clean and in good working order. It also has the procedure for converting from the flow cell to Batch mode measurements with scintillation vials.

CONTENTS **PAGE**

General Maintenance

For general maintenance, we suggest you do the following:

- Keep the DAWN on a flat, clean surface, with space behind and standing on its feet to allow proper air ventilation.
- Keep the case clean. Use a cloth dampened with water to clean it.
- Allow the instrument to warm up for 30 minutes before taking measurements.
- Keep the instrument cover on at all times with the black bib installed.
- Keep the cell inlet and outlet sealed when not in use to prevent solvent evaporation or introduction of particles.
- Check the air filter every month or so. When the air filter gets dusty, pull the air filter cover off and remove the filter. Then gently clean it with warm soapy water, dry, and replace.

  If you are in a dusty environment, clean the filter more often than monthly. Failure to keep the air filter clean will cause the instrument to heat up and will decrease the ability of the fan to blow dust particles out of the instrument.

In addition, you will need to follow certain procedures for keeping the flow cell clean, described next.

Note: For instructions on connecting the DAWN to an HPLC system, see the *ASTRA for Windows User's Guide*.

Flow Cell Maintenance

The flow cell structure is critical to the operation of the DAWN. If you follow the guidelines here, you may never need to delve deeper into the instrument.

If the flow cell is not cared for properly, you will need to remove it from the read head for cleaning (described in the next section). This is a procedure that, while not complicated, can be circumvented if you can successfully clear contaminants, such as particles, from the bore of the flow cell while it is still installed.

On-line Cleaning

To keep the flow cell free of contaminants, we recommend regular maintenance as described here.

At All Times

- Use solvents, including water, that are HPLC grade and filtered through a 0.02 µm filter.
- If the instrument is connected to a chromatography system, keep pure, filtered solvent pumping continuously through the cell.
- If the instrument is in stand-alone mode (batch setup), keep the cell filled with filtered solvent.
- When you do not plan to use the DAWN for some time, check it about once a month for solvent in the cell. Add more filtered solvent as needed.

Before and After Completing Experiments

- With the flow cell still in place, disconnect the DAWN from your HPLC system. Inject a pure, filtered (0.02 µm) solvent to flush the cell. We recommend filtered ethanol or isopropanol be left in the cell.
- *Do not* flush the cell from Outlet to Inlet. Backflushing the cell can cause particles to become lodged in the inlet tube, which has a smaller inside diameter than the outlet tube.
- A mild detergent solution may also help clean the flow cell, and may be kept in it overnight when the instrument is not in use, then purged in the morning.
- There are two extra sets of inlet and outlet tubes in your hardware kit. One set consists of 4 pieces of color-code tubing (white for inlet and blue for outlet). This set of tubes is for use with the unions to make it easy to remove the flow cell for cleaning without breaking the seal at the manifolds. The second set of color-code tubes is for use without the unions.

With either set, you will need to bend the tubes in order to install them in the instrument. The bend radius should not be less than the bend radius of tubing that comes installed in your DAWN. To avoid introducing particles into the flow cell, flush the tubes after bending them and before installation.

Particles in the Cell

Here is a list of symptoms of particles in the cell and what you can do to dislodge them.

Some Symptoms of Particles in the Cell

- Bright stationary spots when viewing the cell bore from above.
- An increase in baseline voltage at all angles.
- Unstable, fluctuating baselines.
- Distorted chromatography peaks (dips below baseline, shoulders on low angle peaks).

Some Suggestions for how to Dislodge Particles

- Change to a solvent with a different polarity.
- Try injecting a small air bubble. If the particle(s) move, repeat until they are flushed out.
- Flush the cell with 0.02 µm filtered HPLC grade water. Fill a syringe with a few mL of 6 M nitric acid, inject and leave the acid in the cell for 10 minutes, then flush with 0.02 µm filtered HPLC grade water again.

Cleaning the Flow Cell and Windows

When the flow cell is dirty, light scatters excessively, which shows up as high voltage, unstable baselines, and distorted chromatography peaks. The flow cell cleaning procedure can be broken down into five major steps:

Step 1—Removing the flow cell

Step 2—Disassembling the flow cell

Step 3—Cleaning the flow cell and windows

Step 4—Reassembling the flow cell

Step 5—Reinstalling the flow cell

What you will need for flow cell cleaning:

- A sheet of clean white paper taped down to your work surface
- Anti-static wrist strap
- Ball drivers: 1.5 mm, 2.5 mm and 4 mm
- 2 Crescent wrenches, ¼"
- Lens tissue. Fold several pieces in finger-width strips for handling the cell and cleaning.
- Lint-free gloves
- Oral-B SuperFloss
- Inert dusting gas. (Photographic supply stores carry this. At Wyatt Technology we use "Tech Spray" from Com-Kyl distributors in Santa Barbara, (805) 520-1731.)
- Filtered methanol, ethanol, or isopropanol
- Tweezers
- Optional: Sonicating bath
- Optional: UV light

Caution: The flow cell you are about to remove constitutes a substantial amount of the purchase price of the DAWN. Its parts are carefully machined and are expensive. If you have any doubts whatsoever about the safest procedure for handling the cell structure, do not hesitate to call Wyatt Technology.

Step 1—Removing the Flow Cell Assembly

In this first step you will remove the cell assembly from the read head.

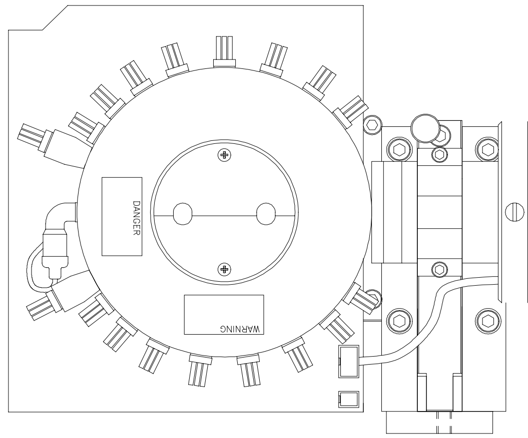
1. Put on the anti-static wrist strap.

   This is an important step. The strap keeps the flow cell glass and windows from building up a static charge and attracting particles while being handled.

2. Disconnect the power cord and remove the bib from the top cover of the instrument.

Looking down at the read head, you will see the two halves of the flow cell cover plate held by two Allen-head screws (See Figure 4-1).

Figure 4-1: Flow cell with cover plate

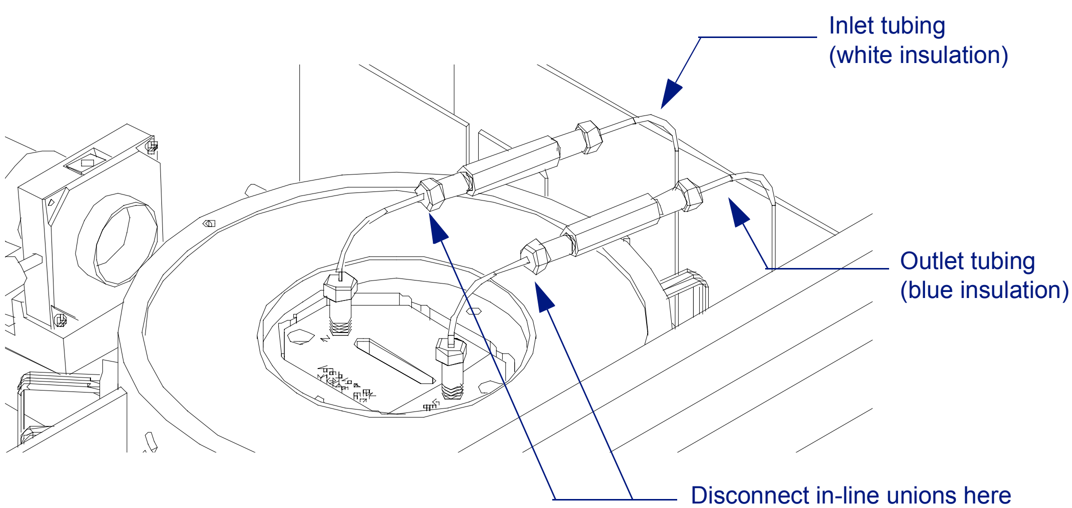


3. Remove the two Allen-head screws with the 2.5 mm Ball driver provided, then lift the cover plate off.

   The flow cell assembly is now visible.

4. Disconnect the short pieces of stainless steel tubing from the in-line unions using the two ¼" Crescent wrenches.

Figure 4-2: Flow cell tubing and unions



5. Use the 2.5 mm Ball driver to remove the two M3 screws, then lift the cell assembly up and out of the read head using the tubing.

IMPORTANT: DO NOT PRY THE CELL OUT WITH A SCREW DRIVER OR ANY OTHER TOOL!

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6. Remove the short stainless steel tubing from the manifolds before proceeding with the disassembly and cleaning. The inlet tube has white insulation and an interior diameter of 0.005". The outlet tube has blue insulation and an interior diameter of 0.010".

Step 2—Disassembling the Flow Cell

The different parts that make up the flow cell assembly are shown in Figure 4-3.

1. Separate the stainless steel manifolds from the flow cell:
   a. Use the 1.5 mm Ball driver to unscrew the two M2 screws holding the bottom cell retainer in place. Remove the bottom cell retainer taking care not to lose the two tiny screws and the bottom retainer O-ring and cord.
   b. Use the 2.5 mm Ball driver to remove the M3 screws that connect the two manifolds.
   c. Gently pull apart the manifolds, taking care not to drop the glass cell or touch its curved optical surfaces.
   d. Place everything on your paper-covered work surface, taking care not to lose the O-rings sealing the manifolds to the cell.

      If the DAWN is configured for use below 80 °C, there is a backing ring outside each 6 mm flow cell O-ring. If the DAWN is configured for use at or above 80 °C, there is a 9 mm flow cell O-ring (but no backing ring) on each side.
2. Use the 4 mm Ball driver to remove one window retainer at a time.

   Figure 4-7 illustrates the window-mount and how it is housed in the manifold.
3. Lightly tap the assembly ONCE against a flat clean surface. The cell window and O-ring should fall out if the cell is dry.

   If the window does not fall out easily, you could carefully apply a very mild burst of pressurized air to dislodge it or you could try gently pushing it out from the opposite side with a small piece of Teflon tubing. If necessary, put some filtered alcohol in all the manifold openings and soak overnight.
4. Repeat Step 3 for the other window.

Figure 4-3: Flow cell assembly, exploded view

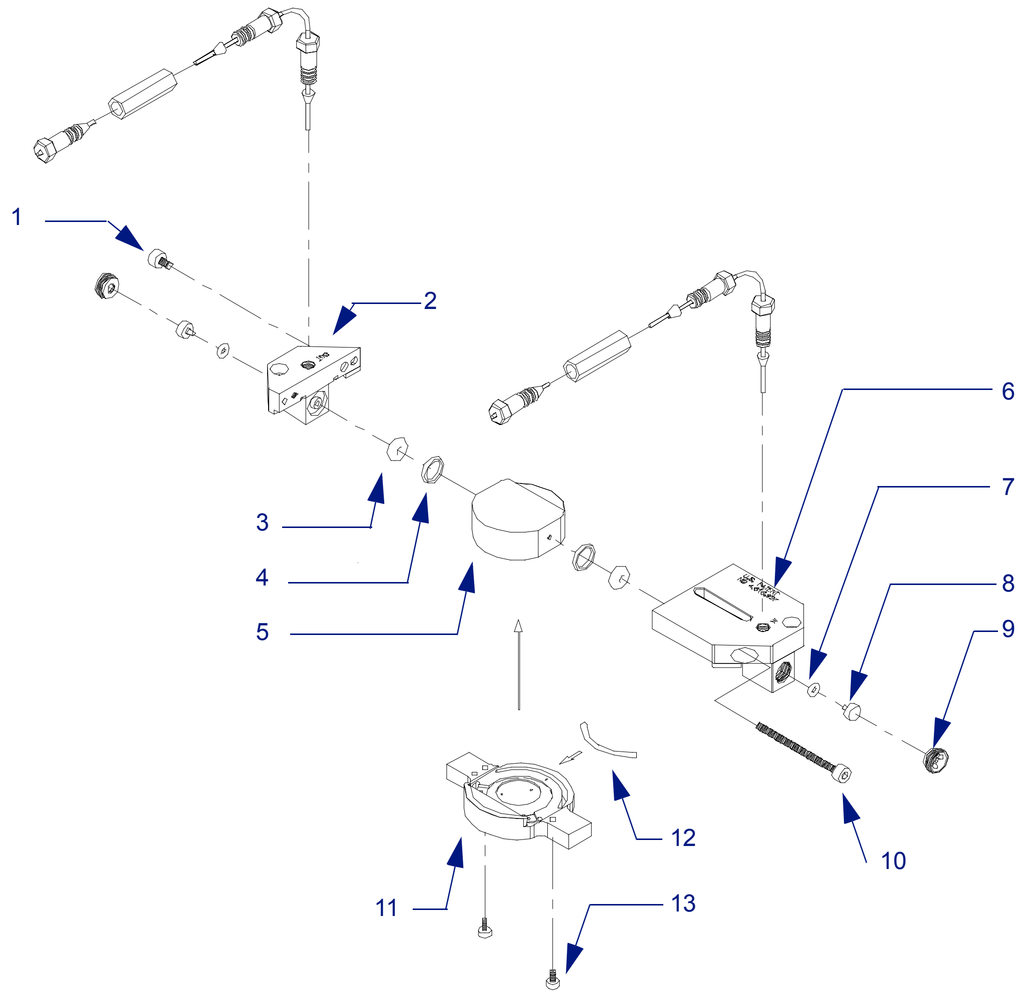


Table 4-1: Flow cell assembly, parts list

Item	P/N	Description
1	S5002-3004	M3 screw
2	200694	Manifold, out
3	P6504-2006	Flow cell O-ring (2) (P6504-2009 if DAWN is configured for use above 80 °C)
4	200609	Backing ring (2) (not used if DAWN is configured for use above 80 °C)
5	212095	Flow cell
6	200690	Manifold, in
7	P6504-2004	Window O-ring (2)
8	116007	Flow cell window (2)
9	212073	Window retainer (2)
10	S5002-3030	M3 screw
11	211048	Bottom flow cell retainer
12	S6501	Bottom retainer O-ring cord
13	S5002-2006	M2 screw (2)

Step 3—Cleaning the Flow Cell and Windows

From here on, you must be fastidious in your handling and cleaning of the flow cell parts. The smallest particle on the flow cell window or inside the bore can introduce stray light and distort your measurements.

Tip: For more thorough cleaning of the optical parts (glass cell and windows), we suggest you use an ultrasonic cleaning unit. If you do, place the parts in a small beaker and cover with filtered alcohol. Fill the ultrasonic unit with enough water to reach part way up the side of the beaker. Place the beaker in the unit and sonicate the parts for about five minutes. Let the flow cell dry on a piece of lens tissue with the bore in a vertical position. Having done this you may not need to clean the cell through-bore (step 2 below).

1. Clean your hands thoroughly or wear lint-free gloves.

   When you disassemble the cell, be careful not to handle the glass cell's curved optical surfaces (the sides).

2. Clean the cell through-bore.

   a. Cut a ½" strip of lens tissue and roll it into a thin wick. Or, you may use "Oral-B SuperFloss", which is available in most pharmacies. The floss is a better tool, as it cannot leave any fibers behind.

   b. Insert the wick all the way through the cell bore, then moisten it with a small amount of filtered alcohol.

   c. While the wick is in the cell bore, untwist it slightly, move it back and forth to clean the cell, then pull it out.

   d. Immediately flush the bore with a stream of alcohol for 10–15 seconds.

      The alcohol stream flushes out any fibers that may have been left behind by the tissue wick.

   e. Blow out the alcohol for 10–15 seconds with inert dusting gas or let the glass bore drain in a vertical position.

   f. Examine the bore with a magnifying loupe.

      Look through the bore, focusing on the bore exit. Repeat from the opposite side. (See the **Note** at the end of this section.)

3. Clean the outside of the cell. (See Figure 4-4.)

   a. Pick up the cell with a folded lens tissue; touch only the flat surfaces.

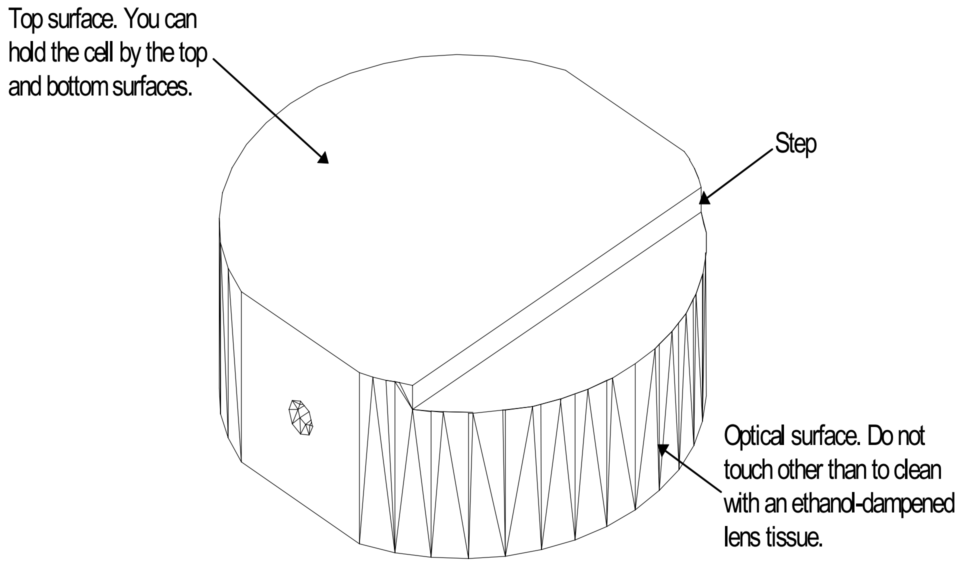
   b. Wipe the curved optical surfaces with another folded lens tissue moistened with alcohol.

   c. If needed, wipe the alcohol off the optical surfaces with dry lens tissue. **Do not** repetitively rub the surfaces since this creates static electricity which attracts particles.

d. Using a magnifying loupe, examine the optical surfaces for any dust. (See the **Note** at the end of this section.)

e. Also, check the bottom and top surfaces for dust and finger marks.

Figure 4-4: Flow cell



4. Clean the window faces.

This is the most important step in cell cleaning. Even the smallest particle left on the window faces will induce stray light and cause signal distortion, especially at low angles.

a. Take a folded lens tissue moistened with a couple of drops of alcohol and hold it against the side of your forefinger with your thumb and third finger.

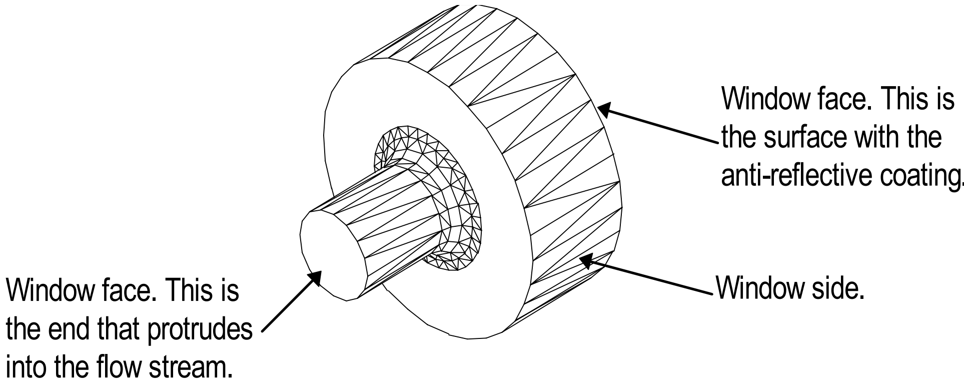
b. Pick up the window with the tweezers. Hold the window by the sides, not by the window faces.

c. Smoothly wipe both window faces across the tissue.

d. Carefully examine both ends of the cleaned window for any particles.

With the loupe look straight through the window from end-to-end. (See the **Note** at the end of this section.)

Figure 4-5: Cell window



Note: By examining the flow cell through-bore and the windows using a bright light you can, with some practice, easily find where any residue has accumulated. Examine them with a jeweler's loupe while back-lighting the glass at a slight angle. The area next to the light should be dark to provide good contrast. The bright light will illuminate any particles on the glass which, when viewed against the dark background, will show up clearly. If you have a UV light, you may shine it on surfaces at a slight angle to make certain types of dust particles, especially clothing fibers, more visible.

Since fingerprints on the glass cell circumference will alter the light scattering characteristics of a sample significantly, we urge you to use great care when handling the cell. Its role is vital in the measurement process and you must be certain to wipe it clean with high quality lens tissue before inserting it again in the cell assembly.

Step 4—Reassembling the Flow Cell

As you reassemble the flow cell you will clean the washers and O-rings.

Note: Assemble the flow cell in a laminar flow hood if there is one available.

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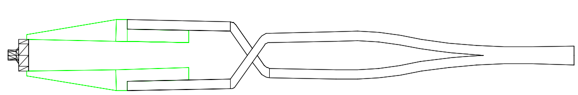
1. Carefully replace the windows with their O-rings, washers and retainers so that the windows are not chipped or over-tightened. (See Figure 4-7.)
   a. Holding the window O-ring with the tweezers, put a drop of alcohol on it, then dry with a burst of pressurized air. Check for particles with the loupe.
   b. Insert the O-ring into the manifold.
   c. Lift the window with the tweezers. (Pick up the window near its back edge as shown in Figure 4-6.)

Figure 4-6: Holding the cell window for reinsertion into the manifold



d. Holding the manifold and window square with one another, gently push the window into the O-ring.

e. Let go of the window with the tweezers, pivoting them before you lift them out of the manifold.

The fit is tight enough that you could dislodge the window if you were to just lift the tweezers straight up.

f. Inspect the tip of the 4 mm Ball driver with the loupe for any particles, and, if necessary, clean with an alcohol-moistened lens tissue before proceeding.

g. Clean the window retainer with alcohol and pressurized air, then place it in the manifold and tighten with the 4 mm Ball driver.

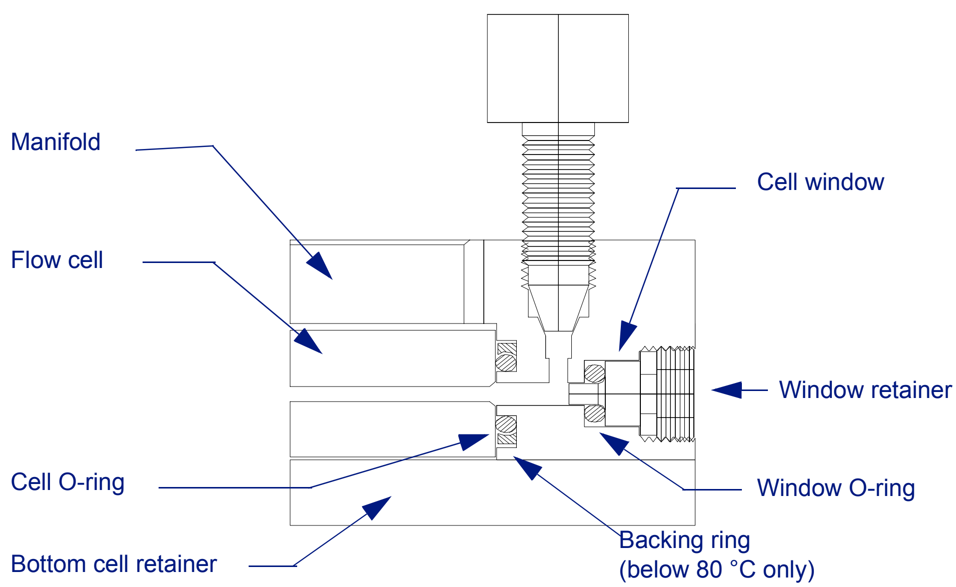
You may need to use your fingers to start the tightening of the retainer.

h. Inspect the window mount with the loupe.

If any particles appear on the window, you need to remove it and its seals and clean again.

i. Repeat steps 1a) through 1i) for the second window.

Figure 4-7: Window mount detail



2. Install the cell in the manifolds.

a. Insert the cell O-rings followed by the backing rings if they were removed in Step 2.1.

If you have an Ambient DAWN or will be operating below 80 °C, install both the 6 mm O-rings and the backing rings.

If you will be operating at or above 80 °C, use only the 9 mm O-rings and do **NOT** use the backing rings. The cell O-rings need room to expand when heated above this temperature. Using backing rings at high temperatures could cause the glass to crack.

b. Holding the cell with lens tissue, place it in the inlet manifold (the larger manifold).

A step is machined into the top surface of the glass cell; the manifold has two pins to help align the cell properly.

c. Push the cell step against the manifold pins.

d. Make sure that the glass step and manifold pins are matched up well.

e. Place the outlet manifold next to the inlet manifold and push them firmly together.

3. Insert the short M3 screw into the outlet manifold and tighten with the 2.5 mm Ball driver. Then, insert the long M3 screw into the inlet manifold and tighten.
4. View the O-rings through the bottom glass surface (make sure the surface is clean) and confirm that the bore is centered in each O-ring.

   Also examine the alignment pins to make sure they touch the cell glass on each side.
5. Inspect the sides of the cell and apply a burst of air if you see any particles.
6. Replace the bottom cell retainer cord and O-ring and attach the bottom cell retainer to the manifolds using the 1.5 mm Ball driver.
7. Clean the fittings that will connect the inlet and outlet tubes to the unions. Use the same method for cleaning as you did for the window O-rings—a couple of drops of alcohol on lens tissue, then dry with a burst of air.
8. Reinstall the blue and white coated tubing in the correct holes. The inlet tubing has white insulation and an interior diameter of 0.005". The outlet tubing has blue insulation and an interior diameter of 0.010". Do not reverse the inlet and outlet tubing.

Step 5—Reinstalling the Flow Cell

1. Replace the cell assembly in the read head, insert the two M3 screws and tighten with the 2.5 mm Ball driver.

   If you are not careful, the cell could be reversed: Make sure that the INlet manifold is in the rear position and the OUTlet manifold is in the forward position.
2. Reconnect the short pieces of stainless steel tubing to the in-line unions using the two ¼" Crescent wrenches.
3. Plug in the power cord and turn on the DAWN.
4. Connect the cell to your HPLC system and make sure the cell does not leak.

Make certain the fittings are tight and leak free. Whenever you pump solvent through the cell, check the fittings at least twice during the first hour. Use a piece of tissue and touch the top of the fitting where the tubing emerges; no solvent should be visible on the tissue.

5. Replace both sections of the flow cell cover plate. Tighten the two Allen-head screws with the 2.5 mm Ball driver.
6. Replace the instrument cover bib.

Flow-to-Batch Conversion

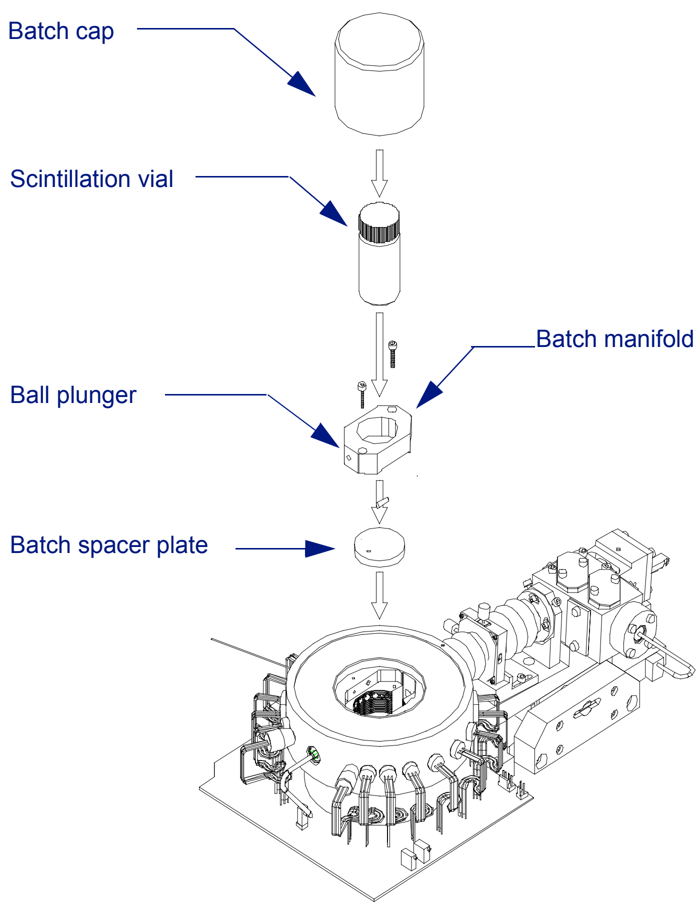
You can easily alter the DAWN read head to take measurements from a 20 mL scintillation vial. The conversion procedure takes a minute or two.

The batch configuration permits a variety of uses that would not be possible with the flow configuration. Among these are the ability to store and analyze sealed samples, and to perform long term time-dependent studies, bioassays, depolarization and aggregation studies. As well, if you believe the sample may contaminate the flow cell it can be measured in a disposable vial.

Because sample measurements can be repeated easily and rapidly, the batch method is often the fastest for determining molecular weight and radius of gyration from a static sample.

Note: If you have an Ultra-High Temperature DAWN or a Peltier Heated/Cooled DAWN, use the instructions in Appendix A instead of those given here.

Figure 4-8: Flow-to-batch conversion kit, exploded



What you need for flow-to-batch conversion:

- 2.5 mm Ball driver
- 2 Crescent wrenches, ¼"
- Ambient Batch Conversion Kit.

To convert from flow-to-batch operation, do the following:

1. Remove the bib from the top cover of the instrument.
2. Remove the read head cover and the flow cell assembly from the instrument.

   If you need instructions, follow Step 1 of flow cell cleaning, described in “Cleaning the Flow Cell and Windows” on page 4-5 in this chapter).
3. Insert the batch spacer plate into the bottom of the read head cavity.
4. Insert the batch manifold and secure it with the two M3 screws.
5. Put a sample scintillation vial in the read head cavity and cover it with the cap.
6. Replace the instrument cover bib.

To replace the flow cell, just reverse the previous process.

Note: When making measurements with scintillation vials, take great care to keep the outside of the vials clean and free of fingerprints, scratches, etc., as this can severely distort the measurement. We also advise you rotate the vial in the read head to find the position where the laser beam enters the cell with the minimum amount of scattering at the air/glass interface. The ASTRA User's Guide has additional information.

Note: The vial should fit snugly in the mount. If it does not, slightly tighten the ball plunger.

Notes for Batch Mode Calibration

If you are calibrating the DAWN EOS with Magic Glass, you will need to place jumpers on the Amplifier Booster board to lower the detector gain for the 90° detector (detector 11) to 21. Otherwise, the detector signals will saturate. The maximum value that can be shown for a detector in ASTRA is 10 volts. The front panel channel monitor can show detector values up to 14 volts before saturating. (Adjusting the detector gains is not necessary with the DAWN DSP. However, the DAWN EOS has a more powerful laser than the DAWN DSP.)

If you are using Magic Glass for calibration, you will also need to add it as a custom solvent in the ASTRA software. Enter the refractive index (1.77862) and the Rayleigh ratio value that came with the Magic Glass.

If you are calibrating with a scintillation vial or with Magic Glass, you should calibrate a total of 4 times. Turn the vial or glass 90° clockwise after each calibration and adjust the position to minimize laser scattering. Disregard any measurement that differs more than 1% from the average measurement. Average the measurements and enter the value as the Calibration Constant.

A Ultra-High Temperature Option

The Ultra-High Temperature DAWN option has some differences from the ambient DAWN. This appendix describes those differences and supplies instructions for making adjustments and operating the Ultra-High Temperature DAWN.

CONTENTS **PAGE**

Overview

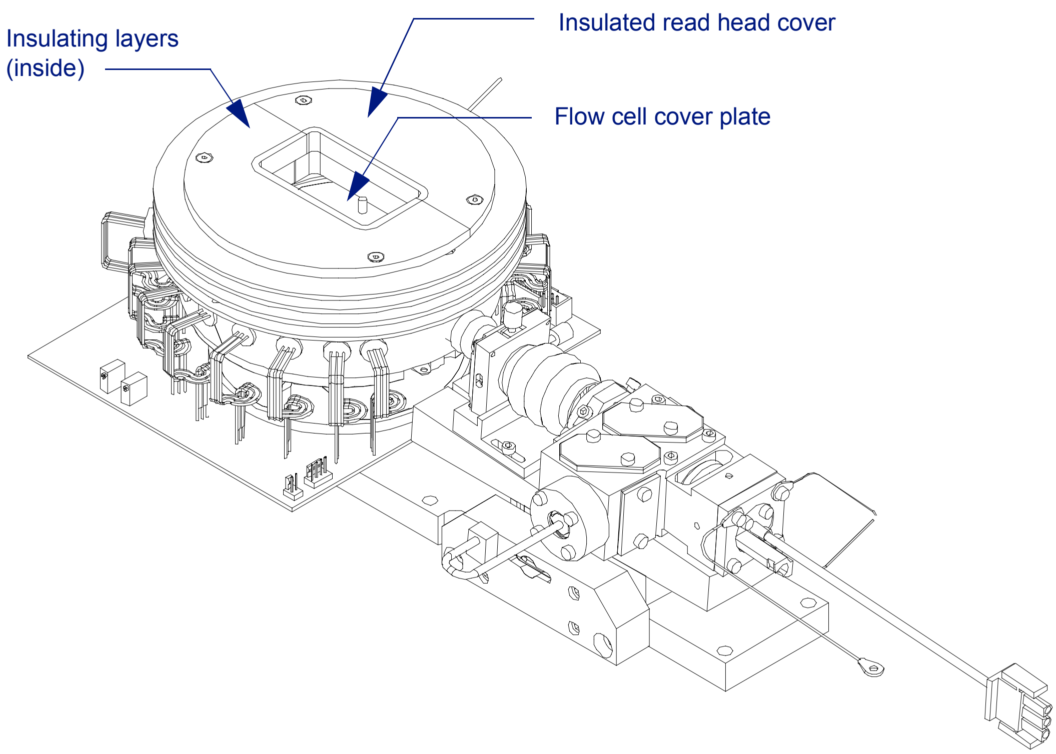
With the Ultra-High Temperature option, the read head may be heated from approximately 10 °C above ambient temperature to 210 °C. The temperature can be controlled to within 0.1 °C and is accurate to ±1 °C.

The temperature-controlled read head is comprised of three distinct shells of material:

- The outer aluminum detector ring, which contains the photodiode detectors.
- A layer composed of two insulating materials that keep the flow cell at a stable temperature while at the same time keeping the photodiodes as close to ambient temperature as possible.
- The innermost shell is the aluminum flow cell cavity.

The heater cartridges are located inside the read head. Directly underneath the flow cell is a platinum temperature sensor.

Figure A-1: Ultra-High Temperature read head and laser assemblies



Heating the Cell

The DAWN flow cell is designed to operate at temperatures up to 210 °C with the Ultra-High Temperature option. The high temperature cell is designed around two cartridge heaters. Heating is controlled by one or two Watlow thermocontrollers. The resolution of the controllers is 0.1 °C and the accuracy is ± 1 °C.

Note: Attempting to heat the cell beyond the temperature limit can damage or destroy your DAWN unit, and void the warranty. The Ultra-High Temperature read head must not be heated above 210 °C.

About the Thermocontrollers

The Ultra-High Temperature and Peltier Heated/Cooled versions of the DAWN have Watlow thermocontrollers on the front panel. The left controller controls the read head temperature. If you purchased the optional heated lines, the right controller controls the temperature of these heated lines.

These controllers are designed to give the best possible temperature regulation. They use a Proportional Integral Derivative (PID) control loop, which measures the difference between the setpoint (the temperature you desire) and the process (the temperature of your system). It also measures the time rates of change of the process temperature to minimize overshoot and errors. Once you have selected a setpoint, you can instruct the controller to "autotune" the PID loop coefficients to give maximum stability and precision. The controllers are pre-programmed by WTC with a custom menu for your convenience.

Setting the Operating Temperature

1. Press the up or down arrow buttons on the read head controller to adjust the read head temperature.

   The green LED display shows the setpoint temperature in degrees Celsius.

2. Allow the read head temperature to ramp to the setpoint temperature.

   The red LED display toggles between the measured temperature and the letters "rP," which stands for Ramp. The temperature changes by 1 °C per minute. For example, if you wish to operate your system at 150 °C, and your system is initially at 25 °C, it will take about two hours for the temperature to reach 150 °C, since the ramp rate is limited to 1 °C per minute.

   The thermocontrollers are programmed to change the temperature at this controlled rate to ensure that the flow cell glass does not crack due to thermal stresses.

Note: If you want to perform temperature ramping experiments, contact WTC for instructions on how to reprogram the ramp rate. The thermocontrollers can be set to ramp at rates as low as 0.1 °C per hour.

3. Once the read head temperature reaches the setpoint and has stabilized, you can autotune the controller to improve temperature stability. Press the left button (with two arrows in a circle) on the temperature controller once.

   The green display says “AUT” and the red display says "off".

Note: Autotuning should only be performed after the system has stabilized around the setpoint. You can return to the temperature display by pressing the infinity key.

4. Press the up arrow button once. The red display flashes “Tune”.

   The controller heats above and cools below the setpoint to determine the system responsiveness. It then chooses PID coefficients to achieve the most stable control loop. Wyatt Technology autotunes the controllers at 40 °C. While the thermocontrollers perform quite well without autotuning, it is recommended that you autotune at your desired setpoint.

5. Press the infinity key to return to the temperature display. The red display toggles between the measured temperature and the word “Tune”. Tuning takes several minutes.

Percentage Output

The thermocontrollers are also programmed to display the percentage of output power. This number is a percentage that indicates the duty cycle of the heaters in the read head or heated line. The temperature stability depends on the percentage output.

To see the percentage output, press the left button (with two arrows in a circle) on the temperature controller twice.

Heated Lines

The optional DAWN heated lines can maintain temperatures up to 210 °C in the inlet and outlet lines if the DAWN is connected to other high-temperature instruments and detectors.

The heated lines consist of two pieces of steel tubing that are insulated and contain a temperature sensor and a heater. One of them is marked at both ends with a piece of metal tape so that you can distinguish the tubings as they protrude from the insulation.

The heated lines controller setpoint is slaved to the read head setpoint. Changing the read head setpoint automatically changes the heated lines setpoint.

You may see a small (~0.2 °C) difference between the two setpoint displays (green LEDs). This is a consequence of sending the setpoint from the read head controller to the heated lines controller as a current signal. The read head controller setpoint is more accurate.

If you are using the Peltier Heated/Cooled model, the read head can be cooled or heated, but the heated lines can only be heated. Using a setpoint below ambient temperature will only cool the read head—it won't cool the lines.

Operating Precautions

Keep in mind these important points:

- Always have the insulating cover plate locked in place when bringing the cell up to temperature, or cooling it down.
- If possible, keep the instrument at operating temperature at all times.
- Replace the cell O-rings whenever the instrument is brought down from an elevated temperature! They conform to the geometry of the cell and, when brought down from an elevated temperature, may not seal reliably.

Removing the Cell Assembly

The Ultra-High Temperature cell assembly is the same as the ambient cell assembly, but with several added components for insulation. These instructions are for those instances when you need to remove the cell assembly—typically to clean the flow cell or to convert to batch mode.

What you will need to remove the cell assembly:

- 2 Crescent wrenches, ¼"
- 2.0 mm Ball driver
- 2.5 mm Ball driver

To remove the cell assembly, do the following:

1. Press the up or down arrow buttons on the read head controller to adjust the read head temperature to 25 °C, then wait for the temperature to reach 50 °C or less before proceeding (this will take about 2 hours).

   The red LED display shows actual cell temperature.
2. Remove the bib from the cover of the instrument. (The bib is not used if you have already installed the heated lines.)
3. Remove the four screws from the insulated read head cover plate using the 2.0 mm Ball driver.
4. Split the cover plate and lift out the two halves, starting with the larger half.
5. Remove the two halves of the flow cell cover plate.
6. Disconnect the short pieces of stainless steel tubing from the in-line unions using the two ¼" Crescent wrenches.
7. Use the 2.5 mm Ball driver to remove the two M3 screws, then lift the cell assembly up and out of the read head.

   Lift the assembly out using the connecting tubing. The cell assembly is the same as described in Chapter 3 under “Flow Cell Design.” Cell disassembly and cleaning is described in Chapter 4 under "Cleaning the Flow Cell and Windows."

Note: Whenever you clean the flow cell, you should replace the O-rings. They become brittle when heated.

Using the DAWN with an Oven

It typically takes two days to install a heated DAWN in an oven such as the Waters 150C or the Polymer Labs 210. The internal plumbing of the oven should be done beforehand with the DAWN heated lines connected between the columns and the RI detector.

This list summarizes the installation process (assuming the oven remains at operating temperature). The following pages provide more details about these steps.

DAY 1:

1. Calibrate the DAWN using toluene.
2. Connect the heated lines to the DAWN flow cell.
3. Set the pump rate to 0.1 mL/min.
4. Install the flow cell cover plate and the insulated read head cover plate.
5. Bring the DAWN to 135° C (about 2 hours).
6. Slowly bring the flow rate to 1 mL/min (or other desired rate).
7. Check for leaks.
8. Check the calibration using TCB.
9. Measure the flow rate.
10. Prepare standards for the next day.

DAY 2:

1. Inject a narrow polystyrene standard (we suggest 400,000 Dalton); calculate the inter-detector delay volume.
2. Inject a low molecular weight polyethylene (we suggest 32,000 Dalton); normalize the DAWN and calibrate the refractometer.
3. Inject two or three standard polymers.
4. Process the data.
5. Check normalization and calibration.

The *ASTRA for Windows User's Guide* provides more details on calibration, normalization, and determination of the delay volume.

General Setup Procedure

Calibrate the instrument

Calibrate the instrument with toluene before connecting it to the oven. Once at temperature, and if the baseline signal is stable and free of particulate noise
(±1–2 mV at detector 11), you can check the calibration with the mobile phase
(if using 1,2,4-trichlorobenzene (TCB) near 135 °C).

Place the DAWN in-line between the columns and RI detector

The DAWN has to be placed in-line between the columns and the RI detector in the oven. Therefore, it is necessary to take the output line from the columns out of the oven, through the DAWN, and back into the RI detector. Use the heated lines provided with the DAWN and additional stainless steel tubing inside the oven, if needed.

The DAWN can be placed either on the right or left hand side of most ovens. Newer Waters 150C instruments have a pre-drilled hole in the left side. If you have an older Waters 150C, you can drill a hole yourself on either side of the 150C at the level of the columns.

Make sure there are no cold spots where the heated lines connect to the oven; the point of connection should be inside the injector or column compartments to ensure this.

The RI and autoinject cables should be attached to the RI detector integrator output and the autoinject terminals. On the Waters 150C, these are on the left side and are clearly marked.

Connecting the Heated Lines and Heating the DAWN

DANGER: The HEATED LINE electrical connector on the side of the DAWN contains live 120 V pins. Keep the dust cap on this connector whenever the temperature controller is on and the heated lines are not connected.

If the oven is at operating temperature (such as 135 °C), leave it there.

What you will need to connect the heated lines:

- 2 ¼" Crescent wrenches
- Stainless steel nuts and ferrules

To connect the heated lines and heat the DAWN, do the following:

1. Make sure the DAWN is switched off using the switch on the back panel of the instrument.
2. Remove the cover bib from the top of the DAWN.
3. On the DAWN end of the heated lines, connect the two pieces of tubing in series using a short piece of stainless steel tubing and two unions.

   Make sure you first seat the ferrules using the DAWN flow cell manifolds. Shorten the exposed stainless steel tubing if needed.
4. Connect the heated lines to the column outlet using the tubing marked with metal tape.

   Which one you connect depends on whether the DAWN is placed to the right or the left of the oven.
5. Run the pump at 0.1 mL/min until the lines are completely filled with solvent, then attach the unmarked tubing of the heated lines to the RI inlet.

6. Turn the pump off and disconnect the short piece of tubing at the DAWN side of the heated lines.
7. Connect the tubing from the columns to the rear inlet of the DAWN cell, and the other tubing to the front outlet of the cell.
8. Run the pump at 0.1 mL/min and replace the insulated read head cover (see "Heating the Cell," earlier).
9. Remove the dust cap from the HEATED LINE connector on the side panel of the DAWN. Be careful not to touch the electrical contact with your hands.
10. Connect the electrical connector on the heated line to the HEATED LINE connector.
11. Turn the DAWN on and adjust the read head temperature setpoint. This will increase the temperature of both the read head and the heated lines by 1 °C per minute. Check for leaks around the connections every 30 minutes or so.

Operating the DAWN with an Oven

Always increase the flow rate slowly (0.1 mL/min increases every 1–10 minutes, initially slower).

Watch the baseline of detector 11 in ASTRA for changes whenever you increase the flow rate.

Check for leaks at all connections. You will need to temporarily remove the insulated read head cover to do this.

If everything is working well, the baseline noise on the DAWN detectors (with booster board jumpers removed) should be random and ±1–2 mV. If the baselines have regular oscillations, check the pump. You may also want to try further insulating the lines next to the read head.

To calculate the inter-detector delay volume and to normalize the DAWN, follow the instructions in the *ASTRA for Windows User's Guide*, "The First Chromatography Run," but use a 400,000 Dalton narrow polystyrene standard and a 32,000 Dalton polyethylene standard, respectively.

Potential Problems

Excessive baseline noise could have several sources:

Particulates and/or air bubbles in the solvent

Use only degassed high-purity HPLC solvents. Always filter your solvent using a 0.2 µm filter. An in-line filter after the pump, but before the injector, may help.

Particulates from the columns

With time (several days under operating conditions) the noise should decrease; if it does not, choose another type of column. Take care not to change temperature or pressure too rapidly.

Pump not operating properly

Ensure that the pump is operating properly. If spikes corresponding to the pump strokes are observed in the baseline, the pump should be rebuilt with new check valves and new seals. Operating the pump with sufficient back pressure is important; to achieve this, always work with at least two columns in-line or place a restrictor immediately after the pump. Also, we strongly recommend a pulse dampener after the pump.

Problem with temperature regulation

If you observe a regular cycling in the baseline, there may be a problem with the temperature regulation. Watch the temperature displays on the Watlow thermocontrollers for stability. Autotune the controller if the temperature varies by more than 0.1 °C. Contact Wyatt Technology if autotuning the controller does not correct the temperature variation.

Also check that the temperature output on the oven is calibrated within 1 °C. Heating and cooling effects between the two instruments could ruin the baseline stability. You may check the reading from the oven by placing a temperature probe under the top lid. Make sure the probe is not in contact with any metal objects within the oven.

If noise spikes appear in the RI signal after each injection, look for insulation problems at the heated line connections. If further insulation does not remove the spikes, try heating the DAWN another five degrees. The spikes are likely due to partial polymer precipitation, and a higher temperature may be helpful.

Disconnecting the DAWN from an Oven

When you decide to disconnect the DAWN from the oven, be aware that you must replace all the O-rings in the flow cell assembly after the instrument has cooled down. If this is not done, the flow cell may leak.

To disconnect the DAWN, do the following:

1. Decrease the pump speed slowly to 0.1 mL/minute.
2. Set the read head temperature setpoint on the DAWN to room temperature.

   The temperature will slowly decrease to room temperature (2–3 hours).
3. When the cell is close to room temperature, turn off both the DAWN and the pump.
4. Disconnect the heated line electrical connector from the HEATED LINE connector and replace the dust cap on the HEATED LINE connector.

DANGER: The HEATED LINE fitting contains live 120 V pins. Keep the dust cap on this connector whenever the heated lines are not connected.

5. Disconnect the heated lines from the flow cell.

6. Remove the insulating read head cover from the DAWN.

7. Flush the cell with a suitable solvent, such as toluene.

8. Continue flushing with methanol/ethanol and then cap the cell.

9. Remove the cell assembly from the read head, disassemble the cell, clean it and replace all O-ring seals.

10. If the disconnection is only temporary, do the following:

a. Leave the heated lines connected to the oven.

b. Attach the small piece of tubing with the unions at the DAWN side of the lines.

Temperature Controlled Flow-to-Batch Conversion

The Heated DAWN Flow-to-Batch conversion differs slightly from the ambient model because of the extra cover plate for the read head, an additional vial insulation ring, and an insulated cap.

What you need for flow-to-batch conversion:

- 2 Crescent wrenches, ¼"
- 2.5 mm Ball driver
- Phillips screw driver
- Heated Batch Conversion kit

To convert from flow to batch operation, do the following:

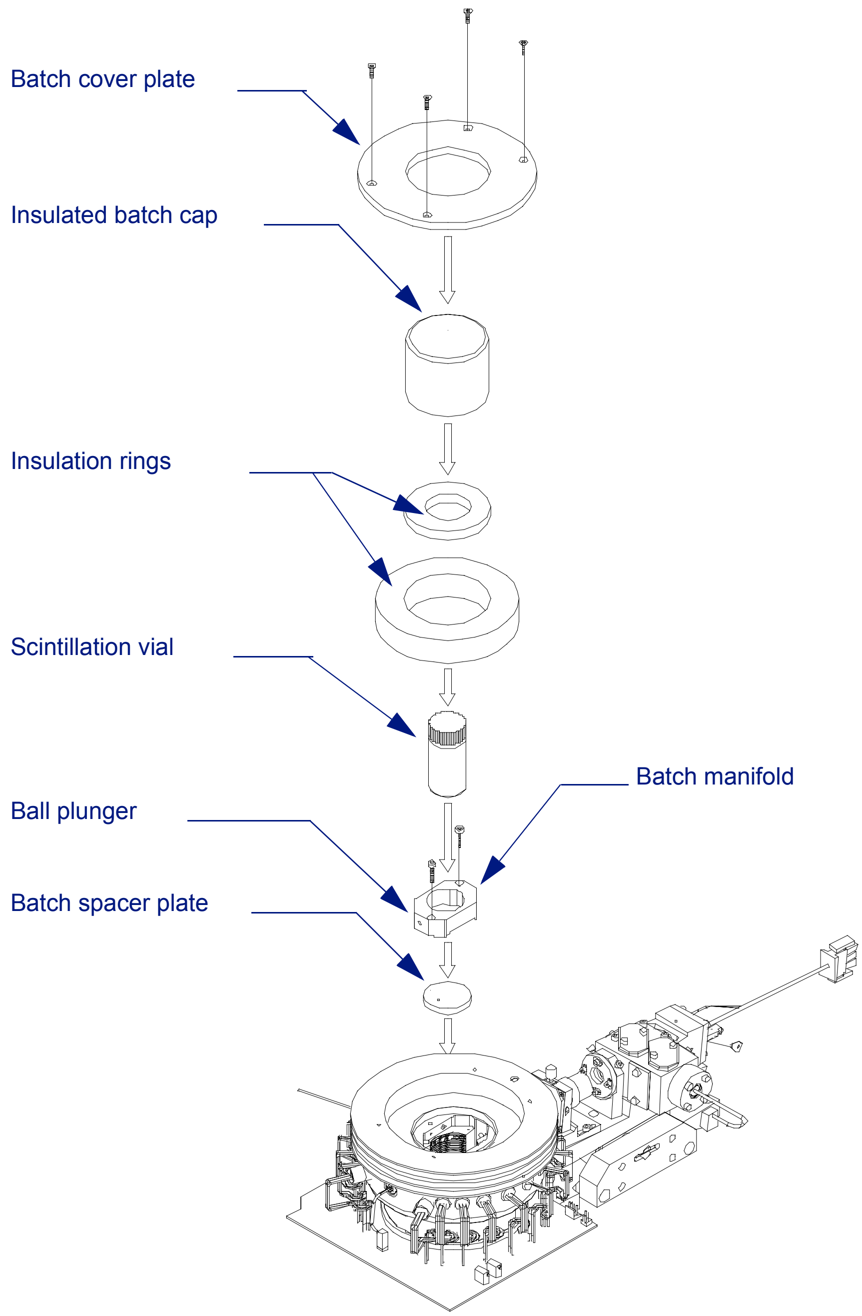
1. Remove the bib from the cover of the instrument.
2. Remove the read head cover, the flow cell cover plate, and the cell assembly from the instrument. (See the section on "Removing the Cell Assembly" in this chapter.)
3. Insert the batch spacer plate into the bottom of the read head cavity.
4. Insert the batch manifold and secure it with the two M3 screws.
5. Insert the foam insulation rings: the large ring, then the small ring.
6. Install the batch cover plate and secure it with the four Phillips screws.
7. Install the insulated batch cap.
8. Heat the read head to the required temperature, then put the preheated sample scintillation vial in the read head cavity and cover it with the insulated cap.

To replace the flow cell, cool down the read head then reverse the previous process.

Notes: The sample should be initially heated in an oven then filtered and transferred to the DAWN. Wait 15–20 minutes before taking a measurement.

When making measurements with scintillation vials, take great care to keep the outside of the vials clean and free of fingerprints, scratches, etc., as this can severely distort the measurement. We also advise you to rotate the vial in the read head to find the position where the laser beam enters the cell with the least amount of scattering at the air/glass interface. See the ASTRA user's guide for further instructions.

Figure A-2: Temperature Controlled flow-to-batch conversion kit, exploded



B Peltier Heated/Cooled Option

The Peltier Heated/Cooled DAWN option has some differences from the ambient DAWN. This appendix describes those differences and supplies instructions for making adjustments and operating this version of the instrument.

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Overview

The read head on the Peltier Heated/Cooled DAWN can be heated up to 150 °C or cooled down to –30 °C. The Heated/Cooled DAWN uses a solid-state Peltier device with a water bath as a source of heat or as a heat sink. The Peltier device can cool the flow cell or heat it up to 80 °C. A heater cartridge inside the read head supplies the additional heat required for flow cell temperatures up to 150 °C.

Figure B-1: Peltier Heated/Cooled read head and laser assemblies

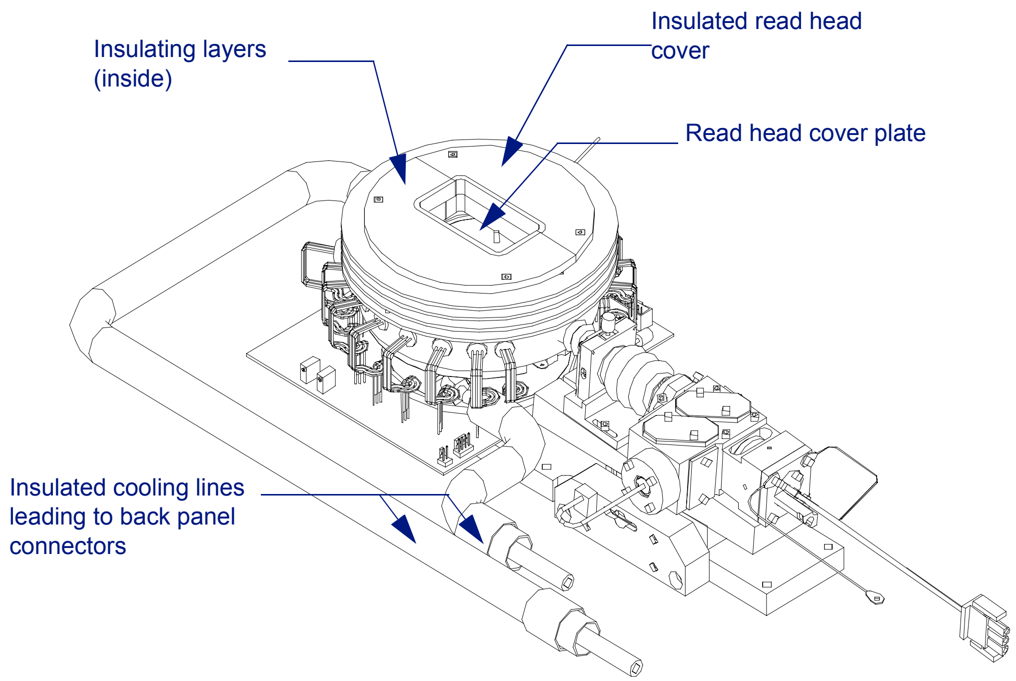
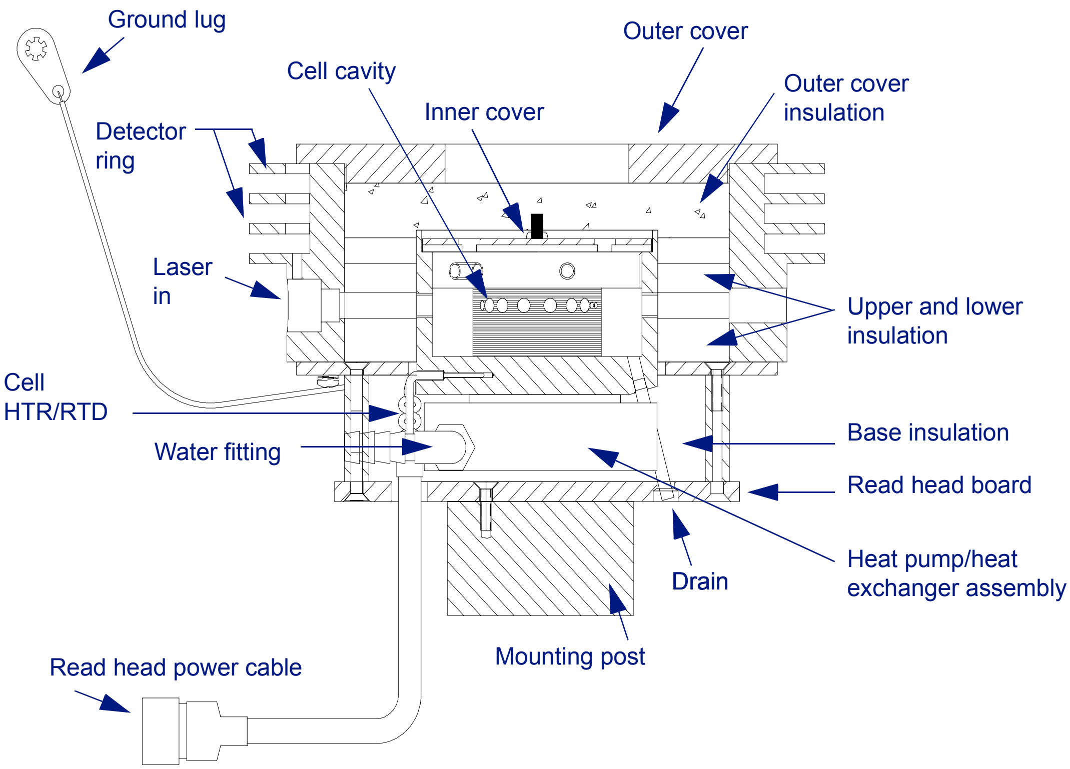


Figure B-2: Heated/cooled DAWN read head, side view



The temperature-controlled read head is comprised of three distinct shells of material:

- The outer aluminum detector ring, which contains the photodiode detectors.
- A layer composed of two insulating materials that keep the flow cell at a stable temperature while at the same time keeping the photodiodes as close to ambient temperature as possible.
- The innermost shell is the aluminum flow cell cavity. Mounted directly underneath the cell cavity, between the read head and the circuit board, is a solid-state heat pump. This is shown in the following side view diagram.

Directly underneath the flow cell is a platinum temperature sensor.

The heat pump requires a water bath as a source of heat when it is heating the flow cell and as a heat sink when it is cooling the flow cell. A water-filled heat exchanger is mounted in the read head. The “working fluid” of the heat pump is the conduction electrons in the material of the pump. These conduction electrons flow through the pump when a voltage is applied across it; as the electrons flow through the heat pump, heat is transferred between the cell cavity and the water bath. The direction in which heat is pumped can be changed by changing the polarity of the applied voltage. The DAWN automatically takes care of these details.

The temperatures of the read head and optional heated lines are controlled by Watlow thermocontrollers. The resolution of the controllers is 0.1 °C and the accuracy is ± 1 °C.

Pre-Operation Inspection

Before making measurements, check that the cell assembly is clean. If you are unfamiliar with the flow cell, see “Flow Cell Maintenance” in Chapter 4.

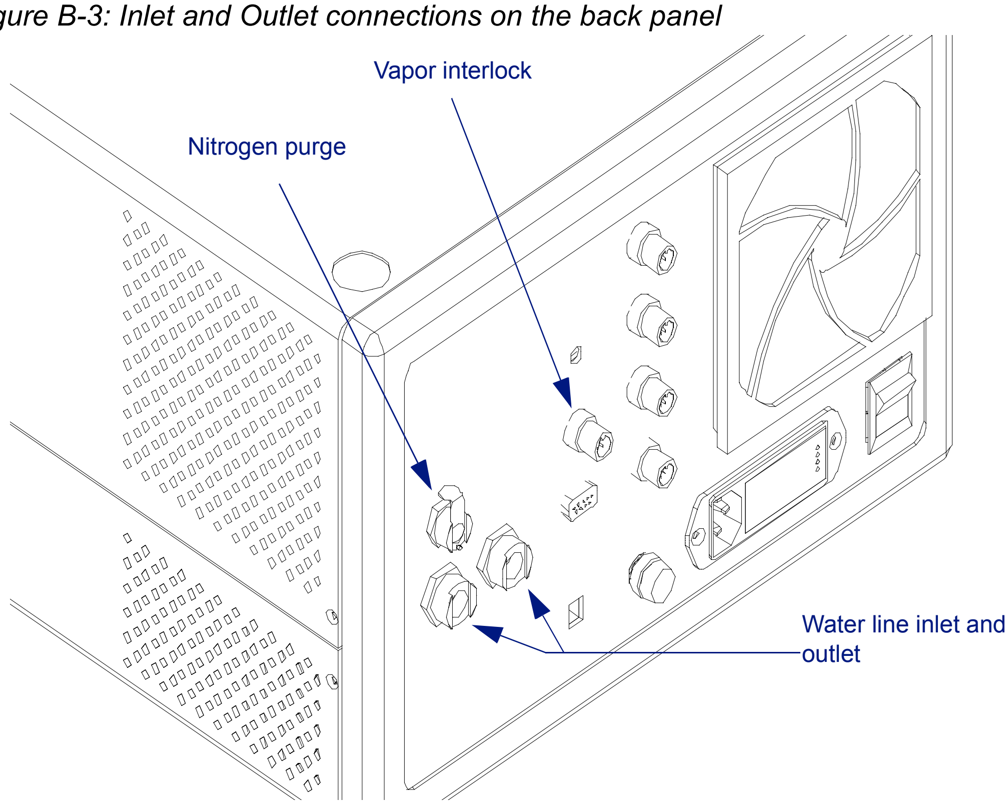
To perform a pre-measurement inspection, do the following:

Inspect the hose fittings at the read head and at the inlet and outlet ports on the back panel. Figure B-3 shows the inlet and outlet ports on the back panel.

Hose clamps secure the water hoses to prevent water leaks, which would seriously damage the DAWN. Two hose clamps, two barbed hose fittings, and some Tygon tubing are supplied as accessories. You can use these clamps, fittings, and tubing to connect to the water pump.

Caution: Power supplies and other electronics are mounted in the subchassis of the DAWN. Use extreme care.

Figure B-3: Inlet and Outlet connections on the back panel



Temperature Control

The DAWN flow cell is designed to operate at temperatures between 150 °C and –30 °C with the Heated/Cooled option. Heating and cooling are controlled by Watlow thermocontrollers. The resolution of the controllers is 0.1 °C and the accuracy is ± 1 °C.

Note: Attempting to heat or cool the cell beyond the temperature limits can damage or destroy your DAWN unit and void the warranty. The Heated/Cooled read head must not be heated above 150 °C. If the read head temperature rises above 175 °C due to a faulty controller, the heating system will shut down automatically.

Water Circulation

Water must be circulated through the heat exchanger when operating the heat pump. The water connections are on the left side of the back panel (shown in Figure B-3).

If water is not supplied, the heat pump will unsuccessfully try to control the temperature, resulting in an unstable baseline. Three gallons of clean water circulated by a small water pump at a flow rate of at least 0.25 gal/min (1.0 L/min) provide a stable water bath. A bucket of water and the submersible pump supplied with the instrument are adequate.

If you are operating at a temperature higher than 80 °C, drain the water from the cooling lines and turn off the Peltier cooling function using the switch in the upper-left corner of the Amplifier Booster board (see Figure 3-18). Higher temperatures may damage the heat pump.

Heated Lines

The optional DAWN heated lines can maintain temperatures up to 150 °C in the inlet and outlet lines if the DAWN is connected to other high-temperature instruments and detectors.

The read head can be cooled or heated, but the heated lines can only be heated. Using a setpoint below ambient temperature will only cool the read head—it won't cool the lines. When the heat pump is cooling the flow cell, the lines are not heated.

The installation and use of heated lines is described in Appendix A.

About the Thermocontrollers

The Ultra-High Temperature and Peltier Heated/Cooled versions of the DAWN have two Watlow thermocontrollers on the front panel. The operation of these thermocontrollers is described in Appendix A.

Note: The Watlow thermocontrollers are programmed to heat or cool by a maximum of 1 °C per minute. This is to ensure that the flow cell does not crack due to thermal stress. For example, if you wish to operate your system at -30 °C, and your system is initially at 25 °C, it will take about one hour for the temperature to reach -30 °C, since the rate of temperature change is limited to 1 °C per minute.

If you want to perform temperature ramping experiments, contact WTC for instructions on how to reprogram the ramp rate. The thermocontrollers can be set to ramp at rates as low as 0.1 °C per hour.

Operation

Above Ambient Temperature

Adjust the setpoint temperature as described earlier. However, be careful not to go above the boiling point of the solvent in the cell! The read head and the heated lines will be warmed until they reach the set temperature. The columns, solvent, and other apparatus must be appropriately insulated and/or heated.

Caution: When operating at elevated temperatures, never inject cold solvent into a hot flow cell. Doing so could shatter the cell!

If you are operating at a temperature higher than 80 °C, do the following:

- Turn off the Peltier cooling function using the switch in the upper-left corner of the Amplifier Booster board (see Figure 3-18). Temperatures higher than 80 °C may damage the heat pump.
- Drain the water from the cooling lines.
- Make sure the flow cell is configured for use at high temperatures. The cell is initially configured for the temperature you indicated you will use when you purchased the instrument. If your instrument is configured to operate at or below 80 °C, you must remove the backing rings and the 6 mm O-rings and install the 9 mm O-rings. Above 80 °C the O-rings expand enough to crack the flow cell glass if the backing ring and 6 mm O-ring are installed.

Below or Near Ambient Temperature

When operating below ambient temperature, you need to protect the flow cell from water vapor condensation and icing. Condensation on the flow cell makes measurements impossible. This problem is characterized by a low reading on the front laser monitor (Channel F) and large readings on the photodiodes.

To prevent condensation, attach a dry air or nitrogen line to the Nitrogen Purge fitting on the back of the DAWN. Use the right-angle male connector and the 10 foot length of Polyethylene tubing provided with the DAWN. The dry gas will flow into the cell cavity. The pressure in the dry air or nitrogen line should be 20 psi or lower.

The Peltier heat pump can cool the flow cell even if the water bath is at ambient temperature. However, the cooling rate will be relatively slow.

The maximum cooling rate permitted by the thermocontroller is 1 °C per minute. However, unless you cool the water bath, the cooling rate may be much slower. Since heat flows naturally from warmer to cooler regions, filling the water bath with ice or cold packs is a simple way to increase the cooling rate of the cell.

To cool to very low temperatures, you can use a commercial chiller unit and insulate the cooling lines to the back of the instrument with foam pipe insulation.

Near ambient temperature, the read head temperature will be more stable if you run cooling water through the read head.

Recommended Procedures

- Be sure all chosen operating temperatures are between the freezing point and boiling point of the solvent you are using!
- Make sure the solvent is at the same temperature as the flow cell.

  A large temperature difference could crack the flow cell! Smaller temperature differences could cause convection in the solvent as it flows through the cell, something which adds to the background noise.
- Always have the insulating cover plate locked in place before heating or cooling the flow cell.
- Check for leaks each time the DAWN has been heated.
- Replace the cell O-rings whenever the instrument is brought down from an elevated temperature! They conform to the geometry of the cell and, when brought down from an elevated temperature, may not seal reliably.
- The flow cell is initially configured for use at the temperature you indicate you will be using when you purchase the instrument. If you decide to operate at a different temperature, you may need to reconfigure the flow cell O-rings.

  If your instrument is configured to operate at or below 80 °C and you decide to operate above 80 °C, you must remove the backing rings and install the 9 mm flow cell O-rings instead of the 6 mm O-rings. Above 80 °C the O-rings expand enough to crack the flow cell glass if the backing ring is installed.

  If your instrument is configured to operate above 80 °C and you decide to operate below 80 °C, install the backing rings and the 6 mm flow cell O-rings. This minimizes dead volume.
- When operating below ambient temperature, be sure to connect a dry air or nitrogen source to the DAWN's Nitrogen Purge connector. Light scattered from condensed water ruins your measurements. It is a good idea to use dry air or nitrogen even at ambient or higher temperatures to minimize the amount of dust within the instrument.

C Polarization Option

The polarization option consists of a special grooved cell retainer which holds two strips of Polaroid film around the sides of the flow cell. The vertically polarized strip has vertical notches which can still be seen when installed in the flow cell assembly. These strips detect the presence of depolarizing molecules or particles.

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Installation

What you need to install the polarization filters:

- 2.0 mm Ball driver
- 2.5 mm Ball driver
- 2 ¼" Crescent wrenches
- 1.5 mm Hex driver

To install polarization filters, do the following:

1. Remove the bib from the cover of the instrument.
2. Remove the cell assembly from the read head:
   a. Remove the two M3 screws with a 2.5 mm Ball driver, then lift off the flow cell cover plate.
   b. Disconnect the short pieces of stainless steel tubing from the in-line unions using the two ¼" Crescent wrenches.
   c. Remove the two M3 screws, then lift the cell assembly up and out of the read head using the connecting tubing.
3. Use the 1.5 mm Hex driver to unscrew the two M2 screws holding the bottom cell retainer in place, then remove the cell retainer.
4. Install a vertically polarized strip facing the odd detectors (left side), including detector 11 at 90°, and a horizontally polarized strip facing the even detectors (right side).

   The small notches at the edges of the Polaroid film indicate its horizontal or vertical orientation.
5. Reinstall the special polarizer bottom cell retainer.
6. Reinstall the flow cell assembly using two M3 screws.
7. Reconnect the tubing to the in-line unions.
8. Reinstall the flow cell cover plate.
9. Replace the instrument cover bib.

Normalization and Calibration

Normalization

To normalize the DAWN, it is necessary for each detector to receive light from an isotropic scatterer. With the polarization strips in, however, half of the detectors are receiving light that has passed through a horizontal polarizer, while the other half are receiving light that has passed through a vertical polarizer. In the case where the normalization standard does not depolarize the scattered light, the detectors with the horizontal polarizer will receive no scattered light at all. Therefore, it is not possible to normalize the DAWN with the Polarization strips installed. Normalization should be performed without the Polarization strips. Then install the Polarization strips after normalization.

Calibration

For calibration, the 90 degree detector must receive a known amount of light. Typically, toluene is used as the calibration standard. However, toluene depolarizes the scattered light, so that there are horizontally and vertically polarized components that reach the detector. Therefore, installing a vertically polarized filter in front of the 90 degree detector blocks some of the horizontally polarized scattered light that is necessary for an accurate calibration. It might seem necessary, therefore, to remove the polarization strips before calibrating. The strips, however, attenuate some of the light, regardless of their polarizing properties, so it is necessary to take into account this attenuation.

There are two strategies to deal with calibration with the polarization strips.

Calibrate using toluene with the polarization strips installed. Then correct the calibration constant by using the Cabannes factor for toluene at the wavelength of the laser light.

Calibrate without the polarization strips installed. Then make a measurement of the scattered light on the 90 degree detector for a known sample that does not depolarize the scattered light (e.g. polystyrene, or any other random coil). Install the polarization strips, then measure the amount of scattered light on the 90 degree detector using the same sample *at the same concentration*. The ratio of the measurements with the polarization strips installed and absent gives the attenuation factor of the polarization strips. Use this factor to correct the calibration constant measured without the strips.

Either strategy should work. Contact Wyatt Technology Corporation if you have further questions.

D Interference Filter Option

Interference filters may be used to prevent light of wavelengths other than the laser's to reach the photodiodes. This can be useful when the sample fluoresces. Without these filters, too high a molecular weight is obtained since both scattered light and fluorescence are detected.

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Installing Interference Filters

What you will need to install interference filters:

- Anti-static wrist strap
- Tweezers
- Nine interference filters with O-rings
- Wooden or plastic spatula (or similar tool)

To install interference filters, do the following:

1. Put on the anti-static wrist strap.
2. Switch off the power to the instrument and laser, then remove the instrument cover.
3. Ground yourself to the chassis and gently remove a photodiode from the read head using a pair of tweezers.

   Be careful not to stress the solder connection of the lead to the PCB. Also, make sure the leads do not touch one another to cause a short circuit.
4. Carefully insert an interference filter into the diode hole using a wooden or plastic spatula. **Touch the outer edge of the interference filter only**. The mirrored side of the filter should face out towards the photodiode; the colored side of the filter should face in towards the cell.
5. Insert the small O-ring and push it firmly against the filter. This holds the filter in place.
6. Remove the black O-ring from the photodiode and push it into the shoulder of the hole.
7. Moisten the O-ring, then push the photodiode through the O-ring, into its hole.

   Moistening the O-ring ensures that the photodiode slides easily into place.
8. Repeat steps 3 to 7 for the other interference filters.

   Installing a filter on every other diode should be sufficient. For example, you might install filters on the odd numbered detectors only.
9. Replace the instrument cover and switch the instrument and laser back on.
10. Repeat the calibration (if you installed a filter on detector 11), normalization and, for Batch mode, solvent offset measurements.

E Laser Specifications

The DAWN EOS contains either a GaAs laser operating at a nominal wavelength of 685nm or Diode Pumped Solid State (DPSS) laser operating at 532nm.

The GaAs laser is a single transverse mode heterojunction that emits light between 680nm and 690nm, where the exact wavelength varies from device to device. Typically diode lasers undergo periodic mode hops between different longitudinal modes which have slightly different efficiencies giving rise to sudden changes in intensity, however Wyatt Technology utilizes a patented intensity stabilization method which achieves a typical long term intensity stability of 0.1%.

The DPSS laser consists of a diode-pumped Nd:YVO_4 gain medium coupled with a nonlinear doubling crystal. The time from unit power-on to laser emission is approximately 10 seconds. The beginning and end of laser emission is accompanied by an audible click. It takes an additional 5 minutes after laser emission begins for the laser to reach thermal stability. It is suggested that the laser be allowed at least 30 minutes to warm up before taking data. Note that the instrument must be connected to a computer running the ASTRA software for laser emission to occur.

While the DPSS laser is not intensity stabilized, it does not suffer to sudden longitudinal mode hopes. Therefore we accurately monitor the laser intensity and correct for slow intensity drifts in software. The laser specifications are:

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Electrical and Optical Specifications

Table E-1: Electrical and optical specifications

	GaAs	DPSS
Power Output	30 mW	26 mW
Laser Operating Wavelength	680 nm – 690 nm	532 nm
Vertical Beam $1.0/e^2$ Intensity Diameter	80 µm	62 µm
Horizontal Beam $1.0/e^2$ Intensity Diameter	52 µm	62 µm
Polarization Ratio	> 100:1	> 100:1
Max Power Stability	< 0.5%	1.0%
Typical Optical Noise	0.1%	0.5%
Typical Operating Voltage	2.4 VDC	5 VDC
Typical Operating Current	85 mA	8 A

Environmental Specifications and Safety Notes

Table E-2: Environmental specifications

GaAs	Operating	GaAs	Non-Operating	DPSS
Operating	DPSS	Non-Operat-ing	Temperature	-10 to +60 °C
-40 to +85 °C	10 to 35 °C	-15 to +50 °C	Relative Humidity	0-95%
0-95%	10-85%	10-85%	Shock	1500 G – 0.5 ms
1500 G – 0.5 ms	1 G - 11.0 ms	25 G – 11.0 ms	Vibration (5 to 500Hz sinusoidal)	N/A
N/A	0.3 G	2.0 G		

The lasers used in the DAWN EOS are classified as Class 1 Laser Product according to IEC60825-1:1993+A1+A2. This means that under normal operation, no laser radiation should escape from the instrument, and no protective equipment must be worn. However the follow warning applies:

Caution: Use of controls or adjustment or performance of procedures other than specified herein may result in hazardous radiation exposure.

The instrument also bears the following warning label:

Danger: Laser Radiation when open. Avoid direct exposure to beam.

F Flow Cell Properties

This appendix contains tables listing thermal and chemical properties of the two types of flow cells, and their refractive indices. Except for Table F-4, all data and descriptions are from the Schott Glass *Optical Glass Catalog*.

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Thermal Properties

Glass Classification	Thermal Expansion		Transformation Temperature	Specific Heat $c_p = (J/g \times K)$
	-30 to 70 °C	20 to 300 °C		
K5	8.2×10^{-6} /K	9.6×10^{-6} /K	543 °C	0.783
F2	8.2×10^{-6} /K	9.3×10^{-6} /K	432 °C	0.557

Refractive Indices

Glass Classification	Refractive Index $\lambda = 633nm$
K5	1.51876
F2	1.61311

Chemical Properties

To interpret the CR, FR, SR and AR values, see “Definition of Terms”.

Glass Classification	Bubble Class	CR	FR	SR	AR
K5	0-1	1	0	1	1.0
F2	0	1	0	1	2.3

Definition of Terms

Transformation Temperature

Temperature at which deformation of precision finished surfaces and a change in the refractive index can occur.

Climate Resistance (CR 1–4)

Class CR 1; after 180 hours of exposure the glasses exhibit no or only slight signs of deterioration due to changing climatic conditions. Under normal humidity conditions that prevail during the processing and storage of optical glasses, no surface deterioration of class CR1 glasses is to be expected.

Resistance to Staining (FR 0–5)

Class FR 0; after exposure to a standard acetate solution (pH=4.6) for over 100 hours, no interference color staining is observed.

Resistance to Acids (SR 1–4)

Class SR 1; after a 100 hour exposure to an aggressive solution of 0.3n nitric acid (pH=0.3), the smallest visible detectable thickness, 0.1 micrometer, is not dissolved.

Resistance to Alkalis (AR 1–4)

A two-digit figure is used to express resistance to alkalis. The digit after the decimal point indicates what surface changes are visible to the naked eye after alkaline exposure. The alkaline resistance class indicates the time in minutes required to decompose a 0.1 micrometer layer of glass in an alkaline solution at 90°C (sodium hydroxide, pH=10).

Table F-1: Flow cell alkaline resistance classes

Alkaline Resistance	Time (in minutes)
1	>120
2	120–30
3	30–7.5
4	<7.5

Table F-2: Flow cell alkaline resistance visible surface changes

Visible Surface Changes	Description
0.0	No change
0.1	Scarred surface but no visible coatings (color change)
0.2	Interference colors
0.3	Whitish staining
0.4	White coating (thick layers)

Scattering Angles

The table below shows the scattering angles for two different flow cells in four different solvents at a wavelength of 690 nm. Note that for a K5 cell in water, the first two detectors are not available; for an F2 cell in water, the first three detectors are not available.

The mathematics behind these changes in scattering angles are discussed in the "Flow Cell" section of Chapter 3.

Table F-3: Flow cell scattering angles (part A)

	K5				**F2**			
	water	**THF**	**tolu-ene**	**TCB**	**water**	**THF**	**tolu-ene**	**TCB**
n_g	1.51876	1.51876	1.51876	1.51876	1.61311	1.61311	1.61311	1.61311
n_s	1.330	1.401	1.488	1.500	1.330	1.401	1.488	1.500

Table F-4: Flow cell scattering angles (part B)

Det	**read head angle**	**K5**				**F2**			
		water	**THF**	**tolu-ene**	**TCB**	**water**	**THF**	**tolu-ene**	**TCB**
1	22.500	batch	batch	batch	batch	batch	batch	batch	batch
2	28.000	N/A	16.831	25.684	26.621	N/A	N/A	16.827	18.281
3	32.000	14.440	23.172	30.051	30.834	N/A	12.461	23.169	24.217
4	38.000	25.862	31.323	36.457	37.073	17.108	24.863	31.321	32.067
5	44.000	34.772	38.757	42.759	43.253	29.254	34.081	38.756	39.323
6	50.000	42.776	45.828	48.999	49.396	38.775	42.260	45.827	46.270
7	57.000	51.542	53.813	56.227	56.533	48.656	51.164	53.812	54.147
8	64.000	59.961	61.626	63.421	63.650	57.881	59.686	61.626	61.873
9	72.000	69.337	70.428	71.615	71.767	67.988	69.157	70.428	70.590
10	81.000	79.710	80.236	80.812	80.886	79.063	79.623	80.236	80.315
11	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000
12	99.000	100.29	99.764	99.188	99.114	100.94	100.38	99.764	99.685
13	108.00	110.66	109.57	108.39	108.23	112.01	110.84	109.57	109.41
14	117.00	121.23	119.48	117.61	117.37	123.41	121.52	119.48	119.22
15	126.00	132.16	129.58	126.87	126.52	135.47	132.59	129.58	129.21
16	134.00	142.49	138.86	135.16	134.70	147.41	143.11	138.86	138.33
17	141.00	152.55	147.40	142.49	141.89	160.49	153.48	147.40	146.69
18	147.00	163.28	155.39	148.87	148.12	180.00	164.94	155.39	154.41
A/C	81.000	79.710	80.236	80.812	80.886	79.063	79.623	80.236	80.315

G Rates and DSP Filter Settings

The DAWN transmits data to the host computer via the RS-232 serial port. You can change several related parameters, including those controlled by the J5 jumper block on the System board:

- The baud rate controls the rate at which bytes are sent out over the RS-232 port. It can be set to 9600 or 19200.
- The data rate specifies how often a packet of data (containing signals from all detectors) is collected and sent to the host computer. The data rate can be set to 2, 4, 8, or 16 Hz at 9600 baud, or 4, 8, 16, or 32 Hz at 19200 baud.
- The DSP filter settings control the roll-off frequency for the 6-pole Gaussian filters. The roll-off frequency can be set to 0.75, 1.5, 3.0, or 6.0 Hz.

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When Should You Change the Transmission Settings?

The factory default settings for data transmission are 9600 baud, 8 Hz data rate (data transmission frequency), and 3 Hz roll-off.

Although we do not recommend it, you might want to alter the factory default settings to collect data at a faster or slower rate. Be aware, however, that the settings are not all independent. For example, if you increase the data rate, you should also increase the roll-off frequency for the DSP filters, and if you increase the data rate to 16 Hz, you must also increase the baud rate.

Many older computers have difficulty collecting at a data rate of 16 Hz and begin to miss data. We have found that 386-based computers cannot collect reliably above 9600 baud and cannot collect at a data rate of 16 Hz. For batch mode, you will need a minimum 486SX-based processor to get an 8 Hz data rate.

Note: If you adjust the data rate, the WTC software (ASTRA) must be made aware of the new data rate (see the software users guide for instructions on setting instrument parameters.) ASTRA for Macintosh does not require any adjustments; the software detects the data rate at the start of a collection.

Changing the Transmission Settings

The settings are controlled by the J5 jumper block on the System board, located on the left side of the instrument and shown in Figure G-1. The pins are numbered from 1 to 13 on one side and from 14 to 26 on the other side. Each jumper connects a pin from one side of the block to a pin on the other side. For example, the factory default jumpers are 2–15, 8–21, 10–23 and 13–26. Table G-1 shows several recommended settings.

Important: Turn off the instrument before changing jumper settings.

The following figure shows the factory default settings.

Figure G-1: Location of the jumpers on the System board

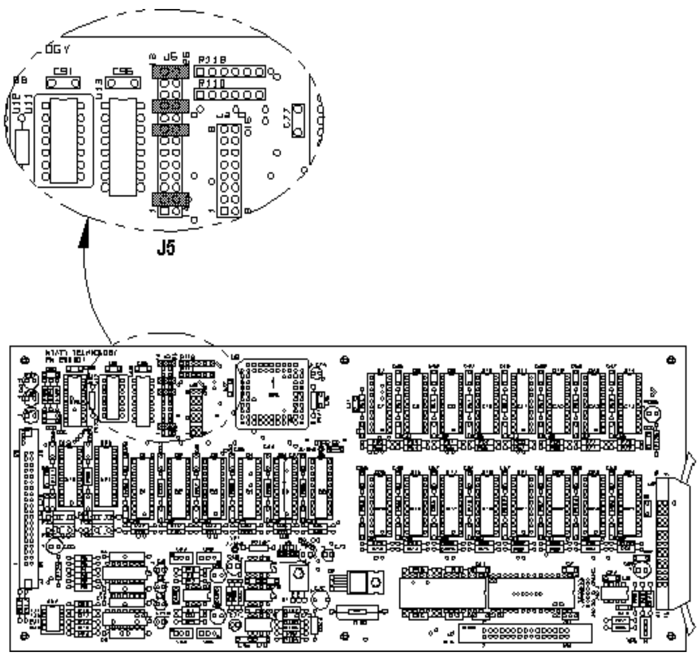

Table G-1: Recommended DAWN settings.

Baud Rate	Data Rate (Hz)	Roll-off (Hz)	J5 Jumper Positions
9600	2	0.75	8–21, 10–23, 4–17
9600	4	1.5	8–21, 10–23, 12–25, 3–16
9600	8	3.0	8–21, 10–23, 13–26, 2–15 (factory default)
19200	16	6.0	7–20, 9–22, 11–24, 13–26, 1–14

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