VARIAN

ProStar 210
PrepStar 218
Solvent Delivery Module

Operation Manual

www.varianinc.com 03-914781-00:Rev. 5

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Sales and Service Contact Details

North America: 800.926.3000, 925.939.2400

Europe, The Netherlands: 31.118.67.1000

Asia Pacific, Australia: 613.9560.7133

Latin America, Brazil: 55.11.3238.0400

Varian, Inc. Web Site

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CE

Declaration of Conformity

We hereby declare that the equipment listed below complies with the requirements of:
The Low Voltage Directive 73/23/EEC (93/68/EEC)
The EMC Directive 89/336/EEC (92/31/EEC and 93/68/EEC)

Applicable Standards

LVD	EN 61010-1 (210/218)		
EMC	EN 50082-1 (210)	EN 55011 (210)	EN 61326+A1 (218)
Equipment Model Number		ProStar 210/PrepStar 218	

Authorized Representative in the EU

Name: G. A. Wassink

Signed:
Position: Quality Manager
Date: 1 March 2008

Company Name	Varian BV
Address	Herculesweg 8 4330 EA Middelburg The Netherlands
Telephone	+31 (0) 118 671 000
Facsimile	+31 (0) 118 633 118

Manufacturer

Company Name	Flextronics International
Address	1 Kallang Place Singapore 339211
Telephone	+65 6843 8970
Facsimile	+65 6844 2251

Manufactured for:

Name: Philip Binns

Signed:
Position: Director of Operations
Varian Australia
Date: 1 March 2008

Company Name	Varian Australia Pty Ltd
Address	679 Springvale Road Mulgrave VIC 3170 Australia
Telephone	+61 (0) 3 9560 7133
Facsimile	+61 (0) 3 9560 7950

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Safety Information

Operating Instructions

This instruction manual is provided to help you establish operating conditions which will permit safe and efficient use of your equipment. Special considerations and precautions are also described in the manual, which appear in the form of **NOTES**, **Cautions**, and **WARNINGS** as described below. It is important that you operate your equipment in accordance with this instruction manual and any additional information which may be provided by Varian. Address any questions regarding the safe and proper use of your equipment to your local Varian, Inc. office.

NOTE:	Information to aid you in obtaining optimal performance from your instrument.

Caution Alerts you to situations that may cause moderate injury and/or equipment damage, and how to avoid these situations.

WARNING Alerts you to potentially hazardous situations that could result in serious injury, and how to avoid these situations.

The following table describes the warning symbols that are found in this document.

Warning Symbol	Warning Description
 **WARNING: SHOCK HAZARD**	Hazardous voltages are present inside instrument. Disconnect from main power before removing screw-attached panels.
 **WARNING: CHEMICAL HAZARD**	Hazardous chemicals may be present. Avoid contact, especially when replenishing reservoirs. Use proper eye and skin protection.
 **WARNING: BURN HAZARD**	Very hot or cryogenically cold surfaces may be exposed. Use proper skin protection.
 **WARNING: EYE HAZARD**	Eye damage could occur either from flying particles, chemicals, or UV radiation. Use proper eye and face protection.
 **WARNING: FIRE HAZARD**	The potential for fire may be present. Follow manual instructions for safe operation.
 **WARNING: EXPLOSION HAZARD**	The potential for explosion may exist because of type of gas or liquid used.
 **WARNING: RADIATION SOURCE**	Ionizing radiation source is present. Follow manual instructions for safe operation.
 **WARNING: MOVING PARTS**	Keep hands and fingers away.
 **WARNING: HEAVY WEIGHT**	Danger to feet and hands.

General Safety Precautions

Follow these safety practices to ensure safe equipment operation.

- Perform periodic leak checks on all supply lines and pneumatic plumbing.
- Do not allow gas lines to become kinked or punctured. Place lines away from foot traffic and extreme heat or cold.
- Store organic solvents in fireproof, vented and clearly labeled cabinets so they are easily identified as toxic and/or flammable materials.
- Do not accumulate waste solvents. Dispose of such materials through a regulated disposal program and not through municipal sewage lines.

NOTICE:

This instrument has been tested per applicable requirements of EMC Directive as required to carry the European Union CE Mark. As such, this equipment may be susceptible to radiation/interference levels or frequencies which are not within the tested limits.

WARNING

This instrument is designed for chromatographic analysis of appropriately prepared samples. It must be operated using appropriate gases and/or solvents and within specified maximum ranges for pressure, flows, and temperatures as described in this manual. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

WARNING:
CHEMICAL HAZARD

It is the responsibility of the Customer to inform Varian Customer Support Representatives if the instrument has been used for the analysis of hazardous biological, radioactive, or toxic samples, prior to any instrument service being performed or when an instrument is being returned to the Service Center for repair.

Electrical Hazards

- Disconnect the instrument from all power sources before removing protective panels to avoid exposure to potentially dangerous voltages.
- When it is necessary to use a non-original power cord plug, make sure the replacement cord adheres to the color coding and polarity described in the manual and all local building safety codes.
- Replace blown fuses with fuses of the size and rating stipulated on the fuse panel or in the manual.
- Replace faulty or frayed power cords immediately with the same type and rating.
- Make sure that voltage sources and line voltage match the value for which the instrument is wired.

Compressed Gas Cylinders

- Store and handle compressed gases carefully and in strict adherence to safety codes.
- Secure cylinders to an immovable structure or wall.
- Store and move cylinders in an upright, vertical position. Before transport, remove regulators and install cylinder cap.
- Store cylinders in a well-ventilated area away from heat, direct sunshine, freezing temperatures, and ignition sources.
- Mark cylinders clearly so there is no doubt as to their contents.
- Use only approved regulators and connections.
- Use only connector tubing that is chromatographically clean (Varian Part Number 03-918326-00) and has a pressure rating significantly greater than the highest outlet pressure from the regulator.

LC Safety Practices

High Pressure Hazard

- If a line ruptures, a relief device opens, or a valve opens accidentally under pressure, potentially hazardous high liquid pressures can be generated by the pump causing a high velocity stream of volatile and/or toxic liquids.
- Wear face protection when you inject samples or perform routine maintenance.
- Never open a solvent line or valve under pressure. Stop the pump first and let the pressure drop to zero.
- Use shatter-proof reservoirs capable of operating at 345-415 kPa (50-60 psi).
- Keep the reservoir enclosure closed when the reservoir is under pressure.
- Read and adhere to all NOTES, CAUTIONS, and WARNINGS in the manual.

Flash Chromatography

The operator should be familiar with the physico-chemical properties of the components of the mobile phase.

Keep solvents from direct contact with the polyurethane supply tubing as certain solvents will cause weakening and leaks with possible bursting.

All components of the system should be connected to a common power supply and common ground. This ground must be a true ground rather than a floating ground.

Non-polar solvents can develop a static charge when pumped through the system. All vessels that contain mobile phase (including tubing and collection vessels) must be grounded to dissipate static electricity.

Employ static measuring and static discharge devices (e.g., air ionizers) to safeguard against the buildup of static electricity.

Ultraviolet Radiation

Liquid chromatograph detectors that use an ultraviolet light source have shielding to prevent radiation exposure to personnel.

For continued protection:

- Ensure that protective lamp covers of variable and fixed wavelength detectors are in place during operation.

Do not look directly into detector fluid cells or at the UV light source. When inspecting the light source or fluid cell, always use protective eye covering such as borosilicate glass or polystyrene.

Varian, Inc. Analytical Instruments Sales Offices

For Sales or Service assistance and to order Parts and Supplies, contact your local Varian office.

Argentina
Buenos Aires
Tel.
+54.11.4.783.5306

Australia
Mulgrave, Victoria
Tel. +61.3.9560.7133

Austria
Vösendorf bei Wien
Tel. +43.1.699.9669

Brazil and Latin America (S)
São Paulo
Tel.
+55.11.3238.0400

Canada
Mississauga, Ontario
Tel. 800.387.2216

China
Beijing
Tel. +86.106209.1727

Europe
Middelburg, The Netherlands
Tel.
+31.118.671.000

France
Les Ulis Cédex
Tel. +33.1.6986.3838

Germany
Darmstadt
Tel. +49.6151.7030

India
Mumbai
Tel.
+91.22.857.0787/88/89

Italy
Torino
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Japan
Tokyo
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Seoul
Tel. +82.2.345.22452

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Russian Federation
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Spain
Madrid
Tel.
+34.91.472.7612

Sweden
Solna
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Switzerland
Varian AG
Tel.
+41.848.803.800

Taiwan
Taipei Hsien
Tel.
+886.2.698.9555

United Kingdom and Ireland
Yarnton, Oxford
Tel.
+44.1865.291500

Venezuela
Valencia
Tel.
+58.41.257.608

United States
Walnut Creek,
California, USA
Tel.
+1.800.926.3000
or
+1.925.939.2400

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Introduction

General

The ProStar 210 and PrepStar 218 Solvent Delivery Systems are identical in appearance and operation. They differ only in one respect: the PrepStar 218 has a more powerful motor, larger power supplie and can operate at higher pressures than the ProStar 210. The pressures are identified in the specifications in the Appendix. The manual will refer to the pumps as 210/218 throughout.

The 210/218 pumps use proven single-piston rapid-refill technology for economy, reliability, and virtually pulse-free operation. A range of interchangeable flow heads allows operation at flow rates from 10 µL/min to 200 mL/min. Biocompatible pump heads are available for those analysts requiring a completely inert flow path. A single-channel 22 bit analog-to-digital converter built in to each 210/218 pump can convert a detector signal to digital form and transmit the data to a computer system. Five programmable analog inputs and three programmable relay outputs are available to further automate the HPLC system.

The 210/218 is easy to use and very flexible in operation. It can be used in several different modes of operation: as a standalone isocratic pump, as either a master pump or a slave pump in a completely automated HPLC system, as a sample inject pump in a preparative system, or in a fully-automated HPLC system controlled by an external computer. In each case, the provides outstanding accuracy over its entire range of pressures, flow rates, and solvents. The 210/218 operates very quietly because of minimal motor noise and resonance vibrations.

A complete 210/218 pump includes a drive module, a pump head, and a pressure module. Only one pressure module per system is required. One of the 210/218 pumps in the HPLC system needs to have a pressure module installed in its compartment in the pump side panel. The pressure module damps pulsations and supplies the current system pressure value to the drive module. Software in the drive module ensures that the system pressure is within pre-set maximum and minimum limits. Flow rates are automatically corrected for solvent-compression effects based on the system pressure value read from the pressure module and a compressibility factor entered by the user for each solvent.

The 210/218 pump operates with all Rainin and Gilson HPLC pump heads (except SD-1 heads) to maintain specified performance over designated flow and pressure ranges. The easily-replaceable pump heads are self-contained units including a spring-loaded piston and check-valve cartridges. Pump heads are not included with drive modules but must be ordered separately.

As a single, stand-alone unit in an isocratic system, the 210/218 provides a constant flow adjustable from 0 to 100% of the maximum flow rate of each pump head. Flow is adjustable in 0.001 mL/min increments on 5, 10, 25, and 50 mL/min pump heads; in 0.01 mL/min increments on 100 and 200 mL/min pump heads.

Programming a multipump system can be done from a single master 210/218 pump. Data about the physical layout of the pumping system (including pump head size, solvent compressibility, refill time, pressure limits, pump ID number) are entered into the master 210/218 pump. Communication between slave pumps and the master 210/218 pump is established through an RS-422 serial interface. For a gradient system, the master 210/218 pump can control up to three other pumps; in quaternary configuration, or with two pumps for ternary gradient elution and one for autoprep sample injection. This configuration provides simple system automation for gradient work where data acquisition and processing is not required.

Alternatively, one or more 210/218 pumps can be connected as slave pumps to form a isocratic or gradient system with PC

based software. (Information about this is covered in the manual for the PC software.)

The 210/218 pump is compatible with the SD-200/300 pump and can control these pumps if the SD-200/300 pump software has been updated to Version 1.71.

Unpacking and Inspection

The 210/218 pump is packed in a single carton. The pressure module ordered with the pump is mounted in the pump. Any pump head ordered with the pump is packed separately.

Check carefully to make sure you received all the items listed on the packing list. If you find any damage, contact the carrier an your local Varian office immediately.

Carefully unpack all the containers and inspect the contents for damage as soon as possible. Save the packing containers; they will be useful if you have to file a claim for damage, or in the case of future transit.

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Installation

Mechanical Setup

This section describes installing the pump head, pressure module, internal mixer and mast clamp/mast. These items, except for the mast, should be installed before positioning the pumps.

Pump Head Installation

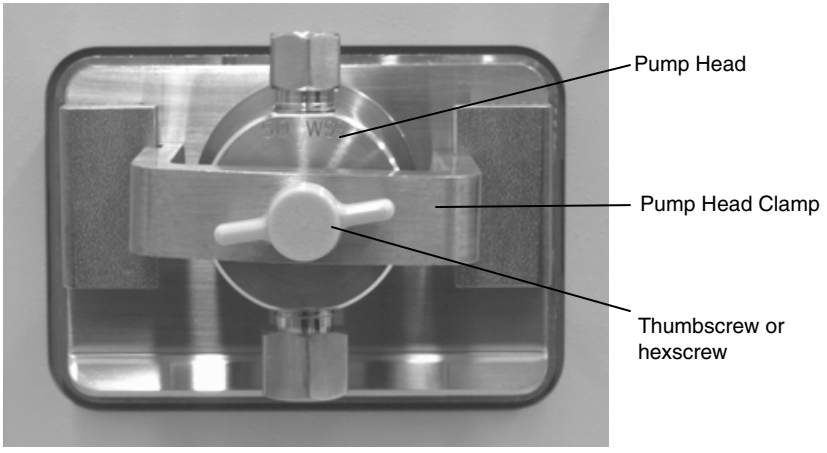


Figure 1 Pump Head Installation

The 210/218 pumps are shipped without the pump head installed. You will have to install the pump head before beginning to run. You can also change pump heads at any time.

1. Remove the shipping plug from the liquid head aperture on the front of the pump. Insert the pump head into the front aperture of the pump. The notch at the bottom of the pump head body must fit the matching pin on the pump, below the aperture. This notch ensures that the inlet and outlet ports are located in the correct position.

2. Holding the pump head in place, slide the clamp (found in the pump head kit) down over the head so the clamp flanges engage the slots on both sides of the pump head. Depending on the position of the pump cam, you may have to push the pump head in to get the clamp on. Make sure that the clamp flanges are in their slots on both sides and finger-tighten the thumbscrew until the clamp holds the pump head securely. In the case of the 200 mL head use the supplied hex wrench to tighten hex screw on the clamp. Tighten very securely. Repeat this procedure for each pump head in your system.

NOTE: There are three size clamps. The smaller one fits all heads that do not have piston wash. The larger one fits all heads that have piston wash. The largest clamp is used only with the 200 mL head.

3. The pump head size must be entered into the pump software for proper operation. This is described in the Operation section.

Pressure Module Installation

Each 210/218 can have a pressure module installed in the panel on the right side of the pump. The pressure module damps pump pulsations and supplies the current pressure value to the 210/218 software. The pump needs this information to implement compressibility compensation and flow rate accuracy corrections and to ensure that system pressure is within the limits entered during setup. Four pressure module ratings are available: 8700 psi (60.0 MPa), 6000 psi (41.4 MPa), 4000 psi (27.6 MPa), or 2000 psi (13.8 MPa). These have different flow rate max/min (see Appendix). The pressure module is identified on the front of its panel. The connector from the pressure module should be plugged into the Master 210/218. Only one

pump in the HPLC system needs to have a pressure module installed.

Figure 2 Pressure Module

The 210/218 will come with a pressure module installed in the factory. Use the following instructions to change pressure modules if needed.

NOTE:	You do NOT need to remove the cover to install the pressure module or mixer. The covers are removed in these photographs for clarity.

1. Decide which pump is to have the pressure module installed, (which pump is the master pump) then remove the panel on the rear of the right side using a Phillips-head screwdriver. Keep the panel in a safe place.

2. Place the pressure module in position and attach the connector to the plug on the inside of the pressure module compartment (see below). The connection is done using a 9 pin “D” shell connector. The 4 pin side of the connector is positioned towards the rear of the pump module. The module and its connector a one-way fit.

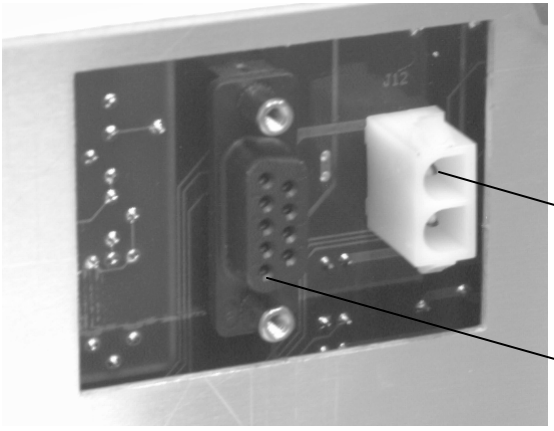


Figure 3 Pressure Module and Mixer

Figure 4 Pressure Module in Place

3. When the module is installed, tighten the screws on the mounting panel to hold the module in place. This is critical as the pressure module can slip out if the pump is picked up without the screws being tightened.

If using an HPLC system with a 210/218 as controller, the pump with the pressure module should be the master controller (device ID = MC).If using a computer as controller, the pump with the

pressure module needs to be identified in the controller configuration window.

Internal Mixer Installation

If 2 or more pumps are being used together to proportion individual solvents into one mixture, a mixer is required. Mixers are available in several different materials and three different sizes, a 0.6 mL, 1.2 mL, and 10 mL mixer. The internal mixer is identical in function and capability as the external mixer except that it obtains power from the 210/218 and it mounts into the pressure module bay at the right rear of the pump. The mixer is identified by a label on the inside of the mixer mounting panel. This identifies the mixer size, material and part number.

Figure 5 Internal Mixer in Place

The mixer connects to the 210/218 using a 2 pin molex connector for power. There is no ON/OFF switch for the mixer. Whenever the 210/218 is power on, the mixer is running. This continuous running does not hurt the mixer. If you look inside the mixer when no liquid is present, the mixing bars may not be moving. This is normal. When liquid is present, they flip back and forth rapidly to mix the solvents.

To install an internal mixer:

1. Be sure the power is turned off on the pump.
2. Remove the cover panel from the right rear of the 210/218. Save the screws.
3. Attach the 2 pronged Molex connector to the white Molex connector in the mixer compartment. The flat sides of the connector should be toward the rear of the pump.

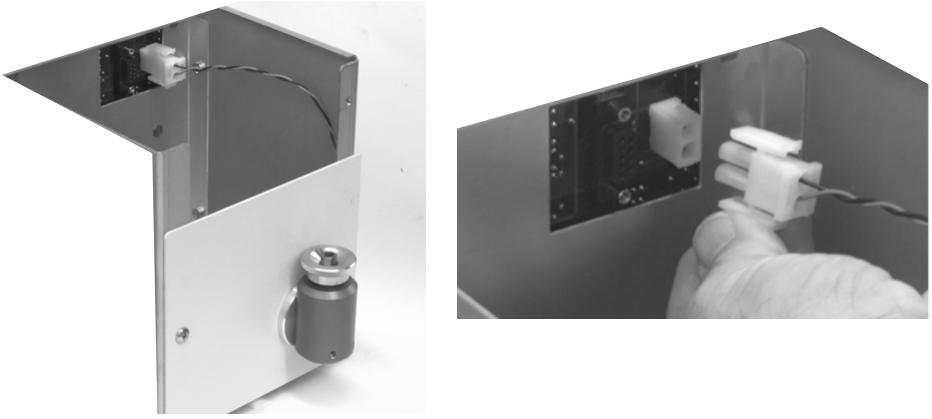


Figure 6 Mixer Internal Connections

4. Fit the mixer panel onto the module and use the screws to fasten it to the pump.

Mast Clamp Installation

Attach a mast clamp to the fitting at either lower front corner of the 210/218 pump, one to each 210/218 pump (or attach two clamps if you are using one 210/218). Secure the stainless-steel mast within the clamps so the lower end of the mast is level with the bottom of the lowest pump. (If a combination of 210/218 and other pumps are being used, fix the mast to two pumps of the same type, i.e. two 210/218s or two SD-200/300s.)

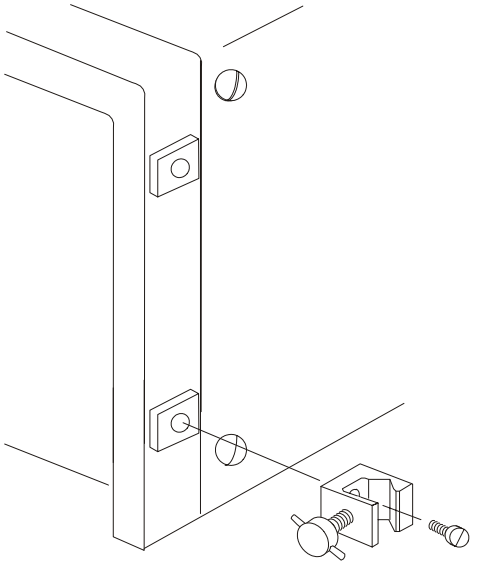


Figure 7 Mast Clamp Installation

Electrical Setup

The 210/218 pumps are shipped with fuses installed, ready for operation at the line voltage at the shipping destination. The fuses are as follows:

ProStar 210	**PrepStar 218**
USA: T3 A H250 V Europe: T1.6 A H250 V, 2 each	USA: T5 A H250 V Europe: T3.15 A H250 V, 2 each

If the pump does not start when connected to AC power, the fuse may be damaged. Fuse installation is described below.

WARNING:
SHOCK HAZARD

Dangerous voltages exposed when cover is removed. Unplug power cord.

Checking the Voltage Selection

The 210/218 Solvent Delivery Systems may be wired for either 115 V ±10%, 50/60 Hz single phase, 230 V ±10%, 50/60 Hz single phase, or 220 V, 50/60 Hz two phase (phase/phase) operating voltage. Generally, units manufactured for USA/Canada users are wired for 120 V and units manufactured for other markets are wired for 115 V ±10% service. Some European areas use two phase power. Instruments shipped to those sites are protected by two fuses. A label stating the operating power rating of your instrument (as wired in the factory) is affixed to the rear panel adjacent to the power receptacle and voltage selection assembly (J1).

Checking and/or Changing Power Fuses (F1)

The fuse rating and operating voltage is printed on the rear panel next to the power receptacle.

If your instrument fails to power up when the power switch is turned on, check that the power cord is properly connected. Check for power at the wall receptacle, then check the main power fuse (F1).

Power Connections

Check that the ON/OFF power switch is off (in the O position).

Connect the power cord to the back panel of the 210/218 pump and plug it into a grounded power socket. A good ground connection is necessary to ensure safety for users and proper communications.

RS-422 Channel

On the rear panel there is a single RS-422 male connector for serial communications. See Figure 23. This connector is used for bi-directional signals to and from the controller, whether the controller is an external computer or another 210/215. Internal software in the 210/218 determines whether the pump is a master controller or a slave pump.

Connections Using Serial Interface

Communications between slave pumps and controller (a computer or master 210/218) are established through the serial interface channel. This bi-directional communication protocol uses the EIA RS-422/RS-485 interface specification for data transmission.

One software-controlled connector located on the back panel sends and receives signals from the controller (master 210/218 pump or external computer). This connector is used on all pumps, both when the pump is used as a controller or as a slave: the software informs the controller of the status of each pump. The various configurations are discussed below. (Connection with a computer is covered in the interface manual of the specific software system used.)

Using a 210/218 as a System Controller

In a gradient system, the master 210/218 pump can be connected to a maximum of three slave pumps. For these connections, use the special flat cable equipped with four 9-pin "D" shell connectors, one male and three females, supplied as an additional accessory. (PN 03-935462-01)

Each pump in the system is connected with the serial interface cable. To distinguish one module from another, each module has a unique ID number. This number must be entered in each 210/218 pump using its own keypad.

The ID number of the master 210/218 pump is set by the user to "MC". Slave pump ID numbers can be set as desired. Each system can have only one master 210/218 pump. Slave pump IDs can also be set from a master 210/218 from the BUS IDs menu.

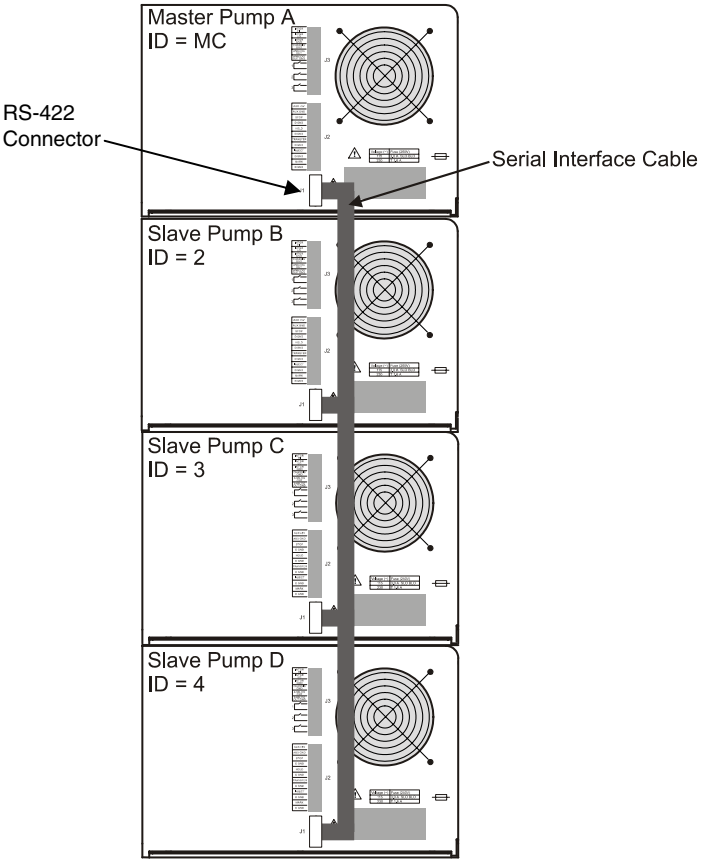


Figure 8 Quaternary Gradient System with 210/218 as Controller

External Contacts Connectors

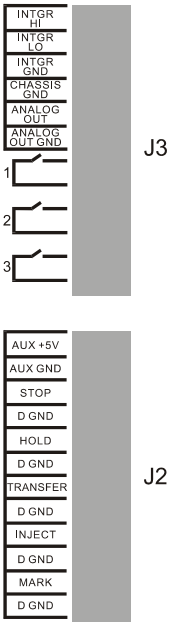


Figure 9 External Contacts Connector

The 210/218 has a number of analog and digital connections on the rear panel as shown in Figure 9. These can be used to digitize data from an analog detector, start and stop other devices through contact closures and to receive contact closures to start and stop the pump. Connections are made to this strip by two connectors included in the Standard Accessory Kit. These two connectors are attached to another device.

J3 Terminal Strip:

Name	***Connection***
INTGR HI	Positive wire from detector
INTGR LO	Negative wire from detector
INTGR GND	Ground wire from detector (do not connect to Chassis Gnd)
CHASSIS GND	Ground wire to chassis
ANALOG OUT	0-10 V output signal. Specifies which option to output as an analog

	signal to a recording device. Programmable options are: %A. %B, %C, %D (solvent composition %), pressure (system pressure), nm (wavelength specified in the I/O window), flow (system flow rate), or off. Full scale voltage is 10 V.
ANALOG OUT GND	Ground wire for Analog Out. (Do not connect to Chassis Gnd)
1, 2, 3	Contact-closure relay outputs. These can be used to start external devices, such as an autosampler.

J2 Terminal Strip:

Name	***Connection***
AUX +5V	5 V positive signal
AUX GND	Ground for auxiliary voltage. (Do not connect to Chassis Gnd)
STOP	Contact closure input to stop the pump from an external device.
D GND	Digital ground for Stop signal. (Do not connect to Chassis Gnd)
HOLD	Contact closure input from an external device to Hold a running method at the current time and flow/composition conditions.
D GND	Digital ground for Hold signal. (Do not connect to Chassis Gnd)
TRANSFER	Contact closure input to Transfer to another method from an external device. Transfer can be immediate, deferred until the end of the current method pass, or automatic at the end of run if no contact closure is received.
D GND	Digital ground for Transfer signal. (Do not connect to Chassis Gnd)
INJECT	Contact closure input from an external device which cancels a programmed Inject Wait or Hold.
D GND	Digital ground for Inject signal. (Do not connect to Chassis Gnd)
MARK	Contact closure input to perform an Event Mark (a 10% vertical trace on the chromatogram) from an external device.
D GND	Digital ground for Mark signal. (Do not connect to Chassis Gnd)

Plumbing Connections

Caution

DO NOT RUN THE PUMP DRY with a liquid head installed; SEVERE DAMAGE TO PUMP HEADS CAN RESULT.

If you want to run the pump without liquid flow, remove the liquid head, or use demo mode.

Manual Injection Systems

Stack the pumps as shown below. In general, with the ProStar/PrepStar line of instruments, stack the pump(s) on the bottom, the detector next and the autosampler, if present, on the top. Position the master 210/218 pump to allow easy access to the keypad and display, usually the highest pump in the stack. For a ternary system, simply add another 210/218 pump and plumb in a tee between the liquid heads of two pumps and the mixer.

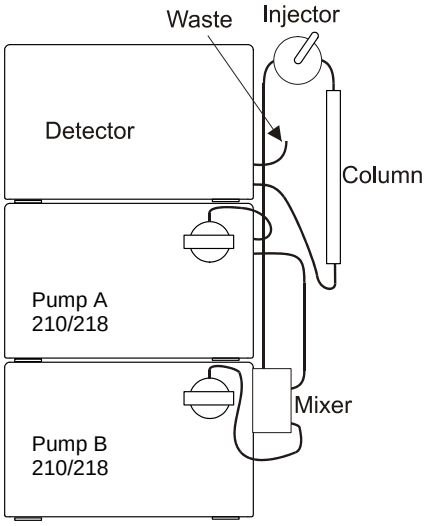


Figure 10 Binary Gradient Analytical or Preparative Systems

Auto-Preparative System

In this configuration, the injection pump is used for automatic injection. Position the injection pump below the slave pumps.

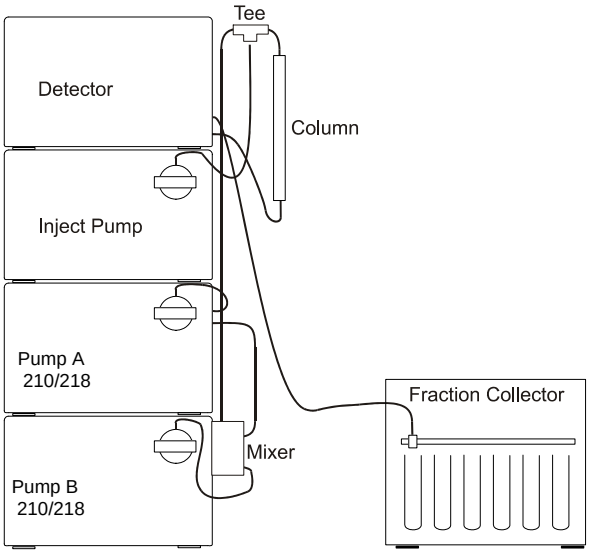


Figure 11 Gradient Auto-Preparative System

Pump Head Connections

Each individual pump head has a different set of tubing that comes with the pump head for connection to the solvent reservoir and to the rest of the system. They also have individual nuts, bushings and ferrules that are used to connect the pump to the rest of the system. Use those parts to make the connections.

Low Pressure Tubing and Inlet Filter Assembly

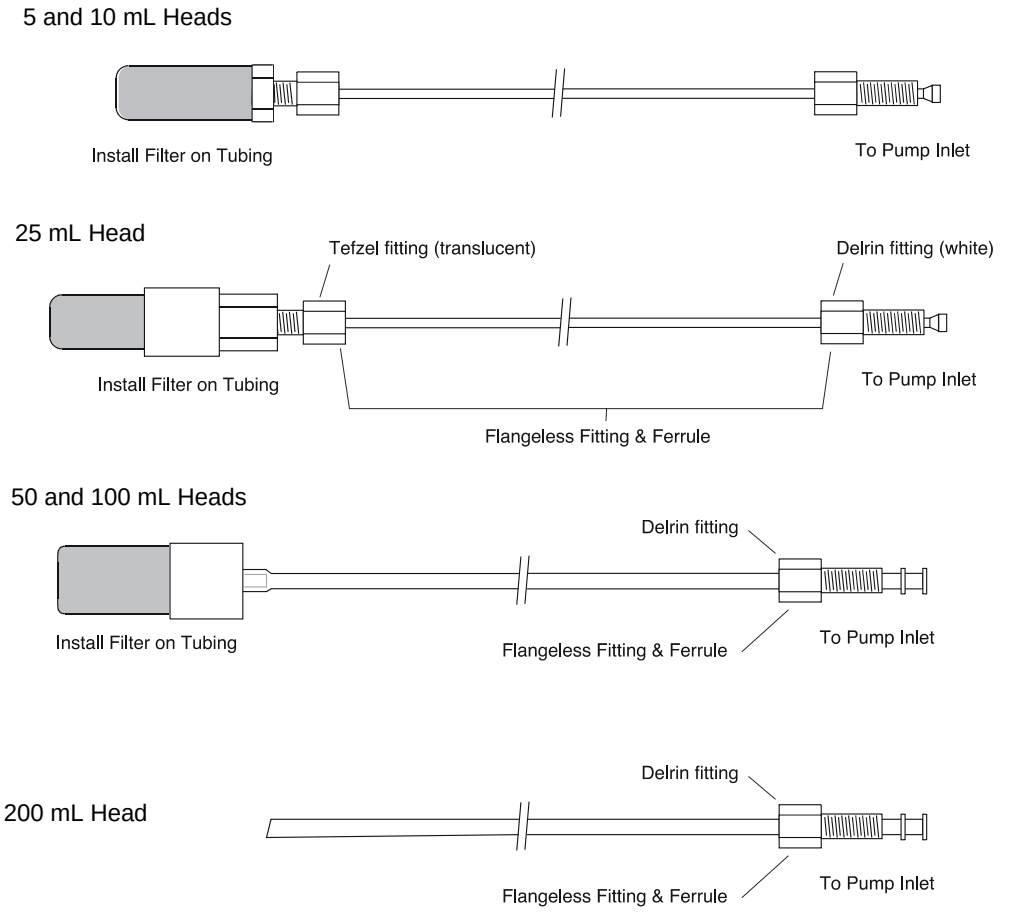


Figure 12 Inlet Filter Assembly Installation

The four types of inlet filter assemblies are shown above.

To install the inlet tubing for 5 – 100 mL heads:

1. Remove the solvent inlet assembly from the accessories package and immerse the inlet filter into clean, HPLC-grade water.

2. Assemble the inlet filter onto the end of the inlet tubing.

3. Connect the inlet fitting to the inlet port on the check valve (the lower port). Tighten the inlet tubing finger-tight. If leakage occurs in use, tighten very slightly with an open-end wrench until the leak stops. Do not over-tighten or the fitting may be damaged.

To install the inlet tubing for 200 mL heads:

1. Remove the solvent inlet assembly from the accessory package and immerse diagonally cut end of tubing into solvent container. The solvent containers should be located on the floor with the pump on the bench.

2. Connect the inlet fitting to the inlet port on the check valve (the lower port). Tighten the inlet tubing finger-tight. If leakage occurs in use, tighten very slightly with an open-end wrench until the leak stops. Do not over-tighten or the fitting may be damaged.

High Pressure Tubing

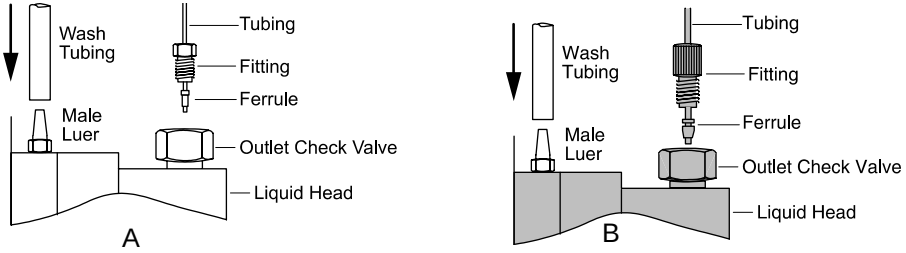


Figure 13 High Pressure Tubing Connections

Titanium or Stainless Steel Heads

Thread one of the Parker-type nuts and ferrules onto the outlet tubing in the orientation shown in Figure 13 (A). With the nut and ferrule in place, insert the tubing into the outlet check valve as far as it will go. Holding the tubing in place, tighten the nut 2/3 turn beyond finger-tight with an open-end wrench to swage the ferrule to the tubing. Repeat this process at the other end of the outlet tubing for the next device in line (mixer, pressure monitor, etc.). If the connection leaks when the system is pressurized, tighten the nut slightly until the leak stops.

PEEK heads

Thread one of the polyacetal nuts and ETFE (ethylene-tetra fluoroethylene, Tefzel) 2-piece ferrules onto the outlet tubing in the orientation shown in Figure 13 (B). With the nut and ferrule in place, insert the tubing into the outlet check valve as far as it will go. Holding the tubing in place, tighten the nut 2/3 turn beyond finger-tight with an open-end wrench to swage the ferrule to the tubing. Repeat this process at the other end of the outlet tubing for the next device in line (mixer, pressure monitor, or drain valve). If the connection leaks when the system is pressurized, tighten the nut slightly until the leak stops.

Refer to Figure 14 for the appropriate outlet connections for your 210/218 pump. The appropriate compression fitting is in the accessories package.

200 mL Head

The 200 mL head uses 1/8 in. (0.318 cm) tubing and fittings on its outlet. The 200 mL pressure module used with this head also uses 1/8 in. (0.318 cm) tubing and fittings. The pressure module comes with two 1/8 in. (0.318 cm) to 1/16 in. (0.159 cm) adapters for use with the 100 mL head. The outlet of the 100 mL head is 1/16 in. (0.159 cm) tubing and fittings.

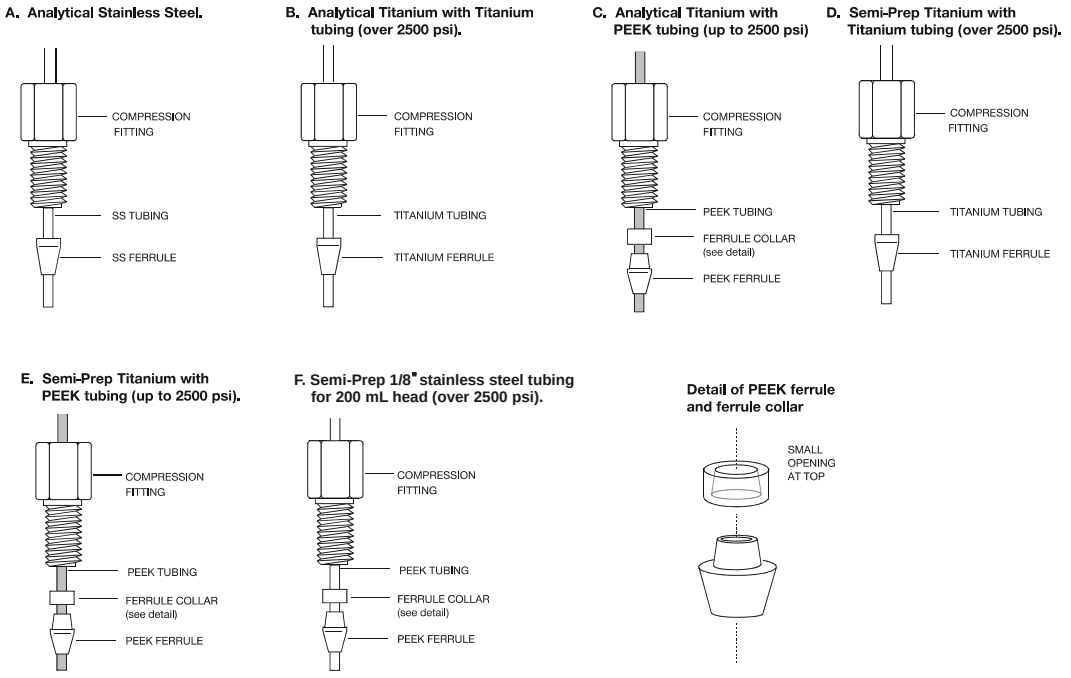


Figure 14 Connections for the Outlet Check Valve

Unit conversions:

2500 psi = 17.2 MPa

1/8 in. = 0.318 cm

Piston-washing tubing

The wash tubing is a single piece. Cut into two pieces of appropriate length for the wash inlet and outlet. Thread male Luer fittings into the inlet (top) and outlet rinse ports and connect the silicone tubing to the Luer fittings. Attach the tubing clamp to the outlet tubing. When pumps are stacked, the tubing from the upper pump rinse outlet can be connected to the rinse inlet of the lower pump, so that pump heads can be rinsed in series. The tubing clamp need only be attached to the outlet rinse tubing on the bottom pump.

Mixer Installation

Dynamax Mixers are dual-chamber high pressure dynamic mixers designed for binary and ternary gradient HPLC and preparative HPLC systems, see Figure 15.

The unique design of the Dynamax Mixer employs a motor driven magnet oriented perpendicular to the mixing chambers. As the magnet turns, it causes two magnetic stir bars inside the chambers to rotate by radial drive rather than by axial drive as in other dynamic mixers. The close proximity of both stir bars to the rotating drive magnet and the fact that the stir bars rotate in opposite directions ensures continuous and thorough mixing. Power is provided by the 9 Vac external transformer.

A unique piston-type closure on the outlet of the mixer allows easy disassembly without tools for cleaning and maintenance. On analytical and Narrowbore mixers the piston incorporates a 2 µm solvent filter to protect system components from contamination.

The mixer is designed to be plumbed into an HPLC system between the pumps and the injection valve. A mounting post and a mast clamp come with the each mixer to allow it to mount to the side of various HPLC pumps or to mount to the mast of an HPLC system.

Titanium and PEEK Dynamax Mixers are available for biochemical applications where 316 stainless steel may be inappropriate because of corrosion or release of metal ions into solution. Titanium or PEEK plumbing components can be used together with PEEK tubing to provide a totally iron-free fluid path.

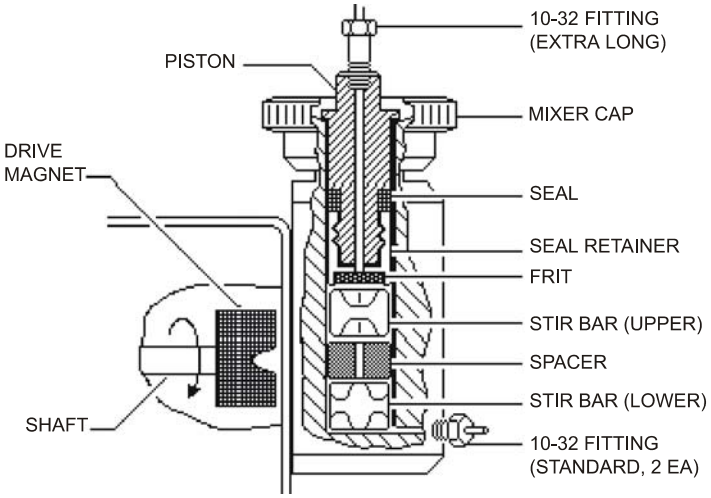


Figure 15 Section View of Dynamax Analytical Mixer Body

Solvents from the pumps enter the mixer via the two inlet ports at the base of the mixer body. They flow into the lower mixing chamber, where they are mixed by the rotation of the lower stir bar. The pressure from the pumps forces the mixed mobile phase upward through the spacer into the upper mixing chamber, where additional mixing is performed by the opposite rotation of the upper stir bar. The fully mixed mobile phase is then forced through a 2 µm frit (in analytical and Narrowbore mixers), through the piston, and out to the rest of the HPLC system.

Since the spacer (the stir bar cage on preparative mixers) assures isolation between the two mixing chambers, the Dynamax mixer acts as a two-stage filter for solvent composition noise. It is more effective in averaging and reducing solvent composition noise than a single-chamber mixer of equivalent volume.

The passive seal used in Dynamax mixers is a hollow molded plastic ring with a circular groove containing an energizing spring. The side of the seal containing the spring faces into the mixer chambers. When the mixer is unpressurized, the small spring inside the seal maintains contact with the mixer bore and the piston with enough force to seal at low pressures, but not excessive force to prevent the seal from sliding as the mixer cap

is hand-tightened. When pressurized, mobile phase entering the mixer body presses the seal against the mixer bore and the piston with increased force. The increased force maintains sealing action at HPLC pressures.

Caution **Overtightening the cap with tools may damage the cap or body.**

The inlet ports on the analytical and narrowbore mixers accept standard 10-32 fittings. The outlet port uses an extra-long 10-32 fitting. On the preparative-scale, both inlet and outlet ports accept 1/4-28 fittings for 1/8 in. (0.318 cm) tubing.

Effective sealing in Dynamax Mixers is a function of the passive sealing mechanism only. The sealing action cannot be improved by tightening the cap with more force than can be applied by hand.

Plumbing Fittings

0.6 mL and 1.2 mL Stainless Steel Mixers

For both the extra-long fitting on the outlet and the two standard fittings for the inlet, slide the fitting and ferrule over the 1/16 in. (0.159 cm) OD tubing and push the end of the tubing into the port as far as possible. Holding the tubing in place, finger-tighten the fitting, then tighten 1/4 turn more with a wrench. When tightening the outlet fitting, hold the top of the piston steady with another wrench.

Figure 16 Compression Fittings
(for 0.6 mL Narrowbore and 1.2 mL Stainless Steel Mixers)

1.2 mL PEEK, 0.6 mL Titanium, 1.2 mL Titanium Mixers

Slide the 1/16 in. (0.159 cm) OD outlet tubing through the one-piece fitting and ferrule and push the end of the tubing into the port as far as possible. Holding the tubing in place, finger-tighten the fitting. Do not use tools to tighten. For both inlet ports, place

a fitting and ferrule on the tubing and tighten in the same manner as the outlet fitting. Do not use tools to tighten.

Figure 17 Compression Fittings
*(*For 0.6 mL Titanium Narrowbore, 1.2 mL PEEK Analytical and 1.2 mL Titanium Analytical Mixers)*

10 mL PEEK and Titanium Mixers

All ports are identical. Slide the fitting and ferrule/ferrule collar over the 1/8 in. (0.318 cm) OD tubing as shown and push the end of the tubing into the port as far as possible. Holding the tubing in place, finger-tighten the fitting. When tightening the outlet port fitting, hold the piston steady with another wrench.

NOTE: When the system plumbing is complete, check for any leaks. If a leak is found, stop the pumps and tighten the affected fitting just enough to stop the leak.

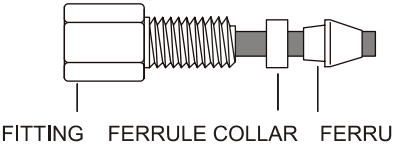


Figure 18 Compression Fittings – 1/8 in. (0.318 cm) Tubing
(For 10 mL PEEK and 10 mL Titanium Preparative Mixers)

Mixer Disassembly

The figures below show an exploded view of the internal components of an analytical or narrowbore mixer body and a view of the preparative mixer. Refer to these figures when you disassemble the mixer body for routine cleaning and maintenance.

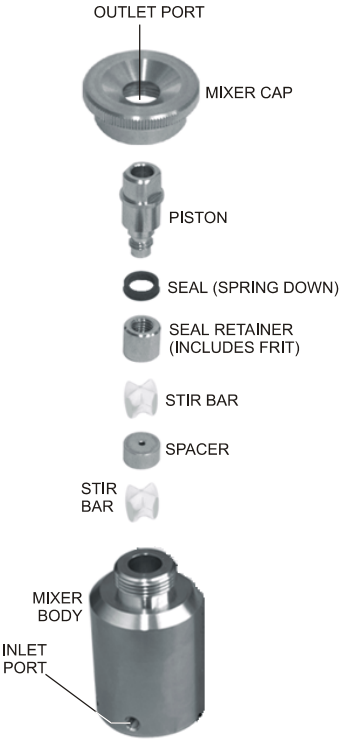


Figure 19 Analytical or Narrowbore Mixer

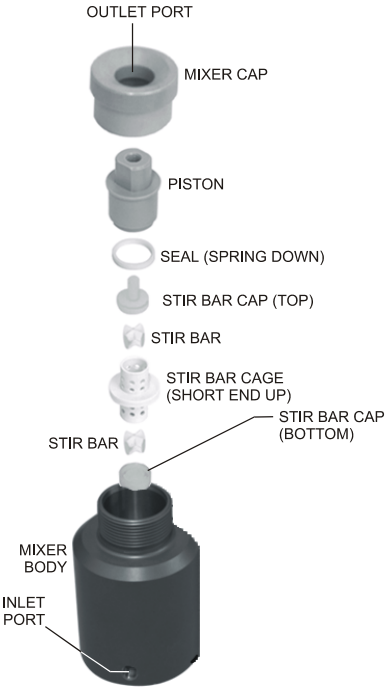


Figure 20 Preparative Mixer

1. Turn off the 210/218 pump.

2. Unscrew the mixer mounting panel from the 210/218 and disconnect the power connection.

3. Unthread the mixer cap by turning it counter-clockwise. The outlet tubing fitting will still be connected.

4. The piston is held in the mixer body bore by the friction of the seal. Pull up on the outlet fitting to extract the piston, the seal, and the seal retainer in analytical and narrowbore models.

5. Disconnect the outlet fitting from the piston using two open-end wrenches: use a wrench across the flats of the piston to hold it in place while you loosen the outlet fitting with another wrench. Finger-tight fittings should be removed without tools. Put the piston assembly and the mixer cap in a clean, safe place.

6. Disconnect the two inlet fittings at the base of the mixer body with the wrench or without tools if finger-tights are used.

7. ***Analytical and Narrowbore Mixers:*** Turn the mixer over to remove the upper stir bar, the spacer, and the lower stir bar. These components should fall freely from the mixer body bore, but you may have to tap the mixer body lightly to loosen them. Unscrew the seal retainer and pull the seal off the piston.

   Preparative Mixers: Turn the mixer over to remove the stir bar cage. The stir bar cage contains two stir bars and is capped at both ends. Disassemble the stir bar cage by pulling off each stir bar cap. Remove both stir bars. Preparative-scale mixers do not use a seal retainer. Simply pull the seal off the piston on these models.

Caution

Be careful not to spill solvent from the mixer body bore during this procedure. Do not use sharp instruments to remove the stir bars, the spacer, or the stir bar cage. The mixer components or the mixer body bore may be damaged.

8. The mixer components are now fully disassembled and can be cleaned or replaced as necessary.

Cleaning the Mixer Components

Unless the mixer components are badly contaminated, they are best cleaned by wiping with a lint-free wipe and using alcohol to remove any small particulate matter. If the mixer is badly contaminated, cleaning all fluid path components by sonication is recommended.

Mixer Reassembly

Analytical and Narrowbore Mixers:

1. Take one stir bar and hold it above the mixer bore so the cross vanes are up and down. Drop the stir bar into place. Drop the spacer into the bore, then the upper stir bar.

2. If you removed the seal, take a replacement seal and place it on the piston so the spring inside the seal is visible. If the seal is put in upside down the seal will leak. Push the seal over the screw threads onto the shoulder. Thread the seal retainer onto the piston and finger-tighten. Do not use tools.

Preparative Mixers:

1. Reassemble the stir bar cage: place one stir bar into one end of the stir bar cage and press-fit the stir bar cap. Both ends of the stir bar cage are symmetrical and the cage fits into the mixer bore in either direction.

2. Slide seal so that the spring cavity is facing downward.

All Mixers:

3. Press the piston with the seal now attached (with seal retainer on analytical-scale models) into the mixer body bore as far as possible.

4. Finger-tighten the mixer cap. Do not over-tighten.

5. Reconnect the mixer power connection to the 210/218 and attach the mixer mounting panel to the 210/218 with two screws.

6. Reconnect the outlet line to the mixer. Tighten the outlet fitting finger-tight, then tighten a further 1/3 turn if using non finger-tight fittings. Tighten using two open-end wrenches as follows: hold the piston steady with a wrench across the flats while you tighten the outlet fitting with another wrench. Do not over-tighten. Reconnect the inlet lines to the base of the mixer body in the same manner.

7. When the plumbing is complete, operate the system to check for any leaks. If leaks are found, stop the pumps and tighten the leaky fittings just enough to stop the leak.

Caution **A leak at the top of the mixer may be caused by a damaged seal. In this case, tightening the outlet fitting further will have no effect on the leak. Over-tightening the outlet fitting may damage the fitting or the piston. If the seal is damaged, replace it.**

Checking and Replacing the Outlet Filter Frit

(Analytical and Narrowbore Mixers Only)

These mixers incorporate a 2 µm frit pressed into the seal retainer to protect the downstream components of the HPLC system from particulate contamination. With normal use, this frit may become clogged, resulting in restricted flow through the mixer and HPLC system. To check for restricted flow you will need a pressure monitor in the HPLC system between the pumps and the mixer:

1. Open the prime-purge valve so the flow is diverted to waste.

2. Run the pumps with methanol (rinsing first with water, if necessary) at a moderate flow rate (1 mL/min) and check the pressure monitor.

If the frit and the fluid lines are in good condition, the pressure reading on the monitor should be minimal. A reading over 100 psi indicates that the frit is probably clogged and needs to be replaced. (A clogged frit cannot be cleaned.)

The frit can be replaced without fully dismantling the mixer or disconnecting the outlet tubing:

1. Follow steps 1, 2, and 3 in the procedure in *Mixer Disassembly*.
2. Loosen and remove the seal retainer (includes frit).
3. Thread the replacement seal retainer and frit onto the piston. Finger-tighten the seal retainer.
4. Press the piston in the mixer body bore. Replace the mixer cap.

Seal Replacement

If leaks are seen at the top of the mixer, and the correct outlet fitting is swaged properly, the seal may need to be replaced.

Caution

Leaks from the top of the mixer cannot be prevented by tightening the mixer cap. Tightening the mixer cap more than finger-tight may deform the cap or the top of the piston. Never use tools to tighten the mixer cap.

The seal can be replaced without fully dismantling the mixer or disconnecting the outlet tubing:

1. Follow steps 1, 2, and 3 in the procedure in *Mixer Disassembly*.

2. ***Analytical and Narrowbore Mixers:*** Loosen and remove the seal retainer and frit. Remove the seal by pulling it away from the piston. Place a replacement seal on the piston so the spring inside the seal is visible. If the seal is put in upside down the seal will leak. Push the seal over the screw threads onto the shoulder. Thread the seal retainer onto the piston and finger-tighten. Do not use tools.

   Preparative Mixers: Remove the seal by pulling it away from the piston. Slide the seal over the piston so the side of the seal with the larger outside diameter is closer to the bottom of the piston.

3. Press the piston, with seal (and seal retainer on analytical and narrowbore models), all the way into the mixer body bore.

4. Replace the mixer cap.

Priming the 210/218

Pump heads are shipped in IPA (isopropyl alcohol) or methanol. For priming, you must use a solvent that is fully miscible with IPA or methanol. IPA, methanol or HPLC-grade water is recommended for priming.

1. Switch on the Pump and press the SETUP key.

2. Press the DOWN ARROW key.

   The top line of your display should now show part of "ID HdSz x L REFILL CIM". If not, go to the next paragraph now. Press the RIGHT ARROW key to get to the HdSz (head size) parameter. Set the HdSz value to the same as the head installed on the 210/218 by scrolling up or down through the preset choices (5, 10, 25, 50, 100, 200) with the UP or DOWN ARROW key.

   * If your display does not show part of "ID HdSz x L REFILL CIM", press the RIGHT ARROW key until you reach PUMPA. Then press the DOWN ARROW. The cursor should be flashing around "MC", the ID number for the master controller pump. Press the UP or DOWN ARROW to change this value to 0, or 1, or an appropriate number corresponding to your system. Then press SETUP again, then the DOWN ARROW key. Then proceed according to the paragraph above.

3. Remove the outlet tubing and fitting from the outlet check valve.

4. Use the syringe supplied to prime the pump head. Attach the Luer fitting to the outlet check valve. Attach the priming syringe to the outlet of the Luer fitting.

5. Press the PRIME key. This will run the pump at the maximum flow rate for that pump head.

6. Pull the solvent through the inlet tubing and the pump head.

7. Once the pump is primed, press the STOP key to stop the pump.

8. Remove the Luer fitting from the outlet check valve and replace it with the outlet tubing.

Adjusting the Flow Rate on the 210/218 Pump

The 210/218 pump is designed to operate accurately and precisely without adjustment. However, the flow rate can be adjusted using the compressibility compensation parameters. This can be especially useful when you performing operational qualification on the pump.

To adjust the flow rate accuracy on the 210/218:

1. Flush the 210/218 system with water. (If you want to adjust the flow rate using a different solvent, flush the system with that solvent.)
2. Enter the starting values the compressibility compensation for water (or whatever solvent you are using to adjust the flow rate). Using the SETUP key and adjust the x value to 46 and the L value to 2995. (For a different solvent, use the values in the Appendix.)
3. Put a restriction into the flow path that provides between 2000 psi (13.8 MPa) and 3000 psi (20.7 MPa) pressure. This can be a column, a long piece of small diameter tubing or a restrictor valve.
4. Set the flow rate to 1 mL/min (for the 5 or 10 mL pump heads) and whatever flow is normally used for larger pump heads and start the pump. Allow the pressure to come to equilibrium.
5. Measure the flow rate accurately using either a calibrated flow meter, a calibrated volumetric flask or by weighing solvent on a calibrated balance.
6. If the measured flow rate is higher than the set flow rate, lower the value of the x parameter. To raise the actual flow rate, increase the value of the x parameter. For water, an increase or decrease of about 20 will lower the flow rate about 0.5% to 1%. For other solvents, the x parameter adjustment value will vary.
7. Continue to adjust the x parameter until the actual flow rate falls within the pump specification of +/- 1% of the set flow rate.

Installing the Door on the ProStar 210

Note: The PrepStar 218 is not equipped with a door.

Once all of the hydraulic lines have been installed and the pump has no leaks, the door can be installed. The door is located in the pump accessory kit. It is not necessary to install the door for proper pump operation.

1. Attach the upper door hinge on the plastic door to the metal pivot on the upper right hand side of the pump.

2. Push the door and the metal door hinge down until the lower hinge can be snapped into place. The door should swing freely and the magnetic door clasp should make contact on the front of the pump.

Figure 21 Installing the Door on the ProStar 210 Pump

Caution

When the door is installed, the solvent lines must run either out the top or the bottom of the door. They must not run through the small holes in the plastic door.

System Description

Physical Layout

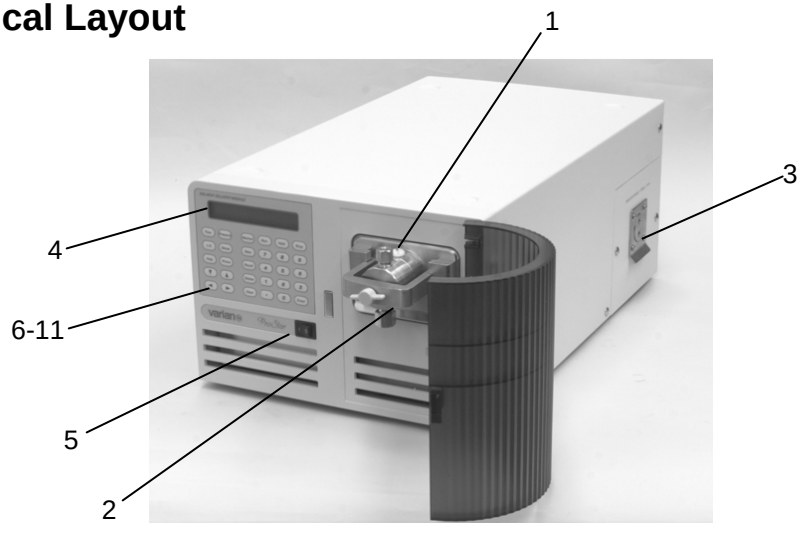


Figure 22 ProStar 210 Solvent Delivery Module

1. Pump Head
2. Pump Head Clamp
3. Pressure module
4. 2-line 24-char Digital Display
5. Power switch
6. Function Keys: FLOW, I/O, PRESSURE, SETUP
7. Control Keys RUN, HOLD, STOP, PRIME
8. Method Keys METHOD, NEW, DELETE, RECALL
9. Numeric Keys
10. Arrow Keys
11. HELP, CLEAR, ENTER

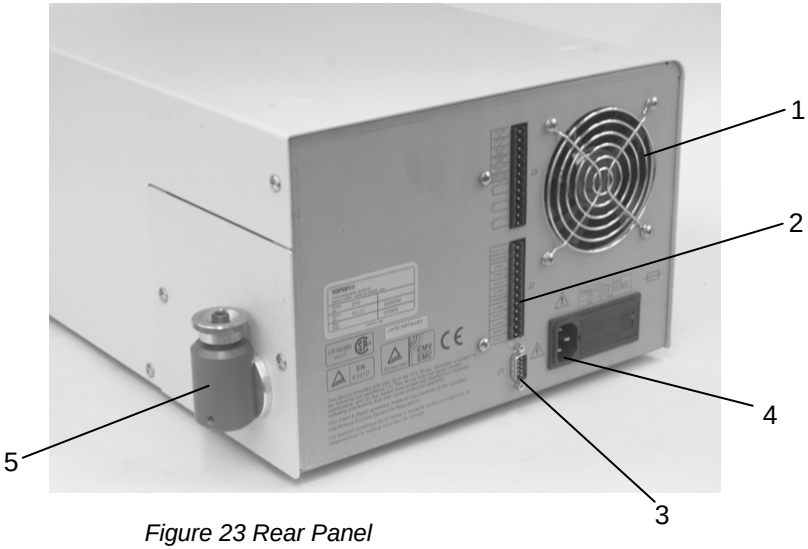


Figure 23 Rear Panel

1. Cooling Fan
2. External Interface connectors
3. RS-422 Connector
4. Power Connector
5. Internal Mixer

NOTE:	It is very important to maintain a 4 in. clear space next to the fan, to avoid objects interfering with air flow into the ProStar 210.

Pressure Module

Each Varian 210/218 pump can have a pressure module installed in the panel on the right side of the pump. Four ratings are available: 8700 psi (60.0 MPa), 6000 psi (41.4 MPa), 4000 psi (27.6 MPa) or 2000 psi (13.8 MPa). Only one pump in the HPLC system (the master pump) needs to have a pressure module installed.

Figure 24 Pressure Module

The pressure module dampens pump pulsations and supplies the current pressure value to the 210/218 pump software. The pump needs this information to implement compressibility compensation and flow rate accuracy corrections, and to ensure that system pressure is within the limits entered during setup.

Choose a pressure module that has a pressure and flow limit greater than the maximum pressure and flow you will be using.

Pump Head

Varian 210/218 pump heads are easily changed, self-contained units including spring-loaded pistons and check valve cartridges. Simply loosen a finger-tight clamp to rapidly change pump heads between analytical and preparative configurations. The clamp on the PrepStar 218 pump with 200mL head requires a ¼ in. hex wrench that is included with the 200 mL pump head kit.

Figure 25 Pump Head Installed on the ProStar 210

For HPLC Applications

Choose from standard pump heads providing flow rates up to 5, 10, 25, 50, 100, or 200 mL/min. Ideally, for single pump operation, the flow rate should be between 5% and 90% of the maximum pump head flow rate. For example, a 10 mL pump head should be used for applications requiring between 0.5 mL/min and 9 mL/min. A 100 mL pump head should be used for applications requiring between 5 mL/min and 90 mL/min. (Note the pump head can be used at its fully specified range but a 10 mL pump head will operate at 1 mL/min better than a 100 mL pump head.)

Choosing the best pump heads for gradient applications is slightly different. If possible, choose the pump head so that the system operates at or above 10% of the maximum pump head flow rate. Also try to use the smallest pump head possible for gradient operation.

For Protein Purification Applications

Biocompatible pump heads constructed entirely of titanium or chemically inert plastics are available. These heads incorporate a second chamber located behind the high-pressure seal. This chamber, filled with water, literally “washes” the piston with each stroke. This prevents scale build-up on the piston that can lead to premature seal failure.

System Overview

A complete HPLC system can be controlled either by a 210/218 pump or PC based software. When the computer controls pumps, all pumps are slaves and programming is done on the computer.

System Configurations

System Controller

A system controller can be either:

- a 210/218 pump, or
- a PC for system control.

On the rear panel there is a single RS-422 male connector. This connector is used for bi-directional signals to and from the controller, whether the controller is an external computer or another 210/218. Internal software in the 210/218 determines whether the pump is a master controller or a slave pump. This topic will be covered in detail later in this manual.

Slave Pumps

Slave pumps can be 210/218 or SD-200/300 pumps. For 210/218 pumps used as slaves, connect the serial cable to the RS-422 male connector.

The possible system configurations (depending on the type of pumps and controller being used) are described below.

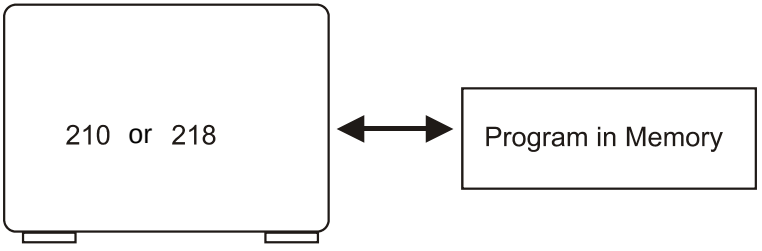


Figure 26 Isocratic System

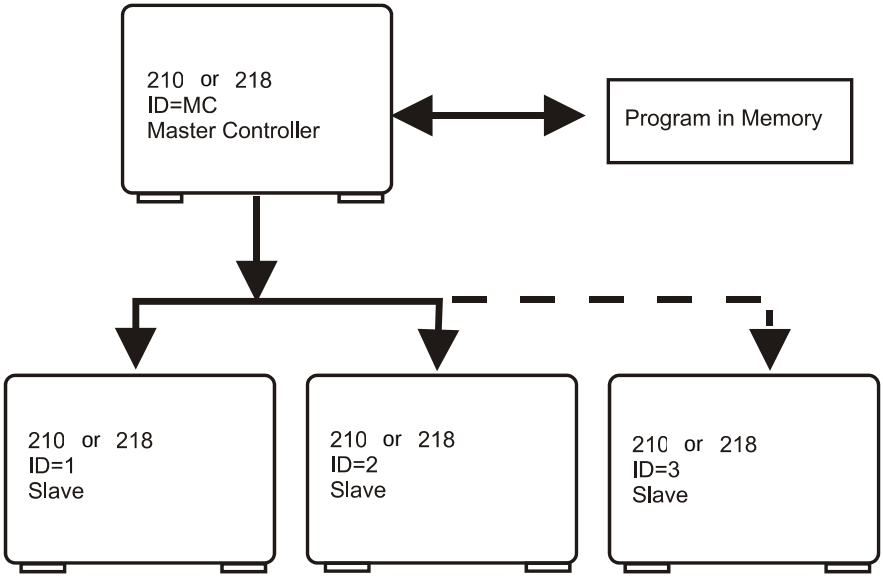


Figure 27 Gradient System with One ProStar 210 or 218 as the Controller

When several pumps are connected together, the master 210/218 pump can control the other pumps in the liquid delivery system. A master 210/218 pump can control up to three other slave units: either three additional pumps in a quaternary system, or two additional elution pumps and one injection pump. The master 210/218 pump can control other modules in the system using outputs, and receive information through input contacts.

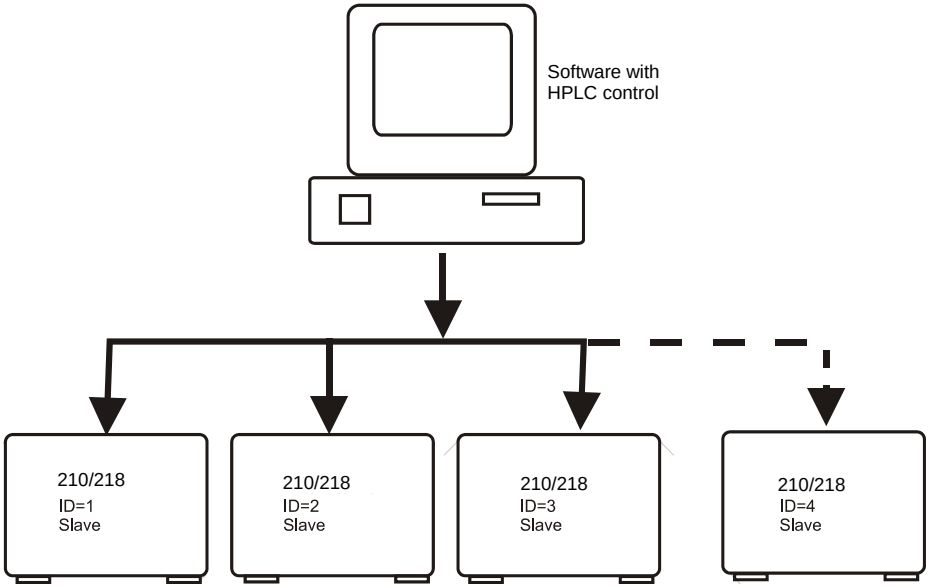


Figure 28 Gradient System with Star Workstation or Galaxie™ Software as a controller

In this configuration all pumps are slaves and the computer is the system controller. The Star workstation controls the pumps via the serial interface cable and other devices through contact closures on the Control/Interface module built into the 210/218.

Power On

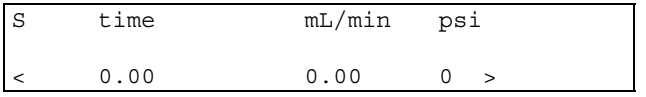
When you switch on the power, the 210/218 will perform a self-check and display the screens below in the order shown.

```
Solvent Delivery System

Version x.x
```

```
Version x.x
Self Test RAM…
```

```
Self Test Ram OK

Pressure Module 8700 psi
```

(Appropriate pressure rating will be shown)



About the Displays

The left and right arrows at the sides of the display (see last display above) indicate that more information is off screen and can be accessed by pressing either the left arrow key or the right arrow key. You can scroll left or right through the off-screen information by repeatedly pressing the key.

About the Cursors

In the 210/218 displays, parameters which can be edited are indicated by one of four types of cursor. All types of cursors flash both sides of the parameter to be edited.

Each type of cursor has a specific function as described below:

CURSOR	NAME	Function
	NUMERIC ENTRY CURSOR	Used for numeric entry only. Values entered or edited while the cursor is flashing are temporary until accepted by pressing the ENTER key, the RIGHT ARROW key, the LEFT ARROW key, or the RUN key. If the edited value is not accepted by pressing one of the above keys, or canceled by pressing the CLEAR key, the parameter reverts to its previous value after 60 seconds.
	SCROLL CURSOR	Used when there is a preset list of choices. Pressing the UP ARROW or the DOWN ARROW with this type of cursor is displayed scrolls up or down through the preset choices.
	DUAL-MODE CURSOR	Used when there is a preset list and numeric entry. Used when the value can be set either by numeric entry or by scrolling through a preset list of choices, as described above.
	MENU CURSOR	Used when the selection is a menu. Pressing the DOWN ARROW or the ENTER key with this type of cursor displays the next level of the menu.

The following are not cursors, but are described here for clarification		
*	ASTERISK	This is used to show cursor position (for accessing HELP) when the parameter in question is a status indicator and cannot be edited.
	LEFT-RIGHT ARROWS	These indicators are used at the right or left edge of the display to indicate that more information can be seen by pressing either the RIGHT or LEFT ARROW key.

Keypad

The keypad is functionally divided into three groups: Display Selection Keys, Action Keys, and Edit Keys.

Display Selection Keys

Key	*Function*
FLOW	This key opens the FLOW window where you can set flow rate and ramp time. The window also shows system pressure. The left and right arrows at the sides indicate that you can access more information with the left-right arrow keys: Method status and name to the left. Current values for composition for %B, %C, %D to the right. Also I/O parameters. You can reach more information to the right in two ways: 1. Press the right arrow to scroll rightward through the entire line. 2. Press the I/O button below. (The entire line of information is divided between the FLOW and I/O buttons for convenience. “time” is always displayed.)
NOTE:	Pressing the FLOW key when in another display returns the display to the part of the Flow field which was last viewed. Pressing the FLOW key a second time returns to the default position, with the cursor on the flow rate value.
I/O	This key opens the second part of the display. Note that you can scroll leftward into the Flow section if you wish. The I/O section contains the following items, from left to right: Analog — Analog Input. This is the current voltage read on the Analog input channel for this pump only. Range from -0.5 V to +2.5 V. ishtm — Input Contact Status. Contacts are: Inject, Stop, Hold, Transfer, and Mark. “1” indicates a closed contact, “0” indicates an open contact. Meth — Method status and name (repeat information from Flow display above).

Key	*Function*	
	nm	This control is used to set wavelength on a suitable detector when the analog out signal has been set to the “nm” option in Setup or there is a detector online. Range is 1.90 volts (190 nm) to 7.00 volts (700 nm).
	w	Inject Wait. When a method is running, this is used to set an inject wait. The method will hold at current conditions until the wait is cancelled, when the method will continue. The wait can be cancelled manually by pressing the RUN key or by contact closure on the Inject input.
	A	Alarm. Can be set to “1” (on), “0” (off), or “P” (Pulse on then off). If Pulsed, the alarm will sound three times then off. If set to Pulse at the same time as an inject wait, the alarm sounds four times, then off. Otherwise the alarm sounds continuously until turned off.
	1–12	Output contacts. Can be set to “0” (off), “P” (Pulse on then off), “1” (on), or “P” (Pulse off then on). Pulses last for 0.5 seconds. Contacts 1 – 3 are for Pump A or the Master Pump in a multi-pump configuration. The Master Pump can control the outputs as follows: Contacts 1, 2, 3 are for Pump A or the Master Pump. Contacts 4, 5, 6 are for Pump B. Contacts 7, 8, 9 are for Pump C. Contacts 10, 11, 12 are for Pump D. One or two contacts can be dedicated for High and Low Pressure signals, defined in the pressure window below. Pressure States are H for High, L for Low, or b for both, if the same contact is used for high and low limits. Dedicated contacts are not available for programming.

NOTE: Pressing the I/O key when in another display returns the display to the part of the I/O field which was last viewed. Pressing the I/O key a second time returns to the default position, with the cursor on “nm”.

Key	*Function*	
PRESSURE	Opens the PRESSURE window containing several pressure-related items.	
	ZERO	The pressure can be zeroed using the up/down arrow key. Executing a Zero command displays a prompt. When system pressure is more than 50 psi, a second prompt with current pressure is displayed.
	psi/bar/ MPa	Current system pressure is shown in the selected units (see below).
	MAX P	Maximum system pressure limit, in the units selected below.
	MIN P	Minimum system pressure limit, in the units selected below.
	UNITS	Select between psi, bar, and MPa (mega Pascals).
	OUTPUT CONTACTS	Set the output contacts to be used for MAX P and MIN P signals. Note: the same contact can be set for both high limit and low limit.
SETUP	Opens the Set Up and Service Log menus. The Service Log is used to log piston seal changes, check valve changes/service intervals, and show the pump drive status. See *Maintenance/Troubleshooting*, for details of this function.	
	Set Up The Set Up menu appears in one of two forms, depending on whether the 210/218 is a master controller or a slave pump. In both cases, Set Up is used to set up various parameters listed below:	
	(As Slave Pump)	
	ID	Pump ID. Set the ID for the 210/218 either by entering a number between 0 and 63, or pressing the UP ARROW or DOWN ARROW key to scroll through a preset list of choices. Available choices are: 0 – 63, MC (master controller) or – – (no ID).
	HdSz	Pump head size. Use the UP ARROW or DOWN ARROW to select between a preset list of choices. Choices are: 5, 10, 25, 50, 100, and 200 (mL/min), 10P, 25P, 50P, 100P. The “P” designation stands for PEEK. The compressibility compensation for PEEK heads is different than for stainless steel or titanium heads.

Key	*Function*	
	x	Compressibility Factor. This is used to calculate the flow rate compensation necessary to correct for the solvent's compressibility. Values can be set between 0 and 2000 $Mbar^{-1}$. Default of 46 is the setting for water. The parameter can be adjusted to set the measured flow rate at exactly the set flow rate. See the installation section for details on how to do this. Other solvents will have other x parameters. See the *Appendix* for a list of values for other solvents.
	L	High Pressure Constant. Range is from 1 to 9999 bar. Default is 2996 bar, the value for water. Consult the available literature for high pressure constants for other solvents. A partial list is given in the *Appendi*x.
	REFILL	Refill time in milliseconds. Refill time is the time required for the piston return stroke. Range is from 100 ms to 1000 ms.
	CIM	Control-Interface Module ID. Set the ID for the CIM installed in the pump either by entering a number between 0 and 63, or pressing the UP ARROW or DOWN ARROW key to scroll through a preset list of choices. Can be set between 0 and 63, or to – – (no ID).
SET UP	(As Master Controller)	
	AOut	Analog Out. 0–10V output signal with 8 options. Output can be sent to a detector (to control wavelength) or to a recording device. Options are: Flow, nm (wavelength), Pres(sure), %A, %B, %C, %D, or off
	PUMPS	Select between A, B, C, and D. Selecting a pump opens a window to set Pump ID, Head size, compressibility factors, and refill speed.
	Detr	Sets the ID number for any detector connected to the serial cable.
	Bus Status	Shows the status of serial devices. The display shows ID numbers of devices and active devices at any of the IDs. Identifiers are "B, C, D, or P" for Pump, "M" for Detector, "I" for CIM, and "E" for Error.

Key	*Function*	
	BUS IDs	Identifies devices defined on the serial bus with their model number, ID number, and status (online or offline) device IDs of some remote devices may be changed in this window.
METHOD	Displays method information. Pressing the METHOD key opens a window where you can see the status of the running method and scroll through a list of existing methods. Method Status codes are:	
	V	View. Indicates that the method in the display is not running.
	I	Initialization. The displayed method is ramping to time 0 (inject time).
	R	Running. The displayed method is running (beyond time 0).
	S	Stop. The displayed method is stopped, and flow rate = 0, by the STOP key or external input, or by the method finishing with 0 mL/min flowrate.
	H	Hold. The displayed method is holding. Either the HOLD key was pressed, an Inject Wait programmed, or an external input was received.
	F	Finished. The method has run and finished normally with flow rate $\neq 0$.
	For non-manual methods the 210/218 displays a list of method parameters, which can be accessed by scrolling with the RIGHT- and LEFT ARROW keys:	
	Meth	This shows the Method name and status (see above).
	PASS	Indicates the current method pass (if there are more than one).
	#TIMES	Indicates the total number of times (up to 99) that the method will be executed before it finishes.
	Access	User can scroll between LOCK and UNLOCK. Locked methods cannot be edited. They are saved intact and when running Locked methods ignore the HOLD key.

Key	*Function*	
	Transfer	Lets you set a method to be transferred to in one of three ways: • immediately on receipt of a Transfer contact closure input • at the end of the current method pass on receipt of a Transfer input • automatically on completion of all the method passes
	Safety	Allows you to assign a safety method for any of the following conditions: • Stop input • High Pressure Limit • Low Pressure Limit • Pump Off-line
RECALL	Pressing this key returns to the current status timeline of the running method. The fields displayed in this view are the same as were displayed the last time the FLOW or I/O key was pressed in the running method. When on the current time line RECALL returns to the last display viewed.	
HELP	Pressing this button opens a Help display for the parameter which is cursored. In most cases, the help information is longer than will fit a two-line display, so you can scroll through the help message by pressing the HELP key, the RIGHT ARROW key, or the DOWN ARROW key. Scroll back through the Help message by pressing the UP ARROW or the LEFT ARROW key. Press the CLEAR key or the HELP key at the end of the message to exit Help.	
L-R Arrows	These keys are used to move right and left in the display to access adjacent menus and to set values.	
U-D Arrows	These keys are used to scroll up or down through preset values or toggle between choices. They are also used to select time lines in a method. The Down Arrow key is also used to open menus.	
ENTER	The Enter key is also used to open menus. It also is used to accept a value.	

Action Keys

Key	Function
RUN	Pressing Run starts the method timer and begins a linear ramp from current conditions to the target conditions at the next time line in the method. If used to clear a Hold, (see below) RUN continues the run from the HOLD point.
HOLD	Pressing this key stops the method timer but does not change current flow or composition conditions. Holds the ramp at its current position. This key is canceled by pressing RUN again or STOP.
PRIME	Pressing this key runs the pump at the maximum flow rate for the installed pump head. Pressing STOP, stops the pump when it is priming. All other keys are locked out from operation while the pump is priming.
STOP	Pressing this key stops flow immediately and aborts the Run method.

Edit Keys

Key	Function
RUN	Pressing Run starts the method timer and begins a linear ramp from current conditions to the target conditions at the next time line in the method. If used to clear a Hold, (see below) RUN continues the run from the HOLD point.
0 – 9, and .	Numeric keys, used to enter numeric values into parameters: method number, flow rate, minimum and maximum pressure limits, pump ID, CIM ID, etc.
CLEAR	Used to cancel a user-entered value or choice, leaving the previously entered setting intact. Also used when zeroing pressure, answers "No" to prompts and clears messages.
U-D Arrows	Used to scroll through a list of options and select an item from the list.
ENTER	Accepts a temporary value into a parameter. Answers "Yes" to prompts.

Operation

Introduction

The 210/218 can be used in several different modes of operation, including operation as a master pump in an automated HPLC system. This section describes method editing in this mode.

Creating the following simple method requires one 210/218 pump ramped to 5 mL/min in 2 minutes to time 0.00. At time 0.00, wait for inject and Alarm; make the injection, and maintain flow rate at 5 mL/min for 5 minutes. After 5 minutes, the flow rate will ramp to 0 mL/min during the course of 5 minutes.

1. Press the METHOD key.

2. Press the NEW key (a new method number will be selected and displayed automatically). The method number displayed will be the next available number from 0 to 99.

3. Press the FLOW key.

   The starting time is shown in minutes (default is -2.00). If this is not displayed, press 2, ENTER. This is the time for the linear ramp to initial conditions.

4. Press the DOWN ARROW key to get to time 0.00.

5. Press the RIGHT ARROW key to move to the FLOW field. Press 5 (flow rate of 5 mL/min.)

6. Press the I/O key then the RIGHT ARROW key to get to the "w" field. Press the UP ARROW key with the cursor on the “w” field. The value changes to “1” (ON).

7. Press the RIGHT ARROW key to get to the "A" field. Press the DOWN ARROW key. The value changes to “P” (Pulse on then off).

8. Press the FLOW key then the LEFT ARROW key to get to the Time field.

9. Press the NEW key.

10. Press 5 to set a time of 5 minutes.

11. Press the RIGHT ARROW to get to the FLOW field and press 5.

12. Press the NEW key and then press 1, 0, then ENTER.

13. Press the RIGHT ARROW key and then 0, ENTER.

Check and Run the Method

Press the LEFT ARROW key until you are at the Time field then press the UP ARROW key a number of times to read through the method time lines. Press the DOWN ARROW key to scroll down through the time lines.

Press the RUN key to begin this method. You will see the time field counting down and the flow rate counting up, to reach 5 mL/min at time zero. Then you will hear the alarm at time 0, indicating there is an inject wait. In the laboratory, the inject wait would be canceled by a contact closure. In this case, cancel it as follows: Press the RUN key to clear the HOLD. This will act as an injection signal in this demonstration method.

The method will continue to run its course, ramping from 0 to 5 mL/min over 2 minutes, then maintaining 5 mL/min until 5 minutes, finally ramping down to zero flow rate at 10 minutes.

On the next page is a diagrammatic representation of a different method, showing the information you will see on the display and the information off screen.

METHOD EDITING: DIAGRAMMATIC FORM

Press METHOD key.

Press NEW key. Set general method parameters.

Set Transfer and Safety Method information as required.

Press FLOW key. Set time for ramp to initial conditions.

Press Down Arrow for time 0.00. Set initial conditions, (Flow = 5 mL/min). Set contact closures.

Press NEW key, then number key(s), for new timeline and new conditions. (Ramp to 50%B).

Repeat for new timeline. (10 min. Hold at 50%B).

Repeat for new timeline. (15 min. Ramp to 75%B).

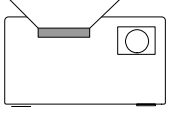
Repeat for new timeline. (20 min. Hold at 75%B).

Repeat for new timeline. (25 min. Ramp to 100%B).

Repeat for new timeline. (30 min. Hold at 100%B).

Repeat for new timeline. (45 min. Ramp to 0 mL/min. 0 %B).

```
Meth
V MM

NEW Meth    COPY OF Meth   PASS    #TIMES   ACCESS    TRANSFER   SAFETY   MODE
    0           - -          0        1     UNLOCK      METH      METH    NORMAL
                                            LOCK                         DEMO
                                            LEARN

                                                  Meth TRANSFER MODE          Meth  STOP  HIGH P   LOW P   OFF-LINE
                                                  V  0     --     IMMED        V  0  --     --       --       --
V  starting time                                                  DEFER
   -2.00

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
    0.00     5.00     0      0          0.0000  00000  V  0      1  P  P  1

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
    5.00              0     50         0.0000  00000  V  0                                  P

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   10.00              0     50         0.0000  00000  V  0                     0

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   15.00              0     75         0.0000  00000  V  0

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   20.00              0     75         0.0000  00000  V  0

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   25.00              0    100         0.0000  00000  V  0

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   30.00     5.00     0    100         0.0000  00000  V  0

V   min     mL/min   psi    %B  %C  %D  Analog  ishtm  Meth  nm  w  A  1  2  3  4  5  6  7  8  9  10  11  12
   45.00     0.00     0      0          0.0000  00000  V  0
```



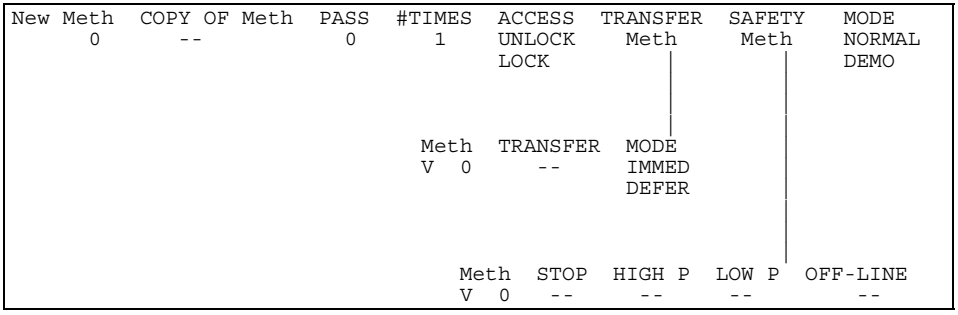
Method Menu

You have already seen an overview of simple method editing. These paragraphs will describe method entries in more detail. The Main Method display, shown below, is accessed by pressing the METHOD key then the NEW key.

You will not see all this information at once, but can access the off-screen portion of the display with the RIGHT ARROW key. The DOWN ARROW is used to select menu choices, such as ACCESS: its choices are UNLOCK AND LOCK.

The TRANSFER and SAFETY method sub-menus are also shown. These sub-menus are used to specify which method is to be used when there is a Transfer or Stop signal received by the SD-200 and are also opened by pressing the DOWN ARROW key.

NOTE: The “New” status and “COPY OF Meth” appear only when you press the New key. Once a method is created, these items do not appear in the display.



Steps in Creating a Method

After powering up, press the METHOD Key. This opens the default method display:

```
Meth
S MM
```

This display shows that the 210/218 is in Manual Method status, the default state which allows you to operate the pump manually by entering flow values and pressing the Run key. Cursors around MM are used to select between EXISTING methods. The first time you open this display these cursors will be inoperable, as there are no methods programmed yet.

To create a method, press the New key. The following display will open:

New Meth	COPY OF Meth	PASS	#TIMES	ACCESS	TRANSFER	SAFETY	MODE
0	—	0	1	UNLOCK	Meth	Meth	NORMAL

New Meth

The cursors around the method number (0 in this case) will be flashing. This means that you can select a method number for your new method. Either press the desired number key(s) or press the UP or DOWN ARROW key to scroll through the available (unused) method numbers or simply access the default number. The first time you do this, all methods from 0–99 will be selectable. However, if you have methods already created, you will not be able to select or enter allocated method numbers.

If you enter a number with the keys that is already used, you will get the message :

```
INVALID
METH:xx  EXISTS
```

You can create up to 99 methods. This may seem like overkill, but is useful when there are multiple users in a lab: each analyst can allocate a decade of numbers for his/her own use. For example, Analyst A could use methods from 20–29, and Analyst B from 40–49. Specialized methods, such as Transfer methods or Safety methods, could be allocated from 90–99.

COPY of Meth

A feature of the 210/218 software allows you to duplicate an existing method. This is useful if you want to create a new method with the same or similar conditions as an existing method. Perhaps you wish to change only a single parameter or condition. To duplicate an existing method, press the RIGHT ARROW key to reach the COPY OF Meth field, then use the UP or DOWN ARROW to scroll through a list of existing method numbers. Or if you already know the method you wish to duplicate, enter the number with the number keys.

PASS:

This is not editable, but is a display of the current pass (if more than one) of the method. See #TIMES, next.

#TIMES

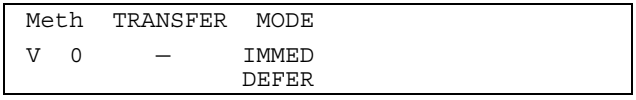
Enter the number of times you wish the method to execute before stopping. When the method is running, the PASS field will increment for each time the method executes.

ACCESS

This field lets you set the access level, or status of the method. Choose between UNLOCK and LOCK. Unlocked methods can be edited and changed, even while running. Locked methods cannot be edited and the steps are protected from change. The Hold key will be ignored when a Locked method is running.

TRANSFER Meth

Pressing the DOWN ARROW opens the following sub-menu, where you set the method to be transferred to in the event of a TRANSFER signal to the 210/218, or automatically at the end of the method if no transfer signal is received. If you do not wish the method to transfer, leave this entry blank.



Use the UP or DOWN ARROW key to scroll between existing method numbers, or enter the method number with the number keys. Under the MODE field, use the UP or DOWN ARROW key to select between IMMED(iate) or DEFER(ed).

If you choose IMMED, the transfer function will occur immediately on receipt of the transfer contact closure. If you choose DEFER, the transfer will take place at the end of the current method pass IF a transfer contact closure is received. If there is no transfer contact closure received, the method will transfer automatically at the end of all method passes.

Press the Method key to leave this sub-menu and return to the Method Menu.

SAFETY Meth

Pressing the DOWN ARROW when the cursor is on SAFETY METH opens the following sub-menu, where you set the method to be transferred to in the event of an emergency condition or contact closure to the 210/218. Select between the available methods for each field with the UP or DOWN ARROW key, or enter the method number with the number keys. If you do not wish the method to transfer, leave this entry blank.

```
Meth    STOP  HIGH P  LOW P   OFF-LINE
V  0     —      —      —       —
```

STOP — Used to set the method to be used in the event of a STOP signal to the 210/218. The current method will stop and transfer to the selected method. If there is no STOP method selected the pump will abort the running method and stop.

HIGH P — Used to set the method to be used in the event of a High Pressure condition (High Pressure Limit, or Max Pressure, is set in the Pressure menu). The current method will stop and transfer to the selected method. If there is no HIGH P method selected the pump will transfer to the Stop Safety method, if one is specified, otherwise it will simply stop when the High Pressure Limit is reached.

LOW P — Used to set the method to be used in the event of a Low Pressure condition (Low Pressure Limit, or Min Pressure, is set in the Pressure menu). The current method will stop and transfer to the selected method. If there is no LOW P method selected the pump will transfer to the Stop Safety

method, if one is specified, otherwise it will simply stop when the Low Pressure Limit is reached.

OFF-LINE — Used to set the method to be used in the event that one of the other pumps in the system goes OFF-LINE. The current method will stop and transfer to the selected method. If there is no method selected the 210/218 will transfer to the Stop Safety method, if one is specified, otherwise it will simply stop if another pump goes OFF-LINE.

Press the Method key to leave this sub-menu and return to the Method Menu.

MODE

This field lets you select between NORMAL or DEMO. Most of the time this will be set to NORMAL, so that the master 210/218 pump will operate normally and respond to pressure, flow and compositional information from the other pumps in the HPLC system.

However, setting DEMO is useful for method development. This mode allows you to create and run methods which control other pumps, without those pumps being physically present.

Also, a single-pump demo method can be run without the pump operating; the display will indicate the changing conditions—current time, flow rate, etc.— but the drive mechanism will not engage.

SAMPLE METHODS

The following pages contain sample methods. Some blank method sheets are also provided.

Method No.: 1	**Method Name:** Proteins on C8			**Operator:** Morris		**Date:** 11-23-98	
Copy of Meth: —	**No. of Pumps:** 3		**No. of Passes:** 99		**Access:** (**LOCK**) / **UNLOCK**		
Transfer Meth: —	**Safety Meth:** **STOP**	90	**HIGH P**	—	**LOW P**	—	**OFFLINE** —

Start Time -12:.00	**FLOW/COMPOSITION**				**INPUT/OUTPUT**														
min	**mL/min**	**%B**	**%C**	**%D**	**nm**	**w**	**A**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
-10:00	1.0	20.0	1.0		280														
-0:00						I	I												
0:00		20.0					O	P											
35:00		55.0																	

Pump	**Model**	**Solvent**	**ID**	**Hd Size**	**x**	**L**	**Refill**	**Max P:**	2000
A	210	Water	MC	10	46	3231	125		
B	210	Acetonitrile	1	10	97.4	1212	125	**Min P:**	100
C	210	Acetic Acid	2	5	128	1000	125		
D								**Units:**	psi

Comments: C8 4.6 mm ID x 7.5 cm L. Ribonuclease/Protein Mixture. Contact 1 used to start data acquisition on integrator. Injector valve contact wired to “inject” (“I”) to release method hold on injection at time 0.00.

Method No.: 2	Method Name: Aromatic Hydrocarbons	Operator: French	Date: 11-24-98
Copy of Meth: —	No. of Pumps: 2	No. of Passes: 99	Access: LOCK / UNLOCK
Transfer Meth: 40	Safety Meth: STOP 90	HIGH P —	LOW P — OFFLINE —

Start Time -2:.00	FLOW/COMPOSITION				INPUT/OUTPUT														
min	mL/min	%B	%C	%D	nm	w	A	1	2	3	4	5	6	7	8	9	10	11	12
-1:00	3.00	75.0			254														
-0:00						I	I	P											
0:00							O		I										
1:00		75.0																	
1:40		100.0																	
4:00		100.0							O										

Pump	Model	Solvent	ID	Hd Size	x	L	Refill
A	210	Water	MC	10	46	3231	125
B	HPXL	Acetonitrile	1	10	97.4	1212	125
C							
D							

Max P: 2000

Min P: 50

Units: psi

Comments: C18, 3 um, 4.6 mm ID x 10 cm L. Contact 1 – start autosampler. Contact 2 – run chart recorder from 0-4 minutes.

Method No.: 3	**Method Name:** AAAnalysis	**Operator:** Ward	**Date:** 11-25-98
Copy of Meth: —	**No. of Pumps:** 2	**No. of Passes:** 99	**Access:** (**LOCK**) / **UNLOCK**
Transfer Meth: 40	**Safety Meth:** **STOP** 90	**HIGH P** — **LOW P** —	**OFFLINE** —

Start Time -15:.00	**FLOW/COMPOSITION**				**INPUT/OUTPUT**														
min	**mL/min**	**%B**	**%C**	**%D**	**nm**	**w**	**A**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
-10:00	1.00	0.0			340														
-0:00		0.0				I	P												
45:00		80.0																	

Pump	**Model**	**Solvent**	**ID**	**Hd Size**	**x**	**L**	**Refill**
A	210	95% 0.1M Na Acetate pH 7.2 4.5% MeOH 0.5% THF	MC	10			125
B	210	MeOH	1	10			125
C							
D							

Max P: 3000

Min P: 50

Units: psi

Comments: Microsorb AAAnalysis, Type O w/guard

Method No.: 40	Method Name: Standby	Operator: Burce	Date: 11-23-98
Copy of Meth: —	No. of Pumps: 2	No. of Passes: 1	Access: LOCK / UNLOCK
Transfer Meth: —	Safety Meth: STOP —	HIGH P —	LOW P —	OFFLINE —

Start Time -2:.00	FLOW/COMPOSITION				INPUT/OUTPUT														
min	mL/min	%B	%C	%D	nm	w	A	1	2	3	4	5	6	7	8	9	10	11	12
0:00	0.10	0					I												

Pump	Model	Solvent	ID	Hd Size	x	L	Refill	Max P:	
A									
B								Min P:	
C									
D								Units:	

Comments: Ramp flow to 0.1 mL/min. Sound alarm indefinitely when autosampler runs out of vials on AAAnalysis routine.

Method No.: 90	**Method Name:** Stop	**Operator:** Lewis	**Date:** 11-24-98
Copy of Meth: —	**No. of Pumps:** 3	**No. of Passes:** 1	**Access:** (**LOCK**) / **UNLOCK**
Transfer Meth: —	**Safety Meth:** **STOP** 90	**HIGH P** —	**LOW P** — **OFFLINE** —

Start Time -0:.00	**FLOW/COMPOSITION**				**INPUT/OUTPUT**														
min	**mL/min**	**%B**	**%C**	**%D**	**nm**	**w**	**A**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
-0:00	0.0						I			I									

Pump	**Model**	**Solvent**	**ID**	**Hd Size**	**x**	**L**	**Refill**
A							
B							
C							
D							

Max P:

Min P:

Units:

Comments: Immediate ramp to 0 mL/min. Alarm sounds continuously. Contact 3 used to shut-down autosampler.

Method No.:	Method Name:	Operator:	Date:
Copy of Meth:	No. of Pumps:	No. of Passes:	Access: LOCK / UNLOCK
Transfer Meth:	Safety Meth: STOP	HIGH P	LOW P	OFFLINE

Start Time	FLOW/COMPOSITION				INPUT/OUTPUT														
min	mL/min	%B	%C	%D	nm	w	A	1	2	3	4	5	6	7	8	9	10	11	12

Pump	Model	Solvent	ID	Hd Size	x	L	Refill
A							
B							
C							
D							

Max P:

Min P:

Units:

Comments:

Method No.:	Method Name:	Operator:	Date:
Copy of Meth:	No. of Pumps:	No. of Passes:	Access: LOCK / UNLOCK
Transfer Meth:	Safety Meth: STOP	HIGH P	LOW P	OFFLINE

Start Time	FLOW/COMPOSITION				INPUT/OUTPUT														
min	mL/min	%B	%C	%D	nm	w	A	1	2	3	4	5	6	7	8	9	10	11	12

Pump	Model	Solvent	ID	Hd Size	x	L	Refill
A							
B							
C							
D							

Max P:

Min P:

Units:

Comments:

Method No.:	Method Name:	Operator:	Date:
Copy of Meth:	No. of Pumps:	No. of Passes:	Access: LOCK / UNLOCK
Transfer Meth:	Safety Meth: STOP	HIGH P	LOW P / OFFLINE

Start Time	FLOW/COMPOSITION				INPUT/OUTPUT														
min	mL/min	%B	%C	%D	nm	w	A	1	2	3	4	5	6	7	8	9	10	11	12

Pump	Model	Solvent	ID	Hd Size	x	L	Refill	Max P:	
A									
B								Min P:	
C									
D								Units:	

Comments:

Maintenance and Troubleshooting

Maintenance

The 210/218 pumps have been carefully designed with continuous, unattended operation in mind. Rugged construction and sophisticated electronics mean a minimum of routine maintenance and years of trouble-free service if treated carefully and if replacement parts are changed when they show signs of wear. This section of the manual describes a maintenance schedule, service logs, changing the piston seals, and changing the check valve cartridges.

You should take advantage of the 210/218 Service Logs. Software in the pump automatically tracks seal wear, check valve use, and pump drive wear. The software also allows the user to enter and record seal and check valve changes. Make it a point to check the Service Log area frequently and make sure to record seal changes and check valve replacements into the software.

Maintenance Schedule

User maintenance on the 210/218 is generally limited to the pump head, as follows:

1. Cleaning the check valves and filter.

2. Replacing components subject to wear and tear: piston seals, check valves, piston assembly, seal back-up, return spring.

Continuous, unattended operation is common with HPLC components. A general guideline for the replacement frequency of consumable components is indicated in the table below. The table assumes the pump is working at half its maximum flow rate and pressure. Replacement frequency is indicated for intensive, regular, and occasional pump use.

The solvent used also effects replacement frequency. Mobile phases with buffers and high ionic strength will cause the seals to fail more frequently.

This chart should be regarded only as a guide and not followed rigidly: changes in performance, or visible leaks, give better indication that a part should be replaced.

Table 1 Frequency of Component replacement

Component/Use	Intensive (168 hrs/wk)	Regular (40 hrs/wk)	Occasional (10 hrs/wk)
Piston seal	4–6 months	1 year	2 years
Check valves	6–12 months	2 years	4 years
Piston assembly	1–2 years	4–6 years	8–10 years
Seal back-up	1–2 years	4–6 years	8–10 years
Return spring	2 years	4–6 years	8–10 years

Note that this table is only a guideline; pump head components may need to be replaced more or less often than indicated.

Service Logs

Varian 210/218 software automatically tracks seal wear, check valve use, and pump drive wear. The software also allows the user to enter and record seal and check valve changes.

To use the Service Logs:

1. Press the SETUP key to open the SETUP / SERVICE log display.

2. Press the right arrow to reach Service Log and then press the DOWN ARROW to see the following display. Select the desired menu by pressing the RIGHT or LEFT ARROW key:

PISTON SEAL	CHECK VALVE	PUMP DRIVE

Piston Seal Log

SL LOG (Seal Log) Displays sequential number of last seal change.

DATE Date of last seal change service. This value is entered numerically by the user.

USE Use units since last seal change, proportional to number of strokes and pump pressure.

LIMIT Use units limit set by user, depending on anticipated amount of use.

CHGD (Changed) Press the DOWN ARROW then the ENTER key to enter YES when seal change is performed.

Check Valve Log

CK LOG Sequential number of last check valve service (check valve cartridge replacement).

DATE Date of last check valve service. This value is entered numerically by the user.

USE Use units since last check valve service.

LIMIT Use units set by user, depending on anticipated amount of use.

IO (Inlet/Outlet) Press the UP or DOWN ARROW keys to scroll between the choices to indicate the check valve. The check valve is referenced in the next menu item (CHGD). Scrollable choices are:

IO
YY *Serviced both check valves*

IO
NY *Serviced the outlet CV, but not the inlet CV*

IO
YN *Serviced the inlet CV, but not the outlet CV*

CHGD (Changed / Serviced)	Press the DOWN ARROW then the ENTER key to enter YES when check valve cartridge replacement (the only check valve user-service item) is performed.

Pump Drive

WEAR FACTOR	This indicates wear in the drive. Both the pump pressure and the flow rate are recorded by the 210/218 software and factored into this indicator.
KCYLS	This is the number of piston strokes recorded by the pump software divided by 1000.
HRS	Cumulative operational hours recorded by the pump software.

Seal Removal and Replacement

Seals need to be replaced every so often. This is because friction from the moving pistons eventually abrades the seal and pressurized liquid in the piston chamber seeps past the seal. Seal wear may be indicated by leaks from the notch at the bottom of the liquid head, although this sign may not be present if the solvent leak evaporates quickly.

Seal wear is accelerated under adverse conditions, such as pumping at high flow rates or pressures, using aggressive or aqueous solutions, or dirty or contaminated mobile phase. Moderate operation (low flow, low pressure, organic solutions, and fresh clean HPLC-grade mobile phases) will result in longer seal life. However, every seal will eventually need replacing. Software in the 210/218 allows you to both check the seal wear and to log when the seals are changed.

Your 210/218 uses either a standard liquid head or a washing liquid head. Both types are shown below.

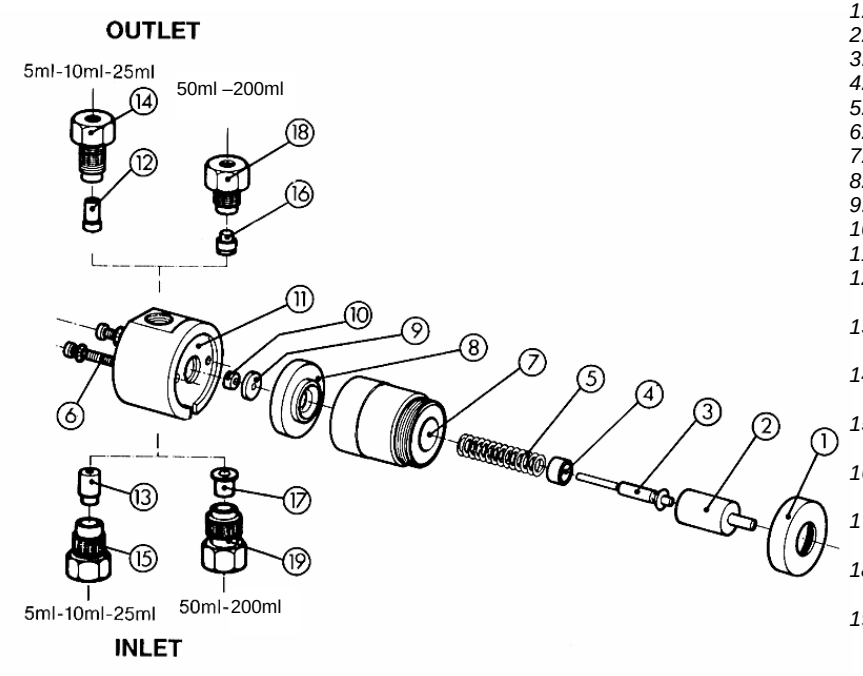
Seal Removal: Standard Head

To replace the piston seal you need a 3 mm hex wrench and the replacement seal kit appropriate for your liquid head.

1. Make sure the pump is stopped and switch off the power switch. Remove the fittings at the inlet and outlet check valves.

2. Loosen the head clamp nut and remove the head clamp.

3. Pull the pump head straight out from the pump body.



1. *Threaded Cap*
2. *Piston Cup*
3. *Piston Assembly*
4. *Piston Guide*
5. *Return Spring*
6. *Screws*
7. *Bearing Housing*
8. *Housing Spacer*
9. *Seal Backup*
10. *Piston Seal*
11. *Liquid Head*
12. *Outlet Check Valve Cartridge*
13. *Inlet Check Valve Cartridge*
14. *Outlet Check Valve Housing*
15. *Inlet Valve Housing*
16. *Outlet Check Valve Cartridge*
17. *Inlet Check Valve Cartridge*
18. *Outlet Check Valve Housing*
19. *Inlet Valve Housing*

Figure 29 Exploded View of Standard Pump Head

4. Refer to the figure above, and disassemble the pump head as follows:

   a. Unscrew the threaded cap (1)

   b. Remove the piston cup (2), piston assembly (3), piston guide (4), and return spring (5).

c. Loosen the two screws (6) at the front of the pump head. Remove the bearing housing (7) and the housing spacer (8).

d. Remove the seal back-up (9).

5. Carefully remove the seal (10). If the seal is stuck, pry it out carefully so that the liquid head (11) is not scratched.

   Do not reuse a seal after it has been removed.

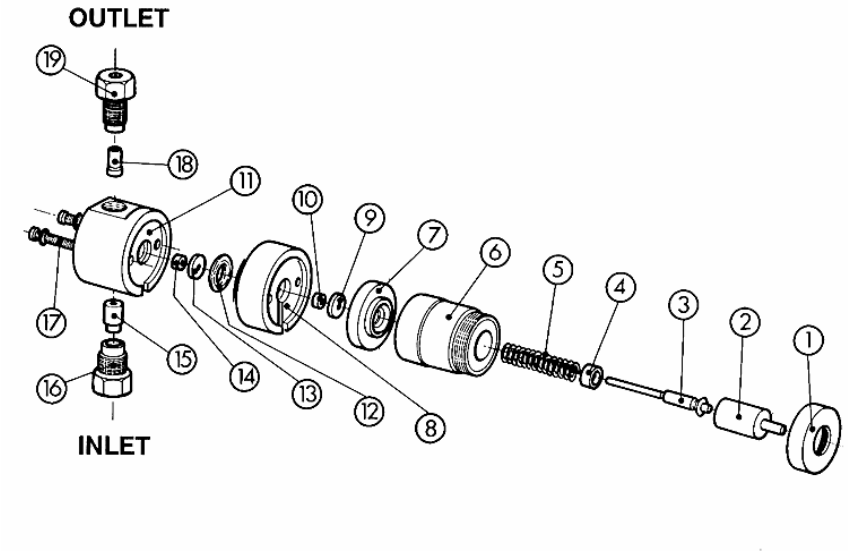
Seal Removal: Washing Head

Two identical piston seals are incorporated into each washing head: one in the head body and one in the washing section. The exception is the 200 mL head which has a different seal for the piston and washing section. See Page 82 for seal replacement with the 200 mL head. Each piston seal consists of a seal ring made from HDPE (high-density polyethylene) and a spring made of Hastelloy®-C276. Both piston seals should be replaced at the same time. To replace the piston seals you will need a 3mm hex wrench and the replacement seal kit appropriate for your liquid head

1. Make sure the pump is stopped and switch off the power switch. Remove the fittings at the inlet and outlet check valves.

2. Loosen the head clamp nut and remove the head clamp.

3. Pull the pump head straight out from the pump body.



1. *Threaded Cap*
2. *Piston Cup*
3. *Piston Assembly*
4. *Piston Guide*
5. *Return Spring*
6. *Bearing Housing*
7. *Housing Spacer*
8. *Washing Section*
9. *Seal Backup*
10. *Piston Seal*
11. *Liquid Head*
12. *O-ring*
13. *Seal Backup*
14. *Piston Seal*
15. *Inlet Check Valve Cartridge*
16. *Inlet Check Valve Support Screw*
17. *Screw*
18. *Inlet Check Valve Cartridge*
19. *Inlet Check Valve Cartridge Support Screw*

Figure 30 Exploded View of Washing Head

4. Refer to the figure above and disassemble the pump head as follows:

   a. Unscrew the threaded cap (1)

   b. Remove the piston cup (2), piston assembly (3), piston guide (4), and return spring (5).

   c. Loosen the two screws (17) at the front of the pump head and remove the bearing housing (6) and the housing spacer (7).

   d. Remove washing section (8), O-ring (12), and seal back-ups (9, 13).

5. Carefully remove the seals (10, 14). If the seals are stuck, pry them out carefully so that the liquid head (11) or washing section (8) is not scratched.

   Do not reuse a seal after it has been removed.

Seal Removal: 200 mL Head

1. Turn off power to the pump. Remove pump head clamp by loosening the hex screw with 1/4" hex wrench. Lift off clamp and pull pumphead out of the PrepStar 218 housing.

2. Unscrew the threaded cap (see Figure 29) and remove all parts possible from this side of the head.

3. Before loosening the two hex head screws draw a line the length of the pumphead body using a marker pen. This line will make it easier to have all of the parts in the correct orientation during reassembly. Loosen and remove the two 3 mm hexhead screws and separate all of the parts.

4. Place the liquid head with both inlet and outlet check valves plugged as shown in Figure 31.

Figure 31 Plugged Check Valves

5. Fill the cylinder cavity half full with HPLC grade water. Insert the ceramic piston into the cavity (Figure 32) through the piston seal.

Figure 32 Ceramic Piston into Cavity

6. Push down on the piston. The piston seal will pop out onto the piston (Figure 33). When the seal pops out a small amount of water is sprayed out so use an area appropriate for this procedure.

Figure 33 Piston Seal Removal

Installing a New Piston Seal

1. Be sure that the piston, seal, and seal location are clean, undamaged, and completely free from foreign matter.

2. Refer to the following illustrations for seal installation, and use the piston seal tool as shown below:

   a. Place the guide on the head or rinse body with the beveled side facing out.

   b. Insert the new seal into the guide with spring down.

   c. Press the seal into place using the seal tool.

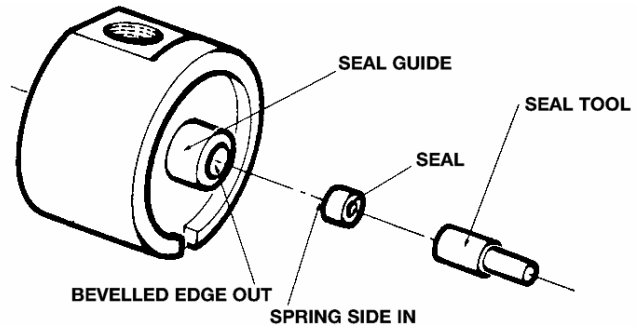


Figure 34 Typical Seal Replacement for Heads Smaller than 25 mL/min

NOTE:	For 5 mL/min head, invert the seal tool

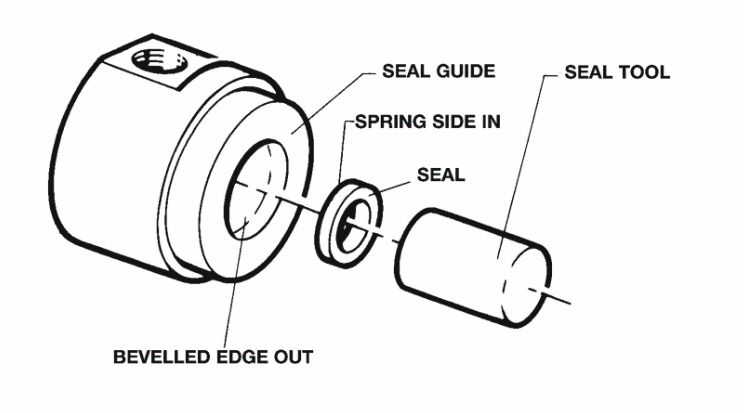


Figure 35 Typical Seal Replacement for Heads Larger than 25 mL/min

3. Reassemble the head by reversing the directions for seal removal, noting the following:

    a. Align the ball housing assembly, the housing spacer, the rinse body (for washing heads) and the head body so the matching hole or notch is on the same side on each component.

    b. Thread the ball housing assembly, the housing spacer, and the rinse body (for washing heads) to the head body. After these parts are attached, put the assembly on a flat surface to facilitate mounting the other parts.

Installing a New Piston Seal: 200 mL Head

1. Before installing a new piston seal make sure you are installing the piston seal and not the washing section seal, see Figure 36. Note that the piston seal has ridges on its edge.

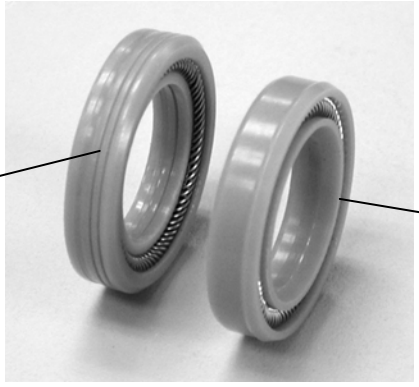


Figure 36 Seals

2. Put the seal insertion tool (with protruding ring down) into liquid head (Figure 37) and make sure it is flush against the liquid head.

Figure 37 Seal Insertion Tool

3. Place the piston seal (spring side down) in the seal insertion tool with the spring side of the seal down, Figure 37 and Figure 39.

Figure 38 Inserting piston seal in tool

Figure 39 Inserted piston seal

4. Place the seal plunger tool on top of the seal and press the seal into place.

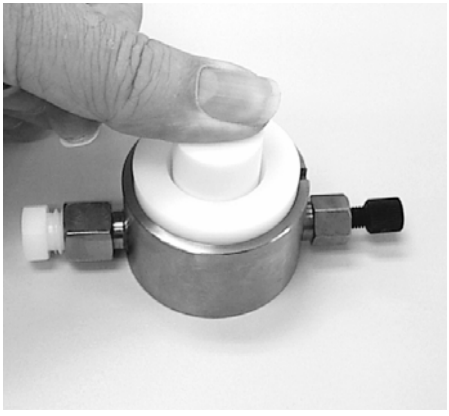


Figure 40 Pressing Seal Into Place

5. Remove seal insertion tools and reassemble the pump head following Figure 30, and the ink mark which was placed on the pump head body before disassembly.

6. Break in the seal using a 100%

Breaking-in the New Seal: 200 mL Head Only

1. Use 100% methanol at 25 mL/min with a 2-3 foot (60 –90 cm) length of 0.010" (0.25 mm) I.D. PEEK or stainless steel tubing to create back pressue.

2. Recycle the methanol back into the supply reservoir. The break-in time should be 5-10 minutes.

Breaking-in the New Seal: All other Heads

After installing a new seal, follow this procedure for maximum seal life:

1. Run the pump without backpressure for 1 to 2 minutes at 20% of nominal flow rate with 100% methanol.

2. Plumb a column into the HPLC system and run the pump at normal operating pressure for 5 to 10 minutes, checking for any leaks.

3. Repeat step 1 for 30 minutes. The seal will then be ready for normal operation.

Check Valves

The liquid head in the 210/218 has one inlet check valve and one outlet check valve.

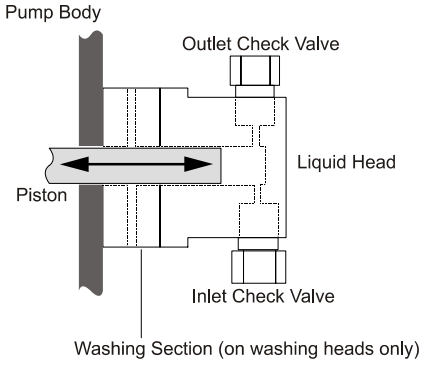


Figure 41 Cutaway View of Typical Liquid Head (washing head shown)

A sectional view of a typical outlet check valve is shown below. Inlet check valves are similar but are installed on the liquid head the other way up. In both types of valve the check valve cartridge assembly is oriented as shown.

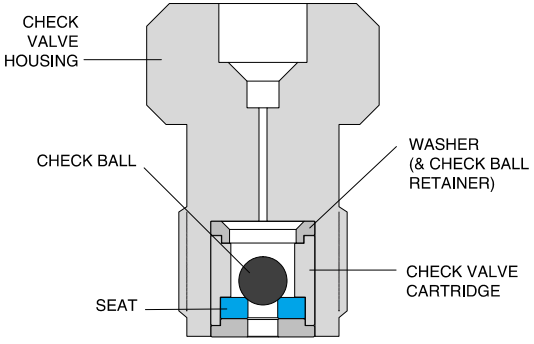


Figure 42 Typical Outlet Check Valve

Inlet and outlet check valves work on the principle described below.

The retracting piston creates a negative pressure in the piston chamber above the inlet check valve. Mobile phase flows upward past the check ball into the inlet check valve, then into the piston chamber. As soon as the piston starts to move forward, gravity causes the ball in the inlet check valve to seat, preventing mobile phase from flowing back out the inlet check valve. At the same time, a positive pressure is created in the

piston chamber which dislodges the outlet check valve check ball. Mobile phase flows upward through the outlet check valve while the piston is moving forward. When the piston retracts again, gravity causes the ball in the outlet check valve to seat, preventing mobile phase flowing back out the outlet check valve, and the cycle is repeated.

Each check valve is closely inspected and then individually assembled in a clean-room. Check valves should be kept clean and in good condition for reliable, reproducible flow.

Check valve failure may be indicated by a severe loss in flow rate. However, a leaking piston seal can also result in low flow rate and is more common than check valve failure. Inspect for a leaking seal before replacing the check valve.

Cleaning the Check Valves

Occasionally the check valves may require cleaning, especially if you notice any drop in back- pressure. A pressure drop may indicate that one of the check balls has become coated with gummy or particulate matter or that a small particle has become lodged on the seat; in either case the check ball will not seat correctly and pressure will be lost. It may be possible to rectify this problem using isopropanol to dissolve the foreign matter, as follows:

1. Disconnect the outlet tubing and connect a line to a waste bottle.

2. Pump isopropanol if it is miscible with the solvent already present in the pump head (or refer to the Solvent Miscibility Table in the *Appendix* and pump an intermediate solvent first). With the pump head filled with isopropanol, stop the flow for 15 minutes or so to dissolve deposits.

3. Flush the isopropanol from the head and return to operating conditions.

If this cleaning does not restore normal performance, you can try the next procedure using 20% nitric acid to dissolve the deposits.

WARNING:
EYE HAZARD

WARNING:
CHEMICAL HAZARD

Wear safety glasses, laboratory coat, and gloves. Observe standard laboratory safety precautions when using strong acids.

Soak check valve in 20% nitric acid for ten minutes and then rinse with water. Reinstall the check valve on the pumphead.

If this procedure fails to correct the problem you should replace the check valve as described below.

Check Valve Cartridge Replacement

1. Turn off the pump, disconnect the inlet and outlet tubing, and remove the pump head.

2. Remove the inlet and outlet check valves; they are threaded into the liquid head.

3. Remove the check valve cartridge. If needed, use compressed air to remove the cartridge. Do not use a sharp tool that could damage the check valve or the support.

NOTE: Do not disassemble check valve cartridges. Reassembly requires strict clean-room conditions and great expertise. Sub-assemblies are not available for check valve cartridges.

4. Insert the new check valve cartridge into the support as shown in Figure 43.

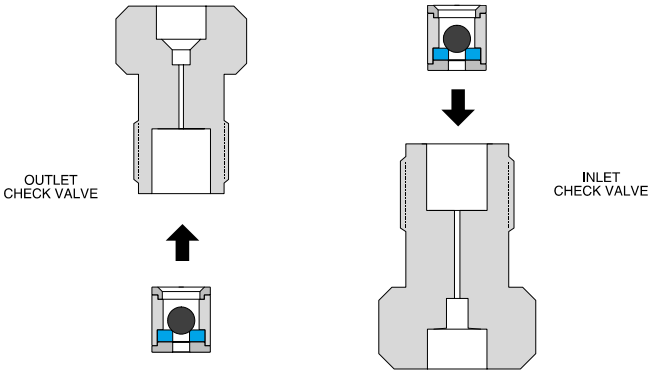


Figure 43 Orientation of Check Valve Cartridges

Note the difference between outlet and inlet check valves – the outlet check valve housing is smaller and threads into the top of the liquid head. The cartridge must be inserted in the check valve housing as shown below. The check ball must be above the seat in both types of check valve housing so that it will seat by gravity.

5. Tighten the check valves into the liquid head by hand, then tighten each liquid head a further 1/8th turn with an appropriately-sized open-ended wrench.

6. Run the pump and inspect for leaks around each check valve. If leaks are present, tighten the check valve only enough to stop the leak. Check for leaks again, tightening only if necessary.

Caution **Do not over-tighten the check valves into the liquid head; doing so would cause the check valve and the liquid head to be damaged.**

Fuse Replacement

If the 210/218 does not operate when the power cord is connected and the power switch is on, the fuse(s) may need replacing. Fuses are located in the power module on the back panel.

ProStar 210	PrepStar 218
USA: T3 A H250 V Europe: T1.6 A H250 V, 2 each	USA: T5 A H250 V Europe: T3.15 A H250 V, 2 each

WARNING:
SHOCK HAZARD

To avoid the danger of electrical shock, remove the power cord before replacing the fuse.

Checking and/or Changing Power Fuses (F1)

The fuse rating and operating voltage is printed on the rear panel next to the power receptacle.

If your instrument fails to power up when the power switch is turned on, check that the power cord is properly connected. Check for power at the wall receptacle, then check the main power fuses (F1).

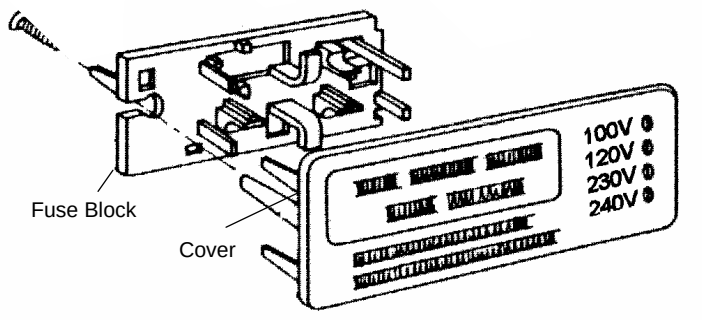


Figure 44 Main Power Fuse Replacement

Troubleshooting

Troubleshooting an HPLC system requires a methodical approach to be effective. To correct a given problem, proceed step-by-step, eliminating each variable in turn before moving to the next. Some problems have more than one cause, and can be difficult to locate and correct. The troubleshooting guide lists some common pump and HPLC system symptoms, with possible causes and suggested corrective actions. In most cases, you will be able to correct the problem. However, sometimes the symptom will remain after you have tried the corrective action. In these cases, please contact your local Varian office.

"Reading" the Pressure Display

The sensitivity of the pressure display is within 10 psi (68.9 kPa). The pressure display can be used as a diagnostic tool to identify the differences between the following similar symptoms:

- bubbles in the solvent
- sticking check valve

Both will cause erratic pressure readings.

If you notice pressure fluctuations from zero to several hundred psi when the HPLC system is operating at normal pressure, there is probably a bubble in the liquid head.

To clear a bubble, operate the pump at moderate flow (10% of maximum) with the system pressurized. Loosen the outlet check valve fitting just enough to make the fitting leak.

WARNING:
EYE HAZARD

WARNING:
CHEMICAL HAZARD

Wear safety glasses, laboratory coat, and gloves. Observe standard laboratory safety precautions when using strong acids.

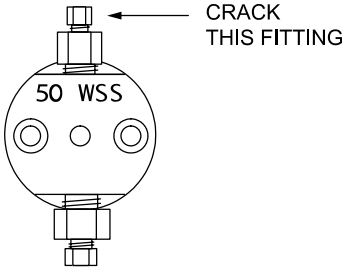


Figure 45 Outlet Check Valve Fitting

You should see solvent sputtering at the fitting as the bubble leaks past the fitting. When the bubble is clear, the sputtering will stop and the solvent will ooze past the fitting. At this point tighten the fitting.

If the fluctuation is much lower, e.g. 10 - 40 psi (68.9 – 275.8 kPa), a check valve is probably sticking. It may be possible to rectify this problem by soaking the check valve in 20% nitric acid for ten minutes and then rinsing with water.

WARNING:
EYE HAZARD

WARNING:
CHEMICAL HAZARD

Wear safety glasses, laboratory coat, and gloves. Observe standard laboratory safety precautions when using strong acids.

If this procedure fails to correct the problem replace the check valve as described earlier.

Troubleshooting Table

Symptom	***Possible Cause***	***Suggested Remedy***
Pump		
Pump dead	Power cord disconnected, power switched off, fuse dead.	Check the pump is plugged in and switched on. If so, check fuses and replace if necessary.
Leaks	Loose fitting(s)	Tighten all plumbing connections no more than 1/4 turn past finger-tight.

Symptom	*Possible Cause*	*Suggested Remedy*
	Worn ferrule or fitting	Replace fitting and ferrule.
	Piston seal needs replacing	Replace piston seal.
	Loose check valve	Tighten 1/16th turn past the leak-point.
No flow or pressure	Pump is not operating	Check the pump is plugged in and switched on. If so, check the fuses and replace if necessary.
	Air in pump	Disconnect outlet fittings. Degas solvent. Divert flow to waste and pump at a high flow rate to prime pump.
	Clogged solvent inlet filter	Check and replace if necessary.
Low flow	Pump is pressure limiting	Reset MIN P setting to higher value.
	Clogged solvent inlet filter	Check and replace if necessary
	Drain valve leaking	Repair leak in drain valve.
Excessive pressure, restricted flow	Tubing clogged/ partly clogged	Crack all fittings one by one until the pressure reverts to normal. Then replace the section of tubing immediately after the last cracked fitting.
	Injection valve clogged	Flush injection valve, replace sample loop. If this does not clear the blockage see the injection valve manual.
	Injector between LOAD / INJECT	Reposition to LOAD or INJECT.
	Frit (filter) in column clogged	Replace the column frit
	Detector flowcell clogged	Attach a syringe to the flowcell INLET and try to clear blockage by drawing on the syringe. Or attach to OUTLET and back-flush to clear blockage by gentle pressure on the syringe. Do not apply pressure to the flowcell inlet.
Erratic pressure	Leak	Check and repair leaks
	Air in pump	Disconnect outlet fittings. Degas solvent. Divert flow to waste and pump at a moderately high flow rate to prime pump.
Air bubble in tubing	Loose inlet tubing connection	Tighten inlet fittings

Symptom	*Possible Cause*	*Suggested Remedy*
	Worn flange in inlet tubing	Remake inlet tubing flange.
	Loose inlet check valve	Tighten 1/16th turn past the leak-point.
	Inlet filter partially clogged	Clean or replace.
	Loose outlet tubing connection	Tighten outlet fittings
Problems in the HPLC System		
Leaks	Loose fittings	Tighten just enough to stop the leak.
	Damaged seal	Replace seal.
	Damaged ferrule in compression fitting	Replace ferrule. Do not over-tighten.
	Incorrect fitting	Reconnect with correct fittings.
Excessive backpressure	Clogged mixer frit	Analytical and narrowbore mixers only. Replace frit.
	Stir bar/spacer sticking	Dismantle and clean mixer. Filter solvents. Check solvent miscibility.
	Blocked tubing	Loosen fitting after each component to find blockage. Replace affected tubing.
	Damaged ferrule in compression fitting	Replace ferrule. Do not over-tighten.
Noisy baseline	Air bubbles through flowcell	Install backpressure regulator. Divert flow to waste and pump at a moderately high flow rate to prime pump. Check tubing fittings. Degas solvent.
	Leak in system plumbing	Check for deposits around fittings and check that all fittings are tight.
	Contaminated flowcell	Attach a syringe to the flowcell INLET and try to clear blockage by drawing on the syringe. Or attach to OUTLET and back-flush to clear blockage by gentle pressure on the syringe. Do not apply pressure to the flowcell inlet.
	Detector lamp failing	Check and replace if necessary.
	Bad grounding	Check all grounding connections on pump and ensure grounded AC power is supplied to all devices in HPLC system.

Symptom	*Possible Cause*	*Suggested Remedy*
	Electronic interference	Check for loose connections. Ensure instruments are not in direct contact with each other or with vibrating parts.
	Localized temperature effects	Wrap tubing, column. Remove or cover heat or cooling source.
Drifting baseline	Contaminated flowcell	Attach a syringe to the flowcell INLET and try to clear blockage by drawing on the syringe. Or attach to OUTLET and back-flush to clear blockage by gentle pressure on the syringe. Do not apply pressure to the flowcell inlet.
	Localized temperature effects	Wrap tubing, column. Remove or cover heat or cooling source.
	Contamination in column	Wash or replace column. Change mobile phase.
	Leak in system	Locate leak and repair.
	Bubble trapped in flowcell	Flush flow ell. Degas solvent. Add back-pressure device to flowcell.
	Column not equilibrated	Flush system until column is equilibrated.
	Mobile phase contamination	Use fresh HPLC-grade solvents.
	Weak detector lamp	Replace detector lamp
Flat-top peaks	Saturated electronics	Reduce sample volume
	Recorder adjusted incorrectly	Set recorder correctly
	Bad grounding	Check all grounding connections on pump and ensure grounded AC power is supplied to all devices in HPLC system.
Baseline spikes	Air bubbles through flowcell	Degas solvent. Pump to waste at a moderately high flow rate to prime pump. Check tubing fittings.
	Bad connections	Check all grounding connections on pump and ensure grounded AC power is supplied to all devices in HPLC system
	Electronic interference	Check for loose connections. Ensure instruments are not in direct contact with each other or with vibrating parts.
	Electrical equipment in circuit cycling on and off	Isolate equipment which cycles on and off to a different circuit.

Appendix

Parts List

Qty	*Part Number*	*Description*
1	03-935500-01	210 drive module
1	03-936500-01	218 drive module

Liquid heads

Part number	*Liquid head*	*Flow rate mL/min*	*Flow rate resolution mL/min*	*Pressure limit – 210*	*Pressure limit -218*
R0-071010-60	5 mL SS	5	0.001	8700	8700
R0-071010-61	10 mL SS	10	0.001	8700	8700
R0-071010-62	10 mL W SS	10	0.001	8700	8700
R0-071010-63	10 mL Ti	10	0.001	8700	8700
R0-071010-64	25 mL SS	25	0.001	4600	6000
R0-071010-65	50 mL W SS	50	0.001	2000	4000
R0-071010-73	10 mL W PK	10	0.001	4000	4000
R0-071010-74	25 mL W PK	25	0.001	4000	4000
R0-071010-75	50 mL W PK	50	0.001	2000	4000
R0-071010-76	100 mL W PK	100	0.01	1200	2000
R0-071010-77	100 mL W Ti	100	0.01	1200	4000
03-936507-01	200 mL W Ti	200	0.01	NR	3500

Pressure Modules

Part Number	*Module*	*Wetted materials*	*Inlet Fittings*	*Outlet Fittings*	*Max Press.*	*Max Flow*
03-935525-01	10 mL Ti	Titanium, FEP	1/4-28	1/4-28	8700	10
03-935526-01	50 mL Ti	Titanium, FEP	1/4-28	1/4-28	6000	50
03-935527-01	100 mL Ti	Titanium, FEP	1/4-28	1/4-28	1200	100
03-935528-01	10 mL PEEK	PEEK, FEP	1/4-28	1/4-28	4000	10
03-935529-01	50 mL PEEK	PEEK, FEP	1/4-28	1/4-28	4000	50
03-935530-01	100 mL PEEK	PEEK, FEP	1/4-28	1/4-28	2000	100
03-936505-01	200 mL Ti	Titanium, FEP	1/4-28	1/4-28	4000	200*

*uses 1/8 in. (0.318 cm) tubing and ferrules

Mixer

R0-070005-07	Mixing seal retainer with Titanium frit 10 µm
R0-070000-54	Inlet solvent filter, 2µ, 10 mm
R0-071001-51	Seal retainer assembly, 1.2 mL mixer
R0-025400-06	Seal, stainless steel 10 mm (0.6 and 1.2)
R0-025400-09	Mixing seal, Titanium, 10 mm (0.6 , 1.2, and 1.2 PEEK)
R0-02540-014	Pressure seal, 0.715" ID, UHMW/perf for 10 mL mixers
15-001410-00	Nut, GC, 1/16", SST
28-694533-00	Ferrule, 1/16", CPI, SST
R0-070100-62	Bushing, extra long
R0-00FTF1-30	Male nut 10-32 PEEK
R0-00FTF3-00	High pressure nut, ferrule PEEK 10-32
R0-000LT2-00	High pressure ferrule, PEEK ¼-28 x 1/8" OD tubing
R0-000LT2-10	Nut, PEEK ¼-28 x 1/8" OD tubing
R0-025000-02	Magnetic mixing stir bar, 3/8" x 5/16"

Part Number/Scale	***Product***	***Materials in Fluid Contact***
03-935546-01 Narrowbore	Dynamax Narrowbore Mixer 0.6 mL, SS	316 Stainless Steel, Teflon, Hastelloy®, Fluoroloy-12
03-935547-01 Narrowbore	Dynamax Narrowbore Mixer 0.6mL, Ti	Titanium, Teflon, Fluorowhite
03-935548-01 Analytical	Dynamax Dual Chamber Mixer 1.2 mL, SS	316 Stainless Steel, Teflon, Hastelloy®, Fluoroloy-12
03-935550-01 Analytical	Dynamax Dual Chamber Mixer 1.2 mL, PK	Titanium, Teflon, PEEK, UHMWPE, Fluorowhite
03-935549-01 Analytical	Dynamax Dual Chamber Mixer 1.2 mL, Ti	TItanium, Teflon, Fluorowhite
03-935552-01 Preparative	Dynamax Dual Chamber Mixer 10 mL, PK	PEEK, Teflon, Perfluoro, Fluorowhite
03-935551-01 Preparative	Dynamax Dual Chamber Mixer, 10 mL, Ti, 1/8" fittings	Titanium, Teflon, Perfluoro, Fluorowhite

Standard Accessory Package

Qty	*Part Number*	*Description*
2	51-408927-00	External Contacts Panel, 12 pin
1	R0-054000-12	Double-ended wrench, 1/4" - 5/16"
1	R0-072001-41	Cable, Recorder/Integrator
2*	67-135430-00	Fuse, 3A
2*	55-500333-00	Fuse, 1.6A

**As required for your voltage.*

Specifications

Display:	Backlit LCD with 2 lines, 48 characters
Programs:	Up to 100 methods with unlimited timed events
Interface:	Digital serial input/output channel (RS-422) 3 programmable contact-closure relay outputs 5 contact-closure inputs 1 analog input (-0.5 V to +2.5 V), 18-bit A/D converter 1 programmable analog output (0-10 V)
Dimensions:	29.2 cm (w) x 19.7 cm (h) x 46.4 cm (d) 11.5 in. (w) x 7.8 in. (h) x 18.3 in. (d)
Flow Accuracy:	1% of selected flow rate or 0.005% of maximum flow, whichever is larger (0.1% for 5 mL heads).
Flow Reproducibility:	0.1% of selected flow or 0.005% of maximum flow, whichever is larger (0.01% for 5 mL heads)
Weight:	21.8 kg (48 lbs) including head and pressure module
Connections:	1/4-28 inlet flanged or gripper-type fitting 1/4-28 outlet for nut and ferrule
Fluid Path:	316 stainless steel, titanium, sapphire or ceramic, ruby, PCTFE, PTFE, or HDPE
Temp. Range:	3–40° C
Rated Voltage:	100-240 Vac (90–264 Absolute)
Frequency:	50-60 Hz

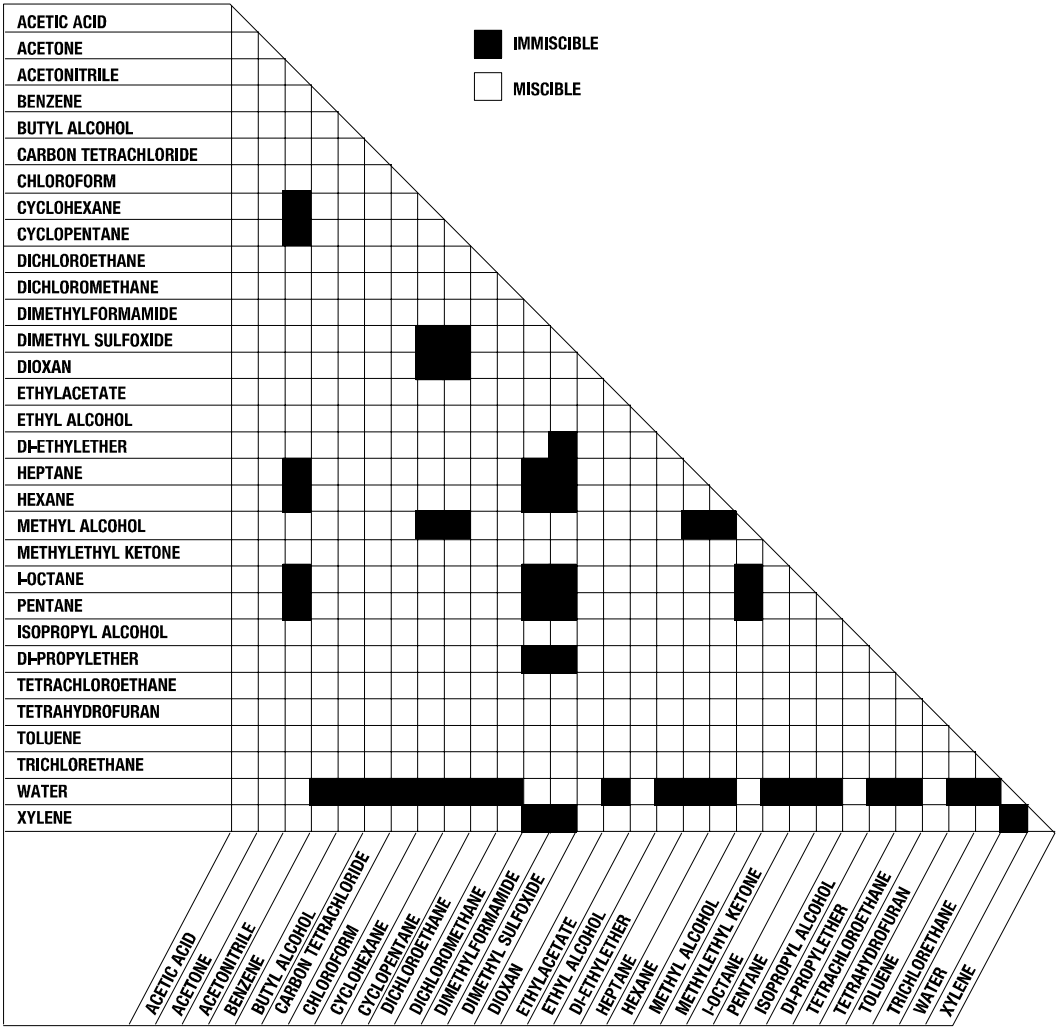
Fuses:	**ProStar 210**	**PrepStar 218**
	USA: T3 A H250 V Europe: T1.6 A H250 V, 2 each	USA: T5 A H250 V Europe: T3.15 A H250 V, 2 each

Pressure Limits (psi)

		ProStar 210		***PrepStar 218***	
Head	***Flow Rate Range (mL/min)***	***SS and Ti***	***PEEK***	***SS and Ti***	***PEEK***
5	0.01-5	8700 (600 bar) (60.0 MPa)	N/A	8700 (600 bar) (60.0 MPa)	N/A
10	0.01-10	8700 (600 bar) (60.0 MPa)	4000 (275 bar) (27.6 MPa)	8700 (600 bar) (60.0 MPa)	4000 (275 bar) (27.6 MPa)
25	0.025-25	4600 (315 bar) (31.7 MPa)	4000 (275 bar) (27.6 MPa)	6000 (414 bar) (41.4 MPa)	4000 (275 bar) (27.6 MPa)
50	0.05-50	2000 (137 bar) (13.8 MPa)	2000 (137 bar) (13.8 MPa	4000 (275 bar) (27.6 MPa)	4000 (275 bar) (27.6 MPa)
100	0.01-100	1200 (85 bar) (8.3 MPa)	1200 (85 bar) (8.3 MPa)	4000 (275 bar) (27.6 MPa)	2000 (137 bar) (13.8 MPa
200	0.01 -200	NR	NR	3500 (241 bar) (24.1 MPa)	NA

Solvent Miscibility Table

Solvents should mix with each other in all proportions. This is important during elution and during solvent changeover. Refer to the following table for miscibility of some common HPLC solvents.



Compressibility

The values in this table should be used for the entries in the 210/218 Compressibility factors when you are setting up the pumping system parameters.

Solvent	x	L
Water	46	3231
Acetone	128.9	956
Acetonitrile	97.4	1212
Benzene	96.7	1046
Carbon Tetrachloride	106.7	998
Chloroform	97.4	1227
Cyclohexane	114	800
Dichloroethane	111.9	1020
Diethyl Ether	188	700
DImethylformamide	80	1500
Dioxane	60	1500
Ethanol	115	1100
Ethyl Acetate	100	1800
Methylene Chloride	97.4	1212
Methanol	125	1200
n-heptane	144	760
n-hexane	167.2	644
o-dichlorobenzene	95	1400
Propanol	98	1200
Tetrahydrofuran	95	1500
Toluene	93	1200
2-Methylformamide	80	1500