

ACQUITY UPLC H-Class or H-Class Bio System Troubleshooting Guide

This manual is a reference tool for field service engineers who are troubleshooting problems in ACQUITY UPLC H-Class® and H-Class Bio Systems (see [Figure 1](#)).

To isolate the root cause of any problem with your system, begin troubleshooting at the system level.

Table of contents

Troubleshooting System-level Symptoms.	2
Troubleshooting Solvent Manager Symptoms	81
Troubleshooting Sample Manager Symptoms	114
Troubleshooting Errors	149

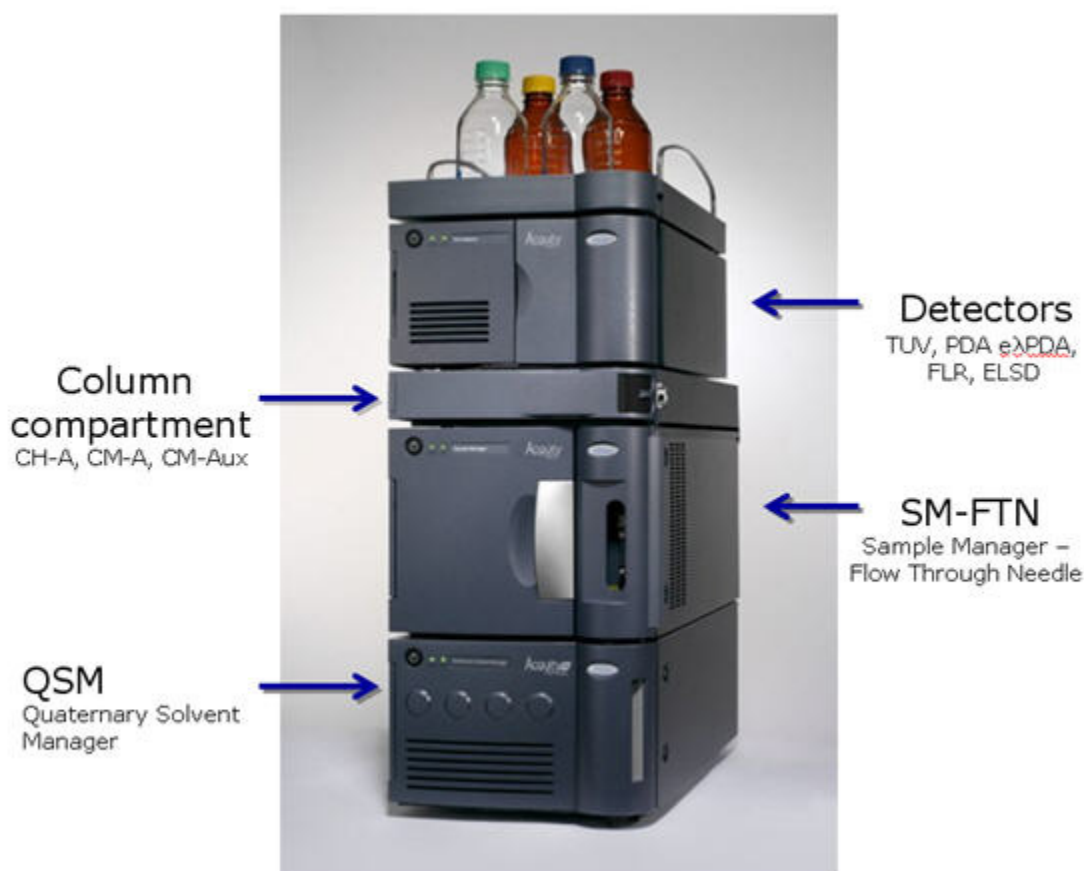


Figure 1 - ACQUITY UPLC H-Class or H-Class Bio System

Chapter 1: Troubleshooting System-level Symptoms

This section outlines troubleshooting for system-level problems in the ACQUITY H-Class or H-Class Bio System. Select the relevant symptom category in [Table 1](#).

Perform troubleshooting steps in the numbered order listed in the troubleshooting tables.

Table 1: System-level major symptom categories

Symptom	Go to
Error message	All errors/warnings index, page 149
Data system problem	Data system problem, page 3
Power LEDs off unexpectedly	All power LEDs off, page 4
Chromatographic results unacceptable	Chromatography problem, page 5
System pressure unacceptable	System pressure problem, page 56

Additional information

For additional information on the ACQUITY H-Class/H-Class Bio System, see:

- [System reference information, page 68](#), of this document
- [ACQUITY H-Class/H-Class Bio Key Documents](#) on the Waters Portal

Data system problem

Empower or MassLynx software or communications problem.

Table 2: Data system problem categories

Symptom	Go to
Empower	
Communications problem	• Ethernet Instrument Getting Started Guide • Empower Communications Troubleshooting Guide
Running samples problem	• Service Notes • Service Training Materials • Empower Key Documents
Processing/reporting data problem	• Service Notes • Service Training Materials • Empower Key Documents • Call GSS
MassLynx	
Communications problem	• Ethernet Instrument Getting Started Guide • MassLynx Communications Troubleshooting Guide
Running samples problem	• Service Notes • Service Training Materials • MassLynx Key Document
Processing/reporting data problem	• Service Notes • Service Training Materials • MassLynx Key Document • Call GSS

All power LEDs off

LED indicators are located on the front of most ACQUITY system components ([Figure 1](#)). [Table 3](#) lists troubleshooting recommendations for systems in which *all* power LEDs are off (unlit).

NOTE: To troubleshoot LED power problems affecting a specific module, refer to the chapter pertaining to that module.



Figure 1 - LED indicators

Table 3: Troubleshooting all power LEDs off

No.	Possible cause	Corrective action	More info
1	System site does not meet requirements	Confirm that system site meets power requirements.	ACQUITY UPLC H-Class and H-Class Bio System Site Preparation Guide
2	No power at outlet	Move system to a working outlet or have customer investigate site power problem.	N/A
3	Power supply failure	Troubleshoot power LED problem at each individual module.	N/A

Chromatography problem

Unacceptable chromatographic results (as compared with established performance).

To begin troubleshooting:

1. Reinject your application standard(s).
2. If the problem persists, select the relevant symptom in the list below and troubleshoot as recommended.
 - [Baseline problem, page 6](#) (baseline noise, drift, or background)
 - [Retention time problem, page 16](#) (retention times incorrect)
 - [Abnormal peaks, page 24](#) (peak shape changed or peaks missing)
 - [Sensitivity loss, page 41](#) (Unexpected decrease in peak response or signal-to-noise)
 - [Loss of resolution, page 52](#) (problem measuring the quality of a separation)
 - [Problems with quantitative results, page 53](#) (peaks not properly identified, or results incorrect)

Baseline problem

Baseline problems are usually caused by fluidics-related (mobile phase, pump, column) or detector/electronic-related factors. Baseline problems are characterized as:

- [Baseline drift, page 7](#)
- [Baseline noise/background, page 10](#)

Baseline drift

Steady movement of the baseline over several minutes or hours.

Select the type of baseline drift present (see [Figure 2](#) through [Figure 5](#)):

- [Rapid baseline drift, page 8](#)
- [Slow baseline drift, page 8](#)
- [Baseline curvature, page 9](#)
- [Baseline drift during gradient, page 9](#)

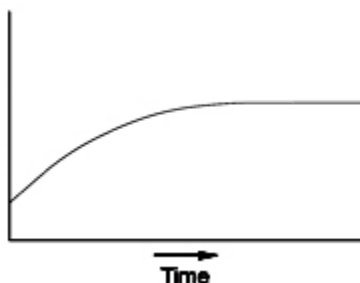


Figure 2 - Rapid baseline drift caused by insufficient stabilization

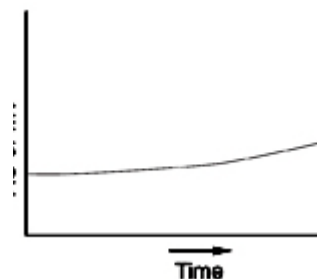


Figure 3 - Slow baseline drift caused by contaminated column

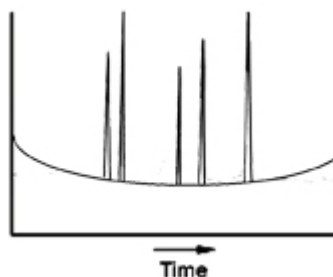


Figure 4 - Baseline curvature

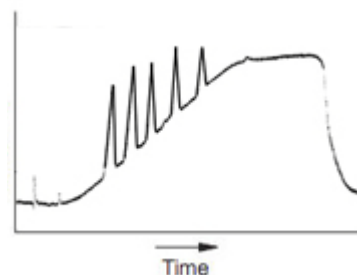


Figure 5 - Baseline drift during a gradient

Table 4: Troubleshooting baseline drift

No.	Possible cause	Corrective action	More info
Rapid baseline drift			
1	Column not equilibrated	Equilibrate the column.	See the appropriate column care and use guide .
2	Detector not allowed to warm up	Allow the detector to warm up until baseline is stable (30 to 60 min.). Time varies with wavelength and sensitivity.	ACQUITY UPLC H-Class System Guide
3	Solvent contaminated	Use fresh or higher-quality solvent.	Controlling Contamination in UPLC/MS and HPLC/MS Systems
4	Flow fluctuations (rapid or slow drift)	1. Prime the pump. 2. Replace pump seals and check valves. 3. Check the degasser pressure reading to make sure it is within range (below 0.9 psia).	Erratic retention times, page 17.
5	Loose or bad fittings	Check/tighten fittings or replace as necessary.	N/A
6	Incorrect wavelength for solvent	Ensure solvent does not absorb at the wavelength used.	N/A
Slow baseline drift			
1	Solvent contaminated	Use fresh or higher-quality solvent.	Controlling Contamination in UPLC/MS and HPLC/MS Systems
2	Decreased UV lamp energy	Determine lamp energy at the Console. If hours are greater than 2500, replace the lamp.	N/A
3	Ambient temperature fluctuations	Stabilize operating environment temperature enough to allow full equilibration.	N/A
4	UV detector flow cell leaking (internal, cross-port)	Inspect the flow cell; tighten connections.	N/A

Table 4: Troubleshooting baseline drift

No.	Possible cause	Corrective action	More info
5	Dirty flow cell	Clean the flow cell. NOTE: The ACQUITY absorbance detectors are equipped with light-guided flow cells that can cause curved baselines showing a "swoop" or "smile" when dirty. (See Figure 25 on page 51.)	• Routine Cleaning for the ACQUITY UPLC System • Light-guided flow cell: usage guide-lines
6	Absorbance of the mobile phases being used are different due to spectral differences in the additives in water and organic solvents	Balance the absorbance of the two mobile phases by reducing the additive concentration in the higher-absorbing mobile phase.	CAUTION: THIS MAKES THE MOBILE PHASES SLIGHTLY DIFFERENT WITH RESPECT TO THE ADDITIVE.
7	Leaking connections at flow cell inlet and outlet	Tighten or replace fittings.	N/A
8	Dirty column	Clean or replace the column.	See the appropriate column care and use guide.
Baseline curvature			
	Flow cell is dirty	Clean the flow cell. NOTE: The ACQUITY absorbance detectors are equipped with light-guided flow cells that can cause curved baselines showing a "swoop" or "smile" when dirty. (See Figure 25 on page 51.)	• Routine Cleaning for the ACQUITY UPLC System • Light-guided flow cell: usage guide-lines
Baseline drift during gradient			
	Absorbance of A and B mobile phases are different due to spectral differences in the additives in water and organic solvents	Balance the absorbance of the two mobile phases by reducing the additive concentration in the higher-absorbing mobile phase.	CAUTION: THIS MAKES THE MOBILE PHASES SLIGHTLY DIFFERENT WITH RESPECT TO THE ADDITIVE.

Baseline noise/background

Baseline noise refers to random fluctuations in the chromatogram or spectrum. The term is often used interchangeably with background. **Background** is consistent excessive signal(s) or increase in baseline response that occurs over a large portion of the chromatogram.

Select the baseline problem category corresponding to your symptom:

- Baseline noise cycling:
 - Long-term baseline noise cycling (60 seconds to 1 hour), page 11
 - Short-term baseline noise cycling (30 - 60 seconds), page 12
- Erratic baseline noise, page 12
- Noise spikes, page 14

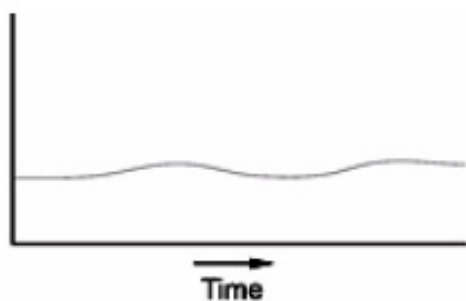


Figure 6 - Long-term baseline noise cycling (10 minutes to 1 hour)

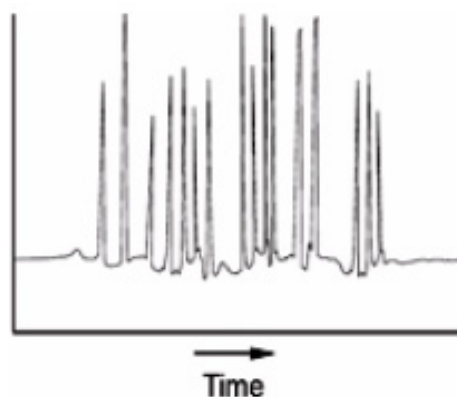


Figure 7 - Short-term baseline noise cycling (30 seconds to 60 seconds)

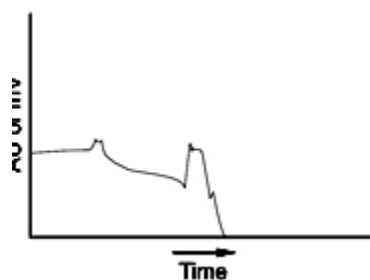


Figure 8 - Erratic baseline noise (caused by leak in detector flow cell)

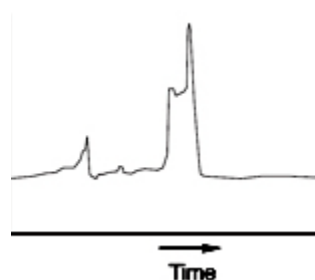


Figure 9 - Noise spikes (caused by air bubbles)

Table 5: Troubleshooting baseline noise

No.	Possible cause	Corrective action	More info
Long-term baseline noise cycling (60 seconds to 1 hour)			
1	Solvent contaminated	Is solvent being recycled from detector waste back to solvent bottles? Use only fresh, clean solvents for your application.	Controlling Contamination in UPLC/MS and HPLC/MS Systems
2	Ambient temperature fluctuations	Stabilize operating environment temperature (for a minimum of 30 minutes) to allow full equilibration. If problem continues: • Use a column heater (run 5° C above ambient). • Relocate the system or column to a thermally stable environment or close any open air vents. Confirm that the column active preheater is used.	ACQUITY UPLC H-Class and H-Class Bio System Site Preparation Guide.
3	Erratic pump pressure/pump pulsations	Prime the pump. If problem persists, troubleshoot pump pressure.	Solvent manager low or erratic flow rate/pressure pulsations, page 98.
4	Loose fittings or bent tubing before or after the column	Check the tubing before and after the column for bends and fittings for dead volume or deformations. Replace as necessary.	N/A
5	Use of immiscible solvents	Verify miscibility of solvents and change to more miscible solvents.	ACQUITY UPLC H-Class System Guide ("Solvent miscibility").
6	Bad lamp	1. Use detector Console diagnostics Read energy test to determine lamp energy. Very low energy may indicate an aged lamp, which can cause baseline drift. If necessary, replace the lamp. 2. Check to see how many hours are on the lamp. If hours exceed 2500, replace the lamp.	ACQUITY UPLC PDA Detector: Console.

Table 5: Troubleshooting baseline noise

No.	Possible cause	Corrective action	More info
Short-term baseline noise cycling (30 - 60 seconds)			
1	Inadequate solvent blending	Is the baseline steady when running a pre-mixed solvent? If yes: 1. For shallow gradients or protein applications that run at lower pressure, consider changing to a larger-volume mixer. Consider using partially premixed solvents to minimize outgassing due to mixing. 2. For TA/FA-absorbing mobile phases at low wavelengths, consider using a larger-volume mixer.	N/A
2	Mixing manifold incorrectly installed	Ensure that the knurled nut at the top of the mixing manifold is installed correctly and that the mixing manifold is level.	N/A
Erratic baseline noise			
1	System not stabilized or chemically equilibrated	1. Allow all system components (including the column and detector) sufficient time to stabilize thermally and equilibrate chemically. 2. Note the operating conditions of your application (such as mobile phase, detector settings, and detector type). 3. If you are running a gradient method, use sufficient and reproducible equilibration times between injections. NOTE: <i>The time needed to equilibrate a column varies with system configuration, flow rate, and injection cycle time.</i>	Equilibrating the column, page 71
2	NanoFlow sprayer/emitter problem	Clean or replace the emitter.	Universal NanoFlow Sprayer Installation and Maintenance Guide.
3	Solvents contaminated	Use fresh or higher-quality solvent.	N/A

Table 5: Troubleshooting baseline noise

No.	Possible cause	Corrective action	More info
4	The mobile phase might absorb too much at the wavelengths selected	Try the following: 1. Do not monitor at such low wavelengths. 2. Lower the concentration of the additive. 3. Use a different additive or solvent with less absorbance at the chosen wavelength.	N/A
5	Flow cell is leaking	Tighten or replace flow cell fittings.	N/A
6	Column contaminated	Clean or replace the column.	N/A
7	Dirty flow cell	Clean the flow cell. NOTE: The ACQUITY absorbance detectors are equipped with light-guided flow cells that can cause curved baselines showing a "swoop" or "smile" when dirty. (See Figure 25 on page 51.)	• Routine Cleaning for the ACQUITY UPLC System • Light-guided flow cell: usage guidelines
8	System improperly grounded	Plug into an outlet on a different electrical circuit. Use a power conditioner.	N/A
9	Unit not cooling properly	Operate the system with all covers in place. Check the back panels for proper clearance.	N/A
10	Air in detector flow cell	Flush the flow cell with 100% methanol to remove air bubbles.	N/A
11	Detector-electronics problem	1. Turn off solvent flow and check baseline. 2. If noise persists, install a shunt cell in the detector and perform a Noise or Drift test to narrow down the problem. 3. If the problem is isolated to electronics, replace the personality PCB. (See Replacing the CPU 2000/Personality PCB.) 4. If the problem persists, replace the front-end amplifier PCB.	• Replacing the CPU 2000/Personality PCB • Replacing the Pre-amplifier Board in the TUV Detector

Table 5: Troubleshooting baseline noise

No.	Possible cause	Corrective action	More info
Noise spikes			
1	Air bubbles	Flush the flow cell with 100% methanol to remove air bubbles.	N/A
2	Erratic pump pressure/pump pulsations	Prime the pump. If problem persists, troubleshoot pump pressure.	Solvent manager low or erratic flow rate/pressure pulsations, page 98.
3	Electrical problem	Is the ACQUITY system connected to an electrical circuit that provides power to other systems (e.g., refrigerator) or components? NOTE: <i>The ACQUITY system requires a dedicated, grounded power source.</i> See ACQUITY UPLC H-Class Site Preparation Guide.	N/A
4	No backpressure regulator installed on the last detector in line	Install back pressure regulator to maintain 250 psi backpressure. NOTE: <i>Do not install the back-pressure regulator if the UPLC detector is connected to an MS.</i>	N/A

Table 6: Troubleshooting increased background

No.	Possible cause	Corrective action	More info
1	Contamination (e.g., solvents, sample)	Troubleshoot contamination	Controlling Contamination in UPLC/MS and HPLC/MS Systems
2	Dirty MS source	Clean the source.	N/A
3	Detector gain setting too high	Is the increased background accompanied by unexpectedly large peaks? If yes, recycle power to the system, ensuring that conditions at power-up mimic run conditions. Follow this procedure: 1. Power off the system. 2. Turn on the pump and establish good flow. 3. Turn on power to the system. See the troubleshooting guide for your detector.	N/A
4	Electronic noise	Troubleshoot electronic noise. See the troubleshooting guide for your detector.	N/A
5	Column problem	Make sure column is used properly.	See the appropriate column care and use guide .

Retention time problem

Unexpected retention time.

Retention time is the time it takes for the analyte to pass through the system from the moment of injection to the time when the peak maximum elutes (see [Figure 10](#)).



Figure 10 - Retention time

Select a subcategory of incorrect/changing retention times:

- [Erratic retention times, page 17](#)
- [Increasing retention time, page 19](#)
- [Troubleshooting decreasing retention time, page 21](#)
- [Troubleshooting retention time changed to a new constant value, page 22](#)

*Erratic retention times***Table 7: Troubleshooting erratic retention times**

No.	Possible cause	Corrective action	More info
1	System not stabilized or chemically equilibrated	• Allow all system components (such as the column and detector) sufficient time to stabilize and chemically equilibrate. • Note the operating conditions of your application (such as mobile phase, detector settings, and detector type). • Refer to the instrument or column operator's manual for recommended equilibration times. • If running an automated gradient method, ensure sufficient and reproducible equilibration times are used between injections. NOTE: <i>If using ion-pairing reagents, ensure that the first time you use the column you provide a sufficient time and volume of solvent to adequately equilibrate the column (for example, running a total volume of 100 mL of a 5 mM solution).</i>	ACQUITY UPLC H-Class and H-Class Bio System Site Preparation Guide
2	Erratic pump pressure/pump pulsations	• Check the pressure trace in the Console. • See Solvent manager low or erratic flow rate/pressure pulsations, page 98, to verify the source of erratic pressure.	N/A
3	Injection volume/sample concentration too high (sample overload), disrupting equilibrium	Reduce the injection volume or dilute the sample with initial mobile phase. If using a weaker solvent, you can inject up to 10% of column void volume. If using a stronger solvent, you can inject up to 1% of column void volume.	N/A

Table 7: Troubleshooting erratic retention times (continued)

No.	Possible cause	Corrective action	More info
4	Ambient temperature fluctuations	Stabilize operating environment temperature (for a minimum of 30 minutes) to allow full equilibration. If problem continues: • Use a column heater (run 5° C above ambient). • Relocate the system or column to a thermally stable environment or close any open air vents. Confirm that the active preheater is used.	ACQUITY UPLC H-Class or H-Class Bio System Site Preparation Guide.
5	Inadequate solvent blending	To confirm a mixing problem: 1. Premix, filter, and degas the mobile phase. 2. Use different solvent lines. 3. With the column in-line, pump a minimum of 5 to 10 column volumes through a single pump (or solvent line) to equilibrate the column. 4. Inject a standard a minimum of 3 times and compare the reproducibility of the retention times to the previous injections (with erratic retention times). If retention times are reproducible with the premixed solvent, this indicates a solvent blending problem. Verify the mixing problem and correct as outlined below: 1. Use of immiscible solvents. Verify miscibility of solvents and change to more miscible solvents. 2. Malfunction in the pump or mixer. See Troubleshooting Solvent Manager Symptoms, page 81. 3. Inadequate blending after the pump. The solution is to add additional mixing. However, the mixing required depends on the severity of the problem.	N/A

Table 7: Troubleshooting erratic retention times (continued)

No.	Possible cause	Corrective action	More info
6	Column contamination	1. Flush the column with 85% B (organic solvent). 2. Clean or replace the column. 3. Re-run the analysis and observe if retention times stabilize. • If the retention time continues to be erratic, investigate contaminated mobile phase (see Solvent properties such as miscibility. • Mobile phase contaminated, page 21). 4. Contaminated guard column or in-line filter (clean or replace).	See the appropriate column care and use guide .

Increasing retention time

Peaks are "drifting" to later retention times and do not remain at any one retention time for very long.

Table 8: Troubleshooting increasing retention time

No.	Possible cause	Corrective action	More info
1	Decreased flow rate	1. Verify the solvent flow rate setting. 2. Set to appropriate flow rate, depending on size of column and type of emitter used.	See the appropriate column care and use guide .
2	Incorrect solvent composition	Change solvent composition.	N/A
3	Incorrect column	Use correct column for your application.	N/A

Table 8: Troubleshooting increasing retention time

No.	Possible cause	Corrective action	More info
4	System not equilibrated or chemically stabilized	- Allow all system components (such as the column and detector) sufficient time to stabilize and chemically equilibrate. - Note the operating conditions of your application (such as mobile phase, detector settings, and detector type). - Refer to the instrument or column operator's manual for recommended equilibration times. If running an automated gradient method, ensure sufficient and reproducible equilibration times are used between injections. NOTE: <i>If using ion-pairing reagents, ensure that the first time you use the column you provide a sufficient time and volume of solvent to adequately equilibrate the column (for example, running a total volume of 100 mL of a 5 mM solution).</i>	N/A
5	Column contaminated	- Flush the column with 85% B organic solvent. - If problem persists, clean or replace column.	Troubleshooting Contamination in Integrated Systems ("Cleaning the column") .
6	Column degraded (loss of column chemistry)	Verify column performance by measuring capacity factor (k') and selectivity. If either measurement has changed, adjust it. Replace the column.	Measuring capacity factor (k_1), page 71 Measuring selectivity, page 73
7	Column heater temperature too low	- Set column heater to correct temperature and wait for a minimum of 30 minutes to allow full equilibration. (Set at least 5° C above ambient temperature.) - Confirm that the column active preheater is active.	ACQUITY UPLC H-Class or H-Class Bio System Site Preparation Guide .

Table 8: Troubleshooting increasing retention time

No.	Possible cause	Corrective action	More info
8	Mobile phase improperly degassed	1. Prime all lines. 2. Try switching the solvent lines. 3. Tighten fittings and check solvents. 4. Degas the solvent(s) and re-equilibrate the system. NOTE: <i>Incorrect solvents can damage the degasser.</i>	See ACQUITY UPLC® System Hexane / Tetrahydrofuran Compatibility Kits .
9	Fluid leak (causes lower flow rate)	1. Inspect fittings for leaks. 2. Perform the leak tests.	See Solvent manager fluidics problems , page 84
10	Solvent inlet filter or inlet lines blocked	1. Check the lines for blockages; replace tubing if necessary. 2. Clean the solvent inlet filter frit; replace the frit if necessary.	N/A
11	Mobile phase contaminated	Troubleshoot contamination.	Controlling Contamination in UPLC/MS and HPLC/MS Systems

Decreasing retention time

Peaks are "drifting" to earlier retention times and do not remain at any one retention time for very long.

Table 9: Troubleshooting decreasing retention time

No.	Possible cause	Corrective action	More info
1	Increased flow rate	1. Verify the solvent flow rate setting. 2. Set to appropriate flow rate, depending on size of column used.	See the appropriate column care and use guide .
2	Incorrect solvent composition	Change solvent composition.	N/A
3	Column heater temperature too high or not equilibrated	1. Set column heater to correct temperature and wait for a minimum of 30 minutes to allow full equilibration. (Set at least 5° C above ambient temperature.) 2. Confirm that the column active preheater is used.	• ACQUITY UPLC H-Class or H-Class Bio System Site Preparation Guide. • Equilibrating the column, page 71
4	Incorrect mobile phase	Use correct mobile phase.	N/A

Table 9: Troubleshooting decreasing retention time (continued)

No.	Possible cause	Corrective action	More info
5	Column contaminated	1. Flush the column with 85% B organic solvent. 2. If problem persists, clean or replace column.	Troubleshooting Contamination in Integrated Systems ("Cleaning the column") .
6	Incorrect column	Use correct column.	Measuring capacity factor (k ₁), page 71 Measuring selectivity, page 73
7	Sample diluent stronger than the initial mobile phase	Do one of the following: • Dilute sample in a weaker solution. • Inject less.	N/A

Retention time changed to a new constant value

Table 10: Troubleshooting retention time changed to a new constant value

No.	Incorrect mobile phase or incorrect diluent for the sample	Prepare fresh mobile phase.	More info
1	Pump flow rate changed	Verify the solvent flow rate setting. Set to appropriate flow rate for the application.	N/A
2	Incorrect flow rate being delivered (due to pump malfunction)	Troubleshoot QSM fluidics problems.	N/A
3	Incorrect temperature setting on column heater	1. Check the temperature setting in the Console to ensure it is working correctly. 2. If necessary, change to the correct temperature setting. 3. Wait for a minimum of 30 minutes to allow full equilibration. Set temperature much be at least 5° C above ambient temperature. 4. Confirm that the column active preheater is used.	ACQUITY UPLC H-Class or H-Class Bio-system Site Preparation Guide .
4	Incorrect column size or type	Verify the source or type of the column. Use a column identical to the column used during methods development.	N/A

Table 10: Troubleshooting retention time changed to a new constant value

No.	Incorrect mobile phase or incorrect diluent for the sample	Prepare fresh mobile phase.	More info
5	Mobile phase contains a stabilizer, or there is a change in the stabilizer	Use a preservative-free solvent. NOTE: <i>Separations may require adjustment if you change to a preservative-free solvent.</i>	N/A
6	Column contaminated	Clean or replace column.	Troubleshooting Contamination in Integrated Systems ("Cleaning the column") .
7	Incorrect gradient delay volume for the fluidic system	Determine whether a change has been made to fluidic system (for example, addition of a gradient mixer). If a change has been made, recalculate the new gradient delay volume. NOTE: <i>The upper limit of the flow rate range is 2 mL/min.</i>	N/A
8	Flow transducer out of zero	Autozero the flow transducer.	N/A
9	Void volume	Is there an abnormally large increase in system volume? This can indicate a void volume caused by the replacement of tubing and/or columns. To correct the problem, replace fluidic components as necessary.	N/A

Abnormal peaks

NOTE: Before troubleshooting abnormal peaks, verify that retention time problems are not affecting your chromatography. (See [Retention time problem, page 16.](#))

Normal peaks are symmetrical, tall, and narrow (see [Figure 11](#)).

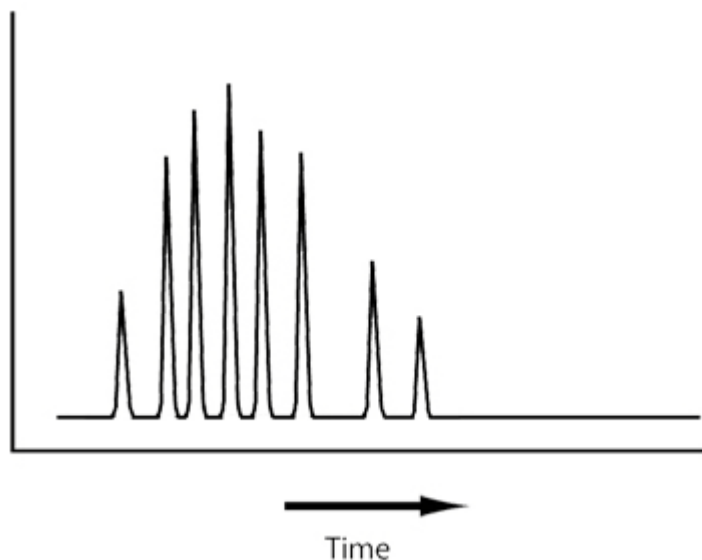


Figure 11 - Example of normal peaks

Abnormal peaks are classified as:

- [Troubleshooting broad peaks, page 25](#)
- [Early eluting peaks are broader than expected, page 28](#)
- [Extra peaks \(see Extra peaks, page 29\)](#)
- [Flat baseline/no peaks, page 30](#)
- [Flat-topped peaks, page 32](#)
- [Fronting peaks, page 33](#)
- [Ghost peaks \(see Extra peaks, page 29\)](#)
- [Late-eluting peaks, page 34](#)
- [Missing peaks, page 34](#)
- [Negative peaks, page 36](#)
- [Smaller than expected peaks \(see Sensitivity loss, page 41\)](#)
- [Split or double peaks \(shoulders\), page 37](#)
- [Tailing peaks, page 38](#)
- [Unexpected peaks \(see Extra peaks, page 29\)](#)

Table 11: Troubleshooting broad peaks

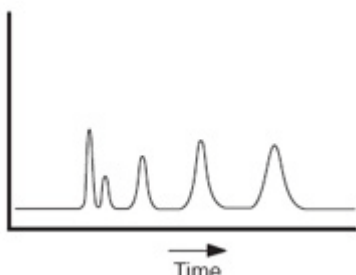
No.	Possible cause	Corrective action	More info
 <i>Figure 12 - All peaks are broad</i>			
1	Low column efficiency	Perform a plate count measurement to diagnose the problem, or replace column.	Measuring plate count, page 75
2	Excessive extra-column volume due to inappropriately large-ID tubing	1. Perform a bandspreading test to diagnose the problem. 2. Install appropriate tubing.	Measuring extra-column bandspreading of the system, page 76
3	Inappropriately made connection or fitting	1. Inspect: - fittings in ports 1 through 4 on the injection valve - connection between the active preheater and the column - fittings at both ends of the tubing that connects the column to the detector 2. Reseat or replace any fitting that does not appear to be seated correctly.	N/A
4	Detector time constant or filter is too high (non-MS detectors) (see Figure 13)	The time constant should be as low as possible and still minimize baseline noise. NOTE: A starting place for time constant is 1/data rate.	N/A

Table 11: Troubleshooting broad peaks (continued)

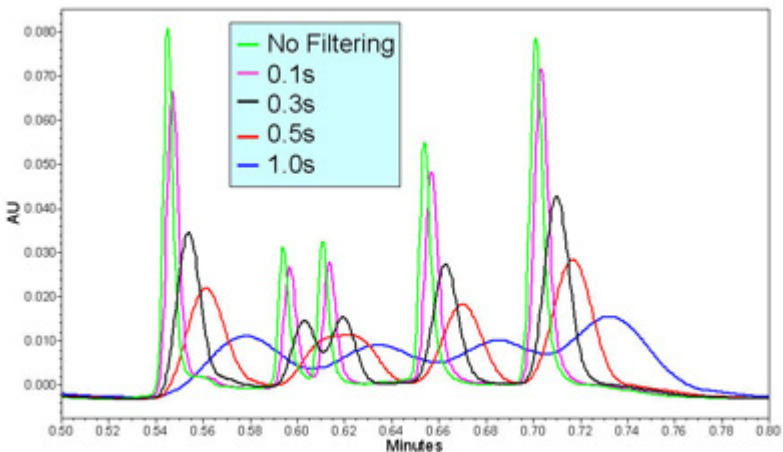
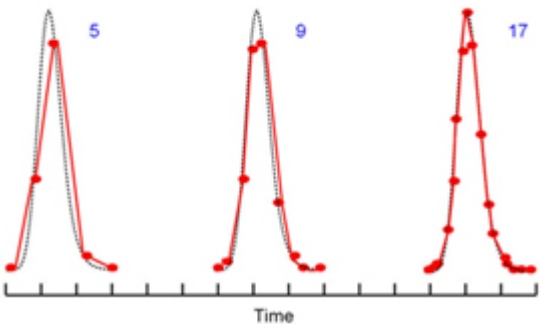
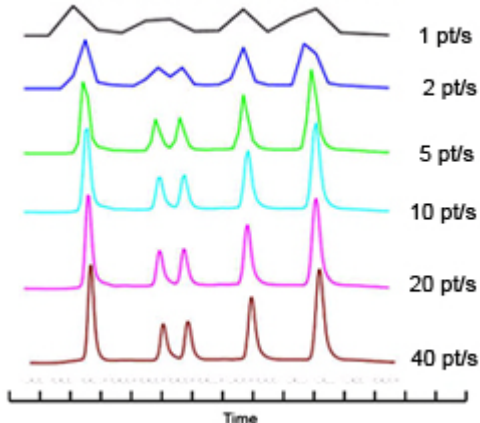
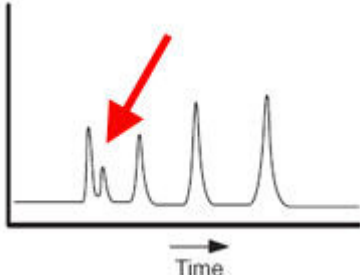
No.	Possible cause	Corrective action	More info
	 <i>Figure 13 - Effect of time constant on peaks</i> Should have 15 to 20 points for quantitation ● ● ● ● ● Chromatographic peak — Peak shape • Data point  <i>Figure 14 - Effect of data rate on peaks</i> Peaks are ~ 1 to 2 seconds wide  <i>Figure 15 - Broad peaks caused by low scan rate</i>		

Table 11: Troubleshooting broad peaks (continued)

No.	Possible cause	Corrective action	More info
5	MS detector scan rate is too low (see Figure 14 and Figure 15)	Increase the scan rate to obtain more data points across the peak. Ideally, acquire 15 to 20 data points across the peak.	N/A
6	Too much peak smoothing	Reduce smoothing to prevent peak shape distortion.	N/A
7	One of the following: - Long retained peak in the sample from a previous run - Long retained junk peak from the mobile phase that accumulated on the column and eventually eluted	Add a high organic wash step at the end of the gradient run and extend the run time.	N/A

Table 12: Early eluting peaks are broader than expected

No.	Possible cause	Possible cause	More info
 Figure 16 - Early eluting peaks are broader than expected			
1	Injection volume or sample concentration too high	1. Reduce the injection volume 2. Dilute the sample. For testing, dilute 5 to 10 times to check peak shape. NOTE: If diluent is weaker in organic than initial mobile phase, you can inject up to 10% of the column void volume. If the diluent is stronger in organic, inject 1% or less of the column void volume.	Measuring capacity factor (k₁), page 71
2	Sample diluent too high in organic for the initial mobile phase	Reduce the injection volume or reduce the percentage of organic in the diluent.	N/A
3	Peaks eluting during the isocratic portion of a gradient separation because of pump dwell (or delay) volume	Use gradient delay volume to offset the isocratic portion to occur prior to injection.	N/A

Extra peaks

Peaks that show up unexpectedly in well-characterized samples. Extra peaks can arise from contamination or carryover. Although the terms carryover and contamination are often used interchangeably, they have different meanings. Carryover is actually a specific type of contamination. It refers to sample left over from a previous injection.

To troubleshoot extra peaks, first determine whether the extra peaks are the result of carryover or contamination:¹

1. Run two to three blank injections, followed by an sample injection with twice the run time, followed by two to three blank injections.
2. Troubleshoot the results as recommended in [Table 13](#).

Table 13: Troubleshooting extra peaks

Test result	Possible cause	Corrective action	More info
Peaks appear consistently in last blank injection	Contamination	Troubleshoot contamination.	Controlling Contamination in UPLC/MS Systems
Peaks appear in sample injection after original run time	Peaks appearing in the next injection	Extend runtime or change conditions to allow elution during normal runtime.	N/A
Peaks appear in the blank injection after the sample injection	Carryover	Troubleshoot carryover.	Troubleshooting Carryover
No peaks appear after first blank injection	Sample or sample vial contaminated	Use freshly made sample or a new sample vial.	CAUTION: Never refill or reuse sample vials.

-
1. For complete information on identifying and troubleshooting contamination, refer to [Contamination/Carryover Tools](#), located in the Portal.
-

Table 14: Flat baseline/no peaks

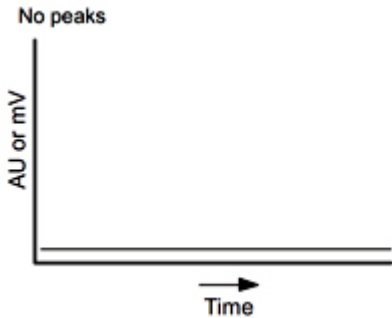
No.	Possible cause	Corrective action	More info
 Figure 17 - Flat baseline/no peaks			
1	No solvent flow	1. Check that there is sufficient solvent in the bottles. 2. Make sure the solvent flow is >0 and the system pressure is normal.	N/A
2	Leak in the solvent path	Check/tighten fittings.	N/A
3	Mobile phase absorbing too much UV at the wavelength selected	1. Try one of the following steps: • Try monitoring at a higher wavelength. • Lower the concentration of the mobile phase additive. • Use a different additive, or a solvent with less absorbance at the desired wavelength.	N/A
4	Incorrect vial position	Place vial in correct position.	N/A
5	No sample in vial	Place sample in vial.	N/A
6	Injector not injecting	1. Prime the sample syringe. 2. Run the sample syringe leak test.	N/A
7	Failed needle seal	Replace needle seal.	N/A
8	Needle not reaching sample in vial	Set needle height lower in method, or add more sample to vial.	N/A
9	Method parameters incorrect	Review method.	N/A
10	System component in error state	Check for error messages or red LED lights on the components.	N/A

Table 14: Flat baseline/no peaks (continued)

No.	Possible cause	Corrective action	More info
11	Lamp power supply problem	1. Check the voltages. 2. Replace the lamp supply problem.	N/A
12	Detector lamp not lit	Troubleshoot "lamp lighting failure" error message.	Troubleshooting Errors, page 149
13	Detector lamp burned out	Replace the lamp.	N/A
14	Detector baseline not zeroed	Zero the detector baseline.	N/A
15	Incorrect detector wavelength	Check wavelength setting.	N/A

Table 15: Flat-topped peaks

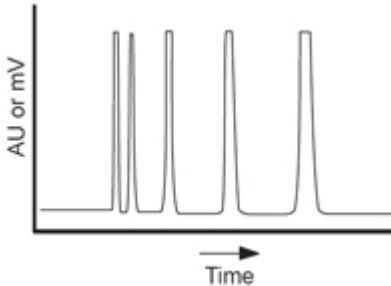
No.	Possible cause	Corrective action	More info
 <i>Figure 18 - All peaks flat-topped</i>			
1	MS detector saturation	1. Dilute the sample (10:1 recommended). 2. Check the detector setup.	N/A
2	Incorrect detector settings (e.g. wavelength, sensitivity)	Check method and correct any wrong setup parameters.	N/A
3	Injection volume/sample concentration too high (i.e., sample overload), disrupting column equilibration	1. Reduce the injection volume. 2. Dilute the sample (10:1 recommended). NOTE: If diluent is weaker in organic than initial mobile phase, you can inject up to 10% of the column void volume. If the diluent is stronger in organic, inject 1% or less of the column void volume.	N/A
4	TUV or PDA mobile phase has very high absorbance at wavelength, reducing the working range, and the sample concentration is too high.	1. Reduce the injection volume 2. Dilute the sample (10:1 recommended). 3. Use a more UV-transparent mobile phase.	ACQUITY UPLC H-Class or H-Class Bio System Operator's Guide ("Mobile phase absorbance") .

Table 16: Fronting peaks

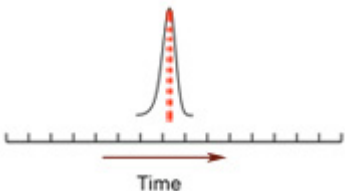
No.	Possible cause	Corrective action	More info
	 Figure 19 - Fronting peaks		
1	Injection volume/sample concentration too high (sample overload), disrupting column equilibration	1. Reduce the injection volume.	N/A
2		2. Dilute the sample. NOTE: <i>If diluent is weaker in organic than initial mobile phase, you can inject up to 10% of the column void volume. If the diluent is stronger in organic, inject 1% or less of the column void volume.</i>	
3	Sample diluent too high in organic for the initial mobile phase	Reduce the injection volume or reduce the percentage of organic in the diluent.	N/A
4	Column or pre-column contaminated	Clean column or pre-column or replace.	See appropriate column care and use guide .
5	Column degraded forming a void	Verify column performance. If efficiency is low, replace it.	Guide to Successful Operation of Your LC System ("Measuring column efficiency").
6	Pre-column degraded	1. Remove pre-column and perform a direct injection. 2. If results are normal, replace the pre-column.	N/A
7	Two very similar compounds — for example, isomers — separating NOTE: <i>ACQUITY columns provide better chromatographic resolution than HPLC columns.</i>	No corrective action is necessary.	N/A
8	Active preheater not properly heating solvent (not raising incoming solvent to within 5° C of column setpoint temperature)	1. Ensure preheater is installed correctly. 2. If necessary, replace preheater.	N/A

Table 16: Fronting peaks

No.	Possible cause	Corrective action	More info
9	Compound is acidic	Acidify mobile phase with $\leq 0.1\%$ trifluoroacetic acid or formic acid.	N/A

Table 17: Late-eluting peaks

No.	Possible cause	Corrective action	More info
<i>Peaks that used to elute at a particular retention time are now consistently eluting at a later retention time.</i>			
1	Inappropriate gradient method	Use the correct gradient method.	N/A
2	Incorrect sample preparation	Prepare sample correctly.	N/A
3	Column problem	Replace the column(s).	N/A
4	Reduced flow	Is system pressure low? 1. Perform flow rate measurement. 2. Determine cause and correct or replace failed component (e.g., check valve).	Systems Qualification Tool Protocol.)

Table 18: Missing peaks

No.	Possible cause	Corrective action	More info
<i>Fewer peaks than expected</i>			
1	Sample or standard degraded or contaminated	1. Inject a known good standard. 2. If the fewer peaks problem persists, use fresh mobile phase and flush the system. 3. If fewer peaks persist, clean or replace the column.	Troubleshooting Contamination in Integrated Systems ("Cleaning the column").
2	Wrong sample injected	Check vial location.	N/A
3	Loss of resolution	1. Check/replace sample. 2. If problem persists, troubleshoot loss of resolution.	Loss of resolution, page 52
4	Loss of sensitivity	Troubleshoot sensitivity loss.	Sensitivity loss, page 41

Table 18: Missing peaks

No.	Possible cause	Corrective action	More info
5	Incorrect mobile phase used	1. Check the mobile phase used with your sample. If the mobile phase is incorrect for the sample, prepare a fresh batch of mobile phase. 2. If problem persists, call GSS.	call GSS.
6	Sample has precipitated or come out of solution (this is sometimes indicated by a sudden increase in backpressure)	Troubleshoot high system pressure.	, page 56
7	Incorrect diluent makeup causing components in the sample to fall out of solution	Check the diluent used for preparing sample.	N/A
8	No flow or low flow due to leaks or failed check valve(s)	Is system pressure low? 1. Perform flow rate measurement. 2. Determine cause and correct or replace failed component (e.g., check valve).	Systems Qualification Tool Protocol
9	Column conditioning or re-equilibration problem	Ensure the column is adequately conditioned or equilibrated.	N/A

Table 19: Negative peaks

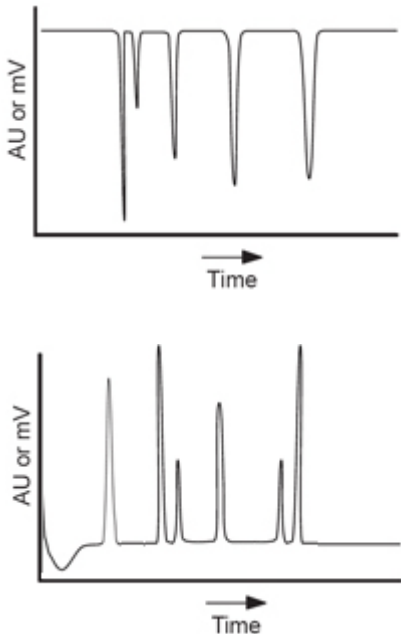
No.	Possible cause	Corrective action	More info
 <i>Figure 20 - Negative peaks</i>			
1	TUV or PDA analyte or junk peaks are less absorbent than the mobile phase	1. Choose a more UV-transparent mobile phase 2. Choose a different (higher) wavelength.	ACQUITY UPLC H-Class System Operator's Guide ("Mobile phase absorbance") .
2	Mobile phase has a higher background UV absorbance than injected compounds	Make fresh mobile phase or remove UV-absorbing modifier.	N/A
3	Solvent front at the beginning of the chromatogram at column void volume (V_0)	Make the sample diluent similar to the initial mobile phase.	N/A
4	Signal cables connected improperly (analog only)	Reset signal polarity, making sure to match positive and negative connections (see Figure 21).	N/A

Table 19: Negative peaks (continued)

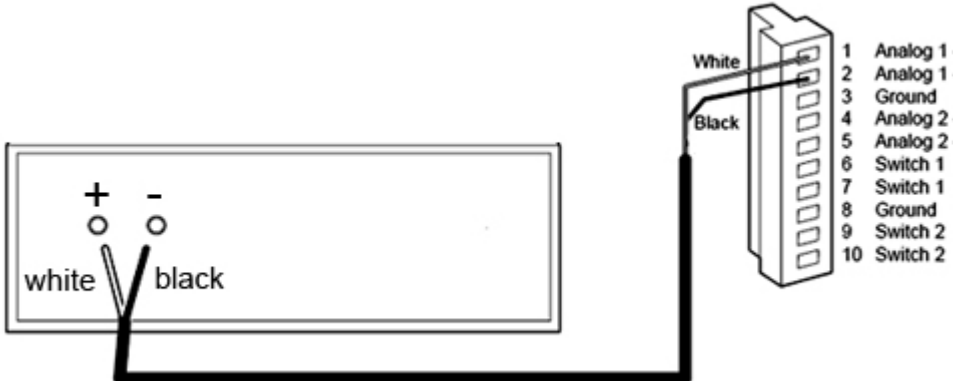
No.	Possible cause	Corrective action	More info
 Figure 21 - Setting signal polarity (analog only)			

Table 20: Split or double peaks (shoulders)

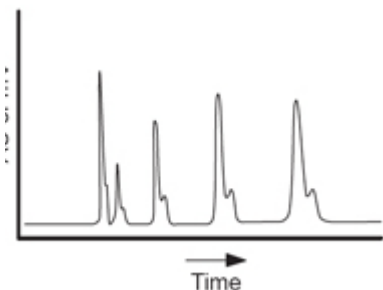
No.	Possible cause	Corrective action	More info
 Figure 22 - Split or double peaks			
1	Column degraded forming a void	1. Check column type. If column is a non-ACQUITY part, verify column performance. 2. If column efficiency is low, replace it.	Measuring plate count, page 75
2	Pre-column degraded	1. Remove pre-column and perform a direct injection. 2. If results are normal, replace the pre-column.	N/A
3	Column or pre-column contaminated	Clean/replace column or pre-column.	See the appropriate column care and use guide .

Table 20: Split or double peaks (shoulders) (continued)

No.	Possible cause	Corrective action	More info
4	Poorly made connection or fitting	1. Check all connections between the injector and the detector for voids (see). 2. Reseat or replace questionable fittings.	• Making proper fittings, page 48 • Measuring extra-column bandspreading of the system, page 76
5	Injection volume/sample concentration too high (sample overload) disrupting column equilibration	1. Reduce the injection volume. 2. Dilute the sample (1:10 recommended). NOTE: <i>If diluent is weaker in organic than initial mobile phase, you can inject up to 10% of the column void volume. If the diluent is stronger in organic, inject 1% or less of the column void volume.</i>	N/A
6	Sample diluent too high in organic for the initial mobile phase	Reduce the injection volume or reduce the percentage of organic in the diluent.	N/A
7	In-line filter, pre-column inlet, column inlet, or connecting tubing partially blocked	Inspect these components for particle build-up. Clean or replace.	N/A
8	Two compounds or isomers separated with better column technology where they formerly coeluted	No action required.	N/A

Table 21: Tailing peaks

No.	Possible cause	Corrective action	More info
1	Column degraded forming a void	1. Check column type. If column is a non-ACQUITY part, verify column performance. 2. If column efficiency is low, replace it.	Measuring plate count, page 75
2	Column or pre-column contaminated	Clean/replace column or pre-column.	See the appropriate column care and use guide .

Table 21: Tailing peaks (continued)

No.	Possible cause	Corrective action	More info
3	Poorly made fittings and poorly cut tubing	1. Check all connections between the injector and the detector for voids (see 2. Reseat or replace questionable fittings.	• Making proper fittings, page 48) • Measuring extra-column bandspreading of the system, page 76
4	Tubing too wide or too long (from injector to column and from column to detector)	Ensure tubing lengths are as short as possible. Using tubing IDs appropriate to the flow rate. For ACQUITY, use 0.005" (red PEEK) or smaller.	• Recommended column and tubing diameters, page 79 • Measuring extra-column bandspreading of the system, page 76
5	Column degraded forming a void	1. Check column type. If column is a non-ACQUITY part, verify column performance. 2. If column efficiency is low, replace it.	Measuring plate count, page 75
6	Too much sample injected onto the column	1. Ensure that injection volume is scaled appropriately to the column dimensions. 2. If necessary, decrease injection volume or dilute sample. NOTE: <i>Injection volume must be scaled down (relative to the HPLC method) for ACQUITY columns.</i>	• ACQUITY UPLC Columns Calculator • Measuring capacity factor (k₁), page 71. • appropriate column care and use guide
7	Very hydrophobic analyte	1. Increase the strength of the organic mobile phase. 2. Increase the gradient slope.	N/A
8	Flow rate too low for the column ID	Change programming to appropriate flow rate for the column ID.	Recommended column and tubing diameters, page 79
9	Injector problem	1. Perform all sample manager service diagnostic tests. If any test fails, troubleshoot the specific test failure. 2. If tests are OK, replace the injector cartridge. 3. If problem persists, replace the injector assembly.	Sample manager service diagnostic test/calibration failures, page 127

Table 21: Tailing peaks (continued)

No.	Possible cause	Corrective action	More info
10	Incorrect detector time constant or filter setting	The time constant should be as low as possible and still minimize baseline noise. NOTE: A starting place for time constant is 1/data rate.	N/A
11	Purge solvents (used for dilutions) are incompatible with chromatography and sample diluent	Ensure that purge solvents are similar to initial mobile phase and sample diluent.	ACQUITY UPLC H-Class or H-Class Bio System Guide.
12	Compound is basic	Make mobile phase more basic by adding ammonium hydroxide, sodium hydroxide, ammonium acetate, ammonium bicarbonate, or similar substance.	N/A

Sensitivity loss

A decrease in peak response or in signal-to-noise when all other system settings and method parameters remain unchanged.

When you experience loss of sensitivity, check (in the order listed):

1. [Method parameters that can cause loss of sensitivity, page 41](#)
2. [Sample factors that can cause loss of sensitivity, page 44](#)
3. [Sample container factors that can cause loss of sensitivity, page 45](#)
4. [Column factors that can cause loss of sensitivity, page 46](#)
5. [Sample manager factors that can cause loss of sensitivity, page 47](#)
6. [Plumbing factors that can cause loss of sensitivity, page 48](#)
7. [TUV or PDA detector factors that can cause loss of sensitivity, page 49](#)

Table 22: Method parameters that can cause loss of sensitivity

Method parameter	Problem	Corrective action
Injection volume	Wrong injection volume programmed. Less sample loaded on a column will result in lower response.	Change to correct injection volume.
Needle wash solvent composition	Weak wash too high in organic solvent. This will result in poor peak shape, especially for the hydrophilic peaks.	Make fresh weak wash solvent.
Gradient	Wrong gradient programmed	Correct the gradient table (requires methods development).
Flow rate	Programmed flow rate too low	Program the correct flow rate. Make sure it is appropriate for the column ID.

Table 22: Method parameters that can cause loss of sensitivity (continued)

Method parameter	Problem	Corrective action
Mobile phase	Percentage of organic used is incorrect	Make fresh mobile phase.
	Wrong solvent used	1. Check that solvent used is appropriate for the method. 2. If necessary, make fresh mobile phase.
	Programming error	1. Check/correct programming for gradient. 2. Check/correct programming for solvent input (e.g., B1 instead of B2).
	Wrong pH	Check pH. If wrong, make fresh mobile phase.
	Bad water	Try a new source of water.
	Mobile phase contaminated. This can cause ion suppression in LC/MS.	Make fresh mobile phase. See Controlling Contamination.
Column temperature	Column temperature programmed too low	Set the correct temperature.
	Column heater problem	See Troubleshooting the Column Heater .
	Column active preheater omitted	Install a column active preheater.
Needle depth	Needle depth programmed too high	Lower the needle.
		Put more sample in the vial.
		Use a narrower vial or wellplate with glass insert.
	Needle depth programmed too low	1. Verify vial type or well depth. 2. Set the correct needle depth.
Injection method	Incorrect inject method selected in the method setup.	Check/adjust configuration in Console.
Plate configuration	Plate configuration is incorrect, so needle does not reach sample	Set correct plate configuration. See Using Plates and Vials with ACQUITY UPLC and ACQUITY UPLC H-Class Systems
Sample manager temperature	Sample compartment temperature programmed too low	Raise the temperature of the sample compartment.
	Sample compartment temperature programmed too high	Lower the temperature of the sample compartment.

Table 22: Method parameters that can cause loss of sensitivity (continued)

Method parameter	Problem	Corrective action
Sample syringe draw speed	Sample syringe draw speed set too high, resulting in incomplete sample aspiration	From the Method Editor, program a slower draw speed.
Sample diluent composition	Too much organic in sample diluent. This will result in poor peak shape, especially for hydrophilic peaks.	Decrease organic in sample diluent.
Vial position	Vial position incorrectly programmed in sample list	Set the correct vial position.
Detector programming	Wrong flow cell selected	See TUV or PDA detector factors that can cause loss of sensitivity, page 49 .
	Wrong wavelength programmed	See TUV or PDA detector factors that can cause loss of sensitivity, page 49 .
	MS detector scan rate is too low (see Figure 14 and Figure 15)	Increase the scan rate to obtain more data points across the peak. Ideally, acquire 15 to 20 data points across the peak.
	Detector filter time constant is set too high (non-MS detectors)	See TUV or PDA detector factors that can cause loss of sensitivity, page 49 .

Table 23: Sample factors that can cause loss of sensitivity

Sample parameter	Problem	Corrective action
Sample	Sample concentration too low	Remake sample.
	Sample is not completely in solution	Check the solubility in the diluent at the compartment temperature.
	Volatile sample is evaporating	1. Make fresh sample and inject immediately. 2. Cool the sample compartment.
	Sample is degraded	1. Remake sample. 2. Cool the sample compartment.
	Sample precipitated over time	1. Remake sample. 2. Check the solubility in the diluent at the compartment temperature. 3. Warm the sample compartment.
	Sample prepared incorrectly	Prepare sample correctly.
Sample preparation	Sample buffers and acids inappropriate for injection method selected	Select the appropriate sample prep method for the injection method selected.

Table 24: Sample container factors that can cause loss of sensitivity

Sample or container factor	Problem	Corrective action
Glassware	Use of non-borosilicate glass may leach ions (e.g., sodium), which may form adducts in the mass spectrometer and lead to multiple masses for the same compound.	Use borosilicate glass bottles (such as Pyrex or Schott). See Controlling Contamination in UPLC/MS and HPLC/MS Systems . See Troubleshooting Contamination in Integrated Systems .
	Glassware washed in detergents may become contaminated. Detergents can cause background in the UV detector and ion suppression in the MS.	Use only HPLC-grade solvents in glassware; never wash glassware with detergents or in a dishwasher. See Controlling Contamination in UPLC/MS and HPLC/MS Systems . See Troubleshooting Contamination in Integrated Systems .
Vial	Wrong vial used	
	Compound is sticking to vial material, particularly glass or plastic	Try a different type of vial material. See Using Plates and Vials with ACQUITY UPLC and ACQUITY UPLC H-Class Systems
	Vial is too narrow for needle to reach sample	Use a wider vial. NOTE: <i>Total Recovery Vials are not recommended.</i>
	Vial has air bubble on bottom. (This is a problem with narrow, tapered vials such as limited-volume inserts.)	Check the residual volume required by the vial. Remove bubble. See Using Plates and Vials with ACQUITY UPLC and ACQUITY UPLC H-Class Systems
	Vial is empty (no analyte) or volume is too low (i.e., correct amount cannot be drawn)	Add sample to a new vial. CAUTION: NEVER REFILL OR REUSE SAMPLE VIALS.
	Vial contaminated with leftover sample	Use a new vial for every new sample. CAUTION: NEVER REFILL OR REUSE SAMPLE VIALS.

Table 24: Sample container factors that can cause loss of sensitivity (continued)

Sample or container factor	Problem	Corrective action
Vial cap	Use of vial caps that are not pre-slit can form a vacuum.	Use pre-slit vial caps. See Using Plates and Vials with ACQUITY UPLC and ACQUITY UPLC H-Class Systems
Wellplate capmat	Use of wellplate cap mat can result in needle not penetrating cap mat.	1. Check needle depth. 2. Change to new Y-carriage with deeper puncture needle.

Table 25: Column factors that can cause loss of sensitivity

Column factor	Problem	Corrective action
Column efficiency	Column degradation has created a void, resulting in loss of efficiency	Replace column.
	Column is contaminated	Clean or replace the column. See Controlling Contamination in UPLC/MS and HPLC/MS Systems . See Troubleshooting Contamination in Integrated Systems .
Column temperature	Temperature is programmed too low. This can cause problems in the chromatogram: retention time may be too long, and peak may be too wide.	Set the correct temperature.
	Radial thermal gradient across column (hot spot on column)	Use column clips to ensure that the column does not contact the rail of the trough.
	Column heater problem	See Troubleshooting the Column Heater .
	Column active preheater omitted	Install a column active preheater.
Column fittings	Incorrect or damaged fittings, resulting in a column leak	Replace tubing and perform set pressure diagnostics.

Table 26: Sample manager factors that can cause loss of sensitivity

Sample manager factor	Problem	Corrective action
Injection volume (Less sample loaded on column will result in a lower response)	Sample manager configured incorrectly	1. Check/adjust configuration of extension loop. 2. Perform needle seal readiness test and characterize needle.
	Sample manager calibrated incorrectly	Perform that needle seal readiness test, and characterize needle.
	Leak in sample manager flow path	Perform sample syringe leak test and troubleshoot leak test results. See Sample syringe leak test fails, page 128 .
Column temperature	Incorrect column temperature	See Column factors that can cause loss of sensitivity, page 46 .
Sample manager temperature	Temperature is too low; compound is not completely soluble at lower temperatures	Raise the temperature of the sample compartment.
	Temperature is too high	Cool the sample compartment.
Needle	Clogged needle	1. Wash the needle with strong wash solvent. 2. If problem persists, replace the needle.
Needle depth	Incorrect needle depth	See Method parameters that can cause loss of sensitivity, page 41 .
Sample syringe	Syringe was not primed, leading to air bubbles in syringe	Prime the syringe (minimum of 10 cycles). Prime for 40 cycles if performing an SQT.
	Weak wash solvent bottle is empty	Fill weak wash solvent bottle and prime.
	Syringe is leaking	1. Replace syringe. 2. Perform sample syringe leak test.
Sample syringe draw speed	Sample syringe draw speed is set too high, resulting in too little sample draw-up	From the Method Editor, program a slower draw speed.

Table 27: Plumbing factors that can cause loss of sensitivity^a

Plumbing factor	Problem	Corrective action
Fittings	Fittings are poorly made, resulting in a void between the tube end and bottom of the fitting hole (see Figure 23)	Tighten fittings to remove leaks or replace damaged fittings.

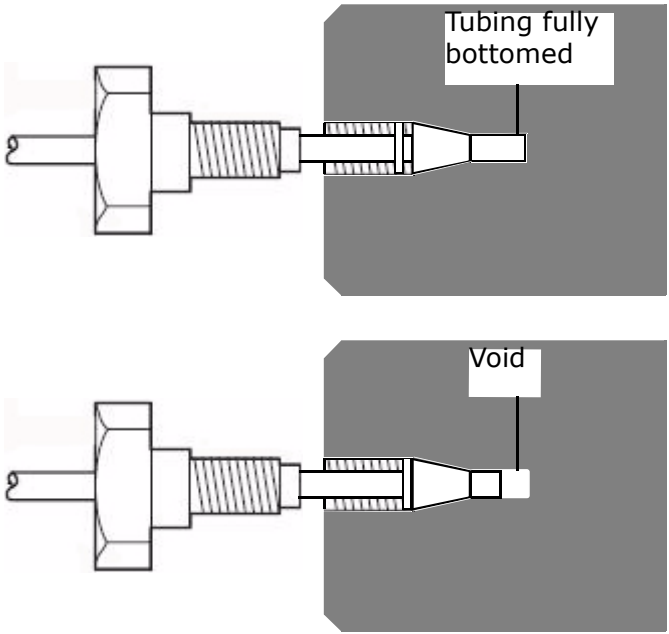


Figure 23 - Making proper fittings

Table 27: Plumbing factors that can cause loss of sensitivity^a (continued)

Plumbing factor	Problem	Corrective action
Tubing	Tubing ID is too large (see Figure 24)	Use only the appropriate-size tubing.
	Tubing is too long (see Figure 24)	Use tubing of the correct length; keep the length as short as is practical.

Figure 24 - Tubing sizes causing loss of sensitivity

a. This table applies to both the binary solvent manager and auxiliary solvent manager.

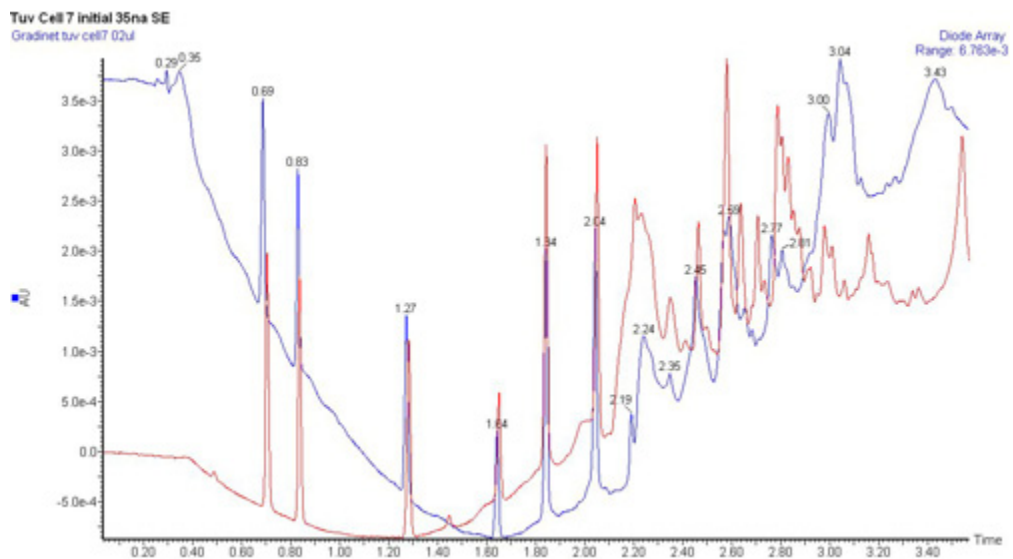
Table 28: TUV or PDA detector factors that can cause loss of sensitivity

Detector factor	Problem	Corrective action
Data rate	Detector data/scan rate set too low. The data rate needs to collect 15 to 20 points across the base of the peak.	See Troubleshooting broad peaks, page 25 .
Filter time constant	Detector filter time constant is set too high (non-MS detectors)	See Troubleshooting broad peaks, page 25 .

Table 28: TUV or PDA detector factors that can cause loss of sensitivity (continued)

Detector factor	Problem	Corrective action
Lamp energy Low lamp energy may lead to high background noise.	Lamp hours are excessive (e.g., >2000 hours).	If lamp energy is low at 230 nm in pure methanol, replace lamp.
	High absorbent mobile phase at the chosen wavelength	Change mobile phase, additive, or buffer.
	For more information, see ACQUITY UPLC H-Class System Guide ("Mobile phase absorbance").	Reduce concentration of additive or buffer.
	Solarized optics	Choose a higher wavelength.
		Investigate light path (mirrors, grating drive, filter assembly, windows, etc.). Replace optical components as necessary.
Wavelength setting	Wrong wavelength programmed	Program the correct wavelength (214 nm is typical for peptides).
Optics	Solarized optics	Investigate light path (mirrors, grating drive, filter assembly, windows, etc.). Replace optical components as necessary.
	Flow cell path length is too short, resulting in loss of transmitted light	Check flow cell type and install correct one.
Flow cell	Flow cell is dirty, resulting in loss of transmittance.	Clean the flow cell. NOTE: The ACQUITY absorbance detectors are equipped with light-guided flow cells that can cause curved baselines showing a "swoop" or "smile" when dirty. (See Figure 25 on page 51.) See: • Routine Cleaning for the ACQUITY UPLC System • Light-guided flow cell: usage guidelines.
	Wrong flow cell selected	Select correct flow cell.

Table 28: TUV or PDA detector factors that can cause loss of sensitivity (continued)

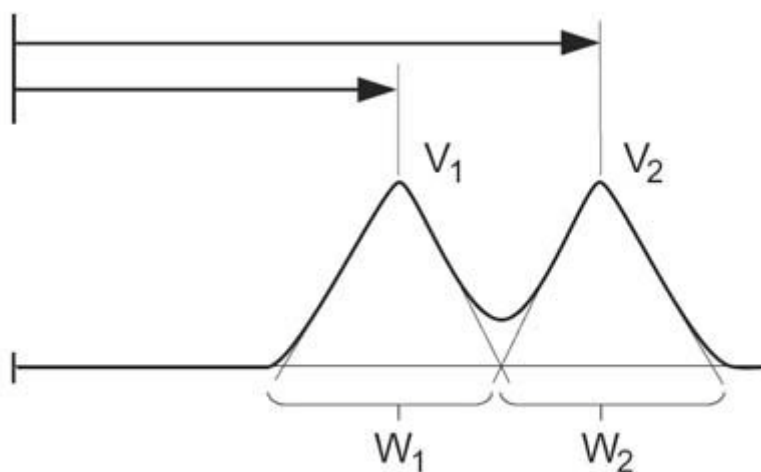
Detector factor	Problem	Corrective action
 Tuv Cell 7 initial 35na SE Gradient tuv cell 7 02ul Diode Array Range: 6.763e-3 Figure 25 - Gradient swoop before (blue) and after (red) flushing flow cell		

Loss of resolution

Resolution (R_s) is a measure of the quality of a separation. It expresses the separation of two peaks as the difference in their corresponding retention times, divided by their average peak width at the baseline (see [Figure 26](#)).

NOTE: For more information on measuring resolution, see [Guide to Successful Operation of Your LC System](#) ("Measuring resolution").

NOTE: For optimal performance of a UPLC system, use ACQUITY columns or VanGuard columns. Use of non-ACQUITY columns causes loss of performance. For more information, see the [appropriate column care and use guide](#).



$$R_s = \frac{V_2 - V_1}{1/2(W_1 + W_2)}$$

Figure 26 - Measuring peak resolution

Loss of resolution typically appears as:

- Poorly separated peaks (see [Split or double peaks \(shoulders\)](#), page 37)
- Increase in peak width (see [Troubleshooting broad peaks](#), page 25)
- [Missing peaks](#), page 34

To troubleshoot loss of resolution, select the relevant section.

Problems with quantitative results

Problems with quantitative results typically exhibit one of the following conditions:

- *Loss of accuracy* is closeness of a result to the true value. In this document we define it more narrowly as accuracy of the quantitation of a known sample.
- *Loss of precision* is inability to reproduce results over a short period of time.

NOTE: Figure 27 shows the difference between accuracy and precision.

- *Loss of reproducibility* is inability to reproduce results within instruments over a long period of time.

NOTE: Reproducibility is not specified on Waters instrumentation. [Call GSS](#) to troubleshoot.

- *Loss of robustness* is inability to reproduce results across multiple systems, users, and environments.

NOTE: Robustness is not specified on Waters instrumentation. [Call GSS](#) to troubleshoot.

Troubleshooting procedure

Perform a minimum of three consecutive injections.

- If the results are incorrect but consistent, troubleshoot [Loss of accuracy, page 54](#).
- If the results are correct but vary over time, troubleshoot [Loss of precision, page 55](#).

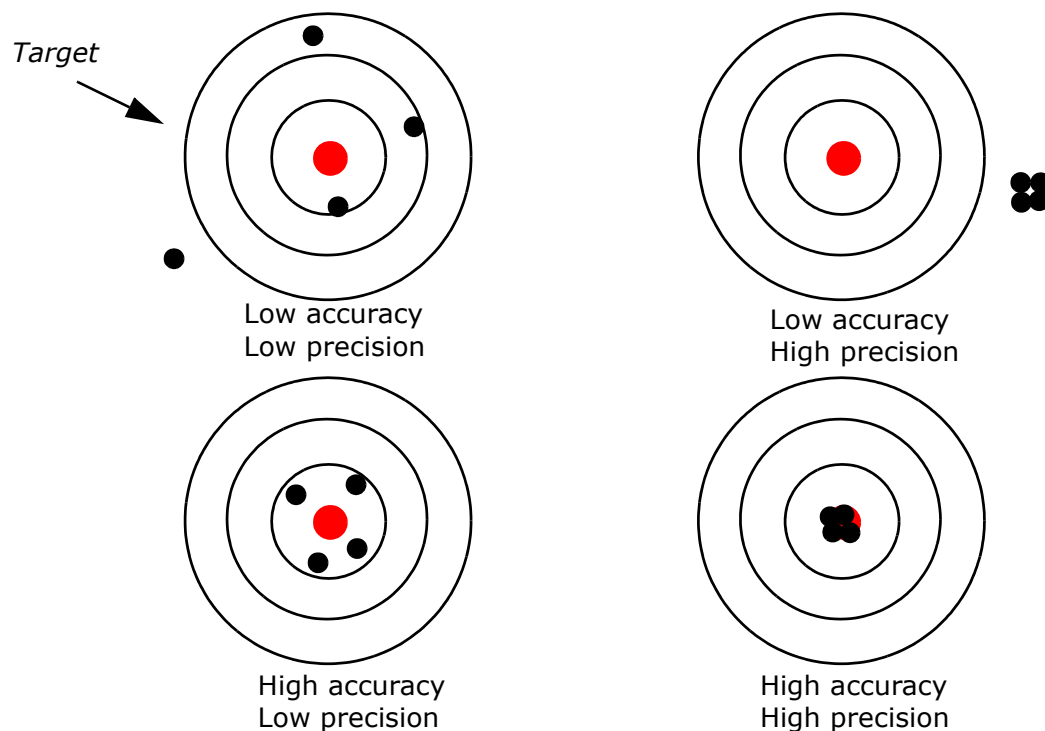


Figure 27 - Accuracy vs. precision

Table 29: Loss of accuracy

No.	Possible cause	Corrective action	More info
1	Incorrect peak height or area integration	1. Verify the integration method. 2. Verify values entered in: • Sample amount • Scale factor • Internal standard • amount • Retention time 3. Make the appropriate change(s), rerun standards, and verify that accuracy improves.	NOTE: If the data-handling system reports an error in component amount, compare the responses of the peak to standard values. If the response (area or height) is accurate, the problem is in the quantitation. If responses are incorrect, the problem is integration (for example, software values) or chromatography.
2	Sample degraded, or impurities introduced during sample preparation	1. Verify chromatography running a standard. If results are normal, there is a problem with the sample. 2. Verify the integrity of sample. Review the sample preparation process. 3. If necessary, replace with a fresh sample	N/A
3	Sample or solvent evaporation	1. Refrigerate sample and solvent, maintain appropriate temperature, seal and store appropriately. 2. Make sure the sample manager temperature is appropriately maintained for samples.	N/A
4	Poor peak shape	Troubleshoot peak shapes. See .	Abnormal peaks, page 24
5	Incorrect sample preparation	Check the sample preparation procedure.	ACQUITY UPLC System Enhanced Sample Management Capabilities
6	Incorrect internal standard preparation	Verify standard preparation/ composition procedure (weighed and diluted properly). Prepare a new internal standard.	N/A

Table 30: Loss of precision

No.	Possible cause	Corrective action	More info
1	Incorrect peak integration	1. Verify the integration method. 2. Verify the acquisition method for number of data points across the peak, filter, and smoothing. 3. Verify values entered in areas such as: • Sample amount • Scale factor • Internal standard • amount • Retention time 4. Make the appropriate change(s), rerun standards, and verify that accuracy improves.	NOTE: If the data-handling system reports an error in component amount, compare the responses of the peak to standard values. If the response (area or height) is accurate, problem is in the quantitation. If responses are incorrect, the problem is integration (for example, software values) or chromatography.
2	Corrupt method	Write a new method from "untitled."	N/A
3	Injection problem	Troubleshoot the sample manager.	Sample manager incorrect sample recovery, page 123.
4	Injector problem (such as a sticking or leaking valve, blocked or damaged needle, plugged injection port)	Troubleshoot the sample manager.	Sample manager incorrect sample recovery, page 123
5	Degraded sample or impurities introduced during sample preparation	1. Inject a blank. 2. If extra peaks are still there, use fresh mobile phase and flush the system. 3. If extra peaks are not there, clean or replace the column.	• Troubleshooting Contamination in Integrated Systems • Controlling Contamination in LCMS Systems.
6	Chromatographic problem (changing retention time, abnormal peaks shape)	Troubleshoot incorrect/changing retention time or abnormal peaks.	Retention time problem, page 16 , or Abnormal peaks, page 24 .
7	Degraded detector response	Troubleshoot your particular detector.	N/A

System pressure problem

This section covers pressure problems experienced at the *system* level. It includes information on troubleshooting:

- [High system pressure, page 56](#)
- [Low system pressure, page 60](#)
- [Erratic system pressure, page 61](#)

NOTE: To troubleshoot pressure problems specific to the solvent manager, see [Solvent manager low or erratic flow rate/pressure pulsations, page 98](#).

High system pressure

Table 31: High system pressure

No.	Possible cause	Corrective action	More info
1	System overpressure error	1. Reset the BSM. 2. If problem persists, troubleshoot overpressure error.	System over pressure (number), page 166
2	Incorrect method	• Has the current method worked before? • If not, use a known working method or troubleshoot the current method for recent changes, wrong parameters, and similar problems.	N/A
3	Laboratory thermal conditions not meeting requirements	Ensure that thermal conditions meet requirements.	ACQUITY UPLC H-Class System Site Preparation Guide
4	Solvents not prepared or handled correctly	Select, prepare, and handle solvents correctly.	Controlling Contamination
5	Column, active preheater, stabilizer, or guard column installed incorrectly	Make sure the column, active preheater, stabilizer, or guard column (if present) are installed correctly.	ACQUITY UPLC Column Care and Use Manual
6	Active preheater not turned on or warmed up	1. Enable the preheater in the software. 2. Start the active preheater and allow it to equilibrate.	N/A
7	Column compartment temperature unstable	Troubleshoot the column compartment temperature.	Column Compartments Operator's Overview and Maintenance Information
8	Column selected incorrectly	Select the appropriate column.	N/A

Table 31: High system pressure

No.	Possible cause	Corrective action	More info
9	Column degraded (loss of column chemistry)	Clean or regenerate the column. 1. Re-run the analysis. 2. If problem persists, replace the column. NOTE: For columns with an eCord, also check column batch and efficiency test results (available through the ACQUITY Console).	ACQUITY UPLC Column Care and Use Manual
10	Plugged column in-line filter (if present)	Replace the column in-line filter.	"Installing the optional column in-line filter" (Column Components Operator's Overview and Maintenance Information)
11	Pump flow rate too high or ramped up too quickly	Decrease the pump flow rate.	N/A
12	Solvent manager pressure problem	Troubleshoot solvent manager pressure problem.	Solvent manager pressure problems, page 96
13	Obstruction in fluid path or clogged mixer/filter	Disconnect fittings to isolate source of blockage.	Troubleshooting system blockage, page 57

Troubleshooting system blockage

After investigating method and environmental factors (see , [page 56](#)), disconnect fittings to isolate the source of a possible blockage. Begin with the column inlet and work *upstream* (in direction opposite to flow), as shown in [Table 32](#) and [Figure 28](#).

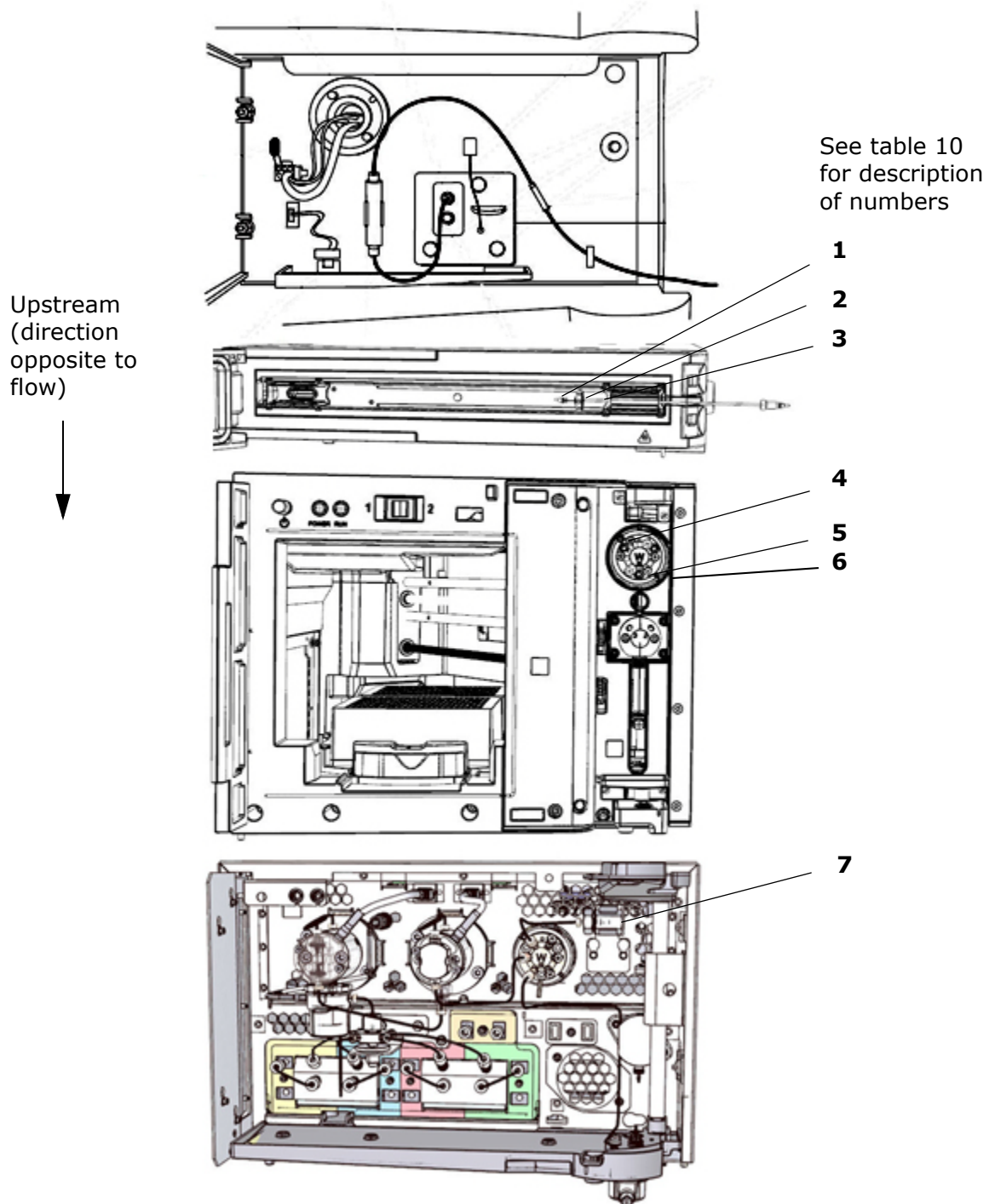
Table 32: Disconnecting fittings to troubleshoot high system pressure

Fitting location	Expected pressure reading ^a	Possible cause if pressure is OK	Action
1. Inlet to column	<300 psi with acetonitrile at 0.5 mL/min	Plugged column or plugged components after the column	Continue disconnecting fittings, proceeding upstream, until you find the defective component. (See Figure 28 on page 59 .)
2. Inlet to guard column (optional component)	<300 psi with acetonitrile at 0.5 mL/min	Plugged guard column	Replace guard column.
3. Inlet to precolumn filter (optional component)	<300 psi with acetonitrile at 0.5 mL/min	Plugged precolumn filter	Replace precolumn filter.

Table 32: Disconnecting fittings to troubleshoot high system pressure

Fitting location	Expected pressure reading ^a	Possible cause if pressure is OK	Action
4. Inlet to pre-heater tube (injection valve outlet)	<300 psi with acetonitrile at 0.5 mL/min	Plugged preheater tube	Replace preheater tube.
5. Injection valve: Ensure valve is in load position (this takes needle and seal offline).	<300 psi with acetonitrile at 0.5 mL/min	Problem with needle, seal extension tube, or needle extension loop (optional component)	1. Replace needle and seal. 2. If problem persists, replace seal extension tube.
6. Inlet to SM-FTN injection valve	<300 psi with acetonitrile at 0.5 mL/min	Blocked injection valve cartridge	Replace the injection valve cartridge. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information .
7. Solvent manager mixer outlet	<300 psi with acetonitrile at 0.5 mL/min	Blocked pump outlet tube	Replace pump outlet tube.
	<300 psi with acetonitrile at 0.5 mL/min	QSM high pressure	Troubleshoot QSM high pressure. See Solvent manager high pressure , page 96.

a. See backpressure calculation formula in [Column Pressure and Solvent Viscosity](#).



Low system pressure

To troubleshoot low system pressure, see [Troubleshooting low or erratic system pressure, page 62](#).

Erratic system pressure

This symptom category contains two sections:

- [Diagnosing erratic system pressure, page 61](#)
- [Troubleshooting low or erratic system pressure, page 62](#)

Diagnosing erratic system pressure

To successfully troubleshoot erratic system pressure, you must first accurately identify the problem:

1. Know the symptoms (see [Symptoms, page 61](#))
2. Verify by testing (see [Testing, page 61](#))
3. Correctly interpret pressure traces

Symptoms

Symptoms of erratic system pressure include:

- Abnormal pressure trace
- Inconsistent pressure from run to run
- Unsteady flow from waste line
- Pulsations in system pressure

Testing

A simple test can help diagnose erratic system pressure:

1. Run 100% acetonitrile for two minutes, or for the amount of time in which you would expect the pressure anomaly to occur.
2. Check system pressure. If pressure changes exceed 50 psi, system pressure is considered to be erratic.

Troubleshooting low or erratic system pressure

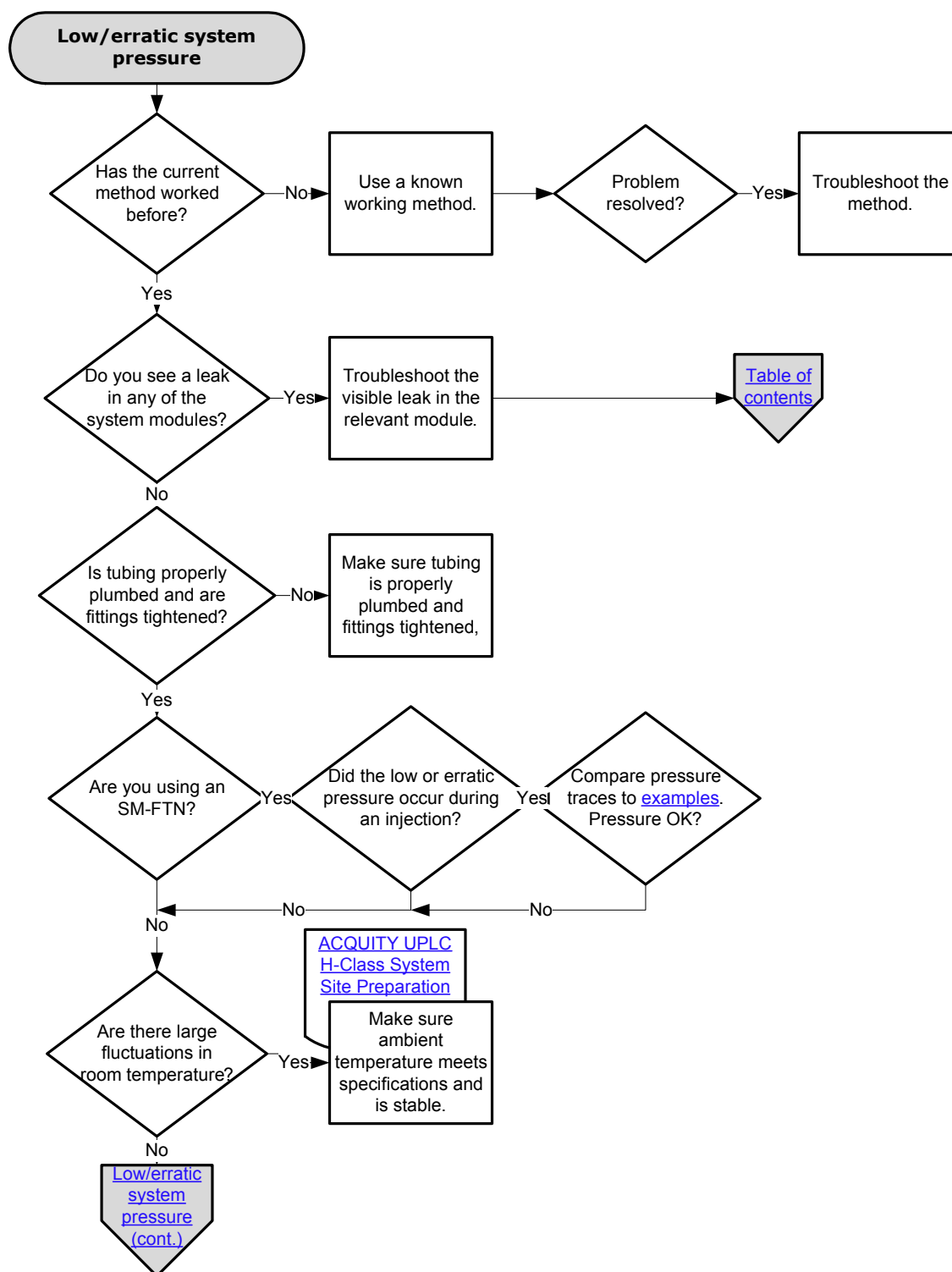


Figure 29 - Troubleshooting low/erratic system pressure

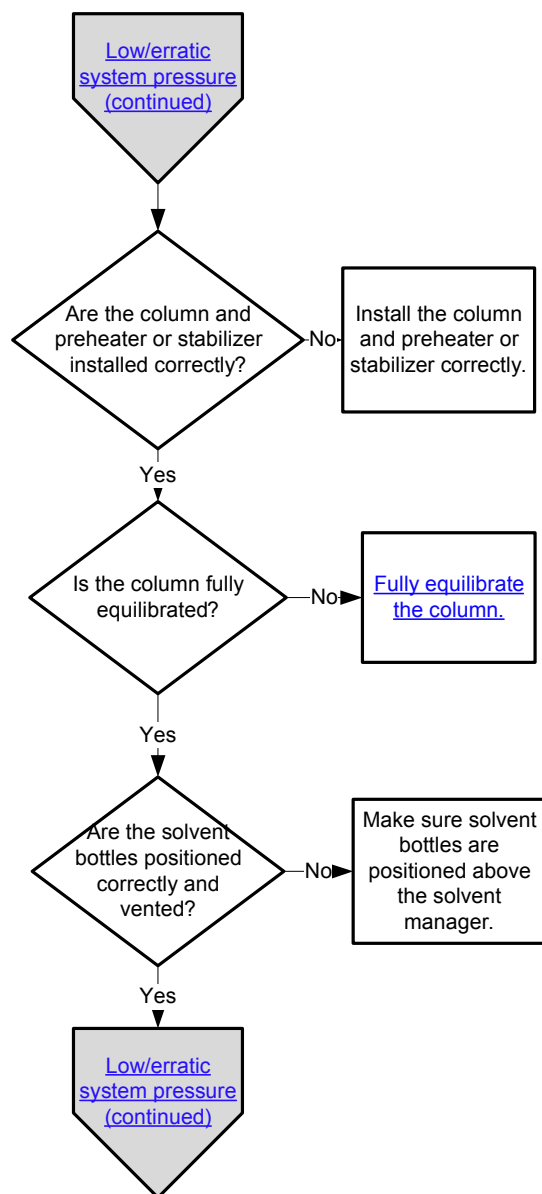


Figure 30 - Troubleshooting low/erratic system pressure (2)

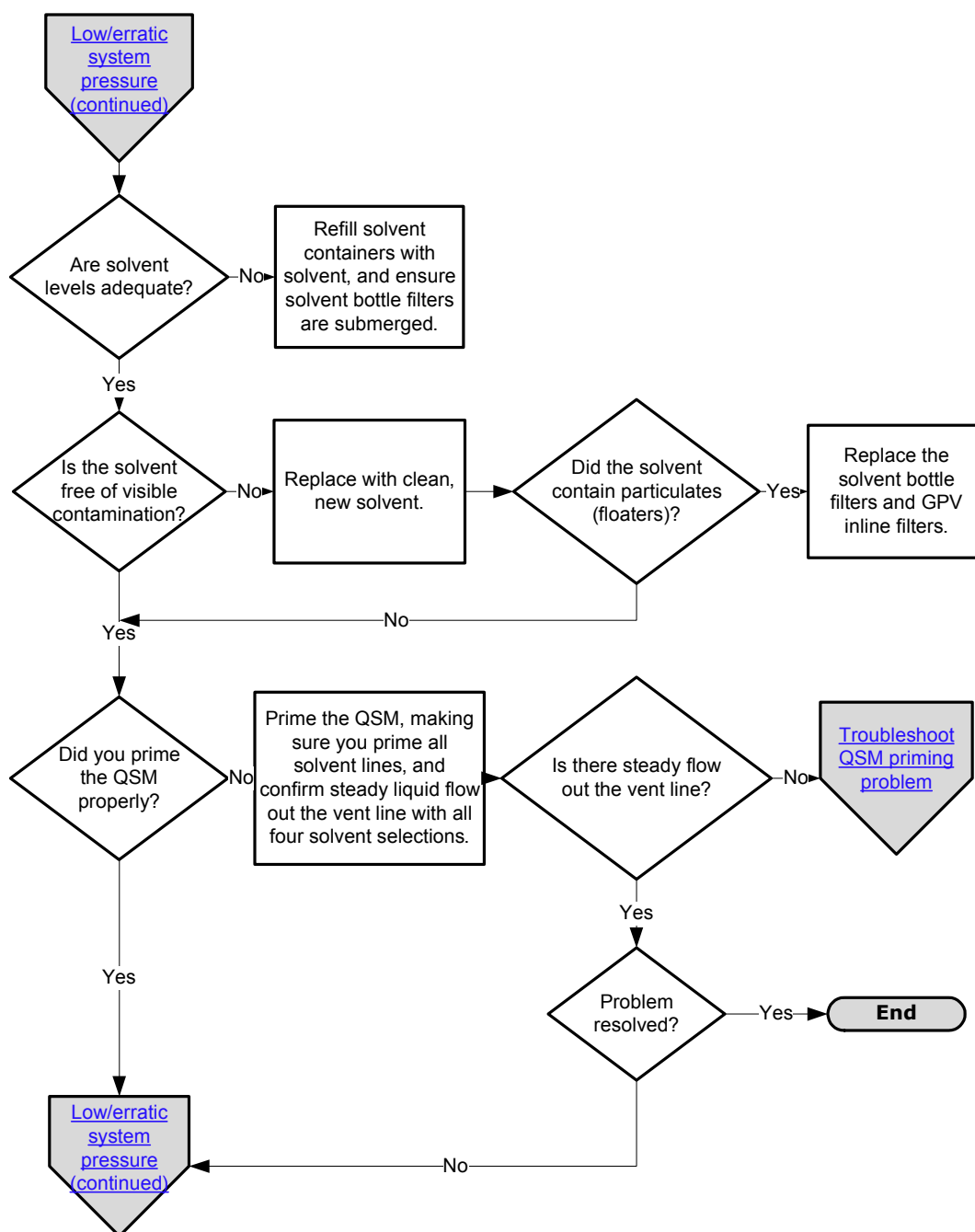


Figure 31 - Troubleshooting low/erratic system pressure (3)

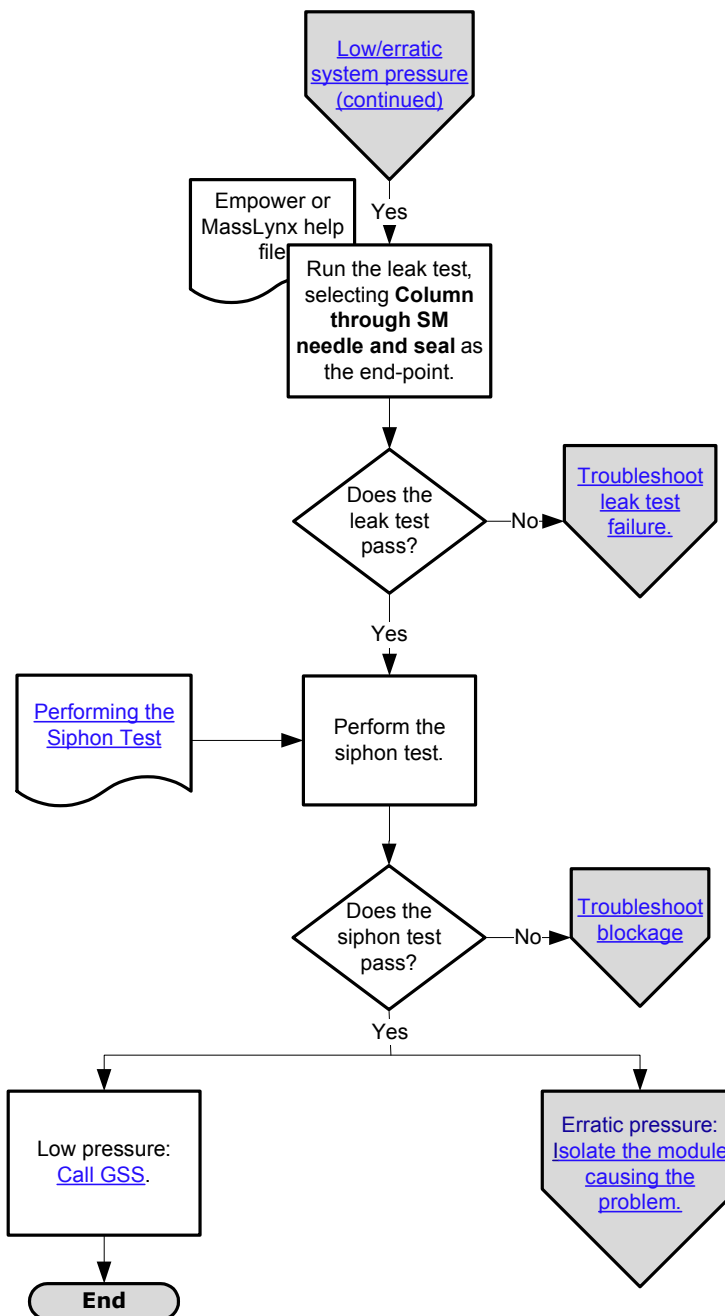


Figure 32 - Troubleshooting low/erratic system pressure (4)

Isolating the module causing erratic system pressure

After eliminating system-level causes, isolate the module causing erratic system pressure. Beginning at the pump and working *downstream* (i.e., in the direction of flow), replace the outlet tube of each module with a restrictor and test the pressure (see [Figure 33](#)). Follow the procedure outlined in Table 33 on 66.

NOTE: In each step:

- Run the same method that was used when the problem occurred.
- Use a flow restrictor adjusted to produce the expected system pressure, and route the output to waste.

Table 33: Using a restrictor to troubleshoot erratic system pressure

Restrictor location	Possible cause if pressure still erratic	Action
1. Solvent manager mixer outlet	QSM erratic flow rate/pressure pulsations	Troubleshoot Solvent manager low or erratic flow rate/pressure pulsations , page 98.
2. Injection valve port 6	SM-FTN erratic pressure	Sample manager erratic pressure , page 126.
3. Active preheater outlet NOTE: Make sure the preheater is at temperature and the temperature is stable.	Defective preheater tube	Replace the preheater tube and retest pressure.
	Column heater temperature unstable	Troubleshoot "column heater unstable" in Troubleshooting the Column Heater .
4. Outlet to column NOTE: Make sure the column is equilibrated and the column temperature is stable. If you are running a column temperature, turn the column temperature off.	Defective column	Replace the column. See the appropriate column care and use guide .
Components beyond the column	Component downstream of restrictor	Replace component as necessary.

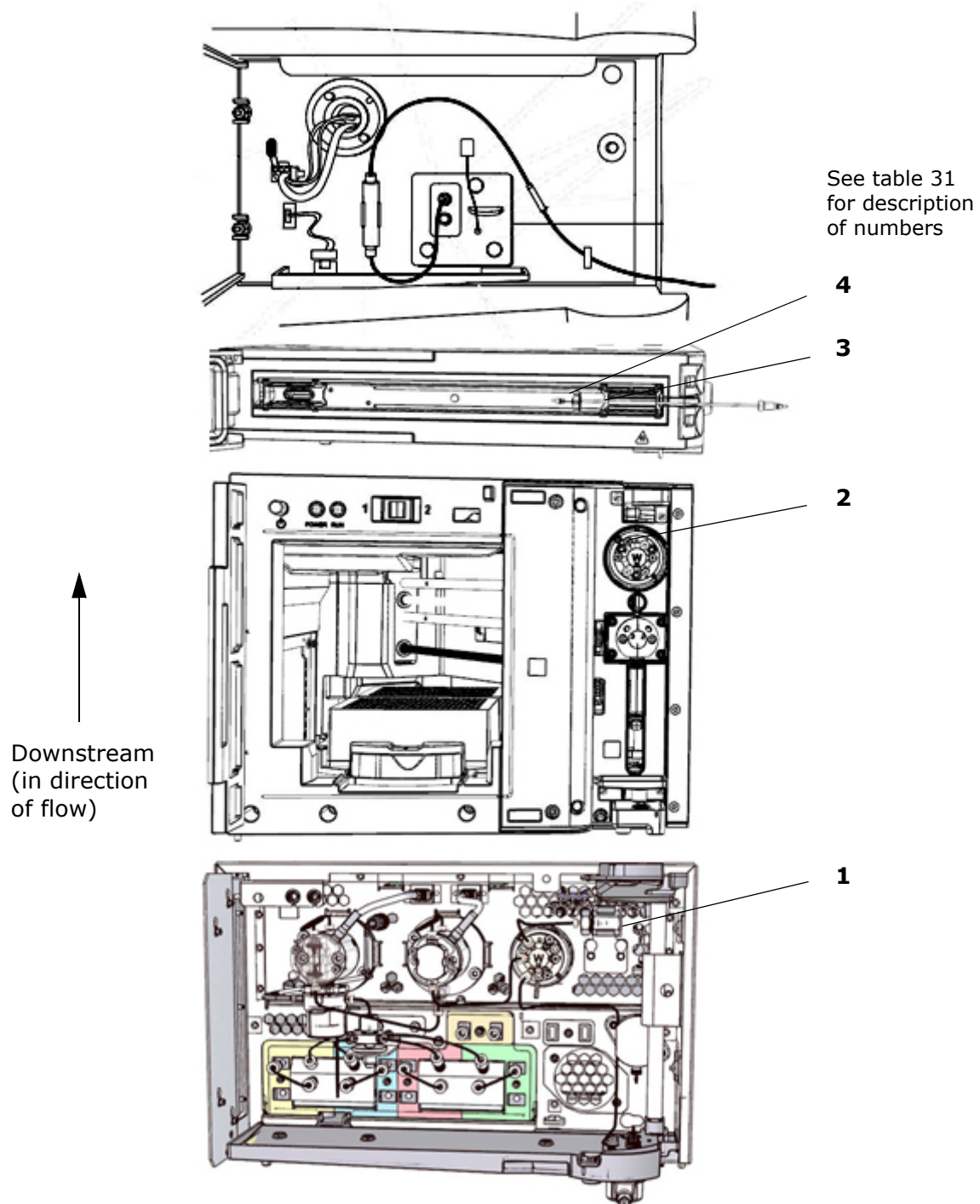


Figure 33 - Restrictor locations for isolating module causing erratic system pressure

System reference information

This section outlines reference information useful for troubleshooting ACQUITY UPLC H-Class or H-Class Bio systems:

- [Checklist of good troubleshooting practices](#)
- [Troubleshooting tools, page 69](#)
- [Method transfer, page 70](#)
- [Equilibrating the column, page 71](#)
- [Measuring capacity factor \(\$k_1\$ \), page 71](#)
- [Measuring selectivity, page 73](#)
- [Measuring plate count, page 75](#)
- [Measuring extra-column bandspreading of the system, page 76](#)
- [Recommended column and tubing diameters, page 79](#)
- [Assembling fittings, page 80](#)

NOTE: For more information, see [ACQUITY UPLC H-Class/H-Class Bio Key Documents](#) on the Portal.

Checklist of good troubleshooting practices

[Table 34](#) recommends some general practices when troubleshooting ACQUITY UPLC H-Class or H-Class Bio systems.

Table 34: Good troubleshooting practices

Area to check	Troubleshooting practice
Method	Ensure proper method assignment, and eliminate unintended modifications.
System	Routinely check the system for leaks.
	Practice cleanliness when changing solvents, cleaning flow cells, and mixing samples.
Detectors	Periodically check the calibration, noise, and drift performance of the detectors.
Column compartment	Handle the active pre-heater properly and with care when installing or replacing columns.
Ambient temperature	Minimize changes in ambient temperature.
Solvents	Use high-grade solvents.
	Consider solvent viscosity when changing flow rates, pressure, and baseline drift.
	When changing from mutually interfering but immiscible solvents, flush the system twice with a solvent that is miscible with both old and new solvents. When changing from an aqueous salt solution to heptane, flush first with water and then with acetone or IPA. Then rinse with hexane once before filling. The reverse applies when changing organics to salt solutions.
Fittings	Do not overtighten fittings, especially if PTFE.
Pressures	Record and monitor the pressures for any given column application.

Troubleshooting tools

When troubleshooting ACQUITY UPLC H-Class systems, use the following tools:

- [System verification tests, page 69](#)
- [Diagnostic tools, page 69](#)
- [Service key documents, page 69](#)
- [Waters Prep Calculator, page 69](#)
- [Global Service and Support, page 69](#)

System verification tests

One of the steps in a general strategy for troubleshooting systems is to compare the system to established benchmarks. In the ACQUITY UPLC system, the key benchmarks are the results of the system verification tests run just after installation of the system - specifically, the system precision and gradient performance tests (see the [ACQUITY UPLC H-Class System with SQD/3100 or TQD System Performance Test](#)). When you believe there is a problem, rerun these tests to narrow down causes.

Diagnostic tools

The ACQUITY Console contains useful diagnostic tools:

- The binary solvent manager, sample manager, and TUV detector *interactive displays* map out the proper fluidic connections.
- The *column usage* function stores key historical data about a column's usage, such as date started, sample set run, user name, and number of injections.
- *Plots* collect up to 96 hours of real-time system usage and performance. Plots obtained under optimal conditions can be compared with plots taken when a problem occurs.
- *Service profiles* store detailed information about the system, such as ICOP and firmware version, IP configuration, methods and samples (for MassLynx), and Registry settings.
- *Serial numbers* create individual log entries for each module so that you can review the usage history of that particular module.

When you are unable to access the Console or need more information about an error message or initialization problem, use HyperTerminal (for instructions, see [Using Telnet, HyperTerminal, and Ping](#)).

Service key documents

Find all essential ACQUITY UPLC information easily with [ACQUITY UPLC H-Class Service Key Documents](#), available in the Service Knowledge Center in the Portal.

Waters Prep Calculator

The [Waters Prep Calculator](#) performs common calculations related to scaling separations and optimizing tubing.

Global Service and Support

If you have followed the recommendations in this manual and still need help, call [Global Service and Support \(GSS\)](#).

Method transfer

When you transfer a method from HPLC to UPLC, you can optimize the method for one of the following objectives.

- Maintain or improve selectivity and resolution of the original HPLC separation.
- Increase speed to achieve higher throughput and productivity while maintaining resolution.
- Improve resolution without requiring longer run times.

Successful method transfer requires consideration of:

- column chemistry and dimensions
- system volumes and configurations
- injection volumes
- analyte molecular weights
- gradient profiles

The ACQUITY UPLC Columns Calculator automates the scaling calculations that are required to convert isocratic or gradient HPLC methods to UPLC methods.

Requirements

- Waters columns are used.
- HPLC separation is reasonable and valid.
- HPLC chromatographic conditions are known and accurate (for example, column temperature).
- Mobile phases, gradient curves, and samples remain unchanged between HPLC and UPLC.
- A binary gradient is used.
- HPLC and UPLC column stationary phase selectivities are similar.

Equilibrating the column

1. Equilibrate the column heater for at least 30 minutes before starting a run.
2. Pump a minimum of 3x system volume (150 μ L) and 5x column volume of initial mobile phase through to column for chemical equilibration (i.e., *column equilibration time* = (system volume $\times$ 3) + (column volume $\times$ 5) / flow rate) – injection cycle time).
3. When the column is fully equilibrated chemically and thermally, the system pressure will be steady with a delta psi on the Console of <20 psi. If pressure is drifting, the column is not fully equilibrated.

CAUTION: TO AVOID ACCUMULATING UNWANTED CONTAMINANTS ON THE COLUMN, DO NOT EQUILIBRATE FOR HOURS.

Table 35 gives some column equilibration times. For more information, see the [ACQUITY UPLC H-Class System Quick Reference Card](#) or the [ACQUITY UPLC BEH Column Care and Use Manual](#).

Table 35: Column equilibration times

Column ID (mm)	Column length (mm)	Column volume (mL)	5x volume (mL)	Flow rate (mL/min)	Equilibration time (minutes)
4.6	250	4.15	20.76	1.00	21.2
3.9	150	1.79	8.95	1.00	9.4
3.9	50	0.60	2.98	1.00	3.4
3.9	20	0.24	1.19	1.00	1.6
2.1	150	0.52	2.60	1.00	3.1
2.1	100	0.35	1.73	1.00	2.2
2.1	50	0.17	0.87	1.00	1.3
2.1	30	0.07	0.35	1.00	0.8
1.0	100	0.08	0.39	0.10	8.4
1.0	50	0.04	0.20	0.10	6.5

Measuring capacity factor (k^1)

Troubleshooting capacity factor (k^1)

Capacity factor (k^1) is a measurement of the retention time of a sample molecule, relative to column dead volume (V_0). Use this for troubleshooting retention time problems.

NOTE: Measure V_0 using a probe molecule that is unretained by the column under standard test conditions. Consult your column operator's manual for the appropriate probe molecule to use.

Capacity factor (k') changes are typically due to:

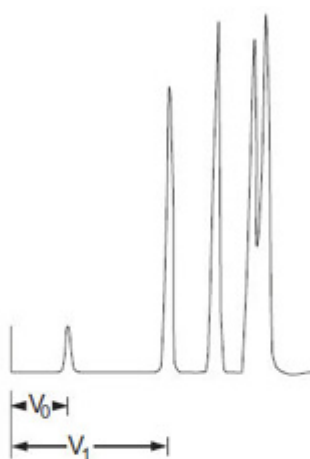
- Variations in mobile phase composition
- Changes in column surface chemistry (due to aging)
- Changes in operating temperature.

In most chromatography modes, capacity factor (k') changes by 10 percent for a temperature change of 5° C.

Calculating capacity factor

Capacity factor, or retention factor, is a measure of the time the sample component resides in the stationary phase relative to the time it resides in the mobile phase.

Use the equation in [Figure 35](#) to compute capacity factor (k').



$$k' = \frac{V_1 - V_0}{V_0}$$

Where:

k' = Capacity factor of the column

V_0 = Void volume (or dead volume) of the column (volume at which an unretained component elutes)

V_1 = Retention volume of peak 1

Figure 34 - Calculating capacity factor

For example, if:

- $V_0 = 2.90$ mL
- $V_1 = 9.75$ mL

Then:

$$k' = \frac{9.75 - 2.90}{2.90} = 2.36$$

Adjusting capacity factor

Good isocratic methods usually have a capacity factor in the range of 2 to 10 (typically between 2 and 5). Lower values may give inadequate resolution. Higher values are usually associated with excessively broad peaks and unacceptably long run times.

If the analytes fall outside their specified windows, run the initial column test protocol to compare the results with those obtained when the column was new.

Capacity factor values are sensitive to the following change in conditions:

- Solvent strength, composition, and purity
- Temperature
- Column surface chemistry
- Sample

If the shift in capacity factor value is observed with both analytes and the column test solution, the problems is most likely due to a change in the column, temperature, or mobile phase composition. This is particularly true if the shift occurred gradually over a series of runs. If, however, the test mixture runs as expected, the problem is most likely sample-related.

From these possible causes, refer to your system benchmark comparison to evaluate the origin of the problem. For example, check the following:

- Mobile phase composition (is it correct?)
- Operating temperature (has it changed?)
- Age of the column

Measuring selectivity

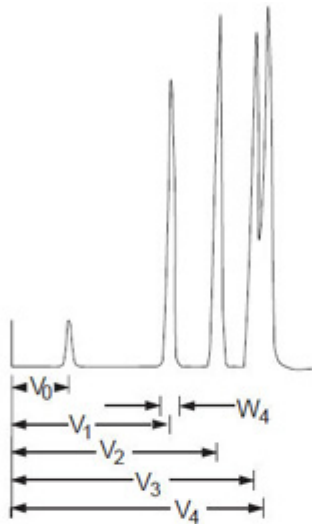
Troubleshooting selectivity

Selectivity (α), or separation factor, is the relative retention of two peaks in a chromatogram (the ratio of two k' values). You can recognize problems in your separation due to selectivity (α) changes when some peaks move significantly relative to other peaks.

Usually, you can control selectivity in LC systems by varying the "chemistry" of the system, such as mobile phase (pH, salt strength, organic solvent and composition type, or modifier type) or type of column.

Calculating selectivity

Use the equation in [Figure 35](#) to compute selectivity (α).



$$\alpha = \frac{k'_2}{k'_1} = \frac{V_2 - V_0}{V_1 - V_0}$$

Where:

α = Relative retention

k'_1 = Capacity factor for V_1

k'_2 = Capacity factor for V_2

V_0 = Void volume (or dead volume) of the column (volume at which unretained component elutes)

V_1 = Retention volume of peak 1

V_2 = Retention volume of peak 2

Figure 35 - Calculating selectivity

For example, if:

- $V_1=9.75$ mL
- $V_2=12.80$ mL
- $V_3=15.20$ mL
- $V_4=16.00$ mL

$$\alpha_{V_1, V_2} = \frac{12.8 - 2.9}{9.75 - 2.9} = 1.45$$

$$\alpha_{V_3, V_4} = \frac{16.0 - 2.9}{15.2 - 2.9} = 1.06$$

Adjusting selectivity

When troubleshooting changes in selectivity, use an approach similar to the approach used to troubleshoot changes in capacity factor.

When selectivity is affected, the corrective action depends on whether the problem is related to mobile phase or to column.

Be sure to compare results obtained with the test solution to those observed when the column was new. Use these results to distinguish column changes from problems with mobile phase or other operating parameters.

Selectivity values are sensitive to changes in the following conditions:

- Mobile phase composition (pH, ionic strength) and purity
- Age of column
- Temperature

Rerun your test solution and compare the results. From the possible causes listed above, evaluate the origin of the problem.

Measuring plate count

Plate count, or column efficiency (N), is a measure of the bandspreading of a peak (see [Measuring extra-column bandspreading of the system, page 76](#)). The smaller the bandspread, the higher the number of theoretical plates, which indicates good column and system performance. Therefore, plate count is a key indicator of column and UPLC system performance.

There are various methods for measuring plate count. The example here uses the caffeine solution for PQ as well as an equation that does not require system suitability software.

1. Set up the conditions for the UPLC system precision test. (See [ACQUITY UPLC H-Class System with SQD/3100 or TQD System Performance Test \("System precision test"\)](#)).
2. Set the flow rate to 0.4 mL/min using 90:10 water:acetonitrile, and equilibrate.
3. Set the detector wavelength at 273 nm, with a data rate of 10 pts/second with fast time constant.
4. Inject 1 μ L caffeine solution (0.10 mg/mL) and run for 1 minute.

Determine plate count using the equation in [Figure 36](#). The result will be similar but not identical to the plate count obtained using system suitability software.

$$N = 2\pi \left(\frac{\text{Retention Time} \times \text{Peak Height}}{\text{Peak Area}} \right)^2$$

Figure 36 - Measuring plate count

where:

retention time is expressed in seconds for Empower and in minutes for MassLynx.

Measuring extra-column bandspreading of the system

Extra-column bandspreading (also called band broadening or peak dispersion) is the broadening of peaks as they flow through the extra-column volume of the system (see [Figure 37](#)).

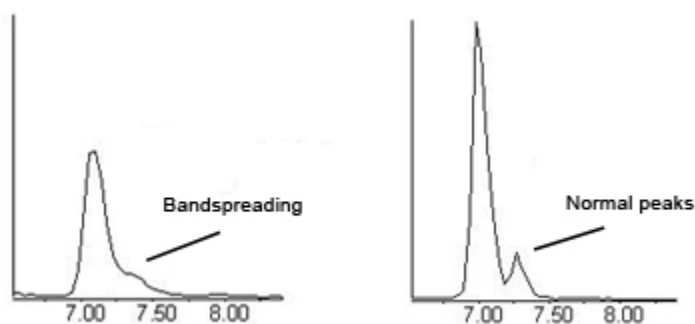


Figure 37 - Bandspreading example

It is caused by collective hydrodynamic effects outside of the packed bed on the flowpath between the injector and detector cell¹ (see [Figure 38](#)).

1. Patrick McDonald, with Uwe Neue, *The Quest for Ultra Performance in Liquid Chromatography*, Waters, 2009.

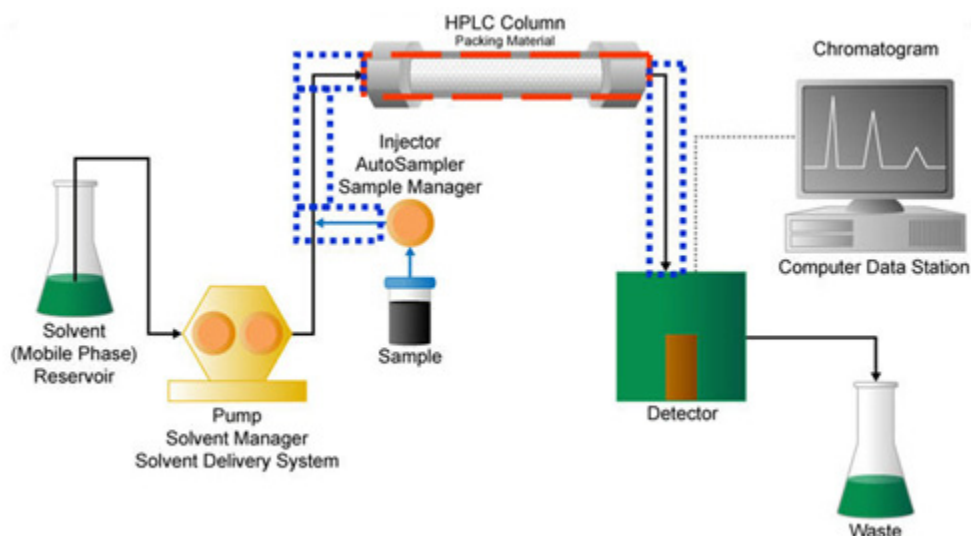


Figure 38 - Flowpath where extra-column bandspreading occurs (blue dots)

Perform a system bandspreading measurement to determine if low column efficiency is due to degraded system performance. If system bandspreading has increased, this allows you to start isolating the hardware problem to such areas as the injector, detector, or tubing (ID, length, and so on).

This procedure illustrates measuring system bandspreading at a peak width of 4.4 percent of the peak height (in μL).

Chemicals needed

- Methanol: Fisher Scientific, A454-4 or equivalent
- Propylparaben: Sigma Chemical, P3255 or equivalent

Sample preparation

To prepare the propylparaben stock:

1. Label a 20-mL scintillation vial "Propylparaben stock - 1mg/mL in methanol," along with the preparer's name and initials.
2. Weigh out 0.0100 ± 0.0004 g (10 mg) of propylparaben.
3. Using a 5-mL autopipette, place 10 mL methanol into the vial and mix well.

To prepare 2.5 $\mu\text{g/mL}$ of propylparaben sample:

1. To a 20-mL scintillation vial, add in 50 ± 1 μL of propylparaben stock using a 100- μL autopipette.
2. Add 19.95 mL of methanol.
3. Label the vial "2.5 $\mu\text{g/mL}$ propylparaben injector linearity sample". Add the preparer's initials and disposal date and store in the refrigerator until ready to use.

To measure extra-column bandspreading:

1. Place all solvent lines in 100% methanol (fresh, degassed). Prime all pump lines for 10 minutes and purge the wash and sample syringes for at least 5 cycles.
2. Connect the column inlet capillary with no column inline directly to the detector inlet capillary using an ACQUITY zero dead volume union.
3. Configure the system to the parameters in [Table 36](#).

Table 36: Parameters for measuring extra-column bandspreading

Parameter	Setting
Flow rate	1.0 mL/min
Column heater set temperature	Off
Wavelength	254 nm
Runtime	0.5 min
Sampling rate	40 points/sec
Filter	None
Air gaps	Automatic
Wash solvents	Same as mobile phase
Wash solvent time	6 secs
Syringe draw rate	Automatic

4. Equilibrate the system for 10 minutes at 1.0 mL/min.
5. Make 3 injections of the blank methanol sample using a 1.0-μL injection volume.
6. Make 5 injections of the 2.5 μg/mL propylparaben sample at 1.0 μL.

Results/calculations

1. Calculate the %RSDs of peak widths measured at 4.4% peak height.
2. Calculate the system bandspreading (in volume unit) using the average peak width measured at 4.4% peak height according to the following formula:

$$\text{Bandspread } (\mu\text{L}) = \text{peak width at 4.4\% (in cm) of peak height (min)} \times \text{flow rate (mL/min)} \times 1000.$$

[Table 37](#) shows the test specifications.

Table 37: Specifications

Test	Test parameter	Specification
Extra-column bandspreading of the system	Extra-column bandspreading (μL)	<15 μL

Recommended column and tubing diameters

Table 38 lists recommended column and tubing diameters for HPLC and UPLC flow rates. Figure 40 illustrates the proper way to install tubing in order to avoid creating a gap at the end.

Table 38: Recommended column and tubing diameters for HPLC/UPLC flow rates

HPLC Flow Rate (mL/min)	UPLC Flow Rate (mL/min)	Column ID (mm)	Tubing ID (inch)	PEEK Tubing Color
1.0 to 2.0	NA	4.6	0.01	Blue
			0.007	Yellow
1.0	NA	3.9	0.007	Yellow
0.20-0.30	0.20 - 1.20	2.1	0.005	Red
			0.004	Black
0.05 - 0.10	0.05 - 0.12	1	0.004	Black
			0.0025	Tan ^a

a. To avoid backpressure that can damage a flow cell, do not use tan PEEK tubing in a PDA detector.

Assembling fittings

The system uses gold-plated compression screws and two-piece ferrules. See [Figure 39](#) for assembly orientation.

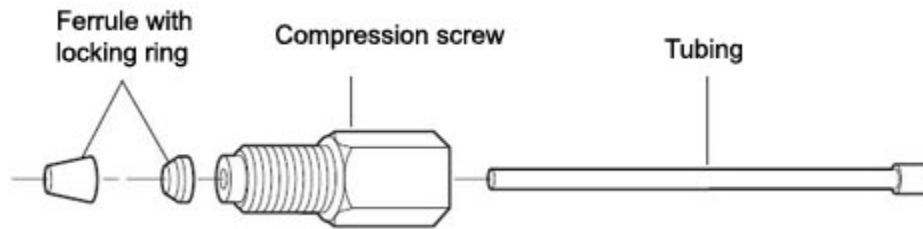


Figure 39 - Assembling a fitting

To prevent bandspreading, ensure the tubing is fully bottomed in the fitting hole before tightening the compression screw (see [Figure 40](#)).

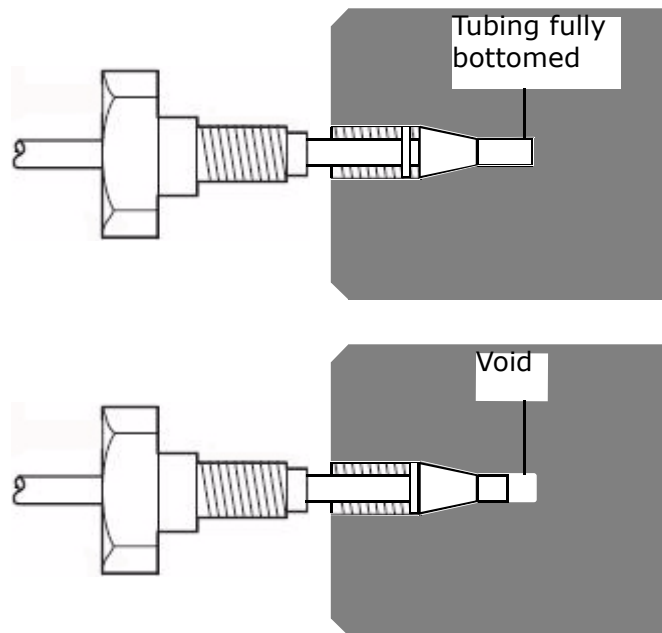


Figure 40 - Seating the tubing correctly

Additional recommendations:

- For easier accessibility, use long compression screws to attach tubes to the injector and vent valve.
- Perform the solvent manager leak test whenever you replace or loosen fittings during maintenance.
- Whenever you loosen fittings during maintenance, examine for cracks, stripped threads, and deformations.
- Do not reuse stainless steel fittings more than six times.

Chapter 2: Troubleshooting Solvent Manager Symptoms

This section outlines troubleshooting for the ACQUITY UPLC System quaternary solvent manager, or QSM (hereafter referred to as the solvent manager).

To begin troubleshooting, click the topic corresponding to your symptom:

- [Solvent manager abnormal LED status, page 82](#)
- [Solvent manager errors, page 163](#)
- [Solvent manager fluidics problems, page 84](#)
- Solvent manager software/communications problem (see [Troubleshooting Empower Software/Communications Problems](#)).
- [System pressure problem, page 58](#)

NOTE: Before troubleshooting the solvent manager, make sure you have eliminated system-level causes first (see [Troubleshooting System-level Symptoms, page 2](#)).

NOTE: For more information on solvent manager problems, see [Solvent manager reference information, page 103](#).

Solvent manager abnormal LED status

Power LED

The power LED, on the left side of the instrument's front panel, indicates the power-on or power-off status of the instrument. This LED is green when power is on and unlit when power is off.

Flow LED

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

NOTE: For more information on troubleshooting electronic problems, see PCB technical references in [QSM Reference Information](#), located in the Portal.

Table 39: BSM Troubleshooting: abnormal LED status

Symptom	Possible Cause	Action
Power LED is unlit	Pump not powered on	Turn on power to the pump.
	Power supply defective	1. Check power supply voltages with a voltmeter. 2. Tighten connection, or replace cable or wiring. 3. If necessary, replace the power supply. (See Replacing the Binary Solvent Manager Power Supply.)
	Power supply fan defective	Replace fan or power supply. (See Replacing the Binary Solvent Manager Power Supply.)
Flow LED is unlit	Solvent manager idle	Normal operation; no action necessary.
Flow LED is flashing green	Solvent manager initializing	No action necessary.
Flow LED is steady green	Solvent manager flowing	No action necessary.
Flow LED is flashing red	A serious error stopped solvent manager operation	To view the error, go to Console > Logs. To troubleshoot the specific error message, see Solvent manager errors, page 163 .

Table 39: BSM Troubleshooting: abnormal LED status (continued)

Symptom	Possible Cause	Action
Flow LED is steady red	A serious failure within the solvent manager prevents further operation	1. Open Console > Logs and look for an error message; if appropriate, troubleshoot the error message. 2. If problem persists, recycle power to the solvent manager. 3. If problem persists, connect an R232 cable and look for the error message in HyperTerminal. If problem persists, contact GSS. Make sure you have the HyperTerminal error text available.

Solvent manager fluidics problems

Fluidics problems include:

- Priming failure (solvent prime or seal wash prime)
- Leak test fails
- Solvent manager pressure problem
- Solvent manager visible leaks

To begin troubleshooting *any* fluidics problem, follow the steps diagrammed in [Figure 41](#).

NOTE: For more information on troubleshooting solvent manager fluidics problems, see [Solvent manager reference information](#) > [Solvent manager diagrams, page 103](#).

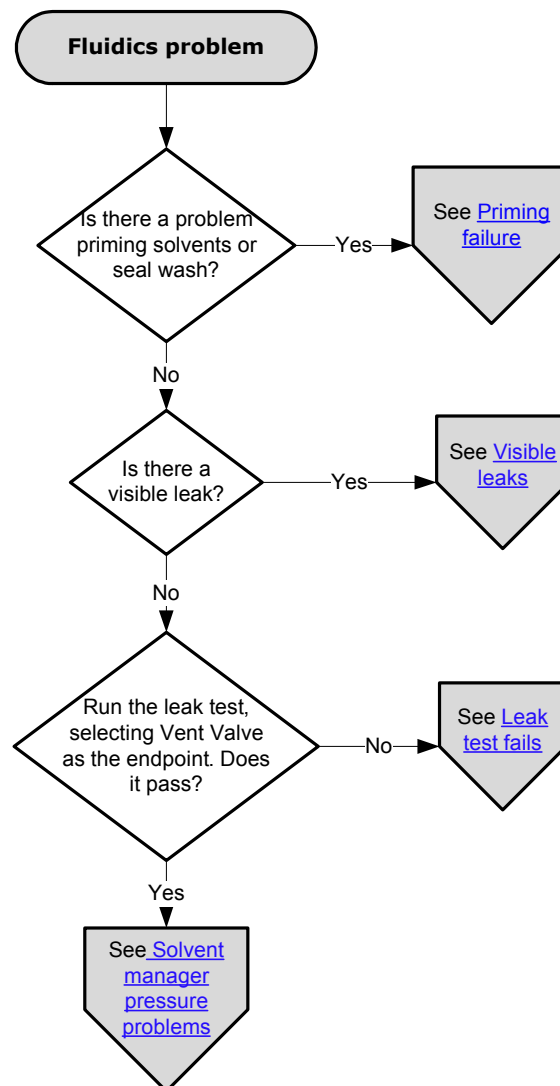


Figure 41 - Troubleshooting a solvent manager fluidics problem

Priming failure

Solvent priming failure: An inability to get steady flow out of the vent line during the prime procedure. This problem can cause low or erratic system pressure, as well as other symptoms. To troubleshoot, see [Figure 43 on page 86](#).

Seal wash priming failure: An inability to get liquid out of the seal wash bottle line during the seal wash prime. To troubleshoot, see [Troubleshooting a seal wash prime failure, page 87](#).

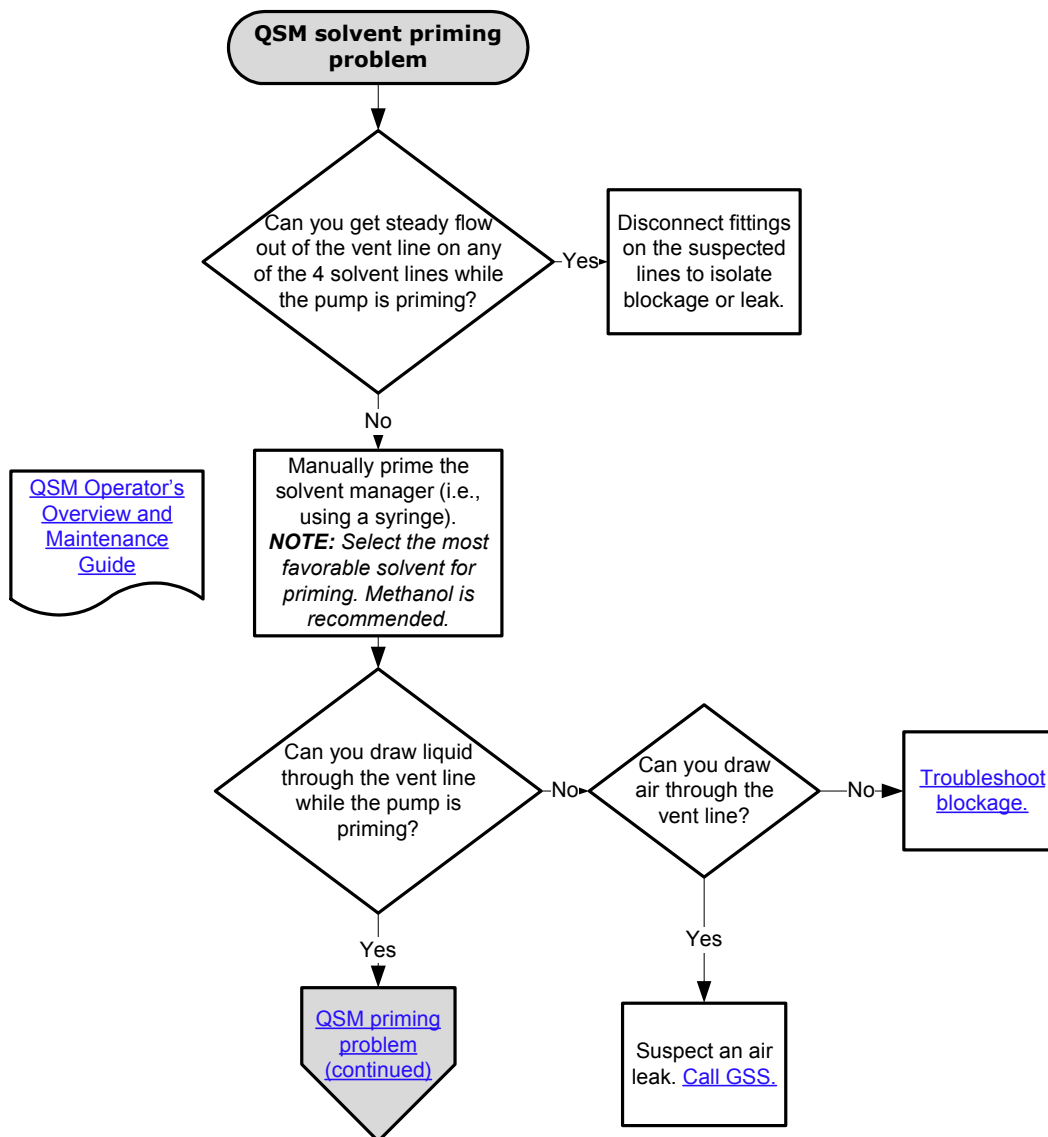


Figure 42 - Troubleshooting a priming problem

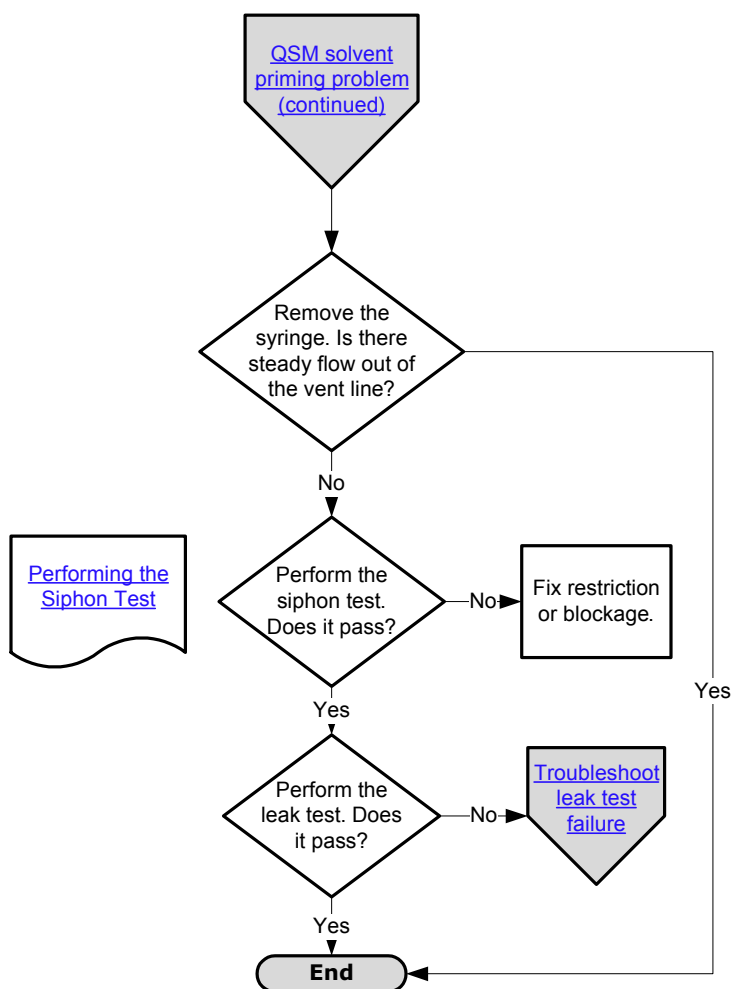


Figure 43 - Troubleshooting a priming problem (2)

Table 40: Troubleshooting a seal wash prime failure

Symptom	Possible cause	Corrective action
Seal wash priming failure	No solvent	Refill solvent containers with solvent, and make sure solvent bottle filters are submerged.
	Clog or leak in one of the seal wash lines	1. Disconnect fittings one at a time along the seal wash path, working backward to the seal wash pump. 2. Re-prime after disconnecting each fitting. Does liquid come out? If yes, replace the component after the break.
	Clog or leak in the inlet line	Fix clog or replace inlet line.
	Faulty seal wash pump or electronics	Can you hear the seal wash pump when priming the seal wash? If no, investigate pump or electronics.
	Clog on inlet line	1. Make sure there is solvent in the solvent bottle. 2. Check the inlet line for leak or clog.

Troubleshooting blockages

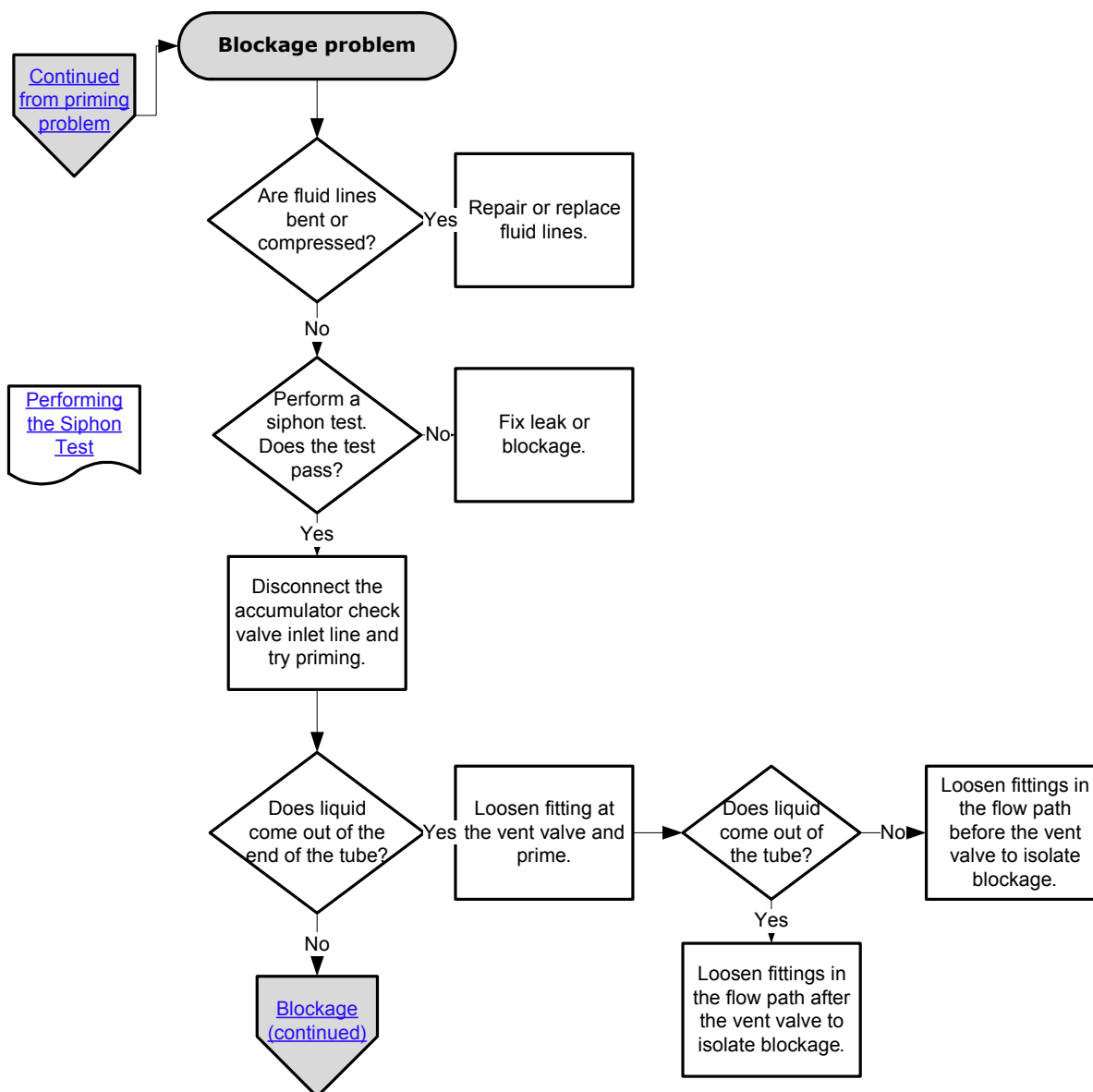


Figure 44 - Troubleshooting a blockage or restriction

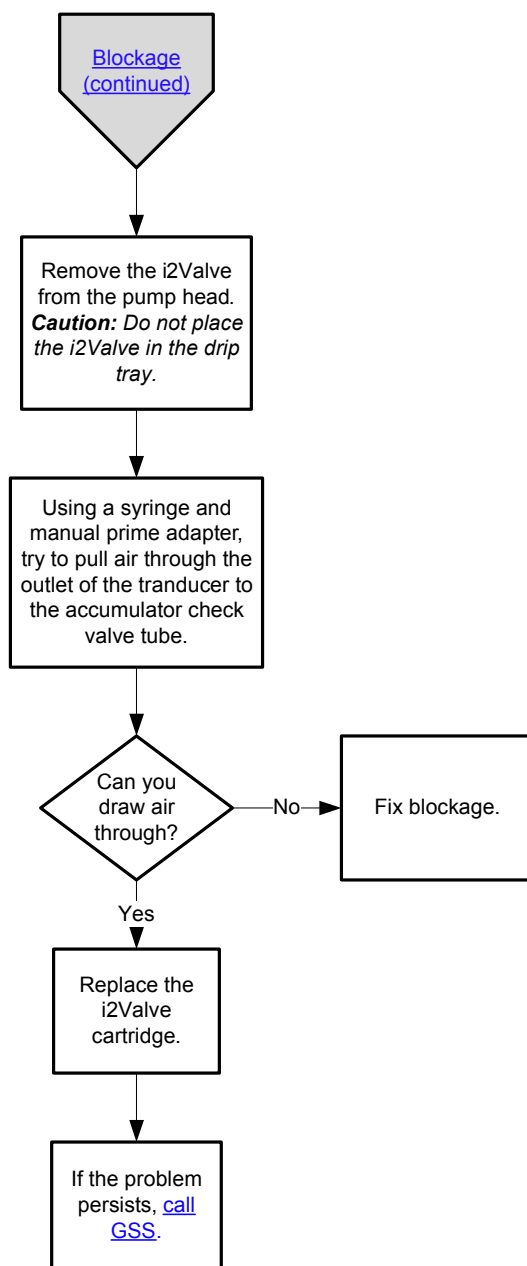


Figure 45 - Troubleshooting a blockage or restriction (2)

Leak test fails

When the leak test fails, a message appears, indicating possible causes. To troubleshoot, follow the recommendations listed in [Table 41](#).

NOTE: For additional information on the leak test, see [Leak test pass criteria, page 108](#), and [Leak test process, page 109](#).

Table 41: Troubleshooting leak test result messages

Message	Possible cause	Corrective action
Excessive back leakage during compression Primary pressure exceeded 200 psi during monitoring of accumulator leak rate.	System not fully primed	Prime with methanol and repeat the leak test.
	Accumulator check valve defective	Replace the accumulator check valve.
Excessive back leakage during Primary test Primary plunger hit bottom dead center during monitoring of primary pump leak rate	System not fully primed	Prime with methanol and repeat the leak test.
	Accumulator check valve defective	Replace the accumulator check valve.
Hardware error	A problem occurs as the leak test attempts one of the following operations: • set SSV position based on user-selected solvent • prepare cylinders • compress accumulator or primary pump • monitor accumulator or primary pump leak rate • start flow controller during compression of accumulator or primary pump • position plunger at bottom dead center during compression of accumulator or primary pump	1. Power-cycle the pump and repeat the leak test. 2. If the leak test fails again, check the Console log and troubleshoot any displayed error message.

Table 41: Troubleshooting leak test result messages (continued)

Message	Possible cause	Corrective action
Leak rate was above the acceptable limit (accumulator side)	Air in system	Re-prime the solvent manager and then repeat the leak test.
	Visible leak, or loose or defective tube or fitting	1. Check solvent manager for visible leaks. 2. Check tubes and fittings to make sure they are installed correctly. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information
	Pump head seal not properly energized	1. If you replaced the seals, run the pump at approximately 96,000 kPa (965 bar, 14,000 psi) for 30 minutes. 2. Repeat the leak test.
	Loose or defective check valve	1. Check and tighten the accumulator check valve. 2. To troubleshoot the check valve, run 100% methanol through the pump to clean the check valve. Then remove the check valve and sonicate it with 100% IPA (if running buffers, flush the valve with water first). 3. Replace the check valve if necessary.
	High-pressure plunger seal damaged	Is there flow from the seal wash effluent during the test? If yes, replace the high-pressure plunger seal, and then repeat the test.
	Plunger damaged	Replace the plunger.
	Defective pump head	Replace the pump head.
	Bad vent valve	If the test fails during the accumulator portion, replace the vent valve cartridge.

Table 41: Troubleshooting leak test result messages (continued)

Message	Possible cause	Corrective action
Leak rate was above the acceptable limit (primary side)	Air in system	Examine the solvent manager for visible leaks and then re-prime it.
	Visible leak, or loose or defective tube or fitting	1. Check solvent manager for visible leaks. 2. Check tubes and fittings to make sure they are installed correctly. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information
	A pump head seal not properly pressurized	1. If you replaced the seals, run the pump at approximately 96,000 kPa (965 bar, 14,000 psi) for 30 minutes. 2. Perform the test again. If the test still fails, investigate a different cause.
	Defective accumulator check valve	Tighten or replace check valve as necessary.
	Bad i2Valve cartridge	Replace i2Valve cartridge.
	High-pressure plunger seal damaged	Is there flow from the seal wash effluent during the test? If yes, replace the high-pressure plunger seal, and then repeat the test.
	Plunger damaged	Replace the plunger.
	Defective pump head	Replace the pump head.
Passed	Leak test passed	No action necessary.
Prime failed	Hardware error during the prime sequence (e.g., a problem with the pumping sequence or vent valve)	Check HyperTerminal for a more detailed description of the error: • Enter "nvfdump" into the command prompt to get last 10 error messages. • Troubleshoot the error displayed. See Using HyperTerminal, Telnet, and Ping.

Table 41: Troubleshooting leak test result messages (continued)

Message	Possible cause	Corrective action
Sample Manager communication error A problem occurs when QSM tells SM to switch injection valve to Load or Inject position, based on user-selected end point	Sample manager communication problem	Troubleshoot communication error. See Troubleshooting Empower Software/Communications Problems
	Sample manager in error state	Check the Console and troubleshoot any error message displayed. See Sample manager errors, page 176 .
Software error A problem occurs during attempt to set solvent composition	Software problem	Reboot the solvent manager and repeat leak test. If problem persists, call GSS .

Table 41: Troubleshooting leak test result messages (continued)

Message	Possible cause	Corrective action
Unable to compress (accumulator side) Plunger traveled more than 30% during compression of accumulator pump	Air in system	Re-prime the solvent manager and then repeat the leak test.
	Visible leak, or loose or defective tube or fitting	1. Check solvent manager for visible leaks. 2. Check tubes and fittings to make sure they are installed correctly. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information
	Pump head seal not properly energized	1. If you replaced the seals, run the pump at approximately 96,000 kPa (965 bar, 14,000 psi) for 30 minutes. 2. Repeat the leak test.
	Loose or defective check valve	1. Check and tighten the accumulator check valve. 2. To troubleshoot the check valve, run 100% methanol through the pump to clean the check valve. Then remove the check valve and sonicate it with 100% IPA (if running buffers, flush the valve with water first). 3. Replace the check valve if necessary.
	High-pressure plunger seal damaged	Is there flow from the seal wash effluent during the test? If yes, replace the high-pressure plunger seal, and then repeat the test.
	Plunger damaged	Replace the plunger.
	Defective pump head	Replace the pump head.
	Bad vent valve	If the test fails during the accumulator portion, replace the vent valve cartridge.

Table 41: Troubleshooting leak test result messages (continued)

Message	Possible cause	Corrective action
Unable to compress (primary side) Plunger traveled more than 30% during compression of primary pump	Air in system	Examine the solvent manager for visible leaks and then re-prime it.
	Visible leak, or loose or defective tube or fitting	1. Check solvent manager for visible leaks. 2. Check tubes and fittings to make sure they are installed correctly. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information
	Pump head seal not properly pressurized	1. If you replaced the seals, run the pump at approximately 96,000 kPa (965 bar, 14,000 psi) for 30 minutes. 2. Perform the test again. If the test still fails, investigate a different cause.
	Defective accumulator check valve	Tighten or replace check valve as necessary.
	Bad i2Valve cartridge	Replace i2Valve cartridge.
	High-pressure plunger seal damaged	Is there flow from the seal wash effluent during the test? If yes, replace the high-pressure plunger seal, and then repeat the test.
	Plunger damaged	Replace the plunger.
	Defective pump head	Replace the pump head.
Unable to maintain pressure Plunger hit top dead center during monitoring of accumulator or primary pump leak rate	Defective plunger and plunger seal	1. Re-prime the solvent manager. 2. Replace the plunger and plunger seal.

Solvent manager pressure problems

Solvent manager pressure problems consist of:

- [Solvent manager high pressure, page 96](#)
- [Solvent manager low or erratic flow rate/pressure pulsations, page 98](#)

Solvent manager high pressure

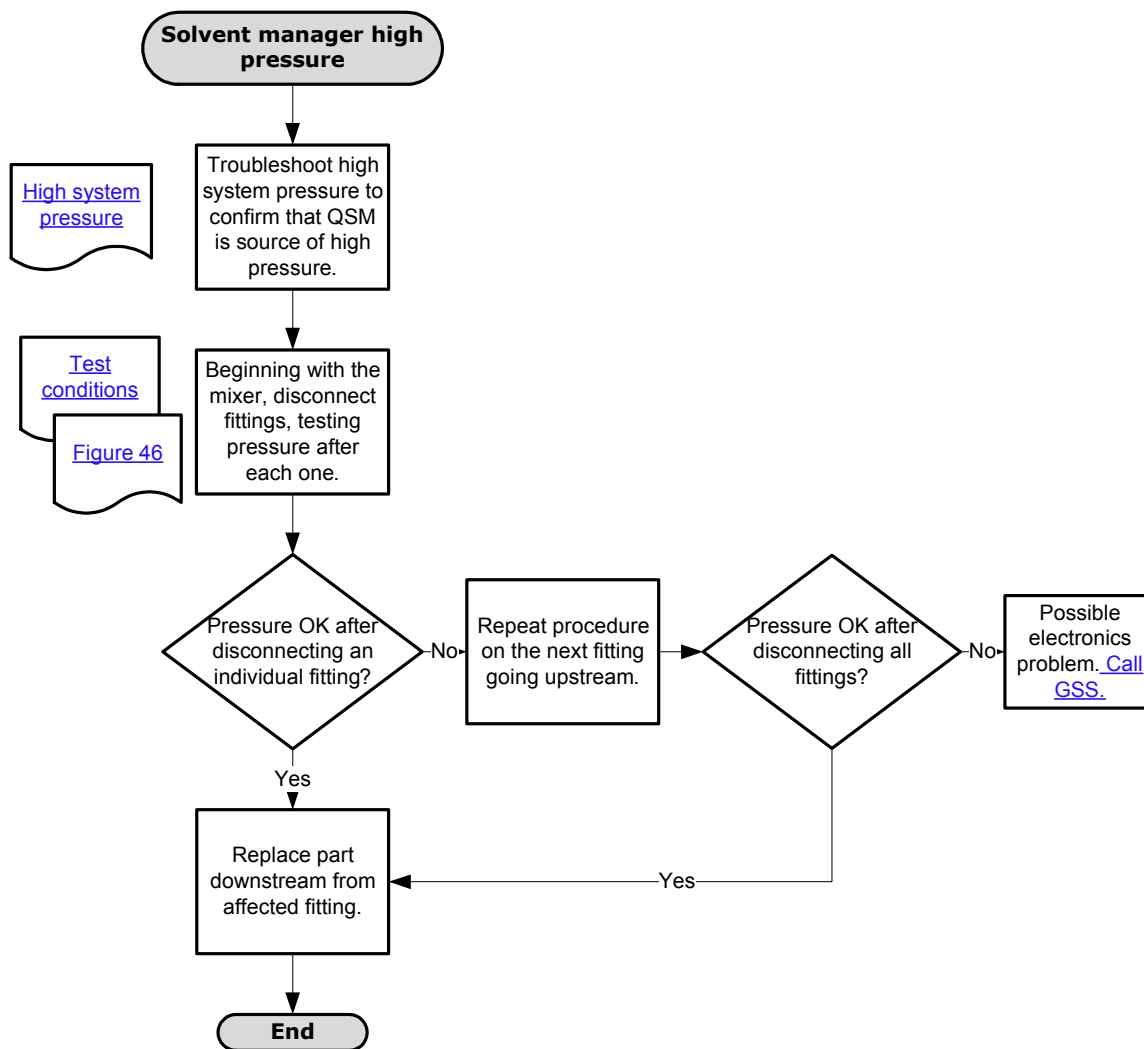


Figure 46 - Troubleshooting solvent manager high pressure

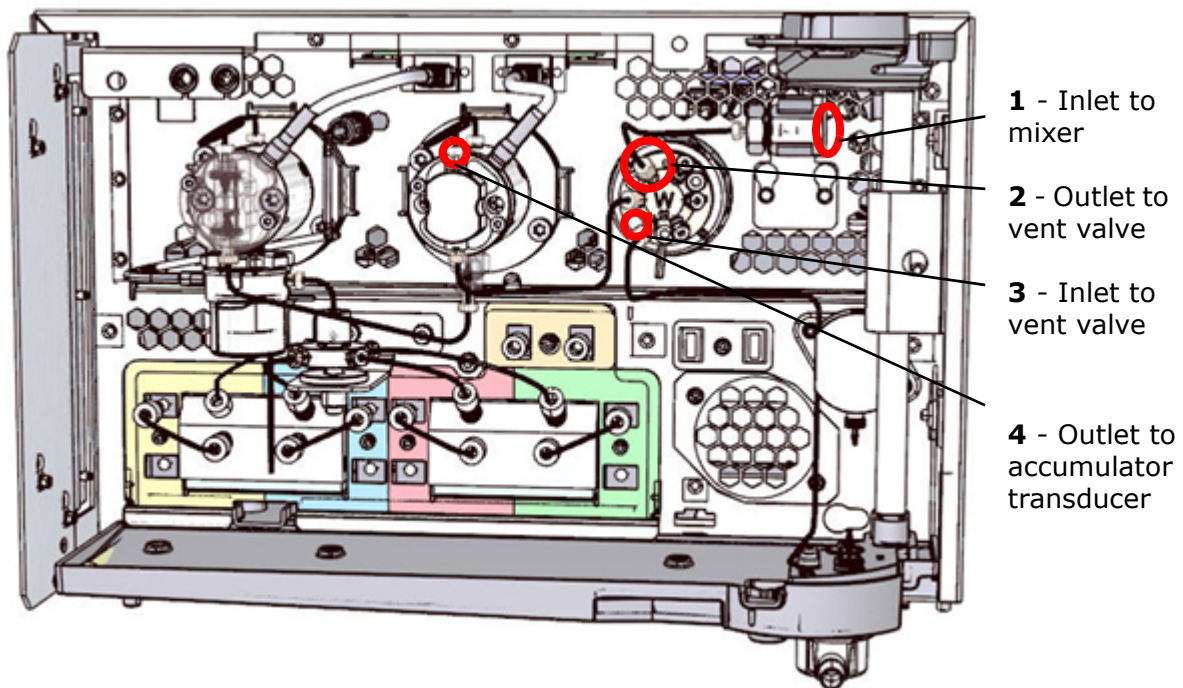


Figure 47 - QSM high pressure problem testing locations

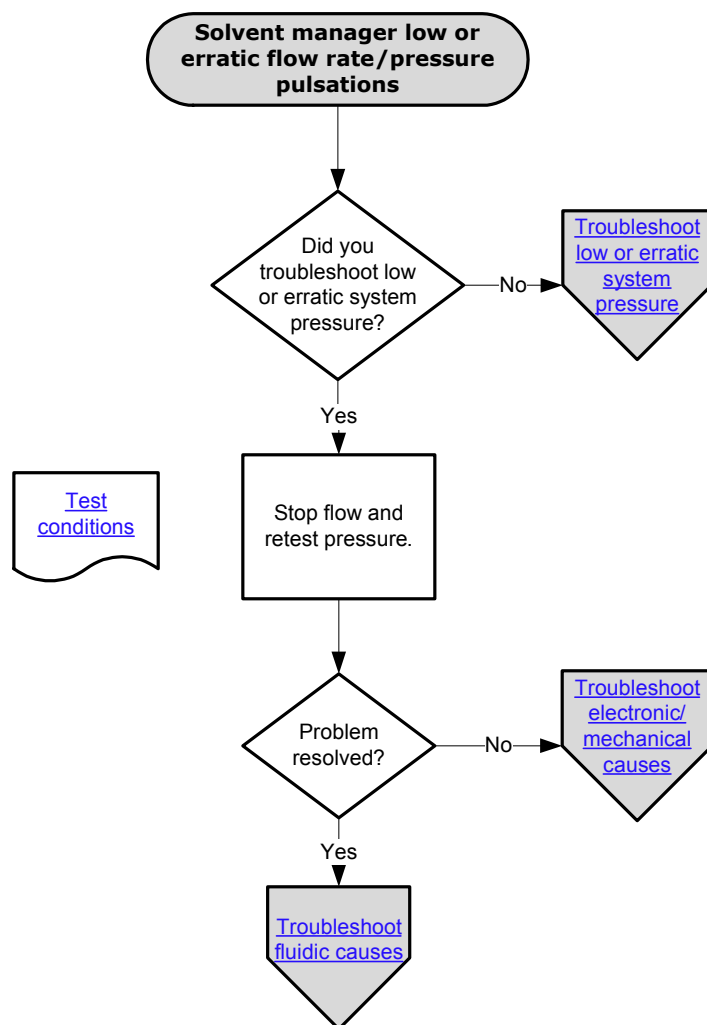
Solvent manager low or erratic flow rate/pressure pulsations*Figure 48 - Troubleshooting solvent manager erratic flow rate/pressure pulsations*

Table 43: Fluidic causes of QSM erratic flow rate/pressure pulsations

Symptom	Possible Cause	Action
Erratic flow rate/pressure pulsations - fluidic causes NOTE: Before using this table, make sure you have investigated system-level causes (see Solvent manager low or erratic flow rate/pressure pulsations, page 98).	Leak or defect in the check valve, head seals, pump head, tubing, or other fitting	1. Prime the binary solvent manager. 2. Perform the leak test to identify the source of the leak. Repeat if necessary. 3. Repair the leak or replace the leaking part. See Leak test fails, page 90 .
	Blockage on the high-pressure side (after i2V) (see Figure 54 on page 105)	Move the restrictor to different connections on the high-pressure path (Figure 54 on page 105) to isolate the blockage.
	Blockage on the low-pressure side (before the i2V) (see Figure 54 on page 105)	1. Check/tighten all low-pressure inlet fittings. 2. Check all inlet fittings for cross-threading or other defects. 3. If problem persists, replace the GPV. 4. If problem persists and optional solvent select valve is installed, replace the solvent select valve cartridge.

Table 44: Electronic/mechanical causes of QSM erratic flow rate/pressure pulsations

Symptom	Possible cause	Action
Erratic flow rate/pressure pulsations - electronic/mechanical causes NOTE: Before using this table, make sure you have investigated system-level causes (see Solvent manager low or erratic flow rate/pressure pulsations, page 98).	Transducer is defective (includes transducer, transducer cable, or transducer interconnect PCB)	1. Swap each transducer from one pump to another to see if the transducer is the problem. 2. If the transducers are OK, swap the transducer interconnect board cables to test the cables. 3. If the cables are OK, replace the transducer interconnect PCB (to remove the PCB, disconnect the transducer cables at the top of the front panel and remove the four T10 screws from the PCB).
	Improper grounding	Follow proper grounding procedures.
	Actuator problem	Replace the actuator.
	Personality PCB problem	Replace the personality PCB. See Replacing the CPU/Personality Card .

Solvent manager visible leaks

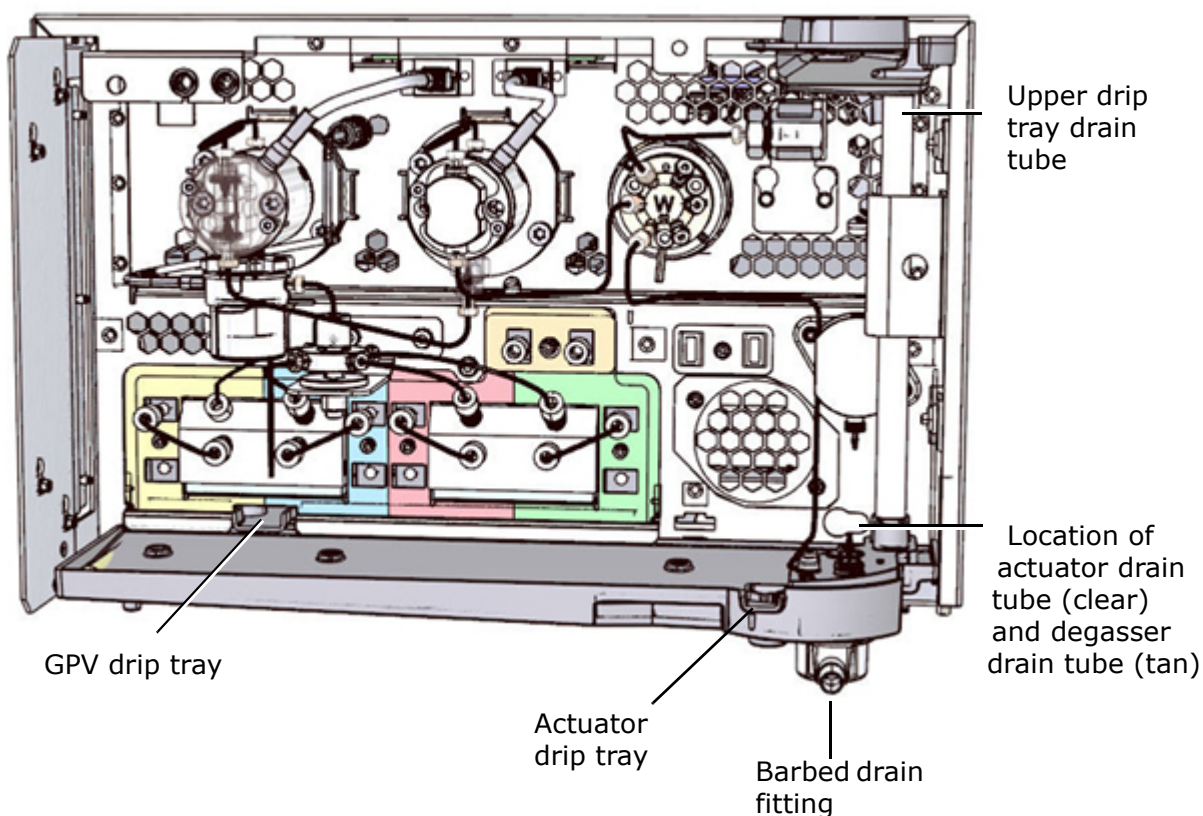
When you observe a fluid leak or buffer residue on the solvent manager, investigate the possible causes listed in [Table 45](#).

Table 45: Solvent manager Troubleshooting: visible leak

Symptom	Possible Cause	Action
Visible solvent leak or external buffer buildup (source known) Examples:	Loose fitting, tube, or other component loose, worn, or incorrectly installed	1. Tighten or replace the component at the observed origin of the leak. 2. If leak was on the high-pressure side of the flow path (see Figure 54), verify that the leak was fixed by running the leak test.
	Seal wash tubes not properly installed	Install tubes properly.
	Loose fitting	Check/tighten fittings.
	Loose check valve	Check/tighten the check valve.
	Loose pump head	Check/tighten head bolts through pressure transducer.
	Worn seal wash seal (see Figure 50 on page 103)	1. Examine the actuator drain tube in the lower-right corner of the solvent manager (see Figure 49 on page 102). If liquid is coming out, there's a leak in the seal wash seal. 2. Replace the seal.
	Worn high pressure seal	Replace high pressure seal.
	Bad GPV	Replace GPV.
	Bad degasser chamber	Replace degasser chamber.
	Bad drain fitting (indicated by liquid on the bench)	Replace drain fitting.
	Improperly aligned drainage system	Align modules correctly. See ACQUITY UPLC H-Class System and H-Class Bio System Installation Manual

Table 45: Solvent manager Troubleshooting: visible leak

Symptom	Possible Cause	Action
Visible leak in drip tray (source unknown)	Loose fitting, tube, or other component	1. Check/tighten the component. 2. Run the leak tests. 3. Troubleshoot "test not completed error" (see Troubleshooting leak test result messages, page 90).
	Incorrect routing of upper drip tray drain tube or other tube going to waste management system (see Figure 49 on page 102)	Route tube correctly. See ACQUITY UPLC H-Class Quaternary Solvent Manager Operator's Overview and Maintenance Information.

*Figure 49 - QSM waste management components*

Solvent manager reference information

This section contains general reference information useful to troubleshooting the solvent manager. Select the topic of interest:

- [Solvent manager diagrams, page 103](#)
- [Solvent manager leak test, page 106](#)
- [High pressure test conditions, page 113](#)

Solvent manager diagrams

Pump head assembly

NOTE: For more part illustrations, go to the ACQUITY UPLC H-Class System part locator, located in the Waters Portal.

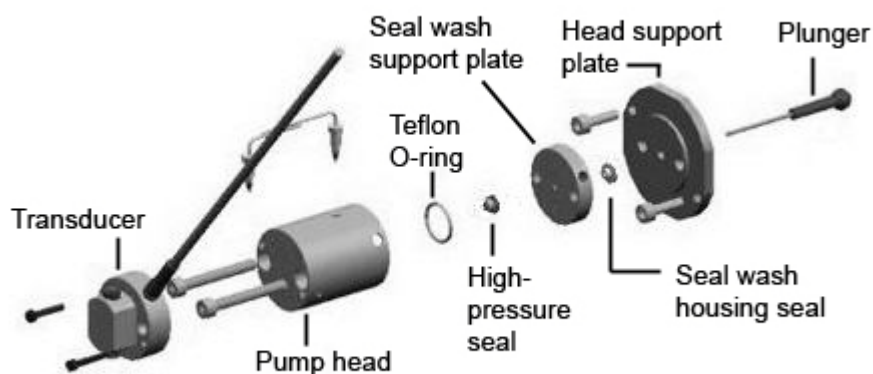


Figure 50 - Exploded view of pump head assembly

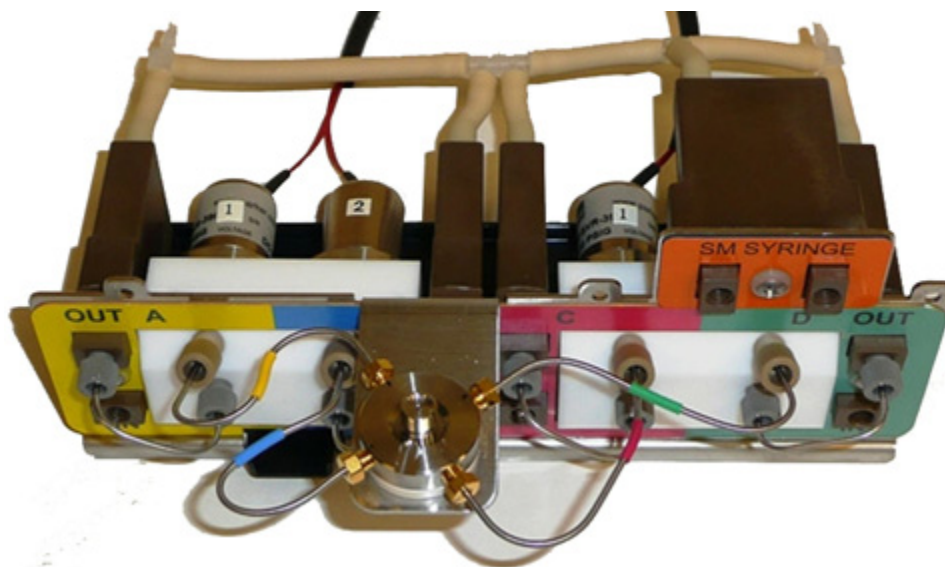


Figure 51 - Degasser assembly

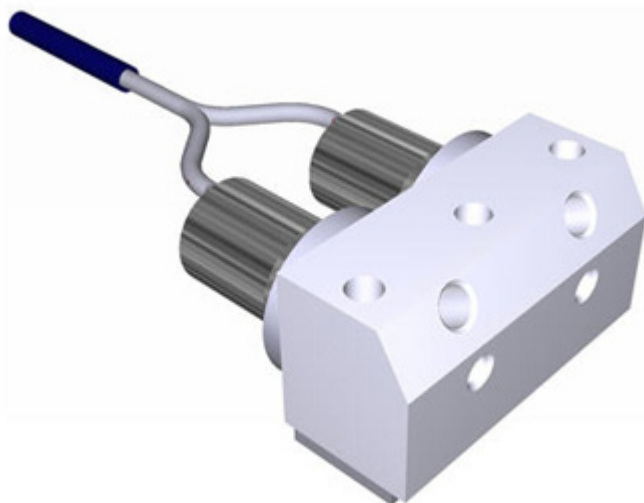


Figure 52 - Gradient proportioning valve, dual-channel

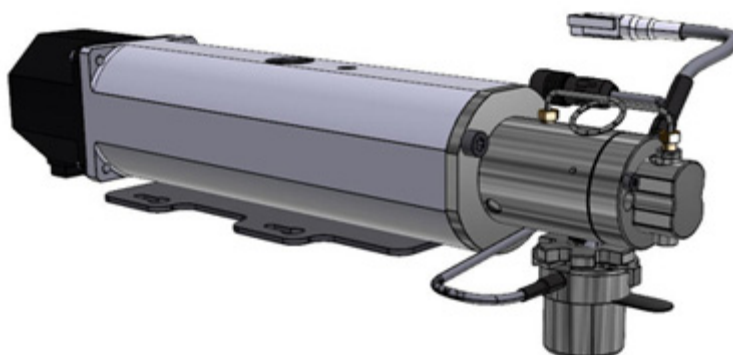


Figure 53 - Actuator with i^2 Valve

Flow path

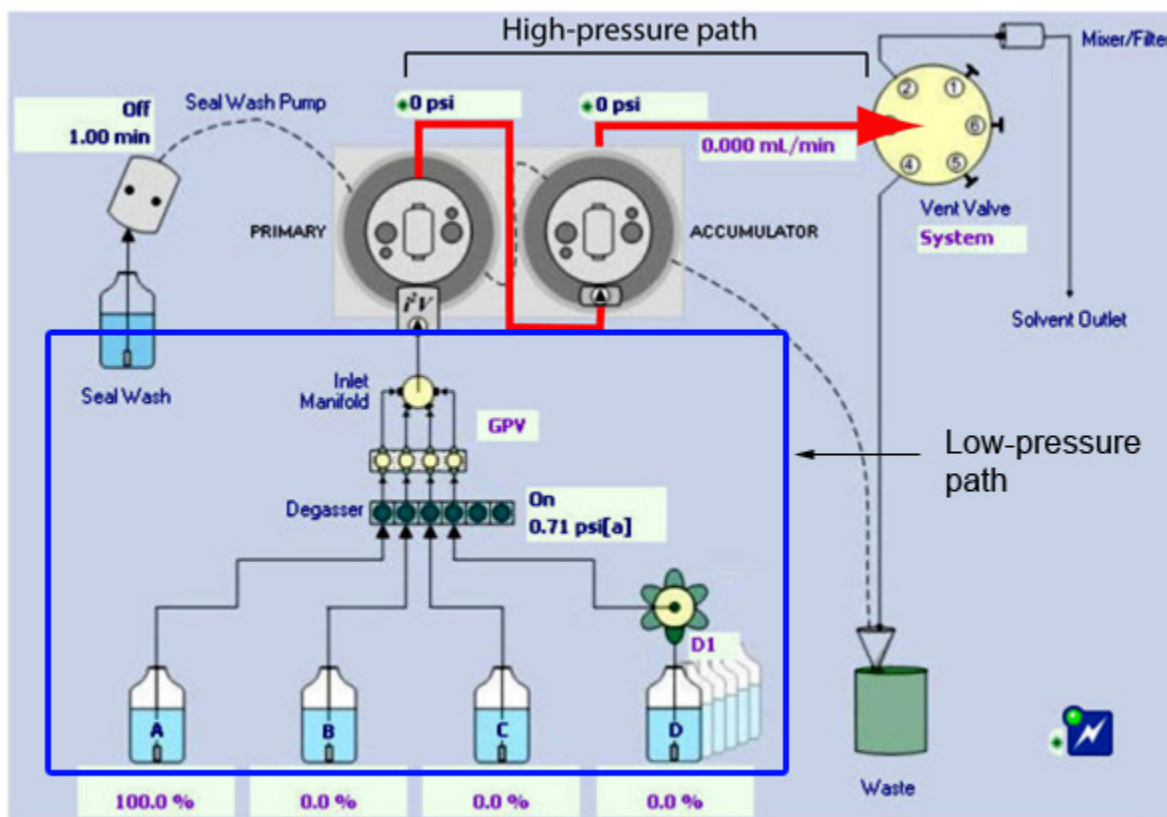


Figure 54 - Solvent manager interactive display/fluidic path

Solvent manager leak test

The solvent manager leak test is a diagnostic tool that helps identify issues with check valves, tubes, fittings, plungers, plunger high pressure seals, or the vent valve on the solvent manager. To narrow down leak locations, perform multiple leak tests with different end points selected and compare the results (see [Table 46](#) and [Figure 55](#)).

NOTE: The solvent manager leak test should not be confused with the SM-FTN sample syringe leak test. The SM-FTN leak test is available through the Console (**SM-FTN > Maintain > Leak test**) and can be used to troubleshoot sample syringe problems.

- [Leak test paths, page 107](#)
- [When to perform, page 107](#)
- [Recommended testing practices, page 107](#)
- [Leak test criteria, page 108](#)
- [Sample results, page 108](#)
- [Leak test process, page 109](#)

Table 46: Solvent manager leak test

Console location	End points	Components tested
QSM > Maintain > Leak test	Vent valve	Pump
	Column	All components up to the column (including the injector valve cartridge). This selection is also known as the system leak test. TIP: Connect the fitting plug (located in the solvent bottle tray front compartment) to the column inlet line to plug the line. This will enable you to test the components up to the column, but not the column itself. TIP: To test individual components, you can also plug the outlet of the mixer, the outlet of the inject valve, and the outlet of vent valve.
	Column (include SM needle and seal)	All components from the pump through the injector (including injector valve cartridge, needle, needle seal, and return line).

Leak test paths

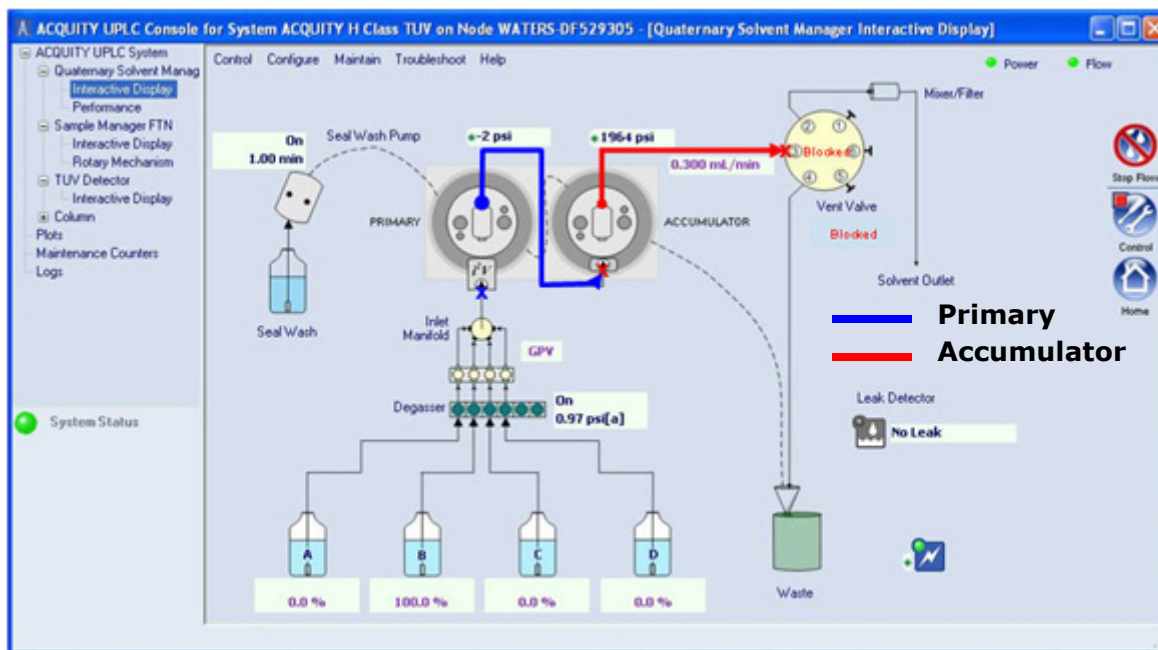


Figure 55 - Leak test paths

When to perform

Perform the leak test whenever you:

- suspect leakage in the check valves or plunger seals
- perform maintenance on the binary solvent manager
- replace fittings in the fluid path

Recommended testing practices

- Make sure that all fittings on the solvent manager are tight, and then prime the system for at least 3 minutes before performing the test.

NOTE: Air in the system can cause the test to fail.

- Use only new, clean solvent.
- Set up the pressure traces before starting the test, and monitor it using the ACQUITY Console. At a minimum, display the primary and accumulator pressure traces for the side to be tested. (Figure 56 shows a normal pressure trace.)
- Set the pressure scale with a low of 0 psi to a high of the test pressure (default: 96,000 kPa, or 965 bar, 14,000 psi).
- Set the time scale to 10 minutes.

NOTE:

- Do not perform the test on new seals until they have been exercised for at least 30 minutes at 96,000 kPa (965 bar, 14,000 psi); otherwise, the test may fail.
- When using very compressible solvents such as hexane, set the initial test pressure to 82,700 kPa (827 bar, 12,000 psi).

Leak test criteria

The main test criterion is the decay rate (see [Table 47](#)).

Table 47: Leak test pass criteria

End point	Decay rate
QSM vent valve	Below (<) 150 nl/min
Column - Column - Column through SM Needle and seal (system leak test)	Less than (<) 300 nl/min

Sample results

The leak test performs a pressure ramp-up and then monitors the loss of pressure from the solvent manager to determine whether the check valves, tubes, fittings, or plunger seals are faulty. See [Figure 56](#) for an example of a passed leak test. ([Figure 57](#) shows a failed leak test.)

Other aspects of the test that determine pass/fail include leak rate, percent of stroke, and final pressure. For example, excessive primary pressure while the actuator is compressed triggers an accumulator failure, the result of excessive valve leakage.

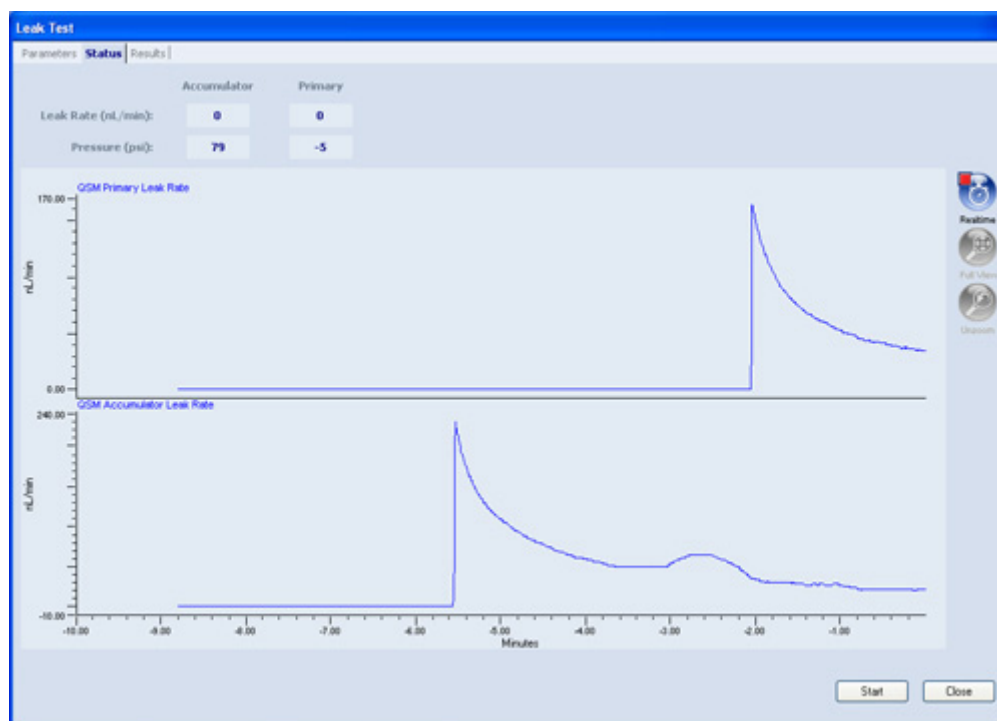


Figure 56 - Leak test (pass)



Figure 57 - Leak test (failure - primary pump)

Leak test process

Table 48 shows each step and associated error message of the leak test process.

Table 48: Leak test process

Diagnostic operation	Possible error code	Error event
User enters leak test parameters in Console	Software error	A problem occurs during attempt to set solvent composition.
SSV position is set	Hardware error	A problem occurs during attempt to set SSV position based on user-selected solvent.
Injection valve switches to the Load or Inject position	Sample manager communications error	A problem occurs when QSM tells SM to switch injection valve to Load or Inject position, based on user-selected end point.

Table 48: Leak test process (continued)

Diagnostic operation	Possible error code	Error event
Priming	Prime failed	Hardware error during prime sequence (e.g., a problem with the pumping sequence or vent valve).
Cylinders are prepared	Hardware error	A problem occurs during the sequence in which cylinders are emptied and filled, and vent valve is moved to Vent position and then to Closed or System position depending on end point.
Accumulator is compressed	Hardware error	Primary flow controller failed to start
	Unable to compress	Accumulator plunger traveled more than 30%
Accumulator leak rate is monitored for 3 minutes	Excessive back leakage during compression	Primary pressure exceeded 200 psi
	Hardware error	Accumulator plunger hit top or bottom dead center.
		Accumulator leak rate is negative
	Leak rate was above the acceptable limit	Accumulator leak rate exceeded 150 nL/min when the end point is Vent Valve.
		Accumulator leak rate exceeded 300 nL/min when the end point is Column, or Column through SM Needle and Seal.
Primary is compressed	Hardware error	Primary flow controller failed to start
		Accumulator plunger hit bottom dead center
	Unable to compress	Primary plunger traveled more than 30%
	Unable to maintain pressure	Primary plunger hit top dead center.
	Excessive back leakage during Primary test	Primary plunger hit bottom dead center
	Software error	Primary plunger hit top dead center

Table 48: Leak test process (continued)

Diagnostic operation	Possible error code	Error event
Primary leak rate is monitored for 3 minutes	Hardware error	Primary flow controller signaled an error condition
		Accumulator plunger hit bottom dead center
		Accumulator leak rate is negative
	Unable to maintain pressure	Accumulator plunger hit top dead center
		Primary plunger hit top dead center.
	Excessive back leakage during Primary test	Primary plunger hit bottom dead center
		Accumulator leak rate exceeded 150 nL/min when the end point is Vent Valve.
		Primary leak rate is negative
	Leak rate was above the acceptable limit	Primary leak rate exceeded 300 nL/min when the end point is Column, or Column through SM Needle and Seal.
Empty the cylinders	NA	NA
End test and display results	Passed	NA
	One of error messages above	NA

Sample pressure traces

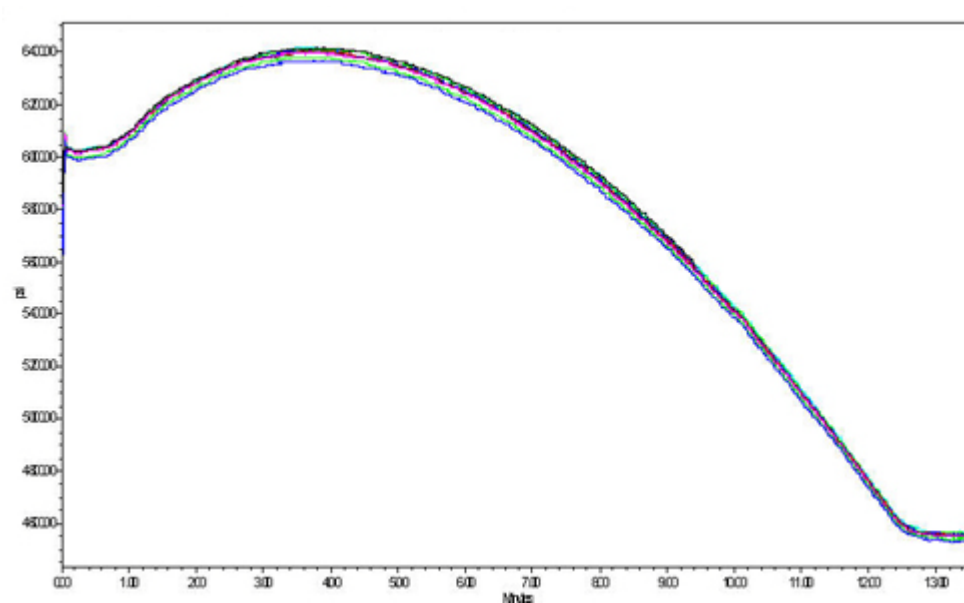


Figure 58 - Normal pressure (overlays)

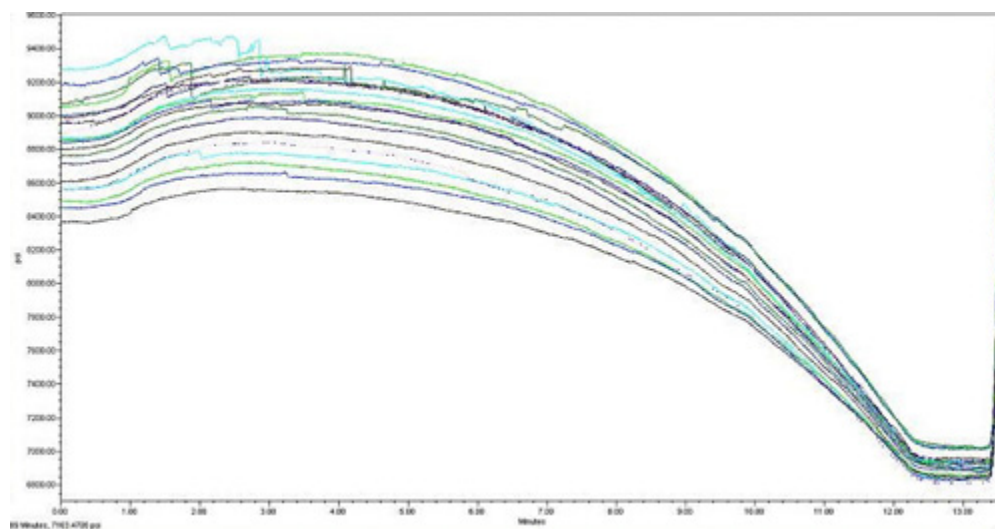


Figure 59 - Gradual jumps in pressure



Figure 60 - Cyclic pressure increase

High pressure test conditions

Run at the same conditions in which you observed high pressure.

CAUTION: MAKE SURE NEEDLE IS ONLINE BY VERIFYING THE INJECTION VALVE POSITION VIA THE INTERACTIVE DISPLAY.

Chapter 3: Troubleshooting Sample Manager Symptoms

This section outlines troubleshooting for the ACQUITY UPLC H-Class System Sample Manager - Flow Through Needle, or SM-FTN (hereafter called sample manager). To begin troubleshooting, click the topic corresponding to your symptom:

- [Sample manager abnormal LED status, page 114](#)
- [Sample compartment temperature problem/error, page 116](#)
- [Sample manager erratic pressure, page 126](#)
- [Sample manager service diagnostic test/calibration failures, page 127](#)
- [Sample manager visible leak, page 132](#)
- [Sample manager troubleshooting reference information, page 132](#)
- [Sample manager errors, page 176](#)

NOTE: Before troubleshooting the sample manager, make sure you have first eliminated system-level causes (see [Troubleshooting System-level Symptoms, page 2](#)).

Sample manager abnormal LED status

Power LED

The power LED, on the left-hand side of the front panel, indicates when the instrument is powered on or powered off. It is steady green when the instrument is working properly.

Run LED

The run LED, on the right-hand side of the power LED, indicates the run status.

Table 49: Troubleshooting abnormal status LEDs

Symptom	Possible cause	Corrective action
Run LED unlit	Sample manager is currently idle	No action required.
Run LED steady green	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 state.	No action required.
Run LED flashing green	The system is waiting for at least one module to become operable. Detector lamp warm-up and column temperature equilibration times are typical causes of such a delay.	1. From the Console, reset the sample manager. 2. If problem persists, reset communications.

Table 49: Troubleshooting abnormal status LEDs (continued)

Symptom	Possible cause	Corrective action
Run LED flashing/steady red	Serious error prevents further operation	Check the Console to identify the error, then troubleshoot the error. See Sample manager errors, page 176 .
	Communications problem	1. Go to Console and reset sample manager. 2. Check Ethernet port connection for green light. See Troubleshooting Empower Software/Communications Problems .
Power LED unlit	Power supply problem	Test the 24V on power supply; replace the power supply if necessary. Replace the power supply. See Replacing the Power Supply .
	Power connection problem	Check/replace power connections.
	Control PCB problem	Ensure connections are seated properly and not damaged. If necessary, replace the control PCB. See: • Replacing the CPU, Control, and Driver PCBs • Control PCB
	Electrical outlet problem	1. Inspect line connections. 2. Test electrical outlet for power.

Sample compartment temperature problem/error

Sample compartment temperature problems include:

- [Temperature does not reach setpoint \(within the -2/+4 specification\), page 116](#)
- Temperature-related error appears in the ACQUITY Console (see specific error in [Troubleshooting Errors, page 149](#))

Temperature does not reach setpoint (within the -2/+4 specification)

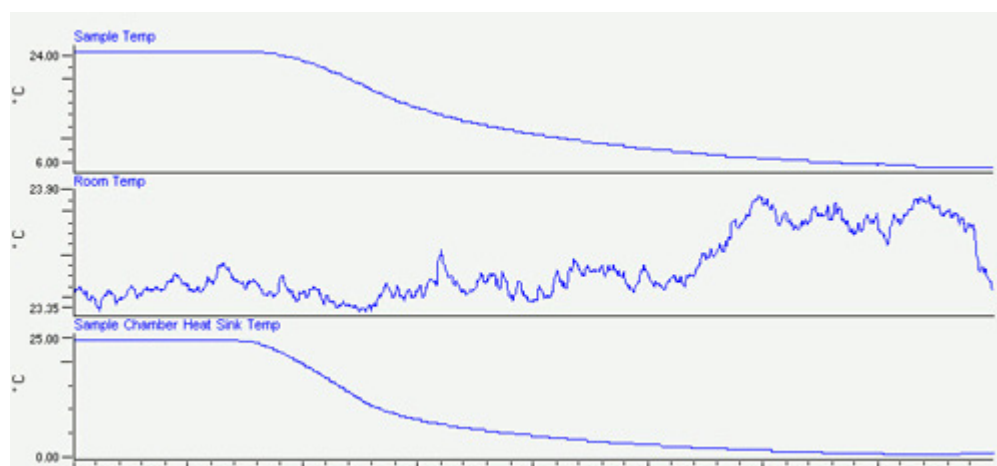
Temperature does not reach setting specified in the instrument method.

Table 50: Temperature does not reach setpoint (within -2/+4 range)

No.	Possible cause	Corrective action	More info
1	Sample compartment has not thermally stabilized	Allow sufficient time for temperature to stabilize. NOTE: <i>Time to setpoint will vary based on sample vial temperature, number of trays, and ambient temperature/humidity.</i>	Figure 61
2	The difference between room temperature and setpoint is too large	Verify that the setpoint is achievable at the current room temperature and that the measured temperature is actually outside the specification.	• Sample temperature worksheets, page 118 • Online Help (Temperature Specification) - cpsm
3	Icing present on the sample compartment heat sink	1. Determine whether icing is present. 2. If icing is present, defrost the sample compartment. 3. Install v1.46+ of the sample manager firmware. (Latest version recommended.) This firmware reduces the likelihood of icing.	• Indicators of icing on the heat sink • Defrosting the Sample Compartment
4	PCB or heater/cooler problem	1. Run the sample heater/cooler hardware test (service mode). NOTE: <i>Available only in Waters Driver Pack 4+.</i> 2. If it passes, check foam compartment sealing areas for proper installation. 3. If the heatsink cooling rate is below 0.2° C/min, check to make sure the PCB is supplying power to the heater/cooler.	• Checking whether PCB is supplying power to the heater/cooler

Table 50: Temperature does not reach setpoint (within -2/+4 range)

No.	Possible cause	Corrective action	More info
4	Loose or damaged cable	1. Confirm that all heater/cooler cables are properly seated. 2. If cable is visibly damaged, replace heater/cooler assembly.	N/A
5	Blown fuse	Check F8 and F22 on the motor/HC driver PCB. If either of the fuses is blown, replace the motor/HC driver PCB. (link to Part Locator)	• Motor/HC Driver PCB
6	Heater/cooler problem	Replace the heater/cooler.	• Replacing the Heater/Cooler

*Figure 61 - Plot showing sample compartment thermally stabilizing*

Sample temperature worksheets

Table 51: Ambient temperature is 23° C or BELOW

Temperature parameter	Specification	Temperature worksheet (fill in unshaded areas)
Setpoint	4° C to 40° C	
		Example: ●5° C
Tolerance range	-2°/+4° C	N/A
Acceptable temperature range (setpoint + tolerance range)	setpoint -2° to setpoint +4°	
		Example: ●(5) - 2 = 3 ●(5) +4 = 9 ●Range = 3 to 9
Console temperature readback	Sample compartment temperature displayed in Console	
		Example 1: ●Console readback = 8.9 Example 2: ●Console readback = 10.1
Results		
Pass (in specification)	Readback is inside acceptable temperature range	
		Example 1: 8.9 is inside 3 to 9 range: Result = Pass
Fail (out of specification)	Readback is outside calculated temperature range	
		Example 2: ●10.1 is outside 3 to 9 range: ●Result = Fail

Table 52: Ambient temperature is GREATER THAN (>) 23° C

Temperature parameter	Specification	Temperature worksheet (fill in unshaded areas)	
Setpoint	4° C to 40° C		
		Example: ●4° C	
Ambient Room temperature measured at the ambient temperature sensor located behind the right side panel of the sample manager	>23° C		
		Example: ●24° C	
Upper tolerance temperature The upper tolerance of the temperature range	Compare: ●Setpoint + 4 ●Ambient - 15 The <i>greater</i> of the two values is the upper tolerance temperature.	(Setpoint)	+ 4 =
		(Ambient)	- 15 =
		Greater value =	
		Example: ●(4) + 4 = 8 ●(24) - 15 = 9 ● Greater value = 9	
Console temperature readback	Sample compartment temperature displayed in Console		
		Example 1: ●Console readback = 8.9 Example 2: ●Console readback = 10.1	
Results			
Pass (in specification)	Readback is less than or equal to (≤) upper tolerance temperature		
		Example 1: 8.9 < 9 Result = Pass	
Fail (out of specification)	Readback is greater than (>) the upper tolerance temperature		
		Example 2: ●10.1 is greater than (>) 9 ●Result = Fail	

Indicators of icing on the heat sink

- Icing is visible on the heat sink (see [Checking for icing on the sample manager heater/cooler, page 121](#))
- Sample compartment temperature remains above 10° C while heat sink remains close to 0° C and heater/cooler power consumption is less than 85-90% ([Figure 62](#)).

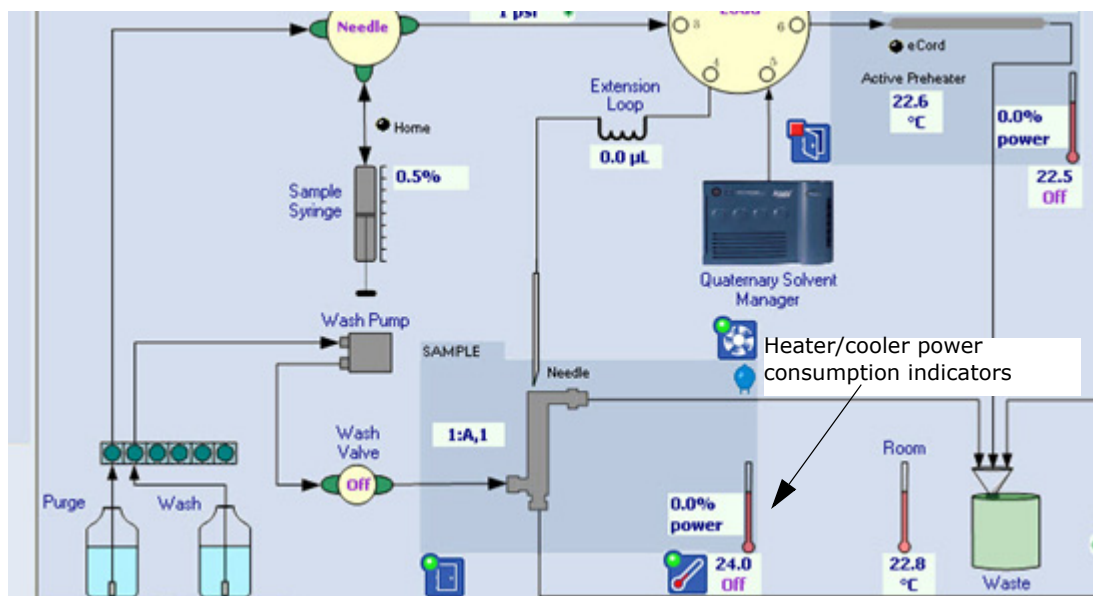


Figure 62 - Power consumption indicators on interactive display

Checking for icing on the sample manager heater/cooler

1. Using an inspection mirror, observe the thermal fins on the heat sink (see [Figure 63](#) and [Figure 64](#)).
2. If you observe icing, defrost the sample compartment (see [Defrosting the Sample Compartment](#)).

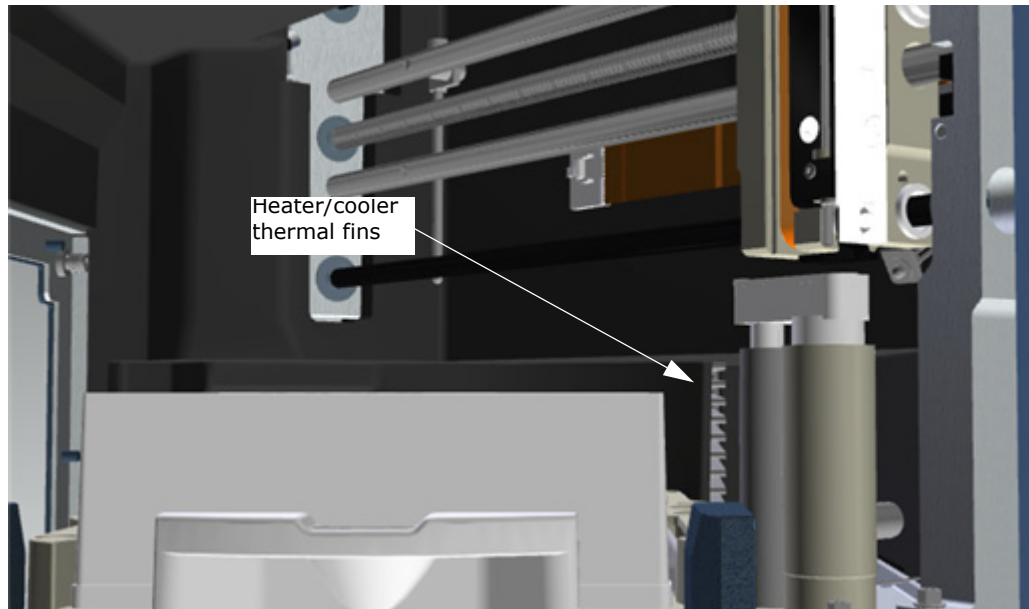


Figure 63 - Location of heater/cooler thermal fins in the sample compartment

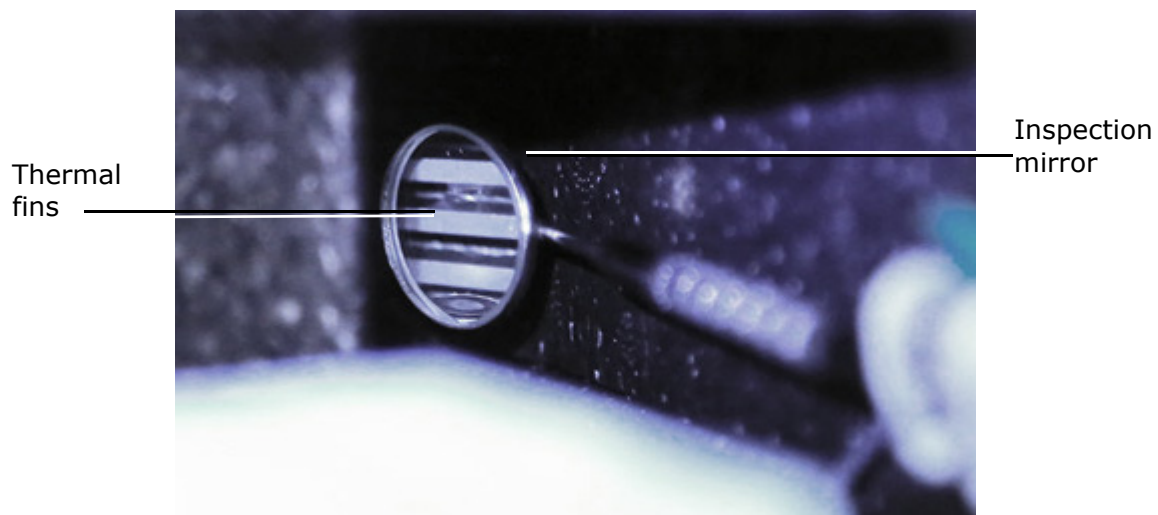


Figure 64 - Checking the thermal fins for icing

Checking whether PCB is supplying power to the heater/cooler

1. Power off the sample manager.
2. Remove any instruments from the top of the sample manager.
3. Remove the side and top covers.
4. Unplug the heater/cooler cable from J34 on the motor/HC driver PCB.
5. Turn on the sample manager.
6. Set the sample compartment temperature to 5° C in the Console.
7. From the Interactive Display, monitor the heater/cooler power reading ([Figure 62](#)). Wait until it reaches 100%. This will take 10 minutes.
8. Using a multimeter, measure the voltage across pins 2 and 7 on the motor/HC driver PCB ([Figure 65](#)).

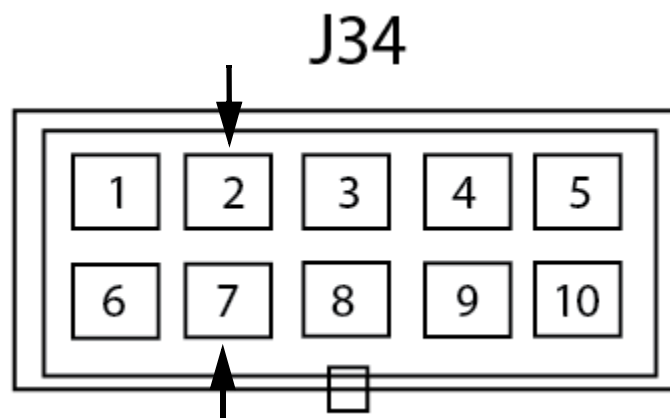


Figure 65 - Measuring the voltage on the motor/HC driver PCB (J34)

9. If the reading is 24V (+/- 2V), the PCB is supplying power to the heater/cooler and is functioning properly.
10. If the reading is outside that range, replace the PCB.

Sample manager incorrect sample recovery

The sample manager fails to inject the correct amount of sample.

Investigate the possible causes listed in [Table 53](#).

Table 53: Incorrect sample recovery

No.	Possible cause	Corrective action	More info
1	Air in syringes	1. Prime the sample manager, and then check the syringes to verify that they are primed. 2. If air is still present, trouble-shoot priming problems.	Sample manager priming problem, page 124
2	Plate/vial problem	Use plate or vial appropriate for your application. See	Using Plates and Vials with ACQUITY UPLC and ACQUITY UPLC H-Class Systems.
3	Wrong volume configurations for needle, extension loop, or sample syringe	Ensure volume configurations are correct for the components installed.	N/A
4	Needle touching bottom of vial (and thus blocking sample aspiration)	Raise the needle.	N/A
5	Sample aspiration rate too fast	Reduce sample aspiration rate.	N/A
6	Sample remaining in needle	If using the loop-offline option, ensure you time it so that the needle and injection loop remain online until the gradient reaches its final conditions. Taking the loop offline before the highly organic portion of your gradient passes through the needle can result in sample remaining in the needle.	N/A
7	MS detector scan rate too low (see Figure 17 and Figure 18)	Increase the scan rate to obtain more data points across the peak. Ideally, acquire 15 to 20 data points across the peak.	N/A

Sample manager priming problem

An inability to get fluid out of the sample manager drain tube or inject valve waste line.

Priming problems include:

- [Wash pump priming problem, page 124](#) - leak in wash pump, or inability to get fluid out of the sample manager drain tube (tube from SM-FTN to QSM); can cause carryover
- [Syringe pump priming problem, page 125](#) - leak or visible air bubbles in syringe or Tefzel waste line coming out of inject valve; can cause incorrect sample recovery

NOTE: For more information on the priming process, see [Priming the sample manager, page 148](#).

Table 54: Wash pump priming problem

No.	Possible cause	Corrective action	More info
1	Solvent bottle problem	1. Make sure solvent is in the bottle. 2. Make sure solvent line is in the solvent. 3. Check filter for clogs. (Replace if necessary) 4. Check tubing for kinks or clogs (replace if necessary)	N/A
2	Loose fittings	Observe the wash pump. If you see a leak, tighten fittings as necessary.	N/A
3	Wash pump failure	If the wash pump has no flow, replace the wash pump.	N/A
7	Solvent bottle problem	1. Make sure solvent is in the bottle. 2. Make sure solvent line is in the solvent. 3. Check filter for clogs. (Replace if necessary) 4. Check tubing for kinks or clogs (replace if necessary)	N/A

Table 55: Syringe pump priming problem

No.	Possible cause	Corrective action	More info
1	Trapped bubble	1. Prime with 100% methanol (ensures that you wet surfaces and remove bubbles). 2. Prime with standard wash solvent.	N/A
2	Solvent bottle problem	1. Make sure solvent is in the bottle. 2. Make sure solvent line is in the solvent. 3. Check filter for clogs. (Replace if necessary) 4. Check tubing for kinks or clogs (replace if necessary)	N/A
3	Sample syringe leaking	1. Run the sample syringe leak test to verify syringe performance. 2. If the test fails, troubleshoot failed leak test.	Sample syringe leak test fails, page 127
4	Degasser leak (indicates syringe priming problem)	Tighten/replace degasser fittings.	N/A
5	Wash line from bottle to pump is improperly connected	1. Ensure the line is properly connected. 2. Verify the degasser is operating properly.	N/A
6	Solvent line to and from degasser is damaged or loose	Check line and repair/replace as necessary.	N/A
7	Solenoid valve problem	1. Check the solenoid valve for loose connections or damage. 2. If necessary, replace the valve.	N/A

Sample manager erratic pressure

Sample manager erratic pressure consists of:

- Erratic pressure within the same run
- Erratic pressure from run to run

NOTE: Before troubleshooting the sample manager, be sure to investigate erratic pressure at the system level (see [Erratic system pressure](#), page 69).

Table 56: Erratic pressure within the same run

No.	Possible cause	Corrective action	More info
1	Needle extension loop used	No action necessary. NOTE: If using large-volume needle extension loops, a dip in pressure when the needle is brought online is normal and will increase with loop volume size.	N/A
2	Sample vials empty	Check sample vials; refill with sample if necessary.	N/A
3	Injection valve problem	If system leak test passes but column leak test fails, replace the injection valve.	N/A

Table 57: Erratic pressure from run to run

No.	Possible cause	Corrective action	More info
1	Sample vials empty	Make sure sample vials are not empty. Refill with sample if necessary.	N/A
2	Needle not sealing properly	1. Run the system leak test (select <i>Column through SM needle and seal</i> as end point). 2. If system leak test passes, run the leak test again, selecting <i>Column</i> as the end point (no needle and seal).	N/A
3	Injection valve problem	If system leak test passes but column leak test fails, replace the injection valve.	N/A

Sample manager service diagnostic test/calibration failures

Service diagnostic tests indicate leaks or problems in the sample manager. For troubleshooting recommendations, select the topic of interest:

- [Sample syringe leak test fails, page 127](#)

NOTE: For leak test criteria, see [Sample syringe leak test criteria, page 141](#).

- [Needle seal readiness test fails, page 129](#)

Calibrations and characterizations are automated adjustments that you must perform at start-up, during performance maintenance, and when replacing parts. For troubleshooting recommendations, select a topic of interest:

- [Calibrate Z axis fails, page 131](#)
- [Calibrate rotary tray fails, page 131](#)
- [Characterize needle seal fails, page 131](#)

NOTE: For more information on tests and calibrations, see [Calibration/diagnostic test procedures, page 141](#).

Sample syringe leak test fails

The sample syringe leak test checks for leaks in the path between the sample syringe and the injection valve (i.e., the low pressure areas of the SM-FTN).

[Figure 66](#) and [Figure 67](#) show sample pressure traces. To troubleshoot a failed test, see [Table 58](#).

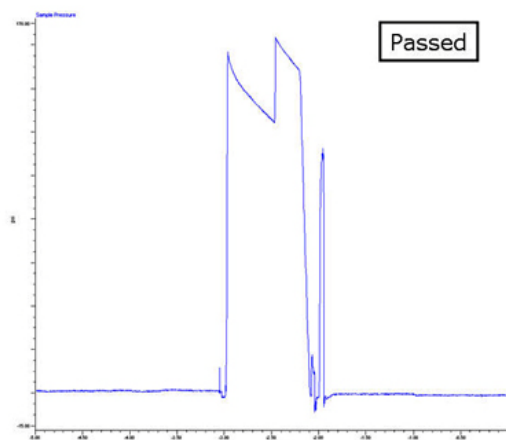


Figure 66 - Sample syringe leak test pass

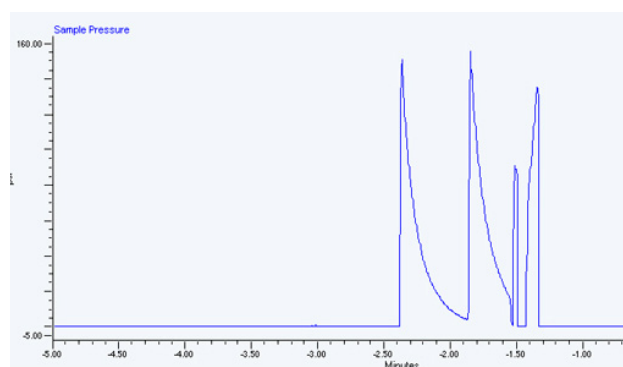


Figure 67 - Sample syringe leak test fail

Table 58: Sample syringe leak test fails

No.	Possible cause	Corrective action	More info
1	Air bubble in syringe	1. Check for air bubbles; if present, prime the sample manager. 2. If problem persists, remove the syringe and fill with weak wash to remove the air bubble; then reinstall.	N/A
2	Leak in path between sample syringe and injection valve	Visually inspect the path: check the connections, replace the tubing, and/or replace the sample syringe.	Figure 70 on page 133
3	Wrong configuration or wrong syringe installed	Verify that correct syringe is configured and installed.	N/A
4	Defective metering syringe valve (MSV) head or MSV assembly	Connect two fittings on MSV head to a union and prime sample syringe to see if it works. • If it primes without error, the problem is in the MSV head or assembly. Replace the MSV head. • If priming fails, check the injection valve cartridge.	Replacing the Metering Syringe Valve Head
5	Injection valve cartridge problem	Replace the injection valve cartridge.	SM-FTN Operator's Overview and Maintenance Information.
6	Pressure transducer problem	1. Power on and off to auto-zero the pressure transducer. 2. Check the transducer voltage readings in the Console; • the pressure transducer voltage should be at or near 0mV • the zero offset voltage should be 500 mV $\pm$ 50mV 3. If the zero offset voltage is out of range, adjust the pressure transducer. 4. If necessary, replace the transducer.	Replacing the Pressure Transducer

Needle seal readiness test fails

The needle seal readiness test gauges the sealing of the needle and seal interface. The sample manager monitors the solvent manager pressure and verifies that, when the needle is in the "seal" position and the injection valve is in the "inject" position, the pressure does not decrease more than a predefined amount.

Table 59: Needle seal readiness test fails

No.	Possible cause	Corrective action	More info
1	Incorrect running conditions	Use correct running conditions: - flow = 90%A:0%B at 0.06mL/min - column = 2.1x50mm BEH ~6000-8000 psi	ACQUITY UPLC H-Class System and H-Class Bio System Installation Manual
2	Bent needle	1. Replace the needle. 2. Investigate cause of bent needle by: • ensuring the sample vial plate is properly positioned in the rotary tray • checking plate configuration to ensure it matches the plate installed	N/A
3	Extension loop used	1. Remove extension loop. 2. Connect needle to injection valve and re-run the test.	"Needle Seal Readiness Test fails to complete" (Service Note)
4	Loose high-pressure fittings	1. Check high-pressure fittings on inject valve ports 1, 4, 5, and 6; tighten as necessary. 2. Re-run the test.	Valve positions, page 134
5	Leak in fluidic path	1. Run the leak test to isolate the source of the leak. (In the QSM information window, click Maintain > Leak test.) 2. Tighten any loose fittings or replace damaged parts as necessary.	Leak test fails, page 98
6	Seal extension tube leak	Check junction between seal extension tube and metal cup for leaks. Tighten or replace as necessary.	Figure 68
7	Needle tip damaged	Replace the needle and seal.	Figure 69
8	Seal damaged	Replace the seal.	N/A

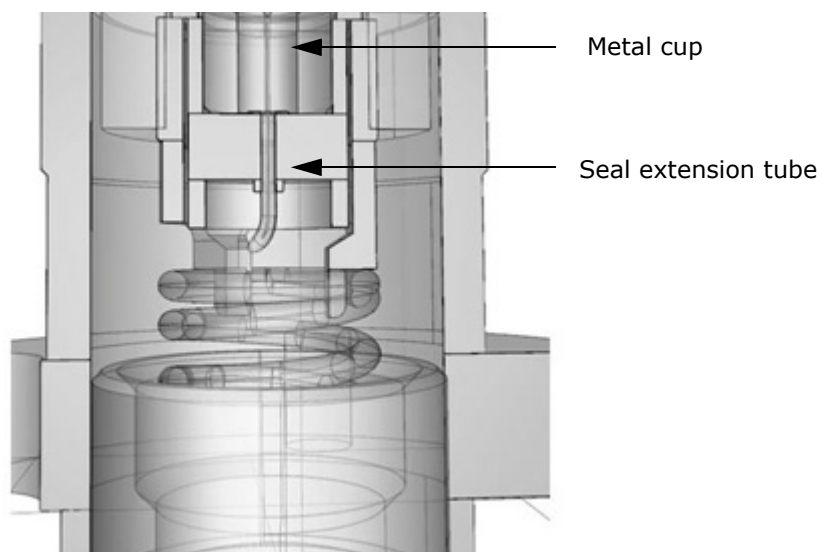


Figure 68 - Checking the needle seal for leaks

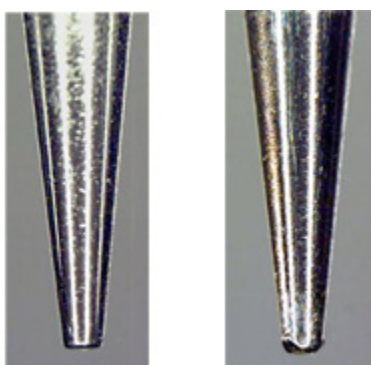


Figure 69 - Damaged needle on right

Table 60: Calibration/characterization problems

Symptom	Possible cause	Corrective action
Calibrate Z axis fails	Check/troubleshoot error message displayed in Console	Check/troubleshoot specific error message displayed in Console. (See Sample manager errors, page 176.) For more information, see Calibrate Z-axis procedure, page 144.
Calibrate rotary tray fails	Check/troubleshoot error message displayed in Console	Check/troubleshoot specific error message displayed in Console. (See Sample manager errors, page 176.) For more information, see Calibrate Z-axis procedure, page 144.
Characterize needle seal fails	Check/troubleshoot error message displayed in Console	Check/troubleshoot specific error message displayed in Console. (See Sample manager errors, page 176.) For more information, see Characterize needle seal procedure, page 142.

Sample manager visible leak

When you observe a fluid leak or buffer residue on the sample manager, or when the leak sensor detects a leak, investigate the possible causes listed in [Table 61](#).

Table 61: Troubleshooting visible leak^a

Symptom	Possible cause	Corrective action
Visible leak Fluid leak or buffer residue	Loose fitting	Check the fittings to ensure they are seated properly.
	Fitting not a Waters-recommended part for the system	Substitute a Waters-recommended part.
	Drain condensation leak	Check for condensate leaking beneath the If condensate is leaking, install the drain hole sleeve. See Installing the Drain hole sleeve .
	Fluidics component leak	Run all service diagnostic tests, and troubleshoot the fluidics component for leaks. See Sample manager service diagnostic test/calibration failures , page 127.
	High salt content in mobile phases or sample (creates salt/buffer buildup that interferes with needle operation)	1. Characterize the needle seal and troubleshoot any resulting error message. 2. If problem persists, clean the injection port. See Cleaning the SM-FTN .

a. The most likely causes are listed at the top. If the problem persists after investigating the most likely causes, investigate other causes in the order they are listed.

Sample manager troubleshooting reference information

This section provides diagrams, descriptions, and references relevant to troubleshooting the sample manager. It includes:

- [Fluidic diagrams](#), page 133
- [Component diagrams](#), page 136
- [Calibration/diagnostic test procedures](#), page 141
- [Reset/initialization procedure](#), page 146
- [Priming the sample manager](#), page 148

NOTE: For electronics information, see [Technical Reference Sheets](#) in SM-FTN Reference Information on the Portal.

Fluidic diagrams

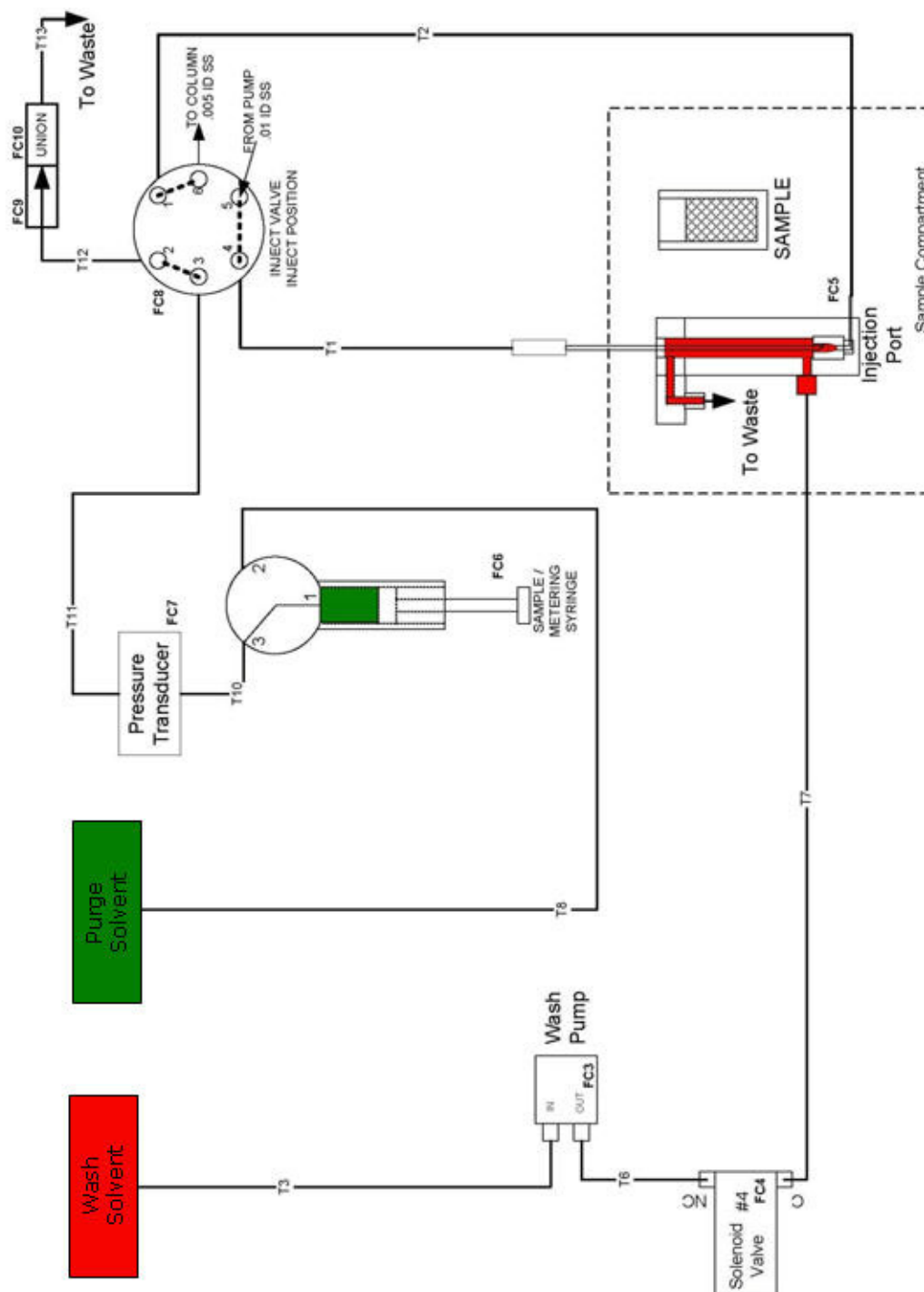


Figure 70 - Flow path through the sample manager

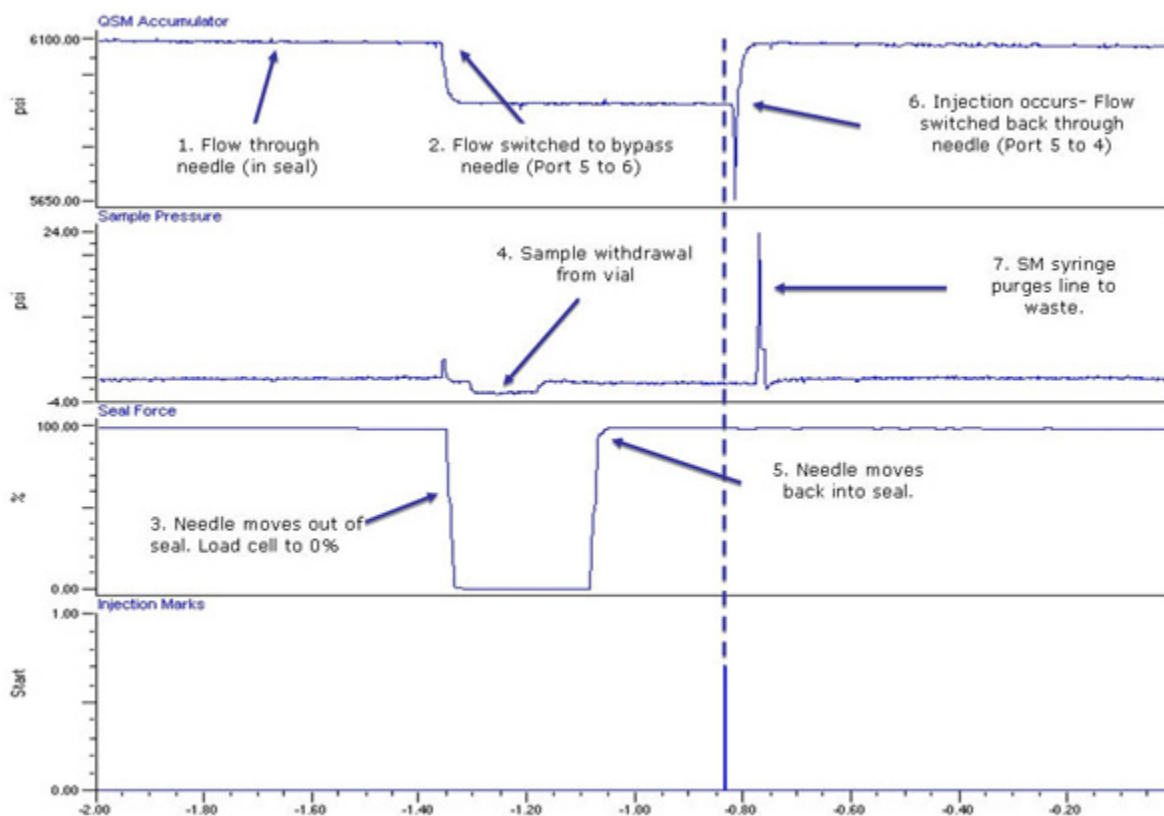


Figure 71 - Pressure trace during injection

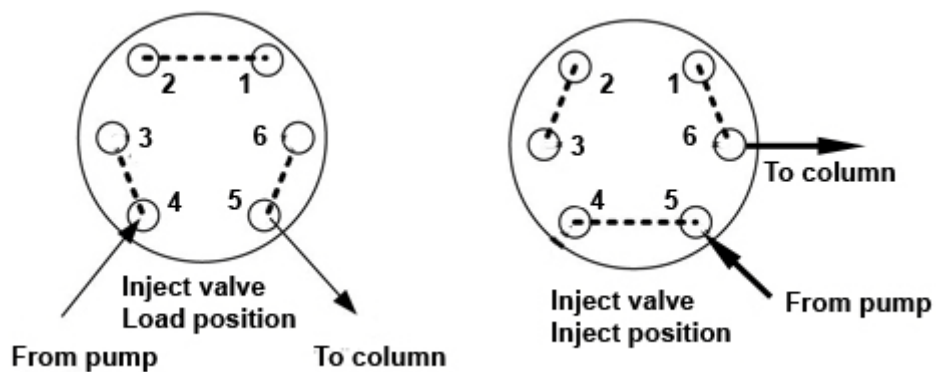


Figure 72 - Valve positions

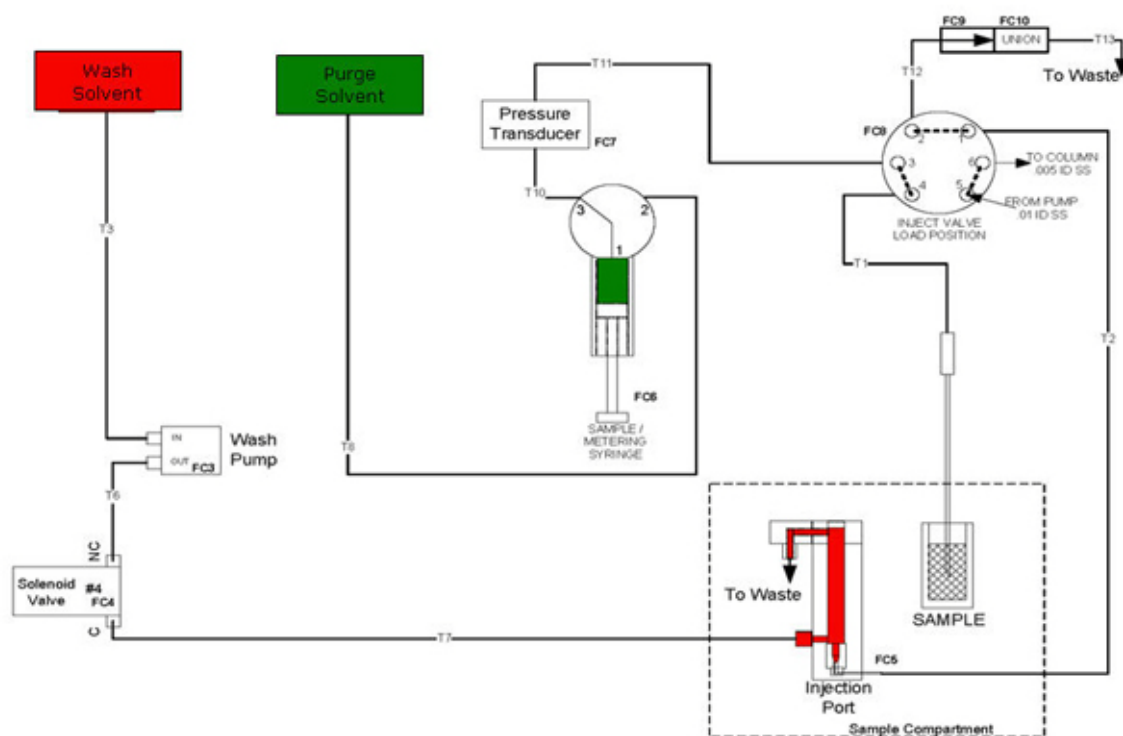


Figure 73 - Sample withdrawal

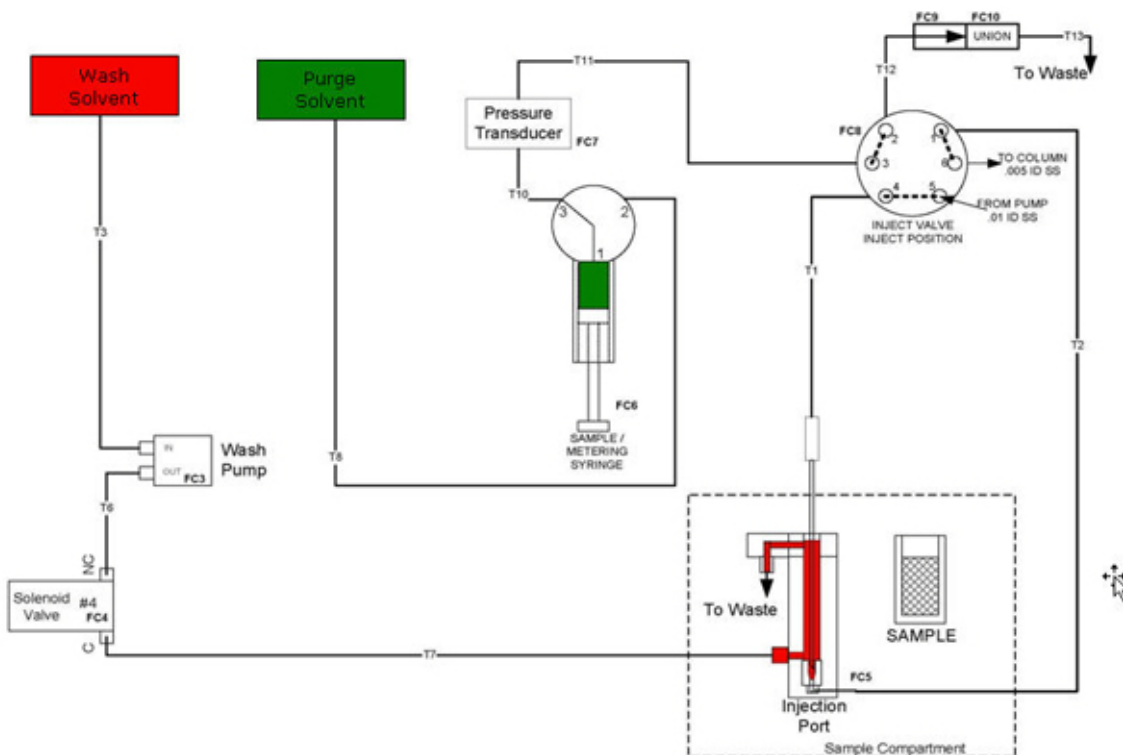


Figure 74 - Inject mode

Component diagrams

- [Injection/wash port components, page 136](#)
- [Sample syringe valve drive components, page 137](#)
- [Sample positioning mechanism components, page 138](#)

Injection/wash port components

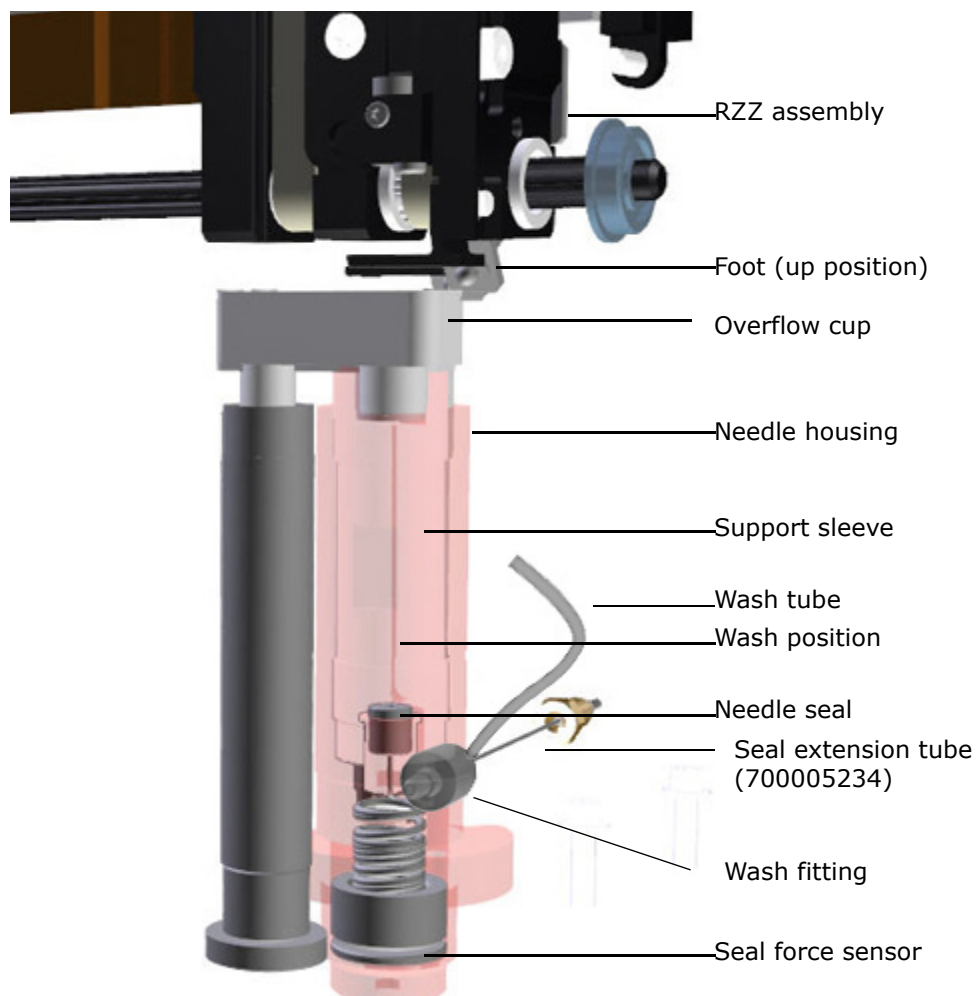


Figure 75 - Injection/wash port components

Sample syringe valve drive components

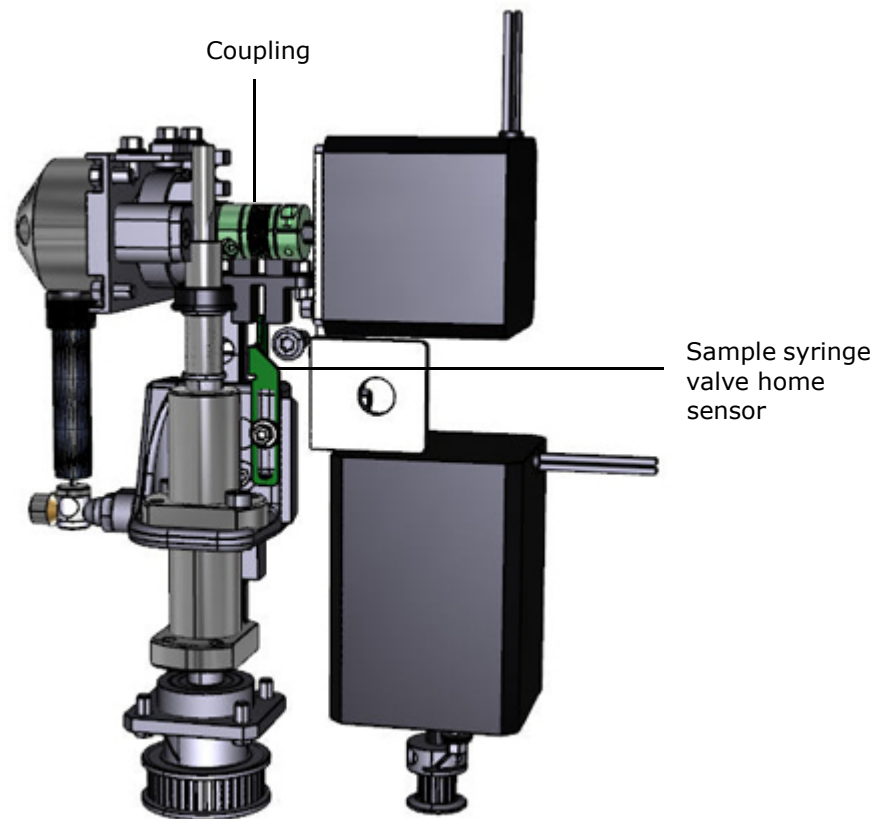


Figure 76 - Sample syringe valve drive components

Sample positioning mechanism components

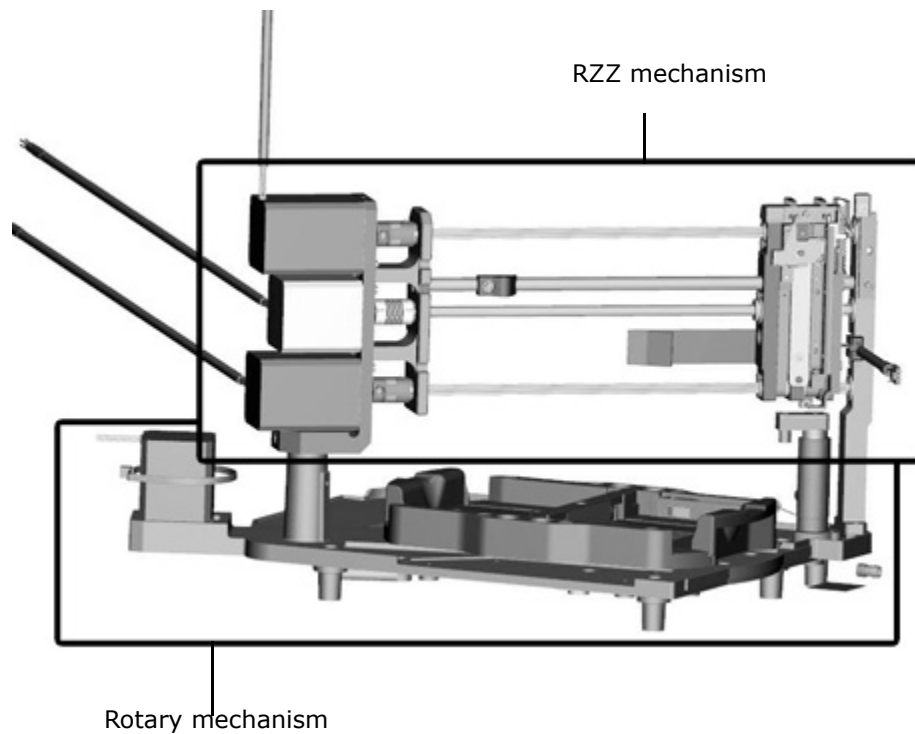


Figure 77 - Sample positioning mechanism subassemblies

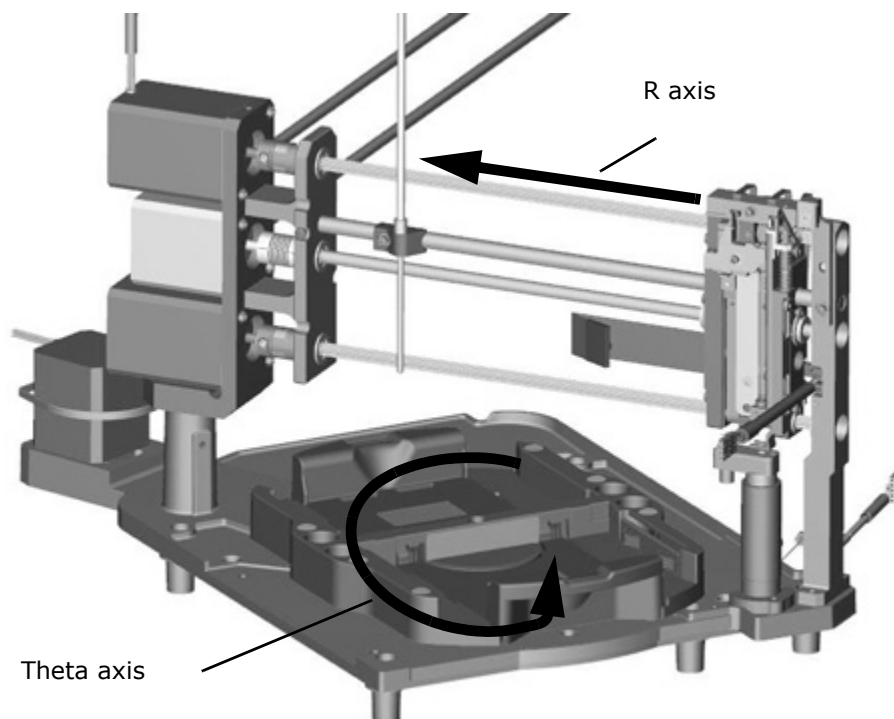


Figure 78 - R- and theta-axis directions

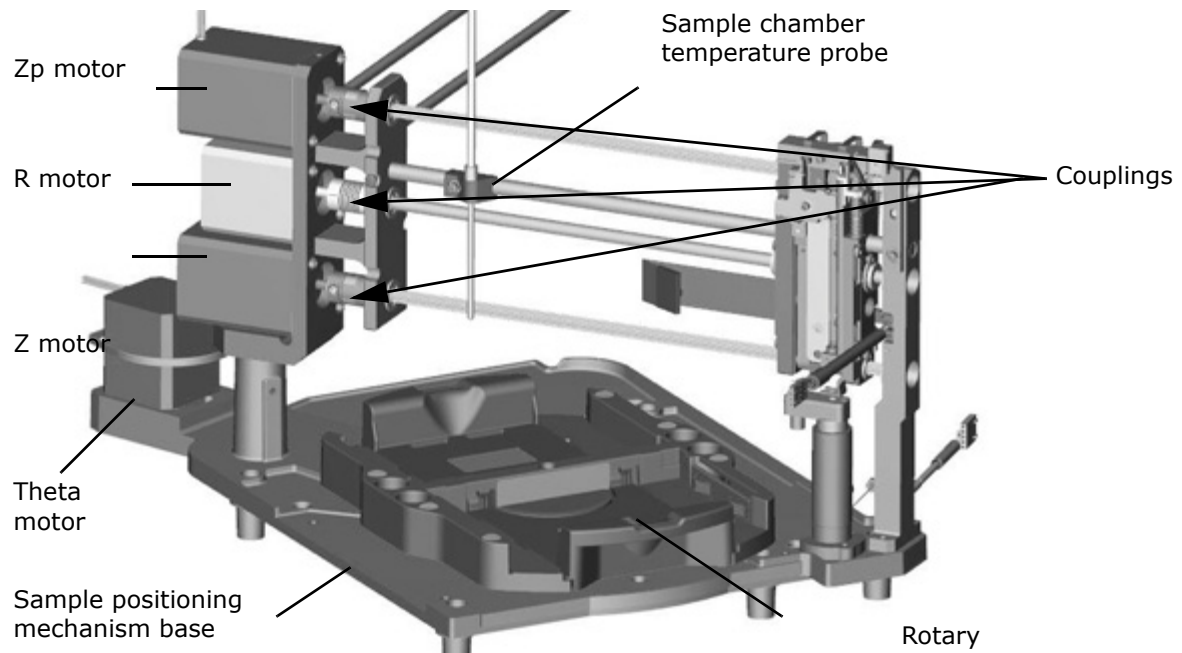


Figure 79 - Sample positioning mechanism components

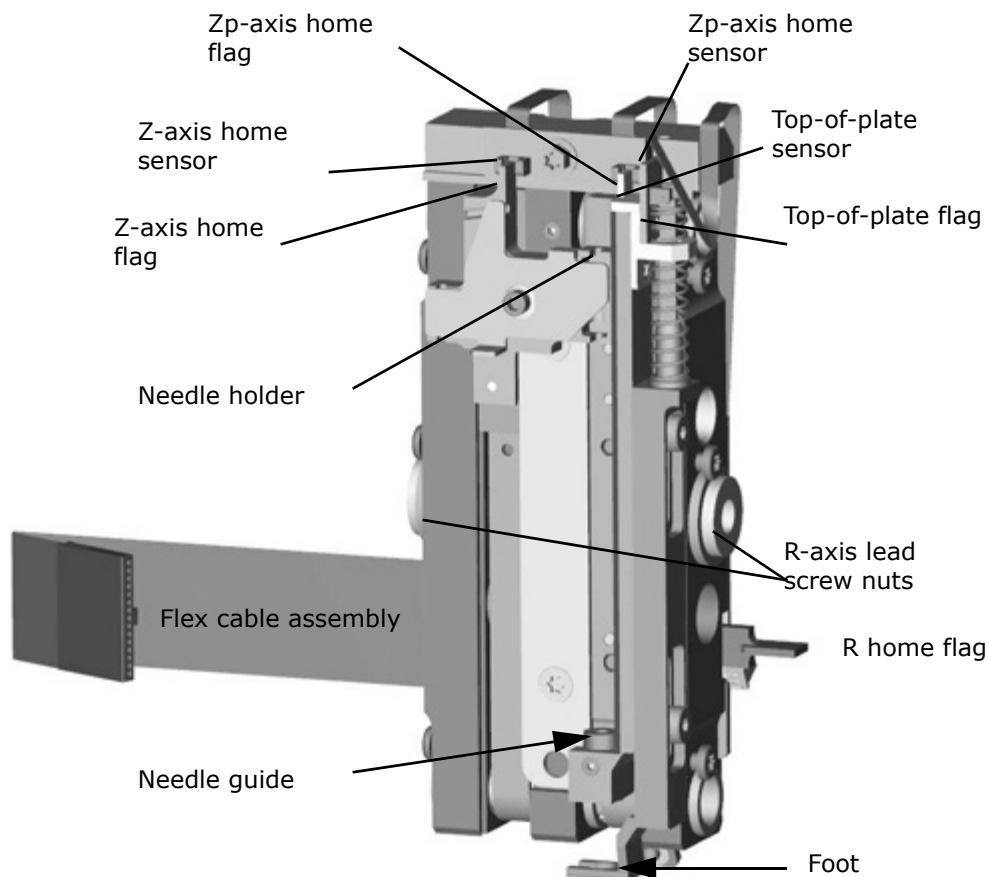


Figure 80 - Needle carriage components

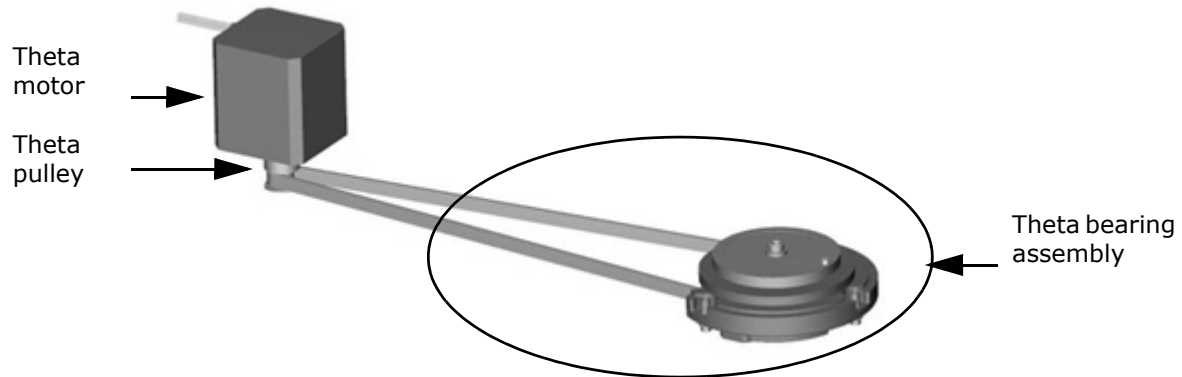


Figure 81 - Theta drive assembly (located beneath the sample positioning mechanism base)

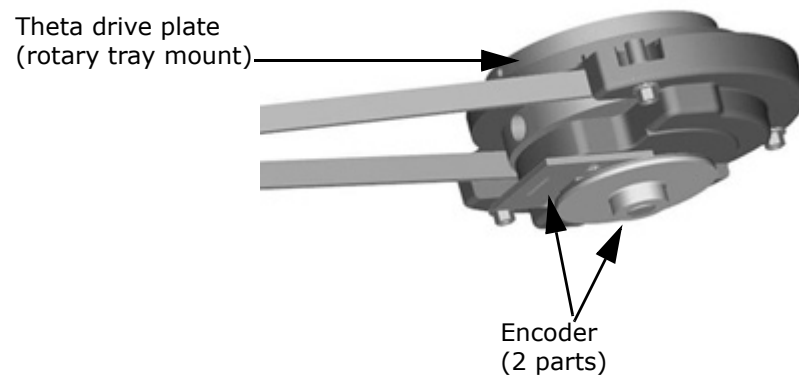


Figure 82 - Theta drive mechanism with encoder

Calibration/diagnostic test procedures

- [Sample syringe leak test criteria, page 141](#)
- [Needle seal readiness test procedure, page 141](#)
- [Characterize needle seal procedure, page 142](#)
- [Calibrate Z-axis procedure, page 144](#)
- [Calibrate rotary tray procedure, page 145](#)

Sample syringe leak test criteria

Table 62: Sample syringe leak diagnostic test criteria

Pass criteria	Pressure	Procedure
Delta psi ≤ 95	150 psi	1. Wait 15 seconds. 2. Check the delta psi.

Needle seal readiness test procedure

The needle seal readiness test gauges the sealing of the needle and seal interface. The sample manager monitors the solvent manager pressure and verifies that, when the needle is in the "seal" position and the injection valve is in the "inject" position, the pressure does not decrease more than a predefined amount.

Steps:

1. The sample manager moves the injection valve to the load position and monitors the solvent manager pressure ([Figure 83](#)).
2. When the pressure is stable, the sample manager engages the needle on the seal and moves the injection valve to the inject position.

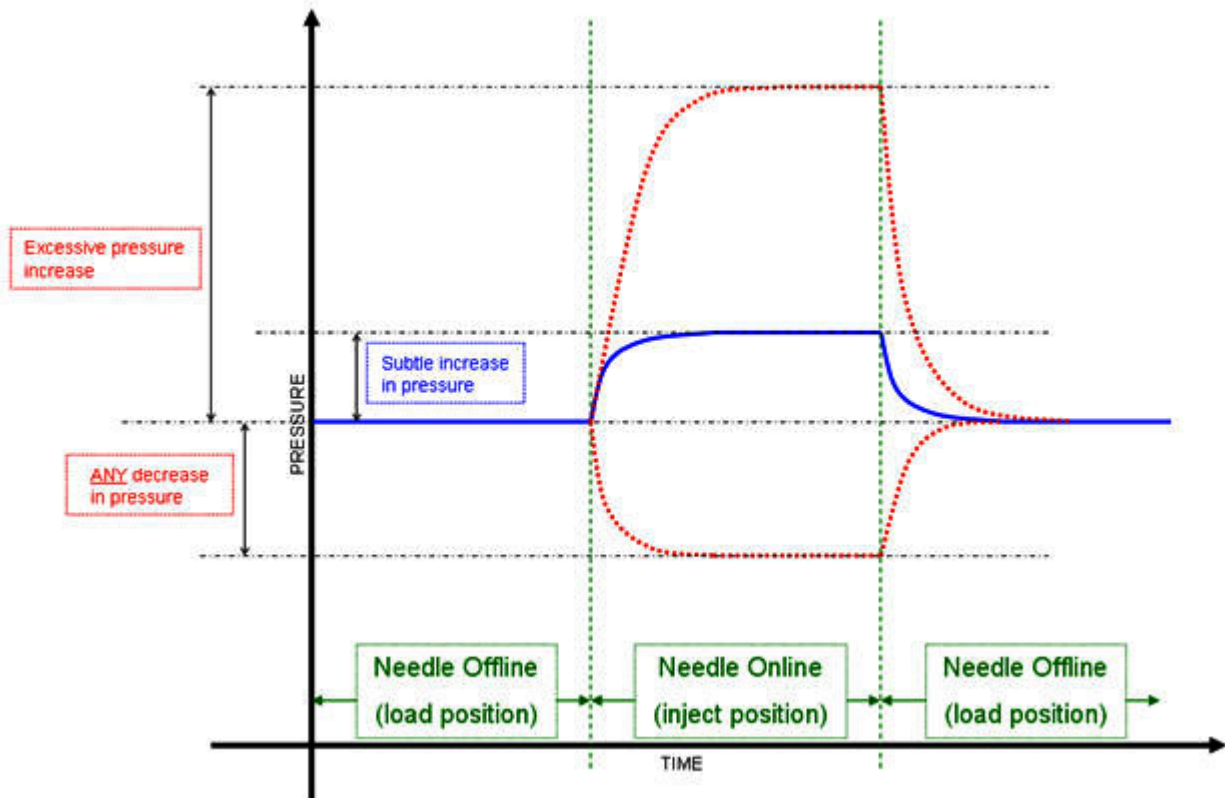


Figure 83 - Needle seal readiness test

Characterize needle seal procedure

The characterize needle seal test finds the position at which the needle contacts the seal within the injection port (see [Figure 84](#)).

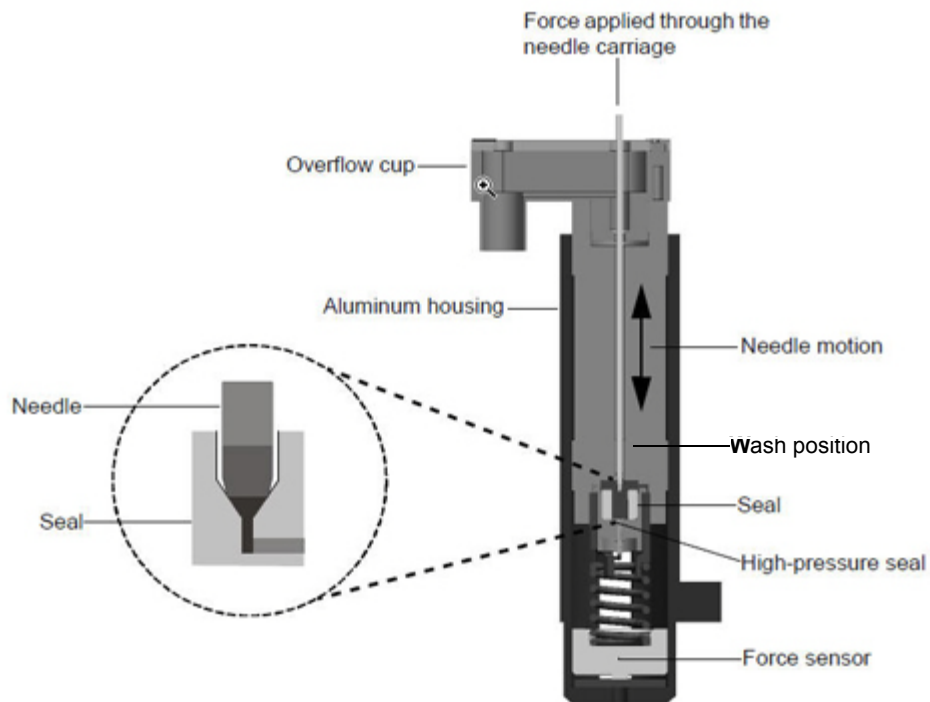


Figure 84 - Characterize needle seal test

It consists of three operations:

1. [Foot calibration, page 144](#)
2. [Seal calibration, page 144](#)
3. [Seal constant calculation, page 144](#)

Table 63 shows each step and associated error message of the needle seal characterization process.

Table 63: Characterize needle seal diagnostic

Diagnostic operation	Error code	Error event
Foot calibration Checks the reading while the sample needle carriage is in the home (up) position. The seal force sensor registers the distance from the wash position to the bottom of the foot.	Seal residual force limit exceeded (Z-up), page 205	The foot moved more than 10 mm, causing the sensor reading to exceed 0.5 lbs.
	Zp-axis calibration out of range, page 210	The sensor registers no value or an unexpected value.
Seal calibration The sample manager moves the needle into the wash position. The sample manager lowers the needle in 0.1-mm increments until it makes contact with the seal and registers a change of at least 0.4 lbs. The seal force sensor detects when the needle touches the seal.	Seal residual force limit exceeded (Z-wash), page 207	The sensor reading exceeds 0.5 lbs.
	Seal force sensor h/w fault (value), page 203	The seal force sensor registers no value or a value exceeding 1 lb.
	Z-axis calibration out of range, page 208	The seal calibration point is outside the expected range (within 2 mm of the nominal seal position)
Seal constant calculation Measures the stiffness of the metal compression spring. During the seal constant calculation, the sample manager lowers the needle 2 mm beyond the seal location, measures the seal force, and then computes the seal constant in Newtons per millimeter (N/mm).	No associated error. NOTE: The seal constant is printed for reference only. If the seal constant is outside the expected range of 8 to 11 N/mm, it indicates a problem somewhere within the injection port. Continue operating with caution.	

Calibrate Z-axis procedure

Calibrating the needle's Z-axis calibrates the vertical position of the needle relative to the rotary tray.

Perform after replacing:

- the sample needle
- the R carriage
- the rotary tray

For instructions on calibrating the Z-axis, see [ACQUITY UPLC H-Class Help](#).

Calibrate rotary tray procedure

The rotary tray calibration aligns the sample tray to the sample positioning mechanism (see [Figure 85](#)).

Perform after replacing:

- the sample tray
- parts in the theta drive plate
- the CPU 2000 PCB or battery

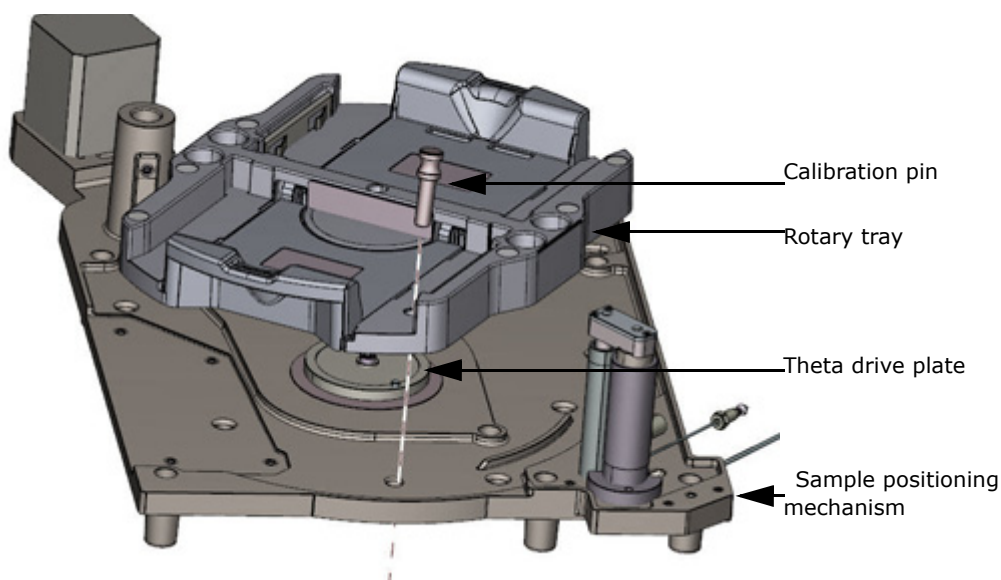


Figure 85 - Aligning the sample tray to the theta drive plate

Table 64: Rotary tray calibration steps

Calibration step	Error code	Error trigger
The sample manager looks for the encoder home pulse.	"Home HW fault"	The sample manager is unable to find the encoder home pulse.
	"Tray lost synchronization"	The sample manager finds a home pulse in an unexpected location.
The user moves the sample tray to the calibration position and inserts the calibration pin.	NA	NA
The firmware calibrates the rotary tray and then verifies that the calibration pin is present.	"Calibration pin not present"	The pin is not present or in the wrong location.

Reset/initialization procedure

Initialization is an automated checking routine performed by the sample manager to verify that it is ready for operation (see [Table 65](#)). It starts when you (1) power on the sample manager or (2) select Reset from the Console Control menu. If any of the checks fail, an error appears in the Console.

Table 65: Initialization/reset procedure

Initialization step	Possible error in Console	Error trigger
Check the Ethernet cable connection to verify that the cable is connected.	"Ethernet cable disconnected"	Ethernet cord is disconnected.
Check the sample temperature to verify that it is in the correct range. NOTE: Performed on power-up only.	"Sample temperature sensor HW fault"	Temperature is outside expected range of 0° to 45° C
Check the heater/cooler engine sink temperature sensor. NOTE: Performed on power-up only.	"Sample heat sink temperature sensor HW fault"	Temperature is outside expected range of -6° to 50° C
Home the injection valve. NOTE: Performed on power-up or on reset after an injection valve error.	"Injection valve home HW fault"	Unable to home the injection valve
Move injection valve to Load position.	"Injection valve move HW fault"	Unable to move the injection valve
Home sample positioning mechanism. <i>The tray rotates during this step.</i>	"Z-axis home HW fault"	Unable to home the sample positioning mechanism
	"Zp-axis home HW fault"	Unable to home the sample positioning mechanism
	"Rotary tray home HW fault"	Unable to home the rotary tray
	"Tray lost synchronization"	The sample manager found a home pulse in an unexpected location
	"Needle arm home HW fault"	Unable to home the R-axis
Re-zero seal force sensor.	"Seal force sensor HW fault"	Unable to re-zero the seal force sensor
Initialize SO.	Various sample organizer errors.	See Sample manager errors, page 176 .
Move needle to wash sink. NOTE: The sample needle carriage moves during this step.	No errors associated with this step	

Table 65: Initialization/reset procedure (continued)

Initialization step	Possible error in Console	Error trigger
Re-zero pressure transducer.	"Sample pressure sensor HW fault"	Unable to re-zero the pressure transducer
Home sample syringe valve.	"Sample valve home HW fault"	Unable to home sample syringe valve
Home sample syringe.	"Sample syringe home HW fault"	Unable to home sample syringe
Move needle to middle of instrument.	"Injection valve move HW fault"	Unable to move injection valve
	"Z-axis home HW fault"	Unable to home Z-axis
	"Zp-axis home HW fault"	Unable to home Zp-axis
	"Z-axis HW lost steps"	Z-axis motion stalled
	"Zp-axis HW needle lost steps"	Z-axis motion stalled
Check CH-A.	"Column active preheater configured but not detected"	SM did not detect preheater
	"Column active preheater not configured but detected"	SM detected a preheater when no preheater was configured

Priming the sample manager

The priming process fills the wash system with wash solvent, or the injection pathway with purge solvent. It changes any solvent already in the lines and/or purges air from them. [Figure 86](#) shows the pathway for priming the purge solvent.

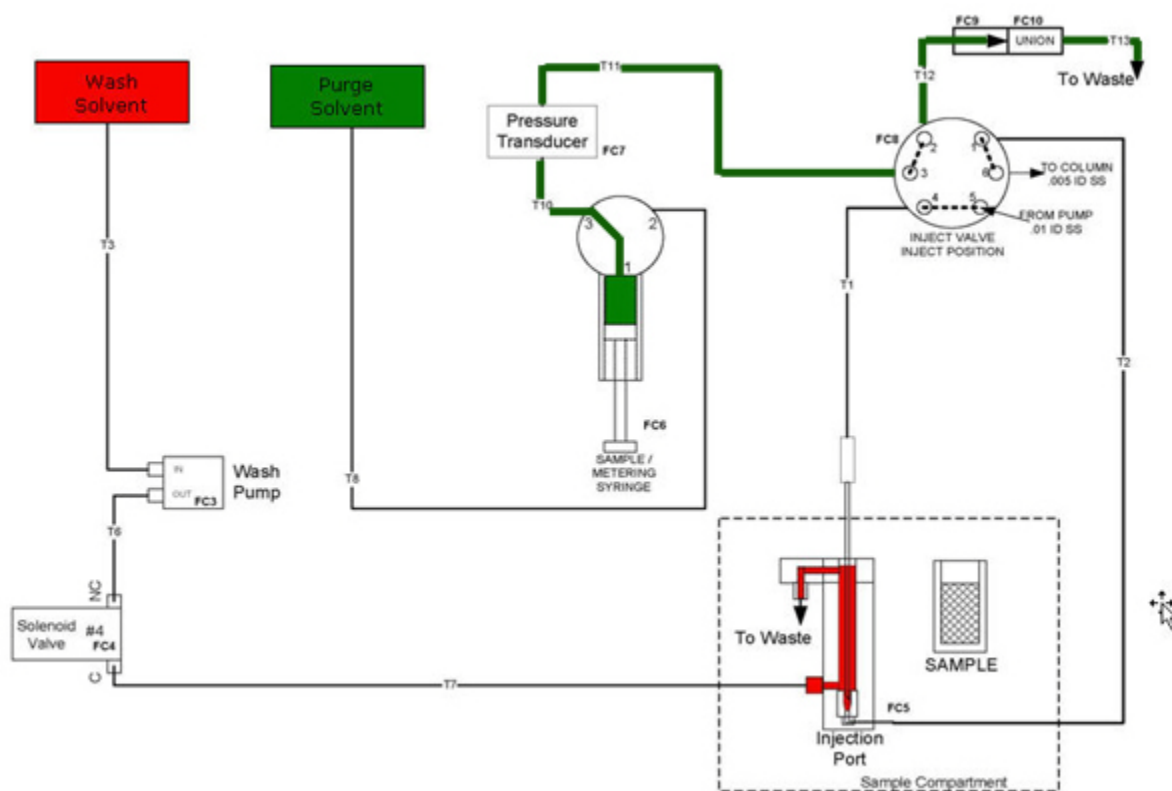


Figure 86 - Priming the purge solvent

Sample compartment temperature specifications

Chapter 5: Troubleshooting Errors

This section outlines troubleshooting for error states corresponding to each component of the core ACQUITY UPLC H-Class/H-Class Bio System.

NOTE: Errors and information messages are displayed in the Console when one of the ACQUITY UPLC H-Class System components is not operating as expected. Error states appear in red and stop the instrument. Information messages appear in black; they are displayed for information only and require no action. Both types of messages are listed in this chapter.

- [All errors/warnings index, page 149](#) (alphabetical list)
- [Solvent manager errors, page 154](#)
- [Sample manager errors, page 167](#) (includes CH-A and CH-30A errors)
- [Column compartment errors, page 203](#) (CM-A and CM-Aux only)

NOTE: To clear any error, reset the instrument using the Console. If the error persists, follow the corrective actions listed in the tables.

NOTE: This section is intended for reference only. To troubleshoot symptoms using a systematic process, see [Troubleshooting System-level Symptoms, page 2](#).

All errors/warnings index

Table 66 is an alphabetical list of all ACQUITY UPLC H-Class error states and warnings. Select the initial letter to jump to the relevant section, or select the specific error/warning:

A **B** **C** **D** **E** **F** **G** **H** **I** J K **L** **M**
N O **P** Q **R** **S** **T** **U** **V** W X Y **Z**

Table 66: All errors/warnings

Initial letter	Error or warning
A	• Ambient temperature range error (value), page 167 - sample manager • Ambient temperature range error, page 203 - column compartment • Autosampler door open, page 168 • Automatic prime failure, page 154 • Auto shutdown invoked, page 203
B	• Battery backed file system reset (value), page 168 - QSM • Battery backed memory HW failure, page 168 - QSM • Battery backed memory h/w failure, page 204 - column compartment • BSM pressure failed to decay, page 204

Table 66: All errors/warnings

Initial letter	Error or warning (continued)
C	• Calibration pin not present, page 168 • Column active preheater configured but not detected, page 168 • Column [n] active preheater configured but not detected, page 204 • Column active preheater HW not supported, page 168 • Column [n] active preheater h/w not supported, page 204 • Column [n] active preheater module 24V fuse h/w fault, page 205 • Column active preheater not configured but detected, page 169 • Column [n] active preheater not configured but detected, page 205 • Column active preheater over-temp fuse h/w fault, page 169 • Column [n] active preheater overtemp fuse h/w fault, page 206 • Column active preheater temperature range error, page 170 • Column [n] active preheater temperature range error, page 206 • Column active preheater temperature sensor hardware fault, page 171 • Column [n] active preheater temperature sensor h/w fault, page 207 • Column (n) door open while running , page 207 • Column (n) heater-cooler 24V fuse h/w fault, page 208 • Column heater cable disconnected, page 171 • Column heater communications time out, page 172 • Column heater door open while running, page 172 • Column heater HW not supported, page 173 • Column heater not present HW fault, page 173 • Column heater over-temp switch HW fault, page 173 • Column (n) heater-cooler over-temp switch h/w fault, page 209 • Column leak sensor enabled, page 173 • Column leak sensor disabled, page 173 • Column leak sensor not present, page 173 • Column manager door is open, page 209 • Column module 24V fuse h/w fault, page 210 • Column module analog fuse h/w fault, page 210 • Column module motor fuse h/w fault, page 210 • Column position in method differs from sample set, page 210 • Column [n] temperature range error, page 210 • Column [n] temperature sensor HW fault, page 211 • Column temperature range error, page 174 • Column temperature sensor hardware fault, page 174 • Communication failure, page 174 • Conflicts with the instrument LAN, page 174 • Cycle power to complete software update, page 154
D	• Degasser fuse h/w failure (F8), page 154 • Degasser h/w failure (number), page 155 • Degasser vacuum HW error (number), page 156 • Diagnostic test interrupted by user, page 211 • Drawing sample rate excessive (value), page 174

Table 66: All errors/warnings

Initial letter	Error or warning (continued)
E	• eCord connected, page 175 - SM-FTN • eCord connected, page 211 - Column compartment • eCord data invalid, page 175 - SM-FTN • eCord data invalid, page 211 - Column compartment • eCord disconnected, page 175 - SM-FTN • eCord disconnected, page 211 - Column compartment • eCord driver h/w fault, page 211 • eCord h/w fault, page 211 • eCord is required, page 175 - SM-FTN • eCord not present, page 175 - SM-FTN • eCord not present, page 212 - Column compartment • eCord s/w fault, page 211 • Ethernet cable disconnected, page 176 - SM-FTN
F	• Fan fuse h/w failure (F1), page 159 • Fuse h/w fault: n, page 212 - Column compartment
G	• General failure, page 159 - Solvent manager • General failure, page 176 - SM-FTN • General failure, page 212 - column compartment • General failure: Not ready to start run, page 159 - Solvent manager • General failure: Not ready to start run, page 176 - SM-FTN • GPV fuse h/w failure (F3), page 159
H	• Host aborted, page 212
I	• Injection count exceeded (value), page 176 - SM-FTN • Injection count exceeded, page 212 - Column compartment • Injection valve home HW fault, page 176 • Injection valve move HW fault, page 177 • Instrument powered off, page 212 • Instrument powered on, page 212
L	• Leak detected, page 177 - SM-FTN • Leak detected (column), page 177 - SM-FTN • Leak detected, page 213 - Column compartment • Leak detector enabled, page 213 • Leak detector disabled, page 213 • Leak detector not present, page 213 • Leak sensor disabled, page 160 • Leak sensor enabled, page 160 • Leak sensor not detected on lowest installed unit, page 213 • Leak sensor not present, page 161 • Left valve home h/w fault, page 214 • Left valve move h/w fault, page 214 • Lower auxiliary module 24V fuse h/w fault, page 214 • Lower auxiliary module analog fuse h/w fault, page 214 • Lower auxiliary module configured but not detected, page 215
M	• Minimum SM firmware x.xx not found Please upgrade, page 177 • Missing/wrong plate or vial, page 178 • Modified SN (serial number), page 178 • Modified SN, page 215 • Motor lost sync, page 161

Table 66: All errors/warnings

Initial letter	Error or warning (continued)
N	• Needle arm h/w lost steps, page 178 • Needle arm home HW fault, page 180 • Needle arm move h/w fault, page 181 • Needle move fault due to foot (Zp) not home, page 181 • Needle move fault due to needle (Z) not home, page 181 • Needle/seal move limit exceeded, page 182 • Needle/seal move limit short, page 182
P	• Plate present, no plate expected, page 182 • Power supply [number] V out of range, page 161 • Power supply h/w -15V out of range, page 162 • Power supply h/w 5V out of range, page 162 • Power supply h/w 15V out of range, page 162 • Power supply h/w 24V out of range, page 162 • Power supply HW fault [21.6 to 26.4 volts], page 183 • Prime failure, page 162 • Pump h/w homing error (number), page 163 • Pump h/w motor driver fault, page 163 • Pump h/w motor lost synchronization (number), page 163 • Pump HW overpressure, page 164 • Pump motor fuse h/w failure (F2), page 164
R	• Rotary tray home hardware fault, page 183 • Rotary tray move h/w fault, page 183 • Rotary tray not calibrated, page 183 • Right valve home h/w fault, page 215 • Right valve move h/w fault, page 215

Table 66: All errors/warnings

Initial letter	Error or warning (continued)
S	• Sample fluidics high pressure limit (value), page 184 • Sample heat sink temperature sensor hardware fault, page 186 • Sample heater/cooler over temperature or HW fault (value), page 185 • Sample manager leak sensor disabled, page 187 • Sample manager leak sensor enabled, page 187 • Sample manager leak sensor not present, page 188 • Sample pressure sensor HW fault (value), page 188 • Sample syringe hardware lost steps, page 188 • Sample syringe home HW fault, page 189 • Sample syringe move to sensor HW fault, page 189 • Sample temperature range error (value), page 190 • Sample temperature sensor HW fault, page 191 • Sample valve home HW fault, page 191 • Sample valve move HW fault, page 192 • Sample volume out of range, page 192 • Seal force sensor h/w fault (value), page 193 • Seal not calibrated, page 194 • Seal residual force high while needle moving down, page 195 • Seal residual force limit exceeded (Z-up), page 195 • Seal residual force limit exceeded (Z-wash), page 197 • Seal wash pump fuse h/w failure (F4), page 164 • Solvent selection valve fuse h/w failure (F7), page 164 • Stop flow input activated, page 165 • Stopped flow due to loss of remote communications, page 165 • Stopped flow due to loss of remote communications with Sample Manager, page 165 • System over pressure (number), page 166 • System under pressure (number), page 166
T	• Temperature controller watchdog time-out, page 197 - SM-FTN • Temperature controller watchdog time-out, page 215 - Column compartment • Transducer h/w range error, page 166 • Tray lost synchronization (value), page 197 • Tray move fault due to foot (Zp) not home, page 198 • Tray move fault due to needle (Z) not home, page 198 • Two eCords connected to column, page 216
U	• Upper auxiliary module 24V fuse h/w fault, page 216 • Upper auxiliary module analog fuse h/w fault, page 216 • Upper auxiliary module configured but not detected, page 216
V	• Value cycles exceeded, page 216 • Vent valve fuse h/w failure (F6), page 167 • Vent valve h/w failure, page 167
Z	• Z-axis calibration out of range, page 198 • Z-axis HW lost steps (value), page 198 • Z-axis home HW fault, page 199 • Z-axis move HW fault, page 199 • Zp-axis calibration out of range, page 200 • Zp-axis home HW fault, page 200 • Zp axis HW lost steps (value), page 201 • Zp-axis move HW fault, page 202 • ZZp not home on a needle move, page 202

Solvent manager errors

Table 67: Solvent manager errors

Error or warning	Possible cause	Corrective action
Automatic prime failure Solvent manager not primed during automatic prime; system unable to prime	Hardware error during the prime sequence (e.g., a problem with the pumping sequence or vent valve)	Check the Console log for additional errors associated with this failure. If problem persists, contact GSS .
Battery backed memory HW failure	Battery problem	1. Reseat or replace battery on CCPU PCB. 2. Restore solvent manager serial number (if pump A PCB lost battery backup).
	CCPU PCB problem	Replace the CCPU PCB. See Replacing the CCPU PCB .
Communications failure	Communications problem	1. Make sure the Ethernet cable is connected. 2. Make sure the instrument is turned on. 3. For further troubleshooting, see Troubleshooting Software/Communications Problems .
Cycle power to complete software update Solvent manager must be rebooted after firmware update	Software update is incomplete	Recycle power to solvent manager.
Degasser fuse h/w failure (F8)	Fuse open or defective	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Cable between personality PCB and vacuum sensor PCB is shorted	Replace cable and fuse.
	Bad vacuum sensor PCB	Replace sensor PCB and fuse.
	Bad personality PCB	Replace personality PCB. See Replacing the Personality PCB .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Degasser h/w failure (number) Problems with degasser components can cause erratic flow rate or pump pulsations. The number in parentheses explains the reason for the error. 0: General degasser hardware failure. 1: On startup, the pressure reading from the degasser pressure transducer was below 0 kPa (0 bar, 0 psi) or above 108 kPa (1.08 bar, 15.663 psi).	Air in solvent lines	1. Ensure that: - all solvent lines are fully primed - all unused lines are plugged - the degasser vent tubing is unobstructed and not submerged in fluid 2. Prime the solvent manager.
	Degasser vent tube blocked, crimped, or submerged in liquid	Reseat the degasser vent tube so it is not crimped or submerged.
	Loose inlet or outlet degasser fittings	Check the fittings. If there are visible leaks, tighten fittings or replace tube and fittings.
	Internal degasser vacuum lines damaged or disconnected	Connect lines or replace as necessary.
	Bad transducer PCB or transducer PCB cable	1. Test the transducer PCB by plumbing it directly to the vacuum pump. 2. If the vacuum is out of range (0-108 kPa), replace the transducer PCB and transducer PCB cable. See : Replacing the Vacuum Transducer PCB Degasser Transducer PCB
	Degasser chamber problem	Test the chamber: - Pinch the vacuum line going to the chamber to isolate the pump and vacuum sensor PCB. - Power-cycle the pump. - If no error occurs, diagnose the bad chamber or fitting and replace as necessary. NOTE: <i>If there is liquid in the vacuum system, remove all liquid. Take the tubing off the pump and let it run for 10 minutes.</i> See QSM Technical Reference Sheets .
	Bad personality PCB	Replace the personality PCB.

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Degasser vacuum HW error (number) Problems with degasser components can cause erratic flow rate or pump pulsations. The number in parentheses explains the reason for the error. 1: It took more than 3 minutes for the pressure to fall to 0.909 psi. 2: The pressure rose more than 0.097 psi over two consecutive 15-minute segments. 3: The degasser vacuum pressure rose above 1.547 psi.	Air in solvent lines	1. Ensure that: - all solvent lines are fully primed - all unused lines are plugged - the degasser vent tubing is unobstructed and not submerged in fluid 2. Prime the solvent manager.
	Degasser vent tube blocked, crimped, or submerged in liquid	Reseat the degasser vent tube so it is not crimped or submerged.
	Loose inlet or outlet degasser fittings	Check the fittings. If there are visible leaks, tighten fittings or replace tube and fittings.
	Internal degasser vacuum lines damaged or disconnected	Connect lines or replace as necessary.
	Bad transducer PCB or transducer PCB cable	1. Test the transducer PCB by plumbing it directly to the vacuum pump. 2. If the vacuum is out of range (0-108 kPa), replace the transducer PCB and transducer PCB cable. See : Replacing the Vacuum Transducer PCB Degasser Transducer PCB
	Bad personality PCB	Replace the personality PCB. See: Replacing the Personality PCB Personality PCB Tech Ref
	Vacuum cable problem	Investigate vacuum cables from degasser chamber manifold to degasser vacuum pump. Replace if necessary.

Table 67: Solvent manager errors (continued)

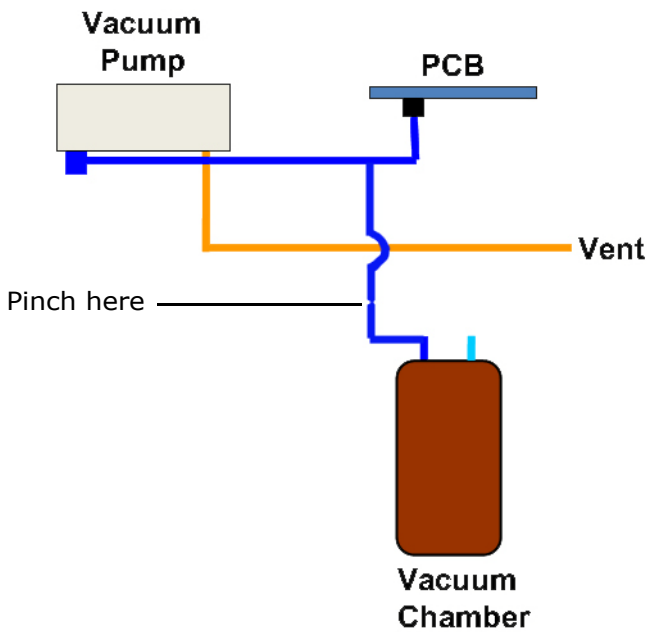
Error or warning	Possible cause	Corrective action
Degasser vacuum HW error (number) (continued)	Degasser chamber problem	Test the chamber: 1. Pinch the vacuum line going to the chamber to isolate the pump and vacuum sensor PCB (see Figure 87). 2. Power-cycle the pump. 3. If no error occurs, diagnose the bad chamber or fitting and replace as necessary. NOTE: If there is liquid in the vacuum system, remove all liquid. Take the tubing off the pump and let it run for 10 minutes. See Replacing the GPV, Inline Filter, and Degasser Chamber.
	 Figure 87 - Testing the degasser chamber	

Table 67: Solvent manager errors (continued)

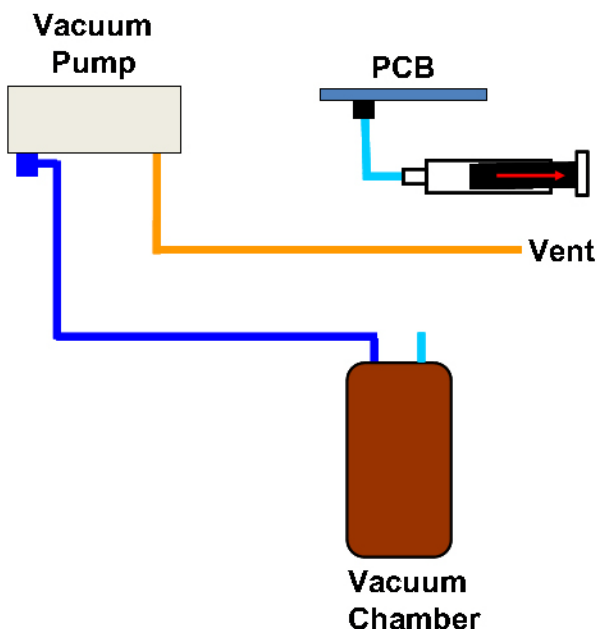
Error or warning	Possible cause	Corrective action
Degasser vacuum HW error (number) (continued)	Vacuum sensor PCB is defective	Test the degasser transducer PCB: 1. Connect a syringe directly to the transducer PCB (see Figure 88). 2. Pull the syringe plunger to manually draw a vacuum. 3. From the Console, monitor the vacuum pressure. If the pressure: • decreases smoothly and then stabilizes, the vacuum control PCB is functioning properly. • is unstable or exceeds 0.9 psi, replace the degasser transducer PCB. See Replacing the Vacuum Transducer PCB.
	 Vacuum Pump PCB Vent Vacuum Chamber <i>Figure 88 - Testing the vacuum sensor PCB</i>	
	Degasser pump problem	Replace the degasser pump. See "Replacing the Degasser Pump" in the Service Video Library.

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Ethernet cable was disconnected This error occurs after communications are re-established; it will not stop the instrument.	Ethernet cable loose or disconnected from the instrument or from the switch	1. Connect the Ethernet cable from the solvent manager to an Ethernet port in the sample manager. 2. Reset the solvent manager. 3. If the alarm persists, connect a shielded Ethernet cable.
	Improper or defective Ethernet cable or switch, or cable from switch to computer	Replace the cable with a shielded Ethernet cable.
	Defective cable from Ethernet port to CCPU, or defective CCPU	Replace the cable and/or the CCPU. See Replacing the CCPU PCB .
Fan fuse h/w failure (F1)	Fuse (F1) open or defective	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Defective fan	Replace the fan.
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
General failure	Software problem	1. Connect to HyperTerminal to diagnose the problem. 2. If problem persists, contact GSS . See Using Telnet and HyperTerminal .
General failure: Not ready to start run	Jumper installed on position 2 of the solvent manager personality PCB. This causes the QSM to run without an SM-FTN.	Remove the jumper from position 2 on the solvent manager personality PCB.
GPV fuse h/w failure (F3)	Bad GPV	1. Replace the fuse. 2. Open and close each GPV channel individually and recycle power to determine which one is blowing the fuse. 3. If the fuse blows on power-up, disconnect GPV pair A/B. 4. Replace the fuse again and power-up. 5. If the fuse is OK, replace GPV pair A/B.

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Intelligent Intake Valve fuse h/w failure	Fuse open or defective	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Bad i2Valve	Replace the i2Valve.
	Bad internal cable	Replace the cable.
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Intelligent Intake Valve h/w disconnected	Intelligent intake valve on the primary pump was disconnected at power-up	Make sure the intelligent intake valve is connected.
Intelligent Intake Valve h/w watchdog time out The current to the intelligent intake valve was applied longer than the maximum allowed time, and power to the valve was turned off.	Memory error	Reset the solvent manager.
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Leak detected	Fluid in the leak sensor	1. Isolate the cause of the leak and repair the module. 2. Remove and dry the sensor. 3. Remove fluid in the leak sensor reservoir and dry it. 4. Reinstall the sensor. 5. Reset the solvent manager. 6. If the alarm persists, power-off and power-on again.
Leak sensor disabled	The leak sensor is installed but not enabled. Displayed for information only.	No action is required.
Leak sensor enabled	The leak sensor is installed and enabled. Displayed for information only.	No action is required.

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Leak sensor not present	Leak sensor not installed, leak sensor not enabled in console, or leak sensor cable unplugged	1. Install the leak sensor if it is not present. 2. Enable the leak sensor (Console system tree > Control > Leak sensors). 3. Ensure the leak sensor cable is connected. 4. Reset the solvent manager. 5. If the alarm persists, power-off and power-on again. 6. If the alarm persists, call GSS.
Leak detected	Fluid is in a leak sensor	Remove and dry the sensor, remove fluid in the leak sensor reservoir and dry it, reinstall the sensor, and then reset the instrument. See ACQUITY UPLC Leak Sensor Maintenance Instructions.
Liters pumped maintenance limit exceeded (number) The pumped volume threshold has been exceeded. The number in parentheses is the volume that caused the message.	Displayed for information only	1. Perform preventive maintenance or increase the pumped volume maintenance threshold (optional) 2. Reset maintenance counter.
Modified SN	User has manually changed the instrument's serial number NOTE: <i>A serial number is required for proper communications.</i>	Displayed for information only; no action required.
	Battery or CCPU PCB problem	Check/replace the battery (see Figure 87) or CCPU PCB. See Replacing the CCPU PCB.
	Firmware problem	1. Recycle power to the pump. 2. Reload latest version of firmware.
Motor lost sync	See Pump h/w motor lost synchronization (number) , page 163	See Pump h/w motor lost synchronization (number) , page 163
Power supply [number] V out of range	Bad power supply	Replace power supply. See Replacing the Power Supply.

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Power supply h/w -15V out of range The power supply electronics reported that the -15V signal was outside the acceptable range of 67% to 133%	Bad power supply	Measure 24 V off the power supply cable. If necessary, replace power supply. See Replacing the Power Supply .
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Power supply h/w 5V out of range The power supply electronics reported that the 5V signal was outside the acceptable range of 85% to 115%	Bad power supply	Measure 24 V off the power supply cable. If necessary, replace power supply. See Replacing the Power Supply .
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Power supply h/w 15V out of range The power supply electronics reported that the 15V signal was outside the acceptable range of 85% to 115%	Bad power supply	Measure 24 V off the power supply cable. If necessary, replace power supply. See Replacing the Power Supply .
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Power supply h/w 24V out of range The power supply electronics reported that the 5V signal was outside the acceptable range of 85% to 115%	Bad power supply	Measure 24 V off the power supply cable. If necessary, replace power supply. See Replacing the Power Supply .
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Prime failure	Hardware error during the prime sequence (e.g., a problem with the pumping sequence or vent valve)	Check HyperTerminal for a more detailed description of the error: • Enter "nvfdump" into the command prompt to get last 10 error messages. • Troubleshoot the error displayed. See Using HyperTerminal, Telnet, and Ping .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Pump h/w homing error (number) The number in parentheses specifies the type of homing error. 1: Excessive restriction on the primary plunger 2: Travel range exceeded on the primary plunger 3: Excessive restriction on the accumulator plunger 4: Travel range exceeded on the accumulator plunger	Blockage in the solvent manager plumbing, between the pump head and vent valve, caused a rapid spike in pressure (1 & 3 only)	1. Prime the solvents, and check the vent line for any blockages. 2. Check other tubing for blockages. 3. If necessary, replace the tubing. 4. Reset the solvent manager.
	Motor power cable problem	1. Reseat motor power cables. 2. Reseat motor encoder cables.
	Support plate is loose or not installed correctly (2 & 4 only)	Make sure support plate is installed correctly.
	Actuator problem	Replace the actuator. See Replacing an Actuator Assembly .
Pump h/w motor driver fault Pump motor driver electronics have signalled that an error has occurred	Solvent manager needs reset	Recycle power to the solvent manager.
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .
Pump h/w motor lost synchronization (number) The number in parentheses specifies the error's location. 0: Primary pump 1: Accumulator pump	Clog or restriction between the pump head and the transducer	1. Reset the solvent manager. 2. If the alarm persists: - locate the fitting(s) between the appropriate pump head and pressure transducer. - Remove the fitting from the pump head, and then run the pump. 3. If the alarm does not return, install new tubing.
	Sample needle tip defect, causing drop in pressure	1. Reset the solvent manager. 2. If the alarm persists, replace the needle and needle seal. 3. Recharacterize the needle seal and perform the needle seal readiness test.
	Motor or encoder cables are incorrectly installed	Install cables correctly.
	Bad actuator	Replace the actuator.
	Bad personality PCB	Replace the personality PCB. See Replacing the Personality PCB .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Pump HW overpressure A system pressure greater than 106,870 kPa (1069 bar, 15,500 psi) can cause this error.	System pressure too high	See High system pressure, page 64 .
Pump motor fuse h/w failure (F2)	Blown fuse or drive overcurrent	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Cable has shorted	Check the cable and replace if necessary.
	Motor has shorted	Using a digital voltmeter, check the coil resistance (should be 0.11 ohms). If necessary, replace the motor.
	Drive component has failed	Replace the personality PCB. See Replacing the Personality PCB .
Seal wash pump fuse h/w failure (F4)	Seal wash pump failure	1. Measure the resistance of the seal wash pump (should be about 144 ohms +/- 15%). 2. If resistance is out of range, replace the seal wash pump.
	Fuse (F4) open or defective	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Damaged electronics	If fuse blows again or seal wash pump fails to operate, replace the personality PCB.
Solvent selection valve fuse h/w failure (F7)	Blown fuse or drive overcurrent	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Cable has shorted	Check the cable and replace if necessary.
	Motor has shorted	Using a digital voltmeter, check the coil resistance (should be 1.65 ohms). If necessary, replace the motor.
	Drive component has failed	Replace the personality PCB. See Replacing the Personality PCB .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Stop flow input activated	The pump received a stop flow contact; contact closure input triggered on back of the binary solvent manager	1. Investigate what is triggering the contact closure input (e.g., gas on for MS). 2. If you did not stop the flow, check rear-panel connections.
	External noise	Use a shielded cable.
	Bad personality PCB	Replace personality PCB. See Replacing the Personality PCB .
Stopped flow due to loss of remote communications	Flow stopped because the communications to the instrument was lost as a result of an instrument problem or Ethernet cable problem	1. Check the Ethernet cables and replace with shielded Ethernet cables if needed. 2. Power-off the solvent manager and power-on again. 3. Reset the workstation. 4. Reset the solvent manager.
	Ethernet switch problem in the sample manager	Ensure the sample manager is powered on.
	Bad internal cable from personality PCB to CCPU	Replace cable.
	Bad CCPU PCB	Replace CCPU PCB. See Replacing the CCPU PCB .
	Bad personality PCB	Replace personality PCB. See Replacing the Personality PCB .
Stopped flow due to loss of remote communications with Sample Manager	Flow stopped because the communications to the sample manager was lost as a result of a sample manager problem or Ethernet cable problem	1. Check the Ethernet cables and replace with shielded Ethernet cables if needed. 2. Power-off the solvent manager and power-on again. 3. Reset the workstation. 4. Reset the sample manager and solvent manager.
	Sample manager communication failure	See Troubleshooting Empower Software/Communications Problems .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
System over pressure (number) - The pressure within the solvent manager exceeds the high pressure limit that the user set in the solvent manager method editor. - The number in parentheses is the pressure that caused the error.	The system is exceeding the high pressure limit that was entered in the software	See High system pressure, page 64 .
System under pressure (number) The system is below the low pressure limit that the user set in the solvent manager method editor, or there is no pressure. The number in parentheses is the pressure that caused the error. The solvent manager leak test determines whether there is a leak in the solvent manager.	System pressure too low	See Low system pressure, page 68 .
Transducer h/w range error	Transducer problem (includes transducer, transducer cable, transducer PCB, or transducer interconnect PCB)	- Swap each transducer connector from one actuator to another to see if the transducer is the problem. - Make sure the cable from the transducer to the transducer interconnect PCB is properly connected. If the cable connections are OK, replace the transducer interconnect PCB (to remove the PCB, disconnect the transducer cables at the top of the front panel and remove the four T10 screws from the PCB). - If the error persists, replace the personality PCB. See Replacing the Personality PCB .

Table 67: Solvent manager errors (continued)

Error or warning	Possible cause	Corrective action
Vent valve fuse h/w failure (F6)	Blown fuse or drive overcurrent	Troubleshoot the fuse failure. See Troubleshooting a Blown PCB Fuse .
	Cable has shorted	Check the cable and replace if necessary.
	Motor has shorted	Using a digital voltmeter, check the coil resistance (should be 1.65 ohms). If necessary, replace the motor.
	Drive component has failed	Replace the pump ROHS PCB.
Vent valve h/w failure	Vent valve problem	1. Reseat vent valve power cable. 2. Reseat vent valve encoder cable. 3. Replace vent valve assembly.
	Personality PCB problem	Check/replace the personality PCB. See Replacing the Personality PCB .

Sample manager errors

This list includes CH-A and CH-30A errors.

Table 68: Sample manager-FTN error messages/error states

Error or warning	Possible cause	Corrective action
Ambient temperature range error (value)	Room temperature (measured at sample manager) is outside the operational temperature range of the system	Set the room temperature to the system's operational temperature range: from 4.0 to 40.0° C. See ACQUITY UPLC H-Class System Site Preparation Guide.
	Air filter clogged	Check/replace air filter.
	Loose cable connection	Check/secure cable connection on control PCB. See Control PCB .
	Ambient temperature sensor PCB damaged	Replace ambient temperature sensor PCB. See Sensor Interface PCB .
	Control PCB damaged	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Autosampler door open	Door open (when it should be closed)	1. Visually inspect and remove any obstructions. 2. Make sure the tray slider is in the correct position. 3. Firmly close the sample manager door.
Battery backed file system reset (value)	Battery failure	Replace battery and/or electronics. Note that all calibration parameters were also probably lost.
Battery backed memory HW failure	Battery or electronics failure	Replace battery and/or electronics. Note that all calibration parameters were also probably lost.
Calibration pin not present	A rotary tray calibration has started, but the calibration pin is not present or not in the correct location.	Insert the calibration pin. NOTE: Verify that the pin is properly inserted and the rotary tray correctly installed. See Calibrate rotary tray procedure, page 149.
Column active preheater configured but not detected	User configures APH but instrument does not detect it	If the APH is not present, remove it from the configuration. If the APH is present, reseal the connections.
	Bad ID on APH	Test APH and, if necessary, replace it. See Active Preheater Technical Reference Sheet (715003021).
	Active heater (flex circuit) cable failure	1. Remove APH and inspect flex circuit that forms the internal socket. 2. If corrosion or damage is present, replace the CH-A front end assembly. See Replacing the Column Heater Front End.
Column active preheater HW not supported	The column heater electronics does not recognize the APH	Disconnect the APH and plug it into the connector pocket on the other side of the column heater. • If the problem is resolved, replace the column heater front end. • If the problem still exists, replace the APH.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column active preheater not configured but detected	Instrument detects the APH but the user has not configured it	Configure the APH in the Console. If the APH is not present, remove it from the configuration.
Column active preheater over-temp fuse h/w fault	APH is improperly connected	Reseat the APH.
	Bad thermal fuse	1. Test the fuse: • Let the APH cool down. • Use a digital multimeter to check the continuity across APH connector pins 1, 2, 3, and 4. 2. If the circuit is open, the fuse is damaged. Replace the APH. See Active Preheater Technical Reference Sheet (715003021) .
	Bad thermistor	Replace the APH.
	Active heater (flex circuit) cable failure	1. Remove APH and inspect flex circuit that forms the internal socket. 2. If corrosion or damage is present, replace the CH-A front end assembly. See Replacing the Column Heater Front End .
	Data cable problem	Replace the CH-A PCB.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column active preheater temperature range error APH went out of range	APH improperly seated or defective	Reseat the APH. If problem persists, replace the APH.
	Column heater front-end problem	Check/reseat connections. If necessary, replace the column heater front end. To test: 1. Access the PCB (remove front end and back panel of CH-A). 2. Unplug the 4-foot right-angle cable. 3. Use a digital multimeter to check the thermistor at pin-outs 5 to 6. • If resistance is out of range, replace the whole front end. • If resistance is within range, investigate another cause. See Active Preheater Technical Reference Sheet (715003021) .
	CH-A PCB problem	Replace the CH-A PCB. See CH-A Technical Reference .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column active preheater temperature sensor hardware fault	APH improperly seated or defective	Reseat the APH. If problem persists, replace the APH.
	Column heater front-end problem	Check/reseat connections. If necessary, replace the column heater front end. To test: 1. Access the PCB (remove front end and back panel of CH-A). 2. Unplug the 4-foot right-angle cable. 3. Use a digital multimeter to check the thermistor at pin-outs 5 to 6. • If resistance is out of range, replace the APH. • If resistance is within range, replace the whole front end. See Active Preheater Technical Reference Sheet (715003021).
	CH-A PCB problem	Replace the CH-A PCB.
Column heater cable disconnected	Loose cable connection or cable not connected	1. Power off the sample manager. 2. Reseat the column heater cable. 3. Power on the sample manager.
	CH-A PCB problem	Replace the CH-A PCB.
	Sample manager PCB problem	Replace the sample manager PCB.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column heater 24V fuse h/w fault	Peripheral cable or component failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CH-A Technical Reference • SM Control PCB Technical Reference
	Bad APH	Check APH with a digital multi-meter. If the APH is bad, replace it. See Active Preheater Technical Reference Sheet (715003021) .
	Bad PCB	Replace the CH-A PCB. See CH-A Technical Reference .
	Active heater (flex circuit) cable failure	1. Remove APH and inspect flex circuit that forms the internal socket. 2. If corrosion or damage is present, replace the CH-A front end assembly. See Replacing the Column Heater Front End .
	SM Control PCB is bad	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Column heater communications time out A disconnect has been identified	4-foot right-angle cable problem	Reseat the cable.
	Sample manager control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
	CH-A problem	Replace the CH-A.
Column heater door open while running This error will shut down a run in progress NOTE: This error can only occur during a run time of at least 1.5 minutes.	Door not completely closed	1. Clear any obstructions from the door, and close the door latch securely. 2. Reset the sample manager. NOTE: There is a 1-minute timeout.
	Magnet in wrong position	Correctly position the magnet.
	Door sensor cable problem	Check/reseat cable.
	CH-A PCB problem	Replace the CH-A PCB. See CH-A Technical Reference .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column heater HW not supported Sample manager reads a wrong ID	CH-A PCB problem	Replace the CH-A PCB.
	CH-A front-end problem	Replace the CH-A front end assembly. See Replacing the Column Heater Front End .
Column heater not present HW fault	4-foot right-angle cable problem	Reseat the cable.
	CH-A PCB problem	Replace the CH-A PCB. See CH-A Technical Reference .
	CH-A front-end problem	Replace the CH-A front end assembly. See Replacing the Column Heater Front End .
Column heater over-temp switch HW fault	See Column (n) heater-cooler over-temp switch h/w fault, page 209 .	See Column (n) heater-cooler over-temp switch h/w fault, page 209 .
Column leak sensor enabled Informational message	Displayed for information only	No action is required.
Column leak sensor disabled	Column leak sensor not enabled.	1. Enable the column leak sensor. 2. If the alarm persists, reset the sample manager. 3. If the alarm persists, power-off and power-on again. 4. If the alarm persists, contact Waters Technical Service.
Column leak sensor not present	Column leak sensor enabled but not installed	1. Install the column leak sensor in the column compartment. 2. If the alarm persists, reset the sample manager. 3. Power-off and power-on again. 4. Disable the column leak sensor. 5. Contact Waters Technical Service.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Column temperature range error Column temperature is out of range	Method configuration is wrong	Did the error occur during a run? If yes, reconfigure the method. If error did not occur during a run, investigate other causes (see below).
	Door open (when it should be closed)	Make sure door is closed.
	Ambient temperature out of specification	Make sure ambient temperature is within specifications. See ACQUITY UPLC H-Class System Site Preparation Guide .
Column temperature sensor hardware fault	CH-A front end problem	Replace the CH-A front end assembly. See Replacing the Column Heater Front End .
Communication failure	User powered off instrument before the software shut down	1. Reset the instrument from the Console. 2. If necessary, reboot the computer and the instrument.
	Ethernet cable or switch problem	See Troubleshooting Software/Communications Problems .
Conflicts with the instrument LAN	ICS found two network cards with the same address	Check the network adapter configuration on your local PC. Contact your local network administrator to resolve the issue.
Drawing sample rate excessive (value)	Syringe draw rate too high, possibly because the solution is viscous	Decrease the syringe draw rate. (In the sample manager instrument method editor, select General tab > Advanced button > Syringe Draw Rate.)
	Clogged needle	1. Check/clean needle tip 2. If necessary, replace the needle.
	Clogged extension loop	Examine loop for damage, and replace if necessary.
	Wrong vial cap	Use vial cap with pre-slit septa to prevent needle/septa sealing.
	Clogged injection valve cartridge	1. Remove and back-flush injection valve cartridge. 2. If problem persists, replace the injection valve cartridge.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
eCord connected Informational message	Displays when the eCord is connected to the instrument	Displayed for information only; no action required.
eCord data invalid Cannot read or display the eCord information because of an eCord connection problem	eCord connection problem	1. Use the column without the eCord, or check the connection of the eCord fob to the instrument; make sure it is fully connected. 2. Check the connection from the eCord to the personality PCB; tighten if necessary.
	Column problem	Use the column without the eCord, or replace the column.
	eCord problem	Replace the column with eCord.
	Sample manager control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
eCord disconnected Informational message	eCord fob is disconnected from the instrument	Displayed for information only; no action required.
	eCord cable to the PCB is broken	Replace the eCord cable.
eCord is required	The sample manager is configured to run with the eCord on a column, but the system does not detect an eCord.	1. If you want to run with the eCord, attach the eCord fob to the receptacle on the side of the column compartment. 2. If you do not intend to run the column with an eCord, turn off the option. 3. Reset the sample manager.
eCord not present Displays when eCord is disconnected while the system is accessing the eCord	eCord connection problem	1. Verify that the eCord fob is fully connected to the instrument. 2. Check the connection from the eCord to the personality PCB; tighten if necessary.
	eCord problem	Use the column without the eCord, or replace the column with eCord.
	Sample manager control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
	eCord cable to the PCB is broken	Replace the eCord cable to the PCB.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Ethernet cable disconnected	Ethernet cable was not connected to the instrument during the initialization/reset process. The error occurs when the cable is reconnected.	1. Connect a shielded Ethernet cable. 2. Check cable integrity; try another cable if necessary. 3. Reset the sample manager. 4. If the alarm persists, power-off and power-on again. 5. If the alarm persists, contact GSS.
General failure	Software problem	1. Check the firmware installed on the system; make sure all versions match. 2. Reinstall firmware on the system. 3. Upgrade the firmware on the system.
	Invalid parameters used	Check the parameters in the instrument method.
General failure: Not ready to start run	Jumper installed on position 2 of the solvent manager personality PCB. This causes the QSM to run without an SM-FTN.	Remove the jumper from position 2 on the solvent manager personality PCB.
Injection count exceeded (value) Information message	Injection count exceeded user-set limit	Enter a higher injection count limit or perform scheduled maintenance.
Injection valve home HW fault Injection valve failed to home during power-up or on reset after an injection valve error.	Problem with encoder, cable, injection valve drive, motor drive cable, or motor	Reboot the instrument. If problem persists, replace the injection valve drive.
	Sample manager control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Injection valve move HW fault Injection valve failed to complete move to designated position.	Cable connection problem	1. Check the cable from the injection valve to the fluidics interface PCB. 2. Check the cable from the fluidics interface PCB to the personality PCB.
	Injection valve cartridge problem	1. Recycle power to the instrument. 2. Inspect the injection valve cartridge and ensure it is securely fastened to the valve drive. 3. If error persists, replace the injection valve cartridge.
	Injection valve drive problem	Replace the injection valve drive.
	Sample manager control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Leak detected	Fluid is in a leak sensor	Remove and dry the sensor, remove fluid in the leak sensor reservoir and dry it, reinstall the sensor, and then reset the detector. See ACQUITY UPLC System Operator's Guide ("Resolving leak sensor errors")
Leak detected (column)	Fluid is in a leak sensor	Remove and dry the sensor, remove fluid in the leak sensor reservoir and dry it, reinstall the sensor, and then reset the detector. See ACQUITY UPLC System Operator's Guide ("Resolving leak sensor errors").
Minimum SM firmware x.xx not found Please upgrade	Firmware too old as detected by ICS	Upgrade firmware.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Missing/wrong plate or vial Incorrect plate/vial on instrument	Plate/vial not present	Confirm that the defined plate or vial is in the correct position.
	Plate/vial not specified correctly	Confirm that the plate is defined correctly in the software.
	Plate/vial is shorter than expected	Select the correct plate/vial, and ensure that the ANSI version of the plate is selected.
	Top-of-plate sensor flag obstructed	Check the top-of-plate sensor for any restrictions or obstructions. (See Figure 74.)
	Seals not calibrated after sample organizer installation	Make sure to calibrate the seals after installing the sample organizer.
	Needle carriage flex cable damaged	Replace the needle carriage flex cable/PCB. (See Figure 74.)
	PCB problem	1. Replace the sensor PCB. 2. If problem persists, replace the control PCB.
Modified SN (serial number) Informational message	Serial number was modified	Displayed for information only; no action required.
Needle arm h/w lost steps R-axis has lost more than 50 steps	R-axis obstructed	1. Check the sample chamber for any obstructions to movement of the R-axis. 2. Clear any obstructions and reset the sample manager.
	Excessive friction in R-carriage	1. Check the needle to make sure it is fully retracted. 2. From the Console, disable the motors. 3. Try to manually move the R-axis. It should move freely.
	Top-of-plate sensor obstructed	1. Inspect the sample chamber to make sure that nothing is blocking the sensor. 2. Clear any obstructions and reset the sample manager.
	Sensor cable loose	Check the sensor cable. Make sure it is securely plugged in and that the pins are secure.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Needle arm h/w lost steps (continued)	Top-of-plate sensor problem	1. Ensure the sensor and flag are secure and not damaged. 2. From the interactive display, check to see if the sensor lights up when you block the sensor light with an opaque object such as a business card. 3. If it does not light up, replace the sensor.
	R-axis lead screw nuts loose	Adjust lead screw nuts (Figure 74).
	Motor coupling loose	1. Check/tighten motor coupling. 2. If problem persists, replace the motor coupling.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Needle arm home HW fault Unable to home the sample positioning mechanism during initialization or reset.	R-axis obstructed	1. Check the sample chamber for any obstructions to movement of the R-axis. 2. Clear any obstructions and reset the sample manager.
	Excessive friction in R-carriage	1. Check the needle to make sure it is fully retracted. 2. From the Console, disable the motors. 3. Try to manually move the R-axis. It should move freely.
	Top-of-plate sensor obstructed	1. Inspect the sample chamber to make sure that nothing is blocking the sensor. 2. Clear any obstructions and reset the sample manager.
	Sensor cable loose	Check the sensor cable. Make sure it is securely plugged in and that the pins are secure.
	Sensor problem	1. Ensure the sensor and flag are secure and not damaged. 2. From the interactive display, check to see if the sensor lights up when you block the sensor light with an opaque object such as a business card. 3. If it does not light up, replace the sensor.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Needle arm home HW fault (continued)	R-axis lead screw nuts loose	Adjust the lead screw nuts. See Needle carriage components, page 143 .
	Motor coupling loose	1. Check/tighten motor coupling. 2. If problem persists, replace the motor coupling.
	Interface PCB problem	Check/reseat the cable from the interface PCB to the control PCB. If necessary, replace the sensor interface PCB. See Sensor Interface PCB .
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Needle arm move h/w fault	Intermittent problem with needle carriage flexible circuit cable	Replace the needle carriage flexible circuit cable.
	Problem with ribbon cable (from interconnect PCB to control PCB)	Replace the ribbon cable.
	Bad sensor interface PCB	Replace the sensor interface PCB. See Sensor Interface PCB .
	Bad control PCB	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
	Stuck lead screw or rail	1. Clean residue or debris from R-carriage lead screw or rail. 2. If necessary, adjust lead screw nuts (Figure 74).
Needle move fault due to foot (Zp) not home	Z or Zp are not in the home position when the R-axis is commanded to move	Call GSS.
Needle move fault due to needle (Z) not home	Z or Zp are not in the home position when the R-axis is commanded to move	Call GSS.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Needle/seal move limit exceeded Needle has moved to the safe limit of travel during injection from the seal calibration point without reaching full sealing force	Needle seal not calibrated or inject/wash port problem	Characterize the needle seal.
	Bent needle	1. Replace the needle. 2. Investigate cause of bent needle by: - ensuring the sample vial plate is properly positioned in the rotary tray - checking plate configuration to ensure it matches the plate installed
Needle/seal move limit short Needle has reached force before it should	Needle seal was not characterized after needle replacement	Characterize the needle seal and troubleshoot any error messages.
	Debris is obstructing needle sealing motion	1. Check inject/wash port for obstructions. 2. Investigate why debris is getting into needle seat (e.g., check capmats, solvent cleanliness).
Plate present, no plate expected	Plate was left in the instrument when no plate was defined in the software	Remove the plate.
	Plate sensor obstruction	Check to make sure that there is nothing blocking the plate sensor on the R-carriage.
	Plate sensor flag obstruction	Check to make sure that there is nothing blocking the plate sensor flag on the R-carriage. See Needle carriage components, page 143 .
	Plate sensor problem	Replace the top-of-plate sensor on the R-carriage.
	Plate present	Remove plate from the sample manager.
	Cable connection problem	Check the cable connection from the R-carriage to the personality PCB.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Power supply HW fault [21.6 to 26.4 volts]	Cable connection problem	Check the cable from the power supply to the personality PCB.
	Power supply problem	Replace the power supply. See Testing/Replacing the Power Supply
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs.
Rotary tray home hardware fault Unable to home the tray axis during initialization or reset	Theta axis obstruction	1. Remove any obstruction above the sample positioning mechanism base (see Needle carriage components, page 143). 2. In rare cases, there may be an obstruction below the sample positioning mechanism base.
	Tray drawer not fully closed	Close the drawer.
	Rotary tray motor problem	Check the rotary tray motor. If there is no resistance, replace the motor.
	Encoder problem	Replace the encoder. (Call GSS.)
	Rotary tray motor problem	Check the rotary tray motor for resistance. If necessary, replace the motor.
Rotary tray move h/w fault Rotary axis is outside allowable limits when moving to a vial (less than 0.15° for 384 wellplates, and less than 0.3° for all other wellplates)	Obstruction in rotary axis	Remove any obstruction above the sample positioning mechanism (see Needle carriage components, page 143).
	Loose theta drive belt	Tighten belt by repositioning theta drive motor.
	Encoder problem	Replace the encoder assembly. (Call GSS.)
Rotary tray not calibrated	Rotary tray needs calibration	Calibrate the rotary tray.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample fluidics high pressure limit (value) High pressure limit reached in fluidic system ($P > 210$ psig)	System obstruction	Check for blockages anywhere downstream from the transducer (see Figure 89 on page 185) as follows: 1. Loosen the fittings on the inject valve, beginning with port 2 (then port 3, then transducer). 2. If the pressure drops to 0, a blockage exists in the fluidic path. Identify/clear blockage or replace appropriate component.
	Transducer problem	1. Disconnect the transducer. 2. If pressure falls to 0, replace the transducer. See Replacing the Pressure Transducer .
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
<i>Figure 89 - Checking for an obstruction in the flowpath downstream of the transducer</i>		
Sample heater/cooler over temperature or HW fault (value) Over-temperature snap switch is triggered/open or disconnected.	Heater/cooler cable connection problem	Reseat connector.
	PCB or temperature sensor (sample thermistor) problem	1. Test thermistor resistance. (See Testing Thermistor Resistance.) 2. If thermistor resistance is outside the expected range, replace the sample thermistor. 3. If thermistor resistance is within the expected range, replace the control PCB. (See Replacing the 3VC-CPU, Control, and Driver PCBs.)

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample heat sink temperature sensor hardware fault Heater/cooler engine sink temperature is outside the expected range of -6° to 50° C. (See Figure 90 .)	Firmware out of date	Check firmware revision; make sure it is version 1.5 or later.
	Short on heat sink temperature sensor (<i>heat sink thermistor</i>) caused by ice in sample compartment	1. Determine whether icing is present in the sample compartment (Indicators of icing on the heat sink, page 120). 2. If icing is present, defrost the sample compartment (Defrosting the Sample Compartment).
	PCB or temperature sensor (<i>heat sink thermistor</i>) problem	1. Test thermistor resistance. (See Testing Thermistor Resistance .) 2. If thermistor resistance is outside the expected range, replace the sample thermistor. 3. If thermistor resistance is within the expected range, replace the control PCB. (See Replacing the 3VC-CPU, Control, and Driver PCBs .)

Table 68: Sample manager-FTN error messages/error states (continued)

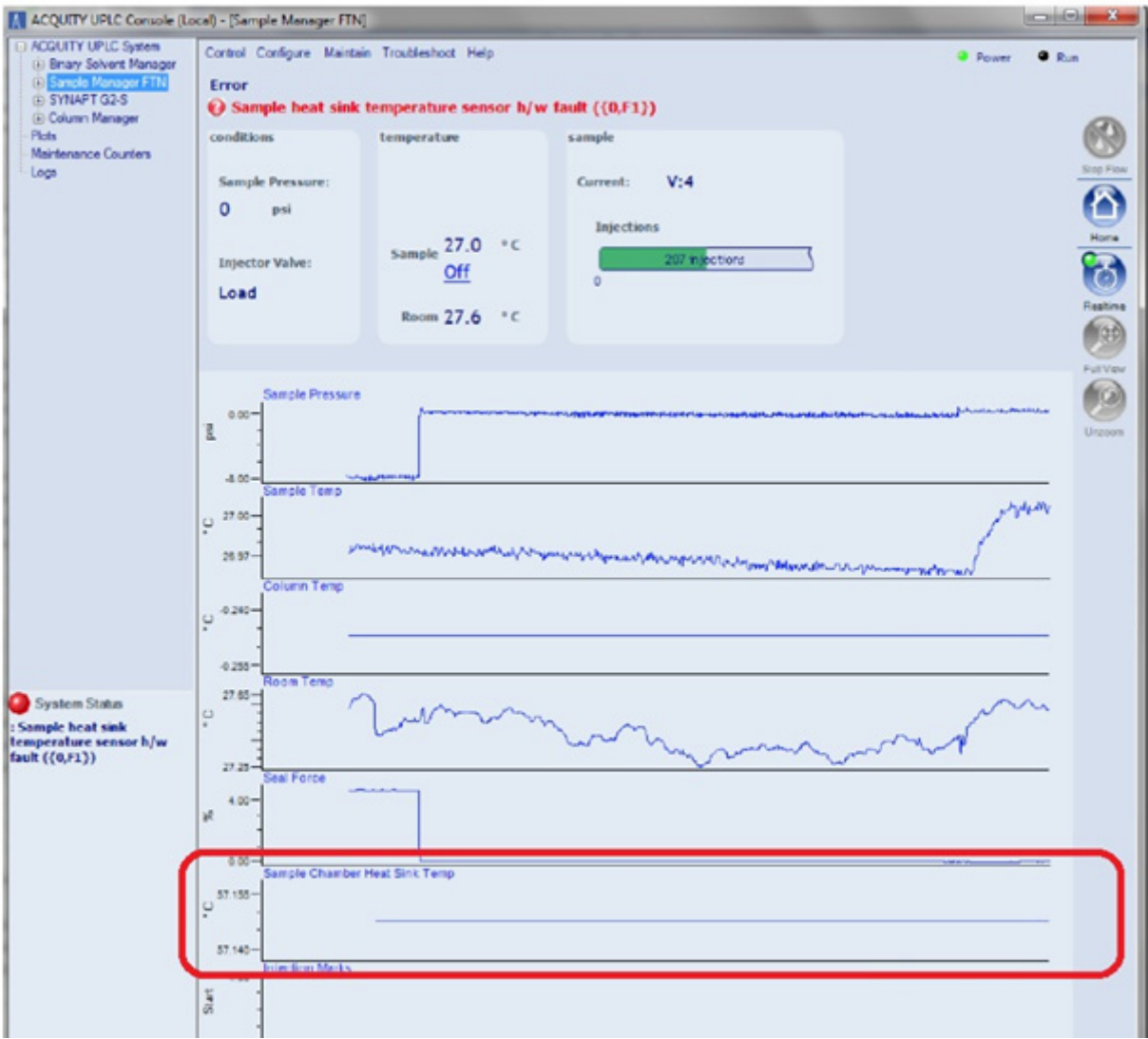
Error or warning	Possible cause	Corrective action
Sample heat sink temperature sensor hardware fault (continued)		
		
Sample manager leak sensor disabled Informational message	For information only	No action is required.
Sample manager leak sensor enabled Informational message	For information only	No action is required.

Figure 90 - Sample heat sink temperature sensor H/W fault

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample manager leak sensor not present Leak sensor is enabled but not detected	Leak sensor is not connected	Check/connect leak sensor.
	Bad leak sensor	Replace the leak sensor.
	Bad leak detector extension internal cable (from chassis to control PCB)	Replace internal cable. See Control PCB .
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Sample pressure sensor HW fault (value) Not enough voltage range available in the transducer to reach high pressure	Pressure in transducer at startup	Loosen the fittings on the transducer and recycle power.
	Zero balance out of range	Adjust pressure transducer zero balance. See service note " Sample Pressure Transducer Adjustment ."
	Bad transducer	Replace transducer.
	Bad control PCB	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Sample syringe hardware lost steps Sample syringe missing steps when homing syringe.	Loose pulley in line with lead screw	Tighten or replace pulley.
	Loose pulley in line with motor	Tighten or replace pulley.
	Damaged drive belt	Replace belt.
	Lead screw is obstructed or damaged	Repair or replace syringe drive assembly.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample syringe home HW fault Sample syringe home sensor not triggered during initialization or reset.	Sample syringe home sensor connection is bad	Verify that sample syringe home sensor is plugged in. See Sample syringe valve drive components, page 141 .
	Sensor is obstructed	Has the syringe drive moved down and stopped? If so, clean/replace the sensor.
	Loose pulley in line with lead screw	Tighten or replace pulley.
	Loose pulley in line with motor	Tighten or replace pulley.
	Damaged drive belt	Replace belt.
	Sample syringe home sensor is damaged	1. Test sensor from interactive display to make sure it is not damaged. 2. Replace the sample syringe drive. See Sample syringe valve drive components, page 141 .
	Lead screw is obstructed or damaged	Repair or replace syringe drive assembly.
	Syringe drive mechanical problem	1. Turn off the instrument and try to turn the belt on the syringe mechanism manually. 2. If it doesn't turn easily, repair or replace the syringe drive.
Sample syringe move to sensor HW fault Sample syringe home sensor not triggered during initialization or reset	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
	See Sample syringe home HW fault, page 189 .	Sample syringe home HW fault, page 189.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample temperature range error (value) This error is triggered when the sample manager is unable to reach the temperature range specified by the method at the start of an injection. NOTE: <i>The sample manager attempts to reach the temperature setpoint for 60 minutes before raising the alarm.</i>	Sample temperature not equilibrated	Allow sample manager to reach temperature before beginning a run.
	Cable connection problem	Check the connection from the temperature sensor to the control PCB.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs.
	Temperature sensor (sample-compartment thermistor) problem	1. Verify that no temperature has been set. 2. Remove the temperature sensor connector from the control PCB (you can leave the power on). 3. Read the temperature in the Console: • If the reading is between 0° and 7°, replace the sample compartment thermistor. • If the reading is outside that range, replace the control PCB. See Replacing the CPU, Control, and Driver PCBs.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample temperature sensor HW fault Sample compartment temperature or heater/cooler engine sink temperature is outside the expected range of 0° to 45° C.	Cable connection problem	Check the connection from the temperature sensor to the control PCB. See Control PCB .
	PCB or temperature sensor problem	1. Test thermistor resistance at J10 and J11 on the control PCB. (See Testing Thermistor Resistance .) 2. If thermistor resistance is outside the expected range, replace the sample compartment thermistor or heater/cooler engine assembly as appropriate. 3. If thermistor resistance is within the expected range, replace the control PCB. (See Replacing the CPU, Control, and Driver PCBs .)
	APH problem	Troubleshoot the APH. See Active Preheater Technical Reference .
	PCB problem	Call GSS .
Sample valve home HW fault Sample syringe valve home sensor did not recognize home sensor on initialization.	Loose or damaged coupling (See Sample positioning mechanism subassemblies , page 142.)	Check tightness of coupling on sample syringe valve drive; if necessary, replace the sample syringe valve head. See Replacing the Metering Syringe Valve Head .
	Motor driver cables and connectors bad	Check/replace as necessary.
	MSV head movement is restricted	1. Disable motors and turn the coupling. 2. Does it move freely? If not, replace the sample syringe drive head. See Replacing the Metering Syringe Valve Head .
	Home sensor problem	Test sensor from interactive display to make sure it is not damaged.
	Home sensor obstructed or dirty	Clean or replace the sensor.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Sample valve move HW fault Sample syringe valve does not recognize home sensor when moving from fill position to needle position.	Loose or damaged coupling	Check tightness of coupling on sample syringe valve drive; if necessary, replace the sample syringe valve head. See: • Sample syringe valve drive components, page 141. • Replacing the Metering Syringe Valve Head.
	Motor driver cables and connectors bad	Check/replace as necessary.
	MSV head movement is restricted	Disable motors and turn the coupling. Does it move freely? If not, replace the sample syringe drive head. See Replacing the Metering Syringe Valve Head.
	Sensor problem	Test sensor from interactive display to make sure it is not damaged.
	Sensor is obstructed or dirty	Clean or replace the sensor.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs.
Sample volume out of range	Sample volume too large for configuration	Reprogram sample volume or check/adjust needle and loop volume configuration.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Seal force sensor h/w fault (value) This error can occur during the reset/initialization procedure or during the needle seal characterization. In both cases, the seal force sensor fails to detect the seal (the load reading is too high or too low).) <pre> graph TD Start([Seal force sensor h/w fault]) --> D1{Did the error occur during reset/initialization?} D1 -- Yes --> EndMech[Investigate mechanical problem] D1 -- No --> D2{Is the needle properly installed?} D2 -- No --> Act1[Install the needle in proper position.] D2 -- Yes --> D3{Is the stripper foot approximately 3 mm above the injection port?} D3 -- No --> Act2[Check for missing parts or incorrect assembly of the injection port.] D3 -- Yes --> Act3[Move the injection port support sleeve up and down.] Act3 --> D4{Does the seal force sensor register a reading in the Console plot?} D4 -- Yes --> EndMech D4 -- No --> Act4[Replace the seal force sensor with a known working one and retest.] Act4 --> D5{Does the new sensor register a reading?} D5 -- Yes --> End([End]) D5 -- No --> Act5[Reinstall the original sensor.] Act5 --> EndElec[Investigate electronics problem] </pre>		

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Seal force sensor h/w fault (value) (continued)	Mechanical problem	Troubleshoot the error as shown in the flowchart on page 202. If the cause is mechanical: 1. Does the error occur during the seal calibration step of the calibrate needle seal diagnostic? Check the tubing. If tangled or bound, untangle or replace. 2. Check the Zp coupling. If it is slipping, replace it. 3. If problem persists, replace the needle wash housing. (See Replacing the Needle Wash Station.) 4. If problem persists, replace the R assembly.
	Electronics problem	Troubleshoot the error as shown in the flowchart on page 202. If the cause is electronics: 1. Check/replace the interconnect PCB cable. 2. Check/replace the ribbon cable. 3. Check/replace the personality PCB.
Seal not calibrated	Seal position not calibrated	Calibrate the seal.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Seal residual force high while needle moving down Excessive friction while needle moving to seal position	Excessive friction caused by debris in needle wash housing	1. With the needle in the up position, manually move the wash support sleeve up and down. Check for two things: • Does the motion feel smooth and unobstructed? • Does the seal force reading increase as you push down and decrease to less than 5% as you lift up? 2. If the motion is not smooth or the reading is outside the expected range, check parts for wear or debris and replace as necessary. NOTE: Debris can build up around the wash fitting and support sleeve (see Injection/wash port components, page 140). NOTE: Do not replace the seal force sensor except as a last resort.
	Injection/wash port components misaligned	1. Make sure the injection/wash port is properly installed. 2. Check the R home sensor, sensor flag, bracket, motor housing, needle, and other housing components for proper alignment.
Seal residual force limit exceeded (Z-up) Seal force sensor reads an unexpected value when Z-axis is in up position (i.e., before starting foot calibration). NOTE: An electronics problem is not likely to cause this error. Check the other causes first.	Excessive friction caused by tangled or improperly routed seal extension or wash tubing (see Injection/wash port components, page 140).	1. Visually inspect the seal extension and wash tubing (see Injection/wash port components, page 140). 2. If it is tangled or routed incorrectly, unbind or straighten as necessary. See Rebuilding the Inject/Wash Station .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Seal residual force limit exceeded (Z-up) (continued)	Excessive friction caused by debris in needle seal wash housing	1. With the needle in the up position, manually move the wash support sleeve up and down. Does the motion feel smooth and unobstructed? Does the seal force reading increase as you push down and decrease to less than 5% as you lift up? 2. If the motion is not smooth or the reading is outside the expected range, check parts for wear or debris and replace as necessary. NOTE: Debris can build up around the wash fitting and support sleeve (see Injection/wash port components, page 140). NOTE: Do not replace the seal force sensor except as a last resort.
	Injection/wash port problem	Reset the sample manager and continue operating. If the problem persists or reappears intermittently, replace the injection/wash port. See Rebuilding the Inject/Wash Station.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Seal residual force limit exceeded (Z-wash) Injector sensor reads an unexpected value when Z-axis is in wash position (i.e. during seal calibration). NOTE: This error will most likely be preceded by the error <i>Seal residual force high while needle moving down</i> , page 195.	Excessive friction caused by debris in needle/seal wash housing	1. With the needle in the up position, manually move the wash support sleeve up and down. Does the motion feel smooth and unobstructed? Does the seal force reading increase as you push down and decrease to less than 5% as you lift up? 2. If the motion is not smooth or the reading is outside the expected range, check parts for wear or debris and replace as necessary. NOTE: Debris can build up around the wash fitting and support sleeve (see Figure 69). NOTE: Do not replace the seal force sensor except as a last resort.
Seal residual force limit exceeded (Z-wash) (continued)	Injection/wash port components misaligned	Verify that: - the injection/wash port assembly and components are properly installed - the needle is properly installed - the needle carriage R home sensors and flags are in proper alignment
Temperature controller watchdog time-out This problem is typically found in older versions of software. It should not occur in later versions.	Software problem	Call GSS.
Tray lost synchronization (value) The tray and motor are out of synch; too many motor steps lost. Checks the difference between motor and encoder pulses; an difference greater than 6 pulses (0.6° C) triggers the error.	Tubing obstruction	Check tubing for obstructions; clear or replace as necessary.
	Tray drawer not fully closed	Close the tray drawer.
	Loose theta motor or pulley	Replace the theta drive.
	Bad encoder	Replace the theta drive.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Tray move fault due to foot (Zp) not home Tray tried to move but Zp home sensor detects that the Zp axis is not home.	Bad/intermittent sensor	Replace the flex circuit cable.
Tray move fault due to needle (Z) not home Tray tried to move but Z home sensor detects that the Z axis is not home.	Bad/intermittent sensor	Replace the flex circuit cable.
Z-axis calibration out of range The Z-axis calibration point is outside the expected range (it should be within 2 mm of the nominal seal position)	Needle installed incorrectly or not characterized	Check the needle mounting and installation to make sure the needle is installed and characterized properly.
	RZZ mechanism assembled incorrectly	Has the RZZ mechanism or rotary tray been recently reassembled? If so, check for proper reassembly. See service video Replacing the Rotary Tray Valve .
Z-axis HW lost steps (value) More than 50 lost steps detected while moving to home	Needle motion obstructed	Check for needle motion obstruction; clear or repair as necessary.
	Loose Z-axis motor coupling	Check/tighten Z-axis motor coupling. See Sample positioning mechanism subassemblies , page 142.
	Sample needle carriage problem	Replace sample needle carriage.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Z-axis home HW fault This error occurs when one of the following events occurs: • Home sensor was not triggered by Z-axis sensor flag during home sequence. • Flag was not detected during a second verification. • Home sensor was triggered at the beginning of the home sequence but never released.	Z-axis has hit something	Open the door and check for obstructions or damage. If there are no obstructions, reboot the sample manager and monitor the Z-axis motion.
	Z-axis sensor flag obstructed or restricted (flag is not reaching the sensor)	1. Check that no cables are blocking the sensor flag. 2. Check for restrictions to the sensor flag - for example, something snagging the sensor cable. 3. Clear or repair as necessary.
	Z-axis sensor problem	During Z-axis homing, does the axis jam at the end of its up or down motion? If so, replace the flex circuit cable.
	Cable connection problem	Reseat or replace the cable from the motor to the control PCB.
	R-carriage problem	1. Disable the motors. 2. Manually turn the Z spline shaft and check for free motion. 3. If the motion is restricted, replace the R carriage.
	Loose motor coupling	1. Enable the motors. 2. Try to manually turn the Z spline shaft. 3. If you can turn it without forcing the motor to skip, tighten the coupling. 4. While tightening, inspect the coupling to determine if it needs to be replaced.
	High salt content in mobile phases or sample (creates salt/buffer buildup that interferes with needle operation)	1. Characterize the needle seal and troubleshoot any resulting error message. 2. If problem persists, clean the injection port. See Cleaning the SM-FTN .
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
Z-axis move HW fault	Firmware problem	Download the service profile and send it to GSS .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Zp-axis calibration out of range The Zp calibration (foot) offset should be: -3.0 to 3.0 mm.	Needle installed incorrectly or not characterized	Check the needle mounting and installation to make sure the needle is installed and characterized properly.
	Inject/wash port assembled incorrectly	If running firmware v1.45, check inject/wash port for correct assembly. If necessary, reassemble correctly. See Rebuilding the Inject/Wash Station .
	RZZ mechanism assembled incorrectly	Has the RZZ mechanism or rotary tray been recently reassembled? If so, check for proper reassembly. See Replacing the Rotary Tray Drive (video).
Zp-axis home HW fault This error occurs when one of the following events occurs: - Home sensor was not triggered by Z-axis sensor flag during home sequence. - Flag was not detected during a second verification. - Home sensor was triggered at the beginning of the home sequence but never released.	Zp-axis hit something	Open the door and check for obstructions or damage. If there are no obstructions, reboot the sample manager and monitor the Zp-axis motion.
	Zp-axis sensor flag obstructed or restricted (flag is not reaching the sensor)	1. Check that no cables are blocking the sensor flag. 2. Check for restrictions to the sensor flag - for example, something snagging the sensor cable. 3. Clear or repair as necessary.
	Zp-axis sensor problem	During Z-axis homing, does the axis jam at the end of its up or down motion? If so, replace the flex circuit cable.
	Cable connection problem	Reseat or replace the cable from the motor to the control PCB.
	R-carriage problem	1. Disable the motors. 2. Manually turn the Z spline shaft and check for free motion. 3. If the motion is restricted, replace the R carriage.

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Zp axis HW lost steps (value) Z-axis motion is stalled	Needle is obstructing the sensor flag	Check to make sure the needle is installed properly and is not obstructing the flag.
	Plate dimensions are incorrectly defined	Ensure the plate dimensions are correctly defined.
	XYZ calibrations are incorrect	Ensure XYZ calibrations are correct.
	Wrong plate inserted	Insert correct plate.
	Plate inserted incorrectly	Ensure the plate is inserted correctly.
	Z-axis has hit something	Reboot the sample manager.
	Zp-axis sensor flag damaged	Replace the sensor flag.
	Zp-axis sensor flag obstruction	Check that no cables are blocking the sensor flag.
	Zp-axis sensor problem	Replace the sensor.
	High salt content in mobile phases or sample (creates salt/buffer buildup that interferes with needle operation)	1. Characterize the needle seal and troubleshoot any resulting error message. 2. If problem persists, clean the injection port. See Cleaning the SM-FTN .
	R-carriage problem	Replace the R-carriage.
	Control PCB problem	Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .

Table 68: Sample manager-FTN error messages/error states (continued)

Error or warning	Possible cause	Corrective action
Zp-axis move HW fault Top-of-plate sensor is triggered outside of expected range based on plate/vial configuration or inject/wash port height.	Incorrect plate/vial configuration	Ensure the plate/vial dimensions are correctly defined. For example, ensure that ANSI plates are configured.
	Plate inserted incorrectly	Ensure the plate is inserted correctly.
	Zp-axis has hit something	Remove obstruction and reboot the sample manager.
	Zp-axis sensor flag damaged	Replace the flex cable.
	Zp-axis sensor flag obstruction	Check that no cables are blocking the sensor flag.
	Zp-axis or top-of-plate sensor problem	Replace the sensor.
	R-carriage problem	Replace the R-carriage.
	Cable connection problem	1. Check the cable connection to the sensor interface PCB, and tighten if necessary. 2. Check the cable connection to the control PCB, and tighten if necessary.
	High salt content in mobile phases or sample (creates salt/buffer buildup that interferes with needle operation)	1. Characterize the needle seal and troubleshoot any resulting error message. 2. If problem persists, clean the injection port. See Cleaning the SM-FTN .
	PCB problem	1. Replace the sensor interface PCB. 2. Replace the control PCB. See Replacing the CPU, Control, and Driver PCBs .
ZZp not home on a needle move Z or Zp axis moved off of home during an R-axis move	Firmware problem	Download the service profile and send to GSS .

Column compartment errors

NOTE: This list includes CM-A and CM-Aux errors. For CH-A and CH-30A errors, see [Sample manager errors, page 167](#).

Table 69: Column compartment error messages/error states

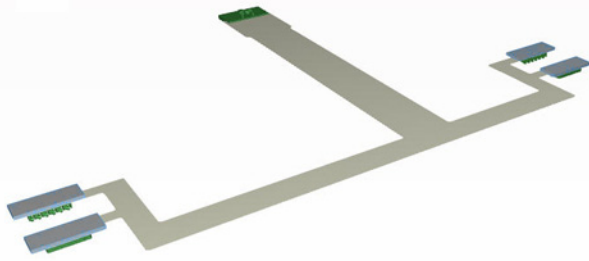
Error	Possible Cause	Corrective Action
Ambient temperature range error	Room temperature is outside the allowable limits defined in the method	1. Ensure the room temperature is within acceptable range. 2. If error persists, try: • increasing the allowable limits defined in the method • moving the instrument to a stable lab environment
	Active heater (flex circuit) cable failure (see Figure 91)	Call GSS.
	 <i>Figure 91 - Active heater (flex circuit) cable</i>	
Auto shutdown invoked	Unspecified software error	1. Reset the column manager. 2. Check the firmware installed on the system; make sure all versions match. 3. Upgrade the software and firmware on the system. 4. If error persists, call GSS.
	Battery failure	1. Reset the column manager via the Console (or, if necessary, Hyperterminal; use the command <code>nvfreset</code>). 2. Replace the CCPU battery.
	CCPU failure	Replace the CCPU. See Replacing the CPU, Control, and Driver PCBs.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Battery backed memory h/w failure Values stored in memory have been reset to default values	Battery failure	1. Reset the column manager via the Console (or, if necessary, Hyperterminal; use the command <i>nvfreset</i>). 2. Replace the CCPU battery.
	CCPU failure	Replace the CCPU. See Replacing the CPU, Control, and Driver PCBs .
BSM pressure failed to decay Pressure failed to go under 500 psi in the allowed 2.0 minutes. Displayed for information. Over time, this problem will cause wear on the valve rotor and loss of column efficiency.	Method problem	1. Reset the column manager via the Console. 2. Check the method parameters; try decreasing flow or composition conditions during the end of the run.
	Firmware problem	Check the firmware; ensure it is the latest revision.
	Hardware problem	Replace the column, inline filter or guard column, and fittings.
	Blockage	Troubleshoot the blockage. See Troubleshooting a blockage or restriction , page 96.
Column [n] active preheater configured but not detected	Configuration problem (mismatch between what is configured in Console and what is physically present)	Check configuration in Console: • If you want to use the APH: set APH to "Active, enabled". • If you do <i>not</i> want to use the APH: set APH to "Active, disabled".
	APH failure	Replace APH. See ACQUITY UPLC H-Class Column Compartments Operator's Overview and Maintenance Information .
	Damaged flex circuit	Call GSS .
Column [n] active preheater h/w not supported	Wrong preheater installed	Install correct preheater.
	APH failure	Replace the APH.
	Driver/interface PCB failure	Replace driver/interface PCB.
	Active heater (flex circuit) cable failure	Call GSS .

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column [n] active preheater module 24V fuse h/w fault	Peripheral cable or component failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
	Bad APH	Check APH with a digital multimeter. If the APH is bad, replace it. See Active Preheater Technical Reference Sheet (715003021) .
	Power supply failure	Check 24V power supply test-point. If it is outside acceptable range (+ or -1 volt), replace the power supply.
	Bad personality PCB	Replace personality PCB. See CM-A Personality PCB Technical Reference .
	Active heater (flex circuit) cable failure	Replace the dual column trough module. See Replacing the Dual Column Trough Assembly .
Column [n] active preheater not configured but detected	Configuration problem (mismatch between what is configured in Console and what is physically present)	Check configuration in Console: • If you want to use the APH: set APH to "Active, enabled". • If you do <i>not</i> want to use the APH: set APH to "Active, disabled".

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column [n] active preheater overtemp fuse h/w fault	APH is improperly connected	Reseat the APH.
	Bad thermal fuse	- Test the fuse: - Let the APH cool down. - Use a digital multimeter to check the continuity across APH connector pins 1, 2, 3, and 4. - If the circuit is open, the fuse is damaged. Replace the APH. See Active Preheater Technical Reference Sheet (715003021).
	Bad thermistor	Replace the APH.
	Active heater (flex circuit) cable failure	<i>CM-Aux only:</i> If preheater works in one of the sockets within the same trough, replace the dual-trough column compartment. See "Replacing the Heater/Cooler Engine Assembly." <i>CM-A only:</i> Swap cable positions on the PCB to see if the error moves with the cable. If it does, you have a bad flex circuit cable and should replace it. Call GSS.
	Data cable failure (<i>CH-A or CM-Aux only</i>)	Replace personality PCB.
Column [n] active preheater temperature range error	Invalid temperature entered in method or Console	Ensure temperature setting is correct.
	The requested temperature is outside the limits defined in the method, due to insufficient equilibration time.	- Make sure the column compartment cover and column manager door are securely closed. - Set the column manager temperature to within the method parameters, and allow the column manager to equilibrate.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column [n] active preheater temperature sensor h/w fault	APH temperature ramps too quickly when setpoint temperature is greater than (>)70° C.	Test column setpoint at temperatures below 70° C. If problem resolves (i.e., you no longer get error): Control the temperature to 70° C, wait for temperature to stabilize, and then set a higher temperature if desired.
	APH thermistor failure	Verify the active preheater (see Active Preheater Technical Reference Sheet (715003021)). If necessary, replace the APH (see ACQUITY UPLC H-Class Column Compartments Operator's Overview and Maintenance Information).
Column (n) door open while running	Column compartment door is open during a run	1. Visually inspect the cover and remove any obstructions. 2. Make sure columns and preheaters are in the correct positions. 3. Align the tabs in the column compartment cover with the slots, push the cover closed, then push the latches inward until they snap onto the latch pins.
	Column compartment reed switch cable disconnected or defective	Reconnect or replace the cable.
	Column compartment reed switch damaged	Use an external magnet to test the switch. If the switch is damaged, replace the cable or column compartment.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column (n) heater-cooler 24V fuse h/w fault	Firmware out of date	1. Recycle power. 2. Ensure firmware is latest revision.
	Peripheral cable or component failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
	Bad APH	Check APH with a digital multi-meter. If the APH is bad, replace it. See Active Preheater Technical Reference Sheet (715003021) .
	Power supply failure	Check 24V power supply test-point. If it is outside acceptable range (+ or -1 volt), replace power supply.
	Bad personality PCB	Replace personality PCB. See CM-A Personality PCB Technical Reference .
	Failed heater-cooler engine	Replace engine. See Replacing the Heater/Cooler Engine .

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column (n) heater-cooler over-temp switch h/w fault A trough sensor has tripped because the temperature inside the heater/cooler engine has exceeded the specified limits of the over-temperature switch.	Firmware out of date	Ensure firmware is latest revision.
	Air filter dirty	Check/clean the air filter.
	Not enough clearance for right-side ventilation	Ensure there is clearance of 3".
	Fan failure	1. Place a kim wipe on the fan intake (located on right side of CM-A) to see if fan is working properly. 2. If necessary, replace the fan.
	Temperature control problem	Turn off temperature control or adjust setpoint.
	Snap switch faulty	If error occurs when you are not heating, check the snap switch with a voltmeter. If switch is open (high resistance or "OL" - over limit), replace the heater/cooler engine. See Replacing the Heater/Cooler Engine .
	Bad APH	Check the APH with an digital multimeter. If the APH is bad, replace it. See APH Technical Reference .
Column manager door is open	Column compartment cover open (when it should be closed)	1. Visually inspect and remove any obstructions. 2. Make sure columns and pre-heaters are in the correct positions. 3. Align the tabs in the column compartment cover with the slots, push the cover closed, then push the latches inward until they snap onto the latch pins. 4. Firmly close the column manager door.
	Magnetic switch sensor disconnected or in wrong location	Ensure magnet reed sensor is securely connected in proper location.
	Magnetic switch cable (J25) disconnected or defective	Reconnect or replace the cable.
	Personality or driver/interface PCB failure	Replace the PCB.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column module 24V fuse h/w fault	Digital regulator fuse (F1) failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
Column module analog fuse h/w fault	Analog fuse (F4 or F5) failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
Column module motor fuse h/w fault	<i>CM-A only:</i> Motor fuse (F2) failure	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • Heater/Cooler Engine Technical Reference
Column position in method differs from sample set	Column position is set both in the instrument method and on the sample set line. You cannot use the sample set line setting to override the selected column position in the instrument method.	To clear the error, reset the column manager and all instruments in the system. Select the column position either in the instrument method or on the sample set line, not both, and select "No change" for the other setting.
Column [n] temperature range error During a chromatographic run, the column compartment's measured temperature falls outside the alarm band limit, which the user set in the instrument method. The instrument is unable to reach the setpoint temperature, or the setpoint is out of range.	Column compartment temperature unstable	See Column heater temperature unstable , page 154.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Column [n] temperature sensor HW fault	Loose connection	Check the connection from the temperature sensor to the personality PCB at J3 or J23.
	PCB or temperature sensor (heat sink thermistor) problem	1. Test thermistor resistance at J11 on the control PCB. (See Testing Thermistor Resistance.) 2. If the resistance is within acceptable range, the thermistor is functioning properly. Replace the PCB and reboot the system. 3. If the resistance is <i>not</i> within acceptable range, replace the dual column trough module. See Replacing the Sample Manager Heater/Cooler .
Diagnostic test interrupted by user	Displayed for information only	No action is required.
eCord connected The serial number and injection count indicate the current status for the connected column.	Displayed when the eCord is connected to the instrument; for information only	No action is required.
eCord data invalid Appears when eCord is disconnected, while the system is accessing the eCord.	Cannot read or display the eCord information due to an eCord connection problem	Use the column without the eCord, or check the connection of the eCord button to the instrument; make sure it is fully connected.
eCord disconnected The eCord is physically disconnected from the port	The eCord fob is not connected to the port. Displayed for information only.	No action is required. However, • If desired, you can reattach the eCord fob to the receptacle on the side of the column compartment. • If the error occurs with the eCord attached, check the one-wire connection at the back of the i-button socket.
eCord driver h/w fault	Firmware problem	Record software version and serial number and call GSS .
eCord h/w fault	Firmware problem	Record software version and serial number and call GSS .
eCord s/w fault	Firmware problem	Record software version and serial number and call GSS .

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
eCord not present	Configuration problem	Check the Console; if the column is not compatible, disable the eCord.
	Bypass tubing resting against the eCord fob	Bend the tube away from the eCord fob.
	Cable disconnected	Reconnect the cable.
Fuse h/w fault: n	One or both of the column manager fuses failed	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
General failure	Software problem	1. Reset the column manager. 2. Check the firmware installed on the system; make sure all versions match. 3. Upgrade the software and firmware on the system. 4. If error persists, call GSS.
Host aborted	The data system stopped instrument operation	1. Review the data system's log for errors. 2. Reset the column manager and the sample manager. 3. If the alarm persists, power-off and power-on again. 4. If error persists, call GSS.
Injection count exceeded The number of injections exceeds the user-set threshold.	Number of injections is greater than the threshold for the specified column. Displayed for information only.	1. Reset the injection count threshold or enter a higher injection count. 2. Cleaning or replacement of the column is recommended. 3. Perform preventive maintenance on the instrument.
Instrument powered off	Displayed for information only	No action is required.
Instrument powered on	Displayed for information only	No action is required.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Leak detected Fluid is in a leak sensor, and the sensor is enabled.	Visible leak	Troubleshoot any visible leak observed. (See Column heater visible leak, page 157).
	Firmware problem	Make sure firmware is up to date.
	Leak sensor damaged	1. Remove and dry the leak sensor and the leak sensor reservoir, and then reinstall the leak sensor. 2. Reset the column manager. 3. If problem persists, replace the leak sensor.
Leak detector enabled	Displayed for information only	No action is required.
Leak detector disabled	Displayed for information only	No action is required.
Leak detector not present	Setup is incorrect (e.g., leak detector is enabled but not installed)	Investigate/correct the settings.
	Cable connection problem	If leak sensor is installed, check cable connections on front bracket and on personality PCB.
	Leak sensor damaged	1. Remove and dry the leak sensor and the leak sensor reservoir, and then reinstall the leak sensor. 2. Reset the column manager. 3. If problem persists, replace the leak sensor.
Leak sensor not detected on lowest installed unit	Leak sensor not installed, leak sensor not enabled in console, or leak sensor cable unplugged in the lowest installed unit (either the column manager or an auxiliary column manager)	1. Install the leak sensor if it is not present. 2. Enable the leak sensor (Console system tree > Control > Leak sensors). 3. Ensure the leak sensor cable is connected. 4. Reset the column manager.
	Leak sensor damaged	1. Remove and dry the leak sensor and the leak sensor reservoir, and then reinstall the leak sensor. 2. Reset the column manager. 3. If alarm persists, power off and power on again. 4. If problem persists, replace the leak sensor.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Left valve home h/w fault The left switching valve cannot move to the encoder's reference (0) position	Valve cartridge (POD) is not installed	Replace the valve cartridge (POD).
	Encoder is not plugged into the personality PCB	Check/reseat connection.
	Valve fails to move to the reference position	Reset the column manager via the control panel or console.
	Valve is damaged	Replace the valve.
	Valve drive/encoder failure	Replace the valve drive/encoder.
Left valve move h/w fault The left switching valve cannot move to the programmed port position	Valve failed to move to home position	Check console for home HW error. If necessary, troubleshoot the error. (See Left valve home h/w fault, page 214.)
	Valve fails to move to the reference position	Reset the column manager via the control panel or console.
	Valve is damaged	Replace the valve.
	Valve drive/encoder failure	Replace the valve drive/encoder.
Lower auxiliary module 24V fuse h/w fault	Blown fuse	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
Lower auxiliary module analog fuse h/w fault	Blown fuse	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Lower auxiliary module configured but not detected	Failed or no lower auxiliary column manager: the column manager is configured with an auxiliary column manager in the lower position, but the hardware is not detected	1. Check the AC cable connections and external power cable connections in the rear of the modules. 2. Reseat or replace as necessary. CAUTION: To avoid damaging cables, handle with care.
	Column module problem	1. Using a known good upper CM-Aux, swap cables between modules to diagnose the problem. 2. Troubleshoot the cause as necessary.
	Bad personality PCB	Replace personality PCB
Modified SN Serial number was modified	Displayed for information only, after a serial number is changed	No action is required.
Right valve home h/w fault The right switching valve cannot move to the encoder's reference (0) position	Valve cartridge (POD) not installed	Replace the valve cartridge (POD).
	Encoder is not plugged into the personality PCB	Check/reseat connection.
	Valve failed to move to the reference position	Reset the column manager via the control panel or console.
	Valve damaged	Replace the valve.
	Valve drive/encoder failure	Replace the valve drive/encoder.
Right valve move h/w fault The right switching valve cannot move to the programmed port position	Valve failed to move to home position	1. Check console for home HW error. 2. If necessary, troubleshoot the error. (See Right valve home h/w fault, page 215.)
	Valve failed to move to the reference position	Reset the column manager via the control panel or console.
	Valve damaged	Replace the valve.
	Valve drive/encoder failure	Replace the valve drive/encoder.
Temperature controller watchdog time-out This problem is typically found in older versions of software. It should not occur in later versions.	Software problem	Call GSS.

Table 69: Column compartment error messages/error states (continued)

Error	Possible Cause	Corrective Action
Upper auxiliary module 24V fuse h/w fault	Blown fuse	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
Upper auxiliary module analog fuse h/w fault	Blown fuse	Troubleshoot the blown fuse. See: • Troubleshooting a Blown Fuse • CM-A Personality PCB Technical Reference • CM-Aux PCB Technical Reference
Upper auxiliary module configured but not detected	Failed or no upper auxiliary column manager: the column manager is configured with an auxiliary column manager in the upper position, but the hardware is not detected	1. Check the AC cable connections and external power cable connections in the rear of the modules. 2. Reseat or replace as necessary. CAUTION: To avoid damaging cables, handle with care.
	Bad personality PCB	Replace upper CM-Aux personality PCB.
Two eCords connected to column Occurs in CM-A only (not the CM-Aux)	Two eCords are connected to the same column	Confirm eCord connection locations.
Value cycles exceeded The number of valve cycles exceeds the user-set threshold.	Displayed for information only.	1. If the switching valve has exceeded 5,000 cycles, perform preventive maintenance on the instrument. 2. Reset the injection count threshold or enter a higher injection count.