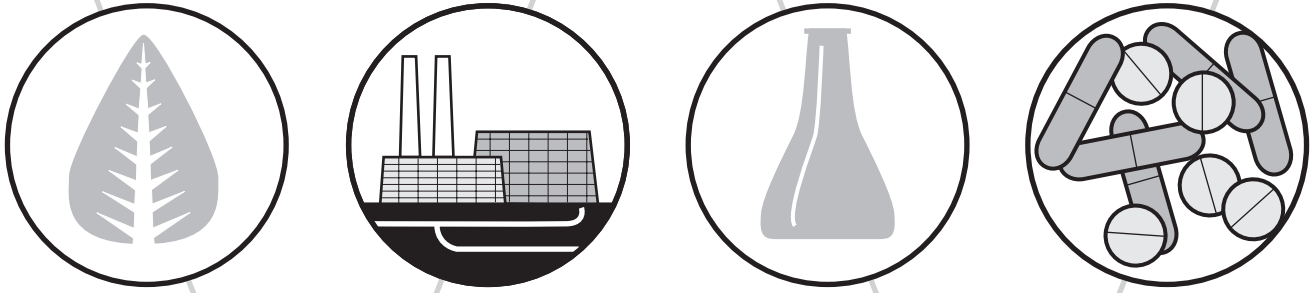
Waters 600E Multisolvent Delivery System

Installation and Maintenance Guide



Waters

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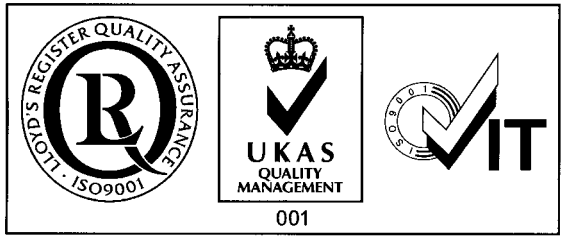


Note: *When you use the instrument, follow generally accepted procedures for quality control and methods development.*

If you observe a change in the retention of a particular compound, in the resolution between two compounds, or in peak shape, immediately determine the reason for the changes. Until you determine the cause of a change, do not rely on the separation results.

Note: *The Installation Category (Overvoltage Category) for this instrument is Level II. The Level II Category pertains to equipment that receives its electrical power from a local level, such as an electrical wall outlet.*

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

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

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

Avvertenza: *eventuali modifiche o alterazioni apportate a questa unità e non espressamente approvate da un ente responsabile per la conformità annulleranno l'autorità dell'utente ad operare l'apparecchiatura.*

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

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

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

주의 : 기기 검교정 담당자의 승인 없이 무단으로 기기를 변경 또는 수정하는 경우에는, 그 기기 운영에 대한 허가가 취소될 수 있습니다.

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

Caution: *Use caution when working with any polymer tubing under pressure:*

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

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

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

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

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

Attenzione: *prestare attenzione durante l'utilizzo dei tubi di polimero pressurizzati:*

- *Indossare sempre occhiali da lavoro protettivi nei pressi di tubi di polimero pressurizzati.*
- *Estinguere ogni fonte di ignizione circostante.*
- *Non utilizzare tubi soggetti che hanno subito sollecitazioni eccessive o son stati incurvati.*
- *Non utilizzare tubi non metallici con tetraidrofurano (THF) o acido solforico o nitrico concentrato.*
- *Tenere presente che il cloruro di metilene e il dimetilsolfossido provocano rigonfiamento nei tubi non metallici, riducendo notevolmente la resistenza alla rottura dei tubi stessi.*

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

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

警告：當在有壓力的情況下使用聚合物管線時，小心注意以下幾點：

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

警告：当在有压力的情况下使用管线时，小心注意以下几点：

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

경고: 폴리머재질의 튜빙을 압력하에서 사용할 때는 다음 사항에 유의하십시오.

- 압력을 받은 폴리머 튜빙 부근에서는 반드시 보호안경을 착용할 것
- 모든 화기의 접근을 금함
- 늘리거나 뒤틀린 튜빙은 사용하지 말 것
- 비금속 튜빙을 테트라히드로퓨란(THF)이나 염산 및 황산과 함께 사용하지 말 것
- 디글로로메탄(methylene chloride)와 디메틸설폭시드(dimethyl sulfoxide)는 비금속 튜빙을 팽창시켜 쉽게 파열되므로 주의할 것

警告：ポリマーチューブに圧力をかけて取り扱う場合は、次のように注意してください。

- 加圧したポリマーチューブの付近では、常に保護めがねを着用してください。
- 付近の火はすべて消してください。
- 激しい応力やねじれを受けたチューブは使用しないでください。
- テトラヒドロフラン（THF）、濃硝酸、あるいは濃硫酸には、非金属製のチューブを使用しないでください。
- ジクロロメタンやジメチルスルホキシドは非金属製のチューブを膨張させ、チューブの破断圧力を大幅に低下させますので、注意してください。

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

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

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

Attenzione: *l'utente deve essere al corrente del fatto che, se l'apparecchiatura viene usta in un modo specificato dal produttore, la protezione fornita dall'apparecchiatura potrà essere invalidata.*

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

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

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

경고 : 제조사가 지정한 것 이외의 방법으로 기기를 사용하는 경우에는, 사용자가 위험으로부터 보호될 수 없는 경우가 발생할 수 있음에 유념하십시오.

警告: ユーザは製造業者が指定していない方法で装置を使用した場合は装置が提供する保護が損なわれることがあるということを承知しているものとします。

Caution: *To protect against fire hazard, replace fuses with those of the same type and rating.*

Attention : *Remplacez toujours les fusibles par d'autres du même type et de la même puissance afin d'éviter tout risque d'incendie.*

Vorsicht: *Zum Schutz gegen Feuergefahr die Sicherungen nur mit Sicherungen des gleichen Typs und Nennwertes ersetzen.*

Attenzione: *per una buona protezione contro i rischi di incendio, sostituire i fusibili con altri dello stesso tipo e amperaggio.*

Advertencia: *sustituya los fusibles por otros del mismo tipo y características para evitar el riesgo de incendio.*

警告：為了避免火災的危險，應更換同种類型及規格的保險絲。

警告: 为了避免火灾的危险, 应更换同种类型及规格的保险丝。

경고 : 화재를 방지하기 위해서는 퓨즈 교체 시 같은 종류, 같은 등급의 것을 사용하십시오.

警告: 火災の危険防止のために、ヒューズの交換は同一タイプおよび定格のもので行なってください。

Caution: *To avoid possible electrical shock, disconnect the power cord before servicing the instrument.*

Attention : *Afin d'éviter toute possibilité de commotion électrique, débranchez le cordon d'alimentation de la prise avant d'effectuer la maintenance de l'instrument.*

Vorsicht: *Zur Vermeidung von Stromschlägen sollte das Gerät vor der Wartung vom Netz getrennt werden.*

Attenzione: *per evitare il rischio di scossa elettrica, scollegare il cavo di alimentazione prima di svolgere la manutenzione dello strumento.*

Precaución: *para evitar descargas eléctricas, desenchufe el cable de alimentación del instrumento antes de realizar cualquier reparación.*

警告：要避免觸電，請在修理或保養器材前把電源線拔出。

警告：为避免可能引起得触电危险，在修理前请切断电源连接。

경고: 전기 충격의 가능성을 피하기 위해서는, 기기를 수리하기 이전에 전원 코드를 차단하십시오.

警告：感電の危険性を避けるために、装置の保守を行う前には装置の電源コードを引き抜いてください。

Commonly Used Symbols

⎓	Direct current Courant continu Gleichstrom Corrente continua Corriente continua 直流電 直流电 직류 直流
~	Alternating current Courant alternatif Wechselstrom Corrente alternata Corriente alterna 交流電 交流电 교류 交流
⏚	Protective conductor terminal Borne du conducteur de protection Schutzleiteranschluss Terminale di conduttore con protezione Borne del conductor de tierra 保護的導線端子 保护性的接地端 보호 도체 단자 接地

Commonly Used Symbols (Continued)

	Frame or chassis terminal Borne du cadre ou du châssis Rahmen- oder Chassisanschluss Terminale di struttura o telaio Borne de la estructura o del chasis 結構或底盤端子 机架或底盘接地端 프레임 또는 틀 단자 フレームまたはシャーシアース
	Caution or refer to manual Attention ou reportez-vous au guide Vorsicht, oder lesen Sie das Handbuch Prestare attenzione o fare riferimento alla guida Actúe con precaución o consulte la guía 小心或查閱手冊 小心或查阅手册 경고 또는 사용설명서 참조 警告またはマニュアルを参照
	Caution, hot surface or high temperature Attention, surface chaude ou température élevée Vorsicht, heiße Oberfläche oder hohe Temperatur Attenzione, superficie calda o elevata temperatura Precaución, superficie caliente o temperatura elevada 警告，熱表面或高溫 警告,热表面或高温 경고, 뜨거운 표면 또는 고온 警告、熱くなっている面、あるいは高温

Commonly Used Symbols (Continued)

	Caution, risk of electric shock (high voltage) Attention, risque de commotion électrique (haute tension) Vorsicht, Elektroschockgefahr (Hochspannung) Attenzione, rischio di scossa elettrica (alta tensione) Precaución, peligro de descarga eléctrica (alta tensión) 警告，小心触電（高壓電） 警告,小心触电（高压电） 경고, 전기충격의 위험 (고압) 警告、電気ショックの危険性（高電圧）
	Caution, risk of needle-stick puncture Attention, risques de perforation de la taille d'une aiguille Vorsicht, Gefahr einer Spritzenpunktierung Attenzione, rischio di puntura con ago Precaución, riesgo de punción con aguja 警告，小心尖狀物刺傷 警告,小心尖状物刺伤 경고, 뾰족한 것으로부터의 상해 위험 警告、ニードルで穴をあける危険性
	Caution, ultraviolet light Attention, rayonnement ultrviolet Vorsicht, Ultraviolettes Licht Attenzione, luce ultravioletta Precaución, emisiones de luz ultravioleta 警告，紫外光 警告,紫外光 경고, 자외선 警告、紫外線

Commonly Used Symbols (Continued)

	Fuse Fusible Sicherung Fusibile Fusible 保險絲 保险丝 퓨즈 ヒューズ
1	Electrical power on Sous tension Netzschalter ein Alimentazione elettrica attivata Alimentación eléctrica conectada 開啓電源 接通电源 전원 켜기 電源オン
0	Electrical power off Hors tension Netzschalter aus Alimentazione elettrica disattivata Alimentación eléctrica desconectada 關閉電源 切断电源 전원 끄기 電源オフ

United States – FCC Emissions Notes

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

Note: *This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio TV technician for help.*

Shielded cables must be used with this unit to ensure compliance with the Class B FCC limits.

Canada – Spectrum Management Emissions Notes

Cet appareil numérique de la classe B est conforme à la norme NMB-003.

This Class B digital apparatus complies with Canadian ICES-003.

600E Pump Information

Intended Use

When you develop methods, follow the “Protocol for the Adoption of Analytical Methods in the Clinical Chemistry Laboratory,” *American Journal of Medical Technology,* 44, 1, pages 30–37 (1978). This protocol covers good operating procedures and techniques necessary to validate system and method performance.

Biological Hazard

When you analyze physiological fluids, take all necessary precautions and treat all specimens as potentially infectious. Precautions are outlined in “CDC Guidelines on Specimen Handling,” *CDC – NIH Manual,* 1984.

Calibration

Follow acceptable methods of calibration with pure standards to calibrate methods. Use a minimum of five standards to generate a standard curve. The concentration range should cover the entire range of quality-control samples, typical specimens, and atypical specimens.

Quality Control

Routinely run three quality-control samples. Quality-control samples should represent subnormal, normal, and above-normal levels of a compound. Ensure that quality-control sample results are within an acceptable range, and evaluate precision from day to day and run to run. Data collected when quality-control samples are out of range may not be valid. Do not report this data until you ensure that chromatographic system performance is acceptable.

Table of Contents

Preface

The *Waters 600E Multisolvent Delivery System Installation and Maintenance Guide* details the procedures for unpacking, installing, maintaining, and troubleshooting the 600E Multisolvent Delivery System. It also includes appendixes for spare parts and validation regulation.

This guide is intended for use by anyone interested in installing, maintaining, and troubleshooting the Waters® 600E system.

Organization

This guide contains the following:

Chapter 1 describes how to unpack and inspect the Waters 600E Multisolvent Delivery System.

Chapter 2 provides procedures for attaching fluidic components to the 600E pump (such as eluent reservoirs, helium tank, column, autosampler, and detector).

Chapter 3 provides procedures for making electrical connections to the 600 controller (such as AC power, Waters data systems, and external devices).

Chapter 4 covers routine maintenance procedures.

Chapter 5 explains 600E system error messages. Contains procedures for using the 600 controller diagnostics to obtain operating information.

Chapter 6 describes troubleshooting procedures for the 600E system, including troubleshooting decision trees and symptom-cause-solution tables.

Appendix A provides a list of recommended and optional spare parts.

Related Documentation

***Waters Licenses, Warranties, and Support*:** Provides software license and warranty information, describes training and extended support, and tells how Waters handles shipments, damages, claims, and returns.

Online Help

A convenient way to look up information while using the 600E System. You access Help by pressing the Help screen key whenever it appears on the controller screens.

Printed Documentation for the Base Product

***Waters 600E System Quick Start Guide*:** Provides concise setup and operational information that is designed to get you up and running right away.

***Waters 600E Multisolvent Delivery System User's Guide*:** Provides an introduction to the features and use of the Waters 600E Multisolvent Delivery System.

Documentation on the Web

Related product information and documentation can be found on the World Wide Web. Our address is http://www.waters.com.

Documentation Conventions

The following conventions can be used in this guide:

Convention	Usage
Italic	Italic indicates information that you supply such as variables. It also indicates emphasis and document titles. For example, "Replace *file_name* with the actual name of your file."
`Courier`	Courier indicates examples of source code and system output. For example, "The `SVRMGR>` prompt appears."
`Courier Bold`	Courier bold indicates characters that you type or keys you press in examples of source code. For example, "At the `LSNRCTL>` prompt, enter **`set password oracle`** to access Oracle."
Keys	The word *key* refers to a computer key on the keypad or keyboard. *Screen keys* refer to the keys on the instrument located immediately below the screen. For example, "The A/B screen key on the 2414 Detector displays the selected channel."
…	Three periods indicate that more of the same type of item can optionally follow. For example, "You can store *filename1*, *filename2*, … in each folder."
>	A right arrow between menu options indicates you should choose each option in sequence. For example, "Select File > Exit" means you should select File from the menu bar, then select Exit from the File menu.

Notes

Notes call out information that is helpful to the operator. For example:

Note: *Record your result before you proceed to the next step.*

Attentions

Attentions provide information about preventing damage to the system or equipment. For example:

Attention: *To avoid damaging the detector flow cell, do not touch the flow cell window.*

Cautions

Cautions provide information essential to the safety of the operator. For example:

Caution: *To avoid burns, turn off the lamp at least 30 minutes before removing it for replacement or adjustment.*

Caution: *To avoid electrical shock and injury, unplug the power cord before performing maintenance procedures.*

Caution: *To avoid chemical or electrical hazards, observe safe laboratory practices when operating the system.*

Chapter 1
Unpacking and Preparing Your System

This chapter describes how to unpack and prepare your Waters® 600E Multisolvent Delivery System for installation.

1.1 Unpacking and Inspecting

The Waters 600E Multisolvent Delivery System is shipped in two containers. System components include:

- 600 controller (electronics unit)
- 600E pump and startup kit

Save the shipping cartons in case you need to transport or ship a component later.

Accessories

Accessories such as columns, column heater, data systems, autosamplers, detectors, and system rack are packed separately. Save the shipping cartons in case you need to transport or ship one of these components in the future.

Procedure

1. Remove the packing material from the cartons.
2. Grasp the units from the bottom and lift straight up and out

Caution: *Lifting most units requires two people.*

3. After unpacking the system and the associated parts, check the contents against the packing slip to confirm that all items are included.
4. Inspect all items for damage.

Reporting Damage

Immediately report any damage to both the shipping carrier and to your Technical Service Representative. You can contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A.).

If any items are damaged, use the shipping container for subsequent claim purposes.

1.2 Selecting the Site Location

Site Selection Requirements

Install the 600E Multisolvent Delivery System in an area where:

- Temperature is 4 to 38 °C (39 to 100 °F). Avoid placing in direct sunlight, or near heat registers or air-conditioning vents.
- Relative humidity is 20 to 90% non condensing.
- Available bench space for the 600E system includes:

  Waters 600E Pump Physical Specifications

Parameter	Specification
Height	9.0 in. (22.86 cm)
Length	22.0 in. (55.88 cm)
Width	11.0 in. (27.94 cm)
Weight	47.5 lbs. (21.56 Kgm)

  Waters 600E Controller Physical Specifications

Parameter	Specification
Height	7.0 in. (17.78 cm)
Length	21.25 in. (53.97 cm)
Width	11.25 in. (28.57 cm)
Weight	13.0 lbs. (5.90 Kgm)

- Bench space is available for detectors, an autosampler, and a data system (see Figure 1-1).
- The bench can support 90 lbs (40.82 kg) plus the weight of a detector, autosampler, or data system.
- There is 6 inches (15.24 cm) of clearance behind the units for ventilation and access to cable connections.
- Vibration is negligible. Prevent instability by ensuring that the shelf unit sits securely on the bench top.
- Static electricity is negligible.

System Dimensions

Figure 1-1 outlines the dimensions of a typical Waters 600E Multisolvent Delivery System (including detector, autosampler, and data system).

STOP ***Attention:*** *Never stack fluidic components (such as the 600E pump or a detector) on top of electronic devices without adequate leak protection.*

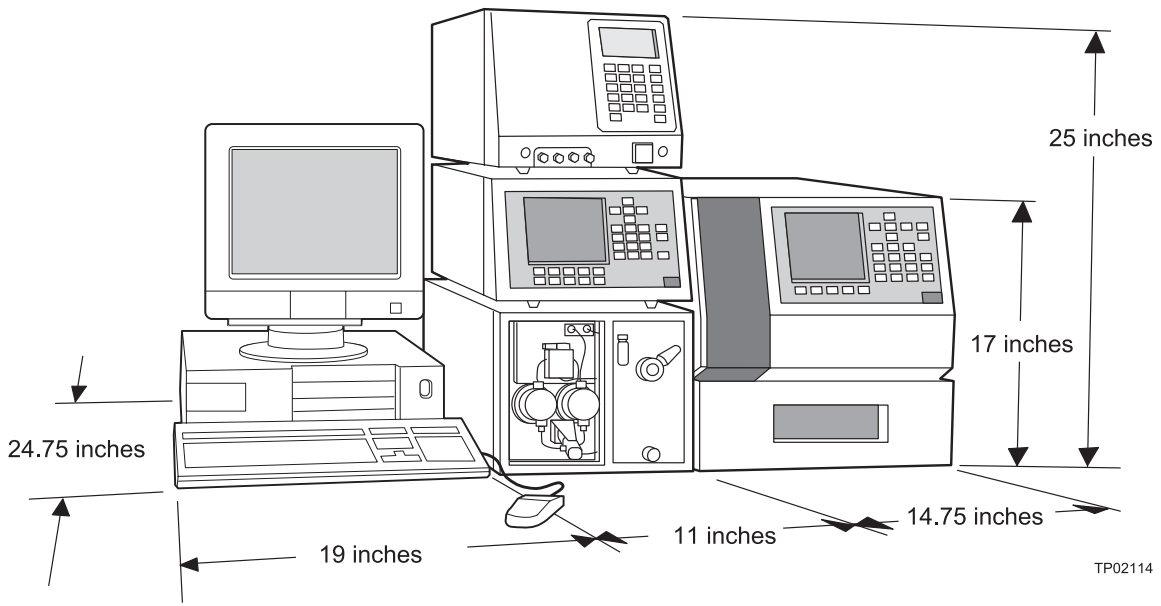


Figure 1-1 Waters 600E System Dimensions

1.3 Determining Electrical Requirements

This section describes the electrical and system power requirements of the Waters 600E system.

Caution: *To avoid the possibility of electric shock, make sure the power cord is disconnected from the rear panel of the instrument before performing the procedures in this section.*

1.3.1 System Power Requirements

The Waters 600E system requires:

- Grounded AC power supply
- No nearby source of electronic noise (such as electric motors or arcing relay contacts)
- No abrupt load fluctuations
- Proper fuses

Attention: *Power surges, line spikes, and transient energy sources can adversely affect 600E system operation. Ensure the electrical supply used is properly grounded and free from any of these conditions.*

Table 1-1 lists the electrical specifications for the 600E system.

Table 1-1 Waters 600E System Electrical Specifications

Component	Condition	Specification
Waters 600E System	Protection class[a]	Class I
	Overvoltage category[b]	Category II
	Pollution degree[c]	Degree 2
	Moisture protection[d]	Normal (IPXO)
	Trademark	600 is not a registered trademark

Table 1-1 Waters 600E System Electrical Specifications (Continued)

Component	Condition	Specification
Waters 600E pump	Voltages input (provided by controller)	12 VAC, 50/60 Hz 12 VDC, 1.1 amps 30 VDC, 4.0 amps 5 VDC, 0.1 amps (600 controller) 15 VDC, 0.1 amps (600S conroller)
Waters 600E controller	⚠ Line voltages (grounded AC), nominal	100/120 VAC 220/240 VAC
	Line frequency ranges	50 Hz: ±2 Hz 60 Hz: ±2 Hz
	Current (max)	2.8 amps

a. **Protection Class I** – The insulating scheme used in the instrument to protect you from electrical shock. Class I identifies a single level of insulation between live parts (wires) and exposed conductive parts (metal panels), in which the exposed conductive parts are connected to a grounding system. In turn, this grounding system is connected to the third pin (ground pin) on the electrical power cord plug.

b. **Overvoltage Category II** – Pertains to instruments that receive their electrical power from a local level such as an electrical wall outlet.

c. **Pollution Degree 2** – A measure of pollution on electrical circuits, which may produce a reduction of dielectric strength or surface resistivity. Degree 2 refers to normally only nonconductive pollution. Occasionally, however, a temporary conductivity caused by condensation must be expected.

d. **Moisture Protection** – Normal (IPXO) – IPXO means that there is *no* Ingress Protection against any type of dripping or sprayed water. The X is a placeholder to identify protection against dust, if applicable.

Chapter 2
Making Fluidic Connections to the 600E Pump

This chapter describes the procedures for making fluidic connections to the 600E pump.

2.1 Selecting and Installing Fittings

The Waters 600E Multisolvent Delivery System Startup Kit includes a variety of tubing and fittings to facilitate connections between the 600E pump and an external autosampler, column, and detector. Refer to the startup kit list for information.

This section describes:

- Cutting tubing
- Installing connectors and fittings

Tubing Considerations

Observe the following rules when installing tubing and fittings.

Caution: *When handling eluents, changing tubing, or operating the 600E Multisolvent Delivery System in general, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

- Before loosening a fitting, stop the pump flow. Vent any pressure in the flow path with the reference valve or allow pressure to decay to zero.

  Caution: *Do not attempt to relieve pressure by loosening a fitting. Attempting to do this with the system operating under high pressure may cause eluent to spray.*

- Minimize dead volume by using the appropriate tubing for each location. Cut the tube following the method described in this section, and install the fittings as

described. Microbore techniques especially require care in tubing and connector installation to ensure optimal chromatographic separation.

- The fittings, connectors, and tubing are chemically resistant to the eluents listed in the *Waters 600E Multisolvent Delivery System User's Guide*, Appendix B, Eluent Properties.

Caution: *Use of solvents that can damage the system could be hazardous to the operator and voids the 600E system warranty. Refer to the Waters 600E Multisolvent Delivery System User's Guide, Appendix B, Eluent Considerations, for eluent compatibility information.*

- Do not nick, kink, or sharply bend the tubing. This may restrict flow. Repeated bending of tubing will cause tubing failure.
- Subjecting the system to a wide temperature change (for example, when going from cold-room operation to room-temperature operation) may result in loosened fittings. Before operating the system at the new temperature, allow the system temperature to stabilize. When first starting up the system, check all connections for leaks and retighten fittings as required.

2.1.1 Cutting and Deburring Stainless Steel Tubing

When cutting tubing, avoid angled cuts. These may cause dead-volume formation at the connection junction due to a poor tubing fit against the connector or part.

Stainless steel tubing with an internal diameter of less than 0.009 inch (0.23 mm) requires a special tubing cutter. When replacing this tubing, it is recommended to purchase precut tubing. Refer to Appendix A, Spare Parts.

Cutting Tubing

1. Measure the length of tubing required to connect the components. Allow for slack so tubing is not pulled tightly around sharp corners.

   Note: *Use the correct ID tubing when replacing tubing.*

2. Use a circular tubing cutter to smoothly cut the tubing to the desired length (Figure 2-1). Rotate the cutter around the tube until it is cleanly scored.

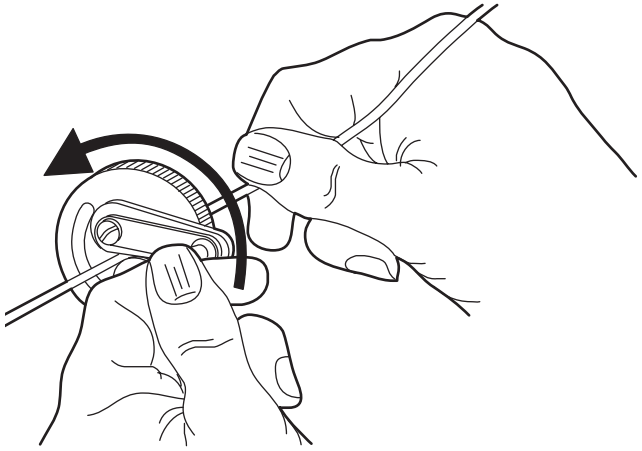


Figure 2-1 Cutting Tubing with a Circular Cutter

If you do not have a circular tubing cuter, use a knife-file to score the tube (Figure 2-2).

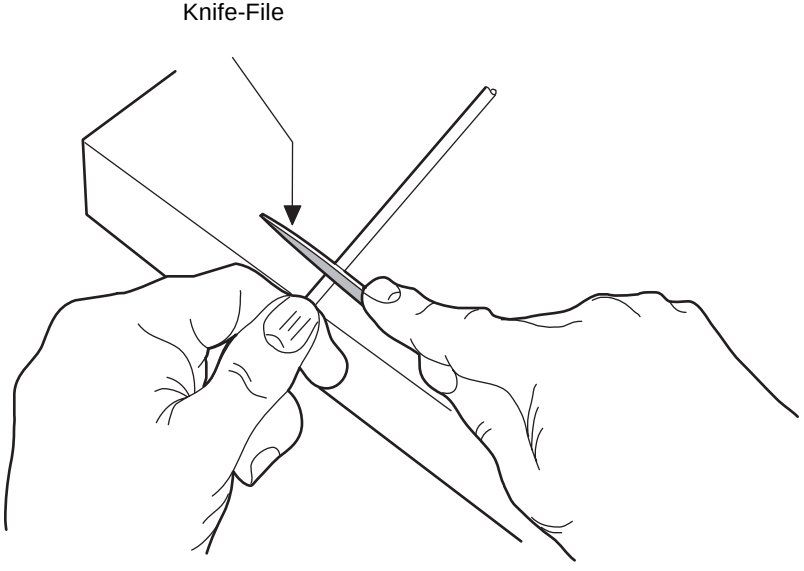


Figure 2-2 Cutting Tubing with a Knife-File

3. Grip the cut tubing with two pairs of smooth-jawed pliers, one on each side of the score (Figure 2-3). Gently bend the tubing back and forth until it snaps. This leaves the tubing bore open with a minimum of burrs.

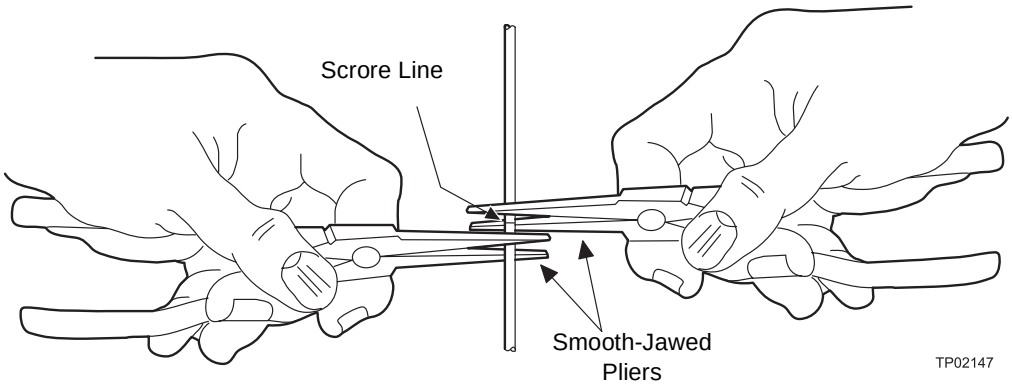


Figure 2-3 Breaking the Stainless Steel Tubing

Deburring Tubing

4. Inspect the cut for burrs or scratches and for perpendicularity. The tubing must be completely open, without debris or burrs in the hole. If necessary, debur the hole with a very fine file or deburring tool.

   Note: *The tubing end must be smooth, fully open, and without burrs to allow proper seating in the compression fitting and to prevent particles from blocking the tubing.*

5. Prior to connection, flush the tubing with solvent to remove any remaining particle.
6. Attach the individual ferrules, compression fittings, and nuts as described below and in the column or instrument operator's manual.

2.1.2 Installing Connectors and Fittings

This section includes procedures for installing different types of connectors and fittings on tubing.

This section covers:

- Connector components
- Assembling a standard ferrule connector
- Assembling a reverse ferrule connector
- Replacing ferrules

Connector Components

Each tubing connector is composed of at least two parts:

- Ferrule
- Compression screw

The ferrule is the component that seals a junction. When pressure is applied to a ferrule, the ferrule forms a seal against the junction surface by tightening the compression screw.

The connectors supplied with your 600E system are standard ferrule connectors used with stainless steel tubing.

Note: *Use of other-than-factory-installed connectors may cause problems. Connectors differ due to ferrule shape and fitting bodies (lengths and threads). For guidance when using nonstandard connectors, contact your local Waters representative.*

Figure 2-4 shows how to use the connectors listed above.

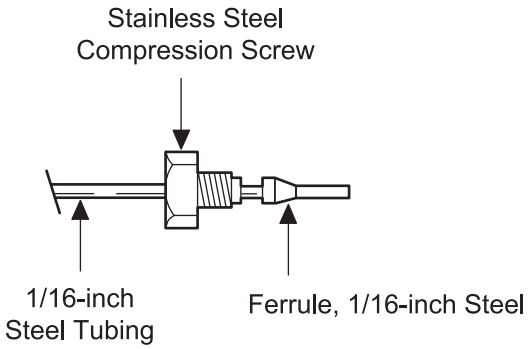


Figure 2-4 Compression Screw, Ferrule, and Tubing

Assembling a Standard Ferrule Connector

1. Slide the compression screw onto the tubing end (see Figure 2-4). Slide the ferrule onto the tubing with the broad end of the taper toward the screw.
2. Push the tubing all the way into the fitting body until the tubing bottoms out. The fitting body can be a stainless steel union, a column end, or any part of the system that has a female receptacle.
3. While you hold the tubing securely in place (bottomed out), finger-tighten the compression screw.

4. Using a 5/16-inch wrench, tighten the screw an additional 1/4-turn. This seats the ferrule against the tubing and prevents it from coming off when you disconnect the tube.
5. Remove the assembled fitting and verify that the length of tubing extending beyond the ferrule is equal to the length of tubing of other fittings previously installed.

Attention: *When the connector is installed in the fitting, ensure the tubing end seats the receptacle cavity. Gaps will cause excessive dead volume.*

6. Attach the connector.
7. Flow eluent through the new connection at typical operating pressures to verify that the new connection does not leak. If the connection leaks, tighten it slightly.

Attention: *When testing the connection, be aware of pressure limitations on other parts of the system, such as columns and detector flow cells.*

Replacing Ferrules

To replace a ferrule, cut off the old ferrule and continue from the start of the ferrule connection procedure. The compression screw may be reusable.

2.2 Making 600E Pump Connections

This section describes 600E pump setup procedures:

- Setting up the eluent reservoirs
- Setting up the sparge system

Use Figure 2-5 as a guide.

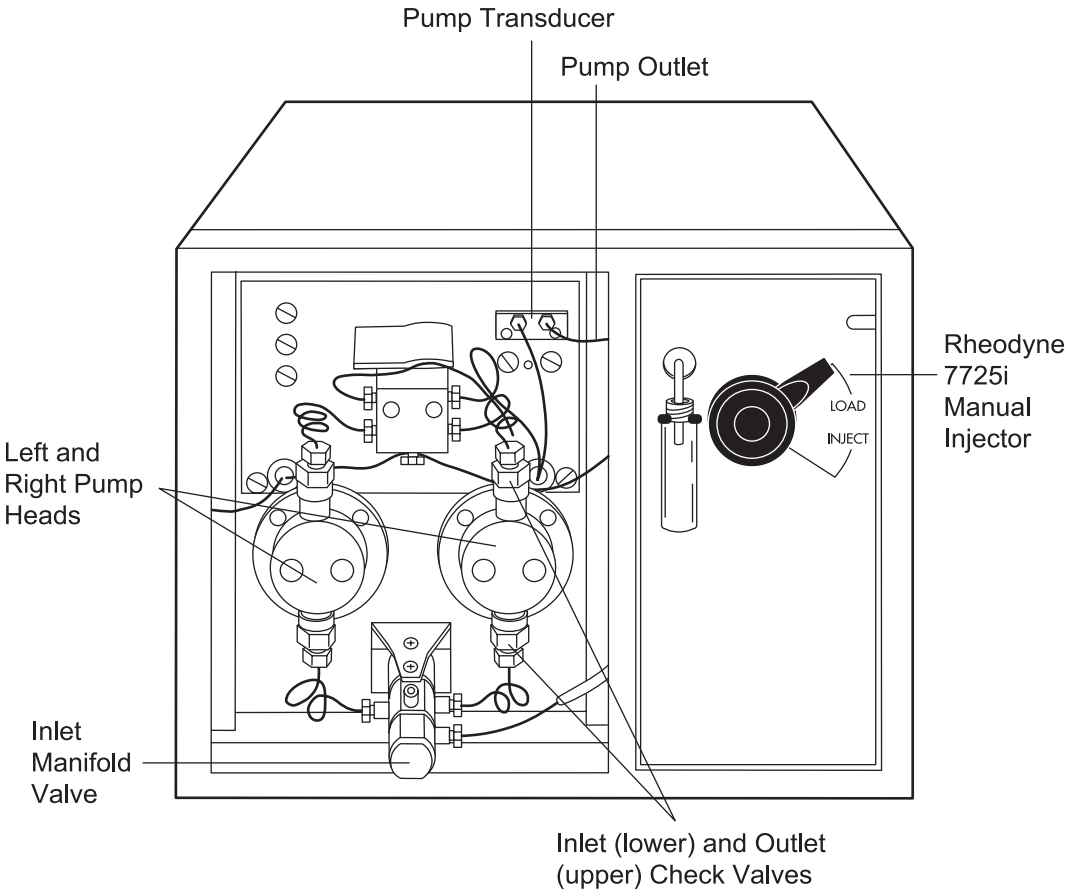


Figure 2-5 600E Pump Connections

2.2.1 Setting Up the Eluent Reservoirs

The 600E system includes the following components used in the setup of your eluent reservoirs:

- Eluent reservoir caps
- Diffuser filters for eluent and sparge tubing
- Vent tubing

The following sections describe setting up your eluent reservoirs using these components. It covers:

- Setting up the eluent reservoir
- Connecting eluent and sparge tubes to the reservoir
- Connecting the vent tube to a fume hood

Setting Up the Eluent Reservoir

Eluent reservoir caps (Figure 2-6) help maintain a continuously sparged environment in the reservoirs (bottles).

Each reservoir cap has three feather-edged holes to produce a positive seal around the eluent, sparge, and vent tubes. The reservoir caps are supplied for a 1-L bottle size but are also available for a 4-L bottle size.

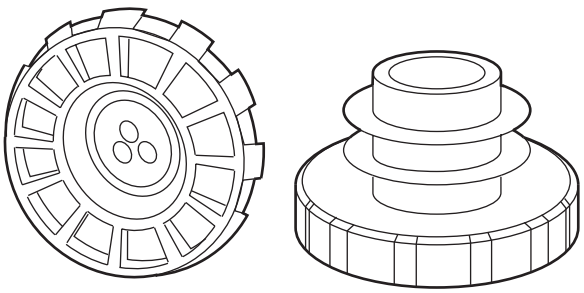


Figure 2-6 Eluent Reservoir Caps

Choose eluent reservoirs which provide a snug fit for the reservoir caps. Waters recommends 1-L bottles.

1. Position the bottles in a convenient location, preferably at a higher level than the pump heads. Eluent bottles must be placed above the inlet manifold. There are optional bottle racks for this purpose as listed in Appendix A, Spare Parts.

   STOP ***Attention:*** *Avoid placing the eluent bottles on top of the system unless they are in a container that can hold the total volume of all of the eluents in case bottle leakage occurs. Leakage or spillage may cause damage to the system.*

2. Remove the protective wrapping from:
   - Four Teflon® tubing lines marked Solvent A, B, C, D.
   - Four Teflon tubing lines marked Sparge A, B, C, D.

The solvent and sparge tubing lines are on the right side of the pump near the front.

3. Uncoil the tubing and direct it around the right side of the 600E pump.

Attention: *Always flush new solvent filters and diffusers with methanol before attaching the filters to the eluent and sparge tubing.*

Flushing Diffuser Filter

1. Attach the filter to a priming syringe with a short length of Teflon tubing.
2. Place the filter in methanol.
3. Pull the syringe handle back to draw methanol through the filter.
4. Expel the methanol into a suitable wash container by pushing the syringe handle forward.
5. Repeat steps 1 through 4 several times to ensure adequate filter flushing.

Connecting the Eluent Reservoir to the Pump

1. Push a labeled eluent tube through a hole in the appropriate reservoir cap (Figure 2-7). Push enough tubing through the cap to reach the bottom of the appropriate eluent reservoir bottle.

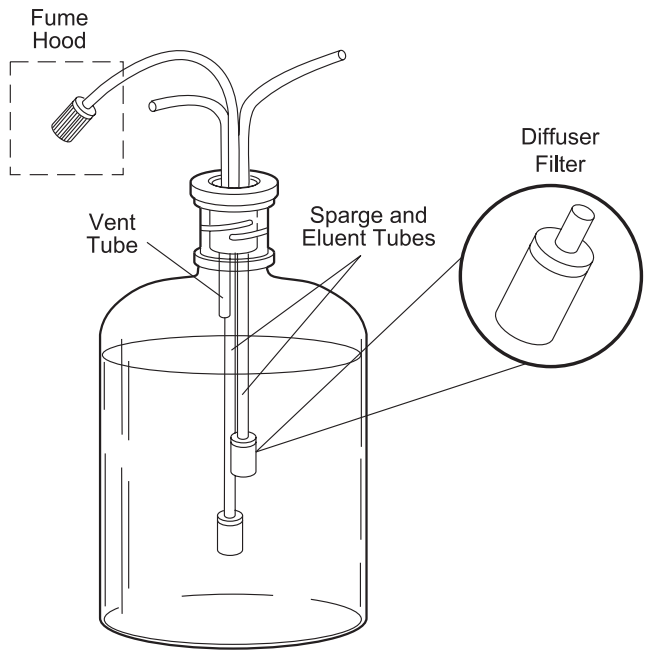


Figure 2-7 Eluent Reservoir Diffuser Filter Placement

2. Attach a clean diffuser filter to the eluent line.
3. Insert a second tube for the sparge line. Attach a clean diffuser filter to the sparge line for the eluent reservoir.
4. Repeat steps 1 through 3 for the eluent and sparge tubes of the remaining eluent reservoirs.

Connecting the Vent Tube to a Fume Hood

When using eluents such as acetonitrile, methanol, or solutions of trifluoroacetic acid, sparging into open air releases harmful vapors. If working with these or other organic eluents, run the vent tube from the eluent reservoir caps into an exhaust hood to capture fumes released at the eluent reservoir.

Caution: *Harmful effects could result from improperly vented eluent or sparge reservoirs. To avoid respiratory problems, remove vented fumes through a fume hood and proper ventilation. Use particular care with volatile eluent in a cold room, refrigerator, or other small enclosed environment.*

1. Cut a length of Teflon tubing (from the 600E Startup Kit) sufficient to reach a fume hood from the eluent reservoir.
2. Push one end of the tubing about one inch into the remaining hole in the reservoir cap. This tubing is the eluent reservoir vent tube.

   Caution: *Ensure that the end of the vent tubing within the bottle remains above the level of the eluent. If not, eluent will flow from the bottle through this vent tube.*

3. Connect the other end of the vent tube to a clean diffuser filter, supplied in the Startup Kit (see Figure 2-7). The diffuser filter provides a slight positive pressure of sparge gas that inhibits airflow into the reservoir while eluent is being withdrawn.
4. Place the filter end of the vent tube in a fume hood.
5. Insert the eluent reservoir cap into the eluent bottle.
6. Repeat steps 1 through 5 for each eluent reservoir.

2.2.2 Setting Up the Sparge System

This section describes how to connect a helium tank to the 600E pump to sparge the eluent reservoirs. This section covers:

- System sparging overview
- Attaching compression fittings to the helium line
- Connecting the helium sparge supply

Note: *The Waters 600E Multisolvent Delivery System Startup Kit includes the compression screw adaptor fitting, valve, tubing, and other fittings required to connect the sparge inlet to a 345 KPa minimum to 1035 KPa maximum (50 to 150 psi) helium supply. The 600E system does not include the high-pressure regulator required to connect the sparge inlet to a helium tank.*

System Sparging Overview

Helium sparging reduces the total dissolved gas in the eluent reservoirs and maintains that condition during operation. Use an ultra-pure-carrier (UPC) grade of helium to prevent eluent contamination.

The helium disperses through the 600E system in the following route:

1. The helium sparge gas is introduced into the eluent through a diffuser filter that disperses the helium stream into small gas bubbles.
2. The bubbles increase the effectiveness of the sparge by increasing the surface area of eluent exposed to helium.
3. The reduction in total dissolved gas occurs as the dissolved gases equilibrate with the helium at the gas-liquid interface of the bubbles.
4. The displaced gases are carried to the surface and expelled through the bottle vent.
5. Minimizing dissolved gases in the eluents decreases the gas that may be released when different mobile phases are mixed in the gradient proportioning valve.

For more information on this process, refer to the *Waters 600E Multisolvent Delivery System User's Guide,* Appendix B, Eluent Properties. For the procedure on sparging the reservoirs, refer to the *Waters 600E Multisolvent Delivery System User's Guide,* Section 3.1, Sparging the Reservoirs.

Helium Specifications

The minimum specifications for helium sparge gas are listed below. The tank or house supply source must be independently regulated between 50 and 90 psi for connection to the sparge inlet.

The required specifications for ultra-pure carrier grade helium gas are:

- Nitrogen less than 5.0 Mppm (molar parts per million)
- Oxygen less than 5.0 Mppm
- Total water less than 1.0 Mppm
- Total hydrocarbon less than 0.5 Mppm

STOP ***Attention:*** *The 600E system warranty may be voided if you use an inferior grade of helium gas.*

Attaching Compression Fittings to the Helium Line

Stainless steel tubing (1/16-inch, with at least 0.020-inch ID, 0.040-inch ID preferred) connects the helium supply to the 600E pump. This tubing requires compression-fitting connections on each end.

1. Slide the compression screw onto an end of the stainless steel tubing. Slide the ferrule onto the tubing with the large end of the taper toward the screw.

   Figure 2-8 illustrates a compression screw assembly.

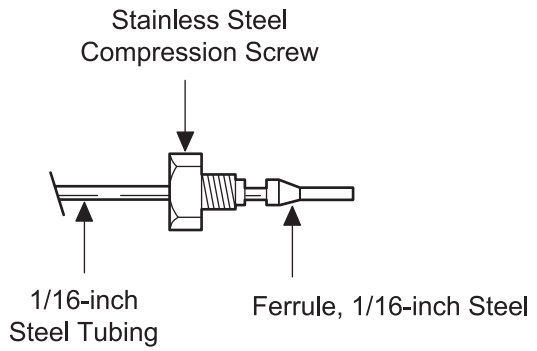


Figure 2-8 Compression Screw Assembly

2. Push the tubing all the way into the fitting body until the tube bottoms out.

3. While pressing the tubing into the bottom of the female connector, tighten the compression screw approximately 3/4 of a turn past finger-tight to seat the ferrule on the tubing.

   Subsequent connections with this fitting do not require the extra 3/4 of a turn. 1/8 of a turn is normally adequate.

Connecting the Helium Sparge Supply

1. Connect the tubing from the helium supply to the sparge gas inlet on the 600E pump rear panel (Figure 2-9) using the tubing and compression fittings assembled above.

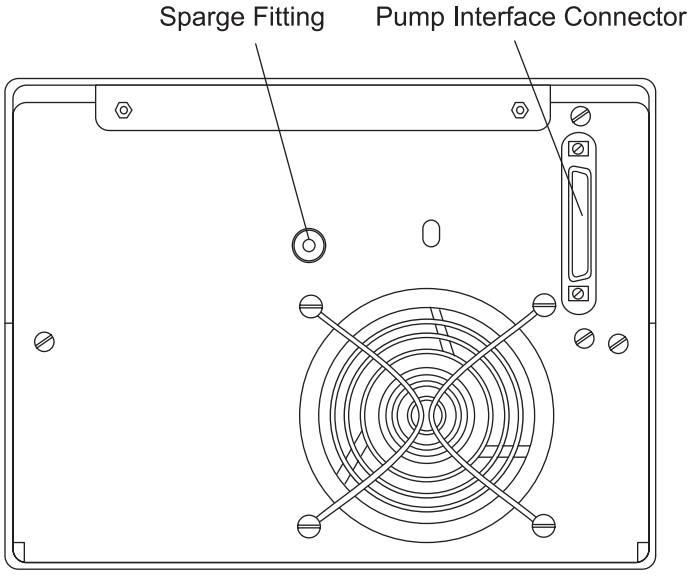


Figure 2-9 Sparge Gas Inlet Connection on the 600E Pump

2. Regulate the helium tank or house supply source between 50 and 90 psi (3.4 to 6.1 atm).

2.3 Installing a Column or Cartridge

The 600E pump slide-out drawer, shown in Figure 2-10, accommodates installation of one of the following column/cartridge options:

- Single column (up to 30 cm)
- Column heater with single column (up to 30 cm)

- RCM 8 x 10 radial compression cartridge holder and Radial-Pak cartridge.

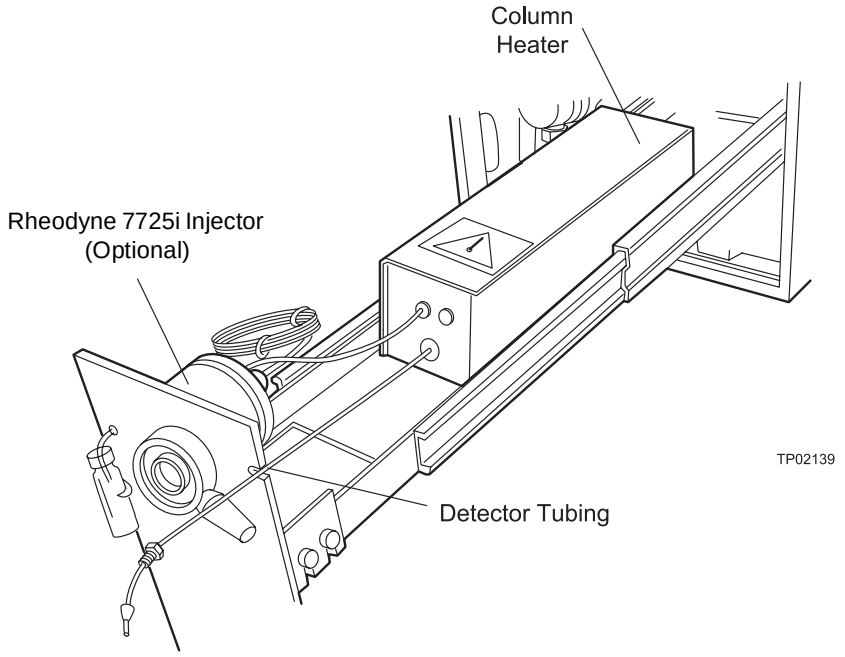


Figure 2-10 Pump Slide-Out Drawer

This section covers:

- Installing a column
- Installing a column heater
- Installing an RCM 8 x 10

Note: *For information on solvent selection and equilibration before use, refer to the Care and Use Manual supplied with your column or cartridge. Observe precautions during use.*

2.3.1 Installing a Column

To install a column in the 600E pump slide-out drawer:

1. Turn the latch on the front of the pump (see Figure 2-5) and pull out the slide-out drawer.
2. Disconnect the tubing.

   Note: *The drawer does not fully extend unless you disconnect the tubing.*

3. Place the column in the tray with the arrow on the column label pointing toward the front of the drawer. Allow the column to lie flat in the drawer (Figure 2-11).
4. Attach the inlet tubing and outlet tubing to the column as described below (Figure 2-11). Follow column instructions for flow direction.
   - **Column Inlet** - Attach the 0.009-inch ID tubing from the Rheodyne 7725i manual injector (or external autosampler) to the column inlet.
   - **Column Outlet** - Attach a piece of 0.009-inch ID tubing to the column outlet.

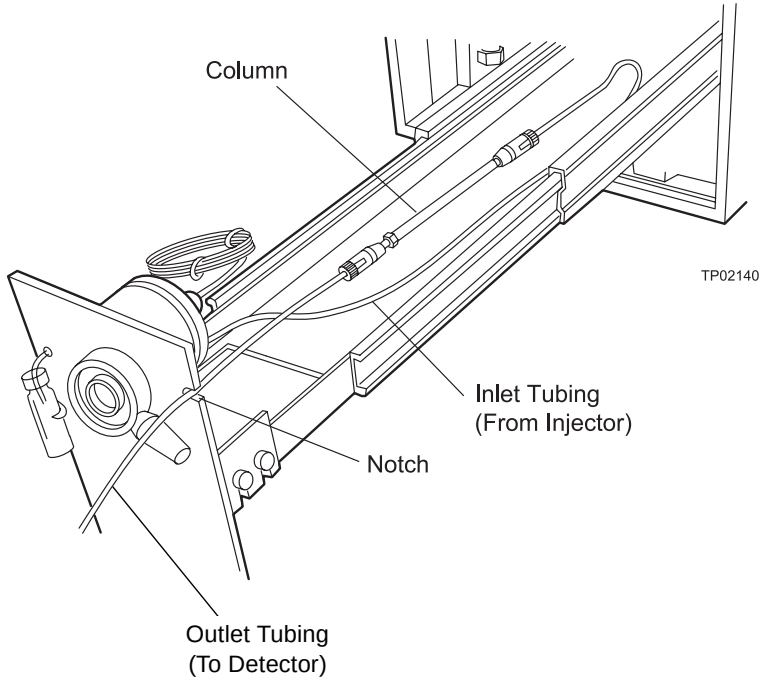


Figure 2-11 Column Installation

5. Pass the column outlet tubing through the notch in the pump drawer front panel. Use the shortest possible length of 0.009-inch ID tubing from the column outlet to the detector cell inlet.
6. Check for leaks by pumping eluent through the column. Ensure there are no leaks at the inlet or outlet connections.

2.3.2 Installing a Column Heater

Caution: *When removing or replacing a column from the column heater, ensure you allow sufficient time for the column heater to cool to avoid the possibility of burns.*

To install a column heater (and column) in the pump slide-out drawer:

1. Turn the latch on the front of the pump (see Figure 2-5) and pull out the slide-out drawer.
2. Place the column heater in the drawer with the column inlet and outlet tubing pointing toward the front of the drawer (Figure 2-12). Allow the column heater to lie flat in the drawer.

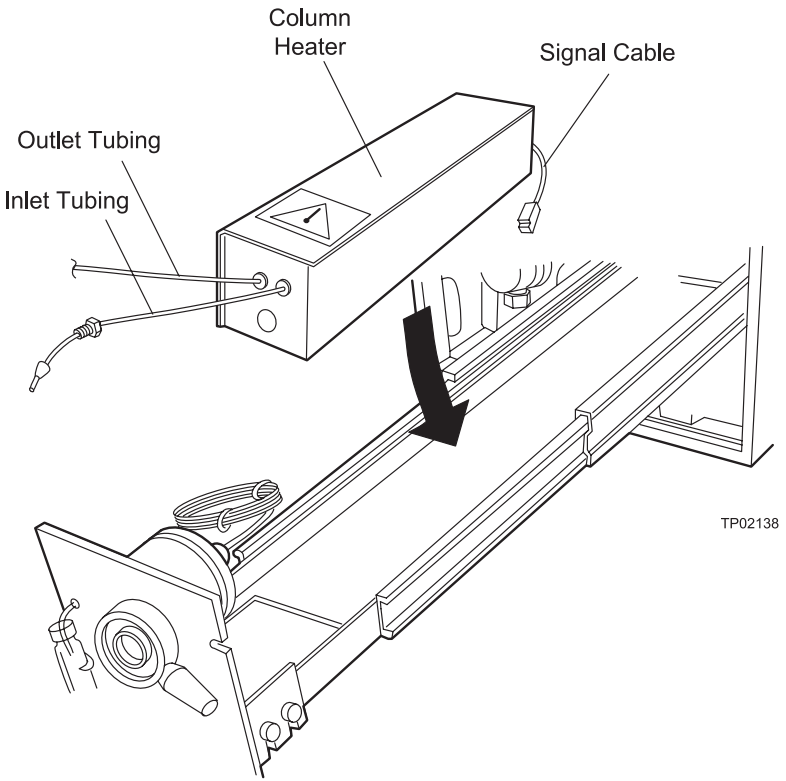


Figure 2-12 Column Heater Orientation

3. Pull the drawer toward you and locate the receptacle at the back of the drawer (Figure 2-13). Plug the signal cable into the receptacle on the right side of the drawer. The receptacle is keyed to ensure correct alignment.

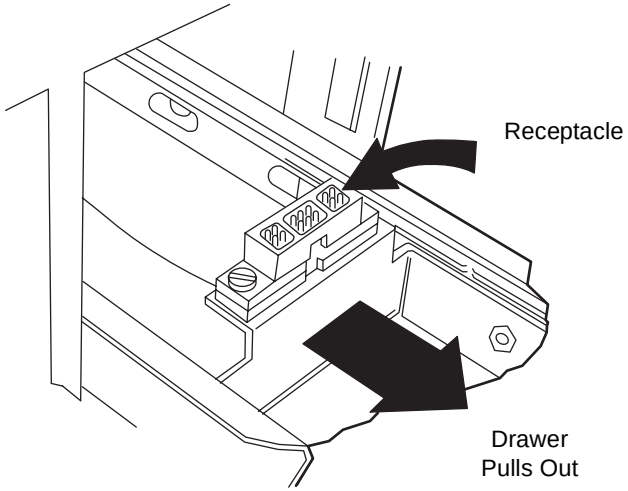


Figure 2-13 Column Heater Signal Cable Connection

4. Lift the column heater covers straight off the column heater (Figure 2-14). Place your column (up to 8 mm ID by 30 cm) in the center channel of the column heater tray with the arrow on the column label pointing toward the front of the drawer.

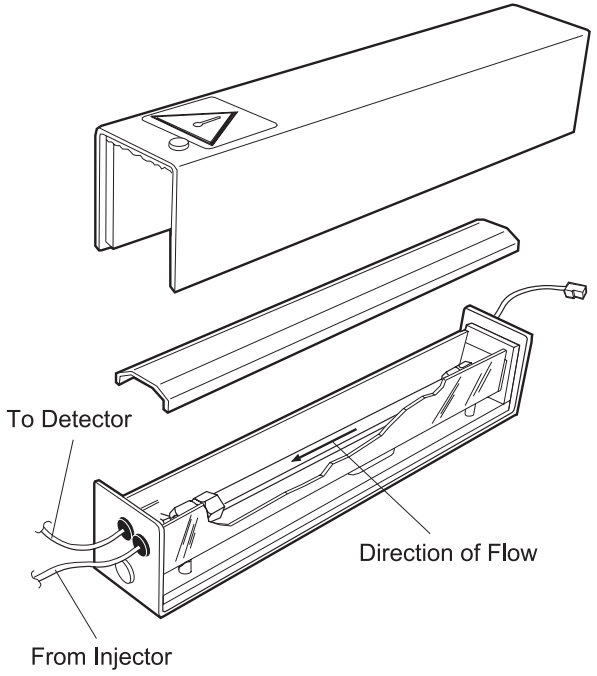


Figure 2-14 Column Installation in the Column Heater

5. Attach the inlet tubing and outlet tubing to the column as described below (Figure 2-14). Follow column instructions for flow direction.
   - **Column Inlet** - Pass a piece of 0.009-inch ID tubing from the Rheodyne 7725i manual injector (or an external autosampler) through the front right port on the column heater and attach to the column fitting at the rear of the column heater tray.
   - **Column Outlet** - Pass a piece of 0.009-inch ID tubing through the front left port on the column heater and attach to the column fitting at the front of the column heater tray.
6. Pass the column outlet tubing through the notch in the pump drawer front panel. Use the shortest possible length of 0.009-inch ID tubing from the column outlet to the detector cell inlet.
7. Check for leaks by pumping eluent through the column. Verify that there are no leaks at the inlet or outlet connections.
8. Replace the column heater covers.

2.3.3 Installing an RCM 8 x 10

To install an RCM 8 x 10 in the pump slide-out drawer:

1. Turn the latch on the front of the pump (see Figure 2-5) and pull the drawer out.
2. Place the RCM 8 x 10 in the drawer with the cartridge outlet tubing pointing toward the front of the pump drawer (Figure 2-15). Allow the RCM 8 x 10 to lie flat in the drawer.
3. Attach the inlet tubing and outlet tubing to the cartridge as follows (see Figure 2-15).
   - **Cartridge Inlet** – Using a union, attach the 0.009-inch ID tubing from the Rheodyne 7725i manual injector (or external autosampler) to the cartridge inlet at the back of the RCM 8 x 10.
   - **Cartridge Outlet** – Using a union, attach a piece of 0.009-inch ID tubing to the column outlet at the front of the RCM 8 x 10.

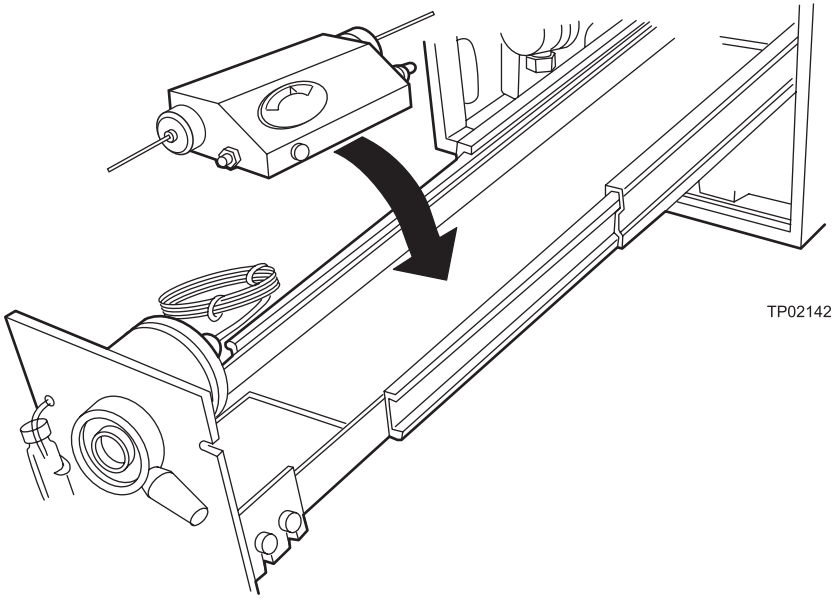


Figure 2-15 RCM 8 x 10 Orientation

4. Pass the cartridge outlet tubing through the notch in the pump drawer front panel.

   Use the shortest possible length of 0.009-inch ID tubing possible from the column outlet to the detector cell inlet.

5. Pump eluent through the RCM 8 x 10. Verify that there are no leaks at the inlet or outlet connections.

For detailed operation information, refer to your *Waters RCM 8 x 10 Operator's Manual*.

2.4 Making Fluidic Connections to an Autosampler

You have the option to use the Waters 600E Multisolvent Delivery System with an external autosampler. You can:

- Connect an autosampler in series with the Rheodyne 7725i manual injector
- Connect an autosampler in place of the Rheodyne 7725i manual injector

Note: *When using a non-IEEE-488 autosampler, you must also attach a cable from the autosampler to the Inject terminal (on the 600 controller) to instruct the 600 controller to acquire data or run methods and tables. See Section 3.5.2, Connecting a Non-IEEE-488 Autosampler.*

Note: *Using a Rheodyne 7725i manual injector and autosampler in series may add bandspreading due to additional tubing between the injector and column. To minimize bandspreading, keep the Rheodyne 7725i manual injector handle in the LOAD position.*

Connecting an Autosampler in Series with the Injector

1. Place the autosampler next to the system (Figure 2-16). Allow room for access to eluent reservoirs.

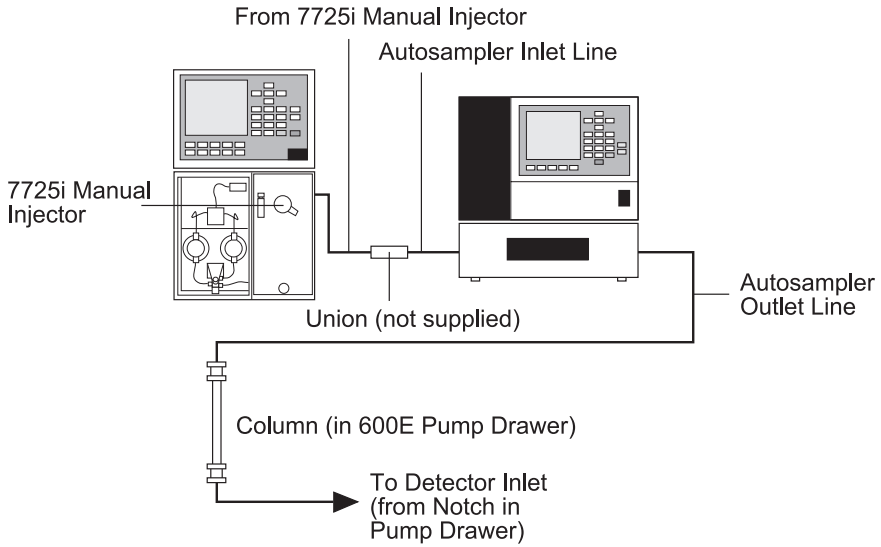


Figure 2-16 Rheodyne 7725i Manual Injector and Autosampler in Series

2. Connect the autosampler inlet line to the Rheodyne 7725i manual injector outlet line (see Section 2.3, Installing a Column or Cartridge). This connection requires a union.
3. Connect the autosampler outlet line to the column or column heater inlet in the pump slide-out drawer (see Section 2.3, Installing a Column or Cartridge).

Connecting an Autosampler in Place of the Rheodyne 7725i Manual Injector

1. Place the autosampler on the selected side of the system (Figure 2-16). Allow room for access to the eluent reservoirs.

2. Disconnect the Rheodyne 7725i manual injector outlet from the column or column heater inlet in the pump slide-out drawer (see Section 2.3, Installing a Column or Cartridge).
3. Connect the autosampler outlet line to the column or column heater inlet in the pump slide-out drawer (see Section 2.3, Installing a Column or Cartridge).
4. Disconnect the Rheodyne 7725i manual injector inlet from the transducer outlet line. Connect the autosampler inlet line with a union to the transducer outlet line.

2.5 Making Fluidic Connections to a Detector

To connect the 600E pump to your detector inlet:

1. Pass the column or cartridge outlet tubing through the notch in the pump drawer front panel. Use the shortest possible length of 0.009-inch ID tubing from the column outlet to the detector cell inlet. For details on attaching tubing to a column or cartridge, refer to Section 2.3, Installing a Column or Cartridge.
2. Pass the waste line from the detector cell outlet to a proper receptacle.

For details on making fluidic connections to your detector, refer to the associated detector operator's manual.

Chapter 3
Making Electrical Connections to the 600 Controller

This chapter describes the electrical connections you make to the 600 controller rear panel.

3.1 Controller Rear Panel Overview

The 600 controller rear panel allows connection to:

- AC power connector
- Pump interface connector
- IEEE-488 interface connector
- RS-232 interface connector
- Screw terminals

Figure 3-1 identifies the rear panel connectors.

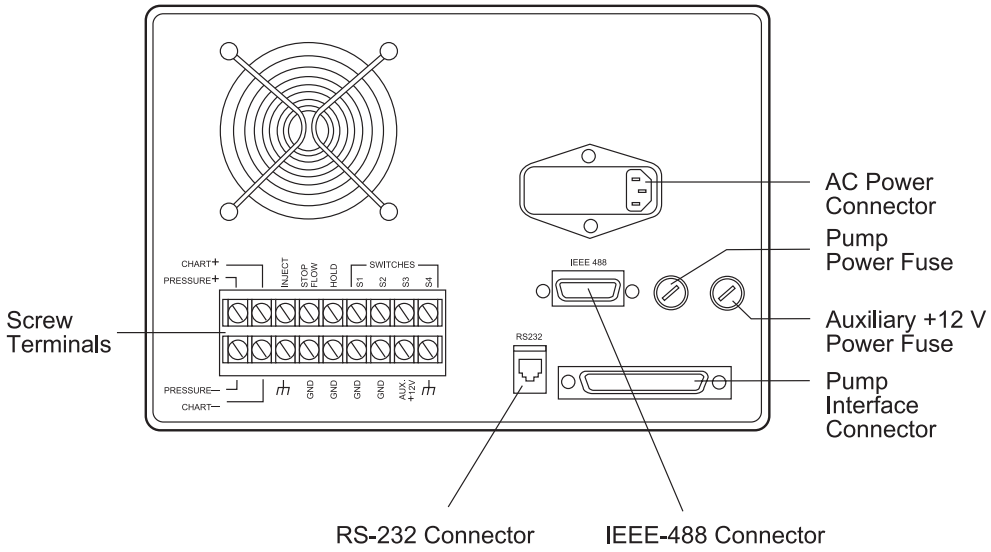


Figure 3-1 600 Controller Rear Panel Connectors

AC Power Connector

Provides electrical power to the 600E system. For details on connecting AC power, refer to Section 3.2, Attaching the Pump Interface Cable and Power Cord.

Pump Interface Connector

Enables the 600 controller and 600E pump to communicate with each other. The pump interface connector also provides power to the 600E pump. For details on connecting the 600 controller and 600E pump, refer to Section 3.2, Attaching the Pump Interface Cable and Power Cord.

IEEE-488 Interface Connector

Enables the 600 controller to communicate with external IEEE-488 devices. The use of the IEEE-488 interface in the 600 controller differs depending on whether you are:

- Controlling the 600E system from a data system (such as Empower or Millennium® Chromatography Manager)
- Using the 600E system as a PowerLine™ Controller to control external detectors and autosamplers through the IEEE-488 bus

For details on connecting the IEEE-488 interface between devices, refer to Section 3.3, Making IEEE-488 Interface Connections.

RS-232 Interface Connector

Enables the 600 controller to communicate with a Waters 746 Data Module. The RS-232 interface transmits commands and report information from the 600E system to the 746 data module. No chromatographic data is transmitted.

For details on connecting the RS-232 interface to the Waters 746, refer to Section 3.4, Making RS-232 Connections with the Waters 746 Data Module.

Screw Terminals

Provide electrical connections to or from external devices. External devices can include:

- Non-IEEE-488 based autosamplers (using the Inject and Hold screw terminals)
- Non-IEEE-488 detectors (using the Inject, Stop Flow, and S1 through S4 screw terminals)
- Waters 746 Data Module (using the Inject, Pressure, and Chart screw terminals)
- Chart recorder (using the Pressure and Chart screw terminals)
- Automated switching valves (using the S1 through S4 and Aux +12 V screw terminals)

For details on connecting the screw terminals with external devices, refer to Section 3.5, Making Screw Terminal Connections with External Devices.

3.2 Attaching the Pump Interface Cable and Power Cord

This section covers the basic connections required to use the 600E system. It covers:

- Attaching the pump interface cable
- Attaching the AC power cord

Attaching the Pump Interface Cable

Attention: *To avoid damaging the 600 controller and/or pump, make sure the 600 controller power switch is turned off before performing this procedure.*

1. Power down the 600 controller power.

2. Connect the 37-pin interface cable to the pump interface connector on the 600 controller rear panel (Figure 3-2).
3. Connect the other end of the 37-pin interface cable to the rear of the 600E pump.

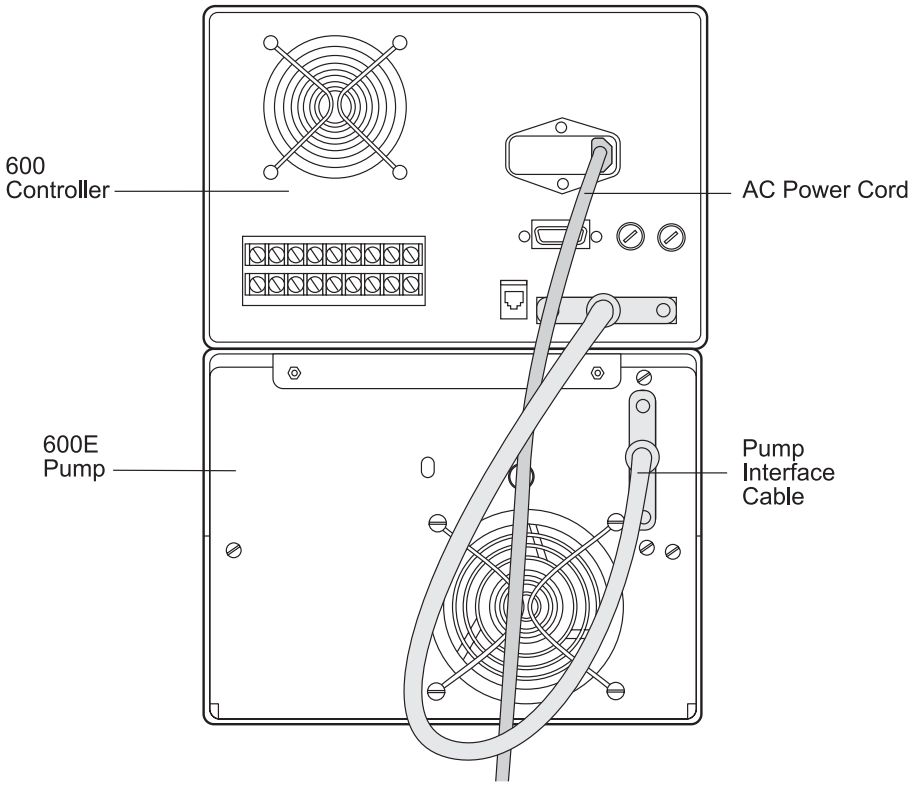


Figure 3-2 Pump Interface Cable and Power Cord Locations

Attaching the AC Power Cord

1. Insert the D-shaped connector end of the power cord into the power receptacle on the 600 controller rear panel (see Figure 3-2).
2. Insert the other end of the power cord into the wall outlet. For more information, refer to Section 1.3.1, System Power Requirements.

3.3 Making IEEE-488 Interface Connections

This section covers the different types of IEEE-488 interface connections you can make with the 600 controller. It includes:

- Making IEEE-488 connections with data systems
- Making IEEE-488 connections with external PowerLine devices
- Setting IEEE-488 addresses
- Performing the IEEE-488 powerup sequence

3.3.1 Making IEEE-488 Connections with Data Systems

When controlling the 600E system from a Waters data system (Empower or Millennium Chromatography Manager), use the IEEE-488 interface to receive information from the data system. Set up the 600 controller as a Gradient Controller. The data system operates as the system controller on the IEEE-488 interface.

Note: *To set the 600 controller as a Gradient Controller, refer to the Waters 600E Multisolvent Delivery System User's Guide, Section 8.1, Setting Up the 600 as a Gradient Controller.*

1. Connect the single receptacle end of the IEEE-488 cable (supplied with either the 600E system or the Waters data system) to your data system and attach the cable to the busLAC/E™ (Laboratory Acquisition and Control/Environment) card (Figure 3-3).

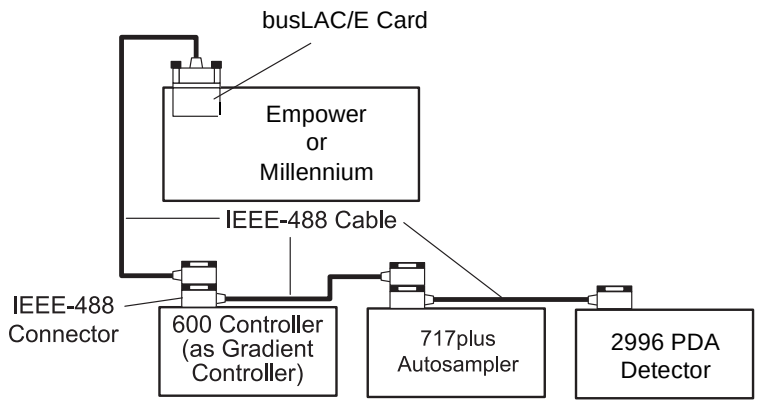


Figure 3-3 IEEE-488 Connections in a Millennium System

2. Connect the other end of the cable (stackable connector for daisy-chaining additional instruments) to the IEEE-488 connector on the 600 controller rear panel.
3. If you are using the 600 controller as part of a multicomponent configuration (as illustrated in Figure 3-3 and Figure 3-4), connect a second IEEE-488 cable to the "stackable" connector on the 600 controller. Connect the other end of the cable to the IEEE-488 port on the next component.

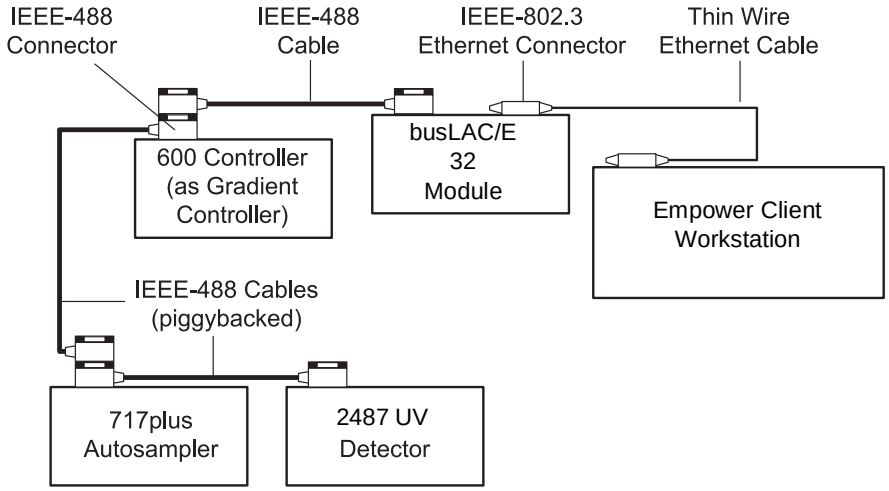


Figure 3-4 IEEE-488 Connections in a Waters 845/860 System

4. Repeat steps 2 and 3 for each additional component.

   Note: *The maximum total cable length between IEEE-488 devices is 65 feet (20 meters). The maximum recommended cable length between two IEEE-488 devices is 13 feet (4 meters). Longer total cable lengths can cause intermittent IEEE-488 communication failures.*

5. Ensure all IEEE-488 cable screws are fastened finger-tight.
6. Set a unique IEEE-488 address between 2 and 29 for each device connected on the IEEE-488 bus (see Section 3.3.3, Setting IEEE-488 Addresses).

Note: *Perform the correct IEEE-488 powerup sequence for the data system as described in Section 3.3.4, Performing IEEE-488 Powerup Sequence.*

3.3.2 Making IEEE-488 Connections with External PowerLine Devices

When controlling external PowerLine devices from the 600E pump, use the IEEE-488 interface to communicate with the PowerLine devices (where the PowerLine Controller is the controller on the IEEE-488 interface). Set up the 600 as a PowerLine Controller.

Note: *To set up the 600 controller as a PowerLine Controller, refer to the Waters 600E Multisolvent Delivery System User's Guide, Section 4.1, Setting Up the 600 as a PowerLine Controller.*

Supported PowerLine devices include:

- Waters autosamplers (717plus, 717, 715)
- Waters detectors (486, 490E, 410, 432)

Note: *In the PowerLine mode, the 600 PowerLine Controller supports operation with a Waters 431 conductivity detector through an interface box. For details, see the "Attaching a Waters 431 Detector to a PowerLine System"* *"Attaching a Waters 432 Detector to a PowerLine System" on page 36.*

When operating with the Waters 432 conductivity detector, the 600 PowerLine Controller supports operation directly over the IEEE-488 interface as described in this procedure.

To connect IEEE-488 cables:

1. Connect the single-receptacle end of the IEEE-488 cable (supplied with either the 600E system or the data system) to the IEEE-488 connector on the 600 controller rear panel (Figure 3-5).
2. Connect the other end of the cable ("stackable" connector for daisy-chaining additional instruments) to the IEEE-488 connector on the next PowerLine instrument.
3. If using a multicomponent configuration (as illustrated in Figure 3-5), connect a second IEEE-488 cable to the "stackable" connector on the PowerLine instrument. Connect the other end of the cable to the IEEE-488 port on the next PowerLine component.

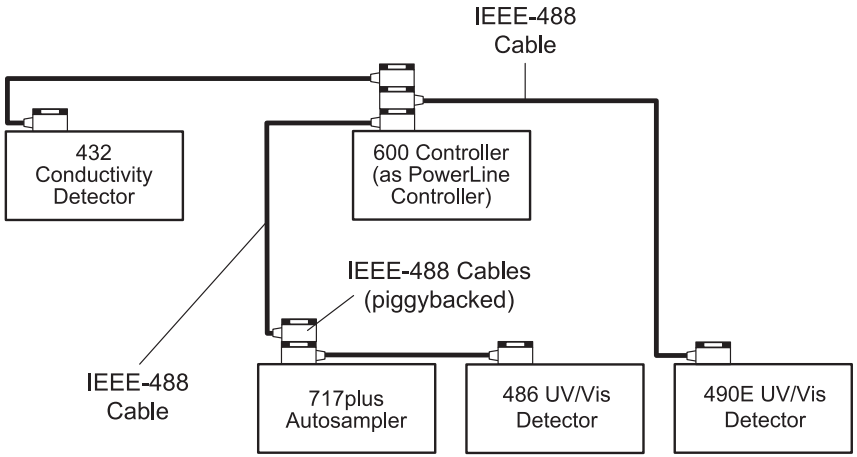


Figure 3-5 PowerLine Controller IEEE-488 Connections

4. Repeat steps 2 and 3 for additional PowerLine components.

   Note: *The maximum total cable length between IEEE-488 devices is 65 feet (20 meters). The maximum recommended cable length between two IEEE-488 devices is 13 feet (4 meters). Longer total cable lengths can cause intermittent IEEE-488 communication failures.*

5. Ensure that all IEEE-488 cable screws are fastened finger-tight.
6. Set a unique IEEE-488 address between 2 and 29 for each PowerLine device connected on the IEEE-488 bus (see Section 3.3.3, Setting IEEE-488 Addresses).

   Note: *Perform the correct IEEE-488 powerup sequence for the PowerLine system as described in Section 3.3.4, Performing IEEE-488 Powerup Sequence.*

Attaching a Waters 432 Detector to a PowerLine System

In the PowerLine mode, the 600 PowerLine Controller supports operation with a Waters 432 conductivity detector through an interface box. You must use the interface box to communicate with the 432 detector over the IEEE-488 interface. When operating with the Waters 432 conductivity detector, the 600 PowerLine Controller supports operation directly over the IEEE-488 interface (as illustrated in Figure 3-5).

1. Connect the IEEE-488 cable (stackable connector for daisy-chaining additional instruments) from the 600 controller to the IEEE-488 connector on the interface box (Figure 3-6).

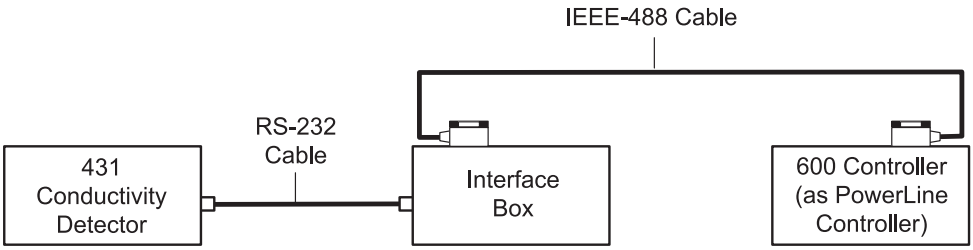


Figure 3-6 PowerLine 431 Connections

2. Connect the interface box to the 431 detector with a RS-232 cable (included with the interface box).
3. Connect the power supply to the interface box. Use the correct power supply (110 or 230 V) for your voltage. Refer to Section 1.3.1, System Power Requirements.
4. Plug the power supply power cord into the wall outlet, then turn on the power supply. LED lights illuminate when the interface box is on and also when transmitting data between devices.

3.3.3 Setting IEEE-488 Addresses

You must set a unique IEEE-488 address between 2 and 29 for each device on the IEEE-488 bus. A unique address is required for the device to be recognized on the IEEE-488 interface. When setting IEEE-488 addresses, note that:

- When using the 600 controller with a data system (Empower or Millennium Chromatography Manager), you set the IEEE-488 address of the Gradient Controller on the Pump Configuration screen.
- When using the 600 controller as a PowerLine Controller, you do *not* set the IEEE-488 address of the 600E pump. In the PowerLine system configuration, you set the IEEE-488 address of each of the other PowerLine instruments through the instrument software or DIP switches. Any previously set address has no effect when in PowerLine configuration.

Recognizing IEEE-488

After you set the address for an IEEE-488 device, power the device off and on again to reset the address in software. The new address is *not* recognized until the device has performed its calibration or diagnostic routines (performed at powerup).

Setting Waters 486 and 490E IEEE-488 Addresses

If you are connecting a Waters 486 and 490E detector to a PowerLine Controller, the address of the 486 *must* be lower than that of the 490E.

3.3.4 Performing IEEE-488 Powerup Sequence

This section describes:

- Powerup sequence for IEEE-488 devices
- Powerdown sequence for IEEE-488 devices

Powerup Sequence for IEEE-488 Devices

This section describes the proper IEEE-488 device powerup sequence when using the:

- 600E System with a data system
- 600 Controller as a PowerLine Controller

You must perform the steps in the following procedures in the *exact* order presented to ensure proper operation of your system (data system-based or PowerLine-system based).

Attention: *If you do not perform the steps in proper sequence, the data system or PowerLine Controller may not recognize the other devices on the IEEE-488 interface.*

For additional 600E system powerup and powerdown information, refer to the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3, Preparing Your System for Operation.

Data System Powerup Sequence

Perform the following powerup sequence when using the 600E system with a data system:

Note: *Power up all devices connected to your data system* ***before*** *you power up the computer. As you power up each component, wait a brief period to allow its internal diagnostic tests to run. These tests ensure that each module is functional, and serve to quickly isolate a failure.*

1. Power up all equipment *not* controlled by the data system.
2. Power up all equipment controlled by the data system that is *not* under direct IEEE-488 control.
3. Power up the 600E pump to establish eluent flow. Then power up all other equipment controlled through the IEEE-488 bus.

Note: *You cannot run methods or method sets, or use the QuickSet Control window unless all devices on the IEEE-488 bus that are assigned to a system on the Millennium Chromatography Manager are powered up and calibrated. You do not need to power up instruments that are not assigned to a system, or that are assigned to a system you do not intend to use.*

4. Power up the printer and monitor.
5. Power up the computer.

PowerLine Controller Powerup Sequence

Perform the following powerup sequence when using the 600 controller as a PowerLine Controller:

1. Power up all equipment *not* controlled through the IEEE-488 interface.
2. Power up all equipment controlled through the IEEE-488 bus.
3. Power up the 600 controller.

Power Down Sequence for IEEE-488 Devices

If you do not plan to use the Waters 600E system for a long period of time (overnight or longer), power down the system.

Note: *For a list of power-down precautions for storing the 600E pump, refer to the Waters 600E Multisolvent Delivery System User's Guide, Chapter 3, Preparing Your 600E Multisolvent Delivery System for Operation.*

To power down the 600E system:

1. Ensure the system is purged of salts.
2. Stop your chromatographic run (if necessary).
3. Press the On/Off switch (on the 600 controller front panel) to power down the 600E system.
4. Power down the other IEEE-488 devices.

3.4 Making RS-232 Connections with the Waters 746 Data Module

The RS-232 interface connects the Waters 600 controller to a Waters 746 data module. The interface transmits:

- Control commands from the data module to the controller
- Commands and report information from the controller to the data module

No chromatographic data is transmitted across the interface.

To make the RS-232 connection:

1. Connect the 25-pin connector (provided with the data module) to the rear panel of the data module (Figure 3-7).

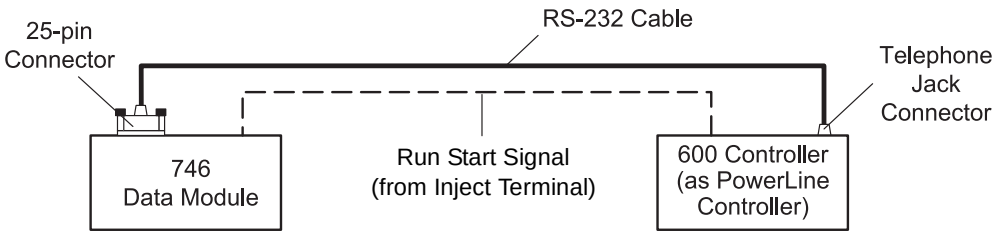


Figure 3-7 RS-232 Connections with a Waters 746 Data Module

2. Connect the cable to the RS-232 telephone jack connector on the controller rear panel (see Figure 3-1).

Note: *When connecting the 746 to the controller, you must also attach a cable from the Inject terminal to the 746 to coordinate the run start signals of the two systems.*

3.5 Making Screw Terminal Connections with External Devices

This section describes how to connect external devices to the screw terminals of the 600 controller. It covers:

- Screw terminal description
- Connecting a non-IEEE-488 autosampler
- Connecting a non-IEEE-488 detector
- Connecting a Waters 746 Data Module
- Connecting a chart recorder
- Connecting external devices

3.5.1 Screw Terminal Description

The screw terminals of the 600 controller enable the controller to receive signals from or generate signals to external devices (for example, a non-IEEE-488 autosampler, a Waters 746 Data Module, or an automated switching valve).

Depending on the external devices within your particular system, use the appropriate screw terminals listed in Table 3-1 (and the procedures in the remainder of this section) to connect the device to the 600 controller.

Attention: *To meet the regulatory requirements of immunity from external electrical disturbances that may affect the performance of the 600 controller, do not use cables longer than 9.8 feet (3 meters) when connecting to the screw-type barrier terminal strips. In addition, ensure you always connect the shield of the cable to chassis ground.*

Table 3-1 describes the screw terminals on the 600 controller.

Table 3-1 600 Controller Screw Terminals

Screw Terminal	Function
S1, S2, S3, S4 (Open Collector Outputs)	Generates an output signal to control external devices requiring a contact closure, TTL-level signal[a], or open collector signal. This output signal is also capable of driving solenoid valves and other power devices requiring up to 1 A. You program the 600 controller to turn switches S1 through S4 ON and OFF, or to generate a 0.6-second pulse. The time-generated events occur as defined in the controller Program Event screen (see the *Waters 600E Multisolvent Delivery System User's Guide*). S4 also serves as a dedicated output to an external device to indicate a stop flow condition. S4 defaults to the Off position when a stop flow condition or critical fault occurs. Use S4 to connect a device (such as an autosampler) that must be shut off when an error occurs, such as a high pressure shutdown or critical fault.
Inject (Digital Input)	Receives a signal from an external injector (autosampler or Rheodyne 7725i manual injector) to initiate the chromatographic run. The Inject terminal also provides a signal to start a Waters 746 Data Module. The Inject terminal accepts signals from several outputs, including TTL signals, open collector outputs, or contact closures.
Stop Flow (Digital Input)	Receives a contact closure signal to instruct the pump to stop flow. The Stop Flow terminal accepts signals from several outputs, including TTL signals, open collector outputs, or contact closures. ***Note:*** *The receipt of the Stop Flow signal at the 600 controller's Stop Flow rear panel terminal suspends the controller's run, gradient, and event clocks. The three clocks resume operation when the Stop Flow signal terminates.*
Hold (Digital Output)	Generates a signal that prevents a non-IEEE-488 autosampler from further injections in case of a power failure, pressure shutdown, or abort condition. The Hold terminal is compatible with TTL inputs, or inputs expecting contact closures. If the input being controlled is polarized, the grounds should be connected together and the input terminal should be connected to the Hold terminal.

Table 3-1 600 Controller Screw Terminals (Continued)

Screw Terminal	Function
Pressure +/– and Chart +/– (Analog Output)	Produces a DC voltage whose magnitude is proportional to the physical parameter being monitored. The voltage range of the analog output is 0 to 10 mV full scale. **Pressure Terminals** - Transmit a voltage representation of the current 600E system backpressure. This is a direct pressure trace from the pump transducer (0 to 6000 psi is full scale), where 10 mV = 6000 psi. **Chart Terminals** - Transmit a voltage that is proportional to the specified Chart monitor function: • Composition of an eluent reservoir (A, B, C, or D) • Current flow rate • Column heater temperature (0 to 99 °C) You select the Chart function to monitor using the controller Pump Setup screen (as described in the *Waters 600E Multisolvent Delivery System User's Guide*).
AUX +12 V (Digital Output)	Provides up to 1.2 A of current at +12 VDC. The Aux +12 V signal is used in conjunction with output switches S1 through S4 for applications such as powering solenoid valves and other automation accessories..  ***Attention:*** *Applying externally generated voltages may damage the instrument. Shorting the Aux 12 V terminal to ground or an event output will cause the Aux +12 V power fuse to blow.*

Table 3-1 600 Controller Screw Terminals (Continued)

Screw Terminal	Function
GND (Signal Ground)	Provides alternative ground connection for signal cable shield connections. Ground terminals reference all 600 controller digital input and output signals. Connect all instrument ground terminals together.
 (Chassis Ground)	Connects the shield lead from an analog signal cable (such as the one used with the Pressure or Chart analog output signals). Connect these terminals to the 600 controller internal sheet metal chassis to reduce stray signal noise. Shields should only be connected at one end of the cable.

a. Transistor-to-transistor logic (TTL): +5 V = OFF (switch open), 0 V = ON (switch closed)

3.5.2 Connecting a Non-IEEE-488 Autosampler

Background

When you use a non-IEEE-488 autosampler *or* a Waters IEEE-488 autosampler in stand-alone mode, you must connect an inject start signal to the 600 controller.

The 600 controller requires an electrical trigger signal from the injector (manual injector or autosampler) at the Inject terminal as each injection occurs. This inject start trigger signal (TTL signal, open collector output, or contact closure) instructs the 600 controller to acquire data, or run methods and tables.

Note: *The Rheodyne 7725i manual injector transmits the inject start signal over the pump interface cable. Waters PowerLine IEEE-488 autosamplers (such as the 717plus) transmit the inject start signal directly over the IEEE-488 bus during data acquisition. Trigger cables are not required.*

Connections

Connect the non-IEEE-488 autosampler to the 600 controller as described below:

Autosampler	Autosampler Connection	600 Controller Connection
717plus, 717, or 715	Inject Start	Inject and Gnd
700 or 712	Integ Start (or Chart Mark)	Inject and Gnd
Non-Waters	----	Inject and Gnd

Figure 3-8 illustrates connecting a non-IEEE-488 autosampler to the Inject terminal.

Attention: *Be careful to maintain trigger cable polarity between devices in order not to close the inject start circuit. If you cross the trigger cables, some devices may not receive the inject start signal.*

When the injector starts the run, some devices may become active but others may not, causing the PowerLine Controller to remain in the Inject wait state. Also, if you cross the trigger cables, some devices may start when the instruments are set up, before the inject start signal.

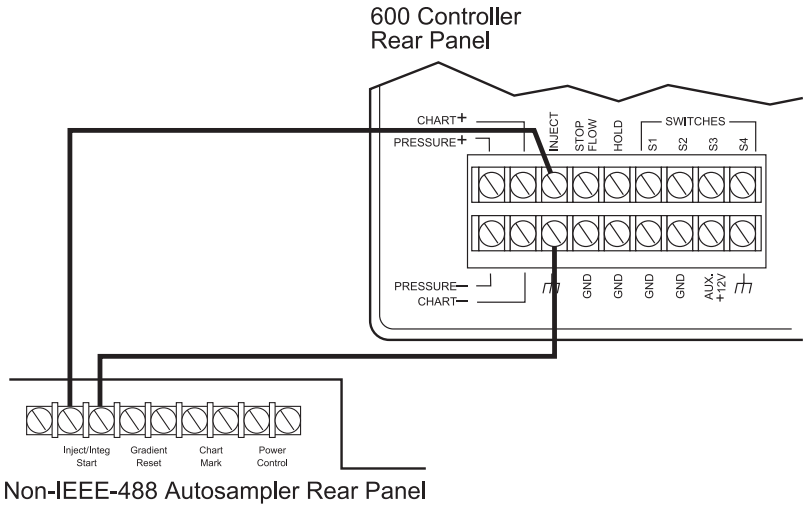


Figure 3-8 Connecting a Non-IEEE-488 Autosampler to the Inject Terminal

Triggering Multiple Devices

To trigger multiple instruments, connect the trigger cable between the inject start input on each device using one of the following:

- To connect the instruments in parallel, use the same port from the autosampler to attach trigger cables from the autosampler to each device. Ensure polarities are consistent and voltages from the various devices are compatible.
- If your autosampler has more than one inject start port, use a separate port to start each device. This eliminates the possibility of closing the inject start circuit.
- To connect the instruments in series, use the port from the autosampler to the inject start port on the first device; then jump the inject start port from the first device to the second device, and so on (stacking the devices).

3.5.3 Connecting a Non-IEEE-488 Detector

Background

When you use a non-IEEE-488 detector or a Waters PowerLine IEEE-488 detector with the 600 controller, you may find that certain trigger parameters are not transmitted during the injection sequence, such as:

- Chart Mark (inject start) signal
- Auto zero signal
- Stop flow signal
- Timed lamp on/off signal

Connections

You can use the 600 controller screw terminals to transmit or receive these signals during operation. These connections vary with the type of detector in use.

For details on making electrical connections with the detector, refer to the appropriate detector operator's guide.

3.5.4 Connecting a Waters 746 Data Module

When using the Waters 746 with the 600 controller, you can make additional screw terminal connections to provide (along with the RS-232 interface connection) the following signals:

- Inject signal (to start Channel A or B)
- Pressure signal (to monitor pump pressure on Channel B)
- Chart output signal (to monitor the selected Chart out signal on Channel B)

Note: *For details on attaching the RS-232 interface to the Waters 746, refer to Section 3.4, Making RS-232 Connections with the Waters 746 Data Module.*

Connecting the Inject Signal to the Waters 746

You must connect a run start signal to the Waters 746 to instruct the device when to initiate data collection. The Waters 746 receives the run start signal in one of two ways:

- If you use the Rheodyne 7725i manual injector, the 600 controller provides the run start signal from the Inject terminal (Figure 3-9).

- If you use a non-IEEE-488 autosampler, the autosampler provides the inject start signal to trigger both the 600 controller and Waters 746. Both the autosampler and the Waters 746 connect to the 600 controller Inject terminal (Figure 3-10).

  Note: *When you connect the Waters 746 to the 600 controller, you must also attach an RS-232 interface cable between the 600 controller and the 746. Refer to Section 3.4, Making RS-232 Connections with the Waters 746 Data Module.*

Connections

Connect the Waters 746 to the 600 controller (using the Remote Start cable) as described below:

Waters 746 Connection	**600 Controller Connection**	**Autosampler Connection (if applicable)**
DIN plug (single 3-pin connector): ARS (White) - Channel A or BRS (Red) - Channel B GND (Green) - Ground	Inject and Gnd	Inject Start or Integ Start

Figure 3-9 illustrates connecting the Waters 746 to the 600 controller Inject signal. Figure 3-10 illustrates connecting both the Waters 746 and a non-IEEE-488 autosampler to the 600 controller Inject signal.

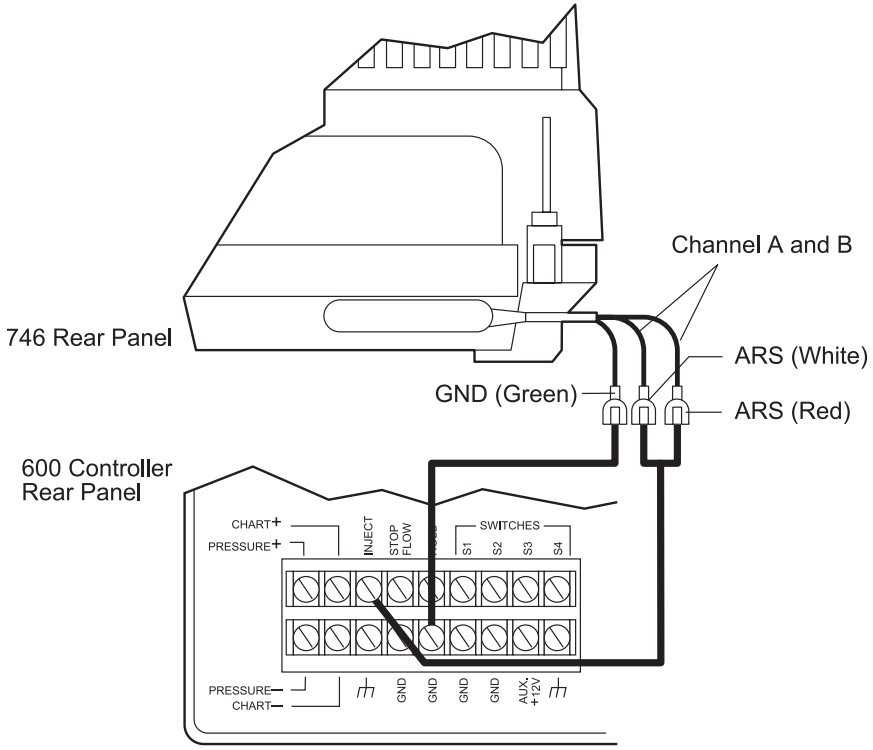


Figure 3-9 Connecting the Waters 746 to the 600 Controller Inject Terminal

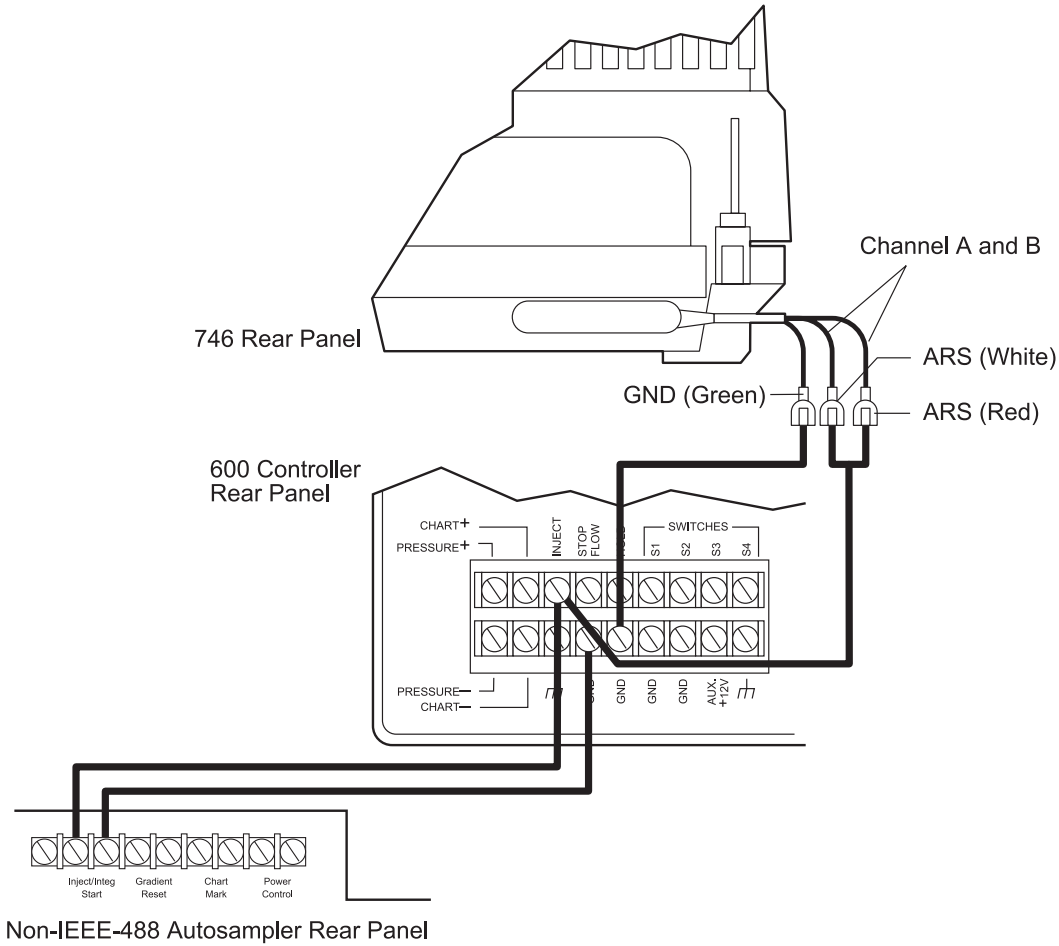


Figure 3-10 Connecting the Waters 746 and Autosampler to the Inject Terminal

Connecting the Pressure or Chart Terminals to the Waters 746

You can use the second channel on your Waters 746 to monitor one of the following pump output signals.

Note: *To use the second channel on the 746 to plot pressure or percent composition, the data module must contain expanded memory. The 746 plots the second channel after the first channel finishes.*

- 600E pump pressure during ramp-up testing (from Pressure terminals)
- Effects that eluents have on pressure during various phases of gradient operation (from Pressure terminals)

- Eluent composition (A%, B%, C%, or D%), flow rate, or column-heater temperature (from Chart terminals)

  Note: *When plotting eluent composition, the output signal reflects the composition at the gradient proportioning valve. This composition is different from the composition within the column or at the detector. This difference is the delay caused by the system volume.*

The full scale range of the Pressure and Chart outputs is 0 to +10 mV. You select the Chart output function to monitor using the controller Pump Setup screen (as described in the *Waters 600E Multisolvent Delivery System User's Guide*).

Connections

To monitor the analog output signal from either the Pressure or Chart terminals, connect the event cable (provided in the 600E Startup Kit) as described below:

Monitor Function	600 Controller Connection	Waters 746
Pump pressure	Pressure + and –	Channel B + and –
Eluent composition (A%, B%, C%, or D%), flow rate, or column heater temperature	Chart + and –	Channel B + and –

Figure 3-11 shows the Waters 746 connected to the 600 controller Pressure terminals. Figure 3-12 shows the Waters 746 connected to the 600 controller Chart terminals.

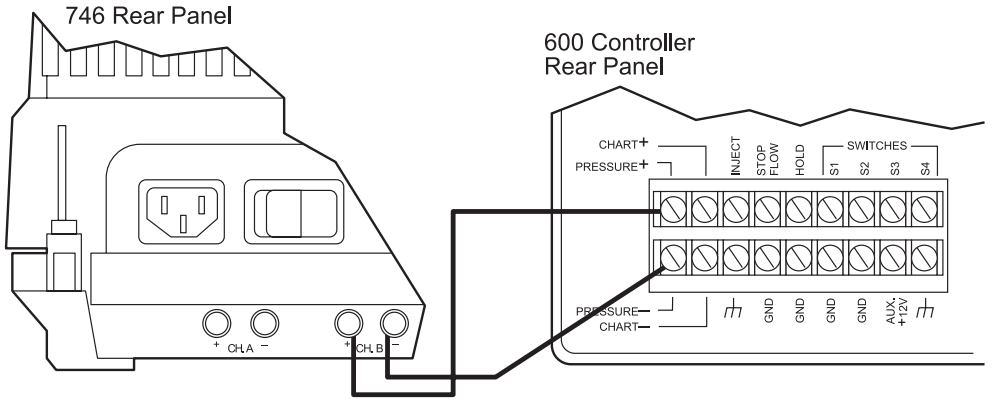


Figure 3-11 Connecting the Waters 746 to the 600 Controller Pressure Terminals

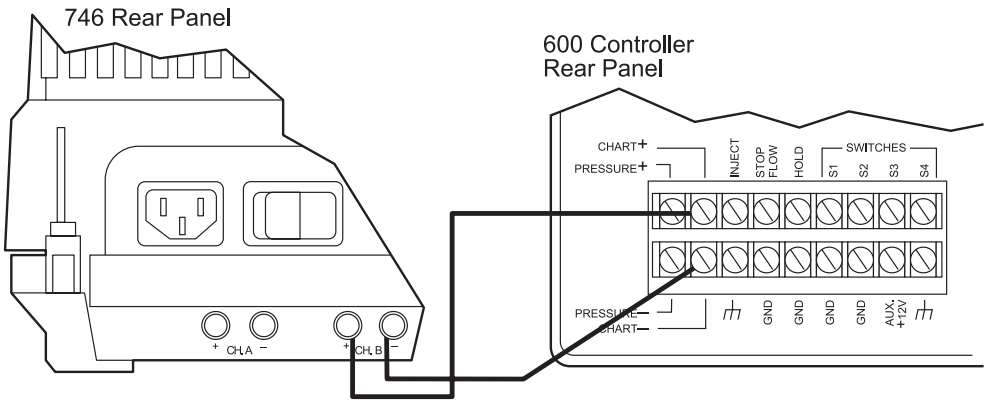


Figure 3-12 Connecting the Waters 746 to the 600 Controller Chart Terminals

3.5.5 Connecting a Chart Recorder

Background

You can use the second pen on your chart recorder to monitor one of the following pump output signals:

- 600E pump pressure during ramp-up testing (from Pressure terminals)
- Effects that eluents have on pressure during various phases of gradient operation (from Pressure terminals)
- Eluent composition (A%, B%, C%, or D%), flow rate, or column heater temperature (from Chart terminals)

  Note: *When plotting the pump percentage, the output signal reflects the composition at the proportioning valve. This composition is different from the composition within the column or at the detector. This difference is the delay caused by the system volume.*

The full-scale range of the Pressure and Chart outputs is 0 to +10 mV. You select the Chart output function to monitor using the controller Pump Setup screen (as described in the *Waters 600E Multisolvent Delivery System User's Guide*).

Connections

To monitor the analog output signal from either the Pressure or Chart terminals, connect the event cable (provided in the 600E Startup Kit) as outlined below:

Monitor Function	600 Controller Connection	Chart Recorder
Pump Pressure	Pressure + and –	Pen 2 + and –
Eluent composition (A%, B%, C%, or D%), flow rate, or column heater temperature	Chart + and –	Pen 2 + and –

Figure 3-13 illustrates connecting the chart recorder to the 600 controller Pressure terminals, and Figure 3-14 illustrates connection to the Chart terminals.

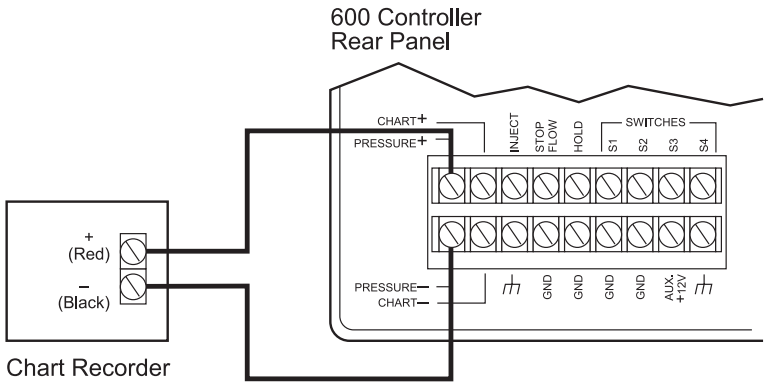


Figure 3-13 Connecting the Chart Recorder to the 600 Controller Pressure Terminals

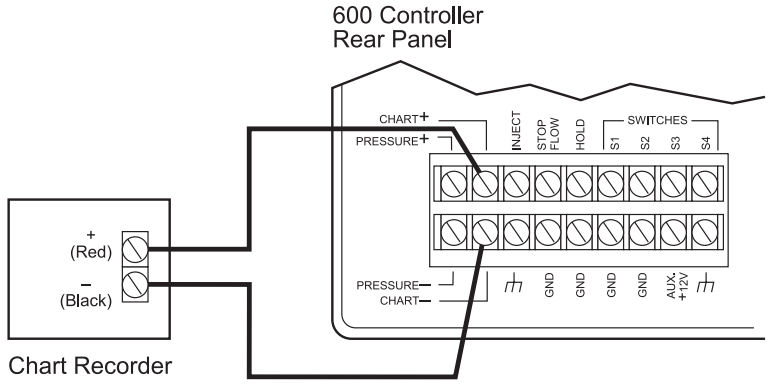


Figure 3-14 Connecting the Chart Recorder to the 600 Controller Chart Terminals

3.5.6 Connecting an External Device

Background

When your system includes an external TTL-level or contact closure device, you can use switches S1 through S4 on the 600 controller to control external devices. External devices can include:

- Automated switching valves
- Fraction collectors

The four external event switches (S1 through S4) control external devices requiring a time-activated contact closure, TTL-level signal, or open collector signal. Each output signal is also capable of driving solenoid valves and other power devices requiring up to 1 A control external devices.

S4 is a dedicated output to an external device to indicate a stop flow condition. S4 defaults to the Off position when a stop flow condition or critical fault occurs. Connect S4 to a device (such as an autosampler) that must be shut off when an error, such as a high-pressure shutdown or critical fault, occurs.

Note: *Certain external devices (such as automated switching valves) require an auxiliary +12 V power source. Refer to* *"Connecting External Devices to Aux +12 V Power" on page 54* *for connection information.*

STOP ***Attention:*** *If you accidentally short 12 Volts to ground, the auxiliary 12 V fuse will blow.*

You define S1 through S4 operation using the:

- Program Event screen (for time-based activation)
- Isocratic or Direct Control screen (for immediate activation)

Refer to Section 5.1 or 6.2 of the *600E Multisolvent Delivery System User's Guide*.

Connections

To control an external device using one of the S1 through S4 screw terminals, connect the event cable (provided in the 600E Startup Kit) as outlined below:

600 Controller Connection	External Device
S1, S2, S3, or S4 (red lead)	+
Gnd (black lead)	Gnd

Figure 3-15 illustrates connecting an external device to the 600 controller S1 terminal.

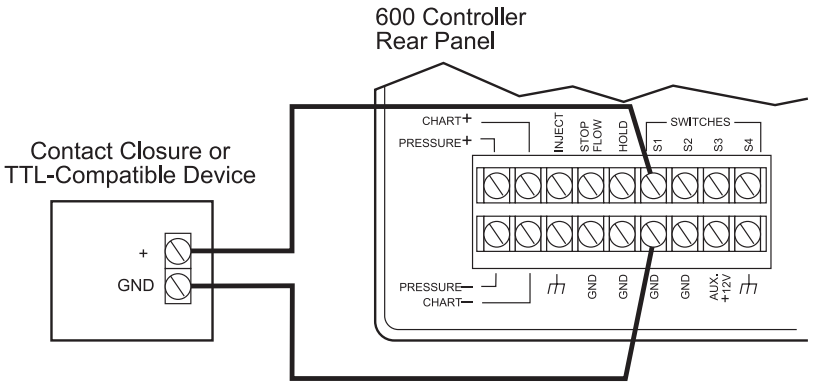


Figure 3-15 Connecting an External Device to 600 Controller Switch S1 Terminals

Connecting External Devices to Aux +12 V Power

For external devices requiring an auxiliary +12 V power source, use the Aux +12 V terminal on the 600 controller.

Note: *The maximum current available from the 12 V power source (divided among all the devices in use on S1 through S4) is 1.5 A. The maximum current capacity of any single event (S1 through S4) is 1.0 A.*

To attach the external device to the Aux +12 V terminal, attach the event cable (provided in the 600E Multisolvent Delivery System Startup Kit) as outlined below:

600 Controller Connection	External Device
Aux +12 V	+
S1, S2, S3, or S4	–

Figure 3-16 illustrates connecting an external device to the 600 controller Aux +12 V and switch (S1-S4) terminals.

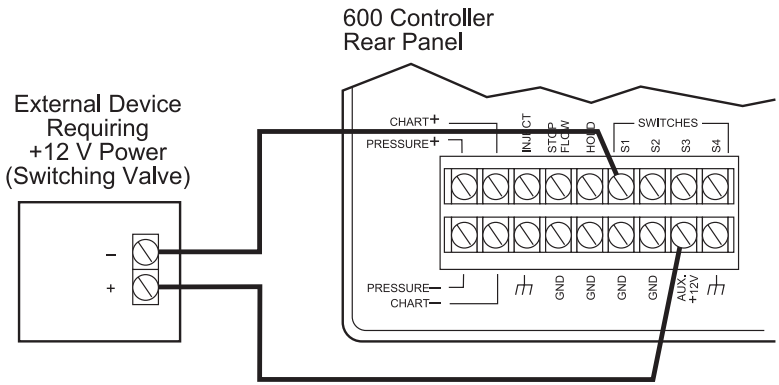


Figure 3-16 Connecting an External Device to the 600 Controller Aux +12 V and S1 Terminals

Chapter 4
Maintenance Procedures

This chapter describes maintenance procedures you can perform to ensure the Waters 600E Multisolvent Delivery System consistently provides accurate and precise results.

4.1 Maintenance Considerations

Safety and Handling

Cleaning

Use a damp soft cloth to clean the outside surface of the instrument.

When performing maintenance procedures on your 600E system, keep the following safety considerations in mind:

Caution: *To prevent the possibility of electric shock, never disconnect an electrical assembly (including the pump interface cable) while power is applied to the Waters 600E system.*

Attention: *To prevent damage to the 600 controller, wait approximately three minutes once power is disconnected before removing an electrical assembly (including the pump interface cable).*

Caution: *When handling eluents, changing tubing, or operating the 600E system in general, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

Attention: *Do not touch integrated circuit chips or other components that do not specifically require manual adjustment. Damage due to static electricity could occur.*

Caution: *To avoid the possibility of electric shock, do not open the 600E controller cover. The 600E controller does not contain user-serviceable components.*

Performing 600E System Operating Procedures

To keep your 600E system running smoothly, follow the operating procedures and guidelines outlined in the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3, Preparing Your System for Operation, which covers such operating practices as:

- Eluent considerations
- Sparging the reservoirs
- Priming the pump
- Flushing the system
- Equilibrating the system
- Changing eluent
- Purging bubbles

Spare Parts

Refer to Appendix A, Spare Parts, for spare part information. Parts not included in Appendix A are not recommended for replacement.

Contacting Technical Service

Waters Technical Service provides preventive or corrective maintenance. You can contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A).

4.2 Maintaining 600E Pump Components

This section describes the maintenance procedures for the 600E pump. Perform these procedures when you determine there is a problem with a specific component in the pump. For troubleshooting information, see Chapter 6, Troubleshooting.

Caution: *When handling eluents, changing tubing, or operating the 600E system in general, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

This section covers:

- Pump overview
- Calibrating/replacing the pressure transducer
- Removing the pump head
- Replacing the plunger seal
- Cleaning/replacing the pump plunger
- Cleaning/replacing a pump check valve
- Replacing the sparge valve

Spare parts are shown where applicable. For a complete list of spare parts, see Appendix A, Spare Parts.

4.2.1 Pump Overview

This section provides an overview of the 600E pump. Figure 4-2 illustrates the various pump assemblies, which are described in Table 4-1.

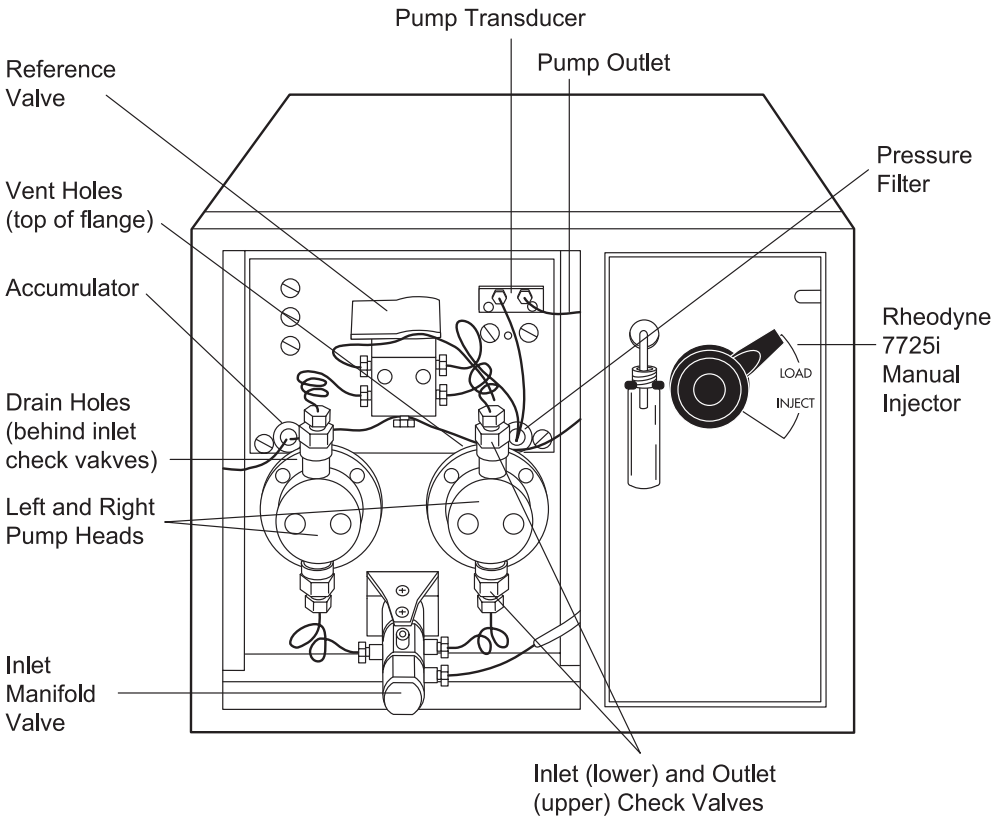


Figure 4-1 600E Pump Assemblies

Table 4-1 600E Pump Assemblies

Description	**Function**
Inlet manifold valve	Eluent purging, pump priming (injection), eluent draw-off.
Pump head assemblies (left and right)	Draw in/expel eluent.
Drain holes (behind inlet check valves)	Drain solvent that collects behind the plunger seals (position on left head shown).
Inlet and outlet check valves	Maintain flow direction by opening in one direction only (for example, the inlet valve opens on piston intake stroke and closes on delivery stroke).

Table 4-1 600E Pump Assemblies (Continued)

Description	Function
Vent holes (top of flange)	Provide access for flushing residue from the backs of the plungers (positions on right head shown).
Reference valve	Assists pump priming. Used with detectors requiring reference solvent stream.
Pressure filter	Smooths minor flow fluctuations and enhances solvent mixing during multi-solvent operation.
Accumulator	Performs a similar function to the pressure filter, but with a larger volume capacity. To use, disconnect the fittings for the pressure filter and substitute the fittings for the accumulator.
Pressure transducer	Senses backpressure developed by resistance to solvent flow.
Pump outlet	Outlet for solvent flow to column or similar device, such as a switching valve.
Rheodyne 7725i Manual Injector (optional)	Manual sample injector.

4.2.2 Calibrating and Replacing the Pressure Transducer

Calibrating the Transducer

Proper pump calibration ensures accurate operation.

1. Disconnect the transducer outlet from the system.

   Attention: *Always open the reference valve to relieve system pressure when performing calibration.*

2. Remove the pump cover.
3. Power on the controller.
4. Access the Isocratic or Direct Control screen (depending on your controller configuration).
5. On the screen, set flow rate to 0.0 mL/min. Verify that flow rate is approximately 0.0 mL/min. If necessary, use the transducer zero adjust screw on the front of the pump (Figure 4-2) to adjust the pressure until the display on the screen reads zero.

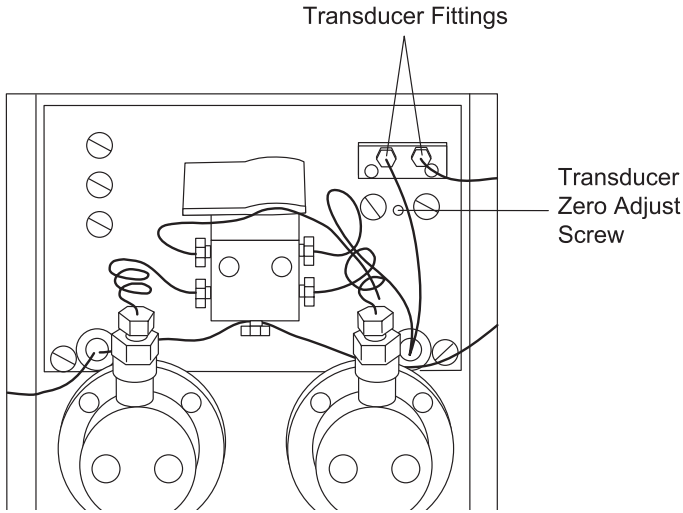


Figure 4-2 Transducer Fittings and Zero Adjust Screw

Replacing the Transducer

1. Power down the 600 controller and disconnect the power cord.
2. Remove the retaining screws from the upper rear panel of the pump and from both sides of the front panel. Slide the cover off.
3. Disconnect the transducer fittings on the front panel (see Figure 4-2).
4. Loosen the retaining screws above the pump heads and on the top rear corners of the pump cover. Lift the pump cover off.
5. Remove the two screws just below the transducer fittings on the front panel (Figure 4-3).

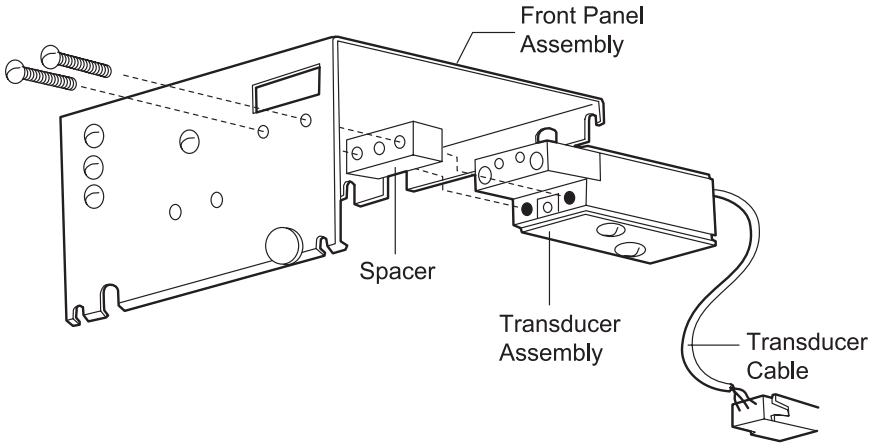


Figure 4-3 Transducer Replacement

6. Disconnect the transducer connector on the interconnect board (Figure 4-4). The interconnect board is on the left rear of the pump. The transducer connection is on the lower front of the board.

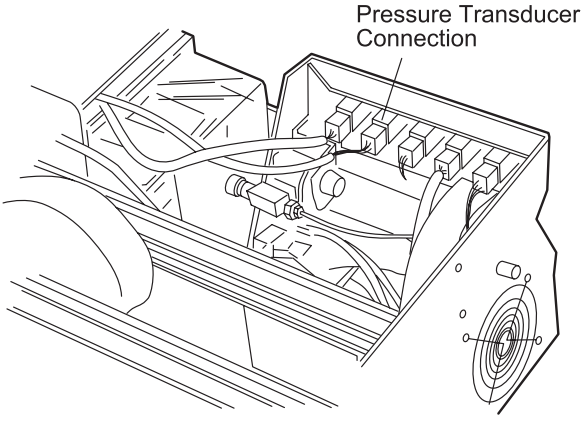


Figure 4-4 Transducer Connection on Interconnect Board

7. Remove the transducer and spacer from behind the front panel.

Installing a New Transducer

1. Line up the spacer and transducer and replace the two screws on the front panel.

2. Reconnect the transducer cable on the interconnect board at J2 and replace the pump cover and tighten the four retaining screws. Connect the pressure transducer connector on the interconnect board (see Figure 4-4).
3. Replace the cover of the pump and connect the power cord.
4. Check the calibration adjustment of the transducer.

4.2.3 Removing the Pump Head

Note: *For information about isolating problems in the 600E pump, see Chapter 6, Troubleshooting.*

Figure 4-5 is an exploded diagram of a pump head. For a list of replacement parts, see Appendix A, Spare Parts.

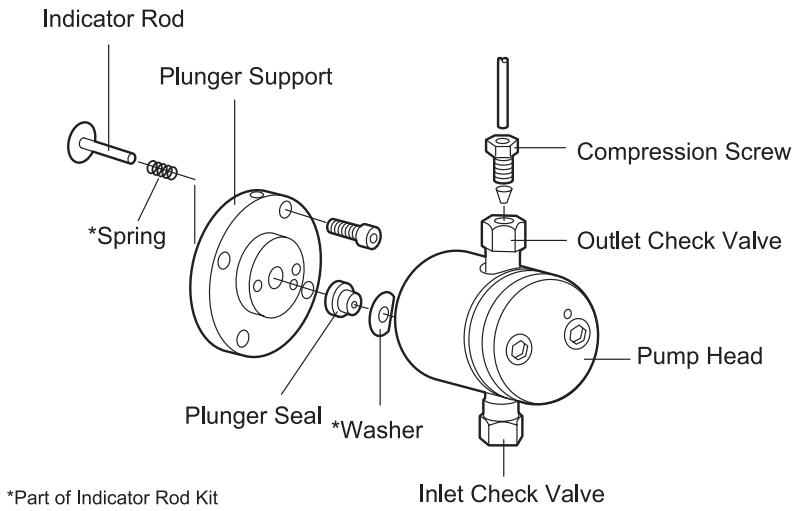


Figure 4-5 Pump Head Assembly

Removing the Pump Head

1. Flush the pump with methanol (if miscible with the previous solvent).
2. Remove the eluent lines from the reservoirs.
3. Turn the inlet manifold knob to the Draw position. Use the priming syringe to draw all of the methanol from the eluent lines.
4. Disconnect the pump head inlet line from the inlet manifold.

5. Set the flow rate to 0.1 mL/min. Run the pump until the indicator rod fully retracts into the pump head.

   Attention: *The indicator rod must be fully retracted into the pump head. The plunger may be damaged during maintenance if the indicator rod is not fully retracted.*

6. Turn off the 600 controller to power down the pump.
7. Remove the inlet and outlet pump lines from the check valve housings.
8. Remove the pump head assembly mounting bolts with a 5/32-inch Allen wrench. Loosen the screws 1/2-turn at a time for the first two turns. Slide the pump head assembly off the pump (Figure 4-6).

   Note: *If desired, you may remove the complete pump head-plunger support assembly. Refer to Section 4.2.5, Cleaning and Replacing the Pump Plunger.*

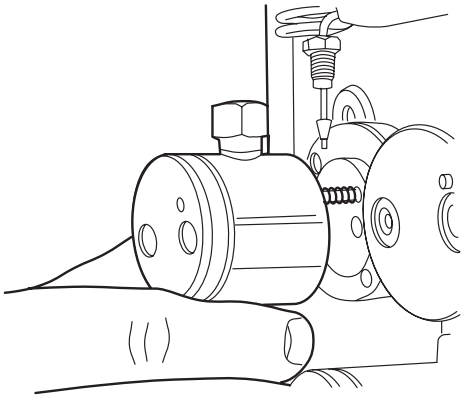


Figure 4-6 Pump Head Removal

4.2.4 Replacing the Plunger Seal

This section describes replacing the pump plunger seal. For information about isolating plunger problems in the 600E pump, see Chapter 6, Troubleshooting.

Note: *To ensure optimum pump performance, replace the seals in both pump heads (instead of only replacing the seal on one pump head).*

1. Power down the 600 controller.
2. Remove the pump head as outlined in Section 4.2.3, Removing the Pump Head.

3. Using the seal insertion tool stand tip, pry the seal out of the pump head (Figure 4-7). The stand tip holds the plunger seal for correct alignment in the pump head.

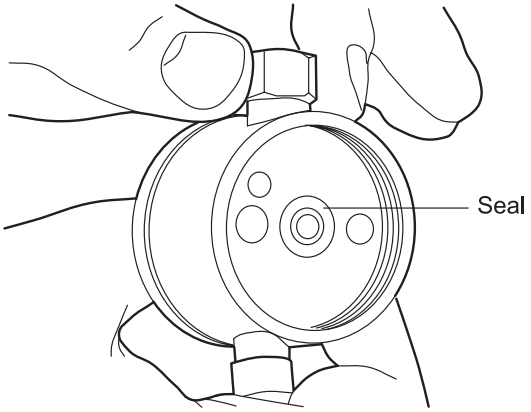


Figure 4-7 Plunger Seal Orientation

4. Place the new plunger seal (wetted with methanol) on the seat (wetted with methanol) for the analytical (100 µL) heads. Insert the plunger seal into the pump head assembly. For 225 µL heads, insert the seal with the solid side facing out.
5. Use the stand tip to firmly seat the seal in the pump head.
6. Slide the pump head assembly into position over the plunger and replace the two pump head mounting bolts. Tighten the bolts evenly by alternately tightening one then the other by half turns.
7. Turn on the pump and set flow rate to 0.3 mL/min. The indicator rod (see Figure 4-5) should move freely.
8. Set flow to 0 mL/min. Reconnect the eluent lines, reposition the eluent lines in the reservoir, and prime the pump. Check for leaks. If there is a leak, verify pump head and plunger seal installation.

   Note: *For priming information, see the Waters 600E Multisolvent Delivery System User's Guide, Chapter 3, Preparing Your System for Operation.*

4.2.5 Cleaning and Replacing the Pump Plunger

This section describes accessing the pump plunger to:

- Clean the plunger
- Replace the plunger if there is excessive wear

Note: *For information about isolating plunger problems in the 600E pump, see Chapter 6, Troubleshooting.*

If you do not need to disassemble the pump head, you can remove the complete pump head-plunger support assembly as a unit. To remove the pump head assembly as a unit, omit step 2.

Removing the Pump Plunger

1. Turn off the 600 controller to power down the 600E pump.
2. Remove the pump head as outlined in Section 4.2.3, Removing the Pump Head.
3. Remove the four plunger support bolts with a 9/64-inch Allen wrench.
4. Slide the plunger support assembly and indicator rod off the plunger (Figure 4-8).
5. Set flow rate to 0.3 mL/min. Run the pump until the plunger fully extends. Turn off the pump.
6. Remove the plunger using a pair of snap-ring pliers (Figure 4-9).

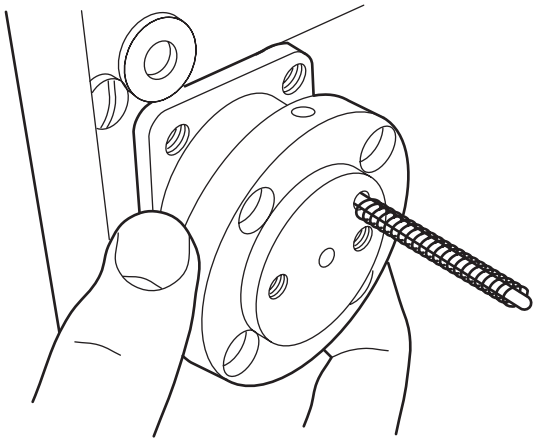


Figure 4-8 Removing the Plunger Support Assembly

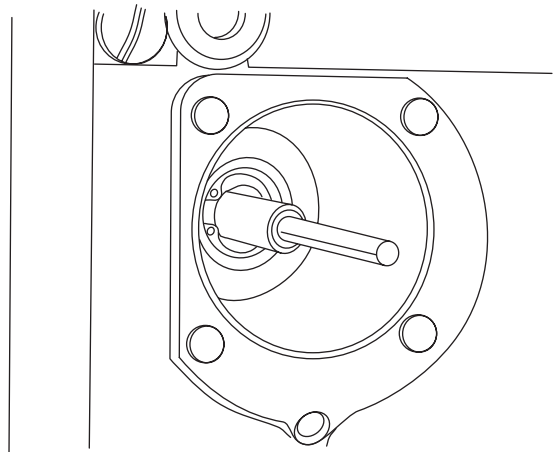


Figure 4-9 Plunger Disassembly

Cleaning the Plunger

7. Inspect the plunger for damage, excessive wear, or mobile-phase debris. (You may see lateral or rotational scratches and solvent residue.) If the plunger seal has excessive wear:
   - Clean the plunger with a fine pumice to remove any coating.
   - Clean the plunger thoroughly to remove all traces of abrasive.

   If necessary, replace the pump plunger seals (see Section 4.2.4, Replacing the Plunger Seal). If this does not extend seal life, replace the plunger.

Installing the Plunger

1. Reassemble the components on the new plunger and insert it into the cavity.
2. Set the flow to 0.3 mL/min to retract the plunger, then shut off the pump.
3. Replace the plunger support assembly with the indicator rod in the upper right corner of the assembly.
4. Alternately tighten the four screws. Do not overtighten. The support assembly need only be flush against the front panel.
5. Gently slide the pump head onto the plunger and alternately tighten the two screws (see Figure 4-5).
6. Turn on the pump and set flow rate to 0.3 mL/min. Pull and release the indicator rod. If it does not snap back, the pump head is misaligned. Stop the flow. Remove and rotate the head 1/2-turn for correct alignment.

7. Reconnect the eluent lines, reposition the eluent reservoir, and prime the pump. (For priming information, refer to the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3, Preparing Your System for Operation.) Check for leaks. If there is a leak, verify pump head and plunger installation.

4.2.6 Cleaning and Replacing Pump Check Valves

This section covers:

- Removing an inlet check valve
- Cleaning an inlet check valve
- Installing an inlet check valve
- Removing an outlet check valve
- Installing an outlet check valve

Note: *For information about isolating check valve problems in the 600E pump, see Section 5.4.1, Testing the Check Valves.*

Whenever you suspect a check valve of contributing to faulty pump operation, loosen and then retighten the check valve housings. This restores the original sealing loads. If there is no improvement, remove and clean the check valve.

Removing the Inlet Check Valve

1. Flush the pump with methanol.
2. Remove the eluent lines from the reservoirs.
3. Turn the inlet manifold knob to the Draw position. Using the priming syringe, draw all of the methanol from the eluent lines (see Figure 4-1).
4. Remove the reverse ferrule connector from the inlet check valve housing underneath the pump head.
5. Remove the pump head as described in Section 4.2.3, Removing the Pump Head.
6. Using a 1/2-inch wrench, remove the inlet check valve assembly and disassemble by tipping the housing upside down. See Figure 4-10 and Figure 4-11.

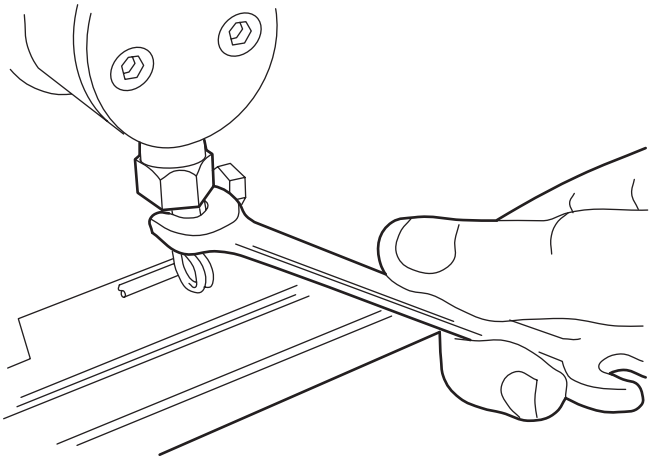


Figure 4-10 Inlet Check Valve Removal

Cleaning the Inlet Check Valve

7. Check the retainer and the ball and seat for damage or debris (Figure 4-11). Clean or replace worn parts as necessary. The housing seal, which may be difficult to remove, does not normally need to be replaced.

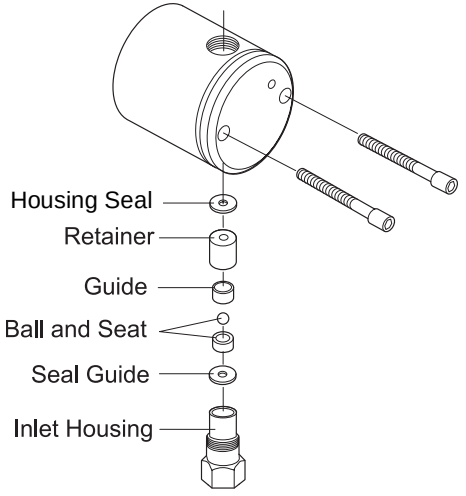


Figure 4-11 Inlet Check Valve Assembly

8. Clean the check valve by sonicating in water, followed by sonicating in methanol.

   Note: *To prevent contamination after sonicating, handle the ball in the valve with tweezers.*

Installing the Inlet Check Valve

If there is no improvement, replace the check valve as follows:

1. Position the inlet check valve housing so you are looking down into it and can see the guide seal.
2. Place the seat in the housing with the shiny side of the seat facing up.
3. Drop the ball into the seat.
4. Place the guide over the ball.
5. Place the retainer over the guide.
6. The housing seal often remains inside the pump head when the housing assembly is removed. If the housing seal came out when you removed the housing assembly, place it back into the pump-head cavity.
7. Holding the inlet check valve housing assembly right side up, screw the assembly into the pump head, being careful not to tip the housing.
8. Hand tighten the assembly.

Removing the Outlet Check Valve

1. Flush the pump with methanol.
2. Remove the eluent lines from the reservoirs.
3. Turn the inlet manifold knob to the Draw position. Using the priming syringe, draw all of the methanol from the eluent lines (see Figure 4-1).
4. Remove the ferrule connector from the check valve housing underneath the pump head.
5. Remove the pump head as described in Section 4.2.3, Removing the Pump Head.
6. Remove the ferrule connector from the outlet check valve on top of the pump head.
7. Remove the pump head as described in Section 4.2.3, Removing the Pump Head.
8. With the pump head upside-down, use a 1/2-inch wrench to remove the outlet check valve assembly (Figure 4-12). Disassemble the check valve by tipping the housing upside down.
9. Check the retainer and ball and seal (Figure 4-13) for damage or debris. The housing seal, which may be difficult to remove, does not normally require replacement.

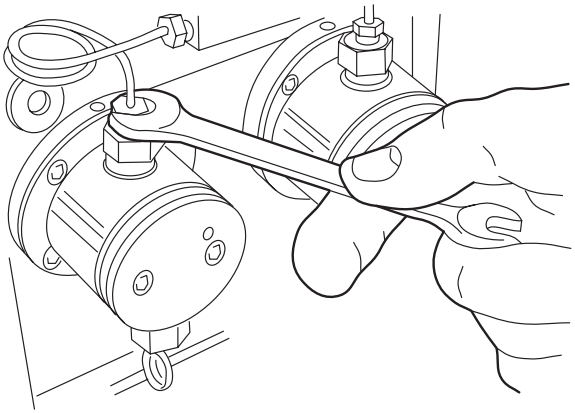


Figure 4-12 Outlet Check Valve Removal

Cleaning the Outlet Check Valve

Clean the check valve by sonicating in water, followed by sonicating in methanol. Replace worn or damaged parts as necessary.

Installing the Outlet Check Valve

If there is no improvement, install a new outlet check valve:

1. Hold the outlet check housing so you can look down into it (Figure 4-13). Drop the rulon washer in the housing. Place the housing aside.
2. Hold the retainer so the cupped side of the retainer faces up. Place the retainer with the rulon washer in the housing. Place the insert into the retainer. Place the ball in the insert.
3. Position the seat over the ball, with the shiny side facing the ball. Add in order the rulon washer, filter retainer, cup filter, and rulon washer.
4. Fit the retainer with the insert, ball, and seat, into the outlet housing. To insert the retainer and other parts into the housing without dropping parts or misaligning them, hold the retainer and with forceps, insert it into the stainless steel housing. Turn the housing and retainer right side up again.

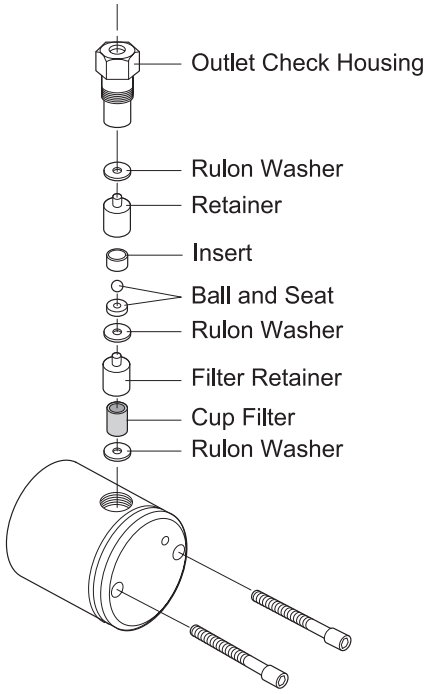


Figure 4-13 Outlet Check Valve Assembly

5. Place the second rulon washer over the seat.
6. Fit the filter retainer into the rulon washer.
7. Place the cup filter inside the filter retainer.
8. Place the third rulon washer on top of the cup filter.
9. Turn the pump head upside down and screw in the outlet check housing.
10. Hand tighten the assembly.
11. Replace the pump head.
12. Tighten the check valve assembly to seal.

4.3 Replacing Fuses

This section includes procedures for replacing the following fuses:

- Operating voltage fuse (on the 600 controller rear panel)
- Auxiliary +12 V and 600E pump power fuses (on the 600 controller rear panel)
- Column heater power fuse (on the pump interconnect board)

4.3.1 Replacing the Operating Voltage Fuse

When to Replace the Operating Voltage Fuse

The 600 controller is supplied with two 2–A fuses installed for operation.

Note: *The Waters 600E is protected from abnormal line power and component anomalies by the fuses located at the AC power cord connector. Check these fuses if the 600 controller LCD screen fails to display the powerup screen or the cooling fans fail to run when the controller is turned on.*

The Waters 600E Multisolvent Delivery System Startup Kit includes the required spare fuses.

Changing the Operating Voltage Fuse

1. Turn off the 600 controller front panel power switch and remove the power cord from its connector on the rear panel of the 600 controller.

   Caution: *To avoid the possibility of electric shock, turn off the 600 controller front panel power switch, and unplug the power cord from the rear panel.*

2. Pry open the power connector cover with a screwdriver.

3. To change the AC power fuses, pull the red fuse holder as though opening a drawer. Spare fuses are included in the 600E Multisolvent Delivery System Startup Kit (Figure 4-14). For ordering information, see Appendix A, Spare Parts.

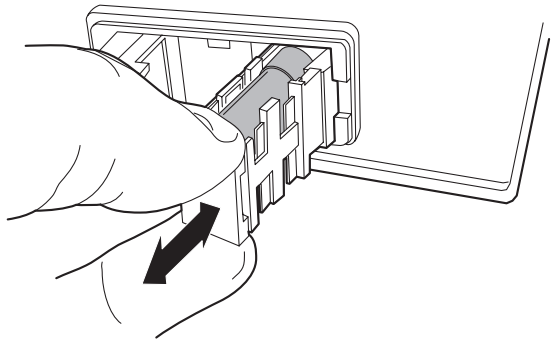


Figure 4-14 Removing the Fuse Holder

4. Install the correct fuse in the holder and slide it back into place (Figure 4-15).

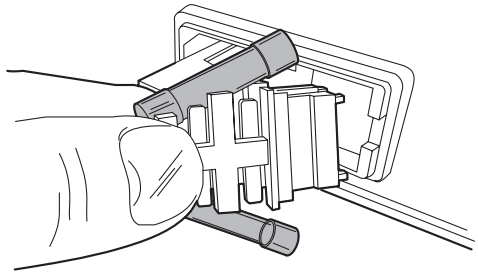


Figure 4-15 Installing the Fuses

5. While securing the fuses in the holder, slide it back into place (Figure 4-16).

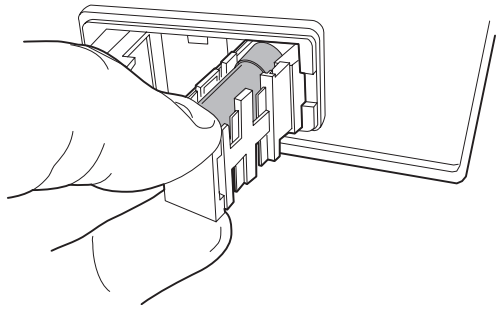


Figure 4-16 Replacing the Fuse Holder

6. Close the power connector cover.
7. Plug the power cord into its connector on the rear panel of the controller.

4.3.2 Replacing Auxiliary +12 V and Pump Fuses

This section includes procedures for replacing the following fuses:

- Auxiliary +12 V power fuse
- 600E pump power fuse

Note: *For information about isolating power problems in the 600E pump, see Chapter 6, Troubleshooting.*

The auxiliary +12 V fuse protects the AUX +12 V terminal on the 600 controller rear panel from excessive current loads. If this fuse is blown, no power is available from this terminal.

Replacing the Auxiliary +12 V Fuse

To replace the auxiliary +12 V fuse:

1. Turn off the 600 controller front panel power switch and remove the power cord from its connector on the rear panel of the 600 controller.

Caution: *To avoid the possibility of electric shock, turn off the 600 controller front panel power switch and unplug the power cord from the rear panel.*

2. Insert a small flat-blade screwdriver into the slot on the fuse holder for the Aux +12 V fuse (see Figure 4-17).

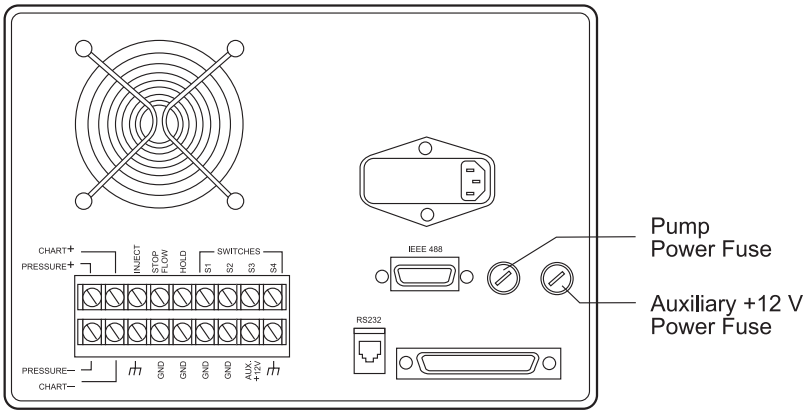


Figure 4-17 Auxiliary +12 V and Pump Power Fuses

3. Turn the screwdriver to release the fuse holder.
4. Slide the holder with the fuse out of the rear panel. Replace the blown fuse with an appropriate new fuse (included in the 600E System Startup Kit).

   Table 4-2 lists the replacement auxiliary +12 V fuses (for use in either North America or Europe).

Table 4-2 Auxiliary +12 V Fuses

Fuse (For North America)	Fuse (For Europe)
1.5 A, 250 V UL/CSA, Fast	1.25 A, 250 V IEC, Fast

5. Insert the new fuse and holder into the fuse chamber on the rear panel.
6. Lock the fuse holder into place using the screwdriver.

Replacing the 600E Pump Power Fuse

The 600E pump power fuse protects the 600E pump from excessive current loads. If this fuse is blown, no power is available at the 600E pump.

1. Turn off the 600 controller front panel power switch and remove the power cord from its connector on the rear panel of the 600 controller.

   Caution: *To avoid the possibility of electric shock, turn off the 600 controller front panel power switch and unplug the power cord from the rear panel.*

2. Insert a small flat-blade screwdriver into the slot on the fuse holder for the pump power fuse (see Figure 4-17).
3. Turn the screwdriver to release the fuse holder.
4. Slide the holder with the fuse out of the rear panel.
5. Replace the blown fuse with an appropriate new fuse (included in the 600E Startup Kit).

   Table 4-3 lists the replacement 600E pump power fuses (for use in either North America or Europe).

Table 4-3 600E Pump Power Fuses

Fuse (For North America)	Fuse (For Europe)
4 A, 125 V UL/CSA, Fast	3.15 A, 250 V IEC, Fast

6. Insert the new fuse and holder back into the fuse chamber on the rear panel.
7. Lock the fuse holder into place using the screwdriver.

4.3.3 Replacing the Column Heater Power Fuse

The column heater fuse, located on the 600E pump interconnect board, is labeled F1. To replace a defective column heater power fuse:

1. Turn off the 600 controller front panel power switch and remove the power cord from its connector on the rear panel of the 600 controller.

Caution: *To avoid the possibility of electric shock, turn off the 600 controller front panel power switch and unplug the power cord from the rear panel.*

2. Loosen the two pump cover retaining screws at the rear of the 600E pump. Lift the cover off the pump.
3. Locate the fuse (see Figure 4-18). Replace the blown fuse with the correct spare fuse (included in the 600E Startup Kit). The fuse has a 2.5 A, 250 V, fast rating.

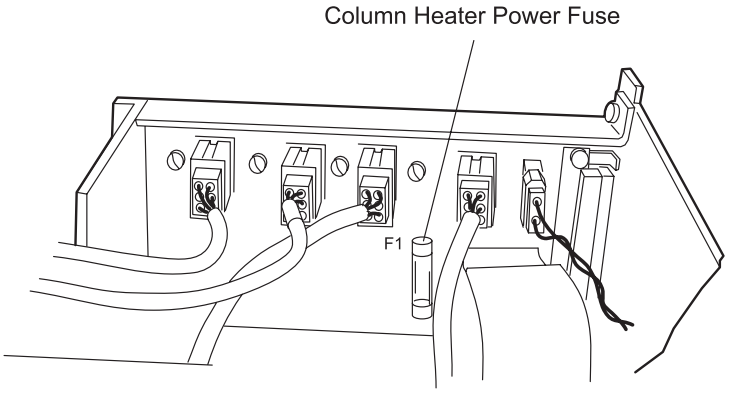


Figure 4-18 Replacing the Column Heater Power Fuse

4. To replace the 600E pump cover, gently grasp the bottom of the cover and slide it into place. Replace the two retaining screws and tighten.

4.4 Maintaining the Rheodyne 7725i Manual Injector

Note: *The Rheodyne 7725i manual injector is optional. If it is not installed on your system, ignore this section.*

The Rheodyne 7725i manual injector requires minimal maintenance. With normal use, the injector should perform thousands of cycles without fail.

This section describes the following maintenance procedures:

- Tightening the needle seal
- Replacing the position sensing switch
- Rotor seal leakage

Refer to Figure 4-19 for each procedure.

4.4.1 Tightening the Needle Seal

The needle seal, a Teflon sleeve in the rotor seal, may not seal correctly around a needle that is smaller than average. A poor seal results in a loss of accuracy in sample loading.

To reform the Teflon sleeve to make a good seal:

- Remove the needle from the needle port.
- Push gently on the plastic needle guide with the eraser end of a pencil. Do not squash the Teflon sleeve. Repeat if necessary.

Attention: *Always use the correct type and gauge needle to load the injector, or damage to the rotor seal may result.*

1. Fill the syringe with water. Place the injector in the Load position and slowly discharge the water in the syringe into the injector. Notice the lack of resistance to syringe discharge.
2. Repeat step 1 with the injector handle halfway between Load and Inject (the pump must be off). The resistance to discharging the syringe should now be much greater.

The needle seal holds only a few psi of pressure, and will not completely prevent syringe discharge with the handle in the halfway position.

4.4.2 Replacing the Position Sensing Switch

The position sensing switch is a magnetic reed switch actuated by a magnet in the shaft. The switch sends the inject signal to the controller, signalling the controller to begin a gradient. If a gradient does not begin after an injection, replace the switch. The switch is rated for 100 V at 200 mA. For ordering information, see Appendix A, Spare Parts.

1. Remove the stator, stator ring, and 60° stop ring.
2. Pull the position sensing switch out of the stop ring.
3. Insert a new position sensing switch.
4. Reassemble the injector according to the instructions in Section 4.4.5, Replacing the Rotor Seal.

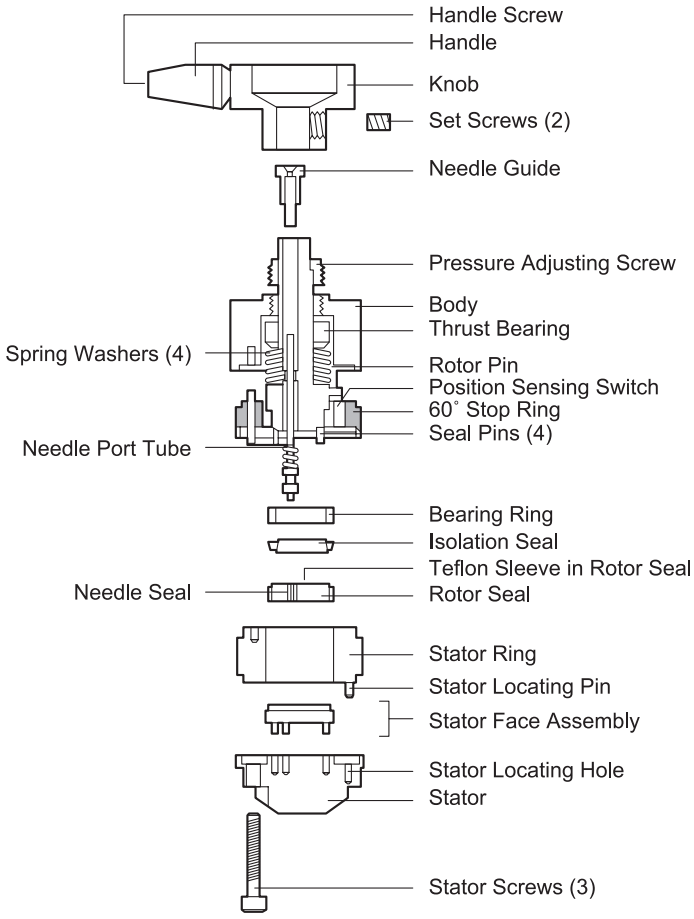


Figure 4-19 Rheodyne 7725i Injector: Exploded View

4.4.3 Rotor Seal Leakage

If you observe liquid leaking between the stator and stator ring, tighten the pressure adjusting screw. If you observe liquid leaking from the needle port or vent tube, replace the rotor seal.

4.4.4 Tightening the Pressure Adjusting Screw

1. Locate the pressure adjusting screw on the shaft of the injector (see Figure 4-19). The pressure adjustment is factory set so that spring force between the valve rotor and stator is sufficient to hold 6000 psi (40.8 MPa).
2. Remove the injector knob.
3. Slip the pressure adjusting nut onto the shaft so the tabs on the nut slip into the slots in the adjusting screw.
4. Use a wrench to tighten the adjusting screw approximately 1/20th of a turn. Use the 20 dial markings on the body and the painted spot on the adjusting screw to gauge how far to tighten the screw.
5. If the new setting fails to accomplish leak-free operation, repeat the procedure by an additional 1/20th of a turn. Avoid excessive tightening, which will increase rotor seal wear.
6. If this fails to stop the leak, replace the rotor seal as described in Section 4.4.5, Replacing the Rotor Seal. Otherwise, finish by removing the adjusting nut and replacing the knob.

4.4.5 Replacing the Rotor Seal

Premature rotor seal failure can be caused by any of the following:

- Abrasive particles in the sample or mobile phase that scratch the rotor seal surface.
- A wrong needle tip that chips the ceramic stator face, causing deep scratching of the rotor seal surface.
- Buffer or salt crystallization, caused by a failure to flush the flow passages and needle port with water after the use of aqueous buffers or salt solutions. The abrasive particles scratch the rotor seal surface, resulting in leakage.

Attention: *After using buffer solutions, flush the valve.*

To order the rotor seal, see Appendix A, Spare Parts.

When replacing the rotor seal, always check the ceramic stator face for chips or cracks. If the stator face is damaged, replace it.

To replace the rotor seal (refer to Figure 4-19):

1. Leave the injector attached to the front panel of the pump, and leave the knob on. If you need to remove the injector from the front panel, remove the knob.
2. Remove the three stator screws.
3. Remove the following by pulling axially:
   - Stator and stator face assembly (remove together). If the stator face assembly is damaged, replace it.
   - Stator ring.
4. Using a screwdriver, pry the rotor seal off the four seal pins. Leave the isolation seal and bearing ring in place.
5. Install a new rotor seal on the four seal pins.

4.4.6 Reassembling the Injector

1. Loosen the pressure adjusting screw 1/2 turn. Note the original position of the two red dots.
2. Orient the rotor seal as shown in Figure 4-20, with rotor seal slots facing the stator.

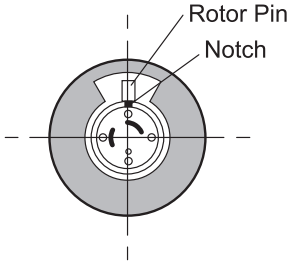


Figure 4-20 Rotor Seal Orientation (Viewed from the Stator)

   - Replace the stator ring so the pin in the 60° stop ring enters the mating hole in the stator ring.
   - Install the stator face assembly on the stator. The three pins on the assembly fit into the mating holes in the stator only one way.
   - Install the stator and stator face assembly on the valve so that the pin in the stator ring enters the mating hole in the stator.

- Tighten each of the three stator screws a little at a time to keep the stator surface parallel to the stator ring surface until all parts are held firmly in place.
- Retighten the pressure adjusting screw until the red dots align as noted in step 1.
- Replace the knob and tighten the two set screws against the two flat areas of the shaft.

Chapter 5
Error Messages, Diagnostics, and Test Procedures

This chapter describes:

- Error messages displayed by the 600 controller
- Self-diagnostic tests performed by the 600 controller
- Performing 600 controller extended test routines
- Advanced 600E pump tests

Caution: *To prevent the possibility of electric shock, never disconnect an electrical assembly (including the pump interface cable) while power is applied to the Waters 600E system.*

Caution: *To avoid the possibility of electric shock, do not open the 600E controller cover. The 600E controller does not contain user-serviceable components.*

Caution: *When handling eluents, changing tubing, or operating the 600E system in general, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

Attention: *To prevent damage to the 600 controller, wait approximately 3 minutes once power is disconnected before removing an electrical assembly (including the pump interface cable).*

Attention: *Do not touch the integrated circuit chips or other components that do not specifically require manual adjustment. Damage due to static electricity could occur.*

5.1 Summary of Error Messages

This section covers 600 controller:

- Error message overview
- Warning messages
- Shutdown messages

5.1.1 Error Message Overview

The 600 controller displays two types of error messages:

- Warning messages
- Shutdown messages

Warning Messages

Warning messages are informational and may not require action. Warning messages appear on the 600 controller screen when you:

- Enter an improper value
- Use an unacceptable entry method

Warning messages typically instruct you to correct an error made during programming or operation of the 600E system. For a list of warning messages and information about correcting problems, see Section 5.1.2, Warning Messages.

Shutdown Messages

Shutdown messages appear on the 600 controller screen when the 600E pump:

- Exceeds an operator-set limit
- Receives a Stop Flow signal from an external device

All shutdown messages require a user action to resolve. For a list of shutdown messages and information about correcting problems, refer to Section 5.1.3, Shutdown Messages.

5.1.2 Warning Messages

Overview

Warning messages appear on the 600 controller screen to instruct you to:

- Enter acceptable values
- Check your entries

Pay attention to warning messages and take corrective action. Failure to do so may cause the 600 controller to produce erroneous results or to fail to perform your chromatographic run.

Resuming Programming or Operation

To resume programming or operation after a warning message appears, you can either:

- Press Clear.
- Wait approximately 5 seconds until the message disappears.

Table 5-1 lists the warning messages shown on the 600 controller screen.

Table 5-1 Warning Messages

Message Displayed	Message Appears	Meaning
`An Inject Occurred`	During operation in the Operate Gradient or Operate Method screen	Informational message indicating that an inject signal has been sent.
`Cannot Save Table Currently Executing`	While running from the Operate Method screen	The table number you intended to save for a new or modified table is the same as the table in process. Abort the run or wait until finished to replace the table with the modified table.
`Check Corresponding Gradient Table/Events Table`	While programming a Gradient or Event table	Because the Gradient and Event tables always run together (dictated by the table number), any modifications made to the Gradient table should be consistent with the Event table of the same table number.

Table 5-1 Warning Messages (Continued)

Message Displayed	Message Appears	Meaning
`Composition MUST sum to 100%`	When programming eluent composition	The composition values for %A, %B, %C, and %D do not total 100%. Check your values for all eluent reservoirs.
`Enter Table Number for New Table`	While modifying a Gradient, Event, or Detector table during operation	The table currently in memory and the table number entered both appear on the screen. The table currently in memory is replaced with the new table in the next step of the Program Methods screen.
`431/432 Detector Not Found`	During operation in the Direct Control or Operate Method screen	The 431 or 432 detector has disappeared from the IEEE-488 bus. Verify if the detector: • Is turned on • Was turned on before the 600 controller
`First Vial Greater Than Last Vial`	While programming a method	The last vial must always be in a higher location than the first vial listed in the Program Methods screen.
`Illegal Vial Number`	When programming in the Program Methods screen	The number of vials is greater than the maximum value for the selected carousel.
`Injector Not Found`	During operation in the Direct Control or Operate Methods screen	The autosampler has disappeared from the IEEE-488 bus. Verify if the autosampler: • Is turned on • Was turned on before the 600 controller Go to the System Configuration screen and rescan the IEEE-488 bus.

Table 5-1 Warning Messages (Continued)

Message Displayed	Message Appears	Meaning
`Invalid Injection Number`	While running from the Operate Method screen	The Injection Number is not part of the Step indicated in the Operate Method screen. Return to the Program Methods screen and verify the program methods table.
`Invalid Vial Number`	While running from the Operate Method screen	A vial number was selected that is not included in the selected step of the Step indicated in the Operate Method screen. Return to the Program Methods screen and verify the program methods table.
`Line is Incorrect Or Incomplete`	While programming a Gradient table, Event table, Detector table, or the Program Methods table	You did not enter all required entries for a specific line. Enter all required entries before attempting to move the cursor to a new location.
`Number Out Of Range`	While entering parameter values in a screen	Entered value is out of the allowable range. Check the range for the parameter. Press the Help key for a summary of allowable ranges.
`Replace with New Table` `1 = Yes  0 = No`	While saving a Gradient table, Event table, or Detector table	Abort the save operation if the table associated with the number entered should not be erased.
`Rear Panel Stop Flow Input Detected`	After 600 controller receives a signal at the Stop Flow terminal	Suspend 600E system operation until the source of the Stop Flow signal is removed.

Table 5-1 Warning Messages (Continued)

Message Displayed	Message Appears	Meaning
`RI Detector Not Found`	During operation in the Direct Control or Operate Methods screen	The 410 detector has disappeared from the IEEE-488 bus. Verify if the 410 detector: • Is turned on • Was turned on before the 600 controller Go to the System Configuration screen and rescan the IEEE-488 bus.
`Step Does Not Exist`	While running from the Operate Method screen	A step number that was inserted into the initial Operate Methods screen does not exist in the Program Method screen. Return to the Program Methods screen and verify the program methods table.
`Table Being Stored... Please Wait`	While saving a Gradient table, Event table, or Detector table	Keyboard is locked while the Save function is storing the new table.
`Table Is Full`	While programming the program methods table	Exceeded the maximum 48 steps for this table. Determine which lines need to be deleted.
`Unable To Set Up Detector`	During operation in the Direct Control or Operate Methods screen	The detector has not been turned on and calibrated. Turn on detector and wait for calibration to complete. (This also applies if the lamp is turned off.) Go to the System Configuration screen and rescan the IEEE-488 bus.

Table 5-1 Warning Messages (Continued)

Message Displayed	Message Appears	Meaning
`Unable To Setup Injector`	During operation in the Direct Control or Operate Methods screen	The 600 controller is unable to set up the autosampler due to one of the following: • Autosampler is not turned on • Carriage door is open • Sample carriage is not locked in place • Autocalibration has not been performed Resolve the problem, then go to the System Configuration screen and rescan the IEEE-488 bus.
`UV Detector 1 Not Found` `UV Detector 2 Not Found`	During operation in the Direct Control or Operate Methods screen	The UV detector (1 or 2) has disappeared from the IEEE-488 bus. Verify if the UV detector: • Is turned on • Was turned on before the 600 controller Go to the System Configuration screen and rescan the IEEE-488 bus.
`Value Entered Is Out Of Range`	While entering parameter values in a screen	The entered parameter value is out of the allowable range. Check the range for the parameter. Press the **Help** key for a summary of allowable ranges.

5.1.3 Shutdown Messages

Overview

Shutdown messages appear on the 600 controller screen when the 600E pump:

- Exceeds an operator-set limit
- Receives a Stop Flow signal from an external device

All shutdown messages require immediate user action (see Table 5-2).

System Shutdown Response

When a shutdown occurs, the following actions occur:

1. A message appears, such as:

   ```
   Shutdown Occurred - Reason:.....
   ```

2. The 600 controller sets the flow rate to 0.0 mL/min. Flow and composition can be viewed on the screen.
3. Any subsequent inject input signals are *not* recognized while the system is in shutdown.
4. The 600 controller software:
   - Activates the Hold output (on the 600 controller rear panel), indicating to the connected instrument (for example, an autosampler) that the system is not ready for operation.
   - Aborts any gradient, program event, and detector tables in process.
   - Resets the Autostart time and Table # fields to blank.
   - Maintains external output switches S1 through S3, sparge valves, and the Alarm in their current state (on or off). S4 is set to the "off" state when a critical fault occurs.
5. If the high temperature limit was exceeded or the temperature setpoint was greater than zero and the column heater was attached, the temperature setpoint is set to OFF (0).
6. Column heater module temperature remains constant throughout the shutdown (or shut off depending on the situation)
7. Sparging continues at the last entered sparge rate.

Resuming Operation

The shutdown message remains on the screen until you resume operation as follows:

1. Press Clear to clear the message from the screen.
2. Check the Pump Setup screen parameters and make any adjustments to the entered values (for details, refer to the *Waters 600E Multisolvent Delivery System User's Guide*).
3. Determine if the 600 controller received a Stop Flow signal from an external device. If the cause is an obvious equipment malfunction, resolve the cause of the problem and continue as follows. This may mean removing the faulty device from the system.

4. When you correct the shutdown situation:
    - For Isocratic or Direct Mode, enter the flow rate.
    - For Gradient operation, press the Resume screen key to resume gradient operation.
    - For Operate Method mode operation, press the Start Run key to resume gradient operation.

If the problem continues, notify Waters Technical Service. You may contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A.).

Another shutdown may occur if the cause is not corrected before restart.

Note: *The 600 controller only recognizes the first shutdown cause. Subsequent shutdown conditions are ignored once shutdown occurs.*

Table 5-2 lists the shutdown messages shown on the 600 controller screen.

Table 5-2 Shutdown Messages

Message Displayed	Meaning	Correction
`Low Pressure Limit`	Exceeded value entered on Pump Setup screen	If you set the low-pressure limit to a high setting and the message appears, check for small leaks at fittings and unions. If you set the low-pressure limit to a low setting and the message appears, the system shutdown was probably caused by a noticeable failure (such as an empty eluent reservoir).
`High Pressure Limit`	Exceeded value entered on Pump Setup screen	If the 600E pump exceeds the high-pressure limit, check for increase in backpressure (such as blockage in the fluid tubing or older column with accumulated debris at the inlet).

Table 5-2 Shutdown Messages (Continued)

Message Displayed	Meaning	Correction
`High Temp Limit`	Exceeded value entered on Pump Setup screen	Before suspecting a column heater, ensure the set point and high-limit values are sufficiently separated to allow minimal temperature fluctuation around the set point without triggering a shutdown. If not, modify the values in the Pump Setup screen.
`Pump Flow Limit`	Incorrect Pump Head Vol. value entered on Pump Configuration screen	Verify that a 100 µL or 225 µL Pump Head Vol. value is entered on the Pump Configuration screen. If the pump head volume value is incorrect for the 600E pump, a mismatch in flow rate occurs, resulting in a shutdown. If the Pump Head Vol. value is correct, there is probably an internal failure (such as in pump drive circuits and pump mechanics). Contact Waters Technical Service.
`Set Point > 0 and No Heater`	Column heater not properly connected	When you enter temperature values on the Pump Setup screen, the column heater must be connected or a shut-down occurs. This feature reminds you not to start a method specifying column heating without installing the heater.

5.2 Running 600 Controller Self-Diagnostic Tests

Self-Diagnostic Test Overview

The 600 controller automatically performs a series of self-diagnostic tests during each powerup. The self-diagnostics perform a check on the following:

- The 68000 processor, associated clock and reset circuitry, LEDs and drive circuitry, and ROM that contains code preceding first entry
- ROM, associated address decoding, bus latch, and drive circuits

- Address at each RAM location, associated address decoding, bus latch, and drive circuits:
  - EEPROM location with interrupt, read/write, associated address decoding, bus latch, and drive circuits
  - Real-time clock, oscillator, counters, and associated interrupt circuitry

When the self-diagnostic routine successfully completes, the Powerup screen appears (Figure 5-1).

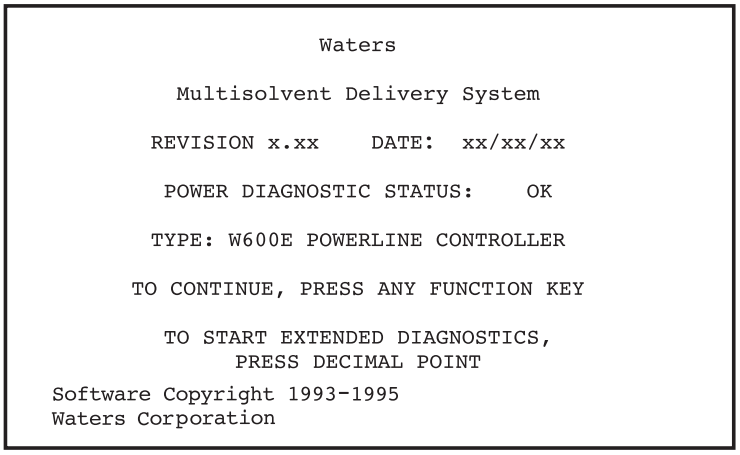


Figure 5-1 Powerup Screen

No Screen Display

If the screen displays no results, the controller failure may be in the LCD display circuitry.

Restarting

To restart the program, turn the power switch off. Wait 10 seconds, and then turn the power switch back on. If characters fail to appear a second time, notify Waters Technical Service.

Contacting Technical Service

If the 600E system fails any of the self-diagnostic tests, contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A.).

5.3 Performing 600 Controller Extended Test Routines

This section describes:

- Extended diagnostic test summary
- Performing the Stop Flow test
- Performing the External Inject test
- Performing the External Switch (S1-S4) test
- Performing the Hold Switch test
- Performing the Chart test
- Performing the Sparge Valves test
- Performing the Gradient Proportioning Valve test

5.3.1 Extended Diagnostic Test Summary

When to Run Extended Diagnostic Tests

Perform the extended test routines if you believe you are having a problem with the Waters 600 controller and want to narrow down the malfunctioning area.

After the automatic self-diagnostic routine finishes (refer to Section 5.2, Running 600 Controller Self-Diagnostic Tests), select the extended test routines by pressing the decimal (**.**) key on the keyboard.

The extended test routine tests the following functions:

- Keyboard operation
- Switch outputs
- Chart terminal
- Pump operation
- Eluent valves
- Sparge valves
- Rear panel connections

Table 5-3 summarizes the 600 controller test routines.

Table 5-3 600 Controller Extended Test Routines

Test	Description
Keyboard test	Tests the keys on the front panel of the 600 controller. The LCD displays an echo of the key as it is pressed.
Stop Flow test	Tests the Stop Flow input terminal on the rear panel.
External Inject test	Tests the Inject input terminal on the 600 controller rear panel.
External switch test	Tests each switch terminal (S1 through S4) on the 600 controller rear panel.
Hold switch test	Tests the Hold output terminal on the 600 controller rear panel.
Chart test	Generates a 0 to 10 mV sawtooth waveform at the Chart terminals on the 600 controller rear panel.
Sparge valve test	Turns each sparge valve on and off in sequence.
Pump and proportioning valve test	Sets the pump to a low flow rate and switches the proportioning valve periodically.
IEEE-488 address test	CPU reads and displays the setting of the 600 controller IEEE-488 address.
RS-232 test	Tests the RS-232 communication interface.
12 V fail test	Operates the valves at a very fast rate causing 12 V power to be applied continuously to the valves. If this condition is detected, the test passes.
Counter test	Verifies that the valves cannot switch to a 50/50 condition.

If any tests fail during this procedure, notify Waters Technical Service.

Required Tools

Tools required for the extended test routines are:

- Jumper wire to short various 600 controller rear panel terminals (Figure 5-2) to a ground screw terminal

  Note: *Use a jumper wire that is a 6 to 8-inch (152 to 203 mm) length of insulated wire (16-18 AWG). Strip the insulation 3/4 inch (19 mm) from each end.*

- Screwdriver

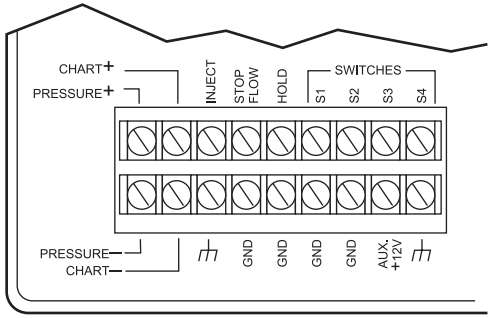


Figure 5-2 600 Controller Screw Terminals

General Test Instructions

To run extended tests from the 600 controller:

1. Select the extended test routines by pressing the decimal (.) key on the keyboard.
2. Press Enter.
3. If necessary, place a jumper across specific screw terminals (as described in the procedures in this section).
4. Make an observation based on the specific test.
5. Advance to the next test by pressing Enter or skip unwanted tests by pressing Enter a second time.
6. Cycle through the tests in order (either performing or bypassing them) to exit the extended test sequence.
7. When the tests are complete, the Powerup screen (see Figure 5-1) reappears. At this time you may:
   - Rerun the extended test routine by pressing the decimal key.
   - Resume normal operation by pressing any function key.

Certain extended tests require additional actions that may need some explanation. These tests are described in the remainder of this section.

Contacting Technical Service

If the 600E system fails any of the extended tests, contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A.).

5.3.2 Performing the Stop Flow Test

The Stop Flow switch accepts a signal from an external device that stops the pump. This test verifies that the Stop Flow input switch is functioning.

1. Attach a jumper wire from the Stop Flow terminal to the Gnd terminal on the 600 controller rear panel (see Figure 5-2).
2. Press Enter.
   - If the test is successful, Got Stop Flow appears on the screen.
   - If the test fails, Did Not Get Stop Flow appears on the screen.
3. To exit the Stop Flow test, press Enter.
4. Remove the jumper wire.
5. Press Enter to proceed to the next test.

5.3.3 Performing the External Inject Test

The Inject screw terminal accepts a signal from the external injector (manual or autosampler) to start a run. This test verifies that the associated inject switch is functioning.

1. Attach a jumper wire from the Inject terminal to the Gnd terminal on the 600 controller rear panel (see Figure 5-2).
2. Press Enter.
   - If the test is successful, Got INJECT appears on the screen.
   - If the test fails, Did Not Get INJECT appears on the screen.
3. To exit the test, press Enter.
4. Remove the jumper wire.
5. Press Enter to proceed to the next test.

5.3.4 Performing the External Switch (S1-S4) Test

This test verifies that external switches S1 through S4 are functioning. This test leads directly into the test for the Hold switch by requesting that you move the jumper wire before pressing Enter.

1. Attach a jumper wire from the S1 terminal to the Inject terminal on the 600 controller rear panel (see Figure 5-2).

2. Press Enter.
    - If the test is successful, Test Passed appears on the screen.
    - If the test fails, Test Failed appears on the screen.
3. To exit the test, press Enter.
4. Repeat steps 1 through 3 for the remaining switch terminals (S2 through S4).
5. When all four external switches have been tested, the screen displays Connect Hold To Inject.
    - If you want to perform the Hold Output test, do not press Enter until you jumper the Hold screw terminal to the Inject terminal.
    - If you want to bypass the Hold Output test, press Enter.

5.3.5 Performing the Hold Switch Test

The Hold switch outputs a signal to devices that are capable of recognizing this type of signal to prevent further injections in case of power failure, pressure shutdown, or an abort procedure.

1. Attach a jumper wire from the Hold terminal to the Gnd terminal on the 600 controller rear panel (see Figure 5-2).
2. Press Enter.
    - If the test is successful, Test Passed appears on the screen.
    - If the test fails, Test Failed appears on the screen.
3. To exit the test, press Enter.
4. Remove the jumper wire.
5. Press Enter to proceed to the next test.

5.3.6 Performing the Chart Test

During this test, the chart output ramps from 0 to 100% and then drops immediately to 0%.

1. Connect a chart recorder to the CHART + and – terminals on the 600 controller rear panel. Zero the baseline at 0% of full scale.
2. Set the chart recorder to accept a 10 mV full-scale signal.
    - If the test is successful, a triangular (sawtooth) 10-mV trace appears on the recorder.
    - If no trace appears, ensure the chart recorder is properly connected and set to the correct scale.

3. Press Enter to proceed to the next test.

5.3.7 Performing the Sparge Valves Test

This test identifies whether a malfunctioning sparge line is due to electronics or sparge-valve failure. Perform this test if you do not see any bubbles when the 600E system sparges eluents.

1. Press Enter.
2. Check for bubbling in the eluent reservoir as each sparge valve is activated. Also listen for the individual clicking of the sparge valves (as they open and close).
3. Press Enter to proceed to the next test.

5.3.8 Performing the Gradient Proportioning Valve Test

Test Summary

The gradient proportioning valve test identifies whether incorrect eluent proportioning is due to electronics or valve failure. Perform this test if you are observing that percentage of eluent flow from any reservoir appears to be incorrect, resulting in nonreproducible or incorrect eluent gradients and retention times.

Procedure

To perform the Gradient Proportioning Valve test:

1. Press Enter.
2. Listen for the individual clicking of the proportioning valves (as they open and close).

   Note: *If eluent proportioning remains incorrect after performing this test, the problem may be with the valve. Check all tubing and fittings for leaks and restrictions. Eluent viscosity must not differ significantly among the eluents being mixed.*

   To perform additional testing of the proportioning valve, refer to Section 5.4, Advanced 600E Pump Testing.
3. Press Enter to proceed to the next test.

5.4 Advanced 600E Pump Testing

There are two procedures for testing the 600E pump:

- Check valve test
- Gradient proportioning valve pair test

Caution: *When handling eluents or operating the 600E system, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

5.4.1 Testing the Check Valves

Use the following procedure to locate specific check valve problems with the 600E pump:

1. Connect a 10-mV chart recorder to the Pressure terminals on the 600 controller (see Section 3.5.5, Connecting a Chart Recorder). Set chart recorder speed between 0.50 and 1.0 inch/min (10 to 25 mm/min).
2. Open the reference valve to release pressure in the system, or allow pressure to decay to zero.
3. Flush the 600E pump with an eluent that is miscible with methanol (used in step 7). To remove any buffers, flush with water, followed by methanol.
4. Disconnect the pump outlet from the junction/transducer (see Figure 4-1).
5. Insert a fitting plug into the junction/transducer.
6. To check the right pump head, disconnect the left pump head outlet from the outlet check valve. Place a tissue under the disconnected left pump head outlet tubing.
7. Enter the following pump setup parameters on the Pump Setup screen:
   - Set the high-pressure limit on the Pump Setup screen to 6000 psi.
   - Set the flow rate to 0.3 mL/min.

   In either the Isocratic or Direct Control screen, run the pump with 100% methanol.
8. Allow the pump to reach the high-pressure limit. The pump should shut off and maintain high pressure for approximately 30 seconds.

   If pressure does not build up or hold under these conditions (due to a check valve problem), gradually increase the flow rate until pressure builds up.

   If the check valve is sticking, repeat step 8 another two times to clear the check valve.

9. For an improperly seated check valve, loosen and retighten the check valve housing. Tighten the check valves 1/4-turn beyond finger-tight (15 to 20 inch-pounds torque).
10. When the pump head operates properly, the pressure should rise with each plunger stroke, then hold as the plunger recedes. This produces a staircase pattern as shown in Table 5-4.

    If the inlet check valve is defective, pump pressure may stop rising at a certain point, or may not rise.

    If the outlet check valve is defective, pump pressure may increase, then immediately decrease when the plunger starts to recede.

    Table 5-4 shows chart recordings of pump pressure during normal and malfunctioning check valve operations.

Table 5-4 Pressure Trace Recording

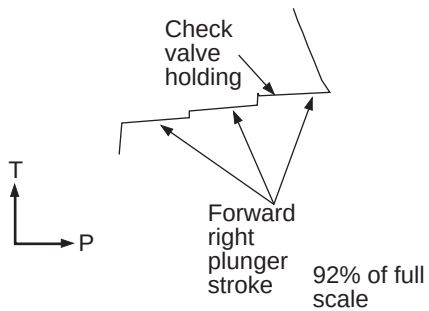
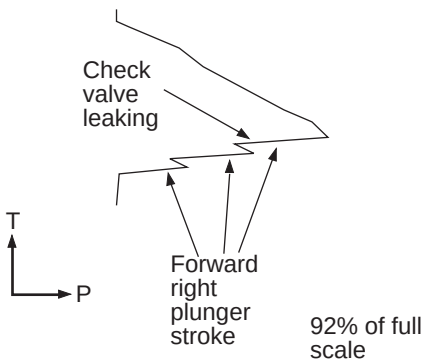
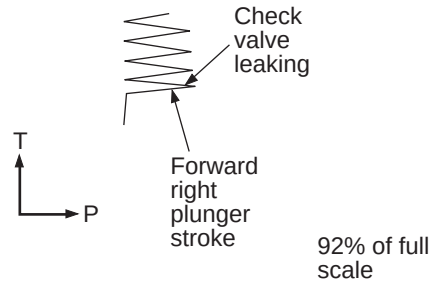
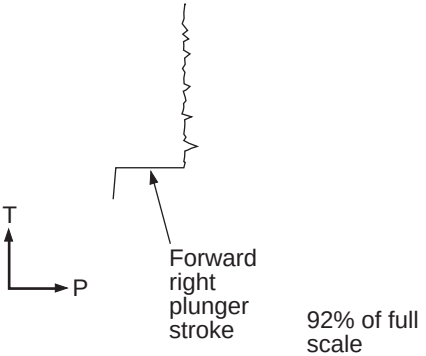
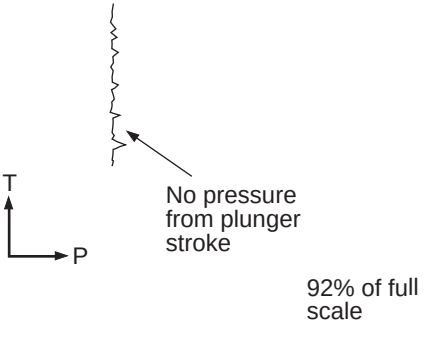
Pressure Recording Example	Condition
	Normal pump operation
	Failing outlet check valve

Table 5-4 Pressure Trace Recording (Continued)

Pressure Recording Example	Condition
	Failed outlet check valve
	Failing inlet check valve
	Failed inlet check valve

11. Repeat steps 6 through 10 for the left pump head.

If you determine there is a problem with a check valve, remove and clean it (see Section 4.2.6, Cleaning and Replacing Pump Check Valves). If a pump problem persists (such as lack of eluent flow, or erratic flow rate), replace the check valve.

5.4.2 Gradient Proportioning Valve Pair Test

The gradient proportioning valve pair test allows you to evaluate the gradient proportioning valve when you suspect a defective valve is causing erratic chromatographic results.

The test can be performed in less than one hour using:

- Pure methanol
- UV-absorbing substance

Preparing Eluent

To prepare the eluent for the gradient proportioning valve pair test:

1. Fill reservoirs A and B with Eluent 1 (100% methanol).
2. Fill reservoirs C and D with Eluent 2 (100% methanol with 5.6 mg/L propylparaben).
3. Eluent sparging is not required.

The concentration of propylparaben in methanol for Eluent 2 should produce approximately 0.45 AU at 254 nm in this test. If you substitute another UV-absorbing substance, determine the concentration that results in about 0.45 AU.

Note: *Do not use acetone as the UV-absorbing substance since the lack of linearity (due to rapid evaporation) will cause problems in interpreting the results.*

Flushing the Eluent Lines

Be sure to flush any previous eluents from the system and change over thoroughly to the test eluents (see *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3, Preparing Your 600E Multisolvent Delivery System for Operation).

Adjusting the Recorder

1. Before you begin, remove the column to prevent damage due to high flow rates.
2. Set the detector to 0.5 AUFS.
3. Pump eluent 1 (reservoir A or B) isocratically at 5 mL/min and adjust the recorder to zero.

4. Pump eluent 2 (reservoir C or D) isocratically at 5 mL/min and adjust the recorder to full scale using the recorder's variable full-scale input.

The recorder is now set to respond so that:

- 0% composition (pure methanol in eluent 1) = 0 percent full scale.
- 100% composition (methanol containing propylparaben in eluent 2) = 100% full scale.

Entering the Recommended Gradient Table

Enter and save the following gradient table (see the *Waters 600E Multisolvent Delivery System User's Guide* for details about entering a gradient table).

Time	Flow	%A	%B	%C	%D	Curve
INITIAL	2.00	100	0	0	0	*
5.00	2.00	90	0	10	0	11
10.00	2.00	100	0	0	0	11
15.00	2.00	90	0	0	10	11
20.00	2.00	0	100	0	0	11
25.00	2.00	0	90	10	0	11
30.00	2.00	0	100	0	0	11
35.00	2.00	0	90	0	10	11
40.00	2.00	0	100	0	0	11
45.00	0.00	0	100	0	0	11

Running the Proportioning Valve Pair Test

1. Proceed to either the Operate Gradient or Operate Methods screen.
2. Press the Start Run function key to execute the gradient table.
3. When the detector baseline is stable at 0%:
   - Change the detector sensitivity to 0.1 AUFS and the wavelength to 254 nm.
   - Adjust the baseline to 10% full scale by adjusting the zero adjustment of the recorder.

The recommended settings allow you to easily visualize 1% compositional variances (1% input changes are set equal to 5% of full scale on the recorder). Therefore, the 10%

changes programmed into the table will be visible as 50% full scale on the recorder (as shown in Figure 5-3).

Figure 5-3 is typical of the valve test results obtained when all valves are in proper working condition.

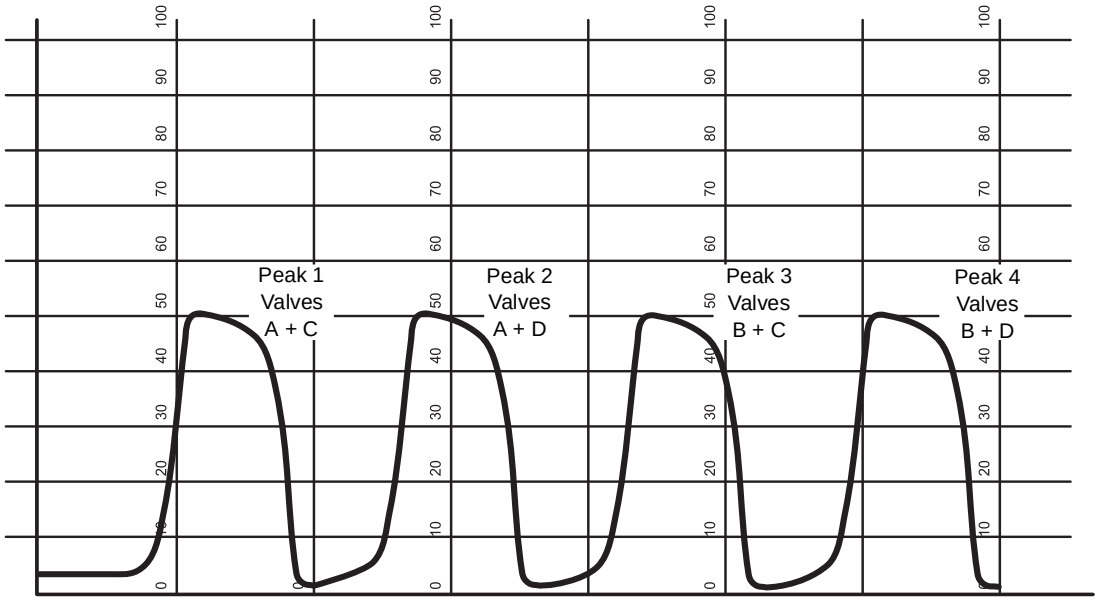


Figure 5-3 Test Results with All Gradient Proportioning Valves Working Properly

Valve Failure

A valve failure identifies itself as a difference in height between the sections common to that valve.

For example, if Valve A is malfunctioning, Peaks 1 and 2 (the only two containing contributions from Valve A) will be irregular when compared to Peaks 3 and 4. Similarly, if Valve B is malfunctioning, Peaks 3 and 4 will be irregular.

Contacting Technical Service

If the 600E system fails the test, contact Waters Technical Service.

Chapter 6
Troubleshooting

This chapter provides information for troubleshooting the Waters 600E Multisolvent Delivery System, and includes a checklist of possible causes and recommended corrective action for each problem.

6.1 Troubleshooting Overview

Safety and Handling

When troubleshooting your Waters 600E system, keep the following safety considerations in mind:

Caution: *To prevent the possibility of electric shock, never disconnect an electrical assembly (including the pump interface cable) while power is applied to the Waters 600E system.*

Attention: *To prevent damage to the 600E controller, wait approximately three minutes once power is disconnected before removing an electrical assembly (including the pump interface cable).*

Caution: *When handling eluents, changing tubing, or operating the 600E system in general, always observe good laboratory practices. Know the physical and chemical properties of the eluents. Refer to the Material Safety Data Sheets for the eluents in use.*

Attention: *Do not touch the integrated circuit chips or other components which do not specifically require manual adjustment. Damage due to static electricity could occur.*

Basic System Troubleshooting Steps

1. Take a step back and look at the system. Check the simple things first. Is something obvious causing the problem (for example, is an instrument unplugged or improperly connected)?

2. Compare current system operation with the way it operated before the problem started. To help you identify normal operating conditions:
   - Record a map of your 600E system (tubing and electrical connections).
   - Keep a daily log.
   - Run test chromatograms regularly.

   This step points out the importance of keeping track of system parameters and the results of your chromatography during normal operation. Troubleshooting is easier if you know the typical conditions when the system is operating correctly.
3. Identify in the order listed below the symptom that varies from normal system operation:
   - System pressure (high, low, erratic)
   - Baseline (fluid-path-related or detector-electronics-related)
   - Changes in peak retention time (incorrect or changing over time)
   - Loss of peak resolution
   - Abnormal peak shape (smaller than expected, broad, tailing, and so on)
   - Incorrect qualitative/quantitative results
4. For each isolated symptom, identify a list of suspected causes. For example, sudden high system backpressure could be due to:
   - Blocked column frit
   - Changed or incorrect flow rate
   - Blocked tubing
   - Defective pump pressure transducer
5. Run the performance tests for each chromatographic instrument to quickly determine if a problem exists with the instrument.

Where to Go for Help

If you determine that there is a problem related to the 600E system, refer to:

- Section 6.2, Troubleshooting the 600E Pump
- Section 6.3, Troubleshooting the 600E System
- Section 6.4, Troubleshooting the Rheodyne 7725i Manual Injector

Note: *If your 600E system includes the optional Rheodyne 7725i manual injector, you will find additional troubleshooting information in the Rheodyne 7725i Manual Injector Installation and Maintenance Guide.*

If you need to perform additional testing of the 600E pump to determine the potential source of a problem, refer to Section 5.4, Advanced 600E Pump Testing.

If you determine that there is a problem related to another system component, refer to the appropriate operator's guide.

When to Call Waters Technical Service

Many problems with a Waters 600E system can be easily corrected by the user. However, if you cannot correct a condition, you can contact Waters Technical Service at 800 252-4752, *Canadian and U.S. customers only.* Other customers, call your local Waters subsidiary or call Waters corporate headquarters for assistance in Milford, Massachusetts (U.S.A.).

When you call Waters Technical Service, have the following information available:

- Nature of symptom
- Serial numbers for the following:
  - Waters 600E pump
  - Waters 600 controller
- Flow rate
- Operating pressure
- Mobile phase(s)
- Type and model number of detector (UV, RI, or conductivity)
- Detector settings (wavelength, sensitivity)
- Type and model number of injector (manual and/or autosampler)
- Type and serial number of column
- Sample type
- Data system (Empower or Millennium Chromatography Manager)

6.2 Troubleshooting the 600E Pump

This section describes troubleshooting 600E pump problems. It covers:

- High system pressure
- Low system pressure
- Erratic (fluctuating) system pressure

System pressure troubleshooting is presented in a flow diagram format. Use Figure 6-1, Figure 6-2, and Figure 6-3 to investigate pressure-problem sources.

6.2.1 System Pressure Overview

This section provides background information for troubleshooting system pressure problems. It discusses:

- Determining your system pressure reference point
- Noting gradual versus sudden pressure increase
- Isolating high pressure locations in the 600E system

Determining Your System Pressure Reference Point

To identify a pressure change from normal operation, it is critical that you have a pressure reference point. System pressure is affected by the column, flow rate, mobile phase, and temperature, and can vary greatly with different methods. When running a gradient, fluctuations in system pressure may be due to viscosity differences among eluents.

Each time you install a new column or start a new method, equilibrate the system and record the system pressure (both with and without the column in-line) to use as a reference.

Noting Gradual Versus Sudden Pressure Increase

When high system pressure occurs, it is important to note whether the pressure increase was gradual or sudden. This can help you isolate the problem source.

If the pressure has risen *gradually* (over a series of injections), it may be due to:

- Particulates in the sample or mobile phase that have accumulated in the column frits
- Debris from failed fluid seals

If the pressure has risen *suddenly*, it may be due to:

- Particulates in one sample
- A system hardware problem (such as blocked tubing)
- Collapse of the column packed bed

Isolating High Pressure Locations

To isolate the origin of high system pressure, slowly loosen inlet or outlet fittings as instructed (see Figure 6-1, Figure 6-2, or Figure 6-3) and observe if pressure stays the same or decreases. Use a tissue to prevent eluent spray and to collect any spilled eluent.

Caution: *Always observe safe laboratory practices when troubleshooting. Always wear safety glasses and gloves. Know the chemical and physical properties of the eluents. Refer to the Material Safety Data Sheet for the eluents in use.*

Attention: *If the source of high pressure is within the detector flow cell, use extreme caution when relieving high-pressure buildup. Many detectors (especially RI and fluorescence) have fragile flow cells. Before backflushing the detector to remove the blockage, review the flow rate specifications and backpressure limits for that flow cell in the detector operator's guide.*

6.2.2 System Pressure Flow Diagrams

This section includes flow diagrams for isolating the source of system pressure problem. It includes:

- High system pressure troubleshooting (Figure 6-1)
- Low system pressure troubleshooting (Figure 6-2)
- Erratic system pressure troubleshooting (Figure 6-3)

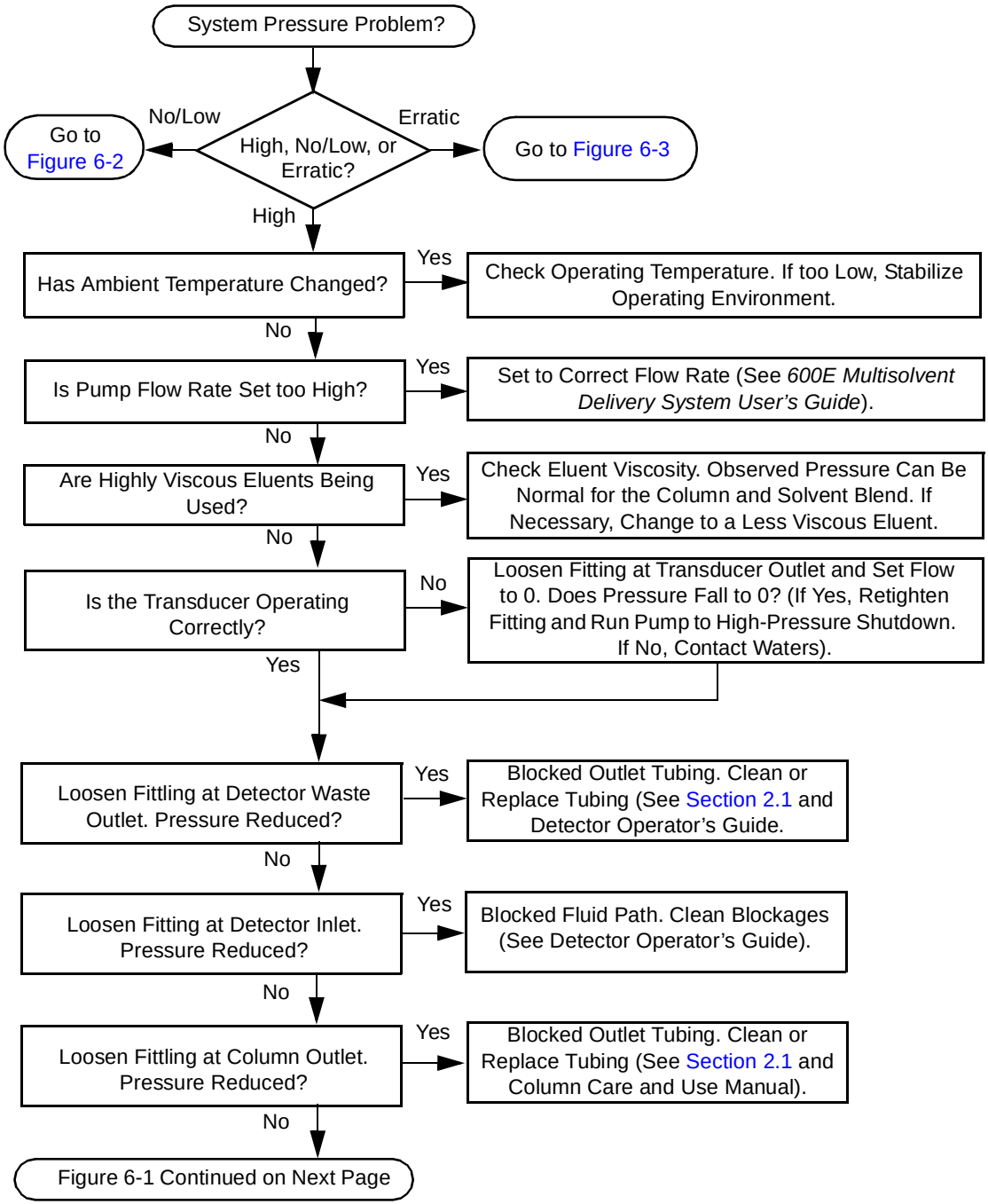


Figure 6-1 High System Pressure Troubleshooting

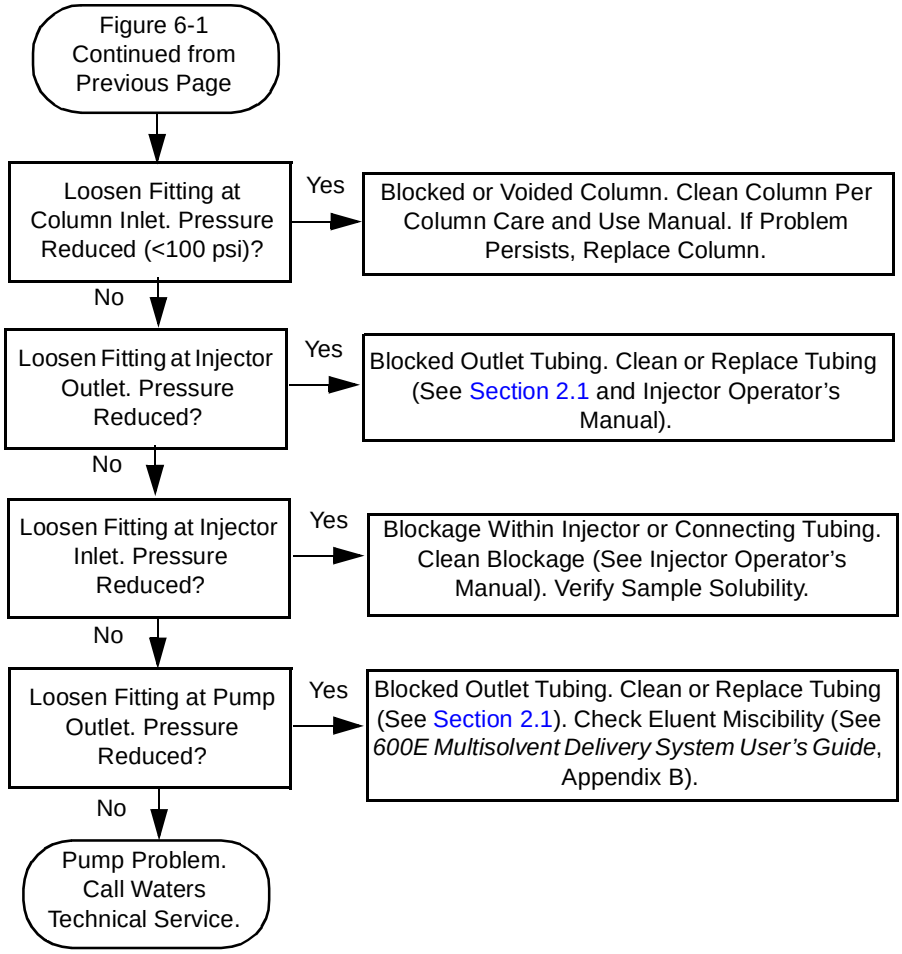


Figure 6-1 High System Pressure Troubleshooting (Continued)

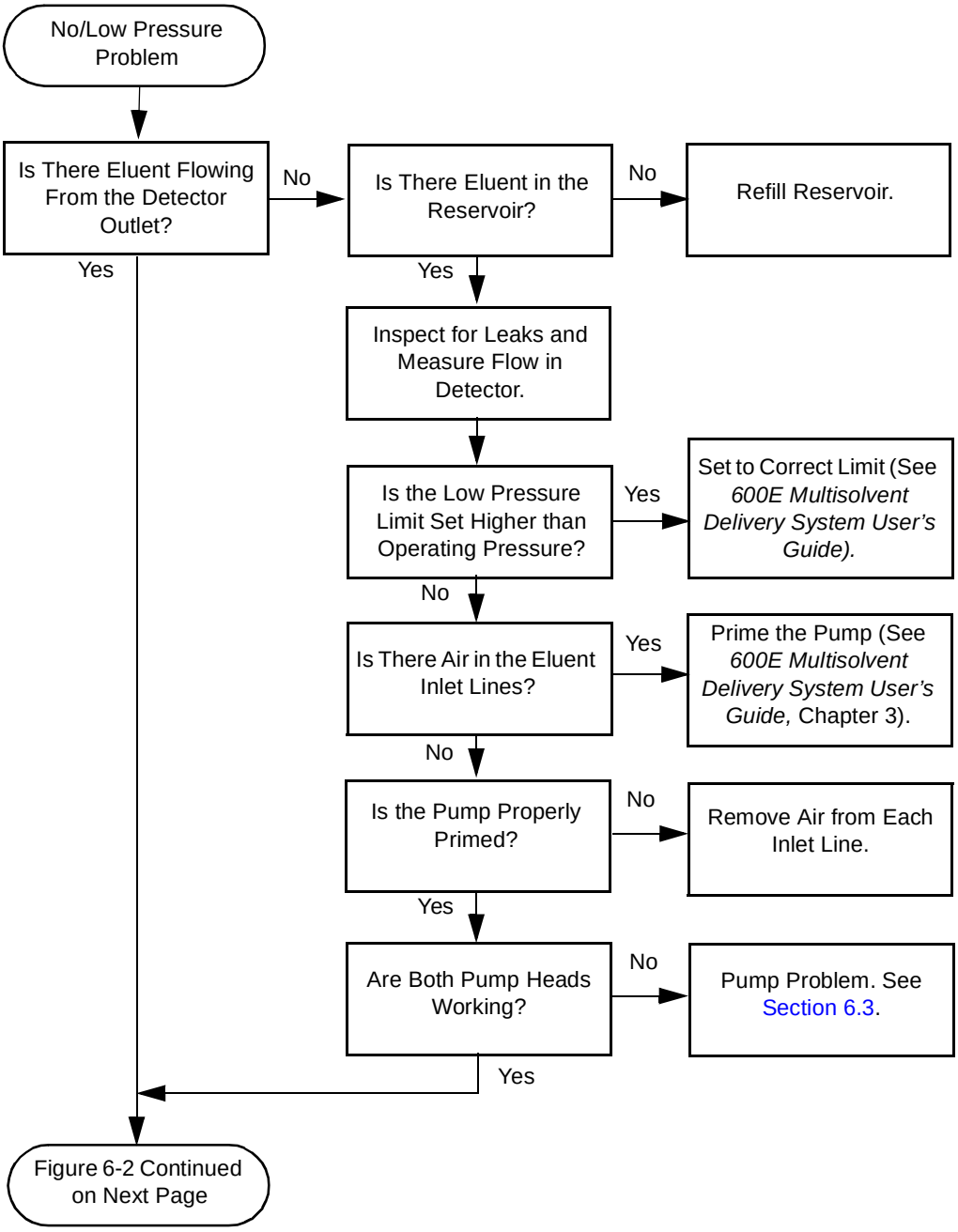


Figure 6-2 Low System Pressure Troubleshooting

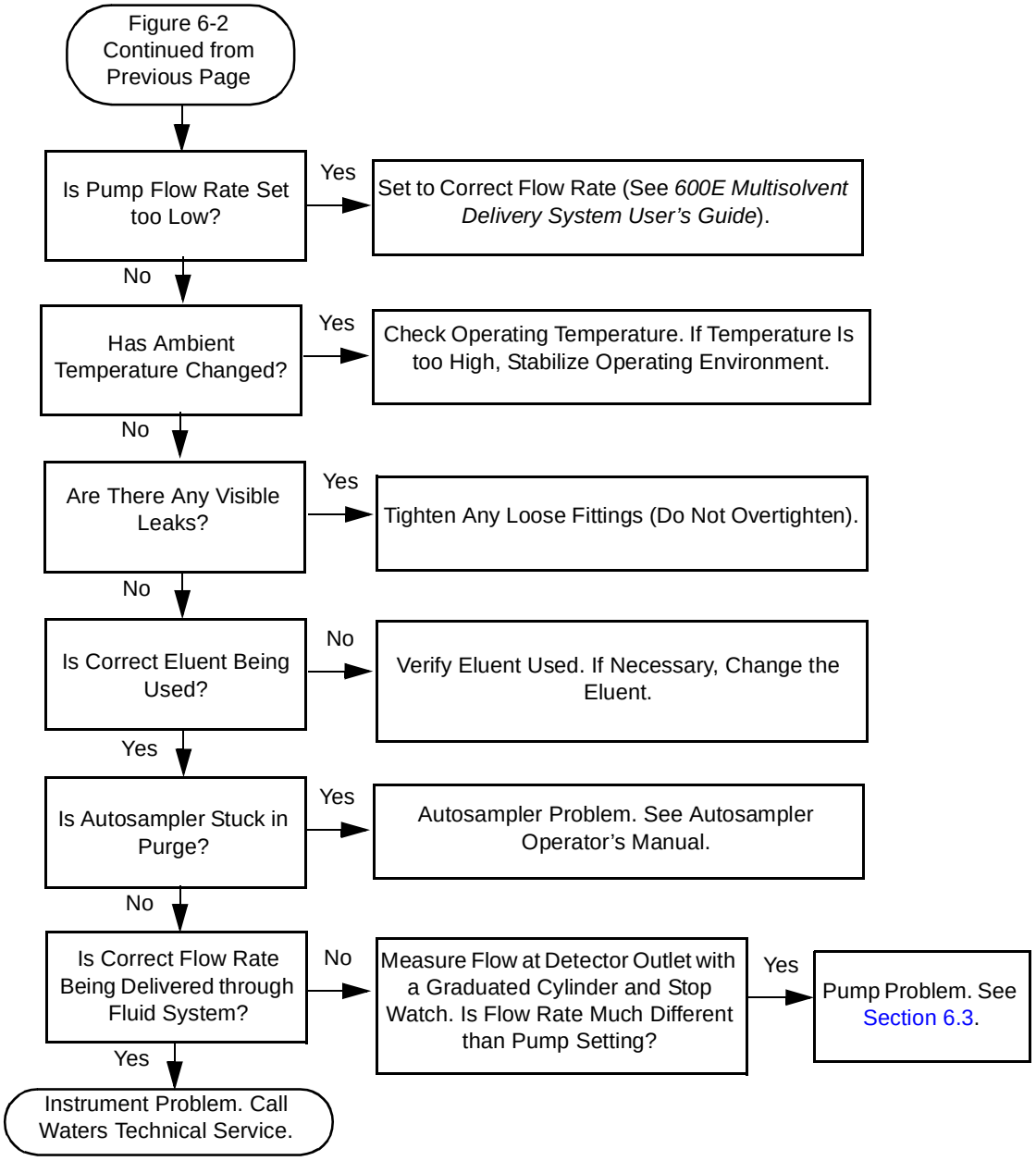


Figure 6-2 Low System Pressure Troubleshooting (Continued)

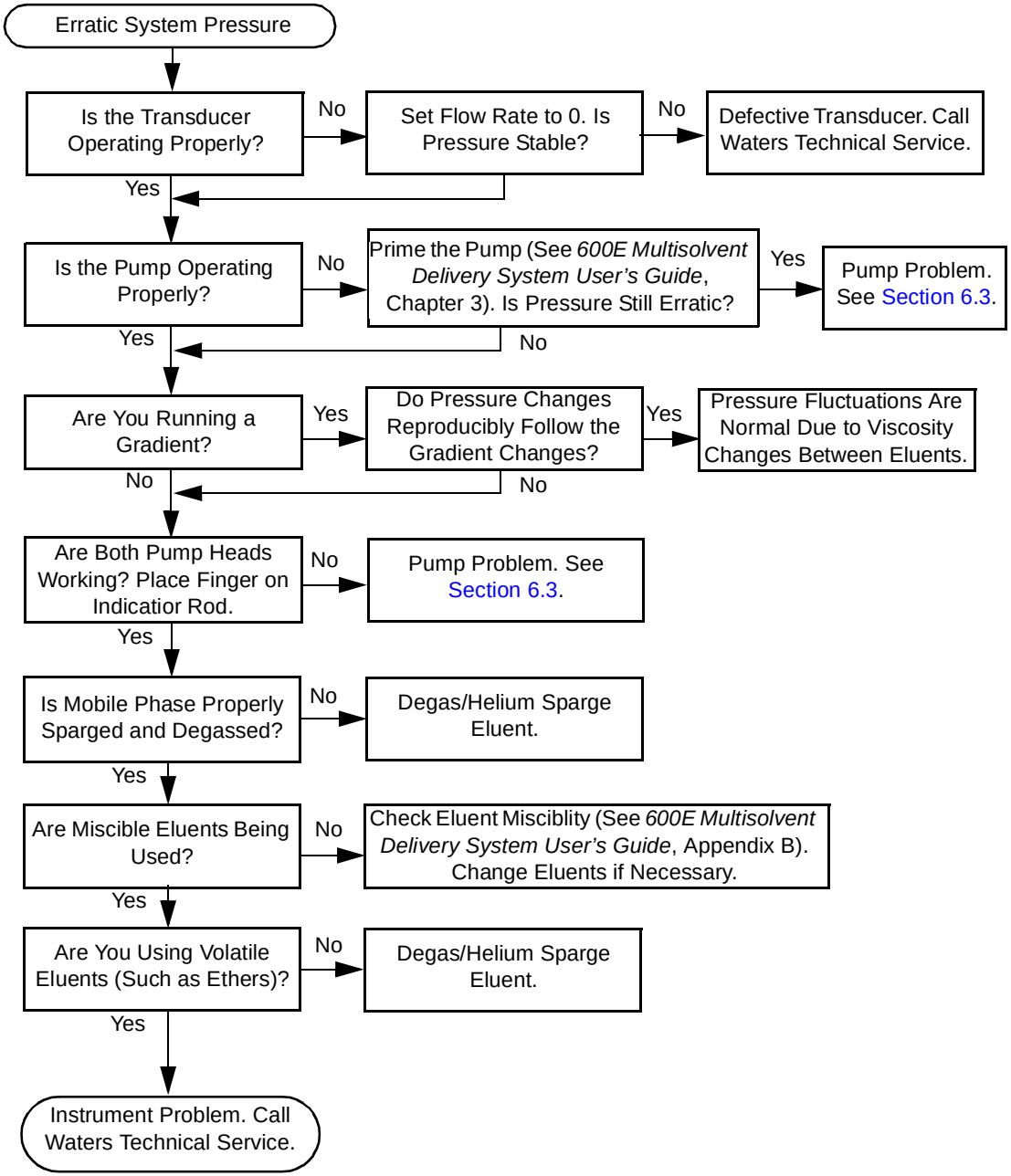


Figure 6-3 Erratic System Pressure Troubleshooting

6.3 Troubleshooting the 600E System

This section covers 600E system troubleshooting. Table 6-1 is a guide to troubleshooting pump problems. It lists pump-related symptoms, possible causes, and corrective action.

To perform additional testing of the 600E pump to determine the potential source of a problem, refer to Section 5.4, Advanced 600E Pump Testing.

Table 6-1 600E System Troubleshooting

Symptom	Possible Cause	Corrective Action
Pump does not run (fan and front panel lights off)	600E pump not connected to 600 controller	Ensure pump interface cable is properly connected to the 600 controller. Verify that the 600 controller is properly connected to the power source.
	No power at outlet	Check the outlet by connecting another electrical unit known to be working. If the outlet does not work, relocate the pump to a functioning outlet.
	Blown power fuse	Replace the fuse (see Section 4.3, Replacing Fuses).
	Broken plunger jamming pump	Replace the damaged plunger. See Section 4.2.6, Cleaning and Replacing Pump Check Valves.
	Defective transducer	Refer to Section 4.2.2, Calibrating and Replacing the Pressure Transducer.
	Defective motor or circuit board	Contact Waters Technical Service.

Table 6-1 600E System Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Pump not delivering eluent	Blown power fuse	Replace the fuse (see Section 4.3, Replacing Fuses).
	600E pump not connected to 600 controller	Ensure pump interface cable is properly connected to 600 controller. ***Attention:*** *Never disconnect the pump from the controller while the two devices are powered on.*
	Pump low pressure limit set to a value that is higher than operating pressure	Set to the correct pressure limit (see the *Waters 600E Multisolvent Delivery System User's Guide*).
	Pump not properly set up (for example, flow rate at zero)	Verify the pump setup parameters in the 600 controller (see the *Waters 600E Multisolvent Delivery System User's Guide*).
	Pressure transducer out of adjustment or defective	Contact Waters Technical Service.
	Pump not primed	Prime the pump (see the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3).
	Immiscible eluents in pump head	Purge pump with appropriate eluents. Verify miscibility of eluents being used (see the *Waters 600E Multisolvent Delivery System Operator's Guide*, Appendix A) and change to more miscible eluents.
	Dirty or malfunctioning check valve	Refer to Section 5.4.1, Testing the Check Valves, to determine if this symptom is due to a problem with the inlet or outlet check valve.

Table 6-1 600E System Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Pump not delivering eluent (continued)	Damaged plunger seal	Check for eluent leaking from behind the pump head. This is an indicator of a damaged plunger seal. Check if both pump heads maintain pressure as outlined in the following section. If not, replace the plunger seal (see Section 4.2.4, Replacing the Plunger Seal).
	Pump head cavitating	Verify if the problem is due to: • **Eluent reservoirs positioned below the pump** - Raise eluent reservoirs higher than the pump heads. • **Loose, bent, or blocked pump inlet tubing** - Check tubing. Tighten, straighten, or replace tubing. • **Improperly degassed eluent** - Degas or helium sparge eluents to prevent cavitation. • **Dirty eluent reservoir inlet filter** - Remove and clean with methanol. Clean eluent inlet filter frit by attaching to priming syringe and drawing methanol through in both directions. • **Volatile eluents in pump head** - Prime pump (see *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3). • **Tubing ID too small for eluent inlet** - Use correct tubing.
	Inlet manifold valve open or leaking	Turn the valve to the Run position. If eluent still leaks, replace the manifold.
	Failure of gradient proportioning valve	Contact Waters Technical Service.
Leak from pump head	Worn pump plunger seals	Replace defective plunger seals (see Section 4.2.4, Replacing the Plunger Seal).
	Worn plunger	Repair or replace plunger (see Section 4.2.5, Cleaning and Replacing the Pump Plunger).

Table 6-1 600E System Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Leak from pump head (continued)	Loose pump head	Tighten the two pump head screw(s). Ensure both screws are tightened equally to prevent seal wear. Do *not* overtighten.
	Loose compression screw(s) on the pump head	Tighten the loose compression screw(s) with a 5/16-inch open-end wrench.
	Loose inlet or outlet check valve	Tighten the loose check valve(s). Do *not* overtighten. Verify fittings and ferrules for under/overtightening and wear. Replace if necessary. Refer to Section 2.1, Selecting and Installing Fittings.
Erratic flow rate/pump pulsations	Mobile phase improperly degassed or sparged	Degas or sparge the eluent(s) and reequilibrate the system (see the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3). Limit the amount of helium sparging to avoid depleting volatile mobile phase components.
	Pump not primed	Prime the pump (see the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3).
	Reservoir low or out of eluent	Check eluent level in reservoirs. Refill as necessary, and degas/helium-sparge.
	Air bubble in pump head	Prime pump to remove bubble (see the *Waters 600E Multisolvent Delivery System User's Guide*, Chapter 3). Ensure there are no air bubbles in the eluent inlet lines. Degas or helium-sparge eluents.

Table 6-1 600E System Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Erratic flow rate/pump pulsations (continued)	Dirty or malfunctioning check valve(s)	To determine if the symptom is due to a problem with the inlet or outlet check valve, refer to Section 5.4, Advanced 600E Pump Testing. If necessary, replace the check valve as described in Section 4.2.6, Cleaning and Replacing Pump Check Valves. Ensure eluent is properly filtered to prevent additional precipitation. Buffer precipitation in a check valve can occur when running a mixture of buffer and an organic eluent in a concentration of 50% or higher. The actual degree of precipitation can vary depending on the organic eluent and the buffer in use.
	Eluent inlet filter or inlet lines blocked	Check lines for blockages. Replace if necessary. Clean the eluent inlet filter frit by attaching to a priming syringe and drawing methanol through in both directions.
	Gradient proportioning valve failure	Contact Waters Technical Service.
	Pump plunger seal leaking (under pump head)	Replace pump plunger seal (see Section 4.2.4, Replacing the Plunger Seal).
	Worn pump plunger	Replace the plunger (see Section 4.2.5, Cleaning and Replacing the Pump Plunger).
	Immiscible eluents in pump head	Refer above to Corrective Action for “Pump not delivering eluent” symptom.
	Pump head cavitation	Refer above to Corrective Action under “Pump not delivering eluent” symptom.
	Pump electronics failure	Contact Waters Technical Service.
Inadequate eluent blending	Immiscible eluents in pump head	Set up eluent reservoirs as described in Section 2.2.1, Setting Up the Eluent Reservoirs.
	Gradient proportioning valve failure	Contact Waters Technical Service.

Table 6-1 600E System Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Inadequate eluent blending (continued)	Pump malfunction	Contact Waters Technical Service.
	Mixers not connected.	Contact Waters Technical Service.
High system pressure due to pump	Pump flow rate set too high	Set to the correct operating flow rate (see *the Waters 600E Multisolvent Delivery System User's Guide*).
	Pressure transducer out of adjustment or defective	Contact Waters Technical Service.
	Blocked outlet tubing	Clean or replace tubing according to Section 2.1, Selecting and Installing Fittings, and the detector operator's guide.
Squeaking noise	Pump seals dry	Wet plunger with appropriate eluent through pump head access holes.
	Indicator rod binding	Replace indicator rod (see Section 4.2.1, Pump Overview). For a list of pump head spare parts, see Appendix A, Spare Parts.
	Pump plunger seal binding	Replace pump plunger seal (see Section 4.2.4, Replacing the Plunger Seal).

6.4 Troubleshooting the Rheodyne 7725i Manual Injector

Table 6-2 lists potential Rheodyne 7725i manual injector symptoms that may occur during operation, along with possible causes and corrective actions.

Table 6-2 Rheodyne 7725i Injector Troubleshooting

Symptom	Possible Cause	Corrective Action
Siphoning (appears as leakage)	Tubes from ports 5 and 6 (see Figure 2-2) do not have outlet ends at the same level as needle port	Allow the loop and connecting tubes to empty.

Table 6-2 Rheodyne 7725i Injector Troubleshooting (Continued)

Symptom	Possible Cause	Corrective Action
Rotor seal leakage (liquid dripping between stator and stator ring, or from needle port or vent tube)	Pressure adjusting screw loose	Tighten pressure adjusting screw. Refer to Section 4.4.4, Tightening the Pressure Adjusting Screw.
	Scratches on rotor seal	Replace rotor seal. Refer to Section 4.4.3, Rotor Seal Leakage.
Needle seal leakage	Syringe needle OD smaller than needle seal, reducing sample loading accuracy	Try another syringe needle. Gently push on plastic needle guide to deform Teflon sleeve to provide a better needle fit. See Section 4.4.1, Tightening the Needle Seal.
Plugged valve passages or vent lines	Unfiltered eluent or sample, or buffer solutions crystallized in vent lines	Remove the stator and clean the passages with a wire of 0.005-inch maximum diameter. If the valve passage remains plugged, disconnect the tubing at the vent valve outlet. If this clears the passage, replace the tubing. If the passage remains blocked, disconnect the compression screw at the vent valve inlet. If this reduces the pressure, rebuild the vent valve (see the documentation included with the 7725i injector. Ensure eluent and sample are properly filtered to prevent additional precipitation. Flush the flow passages and vent lines with water after use of salt solutions. Salt solutions should not sit stagnant in the valve overnight or for long periods of time.
Gradient does not start	Position sensing switch is not sending the inject signal to controller	Replace the position sensing switch as described in Section 4.4.2, Replacing the Position Sensing Switch.

Appendix A
Spare Parts

The following spare parts are recommended for customer installation. Any parts not listed in Table A-1 may require installation by a trained service representative.

Table A-1 Pump Replacement Parts

Item	Part Number
Bottle, 1 L	WAT032750
Bottle caps, 1 L	WAT062479
Bottle caps, 4 L	WAT062341
Cable, IEEE-488, 3.3 ft/1 m	WAT087198
Check valve assembly, inlet, 225 µL head	WAT060307
Check valve assembly, inlet, 100 µL head	WAT033679
Check valve rebuild kit, inlet, ball and seat, 225 µL head (parts for two valves)	WAT088223
Check valve rebuild kit, inlet, ball and seat, 100 µL head (parts for two valves)	WAT060495
Check valve assembly, outlet, 225 µL or 100 µL	WAT025216
Check valve rebuild kit, outlet, ball and seat, 100 µL or 225 µL head (parts for two valves)	WAT026014
Compression screw, 1/16-inch tube, 10/pkg	WAT005070
Compression screw, 1/8-inch tube, reverse, 5/pkg	WAT005148
Compression screw plug, stainless steel, 5/pkg	WAT005079
Ferrule, 1/16-inch, stainless steel, 10/pkg	WAT005063
FHU-mount bottle holder (1 L bottles)	WAT055956
Filter assembly, solvent (stainless steel)	WAT025531
Fuse, 1 A, 250 V, 5 x 20 mm, UL/CSA, time delay, 12 V external, 5/pkg, power primary at 230/240 VAC, North America	WAT055630

Table A-1 Pump Replacement Parts (Continued)

Item	Part Number
Fuse, 1.5 A, 250 V, 5 x 20 mm, UL/CSA, fast, 12 V external, North America, 5/pkg	WAT055632
Fuse, 2 A, 250 V, 5 x 20 mm, UL/CSA, time delay, power primary at 100/120 VAC, 5/pkg, North America	WAT055628
Fuse, 2.5 A, 250 V, for column heater	WAT072919
Fuse, 4 A, 125 V, 5 x 20 mm, UL/CSA, fast, 30 V for the pump, North America, 5/pkg	WAT055631
Fuse, 0.8 A, 250 V, 5 x 20 mm, IEC, time delay, power primary at 230/240 VAC, Europe, 5/pkg,	WAT055629
Fuse, 1.25 A, 250 V, 5 x 20 mm, IEC, fast, 12 V external, Europe, 5/pkg,	WAT055633
Fuse,1.6 A, 250 V, 5 x 20 mm, IEC, time delay, power primary at 100/120 VAC, 5/pkg, Europe	WAT079716
Fuse, 3.15 A, 250 V, 5 x 20 mm, IEC, Fast, 30 V for pump, Europe, 5/pkg	WAT055634
Gas diffuser assembly for sparge lines	WAT007272
Helium sparge hook-up kit	WAT023486
Indicator rod kit (rod, spring, washer), 100 µL or 225 µL heads	WAT069583
Inlet manifold tubing to left pump head	WAT060037
Inlet manifold tubing to right pump head	WAT060038
Manual, Rheodyne 7725i Installation and Maintenance	WAT024776
Plunger (sapphire), 225 µL heads	WAT060304
Plunger (sapphire), 100 µL heads	WAT025656
Plunger seal (1), 225 µL heads	WAT026644
Plunger seal (4), 100 µL heads	WAT022496
Plunger spring	WAT025236
Plunger support, 225 µL heads	WAT060305
Plunger support, 100 µL heads	WAT026650
Power cord (110 V) or Line cord (M440)	WAT097194

Table A-1 Pump Replacement Parts (Continued)

Item	Part Number
Power cord (220 V)	WAT097410
Pump head assembly, 225 µL	WAT060303
Pump head assembly, 100 µL	WAT026550
Pump head assembly kit, 100 µL	WAT062335
Recorder cable assembly	WAT048918
Reservoir rack (1 L bottles)	WAT062060
Rheodyne manual injector (with 600 mounting plate)	WAT024838
Slotted nut driver, 5/16, modified	WAT076374
Sparge valve	WAT062010
Startup Kit, 600E	WAT055979
Syringe, 25 µL	WAT033381
Syringe, safety, 10 mL	WAT027629
Tubing, stainless steel, 0.062 x 0.020 x 60-inch	WAT025592
Tubing, stainless steel, 0.062 x 0.040 x 120-inch	WAT026805
Tubing, stainless steel, 0.062 x 0.009 x 120-inch	WAT026973
Union	WAT097332
Wrench, Allen, 9/64-inch	WAT025567
Wrench, Allen, 5/32-inch	WAT027725
Wrench, open-end, 5/16-inch	WAT096148

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