

# Surveyor LC Pump Plus

## Hardware Manual

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## Regulatory Compliance

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## Surveyor LC Pump Plus

### EMC Directive 89/336/EEC

EMC compliance has been evaluated by Underwriters Laboratories Inc.

EN 55011	1998	EN 61000-4-3	2002
EN 61000-3-2	1995, A1; 1998, A2; 1998, A14; 2000	EN 61000-4-4	1995, A1; 2001, A2; 2001
IEC 61000-3-2	2000	EN 61000-4-5	1995, A1; 2001
EN 61000-3-3	1995	EN 61000-4-6	1996, A1; 2001
IEC 61000-3-3	1994	EN 61000-4-11	1994, A1; 2001
EN 61326-1	1997		
EN 61000-4-2	1995 A1; 1998 A2; 2001	CISPR 11	1999, A1; 1999, A2; 2002

FCC Class A, CFR 47 Part 15 Subpart B: 2004

### Low Voltage Safety Compliance

This device complies with Low Voltage Directive 73/23/EEC and harmonized standard EN 61010-1:2001.

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THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRE OPERATION.



**CAUTION** Read and understand the various precautionary notes, signs, and symbols contained inside this manual pertaining to the safe use and operation of this product before using the device.

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For manufacturing location, see the label on the instrument.

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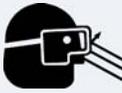
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CAUTION Symbol	CAUTION	VORSICHT	ATTENTION	PRECAUCION	AVVERTENZA
	<b>Electric Shock:</b> This instrument uses high voltages that can cause personal injury. Before servicing, shut down the instrument and disconnect the instrument from line power. Keep the top cover on while operating the instrument. Do not remove protective covers from PCBs.	<b>Elektroschock:</b> In diesem Gerät werden Hochspannungen verwendet, die Verletzungen verursachen können. Vor Wartungsarbeiten muß das Gerät abgeschaltet und vom Netz getrennt werden. Betreiben Sie Wartungsarbeiten nicht mit abgenommenem Deckel. Nehmen Sie die Schutzabdeckung von Leiterplatten nicht ab.	<b>Choc électrique:</b> L'instrument utilise des tensions capables d'infliger des blessures corporelles. L'instrument doit être arrêté et débranché de la source de courant avant tout intervention. Ne pas utiliser l'instrument sans son couvercle. Ne pas enlever les étuis protecteurs des cartes de circuits imprimés.	<b>Descarga eléctrica:</b> Este instrumento utiliza altas tensiones, capaces de producir lesiones personales. Antes de dar servicio de mantenimiento al instrumento, éste deberá apagarse y desconectarse de la línea de alimentación eléctrica. No opere el instrumento sin sus cubiertas exteriores quitadas. No remueva las cubiertas protectoras de las tarjetas de circuito impreso.	<b>Shock da folgorazione.</b> L'apparecchio è alimentato da corrente ad alta tensione che può provocare lesioni fisiche. Prima di effettuare qualsiasi intervento di manutenzione occorre spegnere ed isolare l'apparecchio dalla linea elettrica. Non attivare lo strumento senza lo schermo superiore. Non togliere i coperchi a protezione dalle schede di circuito stampato (PCB).
	<b>Chemical:</b> This instrument might contain hazardous chemicals. Wear gloves when handling toxic, carcinogenic, mutagenic, or corrosive or irritant chemicals. Use approved containers and proper procedures to dispose waste oil.	<b>Chemikalien:</b> Dieses Gerät kann gefährliche Chemikalien enthalten. Tragen Sie Schutzhandschuhe beim Umgang mit toxischen, karzinogenen, mutagenen oder ätzenden/reizenden Chemikalien. Entsorgen Sie verbrauchtes Öl entsprechend den Vorschriften in den vorgeschriebenen Behältern.	<b>Chimique:</b> Des produits chimiques dangereux peuvent se trouver dans l'instrument. Portez des gants pour manipuler tous produits chimiques toxiques, cancérigènes, mutagènes, ou corrosifs/irritants. Utiliser des récipients et des procédures homologuées pour se débarrasser des déchets d'huile.	<b>Química:</b> El instrumento puede contener productos químicos peligrosos. Utilice guantes al manejar productos químicos tóxicos, carcinogenos, mutagenos o corrosivos/irritantes. Utilice recipientes y procedimientos aprobados para deshacerse del aceite usado.	<b>Prodotti chimici.</b> Possibile presenza di sostanze chimiche pericolose nell'apparecchio. Indossare dei guanti per maneggiare prodotti chimici tossici, cancerogeni, mutageni, o corrosivi/irritanti. Utilizzare contenitori aprovo e seguire la procedura indicata per lo smaltimento dei residui di olio.
	<b>Heat:</b> Before servicing the instrument, allow any heated components to cool.	<b>Hitze:</b> Warten Sie erhitzte Komponenten erst nachdem diese sich abgekühlt haben.	<b>Haute Temperatur:</b> Permettre aux composants chauffés de refroidir avant tout intervention.	<b>Altas temperaturas:</b> Permita que los componentes se enfríen, ante de efectuar servicio de mantenimiento.	<b>Calore.</b> Attendere che i componenti riscaldati si raffreddino prima di effettuare l'intervento di manutenzione.
	<b>Fire:</b> Use care when operating the system in the presence of flammable gases.	<b>Feuer:</b> Beachten Sie die einschlägigen Vorsichtsmaßnahmen, wenn Sie das System in Gegenwart von entzündbaren Gasen betreiben.	<b>Incendie:</b> Agir avec précaution lors de l'utilisation du système en présence de gaz inflammables.	<b>Fuego:</b> Tenga cuidado al operar el sistema en presencia de gases inflamables.	<b>Incendio.</b> Adottare le dovute precauzioni quando si usa il sistema in presenza di gas infiammabili.
	<b>Eye Hazard:</b> Eye damage could occur from splattered chemicals or flying particles. Wear safety glasses when handling chemicals or servicing the instrument.	<b>Verletzungsgefahr der Augen:</b> Verspritzte Chemikalien oder kleine Partikel können Augenverletzungen verursachen. Tragen Sie beim Umgang mit Chemikalien oder bei der Wartung des Gerätes eine Schutzbrille.	<b>Danger pour les yeux:</b> Des projections chimiques, liquides, ou solides peuvent être dangereuses pour les yeux. Porter des lunettes de protection lors de toute manipulation de produit chimique ou pour toute intervention sur l'instrument.	<b>Peligro par los ojos:</b> Las salicaduras de productos químicos o partículas que saltan bruscamente pueden causar lesiones en los ojos. Utilice anteojos protectores al manipular productos químicos o al darle servicio de mantenimiento al instrumento.	<b>Pericolo per la vista.</b> Gli schizzi di prodotti chimici o delle particelle presenti nell'aria potrebbero causare danni alla vista. Indossare occhiali protettivi quando si maneggiano prodotti chimici o si effettuano interventi di manutenzione sull'apparecchio.
	<b>General Hazard:</b> A hazard is present that is not included in the above categories. Also, this symbol appears on the instrument to refer the user to instructions in this manual.  When the safety of a procedure is questionable, contact your local Technical Support organization for Thermo Fisher Scientific San Jose Products.	<b>Allgemeine Gefahr:</b> Es besteht eine weitere Gefahr, die nicht in den vorstehenden Kategorien beschrieben ist. Dieses Symbol wird im Handbuch außerdem dazu verwendet, um den Benutzer auf Anweisungen hinzuweisen.  Wenn Sie sich über die Sicherheit eines Verfahrens im unklaren sind, setzen Sie sich, bevor Sie fortfahren, mit Ihrer lokalen technischen Unterstützungsorganisation für Thermo Fisher Scientific San Jose Produkte in Verbindung.	<b>Danger général:</b> Indique la présence d'un risque n'appartenant pas aux catégories citées plus haut. Ce symbole figure également sur l'instrument pour renvoyer l'utilisateur aux instructions du présent manuel.  Si la sûreté d'une procédure est incertaine, avant de continuer, contacter le plus proche Service Clientèle pour les produits de Thermo Fisher Scientific San Jose.	<b>Peligro general:</b> Significa que existe un peligro no incluido en las categorías anteriores. Este símbolo también se utiliza en el instrumento par referir al usuario a las instrucciones contenidas en este manual.  Cuando la certidumbre acerca de un procedimiento sea dudosa, antes de proseguir, pongase en contacto con la Oficina de Asistencia Técnica local para los productos de Thermo Fisher Scientific San Jose.	<b>Pericolo generico.</b> Pericolo non compreso tra le precedenti categorie. Questo simbolo è utilizzato inoltre sull'apparecchio per segnalare all'utente di consultare le istruzioni descritte nel presente manuale.  Quando e in dubbio la misura di sicurezza per una procedura, prima di continuare, si prega di mettersi in contatto con il Servizio di Assistenza Tecnica locale per i prodotti di Thermo Fisher Scientific San Jose.

CAUTION Symbol	CAUTION	危険警告	危險警告
	<b>Electric Shock:</b> This instrument uses high voltages that can cause personal injury. Before servicing, shut down the instrument and disconnect the instrument from line power. Keep the top cover on while operating the instrument. Do not remove protective covers from PCBs.	<b>電撃:</b> この計測器は高電圧を使用し、人体に危害を与える可能性があります。保守・修理は、必ず作業を停止し、電源を切ってから実施して下さい。上部カバーを外したままで計測器を使用しないで下さい。プリント配線板の保護カバーは外さないで下さい。	<b>電撃:</b> 儀器設備使用會造成人身傷害的高伏電壓。在維修之前，必須先開儀器設備並切除電源。務必要在頂蓋蓋上的情況下操作儀器。請勿拆除PCB保護蓋。
	<b>Chemical:</b> This instrument might contain hazardous chemicals. Wear gloves when handling toxic, carcinogenic, mutagenic, or corrosive or irritant chemicals. Use approved containers and proper procedures to dispose waste oil.	<b>化学物質:</b> 危険な化学物質が計測器中に存在している可能性があります。毒性、発がん性、突然変異性、腐食・刺激性などのある薬品を取り扱う際は、手袋を着用して下さい。廃油の処分には、規定の容器と手順を使用して下さい。	<b>化学品:</b> 儀器設備中可能存在有危險性的化學物品。接觸毒性致癌、誘變或腐蝕/刺激性化學品時，請配帶手套。處置廢油時，請使用經過許可的容器和程序。
	<b>Heat:</b> Before servicing the instrument, allow any heated components to cool.	<b>熱:</b> 熱くなった部品は冷えるのを待ってから保守・修理を行って下さい。	<b>高温:</b> 請先等高温零件冷卻之後再進行維修。
	<b>Fire:</b> Use care when operating the system in the presence of flammable gases.	<b>火災:</b> 可燃性のガスが存在する場所でシステムを操作する場合は、充分な注意を払って下さい。	<b>火災:</b> 在有易燃氣體的場地操作該系統時，請務必小心謹慎。
	<b>Eye Hazard:</b> Eye damage could occur from splattered chemicals or flying particles. Wear safety glasses when handling chemicals or servicing the instrument.	<b>眼に対する危険:</b> 化学物質や微粒子が飛散して眼を傷つける危険性があります。化学物質の取り扱い、あるいは計測器の保守・修理に際しては防護眼鏡を着用して下さい。	<b>眼睛傷害危険:</b> 飛濺の化学品或顆粒可能造成眼睛傷害。處理化學品或維修儀器設備時請佩戴安全眼鏡。
	<b>General Hazard:</b> A hazard is present that is not included in the above categories. Also, this symbol appears on the instrument to refer the user to instructions in this manual.	<b>一般的な危険:</b> この標識は上記以外のタイプの危険が存在することを示します。また、計測器にこの標識がついている場合は、本マニュアル中の指示を参照して下さい。	<b>一般性危険:</b> 説明未包括在上述類別中的其他危險。此外，儀器設備上使用這個標誌，以指示用戶本使用手冊中的說明。
	When the safety of a procedure is questionable, contact your local Technical Support organization for Thermo Fisher Scientific San Jose Products.	<b>安全を確保する手順がよくわからない時は、作業を一時中止し、お近くのサーモエレクトロンサンローゼプロダクトのテクニカルサポートセンターにご連絡ください。</b>	<b>如對安全程序有疑問，請在操作之前與當地的菲尼根技術服務中心聯繫。</b>

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## Preface

This manual describes the maintenance procedures that you must perform to keep the Surveyor™ LC Pump Plus in optimal working condition.

## Related Documentation

In addition to this guide, Thermo Fisher Scientific provides the following documents as PDFs for the Surveyor Plus product line:

- *Surveyor Plus Preinstallation Requirements Guide*
- *Surveyor Plus Getting Connected Guide*
- Surveyor Plus LC system user guide for your Thermo Scientific data system

The data system also provides Help.

## Safety and Special Notices

Make sure you follow the precautionary statements presented in this guide. The safety and other special notices appear in boxes.

Safety and special notices include the following:



**CAUTION** Highlights hazards to humans, property, or the environment. Each CAUTION notice is accompanied by an appropriate CAUTION symbol.

**IMPORTANT** Highlights information necessary to prevent damage to software, loss of data, or invalid test results; or might contain information that is critical for optimal performance of the system.

**Note** Highlights information of general interest.

**Tip** Highlights helpful information that can make a task easier.

## Good Laboratory Practices

To obtain optimal performance from your LC system and to prevent personal injury or injury to the environment, do the following:

- Keep good records.
- Read the manufacturers' Material Safety Data Sheets (MSDS) for the chemicals being used in your laboratory.
- Remove particulate matter from your samples before you inject them into the liquid chromatograph.
- Use HPLC-grade solvents.
- Connect the drainage tubes from the pump, autosampler, and detector to an appropriate waste receptacle. Dispose of solvents as specified by local regulations.

### Keep Good Records

To help identify and isolate problems with either your equipment or your methodology, keep good records of all system conditions (for example, % RSDs on retention times, peak areas, peak shape, and resolution). Careful comparison of retention times, peak shapes, peak sensitivity, and baseline noise can provide valuable clues to identifying and solving future problems.

### Chemical Toxicity

Although the large volume of toxic and flammable solvents used and stored in laboratories can be quite dangerous, do not ignore the potential hazards posed by your samples. Take special care to read and follow all precautions that ensure proper ventilation, storage, handling, and disposal of both solvents and samples. Become familiar with the toxicity data and potential hazards associated with each chemical by referring to its MSDS.

### Sample Preparation

Always consider the solubility of your sample in the solvent/mobile phase. Sample precipitation can plug the column, tubing, or flowcell, which can cause flow restriction. This obstruction can result in irreparable damage to the system. To avoid damage caused by particulate matter, filter samples through 0.45 or 0.2  $\mu\text{m}$  (or less) filters.

### Solvent Requirements

Many chemical manufacturers provide a line of high-purity or HPLC-grade reagents that are free of chemical impurities. Routine filtration of all solvents or eluents through a 0.45 or 0.2  $\mu\text{m}$  (or less) fluorocarbon filter before placing them in the solvent reservoir significantly prolongs the life and effectiveness of the inlet filters, check valves, piston seals, autosampler injection valve, and LC column. Typically, HPLC-grade solvents do not require filtration.

Choose a mobile phase that is compatible with the sample and column you have selected for your separation. Remember that some solvents are corrosive to stainless steel.

## **Solvent Disposal**

Make sure you have a solvent waste container or other kind of drain system available at or below the benchtop level. Most solvents have special disposal requirements and should not be disposed of directly down a drain. Follow all governmental regulations when disposing of any chemical.

## **High-Pressure Systems and Leaks**

LC systems operate at high pressures. Because liquids are not highly compressible, they do not store much energy. Accordingly, there is little immediate danger from the high pressures in an LC system. However, if a leak occurs, correct it as soon as possible. Always wear eye and skin protection when operating or maintaining an LC system. Always shut down the system and return it to atmospheric pressure before attempting any maintenance.

## Contacting Us

There are several ways to contact Thermo Fisher Scientific for the information you need.

❖ **To contact Technical Support**

Phone	800-532-4752
Fax	561-688-8736
E-mail	<a href="mailto:us.techsupport.analyze@thermofisher.com">us.techsupport.analyze@thermofisher.com</a>
Knowledge base	<a href="http://www.thermokb.com">www.thermokb.com</a>

Find software updates and utilities to download at [mssupport.thermo.com](http://mssupport.thermo.com).

❖ **To contact Customer Service for ordering information**

Phone	800-532-4752
Fax	561-688-8731
E-mail	<a href="mailto:us.customer-support.analyze@thermofisher.com">us.customer-support.analyze@thermofisher.com</a>
Web site	<a href="http://www.thermo.com/ms">www.thermo.com/ms</a>

❖ **To get local contact information for sales or service**

Go to [www.thermoscientific.com/wps/portal/ts/contactus](http://www.thermoscientific.com/wps/portal/ts/contactus).

❖ **To copy manuals from the Internet**

Go to [mssupport.thermo.com](http://mssupport.thermo.com), agree to the Terms and Conditions, and then click **Customer Manuals** in the left margin of the window.

❖ **To suggest changes to documentation or to Help**

- Fill out a reader survey online at [www.surveymonkey.com/s/PQM6P62](http://www.surveymonkey.com/s/PQM6P62).
- Send an e-mail message to the Technical Publications Editor at [techpubs-lcms@thermofisher.com](mailto:techpubs-lcms@thermofisher.com).

## Introduction

This chapter introduces the Surveyor LC Pump Plus (see [Figure 1](#)), a member of the Surveyor Plus™ family of liquid chromatography (LC) instruments.

### Contents

- [Functional Description](#)
- [Status LEDs](#)
- [Flow Control](#)
- [Specifications](#)

**Figure 1.** Surveyor LC Pump Plus



## Functional Description

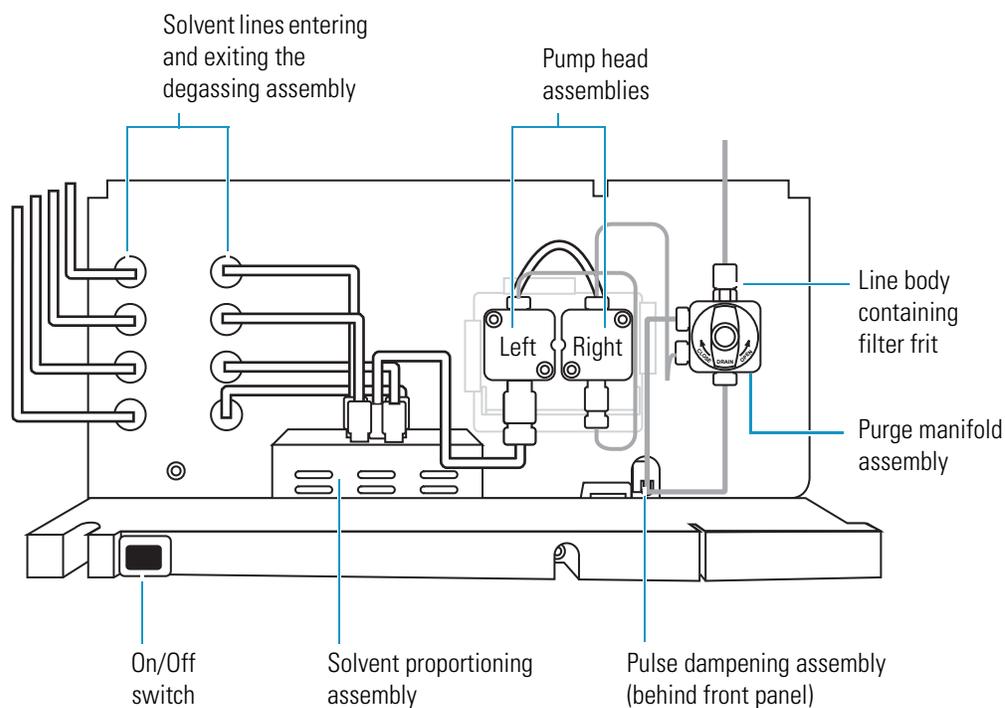
The Surveyor LC Pump Plus is a dual-piston, quaternary, low-pressure mixing pump with a built-in vacuum degasser and pulse dampener. The pumping system provides flow rates from 0.001 to 9.999 mL/min and can run precise gradients from 0.200 to 2.000 mL/min. The integral vacuum degasser offers efficient solvent degassing while requiring only 500  $\mu$ L of volume, and the pulse dampener produces stable flow rates while adding only 400  $\mu$ L of gradient delay volume to the system.

The Surveyor LC Pump Plus is a module of the Surveyor high-performance liquid chromatograph (HPLC). You control the LC pump from a Thermo Scientific data system. The only manual controls are the power switch and the drain valve knob.

Figure 2 shows the major components of the Surveyor LC Pump Plus, which are described in these topics:

- [Vacuum Degasser Assembly](#)
- [Solvent Proportioning Assembly](#)
- [Pump Head Assemblies](#)
- [Purge Manifold Assembly](#)
- [Pulse Dampening Assembly](#)

**Figure 2.** Front panel of the Surveyor LC Pump Plus



## Vacuum Degasser Assembly

The Surveyor LC Pump Plus contains a vacuum-membrane degasser that removes dissolved gasses from the mobile phase. The solvent degassing system consists of four independent chambers (see [Figure 3](#)) maintained at a constant vacuum of approximately 27 in. Hg. Each chamber contains an 18 in. length of 0.045 in. Teflon™ AF tubing. This translates to a volume of less than 500 µL per channel, adding very little to the quantity of solvent required to purge the lines when you are replacing an eluent. The vacuum pump operates continuously, eliminating the excess baseline noise and drift caused by vacuum pump cycling.

**Figure 3.** Vacuum degasser chambers behind the front panel



## Solvent Proportioning Assembly

The Surveyor LC Pump Plus solvent proportioning assembly includes four high-precision proportioning valves. These valves contain Teflon and Kalrez™ sealing surfaces that produce high precision solvent compositions in the flow rate range of 0.200 to 9.999 mL/min.

The pump proportions the requested solvents with each intake stroke of the primary piston. The intake stroke has a fixed volume of 48 µL so that increasing the flow rate increases both the intake stroke frequency and the switching frequency of the proportioning valves. Running gradients at flow rates greater than 2.000 mL/min reduces the lifespan of the proportioning valves.

## Pump Head Assemblies

Two pump head assemblies perform the dual-piston pumping action of the LC pump. The pump head assemblies consist of these components:

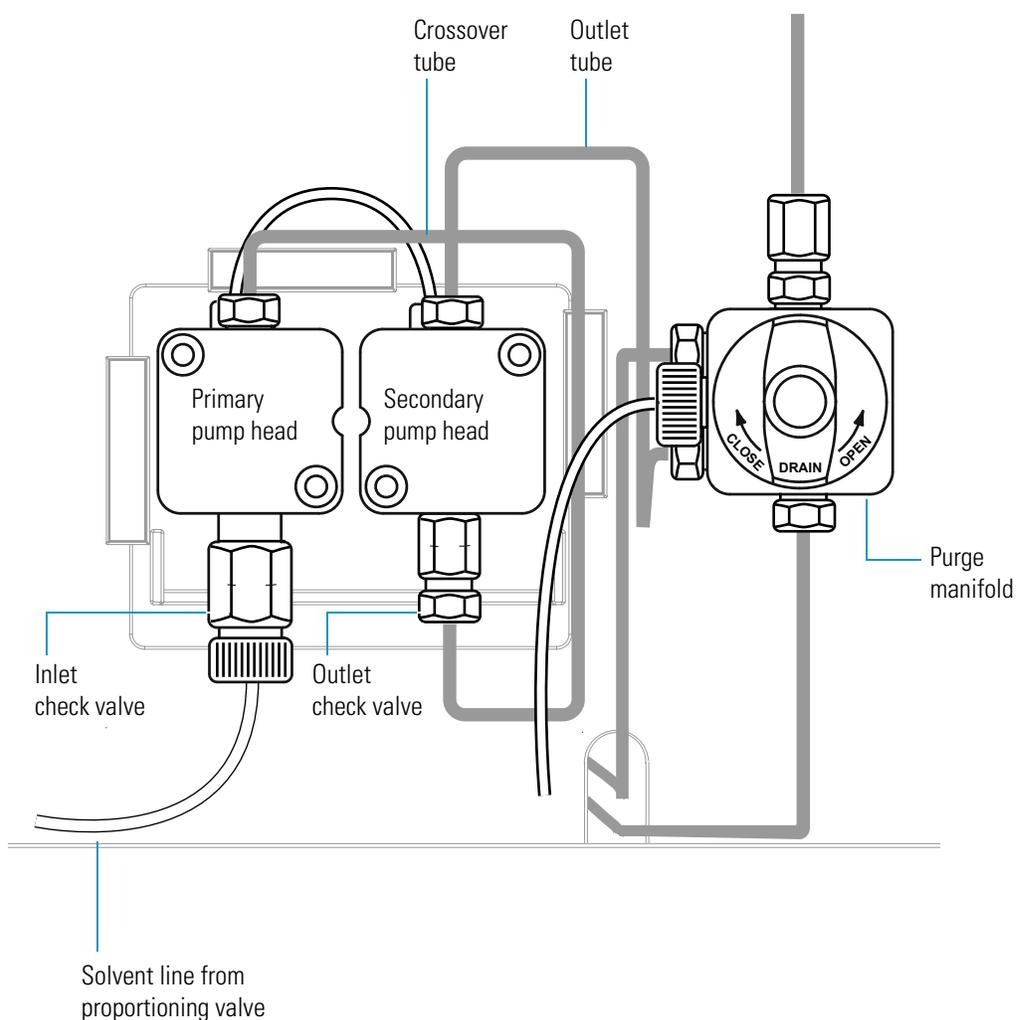
- [Tubing Connections](#)
- [Pump Heads](#)
- [Check Valves](#)
- [Wash System](#)

## Tubing Connections

The solvent path (see [Figure 4](#)) between the proportioning valve and the purge manifold consists of the following:

- A length of 1 mm ID low-pressure tubing that connects the proportioning assembly to inlet check valve
- The inlet check valve, which controls the mobile phase flow into the primary pump head
- The crossover tube, a length of 1/16 in. ID high-pressure stainless steel tubing that connects the primary pump head to the outlet check valve
- The outlet check valve, which prevents backflow of the mobile phase into the primary pump head
- The outlet tube, a length of 1/16 in. ID high-pressure stainless steel tubing that connects the secondary pump head to the purge manifold

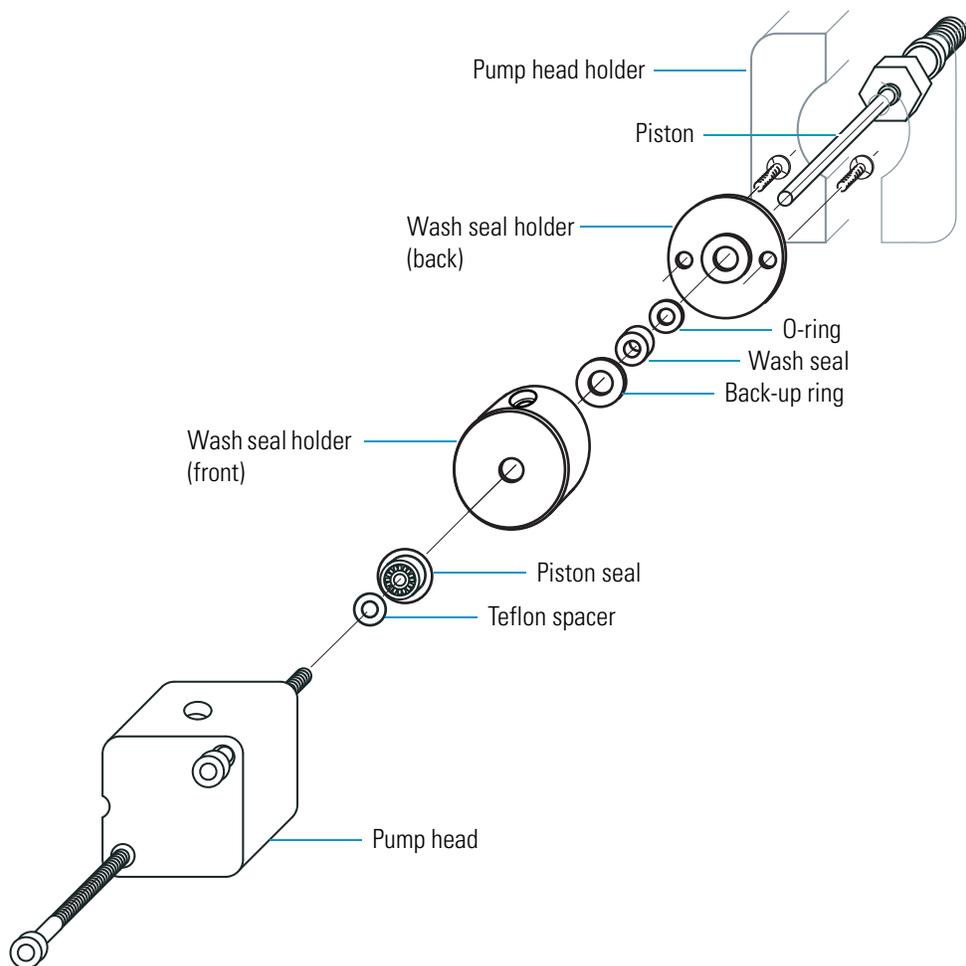
**Figure 4.** Pump heads with tubing connections



## Pump Heads

Each pump head consists of two hex socket head bolts, and a pump head, Teflon spacer, piston seal, wash seal holder, wash seal, and piston assembly (see Figure 5). The inlet check valve screws into the bottom of the primary pump head. The outlet check valve screws into the bottom of the secondary pump head. The pump head mounts onto the pump head holder.

**Figure 5.** Pump head assembly (exploded view)



As the pistons move back and forth inside the pump heads, they draw mobile phase from the solvent proportioning assembly. The pistons are made of sapphire, which is both hard and fracture-resistant, as well as compatible with buffered mobile phases. The floating piston design provides refined piston alignment and smooth piston movement.

The piston seals allow the pistons to move freely within the piston chamber. The piston seals are made of graphite-filled PTFE, an extremely strong thermoplastic. The seals contain a wire spring made of Hastelloy™ C that forces the inside flange of the seal against the piston to prevent leaks. The seals are not leak proof. In fact, wetting the surface of the pistons requires a

small quantity of mobile phase, which acts as a lubricant to reduce wear on the piston seals. Through continued use and over time, the seals degrade and must be replaced. Allowing the pump to run dry and neglecting to rinse the pump head assemblies after pumping buffered eluents shorten the lifespan of the seals.

The wash seals act as backwash seals that prevent liquid from leaking out of the piston chambers onto the electronic drive components of the pump. They also provide better alignment of the piston. The wash seals are made of unpigmented polyethylene.

## Check Valves

The inlet and outlet check valves are shut-off devices that allow the mobile phase to flow in only one direction (see [Figure 6](#)). Both check valves use two ruby balls, two sapphire seats, and a spring (see [Figure 7](#)). The ruby ball sits against the sapphire seat and prevents the flow of liquid by covering the aperture (hole) in the sapphire seat. The added spring prevents back flow even at low back pressures.

Check valves are actuated by changes in the pressure gradient (flow) across the valve. During the piston compression stroke, the pressure in the primary pump head increases. The increased pressure causes the balls in the outlet check valve to rise from their respective seats, allowing the mobile phase to pass through the aperture of each seat, around each ball, and out through the other side of the check valve into the crossover tube. Correspondingly, the increased pressure pushes the balls in the inlet check valve firmly onto their respective seats, sealing the aperture in each seat and preventing mobile phase from flowing back into the solvent proportioning assembly.

Because check valves must have a very precise fit between the balls and seat, particulate matter compromises the sealing action of the check valves and causes erratic flow rates.

Figure 6. Solvent path

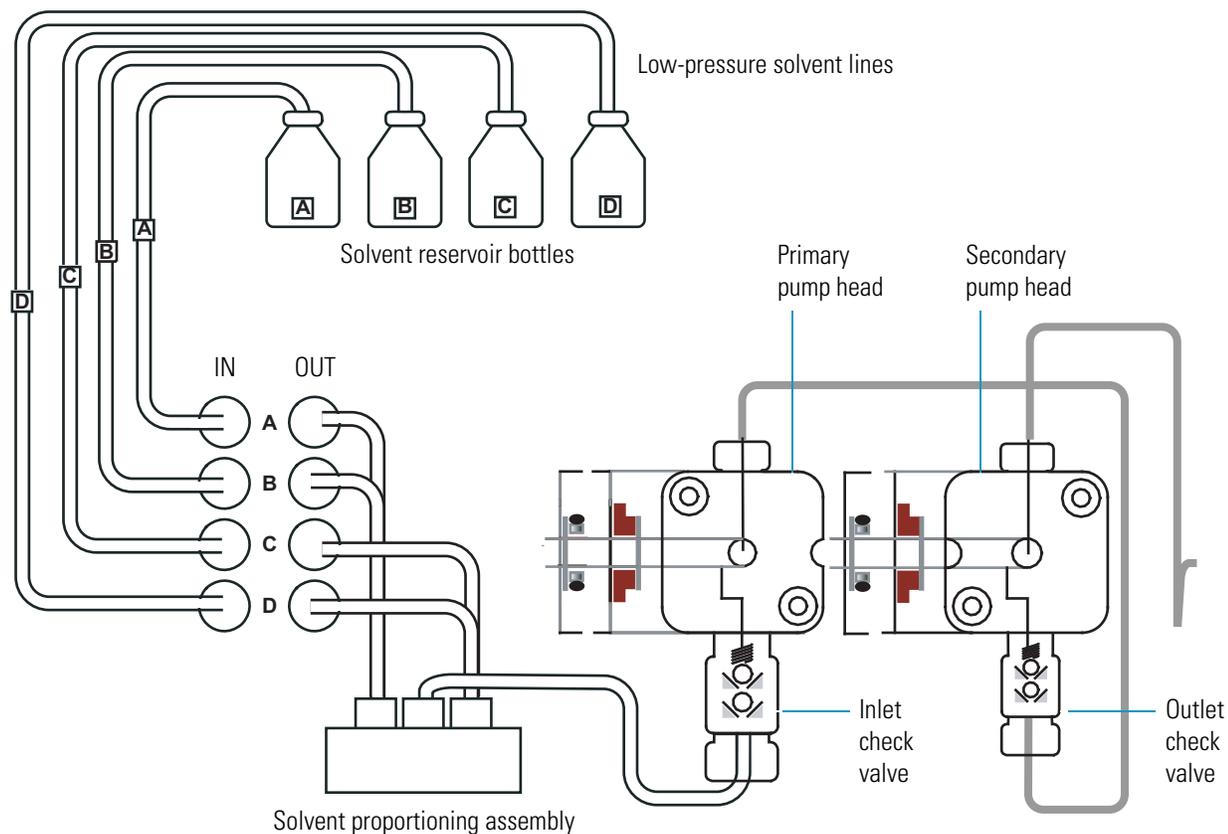
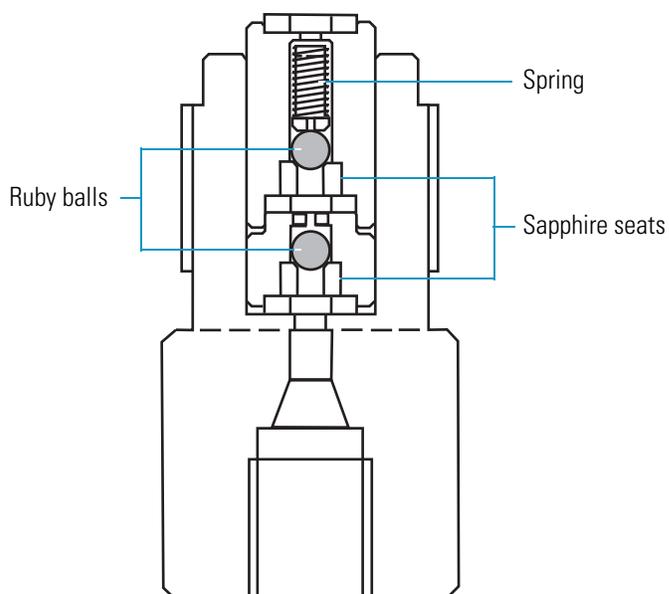


Figure 7. Check valve (schematic)



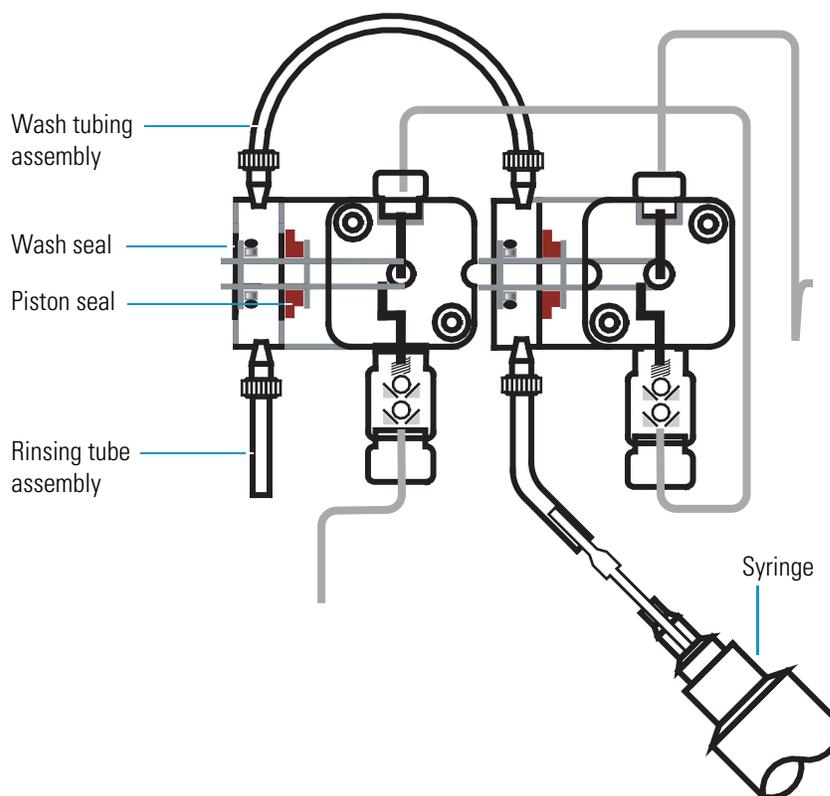
## Wash System

Use the wash tube assembly and the rinse tube assembly to rinse the pump heads with distilled water when you are pumping buffered mobile phases. Rinsing buffered solutions out of the pump heads extends the lifespan of the seals and the pistons.

The bushings of the wash tube assembly slide into the holes on the top of the ring holder and the wash seal holder. The bushings of the rinse tube assembly slide into the holes on the bottom of the ring holder and the wash seal holder. To rinse salts out of the pump heads, attach a syringe to one of the rinse tubes. Place the end of the other rinse tube into a waste container, and then push water through the connected tubing.

Figure 8 shows the setup for rinsing the pump head assemblies.

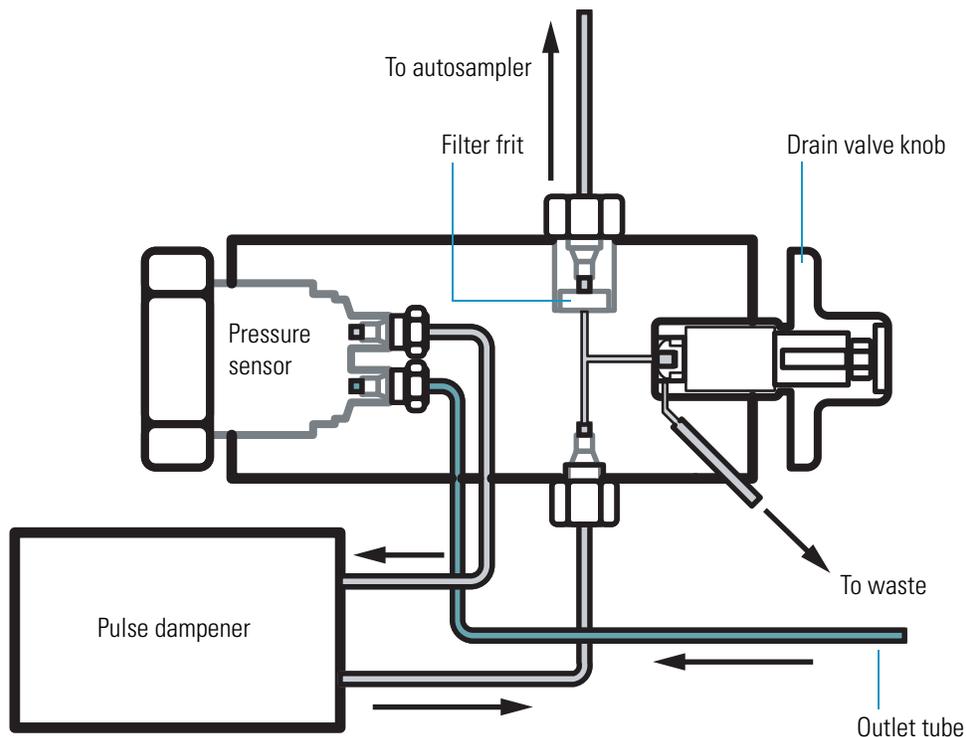
**Figure 8.** Solvent flow path for the pump head assemblies



## Purge Manifold Assembly

The purge manifold assembly consists of the pressure sensor, the drain valve knob, and the line filter body (see [Figure 9](#)).

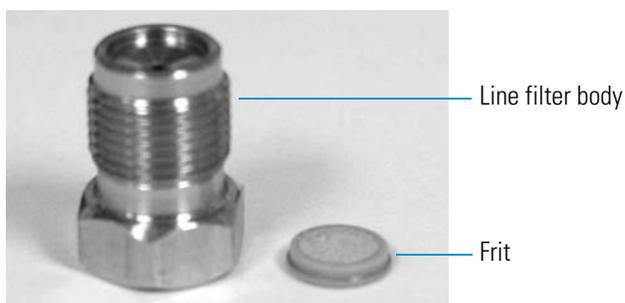
**Figure 9.** Purge manifold assembly (schematic)



The line filter body (see [Figure 10](#)) screws into the top of the purge manifold assembly (see [Figure 9](#)). The line filter body holds a replaceable frit that prevents particulate matter from entering the column. The particulate matter can come from the mobile phase solvents or from the piston seals as they wear. As this filter becomes clogged, the LC system pressure rises.

Replace the frit when the system pressure rises above the typical operating range for your chromatographic application. The replacement frequency for the inline filter frit depends on the purity of your mobile phase solvents and the wear rate for the pump piston seals.

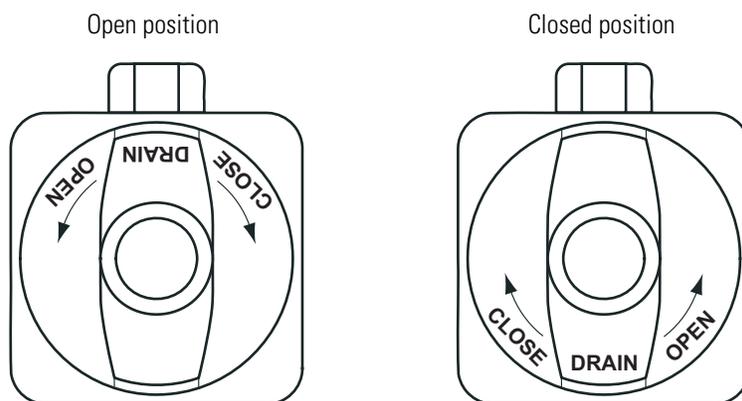
**Figure 10.** Line filter body and frit



The drain valve knob has two positions: open or closed (see [Figure 11](#)). In the open position, mobile phase exits through the left side of the purge manifold toward waste. In the closed position, mobile phase exits through the top of the purge manifold toward the autosampler. Before you perform a purge operation to remove air from the pump heads or solvent lines, you must open the drain valve knob.

To open the drain valve, turn the knob 180° counterclockwise until the word DRAIN is upside down. To close the drain valve, gently turn the knob clockwise until you feel resistance. Do not overtighten the knob.

**Figure 11.** Drain valve knob



## Pulse Dampening Assembly

The pulse dampening assembly is located behind the front panel of the Surveyor LC Pump Plus. This dampening coil effectively smooths the delivery of mobile phase to the rest of the HPLC, while adding only 400  $\mu\text{L}$  of gradient delay volume.

## Status LEDs

Four status light-emitting diodes (LEDs)—labeled Power, Comm, Run, and Degas—are located on the right door of the pump (see Figure 12). Table 1 lists the LED states.

**Figure 12.** Status LEDs



**Table 1.** States and their meaning for the Surveyor LC Pump Plus LEDs

LED	Status	Meaning
<b>Power</b>	Green	The LC pump is switched on and receiving power.
<b>Comm</b>	Amber	The LC pump is not communicating with the data system computer.
	Flashing amber	The rotary switches on the back panel of the LC pump are set to 00 for downloading firmware.
	Green	The LC pump is communicating with the data system computer.
<b>Run</b>	Amber	The LC pump is not communicating with the data system computer, the pump's motor is stopped, the pistons are homing, or the pump is stabilizing (except during a run).
	Flashing amber	The LC pump is experiencing an error condition.
	Green	The LC pump is in the Ready state.
	Flashing green	The LC pump is performing a run or the pump is stabilizing during a run.
<b>Degas</b>	Amber	The LC pump is powering up and the degas unit is building vacuum.
	Flashing amber	The degas unit is experiencing a failure, such as a loss of vacuum.
	Green	The degas unit has developed sufficient vacuum to degas the mobile phase solvents when the pump flow is set to a typical flow rate for chromatography.

## Flow Control

[Figure 13](#) contains a schematic of the Surveyor LC Pump Plus flow control hardware.

A stepping motor that runs at 12 800 pulses per revolution controls the flow rate of the mobile phase. The stepping motor drives a camshaft that is fitted with two cams. As the cams rotate, the cam-followers at the back of the pistons translate the rotary motion of the cams into linear motion. This linear motion moves the two parallel pistons back and forth inside the pump head.

The eccentric shape of the cams determines the stroke length of the pistons. The stroke length of the primary piston is 6 mm, and the stroke length of the secondary piston is 3 mm. Both pistons are 1/8 in. in diameter, so their respective stroke lengths translate to a stroke volume of 48  $\mu\text{L}$  for the primary piston and a stroke volume of 24  $\mu\text{L}$  for the secondary piston.

The pump cycle (see [Figure 14](#) on [page 14](#)), which is one full rotation of the camshaft, consists of three regions. The first region, which is the solvent proportioning region, begins at a 20° rotation with the start of the intake stroke for the primary piston. As the primary piston begins to draw back, it creates a low-pressure zone that causes the inlet check valve to open. As the inlet check valve opens, eluent enters the primary pump head chamber.

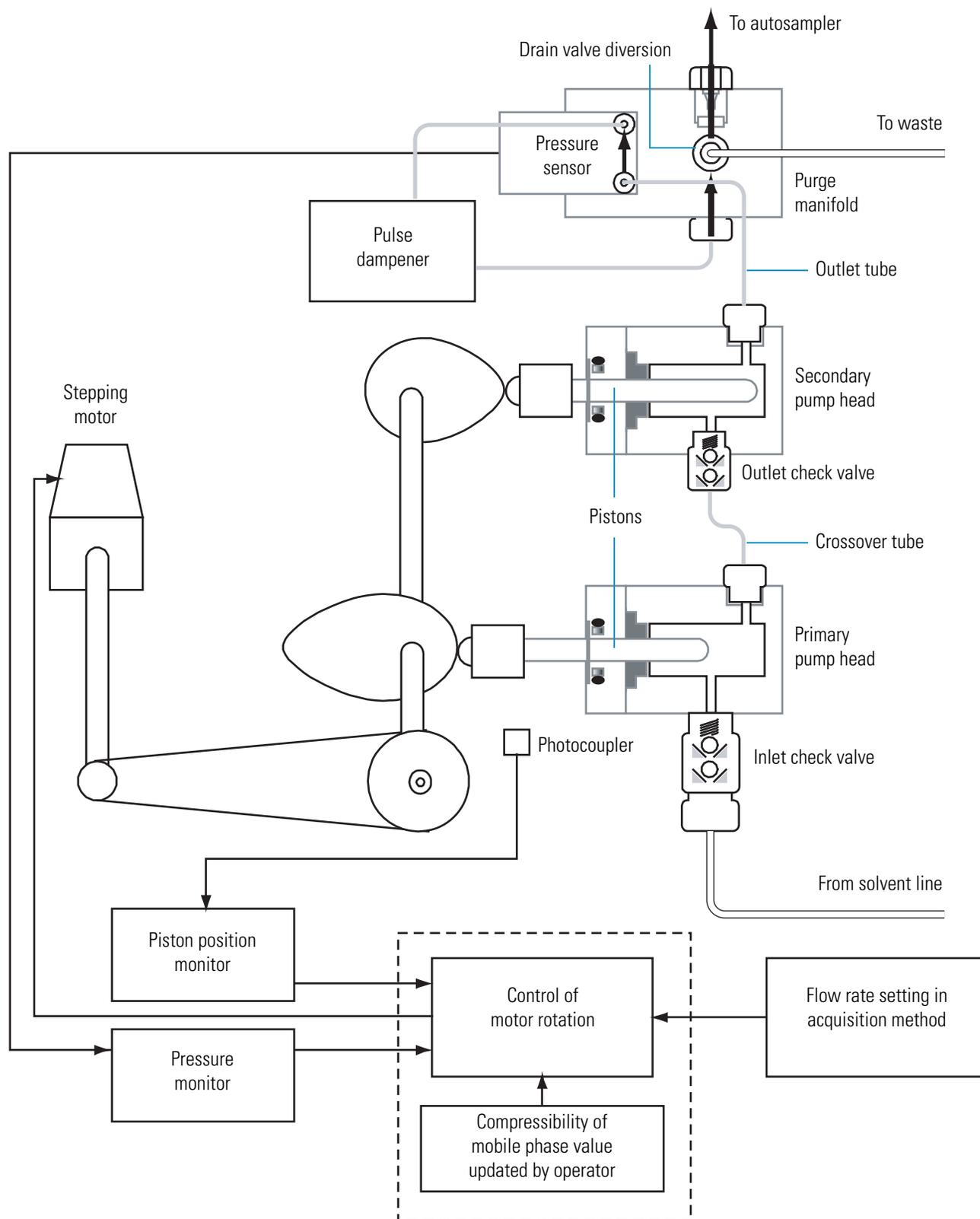
Solvent proportioning occurs during the intake stroke of the primary piston. The valves of the solvent proportioning assembly open and close in the following order: B, C, D, and then A. During the intake stroke, the outlet check valve is closed, and all flow to the system comes from the secondary piston.

The second region, which is the compressibility region of the pump cycle, begins at 180° as the primary piston starts its forward stroke. The resulting high-pressure zone causes the inlet check valve to close while compressing the eluent in the primary pump chamber. As the pressure of the eluent in the primary pump head exceeds the column pressure, the outlet check valve opens and allows eluent to enter the secondary pump chamber. For about 40° of the cam cycle, both pistons contribute flow to the system. The compressibility region of the pump cycle ends at 260° of the cam cycle, when the secondary piston reaches full intake.

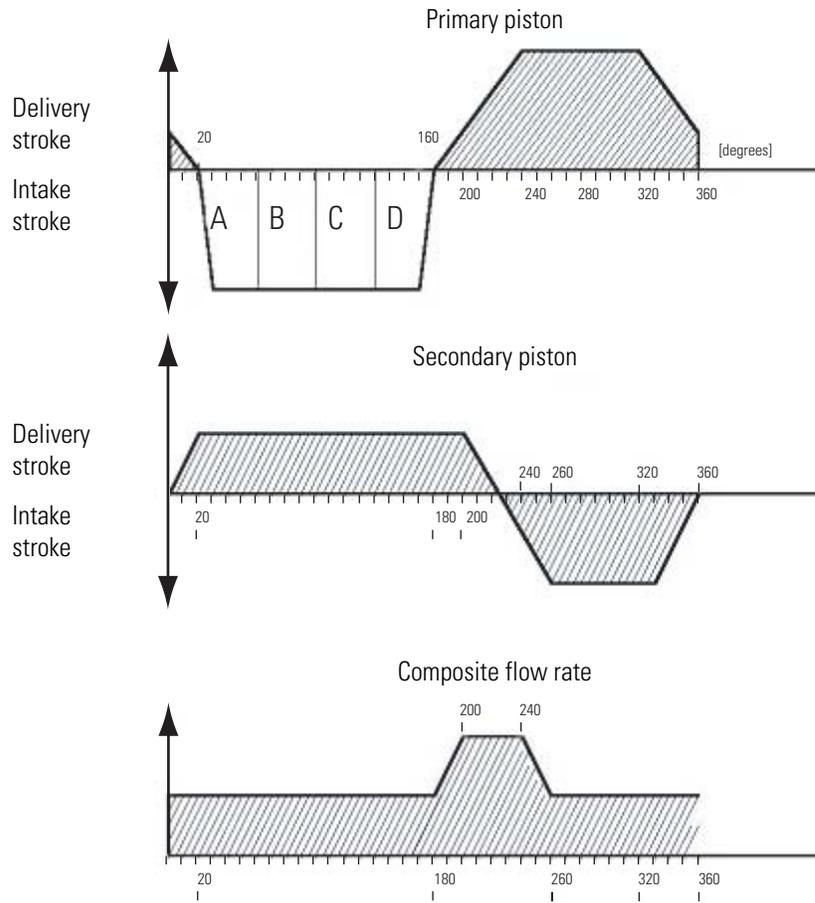
During the compressibility region of the cam cycle, which begins with the forward stroke of the primary piston and ends with the intake stroke of the secondary piston, the on-board CPU monitors the backpressure of the eluent, as well as the position of the pistons, and adjusts the speed of the stepping motor to maintain constant flow.

The third region of the pump cycle extends from 260° to 20° rotation. In the third region of the pump cycle, the primary piston is providing all of the flow to the system as well as refilling the secondary piston chamber.

Figure 13. Flow control of the Surveyor LC Pump Plus by the step motor



**Figure 14.** Composite flow rate produced by the two reciprocating pistons



## Specifications

The Surveyor LC Pump Plus has the following specifications:

Minimum Flow Rate:	0.001 mL/min isocratic, 0.100 mL/min gradient
Maximum Flow Rate:	9.999 mL/min
Flow Rate Accuracy:	±2% or ±2 µL/min, whichever is greater when water is pumped at 0.100 to 5.000 mL/min, 10 to 400 bar, 20 °C
Flow Rate Precision:	±0.3% when water is pumped at 0.100 to 5 mL/min, 10 to 400 bar, 20 °C
Pressure Range:	0 to 400 bar (0 to 5800 psi)
Operating Range:	10 to 400 bar (145 to 5800 psi)
Pressure Resolution:	0.01 bar (0.15 psi)
Solvent Capacity:	Quaternary
Compositional Accuracy:	±1%—for binary gradient—at 1000 µL/min
Piston Volume:	48 µL primary piston, 24 µL secondary piston
Gradient Delay Volume:	785 µL
Degasser Type:	Vacuum membrane
Degasser Capacity:	4 channels
Degasser Volume:	< 500 µL per channel
Pulse Dampener:	400 µL
Wetted Parts:	316 stainless steel, PEEK™, ruby, sapphire, Teflon, Hastelloy C, GFP
Remote Controls:	Ethernet interface to the data system computer
Dimensions:	18 × 36 × 47 cm ( <i>h × w × d</i> ) 7.1 × 14 × 18.5 in. ( <i>h × w × d</i> )
Weight:	12 kg (26.4 lbs)
Power Requirements:	100/120 Vac or 220/240 Vac, 50 to 60 Hz, 500 VA max
Operating Temp:	+10 °C to +40 °C
Storage Temp:	−40 °C to +70 °C
Operating Humidity:	5 to 95% relative, non-condensing



# Installation

Follow the procedures in this chapter to install your Surveyor LC Pump Plus or to troubleshoot the Surveyor LC system connections. Use the “[Installation Checklist](#)” on [page 18](#) as a quick reference to conducting a successful installation. Make a copy of the checklist and fill it out when the installation is complete. Keep the completed checklist in your maintenance records.

## Contents

- [Installation Checklist](#)
- [Unpacking and Inspecting the Instrument](#)
- [Placing the Pump on the Laboratory Benchtop](#)
- [Connecting the Back Panel Cables](#)
- [Connecting the Solvent Lines](#)
- [Powering On the LC Pump for the First Time](#)
- [Preparing the LC Pump for Daily Operation](#)
- [Calibrating the LC Pump](#)

## Installation Checklist

The following checklist summarizes the installation steps for the Surveyor LC Pump Plus.

- Unpack and inspect the instrument. (page 19)
- Read the safety notices (in the preface of this manual).
- Make the initial instrument preparations. (page 19)
- Make the initial back panel connections. (page 20)
- Connect the solvent lines. (page 22)
- Power on the pump for the first time. (page 28)
- Install the instrument control software and connect remote communication outputs, as required.

This LC pump was installed by:

---

(Name)

(Date)

## Unpacking and Inspecting the Instrument

Carefully remove the pump from the shipping container and inspect both the pump and shipping materials for any signs of damage. If you find any damage, save the shipping materials and immediately contact the shipping company.

The shipping container should contain the following items:

- Surveyor LC Pump Plus
- Surveyor LC Pump Plus Accessory Kit (see [“Surveyor LC Pump Accessory Kit”](#) on [page 104](#))
- A CD-ROM containing electronic copies of the manuals for the Surveyor Plus family of LC instruments

Carefully check to make sure that you received all of the items listed on the packing list. If any items are missing, contact your Thermo Fisher Scientific representative immediately.

## Placing the Pump on the Laboratory Benchtop

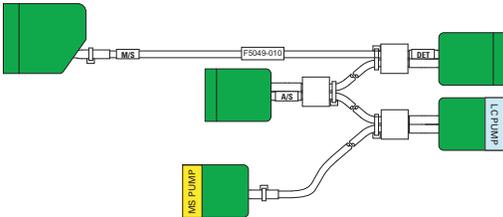
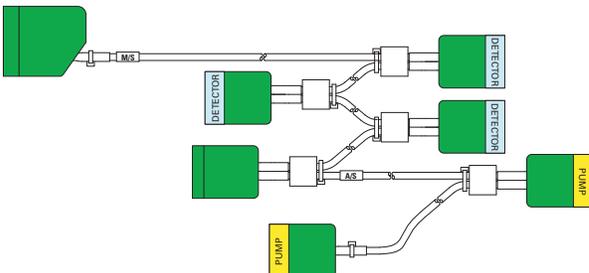
Place the pump on a benchtop. Allow at least 15 cm (6 in.) of space between the back panel of the pump and any wall or obstruction. This clearance provides access to the back-panel connectors and sufficient room for the ventilation of electronic components.

If the pump is part of a stand-alone Surveyor Plus LC system, place the pump at the bottom of the LC stack.



## System Synchronization Cable

The Surveyor System Accessory Kit (P/N SRVYR-SYSKT) contains two system synchronization (contact closure) cables. One cable has five combicon connectors, and the other cable has seven combicon connectors.

System synchronization cable	Part number
	F5049-010
	60053-63034

### ❖ To connect the cable with five combicon connectors to the Surveyor system

1. To connect the Surveyor LC Pump Plus, plug the connector with the blue sticker labeled LC PUMP into the eight-pin socket on the pump's back panel (see [Figure 15](#) on [page 20](#)).
2. To connect the Surveyor Autosampler Plus, plug the connector attached to the cable labeled AS into the eight-pin socket labeled 1 through 8 on the autosampler's back panel.
3. To connect a Surveyor detector, plug the connector attached to the cable labeled DET into the eight-pin socket labeled 1 through 8 on the detector's back panel.

### ❖ To connect the cable with seven combicon connectors to the Surveyor system

1. To connect the Surveyor LC Pump Plus, plug one of the connectors labeled PUMP into the eight-pin socket on the pump's back panel (see [Figure 15](#) on [page 20](#)).
2. To connect the Surveyor Autosampler Plus, plug the connector attached to the cable labeled AS into the eight-pin socket labeled 1 through 8 on the autosampler's back panel.
3. To connect a Surveyor detector, plug the connector labeled DET into the eight-pin socket labeled 1 through 8 on the detector's back panel.

For information about making the contact closure connection between a Thermo Scientific mass spectrometer and a Surveyor Plus LC system, refer to the *Surveyor Plus Getting Connected Guide*.

### Ethernet Cable

The Surveyor System Accessory Kit (P/N SRVYR-SYSKT) contains shielded, CAT-5 Ethernet cables.

❖ **To connect the Surveyor LC Pump Plus to the data system computer**

1. Connect the Ethernet switch to the data system computer with the supplied Ethernet cable.
2. Connect the Ethernet port on the back panel of the LC pump to the Ethernet switch with the supplied Ethernet cable.

### Unit ID Setting

The unit ID consists of two rotary switches located on the pump's back panel. Each switch has ten positions. The arrow on the left switch points to the "tens" digit of the unit ID. The arrow on the right switch points to the "ones" digit of the unit ID. The Surveyor LC Pump Plus ships with the unit ID preset to 1.

You can set the unit ID to values from 0 to 99. However, the unit ID setting must match the integer value that is specified in the instrument configuration application. The value of 0 is reserved for special service functions such as downloading new LC pump firmware.

**Tip** For information about configuring the Surveyor LC Pump Plus, refer to the Surveyor Plus user guide for your Thermo Scientific data system or the Help provided with the data system.

### Connecting the Solvent Lines

You need to connect solvent lines to and from the Surveyor LC Pump Plus before you can operate the pump. There are four low-pressure lines that deliver the four solvents to the solvent proportioning assembly of the pump and one high-pressure line that delivers the mobile phase to the autosampler.

To connect the solvent lines, follow these procedures:

- [Low-Pressure Solvent Reservoir Lines](#)
- [High-Pressure Solvent Line Between the Pump and the Autosampler](#)

#### Low-Pressure Solvent Reservoir Lines

The Surveyor System Accessory Kit (P/N SRVYR-SYSKT) includes a 6 m (20 ft) length of FEP tubing (1/8 in. OD × 1/16 in. ID), which must be cut into four pieces for use as the solvent inlet lines. These lines are used to deliver each of the four solvents to the vacuum degassing assembly inside the Surveyor LC Pump Plus.

The accessory kit also includes four solvent reservoir bottle caps as well as a set of stick-on labels with the letters A, B, C, and D. Place these labels on your solvent reservoir bottle caps, and then use the solvent inlet lines to connect the solvent reservoir bottles to the corresponding degassing inlet.

Super Flangeless™ fittings secure the solvent lines to the inlet ports of the built-in degasser. Connect the solvent reservoir bottle labeled A to the A degas inlet, and so on.

To connect the low-pressure solvent lines, follow these steps:

1. [Connecting the Solvent Reservoir Bottles](#)
2. [Connecting the Solvent Reservoir Lines to the Degassing Unit](#)

## Connecting the Solvent Reservoir Bottles

### ❖ To connect the solvent lines to the solvent reservoir bottles

1. Place a stick-on label either A, B, C, or D on a solvent reservoir bottle cap. Insert the inlet line through one of the holes in the top of the reservoir bottle cap.
2. Screw one of the supplied solvent reservoir filters onto the end of the solvent line (see [Figure 16](#)).

**Note** A Teflon end-of-line filter is supplied with the system accessory kit for the Surveyor LC Pump. As you screw the filter onto the end of the solvent line, the filter scores the end of the line with threads.

**Figure 16.** Solvent reservoir cap assembly



## 2 Installation

### Connecting the Solvent Lines

3. Place the solvent reservoir filter and inlet line into the solvent reservoir bottle. Then screw the cap with the stick-on label onto the solvent reservoir bottle until it is secure.

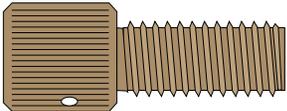
**Tip** The cap is a two-piece assembly. The upper section snaps onto a threaded section. You can screw the threaded section onto the bottle and snap the upper section on after installing the tubing. Or, if you are replacing existing tubing, you can unscrew the entire cap from the bottle.

4. Position the bottle in the Surveyor Solvent Platform, allowing the solvent inlet line to hang down along the left side of the Surveyor system.

### Connecting the Solvent Reservoir Lines to the Degassing Unit

The Solvent Interconnect Kit (see “[Solvent Interconnect Kit](#)” on [page 108](#)) contains the Super Flangeless fittings (see [Table 2](#)) used to connect the solvent reservoir lines to the degassing unit. You can order these fittings from Thermo Fisher Scientific or the IDEX Health and Sciences Web Store. For ordering information, see “[Solvent Interconnect Kit](#)” on [page 108](#).

**Table 2.** Super Flangeless fitting components

Drawing	Description
	Super Flangeless nut, natural PEEK, for 1/8 in. OD tubing
	Compression ring, stainless steel
	Super Flangeless ferrule, natural PEEK, for 1/8 in. OD tubing

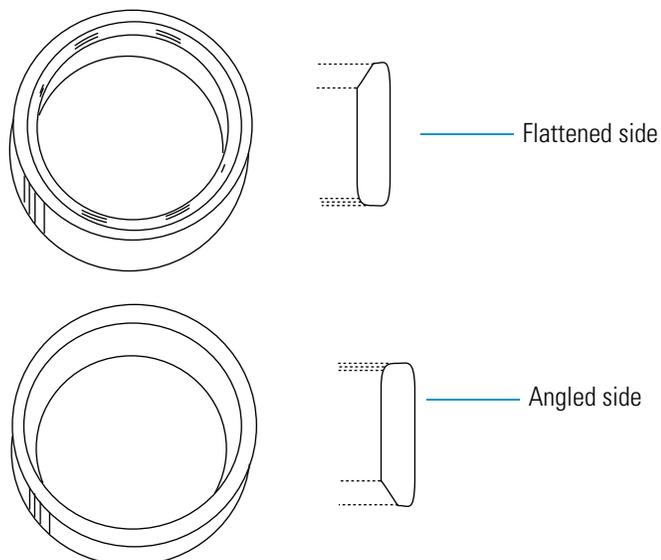
#### ❖ To connect the solvent reservoir lines to the inlet ports of the degassing unit

1. Slide the three components of the Super Flangeless fitting onto the remaining end of the solvent line as follows:
  - a. Slide the nut onto the end of the tubing.

The compression ring has two sides: one side is flat, and one side is angled (see [Figure 17](#)). When you place the three components of the fitting on the end of a solvent line, the flat side of the ring faces the nut and the angled side of the ring faces the ferrule.

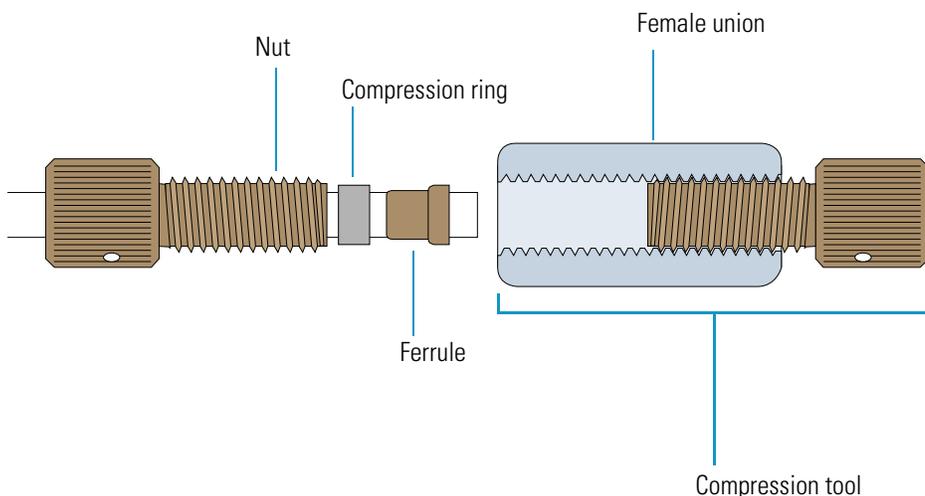
- b. With its flattened side (see [Figure 17](#)) facing toward the nut, slide the compression ring onto the end of the tubing.

**Figure 17.** Steel compression ring with a view of the two sides



- c. With its narrow end facing toward the compression ring, slide the ferrule onto the end of the tubing.
2. Swage the Super Flangeless fitting onto the tubing as follows:
    - a. Create a compression tool (see [Figure 18](#)) by screwing a Super Flangeless nut into one end of a female union (1/4 in. ID × 28 internal threads).

**Figure 18.** Compression tool



- b. Insert the tubing with the fitting assembly into the other end of the union.
- c. Press the tubing to the bottom of the tool while tightening down the nut.

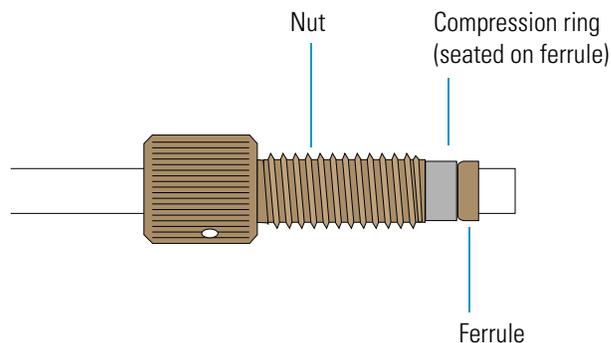
## 2 Installation

### Connecting the Solvent Lines

3. Unscrew the swaged fitting (see [Figure 19](#)) from the compression tool and verify the following:

- The end of the square-cut tubing is flush with the end of the ferrule.
- The steel compression ring is seated over the ferrule.

**Figure 19.** Fitting swaged onto tubing



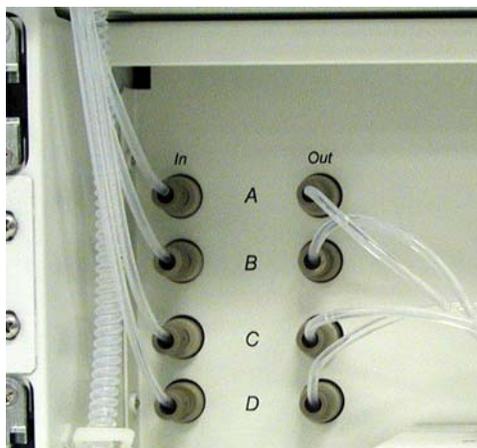
4. Insert the tubing with the properly swaged fitting into inlet port A, and then tighten the nut fingertight. Be careful not to cross-thread the fitting, which can cause solvent leakage.

5. Pass the solvent inlet line through the openings along the left side of each Surveyor module to complete the installation.

6. Repeat this procedure for the B, C, and D solvent reservoir lines.

[Figure 20](#) shows the solvent reservoir lines connected to the inlet ports of the vacuum degassing unit.

**Figure 20.** Vacuum degas connection



## High-Pressure Solvent Line Between the Pump and the Autosampler

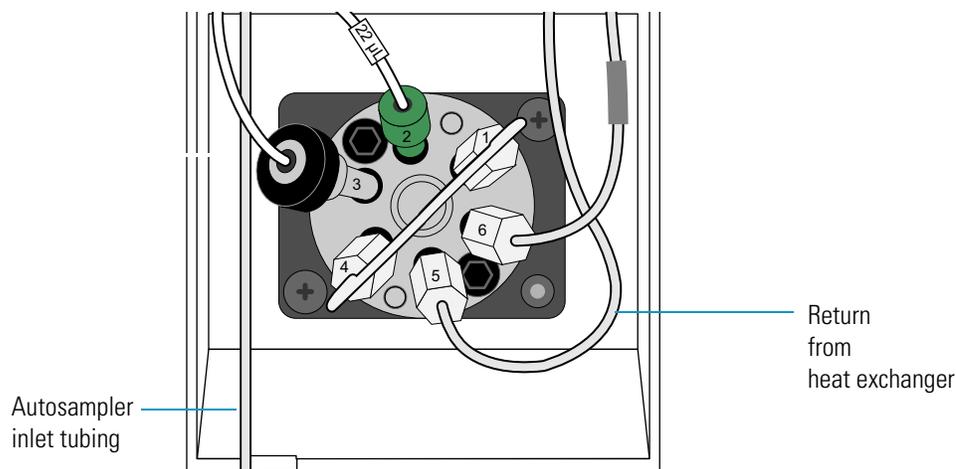
The tubing that connects the solvent path between the pump and the autosampler heat exchanger is preinstalled on the autosampler and has an internal diameter of 0.020 in.

Use the 7/16 in. metal nut and the natural PEEK ferrule in the Surveyor LC Pump Accessory Kit to connect the tubing to the line filter on the top of the purge manifold assembly of the LC pump.

### ❖ To connect the heat exchanger inlet tubing from the autosampler to the pump

1. Place the Surveyor Autosampler Plus on top of the Surveyor LC Pump Plus. Locate the autosampler inlet tubing that extends out of the column oven area.
2. Carefully bend the Surveyor Autosampler Plus inlet tubing so that it passes through the access port on the bottom-right side of the Surveyor Autosampler Plus chassis (see [Figure 21](#)).

**Figure 21.** Injection valve of Surveyor Autosampler Plus



3. Connect the tubing to the purge manifold using the 7/16 in. metal nut and a PEEK ferrule included in the Surveyor LC Pump Accessory Kit (see [Figure 22](#) and [Figure 23](#)). Hand-tighten the fitting. Do **not** use a wrench to tighten the connection.

**Figure 22.** Metal nut and PEEK ferrule

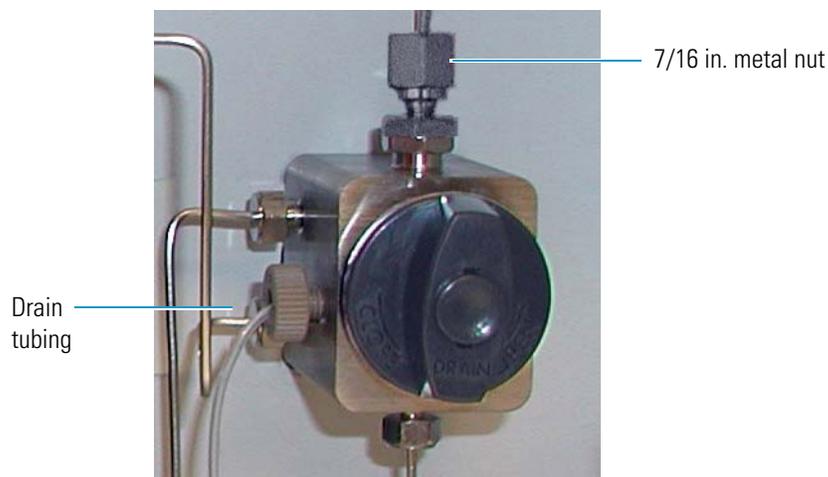


## 2 Installation

### Powering On the LC Pump for the First Time

4. Connect the drain tubing to the left side of the purge manifold (see [Figure 23](#)).

**Figure 23.** Outlet tubing connection to the purge manifold



5. Place the free end of the drain tubing into a waste receptacle.



**CAUTION** To minimize solvent fumes, the waste receptacle should have a tight cap with a hole for the drain tubing. You can also use this waste receptacle to collect the drainage from the autosampler waste line and the detector outlet tubing.

## Powering On the LC Pump for the First Time

After installing the solvent lines and tubing, you can power on the pump.

### ❖ To power on the LC pump

1. Ensure that the power switch at the front of the LC pump is in the Off position (released or out position).
2. Attach the power cord to the power entry module on the back panel of the pump and connect it to line power.
3. Turn the power on by pushing the power button in to engage it.

The Power LED turns solid green. If the LED does not illuminate, see the first troubleshooting tip in [Table 8](#) on [page 98](#). If you cannot resolve the problem, call your Thermo Fisher Scientific service representative for assistance.

## Preparing the LC Pump for Daily Operation

Always use HPLC-quality solvents free of particulate matter to avoid contaminating the check valves and the solvent proportioning valves. Aqueous eluents are particularly susceptible to bacterial growth, which can cause numerous problems.

❖ **To prevent bacteria, particulate matter, or both from entering the pump**

- Filter all solvents thoroughly.
- Discard aqueous mobile phases on a daily basis or add a bactericide such as sodium azide to inhibit bacterial growth (0.65 g/L  $\text{NaN}_3$  will prevent the growth of most kinds of bacteria).



**CAUTION** Sodium azide is highly toxic and carcinogenic and potentially explosive. Take care when disposing of solutions that contain sodium azide because azides can react with heavy metals to form explosive compounds.

Air permeates through FEP tubing and can saturate solvents inside the solvent lines when the system is left static (for example, over a weekend). In this case, purging the lines for a few minutes proves effective.

## Calibrating the LC Pump

The Surveyor LC Pump Plus is factory calibrated to produce a flow rate of 1 mL/min with distilled water at 20 °C. The flow rate adjustment (alpha) value is printed on the motor casing of the pump. The pressure sensor adjustment value is attached to the cable at the back of the pressure transducer. The compressibility value for the mobile phase is set to a default value of  $0.45 \text{ GPa}^{-1}$  (the compressibility ratio for distilled water) in the data system.

For more information about the calibration options for the Surveyor LC Pump Plus, see [“Calibration Options”](#) on page 90.

For information about changing these calibration values and zeroing the readback from the pressure transducer, refer to the Surveyor user guide for your data system.



## Software Instrument Configuration

You can control the Surveyor LC Pump Plus from a Thermo Scientific data system.

To add the LC pump to the instrument configuration and specify the signal polarities for the autosampler, follow the appropriate procedure in this chapter.

**IMPORTANT** If the signal polarities for the Surveyor Autosampler Plus are not configured correctly, the run status remains at “Waiting for Trigger.”

### Contents

- [Adding the Pump to the ChromQuest Instrument Configuration](#)
- [Adding the Pump to the Thermo Foundation Instrument Configuration](#)

## Adding the Pump to the ChromQuest Instrument Configuration

To add the Surveyor LC Pump Plus to the instrument configuration for the ChromQuest™ data system and specify the appropriate contact closure signals for the Surveyor Autosampler Plus, follow these procedures:

- [Pump Configuration Options in the ChromQuest Data System](#)
- [Autosampler Input Signals in the ChromQuest Data System](#)

## Pump Configuration Options in the ChromQuest Data System

The following procedure assumes that you are adding the Surveyor LC Pump Plus to a Surveyor instrument that already exists in the ChromQuest Enterprise. If you have not yet added an instrument to your Enterprise, refer to the *Surveyor Plus User Guide for the ChromQuest Data System*.

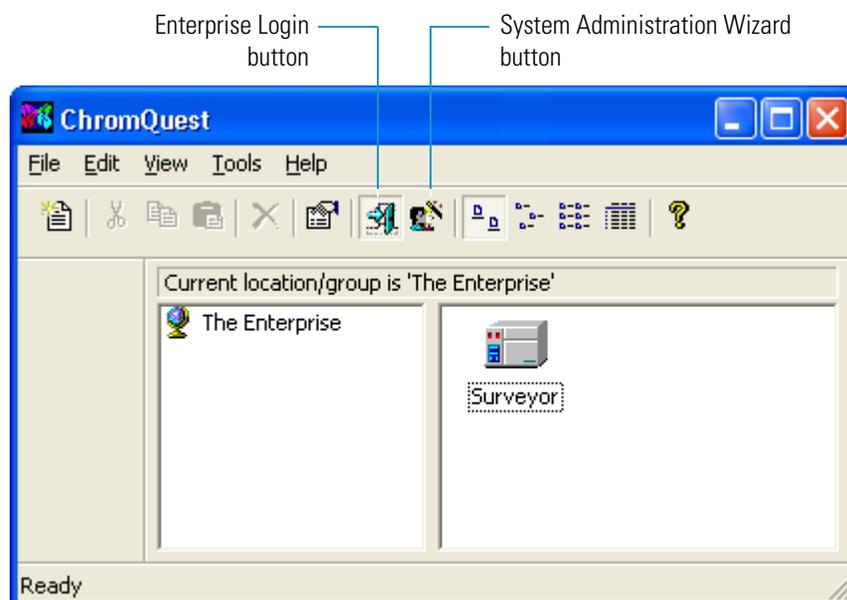
### ❖ To add the Surveyor LC Pump Plus to the instrument configuration

1. Double-click the **ChromQuest** icon on your computer desktop. Or, choose **Start > Programs > Chromatography > ChromQuest**.



The Main Menu window appears (see Figure 24).

**Figure 24.** Main Menu window of ChromQuest



If the System Administration Wizard button  is locked, the security feature is enabled and you are required to log in.

2. If necessary, log in as follows:
  - a. Click the **Enterprise Login** button  to display the Login dialog box shown in Figure 25.

**Figure 25.** Enable Administration dialog box

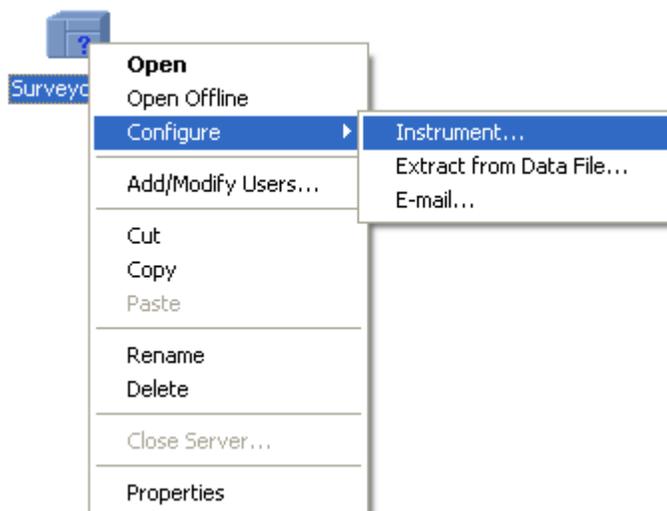


- b. Type your user name in the User Name box.
- c. Type your password in the Password box.
- d. If available, select the appropriate domain in the Domain list.

**Note** If your workstation is not networked to a domain controller, the Enable Administration login box does not contain the Domain list.

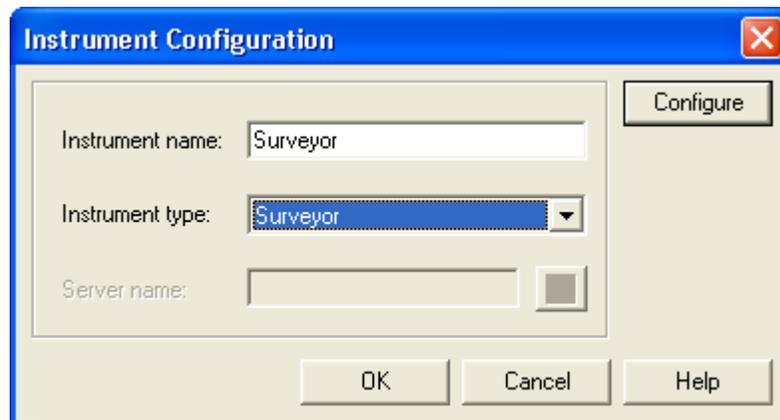
- e. Click **OK**.
3. Open the Instrument Configuration dialog box as follows:
    - a. In the Main Menu window, right-click the icon of the instrument that you want to configure to display a shortcut menu.
    - b. Choose **Configure > Instrument** from the shortcut menu (see [Figure 26](#)).

**Figure 26.** Shortcut menu for an instrument



The Instrument Configuration dialog box appears (see [Figure 27](#)).

**Figure 27.** Instrument Configuration dialog box



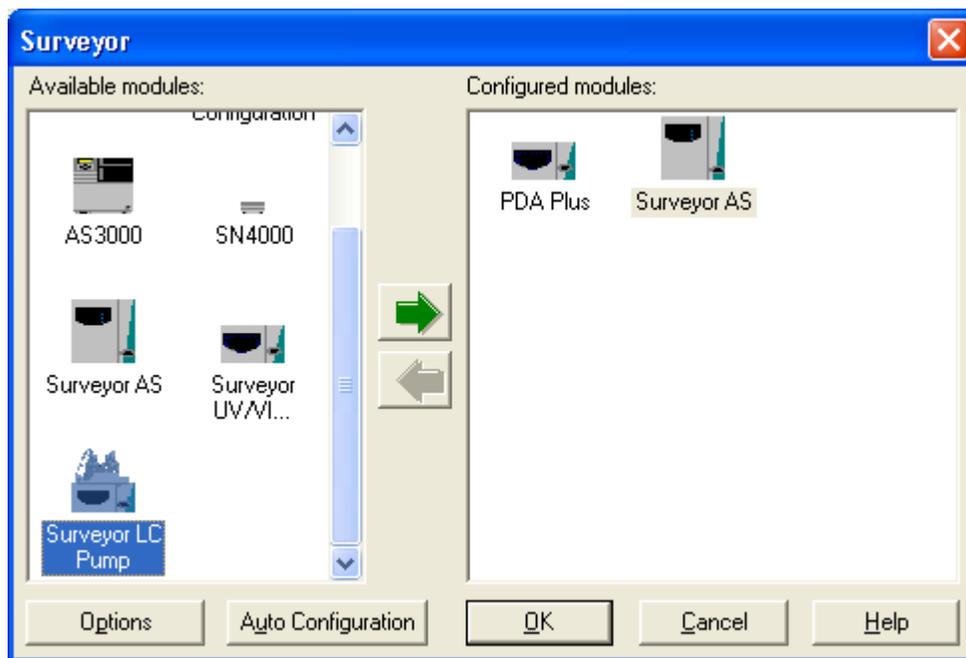
### 3 Software Instrument Configuration

Adding the Pump to the ChromQuest Instrument Configuration

4. In the Instrument Configuration dialog box, click **Configure**.

The Surveyor dialog box appears (see [Figure 28](#)).

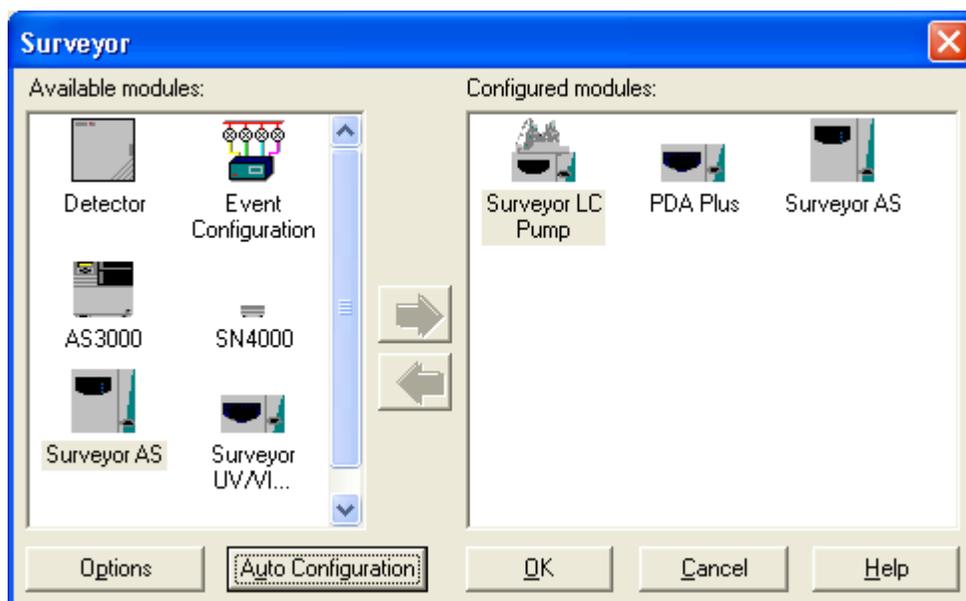
**Figure 28.** Surveyor dialog box with an instrument that has a Surveyor PDA Plus Detector and a Surveyor Autosampler



5. In the Available Modules area, double-click the **Surveyor LC Pump** icon in the Available Modules area to add the pump to the instrument configuration.

The Surveyor LC Pump icon moves to the Configured Modules pane (see [Figure 29](#)).

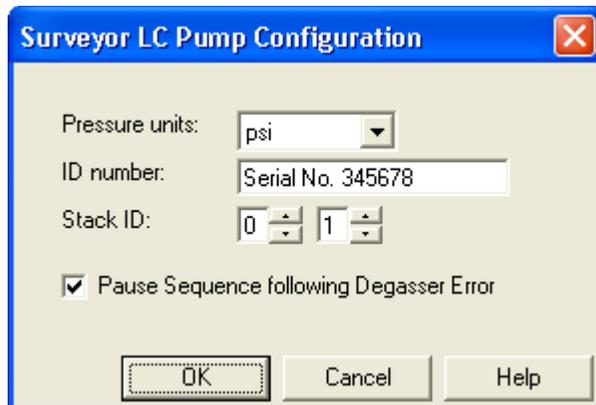
**Figure 29.** Surveyor dialog box with added modules



6. In the Configured Modules area, double-click the **Surveyor LC Pump** icon.

The Surveyor LC Pump Configuration dialog box appears (see [Figure 30](#)).

**Figure 30.** Surveyor LC Pump Configuration dialog box (ChromQuest data system)



7. In the Surveyor LC Pump Configuration dialog box, make the following selections and entries:
- In the Pressure Units list, select the pressure units that you prefer to use to display the system pressure.

**Note** The ChromQuest data system displays the system pressure on the Surveyor LC Pump Instrument Status page and on the Surveyor LC Pump Instrument Setup page (1 MPa = 10 Bar = 145 psi).

- (Optional) In the ID Number box, type an identification number for your pump.
  - In the Stack ID box, type or select the unit ID value for your pump.
 

The unit ID on the back panel of the pump consists of two rotary switches. Each switch has ten positions. The arrow on the left switch points to the “tens” digit of the unit ID. The arrow on the right switch points to the “ones” digit of the unit ID.
  - Select the **Pause Sequence Following Degasser Error** check box if you want the sequence to pause after the data system detects a degasser error.
  - Click **OK** to close the dialog box.
8. Do not close the Surveyor dialog box. Go to the next procedure to modify the signal polarities for the Surveyor Autosampler configuration.

### 3 Software Instrument Configuration

Adding the Pump to the ChromQuest Instrument Configuration

## Autosampler Input Signals in the ChromQuest Data System

### ❖ To configure the signal polarities for the autosampler in the ChromQuest data system

1. In the Configured Modules pane of the Surveyor dialog box, double-click the **Surveyor AS** icon (see [Figure 29](#) on [page 34](#)).

The Surveyor AS Configuration dialog box appears (see [Figure 31](#)).

**Figure 31.** Surveyor AS Configuration dialog box (ChromQuest data system)

**Surveyor AS Configuration**

Communication

Stack: 0 1 Detect

Dead volume: 17.0

Vial bottom sensing: Off

Options

Temperature control

Wait for temperature ready

Verify door is closed

Enable maintenance log

Firmware version: N/A

ID number:

Syringe type: Concentric 250 µL

Tray type: 1.8 mL Vial, 5 trays 40 vials each

A1 well position

Top left

Bottom right

Signal polarity

Input

Run starts when Pump Ready

Inject when Inject Hold signal is "Off"

Output

Autosampler ready active high

Injection out active high

Gradient start active high

Pump stop active high

Timed events active high

OK Cancel Help

2. Ensure that the **Run Starts When Pump Ready** check box and the **Inject When Inject Hold Signal Is “Off”** check boxes are selected.
3. Exit the Configuration application and return to the Main Menu window as follows:
  - a. Click **OK** to close the Surveyor AS Configuration dialog box.
  - b. Click **OK** to close the Surveyor dialog box.
  - c. Click **OK** to close the Instrument Configuration dialog box and return to the ChromQuest Main Menu window.

**Tip** For information about specifying all the configuration options for your Surveyor Autosampler Plus, refer to the *Surveyor Plus User Guide for the ChromQuest Chromatography Data System* or the data system Help.

## Adding the Pump to the Thermo Foundation Instrument Configuration

To add the Surveyor LC Pump Plus to the Thermo Foundation™ instrument configuration and select the appropriate signal polarities for the Surveyor Autosampler Plus, follow these procedures:

- [Pump Configuration Options in the Thermo Foundation Application](#)
- [Autosampler Input Signals in the Thermo Foundation Application](#)

**Tip** If you are controlling the Surveyor LC Pump Plus from the Xcalibur™ 2.0.7 data system or earlier, use the Instrument Configuration window to set up the instrument configuration for the Surveyor Plus devices. To open the Instrument Configuration window, choose **Start > Programs > Xcalibur > Instrument Configuration**.

## Pump Configuration Options in the Thermo Foundation Application

The configuration options for the pump are its IP address (Stack Number) and the units for the pressure display.

### ❖ To add the Surveyor LC Pump Plus to the Thermo Foundation instrument configuration

1. From the computer desktop, choose **Start > All Programs > Thermo Foundation 1.0 > Instrument Configuration**.

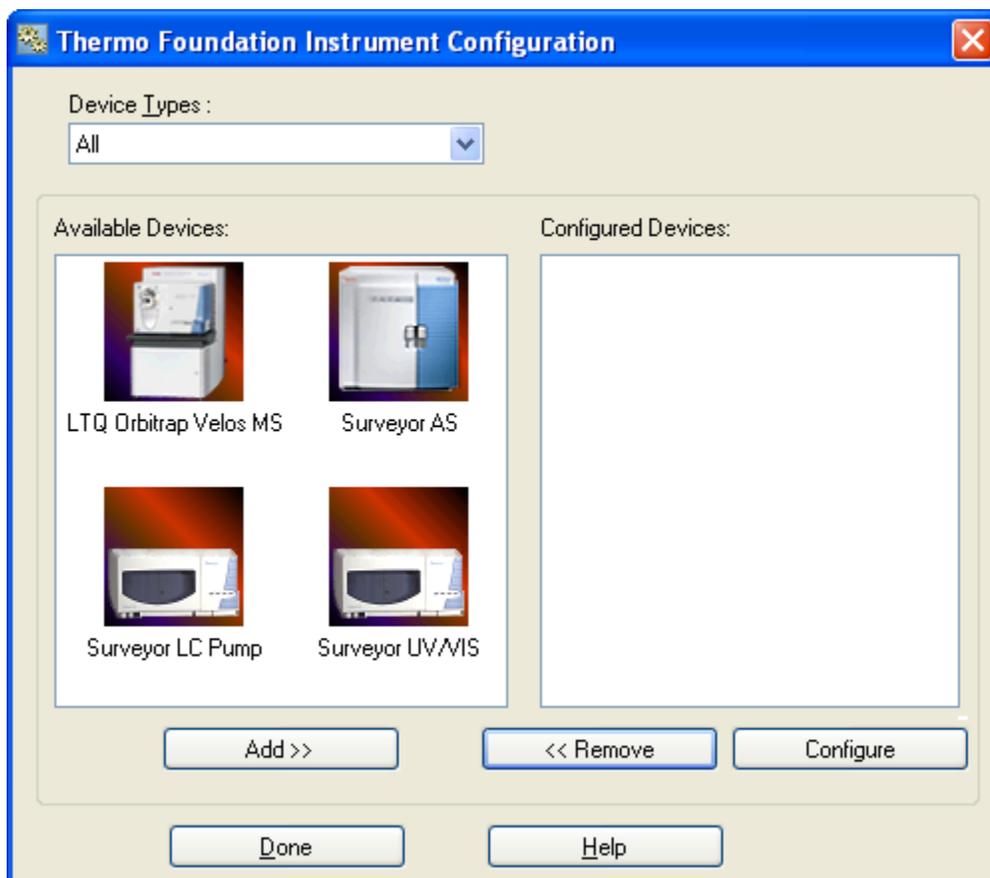
The Thermo Foundation Instrument Configuration window appears (see [Figure 32](#)).

**Tip** If you are controlling the Surveyor LC Pump Plus from the Xcalibur 2.0.7 data system or earlier, open the Instrument Configuration window by choosing **Start > Programs > Xcalibur > Instrument Configuration**, and then go to [step 2](#).

### 3 Software Instrument Configuration

Adding the Pump to the Thermo Foundation Instrument Configuration

**Figure 32.** Thermo Foundation Instrument Configuration window with installed devices in the Available Devices area



2. In the Device Types list, select **All** to show all the instruments.

The configurable instruments appear as icons in the Available Devices area.

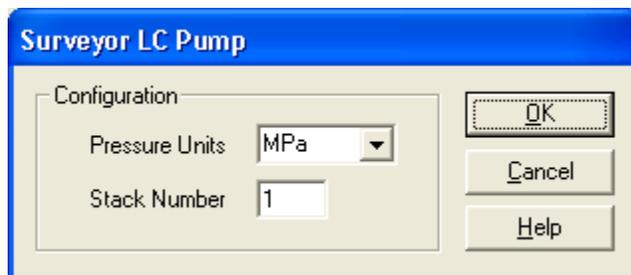
3. In the Available Devices area, double-click the **Surveyor LC Pump** icon.

A copy of the Surveyor LC Pump icon appears in the Configured Devices area.

4. In the Configured Devices area, double-click the **Surveyor LC Pump** icon.

The Surveyor LC Pump dialog box appears (see [Figure 33](#)).

**Figure 33.** Surveyor LC Pump configuration dialog box (Thermo Foundation application)



5. In the Surveyor LC Pump dialog box, make the following selections and entries:

- a. In the Pressure Units list, select the units for the pressure display (1 bar = 0.1 MPa = 14.5 psi).
- b. In the Stack Number box, type the value for the unit ID.

The unit ID, which is located on the back panel of the pump, consists of two rotary switches. Each switch has ten positions. The arrow on the left switch points to the “tens” digit of the unit ID. The arrow on the right switch points to the “ones” digit of the unit ID.

6. Click **OK** to close the Surveyor LC Pump dialog box.

7. Keep the Instrument Configuration view open and go to the next procedure.

## Autosampler Input Signals in the Thermo Foundation Application

During an injection sequence, the LC pump issues a Pump Ready signal and an Injection Hold release signal to the autosampler.

After you submit a run, the Surveyor AS waits for a Pump Ready signal from the pump. The Surveyor LC Pump Plus issues this signal after its pressure transducer monitors a stable pressure. When the autosampler receives this signal, it begins an injection sequence.

After the autosampler begins the injection sequence, it waits for an Injection Hold release signal from the pump. The Surveyor LC Pump Plus issues this release signal when its piston cam returns to the start position. When the autosampler receives the Injection Hold release signal, it switches the injection valve to the inject position, allowing the mobile phase stream to sweep the contents of the sample loop onto the LC column.

When you configure the Surveyor Autosampler, select the **Pump Ready Active High** check box and the **Injection Hold Release Active High** check box (see [Figure 34](#)). If you do not select these two check boxes, the autosampler does not recognize the input signals from the Surveyor LC Pump Plus and does not begin an injection sequence.

### ❖ To verify the input signal polarities for the Surveyor Autosampler Plus

1. Open the Instrument Configuration window if it is not already open (see [step 1](#) on [page 37](#)).

2. In the Configured Devices area, double-click the **Surveyor Autosampler** icon.

The Surveyor Autosampler Configuration dialog box appears with the Tray page displayed.

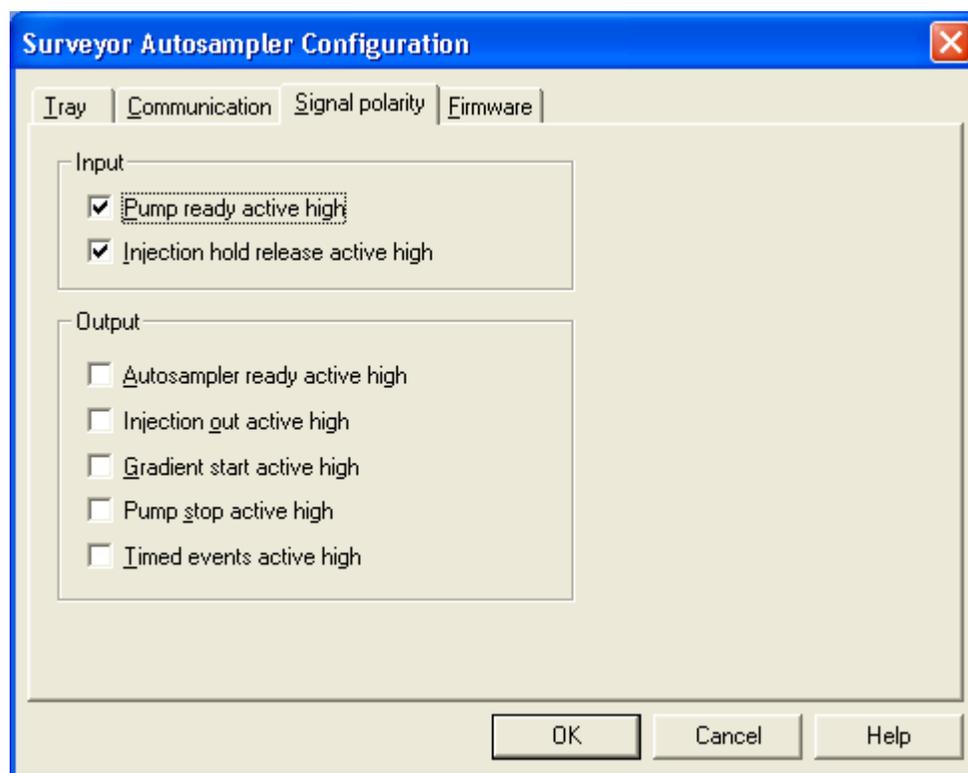
3. Click the **Signal polarity** tab.

The Signal polarity page appears (see [Figure 34](#)).

### 3 Software Instrument Configuration

Adding the Pump to the Thermo Foundation Instrument Configuration

**Figure 34.** Input signal polarities for the Surveyor Autosampler (Thermo Foundation application)



4. Make sure that the **Pump Ready Active High** and the **Injection Hold Release Active High** check boxes are selected.
5. Click **OK** to close the Surveyor Autosampler Configuration dialog box.
6. Click **Done** to close the Instrument Configuration window.

# Maintenance

The five main components of the Surveyor LC Pump Plus are the degassing unit, the solvent proportioning unit, the pulse dampener, the pump head assemblies, and the purge manifold assembly. As a chromatographer, you are responsible for the routine maintenance of the pump head assemblies. You are also responsible for replacing the frit that is inside the line filter body connected to the top of the purge manifold assembly. This chapter covers the routine maintenance of the two pump head assemblies, as well as standard operating procedures to prolong the lifespan of the piston seals and the pistons.

Contact your local Thermo Fisher Scientific service representative if you suspect a mechanical problem with the degassing unit, the solvent proportioning unit, or the pulse dampener.

**Tip** You can track the solvent volume pumped by the pump head assemblies and purge air from the solvent lines and the pump heads from the ChromQuest or Xcalibur data systems.

## Contents

- [Maintenance Schedule](#)
- [Maintenance Page in the ChromQuest Data System](#)
- [Maintenance Page in the Xcalibur Data System](#)
- [Rinsing the Pistons](#)
- [Cleaning the Check Valves](#)
- [Maintaining the Pump Head Assemblies](#)
- [Replacing the Line Filter Frit](#)
- [Replacing the Solvent Reservoir Filter](#)
- [Purging Air from the Solvent Lines or the Pump Heads](#)
- [Replacing the Drain Valve Knob O-Ring](#)
- [Replacing the Fuses](#)

## Maintenance Schedule

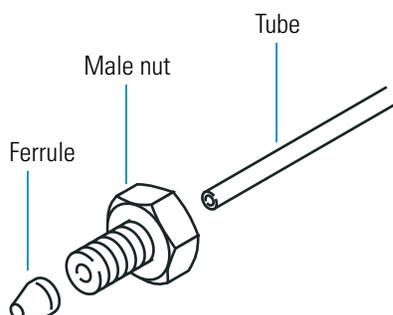
To ensure long-term, trouble-free operation, make sure to periodically inspect and service the Surveyor LC Pump Plus. [Table 3](#) lists the routine maintenance procedures you can perform to keep the pump in optimal working condition.

**Table 3.** Routine maintenance procedures performed by operator

Maintenance indicator	Maintenance procedure	Page
You are using a buffered mobile phase.	Rinsing the Pistons	48
A volume greater than 120 liters of mobile phase has been pumped.	Replacing the Piston Seals	54
Liquid is leaking from between the pump heads and the pump head holder.		
Liquid is leaking from between the pump heads and the pump head holder.	Cleaning and Replacing a Piston	66
The pistons are scratched.		
Wash solution is leaking from the wash seal openings.	Replacing the Wash Seals	62
Flow rate is below the set value.	Cleaning the Check Valves	50
You notice irreproducible retention times.		
You notice a rise in the system pressure.	Replacing the Line Filter Frit	68
There is air in the solvent lines.	Replacing the Solvent Reservoir Filter	70
You notice erratic flow rates.		
Solvent is leaking from the drain valve.	Replacing the Drain Valve Knob O-Ring	75
The pump will not power up.	Replacing the Fuses	76

The high-pressure connections of the LC pump are made with standard 316 stainless steel tubing and two-piece fittings as shown in [Figure 35](#).

**Figure 35.** Standard 316 stainless steel tubing and two-piece fittings



## Maintenance Page in the ChromQuest Data System

If you are controlling the Surveyor LC Pump Plus from the ChromQuest data system, you must open the Maintenance page to perform and record maintenance on the pump head assemblies.

To record maintenance or to set the pump pistons to the maintenance position, follow these procedures:

- [Opening the Maintenance Page in the ChromQuest Data System](#)
- [Recording Maintenance in the ChromQuest Data System](#)
- [Setting the Pistons to the Maintenance Position from the ChromQuest Data System](#)

**Note** Only ChromQuest instrument administrators have access to the Calibration and Maintenance pages.

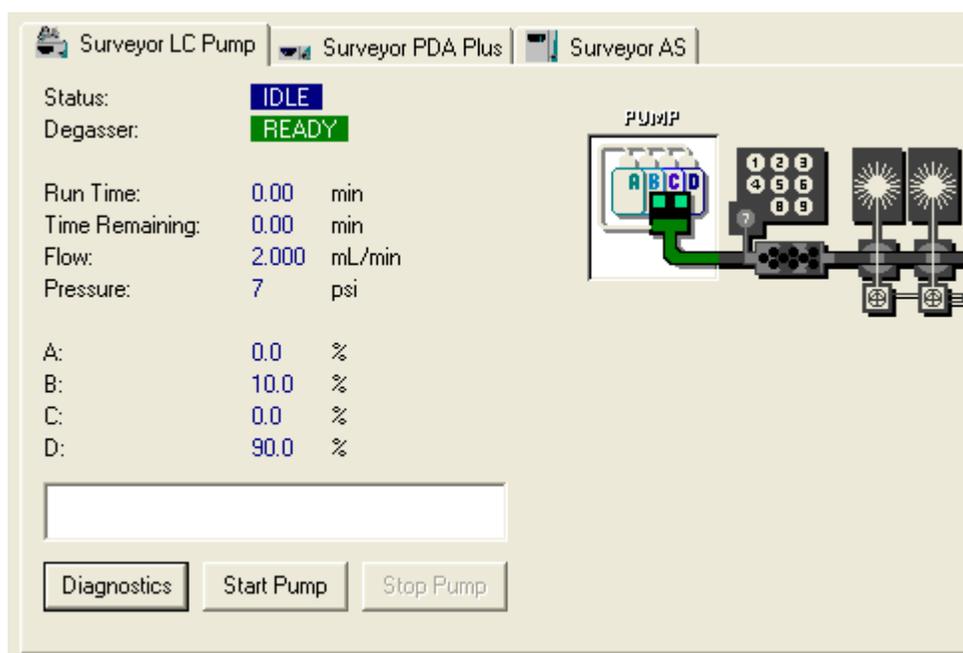
## Opening the Maintenance Page in the ChromQuest Data System

### ❖ To open the Maintenance page in the ChromQuest data system

1. From the online Instrument window, choose **Control > Instrument Status**.
2. Click the **Surveyor LC Pump** tab.

The Surveyor LC Pump page of the Instrument Status window appears (see [Figure 36](#)).

**Figure 36.** Surveyor LC Pump page of the Instrument Status window



## 4 Maintenance

Maintenance Page in the ChromQuest Data System

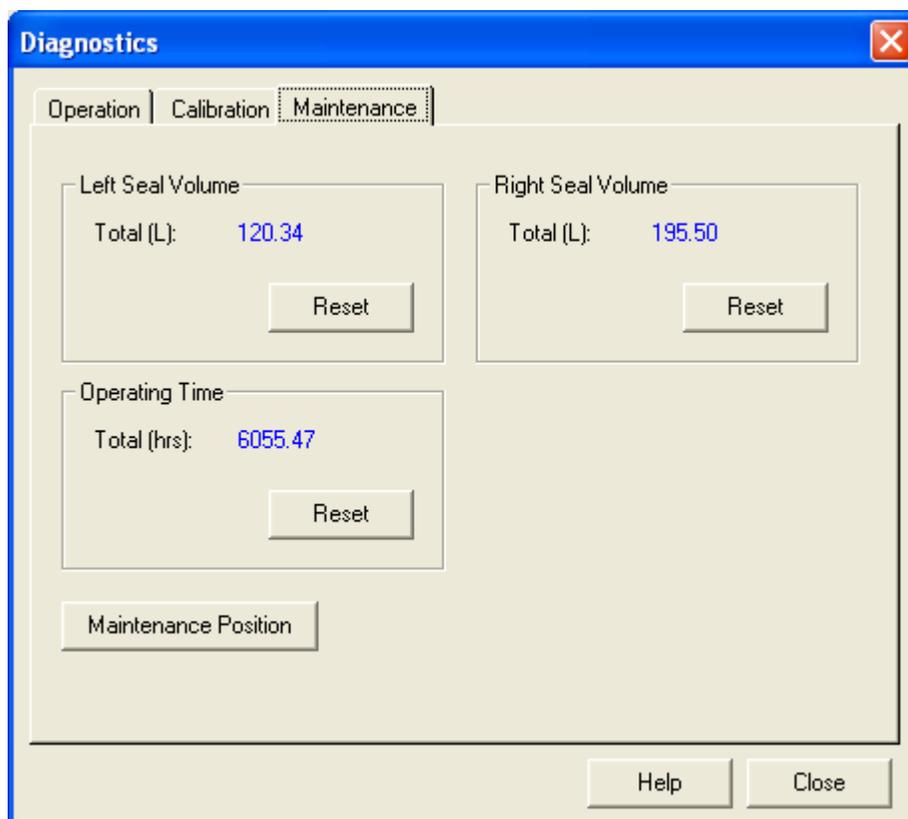
3. Click **Diagnostics**.

The Diagnostics dialog box appears.

4. Click the **Maintenance** tab.

The Maintenance page appears (see [Figure 37](#)).

**Figure 37.** Maintenance page of the Diagnostics dialog box



## Recording Maintenance in the ChromQuest Data System

The ChromQuest data system has a built-in feature for tracking the volume of mobile phase pumped by the Surveyor LC Pump Plus. This information, which pertains to seal wear, appears in the Maintenance page.

Each pump head assembly contains a piston seal. The two seals can wear at different rates, causing leaks to occur in one or both pump heads. Before dismantling the pump head assemblies, attempt to determine the source of the leakage. To save time and materials, replace only the piston seal in the pump head assembly that is leaking. Or, as a preventive measure, replace the piston seals after pumping 120 liters of mobile phase.

On the Maintenance page of the Diagnostics dialog box, perform the following tasks as specified:

- Every time you install a new piston seal, click the appropriate **Reset**.

When you click Reset, the ChromQuest data system sets the volume of liquid pumped by the respective pump head assembly back to zero.

- If you install a new motor, click **Reset** under Operating Time.

When you click Reset, the ChromQuest data system sets the Operating time back to zero.

## Setting the Pistons to the Maintenance Position from the ChromQuest Data System

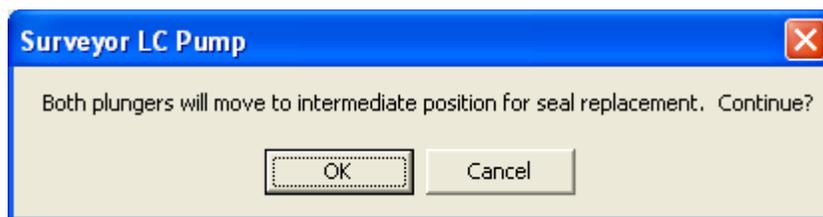
Before you remove the pump heads, set the pump pistons to the maintenance position.

### ❖ To set the pistons to the maintenance position

1. On the Maintenance page (see [Figure 37](#) on [page 44](#)), click **Maintenance Position**.

The message box shown in [Figure 38](#) appears.

**Figure 38.** Maintenance position message box



2. Click **OK** to set the pistons to the maintenance position.

## Maintenance Page in the Xcalibur Data System

If you are operating the Surveyor LC Pump Plus from the Xcalibur data system, use the Maintenance page to set the pistons to the maintenance position and record maintenance.

To record maintenance or to set the pistons to the maintenance position, follow these procedures:

- [Opening the Maintenance Page in the Xcalibur Data System](#)
- [Recording Maintenance in the Xcalibur Data System](#)
- [Setting the Pistons to the Maintenance Position from the Xcalibur Data System](#)

## Opening the Maintenance Page in the Xcalibur Data System

❖ **To open the Maintenance page in the Xcalibur data system**

1. Open the Thermo Xcalibur data system from your computer desktop as follows:

- For Xcalibur version 2.1.x or later, choose **Start > Programs > Thermo Xcalibur > Xcalibur**.

The Thermo Xcalibur Roadmap window appears.

- For Xcalibur version 2.0.7 or earlier, choose **Start > Programs > Xcalibur > Xcalibur**.

The Xcalibur Roadmap – HomePage window appears.

2. In the Roadmap view, click the **Instrument Setup** icon, .

The Instrument Setup window appears.

3. In the view bar, click the **Surveyor LC Pump** icon.

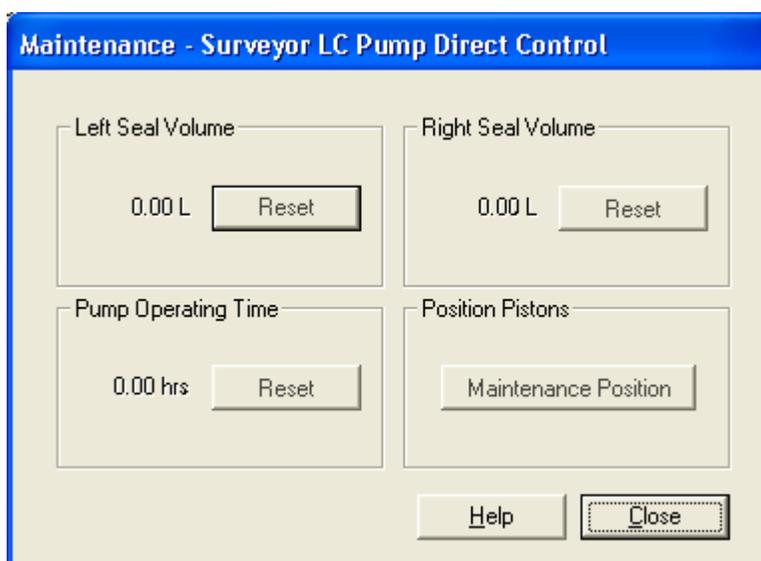


The Surveyor LC Pump view appears. A green triangle appears in the lower-right corner of the icon for the chosen module.

4. From the menu bar, choose **Surveyor LC Pump > Direct Control > Maintenance**.

The Maintenance – Surveyor LC Pump Direct Control dialog box appears (see [Figure 39](#)).

**Figure 39.** Maintenance – Surveyor LC Pump Direct Control dialog box



## Recording Maintenance in the Xcalibur Data System

The Surveyor LC Pump Plus view of the Instrument Setup window in the Xcalibur data system has a built-in feature for tracking the volume of mobile phase pumped by the Surveyor LC Pump Plus. This information, which pertains to seal wear, is recorded on the Maintenance page.

Each pump head assembly contains a piston seal. The two seals can wear at different rates, causing leaks to occur in one or both pump heads. Before dismantling the pump head assemblies, attempt to determine the source of the leakage. To save time and materials, replace only the piston seal in the pump head assembly that is leaking. Or, as a preventive measure, replace the piston seals after pumping 120 liters of mobile phase.

### ❖ To reset the solvent volumes or the pump operating time

1. Open the Maintenance – Surveyor LC Pump Direct Control dialog box.

For information about opening this dialog box, see [“Opening the Maintenance Page in the Xcalibur Data System”](#) on page 46 or refer to the data system Help.

2. Perform the following tasks as specified:

- Every time you install a new piston seal, click the appropriate **Reset**.

When you click Reset, the data system resets the recorded volume of liquid pumped by the respective pump head assembly.

- If you install a new motor, click **Reset** under Pump Operating Time.

When you click Reset, the data system resets the recorded hours for the operating time of the pump.

## Setting the Pistons to the Maintenance Position from the Xcalibur Data System

Set the pump pistons to the maintenance position before performing these maintenance procedures:

- [Installing New Piston Seals](#)
- [Cleaning and Replacing a Piston](#)
- [Replacing the Wash Seals](#)

### ❖ To set the pistons to the maintenance position

1. Open the Maintenance – Surveyor LC Pump Direct Control dialog box.

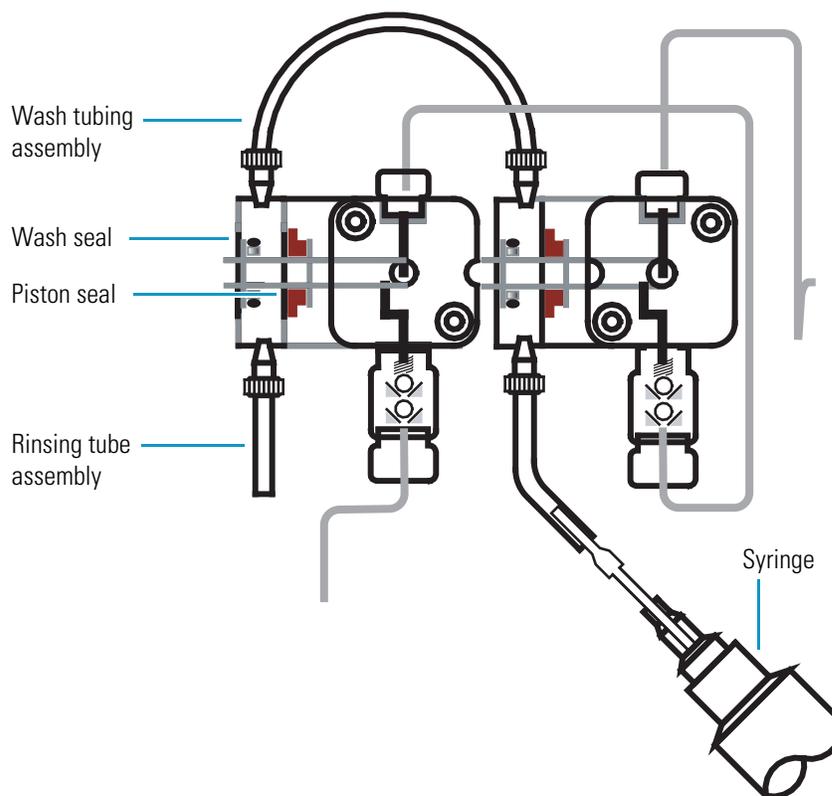
For information about opening this dialog box, see [“Opening the Maintenance Page in the Xcalibur Data System”](#) on page 46 or refer to the data system Help.

2. Click **Maintenance Position** (see [Figure 39](#) on page 46).

## Rinsing the Pistons

As the pistons move back and forth within the pump head, a small quantity of mobile phase leaks behind the piston seals. With buffered mobile phases, a precipitate (also known as creep or salt build-up) forms as the liquid fraction evaporates. The abrasion caused by this precipitate can scratch the piston and shorten the life of the piston seals. To minimize this damage and prolong the life of the piston and the piston seals, periodically rinse between the piston seals and the wash seals with distilled water. Figure 40 shows the use of a syringe to rinse the pistons.

**Figure 40.** Setup for rinsing the pump heads



Rinse the pump heads with distilled water at these intervals:

- For phosphoric acid buffers (low concentration), rinse daily.
- For boric acid buffers (low concentration), rinse every few hours.



Rinsing between the piston seals and the wash seals requires these items:

Description	Part number
Rinsing tube assembly	00950-30001
Disposable syringe	3301-0151
Beaker to be used as a waste-water container	N/A

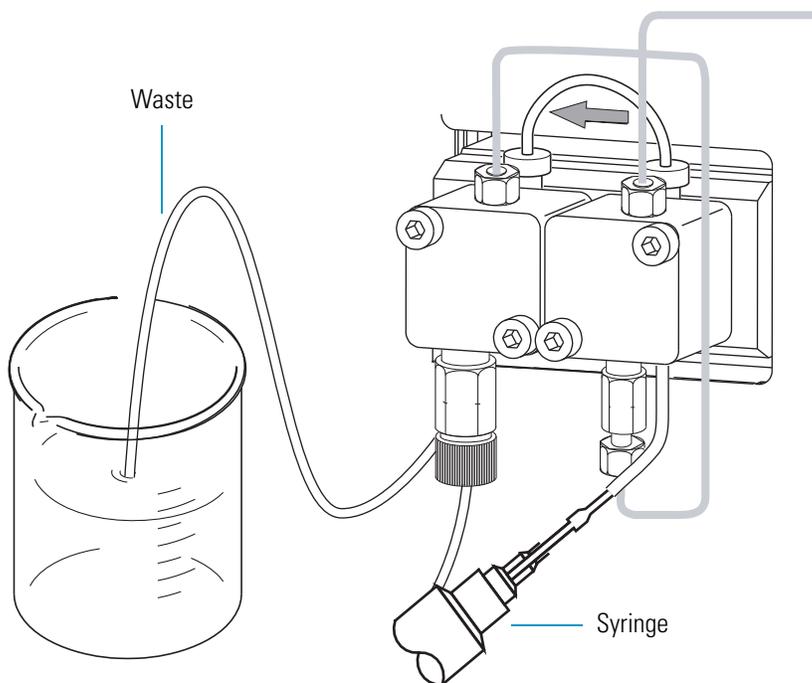
❖ **To attach the bushings to the rinse tubing**

1. Cut the end of the tubing at a 45° angle.
2. Insert the tubing through the bushing, and then cut the end of the tubing at a 90° angle.

❖ **To rinse between the piston seals and the wash seals**

1. Cut the rinsing tube assembly to appropriate lengths as shown in [Figure 41](#).
2. Connect the bushings of the rinsing tubes to the washing flow line openings on the bottom of the ring holder.
3. Draw distilled water into the disposable syringe.
4. Place the end of one of the rinsing tubes into a beaker.
5. Insert the needle of the disposable syringe into the other rinsing tube. Depress the syringe plunger to force water into the tubing and through the pump heads. Collect the wastewater in the beaker (see [Figure 41](#)).

**Figure 41.** Rinsing behind the pump heads



## Cleaning the Check Valves

Contamination of the check valves by particulate matter or insoluble mobile phase modifiers can cause leakage within the check valve. This leakage can cause a reduction in the flow rate, an increase in pump pulsation, and irreproducible retention times.

If you suspect that the check valves are dirty, follow these steps:

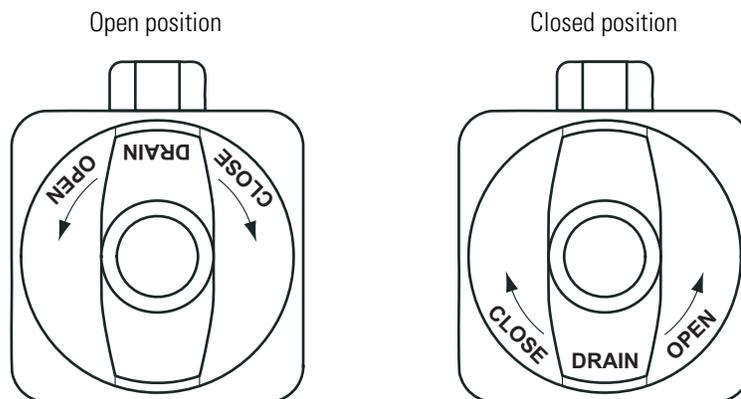
1. Attempt to clean them by pumping isopropyl alcohol (IPA) through the pump as described in [“Pumping Isopropyl Alcohol through the Check Valves.”](#)
2. If the check valves are still dirty, remove them from the pump and sonicate them in IPA as described in [“Sonicating the Check Valves.”](#)

## Pumping Isopropyl Alcohol through the Check Valves

### ❖ To clean the check valves with isopropyl alcohol

1. Replace the mobile phase in the solvent reservoir with IPA.
2. Open the purge valve (see [Figure 42](#)).

**Figure 42.** Two-position purge knob



3. Use the purge feature available from the data system to remove air bubbles from the check valves. For information about purging the pump from your data system, see [“Purging Air from the Solvent Lines or the Pump Heads”](#) on [page 71](#).
4. Close the purge valve.
5. Replace the column with a flow restrictor, and vent the solvent directly to waste.
6. Pump IPA at a flow rate of 2 mL/min for at least 1 hour.

If pumping IPA through the pump fails to clean the check valves, remove them from the pump, and then sonicate them in a solution of IPA as described in the next procedure.

## Sonicating the Check Valves



Before you can sonicate the check valves, you must remove them from the pump heads. Removing and reinstalling the check valves requires these supplied tools:

Description	Quantity
8 mm × 10 mm open-end wrench	2
13 mm open-end wrench	1

To sonicate the check valves, follow these steps:

1. [Removing the Check Valves](#)
2. [Sonicating the Check Valves](#)
3. [Reinstalling the Check Valves](#)

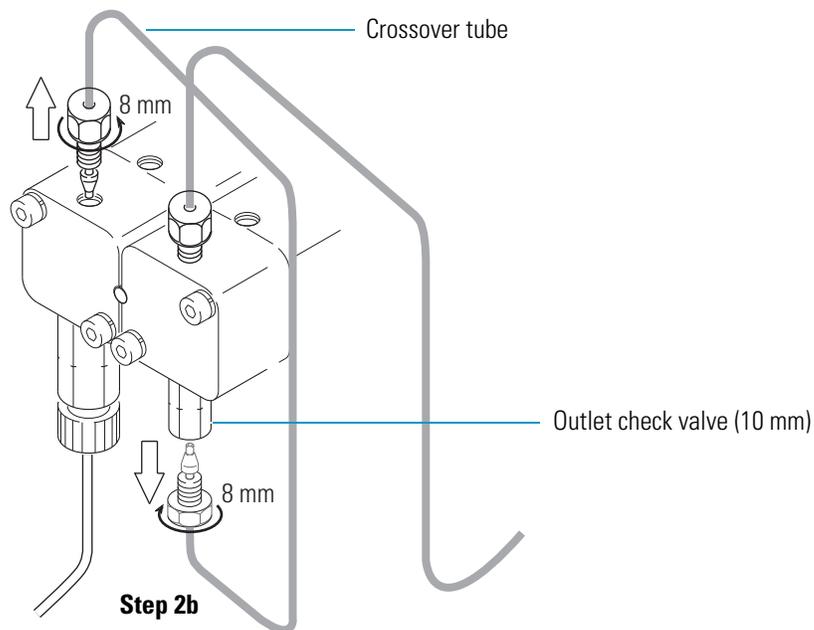
### Removing the Check Valves

❖ **To remove the check valves from the pump heads**

1. Turn off the power to the LC pump.
2. Remove the crossover tube (see [Figure 43](#)) as follows:
  - a. Using an 8 mm open-end wrench, unscrew the fitting that connects the crossover tube to the top of the left pump head.
  - b. Use a 10 mm open-end wrench to hold the outlet check valve. Then use an 8 mm open-end wrench to unscrew the fitting that connects the crossover tube to the outlet check valve.

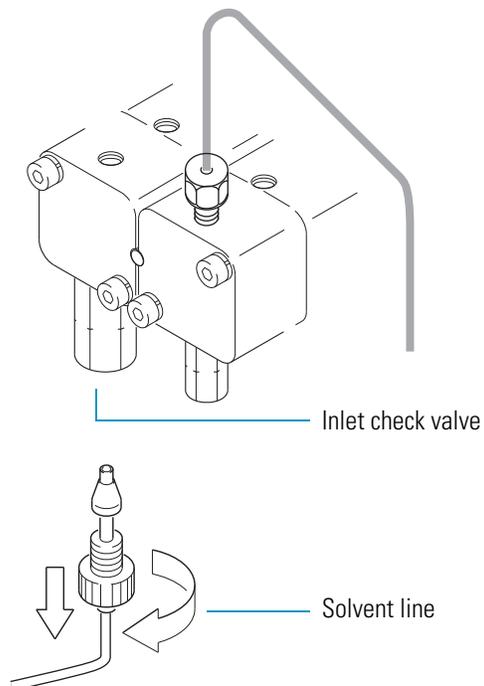
**Figure 43.** Removing the crossover tube

**Step 2a**



3. Unscrew the solvent line from the inlet check valve (see [Figure 44](#)).

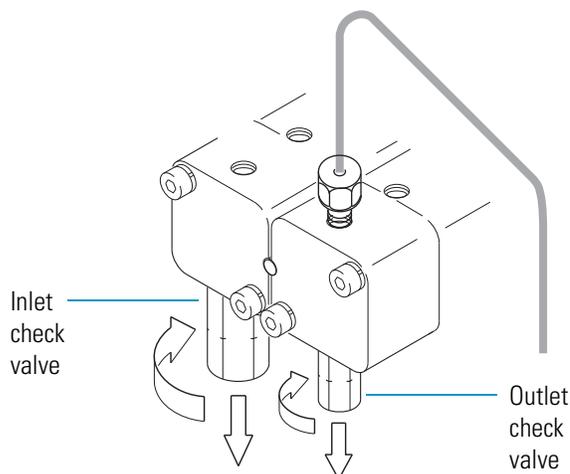
**Figure 44.** Removing the solvent line



4. Remove the check valves (see [Figure 45](#)) as follows:

- Using a 13 mm open-end wrench, remove the inlet check valve from the bottom of the left pump head.
- Using a 10 mm open-end wrench, remove the outlet check valve from the bottom of the right pump head.

**Figure 45.** Removing the check valves



### Sonicating the Check Valves

After you remove the check valves from the pump, clean them.



**CAUTION** To avoid irreparable damage to the check valves, do not disassemble them. If you do disassemble them, replace them. See “[Nonconsumable Replacement Parts](#)” on [page 106](#) for information about ordering new check valves.

#### ❖ To clean the check valves

1. Put the inlet and outlet check valves in an ultrasonic bath filled with IPA. Sonicate them for approximately 5 minutes.
2. Remove the check valves from the bath.

### Reinstalling the Check Valves

#### ❖ To reinstall the check valves

1. Screw the inlet check valves into the bottom of the left pump head. Using a 13 mm wrench, tighten the inlet check valve fitting.
2. Screw the outlet check valve into the bottom of the right pump head. Using a 10 mm wrench, tighten the outlet check valve fitting.

## 4 Maintenance

### Maintaining the Pump Head Assemblies

3. Reattach the crossover tube to the top of the left pump head. Using an 8 mm open-end wrench, tighten the fitting.
4. Reattach the other end of the crossover tube to the outlet check valve. Use the 10 mm open-end wrench to hold the outlet check valve, and then tighten the fitting with an 8 mm open-end wrench.
5. Reattach the solvent line to the inlet check valve.
6. Turn the power to the pump back on.
7. Purge air from the pump heads and solvent lines (see [“Purging Air from the Solvent Lines or the Pump Heads”](#) on page 71).
8. Retest the flow rate. If the liquid does not flow continuously from the drain tube, replace the check valves.

## Maintaining the Pump Head Assemblies

Each pump head assembly contains a piston seal, a wash seal, and a piston. Through constant contact with the moving pistons, the piston seals slowly deteriorate. In general, the pistons will outlast the piston seals, but salt deposits left from buffered eluents and solvent contaminants can scratch the pistons, which leads to leakage. The wash seals generally outlast both the piston and the piston seals, but eventually they degrade as well.

To replace a piston seal, clean or replace a piston, or replace a wash seal, you must open the maintenance page of your Thermo Scientific data system, set the pistons to the maintenance position, and then turn off the power to the pump.

To maintain the pump head assemblies, follow these procedures:

- [Replacing the Piston Seals](#)
- [Replacing the Wash Seals](#)
- [Cleaning and Replacing a Piston](#)

## Replacing the Piston Seals

The piston seal is a special spring-loaded O-ring designed to minimize mobile phase leakage between the piston and the pump head.

Through constant contact with the moving pistons, the piston seals slowly degrade. Initially, this degradation causes an increase in pump pressure variation and a decrease in retention time reproducibility. Eventually, seal degradation leads to visible leaks between the pump head and the pump head holder. To avoid compromising your chromatography, replace the seals after pumping 120 liters of mobile phase or at the first indication of leakage.



Replacing a piston seal requires these tools and parts:

Tools	Part number
3 mm L-hex wrench	00725-00048
Two 8 mm × 10 mm open-end wrenches	00950-30005
13 mm × 17 mm open-end wrench	00950-30006
Piston seal removal and installation tool	A3216-020
Replaceable parts	Part number
Piston seal, polyethylene	00950-30004
Piston seal, GFP	00107-18008
Small Teflon spacer	00950-01-00101

To replace a piston seal, follow these steps:

1. [Removing the Pump Heads](#)
2. [Removing the Piston Seals](#)
3. [Installing New Piston Seals](#)
4. [Reinstalling the Pump Heads](#)

## Removing the Pump Heads

The Surveyor LC Pump Plus has two pump heads. Each pump head contains a piston seal that requires periodic replacement.

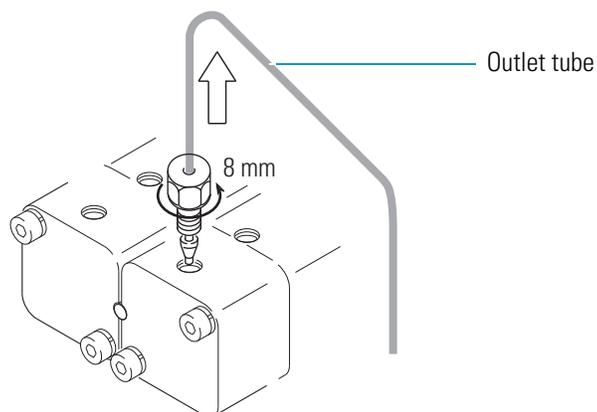
### ❖ To remove one or both of the pump heads

1. Turn on the power to the LC pump.
2. Set the pistons to the maintenance position:
  - For the ChromQuest data system, see “[Setting the Pistons to the Maintenance Position from the ChromQuest Data System](#)” on page 45.
  - For the Xcalibur data system, see “[Setting the Pistons to the Maintenance Position from the Xcalibur Data System](#)” on page 47.
3. Remove the check valve as described in “[Removing the Check Valves](#)” on page 51.
4. Using an 8 mm open-end wrench, unscrew the fitting that connects the outlet tube to the top of the right pump head (see [Figure 46](#)).

## 4 Maintenance

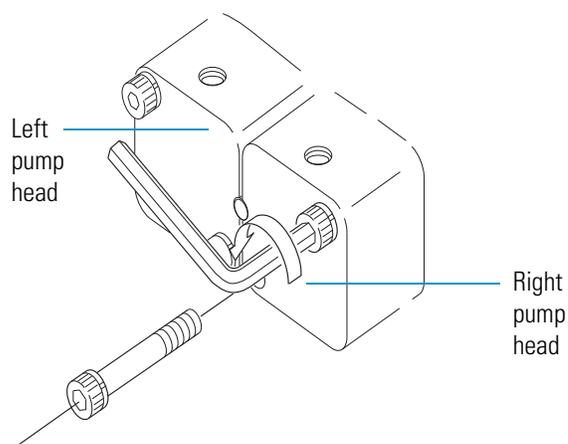
### Maintaining the Pump Head Assemblies

**Figure 46.** Removing the outlet tube from the right pump head



5. Using a 3 mm L-hex wrench, alternately loosen and then remove the two hex socket head bolts that hold the pump heads to the pump head holder as shown in [Figure 47](#).

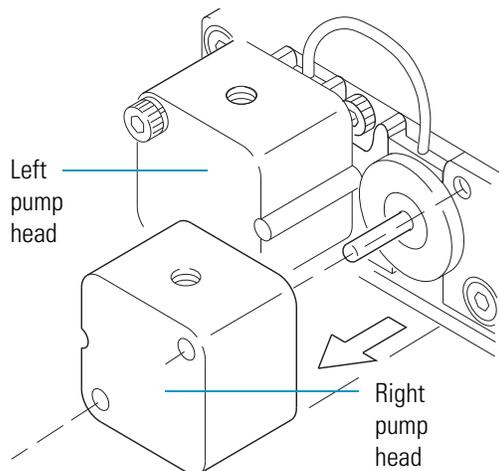
**Figure 47.** Unscrewing the hex socket head bolts



6. Pull the pump head away from the pump head holder, keeping it aligned with the piston (see [Figure 48](#)).

As you pull the pump head away from the pump head holder, ensure that the piston seal remains seated in the pump head and the wash seal holder remains in the piston chamber. After you remove the pump head, place it face down on a flat surface with the piston seal facing up (see [Figure 50](#) on [page 57](#)).

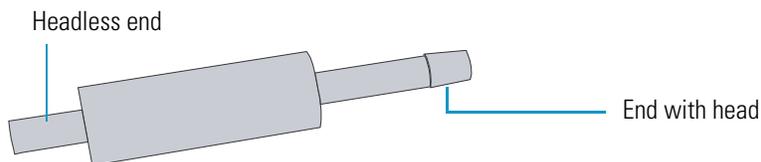
**Figure 48.** Pulling the right pump head off the pump head holder



## Removing the Piston Seals

To install and remove the piston and wash seals, use the special double-ended tool (seal tool) in the Surveyor LC Pump Accessory Kit (see [Figure 49](#)).

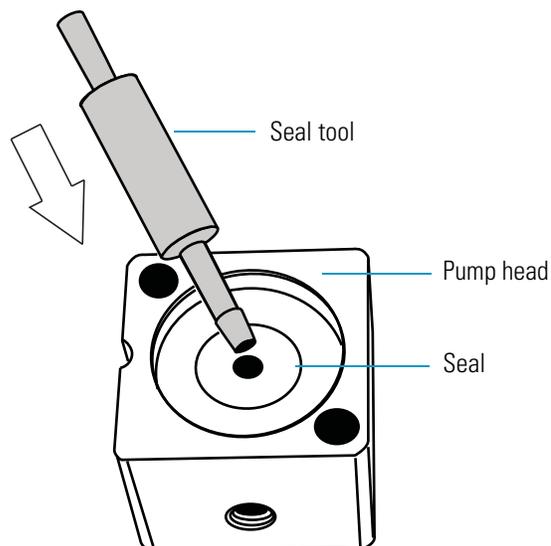
**Figure 49.** Double-ended tool for installing and removing seals (seal tool)



### ❖ To remove the piston seal from the pump head

1. Insert the head end of the seal tool into the piston seal (see [Figure 50](#)).

**Figure 50.** Inserting the seal tool into the piston seal



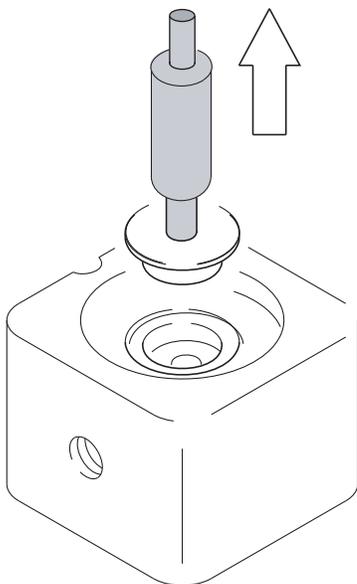
## 4 Maintenance

### Maintaining the Pump Head Assemblies

2. Pull the worn piston seal out of the pump head, and then clean the piston cavity with IPA (see [Figure 51](#)).

**Tip** Place the Teflon spacer on a lint-free cloth. Unlike the piston seal, the Teflon spacer is reusable and can usually be removed from the pump head without damage. Therefore, take care not to lose it as you pull the piston seal out of the pump head.

**Figure 51.** Removing the piston seal

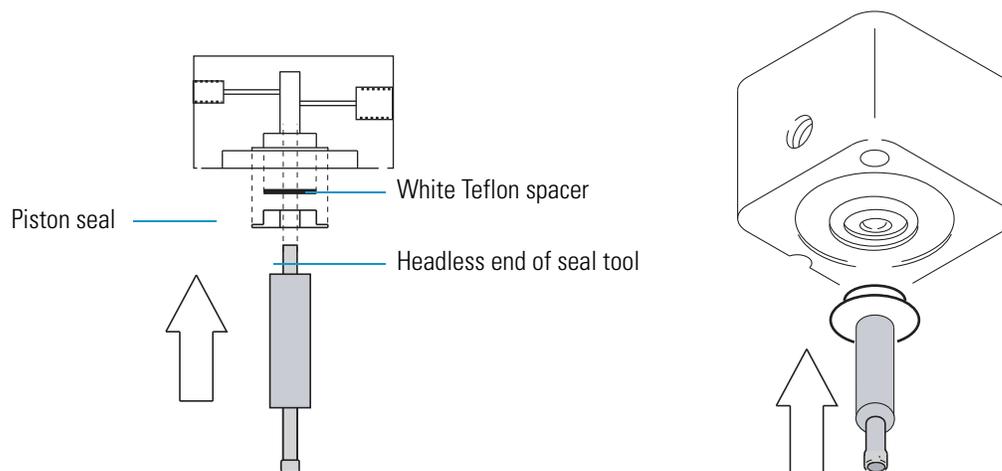


### Installing New Piston Seals

#### ❖ To install a new piston seal in the pump head

1. With its spring facing upward, place the new piston seal and the Teflon spacer onto the headless end of the seal tool.
2. Hold the pump head upside down, and then insert the tool (with the piston seal and Teflon spacer) into the pump head (see [Figure 52](#)).
3. Pull the tool out of the piston seal.

**Figure 52.** Inserting seal into the pump head

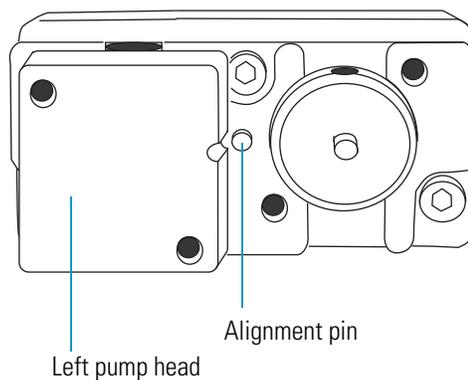


## Reinstalling the Pump Heads

### ❖ To reinstall the pump heads

1. For each pump head, do the following:
  - a. Align the groove in the pump head with the alignment pin, and then mount the pump head onto the head holder (see [Figure 53](#)).

**Figure 53.** Aligning the pump head with the alignment pin

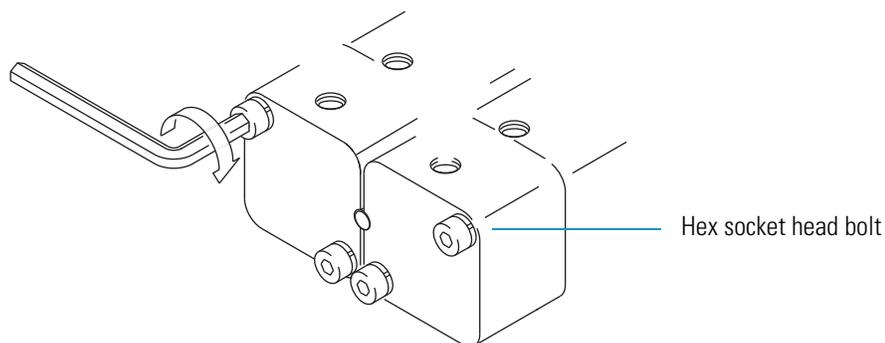


- b. Insert the two hex socket head bolts into the holes in the pump head.
- c. Using a 3 mm L-hex wrench, alternately tighten the bolts (see [Figure 54](#)).

## 4 Maintenance

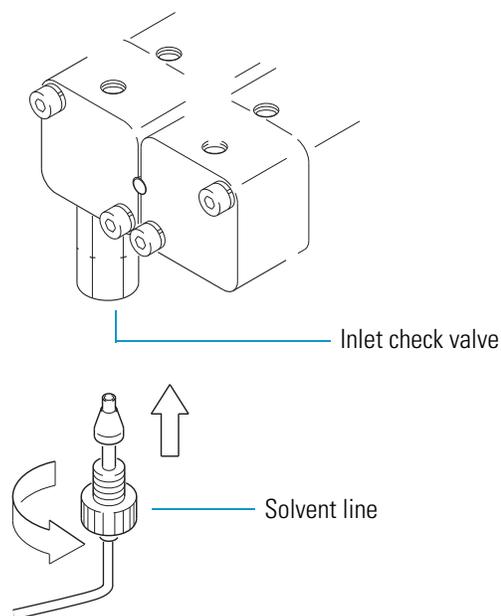
### Maintaining the Pump Head Assemblies

**Figure 54.** Tightening the hex socket head bolts



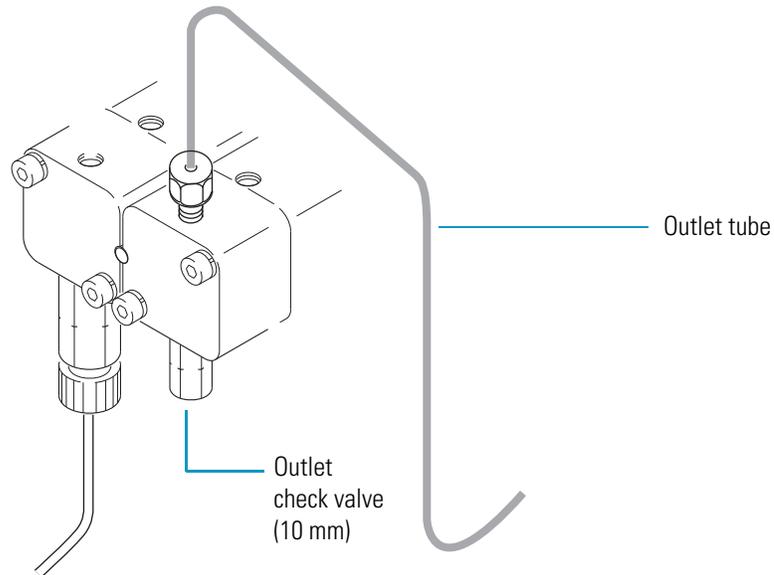
2. To complete the installation of the left pump head (see [Figure 55](#)), do the following:
  - a. Screw the inlet check valve into the bottom of the left pump head, and then tighten the connection with a 13 mm open-end wrench.
  - b. Attach the solvent line to the inlet check valve.

**Figure 55.** Reconnecting the solvent line to the left pump head



3. To complete the installation of the right pump head (see [Figure 56](#)), do the following:
  - a. Screw the outlet check valve into the bottom of the right pump head, and then tighten the connection with a 10 mm open-end wrench.
  - b. Screw the outlet tube into the top of the right pump head, and then tighten the connection with an 8 mm open-end wrench.

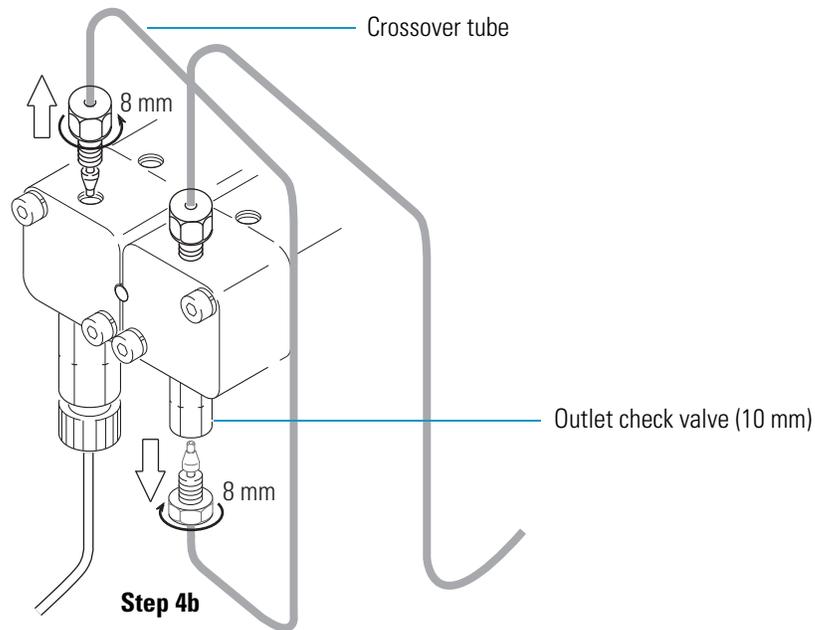
**Figure 56.** Right pump head with the outlet check valve and outlet tube installed



4. Reconnect the crossover tube as follows (see [Figure 57](#)):
  - a. Screw the fitting into the top of the left pump head. Using an 8 mm wrench, tighten the connection.
  - b. Using a 10 mm open-end wrench, secure the outlet check valve as you tighten the fitting that connects the crossover tube to the right pump head.

**Figure 57.** Reconnecting the crossover tube

**Step 4a**



## 4 Maintenance

### Maintaining the Pump Head Assemblies

5. After replacing a piston seal, check for the following:

- Is the pump pressure stable?
- Is any liquid leaking from behind the pump heads?
- Is any liquid leaking from the washing flow line?

If the answer is “Yes” to any of the above questions, clean or replace the piston.

## Replacing the Wash Seals

The wash seal creates a barrier between the pump head assembly and the internal components of the pump and minimizes any sideways movement of the piston that could cause premature seal wear. If liquid is leaking from a wash seal opening, replace the wash seal.



Replacing a wash seal requires these tools and parts:

<b>Tools</b>	<b>Part number</b>
3 mm L-hex wrench	00725-00048
Two 8 mm × 10 mm open-end wrenches	00950-30005
13 mm × 17 mm open-end wrench	00950-30006
<b>Replaceable parts</b>	<b>Part number</b>
O-ring, wash seal holder	00950-01-00108
Wash seal	00950-01-00084

To replace the wash seals, follow these steps:

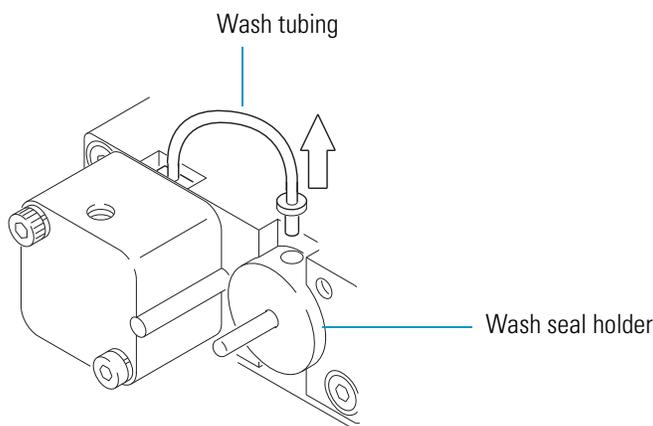
1. [Removing the Wash Seal Holders](#)
2. [Removing a Wash Seal](#)
3. [Installing a Wash Seal](#)

## Removing the Wash Seal Holders

### ❖ To remove the wash seal holders

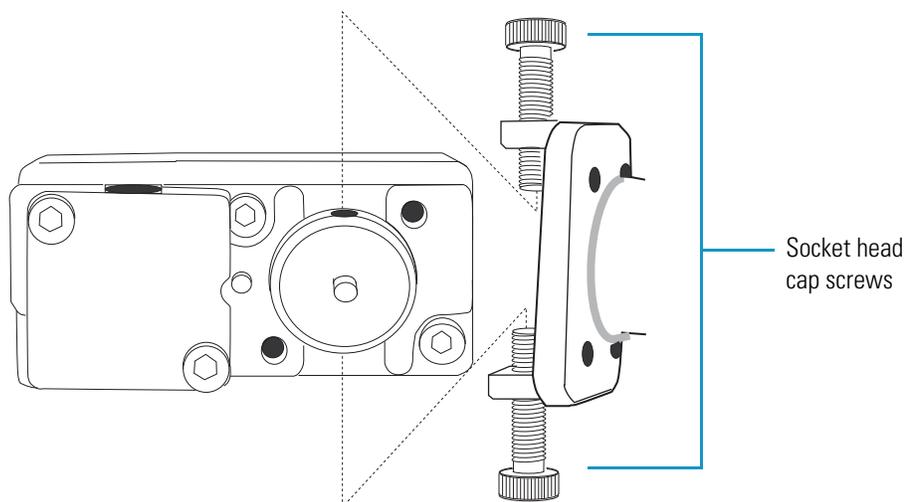
1. Remove the pump heads as described in “Removing the Pump Heads” on page 55.
2. Remove the wash tubing (see Figure 58).

**Figure 58.** Removing the wash tubing



3. Pull the wash seal holder straight forward, off the piston.
4. If the wash seal holder is stuck, use the piston removal tool to remove it as follows:
  - a. Screw the two socket head cap screws (M5 × 20 mm) supplied in the Surveyor LC Pump Accessory Kit part way into the piston removal tool (see Figure 59).

**Figure 59.** Piston removal tool with the socket head cap screws installed

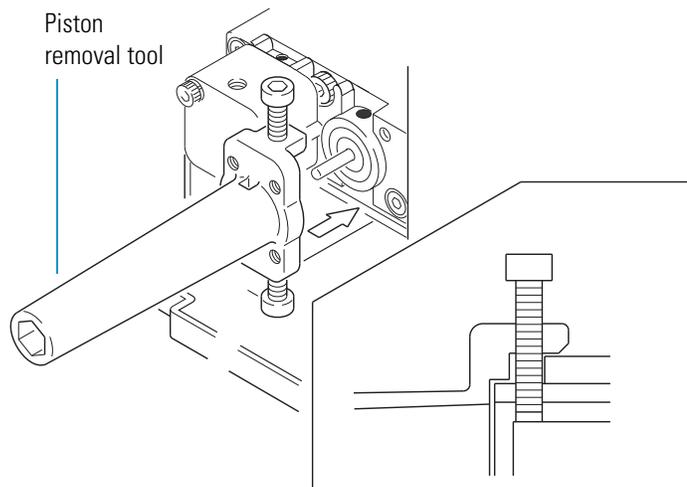


- b. Fit the piston removal tool over the wash seal holder, and then screw in the two socket head cap screws until they contact the washing flow line openings in the wash seal holder (see Figure 60).

## 4 Maintenance

### Maintaining the Pump Head Assemblies

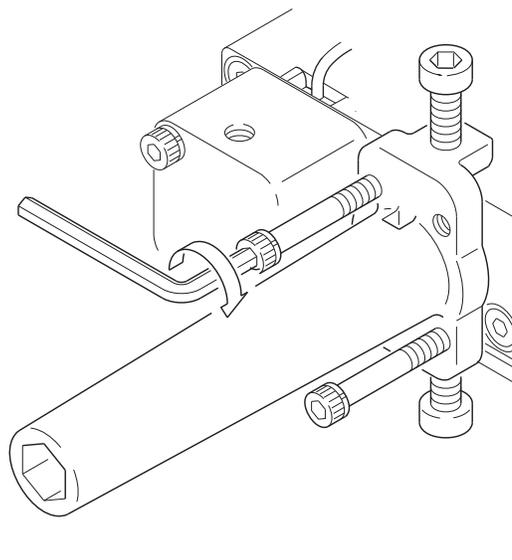
**Figure 60.** Fitting the piston removal tool over the wash seal holder



- c. Insert the two hex socket head bolts that you removed from the pump head through the upper left and lower right bolt holes in the piston removal tool.
- d. Alternately tighten the bolts by using the L-hex wrench until they press against the pump head holder (see [Figure 61](#)).

The compression of the two bolts on the pump head holder forces the ring holder out.

**Figure 61.** Tightening the hex socket head bolts

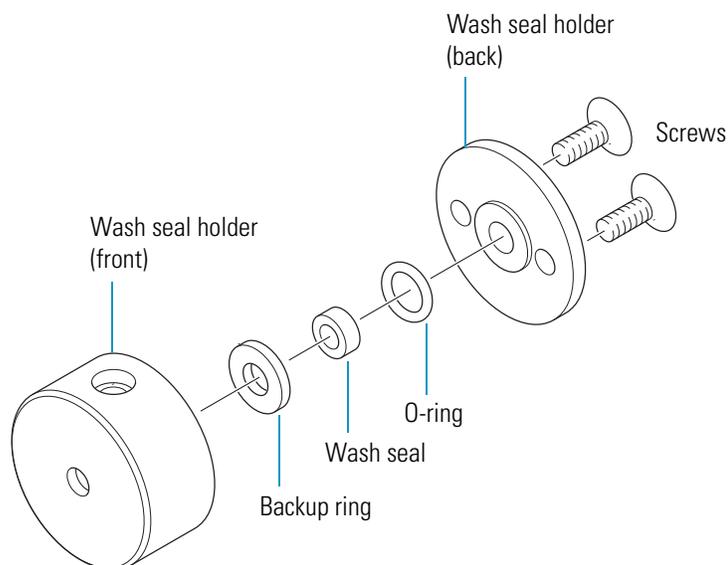


## Removing a Wash Seal

### ❖ To remove the wash seal from the wash seal holder

1. Using a Phillips screwdriver, remove the two screws (see [Figure 62](#)) in the back of the wash seal holder, and then remove the back of the wash seal holder.

**Figure 62.** Disassembling the wash seal holder



2. Insert the headless end of the seal installer/remover tool into the hole in the center of the wash seal, and then pull the wash seal and O-ring out of the wash seal holder.

## Installing a Wash Seal

### ❖ To install a new wash seal

1. Place a new O-ring and wash seal onto the headless end of the tool, push the seal and O-ring into the wash seal holder, and then pull the tool out of the seal.
2. Reinstall the back of the wash seal holder.
3. Replace the two screws and tighten with a Phillips screwdriver.
4. Reinstall the wash seal holder by carefully sliding it over the piston.
5. Reinstall the pump heads as described in [“Reinstalling the Pump Heads”](#) on [page 59](#).

## Cleaning and Replacing a Piston

Some degree of mobile phase leakage continually occurs within the pump heads. However, the leakage is usually so negligible that the mobile phase evaporates before leaking out of the pump head assembly. When you use buffered mobile phases, this evaporation process leads to the buildup of abrasive crystals that can accelerate piston seal wear and scratch the sapphire pistons. If the pistons are dirty or scratched, replacing the piston seals will not stop the mobile phase leakage. If leakage continues to occur after you replace a piston seal, you must remove the pistons for cleaning or replacement.



Replacing the pistons requires these tools and parts:

Tools	Part number
3 mm L-hex wrench	00725-00048
Two 8 mm × 10 mm open-end wrenches	00950-30005
13 mm × 17 mm open-end wrench	00950-30006
Piston removal tool	00950-30010
Hex socket head bolts	00419-63235
Replaceable parts	Part number
Piston assembly	00950-01-00087

To clean or replace a piston, follow these steps:

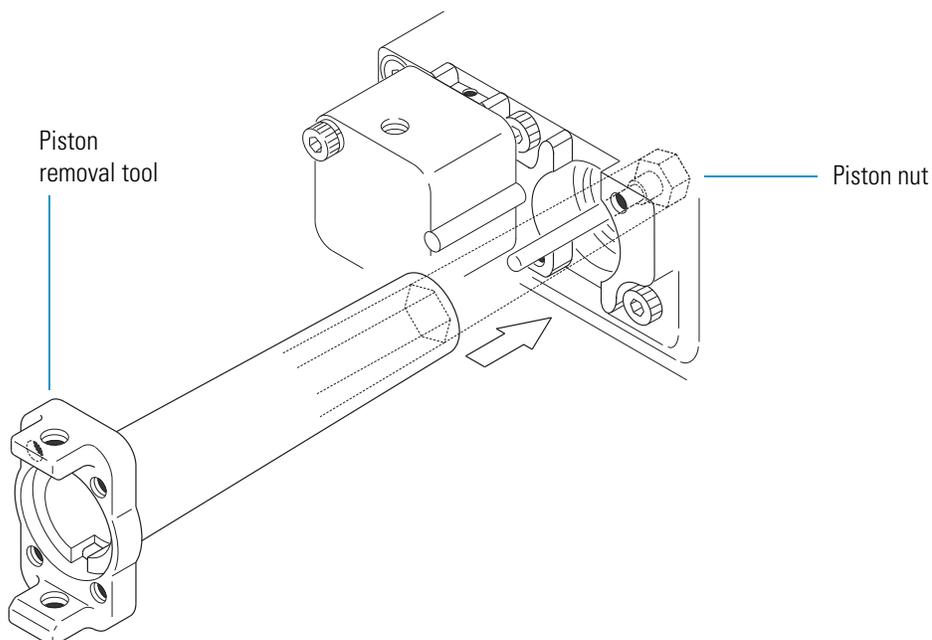
1. [Removing a Piston](#)
2. [Cleaning a Piston](#)
3. [Installing a Piston](#)

### Removing a Piston

#### ❖ To remove a piston

1. Remove the pump head by following the instructions in “[Removing the Pump Heads](#)” on [page 55](#).
2. Remove the wash seal holder by following the instructions in “[Removing the Wash Seal Holders](#)” on [page 63](#).
3. Using the hex socket end of the piston removal tool, rotate the piston nut counterclockwise, and then remove the piston assembly from the piston chamber (see [Figure 63](#)).

**Figure 63.** Removing a piston

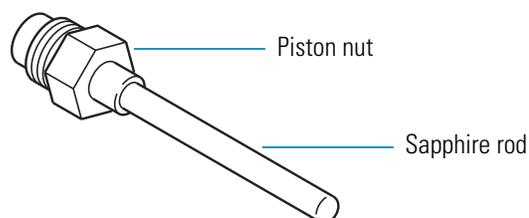


## Cleaning a Piston

### ❖ To clean a piston

1. After removing the piston (see [Figure 64](#)), inspect it for scratches.

**Figure 64.** Piston assembly



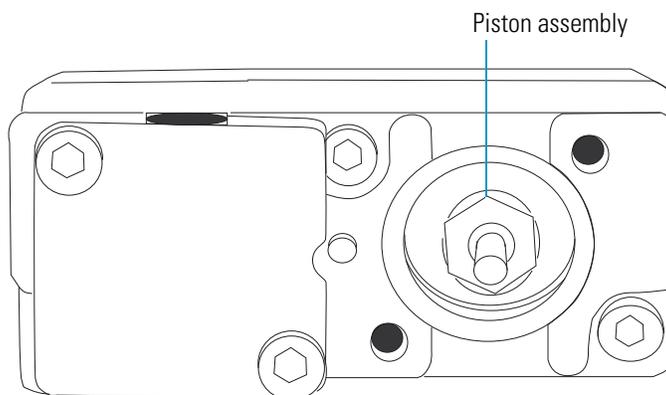
2. If the piston is not scratched, clean it with IPA.
3. If you cannot remove caked-on deposits with IPA, use a mild abrasive, such as toothpaste. Then rinse the piston with water, followed by IPA.
4. If the piston is scratched, replace it with a new piston assembly.

## Installing a Piston

### ❖ To install a piston

1. Holding the piston between your finger and thumb, insert it into the pump chamber, and then screw it in clockwise until hand-tight (see [Figure 65](#)).

**Figure 65.** Piston assembly installed in the pump chamber



2. Fit the piston removal tool over the piston nut, and then rotate it in the clockwise direction to tighten the piston assembly (see [Figure 63](#) on [page 67](#)).
3. Wipe the piston with a soft, lint-free tissue wipe soaked in IPA.
4. Carefully slide the wash seal holder onto the piston.
5. Reinstall the pump head and tubing as described in “[Reinstalling the Pump Heads](#)” on [page 59](#).

## Replacing the Line Filter Frit

The inline filter body contains a frit for removing particulate matter attributable to seal wear, insoluble buffers, or dirty solvents before it reaches the column. Eventually the frit becomes clogged, causing an increase in pump pulsation as well as an increase in system pressure. Replace the frit if the system pressure increases beyond its normal limits.



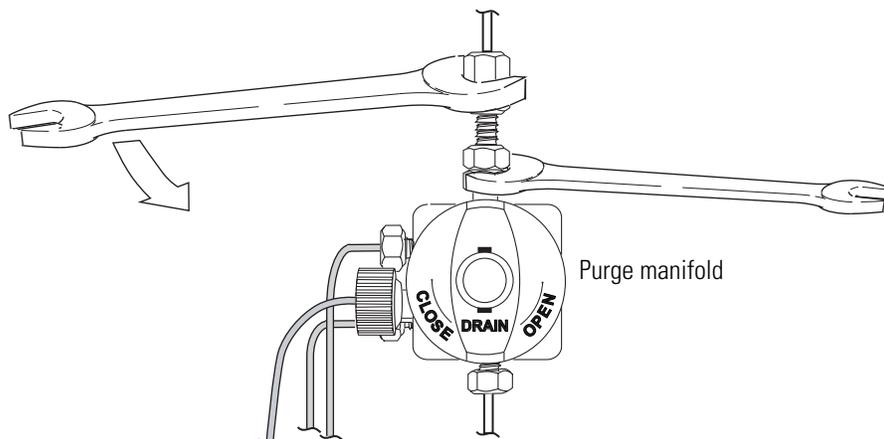
Replacing the line filter frit requires these tools and parts:

Tools	Part number
Two 8 mm × 10 mm open-end wrenches	00950-30005
Replaceable parts	Part number
Filter frit	00950-30009

❖ **To replace line filter frit**

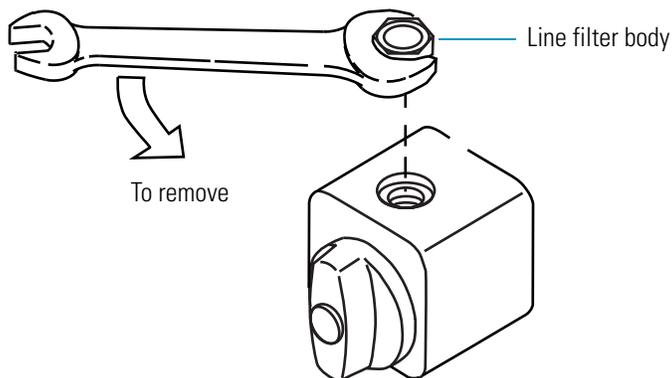
1. Using a 10 mm open-end wrench, unscrew and remove the stainless steel tubing that connects the solvent path from the pump to the autosampler (see [Figure 66](#)).

**Figure 66.** Disconnecting the tubing connecting the pump to the autosampler



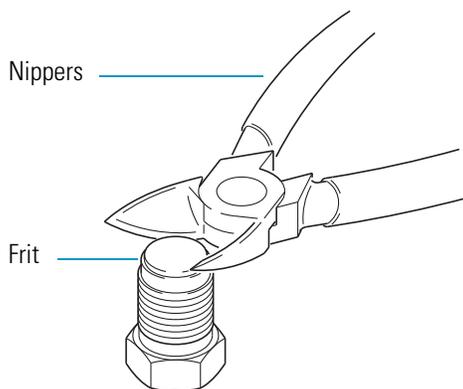
2. Using a 10 mm open-end wrench, unscrew and remove the line filter (see [Figure 67](#)).

**Figure 67.** Line filter body removed from purge manifold assembly



3. Remove the dirty frit from the line filter body (see [Figure 68](#)).

**Figure 68.** Removing the frit



## 4 Maintenance

### Replacing the Solvent Reservoir Filter

4. Press a new frit into the body of the line filter.
5. Screw the line filter body into the purge manifold. Using a 10 mm open-end wrench, tighten the fitting.
6. Reattach the stainless steel tubing that connects the pump to the autosampler. Using a 10 mm open-end wrench, tighten the fitting.
7. Draw solvent through the solvent line by purging the pump. For instructions on how to purge the pump, see [“Purging Air from the Solvent Lines or the Pump Heads”](#) on page 71.

## Replacing the Solvent Reservoir Filter

The solvent reservoir filter removes particulate matter from the mobile phase before it enters the solvent line. Eventually particulate matter from the mobile phase builds up on the filter and restricts the flow of solvent. A clogged solvent reservoir filter can cause the formation of air bubbles in the solvent line, erratic flow rates, and an abnormally low system pressure.

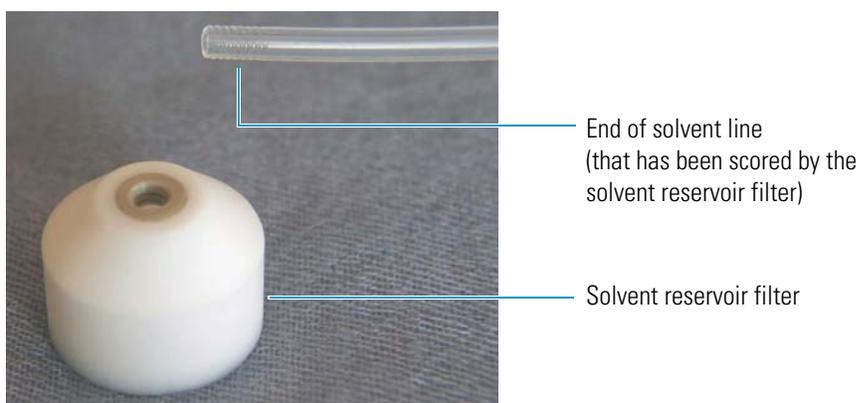
To determine if the solvent reservoir filter is clogged, remove the filter from the solvent line and monitor the system pressure as the pump draws solvent into the solvent line. If the pressure trace is normal in the absence of the solvent reservoir filter, replace the filter.

Thermo Fisher Scientific offers these two solvent reservoir filters:

Description	Part numbers
10 µm pore size, Teflon filter	A4258-010
10 µm pore size, stainless steel filter	A4929-010

Figure 69 shows the Teflon filter.

**Figure 69.** Solvent reservoir filter and solvent line



❖ **To replace a solvent reservoir filter**

1. Unscrew the solvent reservoir filter from the solvent line.
2. Screw the new solvent reservoir filter onto the solvent line, and then insert the line into the solvent reservoir bottle.

**Tip** If the solvent line is dry, turn on the pump, attach a syringe to the drain line, open the drain valve, and then pull solvent into the line by drawing back the syringe barrel.

3. Draw solvent through the new filter by purging the solvent line.

**Tip** If air bubbles still accumulate in the solvent line after replacing the solvent reservoir filter, replace the solvent line.

## Purging Air from the Solvent Lines or the Pump Heads

Use the purge feature when you see air in a solvent line or you suspect the pump heads contain air.

To purge air from the solvent lines or the pump heads, follow these steps:

1. [Opening the Drain Valve](#)
2. [Using the Purge Feature](#)

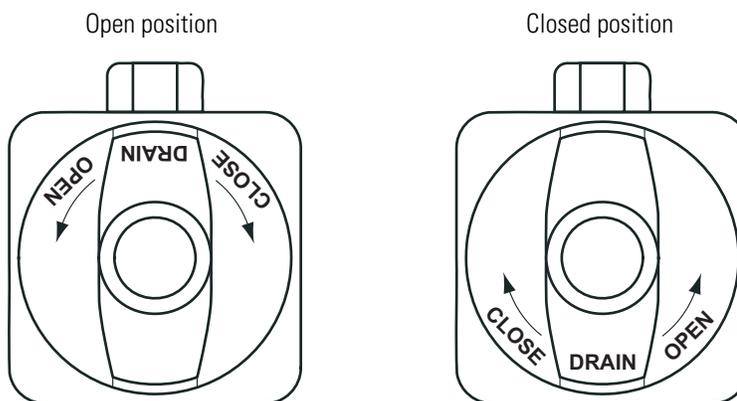
### Opening the Drain Valve

You must open the drain valve before you use the purge feature.

❖ **To open the drain valve**

Turn the drain valve knob 180° counterclockwise as shown in [Figure 70](#).

**Figure 70.** Drain valve in the purge position



## 4 Maintenance

Purging Air from the Solvent Lines or the Pump Heads

### Using the Purge Feature

To use the purge feature, follow the procedure for your data system:

- [Purging a Solvent Reservoir Line from the ChromQuest Data System](#)
- [Purging a Solvent Reservoir Line from the Xcalibur Data System or Tune Window](#)

#### Purging a Solvent Reservoir Line from the ChromQuest Data System

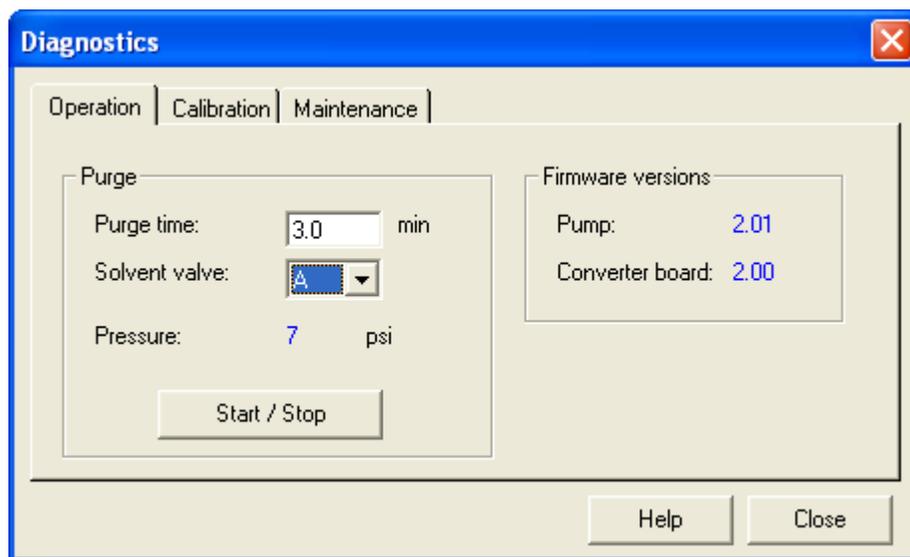
The purge controls are on the Operation page of the Diagnostics dialog box.

##### ❖ To purge the pump using the ChromQuest data system

1. Open the drain valve knob (see [“Opening the Drain Valve”](#) on [page 71](#)).
2. Turn on the power to the pump.
3. Open the Operation page as follows:
  - a. In the Instrument window, choose **Control > Instrument Status**.  
The Instrument Status window appears.
  - b. Click the **Surveyor LC Pump** tab.  
The Surveyor LC Pump page appears.
  - c. Click **Diagnostics**.  
The Diagnostics dialog box appears.
  - d. Click the **Operation** tab.

The Operation page appears (see [Figure 71](#)).

**Figure 71.** Operation page of the Diagnostics dialog box (ChromQuest data system)



4. In the Purge area, do the following:
  - a. In the Purge Time box, type a purge time.  
The range is 0 to 9.9 minutes.
  - b. In the Solvent Valve list, select the solvent line that you want to purge: **A, B, C, or D**.  
  
The Surveyor LC Pump Plus is a quaternary pump capable of proportioning up to four solvents. If the solvent lines have been plumbed correctly, the solvent valves should reflect the contents of the solvent lines and the respective solvent bottles in the solvent platform at the top of the Surveyor stack. See [Figure 6](#) on [page 7](#).
  - c. Click **Start/Stop**. The pump flow increases to approximately 10 mL/min.
5. After you finish purging the solvent line, close the purge valve by gently turning the drain valve knob clockwise until you feel resistance.

### Purging a Solvent Reservoir Line from the Xcalibur Data System or Tune Window

The purge controls are on the Operation – Surveyor LC Pump Direct Control page.

**Tip** The following instructions describe how to open the Operation – Surveyor LC Pump Direct Control page in the Xcalibur data system or the Tune window for your mass spectrometer.

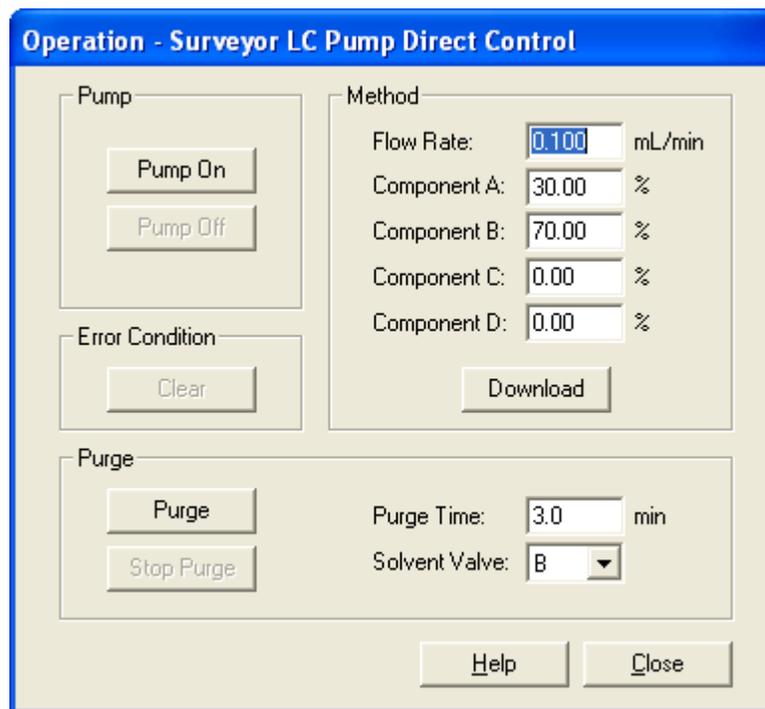
#### ❖ To access the purge controls from the Xcalibur data system

1. Turn on the power to the pump.
2. Open the Operation – Surveyor LC Pump Direct Control page as follows:
  - a. Open the Xcalibur data system (see [step 1](#) on [page 46](#)).
  - b. In the Roadmap view, click the **Instrument Setup** icon, .
  - The Instrument Setup window appears.
  - c. In the view bar, click the **Surveyor LC Pump** icon.  
The Surveyor LC Pump view appears.
  - d. From the menu bar, choose **Surveyor LC Pump > Direct Control > Operation**.  
The Operation – Surveyor LC Pump Direct Control page appears (see [Figure 72](#)).

## 4 Maintenance

Purging Air from the Solvent Lines or the Pump Heads

**Figure 72.** Operation - Surveyor LC Pump Direct Control dialog box (Xcalibur data system)



### ❖ To access the purge controls from the Tune window for your mass spectrometer

1. From the Tune window for your Thermo Scientific mass spectrometer, choose **Setup > Inlet Direct Control**.

The Inlet Direct Control dialog box that contains tabbed pages for each configured LC device appears.

2. Click the **Surveyor LC Pump** tab.

### ❖ To purge air from the solvent reservoir lines and the pump heads

1. Open the Operation – Surveyor LC Pump Direct Control page (see the procedure on [page 73](#) or refer to the data system Help).
2. Open the drain valve knob (see “[Opening the Drain Valve](#)” on [page 71](#)).
3. In the Purge area, do the following:
  - a. In the Purge Time box, type a purge time.  
The range is 0.1 to 9.9 minutes.
  - b. In the Solvent Valve list, select the valve for the solvent line that you want to draw solvent through.
  - c. Click **Purge**.

The pump flow increases to approximately 10 mL/min.

4. After you finish purging the line, close the purge valve by gently turning the drain valve knob clockwise until you feel resistance.

## Replacing the Drain Valve Knob O-Ring

If mobile phase is leaking from the drain valve assembly, replace the drain valve O-ring.



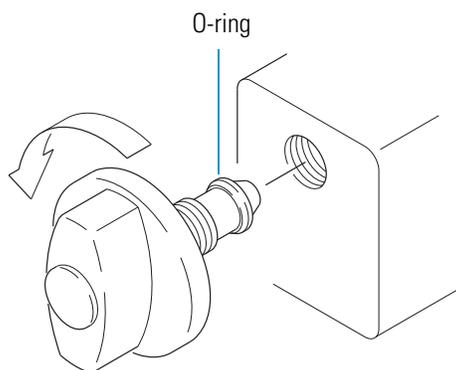
Replacing the line filter frit requires these tools and parts:

Tools	Part number
Needle-nose pliers	N/A
Replaceable parts	Part number
Drain valve O-ring	00950-30029

### ❖ To replace the drain valve O-ring

1. Unscrew and remove the drain valve knob (see [Figure 73](#)) by repeatedly turning it counterclockwise.

**Figure 73.** Drain valve knob O-ring



2. Using needle-nose pliers, remove the O-ring from the drain valve shaft.
3. Place a new O-ring on the shaft.
4. Screw the drain valve knob back into the purge manifold assembly.

## Replacing the Fuses



Replacing the fuses requires these items:

Tools	Quantity	Part number
Flat-head screwdriver	1	N/A
Replaceable parts	Part number	
3.15 A, 250 V, time delay, 5 × 20 mm fuses	2	126078

### ❖ To replace a fuse

1. Turn off the power to the pump.



**CAUTION** Before replacing the fuses, turn off the power and remove the power cord from line power. Only use fuses of the correct type and rating. Failure to heed this warning could result in short circuits, electric shock, or fire.

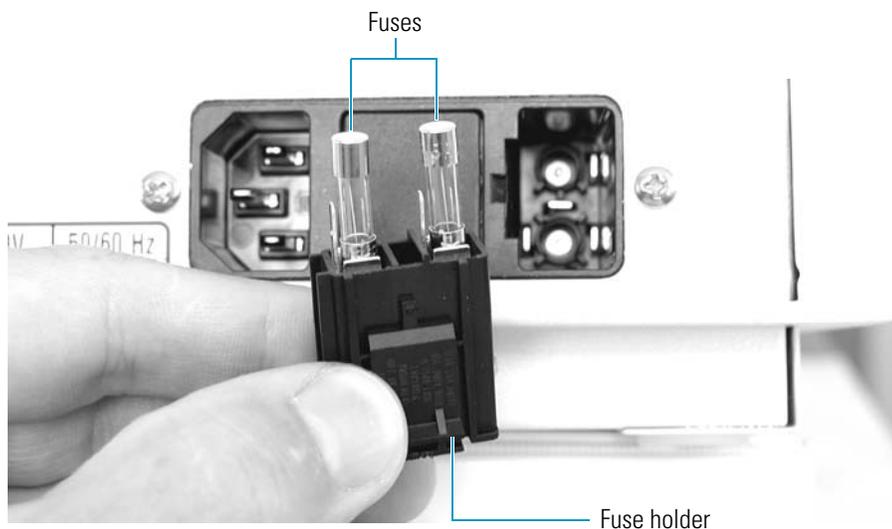
2. Use a screwdriver to pry off the fuse holder (see [Figure 74](#)).

**Figure 74.** Using a screwdriver to pry off the fuse holder



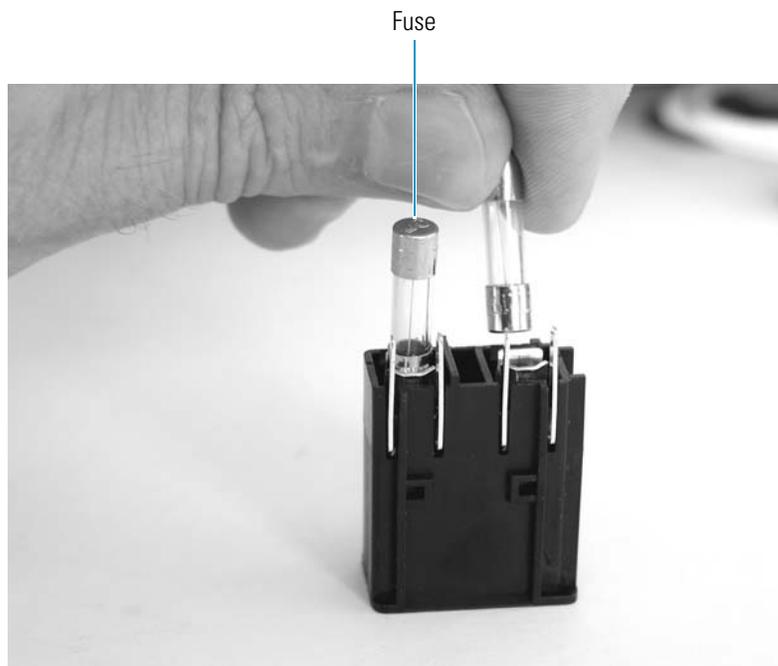
3. Pull out the fuse holder, and remove the fuses (see [Figure 75](#)).

**Figure 75.** Fuses in fuse holder



4. Place new fuses into the fuse holder (see [Figure 76](#)).

**Figure 76.** Placing a new fuse into the fuse holder



5. Push the fuse holder into its socket until it clicks in place.
6. Plug the power cord into line power and turn on the power to the pump.



## Diagnostic Tests and Calibration Options

This chapter provides information about the diagnostic tests and calibration options that ensure the transferability of your chromatographic methods.

### Contents

- [Flow Rate Accuracy Check](#)
- [Pressure Pulsation Check](#)
- [Proportioning Accuracy Check](#)
- [Gradient Delay Volume Check](#)
- [Calibration Options](#)

### Flow Rate Accuracy Check

The flow rate accuracy of your LC pump is an important variable if you are developing analytical methods for transfer to other instruments.

You can determine the flow rate accuracy of the LC pump by comparing the actual flow rate to the set rate. To determine the actual flow rate of the LC pump, measure the volume of water pumped in a measured length of time.

Performing a flow rate accuracy check requires the following items:

- HPLC-grade water
- Column or backpressure regulator that produces a backpressure of 2.9 to 9.8 MPa (420 to 1420 psi) at a flow rate of 1.0 mL/min
- 10 mL graduated cylinder to measure volume
- Analytical balance (optional) to indirectly measure volume
- Stopwatch to measure elapsed time

## ❖ To perform a flow rate accuracy check

1. (Optional) Weigh the empty 10 mL graduated cylinder and record the weight.

**Tip** You can determine the volume of the water that you collect in the graduated cylinder by estimating the level of the meniscus. However, if you need a more accurate measurement for the flow rate, determine the volume of the water that you collect in the graduated cylinder from the difference between the weight of the empty cylinder and the weight of the cylinder filled with approximately 10 mL of water.

2. Set up the instrument to pump water at a flow rate of 1 mL/min as follows:
  - a. Fill the solvent reservoir with distilled water, and then purge the line to remove the former mobile phase.
  - b. Disconnect the column or backpressure regulator from the detector.
  - c. Pump water through the column or the backpressure regulator to remove the former mobile phase.
  - d. Change the compressibility setting to 0.45—the compressibility ratio for water. Or, enter the compressibility ratio for the solvent that you are using.

**Note** Water is the recommended solvent for testing flow rate accuracy.

3. Collect approximately 10 mL of water with a (pre-weighed) graduated cylinder as follows:
  - a. Reset the stopwatch.
  - b. With the mobile phase pumping at the set rate of 1.000 mL/min, start the stopwatch as you place the end of the tubing that is connected to the column outlet or the backpressure regulator into the graduated cylinder.
  - c. Stop the stopwatch when the water inside the graduated cylinder reaches the 10 mL level.
4. Determine the volume of water in the graduated cylinder by reading the level of the meniscus or by reweighing the pre-weighed graduated cylinder as follows:
  - a. Weigh the filled graduated cylinder.
  - b. Calculate the volume of water in the graduated cylinder by using the following formula:

$$[W_{\text{filled}}(\text{g}) - W_{\text{dry}}(\text{g})] / \text{density of water} = \text{Volume (mL)}$$

Where:

$W_{\text{filled}}$  = weight of the graduated cylinder filled with water

$W_{\text{dry}}$  = weight of the dry graduated cylinder

Volume = volume of water in the graduated cylinder

The density of water varies with temperature (see [Table 4](#)).

**Table 4.** Density of water as a function of temperature

Temperature °C	Density of water (g/mL)
20	0.998
25	0.997
30	0.996

- Calculate the actual flow rate by using the following formula:

$$\text{Volume (mL)} / \text{Stopwatch time (min)} = \text{Actual flow rate (mL/min)}$$

- Compare the actual flow rate to the set flow rate of 1.000 mL/min.

The actual flow rate should be within 2% of the set value. If the actual flow rate is not within 2% of the set value, reset the alpha value as described in “[Flow Rate Adjustment \(Alpha\)](#)” on [page 93](#), and then check the new flow rate.

- When you are finished testing the flow rate accuracy, reset the compressibility ratio to an appropriate value for your mobile phase.

## Pressure Pulsation Check

Typically, the Surveyor LC pump operates with less than 2% variation in the pressure pulsation at operating pressures from 29 to 100 bar (421 to 1450 psi). Periodically check the variation in pressure pulsation of your LC pump as a part of your pump maintenance program.

To monitor and troubleshoot pressure variations, follow these procedures:

- [Checking the Pressure Pulsation of the LC Pump](#)
- [Troubleshooting the Cause of Excessive Pressure Variation](#)

## Checking the Pressure Pulsation of the LC Pump

### ❖ To check the variation in pressure pulsation of your LC pump

- Set up your instrument to pump water as follows:
  - Fill one of the solvent reservoir bottles with water.
  - If the solvent line is dry, attach a syringe to the drain line, open the drain valve, make sure that the pump power is on, and then draw the syringe barrel back pulling solvent into the line.
  - Purge the flow line that connects the solvent reservoir to the solvent proportioning valve until water replaces the former solvent in the flow line.

- d. Connect a column or backpressure regulator that produces a backpressure of 29 to 100 bar (420 to 1450 psi) at a flow rate of 1.0 mL/min to the pump outlet.
2. Change the compressibility setting to 0.45—the compressibility ratio for water.
3. Pump water at a flow rate of 1.0 mL/min.
4. Monitor the pressure variation.

**Tip** You can monitor the pressure readback for the LC pump from these areas of your software application:

- For the ChromQuest data system, you can monitor the pressure readback from the Surveyor LC Pump page of the Instrument Status and Instrument Setup windows, and the Operation page of the Diagnostics dialog box.
- For the Xcalibur data system, you can monitor the pressure readback from the Surveyor LC Pump section on the Status page of the Information View.

## Troubleshooting the Cause of Excessive Pressure Variation

A number of factors can cause the maximum pressure variation to increase. The most frequently occurring problems are as follows:

- Solvent leaks from the piston seals
- Air bubbles inside the pump head
- Contamination in the check valves
- Contamination in the proportioning valves

If the pressure pulsation of the pump is greater than 2% at operating pressures from 29 to 100 bar, you need to determine the cause of the problem.

### ❖ To troubleshoot the cause of the excess variation in pressure

1. Visually inspect the pump for signs of leakage. Check for solvent leaks from the piston seals, wash seals, or both. If visible leaks are not present, proceed to [step 2](#).

If you detect a leaking piston seal, replace it. See “[Replacing the Piston Seals](#)” on [page 54](#). Visually inspect the piston for scratches or salt buildup. If the piston is dirty or scratched, clean it or replace it as described in “[Cleaning and Replacing a Piston](#)” on [page 66](#). If you detect a leaking wash seal, replace it as described in “[Replacing the Wash Seals](#)” on [page 62](#).

2. Check the flow rate accuracy. A slow leak behind the piston seal or trapped air bubbles in the pump head assemblies will cause a lower flow rate than the set rate, as well as an increase in pressure variation.

If trapped air in the piston chambers or the check valves is the suspected cause of the increased pressure variation, purge the pump with 100% methanol.

3. If a contaminated check valve is the suspected cause of the increased pressure variation, clean the check valves by pumping 100% IPA at a flow rate of 1 mL/min for a period of 1 hour.
4. If a contaminated proportioning valve is the suspected cause of the increased pressure variation, clean the pump by running it for 1 hour with 100% IPA on all four channels.

## Proportioning Accuracy Check

The proportioning accuracy of your pump is an important variable if you are developing analytical methods for transfer to other instruments.

Inaccuracies in proportioning can affect isocratic methods where the solvent proportioning system delivers a blended mobile phase drawn from two or more solvent reservoir bottles. Inaccuracies in proportioning can also affect gradient methods where the solvent proportioning system varies the percentage of two or more solvents during the run.

Test the proportioning accuracy of the pump periodically by running a step gradient.

To check the proportioning accuracy of your pump, follow these topics:

- [Proportioning Accuracy Test—Preparation](#)
- [Proportioning Accuracy Test—Conditions](#)
- [Proportioning Accuracy Test—Running](#)

### Proportioning Accuracy Test—Preparation

To perform the proportioning accuracy test, prepare a spiked methanol solution and set up your instrument.

Material	Part number
HPLC-grade methanol	N/A
Ethyl paraben	A4904-010

#### ❖ To prepare eluent A

Depending on the length of the detector flowcell, do one of the following:

- If your detector contains a standard 10 mm flowcell, prepare eluent A—7 µg/mL ethyl paraben—by spiking 1 L of methanol with 7 mg of ethyl paraben.
- If your detector contains a 50 mm LightPipe flowcell, prepare eluent A—1.4 µg/mL ethyl paraben—by spiking 1 L of methanol with 1.4 mg of ethyl paraben.

#### ❖ To set up your instrument to test valves A and B

1. Fill solvent reservoir A with the appropriate concentration of ethyl paraben in methanol.

**Tip** Make sure that 100% of the spiked solution in the flow cell of your detector produces an absorbance of approximately 600 to 800 mAU. If the absorbance at the 100% level is above 800 mAU, dilute the spiked solution with methanol.

2. Fill solvent reservoirs B, C, and D with methanol.
3. Purge all four solvent lines.
4. Replace the column with a flow restrictor (backpressure regulator).
5. Equilibrate the proportioning valves by pumping on all four channels (25% A, 25% B, 25% C, 25% D) at a flow rate of 1.0 mL/min for 20 minutes.

## Proportioning Accuracy Test—Conditions

Use these chromatographic conditions to run the step gradient:

Flow:	1.000 mL/min
Pressure:	approximately 100 bar with a flow restrictor
Eluents:	A: methanol spiked with 1.4 µg/mL (for 1 cm path length) or 7 µg/mL ethyl paraben (for 5 cm path length) (absorbance approximately 600 to 800 mAU at 254 nm)
	B: methanol
Detection:	UV (254 nm)

Table 5 lists the gradient program for testing proportioning accuracy. The gradient profile produced by this program contains four steps (see Figure 77 on page 86). Inaccuracies in the step heights indicate proportioning errors.

**Table 5.** Gradient program to test a binary gradient using valves A and B

Time (min)	%A	%B	%C	%D
0.00	0.0	100.0	0.0	0.0
10.0	0.0	100.0	0.0	0.0
10.01	10.0	90.0	0.0	0.0
20.00	10.0	90.0	0.0	0.0
20.01	50.0	50.0	0.0	0.0
30.00	50.0	50.0	0.0	0.0
30.01	90.0	10.0	0.0	0.0
40.00	90.0	10.0	0.0	0.0
40.01	100.0	0.0	0.0	0.0
50.00	100.0	0.0	0.0	0.0

## Proportioning Accuracy Test—Running

To test the proportioning accuracy of your Surveyor LC Pump Plus, prepare your instrument as described in “[Proportioning Accuracy Test—Preparation](#)” on page 83, create an instrument method as described in “[Proportioning Accuracy Test—Conditions](#)” on page 84, and then collect two data files with step-gradient profiles.

### ❖ To collect two data files containing pump gradient profiles

1. If you have not already done so, equilibrate the proportioning valves by pumping on all four channels (25% A, 25% B, 25% C, 25% D) at a flow rate of 1 mL/min for 20 minutes.
2. Create an acquisition method with the chromatographic conditions listed in “[Proportioning Accuracy Test—Conditions](#).”
3. Place a vial that contains methanol in position A1 of the autosampler. Then make two injections of methanol using this method.

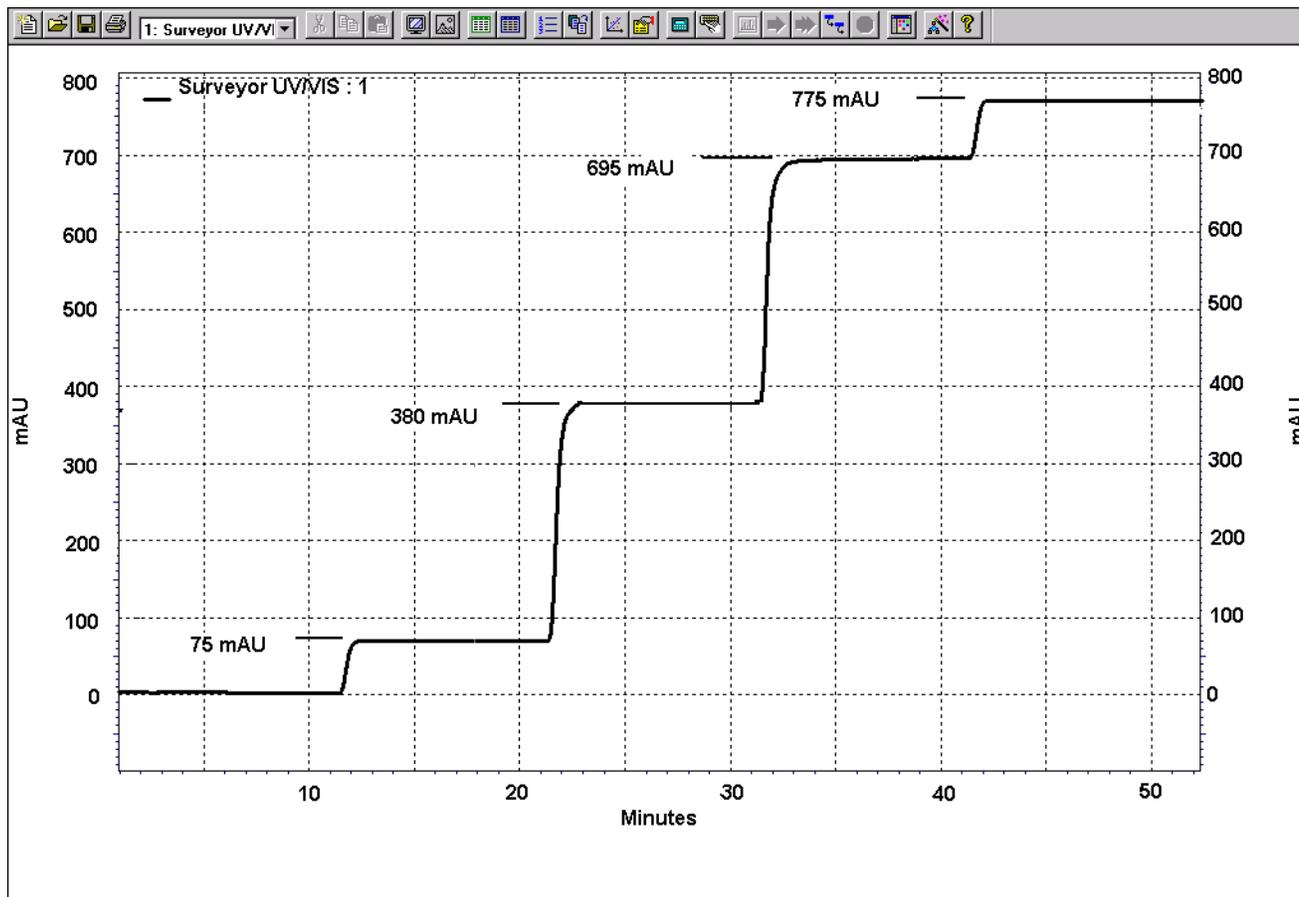
With the current setup, the autosampler injects methanol into the solvent stream at the beginning of the gradient program when the solvent is 100% methanol. Or, you can remove the autosampler from your instrument configuration and trigger the run from the detector.

4. Analyze the results of the second injection as described in “[Analyzing the Test Results](#).”

## Analyzing the Test Results

Check that the chromatogram produced by the proportioning accuracy test looks like the one shown in [Figure 77](#). Record the absorbance levels at the set concentrations of 0%, 10%, 50%, 90%, and 100% spiked eluent.

**Figure 77.** Step gradient for testing the solvent proportioning of your LC pump



$$\text{Actual conc. of 10\%} = \frac{(\text{Absorbance level at set concentration of 10\%}) - (\text{Absorbance level at set concentration of 0\%})}{(\text{Absorbance level at set concentration of 100\%}) - (\text{Absorbance level at set concentration of 0\%})} \times 100 =$$

$$\text{Actual conc. of 50\%} = \frac{(\text{Absorbance level at set concentration of 50\%}) - (\text{Absorbance level at set concentration of 0\%})}{(\text{Absorbance level at set concentration of 100\%}) - (\text{Absorbance level at set concentration of 0\%})} \times 100 =$$

$$\text{Actual conc. of 90\%} = \frac{(\text{Absorbance level at set concentration of 90\%}) - (\text{Absorbance level at set concentration of 0\%})}{(\text{Absorbance level at set concentration of 100\%}) - (\text{Absorbance level at set concentration of 0\%})} \times 100 =$$

The absorbance values for the 10%, 50%, 90%, and 100% steps of the step gradient shown in [Figure 77](#) are 75, 380, 695, and 775 mAU, respectively.

The step heights as a percentage of the absorbance level at 100% spiked eluent are calculated as follows:

$$10\% \text{ step} = [(75 \text{ mAU} - 0 \text{ mAU}) / (775 \text{ mAU} - 0 \text{ mAU})] \times 100 = 9.7\%$$

$$50\% \text{ step} = [(380 \text{ mAU} - 0 \text{ mAU}) / (775 \text{ mAU} - 0 \text{ mAU})] \times 100 = 49.0\%$$

$$90\% \text{ step} = [(695 \text{ mAU} - 0 \text{ mAU}) / (775 \text{ mAU} - 0 \text{ mAU})] \times 100 = 89.7\%$$

Step heights should be within  $\pm 1\%$  of the theoretical values. Therefore, a deviation greater than  $\pm 7.75$  mAU for any of the steps is a failing result. If the pump passes both the pulsation and proportioning tests, it is working properly.

If the pump fails the proportioning test, try to restore proper performance by running the pump for one hour with 100% IPA on all four channels. If cleaning the proportioning valves fails to restore proper pump performance, contact your local Thermo Fisher Scientific service representative.

## Gradient Delay Volume Check

The gradient delay volume of your instrument is an important variable if you are developing gradient methods for transfer to other instruments.

The gradient delay volume of your Surveyor system consists of the wetted components that lie in the flow path between the solvent proportioning valve of the pump and the injection valve of the autosampler. This volume can vary from system to system. For the Surveyor system, the primary contributors to the gradient delay volume are the pulse dampener assembly of the LC pump ( $\approx 400 \mu\text{L}$ ) and the tubing that lies behind the built-in column oven of the Surveyor Autosampler Plus ( $\approx 250 \mu\text{L}$ ).

### ❖ To determine the gradient delay volume of your system

1. Set up your LC system as follows:
  - a. Prepare a spiked methanol solution as specified in “Proportioning Accuracy Test—Running” on page 85.
  - b. Fill one solvent reservoir bottle with 100% methanol.
  - c. Fill one solvent reservoir bottle with the spiked methanol solution.
  - d. Purge the solvent lines until the new solvents replace the old solvents.

2. Create the following acquisition method as follows:

- a. Create the pump program shown below.

Time (min)	Solvent
0.00	100% Methanol
0.01	100% Spiked methanol
10.00	100% Spiked methanol

- b. Program your detector to collect a single wavelength at 254 nm for a period of 10 minutes.
3. Equilibrate your system with 100% methanol until you achieve a stable baseline.
4. Inject a small amount of the spiked methanol solution by using the method that you created in [step 2](#).
5. Calculate the gradient delay volume as follows:
  - a. Subtract the retention time ( $R_t$ ) of the unretained peak from the retention time at the start of the baseline shift ( $T_2 - T_1$ ).
  - b. Subtract the time required to switch mobile phases from 100% A to 100% B. For the pump program given, this switch time is 0.01 minutes.
  - c. Determine the gradient delay volume by multiplying the resulting gradient delay time by the flow rate.

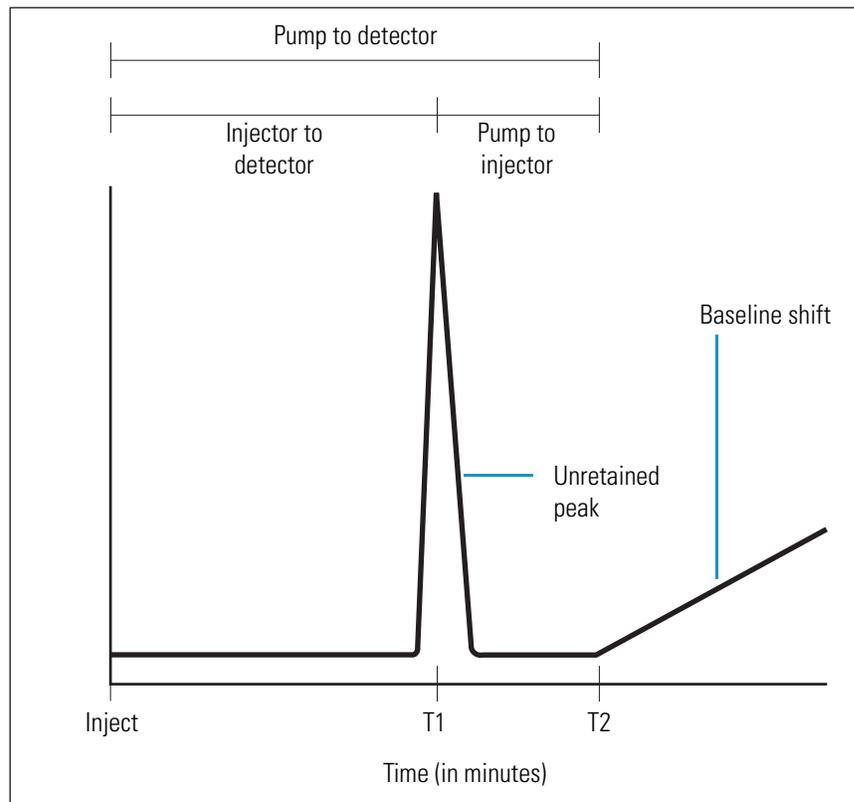
Check that the result of your run looks like the chromatogram shown in [Figure 78](#). If the injection of spiked methanol elutes at 1.00 minutes and the start of the baseline shift occurs at 2.21 minutes, the gradient delay volume is calculated as follows:

$$\text{Gradient Delay Volume} = [(T2 - T1) - \text{Switch Time}] \times \text{Flow Rate}$$

$$= [(2.21 \text{ min} - 1.00 \text{ min}) - 0.01 \text{ min}] \times 1.00 \text{ mL/min}$$

$$= 1.2 \text{ mL}$$

**Figure 78.** Graphical display of the baseline shift that occurs as the spiked mobile phase reaches the detector



## Calibration Options

The Surveyor LC Pump Plus is factory-calibrated to produce an accurate flow rate for distilled water and is shipped with the compressibility setting for distilled water. However, if you are pumping solvents other than water, you might want to optimize the compressibility value for your application. Changing the compressibility factor can affect the flow rate. Therefore, if you change the compressibility value you might also want to change the alpha value.

The pressure transducer that is attached to the back of the purge manifold assembly is also factory-calibrated. However, it can be damaged. If you replace the pressure transducer, you must recalibrate the pressure sensor adjustment setting. Even if you never damage the pressure sensor, its readout tends to drift under normal usage, so you must occasionally zero its output.

The Surveyor LC Pump Plus has these calibration options:

- [Compressibility](#)
- [Pressure Recorder Full Scale](#)
- [Flow Rate Adjustment \(Alpha\)](#)
- [Pressure Sensor Adjustment](#)
- [Pressure Transducer Zero](#)

**Tip** For information about accessing these calibration options, refer to the data system Help for the Surveyor LC Pump Plus or the Surveyor Plus user guide for your Thermo Scientific data system.

## Compressibility

The compressibility of a liquid is a measure of its resistance to a decrease in volume caused by an increase in pressure. Compared to gases, most liquids are relatively incompressible. Water, a commonly used mobile phase solvent, is even less compressible than most organic solvents because of its extensive hydrogen bonding and cluster structure.

### Effect of the Compressibility Setting

Even though liquids are relatively incompressible, the compressibility of your mobile phase can affect your chromatography if you are running the LC pump at the upper limit of its pressure range. By using the compressibility setting of the Surveyor LC Pump Plus, you can compensate for the compressibility of your mobile phase. Changing the compressibility setting simultaneously affects the pressure pulsation of the pump and flow rate of the mobile phase.

The compressibility effect is caused by the portion of the cam cycle where the pistons are compressing the mobile phase. The compressibility portion of the cam cycle extends from the time when the primary piston starts discharging until the time when the secondary piston reaches full intake—approximately 80° of the cam cycle.

To minimize the pressure pulsation and maintain a constant flow rate, the on-board CPU compensates for this compression by making fine adjustments to the speed of the stepping motor. If the compressibility setting is incorrect, the LC pump cannot effectively minimize the pressure pulsation.

Figure 79 shows the effect of the compressibility setting on the pressure pulsation. The pressure trace was recorded as water was pumped at a flow rate of 3 mL/min. Three runs were recorded. The compressibility setting was changed between the runs. The compressibility settings for the three runs were 0.45 GPa<sup>-1</sup>, 1.25 GPa<sup>-1</sup>, and 3.0 GPa<sup>-1</sup>.

**Figure 79.** Overlaid LC pump pressure traces, showing the effect of the compressibility setting

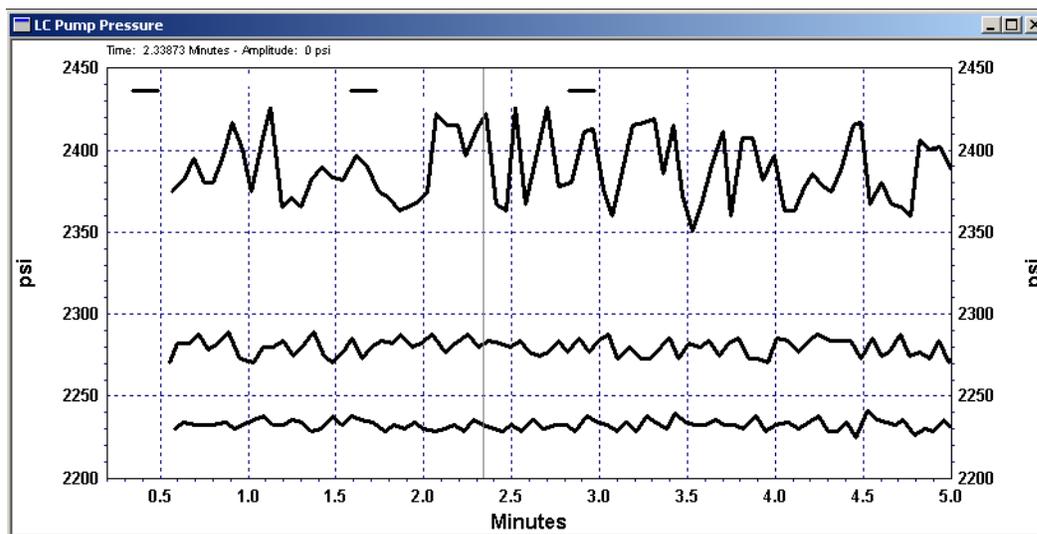


Table 6 shows a comparison of water pumped at three different compressibility settings. The correct compressibility setting for water is 0.45 GPa<sup>-1</sup>. The pressure pulsation, as well as the actual flow rate, increased as the compressibility setting increased.

**Table 6.** Measured flow rate and pressure pulsation versus compressibility setting

Compressibility setting	% Pressure pulsation	Actual flow rate (mL/min)	% Rel diff
0.45 GPa <sup>-1</sup>	±0.2%	3.01	+0.3%
1.25 GPa <sup>-1</sup>	±0.4%	3.05	+1.8%
3.0 GPa <sup>-1</sup>	±1%	3.18	+5.9%

## Compressibility Ratios for Common Solvents

Because most mobile phases are made up of a mixture of solvents, you must determine the correct compressibility setting for a given mobile phase empirically. Table 7 lists the compressibility ratios for a few common solvents.

**Table 7.** Compressibility ratios for common solvents

Solvent	Compressibility ratio (GPa <sup>-1</sup> )
Water	0.45
Acetonitrile	1.20
Methanol	1.25
Hexane	1.60

## Pressure Recorder Full Scale

If you choose to monitor the pressure with a chart recorder, use the pressure recorder full-scale calibration option to set the scaling factor for the pressure trace. The pressure recorder terminals are located on the back panel of the Surveyor LC Pump (see Figure 80). The range is the set of integer values from 1 to 10.

$$\text{Full scale} = \text{Set value} \times 4.9 \text{ MPa (50 kgf/cm}^2\text{)}$$

The full scale voltage equals 1 mV.

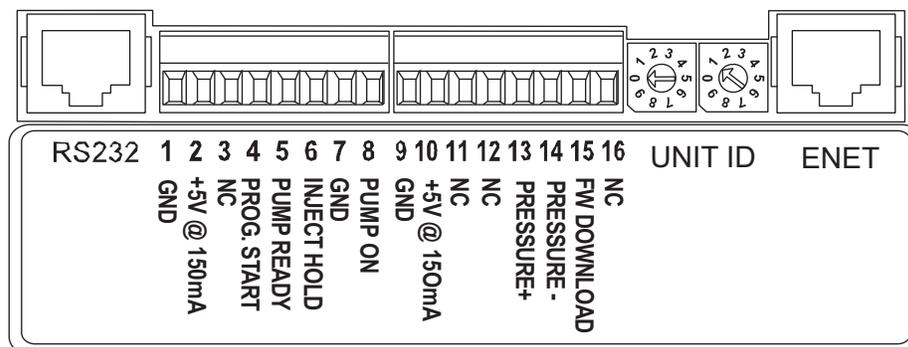
Example:

- When the set value = 1, the full scale is 4.9 MPa (50 kgf/cm<sup>2</sup>)
- When the set value = 10, the full scale is 49.0 MPa (500 kgf/cm<sup>2</sup>)

$$4.9 \text{ MPa} = 50 \text{ kgf/cm}^2 = 49 \text{ bar} = 711 \text{ psi}$$

**Tip** Record the scaling factor. This parameter is not backed up when the power is turned off.

**Figure 80.** Terminals located on the back panel of the Surveyor LC Pump Plus



## Flow Rate Adjustment (Alpha)

The alpha value for your Surveyor LC Pump Plus is factory-calibrated based on a flow rate of 1.000 mL/min for distilled water. A sticker containing the factory-calibration value is located inside the pump on the motor casing. You can optimize the alpha value for your application by updating the alpha setting. The range for alpha values is 1 to 9.9. If you are pumping water, decreasing the alpha value by 1 decreases the flow rate by 1 percent, whereas increasing the alpha value by 1 increases the flow rate by 1 percent.

## Pressure Sensor Adjustment

Reset this parameter when the pressure sensor is replaced. Each pressure sensor is labeled with a data sticker that contains a “0.XXXX” value for the pressure sensor adjustment setting. Multiply this value by 10 000 and then update the pressure sensor adjustment setting for your Surveyor LC Pump Plus.

## Pressure Transducer Zero

The pressure readout for the Surveyor LC Pump Plus is produced by a cell type potentiometer. Because this type of device tends to drift by small increments, you must occasionally re-zero the readout. To update the pressure transducer zero value, turn off the pump flow and open the drain valve knob before clicking the pressure transducer zero button in the software program that operates your pump.



# Troubleshooting

If properly maintained, the Surveyor LC Pump Plus will operate trouble-free for many years. You can avoid most pump problems by simple, periodic maintenance, as described in [Chapter 4, “Maintenance.”](#) However, in the event that an error message is displayed or if you suspect a mechanical or electrical failure, use the troubleshooting information in this chapter to diagnose the problem. If your diagnosis indicates that a problem exists with non-user-serviceable parts inside the pump, a qualified Thermo Fisher Scientific service representative can replace most malfunctioning parts.

## Contents

- [Troubleshooting Tips](#)
- [General System Troubleshooting](#)
- [LC Pump Troubleshooting Guide](#)
- [Pump Pulsation](#)
- [Baseline Noise at Low Pressures \(Under 40 Bar\)](#)
- [Insufficient Solvent Flow from the LC Pump Outlet](#)
- [Irreproducible Retention Times](#)

For more detailed chromatographic troubleshooting, see any HPLC troubleshooting reference book or call your local Thermo Fisher Scientific service representative.

## Troubleshooting Tips

Begin the diagnosis of the problem by performing the following steps.

**Eliminate all other possible sources of trouble:** Before you invest time trying to diagnose a suspected pump problem, verify that the pump is the only source of difficulty. Systematically eliminate all other instruments in your Surveyor HPLC system as the source of trouble. If you are not sure which component of your chromatography system is responsible for poor system performance, the General LC System Troubleshooting section in this chapter contains many useful suggestions.

**When you are sure that it is the pump:** Once you have isolated the pump as the only remaining source of difficulty, proceed to the troubleshooting tables for help in determining the exact cause of the problem.

## General System Troubleshooting

This section contains general troubleshooting tips for the Surveyor HPLC system.

### ❖ **No flow**

1. Check mobile phase connections.
2. Check for leaks.
3. See item #3 on [page 98](#).

### ❖ **High backpressure**

1. Check the flow rate and the system/column specifications.
2. Check for tubing or column blockage.
3. See item #8 on [page 99](#).

### ❖ **Unstable Baseline or Drift**

1. System column not equilibrated; allow more equilibration time.
2. Refer to the troubleshooting guide in the hardware manual for your detector.

### ❖ **Baseline Noise**

1. Check for air bubbles in the system.
2. Check for solvent contamination.

### ❖ **No Peaks**

1. Check the detector and the data system connections.
2. Refer to the troubleshooting guide in the hardware manual for your autosampler.
3. Check the chromatographic conditions.

### ❖ **Contaminating / Ghost Peaks**

1. Clean the system and the LC column.
2. Refer to the troubleshooting guide in the hardware manual for your autosampler.

❖ **Poor Peak Shape**

1. Check the system for leaks.
2. Check the fittings and tubing lengths.
3. Check column performance.
4. Refer to the troubleshooting guide in the hardware manual for your autosampler.
5. Refer to the troubleshooting guide in the hardware manual for your detector.

❖ **Poor Retention Time Reproducibility**

1. Check system for leaks and bubbles.
2. Allow more time to equilibrate the LC column.
3. Check the LC column performance.
4. Refer to the troubleshooting guide in the hardware manual for your autosampler.
5. See item #6 on [page 99](#).

❖ **Poor Peak Area Reproducibility**

1. Check column performance.
2. Refer to the troubleshooting guide in the hardware manual for your autosampler.

❖ **No Instrument or Device Control**

1. Check cable connections.
2. Check the system software configuration.
3. Refer to the troubleshooting guide for the instrument in your LC system that is not communicating with the chromatography data system.

## LC Pump Troubleshooting Guide

Table 8 lists common pump-related problems and suggestions for corrective action.

**Table 8.** Surveyor LC Pump Plus Troubleshooting Guide (Sheet 1 of 2)

Symptom or malfunction	Possible cause	Corrective action
1. The power does not come on when the power switch is placed in the On position.	The power plug is disconnected.	Plug it in.
	The power cord is faulty.	Replace it.
	The power supply does not conform to the power supply specification of the unit.	Use a power supply that conforms to the power supply specification for the unit.
	The fuse is blown.	Replace the fuse.
2. The pistons are not moving and no liquid is pumped.	The flow rate is set to 0.	Set the flow rate to a value between 0.001 and 9.999 mL/min.
3. The pistons are moving, but no liquid is pumped.	There are air bubbles inside the pump head.	Purge the air from the pump heads. Connect a disposable syringe to the drain tube outlet, and draw out the bubbles.
4. The pump pulsation is greater than expected.	There are air bubbles inside the pump head.	Purge the air out of the pump heads. Connect a disposable syringe to the drain tube outlet, and draw out the bubbles.
	There are air bubbles in the solvent lines.	Shake the solvent line filter to drive out the bubbles. If the solvent line filter is clogged, clean it in an ultrasonic bath or replace it.
	The check valve is not working properly.	Pump isopropyl alcohol (IPA) through the flow line to clean the check valve. If this has no effect, clean the valve in an ultrasonic bath or replace it.
	Liquid is leaking from a gap between the pump head and head holder, or from the washing flow line.	Replace the piston seal.
	Liquid is leaking from the flow line connections.	Tighten the fittings. If tightening the fittings does not stop the leaking, replace the nuts and ferrules.
	The flow line is partially clogged.	Replace the line filter. Identify and replace clogged parts.
	The piston seals wear out too quickly.	Replace the piston.

**Table 8.** Surveyor LC Pump Plus Troubleshooting Guide, continued (Sheet 2 of 2)

Symptom or malfunction	Possible cause	Corrective action
5. The flow rate is below the set value.	The check valve is not working properly.	Pump IPA through the flow line to clean the check valve. If cleaning with IPA has no effect, clean the valve in an ultrasonic bath or replace it.
	The solvent line filter is clogged.	Replace the solvent line filter.
6. Retention times are not reproducible.	The check valves are not working properly.	Pump isopropyl alcohol through the flow line to clean the check valves. If cleaning with IPA has no effect, clean the valves in an ultrasonic bath or replace them.
7. The system backpressure does not rise when you start the solvent flow.	The drain valve is open.	Close the drain valve.
	Liquid is leaking from the flow line connections.	Tighten the fittings. If tightening the fittings does not stop the leaking, replace the nuts and ferrules.
8. The pressure rises too high (disconnect the column to confirm).	The line filter is clogged.	Replace it.
	The flow lines are clogged.	Identify and replace clogged parts.
	The inner diameter of tubing is too small.	Use tubes with the specified inner diameter.

## Pump Pulsation

Pump pulsation is the variation in pressure with time due to the motion of the pump pistons.

Pressure pulsation can be divided into two categories:

- [Normal Pressure Pulsation](#)
- [Abnormal Pressure Pulsation](#)

### Normal Pressure Pulsation

Under normal operating conditions, the Surveyor LC Pump Plus shows very small variation in pressure. The pressure variation is about 4 bar with a backpressure of 200 bar (1 bar = 0.10 MPa = 14.5 psi).

### Abnormal Pressure Pulsation

Abnormal pressure pulsations fall into two categories. Large pressure pulsations are generally considered to be those with a standard deviation (SD) of pressure greater than 10 bar (145 psi). Minor pressure pulsations are those with a standard deviation in pressure under 10 bar.

#### Pressure Pulsations with SD over 10 Bar

Pressure pulsations with an SD of pressure over 10 bar are, in most cases, caused by air bubbles trapped in one of the piston chambers. To clear trapped air bubbles, run the LC pump at about 500  $\mu$ L/min with methanol or acetonitrile for about 15 minutes.

Strong pump pulsations can also be caused by insufficient flow to the pump caused by a dirty solvent reservoir filter. To determine if the solvent reservoir filter is clogged, remove it from the solvent tubing and record the pressure trace when mobile phase is pumped. If the pressure pulsation returns to normal in the absence of the solvent reservoir filter, the filter is clogged. Replace the clogged filter and thoroughly purge the system.

If you determine that the cause is not related to trapped air, the cause might be related to one or more worn piston seals. Replace both piston seals as described in [Chapter 4, "Maintenance."](#)

If the problem still persists after you change the piston seals, the problem is likely due to a contaminated check valve. Cleaning a check valve is normally not effective. Most likely, you must replace one or both check valve assemblies.

#### Pressure Pulsations with SD between 3 and 10 Bar

Pressure pulsations with an SD of 3 to 10 bar are of various origins. You can continue working, but you will want to find the reason for the pulsation as soon as possible.

## Baseline Noise at Low Pressures (Under 40 Bar)

HPLC pumps are optimized to deliver a constant flow with a minimum of pressure fluctuations when they are operated in the range of 40 to 400 bar (580 to 5800 psi). The LC pump provides stable flow over the entire pressure range used by HPLC.

With backpressures under 40 bar, you might observe a slight instability in the detector baseline at high sensitivity.

You can usually fix this problem by adding a flow restrictor to your system between the Surveyor LC Pump Plus and the autosampler to increase backpressure back to a level greater than 40 bar.

Capillary LC at 3 to 5  $\mu\text{L}/\text{min}$  and 15 to 20 bar (for example, a 300  $\mu\text{m}$  column at 3  $\mu\text{L}/\text{min}$ ) is a typical application susceptible to this problem.

## Insufficient Solvent Flow from the LC Pump Outlet

If there is insufficient flow when the LC pump is running, the problem is usually a result of one of the following:

- [Pump Cavitation](#)
- [Blocked Proportioning Valve](#)
- [Blocked Check Valve](#)

### Pump Cavitation

A restricted flow from the solvent reservoir to the pump can cause the pump to cavitate, which results in erratic mobile phase delivery. In extreme cases, there might be no flow at all. The reason is usually either a blocked solvent reservoir filter or restricted solvent tubing. A possible, but much less probable, cause could be a restriction inside the vacuum degasser.

#### ❖ To determine the cause of the problem

1. Disconnect (at the inlet to the degasser) the tubing from solvent reservoir A and verify unrestricted flow of solvent.
2. If the flow is normal, reconnect the tubing into the degasser and disconnect the corresponding degasser outlet tubing.
3. Once again, check for unrestricted flow. The flow out of the degasser is normally slower than that going to the degasser.
4. Repeat the procedure for solvents B, C, and D.

Suspect a problem with the degasser only if there is virtually no flow coming out of the degasser.

## Blocked Proportioning Valve

If flow from the degasser is nominal, check the proportioning valve. Measure the actual flow rate at a set rate of 1.000 mL/min with 100% of each solvent. If one or more of the values are low, clean the corresponding proportioning valve (for example, by pumping 100% isopropyl alcohol).

## Blocked Check Valve

An insufficient flow rate can also be a result of a blockage in one or both check valves. In this case, replace the column with a flow restrictor and pump isopropyl alcohol through the solvent lines. If cleaning with isopropyl alcohol has no effect, remove the valve and clean it in an ultrasonic bath or replace it.

## Irreproducible Retention Times

These are some of the more common causes of irreproducible retention times:

- An old or damaged column
- Unequilibrated column (Was a new column installed?)
- A validated method that lacks robustness
- Changes in mobile phase composition
- Temperature fluctuations
- Pump problems

If you are using a pre-mixed mobile phase and you suspect the pump is responsible, irreproducible retention times might be caused by a blocked check valve. If you are running a gradient or using the pump to mix your eluents, another cause of irreproducible retention times might be contaminated proportioning valves. Replace the column with a flow restrictor and run a step gradient as described in [“Proportioning Accuracy Test—Running”](#) on [page 85](#).

Inaccuracy of the steps is most likely caused by contamination of the proportioning valves. Run the pump at least 2 hours with isopropyl alcohol before repeating the test.

## Accessories and Replaceable Parts

This chapter contains a list of parts and tools for maintaining the Surveyor LC Pump Plus, and a list of parts that only a Thermo Fisher Scientific field service engineer can replace. To order parts, contact your local Thermo Fisher Scientific service representative. To facilitate the ordering process, part numbers are listed next to their respective parts.

### Contents

- [Surveyor LC Pump Accessory Kit](#)
- [Replacement Parts Required for Routine Maintenance](#)
- [Nonconsumable Replacement Parts](#)
- [Replacement Parts Required for Nonroutine Maintenance](#)
- [Solvent Interconnect Kit](#)
- [Other Parts and Assemblies](#)

## Surveyor LC Pump Accessory Kit

The Surveyor LC Pump Accessory Kit contains the following items. These items include maintenance tools and other miscellaneous pump accessories.

<b>Kit, Surveyor LC Pump Plus Accessory</b> . . . . .	<b>60053-62003</b>
Assembly, drain tube, OEM LC pump . . . . .	00950-30008
Assembly, rinse tube . . . . .	00950-30001
Assembly, needle, syringe tip, OEM LC pump . . . . .	00950-30007
Cable adaptor, RJ-45/14-D89FM. . . . .	A3538-010
Cable assembly, 6-cond, RJ11-RJ11, 7 ft, silver . . . . .	60053-63003
Connector, 8 pin, 3.81 mm pitch, minicombicon. . . . .	00004-02511
Dual seal removal tool . . . . .	A3216-020
Fitting, nut/ferrule, fingertight, 1/16 in. OD tubing. . . . .	00101-18088
Frit, outlet fitting, OEM LC pump . . . . .	00950-30009
Fuse, 3.15 A, time-lag (5 × 20 mm) . . . . .	126078
Luer type adaptor . . . . .	A0796-010
Patch cable RJ-45, CAT-5, shielded, 7-ft. . . . .	70111-63302
Sample kit pump test mix . . . . .	A4904-010
Screw, socket head cap, M5 × 20 mm, stainless steel . . . . .	00419-63235
Seal, high-pressure, polyethylene, OEM LC pump . . . . .	00950-30004
Seal, high-pressure, GFP, OEM LC pump . . . . .	00107-18008
Syringe, Luer-Lok, 10 cc. . . . .	3301-0151
Tool, Piston removal, OEM LC pump . . . . .	00950-30010
Tool, wrench, Allen Hex, 3 mm, black . . . . .	00725-00048
Tool wrench, open-end, 8 × 10 mm . . . . .	00950-30005
Tool, wrench, open-end, 13 × 17 mm. . . . .	00950-30006
Tubing, convoluted, pump waste . . . . .	F5034-040
Tubing 1/16 in. OD × 0.010 in. ID, 9 in. length, stainless steel . . . . .	A0941-040

## Replacement Parts Required for Routine Maintenance

The following list is for replacement parts required for routine maintenance of the Surveyor LC Pump Plus.

Check valve assembly, outlet, for secondary pump head, 24 mm height . . .	00950-01-00085
Check valve assembly, inlet, for primary pump head, 30 mm height . . . . .	00950-01-00086
Kit, Seal . . . . .	60053-62050
Kit, Maintenance . . . . .	60053-62051
Line filter frit. . . . .	00950-30009
O-ring, drain valve . . . . .	00950-30029
Piston assembly, sapphire. . . . .	00950-01-00087
Rinse tube assembly . . . . .	00950-30001
Seal, GFP, high-pressure, piston. . . . .	00107-18008
Seal, polyethylene, high-pressure, piston . . . . .	00950-30004
Seal, wash . . . . .	00950-01-00084
Solvent reservoir filter, Teflon . . . . .	A4258-010
Solvent reservoir filter, stainless steel . . . . .	A4929-010
Spacer, Teflon, 4.5 mm × 6.3 mm . . . . .	00950-01-00101
Tubing, pump inlet . . . . .	00950-30022
Wash tube fitting. . . . .	00950-30018
Wash tube assembly. . . . .	00950-30019

## Nonconsumable Replacement Parts

The following list includes replaceable parts for the Surveyor LC Pump Plus that might need replacement due to damage or loss.

Chassis, Surveyor LC Pump Plus . . . . .	60053-10001
Check valve, outlet, for secondary pump head, 24 mm height . . . . .	00950-01-00085
Check valve, inlet, for primary pump head, 30 mm height . . . . .	00950-01-00086
Drain valve shaft assembly . . . . .	00950-01-00100
Ferrule, for 1/16 in. OD tubing, stainless steel . . . . .	00950-30031
Front panel, Surveyor LC Pump . . . . .	60053-10051
Gradient valve cover . . . . .	60053-10006
Holder, wash seal. . . . .	00950-01-00105
Housing assembly, Surveyor LC Pump . . . . .	F3050-030
Nut, compression, male, 10-32, for 1/16 in. OD tubing . . . . .	00950-30030
O-ring, wash seal holder, Lpump. . . . .	00950-01-00108
Pump assembly with pump heads . . . . .	00950-01-00092
Pump head, inlet (primary head) . . . . .	00950-01-00093
Pump head, outlet (secondary head) . . . . .	00950-01-00094
Plate, cover, wash seal, Lpump. . . . .	00950-01-00105
Right door assembly, Surveyor LC Pump . . . . .	60053-60066
Ring, backing, wash seal, Lpump . . . . .	00950-01-00107
Screw, flat-Phillips head, M2.5 × 0.45 mm × 5 mm length, stainless steel. . . . .	00407-01-00019
Tube, crossover, stainless steel (primary-secondary) . . . . .	00950-01-00088
Tube, outlet, stainless steel (secondary-pressure) . . . . .	00950-01-00089
Tube, pump inlet. . . . .	00950-30022

## Replacement Parts Required for Nonroutine Maintenance

The following list includes the replacement parts needed for nonroutine maintenance performed by Thermo Fisher Scientific field service representatives.

Belt, pump motor . . . . .	00950-30028
Cable assembly, AC power input . . . . .	60053-63017
Cable assembly, DC power output . . . . .	00950-01-00095
Cable assembly, Event . . . . .	00950-01-00096
Cable assembly, Ethernet I/O . . . . .	00950-01-00098
Cable assembly, Ethernet power . . . . .	00950-01-00099
Cable assembly, fiber optic, 1M. . . . .	00950-30032
Cable assembly, gradient control . . . . .	00950-01-00097
Cable assembly, pressure sensor output . . . . .	00950-30034
Cable assembly, RCA, male to male. . . . .	60053-63018
Cable assembly, signal, Ethernet . . . . .	00950-01-00103
Dampener assembly . . . . .	00950-01-00102
Drain valve shaft assembly. . . . .	00950-01-100
Fan assembly, gradient valve cooling . . . . .	00950-30035
Fan assembly, stepper motor cooling . . . . .	00950-30033
Lubrication, pump cams . . . . .	00950-30014
PCB assembly, gradient controller. . . . .	60053-61004
PCB assembly, pump CPU, TE F/W . . . . .	00950-01-00083
PCB assembly, home position sensor. . . . .	00950-01-00090
PCB assembly, interconnect . . . . .	00950-01-00022
Power supply, 85-264 VAC input, 24 VDC/6.3 A output . . . . .	00012-22110
Pressure sensor assembly . . . . .	00950-01-00091
Pump assembly, with heads . . . . .	00950-01-00092
Pump head, inlet (primary head). . . . .	00950-01-00093
Pump head, outlet (secondary head) . . . . .	00950-01-00094
Valve assembly, gradient, 4-way Teflon block. . . . .	00950-30003

## Solvent Interconnect Kit

The Solvent Interconnect Kit used to connect the solvent reservoir bottles to the degas unit of the Surveyor LC Pump Plus contains these parts:

<b>Kit, Solvent Interconnect</b> . . . . .	F5050-010
Bottle cap, solvent bottles . . . . .	A0343-010
Solvent bottle cap adapter . . . . .	A3191-010
Solvent filter, 10 µm pore size, Teflon . . . . .	A4258-010
Fitting <sup>1</sup> , natural PEEK nut, Super Flangeless, for 1/8 in. tubing . . . . .	00101-18225
Ferrule <sup>2</sup> , Super Flangeless, for 1/8 in. tubing . . . . .	00101-18017
Tubing, 0.063 in. ID (per inch) . . . . .	3219-2004
Label set for the solvent bottles . . . . .	A4158-020
Marker letter "A", clip on . . . . .	608250001
Marker letter "B", clip on . . . . .	608250002
Marker letter "C", clip on . . . . .	608250003
Marker letter "D", clip on . . . . .	608250004

To order the Surveyor Flangeless fitting and ferrule set through the IDEX Health and Science Web Store, go to <http://webstore.idex-hs.com/>.

## Other Parts and Assemblies

The items below include miscellaneous parts and assemblies.

Power cord (European) . . . . .	6003-0330
Power cord (North America) . . . . .	6003-0160
Solvent inlet and outlet line tubing (order by length) . . . . .	3219-2004
Solvent reservoir filter . . . . .	A4258-010
System interconnect cable, 7-connector . . . . .	60053-63034
Vacuum degas assembly . . . . .	00108-00454

<sup>1</sup> The IDEX Health & Science part number is P-331.

<sup>2</sup> The IDEX Health & Science part number is P-350x.

## Firmware

Periodically, upgrades to the Ethernet or CPU firmware for the Surveyor LC Pump Plus might become available. In anticipation of future upgrades, both the ChromQuest and LC Devices CD contain the Surveyor Firmware Upgrade utility and the ROM Upgrade utility. The Surveyor Firmware Upgrade utility provides the capability of downloading Ethernet communication firmware files to your Surveyor LC modules. The ROM Upgrade utility provides the capability of downloading CPU firmware files to the Surveyor LC Pump Plus.

For the ChromQuest data system, the firmware files and the Surveyor Firmware Upgrade utility reside on the ChromQuest CD. Because they are not automatically installed during the installation of the data system, you must copy them to an appropriate folder on your data system computer.

For Thermo Scientific data systems that support the device drivers provided on the LC Devices CD, the firmware files and the Surveyor Firmware Upgrade utility are automatically installed to the following folder on the data system computer:

*drive:\Thermo\Instruments\LC Devices\Surveyor Firmware*

### Contents

- [Copying the Firmware Files from the ChromQuest CD](#)
- [Updating the Ethernet Firmware for the LC Pump](#)
- [Updating the CPU Firmware for the LC Pump](#)

## Copying the Firmware Files from the ChromQuest CD

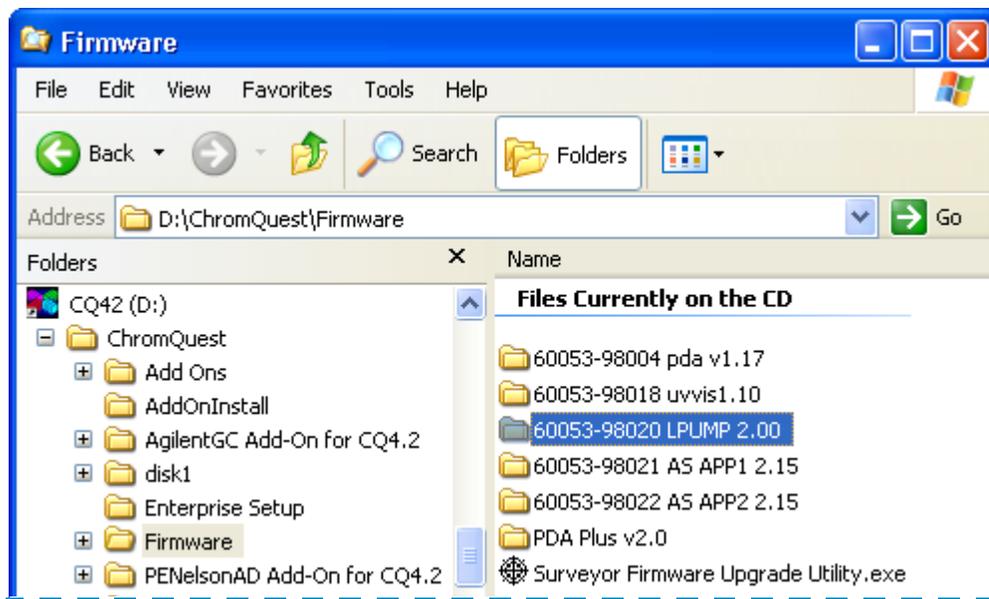
You can find the firmware files for the Surveyor modules on the ChromQuest CD. These files are not automatically loaded to the data system computer during the software installation.

### ❖ To copy the firmware files

1. Insert the ChromQuest CD into your CD-ROM drive.
2. From the Windows™ desktop, double-click **My Computer**.
3. Right-click the CQ icon and choose **Explore** from the shortcut menu to view the CD contents.
4. Copy the contents of the Firmware folder to your ChromQuest directory.

The Firmware folder contains folders for all the Surveyor instruments and the Surveyor Firmware Upgrade Utility. The firmware files for the ChromQuest 5.0 data system might differ from those shown in [Figure 81](#).

**Figure 81.** CD drive:\ChromQuest\Firmware folder for ChromQuest 4.2



## Updating the Ethernet Firmware for the LC Pump

To download the Ethernet firmware to the Surveyor LC Pump Plus, follow these procedures:

1. [Preparing the LC Pump to Download the Ethernet Firmware](#)
2. [Downloading the Communication Firmware Files](#)
3. [Returning the LC Pump to Normal Operation](#)

### Preparing the LC Pump to Download the Ethernet Firmware

#### ❖ To prepare the Surveyor LC Pump Plus to download the Ethernet firmware

1. Ensure that you have the Surveyor LC Pump Plus firmware files that you intend to download and the Surveyor Firmware Upgrade Utility on the data system computer.
  - For the Xcalibur data system (or equivalent Thermo Scientific data system), these files reside in the following folder:  
*drive:\Thermo\Instruments\LC Devices\Surveyor Firmware* (see [Figure 88](#) on [page 117](#)).
  - For the ChromQuest data system, install these files as described in “[Copying the Firmware Files from the ChromQuest CD](#)” on [page 110](#).
2. Make a note of the current settings of the rotary switches (Unit ID) on the back panel of the LC pump.  
  
At the conclusion of this procedure, you return the switches to these settings.
3. Ensure that your LC pump is connected to the data system computer with the standard Ethernet connection.
4. Turn off the power to the LC pump.
5. Use a small flat-head screwdriver to set the rotary switches on the back panel of the LC pump to 00.
6. Turn the LC pump power on.

The Comm LED blinks amber to confirm that the LC pump is configured for downloading the firmware.

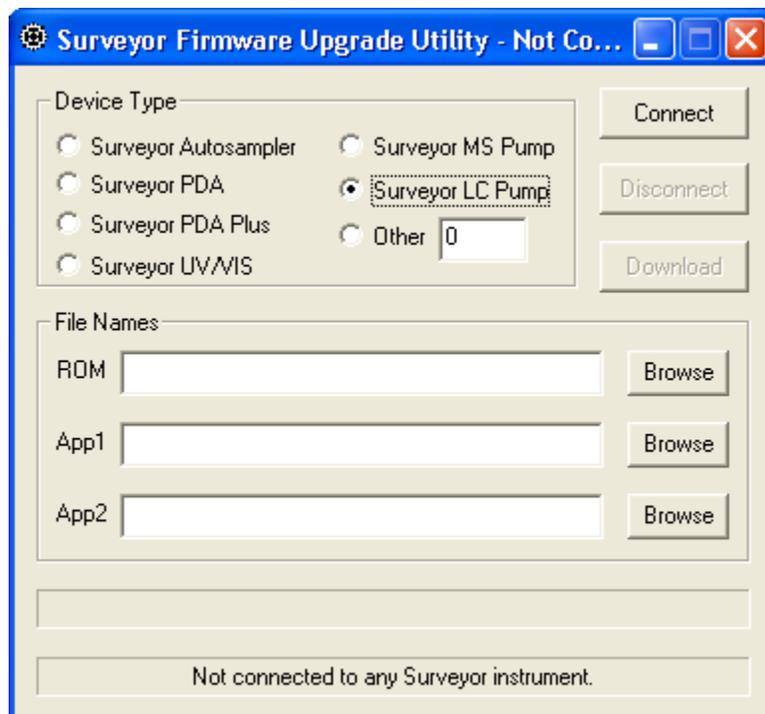
## Downloading the Communication Firmware Files

❖ **To download the communication firmware files to the Surveyor LC Pump Plus**

1. Start the Surveyor Firmware Upgrade Utility by double-clicking the **Surveyor Firmware Upgrade Utility** application.

The Surveyor Firmware Upgrade Utility window opens (see [Figure 82](#)).

**Figure 82.** Surveyor Firmware Upgrade Utility



2. In the Surveyor Firmware Upgrade Utility window, initiate the communication with the pump:
  - a. Under Device Type, select the **Surveyor LC Pump** option (see [Figure 82](#)).



**CAUTION** Avoid interrupting the firmware download process. Do not turn off the power to the LC pump or close the Surveyor Firmware Upgrade Utility after you click **Connect** and establish communication. If you turn off the power to the LC pump or close the utility at this point, you will have to return the pump to the factory for reprogramming.

- b. Click **Connect**.

The status display at the bottom of the Surveyor Firmware Upgrade Utility window indicates that a connection has been made.

3. Select the appropriate firmware files (see [Figure 83](#)) for the LC pump:

- Under File Names, click **Browse** to the right of the ROM box and select **ROM (1.08).bin**.

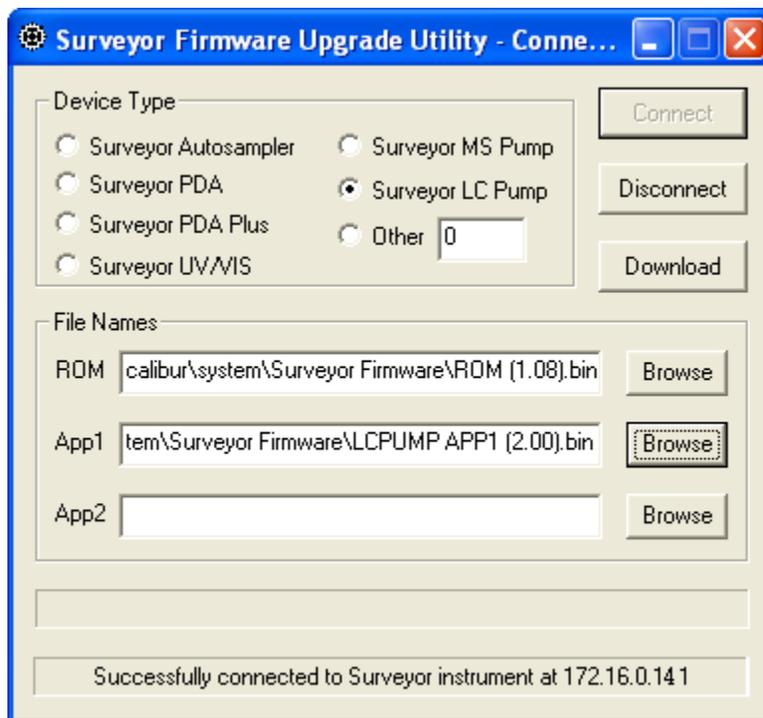
The file name appears in the ROM box.

- Under File Names, click **Browse** to the right of the App1 box and select **LCPUMP APP1 (2.00).bin**.

The file name appears in the App1 box.

**IMPORTANT** You must select both a ROM file and an APP1 file. Otherwise, when you return the LC pump to normal operation, it will not work properly.

**Figure 83.** Surveyor Firmware Upgrade Utility with the LC pump firmware files selected



4. After you select the appropriate firmware files, click **Download**, and then wait for the download to finish.

The utility notifies you when the download is complete.

### Returning the LC Pump to Normal Operation

After you finish upgrading the firmware, return the Surveyor LC Pump Plus to normal operation.

#### ❖ To return the LC pump to normal operation

1. Close the Surveyor Firmware Upgrade Utility to terminate the connection with the LC pump.

**Note** Now that you have terminated the connection, it is safe to turn off the power to the LC pump.

2. Turn the LC pump power off.

**IMPORTANT** Make sure to turn off the LC pump power before adjusting the rotary switches.

3. Set the rotary switches back to their original settings.
4. Turn on the LC pump power to resume normal operation.

### Updating the CPU Firmware for the LC Pump

Occasionally, Thermo Fisher Scientific releases upgrades to the CPU firmware for the Surveyor LC Pump Plus.

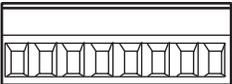
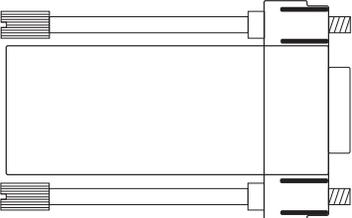
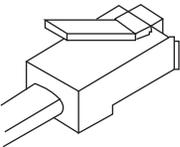
To upgrade the CPU firmware, follow these procedures:

1. [Preparing the LC Pump for a CPU Firmware Upgrade](#)
2. [Using the Flash ROM Update Utility to Update the CPU Firmware](#)

### Preparing the LC Pump for a CPU Firmware Upgrade

To prepare the Surveyor LC Pump Plus for a firmware upgrade, you must change the rotary switch position on the back panel of the pump and connect the LC pump to the data system computer with an RS232 serial communication cable.

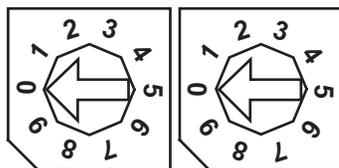
Connecting the RS232 serial communication cable requires these parts:

Figure	Description	Part number
	8-position, minicombicon connector	00004-02511
	RJ45 to DB9 cable adapter	A3538-010
	Serial communication cable	60053-63003

❖ **To prepare the LC pump for a CPU firmware download**

1. Ensure that the pump's power switch is in the Off position.
2. Use a flat-blade screwdriver to set the rotary switches located on the back panel of the LC pump to 00 (see [Figure 84](#)).

**Figure 84.** Rotary switches with unit ID set to 00



3. Create a jumper by connecting a wire, such as a paperclip, to slots 1 and 7 of an 8-position, 3.81 mm pitch, minicombicon connector.
4. Plug the minicombicon connector with jumper into positions 9 through 16 on the back panel of the LC pump (see [Figure 85](#)).



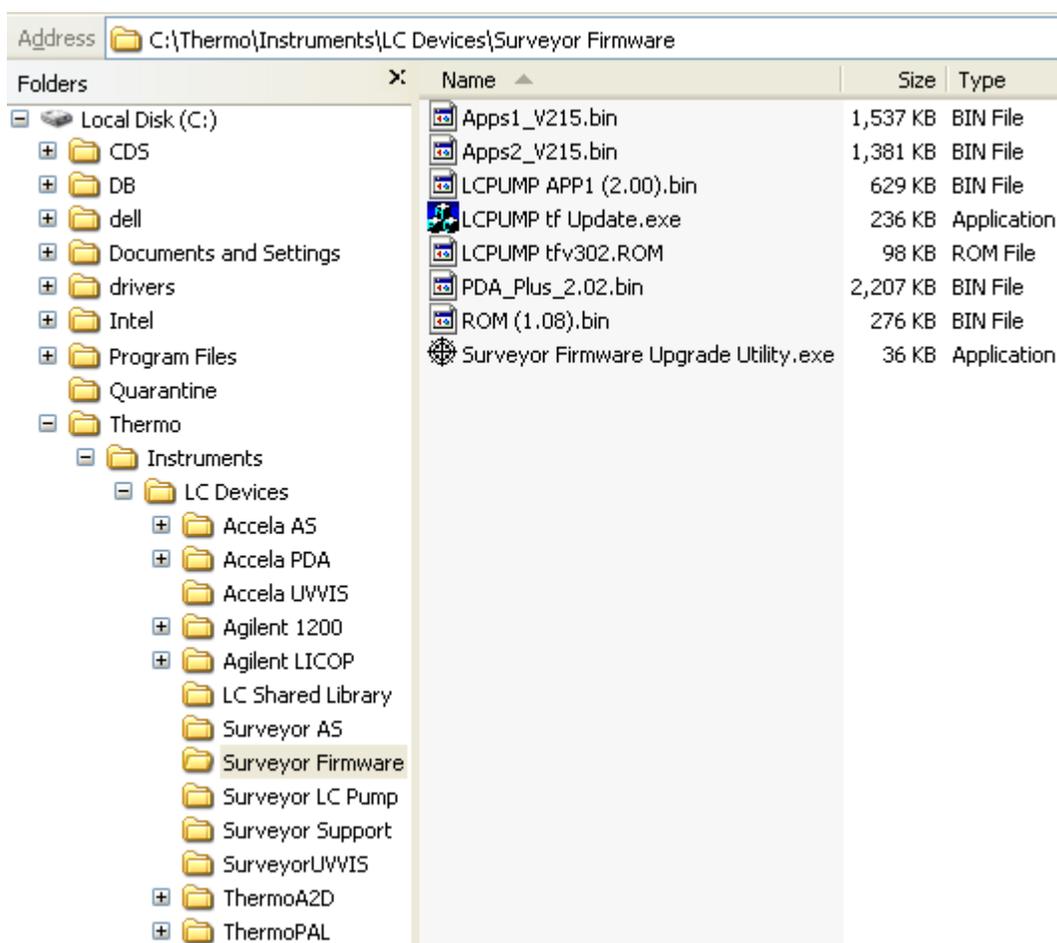
## Using the Flash ROM Update Utility to Update the CPU Firmware

The file name of the CPU firmware update utility for the Surveyor LC Pump Plus is LCPUMP tf Update.exe. The file name of the CPU firmware for the Surveyor LC Pump Plus is LCPUMP tfv302.ROM, where 302 is the version number.

For a Thermo Scientific data system that controls the Surveyor device drivers provided on the LC Devices CD, the Flash ROM Update utility and the firmware files for the Surveyor LC Pump Plus are located in the following folder (see [Figure 88](#)):

*drive:\Thermo\Instruments\LC Devices\Surveyor Firmware*

**Figure 88.** Surveyor Firmware folder (loaded from the LC Devices CD)

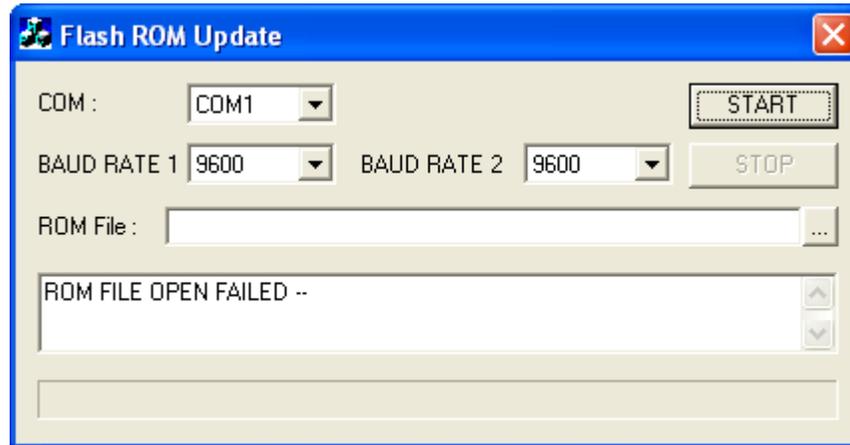


### ❖ To update the CPU firmware

1. Double-click **LCPUMP tf Update.exe**.

The Flash ROM Update dialog box appears (see [Figure 89](#)).

**Figure 89.** Flash ROM Update dialog box



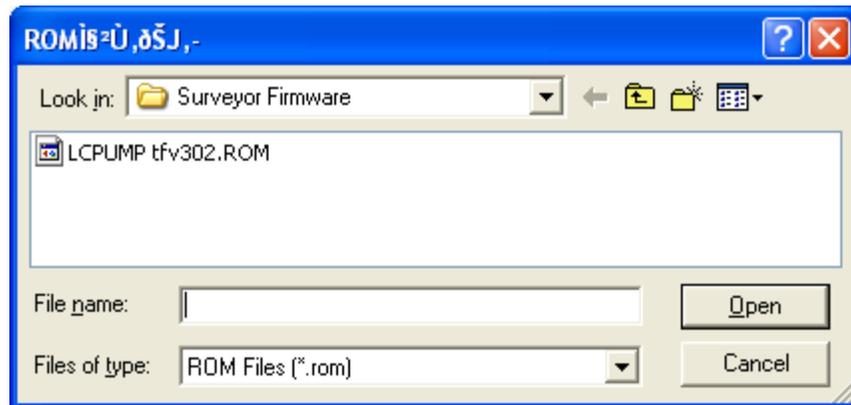
2. In the COM list, select the COM port of the data system computer that you connected to the LC pump with an RS232 cable.

The utility automatically selects the baud rate in the BAUD RATE 1 and BAUD RATE 2 lists.

3. Select the CPU firmware file:
  - a. Click **...** to the right of the ROM File box.

The ROM Open file dialog box appears (see [Figure 90](#)).

**Figure 90.** ROM Open file dialog box

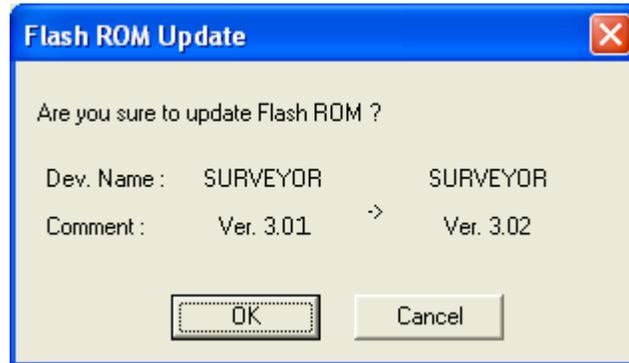


- b. Browse to the following folder:
 

*drive:\Thermo\Instruments\LC Devices\Surveyor Firmware*
  - c. Select **LCPUMP tfv302.ROM**.
  - d. Click **Open**.
4. In the Flash ROM Update dialog box, click **START**.

A message appears showing the current ROM revision of the Surveyor LC Pump Plus and the revision of the selected ROM file (see [Figure 91](#)).

**Figure 91.** Flash ROM Update message listing the current and selected firmware files



5. Check the ROM revisions and make sure they are correct.
6. Depending on whether the ROM revisions are correct, do the following:
  - If the ROM revisions are not correct, click **Cancel** (see [Figure 91](#)).
  - If the ROM revisions are correct, click **OK** to start updating the file.

When updating finishes, the following message box appears (see [Figure 92](#)).

**Figure 92.** Flash Writer message



7. Click **OK** to close the message box.
8. Turn off the power to the Surveyor LC Pump Plus.
9. Reset the rotary switches on the back panel of the Surveyor LC Pump Plus, disconnect the RS232 cable, and remove the 8-pin, minicombin connector with the jumper.
10. Turn on the power to the Surveyor LC Pump Plus and check the status of the LEDs.



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