ACQUITY UPLC I-Class

System Guide

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Waters

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Safety considerations

Some reagents and samples used with Waters instruments and devices can pose chemical, biological, or radiological hazards (or any combination thereof). You must know the potentially hazardous effects of all substances you work with. Always follow Good Laboratory Practice, and consult your organization's safety representative for guidance.

Considerations specific to the ACQUITY UPLC I-Class instruments

See also: For safety considerations regarding specific system modules, consult the appropriate information on the user documentation CD.

High voltage hazard

Warning: To avoid electric shock, do not remove protective panels from the ACQUITY UPLC® I-Class system modules. The components within are not user-serviceable.

Safety advisories

Consult Appendix A for a comprehensive list of warning and caution advisories.

Operating the ACQUITY UPLC I-Class system

When operating the ACQUITY UPLC I-Class system, follow standard quality-control (QC) procedures and the guidelines presented in this section.

Applicable symbols

Symbol	Definition
	Manufacturer
	Authorized representative of the European Community
	Confirms that a manufactured product complies with all applicable European Community directives
	Australia C-Tick EMC compliant
	Confirms that a manufactured product complies with all applicable United States and Canadian safety requirements
	Consult instructions for use

Audience and purpose

This guide is intended for personnel who install, operate, and maintain ACQUITY UPLC I-Class system modules. It gives an overview of the system's technology and operation.

Intended use of the ACQUITY UPLC I-Class system

Waters designed the ACQUITY UPLC I-Class system to perform chromatographic separations. The system is for research use only and is not intended for use in diagnostic applications.

Calibrating

To calibrate LC systems, follow acceptable calibration methods using at least five standards to generate a standard curve. The concentration range for standards should include the entire range of QC samples, typical specimens, and atypical specimens.

When calibrating mass spectrometers, consult the calibration section of the operator's guide for the instrument you are calibrating. In cases where an overview and maintenance guide, not an operator's guide, accompanies the instrument, consult the instrument's online Help system for calibration instructions.

Quality-control

Routinely run three QC samples that represent subnormal, normal, and above-normal levels of a compound. Ensure that QC sample results fall within an acceptable range, and evaluate precision from day to day and run to run. Data collected when QC samples are out of range might not be valid. Do not report these data until you are certain that the instrument performs satisfactorily.

ISM classification

ISM Classification: ISM Group 1 Class B

This classification has been assigned in accordance with IEC CISPR 11 Industrial Scientific and Medical (ISM) instruments requirements. Group 1 products apply to intentionally generated and/or used conductively coupled radio-frequency energy that is necessary for the internal functioning of the equipment. Class B products are suitable for use in both commercial and residential locations and can be directly connected to a low voltage, power-supply network.

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1 ACQUITY UPLC I-Class System

Waters designed the ACQUITY UPLC® I-Class system for optimum performance when running difficult assays. Configure it with a mass spectrometer to take full advantage of the system's design enhancements.

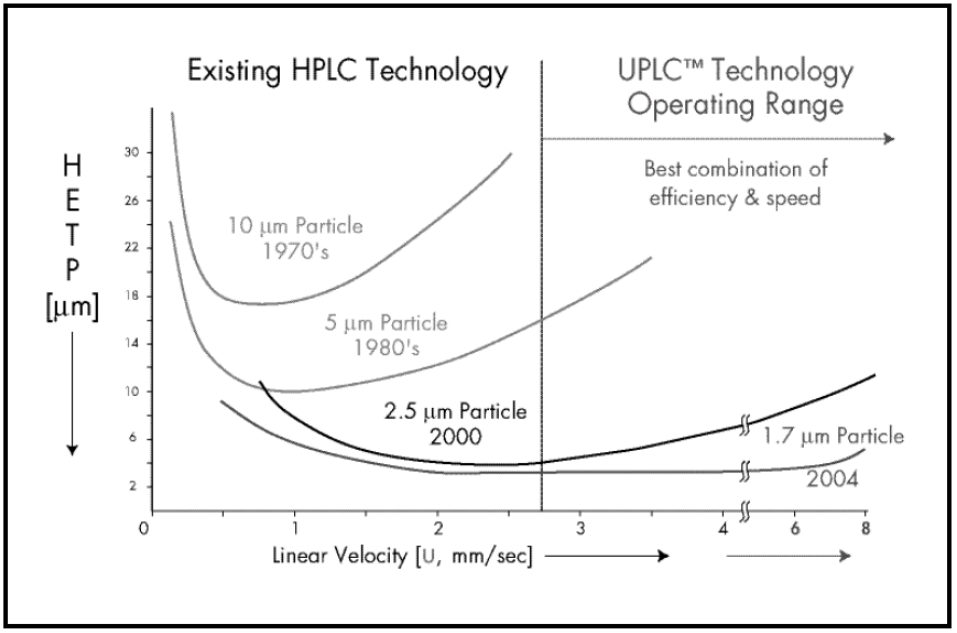
Contents:

UltraPerformance Liquid Chromatography

In 2004, Waters made significant advances in instrumentation and column design when it introduced UPLC® technology to the field of separation science. By employing this technology, Waters' ACQUITY UPLC systems achieve a marked increase in resolution, speed, and sensitivity in liquid chromatography, when compared to conventional systems.

UltraPerformance liquid chromatography uses columns packed with round particles, 1.7 µm-diameter; its operating pressures are as high as 18,000 psi. The van Deemter equation, an empirical formula that describes the relationship between linear velocity and column efficiency, considers particle size as one of the variables. Thus the equation can be used to characterize theoretical performance across a range of particle sizes.

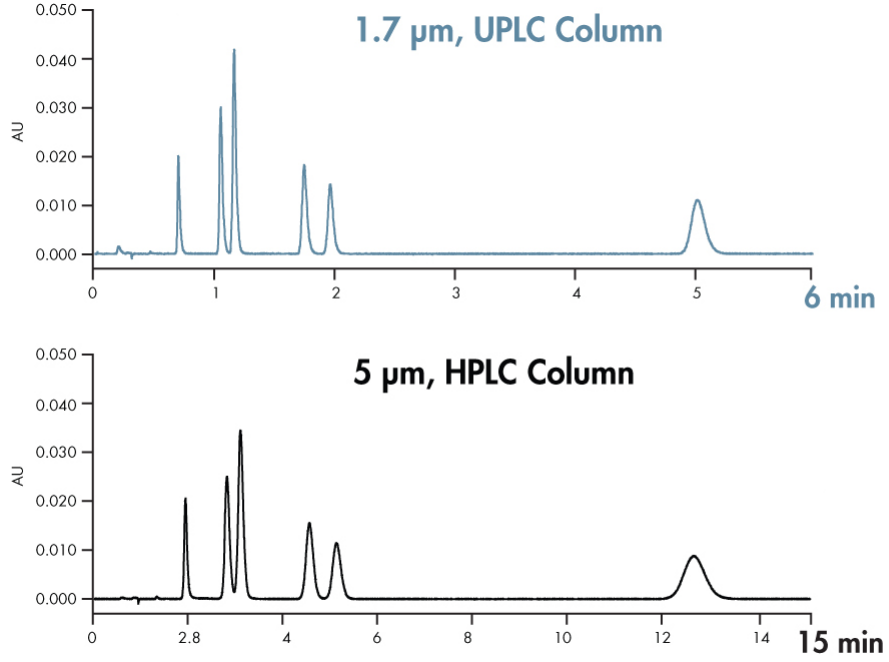
History of particle size in liquid chromatography:



It is apparent from the figure, above, that using 1.7-µm particles achieves higher efficiency that persists as the flow rate increases (lower HETP indicates higher efficiency, HETP = Height Equivalent to a Theoretical Plate). When operating in this area of the plot, the peak capacity and the speed of a separation can set limits well beyond those of conventional HPLC technology.

Waters has defined this new level of performance as UltraPerformance liquid chromatography.

Comparison of chromatographic separations using 5.0-µm and 1.7-µm particles:



Each separation was performed on a 2.1 × 50 mm column. Chromatographic conditions for the separations were identical, except for the flow rate, which was scaled according to particle size.

Features of the ACQUITY UPLC I-Class system

The ACQUTY UPLC I-Class system significantly improves the results of traditionally challenging separations.

When compared to systems typically used for difficult assays, the I-Class system confers these advantages:

- Significantly decreased system dispersion
- Rapid injection cycles and sample throughput

- Greatly reduced carryover

These advantages provide the following benefits over traditional systems:

- Superior peak capacity
- Higher sensitivity
- Faster data acquisition
- Consistent, reproducible results

The I-Class system is an effective tool for analyzing complex or dilute samples, providing high resolution and reproducible results for chromatographic separations.

Binary solvent manager

The ACQUITY UPLC I-Class system employs a binary solvent manager that, like the system, is optimized for sub-2-µm particle liquid chromatography and uses reduced fluid volumes. New pressure management capabilities extend the flow rate envelope for the system to support ballistic gradients. This support enables you to run higher flow rates and faster cycle times to accelerate your chromatography, while maintaining the integrity of the separation.

Column compartments

Column compartments configured with I-Class systems ensure reliable and robust separations. This is especially important when you transfer methods to other systems. UPLC applications can benefit from pre-column, mobile-phase heating to improve chromatographic separations. The ACQUITY UPLC I-Class column compartments use an active preheater to condition solvent as it enters the column. The preheater is a heat source that raises the temperature of the incoming mobile phase and injected sample to the same set point as that of the column compartment. Active solvent preheaters provide precise thermal performance with low dispersion for exact control of chromatographic conditions that remain consistent between systems.

Injector mechanisms

ACQUITY UPLC I-Class system configurations includes a sample manager with either a fixed-loop or flow-through-needle injector mechanism. This flexibility allows you to choose the optimum injector mechanism for your

application. Both mechanisms provide high precision with low dispersion and efficient sample recovery.

The low carryover performance of the injector mechanisms, which enables you to use a wider sample concentration range, is also beneficial for mass spectrometry applications.

Detectors

The PDA and TUV detectors available with the I-Class system feature low-dispersion UV flow-cell technology, which enhances peak resolution.

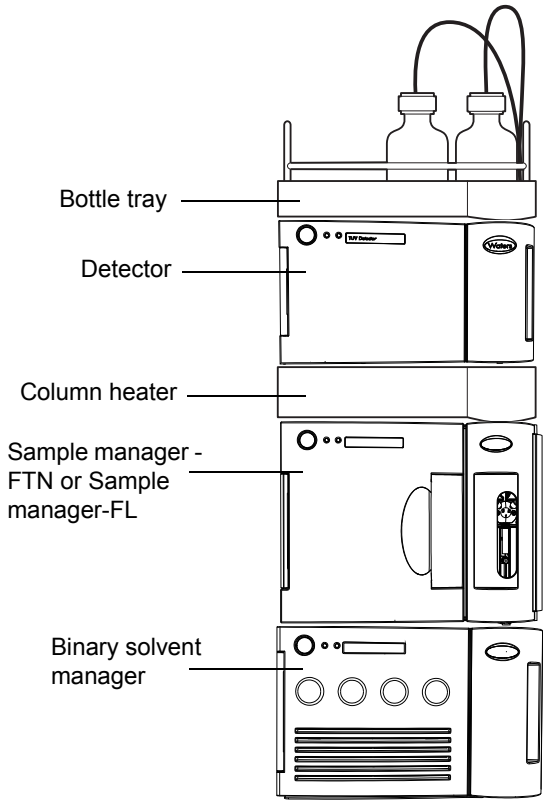
Mass spectrometry

When you configure an I-Class system with a mass spectrometer, the system's design enhancements enable you to separate more peaks with better peak shapes to aid quantitation. You also benefit from improvements in sensitivity and flexibility.

See also: Waters.com for information on compatible Waters mass spectrometers.

System modules

See also: *Configuring ACQUITY UPLC I-Class System Components* (P/N 715003144)



The ACQUITY UPLC I-Class core system includes a binary solvent manager, a sample manager (flow-through-needle or fixed loop), a column heater (CH-A), detectors (tunable ultraviolet, photodiode array, eλ photodiode array, or mass spectrometry), and an ACQUITY UPLC column.

Waters Empower™ chromatography data software, MassLynx™ mass spectrometry software, standalone ACQUITY UPLC Console software, or Analyst® software controls the system.

Binary solvent manager

The Waters ACQUITY UPLC I-Class Binary Solvent Manager delivers solvent compositions for isocratic and binary gradient methods at flow rates of 0.01 to 2.0 mL per minute. Its features include in-line filters upstream of a primary check valve, the Waters® Intelligent Intake Valve (*i²Valve*), automated priming functions, and daily system-setup routines.

The design of the binary solvent manager (and, indeed, the system overall) is optimized for sub-2-µm particle liquid chromatography. The upper pressure limit is set at 124,106 kPa (1241 bar, 18,000 psi) per pump. A maximum flow rate of 1 mL/min is permitted at system backpressures to 124,106 kPa (1241 bar, 18,000 psi), which falls within the range of optimal linear velocity for sub-2-µm particle columns of ID 1.0 mm to 3.0 mm.

See also: The *ACQUITY UPLC Binary Solvent Manager Operator's Overview and Maintenance Information* for more details.

Sample manager-FTN

The ACQUITY UPLC I-Class Sample Manager - FTN uses a flow-through-needle mechanism that differs from a loop-based injector. The mechanism aspirates a sample from plates and vials and holds it in the sample needle in preparation for injecting the sample onto the column. The needle serves as part of the injection flow path when the sample is pushed onto the column.

Optional extension loops (installed between the sample needle and the injection valve) can increase the injection volume beyond that of the sample needle. The sample manager-flow through needle can also dilute samples using the auto-dilution option

Using the flow-through-needle mechanism, the system operates similarly to most traditional HPLC systems, which facilitates the transfer of HPLC methods. The flow-through-needle mechanism also does not require you to learn new injection modes. Moreover, it achieves injection accuracy and decreases cycle time for small volume injections. Gradients pass through the needle during injection, ensuring complete sample recovery.

Sample manager-FL

The sample manager - FL uses a loop-based mechanism to inject samples. After a puncture needle pierces the well or vial covering, a sample needle

emerges from within the puncture needle, to aspirate the sample. In the partial loop needle overfill injection mode (default), the sample needle is then removed from the vial and the sample syringe continues to pull the sample aliquot through the sample needle and through the injection valve until any pre-sample and the sample injection volume pass through the injection valve. The valve actuates, switching the sample loop to the load position. The sample is pushed back toward the needle and the sample volume is then pushed into the sample loop. The sample loop is moved to the injection position and flow from the pump pushes the sample onto the column.

See also: *ACQUITY UPLC Sample Manager - Fixed Loop Operator's Overview and Maintenance Information* for information on other injection modes.

Column heater

Column temperature variations can shift peak retention times and alter peak shapes, increasing the difficulty of achieving precise results. The ACQUITY UPLC I-Class system's column heater helps to ensure precise, reproducible separations by controlling the column temperature.

The column heater (CH-A) heats the column compartment to any temperature from 20 ºC to 90 ºC, that is at least 5 °C above the ambient temperature. A low dispersion, active preheating device heats the incoming solvent before it enters the column. The column compartment can accommodate columns of up to 4.6 mm I.D. and up to 150 mm length.

30-cm Column heater (optional)

The optional 30-cm column heater (CH-30A) heats the column compartment to any temperature, from 20 ºC to 90 ºC, that is at least 5 ºC above the ambient temperature. The 30-cm column heater mounts on the side of the system stack.

The 30-cm column heater can accommodate UPLC® columns of 4.6 mm, or less, ID and 150 mm, or less, length and HPLC columns of 4.6 mm, or less, ID and 300 mm, or less, length. For columns that exceed 4.6 mm ID, use the ACQUITY UPLC 30-cm column heater/cooler with the appropriate compatibility kit.

Note: The ACQUITY UPLC 30-cm column heater/cooler is compatible with I-Class systems. See *ACQUITY UPLC Column Compartments Operator's Overview and Maintenance Information* for details.

Column manager (optional)

The ACQUITY UPLC I-Class column manager (CM-A) is an option for helping to ensure precise, reproducible separations. The column manager can regulate the temperature of columns from 4 °C to 90 °C. Its troughs can accommodate columns of up to 4.6-mm I.D. and up to 150-mm length, depending on the configuration. Each of the two column troughs can hold one column, up to 150 mm in length (with filter or guard column). The column manager also offers a bypass channel and automated, programmable switching between columns, for methods development. The column manager is installed with two, column switching valves.

Restriction: Derating: The minimum achievable column compartment temperature set point must not be greater than 25 °C below the ambient temperature.

Tip: The column manager can be used for column switching and two-dimensional chromatography applications. For information about two dimensional applications consult the *ACQUITY UPLC Systems with 2D Technology Capabilities Guide*.

Sample organizer (optional)

Requirement: Verify that the sample organizer you use with your I-Class system is compatible with sample managers fitted with a rotary tray.

The sample organizer stores multiple microtiter or vial plates and transfers them to and from the sample manager, automating processing and increasing throughput.

The sample organizer's storage shelf compartment can hold a selection of ANSI plates, which you load into the organizer through a large, swing-open front door. A heater/cooler thermally conditions the shelf compartment and, together with the sample manager's heater/cooler, maintains the temperature at a set point determined by the user.

Column technology

ACQUITY UPLC columns are packed with 1.7-µm, bridged, ethylsiloxane, hybrid or 1.8-µm high-strength silica particles that can mechanically endure high-pressure conditions. The column hardware can withstand as much as 124,106 kPa (1241 bar, 18,000 psi). The column dimensions allow optimal MS-compatible flow rates, and matched outlet tubing minimizes the effect of extra-column volume. Although the system works with most analytical HPLC

columns, specially designed ACQUITY UPLC columns maximize its high-pressure capabilities. Compared with traditional HPLC columns, ACQUITY UPLC columns deliver superior resolution and sensitivity in the same run time or equivalent resolution and greater sensitivity with faster run times.

eCord technology

ACQUITY UPLC columns include an eCord™ column chip that tracks the usage history of the column. The eCord column chip interacts with the system software, recording information for as many as 50 sample queues run on the column. The eCord column chip provides documentation of the column used for each chromatographic run and records the following information:

- Number of injections onto the column
- Number of samples injected onto the column
- The highest pressure that the column has experienced (and the date)
- The highest temperature the column has experienced (and the date)

In addition to the variable column usage data, the eCord column chip also stores these fixed, column-manufacturing data:

- Unique column identification.
- Certificate of Analysis.
- QC test data.

When you attach the eCord column chip to a receptacle on the column heater or column manager, information is automatically recorded by the system. No user action is required.

Detectors

These specially matched detectors operate with lower flow cell volume, minimized tubing volume, and specialized fittings to control bandspreading and maintain the characteristic narrowness of the peaks. The small-particle chemistries utilized in UPLC system chromatography produce very narrow peaks. The ACQUITY® TUV, PDA, and eλ PDA detectors and mass spectrometers collect data at sufficiently fast rates, to acquire these peaks without affecting the sensitivity or accuracy of the peak measurement.

Local Console Controller (optional)

The ACQUITY UPLC Local Console Controller (LCC) complements chromatography data system (CDS) software, enabling you to control the systems locally. Designed to emulate a simple keypad, the LCC's minimal functionality bars it from operating as a standalone controller. Its installation in a system does not supplant CDS control. Rather, Waters designed the LCC to prepare system modules for operation, define initial conditions, and run ACQUITY UPLC system diagnostic tests. These basic functions are rapidly performed, even when a system is remote from the software control and acquisition workstation or LAC/E™32 module or when network control is unavailable.

For additional information

On the system documentation CD, you can find this additional information about the ACQUITY I-Class system:

- *ACQUITY UPLC Binary Solvent Manager Operator's Overview and Maintenance Information*
- *ACQUITY UPLC Sample Manager-Flow Through Needle Operator's Overview and Maintenance Information*
- *ACQUITY UPLC Sample Manager-Fixed Loop Operator's Overview and Maintenance Information*
- *ACQUITY UPLC Column Compartment Operator's Overview and Maintenance Information*
- *ACQUITY UPLC Sample Organizer Operator's Overview and Maintenance Information*
- *ACQUITY UPLC I-Class System Specifications*
- *ACQUITY UPLC I-Class System Solvent Considerations*

Visit waters.com for more information and to join the ACQUITY UPLC online community, where you can partake in these activities:

- Share information and ask questions of ACQUITY UPLC experts and scientists.
- Access ACQUITY UPLC publications and user experiences worldwide.
- Review FAQs, tips and tricks, and tutorials.
- Explore the latest ACQUITY UPLC applications and information.

2 Optimizing Performance

Follow the advice and guidelines in this chapter to help ensure optimum performance from your ACQUITY UPLC I-Class system.

Contents:

General guidelines

ACQUITY UPLC I-Class system guidelines differ from those governing standard HPLC practices primarily because a chromatography that uses small (less than 2 µm) particles places certain constraints on the system. Chromatography performed on a UPLC system is of a much smaller-scale than that performed using an HPLC system, yet it gives a higher resolution. Moreover, analysis time for UPLC is shorter, and solvent and sample consumption are significantly reduced.

The ACQUITY UPLC I-Class chromatograph requires optimum performance from the sample manager because sample dispersion is more evident when using smaller columns. The reduction in chromatographic run time also makes efficient management of cycle time essential.

When performing fast UPLC analyses, note that a peak of interest can be less than 0.5 seconds wide. Waters recommends a sampling rate of 25 to 50 points across a peak, which provides good quantitation. Sampling rates faster than 20 points per second yield higher baseline noise, requiring you to adjust filter time constants accordingly. The optimal ACQUITY UPLC flow rate differs from that of a typical HPLC column. The table below offers operating guidelines for ACQUITY UPLC columns under both isocratic and gradient conditions. Note that the values provided are approximations and that optimum performance for your molecule or separation can occur at a different flow rate.

Optimal flow rates for molecular weight range:

Column size	Molecular weight	Flow rate
2.1 × 50 mm	<500	600 µL/min
2.1 × 50 mm	1000	300 µL/min
2.1 × 50 mm	1500	150 µL/min
2.1 × 50 mm	2000	100 µL/min

Follow these general recommendations when performing a UPLC analysis:

- Use high quality solvents, buffers, and additives (HPLC or MS grade, prefiltered).
- Use high quality water (HPLC- or MS-grade).
- Always use solvent filters on tubing lines in solvent bottles.

- Filter buffers with a 0.2-µm filter membrane.
- Keep concentrated stock solutions, to use when preparing working solutions.
- Do not add fresh buffer to old, which can promote microbial growth.
- Make fresh buffer solutions daily.
- Do not block the degasser vent line. Trim the tubing, if necessary.
- Do not submerge the waste or degasser vent lines in liquid. (See the *ACQUITY UPLC Binary Solvent Manager Operator's Overview and Maintenance Information* for details on how to route the tubing.)
- Flush buffers from the system, using water, immediately after you are done with them.
- Use 10-20% organic solvent in water as a storage solvent, if you keep the system idle for extended periods (longer than 24 hours).
- Keep the seal-wash line primed.
- Prime solvent lines during system startup.
- Keep all solvent lines primed.
- Monitor the waste level, to ensure that it is never too high.
- When starting the binary solvent manager, ensure solvent flows through pump A and pump B. Do not specify a 0 mL/min flow rate at startup for either pump.
- Use the Load Ahead option when you desire a shorter cycle time.
- If you experience problems with carryover, do not use the Load Ahead or Loop Offline options while you are troubleshooting.
- When installing or removing a column, always hold the active preheater's reusable compression fitting in place. Rotate the column or optional in-line filter to install or remove it.

Dispersion

UPLC systems exhibit low dispersion, a fixed, instrument characteristic measured by the extent of peak broadening, which occurs because of the system volume.

Small particle chromatography uses small, high efficiency columns. A typical 2.1 × 50 mm UPLC column has an approximate 174-µL volume, compared

with 2.5 mL for a typical 4.6 × 150 mm HPLC column. The smaller column and particle size require a system with low dispersion that reduces dilution and band broadening, thus maintaining the symmetrical peak shape, height, and sensitivity produced by the high efficiency column.

An ACQUITY UPLC I-Class system typically exhibits a bandspread between 4 and 7 µL, or between 6 and 9 µL, depending on system configuration. An Alliance HPLC system can exhibit a bandspread between 35 µL and 50 µL. Because of the dispersion differences, a band on an Alliance system experiences a significant increase in dilution, compared with an ACQUITY UPLC I-Class system. As a result, UPLC peak concentrations are higher than HPLC concentrations. Because solubility effects are more apparent in low dispersion, high pressure systems, it is important to adjust column load appropriately.

Carryover

You observe carryover in chromatographic systems when a previously injected analyte appears as a peak in the chromatogram of subsequent samples. Carryover tends to occur when a small amount of analyte remains in the system after a sample is injected. You can measure carryover by observing analyte peaks that appear when you run a blank sample immediately after an analytical sample.(See *ACQUITY UPLC I-Class System Specifications* for details on carryover performance).

A common cause of carryover is inadequate washing of the system. Choosing an appropriate wash solvent can minimize carryover for a particular analysis. The wash solvent must be strong enough to dissolve any remaining sample and the wash duration must be long enough to remove the residue from the system.

Method conditions also affect carryover. Too short a hold-time at the final conditions of a gradient, especially if the gradient is steep, can fail to remove all analytes from the system. It is important to completely flush the system and reequilibrate the column before proceeding to a subsequent analysis. Use caution when choosing the load-ahead and loop-offline options. Initiating these options before the highly organic part of the gradient reaches the needle can leave sample residue in the system, and whatever time savings you gain can be lost in terms of inadequate system cleaning.

The hydrophobicity and solubility of samples are additional factors to consider when trying to minimize carryover.

Tips:

- Use additional valve cycles (actuate the valve) if you suspect that sample residue in the valve is causing carryover problems.
- When flushing the sample manager - FL, you can use more aggressive solvents than those typically used to clean the system.

Contamination

To minimize contamination, ensure cleanliness during sample preparation (verify that sample preparation tools are cleaned thoroughly, for example).

Reproducibility

The precision (area reproducibility) is less than 0.5% RSD for injection volumes from 2.0 to 10.0 µL (See *ACQUITY UPLC I-Class System Specifications* for details).

Cycle time (between injections)

The short run time of a UPLC separation requires efficient use of the time between analyses.

The ACQUITY SM-FTN and SM-FL have Load Ahead and Loop Offline features to help decrease cycle time. See the ACQUITY UPLC Console online Help for details on how to use these features.

Tip: When using the SM-FL, you can employ a larger ID needle to help reduce cycle time.

Preventing leaks

Preventing leaks ensures that the system maintains adequate pressure and sample integrity throughout the analysis.

Leaks can potentially occur at any tubing connection, gasket, or seal but are most common at tubing connections. Low pressure leaks (on the intake side of the solvent manager's pump) cause solvent loss and air introduction during

the intake cycle. Leaks at high pressure fittings (downstream of the *i*^{2}*Valves*) can leak solvent but do not introduce air.

To prevent leaks, follow Waters' recommendations for the proper tightening of system fittings. Note specifically that different techniques apply to retightening fittings versus installing them for the first time.

See also:

- The user documentation for the specific system modules for more details on leak detection.
- The *ACQUITY UPLC Column Compartments Operator's Overview and Maintenance Information* for details on connecting active preheaters.

Sample preparation

UPLC analysis places some additional restrictions on sample preparation.

Particulates

The small column frit size (0.2 µm) can become blocked more easily than larger HPLC column frits (2.0 µm). Particle-free mobile phase solvents and sample solutions are therefore essential for UPLC analysis. See "General guidelines" on page 2-2 for recommendations on choosing and handling solvents.

Matching sample diluents

When you use the auto-dilution option on the SM-FTN, the purge solvent serves as the sample diluent. Ensure that your sample solution is soluble and miscible in your chosen purge solvent.

Caution: To avoid broad peaks and poor peak shape, ensure that your sample diluents match the initial conditions of your gradient.

3 Preparing the System

Contents:

Preparing system hardware

Powering-on the system

Powering-on the system entails starting the ACQUITY UPLC I-Class system workstation, system modules, and chromatography software. Each device or instrument beeps three times and runs a series of startup tests. See "Status LEDs" on page 3-3 and "Power LED" on page 3-3, for information on how to interpret indicator LED modes for device or instrument flow status and whether the units are powered-on.

Tip: If your system includes a column heater, it is automatically powered-on when you power-on the sample manager.

To power on the system:

1. Power-on the ACQUITY UPLC I-Class system's workstation.
2. Power on the binary solvent manager and sample manager by pressing the power switch on the top, left-hand side of each devices' door.

   See also: "Status LEDs" on page 3-3 and "Power LED" on page 3-3 for information on how to interpret LED modes for device or instrument flow status and whether the units are powered-on.
3. After power LEDs on the binary solvent manager and on the sample manager show as steady green, press the power switch on the top, left-hand side of the detector (or detectors).

   Tip: To prevent initialization errors, power-on the detector (or detectors) only when the flow cell is wetted.
4. Start the chromatography data system software.

   Tip: You can monitor the ACQUITY UPLC Console for messages and LED indications.

Monitoring system module LEDs

LEDs on each system module indicate the module's state of functioning. The LEDs are specific to their modules, so the significance of their various colors and modes can differ from one module to another.

Power LED

The power LED, on the left-hand side of a module's front panel, indicates the power-on or power-off status of the module. This LED is green when power is applied to the unit and unlit when power is not applied.

Tip: To provide adequate ventilation, the sample manager fans run continuously, even when the power switch is in the "off" position. These fans switch off only when you disconnect the power cable from the back of the module.

Status LEDs

Flow LED (binary solvent manager)

The flow LED, on the right-hand side of the power LED on the binary solvent manager's front panel, indicates the flow status. A steady green flow LED indicates flow through the binary solvent manager.

Run LED (sample manager)

The run LED, on the right-hand side of the power LED on the sample manager's front panel, indicates the run status. A steady-green run LED indicates that injections are being run.

Lamp LED (detector)

The lamp LED, on the right-hand side of the power LED on the detector's front panel, indicates the lamp status. A steady green lamp LED indicates that the lamp is ignited.

Status LED indications:

LED mode and color	Description
Unlit	• Binary solvent manager and sample manager – Indicates the device is currently idle. • Detector – Indicates the detector lamp is extinguished.

Status LED indications: (Continued)

LED mode and color	Description
Steady green	• Binary solvent manager – Indicates solvent is flowing. • Sample manager – Indicates the sample manager is operating normally, attempting to complete any outstanding samples or diagnostic function requests. When sample and diagnostic function requests are finished, the LED reverts to the unlit mode. • Detector – Indicates the detector lamp is ignited.
Flashing green	• Binary solvent manager and sample manager – Indicates that the module is initializing. • Detector – Indicates the detector is initializing or calibrating.
Flashing red	Indicates that an error stopped the instrument or device. Refer to the ACQUITY UPLC Console for information regarding the error.
Steady red	Indicates a module's failure that prevents its further operation. Power-off the module, and then power-on. If the LED is still steady red, contact your Waters service representative.

Enabling the leak sensors

Rule: When you power-on the system, the leak sensors default to disabled status unless previously enabled.

To enable the leak sensors:

1. In the ACQUITY UPLC Console, select Control > Leak Sensors.
2. To enable the leak sensor for an individual module, click the status on the left-hand side of the module's description.

   Tip: To enable all leak sensors, click Enable All.

Starting up the system

Use the Start up system function after the system has been idle a short period of time (as much as 12 hours) and when you plan to use the same solvents that you used during the previous run.

You can invoke the "Start up system" function from the control panel, or add it as a line in a sample set.

Recommendations:

- Prime the binary solvent manager for 1 minute for each solvent when the system has been idle for four or more hours, and you intend to use the solvents already in the system.
- Prime the binary solvent manager for four minutes for each solvent when you intend to use fresh solvents of the same composition as those already in the system.

To refresh the system:

1. In the ACQUITY UPLC Console, click Control > Start up system.
2. In the Start up system dialog box, review the settings and select a different option, if needed.
   - Solvent line A only (default)
   - Solvent line B only
   - Both A and B
3. Click OK.

   Result: The system primes the selected solvents, primes the sample manager with one weak-wash prime (using the wash and sample syringes), and ignites the lamp in the detector.

Configuring chromatography data software

Configure the chromatography data system software, for use with ACQUITY:

- Start the chromatography data system software and log in.
- Select system modules, and name the system (see Empower or MassLynx Help for details).
- Open the ACQUITY Console and control panels.

ACQUITY control panels

You can monitor control panels for the binary solvent manager, sample manager, detector, and column manager from your chromatography data system.

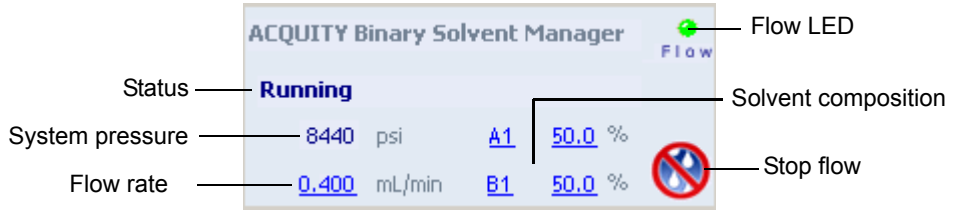
When Empower software controls the system, the control panels appear at the bottom of the Run Samples window. When MassLynx software controls the system, the control panels appear on the Additional Status tab of the Inlet Editor window.

Binary solvent manager control panel

The binary solvent manager control panel displays flow status, system pressure, total flow rate, and solvent composition parameters.

Rule: You can edit these parameters when the system is idle by clicking the underlined value. You cannot edit binary solvent manager parameters while the system is running samples.

Binary solvent manager control panel:



The following table describes the items in the binary solvent manager control panel.

Binary solvent manager control panel items:

Control panel item	Description
Flow LED	Displays the actual flow LED on the front panel of the binary solvent manager unless communications with the binary solvent manager are lost.

Binary solvent manager control panel items: (Continued)

Control panel item	Description
Status	Displays the status of the current operation.
System Pressure	Displays system pressure, in kPa, bar, or psi. You can customize pressure units via the ACQUITY UPLC Console.
Flow Rate	Displays the total flow rate of the binary solvent manager, from 0.000 to 2.000 mL/min under normal operation and 0.000 to 8.000 mL/min when priming.
Solvent Composition	Displays the percentage of solvent to be drawn from the solvent lines (A and B). Composition values range from 0.0 to 100.0%.
 (Stop Flow)	Immediately stops all flow from the binary solvent manager.

You can access these additional functions by right-clicking anywhere in the binary solvent manager control panel:

Additional functions in the binary solvent manager control panel:

Control panel function	Description
Start up system	Brings the system to operational conditions after an extended idle period or when switching to different solvents. See "Starting up the system" in the *Binary Solvent Manager Operator's Overview and Maintenance Information*.
Prime solvents	Displays the Prime Solvents dialog box. See "Priming the binary solvent manager" in the *Binary Solvent Manager Operator's Overview and Maintenance Information*.
Prime seal wash	Starts priming the seal wash. See "Priming the seal wash system" in the *Binary Solvent Manager Operator's Overview and Maintenance Information*.

Additional functions in the binary solvent manager control panel:

Control panel function	Description
Wash plungers	Initiates the plunger wash sequence, which fills and then slowly empties the primary and accumulator chambers (with the current solvent composition) while performing a high speed/volume seal wash. This action helps prevent the buildup of precipitates on the pump plungers which can damage the high pressure seals.
Launch ACQUITY UPLC Console	Launches the ACQUITY UPLC Console.
Reset BSM	Resets the binary solvent manager after an error condition.
Help	Displays the ACQUITY UPLC Console online Help.

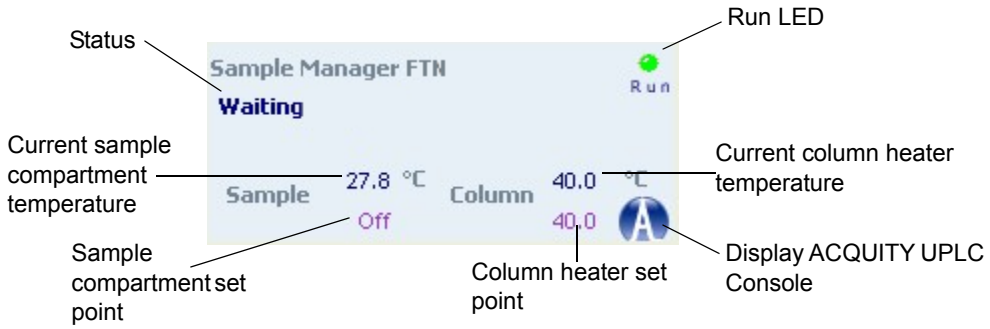
Sample manager control panel

The sample manager control panel displays current sample compartment and column heater temperatures and set points. You can edit these values when the system is idle by clicking the underlined value. You cannot edit sample manager set points while the system is running samples.

Tips:

- To keep the sample compartment at a constant temperature, open its door only when necessary.
- The sample manager's fans stop circulating air whenever the sample compartment door is open.

Sample manager control panel:



The following table describes the items in the sample manager's control panel.

Sample manager control panel items:

Control panel item	Description
Run LED	Displays the actual run LED on the front panel, unless communications are lost.
Status	Displays the status of the current operation.
Current Sample Compartment Temperature	Displays the current sample compartment temperature, to 0.1 °C resolution, even when active temperature control is disabled.
Sample Compartment Set Point	Displays the current sample compartment set point, to 0.1 °C resolution. When active temperature control is disabled, this field displays "Off".
Current Column Heater Temperature	Displays the current column heater temperature to 0.1 °C resolution, even when active temperature control is disabled.
Column Heater Set Point	Displays the current column heater set point, to 0.1 °C resolution. When active temperature control is disabled, this field displays "Off".
(Display Console)	Displays the ACQUITY UPLC Console.

You can access these additional functions by right-clicking anywhere in the sample manager control panel.

Additional functions in the sample manager control panel:

Control panel function	Description
Prime	Displays the Prime dialog box. See "Priming the SM-FTN" in the *Sample Manager - Flow Through Needle Operator's Overview and Maintenance Information*.
Wash needle	Displays the Wash Needle dialog box. See "Washing the SM-FTN needle" in the *Sample Manager - Flow Through Needle Operator's Overview and Maintenance Information*.
Reset SM	Resets the sample manager following an error condition.
Help	Displays the ACQUITY UPLC Console online Help.

TUV detector control panel

The TUV detector's control panel displays absorbance units and wavelength values, which you can edit when the system is idle by clicking the underlined value. Nevertheless, you cannot edit detector parameters when the system is running samples.

Control panels for other detectors function similarly. See the *ACQUITY UPLC Photodiode Array Detector Getting Started Guide.*

Control panel:

The following table describes the controls and indicators in the TUV detector's control panel.

TUV detector control panel items:

Control panel item	Description
Lamp On/Off LED	Displays the actual lamp on/off LED on the front panel of the detector unless communications with the detector are lost.
Status	Displays the status of the current operation.
AU	Displays the absorbance units.
nm	Displays the value of wavelength A, in nm. If the detector is in dual wavelength mode, the value of wavelength B also appears.
 (Lamp On)	Ignites the detector lamp.
 (Lamp Off)	Extinguishes the detector lamp.

You can access additional functions described in the table, below, by right-clicking anywhere in the detector control panel.

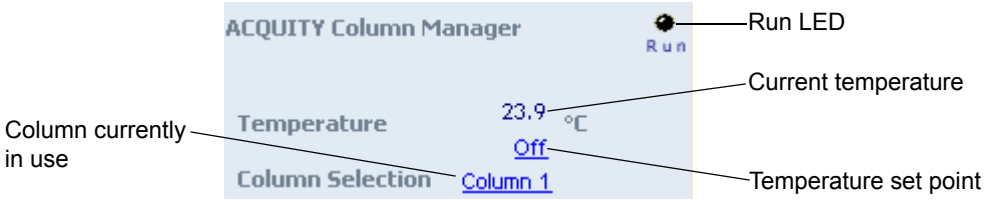
Additional functions in the detector control panel:

Control panel function	Description
Autozero	Resets the absorbance value to 0
Reset TUV	Resets the detector, when present, after an error condition
Help	Displays the ACQUITY UPLC Console online Help

Column manager control panel

Where Empower software controls the system, the column manager's control panel appears at the bottom of the Run Samples window. If MassLynx software controls the system, the column manager's control panel appears on the Additional Status tab of the Inlet Editor window.

Column manager control panel:



The column manager control panel displays the current column temperature and set point. You can edit the set point when the system is idle by clicking on the underlined value. You cannot edit temperature set point and column selection while the system is running samples.

The following table lists the items in the column manager control panel.

Column manager control panel items:

Control panel item	Description
Run LED	Displays the actual run LED on the front panel of the column manager unless communications with the column manager are lost.
Current temperature	Displays the current column compartment temperature.
Temperature set point	Displays the current column temperature set point to 0.1 °C resolution. When active temperature control is disabled, this field displays “Off”.
Column	Displays the column that is currently in use.

You can access additional functions by right-clicking anywhere in the column manager control panel.

Additional functions in the column manager control panel:

Control panel function	Description
Reset CM	Resets the column manager, when present, after an error condition
Help	Displays the ACQUITY UPLC Console online Help

Starting the ACQUITY UPLC Console

The ACQUITY UPLC Console software provides a way to configure settings, monitor performance, run diagnostic tests, and maintain the system and its modules. It replaces the keypads and small-screen displays traditionally found on the fronts of system modules. The ACQUITY UPLC Console functions independently of data applications and does not recognize or control them.

From the ACQUITY UPLC Console's interface, you can quickly navigate to visual representations of each module and its components. You can also navigate to interactive diagrams, which show interconnections and provide diagnostic tools for troubleshooting problems.

To start the ACQUITY UPLC Console from Empower software:

In the Run samples window, click Display console  in the Sample Manager control panel.

To start the ACQUITY UPLC Console from MassLynx software:

1. In the MassLynx window, click Inlet Method.
2. In the Inlet Method window, click the ACQUITY Additional Status tab.
3. Click Display console  .

A Safety Advisories

Waters instruments display hazard symbols designed to alert you to the hidden dangers of operating and maintaining the instruments. Their corresponding user guides also include the hazard symbols, with accompanying text statements describing the hazards and telling you how to avoid them. This appendix presents all the safety symbols and statements that apply to the entire line of Waters products.

Contents:

Warning symbols

Warning symbols alert you to the risk of death, injury, or seriously adverse physiological reactions associated with an instrument's use or misuse. Heed all warnings when you install, repair, and operate Waters instruments. Waters assumes no liability for the failure of those who install, repair, or operate its instruments to comply with any safety precaution.

Task-specific hazard warnings

The following warning symbols alert you to risks that can arise when you operate or maintain an instrument or instrument component. Such risks include burn injuries, electric shocks, ultraviolet radiation exposures, and others.

When the following symbols appear in a manual's narratives or procedures, their accompanying text identifies the specific risk and explains how to avoid it.

Warning: (General risk of danger. When this symbol appears on an instrument, consult the instrument's user documentation for important safety-related information before you use the instrument.)

Warning: (Risk of burn injury from contacting hot surfaces.)

Warning: (Risk of electric shock.)

Warning: (Risk of fire.)

Warning: (Risk of sharp-point puncture injury.)

Warning: (Risk of hand crush injury.)

Warning: (Risk of exposure to ultraviolet radiation.)

Warning: (Risk of contacting corrosive substances.)

Warning: (Risk of exposure to a toxic substance.)

Warning: (Risk of personal exposure to laser radiation.)

Warning: (Risk of exposure to biological agents that can pose a serious health threat.)

Warning: (Risk of tipping.)

Warning: (Risk of explosion.)

Specific warnings

The following warnings can appear in the user manuals of particular instruments and on labels affixed to them or their component parts.

Burst warning

This warning applies to Waters instruments fitted with nonmetallic tubing.

Warning: Pressurized nonmetallic, or polymer, tubing can burst. Observe these precautions when working around such tubing:

- Wear eye protection.
- Extinguish all nearby flames.
- Do not use tubing that is, or has been, stressed or kinked.
- Do not expose nonmetallic tubing to incompatible compounds like tetrahydrofuran (THF) and nitric or sulfuric acids.
- Be aware that some compounds, like methylene chloride and dimethyl sulfoxide, can cause nonmetallic tubing to swell, which significantly reduces the pressure at which the tubing can rupture.

Mass spectrometer flammable solvents warning

This warning applies to instruments operated with flammable solvents.

Warning: Where significant quantities of flammable solvents are involved, a continuous flow of nitrogen into the ion source is required to prevent possible ignition in that enclosed space.

Ensure that the nitrogen supply pressure never falls below 690 kPa (6.9 bar, 100 psi) during an analysis in which flammable solvents are used. Also ensure a gas-fail connection is connected to the LC system so that the LC solvent flow stops if the nitrogen supply fails.

Mass spectrometer shock hazard

This warning applies to all Waters mass spectrometers.

Warning: To avoid electric shock, do not remove the mass spectrometer's protective panels. The components they cover are not user-serviceable.

This warning applies to certain instruments when they are in Operate mode.

Warning: High voltages can be present at certain external surfaces of the mass spectrometer when the instrument is in Operate mode. To avoid nonlethal electric shock, make sure the instrument is in Standby mode before touching areas marked with this high voltage warning symbol.

Biohazard warning

This warning applies to Waters instruments that can be used to process material that can contain biohazards: substances that contain biological agents capable of producing harmful effects in humans.

Warning: Waters instruments and software can be used to analyze or process potentially infectious human-sourced products, inactivated microorganisms, and other biological materials. To avoid infection with these agents, assume that all biological fluids are infectious, observe Good Laboratory Practice, and consult your organization's biohazard safety representative regarding their proper use and handling. Specific precautions appear in the latest edition of the US National Institutes of Health (NIH) publication, *Biosafety in Microbiological and Biomedical Laboratories* (BMBL).

Chemical hazard warning

This warning applies to Waters instruments that can process corrosive, toxic, flammable, or other types of hazardous material.

Warning: Waters instruments can be used to analyze or process potentially hazardous substances. To avoid injury with any of these materials, familiarize yourself with the materials and their hazards, observe Good Laboratory Practice (GLP), and consult your organization's safety representative regarding proper use and handling. Guidelines are provided in the latest edition of the National Research Council's publication, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.*

Caution advisory

Caution advisories appear where an instrument or device can be subject to use or misuse capable of damaging it or compromising a sample's integrity. The exclamation point symbol and its associated statement alert you to such risk.

Caution: To avoid damaging the instrument's case, do not clean it with abrasives or solvents.

Warnings that apply to all Waters instruments

When operating this device, follow standard quality-control procedures and the equipment guidelines in this section.

Attention: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Important: Toute modification sur cette unité n'ayant pas été expressément approuvée par l'autorité responsable de la conformité à la réglementation peut annuler le droit de l'utilisateur à exploiter l'équipement.

Achtung: Jedwede Änderungen oder Modifikationen an dem Gerät ohne die ausdrückliche Genehmigung der für die ordnungsgemäße Funktionstüchtigkeit verantwortlichen Personen kann zum Entzug der Bedienungsbefugnis des Systems führen.

Avvertenza: qualsiasi modifica o alterazione apportata a questa unità e non espressamente autorizzata dai responsabili per la conformità fa decadere il diritto all'utilizzo dell'apparecchiatura da parte dell'utente.

Atencion: cualquier cambio o modificación efectuado en esta unidad que no haya sido expresamente aprobado por la parte responsable del cumplimiento puede anular la autorización del usuario para utilizar el equipo.

注意：未經有關法規認證部門允許對本設備進行的改變或修改,可能會使使用者喪失操作該設備的權利。

注意：未经有关法规认证部门明确允许对本设备进行的改变或改装，可能会使使用者丧失操作该设备的合法性。

주의: 규정 준수를 책임지는 당사자의 명백한 승인 없이 이 장치를 개조 또는 변경할 경우, 이 장치를 운용할 수 있는 사용자 권한의 효력을 상실할 수 있습니다.

注意：規制機関から明確な承認を受けずに本装置の変更や改造を行うと、本装置のユーザーとしての承認が無効になる可能性があります。

Warning: Use caution when working with any polymer tubing under pressure:

- Always wear eye protection when near pressurized polymer tubing.
- Extinguish all nearby flames.
- Do not use tubing that has been severely stressed or kinked.
- Do not use nonmetallic tubing with tetrahydrofuran (THF) or concentrated nitric or sulfuric acids.
- Be aware that methylene chloride and dimethyl sulfoxide cause nonmetallic tubing to swell, which greatly reduces the rupture pressure of the tubing.

Attention: Manipulez les tubes en polymère sous pression avec precaution:

- Portez systématiquement des lunettes de protection lorsque vous vous trouvez à proximité de tubes en polymère pressurisés.
- Eteignez toute flamme se trouvant à proximité de l'instrument.
- Evitez d'utiliser des tubes sévèrement déformés ou endommagés.
- Evitez d'utiliser des tubes non métalliques avec du tétrahydrofurane (THF) ou de l'acide sulfurique ou nitrique concentré.
- Sachez que le chlorure de méthylène et le diméthylesulfoxyde entraînent le gonflement des tuyaux non métalliques, ce qui réduit considérablement leur pression de rupture.

Vorsicht: Bei der Arbeit mit Polymerschläuchen unter Druck ist besondere Vorsicht angebracht:

- In der Nähe von unter Druck stehenden Polymerschläuchen stets Schutzbrille tragen.
- Alle offenen Flammen in der Nähe löschen.
- Keine Schläuche verwenden, die stark geknickt oder überbeansprucht sind.
- Nichtmetallische Schläuche nicht für Tetrahydrofuran (THF) oder konzentrierte Salpeter- oder Schwefelsäure verwenden.
- Durch Methylenchlorid und Dimethylsulfoxid können nichtmetallische Schläuche quellen; dadurch wird der Berstdruck des Schlauches erheblich reduziert.

Attenzione: fare attenzione quando si utilizzano tubi in materiale polimerico sotto pressione:

- Indossare sempre occhiali da lavoro protettivi nei pressi di tubi di polimero pressurizzati.
- Spegnere tutte le fiamme vive nell'ambiente circostante.
- Non utilizzare tubi eccessivamente logorati o piegati.
- Non utilizzare tubi non metallici con tetraidrofurano (THF) o acido solforico o nitrico concentrati.
- Tenere presente che il cloruro di metilene e il dimetilsolfossido provocano rigonfiamenti nei tubi non metallici, riducendo notevolmente la pressione di rottura dei tubi stessi.

Advertencia: se recomienda precaución cuando se trabaje con tubos de polímero sometidos a presión:

- El usuario deberá protegerse siempre los ojos cuando trabaje cerca de tubos de polímero sometidos a presión.
- Si hubiera alguna llama las proximidades.
- No se debe trabajar con tubos que se hayan doblado o sometido a altas presiones.
- Es necesario utilizar tubos de metal cuando se trabaje con tetrahidrofurano (THF) o ácidos nítrico o sulfúrico concentrados.
- Hay que tener en cuenta que el cloruro de metileno y el sulfóxido de dimetilo dilatan los tubos no metálicos, lo que reduce la presión de ruptura de los tubos.

警告：當在有壓力的情況下使用聚合物管線時，小心注意以下幾點。

- 當接近有壓力的聚合物管線時一定要戴防護眼鏡。
- 熄滅附近所有的火焰。
- 不要使用已經被壓癟或嚴重彎曲管線。
- 不要在非金屬管線中使用四氫呋喃或濃硝酸或濃硫酸。
- 要了解使用二氯甲烷及二甲基亞楓會導致非金屬管線膨脹，大大降低管線的耐壓能力。

警告：当有压力的情况下使用管线时，小心注意以下几点：

- 当接近有压力的聚合物管线时一定要戴防护眼镜。
- 熄灭附近所有的火焰。
- 不要使用已经被压瘪或严重弯曲的管线。
- 不要在非金属管线中使用四氢呋喃或浓硝酸或浓硫酸。
- 要了解使用二氯甲烷及二甲基亚枫会导致非金属管线膨胀，大大降低管线的耐压能力。

경고: 가압 폴리머 튜브로 작업할 경우에는 주의하십시오.

- 가압 폴리머 튜브 근처에서는 항상 보호 안경을 착용하십시오.
- 근처의 화기를 모두 끄십시오.
- 심하게 변형되거나 꼬인 튜브는 사용하지 마십시오.
- 비금속(Nonmetallic) 튜브를 테트라히드로푸란(Tetrahydrofuran: THF) 또는 농축 질산 또는 황산과 함께 사용하지 마십시오.
- 염화 메틸렌(Methylene chloride) 및 디메틸술폭시드(Dimethyl sulfoxide)는 비금속 튜브를 부풀려 튜브의 파열 압력을 크게 감소시킬 수 있으므로 유의하십시오.

警告：圧力のかかったポリマーチューブを扱うときは、注意してください。

- 加圧されたポリマーチューブの付近では、必ず保護メガネを着用してください。
- 近くにある火を消してください。
- 著しく変形した、または折れ曲がったチューブは使用しないでください。
- 非金属チューブには、テトラヒドロフラン(THF)や高濃度の硝酸または硫酸などを流さないでください。
- 塩化メチレンやジメチルスルホキシドは、非金属チューブの膨張を引き起こす場合があり、その場合、チューブは極めて低い圧力で破裂します。

Warning: The user shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Attention: L'utilisateur doit être informé que si le matériel est utilisé d'une façon non spécifiée par le fabricant, la protection assurée par le matériel risque d'être défectueuses.

Vorsicht: Der Benutzer wird darauf aufmerksam gemacht, dass bei unsachgemäßer Verwenddung des Gerätes die eingebauten Sicherheitseinrichtungen unter Umständen nicht ordnungsgemäß funktionieren.

Attenzione: si rende noto all'utente che l'eventuale utilizzo dell'apparecchiatura secondo modalità non previste dal produttore può compromettere la protezione offerta dall'apparecchiatura.

Advertencia: el usuario deberá saber que si el equipo se utiliza de forma distinta a la especificada por el fabricante, las medidas de protección del equipo podrían ser insuficientes.

警告：使用者必須非常清楚如果設備不是按照製造廠商指定的方式使用，那麼該設備所提供的保護將被消弱。

警告：使用者必须非常清楚如果设备不是按照制造厂商指定的方式使用，那么该设备所提供的保护将被削弱。

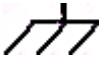
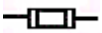
경고: 제조업체가 명시하지 않은 방식으로 장비를 사용할 경우 장비가 제공하는 보호 수단이 제대로 작동하지 않을 수 있다는 점을 사용자에게 반드시 인식시켜야 합니다.

警告：ユーザーは、製造元により指定されていない方法で機器を使用すると、機器が提供している保証が無効になる可能性があることに注意して下さい。

Electrical and handling symbols

Electrical symbols

These can appear in instrument user manuals and on the instrument's front or rear panels.

	Electrical power on
	Electrical power off
	Standby
	Direct current
	Alternating current
	Protective conductor terminal
	Frame, or chassis, terminal
	Fuse
	Recycle symbol: Do not dispose in municipal waste.

Handling symbols

These handling symbols and their associated text can appear on labels affixed to the outer packaging of Waters instrument and component shipments.

	Keep upright!
	Keep dry!
	Fragile!
	Use no hooks!

B External Connections

A Waters Technical Service representative unpacks and installs your ACQUITY UPLC I-Class system modules.

See also: *Configuring ACQUITY UPLC I-Class System Components* (P/N 715003144)

Requirements:

- Contact Waters Technical Service before moving the ACQUITY UPLC I-Class system modules.
- If you must transport a system component, or remove it from service, contact Waters Technical Service for recommended cleaning, flushing, and packaging procedures.

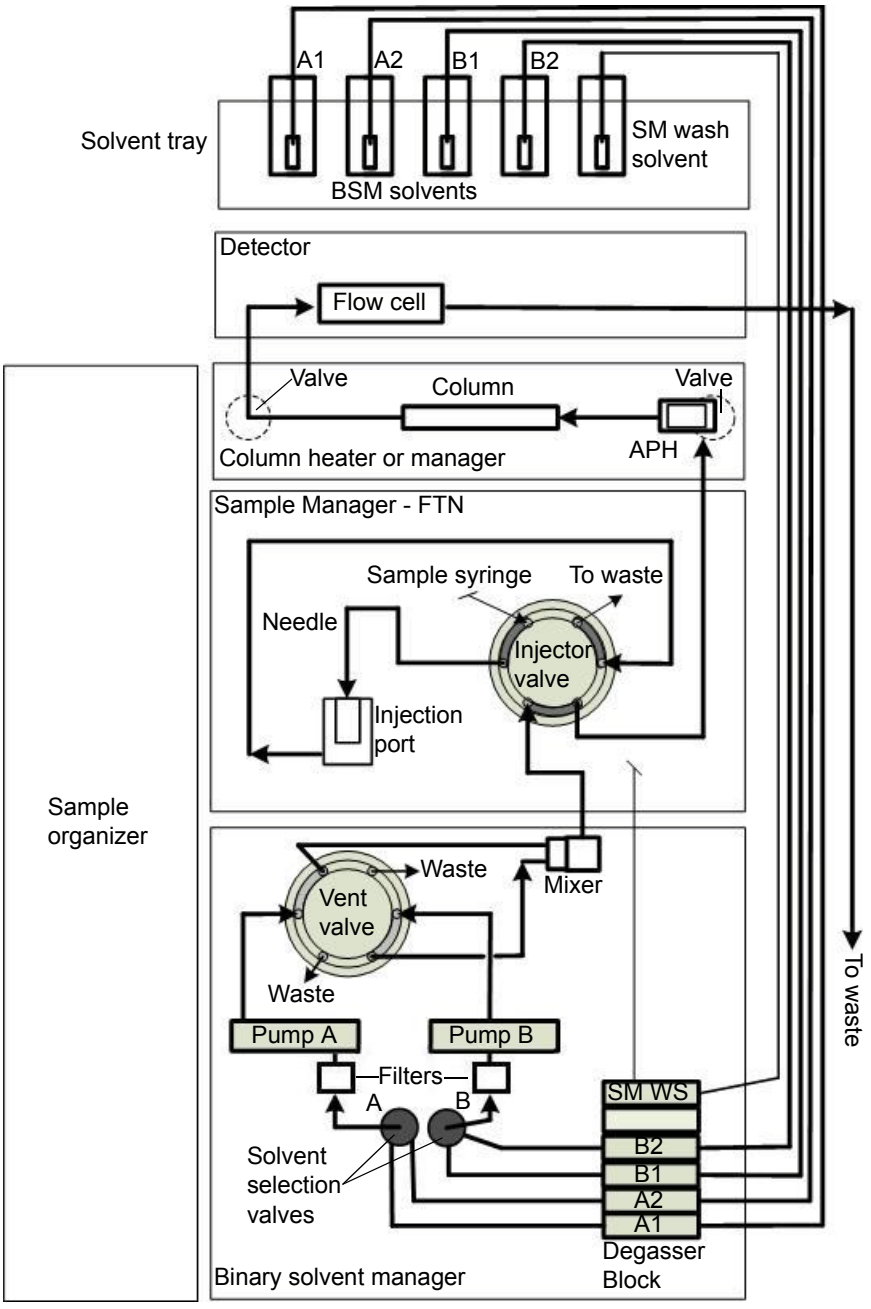
Warning: To avoid back injuries, do not attempt to lift the system modules without assistance.

Contents:

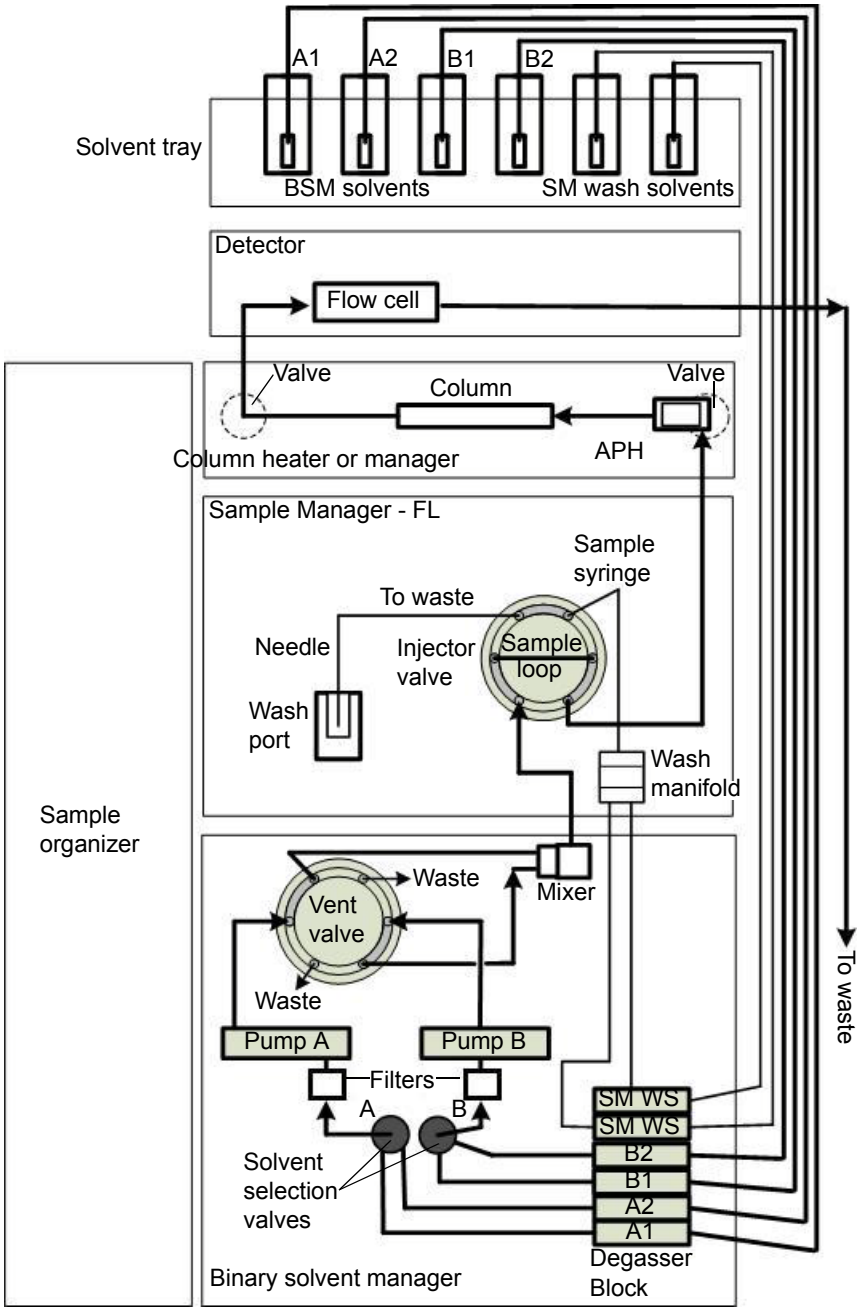
System tubing connections

The system's external tubing connections for solvent flow and drainage are shown below.

Solvent flow for ACQUITY UPLC I-Class system configured with an SM-FTN:



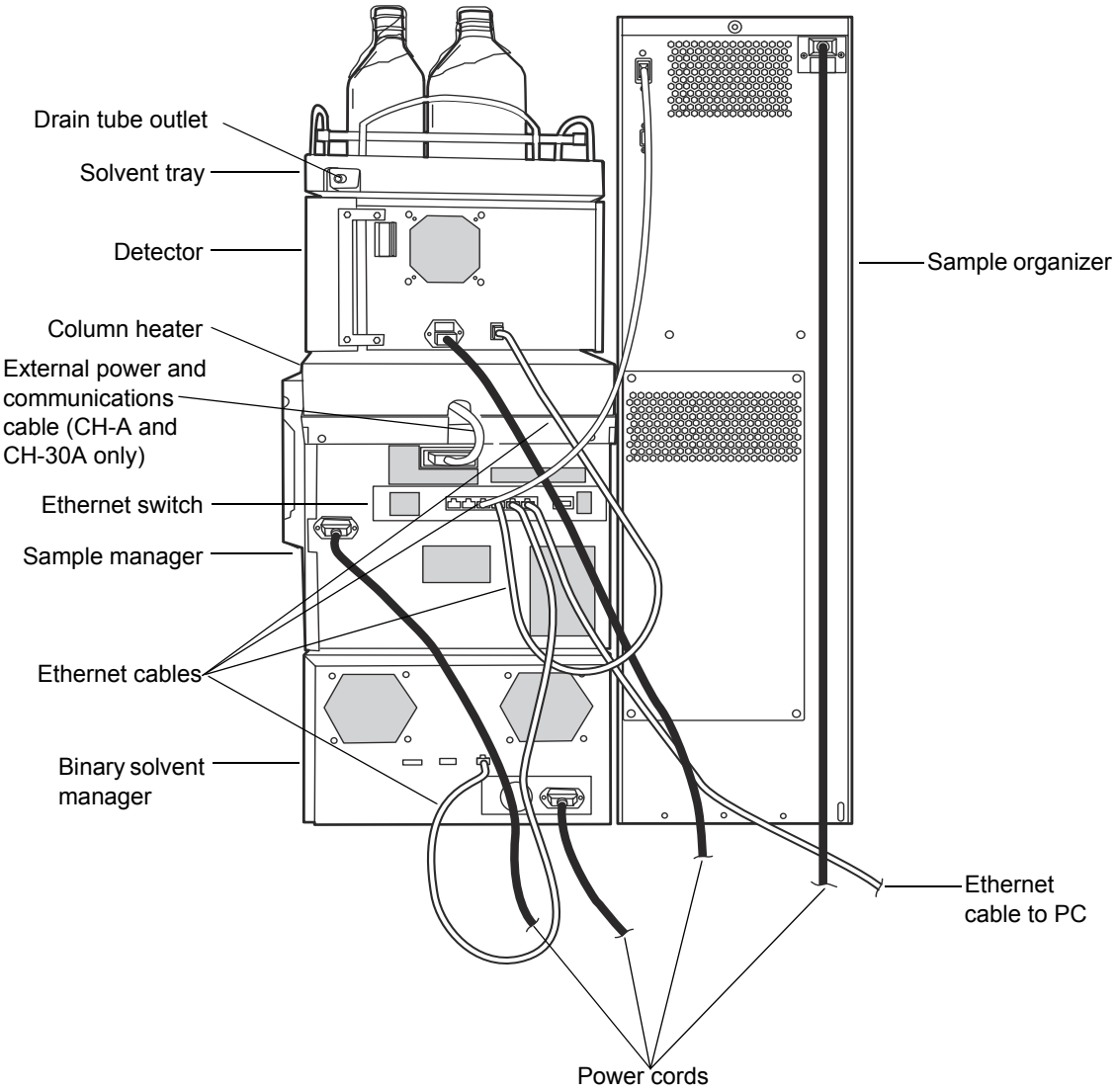
Solvent flow for ACQUITY UPLC I-Class system configured with an SM-FL:



External wiring connections

ACQUITY UPLC I-Class instrument external wiring connections

The rear panel connections for ACQUITY UPLC I-Class system modules are shown below.



Ethernet connections

The sample manager incorporates an internal 10/100/1000 megabit Ethernet switch that accommodates the PC (workstation) and as many as six ACQUITY UPLC I-Class modules. Connect the shielded Ethernet cables from each module to the electronic connections on the rear panel of the sample manager. The sample manager is connected internally to the Ethernet switch.

Tip: Use a Waters switch box if you are running multiple stacks of modules.

Column heater connection

The sample manager powers and communicates with the column heater. The external communication cable must be connected to the rear of the column heater and the sample manager.

To make column heater connections:

Caution: To avoid damaging electrical parts, never disconnect an electrical assembly while power is applied to a system module. To interrupt power to a module, set the power switch to Off, and then unplug the power cord from the AC outlet. After power is removed, wait 10 seconds thereafter before you disconnect an assembly.

1. Make sure the sample manager and the column heater are powered-off.
2. Connect the external communication cable to the High Density (HD) port on the rear of the column heater.
3. Connect the other end of the external communication cable to the QSPI port on the rear of the sample manager.

Signal connections

Making signal connections

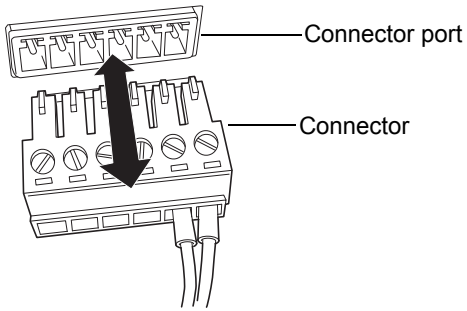
Refer to the signal connection location shown on the silk-screened label affixed to the rear panel of each system module.

Required materials

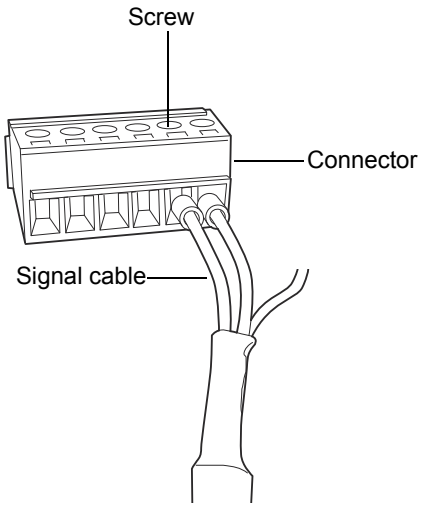
- 9/32-inch nut driver
- Flat-blade screwdriver
- Connector
- Signal cable

To make signal connections:

1. Insert the connector into the connector port on the back of the system module.

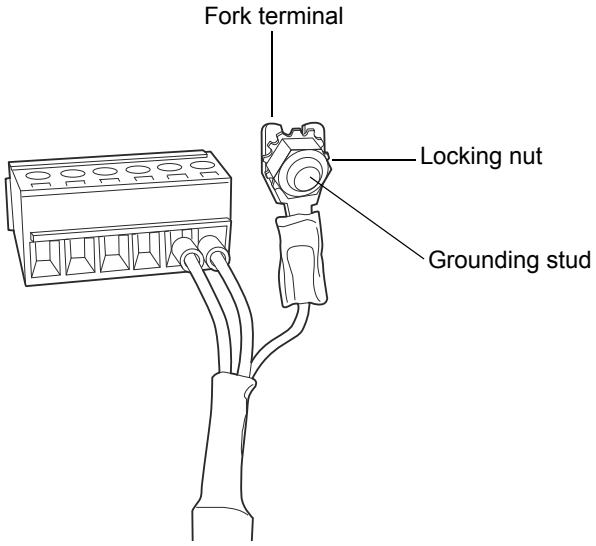


2. Using the flat-blade screwdriver, attach the positive and negative leads of the signal cable to the connector.



3. Fit the grounding cable's fork terminal on the rear panel grounding stud, and secure the terminal with the locking nut.

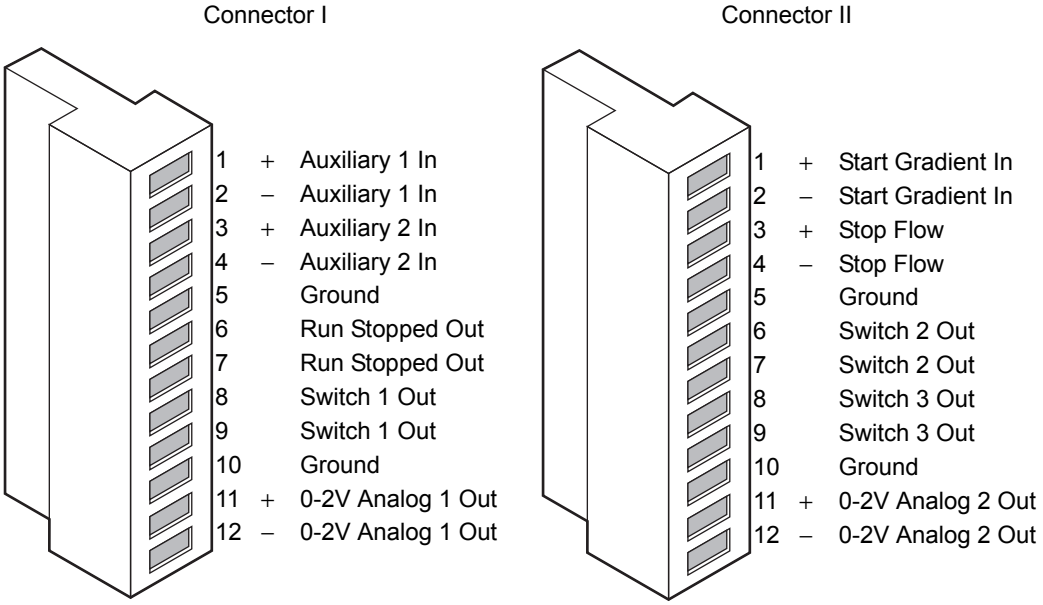
   Tip: Use the 9/32-inch nut driver to tighten the locking nut until the fork terminal does not move.



Binary solvent manager I/O signal connectors

The rear panel of the binary solvent manager includes two removable connectors that hold the screw terminals for I/O signal cables. These connectors are keyed so that they can be inserted only one way.

Binary solvent manager I/O signal connectors



For electrical specifications, see the *ACQUITY UPLC I-Class System Specifications* document.

Binary solvent manager analog-out/event-in connections

Signal connection	Description
Auxiliary 1 In	Reserved for future use.
Auxiliary 2 In	Reserved for future use.
Run Stopped Out	Indicates (with a contact closure) the binary solvent manager has ceased operation because of an error condition or operator request.
Switch 1 Out	Used to send time-based contact closure signals to external devices.

Binary solvent manager analog-out/event-in connections (Continued)

Signal connection	Description
0–2V Analog 1 Out	Outputs the analog signal to a device such as an integrator or strip-chart recorder. Via the Empower or MassLynx software, you can select one of the following signals as the chart out signal: • Flow rate • System pressure • Composition (%A, %B)
Gradient In	Initiates the pumps to begin gradient operation by contact closure input or 0-volt input.
Stop Flow In	Allows you to stop the flow from the binary solvent manager when an error condition or hardware failure occurs on another system module.
Switch 2 Out	Used to send time-based contact closure signals to external devices.
Switch 3 Out	Used to send time-based contact closure signals to external devices.
0–2V Analog 2 Out	Outputs the analog signal to a device such as an integrator or strip-chart recorder. Via the Empower or MassLynx software, you can select one of the following signals as the chart out signal: • Flow rate • System pressure • Composition (%A, %B)

Chart-out signal conditions

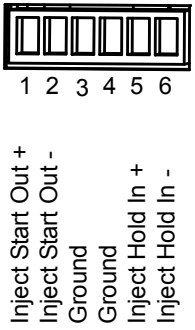
Signal	Parameter Setting at 0 Volts (Minimum)	Parameter Setting at 2.000 Volts (Maximum)
Flow Rate	0.000 mL/min	2 mL/min
System Pressure	–345 kPa (–3.45 bar, –50 psi)	124,106 kPa (1241 bar, 18,000 psi)
Composition	0.0%	100.0%

Sample manager I/O signal connectors

The rear panel of the sample manager includes a removable connector that holds the screw terminals for I/O signal cables. This connector is keyed so that it can receive a signal cable inserted only one way.

Requirement: A contact closure output connection (Inject Start Out) from the sample manager is required to trigger a mass spectrometer or an ACQUITY 2996 PDA detector running under MassLynx software control to start.

Sample manager I/O signal connectors:



For electrical specifications, see the *ACQUITY UPLC I-Class System Specifications* document.

Sample manager event-out/event-in connections:

Signal connections	Description
Inject Start Out	Indicates (with a contact closure output) that an injection has started.
Inject Hold In	Delays the next injection when the sample manager receives a contact closure input (from another system module, for example).

TUV detector signal connectors

If your system includes a TUV detector, see the *ACQUITY UPLC Tunable Ultraviolet Detector Getting Started Guide* for information on signal connectors.

PDA detector signal connectors

If your system includes a PDA detector, see the *ACQUITY UPLC Photodiode Array Detector Getting Started Guide* for information on signal connectors.

Connecting to the electricity source

Each system module requires a separate, grounded power source. The ground connection in all power outlets must be common and physically close to the system.

Warning: Avoid electrical shock:

- Use power cord SVT-type in the United States and HAR-type or better in Europe. For other countries' requirements, contact your local Waters distributor.
- Power-off and unplug each system module before performing any maintenance operation on the module.
- Connect each system module to a common ground.

To connect to the electricity source:

Recommendation: Use a line conditioner and uninterruptible power supply (UPS) for optimum, long-term, input voltage stability.

1. Connect the female end of the power cord to the receptacle on the rear panel of each module.
2. Connect the male end of the power cord to a suitable wall outlet.

   Alternative: If your system includes the optional FlexCart, connect the female end of the FlexCart's electrical cables (included in the startup kit) to the receptacle on the rear panel of each system module. Connect the hooded, male end of the FlexCart's electrical cables to the power strips on the back of the cart. Finally, connect each power strip's cable to a wall outlet operating on its own circuit.

FlexCart power connections: