Varian 500-LC
Column Valve Module

Operation Manual

Installation Category II
Pollution Degree 2
Safety Class 1 (EN 61010-1)

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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 BS EN 61010-1:2001
EMC EN 61326-1:1998

Equipment Model Number Varian 500-LC Column Valve Module

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Contents

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Safety Practices and Hazards

Your Varian instrument and accessories have been carefully designed so that when used properly you have an accurate, fast, flexible and safe HPLC system.

Information about safety practices appears throughout the documentation (both hard copy and online) provided with your instrument. Before using the instrument, you must thoroughly read these safety practices.

Observe all relevant safety practices at all times.

This instrument is designed for chromatographic analysis of appropriately prepared samples. It must be operated using appropriate 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.

It is your responsibility to inform Varian 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, or is being recycled at end-of-life.

General

Operation of a Varian 500-LC Column Valve Module (CVM) involves the use of pressurized liquid, and hazardous materials including corrosive fluids and flammable liquids. Careless, improper, or unskilled use of the CVM and/or your liquid chromatograph can cause death or serious injury to personnel, and/or severe damage to equipment and property.

The CVM incorporates covers that are designed to prevent inadvertent contact with any potential hazards. If the CVM is used in any manner not specified by Varian, this protection may be

impaired. It is essential that no cover is bypassed, damaged, or removed.

The safety practices described below are provided to help the user operate the CVM safely. Read each safety topic thoroughly before attempting to operate the CVM and always operate the module in accordance with these safety practices.

Follow these safety practices to ensure safe equipment operation.

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

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

Electrical Hazards

Exposure to high voltages can cause severe skin damage, while close contact with the electrical components can result in severe heat burns to the skin, and an electrical discharge which may cause death, severe electric shock or sub-surface skin burns.

The Varian 500-LC Column Valve Module has been carefully designed to operate safely and effectively when using components that conform to Varian's design criteria. Use of non-approved components in the CVM may render the module inoperative and/or hazardous. It may also invalidate the warranty on the CVM. Use only related components supplied or authorized by Varian.

- Disconnect the CVM from all power sources before removing protective panels to avoid exposure to potentially dangerous voltages. Panels or covers which are retained by

screws on the module may be opened only by Varian-trained, Varian-qualified, or Varian-approved Representatives.

- 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 shown 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 module is wired.
- Avoid using power supplies from a source that may be subject to electrical or RF interface from other services (for example, large electrical motors, elevators, and welders).

High Pressure Hazards

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 personal protective equipment 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.
- Read and adhere to all notes, cautions, and warnings in the manual.
- Always keep the doors and covers closed during operation.

Solvent Hazards

The operator should be familiar with the physicochemical properties of the components of the mobile phase.

Only use solvents compatible with the HPLC system tubing and fittings as certain solvents may cause weakening and leaks with possible bursting.

Employ static measuring and static discharge devices to safeguard against the buildup of static electricity.

All solvents can create a hazard if they leak into the atmosphere. Even small leaks in solvent supply systems can be dangerous. Any leak (except that of air) can result in an oxygen-deficient atmosphere, which can cause asphyxiation. The area in which solvents are stored and the area surrounding the instrument must be adequately ventilated to prevent such accumulations.

Ignition of Flammable Chemicals

This module is not explosion-proof. In unattended operation, do not use organic solvents having an ignition point below 70 °C.

If a flammable chemical such as organic solvent leaks from the flow path of the instrument and its vapor concentration reaches the explosion limit, it could cause spontaneous combustion with dangerously explosive results.

Beware of ignition hazard when using flammable chemicals such as organic solvents.

Do not bring a heat or flame source near the instrument.

Ventilate the laboratory room where the instrument is used.

Always check the following conditions. If an abnormality is found, stop operation immediately.

- Leakage of solvent or waste solution.
- Leakage of solvent inside the instrument.

When using flammable chemicals, be careful about possible ignition due to static electricity. To prevent the build-up of static electricity, use a conductive container for waste.

Use only approved regulator and hose connectors (refer to the supplier’s instructions). Keep solvents cool and properly labeled. Ensure that you have the correct solvent before connecting it to the instrument.

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Inflammation or Injury Due to Toxic, Corrosive, or Stimulative Solvent

When using a toxic, corrosive, or stimulative solvent, be careful not to contact solvent to prevent physical inflammation or injury. For details of the properties of each solvent and how to handle it, refer to the relevant Material Safety Data Sheet (MSDS). Be sure to handle each solvent properly.

Wear proper personal protective clothes (e.g., safety goggles) so that a solvent will not come into direct contact with the skin.

Ventilate the laboratory room adequately to prevent accidental inhalation of harmful solvent vapor.

Other Precautions

Use of the Varian 500-LC Column Valve Module may involve materials, solvents and solutions, which are flammable, corrosive, toxic or otherwise hazardous. Careless, improper or unskilled use of such materials, solvents and solutions can create explosion hazards, fire hazards, toxicity and other hazards that can result in death, serious personal injury or damage to equipment.

Always ensure that laboratory safety practices governing the use, handling and disposal of hazardous materials are strictly observed. These safety practices should include wearing appropriate safety clothing and safety glasses.

Airflow to the cooling fans of the liquid chromatograph must be unobstructed. Do not block the ventilation grills on the liquid chromatograph and accessories. Consult the manuals supplied with your PC, monitor and for their specific ventilation requirements.

Great care should be taken when working with glass or quartz parts to prevent breakage and cuts.

The Varian 500-LC Column Valve Module weighs approximately 13.6 kg (30 lb). To avoid injury to personnel or damage to the instrument or property, always use appropriate lifting procedures to move the instrument.

Use only Varian-supplied spares with your instrument.

Warning and Caution Messages

A Warning message is used in the text when failure to observe instructions or precautions could result in death or injury. The list of symbols that appear in conjunction with warnings are detailed in the next section.

Warning – Name of Warning
Detail of hazard. Information on how to avoid the hazard.

A Caution message is used when failure to observe instructions could result in damage to equipment (Varian supplied and/or other associated equipment).

Caution Do not lift or hold the CVM by its valves. Always lift gently by the sheet-metal enclosure.

Warning Symbols

The following is a list of symbols that appear in conjunction with warnings in this manual or on the Varian 500-LC Column Valve Module. The hazard they describe is also shown.

A triangular symbol indicates a warning. The meanings of the symbols that may appear alongside warnings in the documentation or on the instrument itself are as follows:

Burn hazard

Chemical hazard

Electrical shock

Explosion hazard

Eye hazard

Fire hazard

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The following symbol may be used on warning labels attached to the instrument. When you see this symbol, refer to the relevant operation or service manual for the correct procedure referred to by that warning label.

The following symbols appear on the instrument for your information.

I	Mains power on
0	Mains power off
	Fuse
	Single-phase alternating current
	Direct current
	When attached to the rear of the instrument, indicates that the product complies with the requirements of one or more EU directives.

US FCC Advisory Statement

This equipment generates, uses and can radiate radio frequency energy, and if not installed and operated in accordance with the instruction manual may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of Federal Communications Commission (FCC) Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference, in which case the user will be required to take whatever measures may be necessary to correct the interference at his or her expense.

CE Compliance

Your Varian 500-LC Column Valve Module has been designed to comply with the requirements of the Electromagnetic Compatibility (EMC) Directive and the Low Voltage (electrical safety) Directive (commonly referred to as the LVD) of the European Union. Varian has confirmed that each product complies with the relevant Directives by testing a prototype against the prescribed EN (European Norm) standards.

Proof that a product complies with these directives is indicated by:

- The CE Marking appearing on the rear of the product, and
- The documentation package that accompanies the product containing a copy of the Declaration of Conformity. The Declaration of Conformity is the legal declaration by Varian that the product complies with the directives listed above, and shows the EN standards to which the product was tested to demonstrate compliance. It is also signed by Varian's Authorized Representative in the EU, and by the representative of the manufacturing plant.

A copy of the EC DoC for the Varian 500-LC Column Valve Module is provided on Page iii of this manual.

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1. Introduction

1.1 Pre-installation Requirements

Prior to receiving your instrument, you will have been provided with a pre-installation manual, which describes the environmental and operating requirements of your Varian HPLC system. You must prepare your laboratory according to these instructions before the module can be installed. You should keep the pre-installation manual for future reference. If you have misplaced your copy, you can obtain a free replacement from your local Varian office. Alternatively, download a PDF from the Varian, Inc. Web site:

www.varianinc.com

1.2 User Documentation

You have been provided with this operation manual to help you set up and operate your Varian 500-LC Column Valve Module. This manual contains safety practices and hazards information, procedures on installing and maintaining instrument components, and a brief operation overview.

1.2.1 Conventions

Keypad entries, menu options, and field names (e.g., press **Valve** on the keypad, then select the **VLV** field) have been typed in bold throughout the procedures documented in this manual.

1.2.2 Notes

A Note is used to give advice or information. See the example below for a Note:

Note The initials CVM are used throughout this manual and stand for column valve module.

1.3 Suitability

The instrument is suitable for indoor use only and is classified suitable under the following categories (EN 61010-1:2001):

Installation category II
Pollution degree 2
Safety class 1

1.4 Environmental Conditions

The area selected for the operation of a Varian 500-LC Column Valve Module must be free from drafts, corrosive atmospheres, and vibration.

Air-conditioning is strongly recommended for control of the environment.

Table 1. Suitable environmental conditions for the Varian 500-LC Column Valve Module.

Condition	**Altitude**	**Temp (°C)**	**Humidity (%RH) non-condensing**
Non-operating (Transport)	0–3 050 m (0–10 000 ft)	−20–60	5–95
Operating within specifications	0–3 050 m (0–10 000 ft)	10–35	5–95

Note For optimum analytical performance, it is recommended that the ambient temperature of the laboratory be between 20 and 25 °C and be held constant to within ± 2 °C throughout the entire working day.

1.4.1 Waste Container

Your HPLC system needs a drain vessel for disposal of fluids and vapors from the system. Suitable tubing is supplied with the HPLC system for use with most HPLC solvents. Always check that your HPLC system tubing is compatible with your solvents.

A chemically inert container, not glass and not sealed, to hold a minimum of 2 liters (4 pints) of waste must be provided by the user. Narrow necked containers are preferred. The waste vessel(s) should be bonded. It should be placed where it is protected by the bench and in full view of the operator.

1.5 Electrical Requirements

All power supplies should be single-phase AC, three-wire system (active, neutral, and ground or two active and ground) and should be terminated at an appropriate connection receptacle that is within reach of the system power cable.

The installation of electrical power supplies must comply with the rules and/or regulations imposed by the local authorities responsible for the use of electrical energy in the workplace.

The connection should be terminated at an appropriate receptacle within reach of the module's power cable. Use of power boards or extension cables is not recommended.

Avoid using power supplies from a source that may be subject to electrical interference from other services (such as large electric motors, elevators, welders, and air-conditioning units).

Local regulations in several European countries do not permit the use of a breakable wall-mounted power supply connection for high current single-phase mains supplies. In these areas, the mains power supply to the CVM should be hardwired to the wall.

In areas where single-phase power supplies are not commonly available, two active phases from a two- or three-phase system may be used to power the instrument as long as the supply is within the instrument ratings (208–240 V).

The instrument supply draws a maximum of 330 VA.

1.5.1 Module Power Connections

Table 2. Varian 500-LC Column Valve Module power connections.

Power supply phase	Single	
Power supply, current rating, and overload protection	Less than 1.5 A (for 220–240 V countries) Less than 3 A (for 100–120 V countries)	
	Supplied plug	**Required wall socket**
Australia	Complies with AS3112	To comply with AS3112 HPM 787 or Clipsal 2015 (250 V, 10 A)
USA	Complies with Nema 5-15P	To comply with Nema 5-15R Hubbell 5262 (125 V, 15 A)
Europe	Complies with CEE 7 Sheet VII	To comply with CEE 7 Sheet VII (250 V, 10/16 A)

1.5.2 Fuses

Table 3. Fuses.

1FS1	T3.15AH250V, IEC 66127 sheet 5, 5 × 20 mm

Note For safety reasons, any other internal fuse or circuit breaker is not operator accessible, and should only be replaced by Varian-authorized personnel.

Fuse information on the rear of the instrument is the most up to date.

1.6 Weights and Dimensions

Table 4. Weights and dimensions

System unit	Width	Depth	Height	Weight
Varian 500-LC Column Valve Module without any valves installed	136 mm (5.4 in.)	381 mm (15.0 in.)	508 mm (20.0 in.)	13.6 kg (30 lb)

1.7 General

The Varian 500-LC Column Valve Module offers great flexibility in the organization and control of HPLC valves, columns and heaters. Analytical- and preparative-scale columns, column heaters, manual injectors, switching valves, and electrically actuated valves may be mounted in and controlled with the CVM. This unit complements the 500-LC line of LC pumps, detectors, and autosamplers.

The 500-LC Column Valve Module contains its own intelligent control system that is accessible both from a front panel keyboard and display and remotely from the control software. The CVM can be coordinated with the entire 500-LC LC system using the control software. Sophisticated automation can be programmed for the unattended analysis of different sample types that require column, solvent, temperature and other method changes. The CVM keypad and LCD display allow local user control at the laboratory bench. Synchronization signals generated from other instruments may also be used to communicate with the CVM's discrete I/O port.

For standard analytical operation, the CVM is typically configured with one to six analytical columns, up to two independently controlled, full-length column heater blocks (capable of holding a

total of four analytical columns)[1], a prime/purge valve, and one or more injector valves or sample input from an autosampler.

Figure 1. Varian 500-LC Column Valve Module – front and side view

Note The side door of the CVM is not shown in Figure 1, so that the interior of the column compartment can be seen.

For automated analytical applications, up to four electrically actuated valves can be mounted in and controlled by the CVM through the control software. In analytical-scale analyses, a column-switching valve and solvent-selection valve are often used. The column-switching valve allows selection among six positions such as five columns and a bypass line. Each solvent-selection valve allows the user to program up to six different solvents to be used by the LC pump.

[1]Each column heater block can accommodate up to two 5- to 25-cm (2- to 10-in.) long columns with maximum outer diameter (OD) of 12.5 mm (0.5 in.).

Figure 2. An example of an analytical-scale CVM configuration with one temperature zone and an automated, column-switching valve.

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2. Installation

The Varian 500-LC Column Valve Module is designed to be completely customer-installable. Instructions for setting up the system are included in this manual.

2.1 Installation Procedure

Basic installation involves:

- Receiving Inspection
- Unpacking
- Site Preparation
- Installing Mechanical Components
- Installing Signal Cable Connections
- Post-Installation Leak Check

2.2 Receiving Inspection

Inspection and unpacking instructions have been provided in the pre-installation manual you received prior to delivery. They are summarized here.

Upon receipt of the Varian 500-LC Column Valve Module, carefully check the packaging for any evidence of shipping damage, i.e., crushed corners, forklift punctures, tears or cuts, and water stains. If such evidence is present, do not open the carton, but report your findings to the carrier, and to your local Varian office.

2.3 Unpacking

Caution Do not lift or hold the CVM by its valves. Always lift gently by the sheet-metal enclosure.

Ensure you have the following items:

- Column Valve Module configured with the ordered options.
- Standard Accessory Kit (part number 0393584791).

Note The contents of the Standard Accessory Kit are itemized in a list enclosed in the kit package. Report any missing items to your local Varian office.

2.4 Site Preparation

Adequate bench space, suitable electrical power and compatible receptacles must be available. These are detailed in the pre-installation checklist.

2.4.1 Location

The CVM is usually placed on the bench to the right of the LC pump and any other stacked modules. This allows access to the columns within the CVM from the CVM side door. It also allows attachment of the CVM to the pumps and detectors for mechanical stabilization, if desired.

Plan space near the CVM for associated peripherals, such as, solvent reservoirs, vessels for fraction collection, and containers for waste solvent as appropriate. Lines for carrying waste solvent from the prime purge valve and leaks caught by the drip tray should be routed to a suitable waste solvent container that is kept below the level of the CVM drip tray.

Note An optional solvent reservoir holder and tray kit (part number 0393556091) is available. The kit provides for the orderly and compact arrangement of solvent reservoirs.

2.4.2 Power

A power cord, which must be specified as an item in the order, is provided with the CVM. An appropriate receptacle must be available at the installation site. For further information on the power connections see Table 2, Page 11.

Note If it is necessary to change the power cord plug to make it compatible with existing power outlet configurations, please contact your local Varian office for further advice.

Warning – Shock Hazard
Death, serious injury, or painful electrical shock can result by contact with these circuits, devices and components. Dangerous voltages exposed when electrical compartment cover is removed. Access intended for Varian service representative only.

2.5 Installing Mechanical Components

2.5.1 Solvent Pathway Configurations and the CVM

The CVM allows great flexibility in hardware setup to optimize space efficiency and ease of use. Carefully plan the tubing connections among your LC modules by following the solvent pathway. In Figure 3 and Figure 4 the solvent line connections to various CVM hardware options are illustrated. See Appendix B (starts on Page 74) for detailed instructions for particular hardware connections.

2.5.1.1 Solvent-Selection Valve

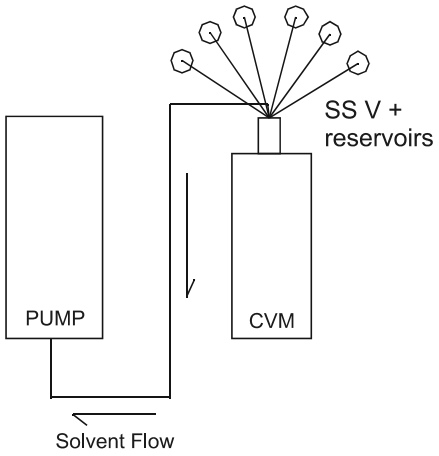

Figure 3. Schematics for solvent line connections for a solvent-selection valve (SSV).

Solvent is pulled by the pump from the valve-selected reservoir to the SSV, through the center port of the SSV, to the pump inlet, all exterior to the CVM.

2.5.1.2 Column-Switching Valve

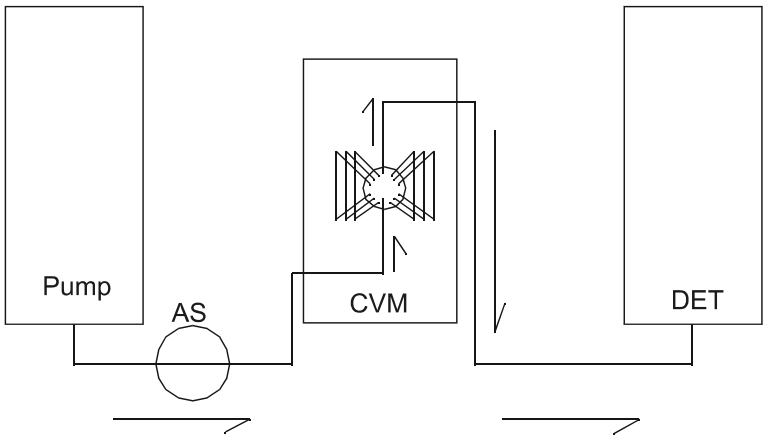

Figure 4. Schematics for solvent line connections for a column-switching valve (CSV).

Solvent from the pump flows to the sample injection device, to the CSV mounted inside the CVM, through the valve-selected column, and out to the detector.

After planning the solvent flow pathway, plumb the solvent lines as needed in the CVM and to the valves on the back panel. See Appendix B (starts on Page 74) for additional information on specific hardware components.

2.5.2 Mounting Columns and Heaters

2.5.2.1 Analytical Columns

Columns are mounted in the column compartment and may be fastened to the backing plate using the supplied clasps. Clasps for analytical columns can accommodate columns up to 12.5 mm (0.5 in.) OD.

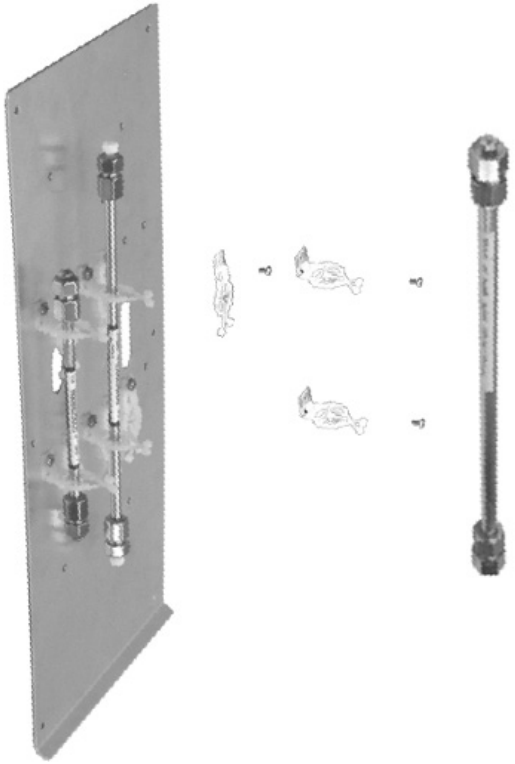

Figure 5. Mounting analytical scale columns with nylon clips on the CVM column mounting plate (shown out of the compartment for clarity).

2.5.2.2 Column Block Heaters

Warning – Burn Hazard
Close contact with the heated surfaces of the column block heater can result in severe heat burns to the skin. Turn off power switch, unplug power cord, and allow the heater to cool before mounting or removing a column.

Each block heater can accommodate up to two columns with an OD of up to 12.5 mm (0.5 in.). Columns are mounted in a heater block by placing the column in the V-shaped groove, sliding the proper length of holding bar over the column, and then tightening the block screws to clamp the column securely between the bar and block. An insulated cover is then placed over the block.

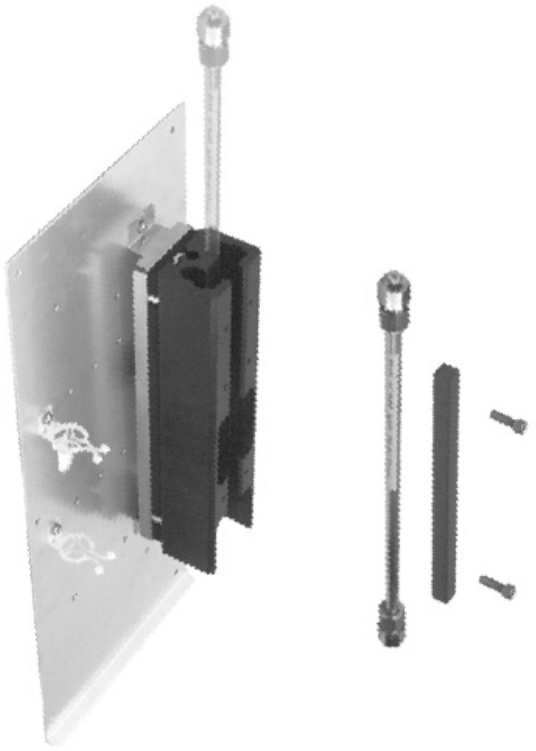

Figure 6. Mounting a column in the column heater block (shown out of the compartment for clarity).

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2.5.3 Configuring Manual Injectors and Prime/Purge Valves

Manual valves are readily mounted on the front panel plates. Plates to hold an injector valve, a prime/purge valve, or both are available. By loosening the screws of the U-shaped, panel-holding brackets, the panels can also be removed and the valves installed on the plates.

Note The holding brackets that secure the front panel plates are accessed from inside the compartment of the CSV, as shown in Figure 7.

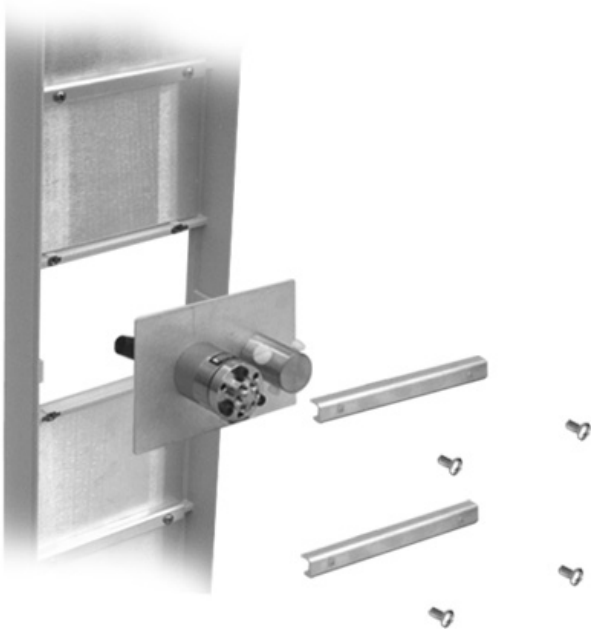

Figure 7. Detail showing the panel-holding brackets and panel assembly (only the inside of the front panel of the compartment is shown for clarity).

Standard loop injectors have sample loop drain tubes. Lengths of $^{1}/_{16}$ in. ID plastic tubing, which is included in the Standard Accessory Kit (part number 0393584791), can be used to drain the solvents to a waste receptacle. Cut sufficient lengths of tubing from the slip the tubing over the ends of the drain lines, and route the drain tubing through one of the exit holes of the column compartment to a waste receptacle.

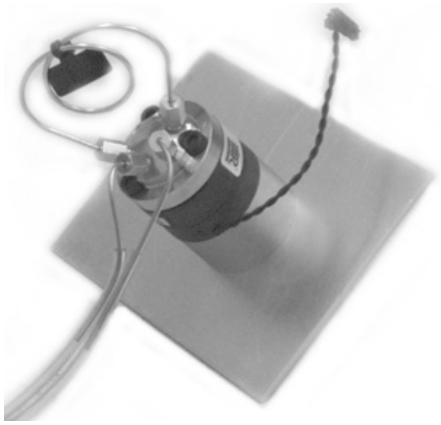

Figure 8. Injector drain tubes extended with plastic tubing to run to a waste receptacle outside the CVM.

Alternatively, the stainless steel drain tubes can be bent to exit out of a hole in the front panels, so the operator can collect the excess sample

Tubing can enter and exit the CVM through various access holes. The access holes lead into the column compartment through the left side panel and the bottom panel. The side panel access holes are covered with black plugs. Remove the plugs as necessary by squeezing the plug's tabs from inside the column compartment and pressing the plug outwards.

2.5.4 Installing Valves with a Position-Sensing Switch

To install a valve with a position-sensing switch:

1. Unlatch and remove the column access side door.
2. Remove an unused front panel plate, then secure the new valve/plate assembly to the front panel with the brackets and screws as shown in Figure 7.
3. Attach the connector from the valve, shown in Figure 8, to the start input of one of the modules, via one of the two-pin connectors of the cable assembly emerging from behind and to the left of the CVM mounting plate.
4. If the valve will be used in Module A, use one of the cables labeled ‘MOD A INJ’.

Note Use the cable labeled ‘MOD B INJ’ for a valve to be configured in Module B. For more information on modules read Section 3.2.2.1.

2.5.5 Installing the Drip Tray Drain Tube

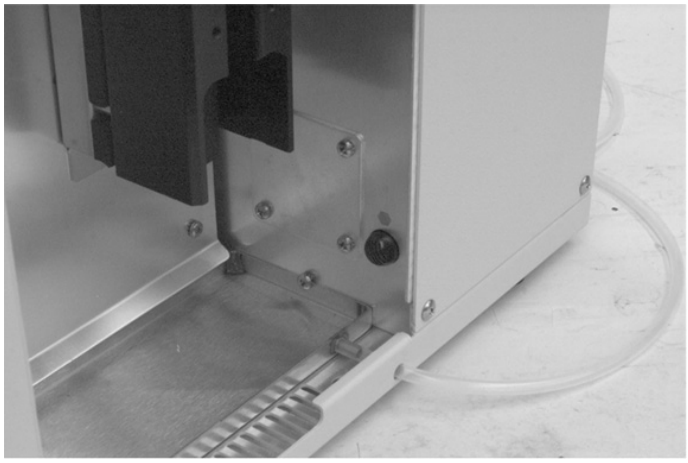

Figure 9. Drip tray with drain tube installed. Drain tube is positioned so tube can be visually inspected.

Note This tubing provides drainage for the drip pan in case a solvent leak develops in the column compartment.

To install the drip tray drain tube:

1. Unlatch and remove the column access side door.
2. Insert one end of the drain tube through the hole in the CVM enclosure near the drip pan connector, Figure 9.
3. Slide the tube over the tubing connector on the drip tray in the bottom of the column compartment.
4. Route the other end of the tubing into a waste receptacle positioned at least 10 cm below the level of the drip tray.

2.5.6 Securing the CVM to Another LC Module

To provide greater mechanical stability while preserving maneuverability, the CVM may be attached to another LC module using the adhesive fabric tape strips supplied in the Accessory Kit. Plan the positions of the strips so the CVM has attachment points low and high, front and back on the other module(s), as shown in Figure 10.

To secure the CVM to another LC module:

1. Press the two fabric tape strips together, and cut into 76 mm (3 in.) sections.

Note Leave the two strips together to simplify installation and alignment.

2. Remove the protective adhesive backing from one side of each section.
3. Press the sections onto the pump and/or detector at appropriate positions.
4. Once in position, remove the remaining adhesive backing from each section.
5. Align the side of the CVM with the side of the stacked modules, such that the CVM is in the position you intend to secure it but that it is not in contact with the adhesive on the sections of fabric tape.
6. Secure the CVM in position by pushing it firmly against the fabric tape strips on the side of the other module(s).

Note The bonding of the adhesive on the fabric tape will maximize over several days.

Figure 10. Example of positioning fabric strips on CVM for stabilization against a one- and two-LC module stack.

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2.6 Installing Signal Cable Connections

2.6.1 Control Strategy

The CVM is typically configured with two communication paths. One path is a dedicated serial line between the CVM and a personal computer running the control software. This allows more sophisticated control, including automation sequences and detailed status reports, than is available from the CVM keypad and display.

The other path uses synchronization signals which allow the CVM to communicate directly with other LC instruments, receiving and sending time-sensitive signals, such as, Start, Ready, and Fault.

2.6.1.1 Synchronization Signal Connections

The exact set of synchronization signal connections can depend on the type of analysis and the capabilities of the LC instruments to which the CVM will be attached.

Ready Out

The Ready Out (relay contact closure) signal can be used to hold up other LC instruments when the CVM is Not Ready (relay open). This allows the LC system to wait for a CVM, such as for a heater to reach temperature or for a solvent flush time as a delay after a valve has turned.

Ready In

A Ready In (high = Ready, low = Not Ready) signal from another LC instrument can be used to hold the CVM from starting its method and runtime clock, as well as from outputting Ready on the CVM Ready Out signal.

Note To respond to a Ready In signal, the Ready Enable must be connected to ground. If left open, the CVM assumes the Ready In signal is Ready.

Start Out

The Start Out (a relay contact closure pulse) signal is issued by the CVM when a front panel manual injector with a position-sensing switch is moved from load to inject, or when a CVM method is started, either internally by AutoStart or by a serial communication command. The pulse width of the Start Out signal is typically two seconds.

Note The duration of the Start Out pulse can be selected from the CVM keypad, via the MODULE setup menu (Section 4.3.3.3, Page 47).

Start In

Start In (senses falling edge of a voltage pulse from another instrument) starts the CVM runtime clock and queued valve motions from a downloaded method. Once the CVM starts, its Start Out signal is given.

Fault Out

Fault Out (relay contact closure) is issued by the CVM if a valve cannot attain the commanded position. Also a Fault Out Signal is issued if a Fault In signal is received.

Fault In

Fault In (fault = high) from another instrument will force the CVM into a Not Ready state and prevent the CVM from starting a method.

Input Signals

Input signals, for example, Ready In, Start In, and Fault In, received by the CVM from other instruments can be configured by connecting correctly polarized TTL signals directly to the CVM. Alternatively, if the other instrument utilizes relay closures, the CVM input lead can be connected to one side of the relay and the CVM Digital Ground is connected to the other.

Note Since input/output capabilities and requirements vary among other LC instruments, always test your system to confirm proper synchronization signal communication.

2.6.1.2 Control Configurations

This section provides two examples of control configurations which demonstrate the communication between a CVM and one or two LC systems, as shown in Figure 11 and Figure 12 respectively.

Note Since input/output capabilities and requirements vary among other LC instruments, always test your system to confirm proper synchronization signal communication.

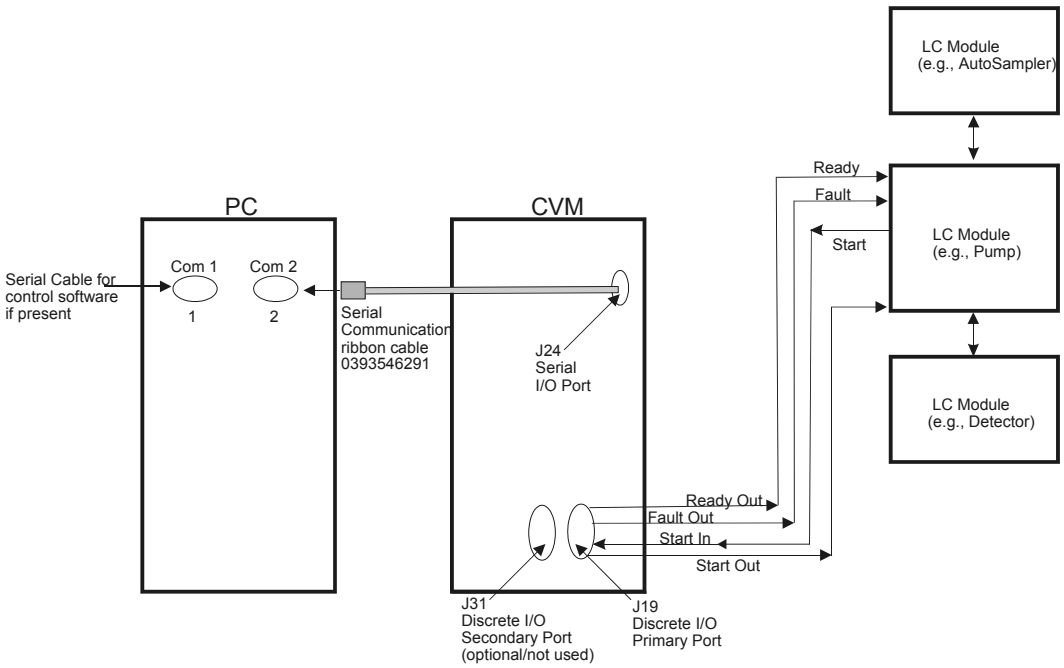

Figure 11. Typical cable connections with synchronization signals and serial communication.

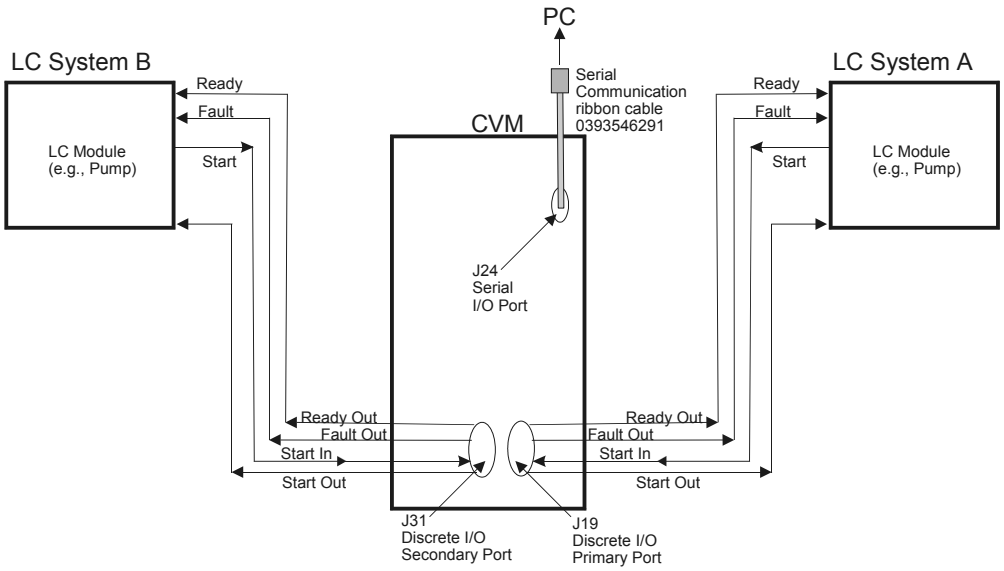

Figure 12. Cable connections for a CVM connected to two LC systems.

For more limited manual control of CVM hardware components, serial control from the computer can be replaced with control using the CVM front panel keypad and display. In this case, only the synchronization cable is used to communicate between the CVM and other instruments.

A more complex control configuration is needed when two LC systems communicate to the same CVM. In this case, the first LC system would coordinate with CVM internal Module A and have its synchronization cable connected to J-19, Discrete I/O Primary Port, as before. The optional Digital I/O board (part number 0393582591) would be installed in the CVM to support a second CVM internal module, Module B, and provide a secondary Discrete I/O port, J-31. The synchronization cable to the second LC system would attach to this port, as shown in Figure 12.

2.6.1.3 J-24 Serial I/O Port (9-pin D-shell)

One end of the RS-422 Serial communications cable (part number 0393546201) for communication with the computer connects to the J-24 Serial I/O port (9-pin D-shell) on the CVM rear panel. The opposite end terminates with another 9-pin D-shell connector and is attached to the RS-232 to RS-422/485 converter (part number 0343542001) which then connects to a serial port on the computer. The same serial communication ribbon cable can be used for the 500-LC and other LC instruments to communicate with the control software.

Note The CVM RS-422/485 serial communication defaults to 19200 baud. The CVM unit defaults to addresses 13 (for CVM internal Module A) and 14 (for CVM internal Module B).

2.6.1.4 J-19 Discrete I/O Primary Port (25-pin D-shell) and J-31 Discrete I/O Secondary Port (25-pin D-shell)

Synchronization cables are available for connecting the CVM to other LC modules and other devices to communicate time-sensitive signals, such as, Start, Ready, and Fault, and to communicate binary-coded valve position changes. The synchronization cables are attached at the CVM Discrete I/O ports (J-19 Primary for CVM internal Module A, and J-31 Secondary for CVM internal Module B when the optional Module B Digital I/O board is installed).

The general purpose synchronization cable (part number 0393585902) has a 25-pin D-shell connector for attaching to CVM J-19 or J-31 and terminates with bare wire leads. These bare leads may be attached to all Varian pumps. This cable can also be used

Table 5. Wire lead functions of the general purpose synchronization cable.

Pin	Function	Base Color/Stripe	Comments
1	+5 V	BLK	
2	−DGND	WHT	
3		RED	Reserved for future use
4	+RDY ENABLE	GRN	Short to DGND to enable READY IN
5		ORN	Reserved for future use
6	+FAULT IN	BLU	Fault = low
7	+READY IN	WHT/BLK	Ready = high
8	+START IN	RED/BLK	Senses falling edge of voltage pulse
9	−DGND	GRN/BLK	
10	RELAY INPUT	ORN/BLK	B0
11	RELAY INPUT	BLU/BLK	B1
12	RELAY INPUT	BLK/WHT	B2
13	RELAY INPUT	RED/WHT	B3
14	RELAY INPUT	GRN/WHT	B4
15	RELAY INPUT	BLU/WHT	A0
16	RELAY INPUT	BLK/RED	A1
17	−DGND	WHT/RED	
18		ORN/RED	Reserved for future use
19		BLU/RED	Reserved for future use
20	1-FAULT OUT	RED/GRN	Relay contact pair (20 & 21)
21	2-FAULT OUT	ORN/GRN	Relay contact pair (20 & 21)
22	1-START OUT	BLK/WHT/RED	Relay contact pair (22 & 23)
23	2-START OUT	WHT/BLK/RED	Relay contact pair (22 & 23)
24	1-READY OUT	RED/BLK/WHT	Relay contact pair (24 & 25)
25	2-READY OUT	GRN/BLK/WHT	Relay contact pair (24 & 25)

to connect the CVM with other equipment with generic relay and signal connectors. Identification of the bare wire leads is documented in Table 5.

2.1 Post-Installation Leak Check

A general leak check of the system is advised after installation is complete, and before running analyses. The purpose of the leak check is to detect and correct any leaks before operation. Of particular interest will be the connections just made in the installation. Look for leaks around compression fittings. Check inlet and outlet fittings on valves and columns.

3. System Description

Note Please read this section and the portions of Appendix B (starts on Page 74) appropriate to the specific hardware for your CVM before proceeding to the Operation sections.

3.1 CVM Hardware

The Varian 500-LC Column Valve Module can accommodate many configurations of injectors, columns, valves, and column heaters. The CVM is configured at the factory as an electrical system capable of automated routines and communication with other LC modules, and a computer controller.

The main physical features of the CVM hardware are:

- The front panel.
- The column compartment.
- The electrical compartment.
- The rear panel.

All of the above features are described in the subsequent sections, and are followed by a note on the default mounting positions of valves on CVMs when shipped from the factory.

3.1.1 The Front Panel

The front panel of the CVM (Figure 13) consists of the manual valves, the keypad, and a display.

Figure 13. Front view of a CVM fitted with two manual valves, showing the front panel with keypad and display.

3.1.2 The Column Compartment

The interior of the CVM is a column compartment that can accommodate analytical and preparative columns, up to two block heaters for columns, and up to two electrically actuated valves.

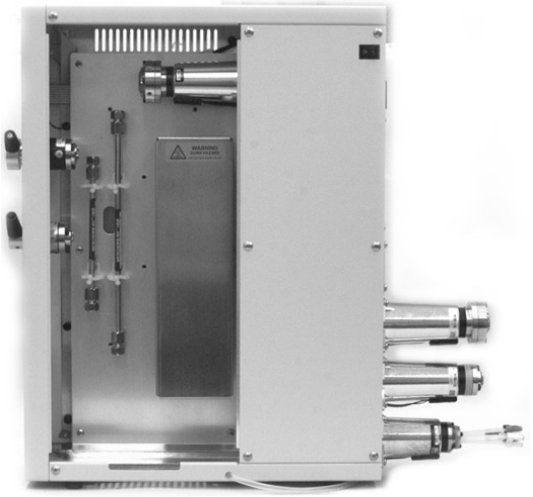

Figure 14. Side view of a CVM with the door removed from the column compartment (left), showing two analytical columns, a column heater block (optional), and a column-switching valve (optional). The electrical compartment (right) is shown closed.

3.1.2.1 Column Heater Blocks

Up to two insulated block heaters for regulating the temperature of columns can be installed and controlled separately in a CVM. Each column heater block can hold two analytical columns, yielding a possible total of four columns in two different temperature zones. The block design can accommodate column lengths from 5 to 25 cm with outside diameters of up to 12.5 mm (0.5 in.).

Note A 30-cm column can also be mounted in a block but both end fittings will not be enclosed by the insulation.

The three-line contact system of holding the columns inside of the blocks, along with the insulated covers, provides for excellent heat transfer and temperature stability. Temperatures can be controlled from 5 °C above ambient to 90 °C.

Warning – Burn Hazard
Close contact with the heated surfaces of the column block heater can result in severe heat burns to the skin. Turn off power switch, unplug power cord, and allow the heater to cool before mounting or removing a column.

Note Temperature rise is rapid, taking approximately 15 minutes to heat from 25 °C to 90 °C.

3.1.3 The Electrical Compartment

Warning – Shock Hazard
Death, serious injury, or painful electrical shock can result by contact with these circuits, devices and components. Dangerous voltages exposed when electrical compartment cover is removed. Access intended for Varian service representative only.

The electrical compartment, which houses the main circuit board, power supply, and motors for the electrically actuated valves, is accessed by removing a cover on the side of the CVM.

Note The electrical compartment, is shown closed in Figure 14.

3.1.4 The Rear Panel

The rear panel, which provides connectors for the main power, serial I/O communications, discrete (analog) I/O communications, and mounting for up to four electrically actuated valves.

Figure 15. Rear view of a CVM,showing the power inlet, communication connections, and electrically actuated valves.

3.1.4.1 Electrically Actuated Valves

As many as four electrically actuated valves can be controlled by a single CVM module. Four valve ports are located on the rear panel. These ports are typically used for solvent-selection and diverter valves. Two valve ports are located on the rear wall inside the column compartment, allowing electrically actuated, column-switching valves and injection valves to be located near the columns. Detailed descriptions of the different valves are presented in Appendix A, starts on Page 72, and Appendix B, starts on Page 74.

3.1.5 Default Valve Mounting Positions

When a CVM is shipped from the factory, the valves are configured into default positions. However, the positions of any of the valves can be changed when the unit is installed or later.

3.1.5.1 Manual Valves on the Front Panel

The valve panels on the front position are filled from the highest to the lowest. If a purge valve has been ordered with an injector, it will be mounted in a two-valve panel. If both an analytical and a preparative valve have been ordered, the analytical valve will be

mounted above the preparative valve. These panels can be exchanged at any time, as described in Section 2.5.3, Page 21.

3.1.5.2 Position-Sensing Valves

If one manual injector valve was ordered, it will be attached to the start input of Module A. If a manual analytical and preparative injector valves were ordered, they will both be attached to the start input of Module A. If two analytical injectors were ordered, the one mounted on the uppermost panel on the front will be attached to the start input of Module A, and the one mounted on the lower panel will be attached to the start input of Module B.

Note The start input connections are located inside the column compartment.

3.1.5.3 Electrically Actuated Valves on the Rear Panel

Valves used for solvent selection, and as diverter valves are mounted on the rear panel of the CVM. The solvent-selection valve(s) will be mounted on the lowest positions of the rear panel. The diverter valve(s) will be mounted above any solvent-selection valve(s).

The positions of the valves on the rear panel of the CVM correlate to their connections to the module's electronics. The position order, from lowest to highest, corresponds to their circuit board connections, from 1 to 4. Therefore, the lowest valve on the rear panel is designated as valve 1 and will be connected to valve connector 1 on the main circuit board, which is located in the electrical compartment of the CVM.

Warning – Shock Hazard
Death, serious injury, or painful electrical shock can result by contact with these circuits, devices and components. Dangerous voltages exposed when electrical compartment cover is removed. Access intended for Varian service representative only.

Note Each valve is labeled with the connector numbers and with its six-digit base model number.

3.1.5.4 Column-Switching Valves Inside the Column Compartment

Column-switching valves (CSV) are mounted on the inside of the column compartment. The first one is mounted in the upper

position. If a second one is present, it will be mounted in the lower position. The valve number for the column-switching valve will always be higher than the valves mounted on the back panel.

For example, if a solvent-selection and a diverter valve are mounted on the back of the CVM, they will have positions 1 and 2 respectively. A column-switching valve will then have position 3. If two column-switching valves were present, they would have position 3 for valve in the lower position and 4 in the upper position.

3.1.5.5 Column Heater Blocks

If two heaters are present, the heater closest to the electronics compartment will be designated as 1 and the other one will be designated as 2. The heater labels are on the column mounting plate, adjacent to their respective heater blocks.

3.2 CVM Firmware and Control Software Driver

Two major control systems are available with the CVM:

- Manual control using the keypad and display on the front panel of the CVM, which permits operation of the module utilizing its firmware.
- Remote control through control software, which allows a computer to operate the CVM hardware and control its communication with other LC modules.

The CVM controls the valve movements, temperature and communications, and run as a standalone module for manual (real-time) control of valve positions and column temperature settings.

3.2.1 Operation Sequence Summary

Whether controlled remotely by the control software or locally through the front panel keypad, CVM operation involves a sequence of three activities:

- Configuring – informing the firmware of how the valves, heaters, and other hardware components will be used;
- Setting initial conditions – valve positions, and temperatures;
- Executing the run – starting, executing, and post-run operations.

3.2.2 Configuration Principles

Configuring involves defining to the firmware how the CVM hardware is to be used. The presence of valves, column heaters, and other components is sensed by the CVM circuitry. However, the way a valve is to be used, the temperature limit of a heater for a specific column, are conditions best determined and set by the user.

The configuration can be defined in the control software and downloaded to the CVM, or directly from the CVM front panel keypad and display. Once programmed, the configuration will remain in effect for future runs. If the analytical needs of the laboratory change, the CVM can readily be reconfigured.

3.2.2.1 Grouping Hardware into Modules

Through configuration, the user also specifies which valves and heaters will coordinate together as a group or “module”. This allows the CVM to monitor those hardware components together so the collective status state (“Not Ready”, “Ready”, “Exec” (executing/running), or “Fault”) can be determined and output to the main controller of the LC system. Those valves or zones not used in a particular application can be assigned to a different module so their states will not interfere with the application of interest.

There are two operational modules (A and B) as well as a module for hardware not in use (nu). Module A and Module B can each be assigned a separate address and a source of control: remote (R) from a computer over the serial port, local (L) from the CVM front keypad and display, or through the Discrete I/O port (D) reserved for future use with analog signals from relays on other instruments. By default, all CVM hardware is considered active and assigned to Module A.

Hardware components configured as not used (nu) are not operable by the Serial or Discrete controls. Heater blocks retain their temperature settings and the valves can be actuated only from the CVM keypad. Hardware that is designated not used can be reassigned either module through the standard configuration procedure detailed below.

The control (CTL) source (R, D or nu) can be readily changed when the CVM module is in the “Not Ready” or “Ready” states. However, once the “Exec” (executing/running) status is attained, the control source is locked until CVM module's Endtime has expired.

The ability to assign hardware to different modules and specify different control sources allows great application flexibility. For instance, a single CVM can be used to hold columns and control valves for two different LC systems. One system would control the hardware in Module A and the other would independently control Module B, providing efficient use of hardware, instrumentation, and bench space.

Additionally, a CVM can have some valves rotated automatically under remote control and others changed manually under Local control by assigning the valves to different modules. This is useful for applications where the user needs to concentrate on changing the positions of the valves real-time under local control.

3.2.3 Setting Initial Conditions

To prepare for an analysis, the initial valve positions and temperatures of the column heaters are set and allowed to stabilize. Each valve and temperature zone has associated a user-entered delay time. While hardware components are achieving their new conditions and stabilizing, the status for the whole module is set by the CVM as “Not Ready”. After conditions are met and the delay time for column heaters, solvent selectors and column selector valves are satisfied, the module's status is changed to “Ready” and the CVM sends a Ready Out signal and monitors for a Start In signal.

If a hardware component cannot achieve its requested initial condition, such as a valve position or a heater temperature, the CVM declares a “Not Ready” state and outputs a Fault signal to alert the LC system's controller. The CVM can also convey a Fault signal received on a synchronization cable. The signal input will cause the CVM to enter its “Fault” state and prevent the CVM module from achieving a “Ready” state.

3.2.4 Executing the Run, Post-Run Operations

When the CVM module receives a Start In signal, typically from an autosampler or a position-sensing switch on a manual injector, the “Exec” (executing/running) state is initiated and the Runtime clock is started. The Start Out relay is pulsed to post the signal to the synchronization cable, which will continue the Start signal to any other LC modules downstream of the CVM.

The Runtime clock continues until it reaches the user-entered “Endtime” value. Methods downloaded by the control software can instruct the CVM valves to change positions at specific preprogrammed times during this period. The user can also

change valve positions during the run using the control software or from the CVM front panel keypad. When its Endtime is reached, the CVM module exits the “Exec” (executing/running) state and enters the “Ready” state.

Caution To avoid accidental valve switching that may mix incompatible solvents, the CVM hardware components maintain the last settings of the run and do not revert automatically to the initial conditions. For running a sequence of analyses in automation, the final valve positions should be chosen to be compatible with the initial conditions of the next method.

If a fault occurs during a run, either from a CVM hardware component or from a synchronization signal input from another device, the CVM will halt its run, and the Runtime and CVM hardware will retain their values at the time of the fault. The CVM module's state will change to “Not Ready”. The control software will recognize this condition and prevent further sample processing.

For maintenance and GLP (Good Laboratory Practices) records, the CVM tracks valve actuations. The cumulative number of actuations for each valve is maintained to allow service of the rotor and stator at regular intervals. When the valve is serviced, its actuation number can be reset to zero using the CVM front panel keypad.

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4. Operation

Before you configure your Varian 500-LC Column Valve Module for use in conjunction with your modular LC system, you should review the following information in this chapter:

- Power-up
- Remote operation using control software
- Manual operation using the front panel keypad
- Module control using relay input

4.1 Overview

4.1.1 Electrical Systems

A CVM may be configured with manually activated injector, solvent-selection, column-switching, and prime/purge valves.

After installation, operation of an electrical CVM system involves power-up, configuration (setup), running methods and hardware, and status checking. A clear plan of the intended operations is important to establish before programming automated or multiple-control methods.

4.1.2 Power-up

Before starting the system, carefully read the Safety Practices and Hazards section at the front of this manual and ensure that the laboratory is set up according to the details specified for your HPLC system.

4.1.2.1 Location of Main Power Switch

The main power switch is located on the cover for the electrical compartment, on the upper-rear corner of the right side of the module.

4.1.2.2 Powering up the Module for the First Time

To power up your CVM for the first time:

1. Check that all tubing on the valves, columns, and drip tray are correctly connected.
2. Ensure that all compartment covers have been replaced.
3. Plug the power cable into the socket on the rear panel of the CVM.
4. Plug the other end of the power cable into the wall socket and set the switch to 'On'.
5. Set the main power switch, located at the side of the instrument, to 'I'.

Note On initial power up, the module will emit a series of beeps and the display on the front panel of the CVM will light to show the version of firmware that is currently installed. On shut down, the firmware settings installed on the CVM are retained in non-volatile memory.

4.1.3 Control Options

The CVM can be configured to either be remotely operated using control software or manually operated from keypad on the front panel.

4.2 Remote Operation Using Control Software

Note For information on the setup, configuration, and control of the CVM from the control software please refer to the online Help accompanying the software.

4.3 Manual Operation Using the Front Panel Keypad

Note Please read the System Description chapter (starts on Page 31) and the portions of Appendix B (starts on Page 74) appropriate to the specific hardware for your CVM before proceeding further.

4.3.1 Introduction

The CVM keypad and display allow the user to configure the hardware, check status, and perform manual, real-time, control of valves and heaters. This control at the CVM is often desirable for instantaneous status checks and fast actions, especially if a PC providing serial control is located some distance from the LC system.

Note Method building is not possible from the CVM keypad and is accomplished through the control software.

4.3.2 Display and Keypad Features and Conventions

Figure 16. CVM front panel keypad and display.

The keypad layout is shown in Figure 16. The menus and parameters that are accessed through the keypad are summarized below.

4.3.2.1 Module

Press the ‘Module’ key to access a menu that lets you view the state of Module A or Module B on the display. There are three statuses: “Ready”, “Not Ready”, and “Fault”.

Note Submenus identify the source of a “Not Ready” or “Fault” status.

From this menu you can also review the following parameters:

- Control Mode – local (L), remote (R), or direct (D)
- Runtime
- Endtime

4.3.2.2 Valve

Press the ‘Valve’ key to access a menu that can display the following information for each valve:

- Current port position number
- Delay time left for this valve
- Type of valve
- Module in which the valve is configured

If the module that it is configured under is operating in local control mode, you can control the currently displayed valve using the arrow and numerical keys:

- Up/Down Arrows – a stepwise change in the position of the valve.
- Numerical Input – rotation of the valve to the entered position.

Note The direction of rotation is that requiring the least travel to accomplish the move.

4.3.2.3 Temp.

Press the ‘Temp.’ key to access a menu that can display the following information for each column heater block:

- Set temperature
- Current temperature
- Delay time left – time the block has to equilibrate at set point
- Module in which the valve is configured

If the module that it is configured under is operating in local control mode, you can control adjust the temperature of the currently displayed column heater block using the numerical keys.

Note Temperature rise is rapid, taking approximately 15 minutes to heat from 25 °C to 90 °C. Cooling down can take longer due to the insulation of the block.

4.3.2.4 Setup

Press the ‘Setup’ key and select from one of the following menus:

- MODULE – use to setup of Module A and Module B.
- VALVE – setup parameters for electrically actuated valves.
- TEMP – setup parameters for column block heaters.
- CHASSIS – this setup menu is no longer used.
- SRVC – this setup menu accesses service functions.

Note The setup menus are used to configure the basic operating parameters of the components of a CVM.

4.3.2.5 Left/Right Arrow

The left arrow (◄) and right arrow (►) keys move the cursor stepwise among fields along lower line of display.

Note A value entered in the current field is saved automatically.

4.3.2.6 Up/Down Arrow

The up (▲) and down arrow (▼) keys are used to select between the available parameters to display or to increment/decrement numeric values in an editable field.

Note An editable field is indicated by the cursor on the display appearing as flashing up and down arrows, or flashing hyphens if an entry using the numeric keys is also possible. If the cursor appears as dots then the field is either always non-editable or the parameter is locked, which occurs when a module is operating in either the Remote or Direct control mode.

4.3.2.7 Numeric Keys

The numbers (0–9) and the decimal point (.) are used to enter values into numeric fields.

Note Numeric fields are indicated by the cursor appearing as flashing hyphens. The up and down arrow keys can also be used to adjust a numeric field.

4.3.2.8 Enter

Use the ‘Enter’ key to indicate that a new field entry is complete, which prompts the system to accept the value entered.

4.3.2.9 Clear

The ‘Clear’ key erases keystroke entries not yet saved by pressing the ‘Enter’ key or moving the cursor using the left/right arrow

4.3.2.10 Back

Pressing the ‘Back’ key returns the display and cursor to the previous field.

4.3.2.11 Unassigned Keys

The function keys (F1–F4) and the ‘Help’ key on the keypad are unassigned.

4.3.3 Configuration and Setup

Configuration of the CVM firmware is required for operation, as the firmware informs the system of how the valves, heaters, and communication signals will be used and controlled. The first step of configuration is system planning.

After system planning, the actual configuration of the firmware may be performed manually via the CVM front panel display and keypad, or remotely using the control software. Configuration from the front panel is initiated through the 'Setup' key.

4.3.3.1 System Planning

Module Assignments

Determine which CVM hardware components will generally be operating during the same analysis run. These components will be assigned to same module so they can be monitored together. When all are in the "Ready" state, a run can be started. These components will share the same Runtime and Endtime, the same Start signal, and operate under the same control mode.

Usually, where the module is incorporated into an LC system, all CVM hardware components will operate together and assigned to Module A.

When two LC systems (autosamplers, pumps, and detectors) are connected to one CVM, the CVM hardware components are divided between Module A and Module B. The CVM valves and heaters associated with the first LC system are assigned to Module A and those operating with the second LC system are assigned to Module B.

Alternatively, both modules A and B are used when control modes differ. For example, when a solvent selection valve is being switched automatically through PC serial communication, and a diverter valve is controlled locally from the front panel by a user making real-time decisions based on the developing chromatogram.

For more information about module assignments refer to the System Description chapter, starts on Page 31.

Maximum Temperatures for Column Block Heaters

Based on the temperature tolerance of the column(s) and the boiling point(s) of the solvent(s) to be used, determine the maximum value (°C) to be allowed as an upper temperature limit.

Valve Use

Decide how a valve will be used so that the appropriate delay parameters can be applied by the CVM controller. The fields used in configuring electrically actuated valves are described in Section 4.3.3.4, Page 48. Also refer to Appendix B, starts on Page 74, for detailed information on specific valve models.

4.3.3.2 Setup

Note Use the generalized instructions below for navigating the fields that enable you to configure each of the setup menus: MODULE, VALVE, TEMP, and SRVC.

To configure setup parameters using the keypad:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to a setup menu and press **Enter**.
3. Use the left/ right arrow key to move the cursor among the display fields.
4. Use the up/down arrow key to step through selection choices in editable fields.

Note An editable field is indicated by the cursor on the display appearing as flashing up and down arrows, or flashing hyphens if entry using the numeric keys is also possible.

5. Use the up and down arrow keys or numeric keys to change an editable field.
6. Press **Enter** to save the new values.
7. Press the **Back** key to return to the list of setup menus.

More specific instructions on configuring parameters under each of the setup menus are provided in the following sections. Refer to the menu-specific tables in each section for detailed descriptions of editable fields that should be configured. Additional information is available in System Description chapter, starts on Page 31, and Appendix B, starts on Page 74.

4.3.3.3 Configuring Modules

The MODULE setup menu configures for each module:

- An address number – used for communication
- The control mode – local (L), remote (R), or direct (D)
- Start Out pulse – duration (seconds)

To configure a module's setup parameters using the keypad:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **MODULE** setup menu and press **Enter**.
3. Use the up/down arrow key to select either A or B. All of the fields for that module are displayed.
4. Use the arrow/numeric keys to adjust each field to the appropriate parameters for the selected module. The module-specific fields that can be configured from this setup menu are listed in Table 6.

Table 6. MODULE setup menu fields.

Field	Values	Comments
MOD	A, B	Selects Module A or Module B.
CTL	L, R, D	Control modes: L = Local (CVM keypad); R = Remote (serial communication with the control software); D = Direct (relay input).
UNIT	0–63	Address number to identify this module for communications with control software. Default values are 13 for Module A and 14 for Module B. Additionally, values 15 and 16 are reserved in the control software for a second CVM unit.
START OUT	0.1, 0.5, 0.6, 1.0, 2.0	Duration in seconds of the Start Out pulse generated by a relay contact closure for the discrete I/O port. Use 2.0 for all Varian hardware. You only need change this pulse duration if you have a pump that has different requirements.

4.3.3.4 Configuring Valves

The VALVE setup menu configures for each electrically actuated valve:

- Model number – required by firmware to identify the valve
- Delay time – used to optimize valve switching time (minutes)
- Use/delay – defines the valve's use and delay
- The control mode – local (L), remote (R), or direct (D)
- Module – Module A (A), Module B (B), or not used (nu)

It is also possible to view the following non-editable fields via the setup menu:

- Actuations – cumulative number of moves made by a valve
- Firmware – the version of control motion profile in use

Note A label on each electrically actuated valve indicates its circuit board connection, which is from 1 to 4 (see Section 3.1.5.3, Page 35). Another label indicates the valve's six-digit model number.

To configure a valve's setup parameters using the keypad:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **VALVE** setup menu and press **Enter**.
3. Use the up/down arrow key to select the valve number (from 1 to 4), which corresponds to the circuit board connection for the valve. All of the fields for that electrically actuated valve are displayed.
4. Use the arrow/numeric keys to adjust each field to the appropriate parameters for the selected valve. The valve-specific fields that can be configured/viewed from this setup menu are listed in Table 7.
5. If you have more than one valve to configure, repeat steps 2–4 for each additional valve.
6. When you have finished configuring your valve(s), power down the CVM and then restart the module. This system restart allows the firmware to register the status of the newly configured valve(s).

Table 7. VALVE setup menu fields.

Field	Values		Comments
VLV	1, 2, 3, 4		Circuit board number.
MODEL	1x106 5x100 5x104 none	(310-107) (5x106) (5x105)	Valve model number (x = 00 or 50). Factory will configure model numbers for each CVM. **Note:** Except for upgrades to the CVM, is usually unnecessary to change this factory-set value. For the models listed in parentheses, use the designation listed to its left in the table. For valve model 310-106, use 1x106.
DELAY	0.00–999.00		Delay, in minutes, for the action in the “USE/DLY” field.
USE/DLY	CS/RDY SS/RDY DVP/ACT INJ/RDY ---/---		**Use Definitions:** CS = column switching; SS = solvent selection; DVP = diverter valve preparative scale; INJ = injector; and --- = not present or none. **Delay definitions:** RDY = at a change position command, the valve executes the position change and starts a countdown until the “Ready” state is asserted. This delay provides equilibration time for solvents to flush lines and columns, needed by SS and CS valves. ACT = at a change position command, starts a countdown after which the valve actuates for position change. This delay is used with diverter valves to compensate for time required for analyte to travel from detector to the valve.
CTL	L, R, D		Control modes: L = local control (CVM keypad); R = serial I/O with a computer (J-24); and D = direct I/O control from relays (J-19 or J-31).
MOD	A, B, nu		Assigns valve to Module A, Module B, or not used (nu).
MOVES	Read only		Number of moves made by a valve since last service reset.
PIC_VER	Read only		Version of valve control firmware currently installed.

4.3.3.5 Configuring Column Heater Blocks

The TEMP setup menu configures for each column heater block:

- Max. temperature – prevent damage to column/CVM (°C)
- Delay – time to reach thermal equilibrium (minutes)
- Module – Module (A), Module (B), or not used (nu)

Note The heater labels are on the column mounting plate, adjacent to their respective heater blocks (see Section 3.1.5.5, Page 36). Typically, the block nearest the electronics compartment is assigned as position 1.

Caution It is important to limit the maximum temperature value of the column block heaters, so as to avoid damage to your LC system and/or minimize any hazards associated with the heating of the column. Always ensure that the value is lower than the boiling point(s) of the solvent(s) that will be used, and that the temperature cannot exceed the tolerance(s) of your column(s).

To configure a heater's setup parameters using the keypad:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **TEMP** setup menu and press **Enter**.
3. Use the up/down arrow key to select the position (1 or 2) of the column heater block. All of the fields for that column heater block are displayed.
4. Use the arrow/numeric keys to adjust each field to the appropriate parameters for the selected valve. The heater-specific fields that can be configured/viewed from this setup menu are listed in Table 8.

Table 8. TEMP setup menu fields.

Field	Values	Comments
TMP	1, 2	Number (position) of the heater.
MAX	0–90	Maximum temperature (°C) that can be entered as set temperature.
DELAY	0.0–99.0	Equilibration time (minutes) after reaching set temperature (± 2°C) before assertion of “Ready” signal.
MOD	A, B, nu	A = Module A; B = Module B; and nu = not used.

Note Assigning a column heater block as not used (nu) does not disable its temperature control. Turn off a column heater block off by setting the DELAY to 0.0, which means the component is always “Ready”, and adjust the set temperature to below ambient temperature. Prevent the column heater block from being heated by setting the MAX value below ambient.

4.3.4 Operation of the CVM Using the Front Panel Keypad

The CVM front panel keypad and display allows status monitoring and real-time (manual) changes to the module, valve, and column heater block parameters.

This section provides stepwise instructions for these operations, which may be divided into two categories:

- View Status – view parameter (always accessible)
- Change Parameter – adjust settings of components

Note The keypad can only be use to adjust the parameters of components assigned to modules operating under Local control mode.

To configure a module to Local control mode:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **MODULE** setup menu and press **Enter**.
3. Use the up/down arrow key to select either A or B. All of the fields for that module are displayed.
4. Use the left/right arrow keys to move the cursor to **CTL**.

5. Use the up/down arrow keys to select **L** and press **Enter**.

The module has now been put under the Local control mode, which means parameters for components assigned to that module can be adjusted using the keypad.

4.3.4.1 View a Module's Run Status

To view a module's run status:

1. Press **Module** and then move the cursor to the **MOD** field and press **Enter**.
2. Select either A or B and press **Enter**.

The current state of the selected module is displayed.

4.3.4.2 Identify Which Component is "Not Ready" or at "Fault" Status

To view the components' run statuses:

1. Press **Module** and then move the cursor to the **MOD** field and press **Enter**.
2. Select either A or B and press **Enter**.
3. Move cursor to **Status** menu and press **Enter**.

The current statuses of all components are displayed in the following format: VVVVTTRF. Where:

- VVVV = Valves 1–4 respectively
- TT = Column heater blocks 1 and 2
- R = Ready In
- F = Fault – incoming and internal signals

The components' statuses appear listed in a row immediately below and are designated accordingly:

- R = "Ready"
- N = "Not Ready"
- F = "Fault"

4.3.4.3 View Runtime/Endtime

To view the Runtime/Endtime field for a module:

1. Press **Module** and then move the cursor to the **MOD** field and press **Enter**.
2. Select either A or B and press **Enter**.

The current Runtime and Endtime are displayed.

4.3.4.4 Change Endtime

To change the Endtime for a module:

1. Press **Module** and then move the cursor to the **MOD** field and press **Enter**.
2. Select either A or B and press **Enter**.
3. Move cursor to **Endtime** and then use the up and down arrow keys or the numeric keys to adjust the value.
4. Press **Enter**.

The Endtime has been changed.

4.3.4.5 View Current Port Position of an Electrically Actuated Valve

To view the current port position of a valve:

1. Press **Valve** and then select the **VLV** field.
2. Use the up and down arrow keys to select the valve number (1–4) and press **Enter**.

The POS field shows the current position of the valve.

4.3.4.6 Change the Port Position of an Electrically Actuated Valve

To change the port position of a valve:

1. Press **Valve** and then select the **VLV** field.
2. Use the up and down arrow keys to select the valve number (1–4) and press **Enter**.
3. Move cursor to **POS** and then use the numeric keys to select the port position.
4. Press **Enter**.

The time taken to switch to the selected port depends on the USE/DLY that is assigned to the valve (Table 7, Page 50):

- */RDY = immediate switch and then delay countdown starts
- */DLY = the delay countdown elapses and the switch occurs

Caution Care must be taken with solvent selection valves to ensure that you do not perform valve switching that may mix incompatible solvents.

4.3.4.7 View the Delay Countdown Progress for a Valve

To view the delay countdown progress for a valve:

1. Press **Valve** and then select the **VLV** field.
2. Use the up and down arrow keys to select the valve number (1–4) and press **Enter**.

The DELAY field shows the time remaining.

Note It is only possible to change the Delay setting via the Setup menu (see Section 4.3.3.4, Page 48).

4.3.4.8 View USE Assignment for a Valve

To view the USE assignment for a valve:

1. Press **Valve** and then select the **VLV** field.
2. Use the up and down arrow keys to select the valve number (1–4) and press **Enter**.

The USE field is displayed.

Note It is only possible to change USE/DLY setting via the Setup menu (see Section 4.3.3.4, Page 48).

4.3.4.9 View the Module Assignment for a Valve

To view the module that a valve is assigned to:

1. Press **Valve** and then select the **VLV** field.
2. Use the up and down arrow keys to select the valve number (1–4) and press **Enter**.

The MOD field shows the module assignment:

- A = Module A
- B = Module B
- nu = not used

Note It is only possible to change a valve's assignment to a module via the Setup menu (see Section 4.3.3.4, Page 48).

4.3.4.10 View Current/Set Temperature of a Column Heater Block

To view the current temperature of a column heater block:

1. Press **Temp.** and then select the **TMP** field.
2. Use the up and down arrow keys to select the block number (1–2) and press **Enter**.

The TNOW field shows the current temperature of the heater block and the SET field shows its set point temperature.

4.3.4.11 Change the Set Temperature of a Column Heater Block

To change the set temperature of a column heater block:

1. Press **Temp.** and then select the **TMP** field.
2. Use the up and down arrow keys to select the block number (1–2) and press **Enter**.
3. Move cursor to **SET** then use the up and down arrow keys or the numeric keys to adjust the value.
4. Press **Enter**.

The change takes effect immediately but the actual time taken to reach the new set point depends upon many factors. Once at the set point temperature (± 2 °C), the delay countdown starts to ensure that the module stays at the “Not Ready” status until it has thermally equilibrated.

Caution Although the maximum value should have already been configured during setup (see Section 4.3.3.5, Page 51), always ensure that the set point temperature entered does not exceed that tolerated by the column(s) that are mounted in the block or exceeds the boiling point(s) of the solvent(s) that are used in the mobile phase.

4.3.4.12 View the Remaining Delay Time for a Column Heater Block

To view the current temperature of a column heater block:

1. Press **Temp.** and then select the **TMP** field.
2. Use the up and down arrow keys to select the block number (1–2) and press **Enter**.

The DELAY field shows the time remaining before the “Ready” status is attained.

Note It is only possible to change the Delay setting via the TEMP setup menu (see Section 4.3.3.5, Page 51).

4.3.4.13 View the Module Assignment for a Column Heater Block

To view the module that a column heater block is assigned to:

1. Press **Temp.** and then select the **TMP** field.
2. Use the up and down arrow keys to select the block number (1–2) and press **Enter**.

The MOD field shows the module assignment:

- A = Module A
- B = Module B
- nu = not used

Note It is only possible to change a heater's assignment to a module via the TEMP setup menu (see Section 4.3.3.5, Page 51).

4.4 Module Control Using Relay Input

Note It is recommended that when you are controlling valves in the Direct mode, you do not attempt to use the control software at the same time.

4.4.1 Introduction

The CVM can be controlled by using relay input to switch a specific valve to a specific port position. The CVM general purpose synchronization cable (part number 0393585902) is used to connect external relays to the CVM. Two wires and a digital ground are used to select a valve and four wires and a digital ground are used to select a valve position.

4.4.2 Initial Setup

The CVM must be configured for the valves you have installed (see Section 4.3.3, Page 46).

Note In order to operate using Relay Input the module(s) of CVM must be put into the Direct control mode of operation.

To configure a module to Direct control mode:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **MODULE** setup menu and press **Enter**.
3. Use the up/down arrow key to select either A or B. All of the fields for that module are displayed.
4. Use the left/right arrow keys to move the cursor to **CTL**.
5. Use the up/down arrow keys to select **D** and press **Enter**. The module has now been put under the Direct control mode.

Note While in the Direct control mode valve position changes cannot be made using the CVM front panel. If the CVM is powered down and

then back up it automatically switches to Local control mode and so you will have to re-select the Direct mode.

6. Connect the CVM general purpose synchronization cable (part number 0393585902) to J-19 on the rear panel of the CVM. Secure the 25-pin connector using the two screws on the plug housing.

4.4.3 Connecting to External Relays

To connect to a relay the digital ground (labeled −DGND) and one of the Relay Input wires of the CVM General Purpose Cable (labeled A0, A1, B0, B1, B2,and B3) are connected to the relay. Relays are available on several Varian LC modules. Table 9 gives the number of relays available for some of the Varian LC modules that might be used with the CVM.

Table 9. Relays available on Varian LC pump modules.

Model Number/Description	Number of Relays Available
210/Pump Module	3
SD-1/Pump Module	6

Many other LC detectors, pumps and sampling devices offer relays. The number of relays needed for valve control depends upon two things:

- The number of valves are to be controlled
- How many port positions each valve has

4.4.4 Selecting a Valve with Relay Input

Inputs A0 and A1 are used to specify which valve is selected:

$$\text{Valve Selected} = 1 + (A0 \times 2^0) + (A1 \times 2^1)$$

This binary-plus-one coding is summarized by Table 10.

Table 10. Selection of valve number from relay inputs A0 and A1.

A0	A1	Valve Selected
Open (0)	Open (0)	1
Closed (1)	Open (0)	2
Open (0)	Closed (1)	3
Closed (1)	Closed (1)	4

Note Closed (1) indicates that the input is connected to digital ground and Open (0) indicates the input is not connected to digital ground. There are three available digital ground (−DGND) wires on the CVM general purpose synchronization cable (see Table 5, Page 29).

4.4.5 Selecting a Valve Port Position with Relay Input

Inputs B0–B4 are used to specify which port position is selected:

$$\text{Port Position} = 1 + (B0 \times 2^0) + (B1 \times 2^1)\,(B2 \times 2^2) + (B3 \times 2^3)$$

This binary-plus-one coding is summarized by Table 11.

Table 11. Selection of port position from relay inputs B0–B3.

B0	B1	B2	B3	Port Position
Open (0)	Open (0)	Open (0)	Open (0)	1
Closed (1)	Open (0)	Open (0)	Open (0)	2
Open (0)	Closed (1)	Open (0)	Open (0)	3
Closed (1)	Closed (1)	Open (0)	Open (0)	4
Open (0)	Open (0)	Closed (1)	Open (0)	5
Closed (1)	Open (0)	Closed (1)	Open (0)	6
Open (0)	Closed (1)	Closed (1)	Open (0)	7
Closed (1)	Closed (1)	Closed (1)	Open (0)	8
Open (0)	Open (0)	Open (0)	Closed (1)	9
Closed (1)	Open (0)	Open (0)	Closed (1)	10
Open (0)	Closed (1)	Open (0)	Closed (1)	11
Closed (1)	Closed (1)	Open (0)	Closed (1)	12
Open (0)	Open (0)	Closed (1)	Closed (1)	13
Closed (1)	Open (0)	Closed (1)	Closed (1)	14
Open (0)	Closed (1)	Closed (1)	Closed (1)	15
Closed (1)	Closed (1)	Closed (1)	Closed (1)	16

Note The CVM firmware ignores relay input signals to move to a port position that exceeds the number of ports available for that valve model. For example, a six-port, column-switching valve will not move if the relay input signals are selected for port positions 7–16.

4.4.6 Starting Relay Control for the First Time

Assume that the CVM General Purpose Cable is connected to the CVM and external relays. With the CVM in Local mode move the valves to the desired starting positions using front panel control. Now change from Local to Direct mode. Notice that no valve changed position even if the relay input should have moved the

valve to another port position. The CVM software is designed to not change current valve position when the Direct mode is activated. This prevents accidental valve position changes when the Direct mode of operation is selected. The valves will change position only when a change in the current external relay input occurs. Before starting the CVM in the Direct mode it will always be necessary to manually move the valves to their starting positions.

5. Maintenance

This chapter includes the 500-LC Column Valve Manual maintenance requirements that may be carried out by an operator. Any maintenance procedures not specifically mentioned in this chapter should be carried out only by Varian-trained, Varian-qualified, or Varian-authorized customer support representatives.

Warning – Eye Hazard – Chemical Hazard
The use of solvents in liquid chromatography is inherently hazardous. Always wear appropriate personal protective equipment when performing maintenance tasks on LC system modules, as both high and low pressure leaks present a danger to eyes and exposed skin. Before using a solvent on your LC system familiarize yourself with the information on all relevant material safety data sheets (MSDS).

Warning – Shock Hazard
Death, serious injury, or painful electrical shock can result by contact with these circuits, devices and components. Dangerous voltages exposed when electrical compartment cover is removed. Access intended for Varian service representative only.

Warning – Burn Hazard
Close contact with the heated surfaces of the column block heater can result in severe heat burns to the skin. Turn off power switch, unplug power cord, and allow the heater to cool before mounting or removing a column.

5.1 Routine Maintenance

The following parts of the instrument require routine maintenance:

Hourly

- Check and, if necessary, empty the waste solvent collection vessel.

Daily

- Check the drip tray drain tube for evidence of leaks within the column compartment and external fittings for any signs of leaks. Eliminate any leaks found by tightening fittings just enough to stop the leaks. If leaks are found in a system that has been run with buffers, it is best to undo the fittings, rinse all fitting surfaces with water to remove salt deposits, reassemble and tighten.

Weekly

- Periodically check the number of actuations for each valve (see Section 5.2, below, for instructions on how to do this).

5.2 Valve Maintenance

As a consequence of normal use, the rotor and stator of a valve will wear. The rate of wear is hard to predict since it depends on the size and concentration of particulates in the mobile phase as well as the lubricity of the solvents themselves. For normal, carefully filtered HPLC solvents, valves can typically run for 10 000 to 100 000 actuations before needing service.

Valves should be monitored for leak-free service and reliable moves to new port positions. When wear is severe, the valve may show solvent leaks around the valve body, leaks between valve ports, or flows from normally closed ports.

Rotor and stator wear can also cause increased friction that disrupts consistent rotation for port alignment. If the CVM or the control software reports of a number of faults from a particular valve then this is a sign that valve service is required.

A preventative maintenance program is recommended. Maintain a performance record for each valve, noting solvents used, frequency of activation, and any faults occurring for that valve. Each valve can be inspected on a regular interval.

The actual number of moves recorded for each valve is stored in the CVM's non-volatile memory, simplifying the implementation of a preventative maintenance program.

To view the number of actuations a valve has made:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **VALVE** setup menu and press **Enter**.
3. Select the **VLV** field then use the up and down arrow keys to select the valve number (1–4) and press **Enter**.

The MOVES field shows the total number of moves since the last reset to 0 using the SRVC setup menu (Section 5.2.1.1, Page 64).

5.2.1 Utilizing the SRVC Setup Menu

The keypad can be used to access to the SRVC setup menu.

To access the SRVC setup menu using the keypad:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **SRVC** setup menu and press **Enter**.

Table 12 lists the fields accessible from the SRVC setup menu.

Table 12. SRVC setup menu fields.

Field	Description	Comments
VLV	Connection number marked on the installed valve (1–4).	N/A
POS	Enter the new position and press the Enter key to start the move.	Uses an accelerated motion profile to move the valve
FAULT FIX	Press up/down arrow to clear a valve position fault.[1]	When fixed, POS value should equal SNS value
SNS	Port position value currently read by valve's sensor	Displays 0 if valve is not aligned with a port.
CLR_VLV MVS	Press up/down arrow to reset the number of actuations made.	Resets the MOVES field (see Table 7, Page 50)

[1] Valve fault implies that the valve's port position is unknown. A constant velocity motion profile is used to find a port.

5.2.1.1 *Resetting the Number of Actuations Recorded for a Valve*

When an electrically actuated valve is serviced and new parts installed, the total number of actuations for the valve should be reset to 0.

To reset the number of actuations recorded for a valve:

1. Press **Setup** on the keypad. The list of setup menus will appear.
2. Move the cursor with the left/right arrow key to the **SRVC** setup menu and press **Enter**.
3. Select the **VLV** field then use the up and down arrow keys to select the valve number (1–4) and press **Enter**.
4. Move the cursor with the left/right arrow key to the CLR_VLV MVS field.
5. Press the up/down arrow key to reset the number of actuations recorded.

5.3 Cleaning

Any spills in the column compartment should be wiped up immediately.

The exterior surfaces of the instrument should be kept clean. All cleaning should be done with a soft cloth. If necessary, this cloth can be dampened with water or a mild detergent. Do not use organic solvents or abrasive cleaning agents.

5.4 Accessories, Spare Parts and Consumables

For the most up-to-date ordering information for accessories, spare parts, and consumables refer to the Varian, Inc. Web site:

www.varianinc.com

6. Troubleshooting

This section consists of a list of possible actions of concern, their probable causes, and recommended corrective actions.

Note If the suggested corrective action fails to eliminate the problem, call Varian Service.

6.1 Power-Up Problems

6.1.1 CVM Does Not Power Up

Description

CVM does not power up: no sound after power switch is thrown, display does not light up.

Probable Cause

No power to the unit.

Corrective Action

- Verify the outlet for the power cord provides proper voltage power.
- Verify power cord is firmly attached at both ends.
- Verify that the fuse in the power inlet assembly on the CVM rear panel is not blown.

6.2 Status Problem

6.2.1 CVM Remains in “Not Ready” State

Description

System remains in “Not Ready” state.

Probable Cause

Synchronization cable not properly attached, long delay time in progress or hardware fault.

Corrective Action

- Verify synchronization cable connections are proper and secure.
- Check hardware using Front Panel (see Section 4.3.4.2, Page 53). If valves or heaters are “Not Ready” (N), check if delay countdown is still in progress. If valves or heaters are Faulted, see sections 6.2.2 and 6.2.3, below. If Ready In (R) is “Not Ready” (N), check other LC instruments for “Ready” status. If Fault (F) is “Not Ready” (N), determine if a Fault signal is being sent into the CVM from another LC instrument and correct its problem.

6.2.2 Valve Status is Reported as “Fault”

Description

The status of a valve is reported as “Fault”.

Probable Cause

Controller cannot identify position of rotor.

Corrective Action

- Turn the power switch on the CVM off then back on.
- Check under the SRVC setup menu that SNS and POS field have same values (see Section 5.2.1, Page 63). If the values are different then move cursor to Fault Fix field and press the up arrow key once. Confirm that the SNS and POS fields are now the same value.

6.2.3 Heater Status is Reported as “Fault”

Description

The status of a heater is reported as “Fault”.

Probable Cause

Heater hardware failure.
or
Heater control circuit failure.

Corrective Action

- Compare reported current temperature and set temperature values (see Section 4.3.4.10, Page 55).

6.3 Heater Problem

6.3.1 "Ready" Status Achieved Below/Above Set Point Temperature

Description

System reaches the "Ready" state before a column heater block has stabilized at the set point temperature.

Probable Cause

Heater delay time is set to 0.

Corrective Action

- Set the delay time to allow for a short period of stabilization after the heater reaches the set point temperature (see Section 4.3.3.5, Page 51).

6.3.2 Temperature of Heater Fluctuates

Description

The current temperature of the column heater block fluctuates greatly.

Probable Cause

Heater cover is not installed properly.

Corrective Action

- Install heater cover to fully cover block.

6.3.3 Heater Does Not Heat

Description

The temperature of a column heater module not changing to reach set point.

Probable Cause

Heater assigned to other module.
or
Hardware failure.

Corrective Action

- Verify that the heater is assigned to correct module (see Section 4.3.4.13, Page 56) and that the current temperature

is not in the process of achieving the set temperature (see Section 4.3.4.10, Page 55).

- If hardware failure is suspected, call Varian Service.

6.3.4 Current Temperature of Heater is 100 °C

Description

Heater is heating continuously with the thermal cutout switch intervening to keep temperature from exceeding 100 °C.

Probable Cause

Heater circuit failure.

Corrective Action

- Call Varian Service.

6.4 Valve Problem

6.4.1 Valve Moves to Incorrect Position During a Method

Description

Valve goes to wrong position during method execution.

Probable Cause

Configuration issue with valve.
or
An error in the method.

Corrective Action

- Check that valve goes to the correct port number (see Section 5.2.1, Page 63). If so, port label in control software may be wrong. Check valve configuration for proper port label assignment (see Section 4.3.3.4, Page 48). If valve goes to wrong port number, verify the valve time program is correct.

6.4.2 Solvent Leaks Around Valve Body

Description

Solvent leaks occur around the body of a heavily worn valve.

Probable Cause

Valve rotor and stator excessively worn.

Corrective Action

- Valve needs servicing.

Note Make sure solvent is free from particulates by filtering before use and install in-line filters on the solvent lines that are placed into solvent reservoirs.

6.4.3 Solvent Transfer Occurs Between Lines to a Selection Valve

Description

Solvent from one mobile phase circuit appears in another after going through a valve.

Probable Cause

Solvent transfer is indicative of port-to-port leakage within the valve, which is due to excessive wear or damage from particulates scratching the rotor.

Corrective Action

- Valve needs servicing.

Note Make sure solvent is free from particulates by filtering before use and install in-line filters on the solvent lines that are placed into solvent reservoirs.

6.5 Control Software Problems

6.5.1 Communication Failure Between Software and CVM

Description

Control software does not “Read Configuration” from or “Download Configuration” to CVM.

Probable Cause

Improper serial communication setup.

Corrective Action

- Check that serial cable is properly and securely installed.
- Check the module has been correctly configured for remote (R) control mode (see Section 4.3.3.3, Page 47).

- Verify that the control software is correctly identifying the COM port that is connected to the CVM.

Appendices

Appendix A – Specifications

Varian 500-LC Column Valve Module

Configurations include LCD display, front panel keypad for local control, serial RS-422 Input/Output (I/O), and discrete (analog) I/O for remote control, power and control of temperature zones and electrically actuated valves.

Column Capacity

Mounts up to six analytical columns (10 mm OD × 30 cm length or smaller) or one preparative column (44 mm × 27 cm length or smaller) plus three analytical columns in the column compartment.

Manual Valve Capacity

The front panel can hold up to four manual analytical or preparative injector or switching valves plus four prime/purge valves.

Electrically Actuated Valves

Operates up to four separate electrically-actuated valves. Valve types offered currently:

Solvent switching for six solvents

Column switching for six columns

Column switching for three columns

Injector/diverter valve – preparative[1]

Column Temperature Zones

Up to two independently controlled heating zones, each holding up to two analytical columns. The column heater block design can accommodate column lengths from 5 to 25 cm with outside

[1] 1.0 mm (0.040 in.) ID, solvent flow rates up to 200 mL/min

diameters of up to 12.5 mm (0.5 in.). The temperature control range is from five degrees centigrade above ambient to 90 °C.

Bus Communication

Serial RS-422/485 I/O for communications with the control software.

Discrete Input/Output Communications

Six synchronization signals:

- Ready Out
- Ready In
- Start Out
- Start In
- Fault Out
- Fault in

Valves

The CVM can be configured with many combinations of manually and electrically actuated valves. This section lists the maximum operating pressure specifications for each valve.

Note Where x is stated in a model name, x = 00 is the stainless steel (SS) version and x = 50 is the polyetheretherketone (PEEK) version. While it is a biocompatible material, PEEK valves have lower maximum pressure limits than their metal equivalents.

Model 7030

Model 7030 valves (part number RE7030) are two-position, six-port, manually actuated, three-way switching valves:

- SS = 34 MPa (5000 psi) max. [48 MPa (7000 psi) in field]
- PEEK = 21 MPa (3000 psi) max. [28 MPa (4000 psi) in field]

Model 7725i

Model 7725i valves (part number RE7725I) are two-position, six-port, manually actuated, injection valves for use at analytical flow rates:

- SS = 34 MPa (5000 psi) max. [48 MPa (7000 psi) in field]
- PEEK = 21 MPa (3000 psi) max. [28 MPa (4000 psi) in field]

Model 3725i

Model 3725i valves (part number RE3725I) are two-position, six-port, manually actuated, injection valves for use at preparative flow rates:

- SS = 28 MPa (4000 psi) max. [34 MPa (5000 psi) in field]
- PEEK = 21 MPa (3000 psi) max. [28 MPa (4000 psi) in field]

Models RV5x-100, -104, -105, and -106

All electrically actuated, column-switching valves, including three-column models (part number 0393588501) and six-column models (part numbers 0393586601 and 0393586602):

- SS and PEEK = 34 MPa (5000 psi)

Note All of the above models are column-switching valves and injection valves that are located downstream of the pump and upstream of the column, which require the capability to withstand operation at high pressures. Below are solvent-selection valves, which are upstream of the pump, and so are not subjected to high pressure.

Model RV100-106 and Models RV310-106 and -107

Model RV100-106 valves are six-position, seven-port, electrically actuated, solvent-selection valves:

- 2.1 MPa (300 psi) max.

Leak Rates

The leak rate specification for all valves is < 3 µL/min at the maximum rated pressure.

Appendix B – Specific Hardware Descriptions and Application Tips

Warning – Shock Hazard
Death, serious injury, or painful electrical shock can result by contact with these circuits, devices and components. Dangerous voltages exposed when electrical compartment cover is removed. Access intended for Varian service representative only.

Please contact your local Varian office to arrange for a visit by a qualified Varian service representative.

Solvent-Selection Valves

This section provides information on the solvent-selection valves (SSV) supported by the Varian 500-LC column valve module.

Applications

Your LC pump can be connected to a six-position SSV (part number 0393586701) mounted in the CVM that allows the pump to access up to six different solvents in reservoirs.

The use of the SSV allows a variety of advanced applications from a single pump:

- Availability of a large number of primary solvents allowing rapid switching among analytical methods and a broader range of conditions to survey during method development.
- System flushing, column conditioning and storage which typically requires solvents additional to those used for the analyses.
- Sample fractionation using accurate and precise step gradients.
- Automated method switching with transitioning where different solvents are required.

Valve Types

Currently, the CVM firmware supports the RV100-106 (part number 0393586701) with integrated 3.2 mm ($^1/_8$ in.) OD PTFE tubing.

This valve has seven ports to which PTFE tubes are connected. The center port is attached to the pump while ports on the perimeter lead to the solvent reservoirs.

Figure 17 illustrates a SSV, showing that the center port of the valve connects to the pump while ports on the perimeter feed solvent from six separate reservoirs.

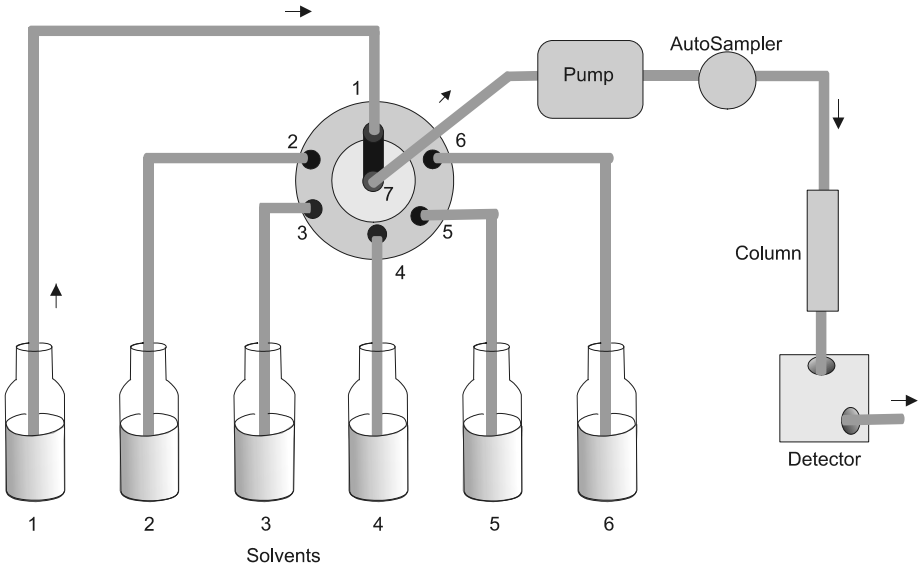

Figure 17. Connections between six solvent reservoirs and a solvent-selection valve, which is upstream of the LC system.

Installation

Inspect the valves mounted in the CVM and check the base model number of the SSV that has been installed.

Valve with Integrated Tubing (RV100-106)

The tubing ends of this valve are flanged, securing the integrated nuts. These valve tubes can be connected to either un-flanged or flanged tubing with the proper coupling and fittings.

Standard Varian pumps and solvent reservoir supplies are supplied with un-flanged tubing so the accessory parts shipped

with the SSV include: a coupler, ferrule, and nut for each tube, as shown assembled in Figure 18.

Note To attach the RV100-106 with integrated tubing to previously flanged tubing, you must order a coupling adapters (part number R100020016, 5 per pack).

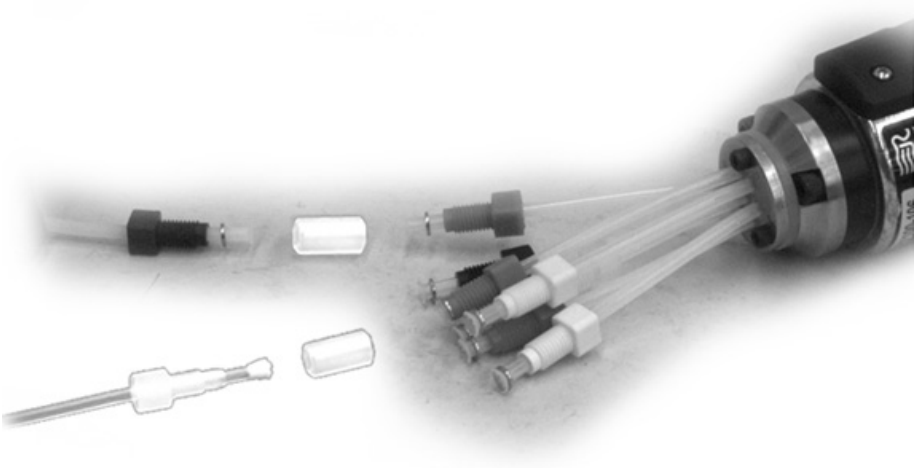

Figure 18. Connection of flanged and un-flanged, 3.2 mm ($^1/_8$ in.) OD tubing to a solvent selection valve with integrated PTFE tubing (RV100-106).

Preparing and Sequencing Solvent Reservoirs

Note It is highly recommended that solvent filters (part number UCA302A) be installed on the ends of the intake tubes entering the solvent reservoirs. Particulates in the solvents are a major cause for premature valve wear and the need for service.

Plan the connection of solvents to the solvent selection valve and consider the transitions among them. Use caution when configuring incompatible solvents, such as a combination that is immiscible or will cause precipitation of salts from one of them. The six solvents attached to the solvent selection valve will flow through the same tube to reach the LC pump, so a change between incompatible solvents must employ a solvent crossover method that uses a solvent compatible to both of them.

For example, to change over from water with phosphate buffer to acetonitrile, water should be flushed through the system first to remove all of the buffer salts and then the system may be flushed with acetonitrile.

When planning to which valve ports the solvent reservoirs will be attached, order the solvents so that adjacent ports will be occupied by compatible solvents. This lowers the chance of system damage if the solvent selector valve is stepped in error.

As a means to recover from a mistake in changing valve positions, it is also advisable to turn the pump flow off. This provides an opportunity to verify that the correct port was chosen before any solvent is pumped.

After the tubing connections from the valve to the solvent reservoirs and from the valve to the pump are made, the lines should be primed. With the solvent selector valve in line, prime each solvent line somewhat longer than without a valve to compensate for the increased volume of 2 to 5 mL in the tubing from the valve to the pump.

Note Remember to verify the compatibility of the sequence of solvents during the priming steps.

Operation

Solvent Quality and Preparation

HPLC grade solvents may be used directly from the bottle without further preparation (unless degassing or sparging is required by the application).

All buffers should be filtered after preparation. HPLC grade water produced by an in-house purification system should have as its final step passage over an activated carbon column followed by filtration.

Solvent Miscibility

Care must be taken to not introduce solvents into the pump which are not miscible with each other. For example, when switching from hexane to water, a mutually miscible solvent such as isopropanol must first be flushed through the hydraulic system. In some cases more than one intermediate solvent will be required. Sufficient time must be allowed for the hydraulics to be completely flushed with each solvent.

Solvent manufacturers' literature contains data on solvent miscibility. For example, American Burdick & Jackson publishes a High Purity Solvent Guide.

Impact on Method Programming and Analysis Runtime

The solvent selection valve and its connection to the pump adds a 2 to 5 mL volume that must be considered when programming

solvent changes. The volume should be determined for the particular setup and allowances made when changing solvents for the time necessary to flush this extra volume.

Service

Warning – Shock Hazard
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Please contact your local Varian office to arrange for a visit by a qualified Varian service representative.

Column-Switching Valves

This section provides information on the column-switching valves (CSV) currently supported by the Varian 500-LC CVM.

Applications

With column switching, a number of columns can be mounted and plumbed, ready for use when sample analysis requires. The solvent flow from the pump and through the injector can be switched to pass through a particular column, or through a bypass tube for rapid solvent changing. The effort to change columns is eliminated and the risk of leaks is greatly reduced.

Column switching is useful for:

- Maximizing the variety of samples that can be analyzed on a LC system without the substantial downtime to reconfigure and condition columns.
- Automating analysis of a variety of samples requiring different analysis methods.
- High throughput laboratories where column efficiency is monitored and rapid, simple switching to a new column is critical.

Note Column switching is usually performed between analyses, after the pump flow has been stopped and the pressure has dropped. This practice avoids solvent contamination of columns not in use, as the rotor must rotate past the passages leading to other columns in order to reach a non-adjacent column. Column switching during an

analysis while maintaining flow (heart-cutting) requires careful planning and typically uses six-port, two-position valves rather than column selection valves in order to simplify operations.

Valve Types

Column selection is most conveniently accomplished with a single valve, either the three-position (two columns and a bypass tube) or the six-position (five columns and a bypass tube) that connect the column inlet and outlet simultaneously. Alternatively, a pair of selection valves may be used, but the motion of the valve for the column inlets must be coordinated with that of the valve for the outlets.

Installation

Inspect the CVM to determine which type of column-switching valve has been installed. The Varian 500-LC CVM supports the use of the following column-switching valves, which are available either in stainless steel (x = 00) or the biocompatible material, polyetheretherketone (x = 50):

- Models RV5x-100 and -106 – three-position,eight-port valves that can be used to control selection between two columns and a bypass.
- Models RV5x-104 and -105 – six-position,14-port valves that can be used to control selection between up to five columns and a bypass.

Connections

Each column is plumbed as a hydraulic circuit loop on the three- and six-position column switching valves. Figure 19 illustrates a six-position valve configured with five columns and a bypass tube.

The mobile phase enters the valve at the inlet port and exits from the outlet port. The valve's internal rotor is moved to direct the mobile phase flow through a particular column or bypass tube. Columns not in line with the mobile phase flow are physically isolated and sealed by the valve's design.

Note Port positions are labeled on the head of the valves. Optional color-coded nuts help identify inlet and outlet tubes for the same column.

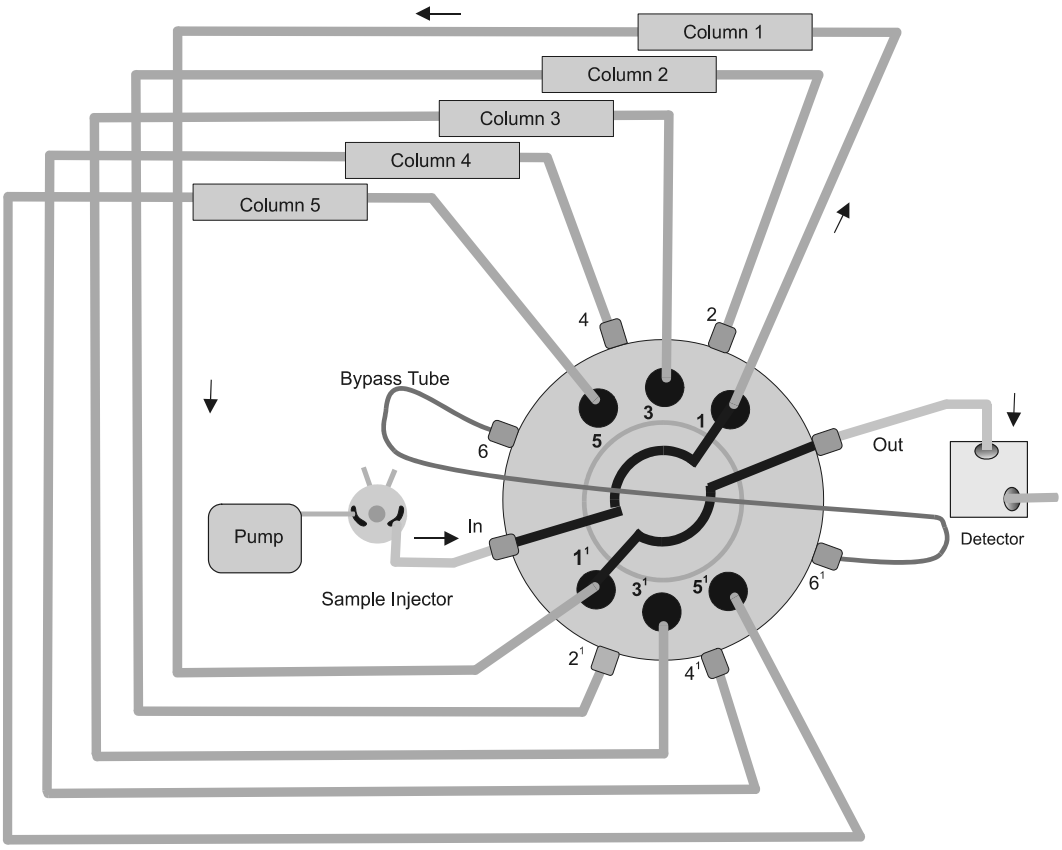

Figure 19. Solvent and column connections to a six-position column-switching valve (CSV). At least one bypass tube is recommended for solvent flushing and exchange.

At least one of the potential column positions should be used for the installation of a bypass tube, which allows for the rapid changing of the solvents through the system without having to subject the column to high flows and solvent changes. The bypass tube is typically located on the first or last column position of the valve for programming ease. However, other locations may be better for certain configurations.

For instance, if the valve services two groups of columns that use quite different solvents, it would be better to place the bypass tube between the column groups. Also, if the column selector valve is not fully loaded with columns, it is useful to connect additional bypass tubes to fill all ports.

Note After planning the positions of columns and bypass tubes on the column selector, prepare for connecting upstream tubing from the

injector or autosampler by running the pump for a few minutes to flush any particulate debris from the lines.

Stop the solvent flow and then make the tubing connections to the valve(s) as shown in Figure 19. Use the appropriate ferrules and nuts supplied for the valve. Optional color coded nuts can be used to identify each inlet and outlet tubing pair for each column.

Ensure that the columns are connected to related ports on the valve(s). For example, where Y = one to the number of positions:

Three- and six position column selection valve configurations

Models RV5x-100, -104, -105, and -106 are plumbed so that the inlet and outlet of column Y is plumbed to ports Y and Y^1 respectively.

Operation

Solvent Compatibility

When switching columns with a valve, it is important to consider the associated solvent changes and evaluate the compatibility of new solvents with old, and with column packing materials. Since the columns share common inlet and outlet tubing to pump and detector as well as narrow valve passages, it is critical that column switching does not mix incompatible solvents, such as a combination that is immiscible or will cause precipitation of salts from one. As a general practice, columns attached to selector valves should never be left in solvents containing solutes that tend to precipitate.

Changeover Methods and Bypass Tubes

To switch between columns which are stored in solvents which should not be mixed, move the valve position to a bypass tube and flush the entire hydraulic system using a solvent changeover method with a series of solvents that are stepwise compatible.

For example, a three-position column-switching valve might have attached to it a reverse-phase column stored in a 50:50 mix of methanol and water, a bypass tube, and a normal-phase column stored in hexane. Since switching from one column directly to the other would mix immiscible solvents, a solvent changeover protocol that utilizes the bypass tube should be run. A series of steps that might be run from the CVM keypad and the pump control panel is illustrated in Table 13.

Table 13. Steps for switching between columns to avoid mixing incompatible solvents.

Step	Valve Position	Solvent	Flow[1] (mL/min)	Comment
1	RP Column	MeOH/H_2O	0	Flow set to zero at end of reverse-phase (RP) method to avoid pressure-induced shock to RP column.
2	Bypass	MeOH/H_2O	0	Valve rotates to bypass position.
3	Bypass	Isopropanol	5	Isopropanol is miscible with the mobile phases used in both methods. Pump until flow path is purged of RP mobile phase.
4	Bypass	Hexane	5	Flush the flow path with the mobile phase used for the normal-phase (NP) method.
5	Bypass	Hexane	0	Flow set to zero at end of purge to avoid pressure-induced shock to NP column.
6	NP Column	Hexane	0	Valve rotates to position for NP method.

Note Using a solvent-selection valve (SSV) in conjunction with the column-switching valve (CSV), the above process can also be automated using the control software.

Service

Warning – Shock Hazard
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Please contact your local Varian office to arrange for a visit by a qualified Varian service representative.

Valve Maintenance

The valve components whose surfaces must seal against solvent pressures and also slide during valve movement are the critical components that will eventually require service. In the column-switching valves, these components are the rotor and stator. Their lifetimes can be greatly impacted by presence of

[1] Set the minimum pressure (P_{min}) of the pump to zero so it does not shut off when the valve is in its bypass position.

particulates in the mobile phase. A column-switching valve is especially vulnerable to particulates in unfiltered samples. Problems can also arise from precipitates formed upon injection if sample solubility is marked less in the mobile phase than in the sample solvent. Proper solvent choices can avoid precipitate formation.

As the valve components wear or are damaged, the ability to seal against the solvent pressure or the ability to slide to a new valve position may be compromised. This may lead to several symptoms that indicate the valve should be serviced:

- Solvent leakage from the valve body.
- Port-to-port leakage.
- Frequent position errors.

Column Heater Blocks

The Varian 500-LC CVM can support up to two independently controlled heating zones, each holding up to two analytical columns. The temperature control range is from five degrees centigrade above ambient to 90 °C. The column heater block design can accommodate column lengths from 5 to 25 cm with outside diameters of up to 12.5 mm (0.5 in.).

Note A 30-cm column can also be mounted in a block but both end fittings will not be enclosed by the insulation.

The column heater block consists of the following:

- A heater block and its mounting hardware.
- The harness assembly which includes the electrical heater cartridges (120 V or 240 V), the temperature probe, and self-resetting thermal cutoff switch.
- An insulated block cover.

The heater blocks can be mounted at two horizontal and two vertical positions on the column mounting plate to accommodate other hardware components. When installed at the factory, the first heater block is mounted on the right side (nearest to the electrical compartment) of the column compartment and in the lower of the two possible vertical positions.

Note With two blocks installed, cross-heating was measured in a closed column compartment with one block set at 90 °C and the other left unheated. With an ambient temperature of 24 °C, the unheated

block rose only 6 °C. When the column compartment door was removed, the unheated block was within 1 °C of ambient.

As detailed in Section 3.1.5.5, Page 36, the heater blocks are designated 1 or 2, according to which column heater circuit controls them. The label for each heater is placed beside it on the column mounting plate.

Column Mounting

Warning – Burn Hazard
Close contact with the heated surfaces of the column block heater can result in severe heat burns to the skin. Turn off power switch, unplug power cord, and allow the heater to cool before mounting or removing a column.

Section 2.5.2.2 and Figure 6, Page 20, describe how columns are mounted in a heater block.

Operation

The column heater block operating parameters (set temperature, maximum temperature, and delay time) are set in with the CVM keypad or in the control software.

Service

Warning – Shock Hazard
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Heater Maintenance

There is no routine maintenance required for the column heater blocks. A section on troubleshooting heater problems is presented in the Section 6.3, Page 67.

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